Understanding Water: The Drop of Life

A Teacher's Guide Book
by Nepal Prakriti Pathshala

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ISBN:978-9937-8277-1-3
Printed 2010

Government of Nepal
Ministry of Education
Department of Education

Ref. No.:-

Sanothimi, Bhaktapur

Foreword

Environment Education is of paramount importance in the present context of Nepal. Nepal's natural resources are one of the most important natural heritages that we must learn to use with care and intelligence. We must ensure that not only us but the future generation also gets the opportunity to harvest its benefits in abundance. And this is only possible if our education system ingrains environmental values in the students from the very beginning.

This is why I am highly impressed with the concept and working modalities of Nepal Prakriti Pathshala, an initiative of Wildlife Conservation Nepal and Danish Forestry Extension that is trying to build new grounds in terms of approach to teaching using integrative and hands-on experience methods.

Department of Education of Nepal appreciates the effort of Nepal Prakriti Pathshala to bring out this series of teachers guides that supplements the government's curriculum in Environment Science and also help the students to become more aware of their immediate natural surroundings and understand the role each human being plays to make it better. I am very happy that these manuals have been tested with more than hundred teachers of Environment Science in a workshop organized by Nepal Prakriti Pathshala and that they have found it to be a highly educational and easy to use tool.

I am confident that this manual "Understanding Water - The Drop of Life" will definitely help the teachers in raising awareness about environmental and natural resource issues among their students and their communities and I hope it also instigates the teachers, and the students to act as agents of change in the society.

Mr. Mahashram Sharma
Director General
Date: 10 Jan. 2010

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ACKNOWLEDGEMENT

The development of this manual has been through many meetings, workshops and interactions with different teachers, academicians and school principals. And Nepal Prakriti Pathshala (NPP), a joint venture of Wildlife Conservation Nepal and Danish Forestry Extension, would like to express gratitude to many individuals and institutions that have directly and indirectly helped in bringing out this manual.

NPP would like to express its sincere gratitude to Mr. Mahashram Sharma Director General, Department of Education, for his invaluable guidance. Our heart felt appreciation to Ms. Rajyalaxmi Nakarmi, Deputy Director, Department of Education for her constant support.

The Project is grateful to all the teachers who gave their time and effort in making this teachers' guide possible especially Ms. Eva Skytte, Nature Interpreter from Denmark and Mr. Prakash Deep Rai.

NPP would like to thank the illustrator Abin Man Shrestha for his beautiful illustrations and to the creative team at WCN for their valuable research and painstaking work in publishing the manual.

Lastly, NPP is most grateful to DANIDA Denmark for their belief in NPP and their kind support without which this manual would not have been possible.

Contents

NOTE TO THE TEACHER

WCN Nepal Prakriti Pathshala's (NPP) objective is to provide quality materials on Environment Education to make classroom lectures more fun, and impart knowledge on the environment. Thus, NPP is introducing a series of Teacher's Guides to teachers.

This manual deals with water. It will support students to understand and value water, the most essential element for survival of life. The students will also learn to use different tools to access information (i.e. libraries, internet, videos) to collect information and knowledge and share it with their colleagues.

This manual has been developed through the outcome of many workshops and brainstorming sessions with teachers, Nature Interpreters and environment educators of Nepal and Denmark. However, we consider this as a new tool for learning and thus invite your valuable suggestions and creative ideas.

In the end we hope that this teaching manual helps the teachers and your students understand "Water : The Drop of Life".

INTRODUCTION

Water is the basic necessities for life on earth. All organisms contain it; many live in it while others absorb or drink it to survive. There is so much water on Earth that the planet is sometimes refered to as Oceanus or the Blue Planet. The oceans cover 71% of earth's surface and are the largest reservoir of water on earth. However, this is salty water and cannot be utilised by humans directly for drinking and other domestic purposes. About 97 percent of water is in the oceans and only three percent accounts for freshwater. The majority of this freshwater, about 67 percent, is locked up in glaciers and icecaps. Of the remaining freshwater, most of it is below our feet, as groundwater and only 0.3 percent contained in rivers and lakes is available for consumption. Thus water, even though plenty is a scarce resource for us.

Based on the renewable annual supply of water i.e supply from both surface runoff and groundwater replenishment, Iceland the richest country in water resources. Annually it gets 606,500 m^3 whereas Kuwait on the other hand gets only 11m^3 water every year, making it the country with least amount of annual renewable supply of water.

Nepal, however is ranked second rich in fresh water resources. It has more than 6000 rivers and streams that rise from four main drainage basins: Sapta Koshi, Gandaki, Karnali and Mahakali. The total area of all the rivers and streams in Nepal is estimated to be about 395,000 hectares. Different rivers of Nepal support many aquatic flora and fauna. Fishes of Nepal are unique depicting the characteristic of three major regions: i) very cold water fishes of the high mountains, ii) cold water fishes of the midlands, and iii) warm water fishes of the lowlands. Nepal has 185 fish species recorded so far.

Despite its importance and abundance, water is a most poorly managed resource, in Nepal. We waste and pollute it. In the cities, massive unplanned infrastructural development leaves little or no space for ground water recharge. This in turn causes run off and floodings.

In various parts of the world the water demand exceeds supply and as the world population continues to rise, so does the water demand. Water is vital to our survival. Preserving water for ecosystem services has emerged as the biggest challenge of the 21st century. We must begin today to make wise choices on how we use, treat and regard water to sustain our future generation

CHAPTER 1: UNDERSTANDING WATER

Activity: Water Cycle in the Classroom

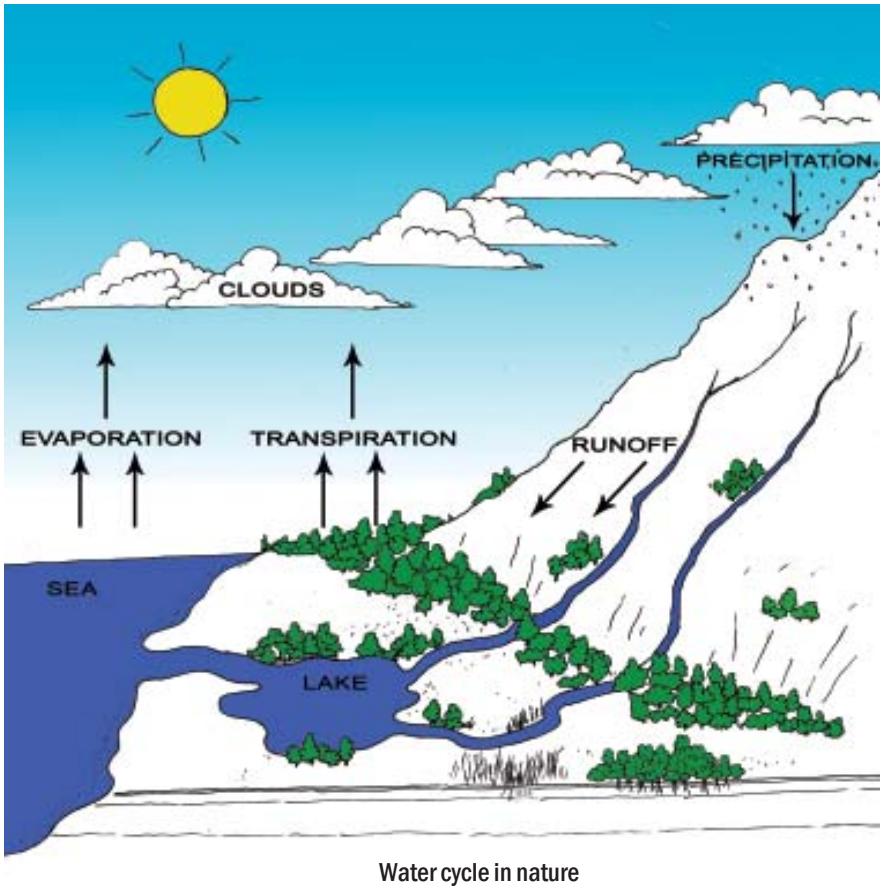
Activity 1

Concept

The water that you drank this morning may have fallen from the sky as rain just last week, but the water itself has been around since the time of earth's early days as a planet. The earth has a limited amount of water and it keeps going round and round in what we call the "Water Cycle". Water cycle is the pathway by which water is recycled in nature. Water evaporates, travels into the air and becomes part of a cloud, falls down to the earth as rain or snow and then flows into rivers, lakes, seas and oceans. Some go down the soil and recharge ground water storage. It again returns to the air through evaporation. This way the water keeps on moving and changing from solid to liquid to gas, over and over again in a never-ending cycle.

Purpose

This activity will help the students understand the concept of water cycle and explain how this cycle recycles the earth's water supply in nature.



Water cycle in nature

Resources & Materials

Water Cycle in the Class:

1. Soil
2. Water
3. Large, clear plastic container or an old aquarium
4. Plastic wrap
5. Tape or large elastic band
6. Bag of ice (optional)
7. Heat lamp (optional)
8. A small bowl

Measuring rainfall: Making my water gauge

1. Clear plastic soda bottle
2. Pair of scissors
3. Permanent marker with a sharp point
4. Small stones or gravel
5. Water
6. Ruler

Activities & Procedures

Water Cycle in the Class

1. Arrange the soil in the container to make mountains, plateaus, hills, etc., and a lake basin. Place the bowl in the lake basin. Fill the bowl with water.

2. Plant moss and /or other plants in the soil.

3. Cover the container tightly with plastic wrap and secure it by means of tape or the band.

4. Set the container in a sunny area and watch what happens over a couple of days.

5. After a day or two, condensation forms on the plastic. When the condensation droplets get larger, they begin to run down toward the center of the plastic and drop back into the small cup. The water evaporates from the cup creating condensation on the underside of the plastic.

6. When enough moisture collects, it will fall onto the landforms as precipitation.

7. In order to speed the process, a bag of ice may be placed on one end of the covered container, while a heat lamp is focused on the other.

Measuring rainfall: Making my water gauge

1. Cut off the top part of the bottle.

2. Fill the curved part of the bottom of the bottle with small stones or aquarium gravel. This will put weight your rain gauge to keep it from falling over.

3. Pour enough water into the bottle to cover the stones. Use the marker to draw a line at the top surface of the water. Mark a “0” next to the line. This is your baseline.

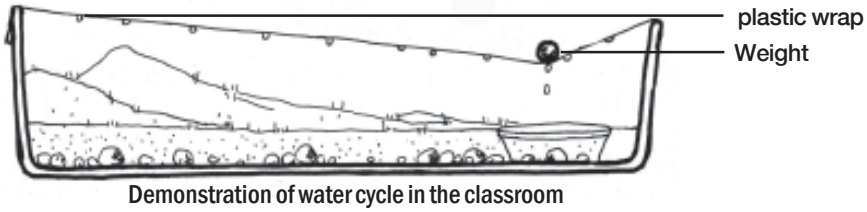
4. Use the ruler and marker to measure 1cm, 2 cm, up the bottle from the baseline. Draw a line at each cm mark and label the lines.

5. When it starts raining, put the rain gauge outside to catch the rainwater.

6. When the rain stops, check to see how many cms of rain fell into your rain gauge.

7. You can record how much rain falls in a week or a month and make a chart. On the chart, list the date it rained and how many inches of rain fell. Add up the rainfall at the end of the week or month.

Important! Be sure the rain gauge is filled to the baseline before you begin collecting.



Demonstration of water cycle in the classroom

Activity: Build your Aquifer

Activity 2

Concept

When rain falls on our watersheds, some of the water soaks through the organic layer, down through the soils and becomes ground water. How fast and how far it moves depends on the type of soil. Gravel has large air spaces so water moves quickly into and through it. Sand has smaller spaces, so the water may not travel quite as quickly through it. Areas of saturated soil from which it is possible to pump water are called “aquifers”. Often these aquifers are composed of fractured rock, sand or gravel since these soils can hold large amounts of water and the water can be more easily pumped from them than from very fine grained soils.

Many communities obtain their drinking water and water for irrigation from these underground sources. Unfortunately, ground water can become contaminated by harmful chemicals, such as lawn care products and household cleaners that were used or disposed of improperly, and any number of other pollutants, that can enter the soil and rock, polluting the aquifer and eventually the well. Such contamination can pose a significant threat to human health.

Purpose

This experiment will help students understand how water is stored in an aquifer, how ground water can become contaminated, and how this contamination ends up in a drinking water well. They will see how careless use and disposal of harmful contaminants above the ground can potentially end up in the drinking water below the ground. To examine how substances can travel with the water through the soil into the aquifer.

Resources & Materials

1. Beaker/plastic cup
2. Sand
3. Moulding clay
4. Gravel
5. Aquarium rock
6. Food colour
7. Pitcher of water

Activities & Procedures

1. Fill the beaker/cup 1/4th with sand.

2. Slowly add water into the sand and watch the sand absorb the water. Continue dropping water on the sand until it is saturated, but not standing. (This shows how water is stored in the ground.)

3. Flatten the clay into a disk that covers half of the cup. Place the clay on top of the sand. Attach the clay to one side of the cup. Drop water onto the clay in the same spot.

4. Water will collect and slide onto the section of sand that is not covered by the clay which shows an area where water cannot permeate (confining area).

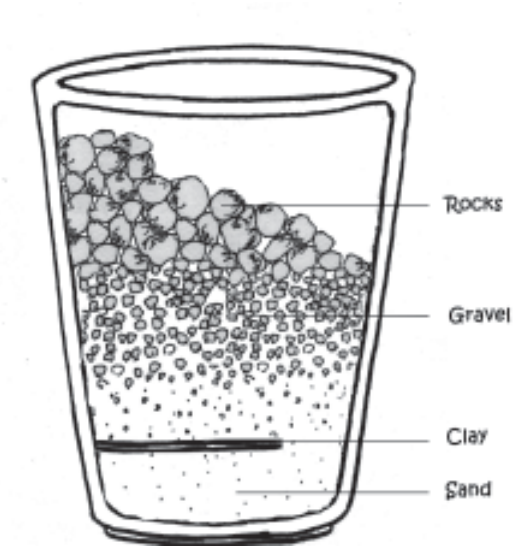
5. Spread gravel across the clay and sand (the full diameter of the cup) creating the next layer of earth.

6. Add the next layer of aquarim rocks above the garvel. Form a small hill with the rock against one side of the cup.

7. Pour a small amount of water slowly down the side of the cup. Pour a small amount of water slowly down the rock hill, filling the valley. Students will observe how the water is stored around the rocks. A small puddle may stand and can be identified as surface water (lake).

8. Add one or two drops of food coloring on the rock hill area, close to the cup wall.

9. See how the food coloring spreads through the rocks, into the surface water and into the bottom of the cup. Record the time it takes for the water to reach the bottom of the glass. This is how pollution spreads and can get into our wells.



Aquifer in a cup

Activity 3

Activity: Learning the Unique Properties of Water

Concept

The density of water is dependent on its temperature. Normally, liquids become dense on cooling. However, water does not follow this typical behaviour and is most dense as a liquid at 4°C. Therfore, solid ice at 0°C is less dense than water at 4°C. This is why ice floats on water. This unusual behaviour of water known as **Anomalous Expansion** of water causes thermal stratification of lakes in temperate regions. Initially, the surface water in water bodies starts cooling. Upon reaching the temperature of 4°C, the surface water descends to the bottom as it denser. Upon further cooling between 4-0 degrees °C, a temperature gradient is set up in depths of the water body whereby, the bottom-most layer is at 4°C and the temperature gradually drops as one goes upwards. At 0 °C, ice is formed. If the temperature falls further, the top layer expands and remains on the top till it freezes. This phenomenon is useful for the preservation of aquatic life in very cold temperatures as even though the upper layer is frozen the water near the bottom is at 4°C and the fishes etc. can survive in it easily.

Temperate lakes have three distinct layers during the summer characterized by temperature. The upper layer is usually warm water with high dissolved oxygen (DO) concentration.The temperatures change rapidly in the middle layer with depth and the middle layer has a moderate level of dissolved oxygen. The lowest layer has colder and denser water which also has lower concentration of dissolved oxygen as it is not exposed to the atmosphere. During the summer, the middle layer prevents the exchange of nutrients and DO from the bottom of the water sytem to the upper layers. As the weather becomes colder, the surface water also gradually cools and sinks to the bottom as it becomes denser with the fall in temperature to 4°C. This mixing brings the DO from the surface to the to the bottom while the nutrients from the bottom is carried to the top. During the winter the cold temperature causes the lake to separate into layers of different densities. With spring, the surface water reaches maximum density when it warms up to 4°C and sinks through the lower levels of less dense water to the bottom. In this process, tne DO from the surface is carried to the bottom and the nutrients from the bottom to the surface. During the spring, the temperature and the DO of the lake is uniform in the entire lake.

Purpose

The activity will help the students understand the effect of temperature on the density of water and the concept of anamolous expansion of water

Resources & Materials

How Hot and Cold Water behave Activity:

1. Large clear jar or small aquarium
2. Smaller jar
3. Two small bottles
4. Red and blue food colours/ink
5. Jug
6. Hot and cold water

Ice is lighter than water and oil Activity:

1. Clear drinking glass/beaker
2. Coloured ice cubes
3. Cooking oil
4. Water
5. Spoon or 1 kitchen tongs(Optional)

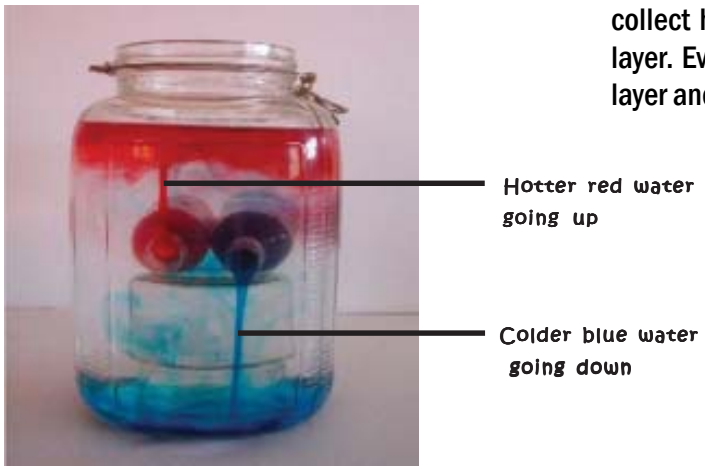
Activities&Procedures

Hot and Cold Water

1. Submerge and invert the smaller jar and rest it on the bottom of the larger jar to act as a platform for the two small bottles.

2. Mix ice, water and about 5 drops of blue food colouring to make cold blue water. Use hot water or boil a kettle to make hot water and colour red. Fill one bottle with the cold blue water and the other with the hot red water.

3.Carefully submerge the bottles into the large jar and rest them on the smaller jar.



Demonstration of the hot and cold water experiment in the class

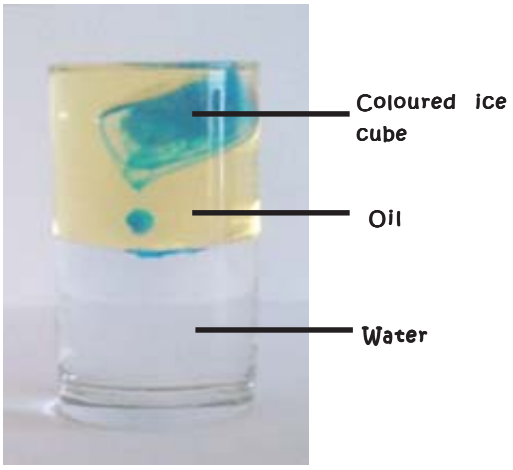
Observations:

The cold water will descend and the hot water will rise– depending on the volume of the large jar, this will continue for many minutes.

Ice is lighter than water and oil

1. Fill 1/3 of the glass with water. Next, carefully top up with oil (hold the glass on an angle and pour slowly).

2. Carefully place the coloured ice cube in the oil using tongs so the cube does not fall too deep



Demonstration of the experiment in the class

Observations:

As the ice melts, a droplet collects at the bottom of the cube, causing it to tilt

Once the droplet is heavy enough, it sinks to the bottom of the oil layer – several droplets may collect here before penetrating into the water layer. Eventually, the droplet penetrates the oil layer and mixes into the water layer.

CHAPTER 2:KNOWING MY WATER BODY

Activity: Looking Around

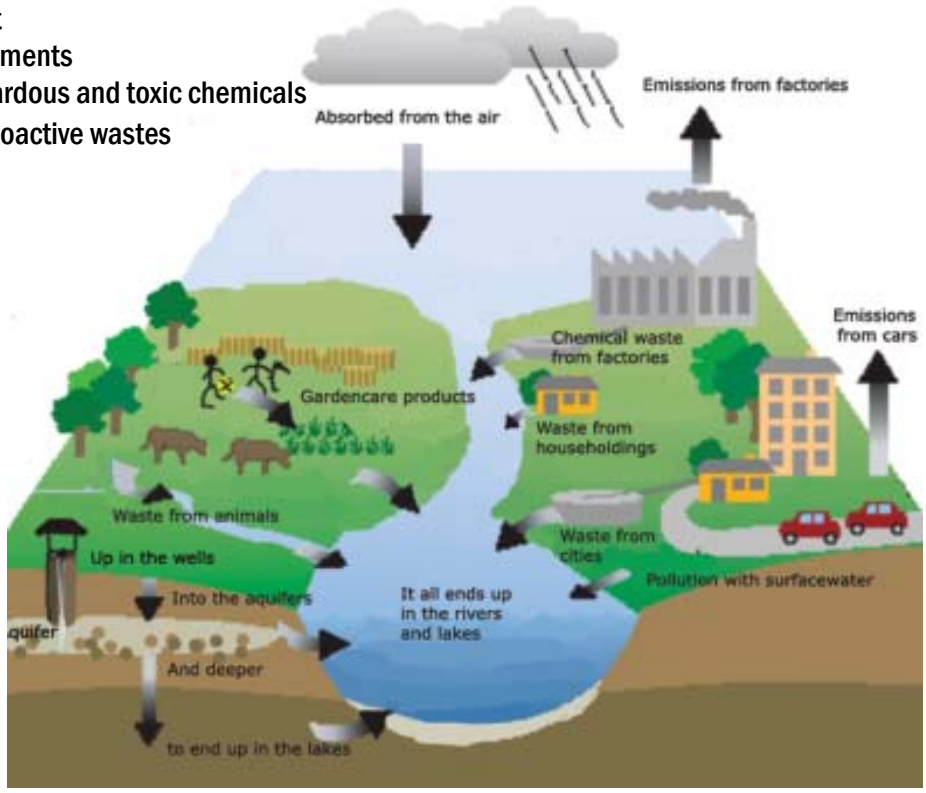
Activity 4

Concept

Naturally, water is absorbed to the land, rivers and streams as it flows from the highlands to the lowlands and ultimately released to the sea. In a small scale, both inorganic and organic pollutants safely decompose throughout the stream, and they don't harm the water bodies. But in an excessive scale, these pollutants have a harmful effect on them. There are a wide variety of pollutants that can affect water and the plants and animals that live in the water. Not all pollution is human produced and there are sometimes "natural" reasons for some pollution like volcanic eruptions.

There are six major types of water pollutants:

*Biodegradable wastes
*Plant nutrients
*Heat
*Sediments
*Hazardous and toxic chemicals
*Radioactive wastes



Purpose

This activity will enable the students to study the area in their vicinity and to analyze the different types of pollution and their causes. Ultimately, students will get a clear understanding of how careless use and disposal of wastes and other pollutants is destroying our water bodies. This particular activity will give the students an opportunity to go beyond their classrooms to understand pollution.

Resources & Materials

1. Paper
2. Pencils
3. Clipboards
4. Rubber gloves
5. Plastic bags

Activities & Procedures

FIELD VISIT

1. Arrange a field trip to a wetland area.

2. Designate a record keeper to record the findings during the field trip.

3. When you get to your wetland look around the wetland area and find as many sources/types of pollution as possible.

4. The designated recorder will record the different types of pollution found.

5. After recording the different types of pollution pass out gloves and bags. Then pick up the litter pollution and take back to school and put in dustbins. After returning back to the classroom discuss the pollution observed and the methods to prevent littering around water bodies. Since the visible pollution is often in the form of litter, discuss with your friends the pollution that may be present, but not seen and the different causes of water pollution.

Activity 5

Activity: Mapping the water body

Concept

Natural forms of pollution have existed since the beginning of this earth and humans have little control over it. On the other hand the major sources of pollution affecting us today are due to human activities and therefore susceptible to human control.

Green Maps are an educational and environmental communication tool for advocacy and public awareness. **Green Maps** are locally created environmentally themed maps which plot the locations of a community's natural, cultural and sustainable resources such as recycling centers, heritage sites, community gardens, toxic waste sites and socially conscious businesses.

The purpose of a Green Map is to serve as a guide for sustainable living and to help everyone get involved with their community's natural and man-made environment.

Purpose

This activity will help the students understand the concept of maps while at the same time help to analyze the surroundings around them and analize the different environmentally benificial and detrimental activities in the area. The students will be able to develop a simple map of the surveyed area representing all the different activities and landmarks they have observed during the survey.

Green map

Resources & Materials

1. Chart paper
2. Marker pens
3. Color pens
4. Pencils
5. Eraser
6. Compass (Optional)

Activities & Procedures

1. Getting started

• Start by choosing an area to explore. Draw or study a map showing landmarks and crossroads of the built environment, including streets, parks and gardens. Check the icons and see if you already know where some eco-sites are located.

• Discuss the target audience (neighbors, city residents, tourists, students, planners & policy makers) and the general outline and goals for your Green Map.

2. Survey the Area and Record Your Findings

• You might want to begin by looking at eco-friendly transportation, recycling/reuse sites, cultural and historic places that make your community special, natural areas, habitats and gardens.

• You can point out polluted hot spots along with sites that degrade your environment. While you are in the field, use notebooks to keep track of the location of each green site. Some places may be very small, but if they are important for the environment record them as well.

• You can also collect notes on noises and smells, to share the general impressions about the area.

3. Discuss and Organize the Green Sites

• Your Mapmaking team should then discuss the sites you've found and decide which of the Icons describe them best . All members of your team should compare their lists of green sites, then share the combined list with your class and community. You can Create your own icon or you can select from the general icons provided in maps.

Once your final list is complete, organize your list of green sites by type of site and also by location.

4. Make your Map

• Plot the Icons in the appropriate places on your map. To identify each site, you can:

a) put the site's name right on the map next to the Icon

b) number each Icon on the map, then put a numerical list on the side

c) number the sites on the map, then put both icon and site name in a list on the side. Include the site's contact information and coordinates.

• Write a short survey to help gather more information from local residents, shopkeepers and other community members about wildlife, significant organizations, public transportation, cherished cultural sites, and other green places in your area.

• Check the library for books on local tourism and natural/cultural history. Check with community and government offices, including Planning Boards and the Parks Department, to find out who is working "behind the scenes" for conservation and a healthier environment. Check bulletin boards for information on eco-events and meetings that might lead you to find more sites or discover greening initiatives already under way in your community. Participate or Volunteer for such causes during your free time. An extra hand of help will always be welcome.

CHAPTER 3: HOW HEALTHY IS MY WATER BODY

Activity: The abiotic factors that affect my water

Activity 6

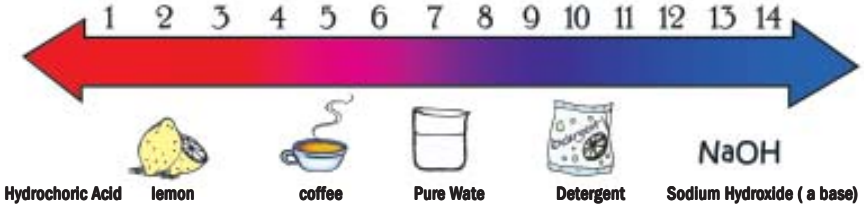
Concept

There are various parameters of water that affect its characteristics which in turn affects the entire ecological system. Few important abiotic factors or parameters are as follows:

pH: It is an important measurement of how acidic or alkaline (basic) the water is. pH is measured on a scale of 0 to 14, with 0 being the most acidic, and 14 being the most basic. Distilled water, which has no impurities, is neutral, and has a pH of 7. The addition or presence of different compounds affects the pH of water according to its characteristics. At both very high or low pH, the water cannot support most organisms. Serious problems occur in lakes with pH below 5, and above 9.

Turbidity: This refers to how clear or how cloudy the water is. Clear water has a low turbidity level and cloudy or muddy water has a high turbidity level. High levels of turbidity can be caused by suspended particles in the water such as soil, sediments, sewage, and plankton. Soil can get in the water by erosion or runoff from nearby lands. Sediments can be stirred up by too much activity in the water, either by fish or humans. Sewage is a result of waste discharge and high levels of plankton may be due to excessive nutrients in the water.

Temperature: It is the measure of how much heat energy water contains. A stream's temperature is affected by the season, but also by the source of water, the geographic area of a stream, the shape of the channel and whether the stream is shaded. High temperature enhances the rate of photosynthesis of aquatic plants and the growth of microorganisms which increase the taste, odor, and color of the water. Most aquatic organisms require a specific temperature range, and many of our sport fish require cold water. If temperatures are outside the optimal range for a prolonged period, it puts stress on the organisms and ultimately causes death. Variation of water temperature caused by anthropogenic activities should not exceed by 1°C in the summer and 2°C in the winter.



pH Scale

Purpose

Different abiotic factors affect the quality of water. This activity will help students to understand different abiotic factors of the water sample collected from their surroundings and its implications to the biotic factors.

Resources & Materials

1. pH test kits (litmus solution or litmus paper)
2. Turbidity tube
3. Field thermometer
4. Pipette

Activities & Procedures

pH measurement

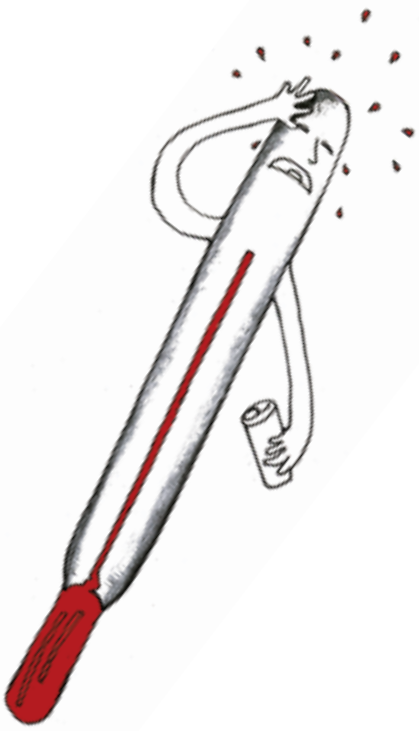
1. Dip one strip of indicator (litmus) paper in to the stream and pull it out quickly.

2. Wait 1 minute.

3. Compare the color of the litmus paper to the pH color key on the pH box.

4. Record the number associated with the correct color match on the student worksheet.

5. Another easy experiment can be conducted to see how respiration alone in absence of photosynthesis and regular mixing of water layers also changes the pH level of water. Take a small beaker or a big test tube with the tap water. Test it with a litmus paper.



Temperature

1. Dip the thermometer into a moving part of the stream or river.

2. Wait for the temperature to stop changing (at least 1 minute)

3. Lead the temperature and record on the student worksheet.

Turbidity

(Turbidity tube)

1. Fill the turbidity tube with the water sample

2. Take your filled turbidity tube to a shaded spot. If there is no shade, use your body to block the sun from shining on the tube.

3. With your hand over the opening, shake the tube vigorously. This will help to re-suspend any sediment that has settled to the bottom.

4. Look down through the tube toward the target disk on the bottom of the tube.

5. If the disk is visible, record the water level in centimeters (cm).

6. If the disk is not visible, slowly release water from the release valve until the disk becomes visible. Record the water level in centimeters (cm) on the worksheet.

7. This method is more appropriate for shallow water.

If the turbidity of the water is high, there will be many suspended particles in it. These solid particles will block sunlight and prevent aquatic plants from getting the sunlight they need for photosynthesis. The plants will produce less oxygen thereby decreasing the Dissolved Oxygen (DO) levels. The plants will die more easily and be decomposed by bacteria in the water, which will reduce the DO levels even further. Suspended particles in the water also absorb additional heat from sunlight which will result in warmer water. Warm water is not able to hold as much oxygen as cold water so DO levels will decrease, especially near the surface.

Activity 7

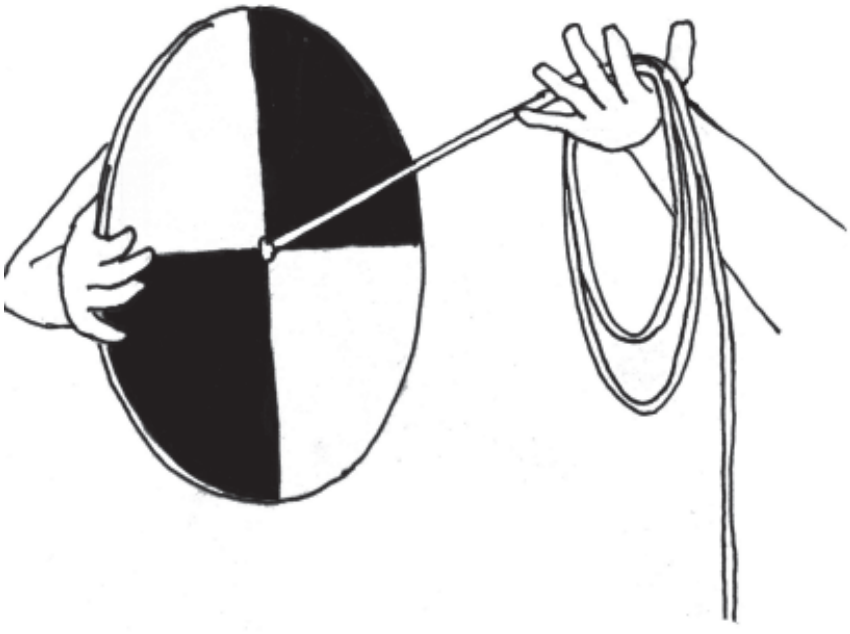
Activity: How clear is my water

Concept

All streams have naturally occurring suspended sediments from decayed organic matter, minerals and sediments carried down from upstream. Light's ability to pass through water depends on how much suspended material is present. Transparency is the measure of how turbid the water is or how cloudy the water is. Low transparency is detrimental to aquatic life. Silt, micro organisms, plant fibers, chemicals, sewage, and plankton are the common sources of turbidity. Turbidity of the water prevents the sunlight from penetrating into the water and reaching to the aquatic plants thereby reducing the rate of photosynthesis. This in turn reduces the oxygen level in the water while increasing the level of carbon dioxide.

Purpose

Through this experiment the students will be able to measure the clarity of the water body.



Secchi disc

Resources & Materials

1. Tin plate
2. Black and white paint
3. Ruler
4. Scissors
5. Ball of string marked in 1cm units

Secchi disc: a black and white circular plate that is used to determine water clarity

Activities & Procedures

Make your Secchi disc:

1. Take a tin plate

2. Draw a circle of around 7 cm radius with a compass.

3. Cut out the circle.

4. Use the ruler to divide and mark the circle in quarters.

5. Color 2 opposite quarters black and 2 other quarters white.

6. Attach a string through the centre of the disc and mark the string every centimeter.

Let's see how clean the water is

1. Lower the Secchi discs into the water with the string that has measurement markings on it.

2. Lower the disc to a point where it is no longer visible. Note the measurement and then raise it up through the water until it becomes visible.

3. The depth of visibility is determined by the degree of turbidity in the body of water.

Activity 8

Activity: Measuring stream flow by Float Method

Concept

The amount of water flowing in a stream or river directly affects its habitat quality and may impact the usage of the waterway. The more water there is, the longer it takes to heat up or cool down. Fish and other aquatic organisms require certain volumes of water for their survival. Stream flow is a measure of the velocity of stream waters. In other words, data on stream flow give information on how fast water is moving past a given point over a given time period.

Velocity: Velocity or rate of flow is the distance the water flows in a certain period of time.

$$V = \text{travel distance} / \text{travel time} = L/t$$

The speed of water, or its velocity, varies greatly between different areas of a stream. A stream's velocity can change from day to day and from year to year depending on various factors such as the rainfall pattern, levels of pollution, erosion, etc.

Purpose

The basic idea is to measure the time that it takes the object to float a specified distance downstream. Float method is an inexpensive and simple method to measure surface velocity

Resources & Materials

1. Stop-watch
2. Highly visible buoyant objects like ping pong balls/empty plastic bottles
3. Measuring tape

Activities & Procedures

1. Choose a suitable straight stretch of the river with minimum turbulence

2. Mark the start and end point of your reach.

3. If possible, travel time should exceed 20 seconds.

4. Drop your object into the stream a few meters ahead of the starting point.

5. Start the stopwatch when the object crosses the start position and stop the watch when it crosses the finishing point. Take atleast 3 readings

Usually in a stream high velocity is considered good as high velocity or stream flow also increases the amount of DO because of the greater movement of water which increases the amount of oxygen absorbed.

Velocity or the stream flow increases after a heavy rainfall. It also on the other hand might increase erosion of the banks, carrying with it sediment and other pollutants.

Activity: Chemicals in my water

Activity 9

Concept

Dissolved Oxygen

Almost all animals and plants need oxygen to survive. Fish and some aquatic insects have gills to extract oxygen from the water. Different organisms need varying levels of oxygen to survive. Low levels or absence of oxygen in an aquatic environment mean the system is going to lose or has lost those creatures that depend on high levels of oxygen.

A certain amount of oxygen diffuses into the water from the air. Fast moving water and waves mix oxygen into the water. Aquatic plants and algae also add oxygen to the water through the process of photosynthesis. Low Dissolved Oxygen concentration is damaging to aquatic life - only the hardiest organisms survive. In order to maintain stable fish populations DO of no less than 5.0 mg/l during early life stages of the fish is required. As the temperatures rise, because the metabolic rates of the organisms increase, the Oxygen Demand also increase but the solubility of oxygen is lower at higher temperatures.Generally DO is low during night as the plants respire and photosynthesis is absent thus DO levels can fluctuate quite dramatically throughout a 24 hour cycle.

Nitrate

Nitrates are a form of nitrogen. Nitrates stimulate the growth of plankton and waterweeds that provide food for fish. This may increase the fish population. However, in excess amounts they can cause significant water quality problems. If algae grow too wildly, oxygen levels will be reduced and fish will die. Humans also add nitrates to the environment through poorly functioning sewage and septic systems, fertilizers, and feed a lot of run-off.

Since nitrogen is a plant nutrient, it encourages excessive aquatic plant growth that leads to **eutrophication**. Water with high levels of fertilizers such as nitrates and phosphates support huge amounts of aquatic plant and algae growth. When these plants die, the organisms that decompose them use up tremendous amounts of oxygen in the water. The decomposition process can use up all oxygen in the water suffocating aquatic animal life in the process. Eutrophication is one of the major water quality problems we face today.

Phosphate

Phosphorous is found in natural rocks, domestic sewage and decaying vegetable matter. Phosphorous as phosphate is an essential element for life as a nutrient and as a key element in the metabolic processes of all living organisms. Nearly all fertilizers contain phosphates. Phosphates stimulate the growth of plankton and water plants that provide food for fish. This may increase the fish population and improve the waterway's quality of life. If too much phosphate is present, algae and water weeds grow wildly, choke the waterway, and use up large amounts of oxygen killing fish and aquatic organisms in the water body.

Purpose

The students will be able to understand the various chemical parameters that affect the water body.

Resources & Materials

DO test kits
Nitrate test kits
Phosphate test kits

Activities & Procedures

1. Collect the water sample from below the surface of the water body.

2. Submerge the sampling bottle and let the water flow into the bottle for several minutes.

3. Make sure there are no air bubbles in the sample jar when you remove it from the water.

4. Follow the directions on the Dissolved oxygen kit.

Testing the sample

DISSOLVED OXYGEN

1. Slowly open the lid of DO bottle and add 11 drops of Dissolved Oxygen Reagent1.

2. Add 11 drops of Dissolved Oxygen Reagent

3. Recap the DO bottle and carefully remove the excess solution.

4. Shake the bottle by inverting several times. Precipitate will form.

5. Allow the precipitate to settle about 5 minutes. The sample is now fixed and ready for test. (The sample need not be tested immediately after being fixed.)

6. Remove the cap of the DO bottle and add 1ml of Dissolved Oxygen reagent 3

7. Carefully throw the overflowing solution and recap the bottle and shake by inverting until the precipitate dissolves.

8. Light straw yellow to brown-orange color will develop, depending on the oxygen content of the sample.

9. Measures 10 ml sample in the 10ml syringe and transfer it to the test-tube and add l drop of Dissolved Oxygen Reagent 4. The color will change from yellow to blue (or dark purple depending on the oxygen content).

10. Fill 1ml syringe with Dissolved Oxygen Reagent

11. Slowly add the Dissolved Oxygen reagent 5 in solution drop by drop. Shake the tube after each drop. Continue adding the reagent till the blue color just disappears and turns colorless.

Calculation:

Dissolved Oxygen (mg/l) = Drops of **Dissolved oxygen reagent 5** consumed X 0.8

Dissolved oxygen is one of the best indicators of the health of a water ecosystem. Dissolved oxygen can range from 0-18 parts per million (ppm), but most natural water systems require 5-6 parts per million to support a diverse population. A decrease in the dissolved oxygen levels is usually an indication of an influx of some type of organic pollutant.

NITRATE TEST

1. Take 5ml water sample in 50ml test tube using syringe. Heat the tube and evaporate all the water.

Nitrates are good indicators of pollution. Usually nitrate concentrations in natural streams and rivers are less than 2 to 3 mg/l. An increase in the nitrate levels is an indication of inorganic pollution.

2. Cool and add 8 drops of Nitrate Reagent 1.

3. Shake briskly and dissolve residue and add 2ml of distilled water and shake. Wait for it to cool down.

4. Add 1 ml of Nitrate Reagent 2. and shake . Then transfer to vial and add 1.5ml of distilled water.

5. Match the observed color with the Nitrate color-chart within one minute.

PHOSPHATE TEST

1. Take 5ml sample in the vial using syringe and add 4 drops of Phosphorus Reagent 1 and shake. Then add 1 drop of Phosphorus Reagent 2 and shake.

2. Match the observed color with the Phosphorus color-chart.

In most uncontaminated lakes the phosphate concentration is 0.01-0.03 mg/L and the recommended maximum concentration for rivers and streams is 0.1 mg/L

Activity: What lives in my water body

Activity 10

Concept

The aquatic **macro invertebrates** are the tiny invertebrates, visible to the eye, living in our water systems. These macro invertebrates include many types of insects as well as other animals such as worms, mollusks and tiny crustaceans. These organisms are influenced by various external factors such as climate, condition of the water including chemical conditions, temperature, clarity, velocity, depth, food availability, presence of predators. Often, polluted water has a high number of organisms but the number of different types of species is greatly reduced.

The types and abundance of macro invertebrates in the water body is an important indicator of water quality. Different macro invertebrates tolerate different types of stream conditions. Depending on what we find, we can make predictions about water quality.

Group 1 - *Sensitive or Intolerant Species*
Organisms that are easily killed, impaired or driven off by bad water quality: these include stonefly, dobsonfly and mayfly nymphs, caddis fly larvae, water pennies and snails.

Group 2 - *Somewhat Tolerant Species*
Organisms that have the ability to live under varying conditions. You may find them in good or poor quality water. These organisms include amphipods, scuds, beetle and cranefly larvae, crayfish and dragonfly nymphs.

Group 3 - *Tolerant Species*
Organisms capable of withstanding poor water quality: these include leeches, snails, aquatic worms, midge larvae and sowbugs.

Purpose

In this activity, students will collect and observe macro invertebrates in an aquatic system and investigate the diversity of living organisms in a specific area through observation and charting.

Resources & Materials

1. Net
2. Plastic pan
3. Petri dishes
4. Magnifying glasses or microscope (optional)

Activities & Procedures

1. Select a sampling site that is safe and easily accessible.

2. Wade into the water body and place your net so the mouth of the net is perpendicular to and facing the flow of water.

3. Stand upstream of the net and disturb the stream bottom with your feet and hands.

4. Scoop material from the stream bottom with the net. Try to scoop up as little sediment as possible as this will make it difficult to sort the macro invertebrates.

5. Carefully remove attached organisms from the stones in the sampling area. The stream bottom material and organisms will be carried by the current into the net.

6. Hand picks organisms from sticks and other structures.

7. Hold your sampling net over a plastic pan and use a bucket of stream water to wash the material into the pan.

8. If your sample contains a lot of rocks or debris, stir the sample in the pan to suspend the animals, then pour the suspended material back into your net. Rinse the debris from the pan, and then wash the animals in the net back into the pan.

9. Pour most of the water from the pan, so that the materials and animals are no longer floating. Distribute the material evenly in the bottom of the pan.

10. Add some stream water back into the pan for easier sorting.

11. Sort and identify the macro invertebrates.

12. Use Petri dishes to group similar organisms.

13. Keep track of the number of types of organisms on the student worksheet.

14. Count of number of different types of each organism in each sample.

15. Present the data in the tables or graph.

How Healthy is my Water Body

Abiotic Components

Site Observations:

1 Site Name: _____

2 Date: _____

3 Time: _____

4 Type of waterbody (e.g., stream, lake, wetland):

_____

5 Weather today:

_____

6 Turbidity and color of water:

_____

7 Water odor:

_____

8 Water temp:

_____

9 What type of land uses are in the immediate area?

_____

10 Is the area shaded by trees? _____

11 List all microorganisms that you observed in this aquatic ecosystem:

_____

_____

_____

_____

_____

Annex 1

12. List all other abiotic factors you can observe that might be important in this aquatic ecosystem:

Parameters	Allowable Range	Your Results
pH	6 to 9	
Dissolved Oxygen	5-6 mg/l	
Turbidity	Less than 2 to 3 mg/l	
Nitrates	Lakes: 0.01-0.03 mg/l	
Ortho phosphates	Rivers & Streams: 0.1 mg/l	

Water Depth	Sechhi Disc Visibility	Turbidity Rating
For water over 4 feet	Disappears in less than 1 foot (30 cm)	*Turbid*
	Disappears in less than 1 to 2 feet (31 to 60 cm)	*Moderately Turbid*
	Disappear in less than 2.1 to 4 feet (61 to 120 cm)	*Slightly Turbid*
	Visible at more than 4 feet (121 cm or more)	*Clear*
For water less than 2 feet	Disappears at less than 1 foot (less than 30 cm)	*Turbid*
For water less than 2 feet (Secchi disc on the bottom)	Visible but black/white boundary not defined clearly	*Moderately Turbid*
	Visible but black/white boundary defined clearly	*Clear*
2 to 4 feet of water	Disappears at less than 1 foot (less than 30 cm)	*Turbid*
	Disappears at less than 1 to 2 feet (31 to 60 cm)	*Moderately Turbid*
2 to 4 feet of water (Secchi disc on the bottom)	Visible but black/white boundary not defined clearly	*Slightly Turbid*
	Visible but black/white boundary defined clearly	*Clear*

Annex 2

Biotic Components

The condition and health of freshwater ecosystems can be assessed by the condition of their biological communities. A healthy water system will have a good balance of biodiversity, water quality and can be also fit for human activities such as fishing, swimming, recreation, tourism and even aquaculture.

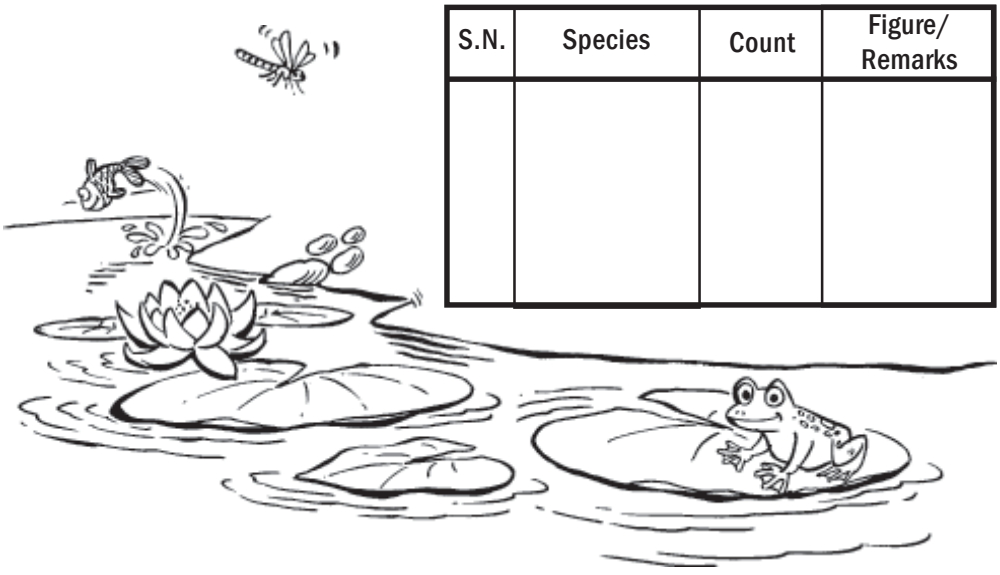
Removal of riverine vegetation, infrastructural developments on the banks, sedimentation from the erosion of land and riverbanks and pollution, introduction of exotic species lead to various problems like loss of suitable habitats for native plants and animals, including loss of wetland areas, changes to flow regimes in rivers, wetlands and floodplains, changes in water quality and declining biodiversity. Increasing levels of pollution and thermal heating will also result in fish exhibiting externally visible abnormalities such as bodies with lesions, ulcers, hemorrhages, fin erosion, skeletal or fin deformities, scale disorientation, or other problems. If there is the presence of the species assemblance of labeo species (Rohu), carps, river trout, tor mahseer (Sahar) etc then it indicates that the water ecosystem is healthy. As fish requires a lot of oxygen to survive, it also indicates that the areation as well as DO is sufficient. However, fish species like the catfish can breathe atmospheric air and can tolerate much higher levels of pollutants than trout or salmon. In some cases, they can survive in only 10 percent of the volume of water. These fish therefore could indicate lower levels of oxygen in the water systems also.

Labeo species

Catfish

Make a List of all fish and macro invertebrates that you can observed that in this aquatic ecosystem and include them in your report as well.

S.N.	Species	Count	Figure/ Remarks



Water macroinvertibrate key

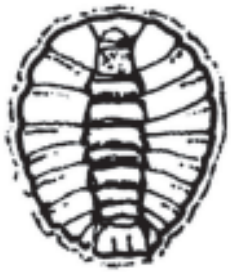
Group 1 - *Sensitive or Intolerant Species*

Stonefly nymph: Stonefly nymphs have two long tails. Their size range from 7-12 mm long. Most Stonefly nymphs eat dead plants and algae. Some species are carnivorous. Stonefly nymphs require well oxygenated water so are consequently found in rivers and streams amongst the rocks and bottom debris, a few species can also be found in the rocky shoals of cold lakes.

Dobsonfly nymph: The dobsonfly nymph feed on smaller aquatic invertebrates. They are large larvae up to 3 inches (7.5 cm) in length. They are most often found in fast moving streams.

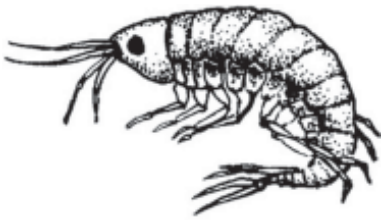
Mayfly nymph: Mayfly Nymphs usually have three long tails or. Some species have leaf-like side gills along their abdomen. They have a single claw on each leg, short antennae and sometimes, wing pads. Mayfly Nymphs live under stones in fast-flowing water or among plants in slow streams. Some species live in small burrows at the bottom of the stream.

Caddisfly larvae: The Caddisfly Larva (plural – larvae) are worm-like with three pairs of well-developed legs on the first three body segments and hooks on the last one. They live in a wide range of environments from fast flowing streams to freshwater ponds. Caddisflies are related to butterflies and moths.The Caddisfly Larva cannot tolerate low oxygen levels.



Water pennies:The water penny is the aquatic larva of a beetle; the adult of the species is not aquatic. The body is often stuck flat to surfaces and looks like a tiny round leaf.

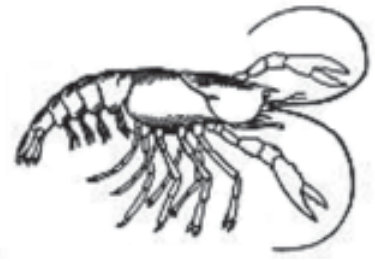
Group 2 - *Somewhat Tolerant Species*



Scuds: Scuds are tiny crustaceans, close relatives of crayfish, water fleas, and shrimp. They probably look the most like shrimp. Scuds live in water, such as streams, ponds, and lakes. They are rarely found in rivers. They like shallow water and do best in water where there are no fish. Scuds have two pairs of antennae (like all crustaceans) and seven pairs of legs (like isopods).

Beetle: Water beetle name for aquatic beetles of several families. They are widespread in quiet streams and ponds. They are black, brown, or greenish, .08 to 1.57 in. (3-40 mm) long, with smooth oval bodies and hairy, oarlike hind legs. They feed on small insects on the surface and seldom dive.

Cranefly larvae: Cranefly larvae are brownish-green to somewhat transparent or whitish; pointed or rounded at one end and a set of disk-like spiracles at the other. They are up to 3 inches in length. They indicate moderately clean water; seldomly found in polluted waters.



Crayfish : Crayfish, crawfish, or crawdads are freshwater crustaceans resembling small lobsters, to which they are related. they are also mostly found in brooks and streams where there is fresh running water. Most crayfish cannot tolerate polluted water. Crayfish feed on living and dead animals and plants.

Dragonfly nymphs: Dragonfly Nymphs are short and chunky with wing pads and internal gills. Their six legs are all located near the head. Dragonfly nymphs live on plants, among stones, leaf litter, or at the bottom of ponds or slow-flowing rivers. They feed mostly on other insects in the water. Sometimes, they can be cannibals and eat each other. Some of the larger species have been known to feed on small fish and tadpoles.

Group 3 - *Tolerant Species*

Leeches: Leeches are segmented, cylindrical worms with a sucker on each end, one being a mouth. Leeches are found in warm, slow-flowing rivers or ponds. They prefer shallow water, and live under rocks and debris, or on plants, where they attach themselves to something solid.Many leeches feed on the blood of vertebrates. Leeches are able to survive where there is not much oxygen. They can also tolerate various chemical pollutants.

Aquatic worms: Aquatic worms can be found anywhere there is fresh water, including lakes, ponds, marshes, and streams. They prefer shallow water. As the worm eats mud with its head down below, the dirt comes out the back end of the worm. This soil-moving is very important to keep the stream or lake healthy. Aquatic worms also break down pollutants which settle to the bottom and poison the water.

Midge larvae: These are sometimes called 'bloodworms' because of their bright red colour, but they are not worms at all. They are midge larvae. The larvae eat the dead organic material at the bottom of the pond. They can tolerate very low oxygen levels and are often found in very large numbers in the sludge at the bottom of stagnant ponds.

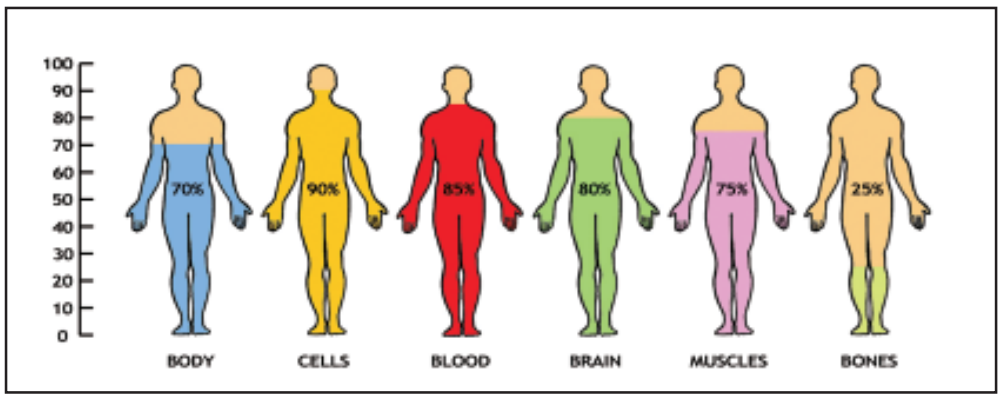
Sowbugs: The sowbug is a scavenger that uses its seven pairs of legs to move around the bottom of streams and ponds feeding on dead plants. It breathes through gills located on its belly. The isopods eyes are very sensitive to light; therefore, it is usually active only at night. It can live in water with low oxygen typical of polluted water.

Snails: Freshwater snails are similar to slugs but have a spiral shell encasing their soft bodies. Freshwater snails live in calm parts of streams or ponds, attached to plants or rocks.They feed on algae, and dead and decaying plants in the water.

FUN FACTS

Annex 3

- Did you know that you could get drunk on water? Well, drinking too much water causes the sodium levels in the bloodstream to dilute causing imbalance of water in your brain. This is called 'water intoxication'.
- Wonder why ice floats on water? That is because ice is about 9% lighter than water.
- Once you drink water, it leaves your stomach in about 5 minutes!
- A person can live without food for a few weeks but a person can only live without water for a few days.
- The father of medicine, Hippocrates, told people to boil their water and strain it before drinking it.
- Water makes up 80% of an earthworm, 70% of a chicken, and 70% of an elephant
- Water makes up 90% of a tomato, 80% of pineapples and corn, and 70% of a tree.
- By the time a person feels thirsty, his or her body has lost over 1 percent of its total water amount.
- The weight a person loses directly after intense physical activity is weight from water, not fat.



Annex 4

TIPS TO CONSERVE WATER

Water conservation is the most cost-effective and environmentally sound way to reduce our demand for water. We use water in many ways, but are we using it wisely? Here are a few things that you can do to ensure that you do not waste water:

- Try to do one thing each day that will result in saving water. Don't worry if the savings are minimal, every drop counts! You can make a difference.
- Remember to use only the amount you actually need.
- Make sure that your home is leak-free. Many homes have leaking pipes that go unnoticed.
- Do not leave the tap running while you are brushing your teeth or soaping your face and body. Just run it long enough to wet your toothbrush or yourself, and then shut it off until you need to rinse.
- Avoid flushing the toilet unnecessarily. Put a brick or any other weight that occupies space to cut down on the amount of water needed for each flush.
- Don't use your toilet as a wastepaper basket. It has its purpose, and use it for that only.
- Do not throw away water that has been used for washing vegetables, rice or dals, use it to water plants or to clean the floors, etc
- You can store water in a variety of ways. A simple method is to place a drum on a raised platform directly under the rainwater collection source.
- You can also collect water in a bucket during the rainy season.
- Always, always shut off the faucet when you are finished using the water.
- Don't pour chemicals down the drain or on the ground.
- Don't pour chemicals down the storm sewer.

Glossary

Biosphere: Biosphere is the zone of the earth where life is found. The biosphere extends to the upper areas of the atmosphere where birds and insects can be found and reaches deep into the ground or to the bottom of the ocean. The biosphere extends to any place where life of any kind can exist on Earth.

Dissolved oxygen: Dissolved oxygen is the amount of oxygen that is dissolved in water. The oxygen dissolves in the water by diffusion from the surrounding air; aeration of water that has tumbled over falls and rapids; and as a product of photosynthesis.

Eutrophication: Physical, chemical and biological changes that take place in a water body when it receives inputs of plant nutrients- mostly nitrates and phosphates from natural erosion and runoff from the surrounding land.

pH: pH is the numeric value that indicates the relative acidity or alkalinity of a substance in a scale of 0 to 14 with the neutral point at 7. Acid solutions have a pH below 7 while the bases have a pH value greater than 7.

Sediment - Solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are influenced by the quantity and intensity of precipitation.

Stream flow: Streamflow is the amount of water flowing in streams, rivers, and other channels over a designated point over a fixed period of time. It is often expressed as cubic feet per second (ft/sec). Streamflow is the main mechanism by which water moves from the land to the oceans.

Temperature: The degree of hotness or coldness of a body or environment.Temperature is measured with thermometers in a variety of temperature scales. The Celsius scale is most widely used scale for temperature measuring purposes.

Thermal stratification: Horizontal layers of differing densities of water produced in a lake by temperature changes at different depths.

Water quality : The chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Water shed: The land area from which surface runoff drains into a stream channel, lake,reservoir or other body of water; also called a drainage basin.

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DANISH FORESTRY EXTENSION

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ISBN:978-9937-8277-1-3
Printed 2010