# DISCOVERING GANGA

## A Teacher's Manual

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

राष्ट्रीय स्वच्छ गंगा मिशन
National Mission for Clean Ganga

**Team Leaders**
Dr. V.B. Mathur
Dr. G.S. Rawat
Dr. Bitapi C. Sinha

**Text Compilation**
Dimpi Patel, Ravi Sharma

**Design & Layout**
Anjali Pathak

**Illustrations**
Dimpi Patel, Shivangi Pant

**Cover**
Shivangi Pant

**Photo Credits**
Kesha Patel, Megha Sinha, Vipul Maurya, Rahim, Kumar Ankit,
Goura Chandra Das, BC Choudhury, G.S. Bhardwaj, Udayan Borthakur,
Abhijit Das and miscellaneous sources.

**Maps**
Zeeshan Ali

## About Wildlife Institute of India

Established in 1982, Wildlife Institute of India (WII) is an internationally acclaimed Institution, which offers training program, academic courses and advisory in wildlife research and management. The Institute is actively engaged in research across the breadth of the country on biodiversity related issues.

The Institute's idyllic campus that has been carefully developed to create state of the art infrastructure encourages scholarly work.

## Our Mission

Nurture the development of wildlife science and promote its applications in the field in a manner that accords with our economic and socio-cultural milieu.

# DISCOVERING GANGA

## A Teacher's Manual

NAMAMI GANGE

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

राष्ट्रीय स्वच्छ गंगा मिशन
National Mission for Clean Ganga

# TABLE OF CONTENTS

# ACKNOWLEDGEMENTS

The Wildlife Institute of India would like to acknowledge the Director, Dr. V. B. Mathur for the continuous guidance. We share our gratitude to the National Mission for Clean Ganga (NMCG) and the Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD and GR) for the support and implementation of the 'Biodiversity Conservation and Ganga Rejuvenation' Project.

We would also like to acknowledge our interns Ms. Kesha Patel, Ms. Monika Saraswat and Ms. Shivangi Pant for contributing in preparing of this manual. We acknowledge Mr. Kuldeep Chauhan and Mr. Neeraj Gupta for providing technical support. We thank Mr. Zeeshan Ali for provision of updated maps of Ganga Basin and Mr. Anurajan Roy for providing editorial support.

We would like to thank the entire Ganga team at WII for their help and support.

# PREFACE

The Ganga River or Ganga is a great river of the plains of the northern Indian sub-continent. Rising in the Himalayas and draining into the Bay of Bengal, it drains one-fourth of India's territory and its basin supports hundreds of millions of people.

The Ganga basin is a home to a wide range of rare and threatened floral and faunal species. The aquatic wildlife of the Ganga basin is under stress on account of reduction in water levels, pollution and over exploitation of riverine resources.

The Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India has launched the National Mission for Clean Ganga (NMCG) to deal with the challenges posed by ganga basin management and to ensure that viable populations of all endemic and endangered aquatic species are maintained and river health is restored. The Wildlife Institute of India has initiated a project on 'Biodiversity Conservation and Ganga Rejuvenation' as an integral part of NMCG.

Raising awareness at the plight of our national river and making citizens particularly youth and children know the role that they can play is crucial. Educators can contribute in this endeavour in a significant manner.

DISCOVERING GANGA ~ A Teacher's Manual, is designed to provide the much needed domain knowledge to both the educator and the student. The materials presented in the form of 'activity-based learning' would help the educators and students in the primary and secondary schools to supplement their existing curriculum with a new set of tools that combine both learning and fun.

22nd July, 2018
Dehradun

Dr. V.B. Mathur
Director, Wildlife Institute of India

# 1 KNOW YOUR RIVER GANGA

Since times immemorial, river Ganga has been the cradle of civilization of India. The river has unique status in the cultural and spiritual lives of people in India, and also to millions of people around the world.

The Ganga river system is the lifeline for more than 40% population of the country. The dependency on the Ganga river system is ever increasing for various reasons including – population growth and that too in a highly concentrated manner in the Ganga basin, rising standards of living and exponential growth of industrialization and urbanization. Ganga drains a basin of extraordinary variation in altitude, climate, land use and cropping patterns.

The source of Ganga water is the melting of snow at Gangotri glacier in the Himalayas and monsoon rains. Mythologically it is believed that Gaumukh (cow's mouth ) at an altitude of 4,000m is the source of Ganga, though factually Ganga has its origin in different small streams at an altitude of more than 6,000m or above. The main stream of the river flows through the Himalayas till two streams, Mandakini and Alaknanda, join at Devprayag. The combined stream is then known as the Ganga. The river after travelling 2525 kms from its source meets the Bay of Bengal at Gangasagar in West Bengal.

The Ganga basin formed by Ganga-Brahmaputra-Meghna rivers, is the largest in India. The “Subderbans” shared by India and Bangladesh, forms a delta 354 km wide in the Bay of Bengal. The Gangetic plain is the most thickly populated and the oldest settled plain in the world. The estimated population of the Ganga river basin is around 448.3 million as per 2001 census. Spread across 11 states, the Ganga river basin covers an area of roughly 1 million $km^2$.

The Ganga was once famous for its ability to retain oxygen as it was the only river in the world which had 12ppm of oxygen. The self-purifying quality of this river leads to oxygen levels that are 25 times higher than any other river in the world. Ganga water has an extraordinarily high rate of oxygen retention, allowing it to remain fresh during long storage periods.

Its water, widely known as “Gangajal”, has certain chemical qualities enriched with many extraordinary healing properties. Indian environmentalists have confirmed that owing to its self-cleaning properties, normally river water begins to purify over a period of time due to lack of oxygen which promotes the growth of anaerobic bacteria, which in turn gives rise to the smell of stale water.  Gangajal does not deteriorate or lose its special values even if it is kept in a closed vessel for years. The high level of oxygen in the waters of Ganga gives it the unique ability to remain fresh over a prolonged period of time. The waters of Ganga, when added to other water resources in adequate amounts causes the “Bacteriophage”, meaning bacteria eater, to quickly multiply cleaning the water. In ancient times people carried Gangajal back home to clean their local water resources.

## HABITATS IN GANGA BASIN

The Ganga river basin is known for rich biodiversity, which sustains diverse group of flora and fauna supporting abundant biological wealth. The faunal resources of the river Ganga can be categorized into three distinct zones: the Upper Ganga in hilly terrain flowing within Uttarakhand; the middle Ganga, which flows through Uttar Pradesh, Bihar, Jharkhand and West Bengal and finally the lower Ganga in deltaic tract. Though the upper portion is the cleanest and contains a wide range of biodiversity and fragile ecosystems, the middle section is the most polluted, due to human actions.

Ganga Basin has a diversity of biological wealth distributed in its forests, wetlands, freshwater river channels and in its marine areas. These constitute the ecologically fragile zones and need to be protected from pollution and abatement of flow rates in various sections of the river. At present about 31% of the National parks in India are located in Ganga Basin along with 15%

of wildlife sanctuaries protecting some of the most endangered species such as Bengal Tigers, Gangetic Dolphins and Vultures. Mangroves which are amongst the more resilient and very unique ecosystems on the planet are also located in the Ganga Basin in the Sunderbans.

1. Out of 18 Biospheres reserves in India, two are within the Ganga Basin- Nanda Devi Biosphere and the Sundarbans National Park.
2. Out of 103 National parks in India, 29 are within the Ganga Basin.
3. Out of 543 animal sanctuaries in India, 75 are located in the Ganga basin.
4. Out of 50 tiger reserves, 10 tiger reserves are found in the Ganga basin.

## POLLUTION

Major sources of pollution are: Industry, Agriculture and Domestic.

- Farmers use pesticides and fertilizers in croplands. These pesticides and fertilizers gets washed during the rains into the river. If a large amount is drained into the river, then the concentration of nitrate and phosphate in the water increases. Algae uses these substances to grow and multiply turning the water green. The growth of algae is called eutrophication and leads to pollution. When algae die, they are broken down by the action of bacteria which multiplies using up all the oxygen of the water leading to death of aquatic animals.
- Chemical wastes from industries are discharged into the river, which includes cyanide, zinc, lead, copper, cadmium and other harmful chemicals. These substances enter the river in such high concentrations that fish and other aquatic animals are impacted. Sometimes the pollutants enter the food chain and accumulate to reach toxic levels eventually killing birds, fish and mammals.
- Factories also use the river waters to cool down machinery. Water used for cooling is put back in the river. This water is warmer than the river itself. Raising the temperature of the water lowers the level of dissolved oxygen and upsets the balance of life in the water.In the Ganga basin approximately 12,000 million litres per day (mld) sewage is generated, for which presently there is a treatment capacity of only around 4,000 mld. Approximately 3000 mld of sewage is discharged into the main stem of the river Ganga from the Class I & II towns located along the banks, against which treatment capacity of about 1000 mld has been created till date.

**River Ganga was declared as national river of India on 4th November, 2008.**

Some Current Figures

- 300 crore litre sewage water is dumped every day in Ganga.
- 2.70 crore litre waste materials dumped every day in Ganga.
- There are about 470 drainage outlets in Kanpur itself.
- 50% of the pollution is from UP itself.
- Water not suitable for even bathing in Varanasi and Allahabad.
- The water has 3000 times more toxic chemicals than normal.
- More than 50 crore people stay near the Ganga river basin.
- 40% of humans are dependent on Ganga water.
- It is the 6$^{th}$ most polluted river of the world.
- More than 1800 villages on the banks of Ganga River are present and all the waste produced by them, is directly dumped into the water.

**Source: https://www.youtube.com/watch?v=ZoYDfEbpWmk*

People washing clothes on Ganga ghats

# ACTIVITY 1

# TRIBUTARIES OF GANGA

## OBJECTIVE

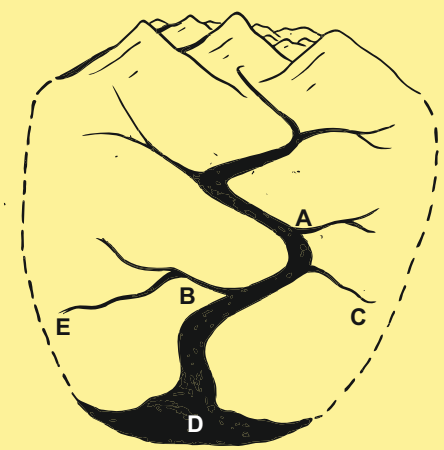
- Making students familiar with some terms related to rivers
- Which are the major tributaries of Ganga?

## BACKGROUND

**River Basins** - A river basin is an area of land drained by a river and its tributaries.

River basins include:

**Tributaries** - Smaller rivers flowing into a larger river.
**Watershed** - An area of highland surrounding the river basin.
**Confluence** - Where a river joins another river.
**Source** - The start of a river.
**Mouth** - Where a river meets a lake, sea or an ocean.




The main features of river basin

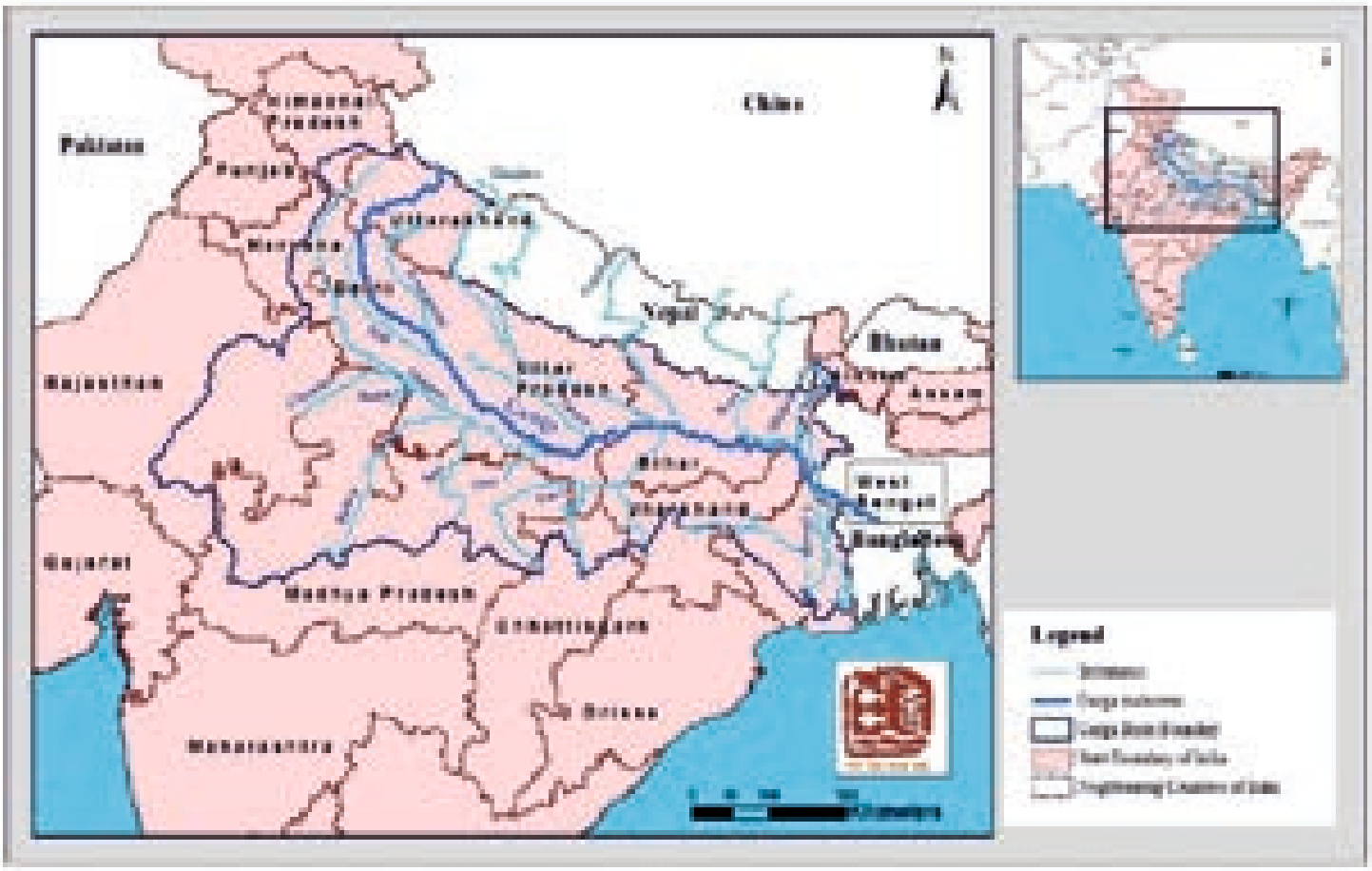
| | |
|---|---|
| A | confluence |
| B | tributary |
| C | watershed |
| D | mouth |
| E | source |

## KEYWORDS

River basin, Tributaries, A watershed, A confluence, Source, Mouth

## MATERIALS

Map of India with Ganga River and its tributaries




Map showing Ganga and its tributaries

## PROCEDURE

- Explain students how Ganga is connected to different other rivers of India and how it provides water to all those areas.

## EVALUATION

- Ask students to identify the tributaries of Ganga in their area.
- Ask them to list down the activities for which the water of the tributaries is used in their area.
- Try to know from students whether the tributary in their area provides water throughout the year or not.

# ACTIVITY 2

# KNOW YOUR NEIGHBOURS

## OBJECTIVE

Students will be able to know about the cities on the bank of Ganga Basin.

## KEYWORDS

Cities, States, India, Map

## MATERIALS

A map of India with depiction of Ganga river, states and cities of India.

## PROCEDURE

- Discuss with the students about their native place and their city.
- Ask if they have visited other cities.
- Ask them if those cities also have the Ganga flowing through?
- Make the session interactive with the help of the map of India.

## EVALUATION

Ask students to list down the cities situated on the banks of Ganga which they can see in the map and also ask them to arrange in ascending or descending order on the basis of their area (Students can compare the shapes of states on the Map).

Map showing the cities from where Ganga flows

# ACTIVITY 3 WORDS OF WATER

## OBJECTIVE

Students will describe a variety of ways and reasons why water is important to people and wildlife.

## BACKGROUND

Water is central to all lives on earth. Water represents about 75% of a person's body weight and covers nearly 75% of the earth's surface. Nearly everything on earth can be directly or indirectly traced to a connection with water. Rocks channel water into streams, and rivers carry water across the land. Ponds, lakes, marshes and swamps often hold water in place. Trees draw water from the soil and transport it up into the leaves and out into the air. Clouds are airborne carrier of water across the sky.

Wildlife needs water for survival. The water must be clean, free of toxic contamination. Humans use water for many purposes other than drinking. Care must be taken to protect water quality.

Water is the basis of a massive planetary transportation system. The driest desert has water – and there are about 320,000,000 cubic miles of water in the oceans. The tiny plants that live in the earth's oceans-phytoplankton- produce one third or more of our oxygen, a gas vital to vertebrate respiration.

## KEYWORDS

Water, ponds, lakes, air, ocean

## METHOD

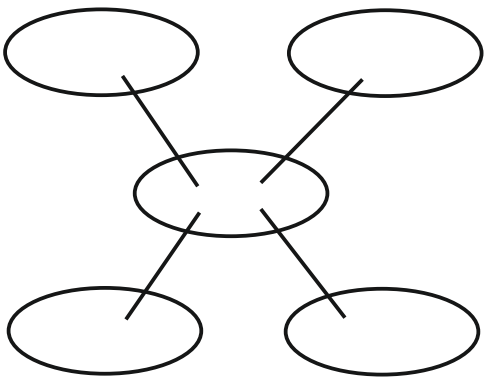
Students brainstorm water words, make word trees with those words and write poetic statements about water.

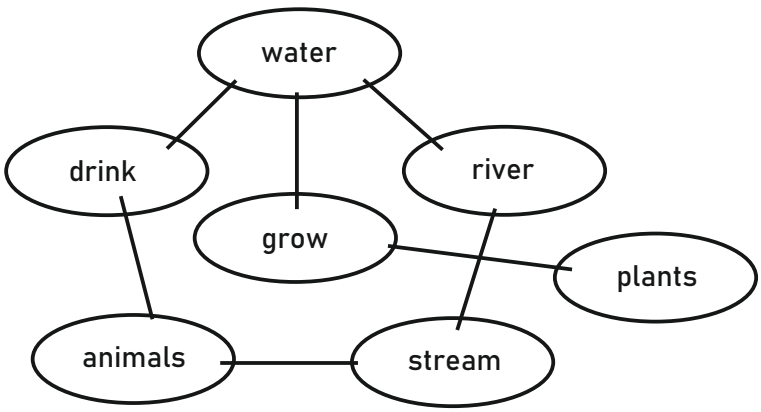
## MATERIALS

Writing material, colored papers

## PROCEDURE

- Ask the students to bring photographs from magazines/newspapers that show water. Ask them to look especially for pictures that show how living things depend upon water. Display these photographs and use them as a basis of discussion.






- Ask students to think about some of the ways they have used water that day. The pictures (if collected) may be used to get them started. Emphasize on how all living things depend on water.
- Ask students to list down at least **50 words** that have something to do with water. Ask them to think of words about water, including its importance to people and wildlife.
- Using the list of words that were recorded, ask them to create word trees of water related words. Begin with a simple word tree given below and ask them to make complex trees.
- When students have finished several word trees, have them look at what they have done and ask them to make sentences out of it.
- When students complete their sentences, have them write them onto various shades of blue, aqua, grey, white and green construction papers cut to graphically fit the feeling of their idea. Arrange these cut outs on a wall of a window.

## EXTENSION

Create a class book with each student's page included.

## EVALUATION

- Tell three ways you use water.
- Tell how plants use water.
- Tell how animals use water.
- Why is water important?

# ACTIVITY 4 FORMS OF WATER

## OBJECTIVES

Students will: 1) Illustrate the water cycle: 2) describe the interrelatedness of the world's waters: and 3) state the importance of water to people, plants and animals.

## BACKGROUND

There is, in a sense, one body of water on planet Earth. Its rivers reach in sinuous paths out from the hearts of every continent. Water, everywhere, is somehow connected. Everyone can rather easily see and sometimes physically touch this universal body of water in some form- perhaps by turning on a water pipe or by looking at clouds moving high in the sky. Lakes, ponds and inland sea was webbed together by waters flowing across the surface of the land or in the seeping flow of groundwater. Through evaporation, condensation and precipitation, the atmosphere transports water from place to place.

Plants also are an active part of the water cycle in many ways- Including by transpiration. Transpiration is a process whereby plants evaporate moisture through the surfaces of their leaves. People seldom think of the waters of the world as being connected into one body. Maps emphasize the continents and political boundaries on land. Geographers have named dozens of sea which in reality cannot be delineated from each other- similar to the way that territorial boundaries on land tend to be more political than geographical.

Human beings are linked to the planet's watery world. Our bodies are approximately 75% water.

Other animals and plants are also tied to the planet's water- directly and indirectly. Living things are partly made of water. All life depends upon water in some way.

The continuous dynamic of the movement of water is called the water cycle. The concept of the water cycle is the way to view the moving connectedness of water in its many forms.

## IMPORTANT TERMS

***Condense:*** to change from a gas to a liquid state of matter

***Evaporate:*** to change from a liquid to a gas

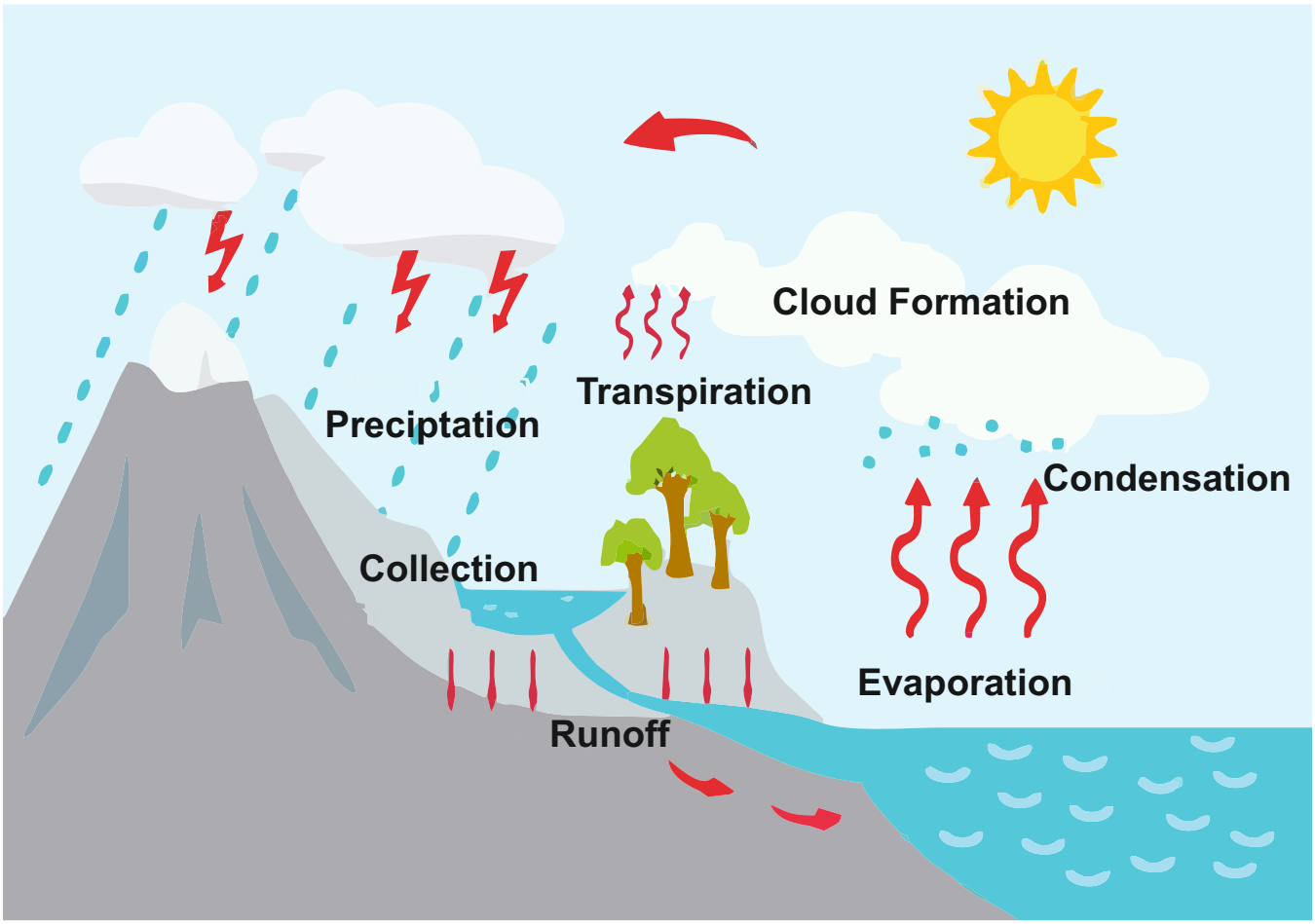
***Groundwater:*** water present in soil and rock underground

***Infiltrate:*** to enter [ground] by moving into spaces between particles

***Precipitation:*** water falling from the sky as rain, snow, hail, or sleet

***Runoff:*** water, from rain or melting snow that flows over the ground

***Transpire:*** to give off vapor through the outer covering of a living thing




Process of water cycle

WATER CYCLE IN SHORT…..

- The water cycle describes the continuous circulation of water from water bodies and the land to the sky and back again. It is truly a cycle; there is no beginning or end.
- Water can change states—become a gas, liquid, or solid—at various places in the cycle.
- The water cycle is powered by solar energy and gravity. Water evaporates into the atmosphere as water vapor. This gas then condenses into droplets that gravity pulls down to earth as precipitation and downhill back to the oceans as runoff. Some precipitation infiltrates the ground and becomes groundwater. It may stay there for millions of years or bubble up in springs, or be taken up by plants and released back to the air through transpiration from their leaves. Water may also be frozen for centuries in snow packs or glaciers before melting and rejoining the cycle.
- There is about as much water on earth today as there was in the time of the dinosaurs.

## KEYWORDS

Water cycle, earth, flow, plants, animals

## MATERIALS

Art materials (water-based paints such as acrylics, water color, or poster paints; brushes, paper, containers for water); writing materials

## METHOD

Students experience a simulated field trip and then create artwork.

## PROCEDURE

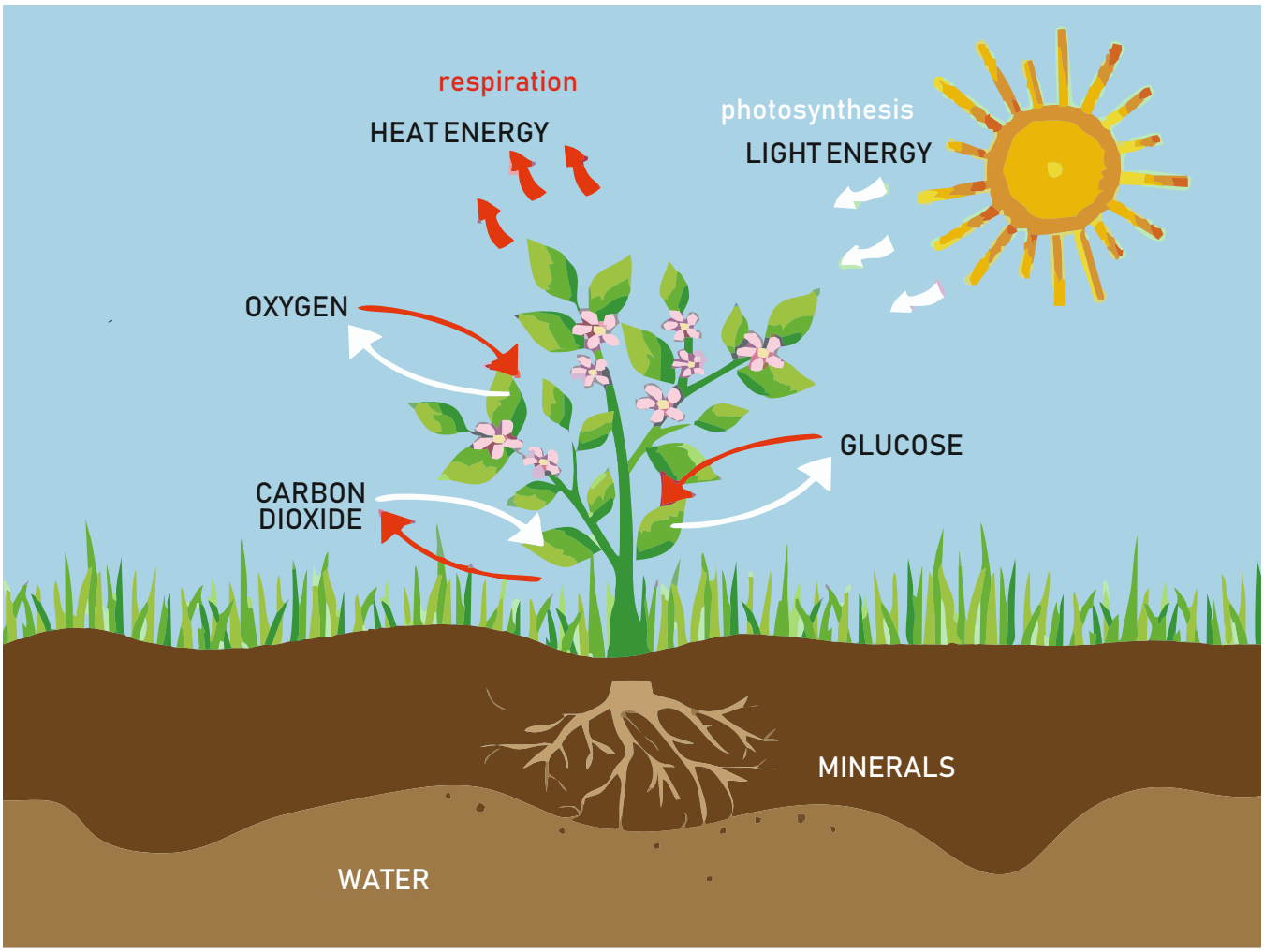
- The students should visit a stream, pond, lake or river. Try to choose one where human-made sounds are at a minimum. Allow the students to touch the water during the part of the activity.
- Provide the art materials and ask them to paint the picture of their favorite place, which has water.
- Once the pictures are complete, ask the students to write short poems that express some of their feelings about water and its importance.
- Emphasize the concept that all the water in the world is interrelated and connected. Help the students understand that the air is a part of that connection too. It is the air that carries the water back to the rivers from the sea. Point out that watersheds are the places where the air rains its water back down on the earth's surface and it accumulates. Talk about the importance of water to people, plants and animals.
- End the activity with a description of water cycle. Ask the students to describe how their favorite place, which they illustrated in their painting, is a part of the water cycle. You might want to point out that the water they used in their paintings have evaporated from the pictures and is back in the water cycle again.

## EXTENSIONS

- Find out the annual rainfall and climate in the area you choose to paint.
- Write a statement or poem about planetary pollution of water and attach it to the art. Write a second statement or poem about what can be done to keep the earth's water healthy and free of pollution.
- Choose a freshwater body near you and trace its path to the sea.

## EVALUATION

- Describe the water cycle. Illustrate your description.
- Describe how all of the earth's water is connected and interrelated.
- List at least ten ways that you use water every day.
- List as many examples as you can of why water is important to plants and animals.
- Draw a picture showing how one drop of water can connect with a dolphin, a school and a plant.




The process of photosynthesis

# ACTIVITY 5

# WATER POLLUTION

## OBJECTIVES

Students will be able to 1) describe water pollution, 2) compare clean and dirty water, and 3) describe the importance of clean water for daily use.

## BACKGROUND

All living things require clean water for survival. Human activities add materials to water that make water unfit for use. Polluted water affects the lives of plants and animals to the point of making them unhealthy.

## DEFINITION

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), very often by human activities.

Water pollution occur when pollutants (waste from homes, factories and other buildings such as particles, chemicals or substances that make water contaminated) are discharged directly or indirectly into water bodies without enough treatment to get rid of harmful compounds. It affects plants and organisms living in the water.

Our water resources are of major environmental, social and economic value, and if water quality becomes degraded, this resource will lose its value. Water quality is important not only to protect public health: water provides ecosystem habitats, is used for farming, fishing and mining, and contributes to recreation and tourism.

## KEYWORDS

Clean, dirty, detergent, smell, pollution

## MATERIALS

3 clear plastic glasses or jars, tap water, pencil shavings, paper strips, sand/soil, filtering material (coffee filter/clean cotton cloth), detergent etc.

## METHOD

Students conduct experiments and observe.

## PROCEDURE

Explain water pollution and its effects on everyday life prior to conducting demonstration.

- Pour water into 2 clear plastic glasses. Set one glass aside.

- Allow students to add items such as pencil shavings, paper strips, styrofoam, detergent, vinegar, etc. to the first glass.
- keep the filter on top of the glass with polluted water and let the students filter off water to a separate glass.
- Ask students to compare the two glasses and discuss the importance of clean water for drinking, swimming, and bathing.
- Discuss the results of the experiment. Is the water “clean”? Have the students feel it and smell it.
- Discuss that even though water looks clean it's not necessarily clean.

## EVALUATION

- What different floating material (garbage) have students seen in their area?
- Discuss about major sources of these pollutants in their area.

Water pollution in human habitation

# ACTIVITY 6

# POINT VS NON POINT SOURCE POLLUTION

## OBJECTIVES

Students will be able to 1) differentiate between point and non-point sources and 2) identify the point and non-point sources that are responsible for pollution in ganga.

## METHOD

Write the given sources of pollution on black board and ask students to identify and divide them into point and non-point sources.

## BACKGROUND

Pollutants enter the water environment from two main types of sources:

**1. Point sources**
A point source is a single, identifiable source of pollution such as a pipe or a drain. Industrial wastes are commonly discharged to rivers and the sea in this way. The main point source discharges are from factories and sewage treatment plants, which release untreated waste water. Other example of point sources are jetties where oil seeps from petrol motor boats, cremation sites and dumping sites near river banks.

**2. Nonpoint sources**
Non-point sources of pollution are often termed 'diffuse' pollution and refer to those inputs and impacts which occur over a wide area and are not easily attributed to a single source. For example, emptied into streams or rivers after accumulating contaminants from sources like rainwater drains, agricultural runoff, water flowing from roads and lanes and construction sites.

### URBAN LAND USE

In urban areas rainfall run-off is one of the major nonpoint sources of pollution impacting the water quality. Runoff from street surfaces is often contaminated with car oil, dust and the carcass of animals, soil and sediment run-off from construction sites, and industrial areas often contains more toxins and chemicals.

### AGRICULTURE LAND USE

In farming areas non-point sources of pollution include pesticides, fertilisers, animal manure and soil washed into streams in rainfall run-off. Where livestock are given access to stream banks for grazing or bathing they may foul the water and accelerate erosion.

### FORESTRY LAND USE

Forestry operations like growing and managing forests, timber harvesting (log extraction, transporting etc.) may contribute to non-point source pollution of streams by increasing soil erosion and sediment run-off.

## KEYWORDS

Point, non-point, pollution, run-off, sewage

## MATERIAL

Exercise: classify the following sources:

1. Boats in ganga.
2. Pipe discharge from waste water treatment plant into the river.
3. Washing clothes and utensils at ghats.
4. Construction site erosion.
5. Factory illegally dumping waste into local waterbody.
6. Effluent from failing septic tank.
7. Fertilizers in agricultural runoff.

Non-point sources of pollution

# ACTIVITY 7

# FROM STREETS TO STREAMS OF GANGA

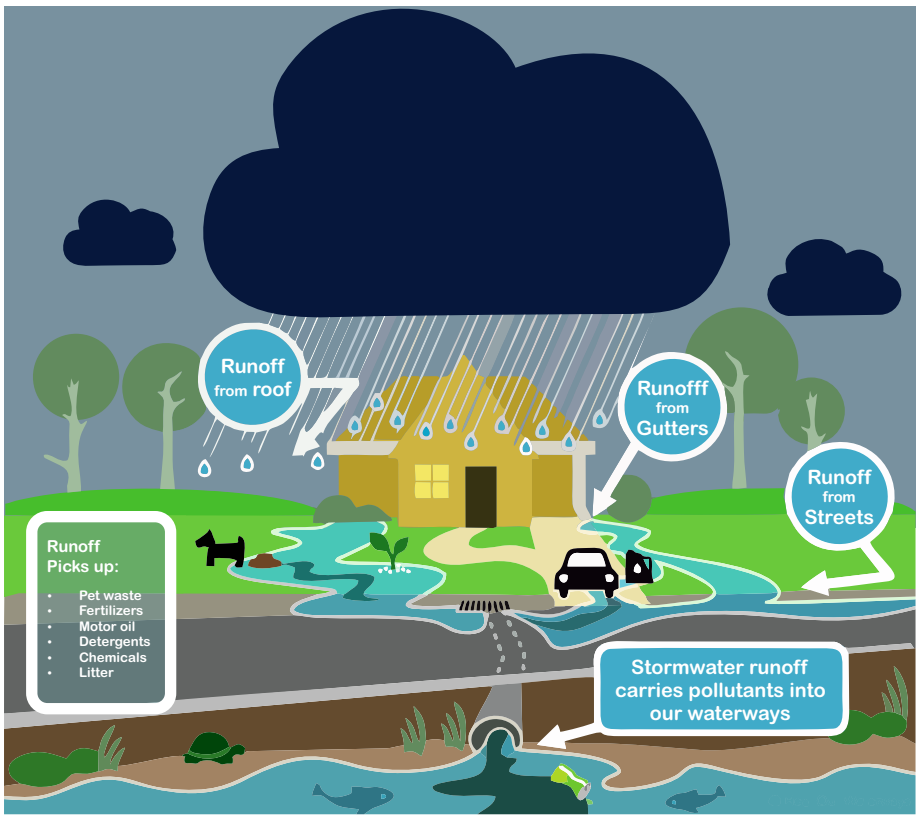
## OBJECTIVES

Students will be able to 1) define the terms runoff, point and nonpoint source pollution and 2) classify pollution sources as either point or nonpoint source.

## BACKGROUND

Rainwater running off roofs, lawns and streets can wash a variety of water pollutants into lakes and streams. These pollutants include nutrients from agriculture fertilizers; bacteria from pet/stray animal wastes and rotting litter; sediment from erosion; toxic chemicals from pesticides, petrol, diesel, and trace metals from emissions like lead, mercury, and cadmium; zinc from roofs.

In developed areas, these pollutants usually collect on hard-surfaced parking lots and streets where they collect in such high concentrations that they kill fish when they are washed all at once by a heavy rain into a water body. This is called *shock-loading*.




Water runoff in urban areas

## DEFINITION

Runoff is water, from rain, snow melt, or other sources, that flows over the land surface. Runoff water carries chemical fertilizers, litter, etc. Runoff that occurs on surfaces before reaching a channel is also called overland flow.

## KEYWORDS

Runoff, litter, roads and gutters, shock-loading

## MATERIALS

Illustrations, piece of brick, concrete, or asphalt, artificial grass, sand, measuring cup, tap water, 3 shallow trays, trash bags, poster board, glue

## METHOD

Students will conduct experiments

## PROCEDURE

- Place a piece of brick, soil and sand in separate shallow trays and set the trays on a table for the students to observe.
- Let the students guess what will happen when water is poured on each surface.
- Pour one cup of water on the hard surface and let the students describe what happened, then repeat the procedure on the other surfaces.
- Explain that the excess water that does not soak is called “runoff”.
- Let students relate this experiment to what happens to runoff in a city. Runoff occurs more often in areas where there are concrete, paved roads, or other hard surfaces, and much less in areas covered with vegetation.
- Explain that wastes from pets, birds, and rodents, are often carried in the runoff, as well as litter, oil, chemicals, and pesticides.

## EVALUATION

Discuss how litter contributes to urban water pollution by having the students describe what kinds of litter they frequently see in their community and what happens to it after a heavy rain. Then have students create a plan for their community to reduce the amount of litter in their area. Have students create a “micro-litter” poster. Allow students to collect litter from school grounds avoiding dangerous items such as glass. Bring the litter back to the classroom and have the students glue litter to a board. Brainstorm with students a catchy environmental slogan on how to prevent litter by non-point sources of pollution. Add message to the poster and display it on the wall of the school where everyone can see.

# ACTIVITY 8

# IS WATER AROUND YOU GOOD OR NOT GOOD?

## OBJECTIVES

Students will be able to learn about components of water and to check the water quality.

## BACKGROUND

The **ph** of river water is the measure of how acidic or basic the water is on a scale of 0-14. It is a measure of hydrogen ion concentration. The optimum ph for river water is around 7.4. A change in the ph of water can alter the behaviour of other chemicals in the water. The altered water chemistry may affect aquatic plants and animals.

**Salinity** is the measure of all the salts dissolved in water. It is increasing due to the discharge of industrial waste water and the agricultural runoff. Because of the increased salinity, the quality of drinking and irrigation water is spoiled and may also affect the ecosystem.

**Dissolved oxygen** is the amount of oxygen dissolved (and available to sustain marine life) in a river body. However, higher dissolved oxygen results in corrosion and lower means less oxygen for aquatic life. The depletion of oxygen indicates death of fishes, high bacterial population, cloudy appearance, strong odor, etc.

**Pesticides** include all chemicals that are used to kill or control pests. This includes herbicides (weeds), insecticides (insects), fungicides (fungi), nematocides (nematodes), and rodenticides (vertebrate poisons).Pesticides typically enter a waterbody through surface water runoff, often from a farm field or from neighbourhoods where they are applied on lawns. Pesticides can also enter a waterbody as a result of “spray drift”.

This occurs when the pesticide is sprayed over an area, and the wind blows some of the spray into a nearby waterbody.

**Toxic and hazardous substances** are materials that are widely used in industries, and to control pests and support our lifestyle. Biomedical waste consisting of poisonous materials is thrown directly or indirectly into the river.
Many of these substances do not degrade, bind to soil particles or

precipitate in water resources. Some are harmful even at very low concentrations. Once they enter into the water bodies they may be harmful for human consumption, aquatic life and irrigation.

**Oil and grease** is a measure of variety of substances including motor oil used in small boats or bajras, cooking oil, etc. Sources of oil and grease are mainly anthropogenic.

**Detergents** are very widely used in domestic premises like soaps and detergents to wash vehicles, clothes, human and animal bathing, utensils, etc. Major entry point is via sewage or by washing and bathing into the waterbody itself.

**Litter and rubbish** (intentional or unintentional, large or small) consisting of tons of garlands, flowers, plastic bags, household substances, etc. That are improperly disposed of in water leads to the bacterial growth and oxygen depletion which can drastically affect the environment for years to come.

| Station | Dissolved oxygen in 1986 (mg/l) | Dissolved oxygen in 2011 (mg/l) |
|---|---|---|
| Rishikesh | 8.1 | 7.6 |
| Haridwar | 8.1 | 7.4 |
| Garhmukteshwar | 7.8 | 7.5 |
| Kannauj | 7.2 | 7.9 |
| Kanpur | 7.2 | 7.7 |
| Allahabad | 6.4 | 7.8 |
| Varanasi | 5.6 | 8.0 |
| Patna | 8.1 | 7.1 |
| Rajmahal | 7.8 | 6.8 |

*Source: data.gov.in*

## KEYWORDS

ph, salinity, dissolved oxygen, coliform, pesticides

## MATERIALS

Water quality testing kit

## METHOD

Students will check water by using the water quality testing kit.

## PROCEDURE

- Collect water samples from different sources like from a running water tap, a water tank, a puddle and from river Ganga.
- Use the given water quality testing kit to analyze each sample. Read the instructions from the provided manual along with the kit.
- Get the students involved in the experiments. Ask them to observe and note down the results.

## EVALUATION

- Compare the results and explain which water is good or bad!
- Also discuss how one can prevent water from getting polluted.

Plastic pollution near ghats of Ganga

# ACTIVITY 9

# TURBIDITY AND LIGHT PENETRATION

## OBJECTIVES

Students will be able to 1) define the term “turbidity”, 2) observe what effect of solids suspended in water have on penetration of light and 3) understand the effect that turbidity has on the health of a water body and it's plants and animals.

## BACKGROUND

The term used for suspended solids within the water is turbidity.
These are soil particles and other matter that are suspended in the water. The amount of turbidity is important because it affects the amount of light penetration and the color of the water. Turbidity also has a negative effect on plants growing in deep waters as plants need a particular amount of light for the process of photosynthesis which is an important process. Plants and phytoplankton are the **producers.**
**Producers:** Organisms that make their own food (e.g. trees, plants) [see chapter 2, activity 4 for details]

## KEYWORDS

Suspended particles, turbidity, light, penetration, photosynthesis.

## MATERIALS

Beaker, some soil, graduated cylinder (given in water testing kit), water samples from various locations, a torch.

## METHOD

Students will conduct experiments.

## PROCEDURE

- Take some tap water in two beakers and add some soil in one of them.
- Stir it and explain to the students the term 'turbidity'.
- Now, keep both the beakers near window where natural light is coming or use a torch to throw the light on water of both the beakers and ask students to observe.
- Discuss the observations with students and explain how turbidity affects the penetration of light into the water. Also discuss how it will affect the plants growing inside rivers and ponds.
- Same way fill the beakers with water collected from different sources and label them.
- Let the students observe them and express their views on it.

## EVALUATION

1. Ask students to divide different water samples into highly turbid, moderately turbid and less turbid waters.
2. What activities would improve the clarity of water?

# ACTIVITY 10

# TOO MUCH OF FERTILIZERS!

## OBJECTIVE

Students will be able to 1) observe algal growth caused by excess fertilizer use.

## BACKGROUND

Farmers can pollute water by improperly using chemical fertilizers and pesticides. Farmers applying too much manure or fertilizer at the wrong time can cause pollution. It is not good to apply fertilizer and pesticide during the rainy season. After heavy rains, fertilizer and pesticide can wash away into rivers and lakes and supply the aquatic plants with too many nutrients. As a result, algae multiply faster and cause **algal blooms**. Algal blooms can reduce the supply of oxygen in the water because oxygen is required for algae respiration and growth. During the day, algae photosynthesize and produce more oxygen than they can use. But at night when **photosynthesis** increases, algae may use more oxygen to grow than may be available. This situation is known as **eutrophication**. This can deplete the supply of dissolved oxygen in the water. When the algae die, oxygen is required to break down or decompose the dead algae. Both respiration and decomposition can make oxygen unavailable to fish and other aquatic life and cause fish deaths.

- Explain about plant fertilizer and animal wastes nutrients that make plants grow.
- Often animal wastes are washed into nearby streams or worse yet, the animals are allowed to stand in the stream, and their wastes go directly into it. These wastes enter the water at many different locations, so it is considered nonpoint source pollution.
- Have the students guess what types of problems this can cause. (messy, smelly, health problems etc.)
- Tell the students that this lesson will show them how too many nutrients can cause too much algae growth.

## KEYWORDS

Fertilizers, nutrients, sunlight, growth, algae, plants, oxygen, eutrophication

## MATERIALS

Two transparent containers which can hold minimum of 5 liters of water, index cards, permanent ink pen/marker, tape, plant fertilizer, measuring spoons, torch or table lamp.

## METHOD

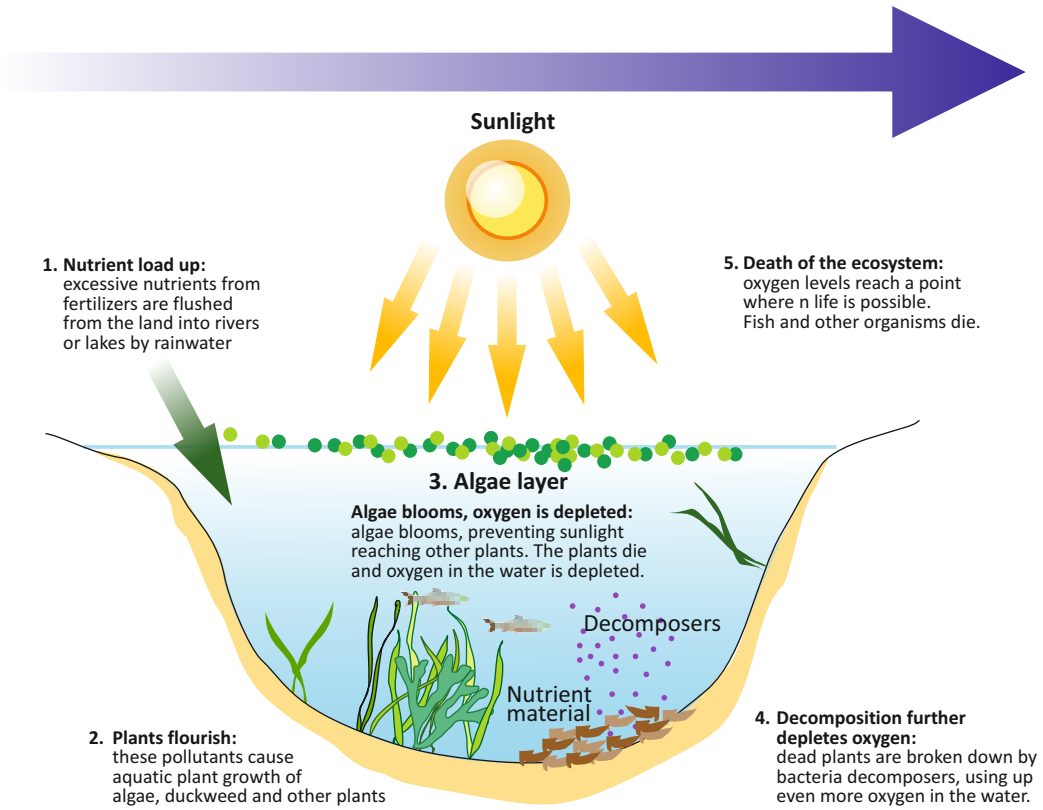



Diagram showing eutrophication process

Students will conduct experiment as follows.

## PROCEDURE

- As the class watches, select volunteers to help you fill two containers with pond or stream water.
- Label one container “a” and one “b” on a card taped to each container.
- Place 3 tablespoons of plant fertilizer in container “a” as you explain that you are adding nutrients in the form of fertilizer in the water.
- Container “b” gets one half teaspoon of fertilizer.
- Place both the containers near a window for light. If sunlight is unavailable use a torch or table lamp.

  Note: Do not place them in a cold place.
- Have students record their observations on a daily basis for a week.

## EVALUATIONS

- Discuss the results of the experiment. Let the students guess why there is a difference in the two containers. Ask them which container looks more polluted.
- Discuss how nutrient pollution could affect aquatic life. (plants use oxygen to grow or respire and oxygen is used to decompose the dead plants. Lot of plants use lots of oxygen and this makes oxygen unavailable to other aquatic life. When this happens, the animals

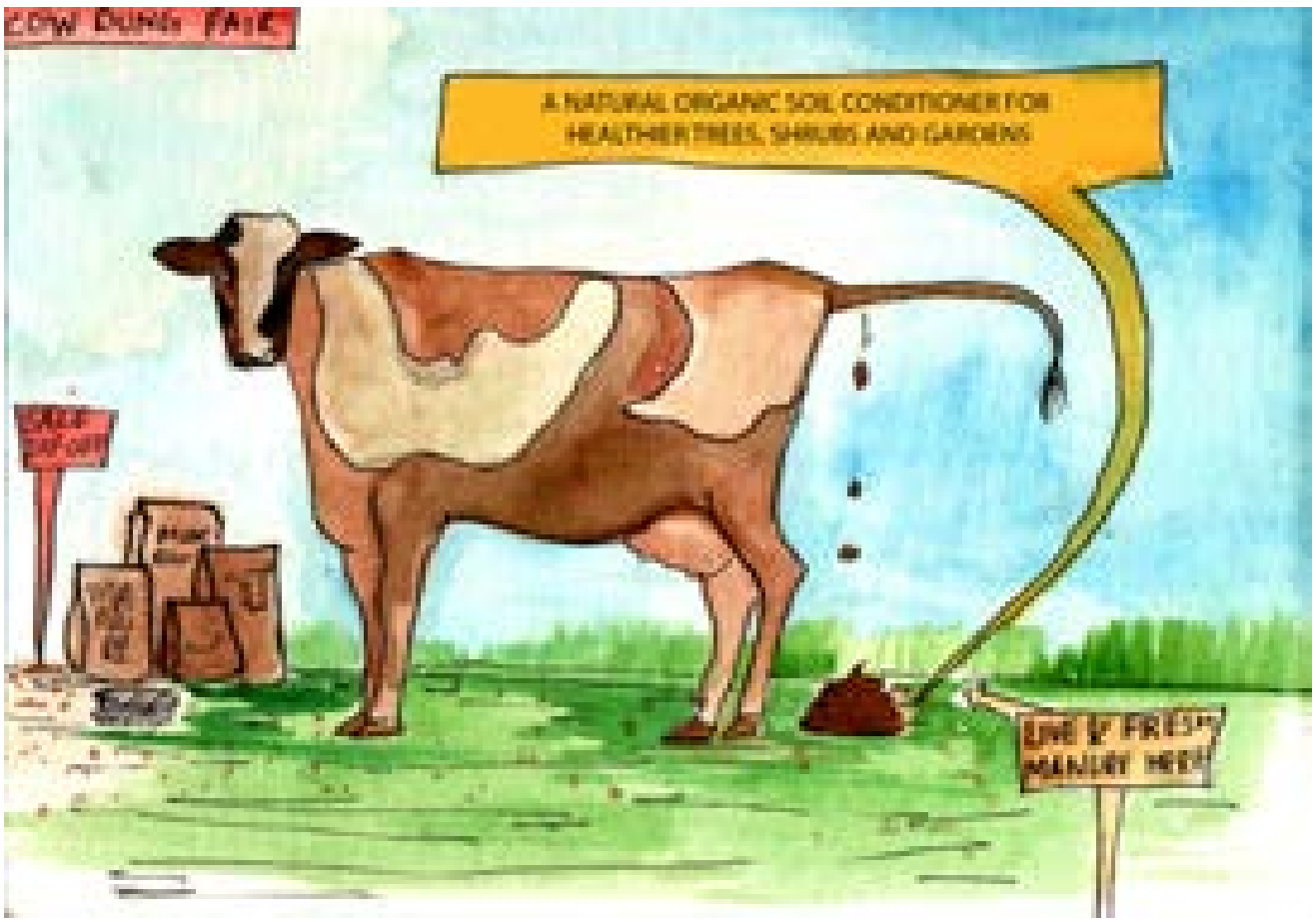
can't breathe and sometimes get sick or die.)

- Have the students imagine they are fish and decide which bowl they would rather live in. Explain that after algae dies the oxygen in the water is used up, which the fish also need to breathe to stay alive. Ask which bowl will use up most of the oxygen when the algae die.

Conclude that small amount of nutrients are beneficial, but too many are not good. Animal waste washed into water bodies is a nonpoint source of pollution that needs to be prevented.

| A | | A | |
|---|---|---|---|
| Days | Observations | Days | Observations |
| 1 | | 1 | |
| 2 | | 2 | |
| 3 | | 3 | |
| 4 | | 4 | |
| 5 | | 5 | |
| 6 | | 6 | |
| 7 | | 7 | |

| B | | B | |
|---|---|---|---|
| Days | Observations | Days | Observations |
| 1 | | 1 | |
| 2 | | 2 | |
| 3 | | 3 | |
| 4 | | 4 | |
| 5 | | 5 | |
| 6 | | 6 | |
| 7 | | 7 | |



# ACTIVITY 11

# OILY FEATHERS

## OBJECTIVES

Students will be able to 1) identify ways by which oil spills can affect birds adversely; and 2) describe possible negative consequences to wildlife, people and the environment from human-caused pollutants.

## BACKGROUND

The impacts of environmental pollution are often difficult to see. Oil spills can happen through the motorboats used for transportation or by washing vehicles near the river. It causes damage to feathers, killing of embryos when oil seeps into eggs, suffocation of fish when gills are clogged and death in some cases.

The fur of animals and the feathers of birds have air spaces between them that act as an insulator to keep them warm. The oil causes the feathers or fur to stick together preventing it from acting as an insulator. This causes their body temperature to drop too much, potentially causing death.

## KEYWORDS

Pollution, oil spill, food-chain.

## MATERIALS

Cooking oil, shallow container, eye dropper, magnifying glass, feather (natural), liquid detergent (dishwashing liquid), hard-boiled eggs

## METHOD

Students conduct experiments using water, oil, hard-boiled eggs, detergent and feathers.

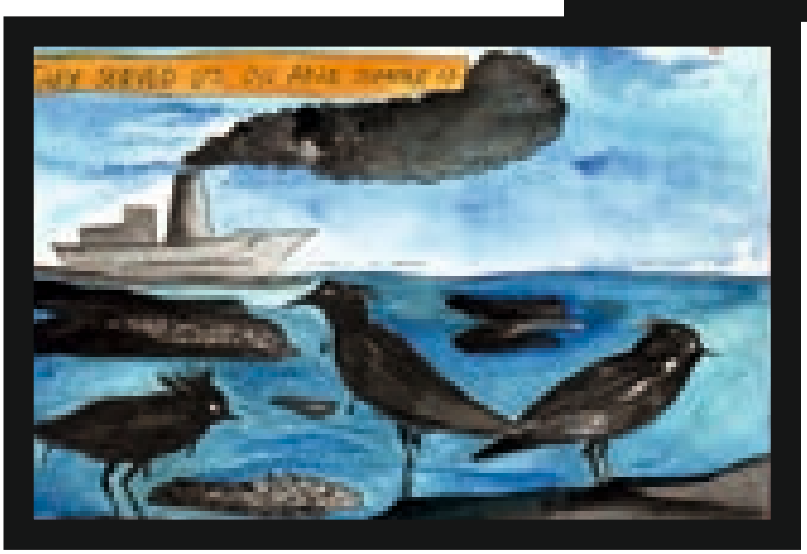
## PROCEDURE

- Divide the class into groups of 3 or 4. Each group should have one container partially filled with water. Add a known amount of oil, one drop to one dropper full. Observe the interaction between water and oil. Using this information estimate the area that might be affected by oil spill and imagine this situation in the case of rivers where motor boats are used.
- Put enough oil in a small container to submerge 3 hard-boiled eggs. Place the container under good light and watch closely. Remove one egg after 5 minutes and observe the following stages. Try to remove excess oil before peeling off the shell.
    1. Before peeling off the shell,
    2. During peeling off the shell, and
    3. After peeling off the shell

- Remove the second egg after 15 minutes and third one after 30 minutes, repeating the procedure and examining each. Discuss observations and also what effects could oil have given to the birds eggs near river bank.
- Examine a feather with a hand lens/magnifying glass and draw what you see. Keep the feather in water for 1 or 2 minutes and examine again with the lens and draw what you see. Dip the feather in oil for 1 or 2 minutes and then watch it through the hand lens and draw the sketch of it. Compare all the sketches. Clean the feather with detergent, rinse with water and dry it. Examine it with lens, draw it and compare all the sketches. Discuss the changes in feather and discuss what kind of changes it can cause in birds' lives.

## EVALUATION

- Observe whether pollution by oil spill is happening in rivers and other water bodies near your area and their source.
- How oil spill can affect the success of birds nesting near water?
- Describe some possible effects of oil on a feather.
- Describe some possible negative effects of three other human-caused pollutants on people, wildlife and environment.



# ACTIVITY 12

# LITTER IS UNSIGHTLY

## OBJECTIVES

Students will be able to: 1) identify and evaluate ways that litter pollution can endanger wildlife; 2) propose ways they can help eliminate these dangers; and 3) Learn how to recycle and reuse the garbage.

## BACKGROUND

Environmental pollution affects all forms of life. It exposes wildlife and other animals to illness, injury and death. Fish line may get tangled on legs and beaks of water birds like geese and herons. Some of these birds need to run short distances to take off when they fly. The fish line prevents birds from flying or swimming as it gets entangled in the feet of the bird. Birds with long bills often get line wrapped around their bills and cannot eat. They starve to death.

Tin cans are a problem. Animals, like deer, can cut their tongues on the cans. Sometimes smaller animals get their heads stuck inside such cans and they can't eat which results in starvation. Cigarette butts, cellophane wrappers, styrofoam cups, eaten by animals cause internal problems and ultimately lead to their death

The major purpose of this activity is to alert students to the dangers of the litter pollution, and consider responsible actions that they can take to minimize consequences of the litter pollution.

## KEYWORDS

Garbage, segregate, recycle

## MATERIALS

Large sheets of thick paper or chart paper for mounting collages, glue, different types of litter.

## METHOD

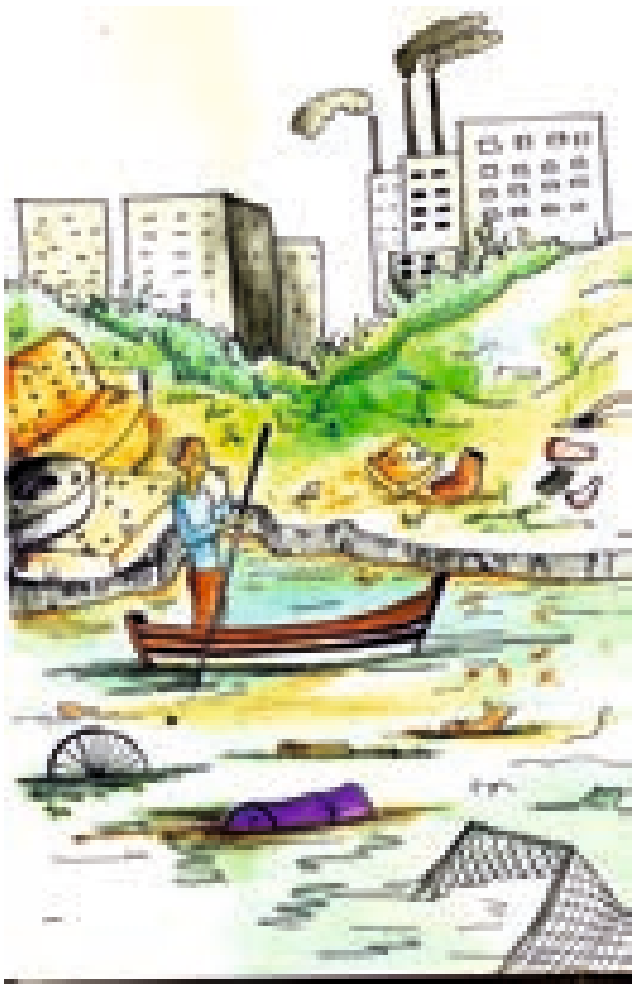
Students collect and evaluate litter, making collages.

## PROCEDURE

- Divide the class into three or four teams.
- Ask each team to bring a collection of litter to class in a paper bag. Suggest they look near ghats of river and on river banks.

**Note:** They should not take things out of garbage bins.

- Have the teams make and display collages of these items. Ask the students to assign a numerical value to each kind of litter. The item potentially most harmful to the wildlife has the highest score; least harmful has the lowest score.
- Have each item figure a total score for their collage based on the numerical values of each piece of litter.
- Propose and evaluate ways that people can eliminate litter pollution. Discuss how they can recycle the waste into useful items.
- Make cloth bags from old school uniform or pants. Decorate the bag with accessories or block-print them.
- Use plastic bottles for planting flower plants or vegetables in school compound or create a vertical garden wall.
- Use plastic bottles as pencil or pen holders. Paint them.



Water pollution from urban areas

## EVALUATION

- Name four ways that litter can harm wildlife.
- List three things you can do to eliminate these dangers.
- Propose what you consider one of the most effective ways to eliminate or reduce litter.

# 2 GANGES BIODIVERSITY

The Ganga is one of the mightiest river of India and is considered as heaven for rich biodiversity of fisheries and economically rewarding aquatic species.

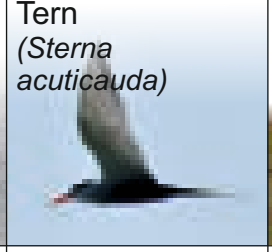
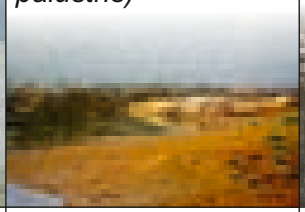
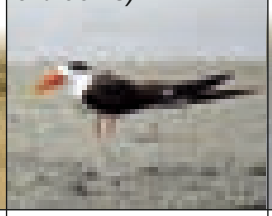
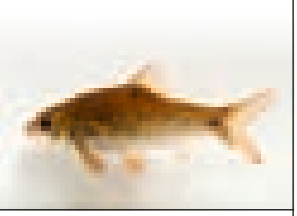
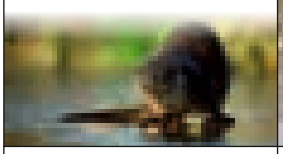
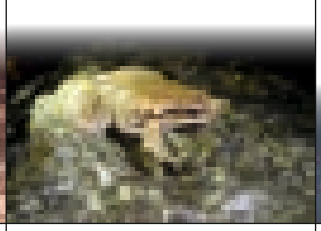
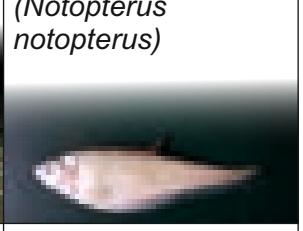
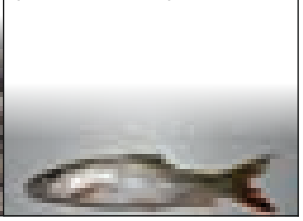
The faunal diversity of Ganga River is represented by the water and water associated birds, amphibians, turtles, gharial and mugger and other aquatic mammals like Gangetic River Dolphin and 3 species of Otters. Some fish species e.g. Hilsa (*Tenualosa ilsa*), Mahaseer (*Tor putitora*), Tiger prawns (*Macrobrachium rosenbergii*) and Indian trout (*Raiamas bola*) are commonly available in river Ganga are at the edge of extinction.

Mammals in Ganga river include Gangetic River Dolphin (*Platanista gangetica*), Indian Smooth-coated Otter (*Lutrogale perspicillata*), Oriental small-clawed otter (*Aonyx cinereus*), and Eurasian Otter (*Lutra lutra*).

The Gangetic river basin supports 177 species of birds including wetland, riverine and terrestrial species. Some globally threatened birds also breed along the Ganga. These species are indicators of healthy river ecosystems.

The Gangetic river dolphin acts as an indicator of river health in the basins where they live. If the dolphin population in a given body of fresh water is thriving, then the overall state of that fresh water system is also flourishing. But if the population is on the decline, then it is considered a red flag for the ecosystem as a whole.

## RESIDENTS OF GANGA

| Mammals | Birds | Reptiles | Amphibians | Fishes |
|---|---|---|---|---|
| Ganges River Dolphin *(Platanista gangetica)*  | Black-bellied Tern *(Sterna acuticauda)*  | Estuarine crocodile *(Crocodylus porosus)*  | Cascade frog *(Amolops formosus)*  | Freshwater shark *(Wallago attu)*  |
| Smooth-coated otter (*Lutrogale perspicillata*)  | Sarus Crane *(Grus antigone)*  | Marsh crocodile *(Crocodylus palustris)*  | Indian Bullfrog *(Hoplobatrachus tigerinus)*  | Golden Mahaseer (*Tor putitora*)  |
| Small-clawed Otter (*Aonyx cinereus*)  | Indian Skimmer *(Rynchops albicollis)*  | Gharial *(Gavialis gangeticus)*  | Marbled Toad *(Duttaphrynus stomaticus)*  | Spotted barb *(Barbodes binotatus)*  |
| Eurasian Otter (*Lutra lutra*)  | River Tern *(Sterna aurantia)*  | Red-crowned roofed turtle *(Batagur kachuga)*  | Himalaya paa frog *(Nanorana vicina)*  | Bronze featherback *(Notopterus notopterus)*  |
| | River Lapwing *(Vanellus duvaucelii)*  | River terrapin *(Batagur baska)*  | Jerdon's Bullfrog *(Hoplobatrachus crassus)*  | Minor carp *(Labeo bata)*  |

| | | | | |
|---|---|---|---|---|
| | | Narrow-headed turtle *(Chitra indica)*  | | |
| | | Three-striped roofed turtle *(Batagur dhongoka)*  | | |
| | | Ganges soft-shell turtle *(Nilssonia gangetica)*  | | |
| | | Peacock soft-shell turtle *(Nilssonia hurum)*  | | |
| | | Black Spotted Turtle *(Geoclemys hamiltonii)*  | | |
| | | Indian Tent turtle *(Pangshura tentoria)*  | | |

## THREATS TO THE SPECIES

- **Habitat degradation**

  - Exploitation and degradation of rivers and lakes through fishing, transportation, domestic use, irrigation schemes and pollution from agricultural and industrial chemicals are largely responsible for the decline of these species as these factors have reduced reproductive and foraging success.
  - The nesting areas of the birds are vulnerable to flooding and predation. Excessive human disturbance on sand-beds also cause a decline in birds' population.
  - Construction of dams potentially poses threat to the species via changes in the flow regime and flooding of nest-sites.
  - Fragmented populations created by dams and barrages have degraded downstream habitat and created impoundments with high sedimentation and altered assemblages of fish and invertebrate species.

### Poaching

- The poaching of adult birds and collection of eggs and chicks for trade, food, medicinal purposes and, in certain areas, to help prevent damage to crops is a serious concern.
- Conflict with humans and recent increase in aquaculture activities leading to indiscriminate killing of otters.
- The main threats to turtles are exploitation for meat and other parts along with the modifications of its riverine habitat. They are exported to other countries and are used for making traditional medicines and soups.

### Accidental deaths due to human intervention

- Collision with power lines poses a significant threat to Sarus Crane population in its range. Deaths of other species are caused through entanglement in fishing gear.

### Pollution

- Polluted wetlands and waterways by eutrophication and accumulation of pesticides such as chlorinated hydrocarbons and organophosphates through agricultural runoffs is a concern for the biodiversity of Ganga.

## INDICATOR SPECIES

An indicator species is an organism whose presence, absence or abundance reflects the condition of an ecosystem. Their presence or absence is an 'early warning system of an unhealthy environment. For example, plants sensitive to acids in precipitation may be indicators of pollution in the air.

- Presence of otters indicate clean and healthy river systems. They live in a habitat that indicates the presence of clean freshwater. They live in dens on the river banks. They are very susceptible to water pollution.
- Gangetic River Dolphin once was found in the entire stretch of Ganga but now it is only found in some parts of the river where river water is comparatively clean. Dolphins have left the areas of Ganga where there is pollution. Dolphins and otters both are reliable indicator species to understand the health of a river.
- Adult frogs and toads live on land and in water and are good indicator species since the skin of the adults is moist and permeable, allowing numerous pollutants enter into their bodies. Tadpoles live in water and indicate the water quality.
- Turtles in addition to being a source of nourishment, medicine and religious worship, they are also cleaners, protectors, distributors, construction workers and vital indicators of environmental concerns. Like vultures, turtles are the garbage men of the animal world. As scavengers, they help clean up dead animals, an important job in the food web that helps the cycle of life continue and reduce the threat of disease.

  With certain diets, turtles also safeguard humans and the environment from pests. Additionally, turtles that feed on floating food ingest mosquito larvae. A decline in turtle numbers would mean an increase in mosquitoes. Freshwater turtles can carry mini gardens on their backs, dispersing seeds as they travel in water or on land.

  Turtles help us learn about our surroundings, too, as indicator species. Research has shown that when the health or behavior of a turtle population changes, it can be linked to environmental issues. For example, turtle illness have been traced back to fertilizer run-off contaminating streams and lakes. When we see an increase in the number of sick turtles, we might want to check out the water quality of their habitat. If their aquatic home has high levels of pesticides, then the soil where crops are grown for human consumption might also be reaching toxic levels. If we pay attention to a turtle's health, it will teach us a few things about our own health.
- Fishes are indicators of riverine ecosystems. These species are at risk due to pollution, river channelization, dams and urban sprawl. The health of the fish helps evaluate ecosystem water quality.
- Freshwater mussels filter feed on algae, bacteria, and organic particles suspended in the water. They feed by taking water in through a siphon and passing it over mucous-covered gills where the food items stick and then are transferred to the mouth. The mussel will flush waste particles out through their exit siphon. They not only act as an indicator of high quality water but their filtering action improves water quality, cleansing lakes, rivers and streams.

# ACTIVITY 1 RIPARIAN RETREAT

## OBJECTIVES

Students will able to: 1) describe habitat characteristics of riparian areas; 2) identify animals that inhibit them; and 3) state the importance of riparian areas to wildlife and humans.

## BACKGROUND

Riparian areas are the green ribbons of life found on the edges of water courses (stream, lakes, ponds, etc.). Conditions there support plant communities that grow best when their root systems are near the level of high ground water. These zones range in width from narrow ribbons in desert and mountain settings to wide bands on the plains and lowlands. Riparian areas provide space, shelter, and food for the plant and animal communities with which they are associated. For examples, leaf litter and terrestrial insect falling from vegetation into a stream are a source of detritus, providing nourishment for some aquatic life. Vegetation may also provide shade from the sun for aquatic plants and animals and land-dwelling creatures at the water's edge. Riparian areas are also transportation corridors or highways for animals that depend on water bodies for food and shelter. The riparian plant community, especially shrubs and trees, provides shelter and food for animals as large as deer. Trees and marshy areas provide shelter for nesting birds and banks provides homes for burrowing animals.

The riparian zone may serve as a buffer between the uplands and the water. For example, rainfall dropping on uplands and following downhill can be cleansed as it flows through a riparian zone. The banks of riparian areas store water during periods of high flow such as rainstorms or snow melt and release this water to the stream during low flow times. Riparian vegetation strengthens the streak banks. This tends to prevent erosion and maintains the stream channel, keeping the water clear.

The major purpose of this activity is for students to increase their appreciation of the importance of riparian areas.

## KEYWORDS

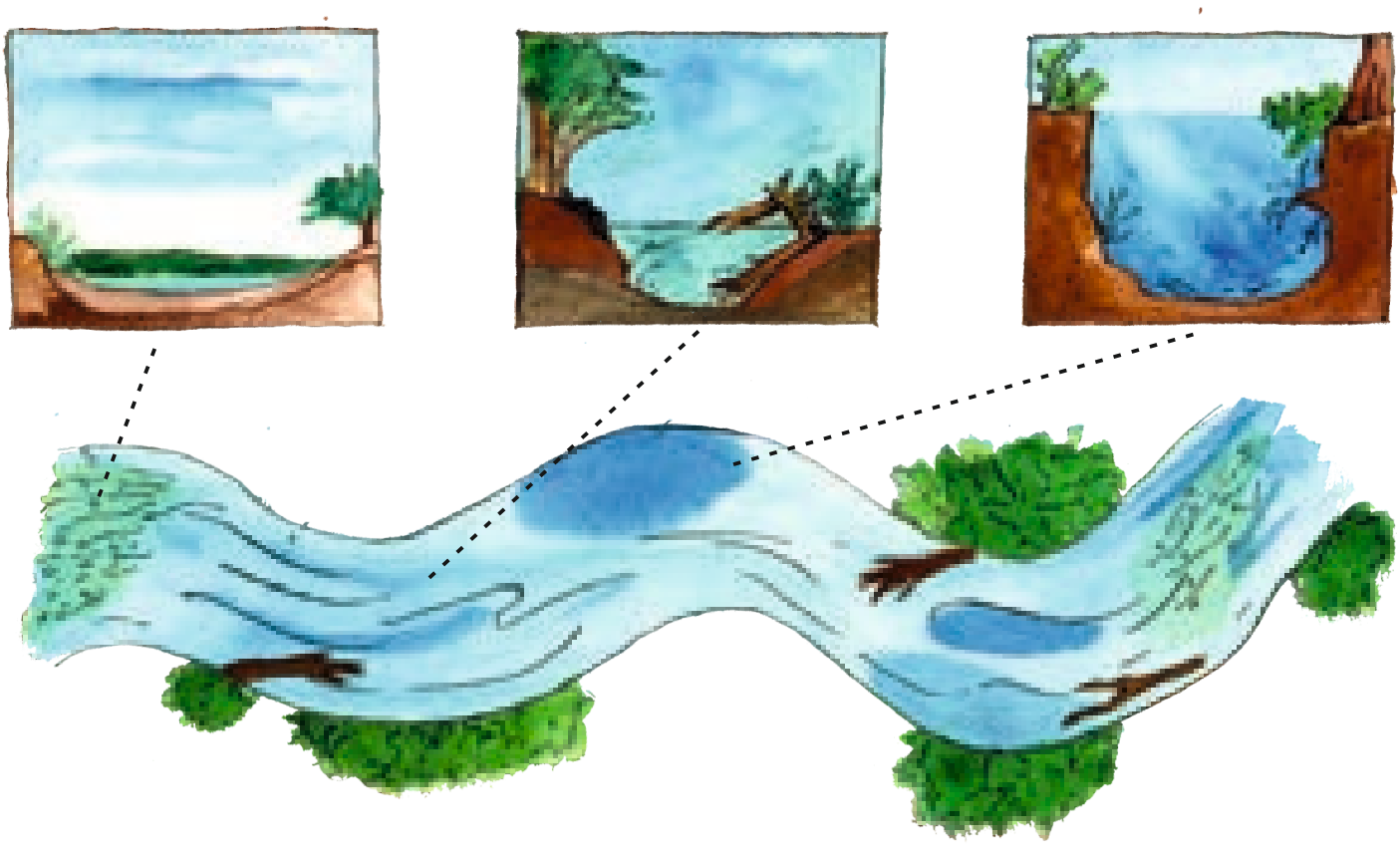
Riparian, ecology, habitat, value

## MATERIALS

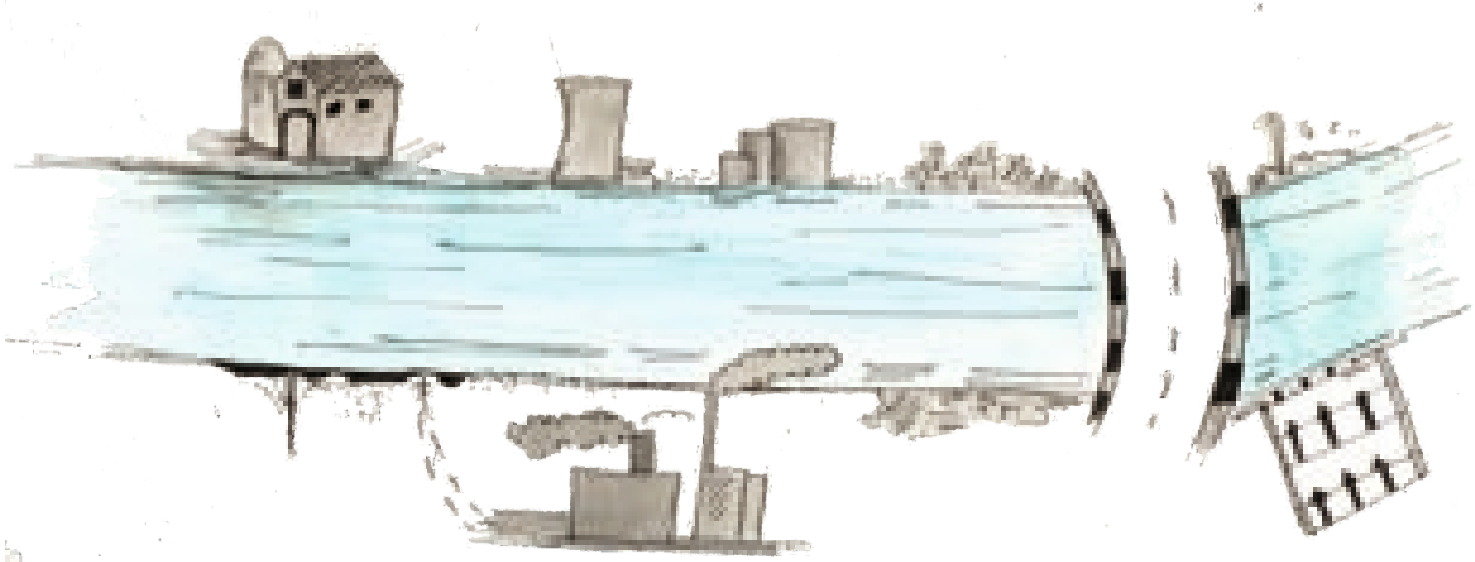
Art materials: water colors, acrylics, poster paints, crayons

## METHOD

Awareness of a riparian zone is created through the use of guided imagery and art work.



# HEALTHY vs UNHEALTHY RIPARIAN HABITAT



## PROCEDURE

- Find out if anyone has ever been to a stream or river bank. What was it like? Were plants growing there? What did the area look like? Was it hot or cool? Simply encourage the students to talk and share descriptions of any area by a stream or riverbank they may have visited or at least have seen pictures of.
- Next tell the students that the kind of area they have been describing has a special name. In some parts of the country, it is called a “riparian area.” “Riparian areas are important natural areas for people and wildlife. In order to learn more about kinds of areas , the students will need to close their eyes and imagine the things you will be describing. Invite the students to get in a comfortable position. Close their eyes, and do their best to imagine what they hear.

## EXTENSIONS

- Visit a riparian habitat. Look for things that you encountered in your imagery. List things that were not in your imagery.
- Generate a list of things that can be done to make it possible for people to visit a riparian area without damaging and destroying it.
- Put your descriptions in writing- if you have not already! Combine words and visual images to convey some of the diversity in riparian areas.
- Is a different word used in your region to describe these kinds of areas? If not riparian areas, what are they called?

## EVALUATION

- What is a riparian area?
- Name four animals that you would expect to find in a riparian area?
- Why are riparian areas important to wildlife and humans?

Riparian habitat

# ACTIVITY 2

# WHAT IS RIVERINE ECOSYSTEM?

## OBJECTIVE

Students will be able to understand the concept of riverine ecosystem

## BACKGROUND

Riverine ecosystem is any spring, stream, or river viewed as an ecosystem. Because rivers always link to the sea, they are more likely to contain fish alongside the usual plants, amphibians and insects. It also includes birds, because birds often hunt in and around water for small fish or insects. Large systems have more types of plants and animals, and there is less in smaller systems, but all systems share the same basic structure.

There are tiny plants and algae in the water that bacteria and other very small organisms feed upon. These small creatures are then food for invertebrates (animals without a backbone like worms) and insect larvae. Insects and larger invertebrates feed on the smaller organisms. Amphibians and small fish feed on the insects and invertebrates. Larger fish, birds, and small mammals feed on the fish and amphibians. Every animal in the system traces back to fresh water. If one of these steps in the food web suffers, the whole system suffers.

There are many threats to the freshwater ecosystems. Some of the major threats are: dams, pollution, diversion, and non-native species.

- Dams can harm the ecosystem by limiting water flow downstream and preventing fish and other organisms from moving up and down the river.
- Pollutants can be caused by runoff from polluted fields that surround the water, or from roads/paths that drain into the water.
- Diversion occurs when part of a water source is used for something else.
- Non-native species often take over habitat of the native species, sometimes pushing them out altogether.

## KEYWORDS

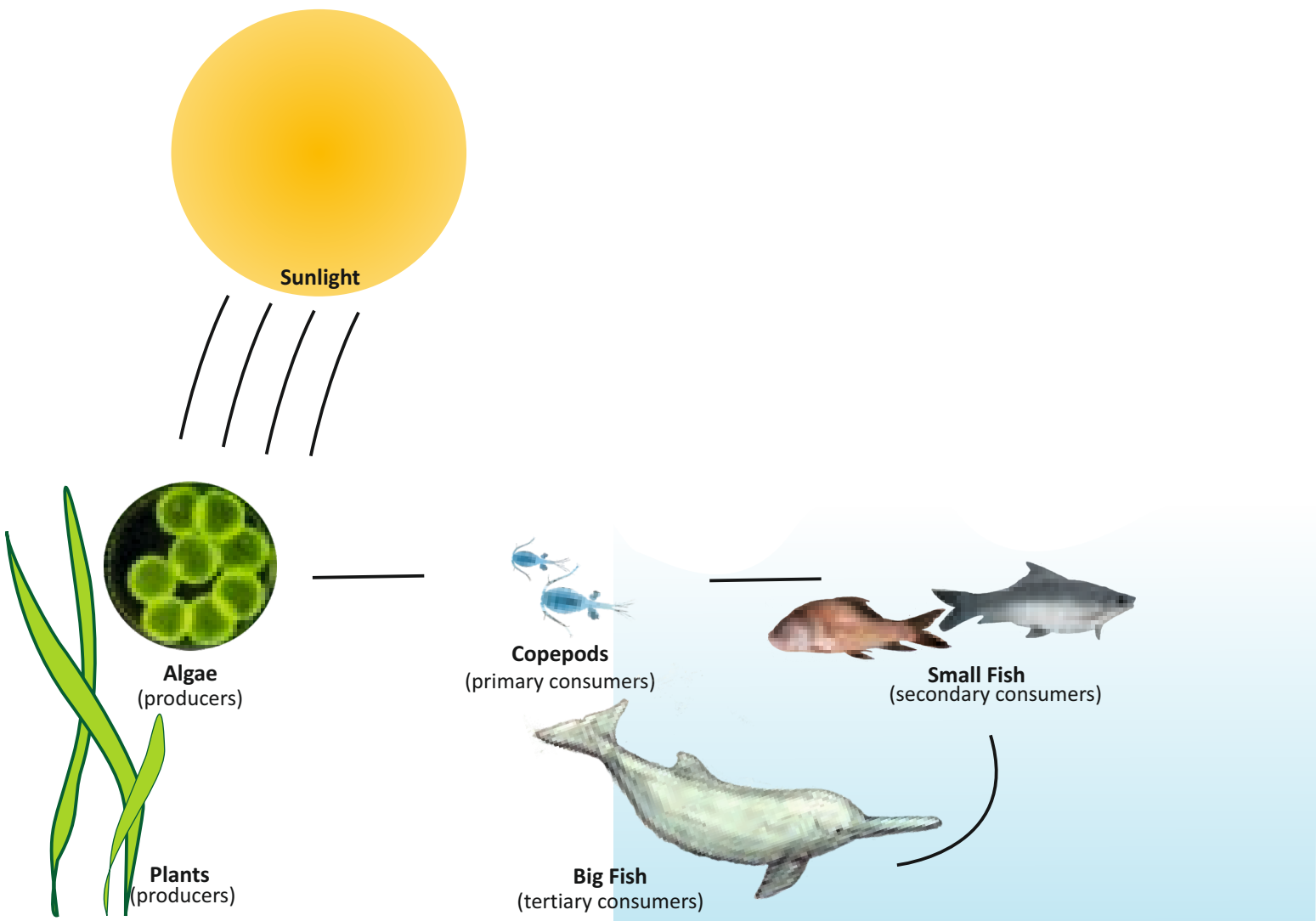
River, sea, fish, planktons, insects

## PROCEDURE

Explain them diagrammatically or with the help of charts or by showing pictures depicting riverine ecosystem.

## EVALUATION

- List down different riverine ecosystems found in your area.
- List down what benefits you get from them.




Riverine Ecosystem

# ACTIVITY 3

# GANGA AS A RIVERINE ECOSYSTEM

## OBJECTIVE

Students will be able to understand the concept of ecosystem, types of ecosystem.

## BACKGROUND

An ecosystem includes all of the living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environments (weather, earth, sun, soil, climate, and atmosphere).

- Ecosystems determine the health of the entire earth system.
- Ecosystems come in many shapes and sizes
- Anytime a 'stranger' (living thing or external factor such as rise in temperature) is introduced to an ecosystem, it can be disastrous to that ecosystem. This is because the new organism (or factor) can distort the natural balance of the interaction and potentially harm or destroy the ecosystem.
- In an ecosystem, each organism has its own role to play.

Consider a small puddle at the back of your home, in which you may find all sorts of living things, from microorganisms to insects and plants. These may depend on non-living things like water, sunlight, turbulence in the puddle, temperature, atmospheric pressure and even nutrients in the water for life. Now there are two types of natural ecosystem:

- Aquatic ecosystem (if the ecosystem exists in water body like ocean, fresh water, puddle, etc.)
- Terrestrial ecosystem (if the ecosystem exist outside the water bodies)

## KEYWORDS

Plants, animals, river, land, energy, food

## METHOD

Students learn from pictures

## PROCEDURE

Explain them diagrammatically or with the help of charts or by showing pictures depicting ecosystem and its types.

## EVALUATION

1. Identify different ecosystems near your area.
2. Also identify the components of the ecosystems around you.
3. Try to draw them in a drawing sheet.

## TYPES OF ECOSYSTEMS

**Natural**

**Terrestial**

Forests

Grasslands

Deserts

**Aquatic**

Ponds

Lakes

Rivers

Wetlands

Marine

**Artificial**

Cropland

Wetland

# ACTIVITY 4

# INHABITANTS OF RIVERINE ECOSYSTEM

## OBJECTIVE

Students will be able to tell how the food web of Ganga works?

## BACKGROUND

An ecosystem can be categorized into its abiotic constituents, including minerals, climate, soil, water, sunlight and all other nonliving elements, and its biotic constituents, consisting of all its living organisms. Linking these constituents together are two major forces: the flow of energy through the ecosystem, and the cycling of nutrients within the ecosystem.

Six major ecosystems of the world are as follows: 1. Fresh Water Ecosystem 2. Marine (Ocean) Ecosystem 3. Grassland Ecosystem 4. Forest Ecosystem 5. Desert Ecosystem 6. Cropland Ecosystem.

The fundamental source of energy in almost all ecosystems is energy from the sun. The energy of sunlight is used by the ecosystem's autotrophic, or self-sustaining, organisms. Consisting largely of green vegetation, these organisms are capable of photosynthesis—i.e., they can use the energy of sunlight to convert carbon dioxide and water into simple, energy-rich carbohydrates. The autotrophs use the energy stored within the simple carbohydrates to produce the more complex organic compounds, such as proteins, lipids and starches, that maintain the organisms' life processes. The autotrophic segment of the ecosystem is commonly referred to as the producer level.

Organic matter generated by autotrophs directly or indirectly sustains heterotrophic organisms. Heterotrophs are the consumers of the ecosystem; they cannot make their own food. They use, rearrange, and ultimately decompose the complex organic materials built up by the autotrophs. All animals and fungi are heterotrophs, as are most bacteria and many other microorganisms.

Together, the autotrophs and heterotrophs form various trophic (feeding) levels in the ecosystem: the **producer** level, composed of those organisms that make their own food; the **primary consumer** level, composed of those organisms that feed on producers; the **secondary consumer** level, composed of those organisms that feed on primary consumers; and so on. The movement of organic matter and energy from the producer level through various consumer levels makes up a food chain. For example, a typical food chain in a grassland might be grass (producer) ? mouse (primary consumer) ? snake (secondary consumer) ? eagle (tertiary consumer). When the food chains of the ecosystem overlap and interconnect it forms a food web.

The final link in all food chains is made up of decomposers, those heterotrophs that break down dead organisms and organic wastes. A food chain in which the primary consumer feeds on living plants is called a grazing pathway; that in which the primary consumer

feeds on dead plant matter is known as a detritus pathway. Both pathways are important in accounting for the energy budget of the ecosystem.

**Fresh water habitats can be divided into two categories:**

(i) Standing water or lentic (calm)—lake, pond, swamp or bog.

(ii) Running water or lotic (washed)—river, spring, stream.

## KEYWORDS

Producers, consumers, energy, flow, web

## MATERIAL

Pieces of rope painted with red at one end of it.

## METHOD

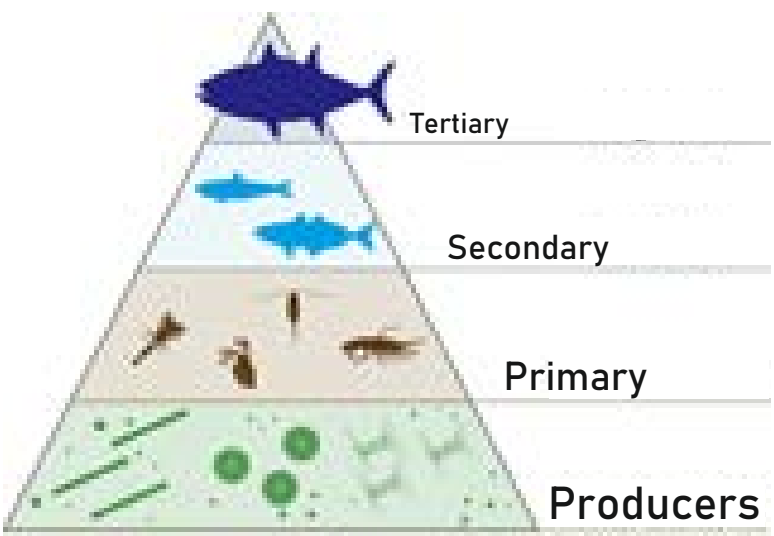
Students play a game.

## PROCEDURE

- Show the given picture/diagram to the students and explain the students that who eat whom and how they are webbed.
- Later, ask each of them to represent one of the animals of Ganga and make a web with the help of pieces of ropes. The end of rope with color can be used to show the flow in the web.

## EVALUATION

- What is the importance of producers in food web?
- What can happen when one or more animals of food chain disappear?



# ACTIVITY 5.1

# COMPANIONS OF GANGA – WEB OF LIFE

## OBJECTIVE

Students will be able to tell how food web works and how important the animals are in food web?

## METHOD

Explain to students that we will each be playing the role of an animal or plant in order to better understand how these things fit into the environment.

## KEYWORDS

Food, energy, autotroph, heterotroph

## MATERIAL

Long string, animal cards

## METHOD

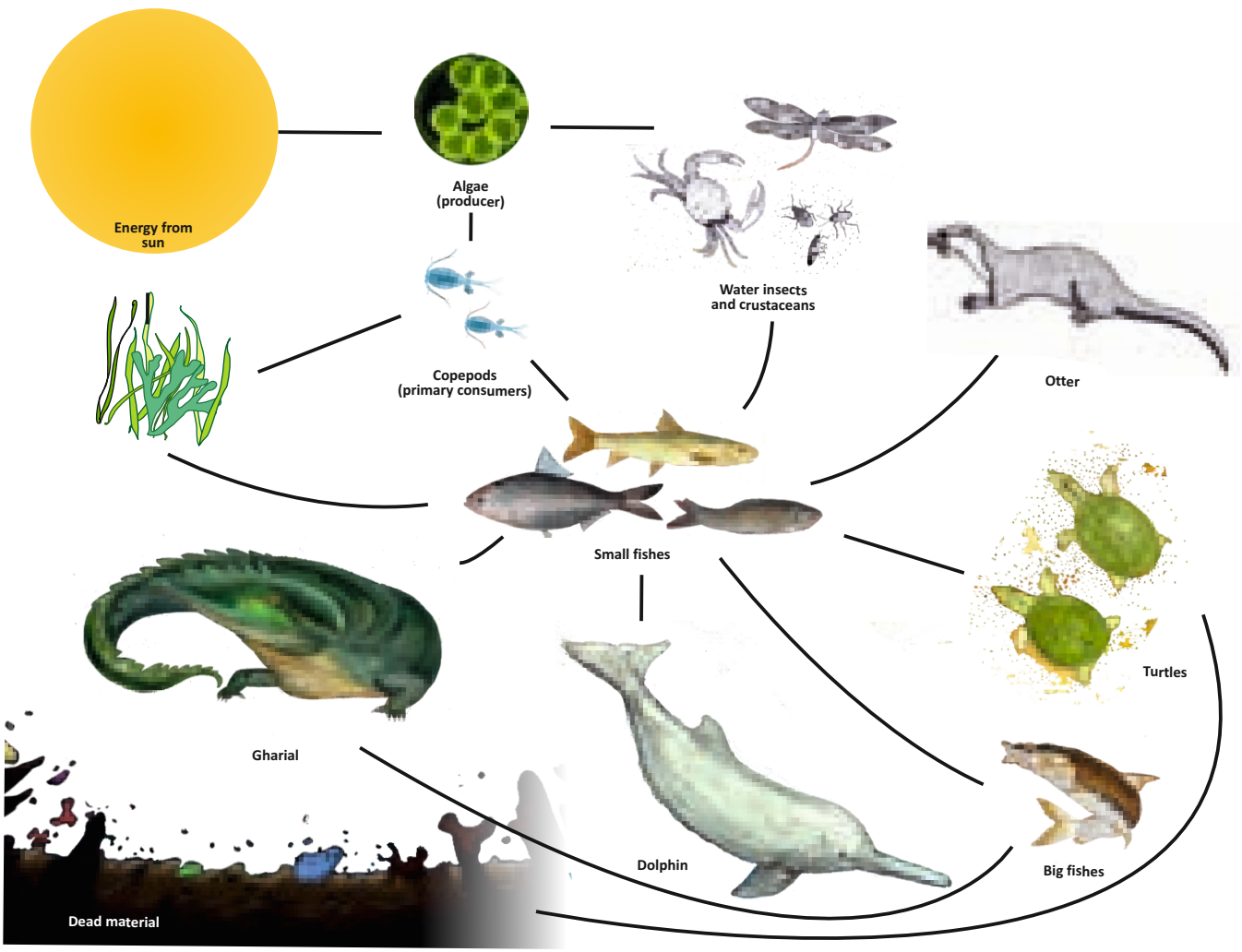
- Gather the students in a circle and give each one an aquatic creature card. Tell the students that they will now assume the role of the group why he/ she is important to the aquatic habitat.
- Ask for a volunteer to go first , and give him/her one  end of the string. Pass the string to one of them and listen to the explanation of relatedness.
- Continue to pass the string in this manner. When everyone has spoken, and each person is holding part of the string, it will form a crisscrossed web.
- Ask everyone to pull the string tight. Ask one student to tug on his / her part of the string and ask anyone who feels a tug to also give a tug. Everyone should eventually feel the tugging.
- Tell the student that this is an example of a food web and it shows how things living in a specific environment are connected to and are dependent upon another.
- Ask students if there is any creature they would like to eliminate from the web.
- Give the creature being eliminated the chance to defend him/ herself. Some organisms have become extinct or will become extinct before we have the time or opportunity to study them and learn about their importance.
- Take a vote among the other student on the matter. A majority is needed for elimination.
- If a creature is voted out, have him / her drop their part of the string . They are extinct.
- What happens now when someone tugs? What happens if two creatures become extinct?

- Tell the students that the web, if you remove any one thing from the system, it can have drastic effects.

## EVALUATION

- Ask students if they know what an ecosystem is.
- Ask students, “What does it mean when something is extinct?” (The last of a species is dead and there is no way for the species to make a comeback.)
- Ask students, “How can the extinction of one thing affect other things?” (Others may have fed on that creature, it may have kept other populations in check, or it may have created or supplied necessary habitat, etc.)

## FOOD WEB OF GANGA



# ACTIVITY 5.2

# COMPANIONS OF GANGA – KNOW YOUR FRIENDS

## OBJECTIVE

Students will be able to identify different animals found in Ganga.

## METHOD

Students discuss about animals found in Ganga

## KEYWORDS

Dolphin, Sarus, Otter, Skimmer, Gharial

## MATERIAL

Clue cards (provided along with this manual) / photograph of different animals of Ganga

## METHOD

- Show photographs of different species/ clue cards to the class and explain about threats to each species.
- Divide the class in group of 5 students. Distribute photographs to each group (a photograph of one animal per group) and ask them to discuss and write about that species on a piece of paper.
- Make one student from each group to read it out in front of others.

**Species name: Otter**

1. Smooth coated otter
2. Eurasian Otter
3. Small-clawed otter

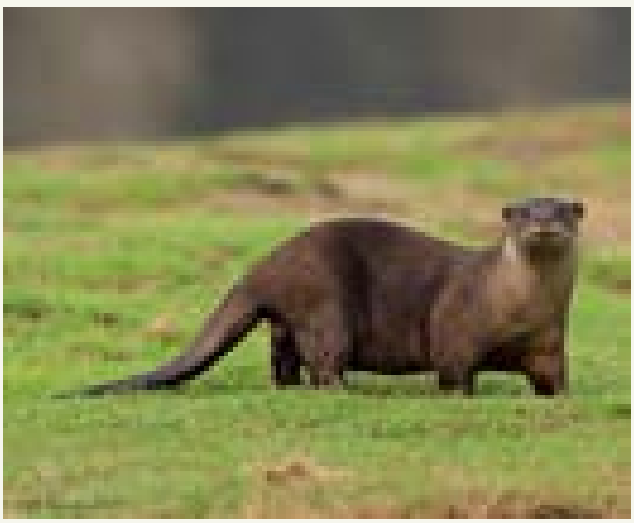
It is a mammal.

They are friends to fishermen as some fishermen train them to chase fish into nets.

## Threats

Habitat loss, pollution because of agricultural and industrial waste waters and poaching for meat

How will you help? (Teachers will seek answers from students)



**Species name: Gangetic Dolphin**

It is a mammal and is known as 'susu' because of the sound it produces while breathing.

An important animal as it balances the food chain by eating variety of fishes.
It is our national aquatic animal.

## Threat

Habitat Loss and degradation, water pollution by sewage and agricultural as well as industrial waste, poaching for meat

**Species name: Sarus Crane**

It is the tallest flying bird.
Feathers are steel grey in color and legs are pink.
Beak is large and greenish grey in color.
It is the state bird of UP.

They are omnivorous. They eat grasshoppers and other insects, tubers and corns of aquatic plants, seeds and grains from cultivated areas and small vertebrates like water snakes, fish and baby turtles.

## Threats

Poaching for meat, pesticides in crops cause serious effects on them and deaths by power line.

**Species Name: Gharial**

Traditionally, the gharial is known as the Vahana of river Ganga.

Some revere it as the vahana of Varuna- the God of water.

It is also known as our 'River Guardian'.

They are shy and do not kill or eat humans. They mainly feed on fishes and thus balance the ecosystem.

They lie in the sun to bask as they are cold-blooded.

## Threats

Humans: Gharials are poached for their skin, meat and gharas.
Habitat Destruction: Their habitat is being modified into agricultural and industrial areas

**Species Name: Indian Skimmer**

These birds are black and white with bright orange yellow bill.

Ganga river banks are very important for their survival as they provide suitable sites for nesting and roosting.

They eat small fishes and insects.

## Threats

Pesticides used in farms are harmful for their lives.

**CONSERVATION STATUS**

**IUCN**
Vulnerable
**CITES**
Appendix II

# Smooth-coated Otter

*Lutrogale perspicillata*

There are 13 species of otters found around the world except Australia, Antarctica and oceanic islands, out of which 3 species are found in the Indian subcontinent namely Eurasian, smooth-coated and Oriental small-clawed otter. Otter body is elongated and built for vigorous swimming. The limbs are short and the paws are webbed. The tail is fully haired, thick at the base and horizontally flattened. There are numerous stiff whiskers around the nose and like the nostrils, are closed under water.

## HABITAT

It is an aquatic and terrestrial mammal. Along the large rivers in India, it shows greater preference for rocky stretches in all the seasons as they provide sites for den and resting.

## BREEDING

Mating takes place during the months of August-November followed by gestation period of 60-62 days. Reaches sexual maturity at the age of 22 months and give first litter at the age of 4 years.

## DIET

Otters mainly eat fish, but also catch frogs, crayfish and crabs. Otters have an unusually high metabolic rate, probably to meet the special demand of their habitat. They hunt in groups.

## DISTRIBUTION AND POPULATION

Discontinuous: Iraq (Tigris river), lower Indus, India, Southeast Asia, Burma, SW China, May Peninsula, Sumatra, Borneo

## FACTS

- Female holds the dominance in the group.
- Fishermen in Pakistan and Bangladesh train smooth-coated otters to chase fish into the nets.
- They swim upstream in a 'V'.

## Threats

Habitat loss and degradation.

Pollution because of agricultural run offs, industrial and sewage wastes.

Poaching for meat and fur.

Construction of large hydroelectric projects.

**CONSERVATION STATUS**

**IUCN**
Endangered
**CITES**
Appendix I
**WPA**
Schedule I

# Gangetic Dolphin

*Platanista gangetica*

There are four fresh water dolphin species found in the world among which Gangetic River Dolphin is found in the Ganga. Grayish brown in color with long thin snout, rounded belly and large flippers while the calves are darker when born. Also known as 'susu' because of the sound it produces while breathing.

## HABITAT

Favors deep pools. Shares habitat with crocodiles, fresh water turtles and wetland birds.

## DIET

Variety of fishes like corps, gobis and invertebrates like prawns, clans, catfish.

## BREEDING

- Mating takes place during the months of August-November followed by gestation period of 60-62 days.
- Reaches sexual maturity at the age of 22 months and give first litter at the age of 4 years.

## DISTRIBUTION AND POPULATION

Ganga-Brahmaputra and Karnaphuli-Sangu river systems in India and Nepal as well as in the Meghna river in Bangladesh (Estimated around 1200-1800 individuals). Sub population in the Karnali river in Nepal having tens of animals only.

## FACTS

It is our National aquatic animal. The atrophied eyes of the Ganges dolphins lack a lens, leaving these species unable to resolve images. The sonar abilities of the dolphin is highly developed, enabling them to detect prey. The Ganges dolphin is known to be a side swimmer i.e. after surfacing to breathe, it immediately rolls on one side, feeling for the bottom with a flipper while scanning the area ahead with constant clicking sound.

## Threats

Habitat loss and degradation. Pollution because of agricultural run offs, industrial and sewage wastes. Fish nets. Poaching for meat and oil. **Dams also impede their natural movements.**

**CONSERVATION STATUS**

**IUCN**
Critically endangered
**CITES**
Appendix I
**WPA**
Schedule I

# Gharial

*Gavial gangeticus*

Gharials are one of the largest species of crocodiles, having a long snout with a pot "ghara" from where they derive the name gharial. They spend most of their time in the water, it leaves the water only to bask and lay eggs on sandy riverbanks.

## DIET

- Gharials have 102 to 110 sharp and slender teeth. They swallow the food instead of chewing.
- Prefer to eat slower moving fish which are generally predatory fish.

**Adults:** fish, small crustaceans (mud crabs)
**Juveniles:** insects, tadpoles, small fish, frog

## IMPORTANCE

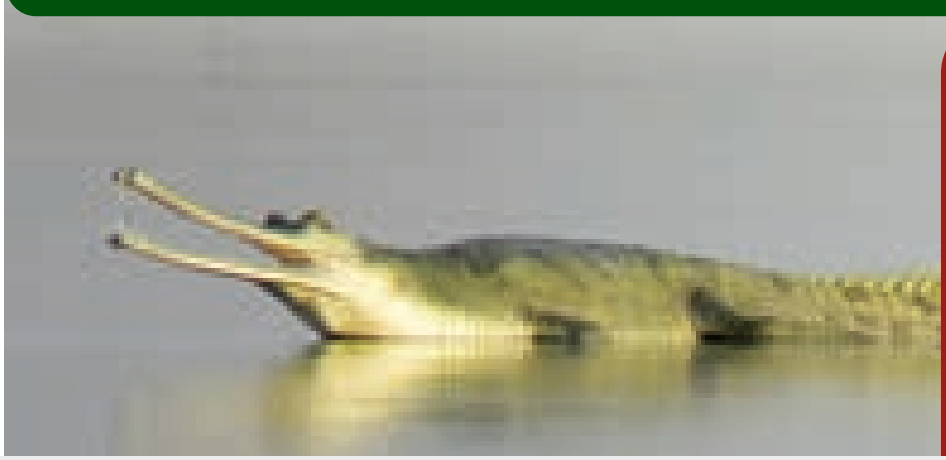
Gharials prefer to eat slower moving, larger predatory fish such as catfish. This would mean they are helpful to fisheries, since they are eating the predators that normally eat commercially valuable fish.

## GHARIAL CONSERVATION

- Project crocodile began in 1975. The project included an intensive captive breeding and rearing program intended to restock habitats with low numbers of gharial.
- There are 9 Protected Areas for Gharials in India which are inked to both captive breeding and 'ranching' operations where eggs collected from wild are raised in captivity and then released back into the wild.

## FACTS

- At about age 12, a wart like appendage grows on the tip of his snout. The ghara presses down on the nostrils and when the male breathes forecefully, it produces a loud flatulent noise. This buzz serves two purpose - to attract females and warn off rivals.
- The pot acts as sound amplifier – carrying the buzzing sound for long distances across waters.
- Help females identify mature males.



## Threats

Humans: Gharials are poached for their skin, meat and gharas.

Habitat Destruction: Their habitat is being modified into agricultural and industrial areas.

**CONSERVATION STATUS**

**IUCN**
Vulnerable
**CITES**
**Appendix II**
**WPA**
Schedule IV

# Sarus Crane

*Grus antigone*

There are 15 different species of cranes around the world out of which, 6 are found in India. Sarus is the only resident crane, seen throughout the year in India and is the **State Bird of Uttar Pradesh.**

## HABITAT

They forage on marshes and wetlands with little depths as they get enough food as well as protection from ground predators.

## DIET

Omnivorous in nature and eat range of foods.

## DISTRIBUTION IN INDIA

Majorly distribution is in the food plains of Ganga including 55 districts of Uttar Pradesh. 90% of the sarus crane population is found outside the protected areas.

## HOW TO HELP

- Identify the 'Rural Protection Groups' to conserve the animal at local level.
- Do not encroach the natural wetlands.
- Do not let anyone steal eggs of the Sarus.
- Avoid doing 'Singhara' cultivation.

## FACTS

Sarus Crane is the tallest flying bird. These birds live in pairs and they have only one partner for life.

## Threats

Habitat destruction mainly due to 'Singhara' cultivation as it destroys natural wetlands which is the home of Sarus.

Poaching for meat

Pesticides on crops affects every stage of cranes' life

Deaths by power lines

# ACTIVITY 5.3

# COMPANIONS OF GANGA – I AM ONE OF THEM!

## OBJECTIVE

Students will be able to tell the importance of animals of ganga.

## KEYWORDS

Dolphin, sarus, otter, skimmer, gharial

## MATERIAL

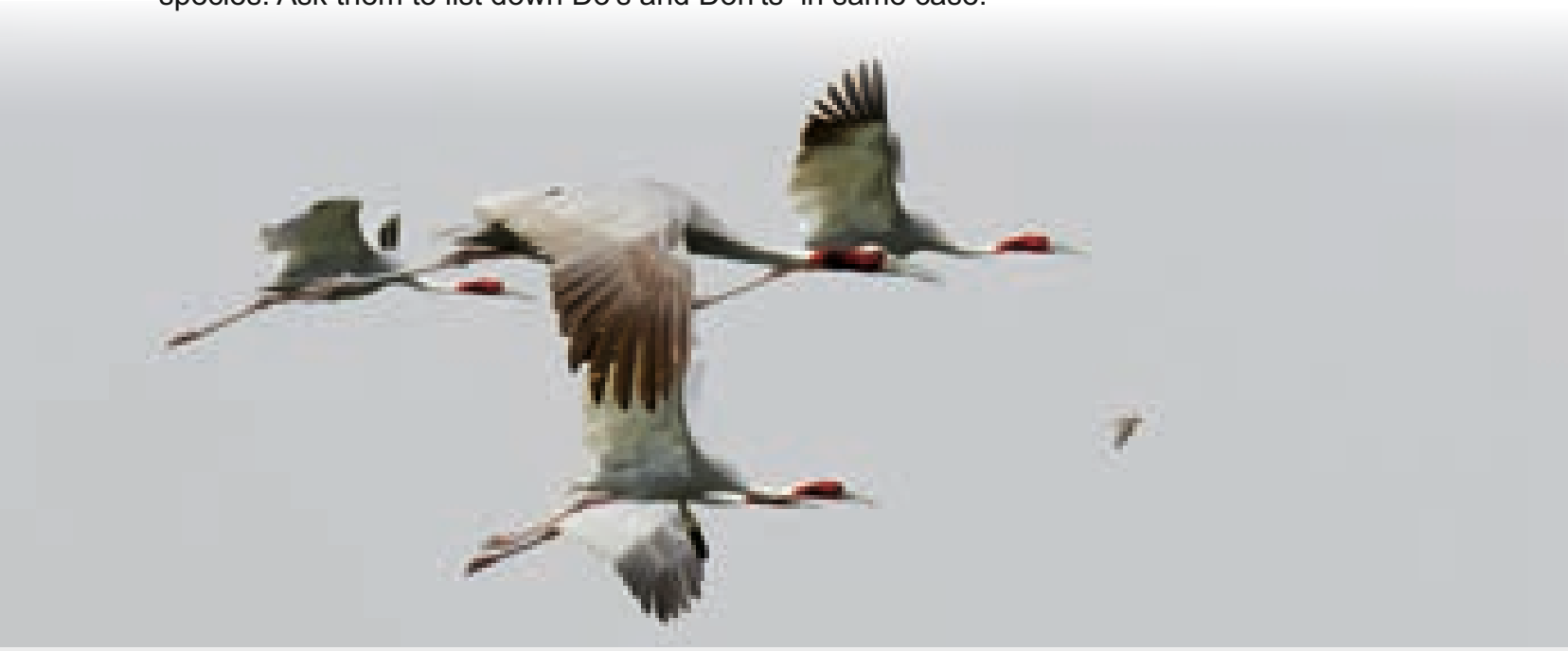
Colours, printouts of sample masks given in the end of this chapter, thread, scissors

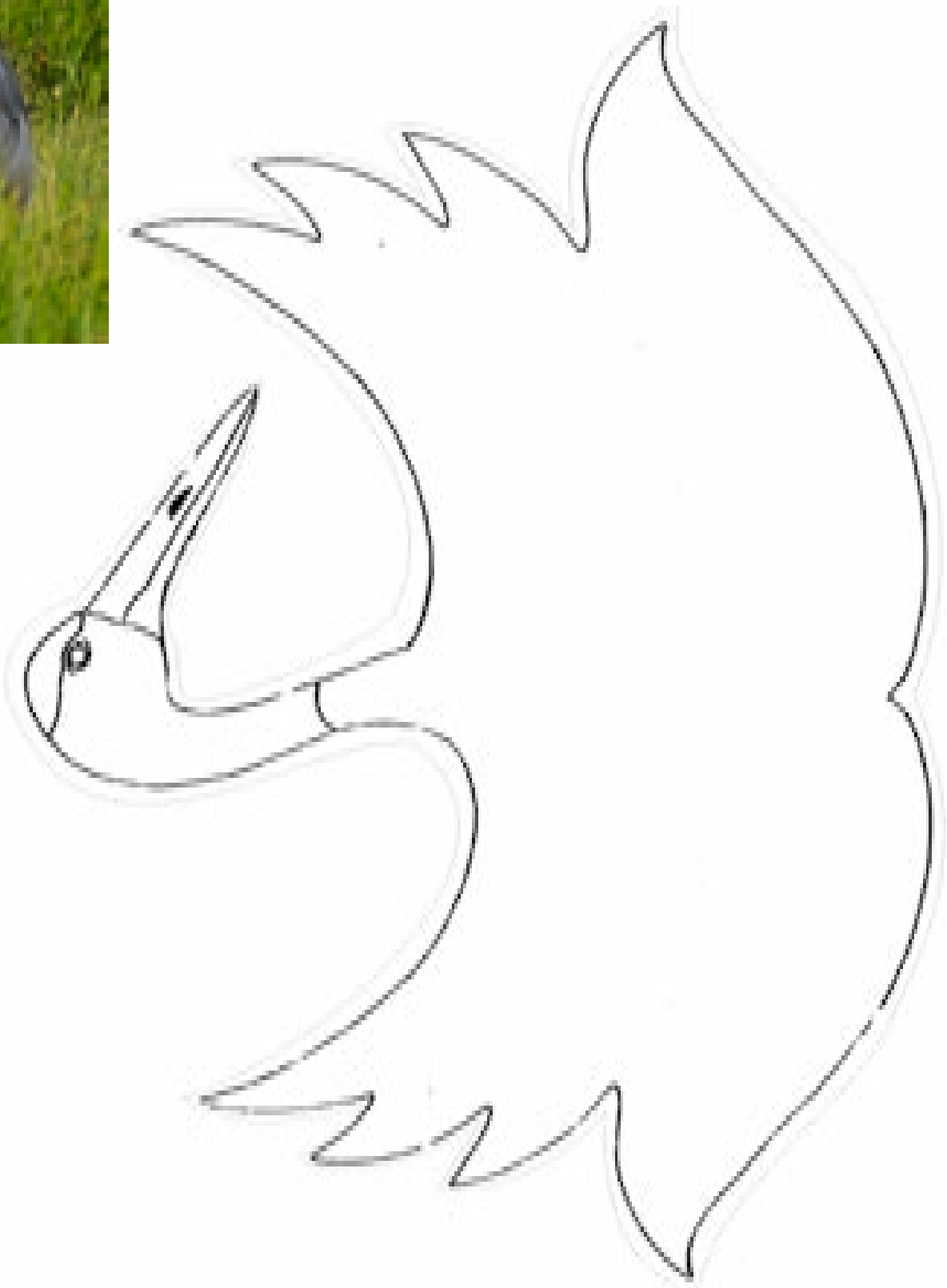
## PROCEDURE

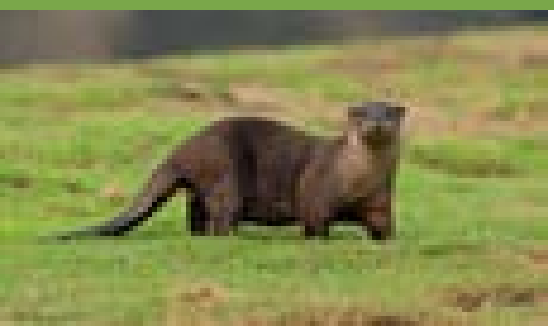
- Distribute the printouts of the masks of different animals among the students and ask them to color them, as by now they already know about the appearance of animals found in Ganga.
- Ask them to cut them from the dotted lines given around the picture and tie a piece of thread to make a mask for their faces.
- Select some of the students and ask them to play animals of Ganga and prepare an interesting story or skit.

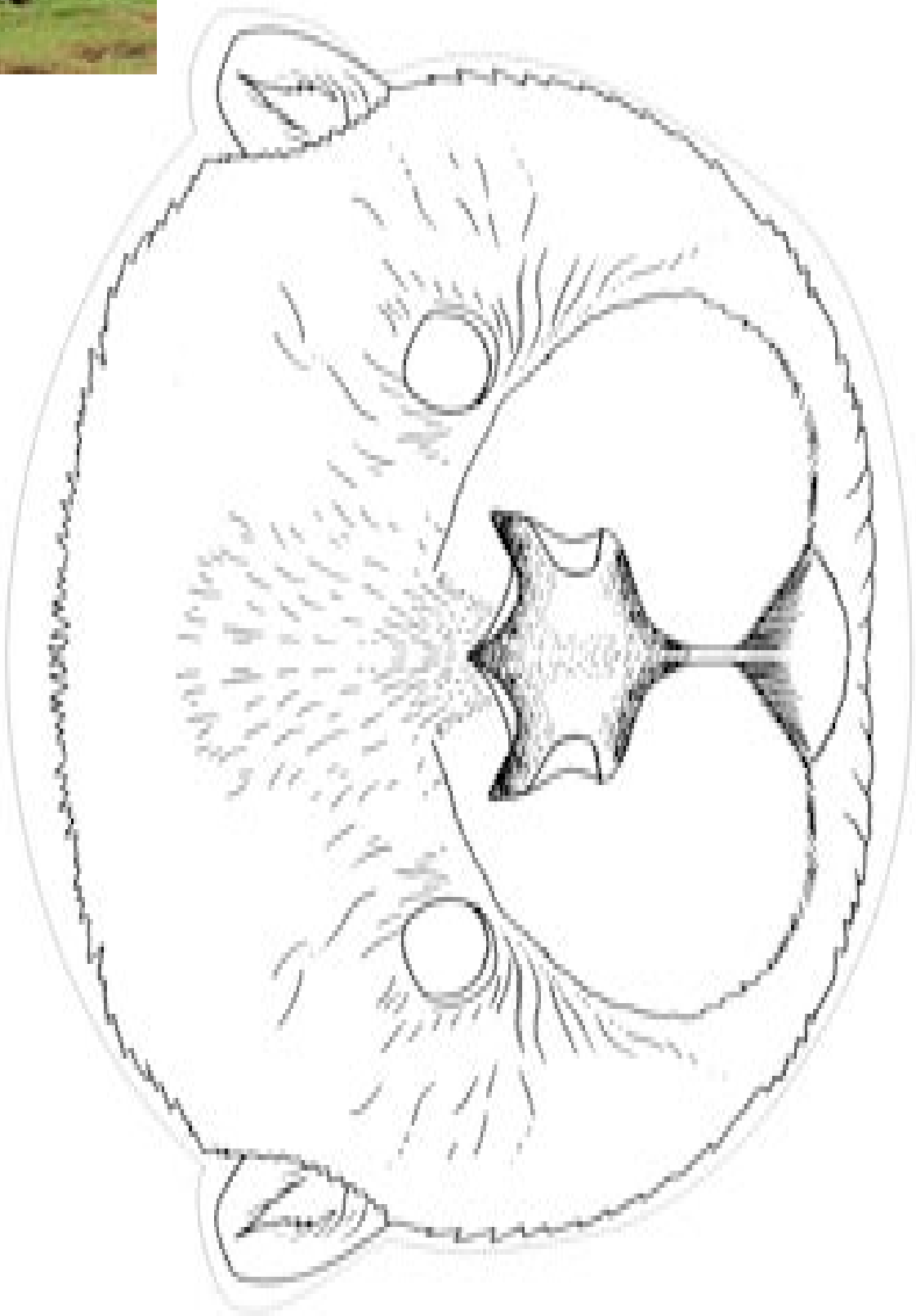
## EVALUATION

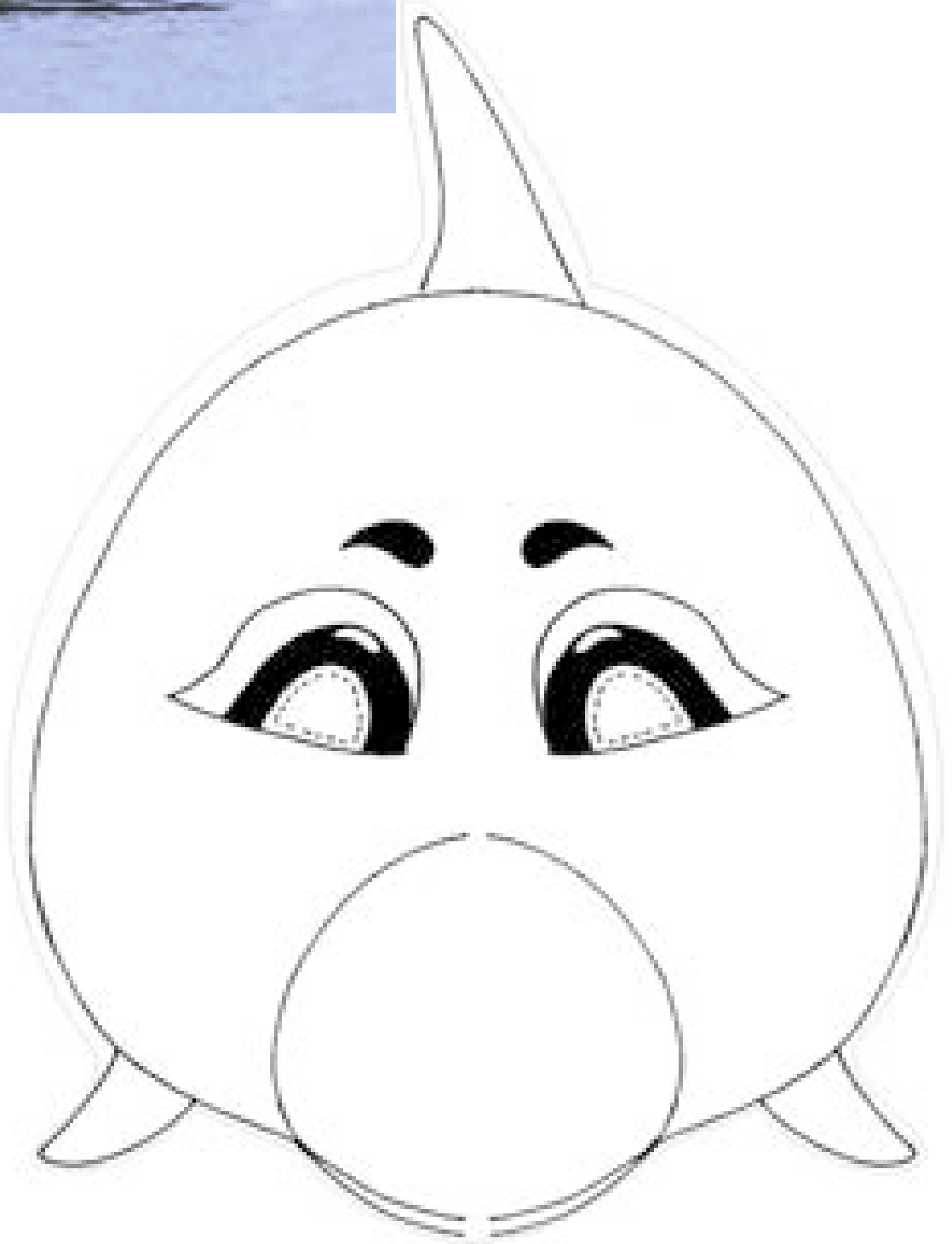
Ask students about the threats to the species of Ganga and discuss how can we save these species. Ask them to list down Do's and Don'ts  in same case.

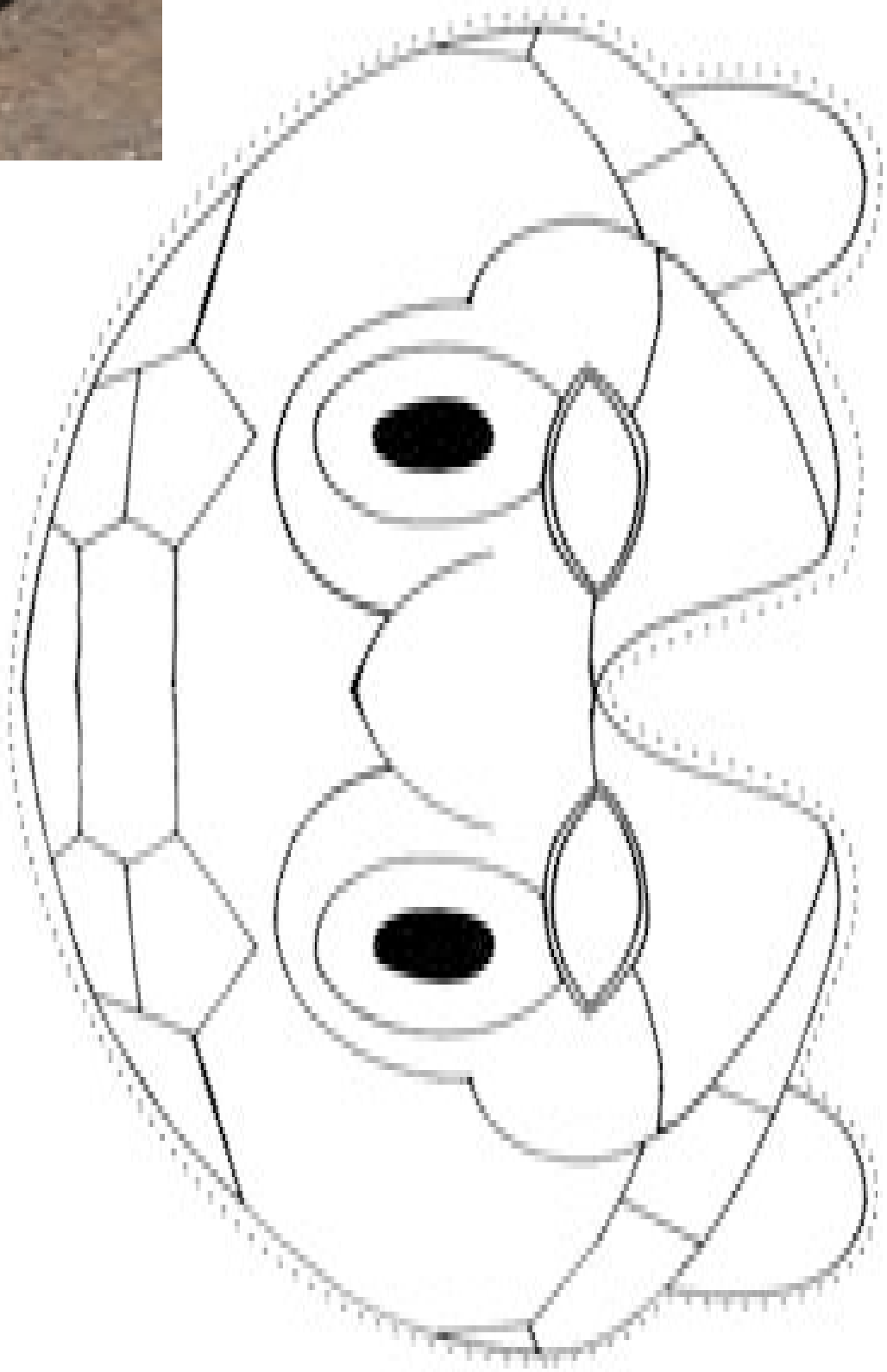












# ACTIVITY 5.4

# COMPANIONS OF GANGA – WHAT ANIMAL AM I?

## OBJECTIVE

Students will be able to identify the species of Ganga.

## METHOD

Students play a game.

## MATERIAL

Photograph of different species found in Ganga

## PROCEDURE

Pin a picture of an animal on the back of one of the children in the group. Do not show him the picture. Have him turn around so all the children can see the picture. He then ask questions to know his identity, others will answer only in 'YES', 'NO' and 'MAY BE'.
For e.g. Human

- I can walk and swim.
- I care for and raise my young
- My body temperature stays the same
- My kind are very adaptable and live in many different environments.
- I walk on two feet and speak several different languages.
- I wear different clothes.

Dolphin:

- I'm not a fish but a mammal
- I'm blind but I can hear voices from distances
- I like deep rivers with fresh water
- I'm the National Aquatic Animal of India

## EVALUATION

Ask students how a particular animal of Ganga is unique?

# ACTIVITY 6

# ARE YOU ME?

## OBJECTIVES

Students will be able to recognize various young stages of aquatic animals and match them with corresponding adult stages.

## BACKGROUND

Many animals look significantly different in their early stages of development. Compared to adulthood, this is obviously true for some aquatic insects. Many aquatic insects undergo metamorphosis. **Metamorphosis** means changes during growth. Some insects experience simple metamorphosis while others have complete metamorphosis. In simple metamorphosis, the insects egg hatches to produce a nymph. Insect nymphs have essentially all the features of adults, as they grow.

Insects that experience complete metamorphosis are characterized by eggs that hatch into larvae. The larva grows through several stages and then changes into a pupa. Pupae are usually encased in a protective cover for their next stage of growth. From the pupae emerges the soft-bodied, often pale-colored, insects. They differ remarkably in appearance from their earlier forms, but are not yet completely formed. Gradually the soft pale body develops firmness and color. In complete metamorphosis, there is a little resemblance between the adult and earlier forms.

There are also remarkable similarities and differences between other aquatic animals in different life stages. The eggs of many animals hide their eventual form (gharials, turtles, birds). Aquatic mammals are often easy to recognize. They frequently do not change as dramatically as some other animals in overall appearance as they grow from young to adult stages.

The major purpose of this activity is for the students to recognize that there are differences in the life stages of aquatic animals as they grow. The students will increase their appreciation of the diversity of wildlife as well as their understanding of growth and change in animals.

## KEYWORDS

Adult, baby, egg, spawn, tadpole

## MATERIALS

Cardboard for making picture cards, marking pens or crayons

## METHOD

Using picture cards, students match pairs of juvenile and adult aquatic animals.

## PROCEDURE

- Make pairs of aquatic animal cards. The animals in the pair should be of the same kind. For example, one might be a pair of otters: another might be a pair of sarus. One animal in the pair should be an adult; the other should be at a younger stage of development. The pairs might include adult, larval, nymph, hatchling, juvenile, infant and/or egg forms of aquatic animals.
- Ask the children to bring two of their pictures from home, one recent and the other when they were infant.
- Divide the class into small groups of three or four students each. Have them hold their own set of paired pictures in their hand. Assign each group a single table or station. Ask them to stand in a circle around the table.
- Have the students at each table place their pair of pictures on the table and mix them randomly. Once the adult-child pictures are mixed at each table, have the entire group shift to another table, so there will not be anyone at the table where their own pictures are placed.
- At the new table, let the group attempt to match pairs of adult/child photos.
- When the students at each table have completed their effort to match the pairs, ask all to return to their original tables- the place they left their own pairs of pictures.
- Are the matches correct? Ask the students to change any pairs that are not correctly matched.
- Talk about how difficult or easy it was to correctly match pairs. Introduce the idea that many animals look remarkably different as adults than they appeared when younger. Tell the students that they are about to learn how to match adult and young forms of different kinds of aquatic animals.
- Introduce aquatic animal cards and divide the class into two. Designate one half of the students "adults" and the other half "young animals." Give each student in the "adult group" an "adult" animal image. Give each student in the "young animal" group a "young animal" image.
- Make sure there is a corresponding match, adult or juvenile, for each card given. Instruct the students to look for their "match " – pairing the appropriate adult and juvenile forms. Note: you can attach each animal card to a string loop so the pictures can be hung around the students' necks as they try to match the pictures.
- Have all the students look at the correctly matched pairs. Look at similarities and differences in how different kinds of aquatic animals grow and change.

## EVALUATION

- Find out about the animals where they live and visit the habitat if possible.
- Pick a pair of images and find out more about their life cycle.

Discuss the concept of metamorphosis.

# ACTIVITY 7

# ADAPTATIONS FOR BEING IN WATER

## OBJECTIVES

For younger students: Students will be able to classify fish according to their body size shape and coloration.

For Older students: Students will be able to: 1) describe adaptation of fishes to their environment; 2) describe how adaptation can help fish survive in their habitat; and 3) interpret the importance of adaptation in animals.

## BACKGROUND

Aquatic animals are the product of countless adaptation over a long period of time. These adaptations, for the most part, are features that increases the likelihood of animals surviving in their habitat.

When a habitat changes, either slowly or catastrophically, the species of animals with adaptation that allows them many options and they are the ones most likely to survive. Some species have adapted to such a narrow range of habitat conditions that they are extremely vulnerable. Purpose of this activity is for students to investigate the concept of adaptation in fishes.

## METHOD

Students design a variety of fishes adapted for various aquatic habitats.

## MATERIALS

Five cards for each adaptation provided: mouth, body, shape, coloration, reproduction; art materials, paper.

## PROCEDURE

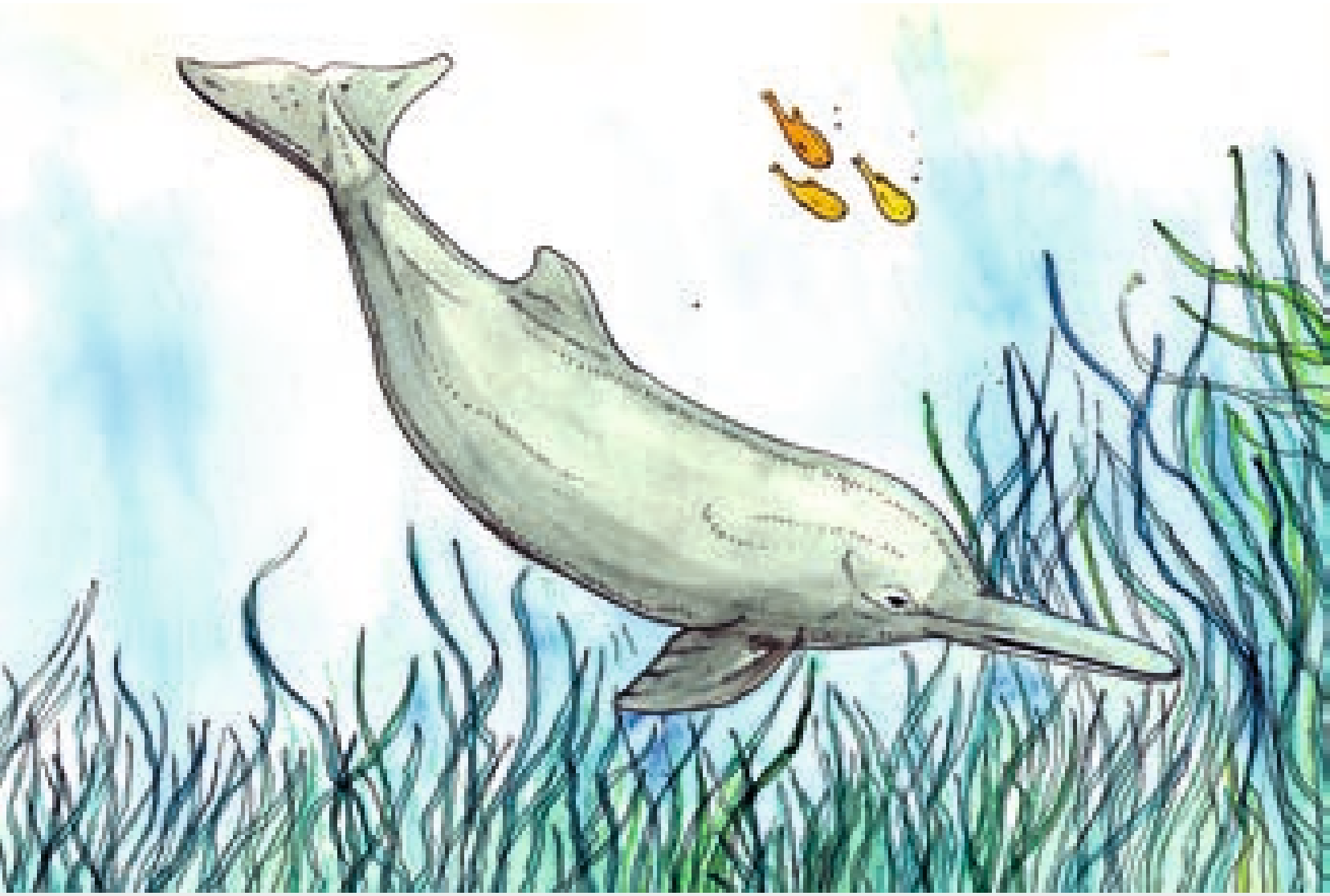
- Assign students to find a picture or make a drawing of a kind of animal that has a special adaptation – for examples large eyes set into feathered cones in the heads of owls to gather light for night hunting.
- Conduct a class discussion, ask the students to identify different kinds of adaptation in humans.
- Pool all the pictures or drawings of adaptations by the students, categorize them into following groups:

- Protective collaboration and camouflage
- Body shape/ form
- Mouth type/ feeding behavior
- Reproduction/ behavior
- Others

- Divide the adaptation cards into five groups of four cards each, one each of collaboration, mouth type, body shape and reproduction.
- Pass one complete set of cards to each group of students. There might be five groups with four to six students in each group.

## EVALUATION

Ask students to compare human body organs to fish and discuss how they are different and why?



# ACTIVITY 8

# WHO'S WHO

## OBJECTIVES

Students will: 1) reorganize and identify the major species of freshwater fishes that live in their area; 2) describe various values of fish species in some aquatic ecosystems.

## BACKGROUND

There are fishes in virtually every area of Ganga. They play a variety of roles in aquatic ecosystem. Some are predators on other aquatic life, some are feeders on plant materials, some others scavenge or feed on detritus. Some species deposit eggs in special nests, some live young. They exhibit a wide range of behaviors. While few fishes are well known by those who do fishing, others are less conspicuous to humans but are nevertheless important performers in freshwater ecosystem. The major purpose of this activity is to expand students' knowledge about of the different species of fish that occur in the Ganga.

## KEYWORDS

Fish, predators, scavengers, aquatic life, humans

## METHOD

Students make an inventory of fish habitats that exist in their area, and obtain information about the various fish species that occur in these habitats.

## PROCEDURE

- Ask the students what fish they think live in their area. Focus on identifiable boundaries such as their community, state or region. What different kind of fish they have seen, caught, heard or read about? Make a list of these different kind of fishes and paste it in the classroom
- Obtain, or have the students make, a large map of the area they have chosen to study land as well as major bodies of water: lakes, rivers, large streams associated with the river Ganga. Locate the actual size of these habitats in the area to be studied.
- Divide the class into teams. Have each team identify possible source of information about fish and fish teams. Develop a plan for getting the information. Don't neglect first-hand sources, such as family members and friends. State Wildlife Department personnel and aquatic biologist and fishermen may be available to help each team should then use their source and develop “biographies” for as many of the fishes that occur in their area as possible.
- In addition to biological information about the fish and its habitat, the biographies should include, possible information about ecological, scientific, recreational, economic, political, cultural, aesthetic and intrinsic reasons for which fish are valuable.

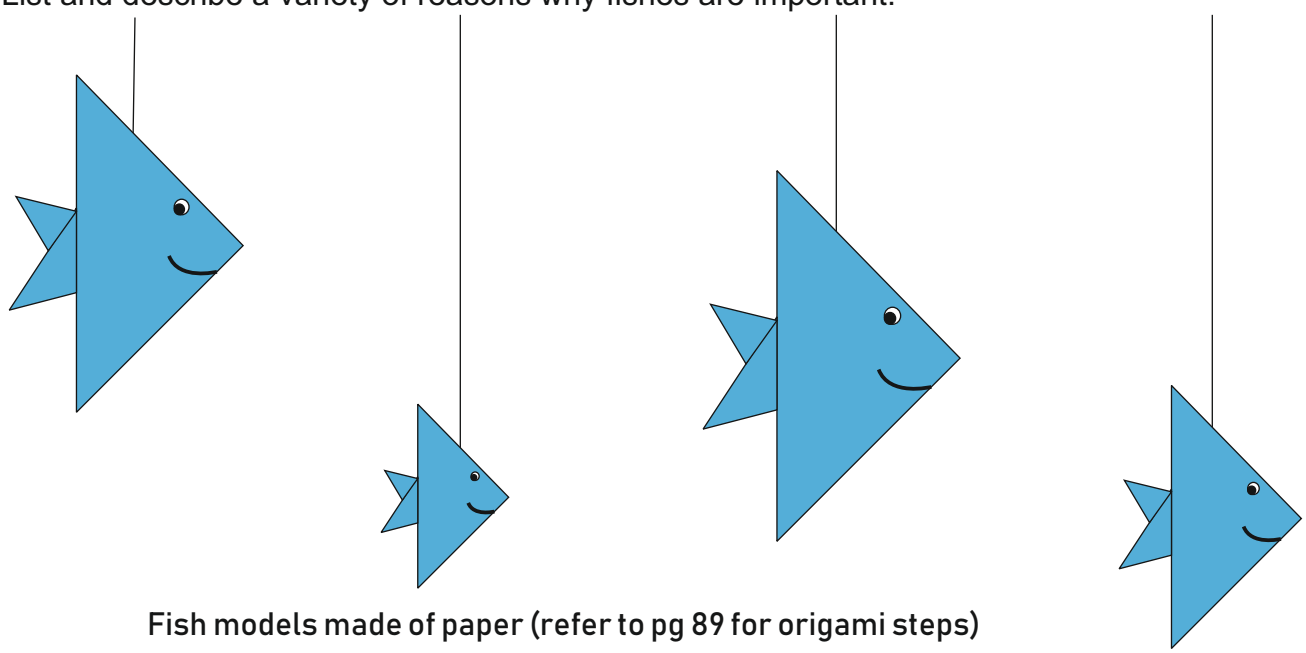
- Have the teams meet and compare the information they got from different sources about the various fish and habitats. In some cases, the information may not be accurate. If so, the students might try to determine why. Through this process of comparing research notes, the students should be able to improve the accuracy and completeness of their descriptions of the various fish and habitats.

## EXTENSIONS

- Make replicas of some of the fish in three dimensions. Hang them on string from the classroom ceilings as mobiles. Let the classroom become an aquatic habitat.
- Explore why some fish species or types occur widely, in various habitats, while others are more restricted or specialized, what special needs they have and what special abilities do they have?
- Find out how some fish got their names. Scientific names are also interesting to explore.
- Invite local fish biologist to come and speak about the fishes and their habitat, but only after you have created your display so that the biologist can provide advice and make suggestions.
- There may be hatcheries, fish research stations, or other place where work regarding fishes are done near your school. If possible arrange a tour there.
- Are there any hot spot for fishes in your state- places where fishes are in danger due to anthropogenic pressure or other reasons? Note these on your wall and describe the problems.

## EVALUATION

- Name five species of fish that live in your area.
- Describe where in the state each of these fish is most apt to be found and in what kinds of habitat.
- List and describe a variety of reasons why fishes are important.



Fish models made of paper (refer to pg 89 for origami steps)

**CONSERVATION STATUS**

**IUCN**
Critically Endangered
**CITES**
Not Listed
**WPA**
Not Listed

# Snow Trout

*Schizothorax richardsonii*

Also known as 'scaly usman', the snow trout has slender head, elongated body, streamlined to resist strong water currents. The body is covered by small silvery cycloid scales and the abdomen by large brown scales. The snout bears a nuptial tubercle with four barbels. Lateral line is associated with 85 to 110 scales.

## HABITAT

The snow trout prefers cold waters between 7.2-22°C. Adults prefer pools (1-3 m depth) and rapids. They prefer boulders and mature cobbles covered with slimy algal material as substratum.

## DISTRIBUTION

Snow Trout inhabits clean, cold and pollution free waters. In river Ganga and its important tributaries, snow trout is restricted in the stretch between Harsil to Devprayag in the main stem (river Bhagirathi) and downstream of Vishnuprayag to Devprayag in river Alaknanda.

## FOOD HABITS

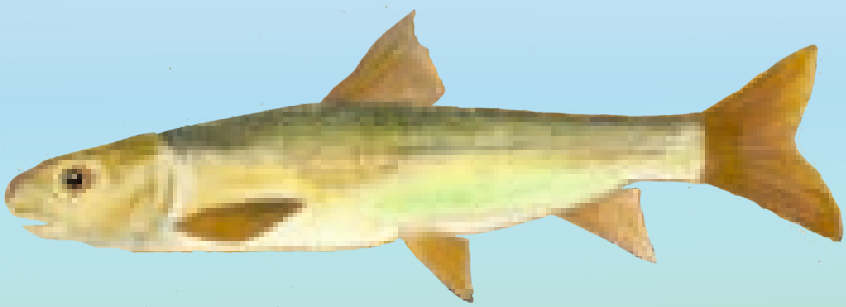
The snow trout is a herbivorous detritophagic bottom feeder fish. It is exclusively adopted for scraping algal slimes and detritus from the surface of the stones.

## BREEDING

The Snow Trout migrates to lower reaches of stream for breeding in July-August and spawns during August-October. The eggs are laid in clear water with rocky bottom at the banks in shallow areas with 30-60 cm of depth where eggs hatch in 50-55 hours.

## FACTS

- Snow trout is bottom dwelling fish that migrates within the fresh waters only.
- It can reach upto the size of as high as 60 cm but majority of them are sized around 20-25.5 cm.
- They are graded as the most important, keystone fish in the reach which controls other species as well as function of ecosystem in general.



## Threats

Due to changes in flow pattern of the river and existence of a number of hydro-electric reservoirs and diversions, the longitudinal and lateral connectivity has been impaired which has obliterated the migration routes and has distributed the migration and breeding cycle.

**CONSERVATION STATUS**

**IUCN**
Near Threatened
**CITES**
Not Listed
**WPA**
Not Listed

# Rohu

*Labeo rohita*

The snow trout has slender head, elongated body, streamlined to resist strong water currents. The body is covered by small silvery cycloid scales and the abdomen by large brown scales. The snout bears a nuptial tubercle with four barbels. Lateral line is associated with 85 to 110 scales.

## HABITAT

Rohu is eurythermal in nature that grows best at temperature >14 degree Celsius. It prefers moderate deep waters on sandy substrate.

## DISTRIBUTION

Rohu is native to Gangetic river system. The species is heavily stocked in reservoirs of India to promote fishery production. Currently, they are found in rivers/ reservoirs/lakes and water tanks throughout India.

## FOOD HABITS

Rohu's food habits changes with age. The main food for Rohu is algae and submerged vegetation. Even after being majorly a column feeder, it explores other layers of water where it feeds on decayed organic matter.

## BREEDING

Complete maturity is attained in males after four years and in females after five years of age. Rohu spawns only once a year in the shallow and marginal areas of the river. Number of eggs produced varies from 2,26,000-27,94,000 depending upon size and weight of the fish.

## FACTS

- Rohu is one of the most important food fish for the people of India.
- The maximum size and weight recorded is 200 cm and 45 kg respectively.

## Threats

The major threats to Rohu is construction of barrages and hydro power plants that hinders the basic ecology.

Over fishing and the contamination of water bodies by industrial and agricultural run offs also cause severe threats to them.

**CONSERVATION STATUS**

**IUCN**
Least Concered
**CITES**
Not Listed
**WPA**
Not Listed

# Mrigal

*Cirrhinus mrigala*

The body is elongated and streamlined, with grayish or greenish color on the back and silvery at the sides and below. Barbels small, in two pairs. Lateral line is continuous bearing 40-45 rows of scales.

## HABITAT

Mrigal is found in fresh water bodies. Its common habitats are ponds, rivers, lake, canals, ditches and floodplains. Like other members of Indian Major Carps. It prefers sandy substrate and moderate current.

## DISTRIBUTION

It is native to Gangetic river system. This species is heavily stocked in reservoirs of India to promote fishery production. Currently, they are found in rivers/ reservoirs/lakes and water tanks throughout India.

## FOOD HABITS

It is a bottom feeder that mainly feeds on dead and decayed materials.

## BREEDING

It attains its first maturity in about one to two years. Spawning occurs during June-August. Heavy monsoon floods are capable of inundating vast shallow areas, which form the breeding grounds of the fish, the optimum temperature of spawning ground ranges between 22-31°C.

## FACTS

- Mrigal is native to Indo-Gangetic riverine systems.
- It has been introduced in many parts of India.
- It can reach upto 1 meter of length and 12.7 kg of weight.

**Threats**

Indiscriminate fishing of juveniles. Contamination of the water bodies due to industrial effluents and agricultural run offs also causes threats to the natural habitat of the fish.

**CONSERVATION STATUS**

**IUCN**
Vulnerable
**CITES**
Not Listed
**WPA**
Not Listed

# Golden Mahseer

*Tor putitora*

Commonly known as Golden mahseer, Yellow mahseer or Thick mahseer. Body color is golden on dorsal side and fins are yellowish with red shade. This can be easily distinguish from other groups of fishes by presence of large scales and thick powerful protrucible jaw with large barbels at the corner of the mouth.

## HABITAT

Inhabits rapid streams with rocky bottom and river stretches with rocky pools.

## DISTRIBUTION

Widely distributed in the foothills of Himalayas. This has been introduced into the high altitude lakes such as Nainital and Bhimtal.

## FOOD HABITS

Young ones are algal feeders. They mainly feed on unicellular diatoms and periphytons. Adults are omnivorous; feed on crustaceans, molluscs, insects and small fishes.

## BREEDING

Breeding usually occur after the monsoon. It migrates upstream for spawning. It produces as low as 6,000-10,000 eggs/kg body weight.

## FACTS

Mahseer roughly translates Mahi-Fish and Sher-Tiger and hence it is referred as King among fresh water fishes. It is one of the most famous angling fishes of India. It reaches 2.74 m in length and 50 kg of weight. But currently, 2-5 kg size fishes occur in native ranges which is mainly due to reduction of freshwater flow and habitat loss.

## Threats

**Pollution in the sea** and destructive fishing practices. Construction of dams and barrages that hinder their breeding and migration. Non selective fishing gears.

**CONSERVATION STATUS**

**IUCN**
Least Concered
**CITES**
Not Listed
**WPA**
Not Listed

# Hilsa

*Tenualosa ilisa*

Hilsa has silver colored body with gold and purple shots. It has a distinct median notch in the upper jaw. Dorsal fin with 18-21 soft rays and spines are absent in fins. Females are usually larger in size than males.

## HABITAT

Adults live in Marine water. However, for breeding purposes, it migrates into the fresh water (ascending rivers) and after that it migrates back to the sea. Young ones spend some time in the fresh and brackish water habitat, then reach to marine water.

## DISTRIBUTION

Hilsa is found in Indian ocean including west and east coasts of India. A few populations are found in the river stretches in Ganga between Jharkhand and Bihar. These populations got isolated after the construction of Farraka barrage. However, the population is not doing well.

## FOOD HABITS

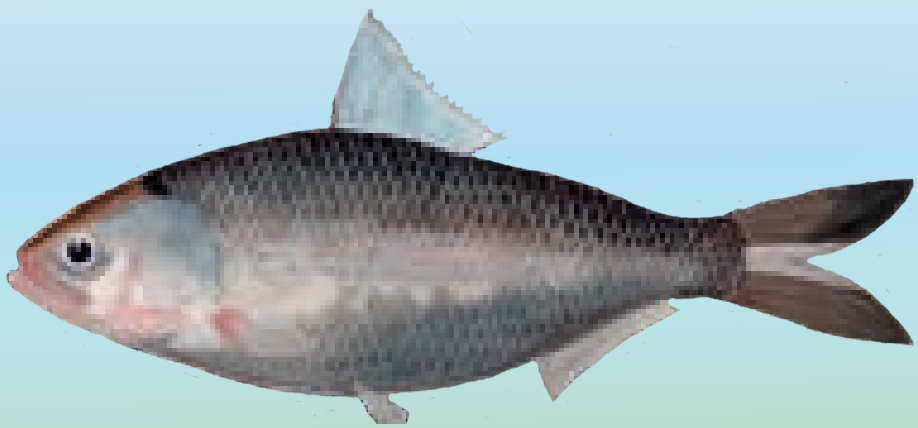
Hilsa mainly feed on zooplankton by filtering layers. It some times feeds on invertebrates and small fishes.

## BREEDING

Hilsa breeds mainly in rivers, migrates upstream to about 50 km to several kms in the Ganges (younger fishes may breed in the tidal zone of rivers). Breeding season is from January to February. Sometimes it extends upto March.

## FACTS

- Historically Hilsa was called 'Matsyaraja'-The king of fishes.
- Hilsa is a fast swimmer. it can easily cover around 71 km in a day. The maximum size and weight recorded for male is 43 cm and 0.68 kg respectively while for female it is 60 cm and 2.49 kg.
- The farakkha barrage lacks proper fish passes, restricting the Hilsa that grows in a marine environment but migrates to freshwater for breeding - this has affected the Hilsa population badly and so as the population of its related species like freshwater prawn.
- Sindhi community believes that Hilsa came from heavens and it is a vehicle of lord Jhulelal.
- Matsyavatar of lord Vishnu is believed to be taken as Hilsa.



## Threats

This species is facing a serious problem of over exploitation by commercial fisheries. Other than that, loss of breeding habitat especially in Ganga due to barrages, reduced water flow and pollution.

**CONSERVATION STATUS**

**IUCN**
Least Concerned
**CITES**
Not Listed
**WPA**
Not Listed

# Calbasu

*Labeo calbasu*

Calbasu has a uniformly dark colored body. Dorsal fin has 16 soft rays and anal fin bears 8 soft rays. It has a small, inferior mouth which is surrounded by fleshy lips.

## HABITAT

Calbasu grows well with other members of Indian Major Carps in rivers/ ponds. It prefers sandy substrate with moderately flowing water.

## DISTRIBUTION

Calbasu is native to Gangetic river system. The species has been heavily stocked in reservoirs of India to promote fishery production in peninsular India. It is found in the major river systems of India such as the Ganga, Brahmaputra, Kaveri, Godavari and Krishna.

## FOOD HABITS

The fish was found to be bottom dwelling illophagic. The food consists of decaying organic matter, molluscs, diatoms, plant matter, blue green algae, green algae and zooplanktons. The fish is omnivorous in nature and feed selectively.

## BREEDING

*Labeo calbasu* normally spawn between July-August. Both male and female prefer shallow water for spawning. Breeding of *L. calbasu* was performed at an ambient temperature of 26.5 to 31.1°C. Number of eggs produced ranges from 1,93,000 to 2,38,000.

## FACTS

- Calbasu is one of the most important Indian Major Carps (IMCs) .
- It is also known as 'Black Rohu' at several places.
- It has a record of reaching upto 90 cm in length.
- As it feeds on dead and decaying matter, they helps to improve the sanitation in the sea.

## Threats

The major threats to Calbasu is construction of barrages and hydro power plants that hinders the basic ecology. Over fishing and the contamination of water bodies by industrial and agricultural run offs also cause severe threats to them.

**CONSERVATION STATUS**

**IUCN**
Near Threatened
**CITES**
Not Listed
**WPA**
Not Listed

# Goonch

*Bagarius bagarius*

Commonly known as Goonch, Devil Catfish or Sand Shark. It is an important food fish, but the meat spoils rapidly and can cause illness. It has a large, inferior type of mouth.

## HABITAT

Goonch prefers fresh water habitats. It inhabits a variety of fluviatile habitats although it is typically associated with swift, clear rivers with a substrate of rocks and sand.

## DISTRIBUTION

Because of taxonomic confusion there is not much data available showing the distribution of the Goonch but further studies in this direction may reveal that it is restricted to Indian subcontinent.

## NOTE

Due to taxonomic confusion between *Bagarius bagarius* and *Bagarius yarelli*, there is a lack of information about the distribution, breeding and habitat of the species.

## FOOD HABITS

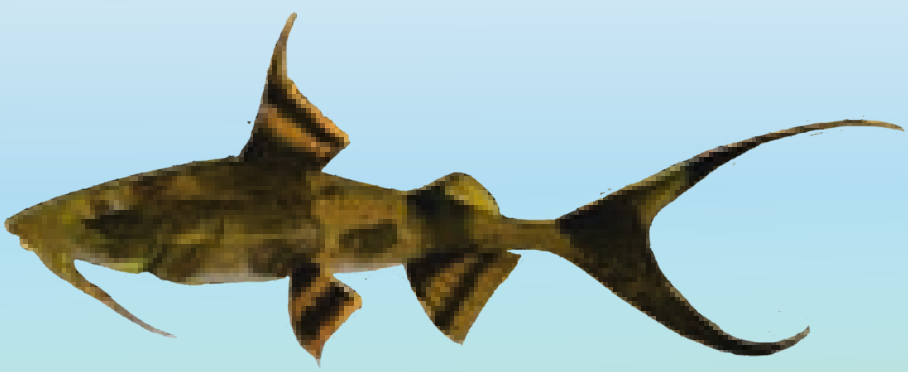
Goonch primarily feeds on insects, small fishes, frogs and shrimps. It also scavenges on half-burned human corpses.

## BREEDING

Breed in rivers prior to the beginning of the annual flood season.

## FACTS

- Goonch is very important to study the species and clear the confusion regarding the taxonomy.
- It is harvested heavily in different parts of its range as food fish and for ornamental trade and as sport fish.
- The maximum length recorded for Goonch is 200 cm.



## Threats

This species is in some danger of being over-exploited. The effects of other potential anthropogenic threats such as habitat destruction and competition from alien species also threaten it more. Juveniles and sub adults are often caught for the ornamental fish trade.

**CONSERVATION STATUS**

**IUCN**
Near Threatened
**CITES**
Not Listed
**WPA**
Not Listed

# Catla

*Gibelion catla*

A stoutly build fish with deep body and large head. The mouth is wide and upturned with a prominent protruding lower jaw. Pectoral fins long and extends up to pelvic fins. Scales along the lateral line ranges from 40 to 43 scales. Barbels are absent. Color is grayish on back and flanks, silvery-white below; fins dusky grey color.

## HABITAT

Catla is a eurythermal species that grows best at water temperatures between 25-32 degreeCelsius. The minimum temperature tolerance limit is~14degree celsius. Generally inhabit in weedy and turbid waters on sandy substrate.

## DISTRIBUTION

Catla is known as the Gangetic carp as they are native to Gangetic river system. The species is heavily stocked in reservoirs of India to promote fishery production. Currently, they are found in rivers/ reservoirs/lakes and water tanks throughout India.

## FOOD HABITS

Catla is a surface feeder, mainly feed on zooplanktons.

## BREEDING

Catla attains maturity at the age of 2 years. Mating occurs with vigorously splashing of water and it breeds in ponds, reservoirs and rivers. Spawning season of catla is June-September in North India and May-August in Eastern India.

## FACTS

- Catla is one of the fastest growing species among Indian Major Carp (IMC).
- It is native to India and it is introduced in many tropical countries as cultivable fish.
- This species is one of the most productive food fishes in India.
- It can reach upto 1.8 m of length and 38.6 kg of weight.

**Threats**
There is no known threats for Catla.

# ACTIVITY 9

# TURTLES DAY OUT

## OBJECTIVES

Students will: 1) recognize and identify the major species of freshwater turtles that live in their area; 2) describe various values of turtle species in some aquatic ecosystems;

## BACKGROUND

Turtles are virtually present in every area of Ganga. They play a variety of roles in aquatic ecosystems. Some are predators on other aquatic life, some feeders on plant materials, while others scavenge or feed on detritus. Turtles help in keeping the water clean by feeding on dead animals and harmful microbes. They exhibit a wide range of behaviors. Others are less conspicuous to humans but are nevertheless important performers in freshwater ecosystem. The major purpose of this activity is to expand students' knowledge of the different species of turtle that occur in Ganga.

## KEYWORDS

Turtle, freshwater ecosystem, dead animals, scavengers

## METHOD

Students prepare an inventory of turtle habitats that exist in their area, obtain information about the various turtle species that occur in these habitats, and locate the turtle species on a map according to where they occur.

## PROCEDURE

- Ask the students what turtle do they think live in their area. Focus on identifiable boundaries such as their community, state or region. What are the different kind of turtles they have seen, caught, heard or read about? Make a list of these different kinds of turtles and paste it in the classroom
- Obtain, or have the students make, a large map of the area they have chosen to study land as well as major bodies of water: lakes, rivers, large streams associated with the river ganga. Locate the actual size of these habitats in the area to be studied.
- Divide the class into teams. Have each team identify possible source of information about turtles. Turtle teams will then develop a plan for getting the information. Don't neglect first-hand sources, such as family members and friends. State Wildlife Department personnel, water quality specialist and aquatic biologist may be available to help. Phone calls or visits to state and federal agencies are invaluable in obtaining materials. Local wildlife clubs, state wildlife agencies, and private groups' organization often have their own publication that would be helpful. Other sources might include the school or public library. Each team should use the sources and develop “biographies” for turtle that occur in their area.

# Story of the Indian Softshell Turtle

*Nilssonia gangetica*

Turtles have existed on Earth since the rise of the dinosaurs about 220 million years.

This peculiar-looking turtle unlike many others does not have a hard shell and is highly adapted for aquatic life having a flattened body, long neck and tube like snout. As a result they are fast swimmers and remain predominantly below the water surface only with its snout sticking out of the water to breathe.

The Indian Softshell Turtle is amongst the giant softshell turtles of the world. It grows up to 94 cm and weighs up to 20 kg. It is found in the major rivers of Pakistan, Southern Nepal, Bangladesh and Northern India, which includes the Ganga river systems. Being omnivorous it helps in cleaning the river by feeding on dead and decaying items.

1

2

During the monsoon season the turtles mate in shallow waters, and can be seen floating on the surface.

3

The females arrive in isolated sandy beaches to nest during May to January. The female digs a flask-shaped cavity in the sand in which she lays a clutch of 8 to 47 eggs.

4

The hatchlings emerge from the eggs after a record nine to ten months.

The hatchling upon emerging from their nest immediately head to water mostly in the cover of darkness to avoid predation by dogs. Once in the water, they disperse quickly to avoid aquatic predators.

5

It will be several years before they mature, and find a mate to start a new batch of unique turtles.

- Each “biography” should include the turtle's name (common and scientific), where it lives and what is their habitat. It should also include specific information about the kind of habitat (freshwater, estuarine, or marine) the turtle needs in order to survive. In addition to biological information about the turtle and its habitat, the biographies should include, where possible, information about ecological, scientific, recreational, economic, political, cultural, aesthetic and intrinsic reasons for which turtle are valuable.
- Have the teams meet and compare the information they got from different sources about various turtles and habitats. Through this process of comparing research notes, the students will be able to improve the accuracy and completeness of their descriptions.
- Returning to the large wall map, ask the teams to paste the biographies, on cards or in a suitable format, along with their artwork depictions of the turtle and their habitats, around the map near locations where the turtle occur. Extend colored string from the cards and sketches to various points where the turtle occur. Use tape, thumb tacks or push pins to attach the string to artwork and map.
- Next have the students compare their original list of turtle with their map entries and note how they have added to their knowledge of turtle in their surroundings.

## EXTENSIONS

- Explore why some turtle species or types occur widely, in various habitats, while others are more restricted or specialized, what special needs and abilities do they have?
- Find out how some turtles got their names! Scientific names are also interesting to explore.
- Invite local turtle biologist to come and speak about the turtle, habitat, but only after you have created your display so that the biologist can provide advice and make suggestions.
- There may be hatcheries, turtle research stations, or other place where work regarding turtles are done near your school. If possible arrange a tour there.
- Are there any hot spot for turtles in your state- places where turtles are in danger due to anthropogenic pressure or other reason? Note these on your wall and describe the problems.

## EVALUATION

- Name five species of turtle that live in your state.
- Describe where in the state each of these turtles are most apt to be found and in what kinds of habitat.
- List and describe a variety of reasons that turtles are important.

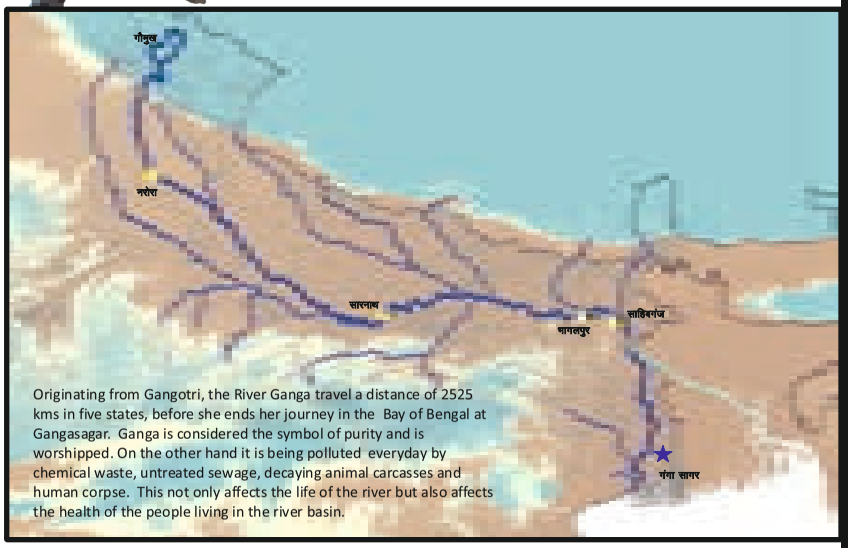
# Turtles of Ganga

*Gangotri mera udgam sthal,*
*pohchti hu sunderban tak*
*Jal mera behta chal chal*
*aradhna krte meri jan jan,*
*Sekdo jivo ka hai mujmain vaas,*
*kachhap hai unme se khaas.*
*Kude-kachre ko krte nasht,*
*aapki ganga ko krte hai swach.*
*Inko na vilupt hone de*
*pradushan ke kono main,*
*Dera unka surakshit rahega,*
*tabhi jab prayatna hoga logon se.*

Originating from Gangotri, the River Ganga travel a distance of 2525 kms in five states, before she ends her journey in the Bay of Bengal at Gangasagar. Ganga is considered the symbol of purity and is worshipped. On the other hand it is being polluted everyday by chemical waste, untreated sewage, decaying animal carcasses and human corpse. This not only affects the life of the river but also affects the health of the people living in the river basin.

Turtles, Kurma avatar is associated with Indian culture. There are 15 species of turtles in Ganga river system. The number of turtles in the Ganga is decreasing due to pollution of the river and illegal fishing. They are significant as they help control river pollution by eating flesh of dead animals and humans and clear the river from unwanted plants and disease causing insects. Turtles are an indicator of a healthy river system.

The only way to save Ganga is by becoming responsible citizen of the country and pledge "I will not pollute Ganga and its basin; will not let anyone else pollute."




Originating from Gangotri, the River Ganga travel a distance of 2525 kms in five states, before she ends her journey in the Bay of Bengal at Gangasagar. Ganga is considered the symbol of purity and is worshipped. On the other hand it is being polluted everyday by chemical waste, untreated sewage, decaying animal carcasses and human corpse. This not only affects the life of the river but also affects the health of the people living in the river basin.


Under National mission for Clean Ganga
Poem: Dimpi Patel
Photo Credit: Abhijit Das, Indranil Das, Anuja Mittal and Rajiv Basumatary

# ACTIVITY 10

# FROGS AND TOADS

## OBJECTIVES

Students will be able to tell 1) the difference between frogs and toads, 2) learn about their life phases and 3) how they are important in an ecosystem.

## BACKGROUND

*What is the difference between a frog and a toad?*

| Frogs | Toads |
|---|---|
| Eyes can look in all directions | Eyes tend to face forward |
| Lay their eggs in clumps, singly, or in floating films | Lay their eggs in long strands |
| Slim bodies and long legs for leaping | Fat bodies and short legs for hopping |
| Long tongues with good aim | Short tongues with excellent aim |
| No separate toxic glands | Toxic Parotoid Glands on back of head |
| Live close to and in water | Live on land |
| Smooth or slimy skin | Dry and warty skin |
| Small upper teeth only | No teeth |

The frog lays its eggs (as many as 20,000) in a clump (toads in long strands). The eggs are called Frog Spawn. They hatch into tadpoles (the larval stage) which look like fish. The tadpoles have gills and a tail and special jaws for eating vegetation.

***Why are there not 20,000 tadpoles in the pond?***
As the pollywogs (another name for tadpoles) mature, they begin to grow hind legs. Their jaws begin changing shape and their gills are replaced with lungs. Front legs emerge and the tadpole now looks like a tiny frog with a tail.
It makes its way out of the water to its edges as its tail is gradually absorbed. The frog now breathes with lungs, has no tail, and eats insects by catching them with its sticky tongue.

Remember that frogs and toads are Anurans which means “tail-less.”
This transformation is called metamorphosis. It can take place in a matter of days or over the course of a year depending on the species and the availability of water.

Frogs and Toads have special skin
First of all, their skins are permeable to water. That means they can get all the moisture they need by absorbing it through their skin. They don't have to drink water like we do. Frogs can just leap into the pond if they are thirsty. Toads can settle into some damp dirt and absorb moisture through their belly. Treefrogs can absorb moisture through their tummy by clinging to the side of a tree.

But that's not all! Their skins are also permeable to oxygen. They can breathe through their skin. In the winter many frogs will hibernate at the bottom of the pond for months – they get their oxygen supply through their skin from the dissolved oxygen in the pond water.

But that's still not all! Frogs and Toads use toxic secretions from their skins to deter predators. Some of the toxins are strong enough to kill a dog. You don't want to get the secretions in your eyes or near your mouth or nose because they will cause you great discomfort. Wash your hands thoroughly after handling any frog or toad, and put them back where you found them.

The toxins of some frogs are some of the deadliest substances on Earth. Natives in Central Americans use the skin toxin of Dart Frogs to coat the tips of the darts used in their blowguns. A monkey hit with the poison dart will die instantly.
*Our country has no poisonous frogs!*

And finally, chemical compounds found in frog skin secretions have been used to make amazing medical discoveries. “Miracle Drugs” such as a pain killer that is more effective than morphine, but non-addictive and potential treatments for the most deadly cancers are some of the benefits.

***Where do frogs fit in the Food Chain?***
**Why does the female lay hundreds, thousands, or tens of thousands of eggs?**

Many of the eggs will hatch into active, plant eating tadpoles. While fattening up on the plants and detritus of the pond, several hunters are scoffing down as many tadpoles as they can find. Predators include fish, birds, insect larvae, and frogs.

Adult frogs and toads are eating machines. Most are just insectivores, several of the frogs, will eat anything that they can jam into their mouths and swallow. And who eats frogs? Snakes, fish, small mammals, lizards, birds, us and even other frogs will eat frogs.

Since they are **ectothermic animals** (an organism that regulates its body temperature largely by exchanging heat with its surrounding environment), they use little to no energy to maintain their body temperature. So what happens to all that food they eat? They keep growing – throughout their life.

**Benefits of Frog for the natural world and humans**

- Predators and prey in the ecosystem

Frogs and toads are right in the middle of the food chain and provide a very efficient transfer of solar energy. They play an important role in consuming insects and are an important food source of birds, snakes and other animals throughout the food web.

- Pest control

They help control insects that may be agricultural pests or carry diseases.

- Medicine

Frogs have been used extensively in medical research, and many Nobel prizes in medicine and physiology have involved frog studies.

- Education and research

The chemical compounds found in the skin secretions of frogs and toads are being studied for their human benefits – everything from non-addictive pain killers to cancer cures. Frogs have been an important part of biology education for centuries.

- Culturally significant

Frogs play an important role in the culture.

http://arkansasfrogsandtoads.org/frog-toad-basics/

KEYWORDS

Tadpoles, froglet, eggs, adult, plants, insects

## MATERIAL

Posters on frogs and toad, documentary

## METHOD

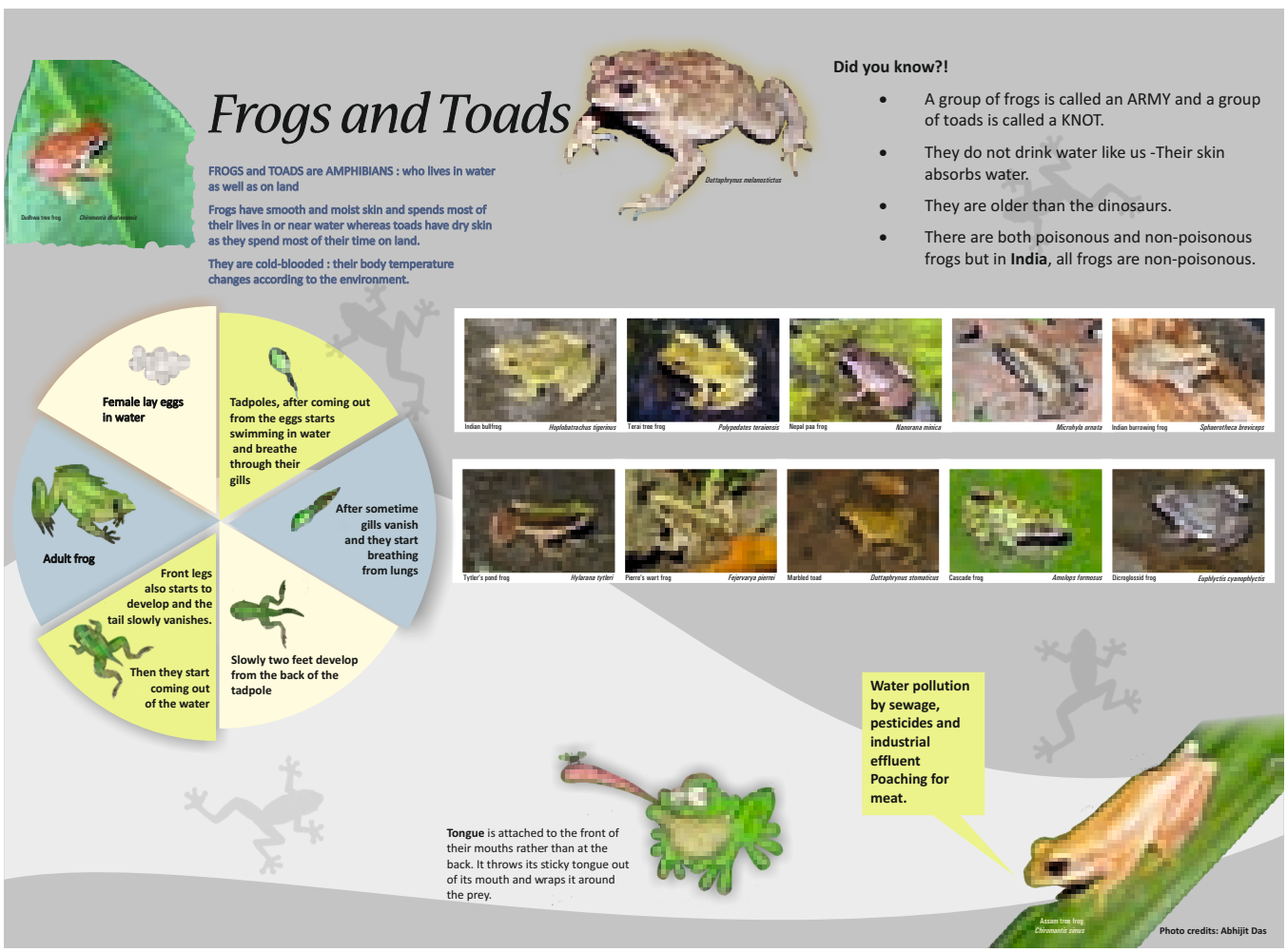
Students watch a documentary on the lifecycle of a frog.

## PROCEDURE

- Show a documentary on 'life of a frog' to the students and explain them how a frog transforms from a tadpole to an adult one.
- Also take them to a nearby wetland or puddles during rainy season and make them observe the different size of frogs and tadpoles.

## EVALUATION

1. Draw the life cycle of a frog.
2. List down different habitats where frogs and toads live during their lives.




Poster showing frog species found in Ganga

# ACTIVITY 11

# HOW YOU SEE YOUR RIVER GANGA?

## OBJECTIVE

Students will be able to portray how they see river Ganga.

## METHOD

Students make drawings of the river with the different components both natural and cultural.

## MATERIAL

A3/A4 drawing sheets, colours

## PROCEDURE

- Give A3 or A4 size drawing papers to the students and ask them to draw and color a landscape of Ganga River as per their understanding.
- Select few best colored sheets and display them on the bulletin board under the title 'Ganga Corner'.

# ACTIVITY 12

# LETS DO ORIGAMI

## OBJECTIVE

Students will be able to make animals of ganga by using the art of origami.

## METHOD

Students make paper animals.

## MATERIAL

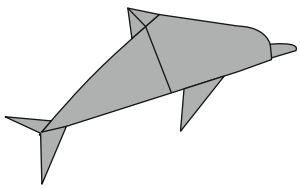
Origami sheets, marker, colors (any medium).

## PROCEDURE

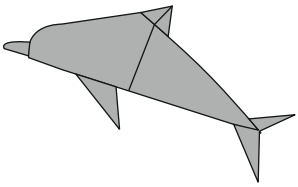
- Distribute origami papers amongst the students.
- Teacher will fold a paper step by step as shown in the diagram and students will follow him/her.
- Students can customize their paper animal by coloring them.

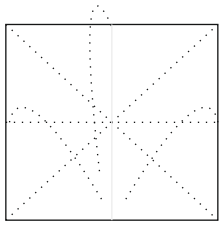
## EVALUATION

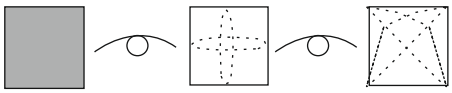
- Are the origami animals identifiable by the students?
- Ask how many things/facts do the students know about these animals.

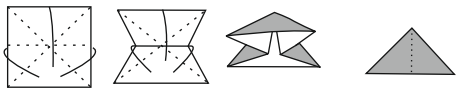


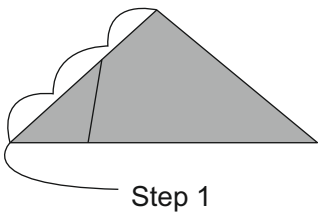
# DOLPHIN



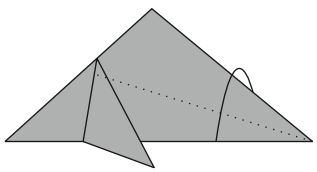




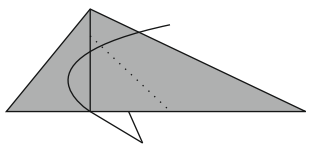




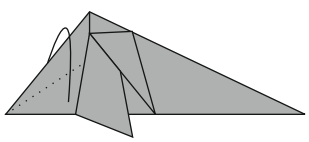
Step 1



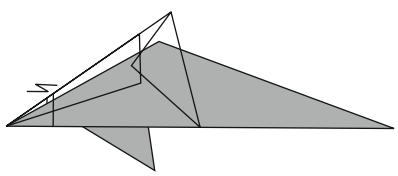
Step 2



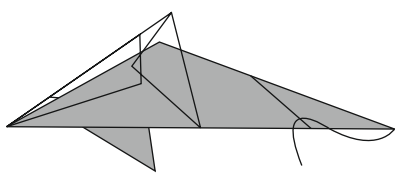
Step 3



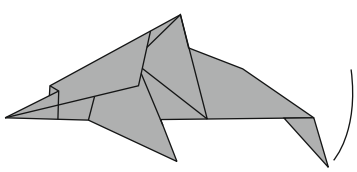
Step 4



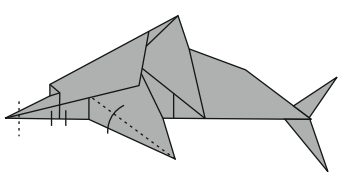
Step 5



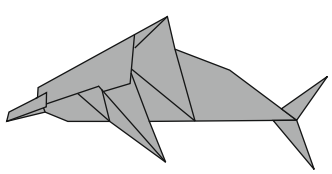
Step 6



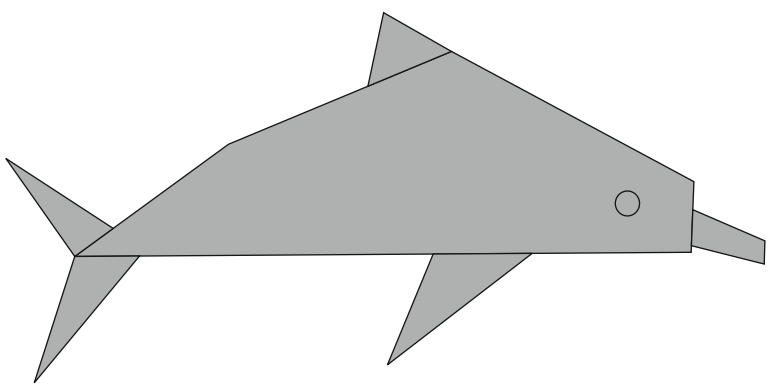
Step 7



Step 8

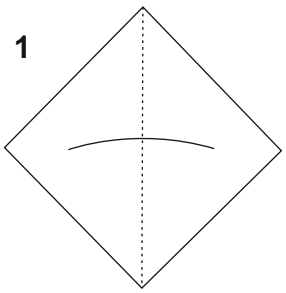


Step 9



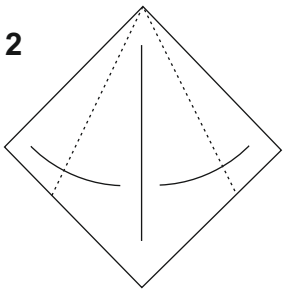
# GHARIAL

1



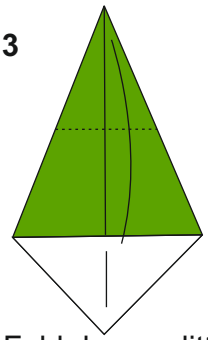
Fold and unfold

2



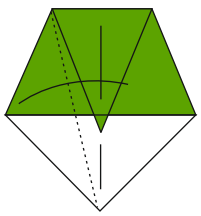
Fold to the center

3

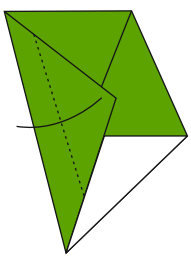


Fold down a little below the dot

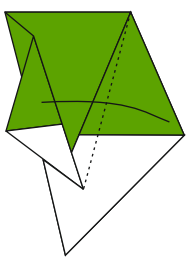
4



5

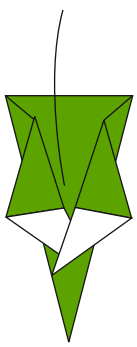


6



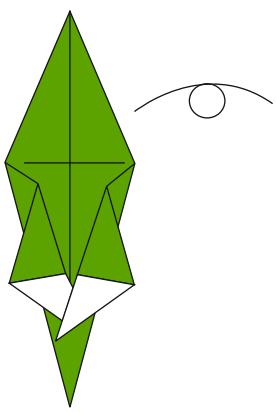
Repeat steps 4-5 on the right

7

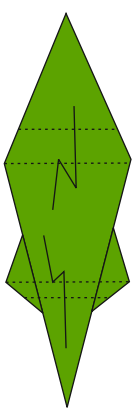


Pull out the hidden flap

8

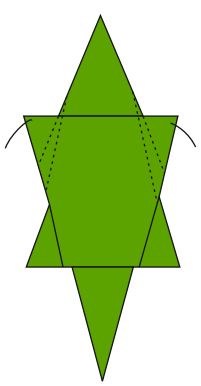


9



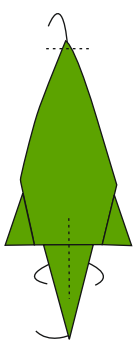
Pleat folds

10



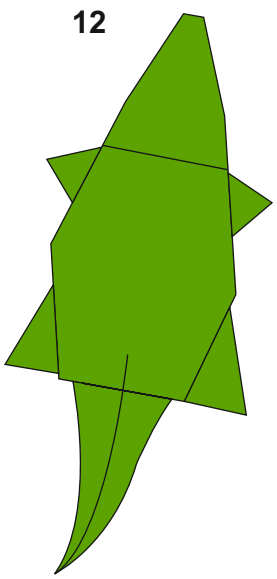
Pleat folds

11



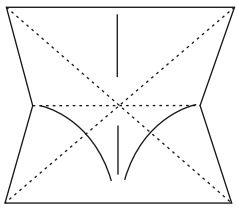
1. Fold the tip behind
2. Bend and curl the tail a little bit

12

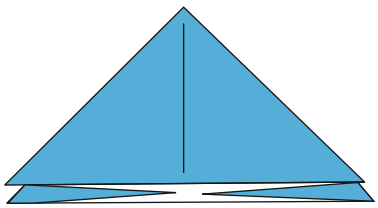


# FISH

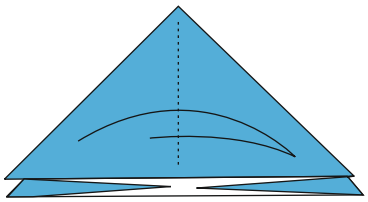
Begin with a waterbomb base



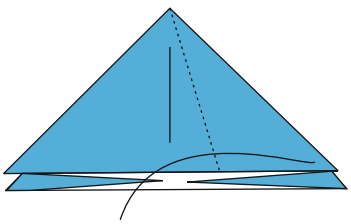
Step 1



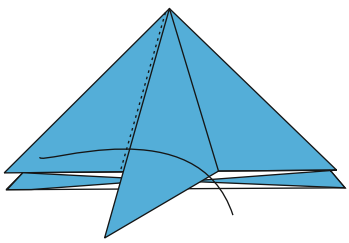
Step 2



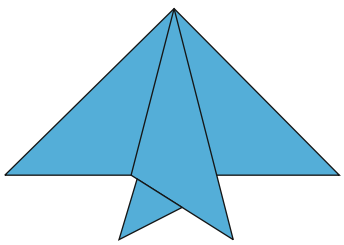
Step 3



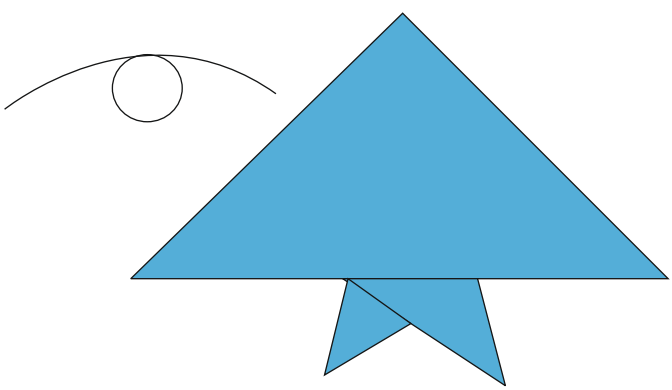
Step 4



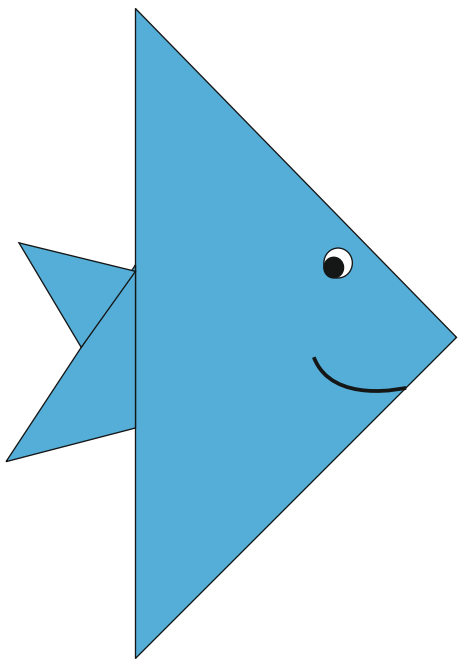
Step 5



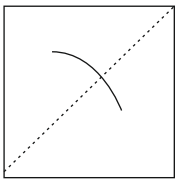
Step 6



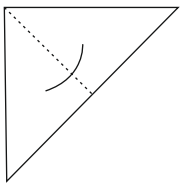
Step 7



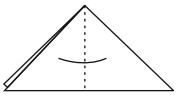
# SARUS



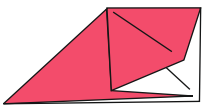
Step 1



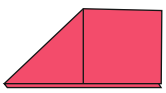
Step 2



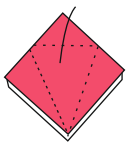
Step 3



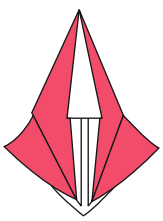
Step 4



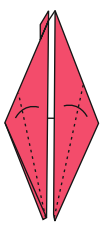
Step 5



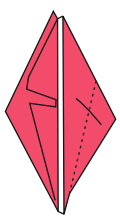
Step 6



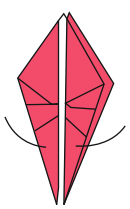
Step 7



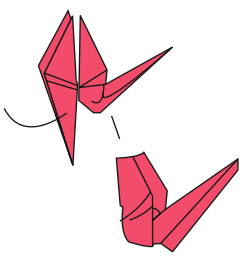
Step 8



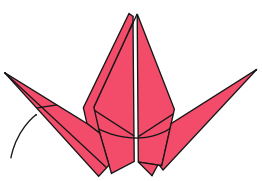
Step 9



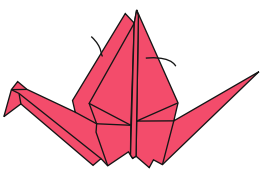
Step 10



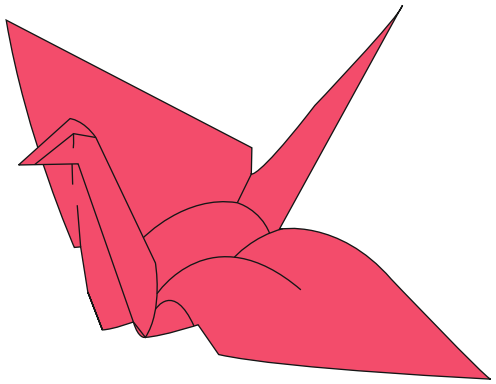
Step 11



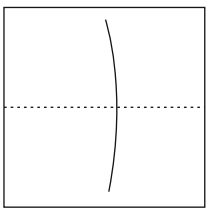
Step 12



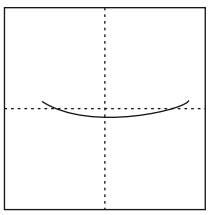
Step 13



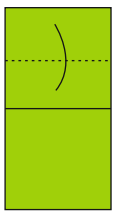
# FROG



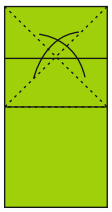
Step 1



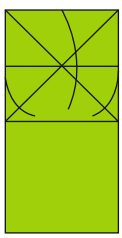
Step 2

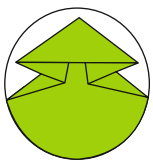


Step 3

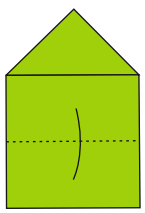


Step 4

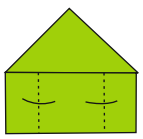




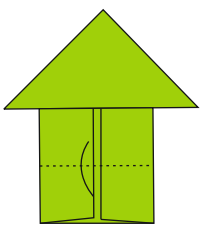
Step 5



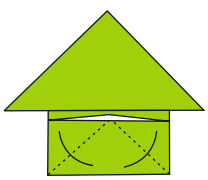
Step 6



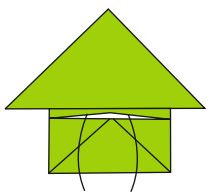
Step 7



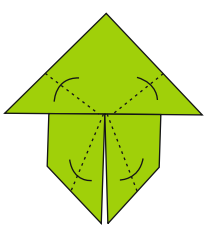
Step 8



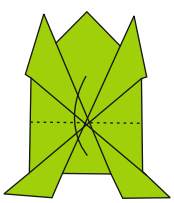
Step 9



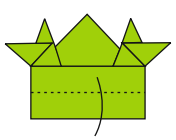
Step 10



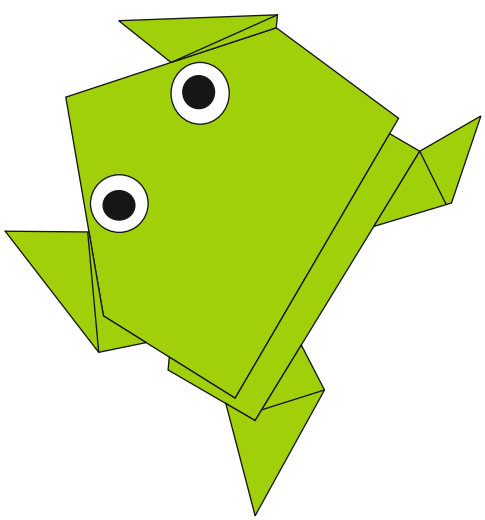
Step 11

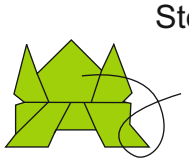


Step 12



Step 13





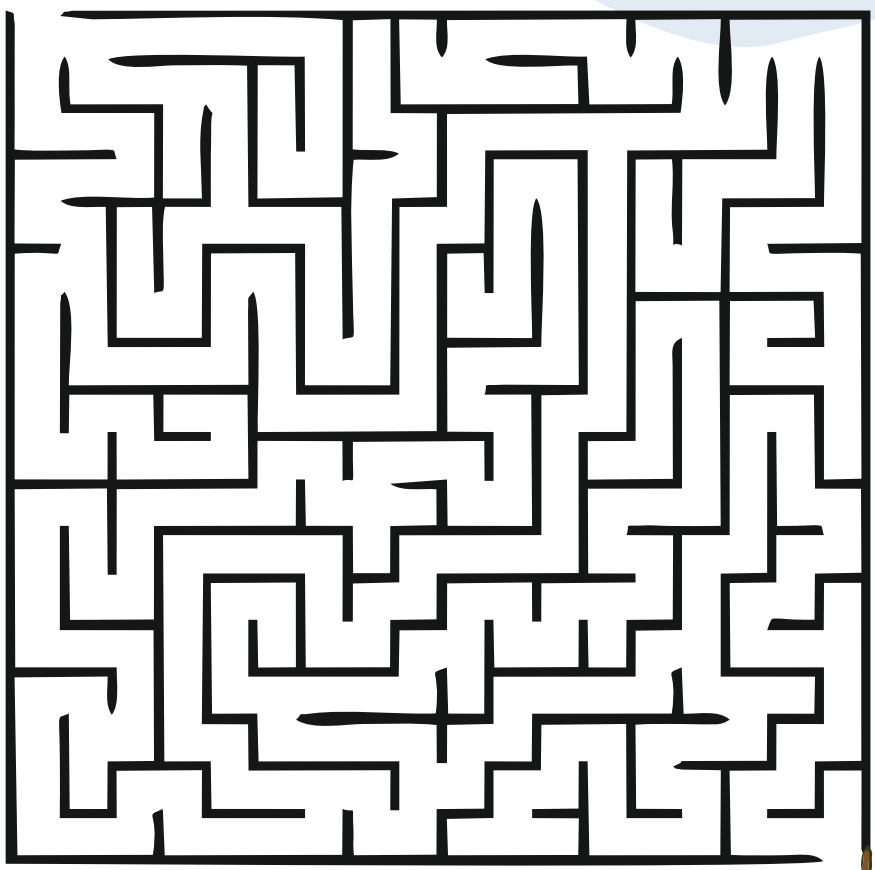
Step 14

# WORKSHEETS

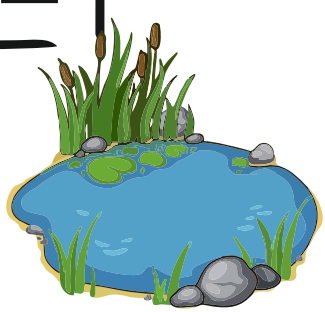
# Finding way out!

Hi friends!
I need to reach the safe water pond out there, but the chemicals from farmlands have made my life miserable.
Please help me in crossing the maze.

START

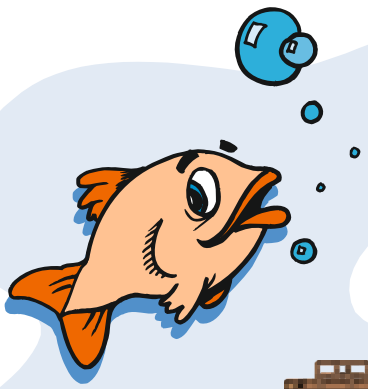


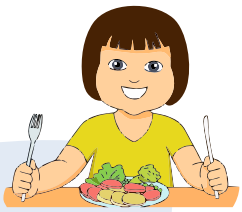
FINISH



Indian Bullfrog (*Hoplobatrachus tigerinus*)
This species is found throughout most wetland areas of India.
Water pollution is a potential threat to this species which may lead to decline in their numbers.

# Ways to Prevent Pollution





## MATCH

1. Throw garbage in the proper places.

2. Reuse bags and containers.

3.Choose paper over plastic

4. Eat healthy food

5. Don't buy products in aerosol spray cans

6. Reduce, reuse and recycle

7. Use non-toxic cleaning materials

8. Use energy-saving lightbulbs like LED

9. Plant more trees and vegetation

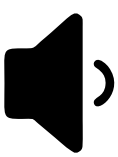
10. Keep the volume of your T.V., music low.

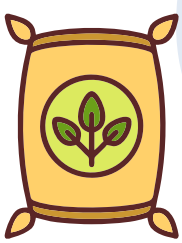
11. Avoid burning garbage

12. Don't smoke

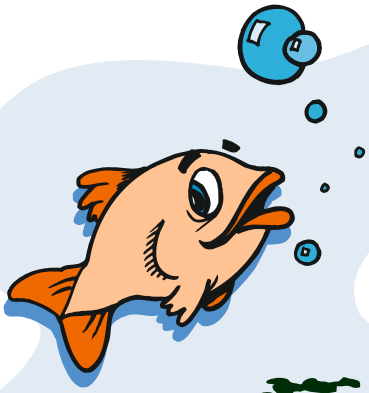
13. Buy biodegradable products

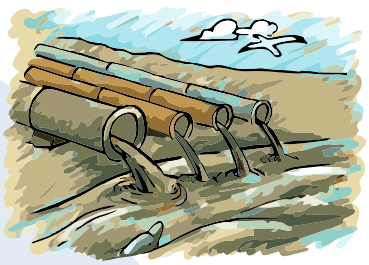
14. Try using natural fertilizers and pesticides





# Causes of Water Pollution

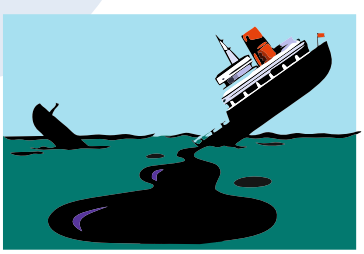


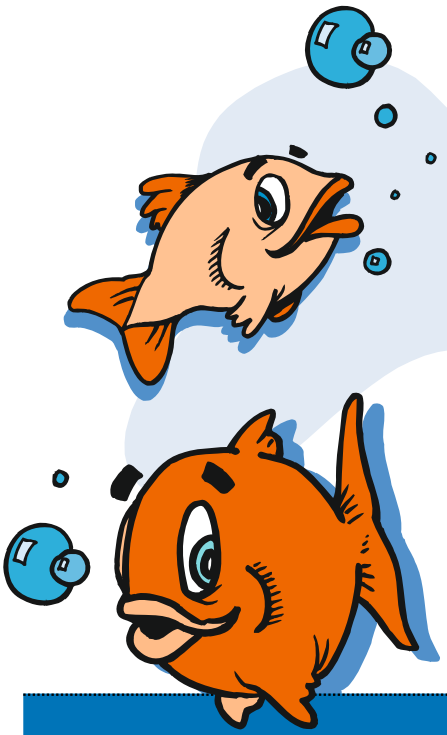


## MATCH

1. WASTE WATER
2. PLASTIC
3. FERTILIZIER
4. CHEMICALS
5. PESTICIDES
6. RADIOACTIVE WASTES
7. SHIPS
8. MARINE DUMPING
9. OIL POLLUTION
10. SEWAGE
11. INDUSTRIES
12. SANITARY WASTES
13. SOLID WASTES

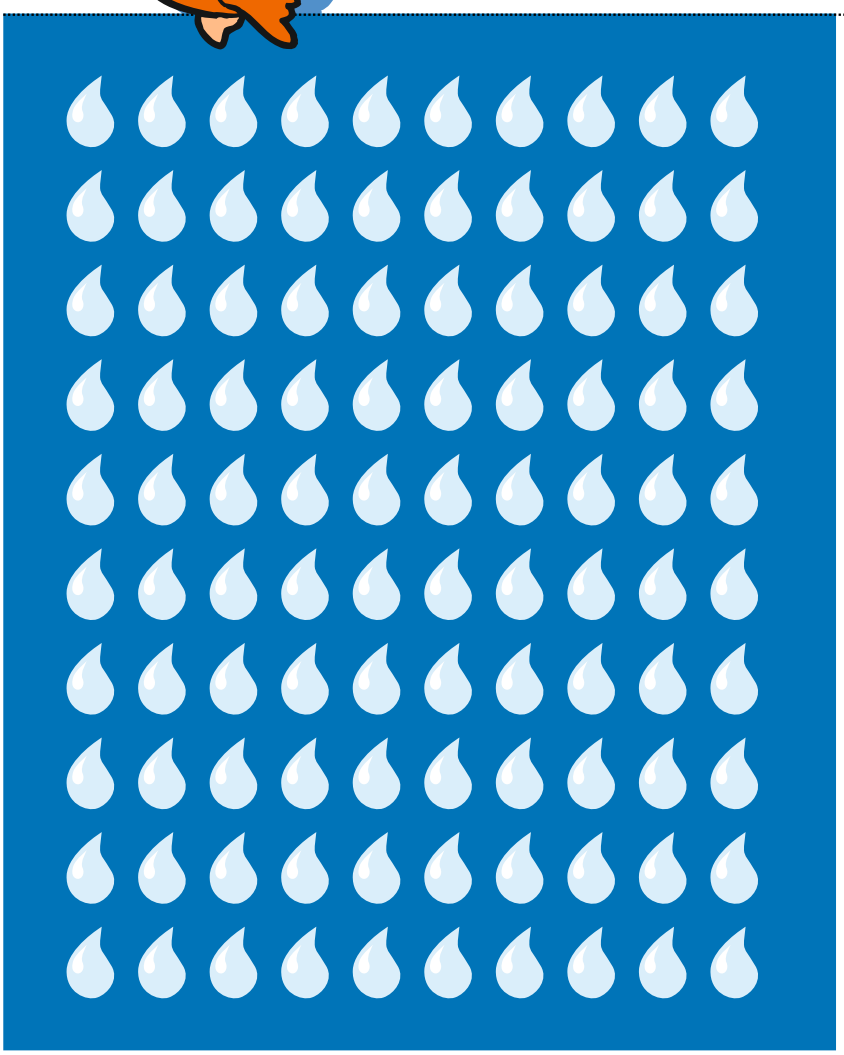






# Fresh Water

***Plants and animals that live on land need fresh water. Fresh water is water that does not have salt mixed with it. We can drink fresh water after treatment. Fresh water is found in lakes and reservoirs, streams and rivers. It falls as rain from storm clouds and is in the snowpack in mountains. Fresh water is found under ground as groundwater and frozen as ice in glaciers.***



## MATH FUN!

**All of something is 100%**
**97% of the water on Earth is salt water. 3% of the water on our planet is fresh water.**

**Here are 10 rows of 10 water drops. How many water drops are there? 10 X 10**

**Color 97 of the drops green to show salt water.**

**Color 3 of the drops blue to show fresh water.**

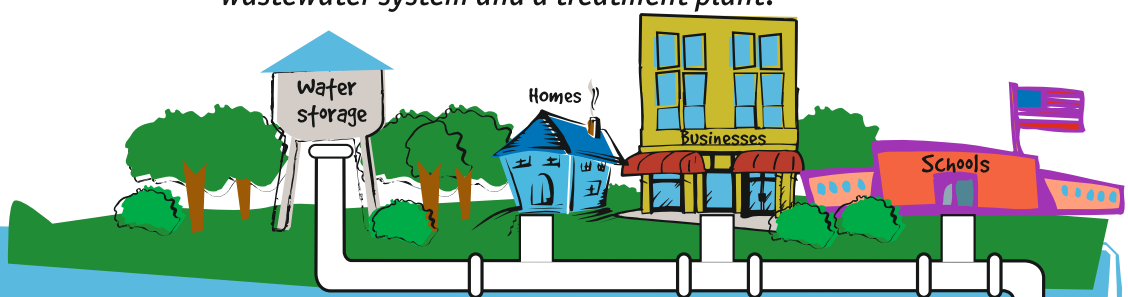
-Adapted from ***Understanding Water - Activity Book***
Colorado Foundation for Agriculture.

# Water Supply

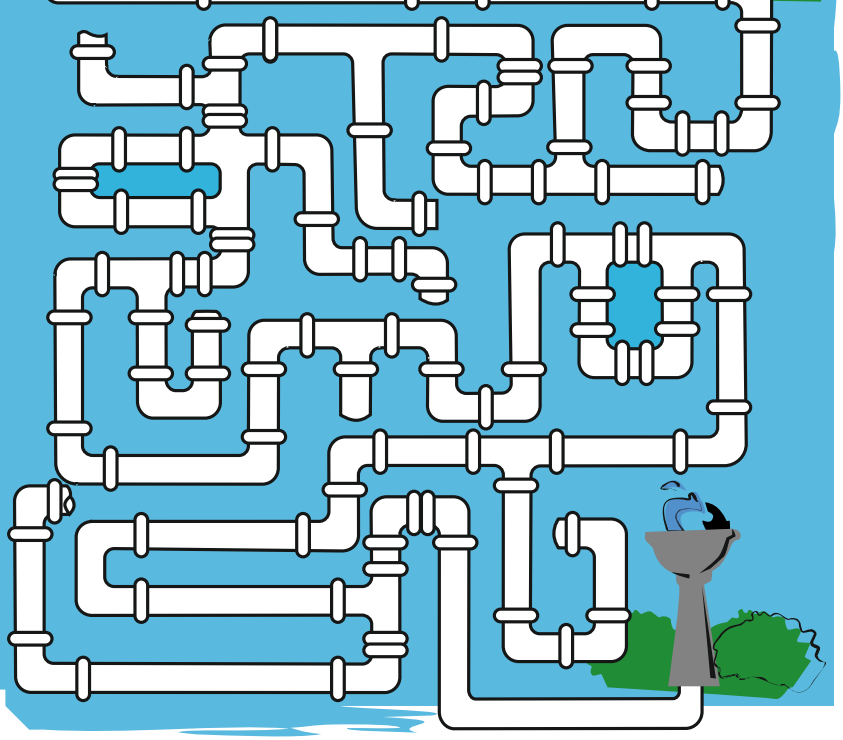
**Water is used over and over** – *as many as five to seven times – before it flows out of Colorado. Someone else uses your water – before and after you! We hose it, flush it, bathe in it, drink it and more. In fact, water is used and cleaned many times over as it makes it way through our state.*

*Communities will use water in many ways. Water that is used inside our homes, schools and businesses will be cleaned and put back into the streams for other uses.*

*Most communities have a storage system, a delivery system, a wastewater system and a treatment plant.*




A lot of water moves from place to place under the ground. Find the right pipes to take the water from the storage tower to the fountain.



-Adapted from ***Understanding Water - Activity Book***, Colorado Foundation for Agriculture.

# Water Pollution?

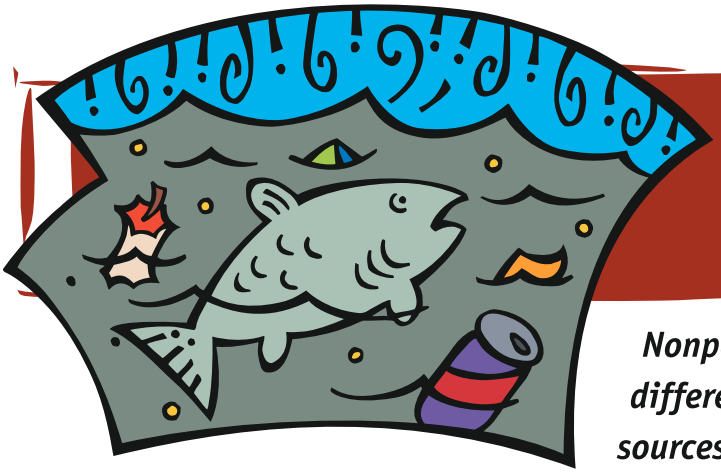
What do you think of when you hear or read the word pollution?

There are two types of water pollution:
point source pollution
and nonpoint source pollution.

## Point source pollution

*Point source pollution can be traced to one source. You can easily identify its source. You can point at sewage flowing from broken pipes or see waste materials coming from a factory. Laws have been passed to stop this type of pollution. In addition to paying fines for breaking the law, polluters must clean polluted water before it goes back into rivers.*

-Adapted from ***Understanding Water - Activity Book***, Colorado Foundation for Agriculture.



# Nonpoint source pollution

*Nonpoint source pollution comes from many different sources. There are many possible sources of the dirty "stuff" in streams and lakes. For example, each time it rains, runoff from the street picks up litter, motor oil, pet (animal) waste, leaves, grass clippings and spilled chemicals. These things are washed into storm drains and make their way to our rivers and streams.*

*Nonpoint source pollution (NPS) is also runoff from rainfall and snowmelt moving over and through the ground. The runoff carries natural and human-made pollutants into lakes, rivers, streams, wetlands and other water systems.*

*Nonpoint source pollution existed even before people started building roads, houses and businesses. Heavy rains carry dirt, soil and other things into rivers and streams.*

Each time it rains, runoff from the street picks up litter, motor oil, pet (animal) waste, leaves, grass clippings and spilled chemicals.

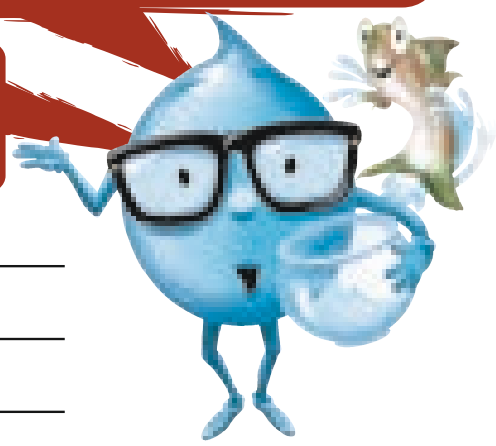
Circle the items that can pollute water.

| | | |
|---|---|---|
| SOIL | MOTOR OIL | BOTTLES |
| PAINT | LITTER | PET WASTE |
| GASOLINE | LEAVES | CHEMICALS |
| PAPER | CANS | ABANDONED CARS |

-Adapted from ***Understanding Water - Activity Book***, Colorado Foundation for Agriculture.

## What do you see in the picture?

## How can we help the fish?

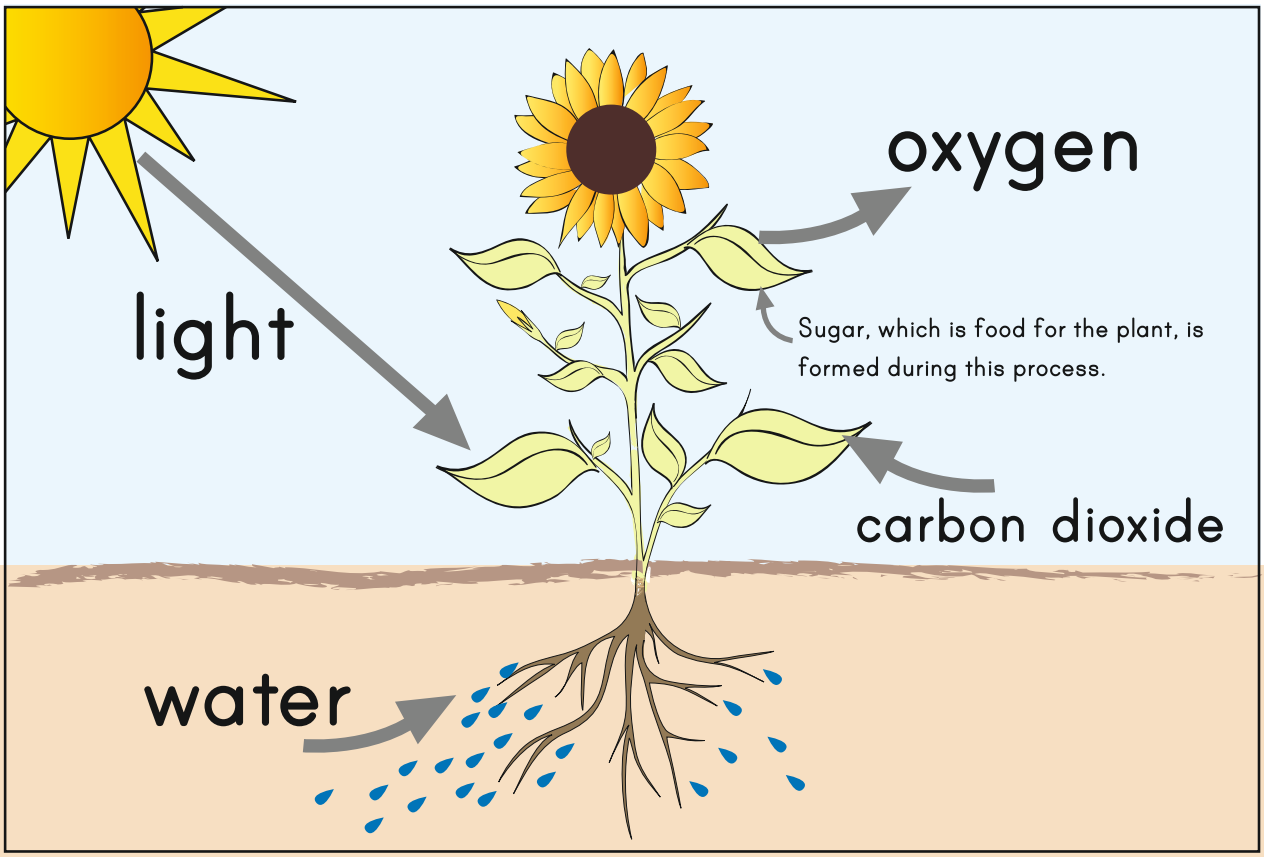


*The Environmental Protection Agency (EPA) says that nonpoint sources are the main cause of our water pollution*

-Adapted from ***Understanding Water - Activity Book***, Colorado Foundation for Agriculture.

# what is Photosynthesis

Look at the picture and fill in the blanks using the words at the bottom of the page.




Photosynthesis is a process where plants use _____ from the sun to convert _____ from the air and _____ from the soil into _____ to feed the plant and _____ is given out in the air.

| water, | sugar, | carbon dioxide, | light, | oxygen |
|---|---|---|---|---|

# BIBLIOGRAPHY

Das, I. (1995). Turtles and tortoises of India. Oxford University Press.

Educator's Guide: Lesson Plans and Activities for the North Carolina River Basin Materials (http://www.eenorthcarolina.org/)

Jayaram, K. C. (1999). The freshwater fishes of the Indian region.

Ken, V. and Pauline, S. (1993). Connecting People and Nature: A Teacher's Guide. Great Smoky Mountain Institute at Tremont.

Project Wild: Elementary Activity Guide, (1983,1985, 1986)., Western Regional Environmental Education Council, U. S. A.

Project Wild: Secondary Activity Guide, (1983,1985, 1986)., Western Regional Environmental Education Council, U. S. A

Rao, R. J. (2001). Biological resources of the Ganga river, India. *Hydrobiologia*, *458*(1-3), 159-168.

Robin L. Welcomme and T. Petr. (2003). Proceedings Of The Second Internationa Symposium On The Management Of Large Rivers For Fisheries., VOL. 1, Sustaining Livelihoods and Biodiversity in the New Millennium, Phnom Penh, Kingdom of Cambodia.

**Websites Consulted**

censusindia.gov.in

Colorado Foundation for Agriculture (www.growingyourfuture.com)

maps.iucnredlist.org

nmcg.nic.in

www.ctriver.org

www.ecoindia.com

www.education.com

www.iucnredlist.org

www.mapsofindia.com

www.otterspecialistgroup.org

http://www.arkive.org/smooth-coated-otter/lutrogale-perspicillata/

http://www.otterspecialistgroup.org/Species/Lutrogale_perspicillata.html

http://maps.iucnredlist.org/map.html?id=1242


WILDLIFE INSTITUTE OF INDIA
Chandrabani, Dehradun - 248003
Uttarakhand, India

Tel: +91 135 2640114-15
+91 135 2646100
Fax: +91 135 2640117