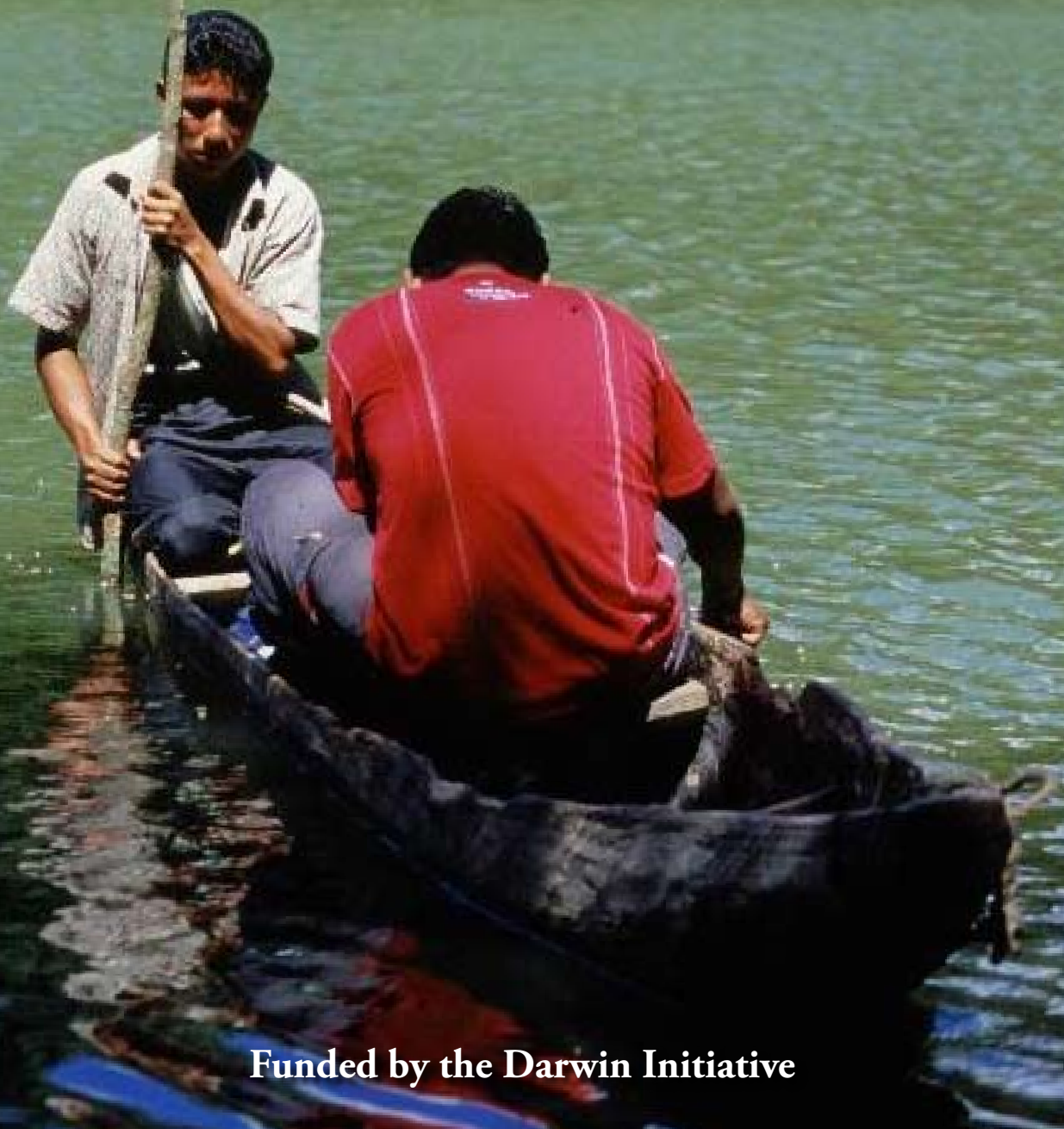


Wetlands Education

Teachers Lesson Plan Guide
Grades Five & Six



Funded by the Darwin Initiative

Darwin Initiative Guyana Partnership

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Forward

The Darwin-Initiative Wetlands Project recognizes the importance of education and public awareness at all levels – youth and adults, as all members of society are responsible for the protection of wetlands and the management of the many resources within them. The ultimate goal of these lesson guides is to educate future generations of leaders about wetlands and the importance of these systems to the region, nation and the world. Emphasis therefore is placed on providing an understanding of the many relationships between people and the environment using wetlands as an example. Wetlands are everywhere in Guyana and people interact with them every day in some way or the other.

The lessons outlined help to identify the links between human activities taking place in wetlands, such as burning and waste disposal, and natural wetland processes, such as the water cycle and food chains/webs. There are four (4) themes under which the lesson plans have been developed. These are:

- (a) Wetlands – These ecosystems are very dynamic in nature and provide ongoing ecological and social services. They are generally highly productive and so support a very high plant and animal diversity. People all around the world depend on wetlands in one way or the other - food, income or recreation.
- (b) Pollution – The importance of proper disposal of garbage and the consequences of littering in the environment is an ever-growing concern in Guyana and the rest of the world. Nature has a natural way of breaking down materials and reusing them in the environment. This occurs over a period of time. Wetlands play an important role in naturally processing waste, as they act as filters of pollutants. However, overall, we are producing far more waste than we can get rid of it, and there are many waste products that wetlands cannot process. The importance of the 3Rs (Reuse, Recycle, Reduce) is therefore becoming an important practice as a means of waste management.
- (c) Fire – Burning is a significant land use practice that takes place in the savannas and farming areas surrounding wetlands. Many times, fires are recognized only as having a negative effect on the environment, including soil erosion and subsequent run-off into wetlands. However, fire also has positive affects on key ecological processes, such as nutrient recycling, and if used effectively, can provide important services to people.
- (d) Biodiversity loss and extinction – Wetlands support a huge range of plant and animal life which play significant ecological roles and also a social function through, for example, ecotourism. With an appreciation for the natural resources around us, it becomes evident that many species may be affected as a result of human activities. By understanding the role of individual species and their link to the overall health of the environment by virtue of their ecological relationships, the need for their survival would be far more appreciated.

The material in the following pages are meant to supplement learning of topics within the Primary School Curriculum for Grades Five and Six respectively in the areas of Science, Social Studies, English and Mathematics. Resource sheets have also been provided for each of the lesson plan guides. These will provide you with an overview of the topics to be covered.

This document has been internally reviewed by the Ministry of Education through the National Centre for Educational Resource Development (NCERD) and NCERD fully supports this initiative.

Wetlands



Wetland ecosystems are very dynamic in nature and provide ongoing ecological and social services. They are generally highly productive and so support a very high plant and animal diversity. People all around the world depend on wetlands in one way or the other - food, income or recreation.

Purpose of Lessons

At the end of these lessons, students will have knowledge of:

- what are wetlands?
- why wetlands are important?
- threats to wetlands
- the services provided by water in wetlands

WETLAND ECOSYSTEMS

Concept: Wetland ecosystems are important.

Resource sheets:

- 1.a. Wetlands are wonderful;
- 1.b. Wetlands are important

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
What are Wetlands?	<ul style="list-style-type: none"> - Understanding the basic types of wetlands - Understanding the role in supporting all forms of life – both plant and animals. 	Resource Sheet 1.a.	Students draw a scene of 'wetlands area and the life it supports' that they can relate to (flooded savannas or mangroves for example).	ART; SCIENCE
	<ul style="list-style-type: none"> - Understanding why wetlands are important ecosystems 	Resource Sheet 1.b.	Students write a short essay on how they think wetlands are helpful to humans.	ENGLISH; SCIENCE

Resource Sheet 1.a. Wetlands are wonderful

Wetlands are defined by the Ramsar Convention on Wetlands (1971) as “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.”

In more general terms, wetlands are areas that are either permanently flooded or flooded only during certain times of the year. Some exist along coastal plains while others are inland. The North Rupununi region is an excellent example of a freshwater wetland ecosystem found right here in Guyana. This area covers a wide area of both forested and savanna regions. Some areas are flooded throughout the year while other areas are subject to flooding only during the rainy season.

Not so long ago, many people thought of wetlands as unhealthy, mosquito-infested wasteland, but over recent years it has become very evident that these ecosystems are important for plants, animals and humans alike. There are many types of wetlands which can be found all over the world. Each is unique in its own way, in terms of the hydrology and biodiversity it supports. In the North Rupununi, for example, there are flooded savanna ponds, permanent ponds, rivers and creeks. These are different from each other in their own way but generally serve the same vital functions of providing food, shelter, breeding grounds and many other roles for a great number of wildlife, as well as livelihood functions of food, income and recreation for people.

Many species of plants and animals depend on wetlands for their survival either totally or partially, year round or at specific times. These ecosystems are usually very productive which allow for such high biodiversity within them. Many species of plants and animals are specifically adapted to these habitats. For these species, there is a direct dependence on wetlands habitats. These would include fishes, amphibians, reptiles, birds, insects and even mammals. Fishes and amphibians depend directly on the water for spawning, laying of eggs and feeding. In some cases, flooding of wetland regions allows for movements of species from different areas so as to allow for genetic variation which is important in the survival of all species. Most insects depend on an aquatic environment during their life cycle. Many species of turtles and caimans also live in wetlands. Birds have great dependence on wetland ecosystems as they (wetlands) provide food, shelter and nesting areas for many species. Most importantly maybe, is the fact that thousands of migratory birds travel great distances every year from wintering countries to warmer climates to breed. Wetlands provide for such species every year.

Below is a list of some of the well-known species that can be found in Guyana that live in wetland ecosystems?

- Anaconda
- Arapaima
- Black Caiman
- Capybara
- Egrets
- Giant River Otter
- Giant River Turtle
- Hérons
- Ibises
- Jaburi Stork
- Manatees
- Spectacled Caiman

Resource Sheet 1.b. Wetlands are important

Not so long ago, wetlands were thought to be unhealthy and so they were easily and extensively destroyed. Little or no appreciation was then known for the ecological and social services they provide thus promoting healthy ecosystems. These dynamic ecosystems are providing many crucial services to say the least. They are also vital for life because they provide many resources such as: fish, shellfish, wild game, fruits, grains (like rice), firewood, fresh water, medicinal plants, construction material and many others.

Some of the services they provide include: climate regulation, flood protection, ground water replenishment, waste treatment, water purification, recycling of nutrients, storage and breakdown of pollutants and food web support. They also assist in climate regulation and storm protection. Wetland ecosystems are sometime referred to as sinks or reservoirs. This is partially due to the fact that water from higher ground all ends up in them. As a result, sediments and pollutants find themselves in wetlands. Wetlands also serve as storage of excess rainfall by retaining water which would otherwise cause flooding of other areas, and with climate change and rising sea levels, flood protection obtained from coastal wetlands, such as mangroves, becomes ever more important. The plants and trees in wetlands also help to slow the flow of water in general. At the same time, nutrients are constantly being recycled as they are utilized by the plants in wetlands and even pollutants are being 'absorbed' or broken down in the environment. Important also, is the fact that wetlands are constantly treating 'polluted water' and so replenishing Earth's groundwater supply which we depend on as the main source of freshwater.

These processes are all occurring simultaneously which support a wide array of organisms – both plant and animals – in an intricate web of life.

Wetlands – natural and artificial- have been the major source of food all over the world. We have been dependent on them for this service for as long as we can remember. With increasing populations across the world, this becomes an even greater task. These ecosystems support the production of fish and grains most importantly. Fish is maybe the most significant source of protein in the world today. Wetlands provide a wide variety of fish/shrimp populations for human consumption. In Guyana, the people of the North Rupununi depend greatly on wetlands for fishing as their main source of protein and as a livelihood activity. Crops such as rice, wheat, barley, and oats are all grown extensively for human consumption. They are especially adapted for growth in wetland areas. In many countries natural wetlands are used to grow these crops but in some cases, such as here in Guyana, areas are flooded (irrigation) to facilitate the growth of grains. Livestock such as cattle are usually reared near wetlands, as water is readily available and in some cases they can be used for grazing. For example, there are still a few communities in the North Rupununi that rear buffalo.

Wetlands are not just a source of food though. They provide a range of other resources that human populations depend on both locally and internationally. Some trees that grow in wetlands are used for a range of activities which include: construction, fuel, and handicraft and also - of much importance – medicinal uses. Construction materials may include the timber or the leaves which can be used for thatching. Many of the communities in the North Rupununi utilize the Ite and Kokrite palm tree leaves as thatching materials for their homes. Other parts of trees/plants such as their seeds are also used for handicraft purposes. Last but not least, wetlands provide a major source of medicinal plants for a selection of sicknesses and diseases.

Wetlands also have cultural importance including spiritual, inspirational, recreational, aesthetic and educational values. Finally, because so many service and opportunities are linked to wetlands it is no surprise that so many people find employment within them – as tourist guides, fishermen, farmers, researchers – and the list goes on. Wetlands will continue to provide these things and many more, so we must protect them!

WETLANDS ARE IN TROUBLE

Concept: Understanding the many threats to wetland ecosystems.

Resource sheets:

- 2.a. Threats to Wetlands;
- 2.b. There is hope for Wetlands!

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Threats to Wetlands	- Understanding the impacts of human activities on wetland ecosystems	Resource Sheet 2.a.	In small groups, students discuss a pre-selected negative impact that humans have on wetlands. Teachers will encourage everyone in the group to share their thoughts on the matter.	SCIENCE
	- Understanding how we can help to protect and maintain healthy wetland ecosystems.	Resource Sheet 2.b.	Each group can then make a short presentation to the class on their topic and give simple ideas/solutions as to how we can stop or prevent such impacts on the environment in general. Finally, students can identify a possible project to be done on World Wetlands Day (February 2 nd)	

Resource Sheet 2.a. Threats to Wetlands

Wetlands have been destroyed extensively in the past by human activity and this sadly continues to occur (see Box 1). In the past, water has been drained out of many wetlands and filled in for commercial and residential use. This is the case with much of the capital of Guyana – Georgetown. The entire area was in fact all coastal wetlands. The consequence of such activity was not comprehensible so many years ago. Now, we are recognizing the many positive roles wetlands play in the environment for human benefit. For example, Georgetown is now more prone to flooding as a result of wetlands destruction. We now rely heavily on man-made structures such as the seawalls and kokers or ‘sluice gates’ to prevent flooding. Development brings its own consequences. We must therefore plan carefully so as to reduce the possible negative impacts of such development.

Box 1: Case study of wetlands loss in the USA

Of the original 215 million acres of wetlands existing 200 years ago in continental United States, less than 100 million acres remain.

Wetland losses from the 1950’s to the 1970’s averaged about 458,000 acres per year. Agricultural development was responsible for about 87 percent of this loss. The remaining 100 million acres of wetlands in continental U.S. comprise an area about the size of California. Alaska has an estimated 170 to 200 million acres, while Hawaii has 52,000 acres. The remaining wetlands, in millions of acres, are (approximately):

- Coastal Wetlands - 5.1
- Inland Marshes and Wet Meadows - 28.6
- Inland Shrub Swamps - 10.4
- Inland Forested Wetlands - 46.3
- Other Inland Wetlands - 6.1

Source: National Audubon Society – web link: <http://www.audubon.org/campaign/wetland/destroy.html>

Even with this growing knowledge of their importance, they are still being threatened. Water pollution is the major threat to wetlands, and can come about through runoff of pesticides and herbicides from farmlands, industrial waste and even basic littering. Mining activities alongside rivers (even miles away) can also have an effect on wetlands as heavy metals such as mercury will eventually end up in wetlands. Although they are known for the ability to breakdown sewage and pollutants naturally, the amount that is currently being deposited in wetlands is far more than they can naturally deal with. As a result of all this water pollution, an unhealthy environment is created for the plants and animals within these wetland ecosystems. Eventually, the wildlife will either leave or die. Each animal within an ecosystem has a specific role to play. So the loss of certain species in wetlands is actually to their demise. Also, bioaccumulation (the accumulation of pollutants in the tissue of animals as it passes up the food chain) becomes inevitable. The higher it reaches in the food chain, the more concentrated it becomes and so more harm is done to wildlife in this way.

Over-harvesting is also a growing concern. Activities such as sports hunting, fishing and timber harvesting have not usually been monitored as carefully as it should and as a result, many wildlife populations have been known to decrease drastically or worse become extinct in an area. It is common to hear about illegal fishing, hunting and logging in such areas of high biodiversity. Sadly, the individuals who engage in such acts have little knowledge of the importance of the resource to the overall health of the ecosystem.

Resource Sheet 2.b. There is hope for Wetlands

Wetlands ecosystems are grossly underestimated for the many vital functions they play in helping to maintain a healthy ecosystem and with that providing services such as flood protection and water replenishment. Thankfully, in recognizing the uncountable benefits of wetlands to human populations around the world, we have been able to better manage and protect these precious ecosystems – locally and internationally.

Today, there now exists many laws and regulations that are intended to help save our remaining wetlands. Many organizations are working specifically to protect, preserve and restore wetlands all over the world. In fact there is the Ramsar Convention that seeks to conserve wetlands all over the world (Read Box 1. for more information).

Box 1

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 157 Contracting Parties to the Convention, with 1702 wetland sites, totalling 153 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance

Source: The Ramsar Convention on Wetlands website: <http://www.ramsar.org/>

Helping to promote an awareness of wetlands to human populations, the Ramsar Convention, every year on the February 2nd celebrates 'World Wetlands Day'. This date marks the date of the signing of the Convention on Wetlands on 2 February 1971. World Wetlands Day was first celebrated in 1997 by conservation agencies, non-governmental organizations, and environmental groups all over the world who took advantage of the opportunity to sensitize the public on the value of wetlands and the benefits they provide to society.

Local conservation-based organizations such as Iwokrama, World Wildlife Fund (WWF-Guianas), Environmental Protection Agency (EPA-Guyana), Conservation International and the Guyana Forestry Commission are all working towards the conservation and protection of wetland ecosystems in some way. Communities of the North Rupununi work along with these organizations and are taking the necessary steps to better manage and protect the wetlands for the invaluable services and resources they provide locally and to the entire world.

WATER ON PLANET EARTH

Concept: Understanding the natural processes that provide water on Earth.

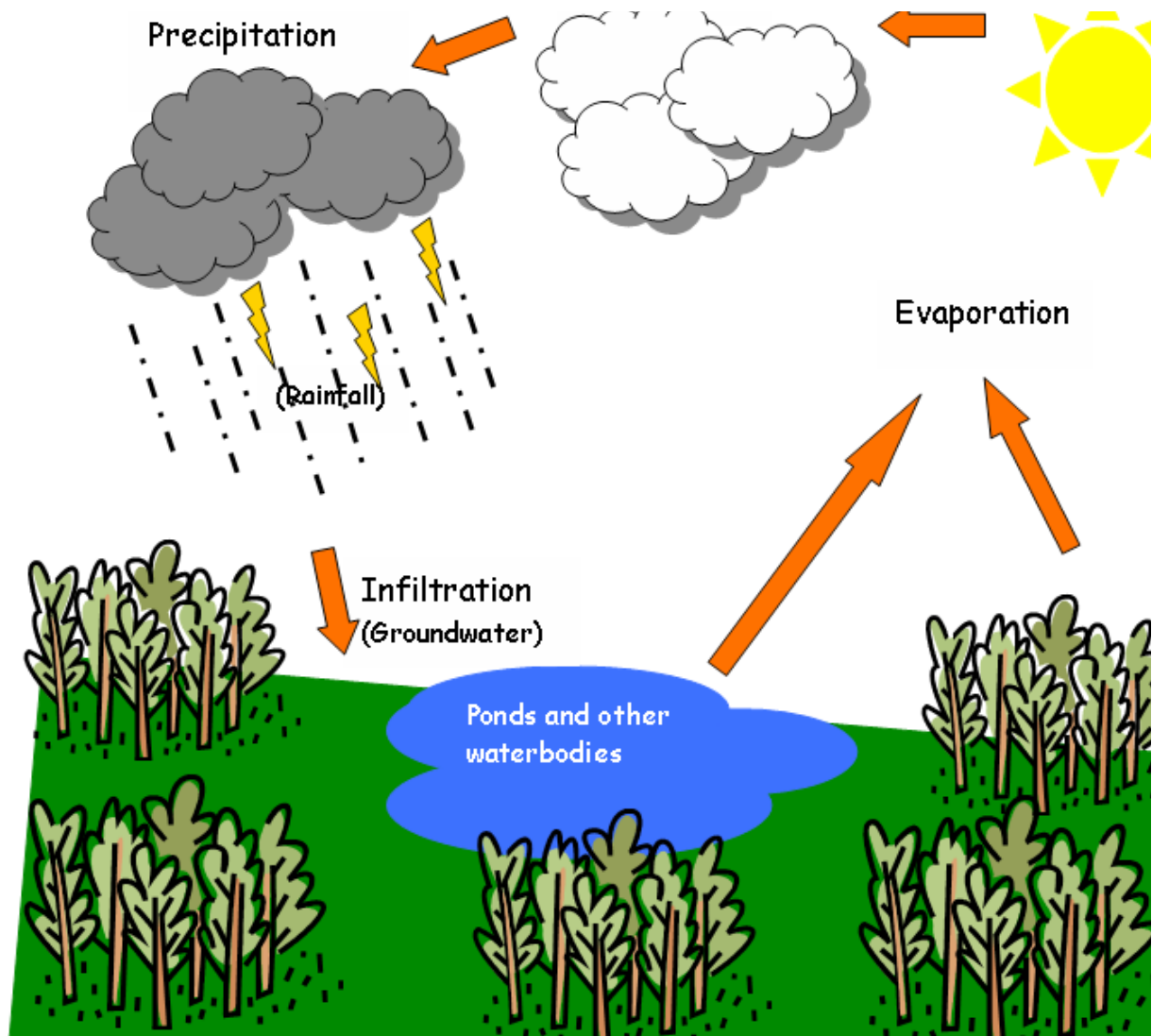
Resource sheets:

- 3.a. Diagram of the Water Cycle
- 3.b. The Water Cycle Explained
- 3.c. Effects of Flooding on the Environment due to Weather Patterns

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
The Water Cycle	- Understanding the different phases of the water cycle	Resource Sheet 3.a. & 3.b.	Students work collectively to create a collage of the water cycle process using different materials to represent water, clouds, rainfall, etc.	SCIENCE; ART
Weather Patterns	- Knowledge of the dry and rainy season in Guyana and specifically, the Rupununi Region	Resource Sheet 3.c.	Students are asked to write a short story essay on how flooding affected their home and family in the past.	SCIENCE
	- Knowledge of the effects of flooding on the environment	Resource Sheet 3.c.		SCIENCE; SOCIAL STUDIES

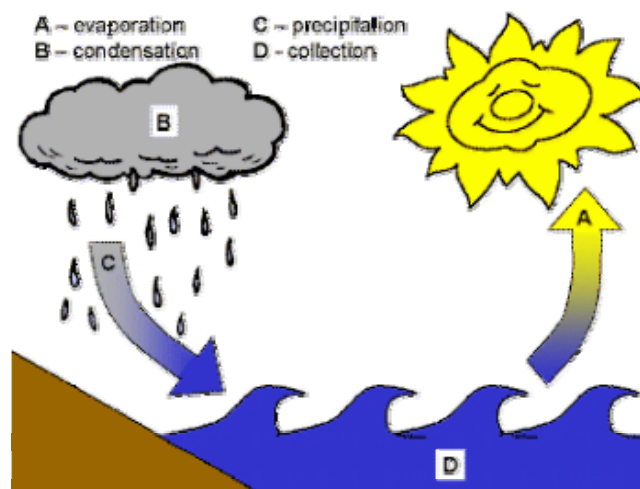
Resource Sheet 3.a. Diagram of the Water Cycle



Resource Sheet 3.b. The Water Cycle Explained

The Water Cycle is the Earth's natural process of recycling its water. It is essential for all life on Earth. Water is a liquid, but can also take the form of a gas (water vapor) and solid (ice). In reality, water is always changing from one form to another and this is an integral part of how the water cycle works. It is continually moving around, through, and above the Earth as water vapor, liquid water, and ice.

The water cycle consists of four (4) main processes. These are illustrated in the diagram of the water cycle below.



Evaporation: This process occurs when the sun heats up the water in the oceans, rivers and other waterbodies, causing liquid water to be transformed to its gaseous state as water vapor. In this form the water molecules will rise into the atmosphere. Plants also lose water this way through the process of transpiration where water is lost through their leaves.

Condensation: As water vapor (hot air) rises into the air, it gets cold and so will eventually change back into its liquid form. During this process clouds are formed.

Precipitation: As a result of condensation, more and more water vapor returns to its liquid state as the clouds are blown higher (over mountainous areas for example). Eventually, the clouds get so heavy that they cannot hold the water any longer. As a result, the water falls back to the Earth in the form of rain or in other countries – snow or hail. This process is referred to as precipitation.

Collection: Rainfall is essentially returning the water that was lost by the oceans and rivers and even plants through evaporation. When it falls back to Earth, the water is collected in several other processes. Some water rains directly back into the rivers and oceans obviously, but some rain also falls on land. On land, it is absorbed by the soil (a process known as infiltration) and may become part of the 'ground water' that plants and animals will utilize. Some water will also run over the surface of the soil directly back into the oceans, lakes or rivers where the cycle started in the first place.

The cycle then goes around all over again and has been the case for millions of years.

Resource Sheet 3.c. Effects of Flooding on the Environment due to weather patterns

Weather patterns in Guyana are seasonal, with rainy and dry seasons. The principal rainy season is from May to September with an average rainfall of 1780 mm. This however, is subject to a great deal of variation, particularly over recent years as the effects of global warming are slowly becoming pronounced. There is also a short raining season during late December/early January.

Data from the Iwokrama Forest indicates that the total annual rainfall usually varies from 1,400 – 3,000 mm (Source: Iwokrama: *Climate of the Iwokrama Forest- unpublished*). In the North Rupununi savannas, rainfall during the wet season months would usually be 300-400mm.

The main rivers within the area include the Rupununi, Rewa and Essequibo Rivers. During the rainy season, the Rupununi River floods into the surrounding savannas and forested areas. This flooding creates a large, unique wetland, which is an important feeding and spawning area for fish from the Essequibo and Rupununi systems. Flooding therefore supports ecosystems in many ways. It brings in nutrients that plants require, assists with the germination and dispersal of seeds and aids migration of fish, to name a few.

On the other hand, the people of the North Rupununi are often exposed to extreme difficulties during these flooded periods in the year. For example, transportation becomes even more difficult as many of the roads and trails are under water making them inaccessible. Communities need to rely on canoes or boats with engines to get from one point to another during this time. Flooding is also associated with damage to roads, buildings and other infrastructure. Of more concern however, are the health issues that may arise as a result of the flooding. Many water-borne diseases are known to be prevalent at such times. Mass populations of disease carriers, such as mosquitoes, are present in greater numbers as a result of ideal breeding conditions. (See Box 1)

Box 1

Taken from an article titled: 'The link between Environment and Disease' by Jane Lloyd.

As scientists look deeper into this phenomenon, they see a strong connection between extreme weather events and mosquito-borne diseases. In 2000, Mozambique was subjected to protracted flooding when it was hit by three cyclones, resulting in a "five-fold increase in malaria", said Dr. Epstein. In Kenya, environmental activist and 2004 Nobel Peace Prize Winner Wangari Mathaai found that the rise in the use of plastic bags could also be linked to incidences of malaria. Mr. Nuttall said that when littered plastic bags are filled with water, they become "a brand new habitat for mosquitoes that carry malaria".

Source: <http://www.un.org/Pubs/chronicle/2006/issue1/0106p68.htm>

Pollution



Nature has a natural way of breaking down materials and reusing them in the environment. This occurs over a period of time. Wetlands play an important role in naturally processing waste, as they act as filters of pollutants. However, overall, we are producing far more waste than we can get rid of it, and there are many waste products that wetlands cannot process. The importance of the 3Rs (Reuse, Recycle, Reduce) is therefore becoming an important practice as a means of waste management.

Purpose of Lessons

At the end of these lessons, students will have knowledge of:

- how to reduce waste that ends up in the environment (different sources and forms of pollution)
- threats and effects of pollution
- the role of wetlands in processing pollution
- how to combat pollution

LITTER BUGS

Concept: Identifying the existing rules for proper garbage disposal and littering, along with their respective penalties

Resource sheets:

- 1.a. Penalties for Littering in Guyana
- 1.b. Reducing Garbage
- 1.c. Methods of Garbage Disposal

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Penalties for littering	- Knowledge of the existing rules for the appropriate disposal of garbage.	Resource sheet 1.a.	In small groups students will make a list of the rules they are aware of as it pertains to littering. This can be followed by a group discussion led by the teacher.	SCIENCE
Litter-free Environment	- Understand the importance of recycling when possible.	Resource sheet 1.b.	(Class or Individually) Make a list of items that are usually thrown in the bin in your class or home. Should these items be reused, reduced or recycled? Have a column for each 'R' and make notes for each item.	SCIENCE
	- Understanding the different methods of disposal of garbage locally and their suitability.	Resource sheet 1.c.	Are any of these items found as litter in your local wetlands area?	SCIENCE

Resource Sheet 1.a. Penalties for littering in Guyana

Under the laws of Guyana, the Environmental Protection Act states: “Any person who throws down, abandons, drops or otherwise deposits or leaves anything in any manner whatsoever in circumstances as to contribute to, or tend to lead to litter shall be guilty of an offense...”

Over the years, Guyana has been faced with the ever increasing affects of littering. Several environmental NGOs constantly encourage environmental clubs and other youth groups to take an active role in helping to keep our country clean through involvement in local and international clean-ups and related community service. (Example: Ocean Conservancy International Coastal Clean-up where worldwide volunteers spend the day in a worthwhile effort to clean-up their environment – specifically coastal areas in this instance).

Ocean Conservancy’s International Coastal Cleanup is the largest and most successful volunteer event of its kind. Since 1986 thousands of volunteers from around the globe have cleared over 100 million pounds of trash from 170,000 miles of shorelines, rivers, lakes, and wetlands! (Ocean Conservancy, 2007)

But how does so much litter find itself in our environment including roads and waterways? Sadly, we are to blame. In fact, many persons in society are still not aware of the dangers and effects of littering (polluting) their environment. There are laws in place to help prevent littering but these may be unknown to most and/or not enforced firmly by the government.

Resource Sheet 1.b. Reducing Garbage

It can be agreed that for the longest while people have come to realize that we produce an extremely large amount of garbage every year. For this reason, we are being encouraged to do things such as recycle used products whenever possible so as to reduce the amount of items going into our garbage each year.

To produce less waste, the 3Rs method has been common in recent times and should be greatly encouraged. The three Rs stand for *Reduce*, *Reuse* and *Recycle*. By applying these 3 simple words to our everyday garbage disposal habits, we can greatly cut-down on a large quantity of items and materials that we normally dispose of in the garbage or by burning or burying.

'Reduce' is referring to the ways we can cut-back on the amount of things we dispose of in the garbage. This may include: purchasing only durable and long-lasting goods; reducing the amount of products that are packaged with materials that may be harmful to the environment. By doing this, we are in a small way helping to reduce the amount of garbage in the environment – believe it or not.

Reusing and recycling go hand in hand and can go a far way in helping to reduce the amount of garbage we dispose of in our homes, work or community. Common items in everyday situations which can be reused or recycled include: newspapers, aluminum foil, plastic bags or disposal cups and plates (plastics or styrofoam).

Note though that recycling is different from reusing as the material being recycled is used to make another product. For example, soft drink and juice aluminum tins may be 'recycled' by smelting the tins to make other products. Glass bottles, such as those used for the soft drinks, are being 'reused'. Recycling in some countries is a large-scale business to an extent that one of its benefits is employment. However, recycling can be done on a small-scale basis; in our households or schools for example. Compost is an obvious and common way of recycling. By recycling we are helping to conserve our natural resources by preventing emissions of many greenhouse gases and pollutants as well as saving energy and the supply of valuable raw materials to industries.

Resource Sheet 1.c. Methods of Garbage Disposal

If we take the time to calculate the amount of garbage a household produces yearly, it is more than likely that the results would be very alarming. Over the years, people have been negatively affected in a number of ways by the inappropriate disposal of garbage. Garbage can have direct and indirect affects on the environment and the people living there. Most commonly and obviously, dumping sites or landfills become a 'sore-eye' to the community and the smell from the decomposing process is sometimes very overbearing. In some instances, individuals are known to do mass dumping of materials in wetlands. For example, rubber tires are known to be found dumped in large quantities at certain spots along the seawalls in Georgetown. All sorts of items ranging from car wreckages to old electrical appliances can be found. This is not healthy at all – for both human life and the environment.

We have various means of disposing of garbage in an attempt to protect our environment. These methods include: (1) Incineration (burning) and (2) Landfills (burying), or a combination of both. Burning garbage is a common practice but even though it is generally an easy means of getting rid of garbage, it contributes to air pollution. It is important therefore to be careful of what garbage we burn. Burning of some items may even be an immediate danger to persons around as is the case with certain canisters that explode when exposed to extreme heat from fires.

Sometimes in small communities, it is common practice to dig holes for the dumping of garbage after which the hole is covered back with soil. In such cases, whatever garbage is buried is left to decompose. The problem with this is that as we have learned, not all material decomposes at the same rate as others. Also, harmful compounds may be released into the soil which can get into groundwater as the materials decompose. Furthermore, these 'dumping' sites attract rats and flies and other pests which may carry diseases and this overall encourages the spread of disease. Wetlands unfortunately provide prime breeding conditions for many insects that spread diseases.

It is important to select the best means of disposal of garbage in your community so as to promote and maintain a clean and healthy environment. But more appropriately, whenever possible we must attempt to reduce, reuse and recycle at all times.

WATER'S ROLE

Concept: Understanding the importance of water.

Resource sheets:

- 2.a. Importance of water
- 2.b. Water Pollution in the environment
- 2.c. Purification of water

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Importance of water	- Understanding why water is so important	Resource sheet 2.a.	In small groups students brainstorm the importance of water for them and their family. A list is produced on the blackboard for all to see. Then, as a class selected points (most important) can be used to create a spider diagram on cardboard: The importance of water.	SCIENCE
Water Pollution	- Understanding the sources of water pollution and the consequences of such on the environment	Resource sheet 2.b.	With a teacher, students visit a waterbody (it can be a trench, pond, canal, etc.) Students will ask themselves the question: what are some ways the pond is or may become polluted? (possible responses: littering & run-off)	SCIENCE

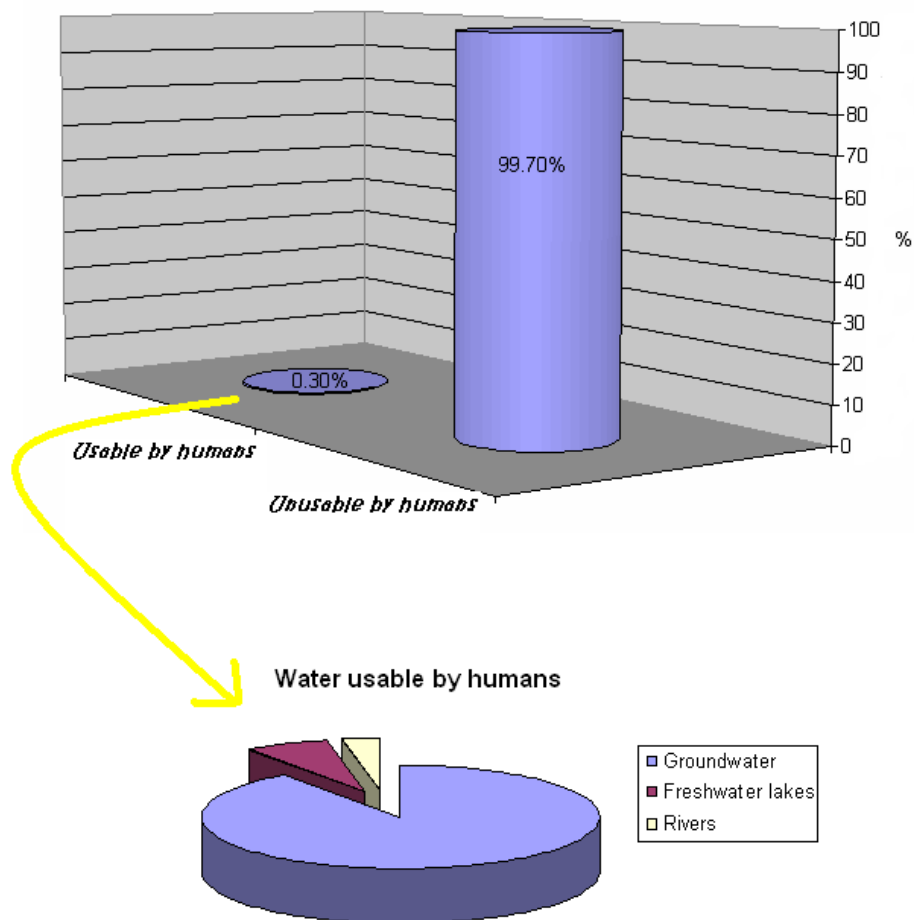
<p>Water Quality</p>	<p>- Knowledge of components such as dissolved/ suspended compounds in water and pH</p>	<p>Resource sheet 2.c. 3 transparent jars, Litmus paper & Universal pH Scale</p>	<p>A simple experiment is conducted to observe if there is any differences in the water from different sources (rainwater, pond, well, etc.) Water is collected and placed in separate clear glass jars and covered. Observations are made immediately and after an hour when the water settles.</p> <p>(if possible: the pH of the water in each glass can be tested) What conclusion can be made?</p>	<p>SCIENCE</p>
<p>Water Purification</p>	<p>- Knowledge of common methods used for purifying water</p>	<p>Resource sheet 2.d.</p>	<p>Art work: Individual students draw and colour a scene under the theme: 'Clean Drinking Water for All'</p>	<p>SCIENCE; ART</p>

Resource Sheet 2.a. Importance of water

It is understood that water has a natural way of recycling itself so that in essence it will always be present on Earth. Water is crucial for the survival of all living things on this Earth. Humans like most other living things, depend on water most importantly for drinking. We also need water for a number of other purposes such as cooking and washing. The type of water required for these purposes is freshwater. However, not all water on Earth is freshwater.

The fact is that approximately seventy (70%) of the Earth surface is known to be covered with water, but only a small fraction is available to us for consumption!

HOW MUCH OF EARTH'S WATER IS AVAILABLE TO US?



From the diagram above, it is quite clear that the amount of water available to us is very small compared to the total amount present on the entire Earth. Ground water accounts for the majority of the clean drinking water for our use. It is therefore, very important for us to manage these resources with the utmost care.

Think about some of the ways we may be wasting our water. In fact, we can save a lot of water by simply ensuring we do not leave the taps running continuously whilst having a bath or brushing our teeth.

Water plays a vital role in all life processes. Plants and animals alike are as dependent on water as humans are and without its presence, life on Earth would literally cease.

Resource Sheet 2.b. Water Pollution in the Environment

Water can be polluted when chemicals and other pollutants are dumped directly into it (see Box 1). But water can also be indirectly polluted when pollutants are deposited on land, which are then absorbed into the soil and then get into the Earth's ground water supply. This is very bad news as the majority of our freshwater comes from ground water. It is important to remember that the environment in which we live consists of many different things which are all linked to each other in some way or the other. The effects of any form of pollution can therefore be observed at all levels of the environment over a given period of time. Wetlands naturally play a role in purification of water and removal of high levels of nutrients and even toxic chemicals. However, an ecosystem can only manage a certain level of pollution. As a result, when the plants and other processes cannot manage anymore pollutants they are passed on to the next level which is the groundwater supply. These nutrients such as phosphorous and nitrogen and other harmful chemicals cannot be stopped

Box 1: Example of industrial accident and its effect on the environment

On August 20, 1995, Guyana and the world awoke to a mining disaster at the Omai gold mine, the largest open pit mine in South America, where the rupture of a dam released 839 million gallons of waste water laced with cyanide and other heavy metals into the Omai and Essequibo rivers of the Amazon River basin. The amount of waste water released was reported to be the equivalent of a one kilometer high tank with a base the length and width of a football field.

The wastes included cyanide and heavy metals and local residents along the Essequibo River were immediately asked not to use the river water or catch fish -- the livelihood of many of the Amerindian communities in the area. As a result of this disaster hundreds of fishes and other aquatic life were harmed or killed. (Source: Saxakali Magazine, 1996)

The effects of this disaster would have been felt for years by the people living in the communities along the river. With the water contaminated, fish being the primary source of protein, would have no longer been safe for consumption, and water from the river and even near-by ponds could not have been safe to use for washing or cooking.

from entering the groundwater supply at this stage.

Wetland habitats and the animal and plant life they support, would obviously be the first to be affected by water pollution. The severity of the impacts would depend on the nature of the pollutant itself and concentration in the environment. Water can become polluted as a result of many factors. Industrial pollution is a great contributor to water pollution where waste products in the form of 'run-off' is usually released directly into rivers and coastal wetlands. In some cases, industrial accidents may occur, such as an oil spill, which usually results in the death of much aquatic life. Even small-scale activities, such as mining, are having an increasing impact on river and creek ecosystems. This is due to the use of heavy metals such as mercury in the processing of raw gold.

Use of chemicals such as pesticides, insecticides and herbicides in agricultural practices also contribute to pollution in wetlands. Some farmers use such chemicals to control harmful insects, pests and weeds that affect the overall productivity of their crop. Sadly, many times too much is used so as when rain falls these chemicals are washed off the treated plants and eventually get into the water via run-off or leaching.

Resource Sheet 2.c. Purification of water

Water is naturally being filtered and purified through aquifers which are underground layers of sand and gravel through which water is constantly passing and may be released in a spring or well. Plants found within wetlands help to purify water by removing high concentrations of nitrogen and phosphorus and some may even remove and store toxic chemicals. In this way, water with high levels of nutrients and toxic chemicals are purified before they enter the 'groundwater' supply.

In the Rupununi, for example, everyday use of water is primarily from the rivers, rainfall or ground wells. However, because of water pollution it is important to know how to purify water ourselves. Even for those areas with pipe systems bringing treated water directly to homes, certain events such as flooding may cause the water to become contaminated. Purification is therefore necessary.

Before we continue, let us clarify the meaning of these two (2) words: *filter* and *purify*. Filtering water has to do with the removal of those particles and other matter that are visible to us. For example, when one pulls up a bucket of water from a well it would usually have particles floating around in it. In such a case, the water is allowed to 'settle' which allows those suspended particles to settle at the bottom of the bucket or container. Alternatively, the water can be filtered using a piece of cloth or thin mesh material.

However, it is important to note that filtering water does not necessarily mean that water is safe to drink or for use in cooking. Why? The answer is that the water may still have 'invisible' or microscopic bacteria, germs and other harmful elements that were not removed by the simple filtering process. The proper and best way of getting rid of these things would be to purify the water.

Purification of water is very important when it comes to the use of water for human consumption. There are three main methods of purifying water.

- (1)**Boiling** - Water can be placed in a pot and heated until it begins to boil; after which it should be left for a further five minutes. At the boiling point of water (100 degrees Celsius), most if not all bacteria and germs are destroyed. After being left to cool, this water can be considered safe to drink.
- (2)**Adding Chlorine/Bleach** – A standard ratio is used to determine how much chlorine is to be added to water (i.e. one drop of Chlorine to every gallon of water). After the chlorine is added, the water would be safe to use after about thirty minutes for consumption purposes.
- (3)**Adding Purification Tablets** – These vary but are similar to adding chlorine. They have a standard ratio and are found in a solid tablet form.

WATER TROUBLE

Concept: Understanding the link between flooding and disease

Resource sheets:

- 3.a. Insects and the Diseases they can spread to humans
- 3.b. Life Cycle of the Mosquito
- 3.c. Ways of reducing the spread of water borne diseases

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Harmful Insects	<ul style="list-style-type: none"> - Knowledge of different disease carriers and their dependence on water. - Knowledge of the basic life cycle of insects 	Resource sheet 3.a. Resource sheet 3.b.	In small groups students work on development a class poster showing the life cycle of an insect that can spread disease (mosquito or housefly for example)	SCIENCE
Water-Borne Diseases	<ul style="list-style-type: none"> - Knowledge of water borne diseases and the preventative methods that can be taken against their spread 	Resource Sheet 3.c.	In small groups students discuss the things they can do to prevent the spread of water-borne diseases. A list of precautions to be taken against water borne diseases is the output. Students come up with an 'action plan' to monitor all water sources around the school as it relates to the prevention of spread of water borne diseases.	SCIENCE

Resource Sheet 3.a. Insects and the diseases they can spread to humans

Insects are known to be very beneficial to man. For example, many act as pollinators (such as bees and butterflies) or even food (example honey from bees). On the other hand, there are a great number of ways in which insects become a threat to humans. This is as a result of their ability to carry and transmit many types of diseases to humans.

Insects are referred to as vectors. Vectors are carriers of bacteria and viruses that cause specific diseases in humans and other animals. A vector is an organism that does not cause disease itself but it helps to spread infections by conveying pathogens from one host to another.



In seasonally flooded areas such as the North Rupununi, mosquitoes are known to be present in great numbers. Some mosquitoes are the principle vectors of malaria. **Malaria** is a disease that is actually caused by protozoa (i.e. microscopic organism) that is present in the saliva of the female mosquito.

Mosquitoes are also the main vectors of the viruses that cause **Yellow Fever** and **Dengue**.



House flies are another well known insect that are generally considered harmful to human health. This has a great deal to do with the fact that they often live among filth and garbage. They are known to help in the spread of **Dysentery**, **Typhoid Fever** and **Cholera** on their feet and mouthparts.

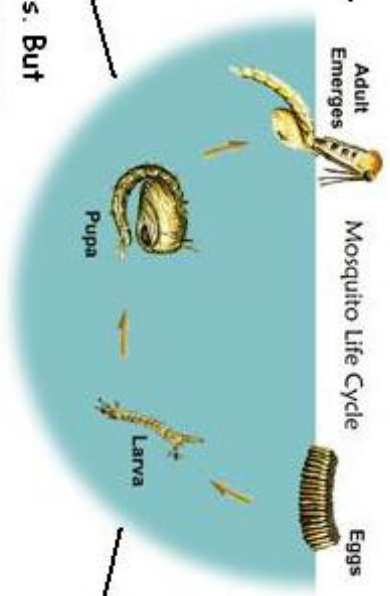
Resource Sheet 3.b. Life Cycle of Mosquito

It is the female mosquito that is responsible for the transmission of the virus that causes the disease



The adult mosquito emerges and flies off shortly after.

This stage, no feeding occurs. But still remains in a water environment.



When the eggs come into contact with water, they soon begin to hatch.

The larva stage is totally dependent on water. It undergoes molting several times before changing into the pupa stage.

LIFE CYCLE OF THE MOSQUITO

Resource Sheet 3.c. Ways of reducing the spread of water borne diseases

Harmful insects need certain conditions to thrive. These include water and/or a steady food supply. Once these conditions are present, populations can become large and this increases the possibility of disease spread.

Simple precautionary actions can be taken that will help to prevent the spread of water-borne diseases. Firstly, there are some basic principals that can be done to avoid and prevent the spread of germs and bacteria that cause illnesses:

- Wash hands thoroughly with soap and clean water after using the toilet, before preparing food, before having meals, etc.
- Cover all food when not being used and wash fruit and vegetables before eating.
- Avoid walking/playing in dirty or contaminated water

Precautions necessary to prevent the spread of germs are the same for all diseases and should be followed regularly and consistently. The single most important precaution is ***hand washing***.

Insect populations that contribute to the spread of diseases need to be controlled if possible in the home and community surroundings. In this regard, it is important to avoid the accumulation of 'stagnant' water which creates the optimum conditions for diseases carriers such as mosquitoes to breed and congregate.

- All vesicles, containers or other things which can collect water should be monitored.
- Vesicles that are used for collecting rain water for drinking purposes should be covered.
- In the case of the spread of malaria, precautions such as using netting at night when sleeping.
- Chemical products such as insecticides (e.g. Bagon, Fish) or mosquito coils can be used within individual households.
- Appropriate garbage disposal is necessary so as to avoid attracting insects and pests that are known to carry disease – such as houseflies and rats.

COMPOSTING

Concept: Understanding the components and methods of composting

Resource sheets:

- 4.a. Decomposition of materials in the environment
- 4.b. Biodegradable and non-biodegradable materials
- 4.c. All about Composting

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Decomposition	- Knowledge of the process of decomposition of materials in the environment.	Resource Sheet 4.a.	Teacher leads the class in the outdoors around the school. As they walk students will stop to pick-up litter a few times. Before moving on each time – the items are identified by the students as biodegradable or non-biodegradable. What conclusions that can be drawn at the end of the exercise?	SCIENCE
	- Knowledge of differences between biodegradable and non-biodegradable materials.	Resource Sheet 4.b.		
Composting	- Knowledge of the methods involved in preparing a compost heap.	Resource Sheet 4.c.	Working in small groups, students create one big classroom poster which shows: (a) A compost bin as the central image; (b) Household items that can be composted (show these around one side of the poster); (c) Household items that cannot be composted (show these around the other side of the poster) & (c) A variety of composting organisms that may live in the compost heap	SCIENCE

Resource Sheet 4.a. Decomposition of material in the environment

Materials that are produced naturally in the environment are referred to as organic. It is the process of decomposition whereby these organic materials are broken down. This process is performed by the thousands of micro-organisms and small invertebrates that live in the soil. Suitably enough, such organisms are referred to a 'decomposers'. Decomposition therefore is a biological process which occurs naturally in the environment.

In nature, leaves, trees, even dead animals will begin to decompose once dead. It is all part of the food chain and an important link. Two (2) things are occurring as a result of decomposition: (a) bacteria and fungi are supplied with a source of food and (b) nutrients such as carbon and nitrogen are released back into the atmosphere and/or soil to be utilized again by other organisms. This is exactly what occurs in wetland ecosystems. They have the ability to breakdown pollutants, thereby releasing the nutrients back into the environment for utilization by the plants and other organisms while at the same time serving as a reservoir for those toxic substances that cannot be breakdown down.

Another important point to note is that different materials will take longer to breakdown in the environment than others. Below is a list of various items and the approximate time it takes to decompose in the environment:

Banana peel, 2 – 10 days	Orange peels, 6 months
Styrofoam cup, 1 – 100 years	Wool socks, 1 – 5 years
Cotton rags, 1 – 5 months	Plastic bags, 10 – 20 years
Paper, 2 – 5 months	Leather shoes, 25 – 40 years
Rope, 3 – 14 months	Nylon fabric, 30 – 40 years
Cigarette filters, 1 – 12 years	Plastic six-pack holder rings, 450 years

So it could be noted that while some materials can be easily and relatively quickly broken down in the environment, others take quite a long time. Furthermore, it is important to note that many of the man-made items that end up in the environment which take so long to decompose can actually sometimes release harmful compounds which will then have a negative effect on the environment.

A famous example of this is the chemical DDT which was used widely as a pesticide until it was determined as the cause of decrease in population size of large raptors, as it caused the eggs of their young to be thin. As a result these eggs cracked before they complete the incubation stage of development.

Resource Sheet 4.b. Biodegradable and non-biodegradable materials

It is important to have an understanding of what happens to garbage after it is disposed in the environment. Decomposition is the natural process which nature has in place to breakdown and recycle nutrients in the environment. However, not all material decomposes at the same rate as others.

The term biodegradable is used to describe materials that decompose naturally in the environment through the actions of organisms specialized or adapted for the decomposition of organic matter. Temperature and sunlight will also play a role in the decomposition of biodegradable materials as it determines the ideal conditions of the presence and abundance of decomposers.

Of course, not all materials are biodegradable - these are referred to as non-biodegradable. These will usually remain in the environment for a long time. In some cases, they may release substances that are toxic and contribute to the pollution of the surrounding soil and water.

Biodegradable materials include those many items we use and throw away in our garbage bins everyday such as: the skins and peels of fruits, paper, cardboard boxes and also grassing cuttings and dead leaves when we clean our yards. These materials and many more are all readily and naturally broken down in the environment.

Non-biodegradable materials are problematic since they take so long to breakdown in the environment. Plastic is surely the most prominent of all non-biodegradable materials (Garbage bags are made of plastic!). Plastic bags and bottles account for the majority of non-biodegradable materials in landfills all around the world.

What is important is that we try to minimize the amount of non-biodegradable materials that ends up in landfills and wetlands. We can help to do this by applying the 3Rs strategy in our homes and schools whenever possible – **Reduce, Reuse & Recycle**.

GAME 1: Guess what's in my garbage bag! (5-10 minutes):

Students will be tested on their knowledge of the terminology of the new words learnt during the lesson through a fun game – biodegradable and non-biodegradable. Review the terms biodegradable, non-biodegradable, reduce, reuse and recycle.

A 'garbage bag' is held up and the student's objective is to identify the mystery object inside. A short description of the object is given using the words reviewed.

For example: 'In this bag, I have a non-biodegradable object that can be reused. It can also be recycled to make more of the same. [Answer: Paper]

Resource Sheet 4.c. All about composting

What is Composting?

Composting is nature's own and oldest method of waste disposal and helps in soil fertilization.

The natural composting process

Leaves/other organic matter -> breakdown by organisms -> humus -> mixing of humus and soil with the aid of the organisms -> natural soil improvement for better plant growth.

It is a natural process whereby micro-organisms and small invertebrates feed on decomposing organic matter. This helps to break down the organic matter and so after six to nine months the organic 'garbage' can be used as a fertilizer. Compost is the organic material derived from decomposed kitchen scraps and garden waste. It has a soil-like, often spongy texture and is rich in nutrients.

Why do Composting?

By composting at home or at school, we are helping to reduce the organic waste that is sent to landfill sites or disposed of in inappropriate ways which can create an unhealthy environment. At landfill sites all the garbage is dumped together. As a result, organic waste is left to rot without air (anaerobic decomposition) and this forms the gas ammonia. Ammonia is poisonous to fish and contaminates drinking water. Anaerobically rotting organic waste also produces methane – a powerful greenhouse gas that is contributing towards climate change. Some greenhouse gases occur naturally in the atmosphere, others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide and ozone. Human activity can add to the levels of these natural gases, trapping heat within the earth's atmosphere, leading to increased global warming.

Generally, composting is a simple way of helping the environment. The advantage of making compost is that it is rich in nutrients and so can be used in gardens to improve soil quality and encourage plants to grow healthy. Compost bins often provide homes to garden wildlife like worms, beetles and toads.

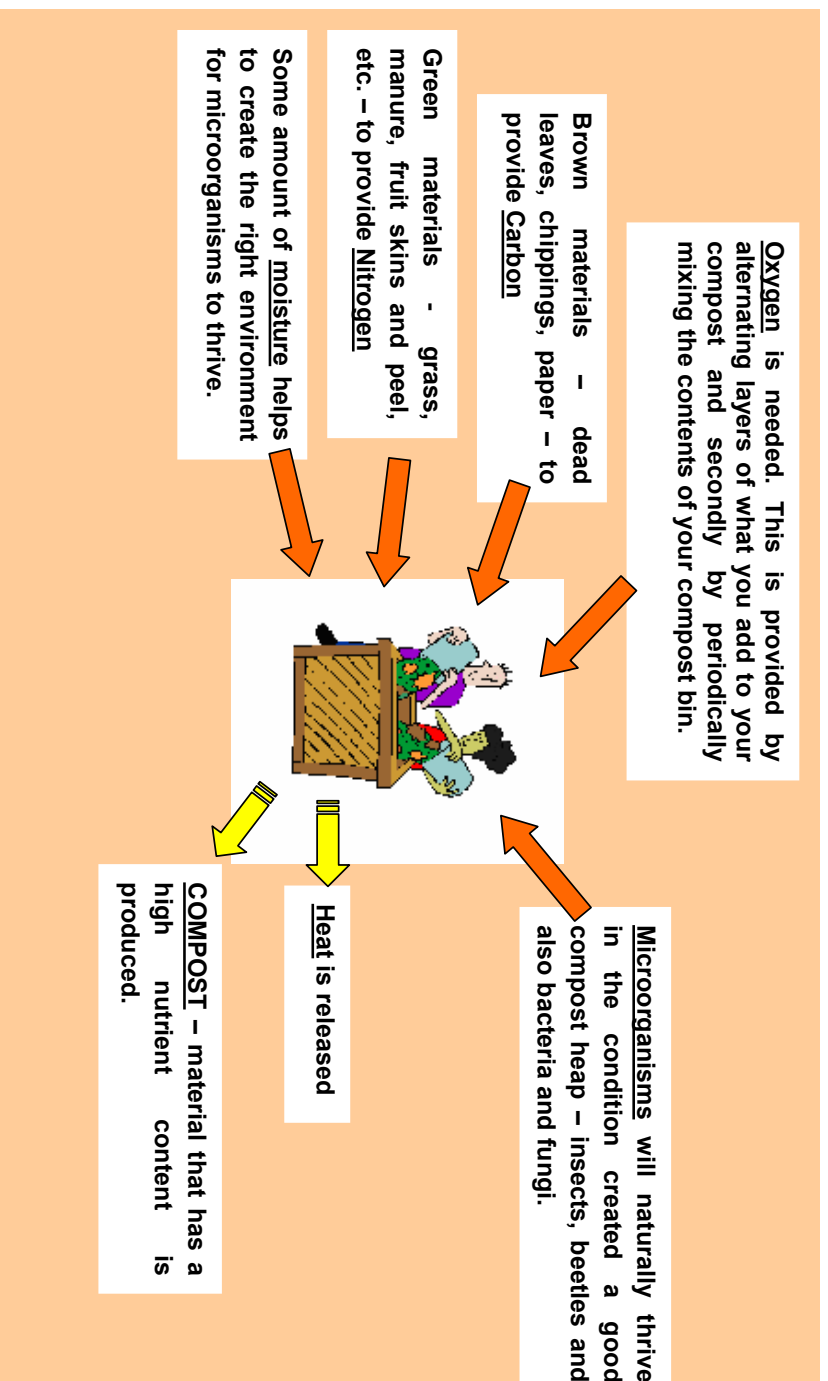
How to go about making a Compost heap?

Compost is made when organic materials such as potato peelings, grass cuttings, banana skins, cardboard and straw, rot away naturally. Rotting takes place when waste is broken down by a range of different organisms including bacteria, fungi, worms and insects. These organisms use the waste as food and help to turn it into compost.

The best environment for the organic matter to break down in is a **compost bin**. A suitable location for your compost bin should be first located (preferably in a shaded area). Your bin can be made using old planks of wood from crates, etc. A suitable cover should also be used over the bin to prevent flies and more importantly, prevent water logging when it rains.

Once you begin to add organic matter to the compost bin, it is important to take the following things into consideration:

- Have the right combination of dry/brown (carbon) elements to wet/green (nitrogen) material which is approximately 3:1. Some examples of carbon sources are: dry leaves, straw, dry grass clippings, paper towels, old newspapers. Some nitrogen sources are: fresh grass clippings, kitchen waste (lettuce leaves, tea bags, coffee grounds, vegetable peelings), old flowers or plants
- Don't add pet waste, grease or dairy products such as cheese or milk to your compost pile. These usually attract pests such as rats and flies and the odor of your bin may become unpleasant. Also, large chunks of food waste or whole leaves take more time to break down. It is important therefore to break or tear them into smaller pieces before adding to your compost bin.
- It is important to keep the compost bin contents **MOIST**. This can be done by sprinkling water generously before covering the bin every once in a while.





Burning is a significant land use practice that takes place in the savannas and farming areas surrounding wetlands. Many times, fires are recognized only as having a negative effect on the environment, including soil erosion and subsequent run-off into wetlands. However, fire also has positive affects on key ecological processes, and if used effectively, can provide important services to people.

Purpose of Lessons

At the end of these lessons, students will have knowledge of:

- the role of fire in our environment
- the negative effects of fires on the environment
- the contribution of fire to the greenhouse effect and global warming.

FIRE IN THE ENVIRONMENT

Concept: Understanding the role of fire in the environment

Resource sheets:

- 1.a. Fires and their effect on the environment
- 1.b. Global Warming - A concern for everyone
- 1.c. Diagrams showing the Greenhouse Effect

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
The role of Fire in the environment	<ul style="list-style-type: none"> - Understanding that fire is part of a natural process in maintaining an ecosystem - Understanding the link between fire and biodiversity 	Resource Sheet 1.a.	<p>Group Discussion (Teacher leads):</p> <p>Discuss the positive and negative effects of fire. On the board or Cardboard sheet, create a Fire Chart Table with two columns: "Harmful" and "Helpful." During the discussion, write the students' responses on your chart. Have students brainstorm ways that fire can be harmful, such as damaging homes, communities, and ecosystems and harming people. Then ask students to think about ways that fire can be beneficial. Students may suggest its value as an energy source for cooking and heating and traditional beliefs. Explain that fire plays an important role in some ecosystems – example: germination of seeds nutrient cycling</p>	SCIENCE
Global Warming	<ul style="list-style-type: none"> - Understanding the greenhouse effect and global warming 	Resource Sheet 1.b. & 1.c.	Teacher can use ice and heat from the sun to simulate the result of global warming for students. Allow students to make their own observations in this way.	SCIENCE

Resource Sheet 1.a. Fires and their effect on the environment

Fire is a very important process. It requires three (3) basic things to occur: fuel, oxygen and an ignition source. Heat is produced as a result of fire and nutrients are released in the form of gases which are present in what we call smoke and in the form of ash that we see deposited on the ground. Although historically, fires occurred through natural sources, such as lightning, today people are the main causes of fire. They use fire for a variety of purposes including clearing areas for farming, burning pastures to encourage grass re-growth for livestock, for the collection of natural resources such as honey, and for spiritual and cultural reasons.

In Guyana, fire plays an important role in savanna ecosystems during the dry season. Most fires in savannas are surface fires that primarily burn undergrowth and leaf litter. It is important to recognize that such fires can prevent larger, more serious fires from occurring! Burning of this undergrowth and litter allows the quick release of nutrients from the vegetation that would otherwise decompose very slowly. Fires are therefore very important for nutrient recycling – that is why farmers use fire to clear their plots ready for planting. They are supplying the seeds with lots of good nutrients. At the same time the fires may also help to reduce the number of pathogens and insects that may be pests to certain plant species. Ranchers also know that fire helps to stimulate the re-growth of good green grass, so they burn their pastures during the dry season when most of the old grass has become dry and inedible.

Fires play a role in plant germination, flowering, fruiting and seed dispersal. For example, some savanna plants have seeds that need a thermal shock to germinate. Others have seed pods that will only open once the heat from fire has triggered their opening mechanisms. However, many plants are also adapted to fire by having thick bark or protecting their seeds and leaves with barriers or tough coats. Fires are also important for many animals. Fires create or help to maintain certain habitat types, for example, open savanna for animals such as the deer and savanna fox. The ash from fire is an important source of nutrients for animals such as deer and the insects that try to escape fires are good prey for the birds!

However, there are negative effects associated with fires. These negative effects usually come about through the inappropriate or misuse of fire. For example, if fires are used too frequently in the same areas, this can lead to changes in the vegetation and associated soil erosion and degradation. Frequent burning can also affect animals which may have died as a result or would have been forced to abandon their habitat or source of food and shelter. Misuse of fire, through arson, or during high risk times, such as during the intense dry and hot weather conditions in the late dry season, can again have detrimental ecological effects, but can also harm peoples' homes and farms and other property.

The gases released during burning also contribute to the greenhouse effect and global warming (See Resource Sheet 1.c. for more information).

Burning has been a common practice by people in the Rupununi over the years. Some burning may be for simple and basic reasons such as cooking or disposal of garbage. At other times, in a more traditional sense, wide areas of vegetated land may be cleared by burning of savanna grass when it is very high to clear foot paths or reduce the dangers of snakes and other threats. Fire is also used for clearing farmlands for growing cassava and other provisions or for providing fresh grass for cattle during the dry season. Appropriately used, fire can be beneficial. However, frequent and inappropriate fire use can have detrimental effects on the wetlands that are surrounded by savannas. Excessive soil erosion and run-off can lead to greater amounts of sediment and nutrients being washed into wetlands and affecting key wetland processes and plant and animal life.

Resource Sheet 1.b. Global Warming – A concern for everyone

The greenhouse effect is a naturally occurring process which helps to maintain a relative temperature within the Earth's atmosphere. The sun's radiation is emitted in the form of short wave lengths which are absorbed by the Earth's surface. Some of this radiation is re-radiated or reflected from the earth's surface back into the atmosphere – but as long wave lengths. As these longer wave lengths rise into the atmosphere, some escape while others are blocked and are again reflected back to the Earth's surface. Greenhouse gases which are present in the atmosphere are responsible for this 'reflection' process. Ultimately, incoming radiation is balanced by outgoing radiation.

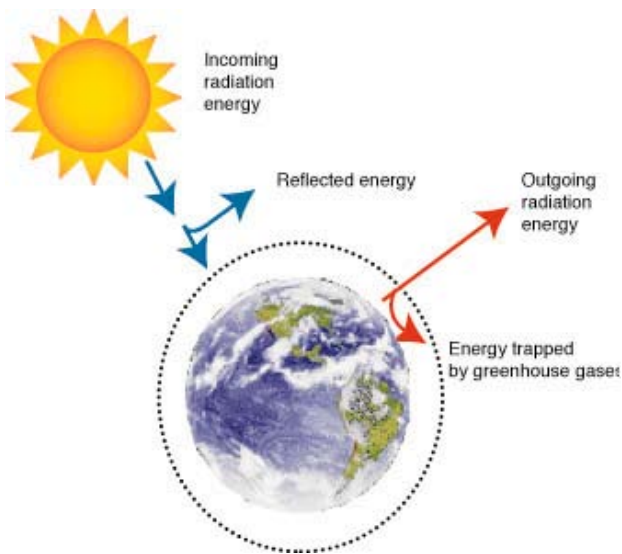


Diagram showing the Greenhouse Effect

As a result of increases in certain human activities more greenhouse gases are being released into the atmosphere, which results in greater amounts of heat being trapped in the Earth's atmosphere. Humans have increased the amount of carbon dioxide in the atmosphere by more than a third since the industrial revolution. Naturally, these changes usually take thousands of years, but are now happening over the course of decades.

Global warming is basically the result of an increase of greenhouse gases in the atmosphere. With more greenhouse gases present, the result is more long-wave radiation being trapped within the Earth's atmosphere thus leading to an increase in overall average temperature. The consequences of this situation are serious and so needs much attention. (Refer to Box 1)

Box 1:

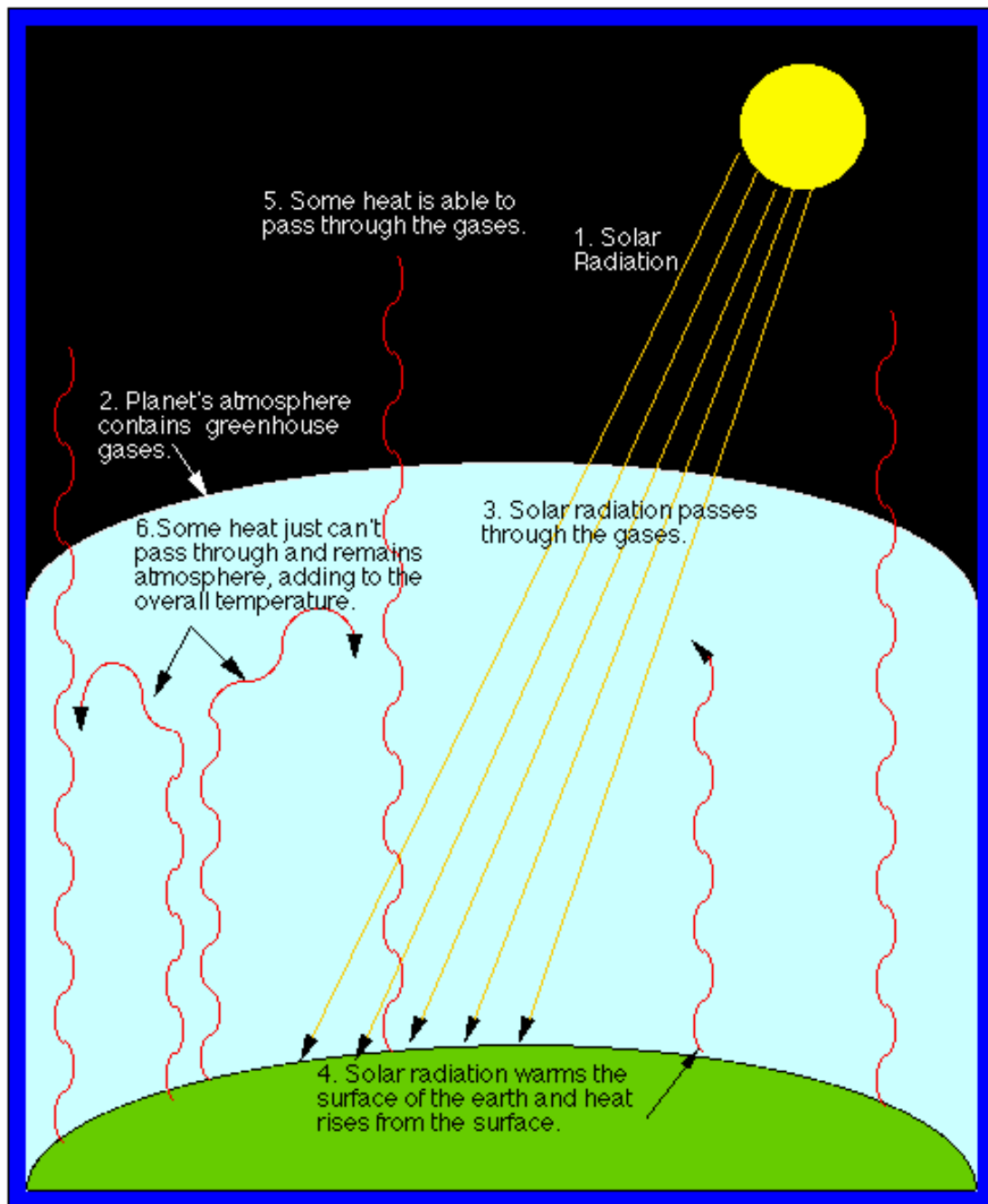
Carbon dioxide, CH₄, and N₂O account for 90% of the 'greenhouse effect'. Much of the current concern about greenhouse gases has arisen from the recent recognition that the concentration of certain greenhouse gases - CO₂, CH₄, N₂O, and CFCs - has been increasing steadily since the industrial revolution, as a result of human activity. By 1992, CO₂ had increased by 30%, CH₄ by 145%, and N₂O by 15%. Current rates of increase are 0.5% per year for CO₂, 0.6% for CH₄, and 0.3% for N₂O. If the current rates of increase continue, many scientists expect significant impact on the world's climate. For example, the Intergovernmental Panel on Climate Change predicts that the doubling of the CO₂ concentration, likely to happen in the 21st century, would increase average global temperatures by 1 to 3°C - a rate of warming unprecedented in the last 10,000 years. In addition, the enhanced greenhouse effect could amplify climate variability.

In short, greenhouse gases have a desirable effect, as they warm the atmosphere and create favorable conditions for biological activity. Further increases in these gases, however, may lead to an 'enhanced greenhouse effect' with uncertain, possibly disruptive, consequences. Change in weather patterns and rising sea levels are already being observed, and certain wildlife species that cannot adapt to drastic changes will be affected. .

Website: http://www.agr.gc.ca/nlwis-snite/index_e.cfm?s1=pub&s2=ha_sa&page=8

Resource Sheet 1.c. Diagrams showing the Greenhouse Effect

THE GREEN-HOUSE EFFECT



Biodiversity Loss & Extinction



Wetlands support a huge range of plant and animal life which play significant ecological roles as well as social functions through, for example, ecotourism. With an appreciation for the natural resources around us, it becomes evident that many species may be affected as a result of human activities. By understanding the role of individual species and their link to the overall health of the environment by virtue of their ecological relationships, the need for their survival would be far more appreciated.

Purpose of Lessons

At the end of these lessons, students will have knowledge of:

- the diversity of wildlife in the wetlands of Guyana
- the role of wildlife in wetland health
- the impacts of people on wetland wildlife populations

SPECIES DIVERSITY

Concept: Understanding biological diversity and their link to the environment

Resource sheets:

- 1.a. Biodiversity in wetlands of Guyana
- 1.b. Wildlife Conservation and Protection
- 1.c. Definition of terms

Lesson Guides

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
What is Biodiversity?	- Understanding the diversity of wildlife in Guyana's wetlands	Resource sheet 1.a. & 1.b.	Draw on the board a scene of a local wetlands habitat showing the wide range of life it supports. Ask students to help add in wildlife that can be found in this habitat and what the link to this habitat is.	SCIENCE
	- Understanding the need to protect and conserve our national biodiversity	Resource sheet 1.b. & 1.c.	Students can draw a scene that represents the rich biodiversity of wetlands in Guyana.	SCIENCE; ART

Resource Sheet 1.a. Biodiversity in the wetlands of Guyana

Biodiversity refers to the different types of flora and fauna present in an area. The presence or absence of biodiversity will vary from one ecosystem to another. Fortunately for us, here in Guyana, we have a very high biodiversity within our lush and mostly pristine rainforests, savannas and wetlands. Wetland ecosystems are particularly prone to very high biodiversity as they provide a host of opportunities for plants and animals to survive. In fact, such ecosystems often accommodate many migratory species during specific times of the year. Wetlands in this way support rich biodiversity – all year round or in some cases during specific periods of the year.

In Guyana, for example, the North Rupununi region is home to a great diversity of wildlife – from jaguars and capybaras to giant otters and caimans to anteaters and savanna foxes. The region is known to have one of the highest freshwater fish diversity in the world, currently estimated at more than four hundred species (comparable wetlands in South America such as the Varzea of Mamiraua and the Pantanal wetlands contain 400 and 200 species of fish respectively), which in turn support endangered species such as the Black Caiman (*Melanosuchus niger*), Giant Otter (*Pteronura brasiliensis*), Giant River Turtle (*Podocnemis expansa*) and recovering populations of the largest freshwater fish in the world, the Arapaima (*Arapaima gigas*). Wetlands exist within a mosaic of savanna and forest ecosystems, and therefore support both savanna and forest species which venture between different ecosystems for food and breeding. Habitats can be observed at the small and large scale, with each animal or plant having a specific niche or function in their surrounding environment.

There are many rare species of wildlife that are only found in a few countries around the world – the wetlands in Guyana support some of these (listed above). Some of these wildlife species are endemic to a particular region, such as the North Rupununi. It is therefore necessary to conserve and protect the wetlands that support them. Many of these animals became extinct in some countries as a result of destruction of such ecosystems.

Fortunately, we have long recognized and appreciate our country's rich biodiversity and much effort has been put into research and monitoring of our wildlife and their habitats to document what we have and help to maintain healthy populations. For, example, in the North Rupununi, Iwokrama and other NGOs have done lots of work in helping to monitoring and document the biodiversity in the area.

Resource Sheet 1.b. Wildlife Conservation and Protection

In 2000, the Wildlife Management and Conservation Regulation was drafted under the Environmental Protection Act 1996 and presently is still in draft form. The objective of this regulation is to provide protection of particular floral and faunal species in Guyana. These include:

- *Convention on International Trade of Endangered Species (CITES)* – This Convention has placed limitations on the use of wildlife by subjecting controls on international trade in specimens of selected species. All import, export, re-exports and introduction from the list of species covered by the Convention has to be authorized through a licensing system. The species covered by CITES are listed in three (3) Appendices, according to the degree of protection they need.
- *IUCN – Redlist* - IUCN stands for ‘International Union for the Conservation of Nature and Natural Resources’. Use of the name “World Conservation Union” began in 1990. This treaty assists in the conservation of wildlife by assessing the status of species, subspecies, varieties and even selected subpopulations on a global scale. In doing so, a Redlist has been generated which highlights specific taxa that may be threatened with extinction. This Redlist highlights those taxa that are facing a higher risk of global extinction (listed as ‘critically endangered’, ‘endangered’ and ‘vulnerable’). It also includes information on: taxa that are categorized as ‘Extinct’ or ‘Extinct in the Wild’; taxa that cannot be evaluated because of insufficient information (indicated as ‘data deficient’); and taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme (‘near threatened’).

Conventions and treaties such as CITES and IUCN-Redlist are all supported by existing national laws that support the protection of species in Guyana. Within Guyana, several institutions have been identified or associated with the protection of species by working directly with such conventions and other regulations.

Guyana’s Wildlife Division is responsible for dealing with a legal licensing system and to give advice on the effects of trade on the status of the species. Other organizations that deal directly with conservation projects and research work directly with such conventions and so have a great role to play in the overall protection of species and overall wildlife management. Such conservation-based organizations include: Iwokrama, Conservation International and World Wildlife Fund (WWF). While these local organizations look at a conservation of several species, there is also other conservation work being done for specific individual species. Two (2) such examples would be the Guyana Marine Turtle Conservation Society (GMTCS) and the ‘Black Caiman Research’ that is presently ongoing in Yupukari; the first looks specifically at the conservation/ protection of marine turtle species while the latter looks at the ecology and status of the Black Caiman.

Whether looking at the protection and conservation of one or several species of wildlife, what is important to note is that these institutions help to assist in the implementation of the rules and regulations of our national laws, and the international conventions/treaties that seek to protect our wildlife species.

Aside from this, however, local communities are known to have in place their own laws and regulations that compliment these national laws and regulations. Such is the case in many of the communities of the North Rupununi.

Resource Sheet 1.c. Definition of Terms

Biodiversity/Biological Diversity - Composition of both flora and fauna in their living and non-living Environment

Conservation - The protection of wildlife species through monitoring and sustainable use

Ecology – the living component of an environment

Ecosystem - The combination of several different species of plants and animals co-existing in a number of habitats and their physical environment

Endangered – means population of species in the wild is low

Endangerment – this is the result of negative impacts on wildlife populations and is primarily due to loss of habitat (shelter and food) and over-hunting/trapping.

Endemic – found specifically in a particular area or region.

Extinction - This is the loss of a species in the wild .i.e. population size in zero.

Fauna - a term used to refer to animals

Flora - a term used to refer to plants

Native species - Refers to species of wildlife that can be found naturally in an area.

Population - Group of one species of wildlife.

Pollution - The introduction of substances into the environment, resulting in negative effects causing danger to human health and ecosystems.

Species - a species is one of the basic units of biological classification; it is an individual plant or animal.

Threatened - Species that has been recognized to be in danger due to negatives impacts on wild populations.

Quotas – a standard limit on quantity (can be a minimum and maximum number)

Terrestrial species - Refers to species of wildlife that have habitats on land.

Wildlife - General term used for plant and animal species.

Wildlife Management – This involves monitoring and implementation of projects in helping to ensure wildlife populations are healthy and safe.

WILDLIFE RELATIONSHIPS

Concept: Understanding the functions and roles that wildlife has in the environment.

Resource sheets:

- 2.a. Food Chains and Webs
- 2.b. Species Relationships

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Circle of Life	- Knowledge of food chains and food webs	Resource Sheet 2.a.	Each student is given the name of an animal to represent. Students must the run and hold on to the shoulder of a student who represents an animal that it feeds on. This exercise will result in (1) simple food chains and (2) food web(s) being formed.	SCIENCE
Ecological relationships	- Understanding predator-prey relationships and symbiotic relationships	Resource Sheet 2.b.	Draw the relationships created by the students themselves on the blackboard. Discuss: Predator Prey, and symbiotic relationships that exist within it.	SCIENCE

Resource Sheet 2.a Food Chains and Webs

In nature one animal depends on another. Food chains and food webs help to show this very simply. A food chain always starts with plant life and ends with an animal. Plants are referred to as *producers* because they are able to use the energy from the sun to produce their food. They make sugar from carbon dioxide and water with the help of sunlight. On the other hand, animals –from the smallest to the largest – cannot make their own food. All animals are referred to as consumers. There are three (3) main groups of consumers: (a) Primary Consumers – these are animals that feed more or less on plant material; (b) Secondary Consumers – these are other animals which feed on the primary consumers (i.e. herbivores and omnivores); and (c) Tertiary Consumers – these are animals that feed on Secondary Consumers.

Primary consumers → Herbivores

Secondary consumers → Carnivores and some Omnivores

Tertiary consumers → Larger carnivores and Omnivores

Herbivores – These organisms eat only plants or plants (including leaves, stem, flowers, fruits or seed). Examples are grasshoppers, mice, deer, cows, sheep, and goats.

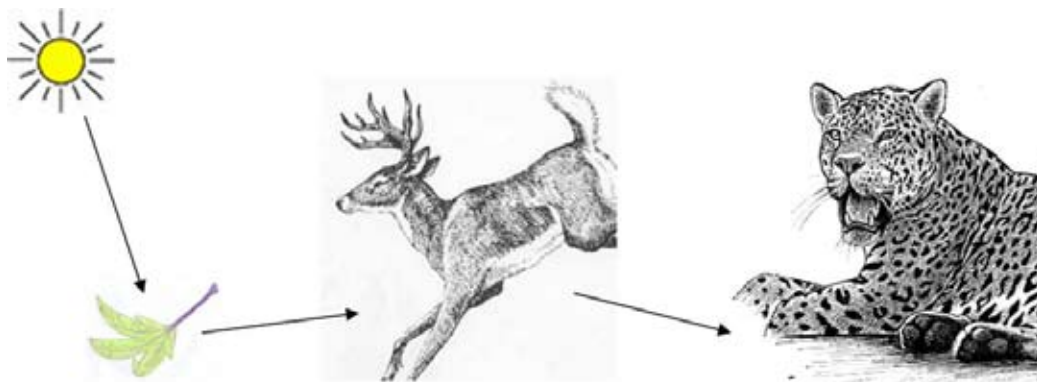
Carnivores – These are animals which have a diet consisting of meat. They feed on other animals. Examples are foxes, snakes, hawks, jaguar, and spiders.

Omnivores – These organisms eat both plants and animals. Examples are turtles, monkeys, and people.

Aside from producers and consumers, there is also another group of organisms that play an important role in all food chains. These are the decomposers and they feed on decaying material – dead plants and animals.

From all the roles of producers, consumers and decomposers, we can fully appreciate that nothing is really 'waste' in nature. This is how energy is passed from one animal to another. Food chains and food webs therefore, essentially show us the flow of energy from one animal to the next.

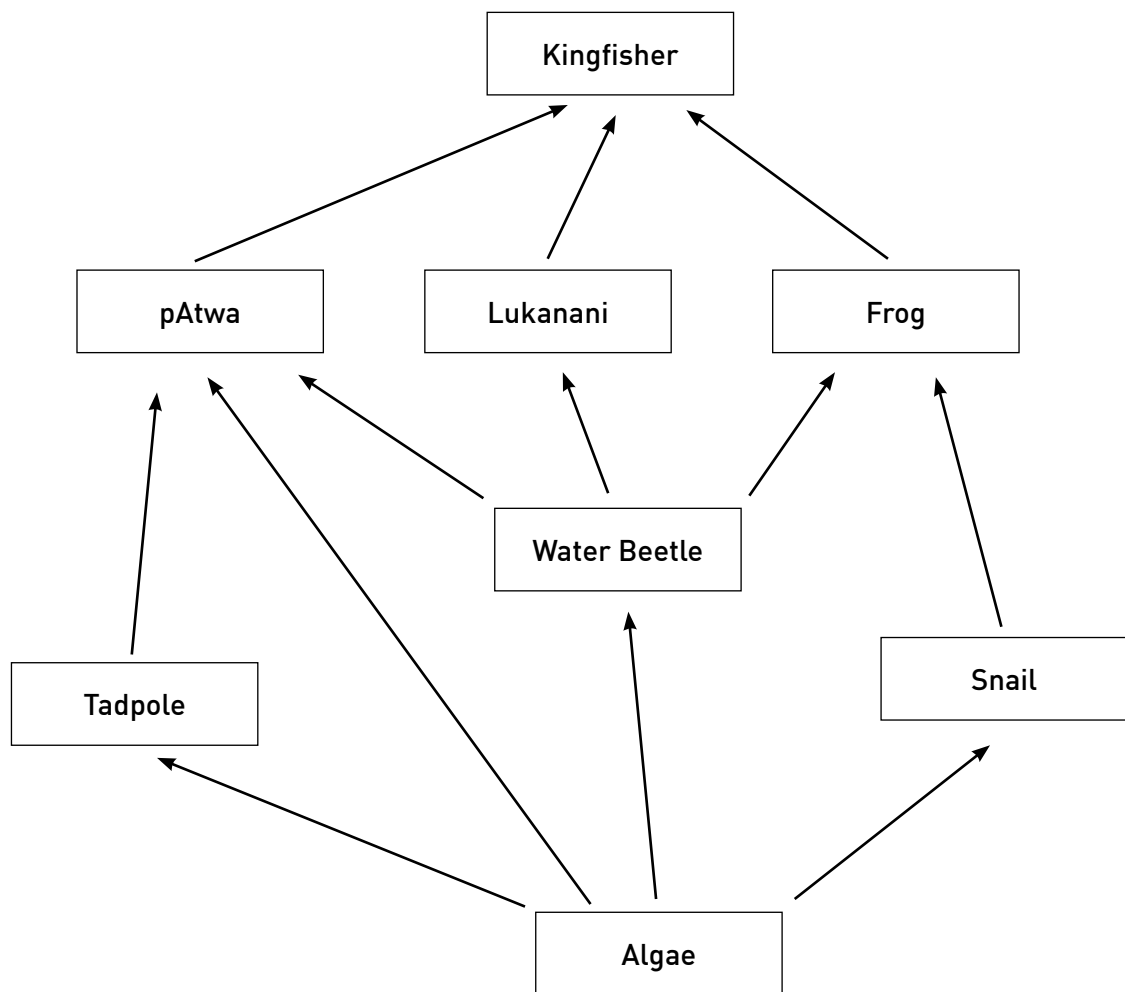
This diagram shows a simple food chain:



Cassava Plant ----- Deer ----- Jaguar

Most food chains are interconnected. Animals typically have a varied diet and, in turn, serve as food for a variety of other creatures that prey on them. These interconnections create **food webs**.

Diagram of a food web:



Resource Sheet 2.b. Species Relationships

Wildlife – plants and animals - are all interconnected to each other as a result of the food chains and food webs. They are all dependent on each other in one way or the other. There are many relationships in nature between two or more animals which form a part of such food chains and webs.

Predator-Prey Relationships

Predators are the animals or plants (i.e. carnivorous plants) that are actively seeking another animal for food. The prey is that animal that is being targeted by another animal for food. Take this simple food chain for example: Insect -> Fish -> Kingfisher. In this food chain, the kingfisher and the fish have a predator-prey relationship where the kingfisher is the predator and the fish is the prey. Similarly the fish and insect are predator-prey respectively. There are some cases when a plant can be the predator. For example: the Venice-Fly Trap is a predator as it preys on flies and other small insects that are 'trapped'.

There are many predator-prey relationships and these help to maintain a natural balance in the environment. If the population of deer is reduced in the wild, the jaguars may starve or have to resort to another source of food until the deer population increases again. Likewise, if the jaguar population decreases, the deer populations may increase as there are fewer jaguars to hunt them. In both cases, competition becomes an issue.

Symbiotic Relationships

The type of relationship observed when two or more organisms live or interact together is called symbiosis. The three (3) basic symbiotic relationships are:

- (1) Parasitism – this is when one organism benefits from the relationship while the other gets no benefit and worse yet is negatively affected. An example of parasitism is the creepers (or epiphytes) that grow on the barks of tall trees in the rainforest. These epiphytes gain nutrients from the tree itself and in so doing will eventually kill the tree.
- (2) Commensalism – this type of relationship involves one organism benefiting while the other does not, but is unharmed. An example of this type of relationship is observed between the Tilapia and the hassar species of fish. The hassar feeds on the waste of tilapia. The hassar therefore benefits from this relationship but the tilapia does not or is not harmed.
- (3) Mutualism – this is a case whereby both of the organisms benefit in some way but neither is harmed by each other. An example of this is the case of algae that grows on the hair of the world's slowest mammal – the sloth. The algae grow with ideal conditions and the sloth is provided with camouflage in the tree tops against predators.

It is amazing just how important these simple relationships are in helping to maintain a healthy and diverse ecosystem. They are also occurring in nature and such relationships actually help to maintain a balance in the environment.

PEOPLE AND WILDLIFE

Concept: Understanding the relationship between people and wildlife

Resource sheets:

- 1.a. Existing threats to wildlife
- 1.b. Need for Sustainable use of resources

Lesson Guide

Sub-topic	Objectives	Materials Required	Student Activity	Link to National School Curriculum
Threats to biodiversity	- Understanding the threats to wildlife due to human activities	Resource sheet 1.a.	<p>Take the student outdoors to a large tree or pond or other habitat. Pose the question: 'If this tree is cut to be cut down OR this pond is fill ed up; what are the consequences for the wildlife?</p> <p>- students must first make a list of the animals and plants that depend on that tree or pond.</p> <p>Example: birds – they build their nests in the trees; birds and other animals feed on the fruits the tree produces, etc.</p> <p>Let students realize that as a result of one action – there are several contacted consequences!</p>	SCIENCE
Sustainable Use of Natural Resources	- Understanding the importance of sustainable use	Resource sheet 1.b.	<p>Ask students to think of products that they see/use everyday that are examples of the 3Rs.</p> <p>e.g. soft-drink glass bottles – these are being 'reused' NOT recycled; Cardboard boxes – these are recycled to produce paper.</p> <p>What are some of the things they can do to help 'reduce' the amount of waste?</p>	SCIENCE

Resource Sheet 1.a. Existing threats to wildlife

There are many threats to the local wildlife. The worst part is that threats to wildlife populations are often only recognized when the population has been affected drastically enough to notice a difference. It is therefore important to be aware of what activities affect wildlife populations and take the necessary precautions to prevent them from becoming threatened or extinct. Furthermore, since the majority of our wildlife is already known to be threatened, we must monitor the remaining populations with greater care.

Examples of activities which have direct impacts on wildlife populations are hunting (both as a sport and for food) and trapping for the continuously growing business of the wildlife trade. Hunting has long been a hobby for some where particular species, such as deer, are targeted. The heads of such species are sometimes stuffed and hung proudly as trophies. In other cases, in a much more serious light, certain species are hunted for a particular body part that holds a high market price. An ideal example of this is the ivory trade which was prevalent in Africa, where hundreds of elephants were killed remorselessly just to be stripped of their tusks. What was sad was that species such as these African elephants were protected by law, and so hunting was usually illegal. Here in Guyana, the Black Caiman – one of our ‘Giants of El Dorado’ was hunted for its hard leathery skin which was valued in the production of bags, belts and shoes. It reached the stage where populations in the wild dropped drastically to the extent that they became endangered, and as a result a law was established that prevents the killing of any Black Caiman today.

Lastly, hunting of species may be done for the wild meat trade. Many times hunting may not be conducted in a sustainable manner and when we do recognize that populations have decreased, it is usually to the point that the species in the wild are very small in number and as a result are extremely threatened or on the brink of extinction. In many cases, quotas and opened and closed hunting seasons are usually established by wildlife management authorities to help protect such species. Unfortunately, in many cases, monitoring and actual implementation of such laws are not easily enforced.

Trapping has also had an impact on wildlife species. The situation is similar to the wild meat trade and hunting – existing populations are not usually monitored, so species are removed at a faster rate than which remaining populations can recover. Similarly, quotas and laws that may exist may not be heavily implemented or enforced.

There are also indirect impacts due to human activities which have been known to affect wildlife species. Such impacts include the destruction of habitats. As human populations grow, more space is required which leads to the clearing of natural landscapes to allow for the construction of roads and buildings and for farming. Clearing of areas may also be for the use of a particular resource, such as mining or timber harvesting. In such a case, even though wildlife species themselves are not targeted, such activities will affect existing wildlife populations due to loss of habitats. Wildlife depend on their habitat for shelter and food. Similarly, aquatic wildlife is also threatened indirectly through water pollution. Gold mining has been the source of much water pollution in many of Guyana’s interior wetlands. This is due to the use of mercury (a heavy-metal) which is used by miners in the extraction process. Heavy concentrations of mercury can build up in the food chain, and as a result, not only is the species in the aquatic habitat threatened, but also terrestrial species.

Other forms of pollution – namely land, air and even noise – have heavy impact on wildlife species. When animals are forced to flee to find new habitats and environments they encounter competition for resources which are being sharply reduced as a result of human activities. Other indirect threats to wildlife include introduction of exotic species. In a worse-case scenario, an exotic species will lead to the extinction of a native species due to competition for the same resources such as food.

Resource Sheet 1.b. Need for sustainable use of resources

There are many threats to wildlife and their environments, and this is usually as a result of over-exploitation of natural resources through human activities. We have always depended heavily on the natural resources found in wetland ecosystems – both for local and international purposes. Many of these resources are at risk of becoming very scarce. This, of course, is the result of very little or no attempt to manage our use of these resources. In some instances resources are just taken and taken until there is little or none left in an area. Many times much is wasted as a result and worse, may never recover fully until after many years later, if at all.

The key to conserving and preserving these natural resources which we depend on so much as a part of our everyday lives is to use them sustainably. In so doing, the overall impact on a particular resource is minimized and consequently the entire health of the ecosystem is maintained. We must recognize that if we intend to still have the resources which we presently enjoy for the future generations, we must act urgently and now in promoting sustainable use of such resources.

Today, more and more effort is being put into gathering data on a particular resource which assists in developing management plans which will help to promote its controlled and sustainable use by people. In some cases, quotas are set. For example, as it relates to the wildlife trade, depending on the estimated populations of species in the wild, quotas are set as to determine how much can be caught for trade. Also, open and closed seasons help to cater for those fragile times when animals may be more at risk than at other times (example: closed seasons are usually set during the breeding season of a species).

In our homes, schools and workplaces we can also practice sustainable use of resources by doing simple things such as practicing the 3Rs (**R**educe, **R**euse, **R**ecycle). In this way, the demand on such resources may be reduced.

In the North Rupununi, for example, communities recognize the importance of conserving the natural resources of the area, as they depend greatly on them everyday. In fact, they provide many of their livelihood activities such as fishing, wildlife trade and wild-meat trade, handicraft, medicinal uses and much more.

