WONDROUS WEST INDIAN

WETLANDS

TEACHERS' RESOURCE BOOK

WONDROUS WEST INDIAN WETLANDS

A resource book on Caribbean wetlands for teachers and other educators

"Come forth into the light of things,
Let nature be your teacher."

William Wordsworth

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West Indian Whistling-Duck Working Group of the Society for the Conservation and Study of Caribbean Birds – Mission Statement

The West Indian Whistling-Duck Working Group of the Society for the Conservation and Study of Caribbean Birds (SCSCB) works to reverse the decline of the endangered West Indian Whistling-Duck, a Caribbean endemic species, and to prevent the further loss and degradation of wetlands in the West Indies. We believe that environmental education and public outreach are crucial to achieving our objectives of long-term conservation and sustainable use of native species and habitats in the West Indies. Through this workbook, our workshops, and other educational materials, we aim to increase appreciation of the value of local wetlands and raise awareness of the consequences of their loss. We also aim to show how individuals can make a difference in caring for and making responsible decisions about their environment. Ultimately, we hope to instill in children a sense of caring, pride, and confidence as stewards of the environment, qualities that they will carry into adulthood.

For more information on the SCSCB, the West Indian Whistling-Duck and Wetlands Conservation Project, our activities, and our other educational materials, please visit us at <www.nmnh.si.edu/BIRDNET/SCSCB/index.html> and <www.whistlingduck.org> or write to: Lisa G. Sorenson, Ph.D., Project Co-ordinator, Dept. of Biology, Boston University, 5 Cummington St., Boston, MA 02215, U.S.A.

Dear Educator,

Welcome to ***Wondrous West Indian Wetlands***, a resource book on wetlands written especially for teachers in the West Indies. This workbook is designed to provide you with a complete resource for teaching students about Caribbean wetlands. It provides background information on the types of wetlands found in the Caribbean, their ecology, and the many functions they perform. It describes what is happening to wetlands - how and why they are being degraded and lost - and spells out the consequences of this loss for ecosystems and, ultimately, for people. Finally, the workbook introduces some important wetland conservation issues and provides students with ideas for conservation action projects that they can undertake in their own schools and communities.

Each section of the workbook contains practical classroom activities and exercises to illustrate and reinforce concepts, thus providing opportunities for learning-by-doing. To reduce the need for supplementary teaching material, we are also producing a field guide featuring the most common wetland invertebrates, plants, birds and mammals. We encourage you to make every effort to get your students into the field, as there is no substitute for experiencing the wonders of a wetland first hand!

We hope you find this book effective, fun, and inspirational. Please take a moment to complete our questionnaire – we welcome your comments and suggestions for improvements to the next edition.

Sincerely,

Lisa G. Sorenson and Patricia Bradley, Co-chairs
The West Indian Whistling-Duck Working Group of the Society for the Conservation and Study of Caribbean Birds.

WONDROUS WEST INDIAN WETLANDS
EVALUATION FORM

Please help us to improve the next edition of this book, by filling in this form and returning it to us.

NAME_____

SCHOOL OR ORGANISATION_____

ADDRESS_____

How many of the activities in the book did you use?_____

With which age groups did you teach the activities?_____

How many students took part in the activities?_____

Which subject areas were you teaching when you used the activities?

☐ Science ☐ English Language ☐ Geography ☐ Social Studies

☐ Mathematics ☐ Physical Education ☐ Art ☐ Other?

During how many class periods or sessions did you teach the activities?

Where did you teach the activities?

☐ In a classroom ☐ In the field ☐ In an informal setting

Which demographic description best fits your students?

☐ Urban ☐ Suburban ☐ Rural

Which activities did you teach?

Which activities did you find worked well?

Please let us know what you liked best about the workbook and what you liked least. Is there anything we could do to improve the activities or make the workbook easier to use? Are there any mistakes? Please send us your comments on the back of this form.

Thank you for completing this form. Please return it to Lisa Sorenson, Ph.D., Project Co-ordinator, Dept. of Biology, Boston University, 5 Cummington St., Boston, MA 02215, USA.

INTRODUCTION

The origins of this book and history of The West Indian Whistling-Duck and Wetlands Conservation Project

On 5 August 1996, at the annual meeting of the Society for the Conservation and Study of Caribbean Birds in Nassau, Bahamas, a workshop was held on the West Indian Whistling-Duck (*Dendrocygna arborea*). It's purpose was to review the status of this species throughout it's range and to formulate conservation strategies that could be implemented on a regional basis.

The West Indian Whistling-Duck is a tall, graceful, brown-spotted duck (19-22 inches in length) with a beautiful, haunting call. It is a non-migratory species found only in the West Indies. Once abundant and widely distributed throughout the Caribbean, the West Indian Whistling-Duck is now scarce and limited in its distribution. The combined effects of wetland habitat loss, overhunting, and predation by introduced rats, raccoons and Indian mongoose have wiped out the species from some islands and reduced its numbers drastically in others. Breeding populations are now known to exist on only a few islands, including several Bahama Islands, Turks and Caicos Islands, Cuba, Jamaica, Cayman Islands, Hispaniola, Puerto Rico and Antigua-Barbuda. The West Indian Whistling-Duck (WIWD) is currently listed as "vulnerable" by the World Conservation Union (IUCN), with a total population believed to be no more than 10,000 individuals (IUCN 1994), and which may be far less.

Workshop participants concurred that habitat loss through wetland destruction and degradation and hunting (both legal and illegal) were the two principal threats to the survival of this species, and that public education could mitigate these threats on both a local and regional basis. Indeed everyone agreed that an education and awareness program was the single most important tool to further local conservation efforts. In addition, there was no basic information on population size and habitat use by West Indian Whistling-Ducks for most islands. Such information is vital to the identification of areas needing protection and for future monitoring of the species. The group therefore recommended that a population survey and monitoring program should be initiated on each island.

With few resources in their own countries, all island representatives asked for financial assistance and scientific advice in developing and implementing these programmes. As a result, the West Indian Whistling-Duck Working Group (WIWD-WG) was formed to develop plans for implementing the conservation strategies discussed in the workshop.

In 1997, the WIWD-WG received funding from the United States Fish and Wildlife Service's Western Hemisphere Program and the American Bird Conservancy and ***The West Indian Whistling-Duck and Wetlands Conservation Project*** was launched. Our primary objective was to develop a public education and awareness program on the decline and threatened status of the WIWD and the importance of wetlands in the West Indies. Specifically, we strive to create pride in the WIWD which is a Caribbean endemic, increase awareness and appreciation of the many functions and values of local wetlands and their birdlife, and equip citizens with the knowledge, skills, ideas, values, and commitment necessary to ensure wise sustainable use of important Caribbean wetlands.

As part of the project, a range of educational materials has been developed, including:

- *Wondrous West Indian Wetlands: Teachers' Resource Book,* a 276-page teacher's manual containing comprehensive background information and educational activities relating to the ecology and conservation of Caribbean wetlands.
- Wetlands Field Trip Notebook
- WIWD and Wetlands Conservation Slide Show
- *Wetlands are Wild* Puppet Show
- WIWD Colouring Book
- WIWD Conservation Posters (produced by RARE)
- WIWD Information Postcard
- *Wetland Birds of the Caribbean* Identification Card
- *Seabirds of the Caribbean* Identification Card
- *Ducks of the West Indies* Identification Card for Hunters
- WIWD Conservation Buttons

Please check the project website <www.whistlingduck.org> for more information on the project and wetlands and to download educational materials. Most educational materials are available in Spanish and French translations.

Activities Sponsored by the WIWD Working Group

Wetlands Education Training Workshops. Intended for schoolteachers, environmental educators, and natural resource personnel, these two-day workshops focus specifically on the use of *Wondrous West Indian Wetlands*. Day 1 of each workshop is spent "in the classroom" learning about wetland ecology, the ways in which wetlands safeguard human health and benefit society, the consequences of wetland degradation and destruction, and alternatives to unsustainable use. Concepts and teaching/interpretation techniques are conveyed through presentations and interactive demonstrations, peer-teaching, games, and role-playing activities. All of these activities are included in the teacher's resource book, such that workshop participants can incorporate the same activities and approaches in their own classrooms, field trips, or other public education events. Day 2 is a field trip to a local wetland to learn bird and mangrove identification, and to sample the field activities from the workbook (e.g., plant sampling techniques, wetland assessment).

Watchable Wildlife Ponds. We encourage and support the development of Watchable Wildlife Ponds in the Caribbean - accessible wetland areas which are managed for interpretation to schoolchildren, local residents and tourists. Watchable Wildlife Ponds serve as centers for wetlands education and help to promote the conservation of key wetlands. Large, beautiful and easy to watch, West Indian Whistling-Ducks can be prime attractions at such areas. A demonstration project has already proved successful in the Cayman Islands; viewing platforms and interpretive signs have been installed on ten major WIWD pond habitats on Little Cayman. Watchable Wildlife Ponds are under development in the Bahamas, Jamaica, Antigua, and the Dominican Republic.

Protecting Wetlands Festivals. Community festivals have been held in two municipalities in Cuba. Activities of the festival included: wetlands education workshops with teachers and community leaders to launch the Spanish version of the book *Los Maravillosos Humedales del Caribe Insular: Libro de Trabajo para el Maestro*, wetland field trips, competitions in different artistic mediums related to the protection of wetlands, a photographic exposition entitled "Towards the Conservation and Sustainable Use of Wetlands," talks and slideshows for different sectors of the population, numerous activities with children and the cancellation of a special festival stamp. A logo and mascot were designed for the campaign and were displayed on all of the published materials and posters. T-shirts, baseball caps, and backpacks were used to award the different contest categories.

Population Surveys and Monitoring. To identify important wetland habitats for protection and promote local conservation legislation, surveys of WIWDs are being conducted on several islands, a training workshop on survey and monitoring techniques has been held, and a manual (standard protocol) for WIWD population monitoring is in preparation.

HOW TO USE THIS BOOK

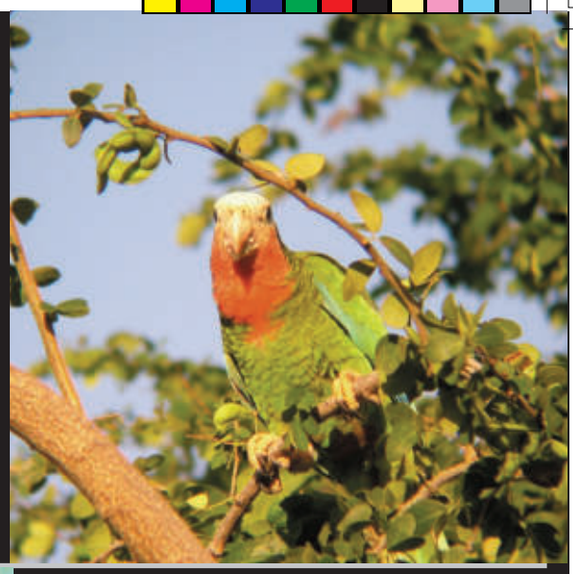
The package is designed with middle-grade (ages 8–14) children in mind, but can easily be modified for use with other ages. Furthermore, the duration of each activity can be adapted to suit individual resources, abilities and needs. The book is divided into six sections with supplementary pages on wetland plants and animals. Each section deals with a major topic relevant to West Indian wetlands and contains three kinds of material: an information section, activities, and worksheets ready for student use. To help integrate environmental studies into other disciplines as well as science, where appropriate, suggestions have been made for the use of this material in other parts of the curriculum. The resource section at the end of the workbook includes a bibliography, glossary, further educational sources and useful addresses.

In the book, students are taken from the discovery of wetlands to awareness of the issues related to wetlands, and are then encouraged to take individual or group action that will have a positive impact on the environment. We recommend using the book as a complete unit, but activities can be used separately. The first three chapters provide an in-depth look at what wetlands are, what lives in them, and how they work. Chapter 4 deals with what is happening to wetlands—primarily their destruction as a result of human actions—and Chapters 5 and 6 give students an understanding of how they can help change this situation by exploring wetlands for themselves and then taking action.

Because the book is based on the concept of implementing classroom learning with work in the field, a field trip is essential. This book gives you a complete guide on the do's and don'ts of running a field trip. It also supplies you with "how-to" instructions and the data-collection worksheets you will need.

WONDROUS WEST INDIAN

WETLANDS



"We have not inherited the earth from our ancestors, we are borrowing it from our children."

- Native American Saying

Chapter 1

WET AND MUDDY: WHAT ARE WETLANDS?

LEARNING OBJECTIVES FOR CHAPTER 1

Students should be able to:

- Identify the main types of coastal wetlands in the Caribbean
- Locate major wetlands of the world, the Caribbean and their island on maps and list them
- Understand wetland zonation and succession of habitats and species
- Understand the relationship between wetlands and the physical processes involved in the water cycle
- Identify the different types of mangroves, where they live and how they are adapted to their habitats

CARIBBEAN WETLANDS

What is a wetland?

A wetland is any place that is regularly flooded with fresh, brackish, or salty water. They are also known as **swamps** (usually with trees) or **marshes** (grassy-looking). There are many types of wetlands in the Caribbean. They are found on offshore and near-shore islands, the coasts, coastal plains, mountain slopes and even on mountain peaks. **Coastal** wetlands are found on the shores and coastal plains and **montane** wetlands are found in the mountains.

Wetlands form anywhere that standing water gathers. They may contain fresh, brackish, salty or super-salty **(hypersaline)** water. Some wetlands are always present, others are seasonal, and some appear only very rarely, after exceptionally heavy rain or high tides. Appearance varies but all wetland soils are saturated with water for at least a week during the growing season every year. Such soils are called **hydric** soils. Oxygen diffuses more slowly in water than in air, therefore hydric soils have an **anaerobic** layer at the surface.

Unusual plants grow in **hydric** soils or in water. Such plants are called **hydrophytes**, and vary from tiny pondweeds less than a millimetre high, to mangrove trees more than 20 m (65 ft) tall. Whatever size, they all have tiny air spaces **(aerenchyma)** in their roots and stems. These air spaces make it easier for oxygen to diffuse to the tissues.

The type of wetland that forms in a particular place depends on many factors, including climate, salinity, tidal range, frequency of flooding, soil type, exposure to waves, frequency of fires, and human disturbance. The wetland's **hydrology**—balance between the amounts of water entering the wetland (from rain, runoff or tides) and leaving the wetland (from evaporation, filtration into the groundwater, rivers or tides)—is very important. This affects frequency, depth and duration of flooding, and hence salinity, the availability of **nutrients**, and the way that energy flows through the system. These factors determine the species of plants that can grow, which in turn determines the species and numbers of animals found there.

What are the main types of wetlands in the Caribbean?

Wetlands are very diverse, there are more than one hundred different types in the Caribbean. The most common include mangroves and associated habitats such as lagoons, salt ponds, fresh and brackish marshes, mudflats, salinas and sounds, as well as freshwater marshes, and swamp forests of many kinds. Some of the main wetland habitats are described below.

Some common types of Caribbean wetlands and associated habitats

TYPE	DESCRIPTION AND HABITAT
Mangroves	Found in salty and tidal areas along coasts, along coastal rivers, streams, and tidal creeks, around ponds and lagoons, and on coastal cays and islets. Dominated by four species of mangrove trees—red, black, white, and button or buttonwood.
Lagoons, salt ponds, salinas and sounds	These are various types of shallow bodies of water near the coast. Surrounding vegetation may include mangroves, shrubs, and sedges, depending on conditions.
Mud flats or tidal flats	Very shallow muddy areas along or near the shoreline that are exposed during low tide.
Estuaries	Shallow, muddy, intertidal areas, formed by the accumulation of silt at the mouth of large rivers. May include mangroves and freshwater marshes.
Tidal creeks	Channels that carry seawater into and out of a wetland, according to the tides. Usually fringed with mangroves.
Freshwater and brackish marshes	A freshwater pond or lake that has become filled with rooted or floating herbs and grasses (e.g. Bulrushes or Cattails, Phragmites, Water Lilies, Water Hyacinth, and Water Lettuce/Swamp Cabbage).
Swamp forest	Trees growing in areas permanently flooded with fresh water. Species composition varies a lot among islands. In some areas dominated by Swamp Bloodwood, others by Royal Palms.
Habitats that are often associated with Caribbean wetlands	
Riverine forest	Trees and shrubs often covered with vines, growing in very wet areas along banks of rivers in floodplains.
Palm and pine barrens	Stands of palm or pine trees with associated low scrubby vegetation, often in sandy areas.
Coastal woodland	Low, scrubby, trees on the beach adapted to tolerate sea spray and breezes. Includes Sea Grape, Beach Mahoe, and Hippomane.
Strand and dune woodland	Herbaceous scrubs and vines growing on foreshores or sandy berms often between a wetland and the sea (e.g., Beach Morning Glory, Beach Pea, Sesuvium)
	Source: adapted from Bacon, 1993.

Mangroves

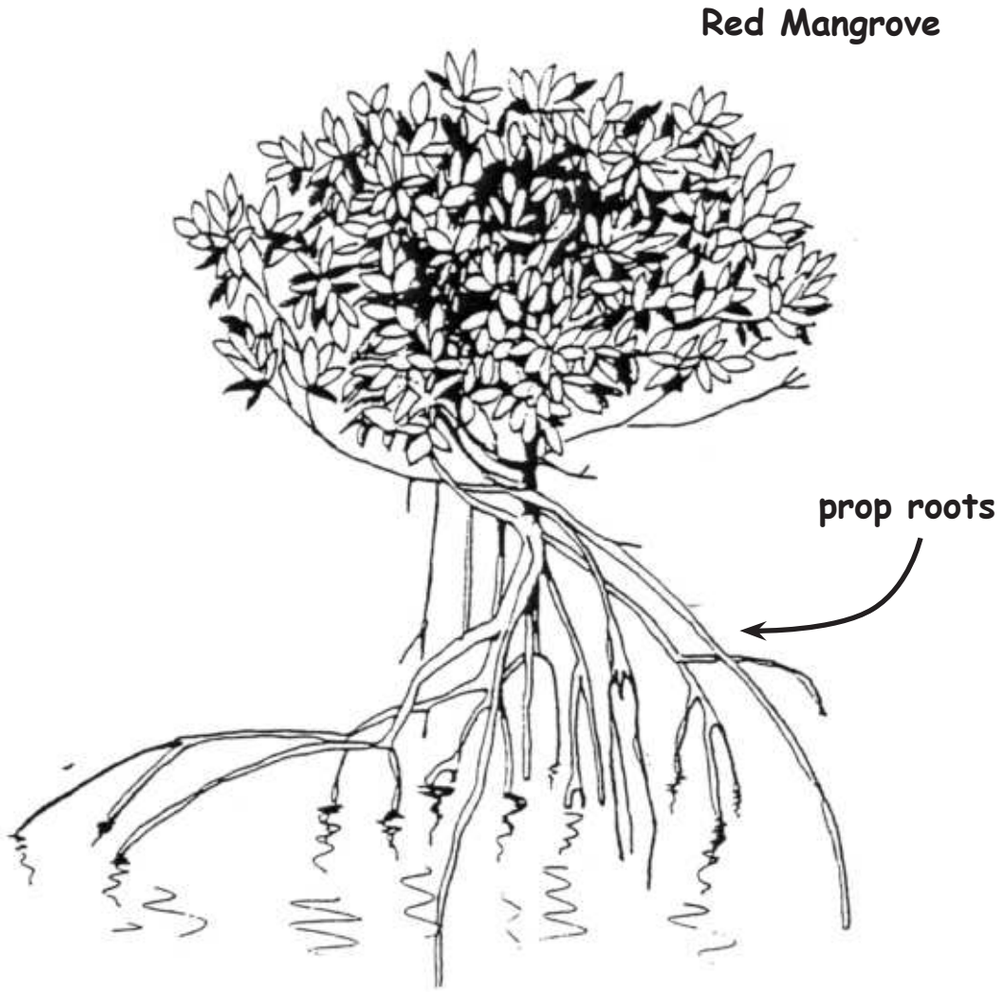
Throughout the tropics and subtropics, wherever coasts are gently sloping and temperatures average 24°C (80°F), there are wetlands inhabited by extraordinary trees called mangroves. They are found along the coastlines of most islands, at river mouths **(riverine)**, fringing sheltered bays, around lagoons and ponds, and on islets and cays. Riverine mangrove trees can grow to more than 20 m (65 ft) high. Scrub mangroves are stunted shrubs, less than half a metre (18 in) high. There are nearly a million hectares of mangroves in the insular Caribbean basin. This is more than 5% of all the mangroves left in the world.

Which species of mangroves occur in the Caribbean?

(See Copy Cat Page "Identification Guide to the Four Most Common Species of Mangroves.")

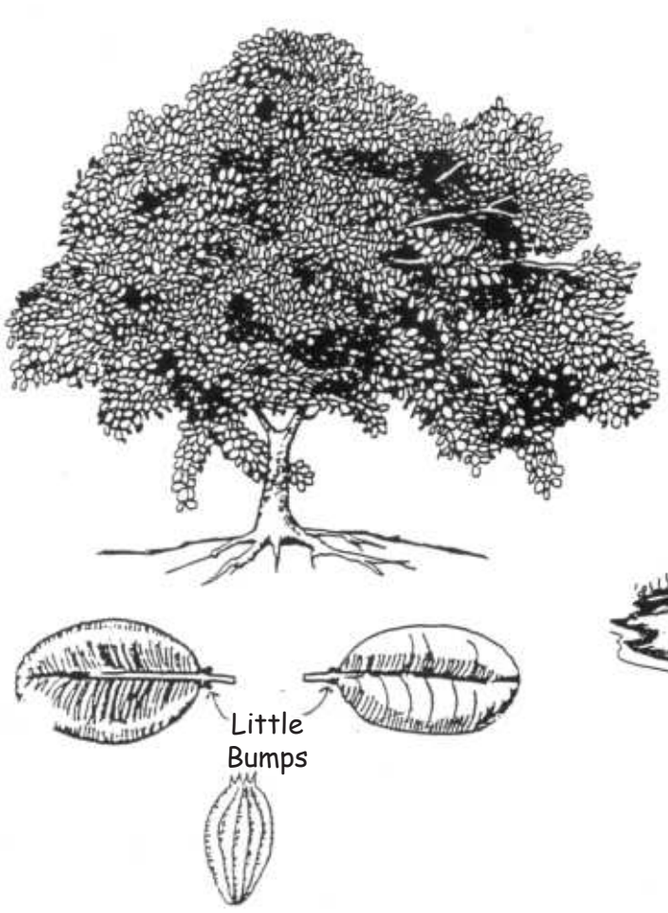
Worldwide, there are more than 50 species of mangroves. Some are closely related to each other, while others may look similar or have similar adaptations but are not related. All share an amazing ability to grow in places shunned by other plants, places that would otherwise be too hot, too salty, too wet, and too exposed to wind, rain, tides, and storms.

All mangroves have some features in common, such as spreading root systems that allow trees to grow in mud or the ability to deal with excess salt in their surroundings. Each species grows in a slightly different part of the wetland and is especially adapted to the conditions. Most Caribbean wetlands are dominated by just four species: Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*), White Mangrove (*Laguncularia racemosa*), and Buttonwood, or Button Mangrove (*Conocarpus erectus*). A fifth species (*Avicennia schaueriana*) occurs on a few islands but is not common anywhere. Two other species (*Rhizophora harrisonii* and R*hizophora racemosa*) are found along the mainland coasts of the Caribbean basin and in Trinidad.



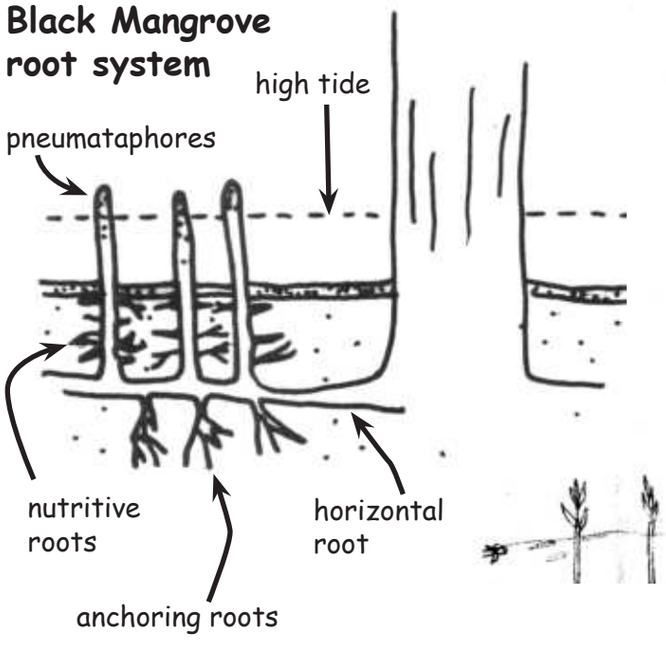
THREE COMMON SPECIES OF MANGROVE

White Mangrove



Black Mangrove

Black Mangrove root system



Red Mangrove

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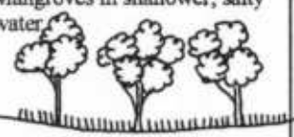
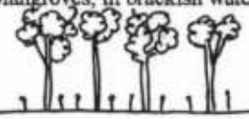
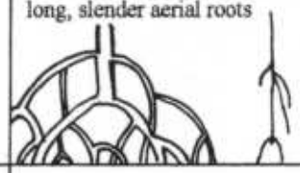
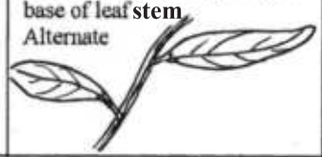
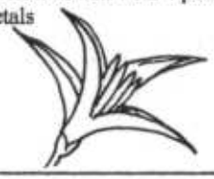
IDENTIFICATION GUIDE TO THE FOUR MOST COMMON SPECIES OF MANGROVES

Identification Guide to the Four Most Common Species of Mangroves in the Caribbean				
Characteristic	**Red Mangrove**	**Black Mangrove**	**White Mangrove**	**Buttonwood**
Habitat	Along the shoreline, and in rivers and lagoons, in salty water 	Usually to landward of Red Mangroves in shallower, salty water 	Usually to landward of Black Mangroves, in brackish water 	Near the sea on rocks, beaches, and berms (not usually in water) 
Roots	Thick stilt or prop roots and long, slender aerial roots 	No prop roots; surrounded by thin breathing roots, which stick out above water 	Thick, knobby breathing roots; no prop roots 	No prop or breathing roots 
Leaves **Appearance** Large, rounded, and leathery **Position** Opposite 	Long and thin, Salt crystals on back Opposite 	Rounded, sometimes with pinkish stems Opposite **2 small bumps (salt glands) at base of leaf** 	Long and thin, 2 small bumps (salt glands) at base of leaf **stem** Alternate 	
Flowers	Yellow-cream with 4 pointed petals 	White, **four petals** 	Very small, white 	Very small, in clusters 
Fruits	Form torpedo-like plantlets on the tree 	About 1 inch long, flattened 	Green and ribbed, in clusters 	In clusters in rounded heads 

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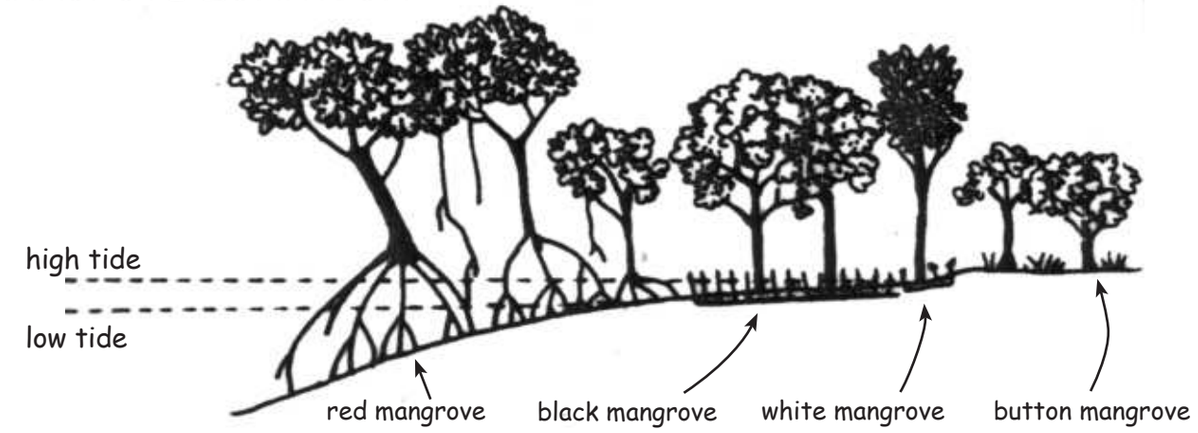
Where do mangroves grow?

Imagine that you are approaching a Caribbean island from the sea. As the island shelf gets shallower and the land gets nearer, the first species of plant that you are likely to see is a Red Mangrove. It grows mostly in places that are permanently wet and salty—on the shores of mainland, cays and islets, along rivers close to the sea, and around salty ponds and lagoons. If you were to land on a coast fringed by Red Mangroves, you would have to do a balancing act to clamber over the arching roots; a very slow process. The world record time for the 100 m Red Mangrove race is reported to be 22.5 minutes! The dense tangle of roots protects the shore from wave action and traps sediments from the land. The roots rot in the soil and form peat. Behind the Red Mangroves, soils are muddy. As soils get muddier, another species of mangrove—the Black Mangrove—takes over.

Black Mangroves prefer the heavy, black, oxygen-poor **(anoxic)** soils and salty conditions that prevail behind the Red Mangroves. Their roots stick up around their trunks like overgrown lawns of fingers. Further inland, away from the direct influence of the sea, the White Mangrove takes over. White Mangroves like less saline conditions, although they can also grow among the other species, especially near rivers or creeks. Still further inland, or on isolated patches of rocks or sand beside the sea, where conditions are drier, you will find the Buttonwood, and behind that, coastal woodland or swamp forest. This pattern of transition from one species to another is called zonation. Many different patterns of **zonation** occur, depending on specific conditions at a particular site.

MANGROVE ZONATION



Global distribution of mangroves

Mangrove swamps are found in the world's warmer regions, where temperatures average 24°C (75°F) or more. They grow on gently sloping coasts.

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a. Mangrove features, adaptations and life history

With their stout, curved **prop roots**, arching into the water from their trunks, their long, slender, leg-like aerial roots, and large, waxy, bright green leaves, Red Mangroves cannot be mistaken for any other tree. These roots have two main functions—support and breathing. Extraordinary conditions require special **adaptations** (changes in structure and function that make a plant or animal more suited to its environment), and prop roots are very different from normal roots. Arching around the main trunk the roots support and spread the weight of the trunk, branches, and leaves, and thus help the tree to stay upright in muddy, tidal, and windy conditions. Like the aerial roots, the parts above the water are covered with tiny pores or **lenticels** (which look like small knobs), through which the tree can breathe. This is necessary because the mud is so low in oxygen that no ordinary roots could survive there. If the lenticels are covered with water for too long, the mangroves will die. This sometimes happens after prolonged heavy rain, e.g., after a hurricane.

Clinging to the edge of the land, Red Mangrove roots trap sediments and build up the land behind them. When the coastal shelf is shallow, they grow out into the sea, extending the land and protecting it from storm damage and erosion. The reproductive cycle of the Red Mangrove is adapted to help this process. It begins when the Red Mangrove bursts into flower, usually spring or summer, but Caribbean mangroves can flower all year round. The waxy bright-yellow star-shaped blossoms attract bees and are quickly fertilised. The mature fruits stay attached to the tree while they develop into **propagules.** The roots of the propagules begin to grow while they are still attached to the parent tree. When they are 20–30 cm (7–12 in) long, the dart-shaped, heavy propagules fall from the tree and plunge into the mud or water below. Some root where they fall, while others are washed away by waves and currents and float for months before they wash up in a nice muddy place. In the right conditions the propagules spring up densely and grow rapidly - more than 60 cm (23–24 in) a year. Their roots arch out into the sea helping them to spread over shallow reefs and mud banks or fill shallow ponds and channels.

The speed with which Red Mangrove leaves grow, are shed, decompose and form food for other living things makes these ecosystems among the most productive in the world. A hectare of average-sized Red Mangrove trees can shed 7-15 tonnes of leaves a year. The leaves are eaten by crabs or fall into the water where they are decomposed by bacteria or bright pink fungi called ascomycetes. Red Mangroves provide a sheltered nursery where young fish, conch and other shellfish, shrimps, lobsters, and turtles can feed and shelter from storms and predators, and in these favourable conditions grow quickly. As soon as the juveniles are big enough, they move out through the sea grass beds to the coral reefs or open ocean to mature and breed. Thousands of other creatures, including many commercial varieties of fish and other seafood, make their homes in and under the roots of Red Mangroves, all completely dependent on the food, water, and shelter that the mangroves provide. Above the water, many species of birds and insects live, nest, or hunt in the trees' roots, trunks or branches or among the leaves. In addition, mangroves provide humans with food, and with shelter from hurricanes and other storms, and filter and clean our groundwater. Throughout the tropics, wherever coastal mangroves have been cleared away, coastal fisheries have collapsed. Red Mangroves also provide a protective barrier that filters sediments and pollutants that wash from the land toward the sea, protecting reefs and coral.

Red Mangroves grow on the seaward edges of the shore. Their roots trap sediments, and the level of the mud rises. Over time, conditions become drier and less suitable for Red Mangrove seedlings and more suitable for other species. This process is called **succession.**

As conditions worsen for Red Mangroves, they improve for Black Mangroves that have found a unique solution to the problems of growing in mud. The horizontal roots of Black Mangroves spread out from the main trunk, with vertical roots sticking up from them. They form a carpet of thin, knobby fingers called **pneumatophores** around the base of the tree, often extending beyond the canopy. The pneumatophores are generally long enough to stick out above the water at high tide so they can breathe. The aboveground parts trap sediments and pollutants washed toward the sea by rivers and streams from the land, thereby helping to protect the coral reefs and seagrass beds. Below ground there are fine horizontal roots, absorbing nutrients from the mud.

Black Mangroves can grow on the edges of ponds that are much saltier than seawater. Where the mud is sometimes exposed evaporation may increase the soil's salt level, or **salinity**. However, Black Mangroves can tolerate high levels of salt in their sap, and control the amount of salt in their tissues by excreting salt through their leaves. If the salt crystals are washed off the leaves, more will form.

White Mangroves prefer less salty water than Red or Black Mangroves. They can often be found further inland than the other species. Like Black Mangroves, they excrete salt. They have small salt glands on their petioles, at the base of their leaves. Another resemblance to Black Mangroves is that they have pneumatophores. However, these are wider and often more knobby (sometimes flattened like small toadstools), and grow less densely, than those of Black Mangroves. The density of pneumatophores around a White Mangrove tree depends on the conditions. In wet conditions trees often have large numbers of pneumatophores but those that grow in sand may have very few.

Buttonwoods (Button Mangroves) are often found growing among the Black and White Mangroves on the landward edge of a wetland. They occur on rocks beside the sea, or among other trees on the berm. The presence of Buttonwood is a good indication of drier, better-drained soil conditions. They excrete salt through salt glands, but unlike other species of mangroves have normal root systems.

Mangroves can be divided into types according to where they grow in relation to water. **Fringe** mangroves grow along coasts - exposed to tidal action and storms. In unfavourable conditions trees may be small and stunted. **Basin** mangroves grow around more sheltered, enclosed water bodies, such as lagoons and salt ponds, but are more likely to be exposed to high or low salinities. **Overwash** islands are located in the sea, on raised outcrops of limestone. They often have tall red mangroves around their edges and smaller black mangroves in the centre. **Riverine** mangroves are found on riverbanks, where salinities are lower. The tallest mangroves are usually found on the banks of rivers or creeks.

b.Lagoons, salt ponds, salinas and sounds

Sand, produced by the decomposition of corals and algae, may be carried along coasts by currents. Sometimes it builds into a projection or **sand spit**. Plants such as *Sesuvium* may grow on the spit and stabilise the sand, which may extend and partly enclose a body of water **(lagoon)**. If the sand spit continues to expand, the lagoon gradually turns into a coastal pond or salt pond, cut off from the sea. The margins of lagoons are often lined with mangroves (e.g., Long Island in the Bahamas). Ponds tend to fill up with detritus washed in from the land and become shallow and dry out. Dried out ponds and their margins may form **salinas**, where conditions are so salty that nothing except algae can grow. Others eventually become filled with vegetation. Salty ponds tend to fill with mangroves, while fresh ponds become filled with grasses or sedges. This is another example of **succession.**

Sometimes this process can be reversed, for example exceptionally heavy rains may drown the basin mangroves and reform a lagoon (e.g. Booby Pond, Little Cayman). Lagoons can also be formed by circular coral reefs, which gradually enclose bodies of water forming an **atoll**. This type of lagoon is very common in the Pacific, where reefs form on the summits of submarine volcanoes, but is rare in the West Indies (e.g. Conception Island National Park, Bahamas).

One distinctive feature of salt ponds and lagoons is their colour: green, brown, red or sometimes even yellow or purple. It is an indication of the presence of **algae** and **bacteria** in the water that are able to grow rapidly in favorable conditions and from a dense growth or **bloom**. The algae form an impervious mat several inches thick on the bottom of the pond and prevent leakage of the water downwards. Salinity increases, the algae die and are decomposed by bacteria, giving off a strong smell. The pond becomes darker in colour and salt crystals begin to form. The dense growth of algae creates an abundance of food. **Molluscs**, fish and invertebrates feed on the algae and their products, which in turn attracts shorebirds and young crocodiles. Salt ponds are often lined with low, shrubby plants, such as *Batis*, *Sesuvium* and *Salicornia* or scrubby Black Mangroves that flourish in salty conditions.

Mangroves also flourish along the sheltered landward fringes of many sounds. A **sound** is a shallow stretch of open water between a coral reef and the shore.

c. Mudflats and tidal flats

Mudflats often form along the shore of the sea, a pond, or a shallow tidal lagoon, where silt builds up. Covered with algae, they attract flies and small shrimp-like creatures (**amphipods**) and are full of burrowing animals such as molluscs. When wet, they are richly productive, and many birds are attracted to feed. Red Mangroves colonise sheltered mudflats, and grow out into tidal flats, extending the land. If the trees are small and stunted they are called dwarf mangroves.

d. Estuaries

Where a large slow-flowing river crosses a flood plain and enters the ocean, large quantities of silt may build up. If the coast is sheltered and currents do not wash the silt away, an estuary may form. As the silt builds up, the mouth of the river expands, creating an intertidal area, alternately covered by fresh and salt water, with channels and mudflats. Large estuaries, and their associated deltas, are more common in the Greater Antilles, or the Caribbean coasts of Central America, because only very large rivers carry enough silt to build out into the sea. Examples can be found in the larger islands such as Sagua la Grande, Sagua la Chica in Villa Clara province, Rio Cauto in Holguin, and Rio Manati in the south-central province of Sancti Spiriti (Cuba). Other examples include the Rio Minho in southern Clarendon, Jamaica and the Orinoco River in Venezuela, which affects the waters around nearby Trinidad. Mangrove islands and mudflats are often found in estuaries.

e. Tidal creeks

Tidal creeks may look like rivers on a map, but they are actually marine features. They are fed by the sea and driven by tides. Their waters are salty and lined with mangroves. Examples are found in the Bahamas e.g. Fresh Creek on Andros, Bonefish Pond on New Providence, and Pigeon Creek on San Salvador; Force Creek in Grand Cayman; and many examples in Cuba and the Turks and Caicos Islands. Many Caribbean rivers have seasonal flow patterns. They may be mainly tidal in the dry season, but carry large volumes of water to the sea in the wet season.

f. Freshwater and brackish marshes

Some wetlands are too fresh for mangroves to establish themselves. In others, mangroves or swamp forests have been cut down, and fires have prevented regeneration. In such places, grass-like plants called reeds or sedges may dominate the vegetation. Such areas are called **marshes** or **herbaceous marshes.** They may be fresh, brackish or salty. They also form when sandbars or vegetation blocks rivers and streams, or when low-lying areas, valleys, limestone basins (depressions), or coastal lagoons are filled with water.

Rivers and streams run through them, and they may be dotted with ponds, pools, or lakes, where the plants can be either floating or rooted to the bottom. Close to the sea, they are usually salty or brackish (**salt marshes**); further inland the water is usually fresh (**freshwater marshes**). Freshwater marshes form when ponds or lakes become filled with rooted or floating plants. Freshwater marshes are among the most rare and threatened types of wetlands in the Caribbean. In some coastal marshes, the fresh surface water floats on a tidal layer of salty water below, forming a **salt wedge**, that may penetrate up river for many kilometres.

In shallow patches of open water (e.g. ponds, pools, streams, and rivers) floating plants, such as Water Lilies, Water Hyacinth or Water Lettuce/Swamp Cabbage may grow. They have long, trailing roots, which absorb water and nutrients. Because they are rooted to the ground they cannot grow very tall, so they tend to spread over the water to increase their leaf areas. Thus, they often block rivers, increase the likelihood of flooding and make it difficult for boats to get through (Water Hyacinth is a devastating introduced **invasive** species). Such plants slow down the water as it enters the marsh, causing it to drop its burden of silt and **detritus**. Under the floating leaves, many species of fish and shrimp feed on the detritus.

In shallow water or on floating mats of vegetation, other plants put down roots. Reeds (such as various species of *Eleocharis*), sedges, and taller plants like the Common Reed (*Phragmites*) and Bulrushes or Cattails (*Typha*) grow densely. Birds take advantage of the dense cover to stalk their prey, such as fish, grasshoppers, and spiders. Others, like West Indian Whistling-Ducks, may shelter in reed beds during the day.

g. Swamp forests

On limestone islands or other patches of slightly firmer soil and peat in a freshwater marsh, or on the landward side of mangrove swamps, though permanently flooded, the ground may be firm enough for trees to grow. Conditions are rarely salty, so mangroves cannot compete. The trees that grow in swamp forests are as amazing as mangroves. Many of them are **endemic** to the island or group of islands on which they are found. The many different types of Caribbean swamp forests (too numerous to describe here) are under great pressure from development, timber harvest and other forms of disturbance, and may be one of the most endangered ecosystems in the region.

In Trinidad, Guadeloupe, and Puerto Rico, and other parts of the Lesser Antilles, huge Swamp Bloodwood trees dominate some of the swamp forests. Despite growing in water, these trees can grow to heights of more than 20 m (65 ft) tall because they are supported by huge buttress roots. The breakdown products from their leaves and roots stain the water red—hence their name.

Other swamp forests have large numbers of palm trees, including endemic species of Royal Palms on several islands. Some rainforest trees that are usually found only in the mountains also find a refuge in swamp forests. Wherever they survive, swamp forests are very interesting and diverse habitats. Unfortunately, they are generally very rare and highly endangered.

What types of habitats are associated with Caribbean wetlands?

Various other habitats are often found close to Caribbean wetlands. These will be mentioned below but are not discussed in detail in this workbook.

a. Riverine forests

Where large rivers flow across coastal plains, unique communities of large trees, with many vines and orchids, may form on their banks. Unfortunately, few examples of this type of habitat survive.

b. Strand dune, strand woodland and coastal woodland

Where wetlands are separated from the sea by a sandy beach, their vegetation plays an important role in stabilizing the shoreline. A transition can be seen from the beach to the wetland. Close to the sea, on the exposed foreshore is the strand dune community. The plants (mostly vines) can tolerate salty conditions and occasional exposure to waves (e.g. Beach Morning Glory and Beach Pea). To landward the plants get scrubbier and include low succulents (e.g. *Sesuvium*) as well as more bushy ones (e.g. *Suriana* and Sea Lavender). Between the strand dune community and the wetland, the conditions are still salty and exposed, but stable enough to support a diverse coastal woodland community. This includes trees such as Sea Grape, Beach Mahoe and Hippomane.

c. Barrens

Barrens occur between wetlands and hardland. They usually have a layer of low shrubby trees, shaded by tall trees belonging to one species, usually palms or pines.

Whistler says...

WEST INDIAN WHISTLING-DUCK
DESCRIPTION, DISTRIBUTION AND HABITATS

DESCRIPTION: The West Indian Whistling-Duck is a large, mostly brown, goose-like duck, with relatively long legs, that extend beyond the end of the tail in flight. It stands about 19-22 inches tall. Its back is brown but its throat is white and the chest is reddish brown. The under parts are white with dark spots.

DISTRIBUTION: This duck is found only in the West Indies and nowhere else in the world. It lives in the Bahamas, Turks and Caicos Islands, Cuba, Cayman Islands, Jamaica, Hispaniola, Puerto Rico and the northern Lesser Antilles, but is not common anywhere.

HABITATS: It inhabits fresh and salty wetlands, using lagoons, swamps, marshes, mangroves, rice fields, and palm savannas.

ACTIVITY 1-A

WHAT DO *YOU* THINK ABOUT WETLANDS?

Summary

An introductory activity for programmes about wetlands, designed to encourage students to explore their own attitudes and thoughts.

Learning Objectives

Students will:

- Explore and discuss their prejudices about wetlands

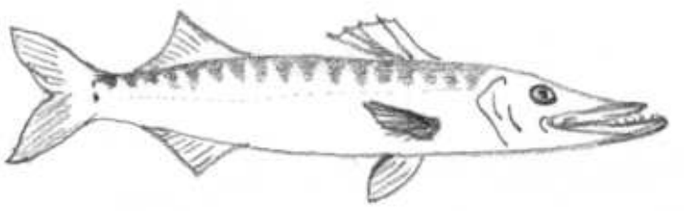
Materials

- Slips of paper and writing materials
- Chalkboard and chalk

Age Levels All

Subject Areas Social studies

Time 10-20 minutes



Background

In the past, wetlands were perceived as dangerous places, the haunts of evil spirits and source of noxious diseases. Before the discovery that mosquitoes transmitted malaria and yellow fever, people believed the bad air from the swamps caused the diseases. In the late seventeenth and early eighteenth centuries the mortality rates among people living in coastal parts of the West Indies were high. British military commanders estimated they would lose at least one man in seven per year on West India station. Nevertheless, economic and strategic advantages provided by the wetlands meant that most of the capitals of the islands were constructed in coastal swamps.

Health problems, combined with difficult access and unsuitable conditions for crops and livestock, as well as the failure to recognize the relationship between wetlands and marine productivity, gave wetlands a poor image. Draining and clearing wetlands was generally considered a public good. These attitudes persist and many people still view wetlands negatively. However, in their natural state, wetlands are generally beautiful, highly productive habitats with many functions and values. (See Chapter 3).

Preparation

Provide each student with a piece of paper marked with a letter of the alphabet.

Procedure

1. Ask each student to write the first word beginning with that letter that comes into their heads when they think of wetlands.
2. Collect the slips.
3. Ask a volunteer to draw three columns on the board: positive, negative or neutral. As each slip is read, add the word to the appropriate column.
4. Discuss:
   - Which list is longer? *The negative one.*
   - Why do people have these perceptions of wetlands? *People think that wetlands are valueless, unhealthy, inaccessable, and the source of dangerous diseases and animals.*
   - Are these perceptions justified? *Treated with respect, wetlands are productive and important habitats with many functions and values (e.g., they serve as nurseries for marine fisheries, habitat for wildlife, protect coastlines and help control flooding).*
   - How do people express these perceptions? *They use wetlands as rubbish dumps, harvest their resources unsustainably, and build over them.*
   - Which wetland animals have the biggest public relations problems? *Crocodiles, mosquitoes.*
   - What could be done to improve attitudes to wetlands?

Evaluation/Assessment

Older children: Write an essay on the topic "Why some people like wetlands and others dislike them."
Younger children: Draw a picture showing why some people like wetlands and others dislike them.

Source Adapted from WOW The Wonders of Wetlands

Activity 1-B

WHERE'S MY WETLAND?

Summary

Use geographical and mathematical skills to find out more about the wetlands on their islands.

Learning Objectives

Students will learn:

- Which islands have the most wetlands
- The main types of wetlands
- The names and locations of the major West Indian and Caribbean wetlands

Age Levels 8 +

Subject Areas Mathematics, geography

Time One or more classes depending on how many of the activities are undertaken.

Materials

- Copy Cat Pages: "Where are the Mangroves?," "Some Types of West Indian Wetlands," "Major Mangrove Coastlines of the West Indies"
- Copies of a map of your island showing the major wetlands (not included)
- Graph paper
- Caribbean Atlas

Preparation

Copy Cat Pages and map for your island (either one of each per student or group of students or overhead transparencies).

Procedure

1. **What are the main types of wetlands and where are they found?**

Explain what wetlands are and describe the main types of Caribbean wetlands. Show the students the pictures of the wetland types Copy Cat Page "Some Types of West Indian Wetlands." Which geographic locations are most likely to contain wetlands?

2. **Which countries have the most wetlands?**

a) Divide the class into groups of four. Distribute copies of the Copy Cat Pages "Where are the Mangroves?," "Some Types of West Indian Wetlands" and "Major Mangrove Coastlines of the West Indies." In each group one student will draw a bar graph of the ten Caribbean countries with the most wetland sites, the second a similar graph of the ten countries with the greatest area of wetlands; a third a similar graph showing the countries with the highest percentage of wetlands; a fourth will use an atlas to label the islands and write the total area of wetlands beside the name of each territory.

b) Discuss the findings.

3. **Where are the wetlands?**

a) Explain that the Copy Cat Page "Major Mangrove Coastlines of the West Indies" shows where the main wetlands of the Caribbean are located. Use the key to find out where the largest wetlands are. Mark them on the map.

4. **Who gets the benefit?**

a) Explain that many wetlands are important sources of fish, lobsters, conch, coral larvae and shrimp that live on reefs and sea grass beds. For example fish spawned on the reefs are washed into the mangroves where they shelter, feed and grow. Later they leave the wetland and are transported along the coastline by the current. Thus, a wetland will be a source of young fish for fishing grounds down current.

b) Study a map of the Caribbean, showing the main ocean currents. Try to determine where young fish on your reefs might come from and where they go. Do your wetlands supply neighbouring islands?

c) Similarly, mangroves in one area may be vital to the sedimentary stability of coasts in adjacent areas and islands under the influence of coastal currents, littoral sediment drift and other geomorphological processes. The health of coral reefs throughout the region depends on a constant supply of clear water. Which coral reefs are at risk? Which mangroves are most important regionally? Do the mangroves in your island help to protect coral reefs in other islands?

Extension

Encourage students to:

- Find out the names of wetlands in your country, and mark them on a map
- Identify any protected wetlands in your country
- Use the pictures in this chapter, or from atlases or websites to make drawings or paintings of the wetlands
- Ask students to choose a wetland and find out as much as possible about it. They may choose a wetland anywhere in the world
- Wetland Jeopardy: Students could make up ten wetland quiz questions, pool them and compete in teams to answer them

Source Ann Sutton

Some Types of West Indian Wetlands

Mangrove fringed lagoon

Coastal Red Mangrove in a sound

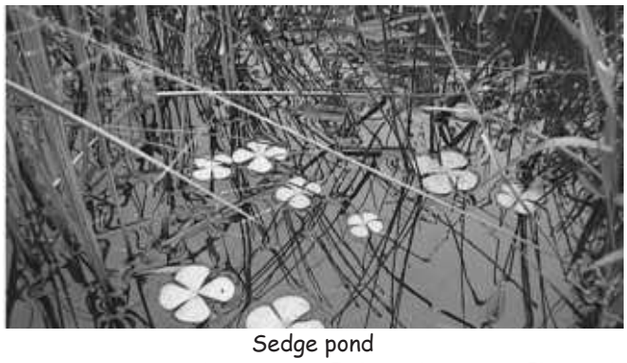
Typha fringed brackish pond

Tidal creek

Herbaceous freshwater wetland

Red Mangrove wetland (aerial view)

Saline lagoon



Sedge pond

COPY CAT PAGE

WHERE ARE THE MANGROVES?

WEST INDIAN MANGROVES – AREAS OF MANGROVES IN CARIBBEAN TERRITORIES			
COUNTRY	AREA OF MANGROVES IN HA (ACRES)	ESTIMATED NUMBER OF MANGROVE SITES	% LAND SURFACE OF COUNTRY/ TERRITORY/ ISLAND
Anguilla	270 (667)	10	2.8
Antigua	559 (1,381)	36	2.7
Barbuda	616 (15220	9	
Bahamas	141,957 (350,776)	20	10.2
Bermuda	20 (49)	Data not found	<0.1
Barbados	20 (49)	14	<0.1
British Virgin Islands	627 (1,549)	55	Data not found
Cayman Islands	7,268 (17,959)	25	27.6
Cuba	529,700 (1,308,889)	Data not found	4.8
Dominica	10 (25)	10	<0.1
Dominican Republic	9,000 (22,239)	Data not found	0.2
Grenada	149 (368)	24	0.6
Grenadines (Grenada)	67 (166)	4	
Guadeloupe	8,000 (19,768)	Data not found	4.5
Haiti	18,000 (44,478)	Data not found	0.7
Jamaica	10,624 (26,252)	101	1.0
Martinique	1,900 (4,695)	Data not found	1.7
Montserrat	4 (10)	4	<0.1
Puerto Rico	6,500 (16,062)	Data not found	0.71
St. Kitts and Nevis	79 (195)	16	6.1
St. Lucia	157 (388)	18	0.3
St. Vincent	2 (5)	4	1.5
(St. Vincent) Grenadines	48 (119)	13	
Trinidad	7,020 (17,346)	38	1.4
Tobago	130 (321)	11	
Turks and Caicos	23,600 (58,316)	95	Data not found
US Virgin Islands	978* (2,417)	21	Data not found
TOTAL	767,305		
Data from Bacon, 1993			

*This is the total area of wetland. No specific data for mangroves were available.

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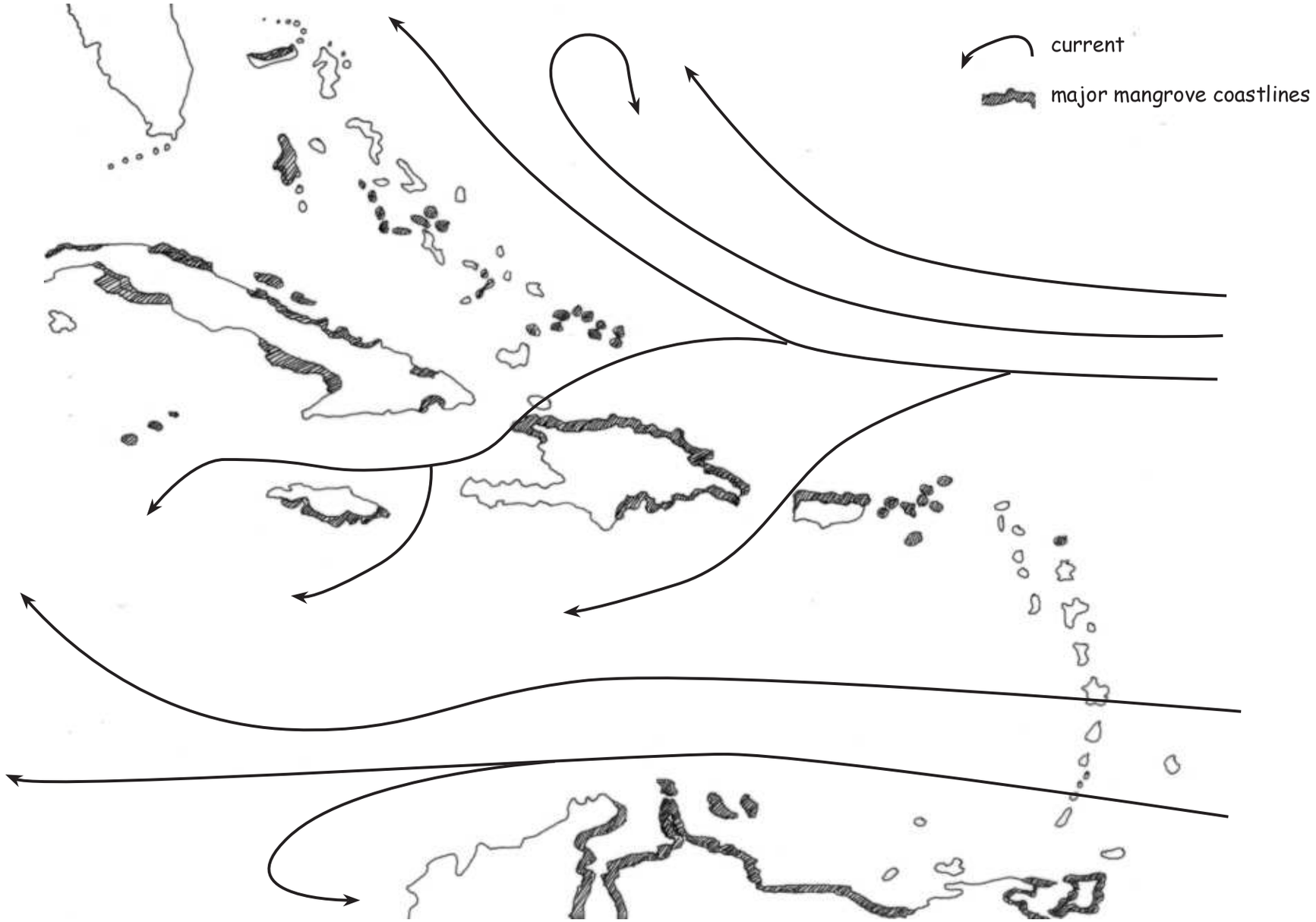
MAJOR MANGROVE COASTLINES OF THE WEST INDIES



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Activity 1-C

Salty Currents

Summary

Practical demonstration of some physics of coastal waters, especially how saltwater and freshwater mix.

Learning Objectives

Students will be able to:

- Observe and explain what happens when fresh and salt waters meet
- Understand the relevance of their observations to coastal wetlands
- Discuss how water temperature and salinity influence plant and animal habitats in wetlands

Materials

- Two 25-50 litre (5-10-gallon) aquaria or clear plastic containers of similar size and shape (if using aquaria, make sure the one that contains salt water will not be used later for freshwater fish)
- Two 100 cc (6 or 8 oz) glass soda or mineral-water bottles, with caps, or 1 to 2 ounce plastic bottles with caps
- Labels or permanent marker for labeling bottles
- Salt (coarse or table salt)
- Food colouring (preferably two colours)
- Paper and pencil for recording results
- Blackboard/flip chart and chalk/markers

Age Levels 10 +

Subject Area Integrated science

Time 30–60 minutes

Background

Some wetlands (including mangroves) are located where fresh water from the land meets salt water from the ocean. Seawater is always salty, its **salinity** is relatively constant. In contrast, coastal wetlands may be less or more salty than the ocean. Their salinity may fluctuate according to the amount of fresh water that enters (from rainfall, runoff, streams or springs) or leaves (by evaporation) (see Activity 1-E). Fresh water is less dense and usually cooler than salt water, and, if undisturbed (e.g. by waves, wind or other turbulence) floats on top of it. The freshwater on the surface will be divided from the salt water below by a thin band of brackish water. The effects of wind, waves, tides and seasonal rains mean that wetland animals and plants are exposed to continual fluctuations in salinity.

Procedure

1. Tell the students that they will experiment to find out whether salinity affects the way that water from the sea mixes with water from rivers in wetlands. Older students should formulate a null and alternative hypotheses and predictions.

2. Ask two students to demonstrate the following procedure to the rest of the class:
   - Half-fill the aquaria with cold fresh water
   - Fill the two small bottles with water
   - Cap and label one bottle "FRESH WATER"
   - Add enough salt to the second bottle to make a mixture saltier than the sea (approximately two teaspoons)
   - Cap and label bottle "SALT WATER," then shake salty mixture until the salt is thoroughly dissolved.

3. Tell students they will be placing one bottle uncapped at the bottom of each aquarium. Lead class in discussion about what they think will then happen to the water. Remind the students about the definition of density (mass/unit volume). What chemical and physical conditions influence the density of water? *Concentration of dissolved salts and temperature.*

4. Record the students' predictions and reasoning on the blackboard.

5. Ask students to suggest how they can observe what the water in each bottle will do, since the water in both bottles looks the same as the water in the tanks. *By adding colouring to the water in the bottles.*

6. Ask a student to place the bottle of coloured saltwater on the bottom of one aquarium, and then uncap it. *Note: If you do the saltwater demonstration first, the results are more surprising to the students, and usually indicate whether their predictions are correct for the second demonstration.*

7. Observe what happens as the water leaks out of the bottle into the aquarium. *The layer of salt water does not mix but forms a layer on the bottom.* Discuss why this happened. *Salt water is denser than fresh water.* Compare the predictions to the actual event. If time permits, leave the basin undisturbed to see what will happen to the water over time.

8. Follow the same procedure with the bottle of coloured fresh water in the other aquarium. *The fresh water from the bottle mixes with the water in the tank.*

Alternative procedure

If you have only one aquarium, follow the same procedure, and do the two tests simultaneously. Make sure you use different colours in the water in the salt water and fresh water bottles.

Discussion

- What does this demonstration tell us about our wetlands? *Fresh water is less dense than seawater and floats above it, unless mixed by winds and waves. Therefore, many wetlands have a fresh layer (a freshwater lens) on top of a salty one (a salt wedge).* ***Salt wedges*** *can persist more than 8 miles up stream.*

- Which is saltier, water in a wetland or water in the sea? *Wetlands that are connected to the sea and fed by rivers and springs are generally less salty than the sea. By contrast, wetlands that are isolated from the sea, but fed by saline springs or filled by occasional overwash at high tides may be* ***hypersaline*** *– more salty than the sea. The salinity of a coastal wetland tends to fluctuate but the salinity of the sea is relatively stable.*

- What causes salinity to fluctuate? *During the day, the sun's heat causes evaporation and makes conditions saltier but this may be moderated by twice-daily tidal flushing. Winds cause waves that mix the upper floating layers of fresh water with the underlying layers of salt water. Seasonal variations may be caused by drought and rain cycles. Hurricanes can bring extremely heavy rainfall, sometimes diluting water in coastal wetlands so much that mangroves die.*

- Why is the variation in salinity important to wetland life? *There are many reasons, e.g., rapid changes in salinity affect suspended solids (sediment, detritus) in rivers, causing them to drop to the floor of the wetland, where they may be eaten by fish and shrimp. Most aquatic animals and plants are adapted to live either in the sea or in fresh water, but coastal wetland animals and plants must be able to live in an environment that may change rapidly from salty to fresh.*

- Ask the students if they have bathed in the sea where a river or waterfall enters it. Was the sea or the river hotter? *The sea.* Is the water in the wetland likely to be hotter or colder than the surface layers of the sea? *This depends on how much freshwater is entering the wetland, but generally water in shallow wetland pools will be heated rapidly by the sun and can be much hotter than the sea.* In tropical conditions, which is denser, hot water or cold water? *Cold water.*

- What happens when cold water is heated, e.g., by the sun? *It gets less dense and rises. This process is called* ***convection****. Convection tends to keep the freshwater on the surface, although it is colder than the salt water below.*

- How does this affect wetland animals and plants?*Since the fresh water at the surface tends to be cooler than the seawater, they may have to deal with extremes of temperature and salinity. Such fluctuations kill sensitive animals such as corals, which need constant salinity and temperature - so few corals are found inside wetlands. Shallow, hot, salty ponds can be highly productive, because plants grow faster in warm conditions, and nutrients, provided by mangrove leaves and other sources of organic matter, are abundant. However, few animals are able to take advantage of this production. Those that can, such as wading birds, may congregate in large numbers to feed in these pools. For example, brine shrimp are among the few animals that do well in salty coastal pools. Where there are many brine shrimp, flamingoes congregate to feed on them. The natural colouring agents in the brine shrimp give the flamingoes their brilliant colours.*

Evaluation/Assessment

Older students should write up the experiments, explaining their hypothesis, methods, results, conclusions, and the implications of their findings for wetland animals and plants.

Extension

Wetlands act like sponges, forming barriers between the sea and the land. They protect marine ecosystems such as coral reefs from freshwater inflows. In the same way wetlands protect coastal ground water from salty water that might seep in from the sea (saline intrusion) or be carried inland by an exceptionally high tide. To test this process, students will need:

- Two shallow square or oblong dishes
- A piece of flat sponge wide enough to fit across the dish
- Coloured, salty water
- Plain water

1. Students place the sponge across the middle of one dish, leaving a space on either side. The sponge represents the wetland.

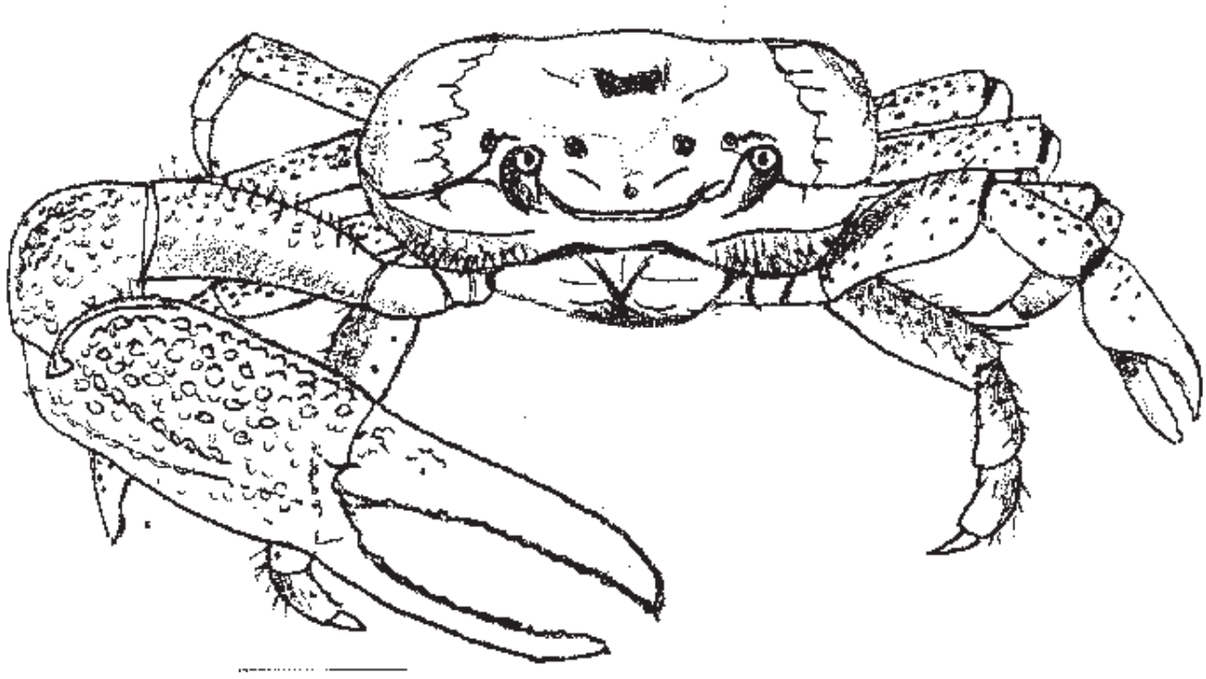
2. Pour some water into the dish, so that the sponge is soaked and the bottom of the dish is wet.

3. Ask for two volunteers. Each should have a container with the same amount of coloured salty water. One has the dish with the sponge, the other has the dish with just water. When told they should pour the coloured water into their respective dishes.

4. What happens? *The sponge reduces the rate of mixing of the salty and fresh waters.*

5. Discuss what this means for coastal ecosystems? *Wetlands protect inland waters from salt and marine ecosystems from freshwater.*

6. How could one test whether wetlands protect coastal ecosystems from sediments? *Repeat the experiment but add muddy fresh water instead of coloured salt water.*



Activity 1-D

THE RAINMAKERS
Wetlands and the water cycle

Summary

Students make experimental observations of the physical and biological processes involved in the water cycle.

Learning Objectives

Students will be able to:
- Understand how physical process affect Caribbean wetlands

Part 1: Evaporation and transpiration
- Define evaporation and transpiration
- Explain how physical conditions (e.g. exposure to sun and wind) affect evaporation and transpiration
- Explain how salt ponds form

Part 2: Condensation
- Define condensation and explain how it occurs and why it is important to maintenance of climate

Part 3: The water cycle
- Understand the water cycle and how it affects wetlands
- Define technical terms used in describing the water cycle

Age Levels 7 – 14

Subject Areas Science, English Language

Time (Total) 3 – 6 lessons
- Part 1: Evaporation and transpiration, 2 lessons a week apart
- Part 2: Condensation, 1 – 2 consecutive lessons
- Part 3: Water Cycle, 1- 2 lessons

PART 1: EVAPORATION AND TRANSPIRATION

This activity may be done in front of the class as a demonstration; OR by groups of two to four students; OR by individual students as homework.

Background

Physical processes such as evaporation and transpiration are very important determinants of the conditions of wetlands. They influence overall climate, as well as the conditions in specific wetlands.

Materials

For each set of experiments:
- 12 identical transparent glass jars with covers, a measuring spoon
- Water and salt
- Four cuttings of a plant that is easy to grow in water
- Labels and a permanent marker for labeling jars
- Pencils, markers, notebooks

Procedure

1. Remind the students what **evaporation** means and what **transpiration** means. See Copy Cat Page "Water Cycle Factsheet."

2. Then ask:
   - What happens to water when it is left in the sun? *It dries up.*
   - What is this process called? *Evaporation.*
   - How else does water enter the atmosphere? *From plants, via transpiration; from animals in sweat and exhaled air.*

3. Lead a discussion about how to design an experiment to investigate whether the environment influences how water enters the atmosphere. Formulate hypotheses and predictions.

4. Carry out the experiment as follows:
   - Ask students to put the same amount (four centimetres) of fresh water in each of the twelve glass containers.
   - Separate four of them and add a teaspoon (5 ml) of salt to each. Cap jars and shake to dissolve salt.
   - Label the containers "salt water" and date. Leave space to write on the label where the containers will be placed, and the class and students' names.
   - Discuss the conditions that might influence evaporation and transpiration. *Exposure to drafts and direct heat from the sun.*
   - Ask the students to select four places in the school grounds or classroom (or at home) and place three containers (one with salt water, one with fresh water, one with water and a plant cutting) in each of them. *The places should be sheltered from rain and accidental human disturbance. They should include a hot, sunny, dry place; a hot, sunny, dry but drafty (windy) place; a cool, shady, damp place; and a drafty, cool, shady, damp place.*
   - Take the top off each container. Label each container with the date, the place, the conditions (e.g. cool shady), the class and/or students' names. Mark all glass containers with the original water level.
   - Make predictions, based on your hypotheses, about what will happen to the level of water in each container.
   - Leave the containers for a week.
   - Collect the jars.
   - Ask students to measure the water levels in each. *The containers have lost different amounts of water. Most has been lost from the container in the hot sunny dry place, and salt crystals may have formed around the edges of the container with salt in this location. Containers with plants should have lost more water than those without plants.*

5. Discuss the findings. Did they confirm the students' predictions? Which of the containers is most like a salt pond? *Hot, dry, windy.* Why are salt ponds surrounded by salt crystals and why do they contain water that is more salty than the sea? *They are supplied by occasional high tides or by saline springs. They often form by the sea, where it is dry, hot and breezy. The rate of evaporation is greater than the rainfall.*

6. Compare the containers with fresh water and plants and fresh water and no plants. Which lost more water? *The containers with plants*. Why? *Containers with no plants lost water by evaporation only. Containers with plants lost water by both evaporation and transpiration.*

Evaluation/Assessment

Students should write an account of the experiment, including their hypothesis, predictions, methods, results, and conclusions.

Extension

During a field trip to a local wetland, students should look for white salt crystals in soils around the wetland OR visit a solar salt works to observe how salt is made.

PART 2: CONDENSATION

Background

When water vapour rises, it meets cool air and forms into tiny droplets of liquid, forming clouds. If the air around a cloud becomes cooler larger droplets form. This process is called **condensation**. When the droplets can no longer float in the air, they fall to land as rain, or in cold climates, snow, sleet, or hail. Sometimes condensation happens close to the surface of the ground or water forming a low cloud - such as mist, fog, or steam. The purpose of this activity is to demonstrate how water condenses.

Materials

- A large Pyrex glass jar
- An extra-large jar lid
- A small tin can containing ice cubes
- A small jug containing very hot water
- Salt (coarse or table salt)

Procedure

1. Pour half a cup of very hot water into the large Pyrex glass jar.
2. Cover the jar with an extra-large jar lid turned upside down.
3. Place a small tin can containing ice cubes on top of the jar lid.
4. The students should watch carefully and describe what happens. *Water vapour forms a cloud of steam in the air. Large water droplets form on the inside of the glass jar as the steam cloud meets the lid, which has been cooled by the ice. Condensed water drops roll down the side of the lid or just drop.*
5. Repeat the experiment with very salty water - to represents a saltwater pond or the ocean.
6. After several minutes, ask the students if the water in the drops is different from the hot salt water. What do the drops taste like? *They are fresh.*
7. Discuss why the condensed drops were fresh. What happened to the salt in the water? *It was left behind when the water evaporated.* Discuss why rainwater does not contain salt; even when rain clouds form over the sea. *Because it forms by evaporation.*

PART 3: WETLANDS AND THE WATER CYCLE

Background

See Copy Cat Page "Water Cycle Factsheet"

Materials

Copy Cat Pages "Water Cycle Factsheet" and "Water Cycle Words" worksheet

Procedure

- Distribute the "Water Cycle Factsheet" and discuss it with reference to the experiments in Parts 1 and 2.
- Ask students to complete the "Water Cycle Words" worksheets (definitions and diagram of the water cycle). For answers check the glossary.

Extensions

Discuss the water cycle with reference to deforestation and pollution. Have the students research one or more of the following topics: how deforestation affects water supplies and water that sustains coastal wetlands, the types of pollution that affect water, where pollution enters the water and where and how it accumulates, and how pollution affects water for drinking, recreation and fishing.

Source Adapted from various sources by Martin Keeley, Ann Sutton and Lisa Sorenson

WATER CYCLE FACT SHEET

The total amount of water in the world never changes—but it does change form, from liquid to gas (water vapour) or solid (ice), and back again. The movement of water from the land and the sea, to the atmosphere, and back to land is called the **water cycle**. It is driven by solar energy.

The heat of the sun makes water **evaporate** from sea, open water and wet surfaces in general. It also causes plants to lose water through their leaves, by a process called **transpiration**. Caribbean wetlands are often made up of a patchwork of open water and clumps of vegetation that encourages evaporation and transpiration.

As the day warms up, the water vapour formed in the air by evaporation and transpiration rises. When it reaches the upper atmosphere, it cools. Cool air holds less water vapour than hot air. As the air cools, the water vapour forms into tiny droplets of liquid which forms clouds. This process is called **condensation**. The droplets come together and fall as **precipitation**—rain, hail, or even snow.

Plants (such as bromeliads in trees) catch some of the rain. The rest falls on the ground, where it may soak in, flow away (as **run-off**), or be absorbed by plants. Water that soaks into the ground flows in underground rivers (called **aquifers**) that fill underground reservoirs. This is the **groundwater**—supplying springs and wells.

Water flowing above ground is known as **surface water**—supplying lakes, rivers, streams, reservoirs, wetlands and eventually the sea. Every river, stream, and underground reservoir is supplied with surface and ground water by its own area of land. This area is called its **watershed**.

Wetlands, forests, climate and the water cycle

In mountainous islands, the climate is often very predictable, with hot sunny mornings followed by heavy afternoon showers. Wetlands and forests play an important role in maintaining this pattern.

After sunrise, the atmosphere heats up and water **evaporates** from the sea and open water, and is **transpired** by plants, particularly in wetlands and forests. Meanwhile, the land becomes warmer than the sea and warm land breezes blow inland. They carry the water vapour towards the mountains. The warm, moist air rises by a process called **convection**. Warm air carries more moisture than cool air. As it reaches higher altitudes, it cools. The water vapour it can no longer carry **condenses**, forms thunderclouds, and falls as heavy afternoon rain.

Of course, not all rain forms like this. During the day, water is constantly evaporating from the sea, and forming clouds that fall as rain or hail in heavy squally showers.

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Water Cycle Words

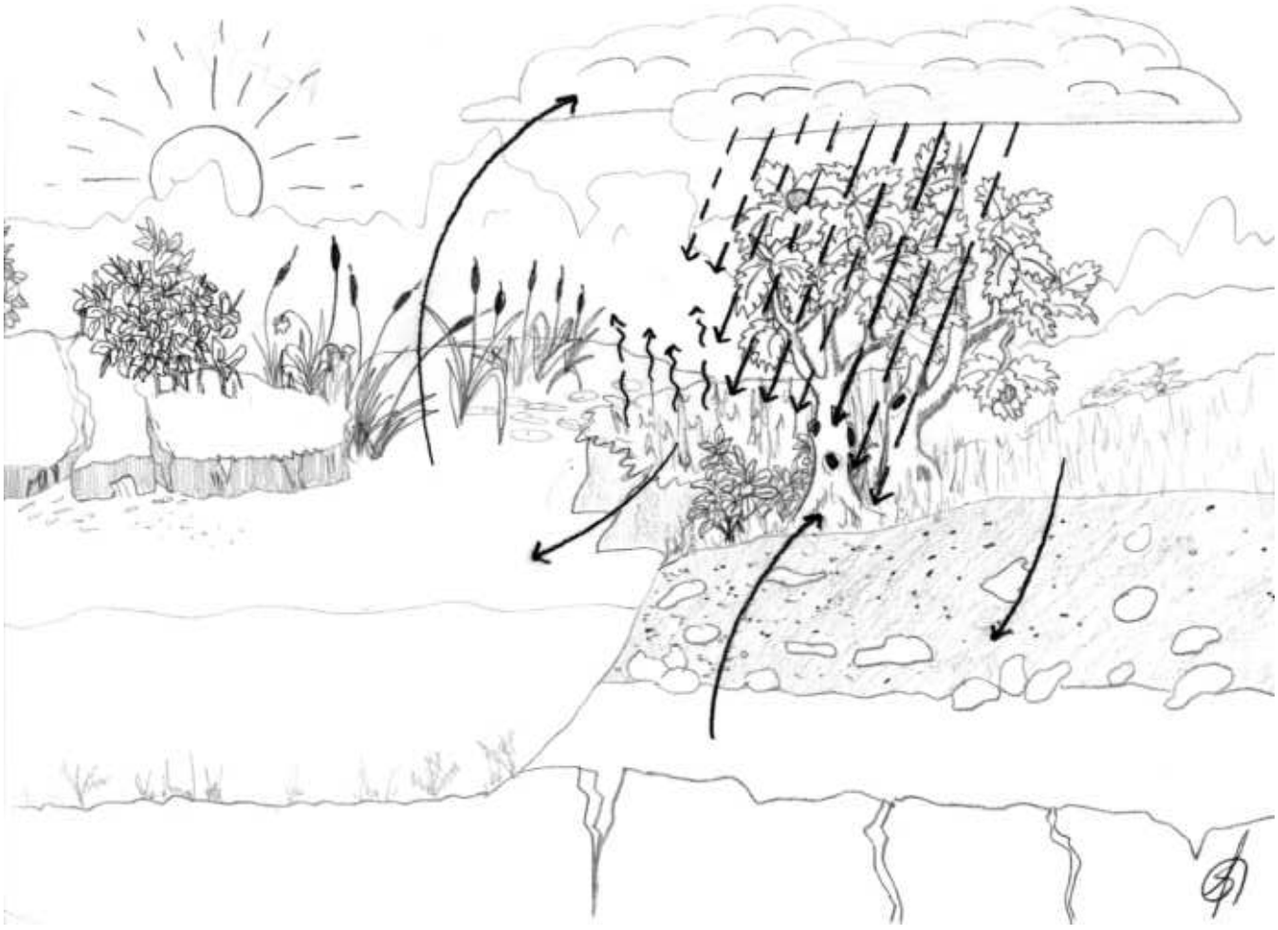
Are you a water cycle expert? Find out by trying to fit the following words to the definitions below. Using your answers, label the diagram below.

PRECIPITATION, EVAPORATION, CONDENSATION, RUN-OFF, GROUNDWATER, TRANSPIRATION, THE WATER CYCLE

The water cycle

a.	is the change of a gas or vapour to liquid (e.g. the formation of rain in the atmosphere)
b.	is the process whereby water travels from the Earth to the air and back to the Earth
c.	is the loss of moisture from the surfaces of living plants
d.	is water that collects naturally in underground reservoirs
e.	is the change of water from liquid to gas
f.	is any type of moisture that falls to Earth
g.	is the flow of water from land into lakes, rivers, or wetlands

Use the words you defined above to label this diagram.



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Activity 1-E

MANGROVES

Spot the difference

Summary

This activity can be done in the field or in the classroom or started in class and finished in the field. Students will learn that the four common species of mangroves (red, black, white and buttonwood) have very different seeds, roots, and leaves. These adaptations reflect the ways they are adapted to the particular conditions in the different parts of the wetland they occupy.

Learning Objectives

Students will be able to:

- Identify four species of mangroves
- List the adaptations of each species to its habitat

Age Levels 8 +

Subject Area Science

Time 1 hour

Materials

- Copy Cat Pages "Mangrove Plant Worksheet" and "Three Common Species of Mangroves" (page 4)
- Pencils

EITHER **FRESH SAMPLES OF MANGROVES:**

- Red Mangrove propagule with top attached, twig with leaves, flowers and root if possible
- Black and White Mangrove twigs with leaves, flowers and fruit if possible
- Buttonwood twig with leaves, flowers and fruits if possible

OR **PICTURES AND PHOTOGRAPHS OF MANGROVES**

- Photographs or drawings of Red, Black, White Mangrove and Buttonwood trees (from Copy Cat Page "Wetland Plants" at back of book)
- Photographs can be downloaded from: www.whistlingduck.org/downloads.html
- Photographs or drawings of Red, Black, and White Mangrove roots **(pneumatophores)** (from introduction to Chapter 1)

Background

Mangroves are the only tropical trees that are fully adapted to growing in salt water and saline soils. They have developed special features that enable them to tolerate the extreme conditions (including soft, muddy soils, anaerobic [low oxygen] soil conditions, and exposure to salt water, tides, winds and waves) that prevail in coastal wetlands.

- Red Mangrove adaptations: waxy leaves; prop roots for breathing and support, also help the tree extend into shorelines and lagoons and stand up to waves and winds; propagules ready to grow as soon as they drop off the tree.
- Black Mangrove adaptations: can tolerate higher salinities than seawater and high levels of salt in their sap; excrete salt from their leaves, which are often covered with salt crystals; breathing root system (pneumatophores), often extends beyond the canopy, also helps to support the tree.
- White Mangrove adaptations: excrete salt from salt glands on the petioles at the base of their leaves; breathing root system helps to support the tree in muddy conditions; tolerate freshwater better than other species
- Button Mangrove adaptations: grow on rocks or sand and have normal root system; excrete salt from salt glands at the base of their leaves.

Preparation

To do the activity in class

1. Collect fruits, twigs with leaves and roots from each of the four species of mangroves. If collected a day in advance, place them in garbage bags and store them in a fridge or cooler overnight. Bring them to class and lay them out on a table. If possible, obtain enough material to enable each student to have a piece of at least one species.
2. Copy pictures or diagrams of trees and root systems
3. Copy worksheets

To do the activity in the field: copy worksheets

Procedure

1. Ask students to complete the Mangrove Plant Worksheet by drawing pictures of each set of leaves, fruits, roots, and stems in the appropriate boxes on the worksheet.

2. Examine the Red Mangrove twig.
   - Is there a difference between the top and bottom sides of the leaf? *The top is more shiny and waxy. The sides of the leaf curl under.*
   - What is the shape of the leaf? *Elliptical.*
   - Are the leaves opposite or alternate? *Opposite.*
   - How do you think these leaves help the Red Mangrove tolerate salt? *The waxy surface reduces water loss by transpiration.*

3. Examine the Red Mangrove flower
   - What colour is it? *Yellow (yellow sepals, white petals).*
   - How many petals does it have? *Four.*

4. Examine the Red Mangrove fruit or propagule.
   - Can you identify its parts? *The dark part at the top is the fruit with the remnants of the flower and the stem. The long torpedo-shaped part is the developing root.*
   - Bend the propagule just below the seed. What happens? *The plantlet breaks off cleanly.*
   - Drop it into water. Which end falls first? *The root.*
   - How do you think these propagules help red mangroves to spread? *They are ready to grow as soon as they find themselves in a suitable spot.*

5. Examine the Red Mangrove root illustration.
   - Is there a main taproot? *No.*
   - Where are the roots attached to the tree? *From the branches and from other roots.*
   - Can you think of two reasons why roots would grow like this? *Supporting the tree in muddy conditions, getting oxygen from the air.*
   - How do you think these roots help Red Mangroves to spread? *By 'walking over the water.'*

6. Examine the Black Mangrove twig
   - What is the difference between the upper and lower surfaces of the leaf? *The lower surface has salt pores.*
   - What do you think the little crystals on the leaves are made of? *Salt.*
   - What shape is the leaf? *Oblong.*
   - Are the leaves opposite or alternate? *Opposite.*
   - How do you think these leaves help Black Mangroves tolerate salt? *They excrete salt, their leathery texture helps reduce water loss.*
   - Describe the flowers. *White with four petals.*

7. Examine the Black Mangrove fruit.
   - What colour and shape is it? *Green or yellow, and flattened, rounded at the stem end, and pointed at the other.*
   - Can you find any evidence to suggest whether it germinates on the tree? *Older fruits split open, showing folded leaves inside.*

8. Examine the illustration of the Black Mangrove root system.
   - Estimate the extent of the root system and the tree cover (canopy). Is the root system larger, smaller, or the same size as the tree canopy? (Check this during field investigation or homework.) *Larger.*
   - Most roots grow down into the soil. Why would roots grow up into the air? *To get oxygen to breathe.* What conditions in the soil make this necessary? *Low levels of oxygen in the mud.*

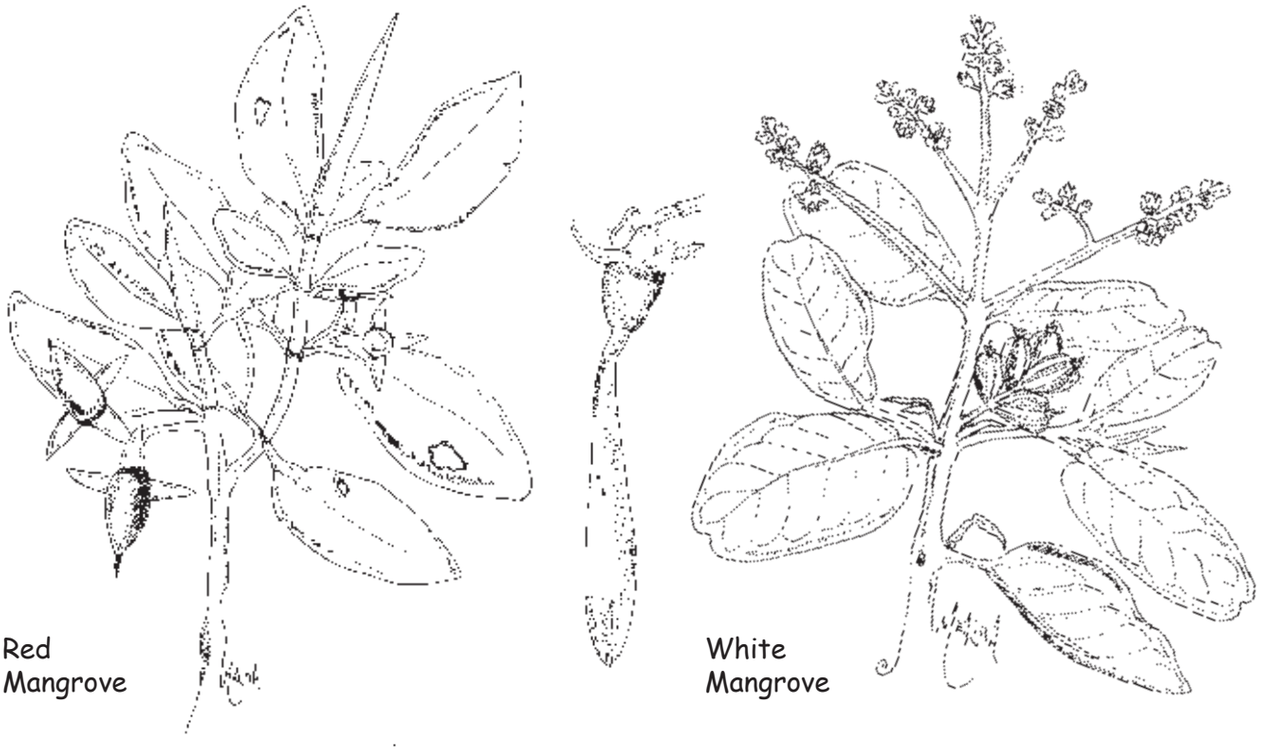
9. Examine the White Mangrove leaf and stem.
   - What shape is the leaf? *Broader and more rounded than the Black Mangrove.*
   - Are the leaves opposite or alternate? *Opposite.*
   - What colour is the petiole (leaf stem)? *Red or reddish green.*
   - What do you think the little bumps are on the stem just below the leaf? *Salt glands.*
   - Describe the flowers. *A spike with many very small, white flowers.*
- Describe the fruits. *Small, green, with ribs*

10. Examine the illustration of the White Mangrove root system.
    - How are the roots similar to those of the Black Mangrove? *They grow up out of the soil.*
    - How are the roots different from those of the Black Mangrove? *They are thicker and more knobby. Some have flattened ends like mushrooms.*

11. Examine the Buttonwood leaf and stem.
    - What shape is the leaf? *Narrower and more pointed than the other species.*
    - Are the leaves opposite or alternate? *Alternate.*
    - What do you think the little bumps are on base of the leaf stem? *Salt glands.*
    - Describe the flowers and fruits. *Flowers are very tiny, in clusters. Fruits are in clusters in rounded heads.*

12. Examine the illustration of Buttonwood
    - Does it have aerial roots like the other species? *No.*
    - Why do you think the Buttonwood lacks aerial roots? *It grows on sand and rocks rather than mud.*

13. Look at the picture of mangrove zonation (page 6). Which of the species grows closest to water? Which species are most exposed to inclement weather? Which to high salt levels? Which to flood waters? How does each species deal with the salt in its environment?



Red Mangrove

White Mangrove

Evaluation/Assessment

Write an essay entitled "How mangrove trees are adapted to their environment" or write a story entitled "A day in the life of a mangrove tree."

Extensions

If you can find Black, Red or White Mangrove seeds or small plants, bring them back to the classroom together with water and samples of mud and detritus from a nearby pond or mangrove swamp. Put the water and mud and detritus into a container (preferably one like an aquarium) and plant the seeds in the mud and detritus. Every few days add water obtained from the same location where the seeds were found. Initially, the water will stink, but if the seeds take root, they will ultimately remove the smell.

Source Martin Keeley, Ann Sutton and Lisa Sorenson

MANGROVE PLANT WORKSHEET

Characteristic	Red Mangrove	Black Mangrove	White Mangrove	Buttonwood
Habitat				
Roots				
Leaves Appearance Position				
Flowers				
Fruits				

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Black Mangrove

Buttonwood

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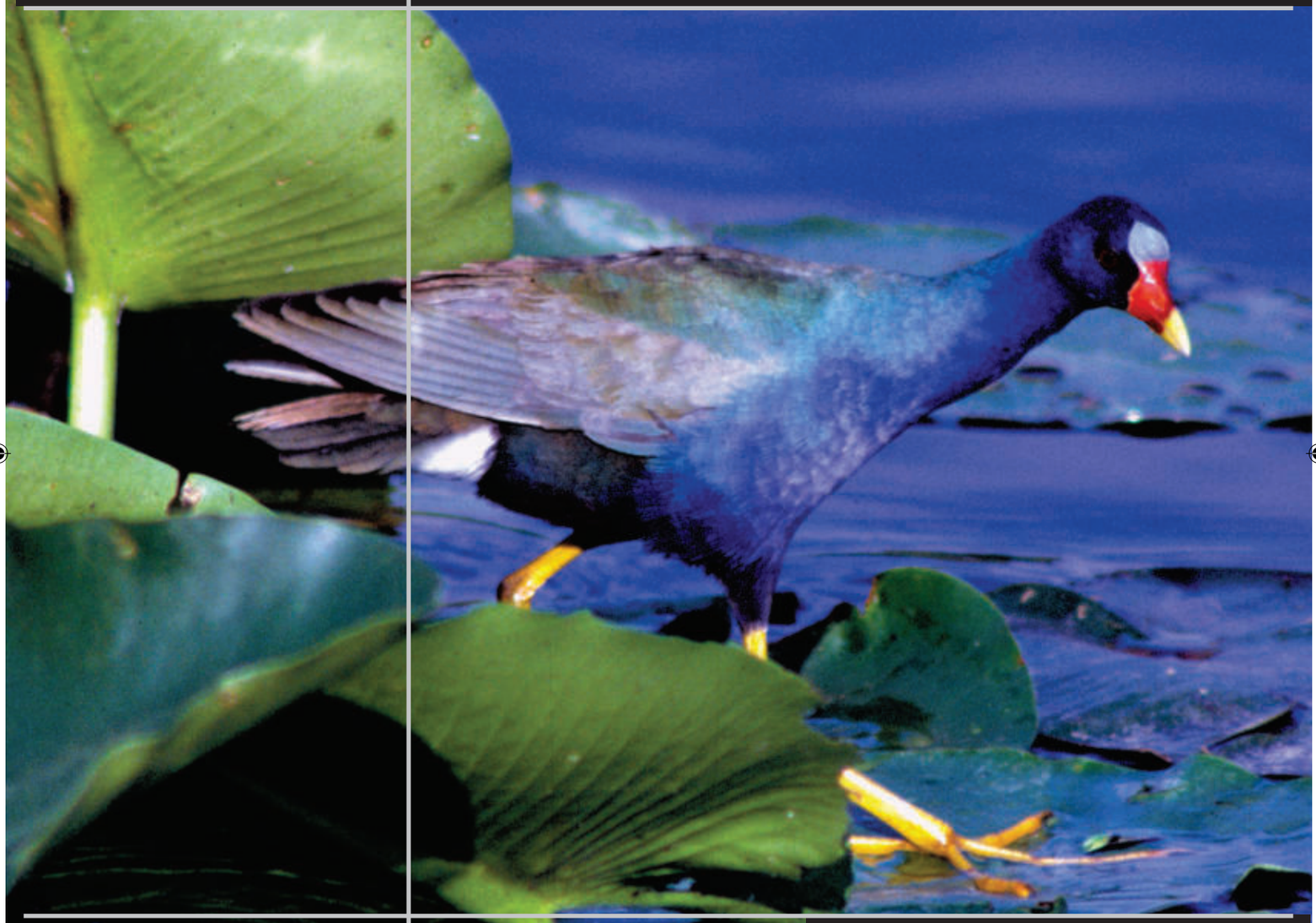
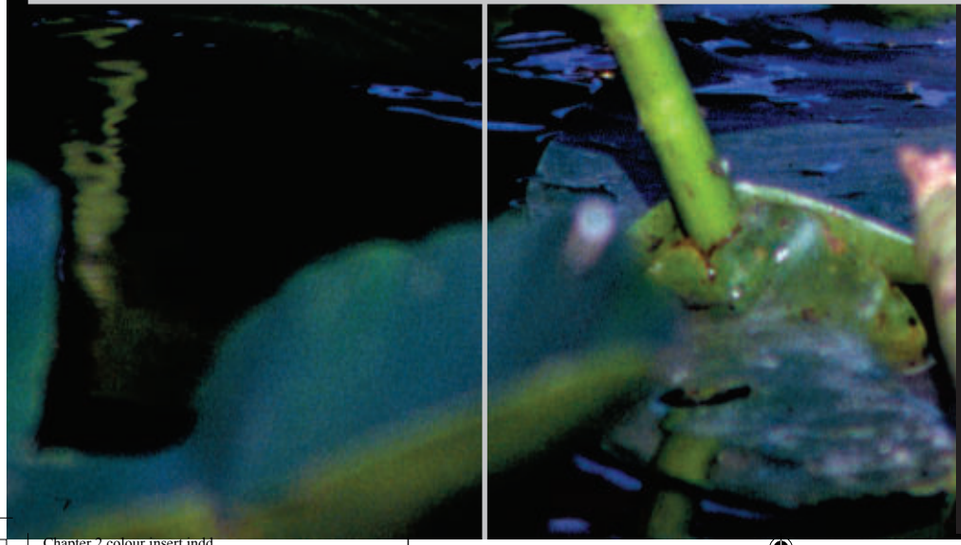
WETLANDS





"Humankind has not woven the
web of life.
We are but one thread within it.
Whatever we do to the web,
we do to ourselves.
All things are bound together.
All things connect."

- Chief Seattle

Chapter 2
WILD, WET AND WEIRD
What lives in wetlands?

LEARNING OBJECTIVES FOR CHAPTER 2

Students should be able to:

- Identify the most important plants and animals of Caribbean wetlands
- Understand ecological interactions among mangroves and other species
- Understand the concept of adaptation and how plants and animals are adapted to live in Caribbean wetlands
- Understand why habitat is important to species
- Understand wetland food chains

WHAT LIVES IN WETLANDS?

Life on the edge

Caribbean wetlands are teeming with life—full of living things that are different in unexpected ways. Living where the land joins the water exposes them to unique and constantly changing conditions. At high tide the wetlands are flooded. At low tide water levels are low, exposing mud recharged with food particles. During the day the sun heats the shallow, dark water and the temperature soars close to boiling point, but at night, the temperature of the water falls quickly. Sudden tropical storms and hurricanes may cause flooding and in dry weather water evaporates from ponds and mud flats. Both conditions lead to rapid changes in salinity. Generally food is abundant, but it may be seasonal, salty, indigestible, or in the form of small particles. Through a process of **adaptation** wetland plants and animals have evolved to take advantage of these unstable and extreme conditions. This takes a long time, but it allows plants and animals to survive in otherwise inhospitable conditions and enables many species to share the same wetland.

Habitat is home

A **habitat** is the place where an animal or plant lives. It provides food, shelter, water and space (including places for resting and all the different stages of life that the organism passes through). If even one important element of a habitat is destroyed, the plant or animal may not survive. Many habitats together make up an **ecosystem** e.g. a wetland. Every habitat supports its own type of living things, each of which is specially adapted to the conditions.

What types of habitats make up a wetland?

Copy Cat Page "What Lives in Wetland Habitats?" provides a description of the different habitat types found in wetlands and the plants and animals that live there.

WHAT LIVES IN WETLAND HABITATS?

Habitat	Description	Plants and animals
Open water	Still or slowly flowing water – river estuaries, lakes, lagoons, pools, ponds, fish ponds, sea grass beds. Tidal water - coastal inlets and beaches	Plants may be rooted or floating. Some, like water lilies, spread over the surface of the water, where animals like the Jacana (bird with long toes for walking on floating leaves while it forages for snails) and Pond Skaters (insect with water-repelling hairs on their feet) live. Among the floating plants small shrimps, snails and small fish reside. Ospreys dive from the air to catch the fish. Close to the bottom Upside Down Jellyfish wait for falling scraps. On the bottom, sea grass, algae, mud, sand or rocks harbour fish, crabs, starfish, sea eggs, sea hares and many types of worms. Some animals, like Pond Turtles and frogs, can move from the bottom to the surface of the water to feed and breathe. Ducks and grebes dive or dabble from the surface to feed on aquatic plants and animals.
Marshes	Water-logged soils covered with grassy-looking plants – peat, sand, alluvium and clay	Common plants include sedges, Bulrushes and Reeds, as well as a few herbs and ferns. Moorhens and coots use the leaves to build and hide their nests. Many species (including West Indian Whistling-Ducks and crocodiles) shelter in the marshes during the day, coming out to feed at night. Crabs, insects and frogs live among the roots and in the mud.
Mud flats	Shallow muddy areas, exposed at low tide	Mud exposed by tides provides a wonderful growing surface for algae. Many animals e.g., crabs, molluscs and worms make their homes in burrows in the mud, venturing out to feed on algae and detritus. Sandpipers, egrets and herons prey on the animals of the mud. Swallows and martins swoop in to catch flying insects.
Mangroves	Mud	Bacteria and fungi rapidly decompose mangrove leaves increasing the protein content from 3% to 21% protein, providing a rich (and smelly) food source for animals.
	Red Mangrove Roots	On the roots, just above the mud, there are brightly coloured sponges and fan worms. Above them there are sea squirts, sea anemones and algae. At the surface, there are mangrove oysters and barnacles. Juvenile fish and shrimp shelter and feed among the roots. Herons, egrets and crabs perch on the roots to feed and rest. See copy cat page "Red Mangrove Root"
	Mangrove Trunk	Insects bore into the orange and green lichen-streaked trunks. Woodpeckers feed on the insects. Parrots and woodpeckers nest in holes in mangrove tree trunks.
	Mangrove Canopy – leaves and branches	Mangrove crabs, caterpillars and many other insects feed on the leaves, attracting Yellow Warblers. Herons, pelicans, vultures and seabirds perch and nest among the branches.

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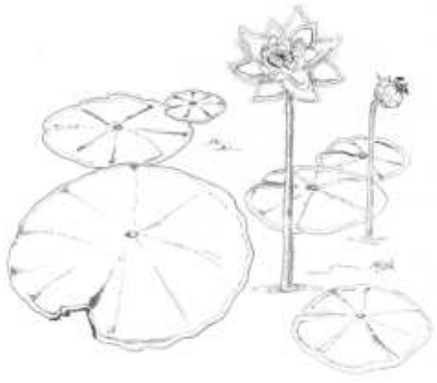
How are wetland plants and animals adapted to wetland conditions?

Wetlands provide special challenges for animals and plants. Plants and animals that survive and flourish in wetlands have evolved a wide variety of physiological, anatomical and behavioural adaptations. Some of the main wetland plant and animal adaptations are described below.

Wetland plants and their adaptations

Growing in waterlogged soil poses special problems for plants.

Need	Adaption
Standing up in muddy soils	• The roots of wetland plants do not have much to hold onto because wetland soils are sloppy, so staying upright can be a problem. Some mangroves have prop roots to help spread the load of the trunk over a broader area. Other trees, like Swamp Bloodwood, have **buttresses**. Some places are too wet to support trees, and only grasses and herbs grow there. Some grassy plants, like *Phragmites*, spread by falling down across the water, trapping sediments and forming their own soil. In open water, water lilies float on the surface, growing horizontally rather than vertically.
Breathing in soils which have little oxygen:	• Wetland soils are often black and smelly. This is because they are low in oxygen (or anoxic). Waterlogged soils are often anoxic because oxygen spreads more slowly through water than through air, slowing the decomposition of plant materials. The bacteria that live in anoxic conditions produce sulphur-rich compounds—and bad smells. To compensate for the lack of oxygen, wetland plants often have roots that grow out into the air—aerial roots or breathing roots, also called pneumatophores.
Getting rid of excess salt:	• Some wetlands are even saltier than the sea. This occurs when water evaporates from the surface, leaving salt behind. Water or soil that is saltier than the sea is hypersaline. Plant cells cannot function properly if they contain too much salt. Some plants, like Red Mangroves, try to prevent salt getting into their tissues. They deposit excess salt in old leaves, getting rid of it by shedding them. Others, like Black Mangroves, can tolerate more salt than usual in their sap, and control the salt in their tissues by excreting it through specialized salt glands on their leaves.
Getting enough water:	• It seems odd that plants growing in the sea should be short of water; but where the water is salty, fresh water can be hard to get or keep because it is sucked out of tissues by **osmosis**. Plants that grow in salty water often have thick, waxy leaves (like Red Mangrove), which help to reduce such water loss, or fleshy leaves (like Black Mangroves), which can store water. Similar adaptations are found in plants that live in dry places.



Wetland animals and their adaptations

Need	Adaptation
To prevent themselves from drying out and to protect themselves from severe temperature changes	• Ability to hide under rocks, plants and detritus (crab, amphipod) • Ability to burrow in mud (bivalve mollusks, shrimp) • Ability to survive high temperatures and salinities (small fish) • Hard outer shell to retreat into (crab, hermit crab, barnacle, oyster, snail)
To avoid getting washed away	• Foot that acts like a suction cup to hold animal in place (snail) • Strong "byssal threads" that attach shell to rocks, roots or other surfaces (oyster) • Strong glue (barnacle)
To protect themselves from predators	• **Camouflage** – possessing concealing colours or ability to change colour to blend into the surroundings (Mangrove Snapper) • Ability to retreat under rocks, branches, or roots, or into holes (fiddler crab, shore crab) • Strong, hard shell (oyster) Sharp prickles (urchins/sea eggs)
To obtain food	• Scavengers: Ability to scrape or graze algae and detritus from mud and rocks (snail) • Predators: Claws to rip flesh, leaves, and detritus (crabs). Tongue (radula) that acts like a file to drill a hole through the shell of an oyster so the oyster can be digested (West Indian Murex Snail) Ability to pursue prey (Barracuda, Osprey) • Filter feeders: Ability to sweep through water with their legs and filter plankton from water (barnacles) • Herbivores: Strong teeth and jaws to crop and grind plants (manatees, turtles)

Who eats what? – Food webs and food chains

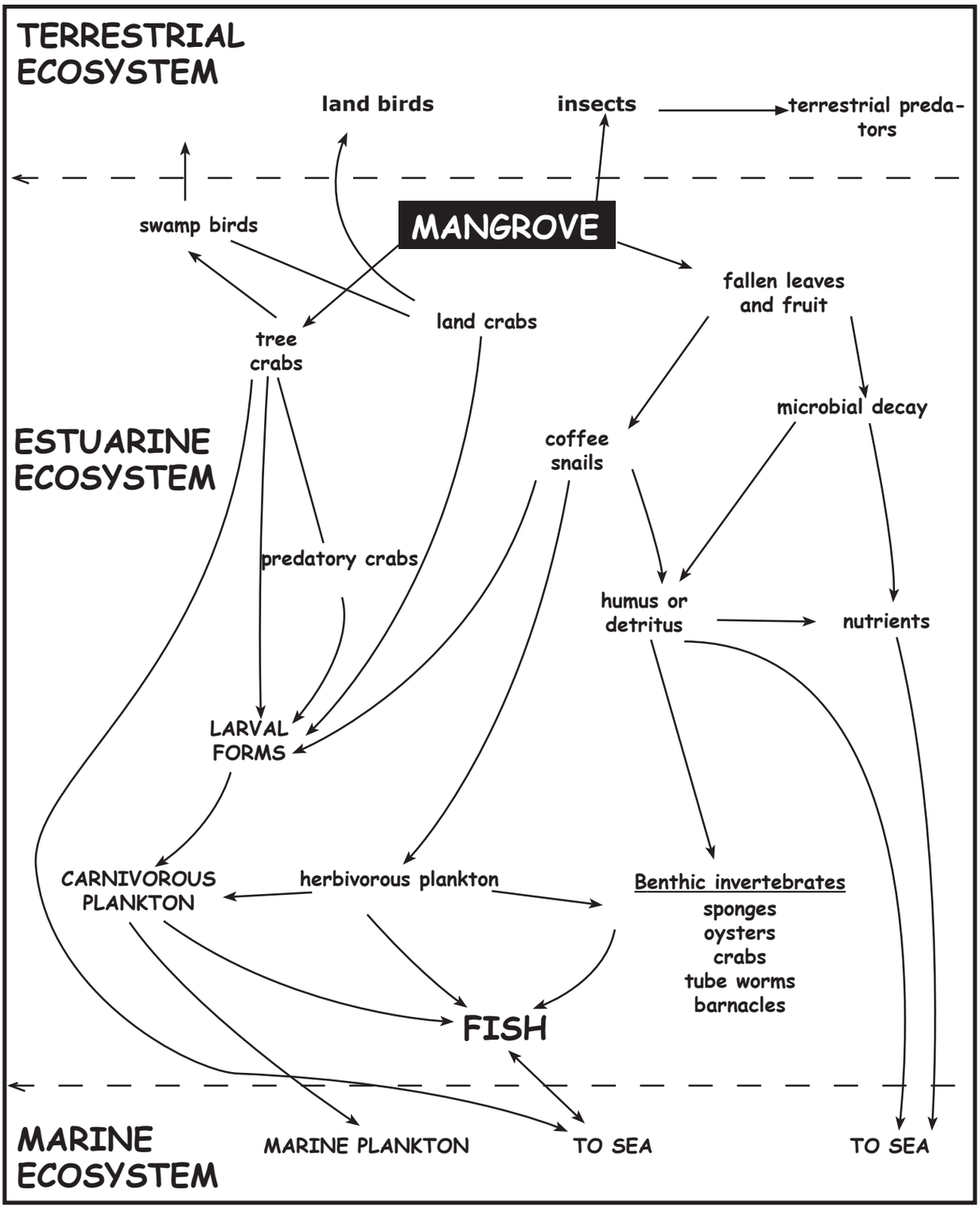
All the worlds energy comes from the sun. Plants capture this energy and use it to make carbohydrates. This process, called **photosynthesis,** uses water, nutrients from water and soil, carbon dioxide from the air and the suns energy to build living tissues, and hence to grow and reproduce. This conversion of energy and nutrients into plant tissues is called **primary production**. Plants are **primary producers**. The main **primary producers** in a mangrove swamp are mangroves, **phytoplankton** (microscopic floating plants) and **algae.** Conditions in mangrove swamps are ideal for **primary production** because there is plenty of water and nutrients, light and warm conditions.

Primary producers (plants) are eaten by **primary consumers** (animals that eat plants) which in turn are eaten by **secondary consumers** (animals that eat animals). **Secondary consumers** may be eaten by **tertiary consumers** and so on. Some animals eat only plants (**herbivores)**. Others eat only animals (**carnivores)**. A third group, that includes human beings, can eat animals and plants (**omnivores)**. All animals that eat living animals are called **predators**.

As producers and consumers grow and reproduce, they also excrete and die. **Decomposers** (e.g. fungi and bacteria) break down waste products, dead animals and plants into **nutrients**. Soluble nutrients dissolve in the water, insoluble ones form **detritus**. Some animals specialize in eating detritus. They are called **detritivores**.

Thus, animals and plants are linked by their feeding relationships. For example, a mangrove leaf is eaten by a crab that is eaten by a fish that is eaten by a bird. The bird dies, falls into the water where bacteria breakdown its body to make nutrients absorbed by the mangrove tree to make leaves, and so on. This is an example of a **food chain** (see pages 65 and 66). Many food chains go on at the same time in an ecosystem, linked together they form complex **food webs**. (see Copy Cat page "Simplified Mangrove Swamp Food Web").

SIMPLIFIED MANGROVE SWAMP FOOD WEB



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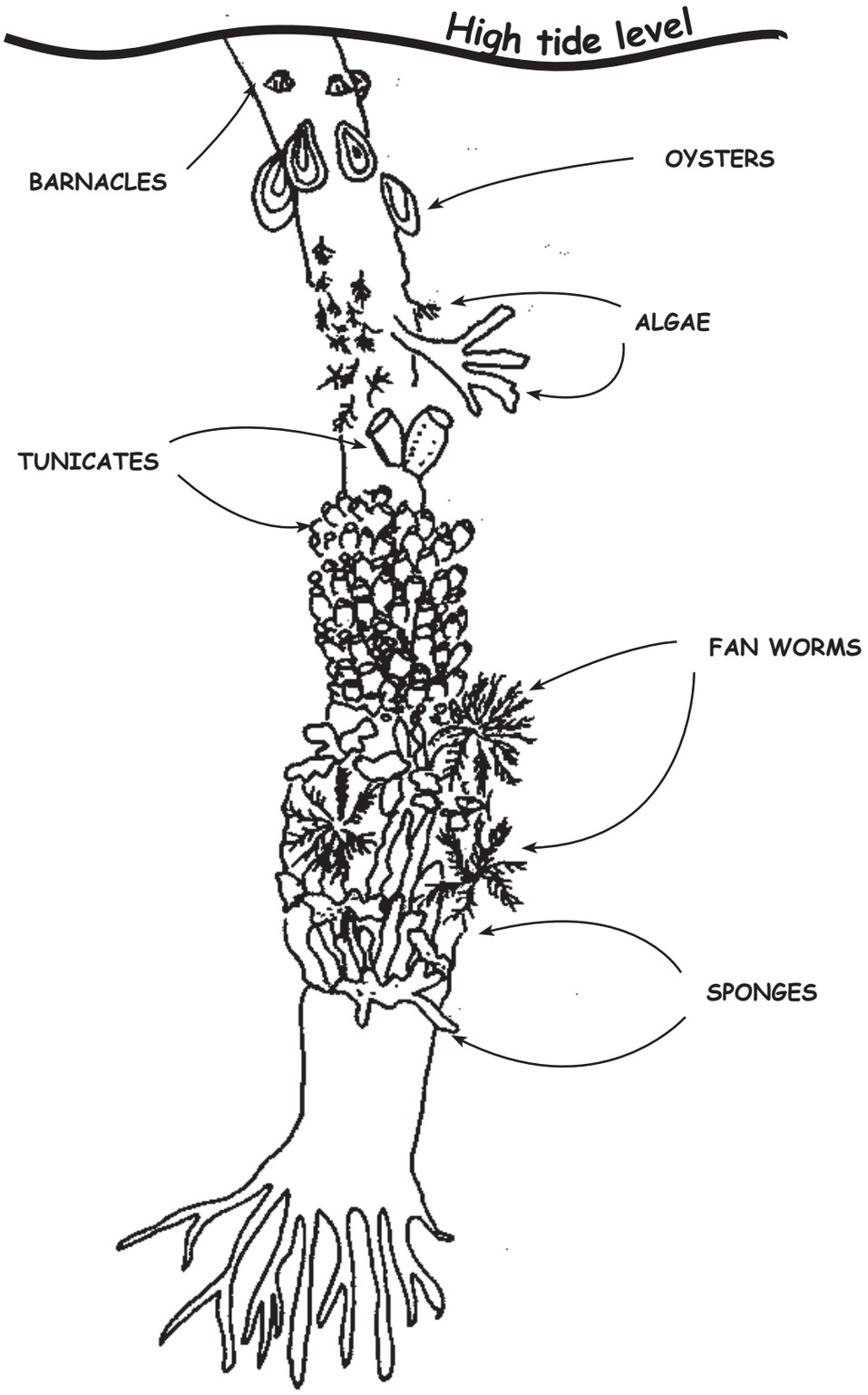
RED MANGROVE ROOT



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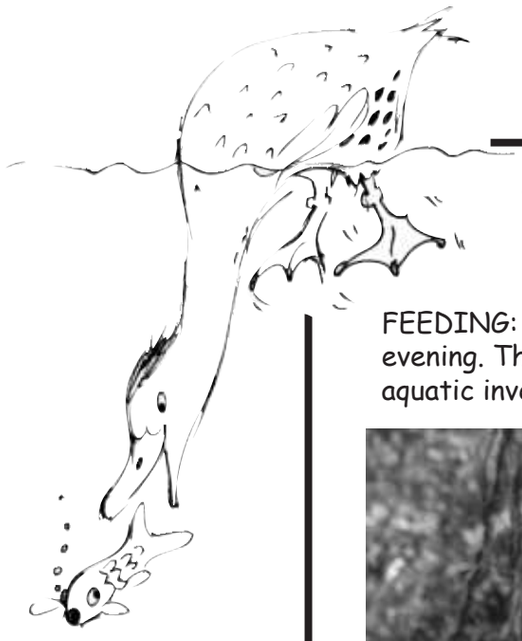


WEST INDIAN WHISTLING-DUCK
Ecology and habits

FEEDING: West Indian Whistling-Ducks feed mostly in the evening. They eat fruits, seeds, grasses and corn, as well as aquatic invertebrates and small fish.

NESTING: They usually nest among dense vegetation on the ground, but sometimes nest in holes in trees or in bromeliads. They lay 6-10 eggs, which both the parents incubate in 24 hour shifts. After 30 days, the eggs hatch. The parents both care for the young for several months. This is unusual in ducks. Families feed together and defend their feeding areas from other groups.

Activity 2-A

ANYONE AT HOME? MANGROVE HABITAT STUDY

Summary

Mangroves provide habitat to a large number of animals

Learning Objective

Students will be able to name some of the plants and animals that live in the mangroves.

Age Levels 8 +

Subject Area Science OR a follow-up activity to a field trip

Time 30 minutes

Preparation Read introduction to this chapter.

Materials

- Copies of Copy Cat Pages "Anyone at Home? Mangrove Habitat Study Worksheet 1" and "Anyone at Home? Mangrove Habitat Study Worksheet 2"
- Pencils and crayons
- Copies of wetland field guide

Procedure

1. Give each student a copy of both worksheets .
2. Discuss the picture on the worksheet with the students. Explain that students should go through the picture on the first worksheet and use the information on the second to work out what all the animals and plants are. The students should then write the names of the animals and plants on the pictures. Identify and discuss some of the adaptions of these animals to their mangrove habitat.

Assessment

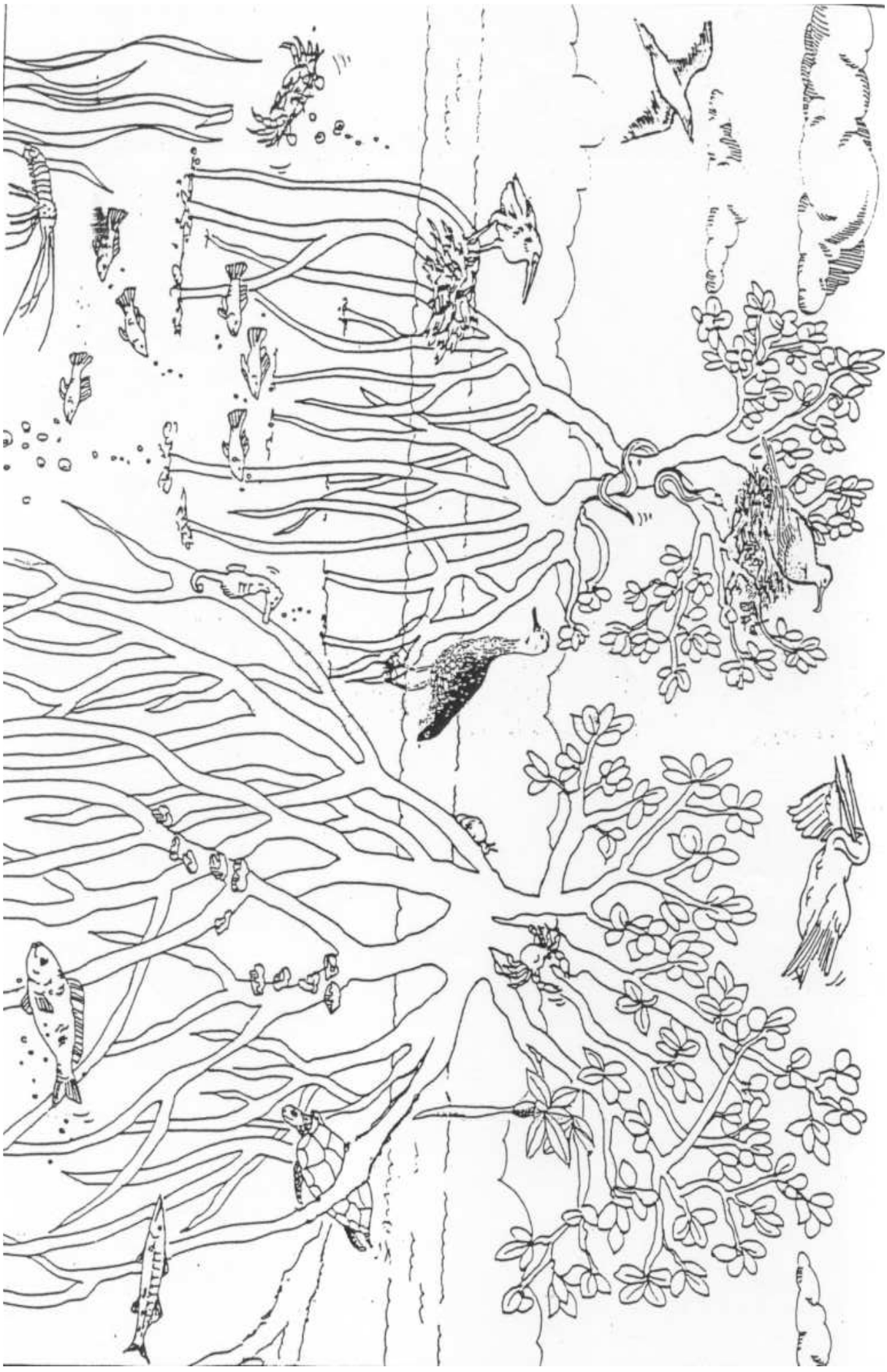
Have students discuss some of the animals and plants in the pictures.
Younger students may colour the picture on the worksheet.

Extension

Have students research and do a short report on one of the animals in the picture.

Source Adapted by Martin Keeley.

ANYONE AT HOME? Mangrove habitat study worksheet 1



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ANYONE AT HOME? Mangrove habitat study worksheet 2

SPECIES	NOTES
Birds	
West Indian Whistling-Duck	Shelters in the mangroves during the day and comes out at night to feed.
Brown Pelican	Roosts and nests in the mangroves, dives for fish in open water.
Egret	Roosts and nests in the mangroves, feeds on fish in the shallows.
Brown Booby	Feeds on fish
Reptiles	
Green Turtle	Feeds on sea grass in mangrove lagoons, nests on sandy beaches
Snakes	In some islands snakes are found in mangroves
Fish	
Barracuda	Juveniles live among mangrove roots. Adults feed in creeks and sea grass beds.
Snapper	Juveniles live among mangrove roots.
Mosquito Fish	Live among mangrove roots.
Invertebrates	
Oyster	Lives attached to mangrove roots, where they filter feed on small particles of detritus.
Mangrove Snail	Feeds by scraping algae from the roots and branches of mangrove trees.
Sea Horse	Lives in seagrass beds and on mangrove roots.
Lobster	Breeds in mangroves.
Mangrove Crab	Feeds on mangrove leaves.
Swimming Crab	Lives and feeds among mangrove roots.

COPY CAT PAGE

Activity 2-B
LOST IDENTITIES

Summary

Many different types of animals and plants live in mangroves. This activity introduces students to some of them.

Learning Objectives

Students will:

- Learn to recognize some of the common wetland animals and plants
- Be able to identify their habitat
- Be able to describe ways that they are adapted to their habitats

Age Levels 6 +

Subject Area General Science

Time About 30 minutes.

Materials

- Pictures of mangrove animals and plants, cut out from Copy Cat Pages "Wetland Animals" and "Wetland Plants" and ready for use
- Handout (prepared by teacher) to accompany each picture with the name of the plant or animal, its' habitat, size, feeding habits, place in food chain, how it moves, where it breeds, etc.
- Pins to attach pictures to students backs, or, the picture and information can both be glued or taped to a piece of cardboard with a string attached (so that the card can be hung over a person's head with the card on their back)

Preparation

Use the pictures from the Copy Cat Pages "Wetland Animals" and "Wetland Plants" and information from the field guide to prepare the identity cards and handouts. The handout could feature:

- A picture of animal or plant (e.g., Mangrove Oyster)
- Description of where it lives: (e.g., on mangrove root)
- Identification of its place in food chain: (e.g., primary consumer)
- What it feeds on, where it breeds, how it moves (animals only): (e.g., detritus)
- Size: (e.g., 5 cm)

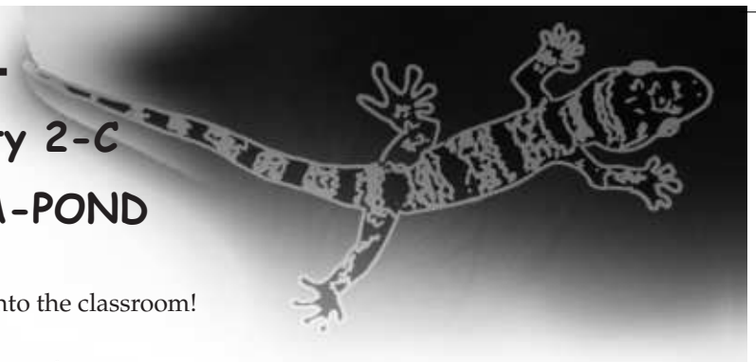
Procedure

1. Pair the students up. Explain that one member of the pair is going to become an animal or plant and must ask questions of their partner to find out who they are.
2. Have one member of the pair sit in a chair and their partner stand behind them. Hand out a picture and accompanying handout to each standing partner and have him pin or hang it on his sitting partners' back *without* his partner seeing the picture.
3. The sitting partner must ask questions about their identity to their standing partner behind them. They may only ask questions to which the answer is yes or no (partner can only answer yes or no; may not give other information).
4. Encourage the students to ask questions related to their habitat, place in the food chain, life style, adaptations, etc. (e.g., Do I live in the water? Am I a predator? Do I have gills?).
5. Reassemble the group after everyone has guessed their identify. The game can be replayed by shuffling the cards and handing them out again. Wrap up the activity by discussing how the organisms are adapted to their habitats.

Assessment

Each student should draw a picture of himself or herself as an animal, in the appropriate habitat.

Source Adapted from Oak Hammock Marsh Interpretive Centre.



Activity 2-C

POUR-A-POND

Summary

When the class cannot go to a wetland, bring a wetland into the classroom!

Learning Objectives

Students will learn to catch and identify some common wetland plants and animals.

Subject Area General Science OR preparation for a field trip.

Time 30 minutes + (depending on the number of aquatic creatures)

Age Levels 6 +

Materials

To make and fill the pond

- 1 sheet of 6 ml polyethylene plastic about 2-3 m square. A white (or clear) plastic shower curtain can also be used.
- Several large buckets of water from a wetland. If you scoop up some aquatic vegetation, you should get a good variety of small aquatic animals.

To take animals and plants out of the pond

- Small sieves or scoops
- Bug suckers (plastic pipettes with the ends cut to different diameters)
- Plastic kitchen sieve attached (with duct tape or cable ties) to a stout stick (for collecting aquatic invertebrates from a wetland)

To store animals and plants while you are looking at them

- Ice trays or plastic egg boxes
- Petri dishes or glass jars
- Bug boxes with magnifying lids
- Home-made bug storage containers can be made by cutting off the tops of yogurt containers or 1 cup milk cartons to a 1-2 inch height

To look at animals and plants more closely (if available)

- Magnifying glasses
- Binocular microscopes

To identify animals and plants

- Copies of "Pond Life: A Guide to Common Plants and Animals of North American Ponds and Lakes (Golden Guide)"
- Copies of Marsh Monster ID sheets (aquatic invertebrate identification card)
- Paper cut into squares for labels.

Background

Wetlands provide habitat for a wide range of animals and plants, all of which have special adaptations for their wetland habitats. This exercise will help students to learn to recognize some wetland creatures, using simple keys to identify animals. It will stimulate them to think about how animals and plants are adapted to their habitats.

This is an important opportunity to remind students that they are handling living creatures, which should be treated carefully. They should not be tormented, allowed to dry out or thrown away. If possible, they should be returned to their habitat after the class.

Preparation

- Assemble the equipment
- Collect the specimens either the afternoon before or on the morning of the class. More than one wetland may need to be sampled in order to get a variety of organisms. Golf course ponds and sewage lagoons (rich in nutrients) tend to have the highest diversity and abundance of aquatic invertebrates. Be sure to cover the bucket when storing it overnight as some invertebrates can and may fly out.
- Be aware of what species you have and that the food chain is in action in your bucket. If you have too many predators (e.g., damselflies), the next day you may have very few prey left in the bucket and one very fat predator!

Procedure

1. Spread the plastic sheet in an open area on the floor (preferably on a white or light background) and ask the students to gather around. Everyone should bend down, pick up the plastic and begin to roll the edge under in unison – forming a lip to hold water. The persons at the corners may need a little extra time to roll their lip.

2. When the lip is about 10 cm (4 inches) deep, the pond can be placed on the floor and filled with the contents of the buckets.

3. Point out the different organisms that are present (e.g., "there are some with oar-like legs, some that wiggle," etc.). Do not, however, tell the student the names of the species that are present! The students' interest is better maintained when they have to solve the mystery themselves.

4. Have the students catch some of the invertebrates with the sampling equipment for closer examination (use magnifying lenses, microscopes, and bug boxes). Display the catch in ice trays, jars, home-made bug containers, or Petri dishes.

5. Pass out the Marsh Monster sheets and copies of the Pond Life book. Can anyone identify what they caught? Once the organisms have been identified, label them and pass them around. Point out different adaptations and life history notes for the different creatures you have on hand (e.g., different stages of the mosquito).

6. Make a list of what was found.

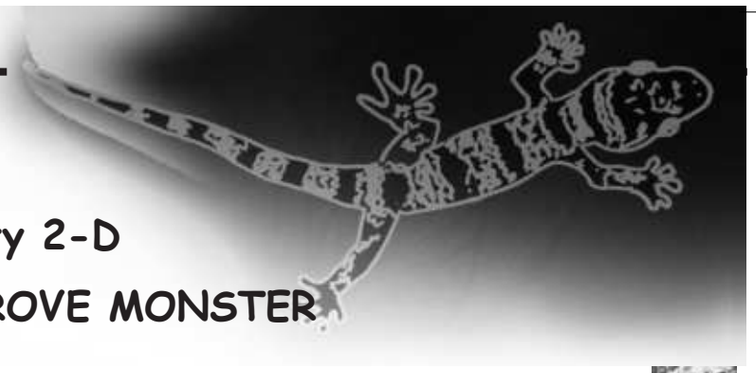
7. The pond can be easily cleaned up by having all the students gather around and carefully pick it up again. Form a spout at one end by bending the lip, have another student ready with the buckets. Working together, the students should tip the pond so that the water is poured slowly back into the buckets (they will need to pause mid-way to change buckets). Lay the plastic out to dry.

8. Be respectful of life – return the invertebrates to the wetlands when you are through with them.

Extension

Have the students choose one of the organisms for in-depth research on it's life history.

Source Oak Hammock Marsh Interpretive Centre



Activity 2-D

MEET A MANGROVE MONSTER

Summary

Students will identify wetland plants and animals and study their adaptations through observation and drawing of live specimens.

Learning Objectives

Students will:

- Learn how to carefully observe plants and animals and record their observations
- Identify and understand adaptations

Age Levels 6 +

Subject Areas General Science, Art

Time 30 minutes +

Materials

- Copy Cat Pages "Wetland Animals" and "Wetland Plants" and field guide (Pond Life: A Guide to Common Plants of North American Ponds and Lakes)
- Drawing paper, pencils, erasers
- Knife (optional)
- Copy Cat Pages "Mangrove Monster Interview Sheets for Animals" and "Mangrove Monster Interview Sheets for Plants"
- Copies of Marsh Monster Sheets (aquatic invertebrate identification card)
- Animal and plant specimens (if possible in clear plastic containers)

Background

Introduce the concept of adaptation. Adaptations can be structural, physiological or behavioral. In this activity the students will look at animals and plants and try to decide what signs they can see of adaptations. Refer to the introduction to this chapter.

Preparation

Collect animals and plants (as part of a field trip or special trip to get specimens). Otherwise, work from pictures. This activity may follow up the Pour-a-Pond activity (2-C) or a field trip (See Chapter 6).

Procedure

1. Obtain, then distribute at least one animal or plant specimen to each pair of students.
2. Have students work through the interview sheets, answering questions and making drawings as necessary. For students whose monster is a plant, the teacher may want to use the knife to cut a section of the stem, leaves or roots.
3. Repeat with additional specimens if time allows.
4. Students should walk around the classroom examining all the monsters.

Assessment

Discuss the adaptations the students observed. What did the monsters have in common? How did they differ?

Source Adapted from Oak Hammock Marsh Interpretive Centre

MANGROVE MONSTER INTERVIEW SHEET - ANIMALS

What's your name?	
Where do you live?	
How many legs do you have?	
What colour are you?	
How do you move about?	
What do you eat?	
Who eats you?	
May I draw your picture?	

COPY CAT PAGE

MANGROVE MONSTER INTERVIEW SHEET- PLANTS

What's your name?	
Where do you live?	
Tell me about your leaves • What shape are they? • How big are they? • Are they opposite or alternate?	
Tell me about your flowers • What colour are they?	
Tell me about your fruits • What size and colour are they?	
Who eats you?	
May I draw your picture?	

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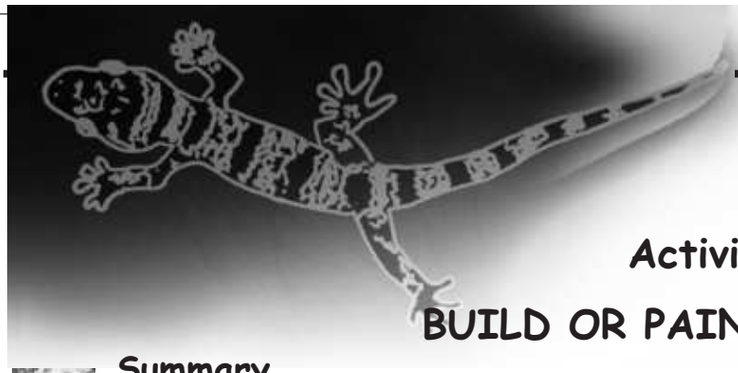


Activity 2-E

BUILD OR PAINT A MANGROVE

Summary

Working together, students will either build a large model of a Red Mangrove tree OR paint a mural of one on a large sheet of paper on the classroom wall.

Learning Objectives

Students will be able to:

- Name and locate some of the animals that live in a mangrove swamp;
- Understand the ecological importance of Red Mangrove trees.

Subject Areas Science, Art

N.B. This could be part of a community outreach project, a special activity for a science fair or it could follow-up a field trip.

Time 2 - 4 lessons, or more

Age Levels 8 +

Materials

Reference

From this activity

- Mangroves painted by students on back cover
- Copies of Copy Cat Page "How to Build a Mangrove"

From other activities and sources

- Copies of Copy Cat Pages "Anyone at Home? Mangrove Habitat Study Worksheet 1" (Activity 2-A) and "Red Mangrove Root" (page 35)
- Copies of Copy Cat Pages "Wetland Animals," "Wetland Plants" and "Red Mangrove Root" (page 35)
- Field Guides (e.g. Birds of the West Indies, Pond Life)
- Pictures of Red Mangroves from magazines or books

Construction materials

- Plain, tissue and crepe paper of different colours (several greens, brown, red, black, white, etc.)
- Thin cardboard
- Styrofoam trays (the kind produce and meat is packaged on)
- A large and a small brown paper bag
- Old newspapers
- Option B (moveable): Several old broom handles or an old hat stand
- Option B (moveable): Two pieces of 2" x 4" lumber, each about 1.2 m (4 ft) long, joined together in a cross, with a hole drilled in the middle
- Small paper plates
- Curling ribbon or pastel-coloured "icicles"
- Egg cartons, pipe cleaners, old cardboard boxes
- Butcher paper or cartridge paper, sufficient to cover the selected wall space (mural)

Sticking materials

- Brown tape
- Clear sticky tape
- Stapler
- Glue (for moveable model a hot-glue gun works best)

Other materials and equipment (also suitable for the mural)

- Scissors or cutting knife
- Crayons, felt-tip markers, paints

Procedure

1. Decide whether you will be painting a mural or constructing a portable or stationary mangrove. Work accordingly, allowing enough space for the structure.

2. If possible, give each child a copy of a picture of a mangrove e.g. "Anyone at Home" or a photograph. Explain that this shows where many mangrove creatures live. Therefore it also shows where they will go in the mural or model.

3. Students will work in teams to paint or build a Red Mangrove tree complete with wildlife. One or two teams will paint or build the mangrove tree - its trunk, branches, and roots. The other team(s) will paint or make the fish, birds, crabs, turtle, etc. that live in the mangrove.

4. Bring out the construction materials and watch the mangrove grow. Improvise with whatever materials are available.

Mangrove model

Trunk

Option A (stationary)

- Tape or staple several sheets of brown construction paper together to form a trunk about 30 cm (1 ft) wide and 90 cm (3 ft) long.
- Tape the trunk in the corner, attaching the sides of the trunk to the two walls. (This will give the effect of a three-dimensional tree.) The base of the trunk should be about 60 cm (2 ft) above the floor (see diagram).

Option B (portable)

- Take two or three broomsticks and tape them together so they are about 2 m (7 ft) tall. Drop one end into the hole in the middle of the crossed 2 x 4s each about 120 cm (4 ft long). Glue it in place with hot glue. An old hat stand also works extremely well.
- Tear up old cardboard boxes and wrap strips of cardboard around the broomsticks all the way to the floor. Tape in place with brown parcel tape. Glue to crossed 2 x 4s.

Water

- Create water around the mangrove by taping several sheets of blue tissue or crepe paper to the wall, or attach it to the base of the trunk and, later, the roots. The "sea" should reach from the floor to the base of the trunk.

Roots

- Cut black or brown construction paper, or cardboard boxes, into strips about 2.5 cm (1 in) wide and 60–90 cm (2–3 ft) long. Also, cut shorter strips to make "accessory" roots that branch off the longer ones.
- Beginning at the bottom of the trunk, tape the strips end to end to form roots reaching along both walls, extending away from the corner **or** cut a slit in the trunk and slide the end of the roots into the trunk, taping the slit closed around them. Anchor roots by taping them to the floor, or to the 2 x 4s (portable). Tape more strips along the main roots to make a maze of roots until the tangle reaches into the "water" a little higher than the base of the trunk.

Branches and leaves (canopy) and seeds

- Cut branches out of black or brown construction paper, or cardboard boxes, and tape them to the trunk (or insert in slits in the trunk).
- Use sheets of green paper or rags to make layers of leaves. Tape a few sheets of the paper to the wall (stationery model).
- Add a few more layers of paper or rag strips, each one a little higher and a bit further from the corner and floor (see diagram and picture).
- Draw and cut out Red Mangrove seeds (propagules) in bunches to hang from the branches of the tree.

Mangrove animals

- For larger animals (herons, pelicans, and West Indian Whistling-Ducks) cut outlines out of thin cardboard. Colour, then tape them in appropriate places on the tree.
- Build a birds nest in the tree by cutting and gluing strips of cardboard.
- Cut smaller animals (fish, snakes, turtles) out of construction paper or styrofoam trays, paint or colour, and tape them to the tree or water.
- For a slightly larger turtle, stuff a large and a small brown paper bag with crumpled newspapers and staple the open ends shut. Glue the "head" to the "body". Cut out flippers and tail from thin cardboard and glue to body.
- Bright-coloured sea anemones are frequently found on mangrove roots. Make them by wrapping colourful crepe paper around parts of the roots that are "underwater".
- With a bit of imagination and improvisation you can use the eggs cartons, pipe cleaners and other materials to make crabs, snails and spiders. An upside-down jellyfish (look at pictures of *Cassiopeia*) can be made out of paper plates and curling ribbon or icicles.

Mural

Attach paper to wall or walls. Begin painting in teams!

Extensions

The mangrove model and mural can be used for many other class or community education projects—for example:

- as a backdrop to a play about wetlands
- as a class project for a science fair
- for community outreach, to show functions and benefits of mangroves
- for peer teaching of other students

If you choose to make the mangrove mural and the other children like it when they see it, you might be able to get support to paint a permanent version on an outside wall of the school.

Source Adapted from Ranger Ricks Nature Scope "Wading into Wetlands".

How to build a Mangrove model

COPY CAT PAGE

Activity 2-F

FILL THE BILL

Summary

In this demonstration, students can find out how bird bills are adapted to tearing, scooping, stabbing, sucking, cracking, and picking up different types of food.

Learning Objectives

Students will be able to:

- Describe eight different kinds of bills and how each is adapted to feed on different kinds of food
- Relate this adaptation to the birds survival in wetlands

Age Levels 7 +

Subject Area Science

Time 2 hours

Materials

- Copies of Copy Cat Page "Fill the Bill Matching Game" (one per student OR one per group)

Containers

- Two aquaria or other large clear containers
- Large saucepan
- Tall, thin vase, bottle, or glass jar
- Small log or large tree branch
- Long piece of string
- Eight pieces of paper to label the feeding stations

Foods

- Raw rice
- Rice cereal (like Puffed Rice or Rice Krispies)
- Plastic fishing worms or gummie worms or three-inch pieces of string
- Popcorn or tiny marshmallows
- Styrofoam chunks or pieces
- Oatmeal (oats porridge)
- Peanuts or other nuts
- Prunes hanging from a string

Bills (tools)

N.B. If you do not have access to some of the more expensive items, try to think of cheap substitutes.

- 4 pairs chopsticks, toothpicks, or small twigs (in pairs)
- 3 pairs pliers or nutcrackers
- 3 tweezers
- 3 strainers
- 3 small fishnets or envelopes
- 2 bamboo skewers
- 3 eyedroppers or straws
- 2 slotted spoons or large scoops

Background

Different types of birds eat different types of food. Each species has evolved a specialized bill and tongue that enables it to feed on a particular kind of food. If you look carefully at a bird's bill, you may be able to guess what type of food it eats. Wetlands provide a variety of food types, and attract many species of land and waterbirds. For example:

- **Hummingbirds and bananaquits** have long, narrow, hollow bills. The bill probes into flowers and protects the tongue, which licks up the nectar from flowers. Flowers that attract hummingbirds are often brightly-coloured. Hummingbirds also catch small flying insects.
- **Snipes, sandpipers, and stilts** have long pointed bills whose tips can sense movement. They use their bills to probe for worms, crustaceans, and other small creatures in mud and water.
- **Pelicans** have long, flattened and pouch-like bills that they use to scoop up fish.
- **Egrets and herons** have long, thin bills for spearing frogs or fish in the water.
- **Flamingos and some ducks** have bills that act like strainers, which they use to filter tiny plants and animals.
- **Parrots** have short, powerful conical bills that are very strong, with which they can break open tough seeds and get the fruit from around a seed.
- **Bullfinches, grassquits** and similar birds have short, conical bills that are very strong and can break open seeds.
- **Warblers** have small, sharp, pointed bills for picking insects from leaves, logs, and twigs.
- **Nighthawks, potoos, swifts, and swallows** have large, gaping mouths that act like nets to trap insects. These birds catch insects on the wing.

Preparation

1. Assemble the equipment.
2. Set up eight different stations, each with a special type of food. At each station you will need three different tools, one that represents the bill that best fits the food (in one case, two) and two that don t fit so well.
3. Place a sign at each station to say what type of food is represented (e.g., At station 1, *Nectar*; at station 2, *Worms,* etc.).
4. The following is a list of food and tools for each station. The correct tool is indicated by an asterisk (*). In one case (station 4), there are two correct tools, for two different types of fish-eating birds; the second correct choice of bird and tool is indicated by a double asterisk (**).

Station 1: Water in a thin vase or glass to represent **nectar** in a flower (hummingbirds and bananaquits).

Tools:
- eyedropper or straw*
- envelope or small fishnet
- large scoop or slotted spoon

Station 2: Large saucepan filled with dry oatmeal, with pieces of string or plastic (or gummie) worms on the bottom to represent **worms** buried in the mud (snipes, sandpipers, and stilts).

Tools:
- chopsticks, toothpicks, or twigs*
- pliers or nutcrackers
- strainer.

Station 3: Whole peanuts or other nuts to represent **seeds with hard coverings**, such as sunflower seeds (bullfinches, grassquits, sparrows, buntings, and other finch-like birds, and also parrots).

Tools:
- pliers or nutcrackers*
- tweezers
- chopsticks, toothpicks, or small twigs

Station 4: Styrofoam chunks floating in an aquarium or other large container filled with water, to represent **fish and other aquatic animals** (pelicans,* herons, and egrets**).

Tools:
- large scoop or slotted spoon*
- bamboo skewer**
- eyedropper or straw
- chopsticks, toothpicks, or twigs

Station 5: Puffed rice in an aquarium or other large container filled with water, to represent **tiny aquatic plants and animals** (flamingos and ducks).

Tools:
- strainer*
- tweezers
- pliers or nutcrackers

Station 6: Popcorn or tiny marshmallows, which must be tossed in the air and caught in the air, to represent **flying insects** (nighthawks, swifts, and swallows).

Tools:
- envelope or small fishnet*
- tweezers
- chopsticks, toothpicks, or twigs

Station 7: Rice spread on a log, surrounded by leaves (put rice under leaves as well) to represent **caterpillars and other insects** (warblers).

Tools:
- tweezers*
- chopsticks
- strainer

Station 8: Prunes hanging from a string to represent **fruit** hanging from a branch (parrots).

Tools:
- eye dropper or straw
- strainer
- nutcracker or pliers*

Procedure

1. Pass out the Copy Cat Page "Fill the Bill"
2. Divide your group into eight teams. Each team will start at a different station.
3. Explain that there are three different tools at each station, each of which represents the bill of a different type of bird. Each group **must test and decide** which tool is <u>most</u> efficient at getting the food. Also explain that one station will have two tools that work well for the food provided.
4. Once they pick the best tool, they write it in the appropriate square on the handout (e.g., in square 1 Nectar, write eye dropper or straw.)
5. On the line underneath each picture on the handout, students should write the type of food and the number of the tool that represents the correct bill. For example, beside the hummingbird write nectar, 1.
6. Discuss bill adaptations,, explaining how, after millions of years, many birds have evolved very specialised bills. Remind the students that some birds are so specialised that they can only eat one type of food. For example, Flamingoes use their bills to feed on brine shrimps in very salty water. If the water dries up or there are no shrimps, they must move to another place or starve.
7. Other birds have less specialised bills (e.g., Grackles). If one type of food is in short supply, they simply eat something else.

Extension

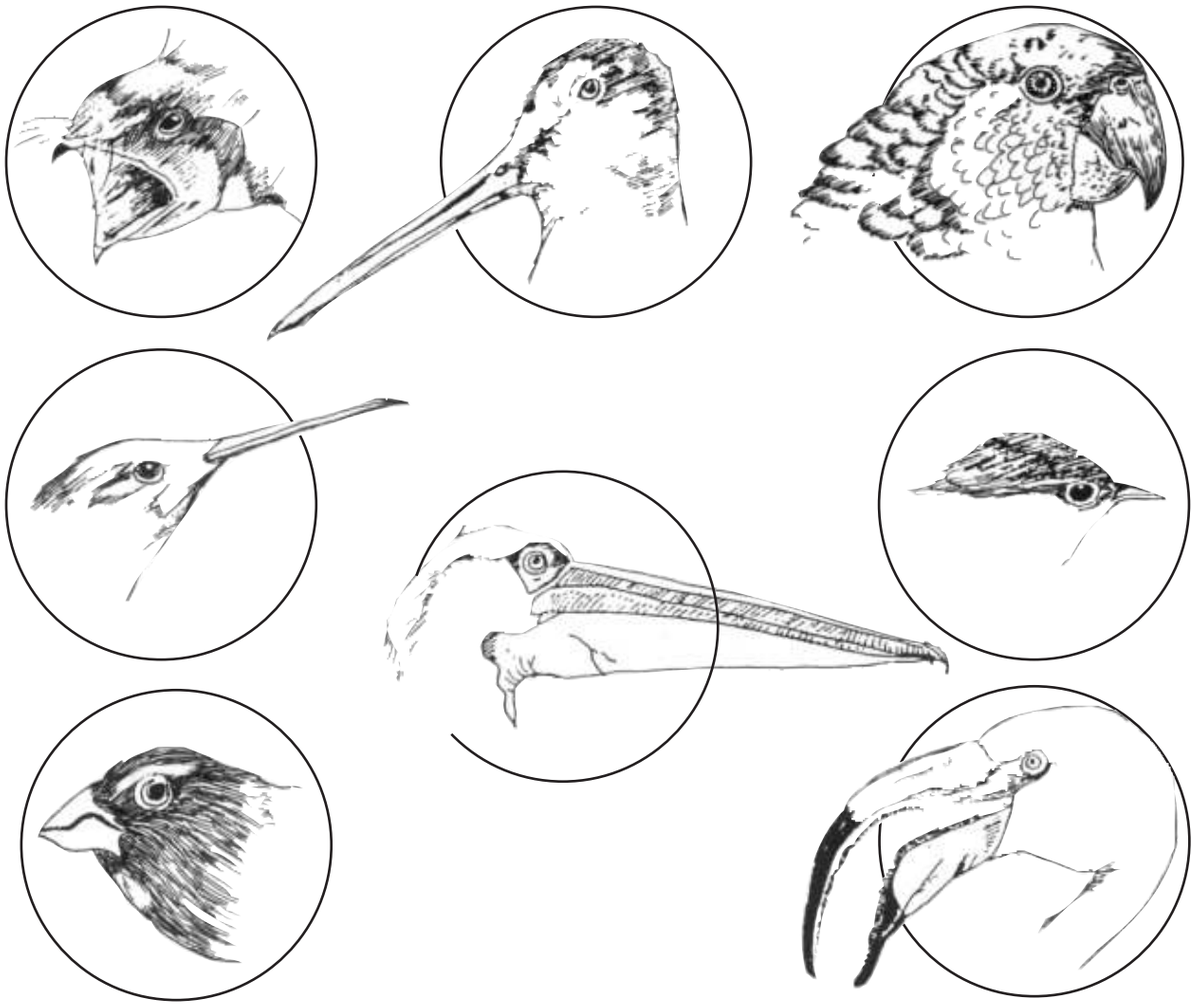
Discuss what other things wetland birds use their bills for, such as:
- Display
- Singing
- Aggression and defence
- Nest building

Try to think of examples of each.

Discuss what other adaptations wetland birds have for feeding, such as:
- Feet (e.g., Osprey catch fish with feet)
- Wings (e.g., Grebe's wings allow them to "fly" under water in pursuit of fish)
- Body camouflage (to hide from prey)
- Special behaviour (e.g., stalking, herding prey)

Source Adapted from Ranger Rick's Nature Scope "Birds, Birds, Birds"

Fill the Bill matching game



Match the food in column 1 with the best tool for the job in column 2. Write the number of the correct tool on the blank next to the name of the food.

_____Nectar (Hummingbird)

_____Worms (Snipe)

_____Seeds (Bullfinch)

_____Fish and frogs (Pelican)

_____Tiny water plants and animals (Flamingo)

_____Flying insects (Swallow)

_____Caterpillars and crawling insects (Warbler)

_____Fruit (Parrot)

1. Pliers or nutcrackers
2. Slotted spoon or scoop
3. Strainer
4. Eyedropper or straw
5. Bamboo skewer
6. Tweezers
7. Fishnet or envelope
8. Chopsticks or toothpicks

COPY CAT PAGE

Activity 2-G

ANANSI AND THE AMAZING MANGROVE MARCHING BAND

Summary

This interactive story uses traditional Caribbean story form to introduce familiar sounds of the wetlands.

Learning Objectives

Students should

- understand that all the creatures of the swamp make distinctive sounds
- be able to recognise some animals by the sounds they make
- be able to use simple phrases as mnemonics for some common animals
- be able to identify some of the common wetland species by their sounds

This activity also creates the opportunity to discuss why and how animals communicate with each other.

Age Levels 6-12

Subject Areas English, Science

Time About 25 minutes, plus time for discussion.

Materials

- A copy of the story
- Copies of pictures of the animals mentioned in the story (Use Copy Cat Pages "Wetland Animals" or the field guide).
- A CD or tape of bird songs of your island, and a suitable player (if available)
- Bird songs can be downloaded from <www.mbr-pwrc.usgs.gov/bbs/song.html> and http://enature.com/audio/audio_home.asp

Background

The animals of the swamp all have distinctive voices. Animals call to each other for many reasons. They call to establish their territories, to attract mates, to maintain contact with members of their family or flock, to raise an alarm of there is danger in the area, or to tell their parents they are hungry. Many animals have a range of different calls.

Preparation

Before the class: Read the story. If necessary, modify catch phrases and animal names to reflect the ones that are most commonly used in your island. Add animals that are found in your particular island (e.g. Jamaica-add Jamaican Oriole "You cheat, you cheat.") and take out animals that do not occur in the wetlands of your island. Prepare pictures of the animals for distribution to the groups.

Procedure

1. Before starting the story, discuss briefly some of the animals that live in the mangrove swamp and show them pictures of each animal (Fiddler Crabs, Crocodiles, Woodpeckers, Tree Frogs, White-crowned Pigeons, Zenaida Doves, Common Ground Doves, Black-whiskered Vireos, Yellow Warblers, Snapping Shrimps, Snapper, Mosquitoes, Croaking Lizard, West Indian Whistling-Ducks, Gray Kingbirds and Antillean Nighthawk). If possible, play back the real calls of these animals.

2. Tell the students that all species make distinctive sounds and calls. Discuss briefly the types of sounds animals make, why they call, and what the calls mean. Explain that you are going to tell a story and the class will have to help by making animal sounds when asked. Organise the class into groups of animals. Ask the class to help you decide what sounds the animals make, and how to imitate them. Write the calls down on the handouts (or blackboard) to help the students remember them.

Some examples:

"Drum, drum, drum," (Woodpeckers) (They knock their knuckles gently on books or desks)
"Whistle, whistle, whistle." (Tree frogs)
"Two bits for twoo!" (White-crowned Pigeons)
"Moses preach God's word!" (Zenaida Dove)
"Sister Sue is sweetaaa!" (Yellow Warblers)
"John Chewit, sweet John." (Black-whiskered Vireos)
"Pop!" (Snapping Shrimp). (Sound made by holding lips together and pulling them apart with a pop)
"Snap! Snap!" (Snapper). (Sound made by clapping hands)
"Ning, ning, ning." (Mosquitoes)
"K-k-k-k key-oooo" (West Indian Whistling-Ducks)
"Click, click, click." (Croaking Lizards) (sound made by folding tongue back on roof of mouth and sucking to make a loud noise)
"Petcharie! Petcharie!" (Gray Kingbird)
"Pid-a-ma-dix, pid-a-ma-dix" or "gimme-me-bit" (Antillean Nighthawk)

The number and types of animals are flexible. You may wish to add any others.
(The narrator will take the parts of the Fiddler Crab, Crocodile and Anansi).

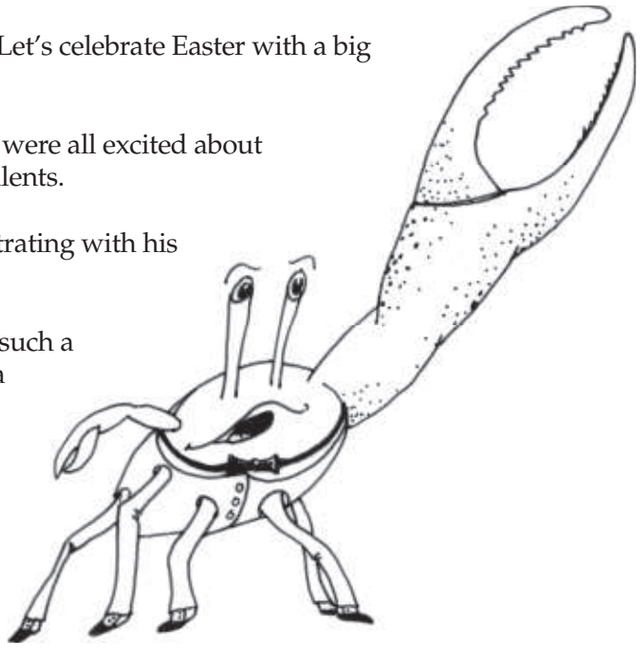
Each group of students/animals should know that they should make the appropriate call when the teacher signals them to do so. Have a practice run through with students making their sounds in turn, in small groups, and all together. When everyone understands what to do get the class settled and read the story.

N.B. *Stage directions in italics should not be read aloud.*

ANANSI AND THE AMAZING MANGROVE MARCHING BAND

Down in the mangrove swamp, in a small village called Mangrove Walk, it was nearly Easter time. All the animals had assembled to discuss how to celebrate Easter. Some fancied a trip to the beach. Others fancied a cookout or a dance. Everyone was chatting, but the discussion was not getting anywhere.

Bro Fiddla, the Fiddler Crab, who always knew best about everything, waved his big claw in the air to get everyone's attention.



"Brothers and sisters of the swamp," he declared, "Let's celebrate Easter with a big parade, a marching band, fireworks and a dance."

Everyone thought that was a wonderful idea. They were all excited about getting dressed up and showing off their musical talents.

"I'll be conductor," announced Bro Fiddla, demonstrating with his big claw.

"I'll play the drum," said Bro Woodpecker, beating such a fast rhythm on a nearby tree that his red head was a blur.

"We'll play piccolo!" whistled the tree frog sisters.

"Two bits for twoo!" boomed Mr. Baldpate, the White-crowned Pigeon, "I'll play bass."

"Coo, coo, coo, coo!" chorused the Ground Doves. "Us too - we'll play flute!"

"Moses preach God's word!" cooed the Zenaida Dove. "I'll play horn."

"I'll sing soprano!" chattered the Yellow Warbler. "Sister Sue is sweetaaa!"

"I'll be the tenor!" interrupted the bossy Black-whiskered Vireo loudly. "John Chewit, sweet John, sweet John."

"Pop!" exploded the Snapping Shrimp.

"Snap! Snap!" went the Snapper.

"Ning, ning, ning" buzzed the Mosquitoes, making up for their quiet voices by playing close to everyone's ears.

"I'll play the castanets!" screeched the Croaking Lizard. "Click, click, click."

"I'll play the fife" called the West Indian Whistling-Duck. "K-k-k-k-key-oooo! K-k-k-k-key-oooo!"

"Petcharie! Petcharie!" cried the Gray Kingbird. "Don't forget me!"

"Whistle, Whistle, Whistle!" sounded the Tree Frogs.

"Gimme me bit! Gimme me bit!" grumbled the Antillean Nighthawk, swooping down from the sky to make sure he wasn't left out.

"We'll do the best fireworks display you've ever seen!" The Fireflies offered.

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Soon everyone had a part. They started to practise at once.

The storyteller (who also takes the part of the Fiddler crab, directing the music) conducts the band in a run through, signaling the animals to call in turn or all together.

They were all so excited, noisy and busy that they forgot that two important swamp animals had been left out.

Later that afternoon, Bro Anansi, the trickster spider, was sauntering down the path by the river, threading his way between the mangrove roots. He had left home early in the morning to walk to the hills to visit his old friend the Iguana, so he was not around when the other animals were discussing the Easter celebration. Now he was on his way home, thinking about Easter and the nice fat fly that he had saved for his dinner. He was humming to himself in his high voice.

"Easter a come! Easter a come!"

As he got near to the village of Mangrove Walk, he heard music. He decided to go and see what was happening. When he got there, he saw all the animals gathered together under the arching roots of the big Red Mangrove tree.

"Hello Bro Fiddla, what's all this noise? " he demanded.

"Evening Bro Anansi. We're practicing for the Easter parade," said Bro Fiddla, rather pompously. "Sorry you're not part of it, but you can't play an instrument."

This was true, but the truth often hurts. Bro Anansi was very upset. He hated being left out. He decided to use his brains to make sure he was part of the parade.

He went to visit his good friend, Sista Crocodile. Sista Crocodile was lazing in the sunshine on a soft sandy bank beside a mangrove pool.

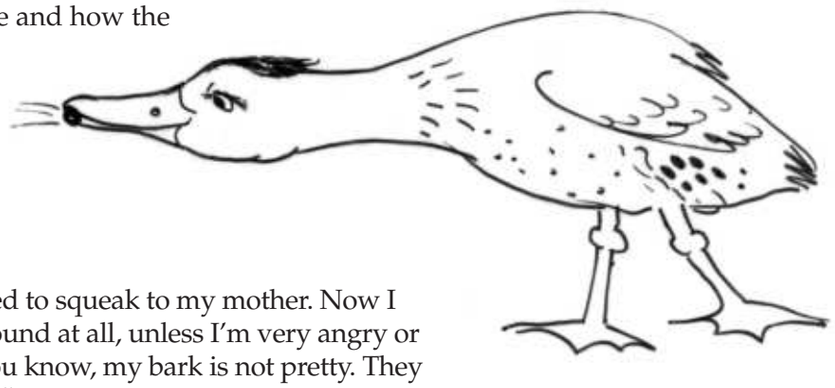
"Sista Crocodile, Sista Crocodile, did you hear about the Easter parade?" asked Anansi.

"Who me?" grumbled Crocodile, who was rather sad and lonely. "Nobody bothers to tell me anything 'round here. They just leave me here, all on my own. It's not much fun being top predator, you know."

"Perhaps they're afraid of being eaten," thought Anansi. But what he said was, "Sista Crocodile, Sista Crocodile, you know that I'm your very good friend. Would you like me to make you a star?"

"Depends what I have to do." mumbled the Crocodile.

Anansi explained about the parade and how the animals were forming a marching band. Everybody was going to play an instrument or sing, except Sista Crocodile and Bro Anansi.



Crocodile was worried.

"Bro Anansi, when I was little, I used to squeak to my mother. Now I am grown up, I hardly make any sound at all, unless I'm very angry or want to call my husband. But, as you know, my bark is not pretty. They will never ask me to be in the band."

"No problem Sista Crocodile. When you have clever friends like me, you don't worry about little things like that," chortled Anansi. "You're going to be a star!"

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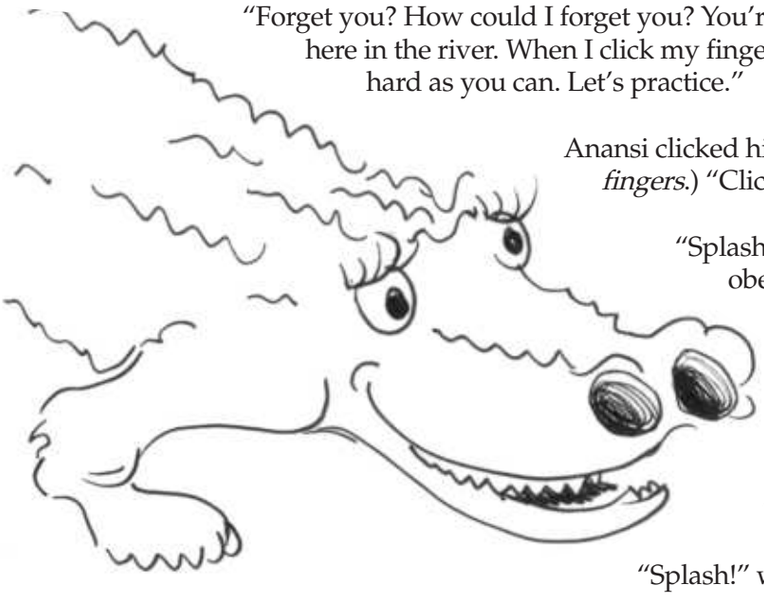
Sista Crocodile was excited. She eased herself off the bank into the water, and swam gently down the river, following Anansi, to the big Red Mangrove tree. As they got near, they could hear all the animals practising.

(The narrator as Bro Fiddla, conducts the band again and they all do their parts.)

Bro Anansi pretended to be thoughtful. He pointed to the space under the big Red Mangrove tree where all the animals were gathered.

"Sista Crocodile, Sista Crocodile, you're so big that if you go in there, there won't be any room for anyone else. So you stay here, and I will go and tell everyone what a wonderful noise you can make."

"I suppose you're right, Bro Anansi," sighed Sista Crocodile. "But you won't forget me out here will you?"



"Forget you? How could I forget you? You're going to be the star! He, he, he! Just wait here in the river. When I click my fingers, you splash your tail in the water as hard as you can. Let's practice."

Anansi clicked his fingers. *(The narrator snaps his/her fingers.)* "Click"

"Splash!" The Crocodile splashed her tail obediently.

"Oh well done Sista Crocodile!" giggled Anansi. He was sure that his cunning plan was going to work. "Let's do it one more time, to make sure we get it right."

"Click!" went Anansi's fingers.

"Splash!" went the Crocodile's tail.

"Perfect!" said Anansi.

"Do you really think so?" sighed the Crocodile, in her slow sad voice.

"Trust me!" Anansi assured her. "Now remember, when I click my fingers, make a big splash!"

He scuttled off across the mud into the big hall under the Red Mangrove tree roots. Anansi was humming happily to himself.

"Easter a come! Easter a come!"

He bounded up behind Bro Fiddla and tapped him on the shoulder with one of his long legs. Bro Fiddla looked round.

"Hello Bro Anansi," said Bro Fiddla. "What's happening? It's nice to see you but we're very busy practising. Can it wait 'til later?"

"Well that's the thing, Bro Fiddler," said Anansi, "I've learned to play an instrument and I want to join the band!"

"Have you now," said Fiddler, scratching his head with his big claw in surprise. "What instrument have you learned to play, Bro Anansi?"

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Anansi could hardly contain his excitement. "The cymbals, Bro Fiddla, the cymbals."

Fiddler was very surprised, but he did not want Anansi to feel bad.

"Of course, my dear Bro Anansi, of course. Now would you like to show us how well you play the cymbals?" He turned to the band. "Everybody quiet now. Let's hear Bro Anansi play."

Everybody looked at Bro Anansi. Bro Anansi clicked his fingers. *(Narrator clicks).* "Click!"

Nearby, in the river, Sista Crocodile heard the sound. She splashed her tail hard down into the water. "Splash!"

All the animals were surprised at how little Anansi could make such a loud and wonderful sound.

"Would you mind doing it just once more?" asked Fiddler.

"No problem, no problem, Bro Fiddla! He, he, he!" laughed Anansi. Again he clicked "Click!" and again the crocodile beat the water with her tail. "Splash!"

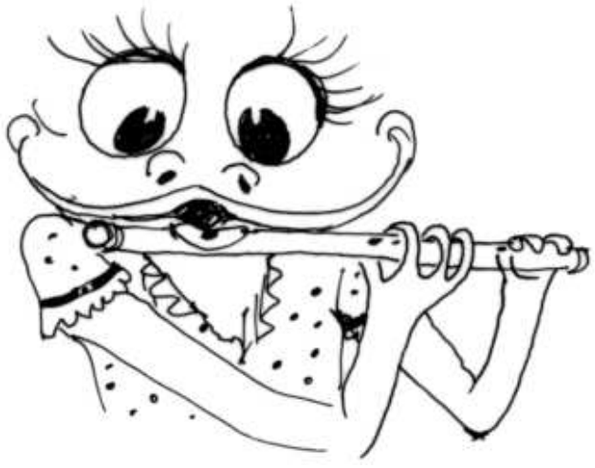
Everyone was very impressed. Then the Yellow Warbler piped up. "Bro Fiddla, Bro Fiddla, you know we were wondering how to introduce the Firefly Fireworks. The sound of Anansi's cymbals is just what we need."

The animals all agreed that the cymbals would be the perfect introduction for the fireworks. They made a big fuss of Bro Anansi and welcomed him into the band. The practice continued.

But, while Crocodile was waiting for her cue in the river, she overheard two little ticky-ticky mosquito fish gossiping to each other.

"Oh what a way Bro Anansi has made a fool of Sista Crocodile!" said one.

"Yes," answered the other, "Everyone thinks he is the star of the parade, with his wonderful cymbals, but he really can't play cymbals at all. It's just like him. He's played a naughty trick on Sista Crocodile. I wonder what Sista Crocodile will do when she finds out!"



Sista Crocodile was very angry. She decided that she would play her own trick on Bro Anansi.

At last, Easter Monday arrived. All the people of Mangrove Walk were lined up along the bank, waiting. The animals that were playing in the band met under the big Red Mangrove tree. They were wearing their best clothes, and looked very smart. Anansi was the smartest of all. He was wearing a brand new suit, with lots of gold braid and a matching hat. He looked very grand.

The players raised their instruments. Bro Fiddler, the conductor, waved his big claw like a baton, and the band set off, marching along the river bank. Bro Anansi was right behind Bro Fiddla. Sista Crocodile glided along beside him. Except for her beady eyes, that saw everything, she looked like a log of wood. She swam so quietly that no one noticed she was there. Except Anansi, of course.

As the animals marched, they played. This was the big performance and all the animals performed brilliantly.

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(The narrator conducts the class through their parts again).

As they finished, there was a burst of applause. Then Bro Fiddler signalled to the audience to be quiet. It was time to start the Firefly Fireworks. Bro Fiddler waved his claw at Bro Anansi. This was Anansi's big moment. His heart was beating fast. He clicked his fingers.
Narrator clicks his/her fingers. "Click!"

Nothing happened.

(Narrator clicks). "Click!" He clicked his fingers again.

Nothing.

Very worried now, he clicked with one, two, three, and finally three pairs of legs at a time. (*Narrator clicks several times). "*Click, click, click, click!"

Still nothing.

Anansi was in a big fret. The sweat glistened on his forehead below his new hat.

"Sista Crocodile, Sista Crocodile!" he whispered as quietly as he could, edging closer to the river to look for the crocodile, who was hiding under the bank. "What's happened to you? Splash now! Please splash now!" Of course, it was so quiet that everyone heard what he said.

"No problem, Bro Anansi!!!" bellowed the Crocodile, raising herself up for all to see. She drove her enormous tail down into the water as hard as she could. The water splashed over the bank and caught Bro Anansi. Bro Anansi was washed right off the bank and into the muddy, smelly water.

Everybody understood what had happened. They laughed and laughed to see how Bro Anansi's boasting had got him into trouble, yet again.

The fireflies heard the splash of Sista Crocodile's tail, and started the firework display. The sky was full of dancing lights of many colours. Everyone, including Sista Crocodile, had a wonderful time. They danced and played among the mangrove roots all night, until first light broke over the swamp.

But Bro Anansi was not among the dancers. While everyone else was watching the fireflies, he climbed out of the river on the other bank, hoping that no one would notice him. The gold braid on his suit was caked with mud. Where was his beautiful new hat? Lost in the river. Cold, wet and humiliated, he crept home to change. He was too ashamed to come back to the party.

So you see, it doesn't pay to pretend to be cleverer than you are. Jack Mandora, me no choose none.

COPY CAT PAGE

Story written by: Ann Sutton with help from Brandon Hay and Robert Sutton.

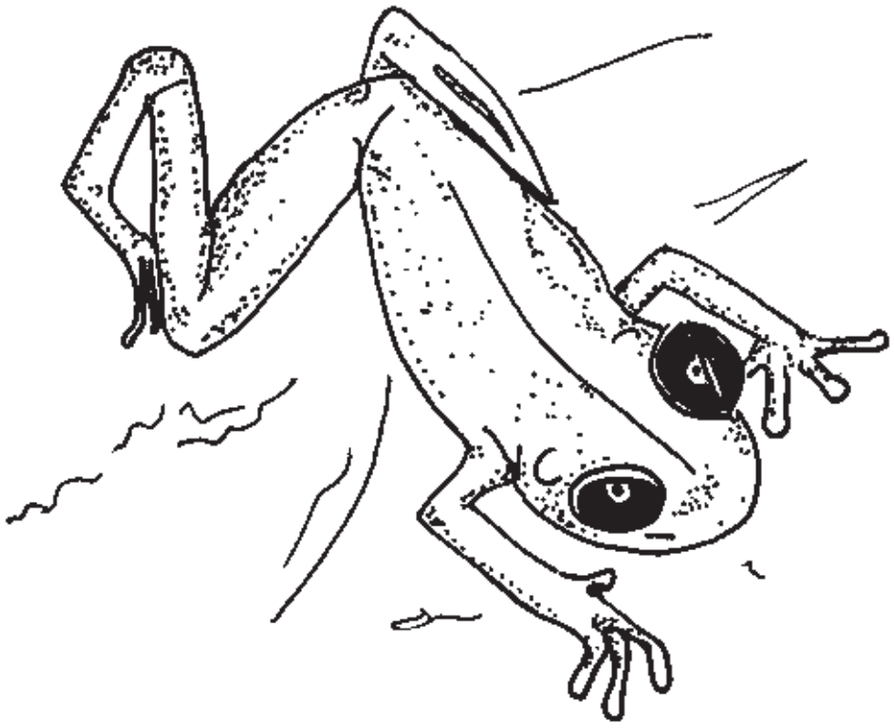
Discussion and assessment

Ask the students:

- Why do animals make sounds? *To find each other, to call their parents to feed them or to protect them, to find mates, or to raise an alarm.*
- Why do all animals have distinctive sounds? *So that the members of each species can recognize each other.*
- How can we recognize animals in the swamp, even when we cannot see them? *By learning the sounds they make.*
- What could you do if you heard a sound you did not recognize? *Try to trace it back to the animal that made it.*
- How can we use mnemonics to help remember the sounds animals make? *By fitting phrases or words to the sounds – many are already part of folk culture.*

Extensions

- If this activity is done shortly before a field trip to the wetlands, the students could review the sounds at the beginning of the trip, and then be asked to identify, by sound, as many animals as they can during the field trip.



Activity 2- H
TOUCHY-FEELY BAG

Summary

Mangrove ecosystems support many different animals and plants that form a complex food web. Students will select an object and say where it is found in the mangrove ecosystem, and how it relates to the food web.

Learning Objective

Students will be able to understand the basic functions of mangrove wetlands from the plants and animals that live there.

Age Levels 4–11

Subject Area Science

Time 30–60 minutes

Materials

- Large opaque bag that looks mysterious, containing a selection of items illustrating the important relationships in a mangrove food web
- Mystery items to fill your bag:
  - Mangrove swamp mud (in a sealed clear plastic bag)
  - Sand (in a sealed clear plastic bag)
  - Water in a small, squeezable container
  - Mature Red Mangrove seedling
  - Any plant that grows in mangroves
  - Black Mangrove root
  - Feather
  - Shells (e.g., mangrove oyster or conch)
  - Crab claw (preferably fiddler crab) or shell
  - Leaves (Black Mangrove if possible)
  - Toy animals (e.g., frog, fish, insect, duck, crocodile, turtle, lobster, etc).
  - Bird's nest (if you can find one that has fallen out of a tree)
  - Fish bones (remnants of a bird's lunch, in a sealed clear plastic bag).
- Blindfold

Preparation

Assemble the mystery items and place them in the bag. Add other items or substitute as necessary. Keep these items in a safe place for future use, to lessen the impact on our environment of collecting natural items. Make sure that you can explain how these items fit into the mangrove ecosystem.

Procedure

1. Remind the class about mangrove wetlands and the importance of **food webs**. Summarise how a mangrove ecosystem works.
2. Blindfold a student volunteer in front of the class.
3. Take out an object from the bag; let the class see it, then put it into the student's hands.
4. Ask the student to feel and smell the item, describe to the class how it feels and smells, and try to guess what it is. If necessary, the class may help with clues.
5. Remove the blindfold so the student can see the object.
6. Once the object has been identified, guide the class in working out how it fits into the mangrove ecosystem. Where does it live? What does it eat? What eats it?
7. Ask another student to sketch each object on the chalkboard. As each successive item is added, the students should try to work out how the items depend on each other and illustrate the relationships with arrows.
8. Repeat for several items and volunteers.

Evaluation/Assessment

Students should draw pictures of the items showing how they fit into the mangrove ecosystem.

Source Adapted from "WOW The Wonders of Wetlands"

Activity 2-I

MANGROVE FOOD CHAIN RELAY

Summary

Mangrove ecosystems have a complex food web

Learning Objectives

Students will be able to:

- Identify the main elements of the food chain: producers, primary, secondary, and tertiary consumers, and decomposers
- Understand the distinction between herbivores, carnivores, and omnivores
- Describe a mangrove food chain

Subject Area Science

Time 1 hour

Materials

- One copy of Copy Cat Pages "Mangrove Food Web Worksheet,""Wetland Food Chain 1" and "Wetland Food Chain 2" per student, if possible
- Cut out suns or sticks with a cut-out sun stuck on to them, to serve as batons

Age Levels 8 +

Background

Plants and animals in any given ecosystem or habitat are linked by their feeding relationships. The complex web of linkages is called a food web. Within a **food web** there are simpler relationships called **food chains**. **Food chains** typically recycle energy from the sun, carbon dioxide and oxygen from the atmosphere, water and nutrients through a series of living things, including plants (**primary producers**), herbivorous animals that eat plants (**primary consumers**), carnivorous and omnivorous animals that eat other animals (**secondary consumers**), and bacteria, and fungi (**decomposers**). A **food chain** is one feeding cycle within a larger or more complex system called a **food web.**

Procedure

1. Introduce the concept of food chains and explore how they apply to wetlands. Distribute copies of Copy Cat Page "Wetland Food Chain 1." Explain what is happening in the diagram.

2. Tell the students that food chains are rather like endless relay races where the batons are the nutrients that living things need, and the sun's energy.

3. Ask the students to form themselves into teams of four to run a relay race.

4. In order to run in the race, a team must identify a food chain with four stages. Each student in the race will represent a stage in the relay.

5. Each team should identify a simple food chain with four steps. Some suggestions are shown in "Some Simple Food Chains" below. Then they should decide which student will represent which animal or plant in their food chain relay team.

6. Each team should describe the food chain to the class.

7. Go outside to an open space and run the relay.

8. When the students return to class ask the winners to remind the class what they represented. What would have happened if one team member was missing? *The team would not have been able to complete the race.* Explain that if food chains are disrupted because pollution, disease or hurricanes, affects one animal or plant, the effects can spread to many other organisms.

9. Hand out the other Copy Cat Page, "Mangrove Food Web Worksheet" and use the clues to fill in the circles

10. Discuss: What other plants and animals could fit into the charts?

Alternate Procedure

1. Use the food chain examples on this page and/or make up some of your own. Write down the names of the organisms on colored cards or paper (one color for each level of the food chain).

2. Form relay teams of four as in step 3 and position the teams for the relay race (e.g., first runners on a start line, second stage runners on a line some distance away, etc).

3. Randomly hand out the cards to all the runners, one primary producer card to each runner in stage 1, one primary consumer card to each runner in stage 2, one secondary consumer card to each runner in stage three, and a tertiary consumer or decomposer card to the last runner.

4. Explain to the students that this a race to determine which team can identify a correct food chain most quickly. Instruct the students that each runner in stage 1 must run to stage 2, look at all the cards that these runners are holding, and identify the organism that consumes him or her (runners at each stage can display their names). These two runners must then run to stage 3, decide on the correct consumer, then run altogether to the final stage. Once again, each team must decide on the correct organism for the final level of their food chain, and then run together to the finish line. The team that wins is the team that has reached the finish line first AND has correctly identified all the levels of their food chain.

Extension

Have the students work together in their teams to fill out the Mangrove Food Web Worksheet (Copy Cat Page on pg. 67). Members of the team that fill out the sheet the fastest and with the most correct answers are the winners.

Some simple food chains

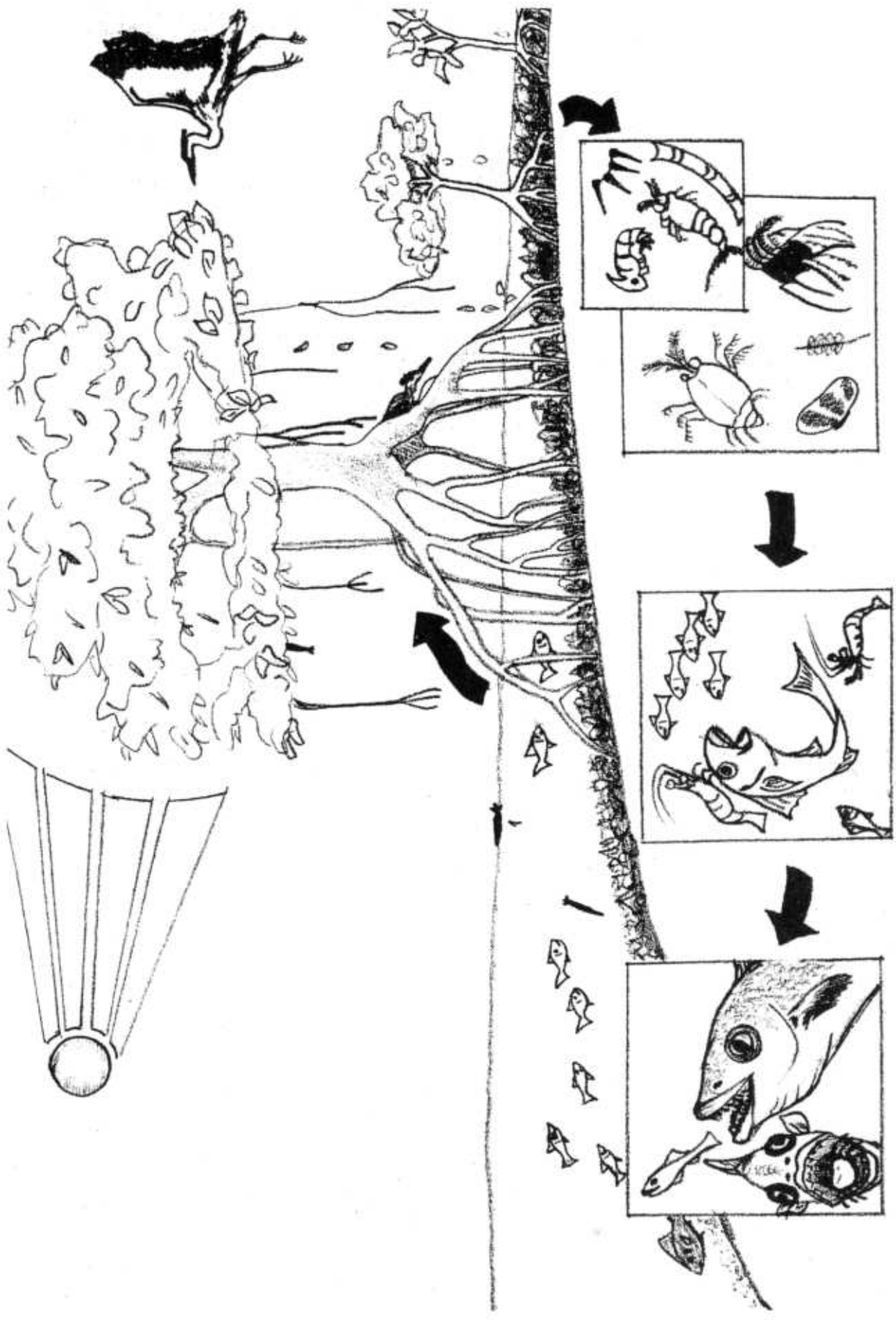
	Example 1	Example 2	Example 3	Example 4
PRIMARY PRODUCER	Algae	Phytoplankton	Red Mangrove Tree	Button Mangrove
PRIMARY CONSUMER	Parrot Fish	Shrimp	Mangrove Crab	Caterpillar
SECONDARY CONSUMER	Grouper	Snapper	Night Heron	Yellow Warbler
TERTIARY CONSUMER OR DECOMPOSER	Man	Crocodile	Bacteria	Peregrine Falcon

Evaluation/Assessment

Ask the students to look at Copy Cat Page "Wetland Food Chain 2," describe the food chain and write a story from the animal's perspective. What problems do they have finding food? How do they escape from predators?

Sources Adapted from various sources by Ann Sutton and Martin Keeley.

Wetland Food Chain 1



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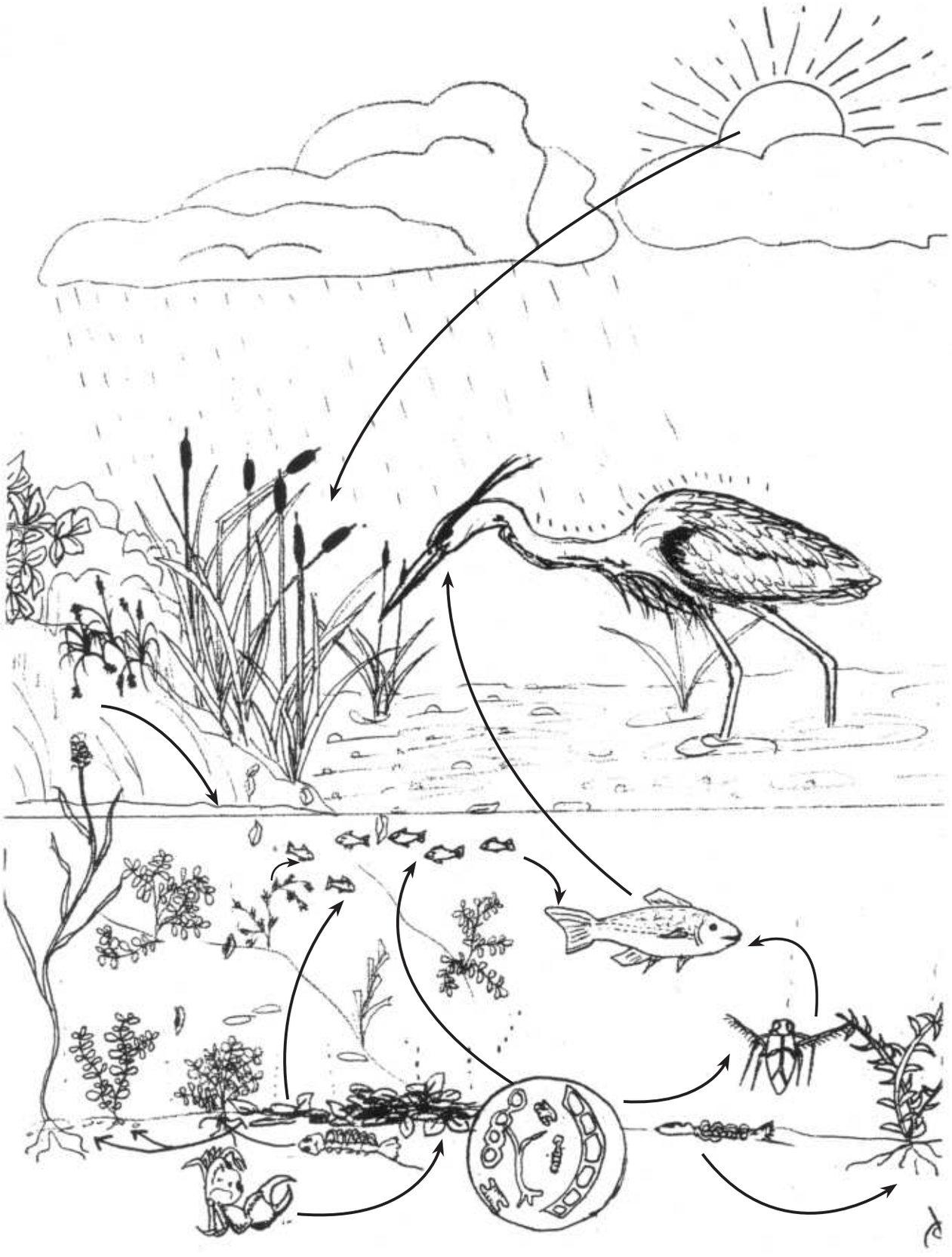
Wetland Food Chain 2



COPY CAT PAGE

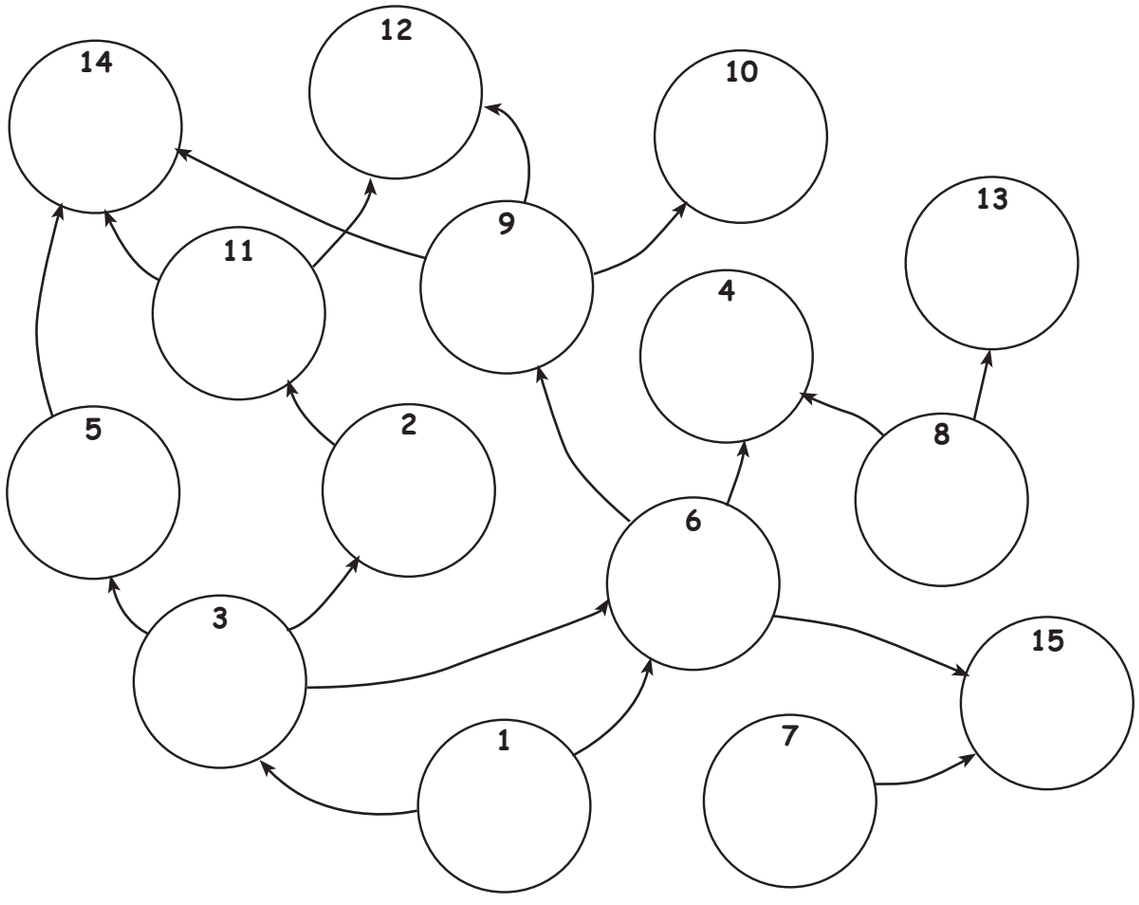
Mangrove Food Web Worksheet

Complete the simplified food web for a mangrove habitat, using the following words to fill in the correct numbered circles:

oyster, heron, amphipod/shrimp, Osprey, plants, Mangrove Snapper, detritus, Black-Necked Stilt, Mangrove Crab, West Indian Whistling-Duck, phytoplankton, Red Mangrove, insect, Yellow Warbler, humans.

Clues for numbered circles

1. These microscopic organisms live in water and use energy from the sun to make food.
2. These trees are among the most productive in the world.
3. This is dead plant material broken down by bacteria and fungi. It returns plant nutrients back to the mangroves.
4. This black-and-white water bird eats mainly insects and shrimp.
5. These shelled animals live on Red Mangrove roots and feed on small particles of organic matter which they filter out of the water at high tide
6. This tiny invertebrate swims around and feeds on organic matter.
7. This photosynthetic organism has cellulose cell walls, grows on the earth or in water, and usually has green leaves.
8. This is an air-breathing invertebrate animal that has body segments, two antennae, three pairs of legs, and usually two sets of wings.
9. This vertebrate with fins lives underwater and feeds on bottom-dwelling invertebrates.
10. This animal usually hunts for fish.
11. This animal lives on the land and lays its eggs in the sea; it eats mostly mangrove leaves.
12. This long-legged animal can be seen patiently standing in shallow water looking for fish and crabs to eat.
13. This small brightly coloured animal feeds on insects.
14. This large omnivorous vertebrate feeds on fish and oysters, and many other things.
15. This large, mostly brown creature comes out at night to feed on plants and small creatures in the water.



COPY CAT PAGE

Activity 2-J
LIVING WEB

Summary

Students will learn that mangrove ecosystems have a complex food web with many different kinds of wildlife and plants dependent on each other for food and shelter.

Learning Objectives

Students will be able to:

- describe a mangrove system food web
- predict changes in a mangrove system that will occur if one or more parts is removed

Age Levels 6 +

Subject Area Science

Time 30 minutes

Materials

- A ball of string or thick wool at least 20–30 m (65–100 ft) long
- One picture card for each member of the class. Picture cards should be about 5 cm square with pictures of representative items from each of the lists below.
- Pictures can be photocopied or handcopied from drawings in this workbook (Copy Cat Pages "Wetland Animals" and "Wetland Plants." If your drawings are not clear, you can write the name of the animal on the square.
- If necessary, punch a hole in each and attach string or flagging tape long enough to hang the cards around the students necks.
- Picture cards should include
  - Sun (sketch)
  - Water, soil, sediment, detritus (use symbols or words)
  - Plants: Phytoplankton, algae, Red Mangrove trees, Black Mangrove trees, and White Mangrove trees, Sea Grass, fungi, Cattails
  - Animals: dragonfly, mosquito, Fiddler Crab, Mangrove Crab, Land Crab, amphipod, shrimp, lobster, conch, Mangrove Oyster, Mangrove Snapper, Green Turtle, West Indian Whistling-Duck, lizard, Osprey, egret, night-heron, parrot, Yellow Warbler, sandpiper.
- Master list for teacher.

Background

Everything in a mangrove ecosystem is dependent on everything else—the baby fish that need the invertebrates as food and the mangrove tree roots as shelter; the fiddler crab that needs the mud as shelter and the leaves as food; the Black-necked Stilt that eats tiny fish and invertebrates in the mud and nests on the ground at the edges of ponds; and the Great Egret that wades in the water hunting for fish. And, of course, almost everything needs the sun and water for its survival. The removal or damage of any part of this ecosystem by pollution or any other form of destruction will have a profound effect on the rest of the creatures that live within it.

Mangrove leaves (**primary producers**) are tough and few things eat them, but some crabs have developed a taste for them. Examine the leaves on a mangrove tree closely and you will probably see where they have been nibbled. The crabs are called **primary consumers**. The unlucky ones are eaten by night-herons. The night-herons are **secondary consumers**, which eat primary consumers.

As the fish and shrimp feed and grow, they get too large for the narrow spaces between the roots. Soon they must venture out. There they may be eaten by bigger fish, such as barracuda, that feed in the channels and lagoons. These bigger fish, along with other animals and birds that eat primary and **secondary consumers**, are **predators**. Predators lurk in the canopy of the Red Mangrove trees or out in open water, ready to swoop down and feed on the unwary. Green Herons often skulk on roots near the water, ready to spear a fishy victim. Spiders, geckos, anole lizards, and Yellow Warblers feast on the mosquitoes that breed in the water. Other birds like Brown Pelicans roost and nest in the canopy, close to their open-water feeding grounds.

Much of the food produced in mangroves is washed away (or **exported**) by tides and currents, and provides food and nutrients for animals and plants along the coast. Thus, disruption of the mangrove food web can have far-reaching effects.

Procedure

1. Attach a card representing a member of the mangrove ecosystem (including sun, water, sediment, phytoplankton, algae, detritus, leaves) to each student.

2. Have the students stand in a small circle; the teacher stays outside the circle.

3. As the teacher calls out an item, the student holding the ball passes it to the student wearing the appropriate card. The teacher first calls out "Sun" and passes the ball of string to the student wearing the Sun card. From then on, depending on age level and the particular class, either the teacher or the students can call out the names of the items in turn.

4. Someone who needs the sun (all qualify) calls: "I'm Red Mangrove, and I need Sun." Sun passes the ball of string to Red Mangrove, but still holds onto the end of it. Fiddler Crab might say "I need Red Mangrove leaves for food" and is passed the string while Red Mangrove and Sun still hold onto it . . . and so on. The reverse relationship might also be used; for example, Water might say, "I'm Water, and Fiddler Crab needs me."

5. Continue game, connecting all the correct items. The string should join all the students in a web.

6. Remove an item (a student drops the string and backs out of the circle) because of pollution or other harmful impact on the ecosystem. Remove other items that might be affected by the particular impact. Ask students to explain what is happening to a healthy food web. What is the result if an item within this web is removed—say Red Mangrove dies (Red Mangrove lets go the string). How does it affect the species connected to it?

Alternate Procedure: Create a Human Food Web

If the number of students is small (i.e., less than 15-16), do this as one group. If more than 15, do this as 2 groups. This variation of the Living Web can be done with or without the picture cards. It is a great ice breaker and group cohesion activity.

1. Form a tight circle, standing shoulder to shoulder. Designate someone to be the sun.

2. Ask someone to call out the name of an organism that needs the sun to grow, i.e., a primary producer (e.g., Red Mangrove). Sun and Red Mangrove reach across the circle and join hands (any hands). Next ask for someone else to say the name of a primary consumer that would eat the primary producer (e.g., Land Crab). Red Mangrove and Land Crab join hands while Sun and Red Mangrove still hold hands. Then ask someone to name a secondary consumer "Who eats Land Crabs?" (e.g., night herons). Land Crab and night heron join hands . . . and so on. When you reach a top predator, (e.g., human, osprey, alligator), continue by saying "If the osprey dies and decomposes, who would eat the osprey?" (e.g., bacteria, fungi). Then, "Who eats bacteria?" and so on.

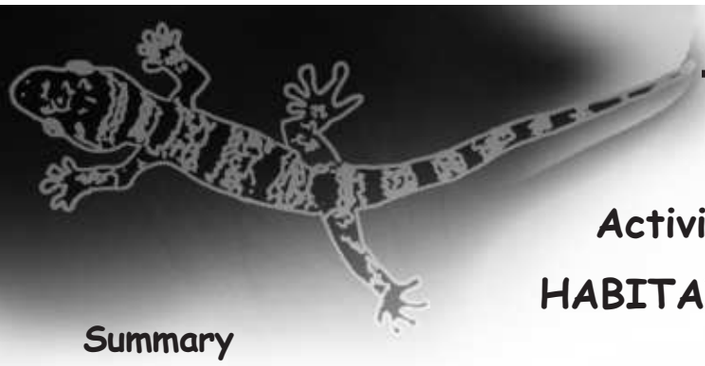
3. Continue this process until ALL hands are joined in a human food web (everyone's arms should be crisscrossing). Be sure that the Sun and last person join hands.

4. Then say: "My challenge to you is to unravel the food web back into our circle WITHOUT letting go of your hands." Students will need to duck under or over each other's arms, twist around, etc. until all are standing in a circle again with hands still joined (several people may be facing out). It may seem impossible, but we have never had this not work!!!

Discussion/Reflection

- Ask students which items are **producers** (*plants*) and which are **consumers** (animals).
- Ask students to describe **one food chain** in the student-made web.
- Discuss how human activities and their consequences, such as pollution, over-hunting, development could remove some items from the food web, and how this could disrupt the ecological balance.

Source Adapted from Project Wild and Oak Hammock Marsh Interpretive Centre.



Activity 2-K
HABITAT HAVOC

Summary

Students play a game and learn the components of habitat and how the availability of habitat affects the population size of wildlife.

Learning Objectives

Students will understand that

- wildlife needs good habitat to survive
- populations of wildlife tend to fluctuate
- if wildlife population increases until it exceeds carrying capacity, limiting factors will act to reduce population
- habitat destruction can lead to extinction

Age Levels 8-16

Subject Areas Science, Mathematics, Physical Education; also suitable for Science Clubs and Youth Groups

Time 30-45 minutes

Materials

- Large area, e.g., playing field, where students can run.
- Flip chart or other large board for scoring.
- Writing materials.
- Chalk or string to mark lines.

Background

If living things are to reproduce successfully and maintain their populations, they need good quality habitat. Many things influence survival and breeding success, but the most important are the availability of food, shelter, water and living space (habitat). Other factors include weather conditions, disease, predation, pollution, and habitat destruction and degradation.

Environmental conditions are constantly changing and wildlife populations change too. When conditions are good (e.g., when there is abundant rainfall) breeding will be successful and populations will increase. As a population increases, **competition** among its members for available resources also increases. Very large increases may cause a population to exceed the **carrying capacity** (number of individuals the resources of a given area can support) of the environment. This may also happen in times of environmental stress (e.g., during severe drought). When the carrying capacity is exceeded, food, water, shelter, or living space become **limiting factors**, i.e., they limit the abundance and distribution of an organism. Reproduction decreases, mortality increases, and some individuals move to another area, leading to a decline in population size. Fluctuations in population size are a natural phenomenon. Under normal conditions, animals are adapted to cope with varying environmental conditions and can usually recover from population lows. However, when people permanently damage a species' habitat, population size may decrease, and recovery may be difficult. Small populations are highly vulnerable to predation and environmental catastrophes (e.g., hurricanes). This is particularly problematic for an endangered species that may be represented by a single population since the entire species may be wiped out (be made **extinct**) by a single natural or human-caused environmental change.

Extinction is a natural process. Over long geological periods of time, species disappear and new ones evolve. However, the recent wave of extinctions (unparalleled since the mass extinctions 65 million years ago) and rapid decline of so many species is unnatural, the result of ever-increasing pressures of human population on natural resources. One by one, forests are cleared, wetlands are drained and filled, and grasslands are paved over, and replaced with housing, hotels, industry, farms, malls, highways, and golf courses. When each habitat disappears, its unique plant and animal life also disappear. Cumulatively it may lead to extinction of most of the earth's **biological diversity**.

Procedure

Getting ready

1. Ask the children to identify the most important elements of **habitat** (*food, shelter, water, and living space*) and what they think would happen to animals if one or more of these elements were missing from their habitat.

2. Explain the concept of **carrying capacity.** Ask what natural events could cause a change in one of these elements that could lead to there being more individuals in the population than can be supported by the habitat. What human activities might have this effect?

3. Count the students off in fours. The ONES form the first group, the TWOS, THREES and FOURS, a second.

4. Mark two parallel lines on the ground, 10-20 m (30-60 ft) apart.

5. All the ONES will line up along one line; everyone else faces them on the other.

6. Stand in the middle to explain that the ONES are WHISTLERS - West Indian Whistling-Ducks. All the rest are HABITATS (actually the elements of habitat; food, water and shelter).

7. As the students to answer the following questions:

   - What sort of food would WHISTLERS be looking for? *Fruits, seeds, roots, algae, invertebrates in the water.*
   - What sort of shelter do they need? *Trees and reed beds to hide and roost in during the day; roots, holes in trees, grassy clumps for nesting.*
   - Why do they need water? *To feed in, drink, bathe, and swim.*
   - Tell them that space is very important, but in this game they will assume that it is not a limiting factor. (Pretend the ducks are in a large mangrove wetland and there is plenty of space).

8. Explain that in this game, the WHISTLERS are looking for food, shelter and water. The players will use the position of their arms to show what they are looking for:

   - When a WHISTLER is looking for **food**, it clasps its arms (wings) around its stomach
   - When it is looking for **water**, it puts its hands over its mouth (bill)
   - When it is looking for **shelter**, it holds its hands (wings) together over its head.

Tell the students that each WHISTLER must decide what it is looking for during each round, and must indicate this by using the appropriate hand signals. It cannot change what it is looking for in the middle of a round. If it survives the round, it can change (if it wants to) before the next round.

Similarly, the HABITATS must decide before each round whether they are providing food, shelter or water. They must indicate which one they are by holding their arms in the same positions as the WHISTLERS. Like the WHISTLERS, they cannot change into another type until the end of a round.

Starting the Game

1. The WHISTLERS should be on one line, the HABITATS on the other. The scorekeeper notes the round number and the number of ducks.

2. Tell the students to turn so that they are facing away from each other. The WHISTLERS should signal the habitat component they are seeking. They should also whistle as they fly. Remind the students about the call of the West Indian Whistling-Duck ("KKKK Key-ooo). Ask them to practice the call. The best way for them to imitate it is by whistling though their teeth. The HABITATS show what they are by making their signs.

3. **Round One**
   - On the count of three, the WHISTLERS and HABITATS should turn to face each other, still making their signs.
   - As quickly as possible, the WHISTLERS, still making their signs, should run over to the HABITAT line, and find the type of HABITAT resource for which they are looking (i.e. someone making the same sign).
   - If they find a person with the same sign, they take them back to the WHISTLER line. This represents successful reproduction.
   - Any WHISTLER that does not find a HABITAT dies and becomes part of the habitat (i.e. joins the HABITAT row).
   - When more than one WHISTLER needs a single HABITAT, the first one to arrive gets it.
   - At the end of the round the scorekeeper counts and records the number of WHISTLERS on the board.

4. **Round Two**
   - HABITATs do not move, but stay put on their line. They may decide to change what sort of habitat they are.
   - On the other line, the WHISTLERS decide what they are looking for.
   - Everyone makes their signs and on the count of three, the process is repeated.

5. **Subsequent Rounds**
   - This game can go on for about 15 rounds. If you minimize the delay between rounds, the students' interest will be maintained.

Discussion/Reflection

- Find a quiet place, sit down and **discuss** what happened. *When there was a small group of WHISTLERS, there was lots of habitat and the population expanded. As the population expanded, habitat became limiting and some WHISTLERS died and became part of the wetland habitat.* Explain that this also happens in natural **ecosystems**.

- Use a flip chart or chalkboard to draw a graph of the WHISTLER population size (y axis) against the number of the round (x axis). What does it show? *WHISTLER numbers fluctuating about a mean.*

- What are the important components of **habitat***? Food, water, shelter, and living space*

- When do they become **limiting factors**? *When the carrying capacity is exceeded.*

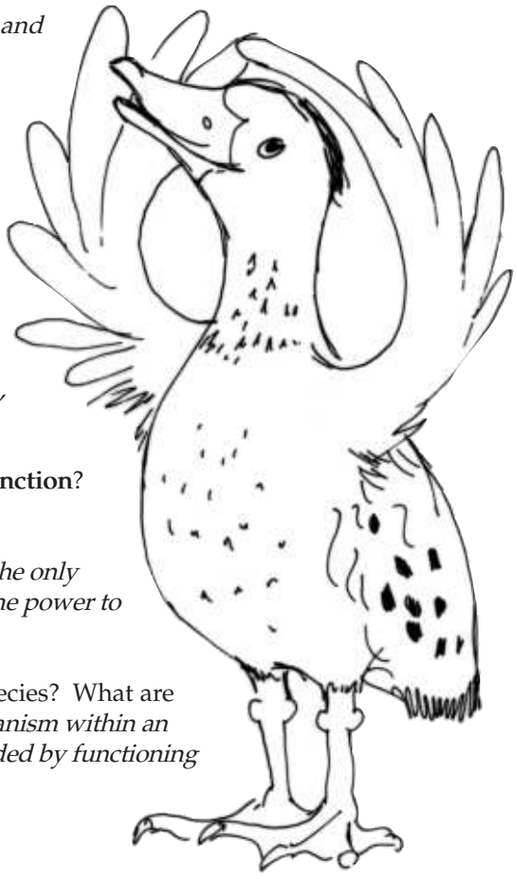
- What would happen if one of the limiting factors was depleted so badly that it could not recover? *Gradual or rapid population extinction.*

- How might habitats change so that one or more factors becomes limiting for West Indian Whistling-Ducks? *Wetland destruction or serious degradation, or a major change in the wetland s hydrology, e.g., prolonged drought, flow of water into the wetlands obstructed.*

- Could these changes in West Indian Whistling-Duck habitats cause **extinction**? *Yes*

- How does our species differ from all the others on this planet? *We are the only ones with free choice and the ability to think critically. We alone have the power to sustain life on earth for millions of species or destroy it.*

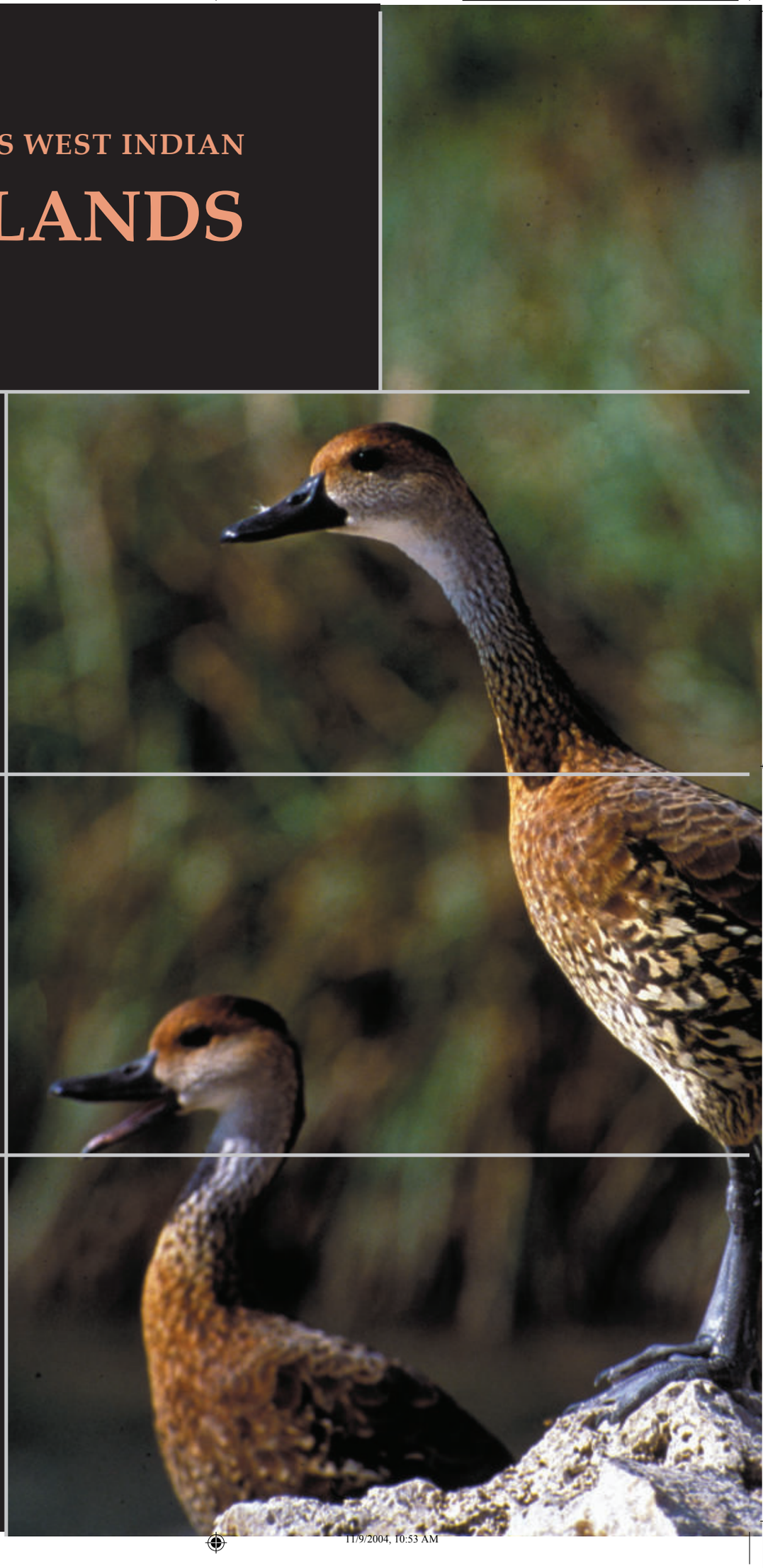
- Does our species have the right to cause the **extinction** of another species? What are the dangers of doing this? *Think about food webs, the role of each organism within an ecosystem, the intrinsic value of nature, and the many "services" provided by functioning ecosystems that sustain human life on earth.*



Source Adapted from "Oh Deer!" Project Wild.

WONDROUS WEST INDIAN

WETLANDS



"We still do not know one-thousandth of one percent of what nature has revealed to us."

- Albert Einstein

Chapter 3

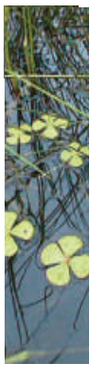
WETLANDS ARE NOT WASTELANDS

What do wetlands do?

LEARNING OBJECTIVES FOR CHAPTER 3

Students should be able to

- List some of the ways in which wetlands contribute to the ecology, economics and culture of the Caribbean
- Understand and describe how wetlands benefit people and animals



Wetlands are not wastelands what do wetlands do?

What if there were no wetlands? Without them Caribbean islands would be subject to much greater damage from storms and hurricanes, there would be fewer fish to catch and eat, and fewer beaches for tourists to visit. Inland, flooding from storms would be more severe and our water more polluted. Without wetlands there would be no habitat for West Indian Whistling-Ducks and many other animals and plants that share our island homes and provide much enjoyment. Without the coal and oil formed about 350 million years ago in the great swamps of the Carboniferous Period, our lifestyles would be very different. Without wetlands, our world would be very different.

In the West Indies, the relationship between man and wetlands dates back to Pre-Columbian times. Early settlers lived by the sea, where food was abundant. Like some modern people, they dumped their rubbish in the swamps. We still find huge piles of shells and other organic remains, mixed with pieces of pots and other relics. In Spanish these heaps are called "conchales" and in English, "middens."

The Spanish and British colonizers were fascinated by the curious growth habits of mangroves. When Sir Walter Raleigh returned to England after travelling to Venezuela, he wrote about the trees that grew in the sea at the mouth of the Orinoco, an account that was considered so fantastic that it could not be true. This helped to undermine his reputation, costing him his freedom and eventually his head. In the sixteenth and seventeenth centuries, mangroves were used intensively for buildings and boats. Soon, high quality, accessible local mangroves were depleted. As early as 1677, Cuba was importing thousands of mangrove poles from Columbia. One of the first conservation laws was enacted in 1839 in Puerto Rico to stop the naval industry from using Red and Black Mangroves.

All the major cities of the Caribbean (e.g. Havana, Port-au-Prince, Santo Domingo, Kingston, Nassau and San Juan) and indeed most of the great cities of the world were built on wetlands. This did not happen by chance, nor was it a mistake. The wetlands formed by great rivers, such as the Tigris and Euphrates of the Middle East, the Niger and Nile of Africa and the Indus and Mekong of Asia, nurtured the greatest human civilizations. They provided drinking water, fish, building materials, fuel, pasture land and transportation. Regular flooding maintained the fertility of agricultural lands. In many places, the towns have expanded into great cities. Only occasional floods remind their inhabitants that they are living on land stolen from wetlands.

In many places, people consider that the risk of an occasional flood is a small price to pay for the benefits. They hope that technology can minimize the risks, and ensure that people can still reap the wealth of the wetlands and the cities that have sprung up around them. For, like cities, wetlands are indeed wealthy – among the richest, most productive ecosystems in the world.

The economic services that wetlands and other ecosystems provide can be divided into **components, functions** and **attributes**. Wetland **components** include living and non-living things, such as soil, water, plants and animals. These components are not isolated but interact in complex ways contributing to the functions of the ecosystem. **Functions** are the things that wetlands do, such as acting as nurseries for fish, cycling nutrients and water, and protecting coasts from storms. Together the components and functions compose **attributes**, such as the diversity of life, heritage and culture. Attributes are qualities that people respect but their economic value is not easy to measure.

Today, wetlands are still very important to Caribbean people. Some of the ways people and ecosystems depend on wetlands are described below. Wetlands are in need of our protection, not just as habitat for wildlife, but also to guarantee the health, wealth and welfare of local people.

What do we get from a wetland? Wetland components

Fish and Seafood (Activity 3-F)

West Indian people and their visitors like fish and seafood. Some tourists come to eat fish, others to catch them. Supplying fish and supporting the recreational fishing industry is a major source of income for coastal settlements throughout the region.

Most of the fish, lobsters, conch, shrimp, crabs and oysters that are harvested and sold in the markets of the Caribbean have spent at least part of their lives in a wetland. Many species of fish, including groupers, jacks and snappers, spawn at sea on the reefs, at the drop-off or in the sea grass beds. Their eggs and young are washed into the mangroves where they flourish on the abundant food supplies from the richly productive wetlands. Shallow waters and complex root systems

protect the young fish from predators and storms. As they mature, they venture out to feed on the sea grass beds and coral reefs that are usually found beside wetlands. In this way, a functional wetland can supply fish fry to reefs for many kilometres down stream. Destroying even a small wetland can decimate fish stocks over a large area. While fish spawn at sea and migrate into the wetlands to mature, the young of some shrimps hatch in the rivers and migrate to the sea, returning to the rivers and wetlands to breed. If the wetlands are destroyed, these links are broken, and fish and shrimp populations collapse

.

Timber, fuelwood, charcoal, biomass and other wood products

Many people in the West Indies depend on fuelwood or charcoal for cooking. Much of this is supplied from mangroves or the woodlands close to them. Mangrove timber is used for building homes and chicken houses, scantlings for house walls and nog, fence posts, scaffold poles and fish pot construction. In the past, mangrove bark was harvested to make tannins, which were used to tan leather and make floor polish. Sustainable harvesting of mangrove timber (but not bark) is possible, and a model for it has been developed in St. Lucia. In some parts of the world (for example, Eastern Europe) swamp plants are grown and harvested as **biomass** to be burned in power stations to make electricity. This has never been tried in the Caribbean

Non-wood products

Caribbean wetlands produce many important non-timber products. Most of them are produced on such a small scale that their importance is rarely recognized. Some examples include mangrove leaves - harvested for their medicinal value, outstandingly high quality honey produced by hives placed among Black Mangrove trees, shoots of Royal Palms harvested and eaten as "Hearts of Palm" – a delicacy, and orchids harvested for horticulture.

Wildlife

Caribbean wetlands abound with life. They may have fewer endemic species than Caribbean rainforests (although Jamaica, for example, boasts 72 species of mosquitoes of which 25, or 36% are **endemic**) but their wildlife is rich, varied and of immense ecological and economic importance. Shallow water, warm conditions and an abundance of nutrients and water contribute to high **primary production** (see below). Much of this production is available as food for plants and animals. It provides the basis for food chains that support populations of **migrant** birds (some over-winter in the region, others use it as a staging post for longer journeys) and endangered species such as crocodiles, manatees, West Indian Whistling-Ducks and sea turtles.

How is wildlife utilized? Although **ecotourism** and **nature tourism** are increasingly popular worldwide, bringing tourists to see wetlands is a relatively new idea in the West Indies. Learning from the Everglades National Park in Florida, which is visited by almost one million people a year, some islands have started to bring tourists into their swamps. The Caroni Swamp in Trinidad and the Black River Lower Morass in Jamaica are the best-known examples. Wetland tours generate revenue from access charges, boat hire, and payment for guides and boat drivers. They attract people to the area and generate business for hotels, villas, taxi operators, supermarkets, fish vendors, craftsmen and restaurants. Beautiful landscapes also attract scientific and educational studies, as well as people interested in making films and documentaries.

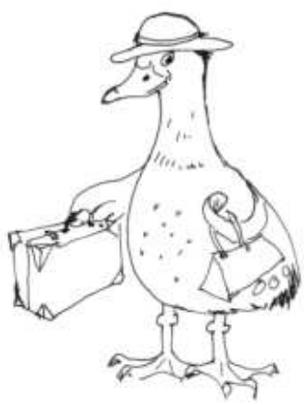
Hunting is popular in many islands. Ducks, waterfowl, doves and pigeons are among the wildlife that is hunted (See Activity 4-L). Hunting generates revenue from the sale of permits, and hire of guides and bird boys. In the past wild meat was an important source of protein. Before hunting, however, be sure to check the hunting regulations in your country to determine which species are legal game, when the hunting season starts and what are the bag limits. West Indian Whistling-Ducks and White-Cheeked Pintails are protected species in most countries and should not be taken for sport or food at any time or by any method.

Fibre

Some wetland plants, such as Bulrushes, were once used to make mats and ropes.

Whistler says...
The term "ECOTOURISM" is used to mean tourism based principally on natural and archaeological/historical resources such as birds and other wildlife, scenic areas, reefs, caves, fossil sites, archaeological sites, wetlands and areas of rare or endangered species. It differs from mass tourism based on man-created attractions such as night clubs, restaurants, shops, amusement parks, tennis clubs, etc. or partially man-created such as beach-front hotels and associated manicured beaches.
(J.A. Kusler, 1991).

Globally, it is the fastest growing segment of the tourism market, worth billions of dollars annually.



Wild Food

Traditionally many wetlands plants were used as food (for instance, the roots of Bulrush and *Sagittaria*). Today these plants are seldom eaten.

Fertile agricultural land

Regular flooding helps to maintain fertile soils and contributes to production. This benefits some sugar and rice-producing areas, many of which were established by draining wetlands. In many places, people graze cattle and goats in wetlands. They graze on mangrove seedlings and other wetland plants. Farmers often set fire to salt marshes and freshwater marshes to encourage the growth of soft new shoots for forage. This damages the wetland and prevents regeneration of mangroves (see Activity 4-C). Small farmers also cultivate patches carved out in herbaceous marshes, swamp forests and mangroves. Some grow food crops that can tolerate flooding, such as dasheen (eddoes). Others take advantage of the inaccessibility of their sites to grow ganja.

Craft materials and thatch

Many traditional crafts, such as basketry, use wood, leaves and vines from the wetlands. Traditionally, thatch was used for roofing but its use has declined in favour of corrugated iron, except in tourist resorts. In Jamaica, the men control the harvest of thatch palm leaves, selling the leaves to women who use them to make baskets. This activity is dying out because of the high cost of the raw materials and the low price of the final products, as well as competition from cheaper Asian products.

Water supply

Water is essential to human life. Wetlands are important for maintenance of water supplies. They catch and store water, recharge aquifers and protect coastal aquifers from salt water.

Water transport

In the past, land transportation across islands was difficult because of the hilly or rocky terrain and dense forests. Often wetland watercourses provided the main routes for transporting goods and people. Except possibly in Cuba, few people in the Caribbean islands now travel by water. However, wetland watercourses are still heavily used by fishers, hunters and tourists. The demand for waterfront villas and condominiums for boat owners and marinas, has worked against many wetlands. In the Bahamas, Cayman Islands, Antigua and many other places, wetlands have been filled and canalized to create waterfront developments. Many of these developments (e.g. Jolly Harbour in Antigua) have failed (See Activity 4-E).

Peat

Red mangroves often grow on peat, which is formed by the slow, incomplete breakdown of plant material in wetlands. In some parts of the world (for example, Ireland) it is mined and used as fuel. Peat is also a very good medium for growing plants. Mining peat transforms a highly productive wetland into a dark, unproductive lake. In the 1980s a plan to mine peat to fuel two power stations in Jamaica was abandoned because it met with stout opposition from locals who feared the disruption to the tourist industry that might result from unsightly surface mining and power stations, and because it was not economical.

Salt

Historically, many salt ponds around the Caribbean were used to produce salt. This was done by evaporation in a series of shallow ponds or pans, each with a slightly greater salinity. Salt is still produced in this way in some places. However, the environmental impacts can be severe if mangroves are destroyed to create salt ponds (e.g. in Portland Bight, Jamaica) if the salt or its by-products leak back into the environment. Grand Turk, in the Turks and Caicos, was once covered with huge trees, which were cleared to make space for salt production. Once the trees were gone, mean annual rainfall fell to about 30 cm (12 in) a year. In such desert conditions, nothing can grow except scrub.

What do wetlands do? Wetland functions

Biological diversity (Activity 6-O)

Wetlands are important for biological diversity or **biodiversity** — the richness of living things. Overall it appears that higher biodiversity makes for a more stable and productive ecosystem. Because wetlands are so productive, many species of plants and animals use

Whistler says.. West Indian Whistling-Ducks spend most of their time in wetlands. During the day they rest in shady places, such as among mangrove roots or in reed beds. At dusk, they fly out to their feeding grounds, including mud flats, salt marshes, shallow ponds and rice fields. Often they can be seen in groups of between two and fifteen. These are family parties, including adults and "teenagers." The groups stay together and defend their territories from other groups.

The presence of West Indian Whistling-Ducks in a wetland is an indication that the wetland is relatively undisturbed and healthy.

them for food, shelter, spawning, nesting, or hunting. Eighty percent of all breeding bird populations in the West Indies, together with more than half the protected migratory bird species, rely on wetlands at some point in their life cycles. Many species of plants and animals are found only in Caribbean wetlands and nowhere else in the world. One example is the West Indian Whistling-Duck. Some species, are found only on a few islands (like the Swamp Bloodwood), only one island (like the endemic Royal Palms of Cuba, Jamaica, and Hispaniola), or even in only one wetland.

Primary production, nitrogen fixation, and nutrient cycling and export

Coastal wetlands in the Caribbean are among the most productive ecosystems in the world. Wetlands cover only 6.4% of the Earth's surface, yet they account for 24% of global productivity. This results from the availability of nutrients and shallow, warm water. The level of productivity in a specific wetland depends on many factors, including availability of freshwater and nutrients. Nitrogen-fixing bacteria flourish in warm, wet conditions. The abundant decomposers, grazers and other animals of the wetland food chain ensure that the nutrients in leaves are quickly recycled. This contributes to the richness of life in wetlands. Rivers, flood rains, and migratory animals carry a proportion of this production out to sea, where it supports marine productivity.

Carbon fixation

As forests grow, they absorb carbon dioxide from the atmosphere to make proteins and sugars by **photosynthesis**. The amount they absorb or fix is greater than the amount they release from respiration. Thus, forests help to reduce global warming (see Chapter 4). Mangroves have a large potential for fixing carbon. For example mangroves in Thailand fix 15.1 tons of carbon per square hectare per year. Under the Kyoto Protocol, countries may soon start to trade carbon emissions. Caribbean states might be able to reap cash benefits from protecting mangroves.

Water supply

Every year about 100,000 cubic km of rainwater fall on the Earth. What happens to all this water? Much of it is caught by wetlands. They act like huge basins, collecting and storing rainwater and helping to prevent floods (see below). The water in the wetland may accumulate, soak slowly into the ground, run off into rivers, or evaporate and contribute to clouds and rain. If the ground below the wetland is **permeable**, water will seep down into the ground, where it will help to recharge the underground **aquifers** supplying wells, springs, lakes and other wetlands downstream. By helping to recharge aquifers, coastal wetlands maintain the pressure of freshwater. This helps to keep sea water out of inland water supplies. When coastal wetlands are cleared and drained, nearby agricultural land may become unusable because the groundwater becomes salty. This happened in the 1970s in the plains of Vere, Jamaica.

Flood control (Activity 3-C and 3-E)

About one quarter of the rain that falls on the Earth runs off as flood water, causing loss of life and billions of dollars of damage annually. Like huge sponges, wetlands and flood plains around them, catch and store the floodwaters. This ensures that floodwaters do not all reach the coast at the same time, and reduces the likelihood of floods. By minimizing the amount and rate of freshwater flowing out to sea after heavy rains, wetlands reduce the likelihood of damage to coral reefs, which cannot tolerate changes in salinity or turbidity.

Sediment trapping (Activity 3-D and 3-E)

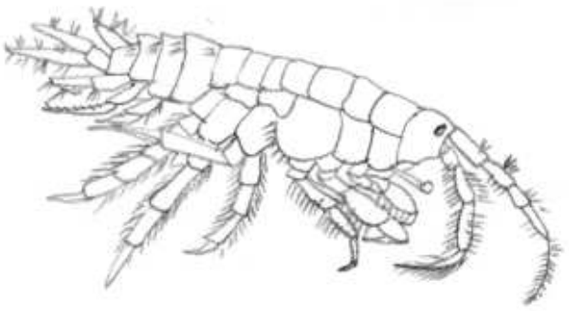
Throughout the region, forested hills are being cleared, settled and planted with agricultural crops. When it rains, the water rushes off into rivers and seasonal gullies carrying large amounts of soil and contaminants, including pesticides, sewage and fertilizers. To make it worse, in many places, such as the Black River in Jamaica, the wetlands and rivers have traditionally been used for waste disposal (e.g. for wastes from a sugar factory and rum distillery). All this contributes to severe coastal pollution - one of the main causes of the death of corals in the seas around Jamaica and other countries. Wetlands catch polluted water on its way to the sea and as the water flow slows, sediments settle out together with pollutants (such as heavy metals), which have adhered to them.

Nutrient trapping and wastewater treatment (Activity 3-D)

Many wetland plants, such as Water Hyacinth (a devastating **invasive** species), flourish on elevated levels of nitrogen and phosphorous. They grow quickly and remove excess nutrients from the water. In doing so they may cause other problems, such as blocked waterways. Some places have found ways to put this to good use. In Hellshire, Jamaica, a wastewater treatment plant has been constructed to treat domestic sewage from a large sub-division, using a series of artificial wetland ponds. The area has become an important site for wetland birds.

Storm protection

Coastal storms and hurricanes are likely to increase in intensity and frequency as the global climate changes. Already they cause millions of dollars of damage annually. Hurricane Gilbert caused more than US$ 900 million damage, much of it in coastal areas. Mangroves protect coasts and coastal developments by breaking the force of the storm and lessening the effects of winds and waves.



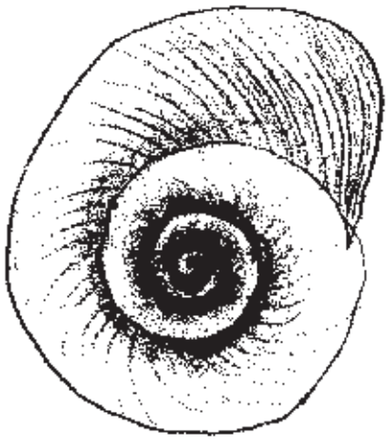
Climate control

During the heat of the day, water evaporates from wetlands. Breezes carry it inland, where it contributes to local rainfall. The contribution of wetlands to local climate is often overlooked.

Why should we care about wetlands? Wetland attributes

Cultural heritage

In many countries, where people have depended on wetlands for generations, there is a tradition of reverence for wetlands and wetland creatures. This is not generally the case in the Caribbean, where the popular culture abhors wetlands. Clearing, draining or dumping in wetlands is still often regarded as a public-spirited activity.



Educational value

Wetlands make excellent living laboratories for studying ecology, geography, history, and many other subjects. They are attractive sites for research because they tend to be compact in area, and diverse and complex in nature. The acidic conditions found in peat bogs can preserve archaeological remains. Few Caribbean wetlands have been excavated by archaeologists and their importance remains undetermined.

Natural beauty

Increasingly, people are seeking natural beauty and quiet places to get away from city life. In the wetlands, they find beautiful landscapes, quite different from the ones they left. Besides hunting and fishing, activities such as canoeing, walking, and bird watching attract millions of people to wetlands every year. Artists and photographers also are drawn to wetlands because of the many species of plants and animals that can be seen there.

Activity 3-A

WHAT ARE WETLANDS LIKE?

Mystery metaphors

Summary

Everyday objects are used as metaphors to encourage students to think about what wetlands are like, and what they do.

Learning Objectives

Students will be able to:

- Describe the most important ways in which wetlands help to sustain life on earth
- Identify some ways in which wetlands contribute to the global economy

Materials

- Make copies of the Copy Cat Page "Wetlands Top Ten Values" as background information
- Mystery Metaphor Grab Bag i.e. a large box or pillowcase, containing a range of items that will stimulate ideas (see "Suggestions for the Mystery Metaphor Grab Bag")
- *Optional*: Video or slide show on wetlands or mangroves

Age Levels 6 +

Subject Area Science

Time 30–60 minutes

Background

The functions and importance of wetlands are described in the introduction to Chapter 3 and summarized in the Copy Cat Page "Wetlands Top Ten Values."

Preparation

Imaginary field trip

This can be a powerful tool for engaging the attention of students. Careful preparation is essential. If the students have already been on a wetland field trip, or if the school is near a wetland and most of the students are already familiar with wetlands, they will be able to imagine the field trip with minimum guidance from the teacher. Otherwise, the teacher will have to guide their imaginations by describing the wetland to them. Alternatively, if the school has the facilities, the students could watch a short video or slide show before the "field trip."

Mangrove Metaphors

1. Using the following table as a starting point, try to find common household objects or pictures to associate with every major function of wetlands.

2. Assemble the objects and pictures in a large pillowcase or box. The contents should be arranged so that the students can put their hands in and take out an object easily, without seeing what else is in the box.

Procedure

1. Tell the students that they are going on an imaginary field trip. Ask them to sit quietly, closing their eyes.
   If the students are familiar with wetlands: Ask them to imagine a mangrove wetland near where they live, to describe plants, birds, animals, and other small creatures they see; what they hear and smell and how the air feels and, if they were barefoot, what the earth would feel like. If people were present, what would they be doing? Imagine the wetland in a hurricane.
   If the students are not familiar with wetlands: *either*
   - Show them a short video or slide show before asking them to imagine the wetland

   or
   - Follow the above outline and answer the questions yourself (describe the wetland).
2. Invite the students to describe what they imagined. List their ideas. Encourage discussion and sharing.

3. Referring to the students' ideas help them identify which plants and animals are most likely to be found in a wetland near where they live.

4. Encourage students to think about why wetlands are important. Use the students' own questions and ideas to provide them with background information about the importance of wetlands. Once the students have developed their own ideas, you might circulate the Copy Cat Page "Wetlands Top Ten Values" table to reinforce their observations.

5. Now introduce the idea of metaphors. Review the definition of metaphor and give/ask for several examples. Explain that metaphors will be used to explore the importance of mangroves. The secret metaphors are in your Mystery Metaphor Grab Bag. Divide the students into groups of 2-5 depending on class size. The number of groups should be the same as the number of objects. One person from each group should come forward and take an object from the bag.

6. The groups should spend about 5 minutes working out how their object could represent the various functions of a wetland—what it is or what it does.

7. Ask each group to report to the class. Encourage the class to discuss the findings and build on one another's ideas.

8. Ask the class to work together to summarise why mangrove wetlands contribute to a healthy environment. How is our own well-being connected to that of a wetland ecosystem?

Alternate Procedure: Wetland Metaphor Game

1. Lay out all your metaphor objects on a table (gather as many as possible).

2. Divide the class into 2 teams. Have each team stand a few feet away from the table.

3. Read a one sentence description of a wetland function or value. Representatives from each team take turns to see who can select the correct object (metaphor that matches the function) the fastest. Repeat for a number of rounds and keep score. The team with the most points wins. The game can either be played after doing the grab bag exercise or as an alternative to the grab bag.

Assessment

Primary school students: Draw a picture showing why wetlands are important.

Secondary school students: Write an essay on the topic "Why wetlands are important to the environment and man."

Extension

Make a short video of a local wetland with your school or a local photographer or as a community project.

Source: Adapted from Aquatic Project Wild.

WETLAND TOP TEN VALUES (not necessarily in order of importance)

Flood Control	Wetlands in their natural states act as sponges, capturing, storing and slowly releasing floodwater. Thus, they reduce the risk of damage to houses, farms, businesses and roads from flash flooding, and lessen the height and duration of floods. At the same time they protect coral reefs and sea grass beds from the damaging effects of freshwater and silt carried by floods into the sea.
Coastal Protection	Coastal marshes, mangrove swamps and other wetlands act as storm buffers. Their roots, trunks, stems and branches break the force of wind and waves. The roots of wetland plants bind soil and reduce soil erosion.
Water Supply	Wetlands are sources of fresh, unpolluted water. Wetlands recharge groundwater supplies and act as filtering systems that remove water impurities and return clean water to the water table. When wetlands are drained, there is less fresh water in the ground, and coastal wells may be polluted by seawater drawn in by osmosis.
Nursery for marine fisheries	Abundant water, nutrients and a year-round growing season, mean that Caribbean wetlands are extraordinarily productive. They fix huge amounts of nitrogen annually. This forms the basis for wetland and marine food webs. Plants and detritus are eaten by larvae, single-celled organisms and fungi. These form food for fish, worms, birds and other animals, that in turn are eaten by larger animals. Caribbean wetlands are very important for coastal fisheries.
Habitat for biodiversity	Many plants and animals find a place to grow or live, feed, shelter, grow, breed or spend the winter (e.g. migratory birds) in wetlands. Most commercial varieties of fish in the Caribbean depend on wetlands at some phase of their lives. Several threatened species live in Caribbean wetlands (e.g. American Crocodiles and West Indian Whistling-Ducks).
Heritage, Recreation and Education	People want and need to visit beautiful places to relax. Wetlands are beautiful and offer many recreational opportunities such as boating, hunting and fishing. Other benefits are more difficult to quantify. Educational trips for students, bird watching tours, visits to historical sites, and wetland photography attract tens of thousands of people annually. Wetlands are important for nature tourism.
Climate Control/ Improvement of Air Quality	Wetland plants absorb carbon dioxide from the air and produce oxygen through photosynthesis. They also absorb sulphur. Preserving wetlands may be an important way to reduce global warming.
Sediment/ NutrientTrap	Wetlands trap sediments and nutrients (e.g. excess fertilizers) that are washed from the land to the sea. This helps to protect coral reefs, which cannot tolerate cloudy, polluted water.
Waste Treatment	Under controlled conditions, wetlands can be remarkably effective in treating human and animal wastes. Biological chemical and physical processes in wetlands can immobilize and transform a wide range of environmental contaminants and nutrients, which in excess cause **eutrophication** and pollution.
Wetland Products	Many people depend on wetlands for fuel, fish, wood for construction, craft materials, medicines and honey.

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SUGGESTIONS FOR THE MYSTERY METAPHOR GRAB BAG

VALUES	OBJECT	MYSTERY METAPHOR
1. FLOOD CONTROL	Sponge	• Absorbs and holds water.
3. WATER SUPPLY	Plastic cup or jar of water	• Catches water and recharges aquifers
4. NURSERY FOR FISHERIES	Pacifier or picture of nursery or baby's crib	• Provides a safe place for marine fish, conch, shrimp and lobsters to mature. • Provides ample supplies of food for young creatures.
5. WILDLIFE HABITAT	Picture of vegetable garden	• Provides a fertile place for plants to grow and form the basis of the food chain though primary production.
	Fertilizer	• Provides a rich source of nutrients for plants.
	Cereal box or tin of food/drink	• Provides a rich source of nutritious food for many species of wetland animals.
	Bean bag, small pillow, or picture of tourist resort or hotel	• Provides important feeding and resting habitat for birds on migration.
	Picture of a village or town	• Provides places for many different animals and plants to live and breed.
	Picture of dining room/kitchen	• Provides food for many species of animals e.g. birds, crabs, shrimp, crocodiles.
	Picture of a zoo	• Provides a place for many different plants and animals to live.
6. RECREATION AND EDUCATION	Toy boat, video tape, binoculars, notebook and pencil	• Provides recreation and education.
7. CLIMATE CONTROL/ IMPROVEMENT OF AIR QUALITY	Air Filter Picture of air conditioner	• Cleans the atmosphere by removing carbon (in the form of carbon dioxide).
	Evaporating dish	• Maintains local climate, because water that evaporates from wetlands may fall as rain nearby.
8. SEDIMENT/ NUTRIENT TRAP	Basin	• Catches water, slows flow so that sediments can settle out.
	Sieve, strainer or paper coffee filter	• Strains out sediments and pollutants from the water that flows through the wetland in rivers, streams or floods.
9. WASTE TREATMENT	Bar of soap or picture of sewage plant	• Removes nutrients, including nitrogen and phosphorous, cleanses water.
10. WETLAND PRODUCTS	Picture of a supermarket, jar of honey, basket	• Provides a place to go to get many useful things, such as salt, wood, fish, medicines, croft materials and honey

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Activity 3-B

WHAT'S THIS WETLAND GOOD FOR?

Summary

Students will use a practical technique to investigate the likely functions of a wetland they have visited.

Learning Objectives

Students will be able to

- Apply their knowledge of wetland functions to a particular wetland
- Make predictions about its importance to people and the environment

Age Levels 13 +

Subject Areas Geography, Social Studies, Biology; also suitable as a project for a school or science fair.

Time Field trip, plus about 60 minutes

Materials

- Copies of the Copy Cat Pages "Important Wetland Functions Factsheet" and "Wetland Assessment Worksheet"
- Notes or report from field trip
- Map of wetland if available (e.g., from 1:50,000 topographic series or sketch map)

Background

There are often conflicts about how best to use a wetland. Developers may want to change it, conservationists to protect it or restore it. Very often one side asserts that the wetland is at best useless, at worst unhealthy and dangerous. The other side claims that it is of immense importance. The truth often lies somewhere in between. The facts are urgently needed. Usually they are not available and getting them would often involve many long-term, expensive studies. Fortunately, some wetland scientists are experimenting with simple techniques that can provide some insight into wetland functions. The following is an adaptation of one of these methods.

Preparation

Make copies of the Copy Cat Pages "Important Wetland Functions Factsheet" and "Wetland Assessment Worksheet."

Procedure

1. This should be a follow-up to a visit to a wetland, or if there are wetlands close to your school, a special visit could be arranged.

2. Explain that the class is going to evaluate the most important functions of the wetland.

3. Divide the class into groups of "experts" (hydrologists, who will study the water relations; wildlife biologists/ecologists who will assess the plants and animals; socio-economists who will look at the ways people depend on the wetland; tourism and recreation specialists; pollution specialists). Provide each group with a map and a copy of the Factsheet and Worksheet (OR if copies are in short supply, the exercise could be done by the whole class). Tell them that each group must pretend to be experts, and to evaluate the wetland from the point of view of their speciality. Later, they will work together as a team to assess the important functions of the wetland, using a set of criteria.

4. Once the project team has been assembled, they should spend about 10 minutes discussing the wetland in groups, and trying to find the information listed to determine which criteria apply. The whole class will then work together to fill out Copy Cat Page "Wetland Assessment Worksheet" by:
   - Discussing whether or not the particular criteria apply, marking "Yes" or "No" in the appropriate column

- Determining which functions are most important by counting how many times "Yes" occurs under each function
- If a map is available, plotting the locations of the attributes so that concentrations of important attributes will be represented by clusters

5. Discussion: What functions does the wetland carry out? *These will be indicated by the functions with "Yes" in the third column.* Which are most important? How should the wetland be managed in future?

Evaluation/Assessment

Write a "consultant" report on the functions of the wetland. What would be the best use for this wetland?

Extensions

This project could be developed as a class project for a science fair or competition.

Source: Ann Sutton and Lisa Sorenson. Methodology adapted from USACE (1997)

IMPORTANT WETLAND FUNCTIONS FACTSHEET

1) Flood control

Wetlands provide flood control. Acting as nature's sponges, they prevent flooding of roads, farms, businesses, and homes by providing a place for excess rainfall to be absorbed and held. By catching storm water, wetlands also protect coral reefs and sea grass beds that can be damaged from sudden flooding with fresh water. Flood control is very important in the West Indies where hurricanes or tropical storms dump huge amounts of rain in a short time.

2) Coastal protection

Coastal mangrove wetlands are critically important in protecting shorelines from tropical storms and hurricanes. They do this by acting as a buffer to the strong surf, high tides, gale-force winds, and surges of sea that accompany severe storms. The roots of mangroves help to bind and stabilise the soils along the coast, thereby reducing coastal erosion. Mangrove leaves, branches, trunks, and roots break the force of storm winds, waves and tides, reducing flooding and wind damage. Although precise figures are not available, it is estimated that mangrove wetlands protect millions of dollars of property (homes, hotels, etc.) each year from storm damage.

Scientists project sea levels will rise in the coming decades owing to the melting of polar ice sheets and glaciers and the thermal expansion of the ocean from global warming. This rise (9-88 cm (4-35 in) over the next century) will cause inland and upstream salt water intrusion and make our islands even more vulnerable to damage from storms and hurricanes. Caribbean mangrove wetlands may not be able to grow fast enough to keep pace with the rise in sea level. Climate-change studies also project that extreme weather events (e.g., hurricanes, tropical storms, severe droughts) may become more frequent and intense under global warming. This could lead to net loss in the size and extent of mangroves and other coastal wetlands.

3) Sediment and nutrient trap

Coastal mangrove wetlands trap sediments that are washed to the coast by rivers and runoff, and so protect the reefs and sea grass beds. Excessive sediments can clog the gills of aquatic animals and bury their eggs. Often these sediments include large amounts of dangerous substances, such as excess nutrients from fertilisers and pesticides washed from agricultural land in the upper watersheds, or heavy metals from mining. Excessive runoff of nutrients and sediments causes algal blooms and high turbidity. This decreases the amount of light and oxygen in the water, which stunts the growth of coral reefs and aquatic plants. Wetlands stop these environmental contaminants from getting to the sea, and can often transform them through biological, chemical, and physical processes into harmless substances.

4) Water supply

Wetlands are sources of fresh, unpolluted water that we need for drinking, washing, irrigation and industry. Wetlands recharge groundwater supplies and act as filtering systems that screen water of impurities and return clean water to the aquifers. In some wetlands, there are beautiful springs or blue holes, where fresh water bubbles out of vertical caves in the limestone. These supply water for many coastal communities. There may also be underwater springs in the beds of rivers or even under the sea. When wetlands are drained, there is less fresh water in the ground, and coastal wells may be polluted by seawater draining in to take its place.

5) Nursery for marine fisheries

Abundant water, nutrients and a year-round growing season mean that Caribbean wetlands are extraordinarily productive ecosystems. They trap carbon and fix huge amounts of nitrogen annually. This forms the basis for wetland and marine food webs. Plants and detritus are eaten

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by larvae, single-celled organisms, and fungi. These form food for fish, worms, birds, and other animals that, in turn, are eaten by larger animals.

It is estimated that over 80% of commercial fish, including crawfish, grouper, snapper, jack and conch, live in mangroves at some stage of their development. Coastal mangrove wetlands are well known for their role as "nurseries" for marine fisheries. Typically, fish spawn on reefs some distance from shore. Currents and tides sweep the young fish toward the land and into the mangrove roots. Juveniles of about 400 species of fish are known to find shelter, protection and food. Mangroves are very productive due to the huge amount of leaf litter that is broken down to become food for larval crabs, shrimps and molluscs, which in turn become food for the young fish.

Mangrove wetlands are of great economic importance to people throughout the West Indies. Imagine life here without fresh seafood to eat! When wetlands are filled, destroyed, or polluted, fisheries may collapse. The effects can often be felt hundreds of miles away, because healthy wetlands in one location are often sources for young fish, conch, and large shrimp (or crawfish) down-current.

6) Habitat for wildlife and endangered species, biological diversity

Because Caribbean wetlands are so productive, they serve as habitat for many species of birds, fish, mammals, invertebrates and a wide variety of plant life—all interconnected in an enormous food web. Caribbean wetlands are therefore important for biological diversity—the richness of living things. Many species of plants and animals are found only in Caribbean wetlands and nowhere else in the world. One example is the West Indian Whistling-Duck. Some species, like the Swamp Bloodwood, are found only on a few islands. Others are found only on one island, or even in only one wetland. The Royal Palms of Cuba, Jamaica, and Hispaniola are examples of species that are endemic to the wetlands of those islands.

Many bird species utilise wetlands for food, shelter, or nesting. Some are resident, meaning they live here year-round and breed here; others are migrants - birds that spend the winter here or pass through the West Indies on their migrations to and from wintering and breeding grounds elsewhere. An estimated 80% of all breeding bird populations in the West Indies, together with more than half the protected migratory bird species, rely on wetlands at some point in their life cycles. Virtually all the Caribbean commercial fish and shellfish species depend to some extent on wetlands.

Destruction of wetlands throughout the region means that many species that were once common have become rare. They include the magnificent but widely feared American Crocodile and several species of birds, including the West Indian Whistling-Duck.

7) Natural beauty, heritage, recreation and education

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People need places of natural beauty and quiet where they can rest and recreate. In wetlands, one may find beautiful landscapes to view and explore and a remarkably rich and diverse array of animals and plants to observe and enjoy. Bird watching is a delightful wetland pastime, either alone or with family and friends. Wetlands are an excellent place to see West Indian Whistling-Ducks and many other fascinating birds and creatures.

Wetlands also provide a place for activities, such as walking, canoeing, nature photography and art, fishing and hunting. Hunting (as a sport) is an important tradition on many islands and ducks are the most common game species found in wetlands. Wetlands also make excellent living laboratories for studying ecology, biology, zoology, ornithology, botany, geography, history, and many other subjects. They are attractive sites for research because they tend to be compact in area and

diverse and complex in nature. Some species that live in Caribbean wetlands have never been studied. Much remains to be discovered about their ecology and life histories.

In addition to providing local populations with a place to enjoy nature, Caribbean wetlands also attract millions of tourists every year. Millions of dollars are earned from boat trips, and hunting and fishing expeditions in wetlands. Tourists also like to observe and photograph native flora and fauna and explore wild places. Wetlands have great economic value and their potential for eco-tourism should be put to use.

8) Climate control and improvement of air quality

Wetland plants absorb carbon dioxide and produce oxygen through the process of photosynthesis. Atmospheric levels of carbon and sulphur, both of which have increased dramatically as a result of the burning of fossil fuels and peat, are lowered by wetlands' ability to act as sinks (natural catchment basins) and to reduce these elements to harmless forms. Wetland preservation and restoration is, therefore, like the conservation of forests, an important means of reducing global warming.

9) Waste treatment

Under controlled conditions, wetlands can be remarkably effective in treating human and animal wastes. Biological, chemical and physical processes in wetlands can immobilise and transform a wide range of environmental contaminants and nutrients, which in excess cause eutrophication and pollution. Excess nitrogen, like that contained in fertilisers, is broken down in wetlands through a process called denitrification.

10) Wetland products

In addition to their very important role in fisheries (see #4 above), wetlands also provide many other resources including timber, craft materials, forage and food. Some uses are clearly sustainable, for example, honey production in Black Mangroves. Others, such as hunting of game species, extraction of timber, fuelwood, and roundwood for house construction, and sticks for yams and fish pots, may be sustainable if properly managed. A model for sustainable harvesting of mangroves has been developed in St. Lucia but the technology has not spread widely through the region.

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WETLAND ASSESSMENT WORKSHEET

NAME OF WETLAND:	
Date of assessment:	
Assessed by:	
Location:	
Brief description of wetland:	

FUNCTION	CHECK LIST OF THINGS THAT SUGGEST WHETHER A WETLAND IS CARRYING OUT A FUNCTION	YES/ NO
1. Flood Control	a) The wetland includes large areas of concrete or the watershed above the wetland has high rainfall and is deforested. b) The surrounding area has a history of economic loss due to flooding. c) Coral reefs and sea grass beds are close to the wetland. d) Hotels, villages or roads, bridges, factories or farms are close to the wetland. e) The wetland can absorb or slow down flood waters (e.g., if it contains absorbent soils, winding watercourses, or ponds).	
2. Coastal Protection	a) The coastline is exposed to trade winds and has a history of storm damage or erosion. b) Potential sediment sources (e.g., deforested land, agricultural areas, other exposed land) are present in the **catchment** area. c) There are signs of coastal **erosion** (e.g., the sand is cut into steep steps on the beach) or of **siltation** (e.g., extensive mudflats). d) People use large motor boats (whose wash might damage banks) in the wetland. e) Hotels, houses, farms or main roads are close to the wetland. f) There are mangroves and other large trees and shrubs along the shore, which can help stabilize the shoreline and provide protection from hurricanes. g) Sea grass beds are present to help stabilize sediments in lagoons, channels and shallow areas.	
3. Sediment and nutrient Trap	**a)** **Sediments** or **pollutants** are likely to be washed into the wetland from nearby farms or industrial areas. b) Sea grass beds and coral reefs are close to areas that are important for tourism or fisheries. c) There are public or private wells or spring sources in or near the wetland. d) There is deep or slowly moving water in the wetland. e) Mineral, fine-grained or organic soils are present. f) Drainage ditches have not been constructed in the wetland. g) Flooded areas are present after heavy rainfall showing that water is being held in the wetland. h) There is little erosion in the wetland, i.e. river beds are not scoured and water velocities are low. i) Dense vegetation or sea grass in the wetland traps **sediment**.	
4. Water Supply	a) Public or private wells or potential sources of water for drinking or irrigation occur in or near the wetland. b) The wetland lies between the water source and the sea and might be protecting the groundwater. c) The **bedrock** is limestone, gravel or sand or other **pervious** rocks, through which water can soak into the aquifers. d) The river or stream that carries water into the wetland is larger than the outlet (suggesting that water is soaking into the ground).	

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5. Fish Nursery	a) Water quality is good enough to promote healthy fish or shellfish populations. b) Mangroves and other bank vegetation provide shade, food and cover for young fish and shrimp. c) Fishers already use the area or report presence of commercial varieties of fish or shellfish. d) Marshes, channels, shallow pools, mud flats or sea grass beds are present. e) Spawning areas are present offshore and fish can move freely between them and the wetland.	
6. Habitat for Wildlife and Endangered Species, Biological Diversity	a) Wetland is not degraded or fragmented by human activity. b) It is bordered by other wildlife habitats (e.g. woodland, forest, scrub, active farmland or idle land or another wetland) and animals can move freely in and out. c) It includes islands of vegetation or other habitats favoured by wildlife, such as mangroves, mudflats, swamp forests. d) It provides habitat for threatened or rare species (such as West Indian Whistling-Ducks, manatees, sea turtles and crocodiles); or endemic or locally rare species. e) The water is clean and clear.	
7. Natural Beauty, Heritage, Recreation and Education	a) The wetland is naturally beautiful with vistas, landscapes, geological features or interesting vegetation and visible wildlife (e.g. whistling-ducks, crocodiles or large flocks of birds) and historical or architectural sites. b) It could be used for bird watching, photography, hiking, picnics, swimming, scuba diving, snorkeling, canoeing, sport fishing, hunting, etc. c) It is easily accessible on foot or by road and suitable parking sites are available. d) It can be managed for sustainable use (e.g. it is located within a nature preserve or wildlife management area). e) Views are free of rubbish, debris and signs of disturbance.	
8. Climate Control and Improvement of Air Quality	a) It is healthy and includes plenty of vegetation that could absorb pollution. b) It is close to a pollution source such as an industrial area.	
9. Waste Treatment	a) There are nearby villages, towns, hotels, industries, farms or processing plants whose effluents are likely to be washed or dumped into the wetland. b) The wetland includes slow-draining mineral, fine-grained or organic deposits or dense vegetation that could retain pollutants. c) Water is held in the wetland long enough to allow **nutrients** to be absorbed. (e.g., because there are many small streams, thick vegetation or a narrow outlet)	
10. Wetland Products	a) Fishable resources (e.g., fish, conch, lobster, oysters, bivalves and shrimp) are present. b) Timber resources (e.g., roundwood, fence posts, pot sticks or thatch) are present. c) Craft materials (e.g., thatch and vines) are present. d) Black Mangroves suitable for honey production are present. e) Resources can be used sustainably (e.g., a model of sustainable harvesting of mangroves has been developed in St. Lucia). f) There is adequate access by road or water to allow for extraction of products.	

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Activity 3-C

WATER SOAKERS

Summary

Students will learn how wetlands absorb water, thereby controlling damage from floods.

Learning Objectives

Students will be able to:

- Observe the way different natural materials absorb water
- Describe one way in which wetlands control floods, and release water slowly during a drier time

Age Levels 9 +

Subject Areas Science, Mathematics

Time 30–60 minutes

Materials

- Water absorbing materials
  - Sphagnum moss or dry peat (plant stores or nurseries; long fiber sphagnum moss is preferable)
  - Sand (from your yard or beach)
  - Grassy turf with roots and soil (a small piece from your yard) or leaf litter
  - 1 or 2 small rocks
  - Kitchen sieve
- Cheesecloth, thin cloth wipe (e.g., Handy Wipe or Brawny towel), nylon stocking or mosquito netting (to cover the sieve)
- Bowl (large enough to hold the sieve)
- Scales
- Copies of Copy Cat Page "Water Soakers Worksheet"

Background

One of the primary functions of wetlands throughout the Caribbean is to help prevent flooding. This is because wetlands act like giant shallow bowls and sponges. Water flowing into these bowls naturally loses speed as it collects and spreads out. Wetland vegetation and soils absorb the water like a sponge. The vegetation also helps to slow down fast-moving water. As a result, flood damage to developed areas near wetlands is often much less than damage to areas located near drained and filled wetlands. This is never more apparent than during hurricanes or tropical storms, when wetland areas soak up the run-off from heavy rain.

Procedure

1. Measure out a sample of each of the water soaker materials. Each sample should be about the same volume (e.g. 1 cup packed).
2. Put the cheesecloth on the sieve, and add one of the samples to the sieve.
3. Carefully weigh the sieve, cheesecloth and dry sample. Write down the total weight in the appropriate space in "Column A" of the Worksheet.
4. Add water to the bowl until it is nearly full. Put the sieve with the sample in the water and allow them to soak for five minutes.
5. Remove the sieve, re-weigh it and write the weight in "Column B" of the Worksheet .
6. Repeat steps 3 to 6 using the other soaker materials. Note the weights in the proper places in the Worksheet.
7. What is the weight of water each material soaked up? Find out by subtracting the number in Column A from the number in Column B. Write the results in Column C.

Note: This activity can also be done with a spring scale. Enclose the dry sample in the cheese cloth, weigh it with the spring scale, soak it for 5 minutes, let it drain briefly, then weigh it again.

Discussion

- Which material holds water best?
- Which of the materials you tested would you most likely find in a wetland? *Sphagnum moss, peat and plant matter. You may find sand and rock below; however, their role in water storage is less important.*

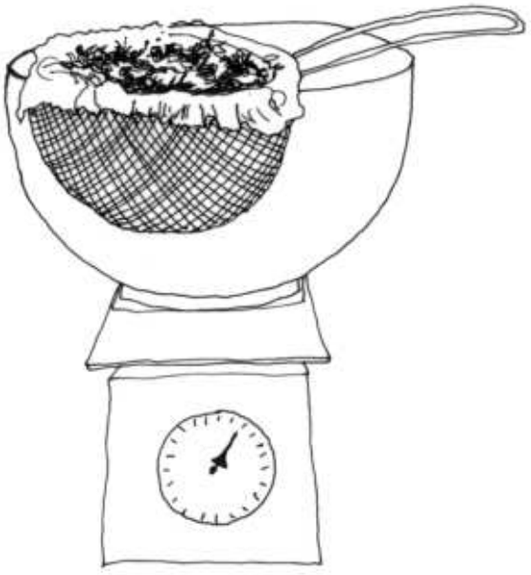
Evaluation/Assessment

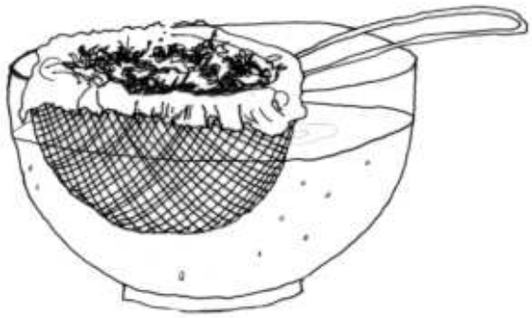
Students should write up the experiment.

Source Adapted from Discover Your Estuary.

WATER SOAKERS WORKSHEET

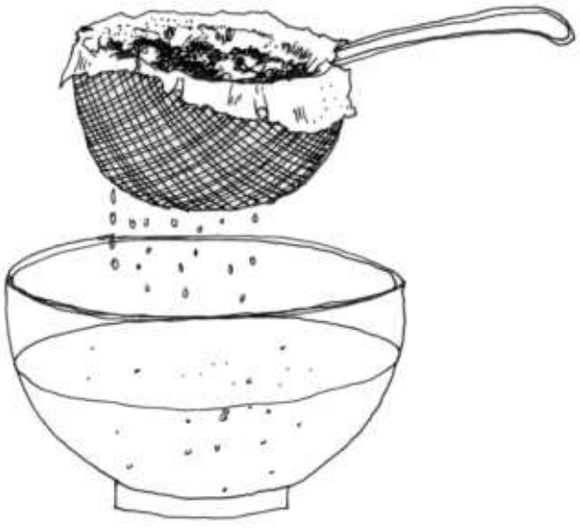
1. Weigh sieve, cloth and sample.
   Write weight in 'column A'

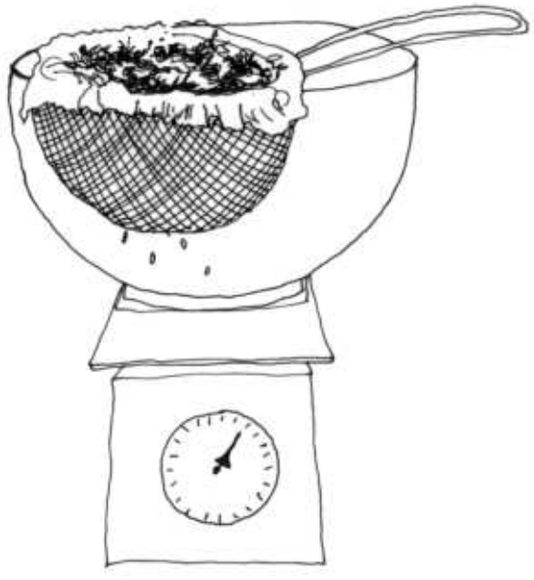




2. Soak sieve in water

3. Remove seive from water, let it
   drain briefly





4. Weigh water-soaked sample.
   Write weight in 'column B'

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Water Soakers Worksheet

Material	Column A **Weight of Sieve plus Sample (DRY)**	Column B **Weight of Sieve plus Sample (WET)**	Column C **Weight of Water** **(B – A = C)**
Sphagnum moss, peat or other moss			
Turf (block of grass with leaves and roots still attached) or leaf litter			
Sand			
Rock			

Results

Which material absorbed the most water?

Which of the materials would you expect to find in a wetland?

From your experience in this activity, can you identify one way wetlands help to control floods?

Conclusion

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Activity 3-D

NUTRIENT AND SEDIMENT TRAP

Summary

By playing a game students learn that wetlands trap excess nutrients and sediment through the process of filtration and help to keep them out of the water.

Learning Objectives

Students will understand how wetlands trap nutrients and sediments and help keep waterways clean

Age Levels 7–11

Subject Area Science

Time 30–60 minutes

Materials

Cards (marked with an "N" or an "S") - enough for half the class

Background

Where do sediments and nutrients come from? Sediments are small particles of soil that are washed away by flowing water, such as rain, floods or rivers. Nutrients are the foods used by plants. They are returned to the soil and water when they die to be "recycled," or reused by other things.

People also use nutrients as fertilisers on the land, in the soil, and in the water. Ask the students which of their daily activities might add to the nutrients in soil or water? *E.g., excretion, using soap, detergents, fertilizers, dumping garbage or keeping animals.* Human and animal wastes contain nutrients, such as nitrogen and phosphorus in various forms, and they often get washed or flushed into the water.

Too much of any nutrient makes water unhealthy. Remind students that nutrients combine with particles of soil. When the soil washes away and ends up in the water, two forms of pollution result: muddy and cloudy water from too much sediment or soil, and "pea soup" or red tides caused by excess algae growing on the excessive amounts of nutrients. Ask the students: "What are some ways that fertilizers and soil wash off the land?" *Rain picks up loose soil from construction and from bare spots under downspouts and roofs, and rivers and streams carve and carry away soil from their banks.*

Wetlands trap soil and nutrients and help to keep them out of the water. Run-off is filtered as it passes through wetlands on its way to water bodies. Therefore, water in streams and rivers and from direct run-off is cleaned as it passes through a wetland. The objective of this activity is to demonstrate this function to students.

Procedure

1. Discuss basic ideas about the importance of wetlands as a trap for sediment and nutrients. Take the class outside to a large play area. Divide the class into two teams. Team 1 will be "plants" growing in a wetland. Team 2 will be "sediments and nutrients." This team will wear a card or tag with an "N" for nutrients or an "S" for sediments. **Explain the rules of the game** (see over) and play a few rounds.
2. Repeat the game several times, using students' suggestions for modifying the plant spacing to change the rules. Keep count of the number of rounds required to complete each game with the modified spacing. Give each student a chance to play both roles.
3. After the game, discuss the roles played and relate the results of the rounds to what actually happens when it rains or when water flows through a wetland.

Rules of the Game

1. The "plants" form an irregular line at one end of the outside area, spaced so that their outstretched arms do not touch. The plants must try to trap "nutrients" and "sediments" by tagging them.

2. The area behind the plants is designated as a waterway (river, stream, ocean, etc.). This can be a rope laid out to make a line, the edge of a playing field, or stones.

3. The "sediments" and "nutrients" line up facing the plants and, at the signal, must make their way to the waterway without being touched by a plant. They must drag one foot as they run, or hop on one foot, so they do not move too quickly.

4. The plants may bend, stretch, and stoop, but they may not move their feet (roots) to tag those pretending to be the nutrients and sediments. Meanwhile, the "N" and "S" players may not go around the end of the plant line.

5. When an "N" or "S" is tagged, the student must remove the tag and give it to a plant. They now become plants and join the line of plants at the exact spot tagged.

6. Any particles of soil that escaped to the waterway will then go back to the starting line and, at the signal, will try again to pass safely through the wetland. The game continues until all the "N' and "S" players have been caught.

7. **Discuss**

- Were the plants able to trap more particles in areas where they grew closer together?
- What happened when there were gaps or bare spots in the line of plants?
- Would more plants help?
- Why are shoreline or wetland plants important to the water they grow beside?
- Why is it important to establish and maintain plants everywhere, even in yards and areas near pavement?

Source Adapted from "WOW The Wonders of Wetlands."

Activity 3-E

DO IT YOURSELF WETLAND

Summary

Students will learn that wetlands trap sediment and control floods. They will build a model wetland, flood it with muddy water and observe the outcome.

Learning Objectives

Students will:

- Understand how wetlands absorb water, thus reducing floods
- Understand how wetlands trap nutrients, stopping them reaching the sea where they can harm sea grass beds and coral reefs

Age Levels 9 +

Subject Areas Science, Art

Time 1–2 hours

Materials

- Large, shallow pans (e.g., aluminum pans, greenhouse germination flats, or plastic trays), one for the class **or** one for every five students
- Modeling clay (preferably a variety of colours including brown for soil, pink for coral reefs)
- Florist's green Styrofoam, large sponges, or indoor/outdoor carpeting
- Thin piece of green plastic tape or paper (to represent seagrass)
- Variety of model-building materials: toothpicks, cotton swabs, glue, poster paint
- Natural materials including pine or Casuarina needles, twigs, grass, weeds, and soil
- Glass container of muddy water
- Pictures of mangroves

Background

Review the introductory material in Chapter 3 and the Background in Activities 3-C and 3-D. See Copy Cat Page "Wetland Model."

Procedure

1. Explain that wetlands have many important functions. This exercise will demonstrate how wetlands:
   - Help to reduce flood damage by soaking up excess water and then releasing it slowly
   - Help to protect coral reefs and sea grass beds from damage by fresh water and silt

2. This can be a class project, or done in groups of five, each group having a set of materials.

3. Instruct each group to build a wetland model as follows:
   - Spread a thick layer of modeling clay in half the pan (land). Leave the other half of the pan empty (ocean)
   - Shape the clay to represent how the land gradually slopes down to the sea (see diagram). Make one or two meandering streams in the clay leading to the "sea." In the sea construct a low ridge parallel to the shore to represent a coral reef. Between the sea and the shore use a thin piece of green plastic to represent sea grass. Smooth the clay along the sides of the pan to seal the edges
   - Cut a piece of the florist's Styrofoam or sponge to completely fill the space across the edge of the clay (see diagram). The Styrofoam represents the wetland buffer between dry land and open water
   - The students should add the final touches to their models by attaching plants (make Cattails, Reeds, Red Mangroves, etc.) and animals (moulded from additional clay) with toothpicks to the wetland buffer. Show students pictures of different wetlands as a guide

4. Test your wetland model
   a. Tell the students they are going to simulate the effects of a very heavy rainstorm by slowly pouring muddy water onto the land part of the model. Discuss why the water is muddy. *Heavy rain erodes the soil, especially when the forests have been removed from the land around the wetland.*
   b. Ask students to describe what happens. *The water should soak into the "wetland" and slowly drain into the "sea".*
   c. Now look at the water in the "sea" of the model. Is it muddy or clear?

d. Discuss the value of the marsh in water filtration and sediment reduction. *Most wetlands are like shallow basins full of sponge. Flood waters collect in them and are absorbed by the spongy wetland soils. Dense wetland plants and winding river courses slow the water as it crosses the wetland. This reduces the risk of flooding and allows time for sediments to drop to the bottom . The plants also help to filter out the sediments.*

e. Discuss why sediments and fresh water are bad for coral reefs. *Coral reefs are made up of many small animals called **polyps**. They are used to stable conditions in the sea and cannot tolerate changes in salinity. As they feed on small particles that they filter from sea water, they are assisted by tiny algae that live inside them and share the products of photosynthesis. Large amounts of sediments smother the polyps so that they cannot feed or breathe, and the algae that live inside them die because there is not enough light.*

f. Discuss why too much sediment is bad for sea grasses. *Sea grass beds can tolerate some sediment, but too much smothers the sea grasses, which can no longer photosynthesize because their blades are covered with mud.* Remind students that many wetlands are being destroyed. Briefly, discuss the reasons for this. *Wetlands are being "reclaimed" for agriculture, housing, tourism and industry.*

g. Ask the students what they think would happen if the wetland in their model was destroyed.

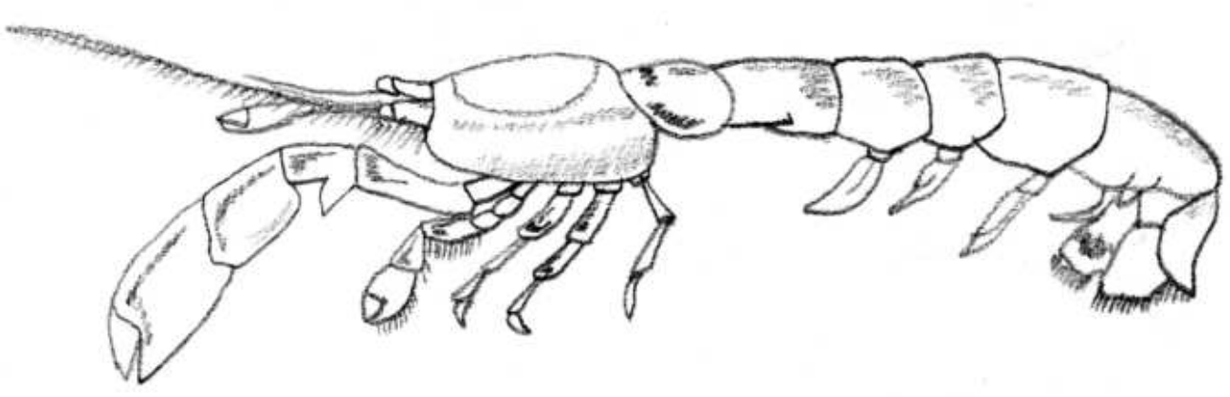
h. Remove the wetland from one of the models and pour the same amount of water on it.

i. Have the students note any difference. *The water should fill the "sea" much more quickly, and it should be dirtier because the "sea" is no longer protected by a wetland.*

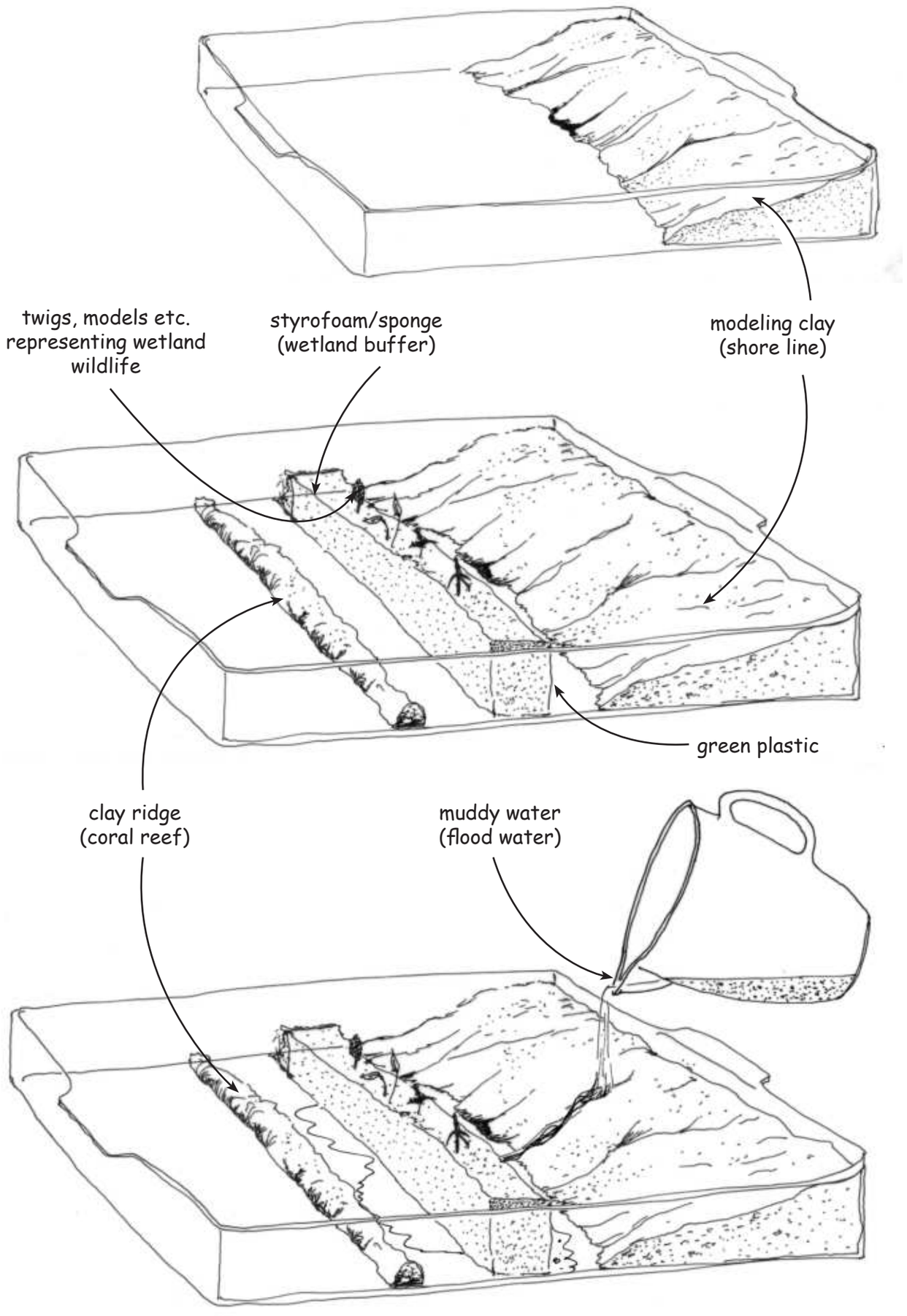
5. Encourage the students to discuss the findings.

- What would happen if the marsh were paved over? *The water wouldn't soak in.*
- What would happen to areas downstream? *Could result in flooding.*
- Why are wetlands important to people? *They can reduce flooding, prevent erosion, and help to protect coral reefs and sea grass beds from dirty water.*

Source Adapted from Discover Your Estuary.



WETLAND MODEL



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Activity 3-F

FORESTS OF FISH

Mangroves and fisheries

Summary

There is an intimate relationship between mangroves and fisheries. This activity explores some aspects of it.

Learning Objectives

Students should:

- Appreciate the relationship between coastal ecosystems and fisheries
- Know the life history of a Caribbean fish
- Understand the concept of critical habitat and its importance to fisheries conservation
- Understand that some methods of fishing harm fish populations and habitat

Background

(See also Chapter 2)

About 50-70% of the world's commercial seafood catch comes from fish and shellfish that spend all or part of their lives in wetlands and associated habitats - especially shallow-water habitats such as seagrass beds, coral reefs, coastal marshes, mangrove swamps and mudflats. Many of these habitats are threatened by disturbance and destruction (see Chapter 4). When they are lost, fisheries decline. It is easy to see why fish species that spend their whole lives in wetlands would be wiped out if their wetland habitats were destroyed, but why should destroying wetlands undermine marine fisheries?

The answer lies in the complex life histories of many fishable species. One example, the Gray Snapper, *Lutjanus griseus*, is described in this story, but there are many variations. Some fish larvae (such as the Mullet, *Agonostomus monticola*) move up river as soon as they are large enough. Many crustaceans (such as shrimps, *Penaeus* spp. and Blue Swimming Crabs *Callinectes* spp.) migrate up rivers to spawn, and their young move slowly down river, mature in mangrove swamps and spend their adult lives at sea. The common themes linking these life histories are their use, at each stage, of different habitats, a range of salinity gradients (freshwater to salt water), variation of food availability from mangrove detritus (high in mangroves, low on reefs), and substrates (from high organic mud to low organic sand); all juveniles use mangroves as nurseries. If any link in the chain is broken or the habitat needed by a particular life stage of an animal is destroyed, the animal will no longer be able to reproduce, and its population will decline.

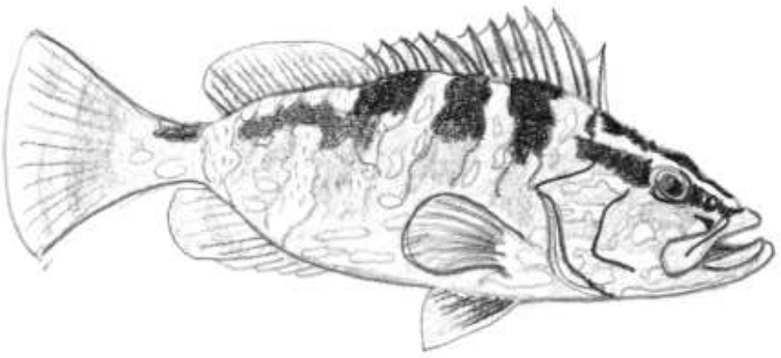
Age Levels 7 - 14 +

Time About 60 minutes class time, plus homework

Subject Areas Science, Social Studies, Language Arts/English Comprehension

Materials

Copy of story "The adventures of George. the Gray Snapper"



The habitats that an animal requires in order to complete its life cycle are known as **critical habitats.** They are not the same for all species and some species are more flexible than others. Mangroves, especially Red Mangroves, provide critical habitat for many species.

Throughout the West Indies, fishermen are spending more time fishing, but they are catching fewer, smaller fish. Choice fishes (such as jacks and snappers) are becoming harder to find, and people are turning to fish that they previously rejected, such as parrotfish. The main causes are loss of wetlands, sea grass beds and coral reefs, but over fishing and associated bad fishing practices, such as use of fish pots, seine nets, fish guns and dynamite are also to blame (see "Some Potential Damage That Can Be Done By Fishing"). These poor fishing practices also damage fish habitats, and therefore contribute to a further decline in fish populations.

Fisheries can recover rapidly if their breeding areas are protected and stocks are allowed to replenish. No-fishing zones in protected areas help fish to grow big enough to reproduce. However, protection of marine areas is not enough. The associated critical habitats, especially mangroves must also be protected.

Some potential environmental damages from poor fishing practices

FISHING METHOD	DESCRIPTION OF METHOD	IMPACTS ON FISH	IMPACTS ON HABITAT	CONSERVATION MEASURES
Fish pots	Trap made out of sticks and mesh wire – fish swim in and cannot get out.	Lost pots go on catching fish until they rot. Small mesh pots catch juvenile fish.	Can rub against corals and sea grasses and kill them.	Increase mesh size to more than one inch to protect juvenile fish.
Seine nets	Long heavy net that is set in a loop from the shore and dragged in.	Kills juvenile fish.	Scoops up everything including plants. Damages the bottom.	Ban seine nets in sensitive areas.
Hook and line	Lines set from rods or hand lines	May affect some sport fish.	None.	Set limits on sport fishing.
Spear guns	Fish are speared.	Selective removal of large predators and grazers leads to ecosystem unbalances	Fishers can damage reefs by standing on them. Reefs get over grown by algae because of lack of grazers.	Ban fish guns from selected areas.
Dynamite	Dynamite is thrown into water. Large fish are collected.	Kills everything in range.	Causes serious damage to reefs and mangrove.	Enforce rules prohibiting use of dynamite.

Preparation

a) First session

- Pictures for storyboard (see Copy Cat Pages "Wetland Plants" and "Wetland Animals") for students to colour OR prepared pictures to place on board.
- Board with outline picture of mangrove (ideally felt board, but it could be drawn on poster-paper or on the chalk board)

b) Second session Assignments at end of first session

Procedure

1. Introduce the activity with a discussion about coastal fish and fisheries. Do the students like to eat seafood? What types of fish and shellfish do they prefer? What do they know about the life cycles of the fish and shellfish they like to eat? Explain that you are going to tell them a story about the life cycle of a food fish - the gray snapper.

2. Using the animals printed in bold in the story, ask each student to draw at least one of the animals, using the general copy cat pages, field guide or other sources as necessary OR have all the animals cut out and coloured in preparation for the activity. Set up the felt board with the drawing of a mangrove, sea grass beds and coral reefs. Tell the students to put their drawing in the right place on the board when its name is mentioned in the story OR that you will add the prepared drawings to the board as they are named in the story.

3. Read the story aloud. As each thing is named, add it to the board in the right place.

4. **Discussion**

- **Mangroves and fisheries**: Discuss the types of habitats *(coral reefs, sea grass beds, mangroves)* and resources *(food, shelter, resting places)* that George needed to grow up

- **Food**: Discuss how George fits into the mangrove food chain (see Chapter 2)

- **Shelter**: What habitats sheltered George? Why did he have to move out of the sea grass bed? Why did the mangrove roots provide better shelter? Why could he return to the coral reef when he was nearly an adult?

- Introduce the idea of **critical habitats**. Ask the students to discuss which are the critical habitats for snappers. *Coral reefs, sea grass beds, mangroves*. What would have happened to George if the coral reefs, mangroves or sea grass beds had been removed? What would have happened if the channel into the mangroves had been blocked?

- **Fisheries**: What other types of seafood were mentioned in the story? What would happen to them if mangroves were removed? Use the information in the table to explain how some methods of fishing destroy fish habitats and also discuss impact reduction measures. Use the introductory material to describe how removal and damage to mangroves has affected fisheries around the world and the impacts on fisheries. What measures can help to reverse this trend? *Protected areas and mangrove rehabilitation can contribute to the regeneration of damaged and destroyed mangroves. Once mangroves have been protected, they quickly start to contribute to marine productivity.* If you were going to design a protected area to enhance fisheries, what types of habitat should you include? What might happen if you set up a fish sanctuary and protected only coral reefs and sea grasses? (You might illustrate this by removing the pieces from the board)

Evaluation/Assessment

- Draw a picture to illustrate George's adventures.
- Add to the story by describing how he nearly got caught on a hook, blown up by dynamite, shot by a spear gun or scooped up in a seine net.

Extensions

For homework:

1. Ask students to visit a local fishing beach, fish market or supermarket that sells fish and to make list of the types of fish that are for sale. Ask them to find out about the habitats these fish use and their life cycles. They may get information from the fishermen or from books.

How many of the fishes use mangroves during their life cycles?

2. Select one or more of the following mangrove-dependent fishable species and study their life histories:
   Conch
   Lobster
   Jack
   Oysters
   Land Crabs

3. Have older student conduct research on threatened or endangered commercial fish in the Caribbean. They may use a variety of research methods including the internet, interviews with fishermen, and visits to local non-government and government agencies that are involved in fisheries management.

Source Ann Sutton.

The Adventures of George, the Gray Snapper

The **island** was surrounded by a **coral reef**. Beyond lay the dark blue waters of the deep. Inside the reef, the water was turquoise and shallow. Huge waves broke on the outside. Their force made the large **sea fans** flap and threatened to tear them from the reef. In this unlikely place George, the **Gray Snapper** started his life. Out of the thousands of **eggs** his mother had laid, he was one of the few to survive. Most of the rest were eaten by fish or shrimp, or simply washed away. George was lucky. He hatched into a tiny **larval fish**, hardly big enough to see. For two weeks, he hid among the corals. One day he was washed away from the safety of the reefs. He wouldn't return until he was grown up.

The current wafted him towards the island, through the bright blue waters, over the shining white sands dappled with light and shade. At first he was frightened. There was no way he could decide where he wanted to go. The current was so strong that he would just have to go with it and see where he ended up.

Suddenly he found himself in shallow water. He looked down and saw that he was swimming over a vast green plain. Instinctively, he knew that this was where he was supposed to be. He pushed his way down between the gently waving blades of the **sea grass** bed – and almost bumped into a small **shrimp**. He did not think twice - just gulped it down. With a full stomach, he felt much better about life. He set out to explore his new habitat.

As George swam cautiously through the sea grass, he encountered many animals that he had never seen before. Bright **blue** and **red parrotfish** grazed on the sea grass, leaving a trail of little rounded bites. Green **sea eggs** tried to camouflage themselves with small pieces of sea grass. Bright orange **starfish** stalked unwary **shellfish**. Huge **conchs**, with their heavy shells, fed on the **sea grasses**. Sometimes, looking up, George saw a silver flash reflected from the spotted side of the long body of the dreaded **barracuda**. One look at the long jaws and large teeth of this metre-long fish was enough for George. He did not want to be anyone's breakfast.

One day, George followed a trail of mud, and found himself looking up at the biggest animal he had ever seen. The **manatee** was grey, cigar-shaped and nearly 4 m (12 ft) long. It was swimming slowly over the sea grass, using its large, rounded tail for power and its two small flippers to steer and its big, fleshy lips to tear huge mouthfuls of sea grass.

George grew quickly and soon he was a post-larva, about 7 cm (3 in) long. It was getting harder to hide among the sea grass leaves. George began to feel restless. Something inside told him it was time to go, but where? One dark night, he swam out above the sea grass bed. The vast sea was all around him—where to go? Then he had an idea. He swam a little and tasted the water, he swam a little more and tasted again. The second time the water was definitely fresher. Now he knew where to go! He followed the taste of freshwater, and found that it was getting harder to swim. The current was trying to wash him back out to sea. He swam as strongly as he could. Just as he began to feel that he could swim no further, a glimmer of moonlight hit the water. George found himself in a different world.

He was in a narrow channel whose sides were lined with a tangle of thick, round **red mangrove** roots that formed arches as they entered the water from the air above. Many small fish were sheltering among the roots. There were thousands of small **snappers** like him, silvery **jacks**, tiny stripy **sargent majors**, **mojharras**, snook, mullet, tarpon and many others beside. Thankfully, he joined them, and found that the roots broke the force of the current. Restoring his strength with a quick snack of shrimp and **amphipods**, which were abundant here, he began to look around. This was a world bustling with life. Everywhere he looked, he saw new and wonderful living things.

Looking up he could just make out the shape of the trunk and aerial roots of the red mangrove tree whose roots were sheltering him. Occasionally a **yellow leaf** fell from the tree, settled on the surface and eventually drifted downwards to the bottom. The bottom was carpeted with many leaves, and many small animals, including **crabs**, were busily feeding on and around them. As he watched, he saw fishes dart out from the mangrove roots to feed on the crabs.

A large **lobster** was meandering across the bottom, looking for tasty morsels to eat. A bright **blue swimming crab** swam by, moving sideways. A **green sea turtle** was grazing on sea grass in the channel, while another rested quietly on the bottom. Although the turtles were large - about 1 m (3 ft) long - they were dwarfed by the huge but ugly **Junefish** which lazed in a pool nearby. An **upside-down jellyfish**, like a soft umbrella with purple patterns, opened and closed as it drifted into view. It paused near the bottom, waiting for little bits of food in the water to fall into its outstretched arms. It was unlucky - a fish darted out and gobbled it up.

The channel in the mangroves was like a highway. Schools of millions of tiny fish swirled and glittered as they passed along or across the channel. They were often pursued by hungry **pipefish** or **jacks**.

Once, as George explored around a mangrove root, admiring the bright orange and purple **sponges**, the **corals** like chains of stars, the greenish **sea squirts** like tubes of jelly and the clusters of **oysters** and **barnacles**, he was attacked by a small but very angry fish. The black **damselfish** darted out at him looking as large as it could and making it quite plain that he was not wanted in its territory.

Swimming quickly away, he forgot to stay within the mangrove roots. A loud snap behind him made him look around. What he saw terrified him! A small **crocodile**, with its mouth wide open, showing its shining, white teeth, was following him! He flashed his tail and worked his fins as fast as he could. With the crocodile only inches behind, he gained the safety of the roots.

In his panic, he had too swum close to the surface. There was another noise, this time above him, and a long sharp beak snapped water beside him. A **great egret** was perched on the mangrove roots, just above the water, fishing. It barely missed him.

In October, the skies suddenly got dark in the middle of the day. There was a loud roaring noise in the sky, and the wind blew so strongly that some of the trees fell over, while others were snapped off. Huge waves pounded the shore, but the mangrove roots broke their force. Rain began to fall heavily. Floodwater poured through the channel into the sea. George watched as less fortunate fish were washed away by the hurricane.

Protected by the mangrove roots from storms, predators and drought, with food in abundance, George fed, rested, and grew. The roots and channels of the mangrove swamp were his home. He knew little of the world above, where the brightly coloured **yellow warblers** feasted on **caterpillars**, **ospreys** and **kingfishers** dived for fish, and **mangrove crabs** feasted on leaves.

As he grew larger, he spent less time in the mangrove roots. Every night he swam away from the safety of the roots, to feast in the sea grass beds nearby. Every morning, as the first light of dawn broke over the sea, he swam back to the mangroves.

One morning, he realized that he was almost grown up. It was time to return to the place of his birth - the coral reef. He would spend the rest of his life among the orangey branching **staghorn corals**, the **red fire corals**, the huge yellow cushion-like **brain corals**, and the blue and **purple sponges**. This would be his final home. George swam away from the mangrove swamp. What adventures would he meet when he got back to the coral reef?

Source: Ann Sutton

Activity 3-G

WETLAND WORD GAMES

Summary

Students play a variety of word games to remind them about the importance and functions of wetlands.

Learning Objective

Students will reinforce their wetland vocabulary by playing word games.

Age Levels 8 - 16

Subject Areas English Language, Science.

Time 30 minutes or more.

Materials

Copies of word searches or crosswords (see Copy Cat Pages following), Pencils

Background

The words contained in the following games have mostly been used in previous activities.

Preparation

Students should already have done some of the other activities to familiarise themselves with the vocabulary in these games.

Procedure

The word games may be done in class or as homework. The Wetland Charades activity is a great icebreaker or a fun way to begin or end a lesson on wetlands.

WETLAND WORD SEARCH

M	M	U	D	F	L	A	T	E	A	L	X	C	Q	A	B	C	W	I	O
A	A	N	A	E	R	O	B	I	C	R	S	R	M	O	O	R	H	E	N
E	R	N	S	H	R	I	M	P	O	B	L	A	C	K	O	W	I	M	H
R	S	Z	G	P	O	L	Y	P	O	A	A	B	O	O	B	Y	S	O	F
E	H	C	F	R	E	D	X	T	T	F	G	W	B	S	Y	L	T	S	D
N	B	U	T	T	O	N	H	Y	D	R	O	P	H	Y	T	E	L	Q	S
C	R	E	E	D	V	V	W	F	R	T	O	S	P	R	E	Y	I	U	F
H	O	R	R	T	E	W	E	T	L	A	N	D	N	E	Q	M	N	I	R
Y	Y	G	N	I	R	I	S	S	E	S	U	V	I	U	M	N	G	T	I
M	A	J	B	L	W	L	T	W	H	I	T	E	C	J	Z	B	D	O	G
A	L	C	E	A	A	D	U	A	B	T	C	C	O	R	A	L	U	U	A
W	P	A	E	P	S	E	A	M	O	R	A	S	S	R	X	C	C	C	T
S	A	T	T	I	H	R	R	P	G	N	S	A	L	I	N	A	K	R	E
P	L	T	L	A	H	N	Y	F	H	O	W	L	B	N	H	V	Y	O	B
O	M	A	E	H	G	E	W	O	S	A	L	T	C	R	E	E	K	C	I
N	M	I	L	R	D	S	O	R	S	N	A	P	P	E	R	G	R	O	R
G	U	L	L	A	L	S	R	E	V	S	N	O	O	K	C	R	T	D	D
E	S	S	A	I	F	I	M	S	W	D	S	N	A	I	L	E	R	I	N
F	I	D	D	L	E	R	L	T	M	B	F	D	U	C	K	T	E	L	A
J	A	C	A	N	A	F	R	Y	D	R	A	G	O	N	F	L	Y	E	Q

CAN YOU FIND THESE WORDS?

Some words for places that are usually wet _____, _____, _____, _____, _____, _____.

Trees that can grow in salt water are called _____.

Some types of places in which mangroves may grow _____, _____,

Some species of mangroves _____, _____, _____, _____

This word describes the low oxygen conditions in wetland soils _____.

Air spaces in the tissues of wetland plants are called _____.

This word describes plants that grow in waterlogged soils or in water_____.

This tall tree can grow in fresh water wetlands _____.

Some common wetland plants_____, _____, _____, _____, _____.

Some birds that can be seen in wetlands _____, _____, _____, _____, _____, _____, _____, _____, _____.

Some common insects _____, _____, _____.

Some other common invertebrates found in wetlands_____, _____, _____, _____, _____, _____.

A word for a coral animal _____.

Some wetland fish _____, _____, _____, _____,

The most feared animal in some wetlands _____ .

A word for young fish_____

COPY CAT PAGE

EASY WETLAND WORD SEARCH

M	B	L	A	C	K	O	R	E	D
A	L	W	O	R	M	P	M	J	U
N	O	H	W	A	I	A	O	H	C
G	B	I	E	B	F	I	S	H	K
R	S	T	R	U	H	S	Q	S	C
O	T	E	G	R	E	T	U	N	O
V	E	Q	T	Y	R	D	I	A	N
E	R	E	E	L	O	F	T	I	C
S	J	A	C	K	N	G	O	L	H
W	A	T	E	R	L	I	L	Y	K

WETLAND RIDDLES

Try these riddles and then make up some of your own.

I stand at the edge of the water, but my some of my roots are in the air. What am I? (Mangrove)

I look like a duck, I feed like a duck, I live in a pond, but I never quack. What am I? (West Indian Whistling-Duck)

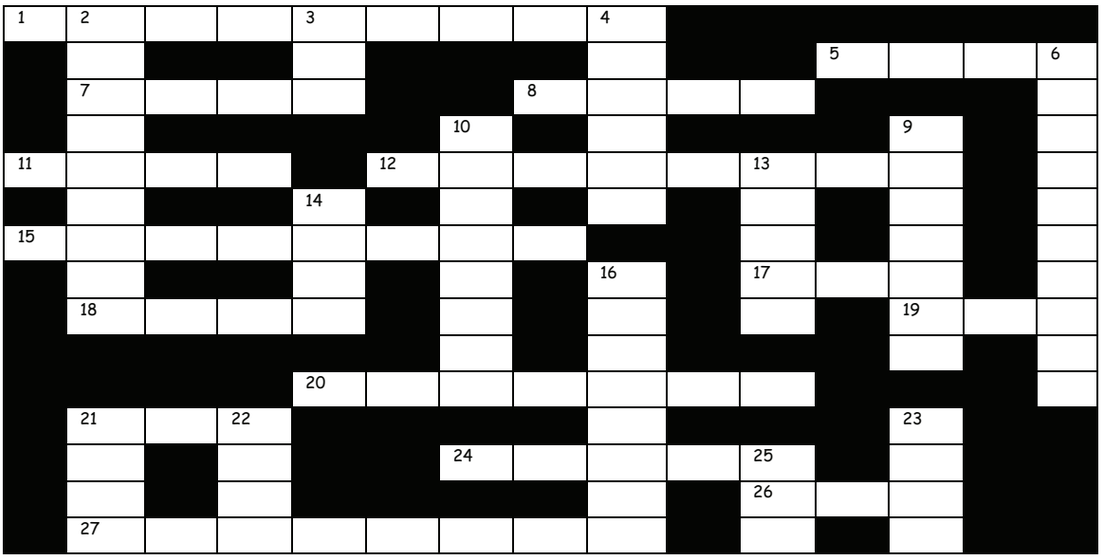
WETLAND CHARADES

Write wetland/ecology words from the glossary on slips of paper (one word on each side) and place them in a bag. Divide students into small groups. Have each group pick a slip of paper from the bag. Instruct the groups that they are to choose one of the words and act out the definition or concept as a charade. All members of the group must participate in the charade and no words may be spoken (sound effects can be allowed if you like). After acting out their word, the other students should try to guess the word. If the correct answer is not given, the group should repeat the charade.

Give the groups a few minutes to prepare their charade and then invite each group to come up in turn and deliver it. This activity is a great icebreaker or a fun way to begin or end a lesson on wetlands.

COPY CAT PAGE

WETLAND CROSSWORD 1

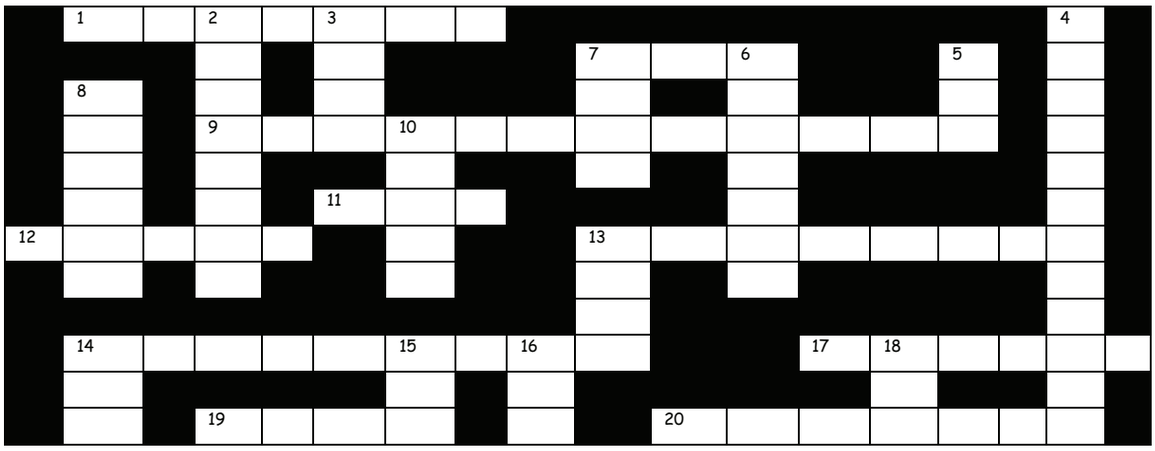


ACROSS
1 These trees grow in salty water in the tropics.
5 These animals damage wetlands by grazing on young plants.
7 This body of water is not connected to the sea.
8 This animal walks sideways.
11 This animal has fins.
12 This is a type of palm tree.
15 This insect can be very annoying.
17 This household pet kills birds in wetlands.
18 A ___ away is a type of toilet that can be a source of water pollution.
19 This fish looks like a snake.
20 A _ _ _ _ _ _ _ crab waves its large claw in the air.
21 A fishing _ _ _ is a mammal that catches fish in wetlands at night
24 This tasty mollusc has a large shell.
26 If this fuel or lubricant is accidentally spilt in a wetland, it will kill animals and plants.
27 These large mammals feed on sea grass.

DOWN
2 These animals look somewhat like shrimps.
3 You might use this to catch fish with a hook and line.
4 These animals feed on detritus in wetlands.
6 These ancient reptiles nest on sandy beaches.
9 These animals turn red when they are boiled.
10 A _ _ _ _ _ _ _ _ may be more salty than the sea.
13 A large vehicle used to transport lumber _ _ _ _ _ rhymes with 14 down
14 West Indian Whistling-_ _ _ _
16 Mangroves, marshes and swamps are all _ _ _ _ _ _ _ _.
21 A mound of sand between a beach and a wetland.
22 A Royal _ _ _ _ is a common seabird.
23 Washed off agricultural land by rain, _ _ _ _ can make water cloudy and kill corals.
24 Shallow water often gets very _ _ _.

COPY CAT PAGE

WETLAND CROSSWORD 2



ACROSS

1 Wetlands provide a _ _ _ _ _ _ _ for many animals and plants.
7 _ _ _ falls in the early morning.
9 Wise use and protection of natural resources.
11 The most destructive animal in the world.
12 Wetland with herbaceous plants.
13 Plant with stilt-like roots.
14 A local name for one of the rarest ducks in the world.
17 A soil that is regularly soaked with water is _ _ _ _ _ _.
19 This animal can live in water and on land.
20 A wetlands may be a _ _ _ _ _ _ _ _ _ for young fish.

DOWN

2 Water that is slightly salty.
3 A type of seabird.
4 The variety of living things.
5 The source of light and energy.
6 Land covered with shallow water.
7 White-winged _ _ _ _ .
8 An international convention that protects wetlands.
10 Wetland with mostly woody plants.
13 Irish _ _ _ _ is a type of seaweed, used to make a drink.
14 Wetlands are _ _ _.
15 From a distance a crocodile may look like a _ _ _.
16 This exotic species carries diseases and is a nuisance in houses and in wetlands.
18 Can we save our wetlands if we work together? _ _ _!

SOLUTION TO WETLAND CROSSWORD 1

1M	2A	N	G	3R	O	V	E	4S							
	M			O				H			5C	O	W	6S	
	7P	O	N	D			8C	R	A	B				E	
	H					10S		I				9L		A	
11F	I	S	H		12P	A	L	M	E	13T	T	O		T	
	P			14D		L		P		R		B		U	
15M	O	S	Q	U	I	T	O			U		S		R	
	D			C		P		16W		17C	A	T		T	
	18S	O	A	K		O		E		K		19E	E	L	
						N		T				R		E	
				20F	I	D	D	L	E	R				S	
	21B	A	22T					A				23S			
	E		E			24C	O	N	C	25H		I			
	R		R					D		26O	I	L			
	27M	A	N	A	T	E	E	S		T		T			

SOLUTION TO WETLAND CROSSWORD 2

	1H	A	2B	I	3T	A	T								4B	
			R		E				7D	E	6W			5S	I	
	8R		A		R				O		E			U	O	
	A		9C	O	N	10S	E	R	V	A	T	I	O	N	D	
	M		K			W			E		L				I	
	S		I		11M	A	N				A				V	
12M	A	R	S	H		M			13M	A	N	G	R	O	V	E
	R		H			P			O		D					R
									S							S
	14W	H	I	S	T	15L	E	16R	S			17H	18Y	D	R	I	C
	E					O		A					E			T	
	T		19F	R	O	G		T		20N	U	R	S	E	R	Y	

SOLUTION TO WETLAND WORD SEARCH

Have you found all the words in the puzzle? These are the words that you should have found. N.B. some words occur more than once.
FRY, ROYAL PALM, SESUVIUM, CATTAILS, REED, WATER LILY, OVERWASH, JACK, SNOOK, TILAPIA, SNAPPER, CRAB, FIDDLER, SNAIL, SHRIMP, CORAL, SPONGE, WORM, RED, BLACK, BUTTON, WHITE, ANAEROBIC, AERENCHYMA, HYDROPHYTE, MANGROVES, WETLAND, SWAMP, MARSH, MORASS, LAGOON, SALT POND, ESTUARY, SALINA, MUD FLAT, SALT CREEK, CROCODILE, EGRET, FRIGATEBIRD, OSPREY, WHISTLING DUCK, RAIL, JACANA, COOT, MOORHEN, GULL, TERN, BOOBY, TEAL, DUCK, OWL, BEETLE, DRAGONFLY, MOSQUITO, WILDERNESS, POLYP, FOREST, BOG

SOLUTION TO EASY WETLAND WORD SEARCH

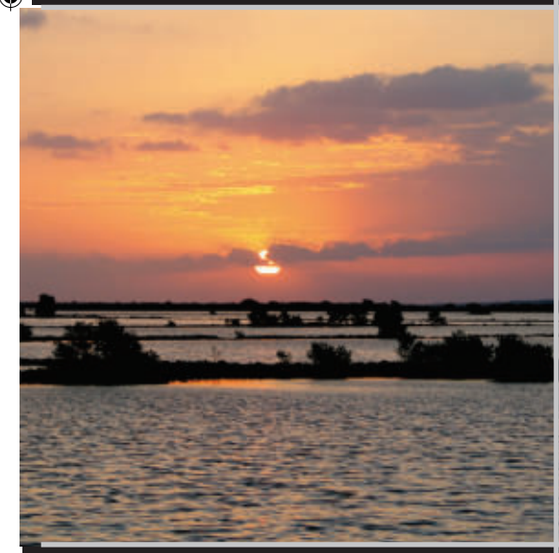
MANGROVES, BLACK, WHITE, RED, CRAB, EGRET, HERON, WATER LILY, MOSQUITO, FISH, LOBSTER, CONCH, WORM, JACK, EEL, SNAIL, DUCK

COPY CAT PAGE

Sources Ann Sutton and Monique Clark Sweeting.

WONDROUS WEST INDIAN

WETLANDS



"Few problems are less recognized, but more important than, the accelerating disappearance of the earth's biological resources. In pushing other species to extinction, humanity is busy sawing off the limb on which it is perched."

- Paul Ehrlich

Chapter 4

GOING, GOING, GONE

WHAT IS HAPPENING TO WETLANDS?

LEARNING OBJECTIVES FOR CHAPTER 4

Students will:

- Be able to identify direct and indirect causes for wetland loss and degradation in the Caribbean
- Understand how wetland loss and degradation are affecting the ecology and economy of the Caribbean
- Give examples of sustainable and unsustainable use of wetland resources

Whistler says..

ENVIRONMENTAL IMPACT ASSESSMENT is a way of assessing the probable effects of a proposed development on the physical, social, biological and cultural environment. Multi-disciplinary teams visit the site, describe its resources and use a variety of techniques to determine how they might be affected by the development and to propose mitigation measures, if necessary to minimise the negative effects. The assessment is submitted to the government, which uses it as a basis for deciding whether to approve or reject the proposal.

WHAT IS HAPPENING TO OUR WETLANDS?

Over the last four hundred years, most West Indian wetlands have been damaged or destroyed. In 1991, a study of 195 Eastern Caribbean wetlands showed that all had been damaged by human activities, 47% were seriously damaged. This included 100% of the wetlands in Barbados, 75% in St. Vincent and 63% in St. Kitts. Losses in other islands have probably been similar or greater (e.g. more than half of the wetlands in Puerto Rico were destroyed or degraded before 1975, and the damage is continuing). Why are these vitally important areas under such pressure? What are the effects of these losses?

Destruction of wetlands began with the first human settlers. The Caribs, Tainos, Arawaks, Spanish, and British, all arrived by sea and made their first settlements close to the shore. They chopped, burned, cleared and drained wetlands to create land for settlement, agriculture, ports, warehouses, roads, canals and forts. The belief that wetlands were "wastelands" and harbored diseases justified further draining and use of wetlands as dumping sites. In the twentieth century, rapid population growth has increased pressure on coastal resources in many islands and the pace of wetland destruction has accelerated. A Bahamian neatly summarised the problems, which are similar to those faced by almost every island.

"In the perpetual quest for economic advancement our people and leaders are increasingly lulled by our own tourist image, remaining oblivious of or forgetting that in truth, in vast areas of the Bahamas, the original natural resources have already been heavily exploited during past centuries.

The destruction of our rain forests and dry forests and the attendant extinctions of numerous species happened centuries ago, as valuable timber and barks were cut, haciendas and plantations developed with monocultures and introduced livestock, and slash and burn agriculture expanded to less arable areas. At the same time, subsistence, commercial and recreational hunting and fishing, introduction of alien species, urban sprawl, roadworks, careless tapping of fresh water, pesticide spraying to eradicate mosquitoes, malaria, yellow fever and crop pests, problems of sewage and solid waste disposal, and many other human intrusions have all taken a fearful toll on local biodiversity, not least the Bahamas' bird life.

To summarize modern conservation problems of the Caribbean in general and the Bahamas in particular, all of the above needs to be recalled. These very same processes and consequences, coupled with our attitudes, traditions, cultures and indifference largely continue unabated. Rising population pressures, patterns of land ownership and new technologies only exacerbate the destruction of nature and the march towards extinction of many species.

In the past, people came to the Bahamas to live, farm and take up permanent residence. In many cases, these settlers occupied the safest and best lands. The modern world brings tourism and second-home ownership. The business of accommodating large numbers of transient and semi-permanent residents brings hotels, golf courses, housing and marinas into areas formerly considered unsafe from hurricanes (beach ridges and coastal zones), unhealthy (wetlands) or unusable (too steep or inaccessible). These areas, which were often the last refuges for biodiversity in earlier centuries, are now under accelerating assault fed by greed and poverty.

The promise of ecotourism may help in some cases, but only if carried out with due care and attention. Our tourism marketing potential can easily run far ahead of the carrying capacity.

Overshadowing all these problems is the lack of a conservation ethic, ignorance, sloth and indifference to conservation and population explosion. Needs: Our greatest needs are massive public and decision-maker education and intensified scientific research. Without these, we will not negate the problems touched upon, nor herald in a new century of restoration, and biodiversity and the quality of human life will continue to diminish." Pericles Maillis (in Birds of the West Indies, by H. Raffaele, 1999).

Unfortunately, the benefits provided by wetlands are less obvious and more difficult to measure than the benefits from a commercial crop, such as sugar or bananas (see Chapter 3). Worse still, the owner of the wetland rarely reaps the benefits. Hence, the value to society of a particular wetland in its natural state is not reflected in the potential selling price. Wetlands are seen as expendable and are often neglected and exploited.

Some developers may be unaware of the potential environmental impacts of their actions. Others realise the public harm they will be doing, but are happy to make a quick profit for themselves or their company. To a farmer in need of more land, an unemployed construction worker, a town or city council in need of more space for housing, a tourism developer interested in building a new hotel, a power company seeking a site for a new power station, a road engineer seeking a route for a new highway, a politician in need of good publicity, or a tiny island in urgent need of a new port, the loss of a wetland or two seems a reasonable trade-off for the expected benefits. Difficult decisions have to be made, balancing short-term benefits for the few with long-term benefits to the environment and society as a whole (see Activity 3-D). The process is made harder by lack of information and awareness of the true value of West Indian wetlands, combined with an urgent need to provide food, jobs and houses.

The effects of each individual development may appear negligible, but the cumulative effect is huge. Before anyone realises what has happened, productive wetlands may be completely destroyed. Each development may bring benefits such as jobs or services, but it also brings costs such as increased flood damage and damage to fisheries. Whilst the benefits accrue to individuals and are easy to identify; the costs are borne by others, often the poor and powerless (see Activity 4-E). Imagine that society is a mad hairdresser and wetlands the unfortunate client. The hairdresser takes a small snip from here, another from there, then more and more. Each snip is very small – but the result is a shorn head!

Natural and man-made changes to wetlands

Change is a natural feature of wetland ecology. Some wetlands gradually become filled with plants, forming peat, trapping sediments and eventually turning into hard land. This process is called **succession** (see Chapter 1). Others are opened up by floods, wave action or storms that may uproot trees and drown mangroves. Most mangroves can recover from moderate hurricane damage, but with global climate change (See Activity 4-B) the storms will worsen and make it harder for mangroves to survive the other stresses they face, some of which are described below.

Most changes in wetlands are man-made. The most drastic change is conversion of the wetland into another type of habitat (see Copy Cat Page – Wetland Destruction). This happens when wetlands are altered for housing, tourism, agriculture, fish farms or industry (see Activities 4-D and 4-E). For example, if a development blocks the mouth of a coastal lagoon cutting it off from the sea, young fish can no longer get in to seek food and shelter, and coastal fisheries suffer. Without the normal flushing by the sea, the pond may become too salty, even for mangroves. The trees die, and bare salt flats develop. Without protection from coastal mangroves, buildings and roads are vulnerable to storm damage. These losses can be reduced by maintaining the connection to the sea, preferably by prohibiting development of the coastal fringe of lagoons.

In addition, there have been many schemes to drain wetlands to create agricultural land for rice and other crops. Large sums have been spent on dykes, dams and pumps, to create land that frequently turned out to be too salty or too expensive to maintain for agriculture. In some places, the result was an overall loss in agricultural land, because when the wetland buffer is destroyed seawater penetrates the **groundwater** making it salty. Similarly, wetland fish farms may produce fewer fish than the wetland did in its natural state. Some become too salty for pisciculture and are abandoned leaving an unproductive mess.

Some people use wetlands as dumps. Not only individuals, but also whole towns locate municipal dumps in mangroves, while companies pour their untreated wastes straight into rivers. The environmental damage is severe. Rubbish and effluents prevent natural regeneration of wetland vegetation, pollute water, and are dangerous to health. Excess nutrients from sewage and food processing enrich water and cause **eutrophication** while chemical wastes include poisons that may accumulate and harm living things in the adjacent area (see Activities 4-M and 4-N).

Not all damage to wetlands is deliberate. Accidents, such as oil spills, can cause serious damage to wetlands (see Activity 4-M). Oil smothers mangrove roots and the trees die. It may take mangrove more than 20 years to recover. Accidental or deliberate introduction of non-native animals and plants can have far-reaching and unpredictable effects on wetlands (see Activity 4-K).

Wetlands can also be degraded or destroyed by seemingly unconnected activities in the watershed. Water extraction from aquifers and rivers can reduce the amount of water getting to a wetland. Silt washed down from deforested hills can fill wetlands causing them to dry out and hence become more vulnerable to fire. Fires are sometimes set on purpose by farmers who want to improve grazing, or fishermen who want to drive fish into traps. Occasional fires (started by lightning) are a natural part of the cycle of wetland

ecosystems, but when fires happen too frequently, they prevent the natural regeneration of swamp forests and mangroves (see Activity 4-C).

Pollution and fire rarely cause total loss of a wetland. They are examples of wetland degradation or unsustainable use. (See Copy Cat Pages "Wetland Degradation" and "Unsustainable Use of Wetlands"). When wetlands are damaged, the wildlife they support is also damaged. Certain species can survive the loss of one or two wetlands, but in the Caribbean there has been major loss throughout the region and some species may soon have nowhere to go (see Activities 4-G, 4-H, 4-I and "Whistler says…"). The impacts of loss of wildlife spread far beyond the wetlands. For example, White-crowned Pigeons are favourite game birds on many islands where they breed and roost in the mangroves. When mangroves are destroyed, or hunting is not properly managed, their populations are reduced. White-crowned Pigeons feed on seeds and spread the seeds of forest trees and when pigeon populations are reduced, forests can no longer regenerate as they once did.

Crocodiles feed on fish; therefore fishermen think that they are competitors. In fact, theycull the fish populations, eating many sick and injured fish and thus help to keep the fish stocks healthy and strong. Crocodile populations, too, are dwindling because of hunting and habitat loss. Wetland loss forces them closer to human habitation and increases the likelihood of conflict with people.

It is important to know that there are almost always alternatives to wetland destruction, degradation or unsustainable use. A better site can be found or a project modified to reduce the damage. These changes may actually improve the project by making it more resistant to natural disasters, thus saving money. Increasingly citizens, developers and governments are realizing that protecting the environment makes economic sense. They are working together with citizens and non-government organizations to find solutions to problems (see Chapter 5).

Whistler says… The West Indian Whistling-Duck was once common throughout the Greater Antilles and northern Lesser Antilles. Although there are still healthy populations in the Bahamas and Cuba, the combined effects of hunting and catastrophic losses of wetlands have wiped out the species from some islands, including the British Virgin Islands and Guadeloupe, and reduced the species drastically in others (e.g. there are fewer than 200 left in Puerto Rico and about 500 in Jamaica). If wetland losses continue, the species could soon become extinct. Fortunately, the process is not irreversible. In the Cayman Islands, the population had declined to about 200 in 1986. The government and private individuals stepped in. They protected the species from hunting, and strictly enforced the law, ran a public education campaign and started a feeding station. By 2000, the population had rebounded to 1000-1200 individuals.

The species is listed as vulnerable in the World Conservation Union's Red Data Book. It is protected by several international conventions, including CITES (Convention on International Trade in Endangered Species) and the Specially Protected Areas for Wildlife Protocol of the Cartagena Convention. It is protected by national laws in most countries but strict enforcement of regulations about hunting and habitat protection are both needed to ensure the survival of the species.

Whistler also says... Too many West Indian wetlands have been destroyed! This is how it happens...

Wetland Destruction

ACTIVITY	IMPACTS
Filling for ports, resorts, housing, industrial sites	⇨ Increased risk of damage to structures from hurricanes, tsunami and flooding
Drainage for agriculture (including rice and cane) or mosquito control	⇨ Land becomes saline and unproductive, abandoned, polluted and ruinate
Excavation of ponds for farming fish and shrimp	⇨ Productive mangroves are converted into ponds but after a few years, some ponds become salty and are abandoned. ⇨ Introduced fish and shrimp escape and disrupt food chains
Excavation and operation of solar salt works	⇨ Very salty water with chemicals can escape into mangroves and harbours, killing all living things
Dredging of channels for navigation and drainage	⇨ Increased sedimentation ⇨ Changes in drainage patterns ⇨ Increased salinity ⇨ Loss of marine life including reefs
Cutting of forests for timber and charcoal	⇨ Loss of wildlife habitat ⇨ Decreased coastal protection ⇨ Increased coastal erosion ⇨ Loss of coral reefs and sea grass beds.

COPY CAT PAGE

Wetland Degradation

ACTION	LIKELY IMPACTS
Changes in water level as a result of blocking of channels, reduction of inflows from land, relocation of channels	⇨ Increased salinity. Loss of plants and animals. ⇨ Increased saline intrusion into aquifers and consequent loss of potable water and agricultural land.
Fires set to clear land for planting, promote growth of new grass, or for fun	⇨ Reduction of natural regeneration of mangroves, royal palms, etc. ⇨ Loss of soil and nutrients. ⇨ Air pollution.
Grazing animals in wetlands (e.g. cows and goats)	⇨ Reduction of natural regeneration of mangroves, royal palms, etc.
Pollution from untreated sewage, garbage dumps, fogging for mosquitoes, farm **effluents**, fertilisers, sewage farms, **dunder** from rum distilleries, oil spills	⇨ Possible local increase in productivity, overall loss of productivity due to excess nutrients. ⇨ Sickness and disease. ⇨ Fish kills and general loss of biodiversity.
Removal of trees from surrounding watersheds	⇨ Increased soil erosion may eventually fill in wetland completely. ⇨ Increased flash flooding may exceed capacity to store water.
Dumping of garbage	⇨ Loss of aesthetic qualities. ⇨ Release of toxins into environment affecting health and survival of all animals in the food chain including humans. ⇨ Contamination of groundwater.

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Whistler says... Most remaining West Indian wetlands have been damaged by human activities.

Unsustainable Use Of Wetland Resources

ACTION	POSSIBLE IMPACTS
Unsustainable hunting (e.g. of doves, pigeons, ducks, crocodiles)	⇨ Loss of resource. ⇨ Indirect effects on other resources (e.g. eliminating crocodiles weakens fish stocks because sick and ill fish are no longer culled). ⇨ Extinction of threatened species.
Unsustainable fishing (especially the use of gill nets in rivers, seine nets at river mouths, fish traps, dynamite and bleach)	⇨ Collapse of fisheries. ⇨ Rural unemployment. ⇨ Increased crime.
Use of fire to improve access, drive fish into traps, generate new shoots for grazing	⇨ Interruption of natural regeneration of wetland vegetation (e.g. mangroves). ⇨ Loss of habitat.
Tourism in excess of carrying capacity	⇨ Loss of aesthetic value. ⇨ Damage to resources (type depends on activity, e.g. damage to banks by boat wash).
Use of fossil fuels resulting in global climate change and sea level rise	⇨ Wetlands are damaged by increased flooding and storms.
Cutting of mangrove forests for timber and charcoal	⇨ Loss of habitat, damage to fisheries. ⇨ Loss of coastal protection.

Whistler says... Use my wetlands wisely!

COPY CAT PAGE

Activity 4-A

KNOWING OUR WETLANDS:

Family knowledge and island lore

Summary

Students will interview family members and friends, particularly older people, for stories about local wetlands.

Learning Objectives

Students will be able to:

- Interview an older person and take notes
- Connect local bird names to standard names in field guides
- Document some of the changes in local wetlands

Age Levels 8 +

Subject Areas English Language, Oral History. Also suitable for science clubs and special projects.

Time 1–2 hours

Materials

- Field guide supplied with this workbook
- Pencil and paper
- Clip board
- Optional: old photographs or maps showing what the landscape looked like many years ago (information may be available from Lands and Survey Departments or libraries).

Background

Fishermen, hunters, the elderly and other local people are often very knowledgeable about wetlands and wetland resources. Sometimes they are the only ones who know how things used to be and the ways people used to depend on wetlands. Remember that attitudes to natural resources change over time. Different cultural groups may value the same resource differently.

Procedure

1. Lead the class in a discussion of local wetlands. Select a nearby wetland to study.

2. Who knows most about the wetland you have chosen? The government? Scientists? Local people? Others?

3. Attitudes affect the way people use their knowledge. How do attitudes change over generations? What things do the students like that their parents do not like?

4. Tell the students that they are going to investigate local knowledge and attitudes to wetlands. Ask them to think about a cross-section of community members (e.g. hunters, fishermen, tour operators, farmers, business people, very old people and people who might have different attitudes such as Rastafarians). Each student should select someone he or she knows to interview.

5. Discuss with the students what the older people might be able to tell them. How can they find these things out? What will happen to the information if they do not record it? What is the best way to get people to share and record their memories?

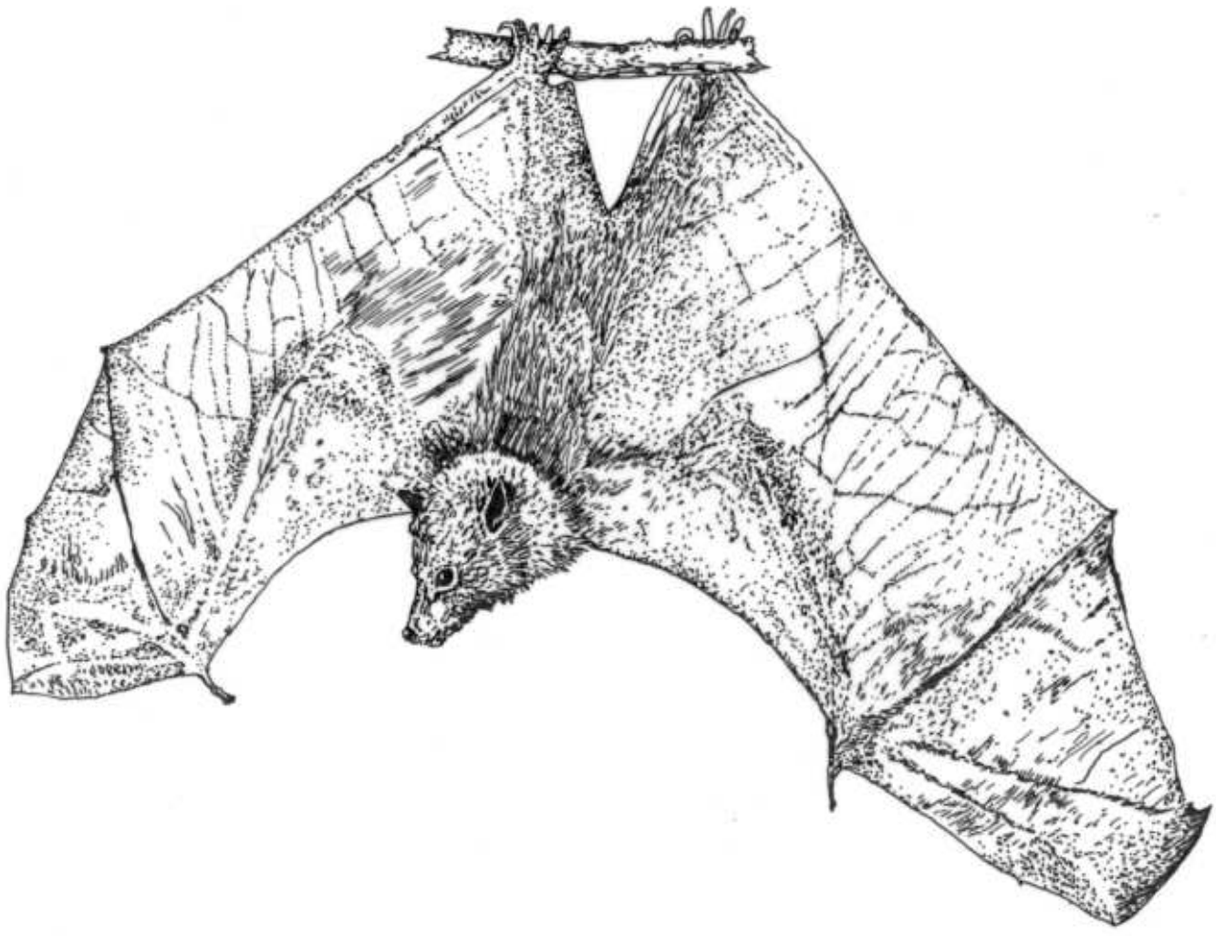
6. The students might ask an older person what they know and how they feel about wetlands. What were the wetlands like in the past? What changes have there been? What caused the changes? Do they know any stories about the wetlands (e.g., folklore or stories about amazing things they saw, or events that happened many years ago) wetland birds, fish or other wildlife? Are the populations of birds (especially West Indian Whistling-Ducks), turtles and fish the same as they used to be? Are there things they used to do when they were young that people don't do any more? Why? Can they remember any floods or hurricanes? How did these affect the wetlands and the communities around them? Does anything worry them about what is happening to wetlands? What changes would they like to see?

7. If maps and photographs are available, try to relate the changes reported by the local people to actual changes on the maps.

Evaluation/Assessment

- Each student should write up his/her interview as an individual report.
- Once the individual students have written their reports, ask a few students to summarise the findings for the class. Allow the other students to discuss the findings and identify trends in changes of attitudes and resources.
- If there is sufficient time, summarise the results and write a class report.

Source Ann Sutton



Activity 4-B

WARMING UP!

Summary

Students will learn about global warming, its likely effects on the West Indies and what they can do to help stop it.

Learning Objectives

Students should:

- Understand what global warming is and be able to identify its main causes and impacts
- Understand how global warming is likely to affect the environment and economy of West Indian islands
- Be able to list some important actions that they can take to help stop global warming

Age Levels 8 +

Subject Areas Science

Time About 30 minutes.

Background

Anyone who has visited a greenhouse for growing plants or sat in a parked car with the windows closed on a warm day has experienced the principle behind global warming. The sunlight goes through the glass and the heat is trapped inside. The gases in the atmosphere surrounding the earth act much the same way, trapping heat and warming the earth's surface. This natural **greenhouse effect** keeps the earth about 40°C (60°F) warmer than it otherwise would be. Without the greenhouse effect, life as we know it would not be possible.

Since pre-industrial times, human activities have added to the natural greenhouse effect by releasing additional greenhouse gases to the atmosphere, mostly carbon dioxide but also methane and nitrous oxide. The increase of these pollutants in our atmosphere has caused retention of more and more heat and a warming of the earth's surface. Over the last century, the global average temperature has risen by about 1°F. The last two decades of the twentieth century are the warmest on record. The term **global warming** is used to describe the enhanced greenhouse effect resulting from human activities.

Precisely how the earth's climate will respond to increasing greenhouse gases is not known, but changes have begun and they are already altering ecosystems and species. Glaciers and Antarctic ice are melting, our oceans are warming, and snow cover in the Northern Hemisphere is decreasing. Globally, sea level has risen 10-20 cm (4-8 in) over the past century. Winters are milder, spring is earlier and the frequency of extreme weather events has increased. Scientists believe that the global average temperature will increase between 1.4 and 5.8°C (2.5 and 10.4°F) over the next 100 years (IPCC 2001), a rate of change not seen on our planet for the last 10,000 years. It is this unusually large and rapid increase in temperature which causes great concern. Many species will not be able to able to adapt to the changing climate quickly enough, leading to extinctions and disruptions of entire ecosystems.

Climate change will affect almost every aspect of human society and the natural world. Hardest hit may be the tropics and subtropics, where many of the world's poorest people live. Human health will be affected in a variety of ways including higher mortality from heat stress, spread of diseases that thrive in warmer climates (e.g., malaria, dengue fever, and cholera), and worsening air quality from smog and increased levels of airborne pollen and spores. Climate change could also dramatically alter the composition, geographic distribution, and productivity of many ecosystems, such as forests. Finally, a rising sea level erodes beaches and coastal wetlands, floods low-lying areas, and increases the vulnerability of coastal areas to flooding from storm surges and intense rainfall which will likely increase under global warming.

The most severe impacts in the West Indies will likely come from rising sea level, worsening storms, loss of mangroves, and bleaching of coral reefs. Islands are especially vulnerable because of their limited land space and the way their economies focus on the coasts. Many sites may become uninhabitable. The preservation of our coastal mangrove (and other) wetlands is of utmost importance in protecting our shorelines and property.

Coral reefs, so vitally important in protecting coasts from storms and erosion, creating sand for beaches, and providing essential habitat for fish, are under threat from global warming. Warming seas have already been implicated in massive coral bleaching both in the Caribbean and around the world. In Jamaica, 95% of the coral is dead. Globally, more than one tenth of coral reefs have died and, even without global warming another third may die over the next ten years. As sea levels rise, some West Indian islands including many cays in the Bahamas and elsewhere, will disappear completely under the waves, whilst others shrink. People and wildlife will be forced to retreat inland.

We can reduce global warming by minimising the amount of energy we use by turning off lights and appliances when they are not in use, driving a more fuel efficient car (or using public transportation), using energy efficient appliances solar water heaters, and compact fluorescent light bulbs, and generally promoting the use of alternate forms of energy such as solar and wind power. Another way is to promote the protection and restoration of natural habitats (forests and wetlands store carbon and therefore act as "carbon sinks"). Recall the sayings "Think globally, act locally" and "A journey of a thousand miles begins with a single step."

Whistler says...

Scientists predict that if sea levels rise by one metre, half of the world's important coastal habitats for waterbirds will be threatened. In the West Indies, this will reduce the amount of habitat for resident species, including West Indian Whistling-Ducks, while many migratory birds will experience problems throughout their migration routes. For Blue-winged Teal and other ducks and shorebirds, this will mean loss of breeding habitat in the prairie potholes of North America, loss of stop-over habitat on their migration routes, and loss of wintering habitats in the West Indies and elsewhere.

Preparation

Read the background information above and interpret it in a form suitable for your students.

Procedure

- Introduce the material and lead a discussion on the topics: the greenhouse effect, global warming and climate change. How will it affect the West Indies and your own neighbourhood?

- How do your own students contribute to global warming? Students should estimate how much carbon dioxide they (or their families) personally contribute to the atmosphere every year. A web-based climate change calculator is available at: http://www.climcalc.net/eng/Calculator/start.html Ask students to identify what they could do to reduce global warming, perhaps researching which of these things is most effective (i.e., results in greatest reduction of greenhouse gas emissions). Discuss the saying "Think globally, act locally." Remind the students of the idea of "a thousand points of light": many small efforts can add up to make a big difference. And remember: reduce, reuse, recycle!

Evaluation/Assessment

Write an essay or draw a picture about a) the effects of global warming on your island or community OR b) what you can do to lessen your contribution to global warming.

Extensions

Students could select a natural area, such as a mangrove wetland, coral reef, seashore or forest, on their island and research how it will be affected by global warming.

- Students could write a fictional diary for a day in 2050 and describe how climate change has affected their lives.

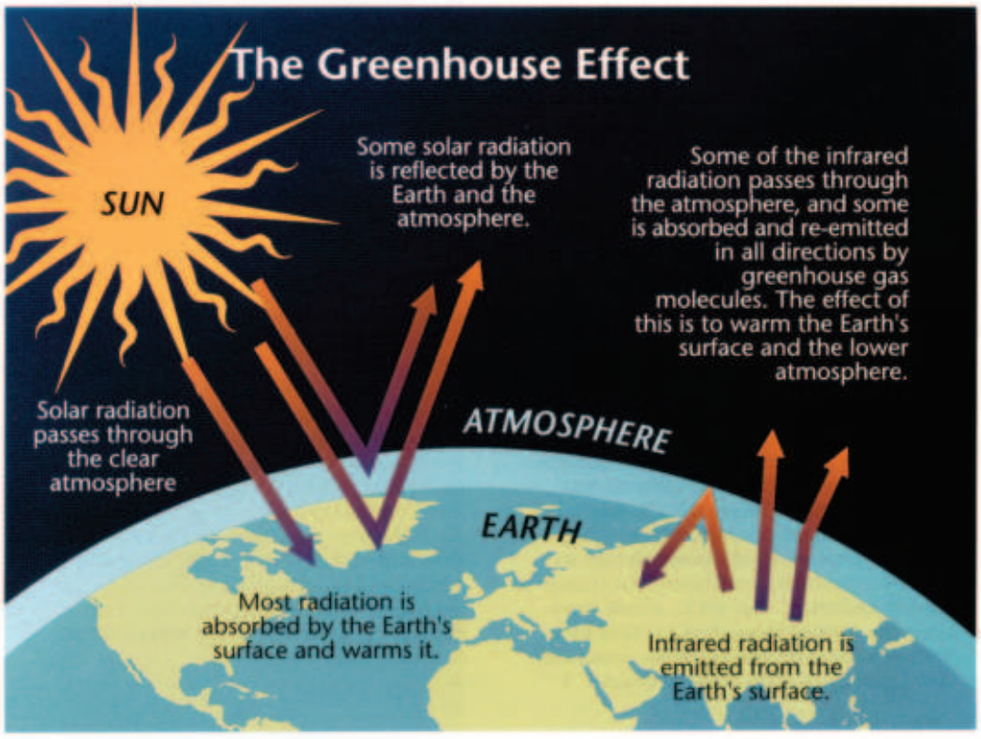
- Students could identify the people in their community who are most likely to be affected by global climate change and pretend to be one of these stakeholders. After a short period in breakout groups they reassemble, and one person from each group should explain how global warming might affect their interests. Finish with a discussion about how these effects could be reduced.

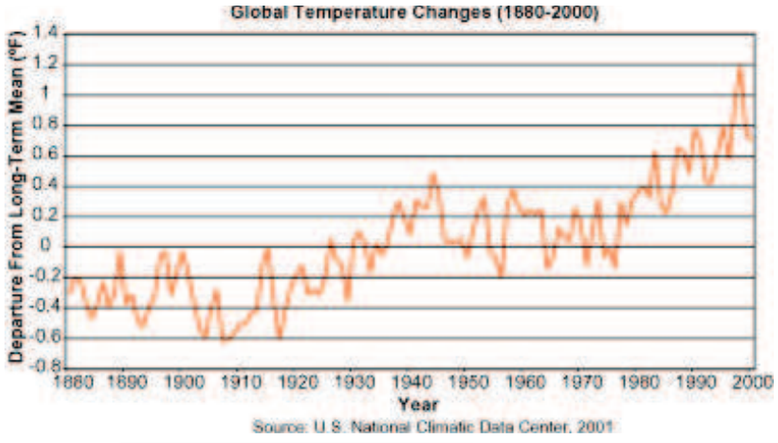
- The US and other industrial nations produce most of the world's carbon dioxide – far more per capita than people in other countries, including the Caribbean. In the US, for example, about one third of carbon dioxide pollution comes from cars and trucks, one third from electricity production and the rest from industry. In the West Indies the balance is probably similar but the total amount is much lower, although the relative amounts will change from island to island. Students could do a group project to design a plan that outlines how individuals, families, schools, local communities, businesses, or nations can reduce the amount of carbon dioxide they produce.

For more information and to find out what you can do to help, check out the following websites.

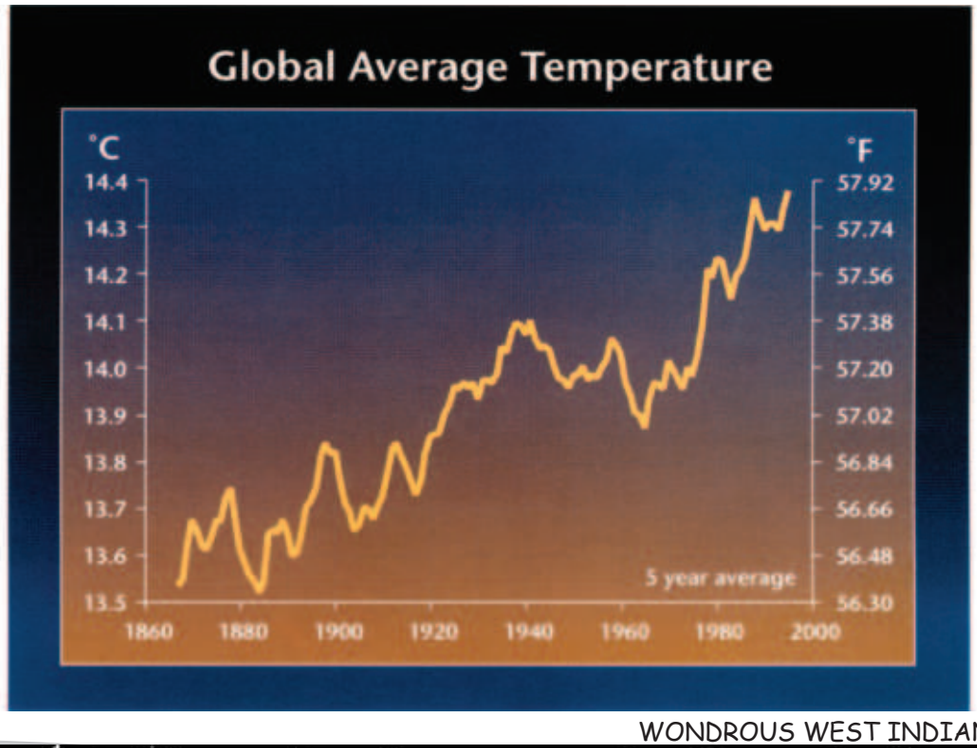
- The Environmental Protection Agency: http://www.epa.gov/globalwarming/
- The Union of Concerned Scientists: http://www.ucsusa.org/index.cfm
- World Wildlife Fund: http://www.worldwildlife.org/climate/index.cfm

Source Lisa Sorenson and Ann Sutton. Figures from: White House Initiative on Global Climate Change (Clinton), Office of Science and Technology Policy: http://clinton4.nara.gov/Initiatives/Climate/main.html
Activities adapted from "Early Warning Signs of Global Warming: Classroom Activities" The Union of Concerned Scientists.





Average Global Temperature Has Risen By More Than 1 Degree Over the Last Century



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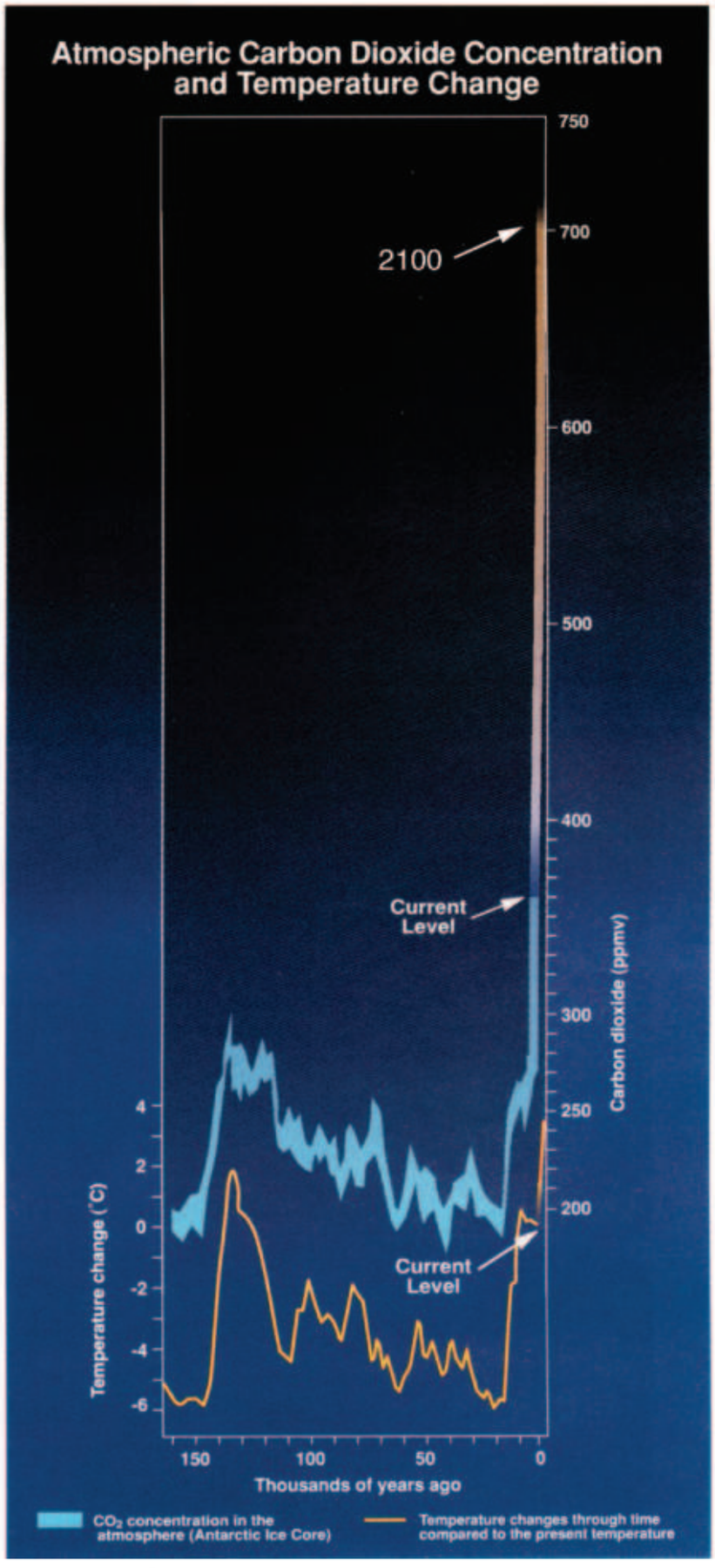
In the Next 100 Years, the Global Average Temperature Will Probably Increase Between 2.5 and 10.4 Degrees Fahrenheit



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Activity 4-C

FIRE! FIRE!

Summary

Students learn about the positive and negative effects of fire in wetlands, and compose and sing a song about fire.

Learning Objectives

Students should:

- Appreciate that fire is a natural part of the wetland environment, but that most are started by man; and
- Understand that natural fires can be beneficial, but that frequent fires damage wetlands.

Age Levels 8 +

Subject Areas Science, Social Studies, Geography

Time About 30 minutes.

Background

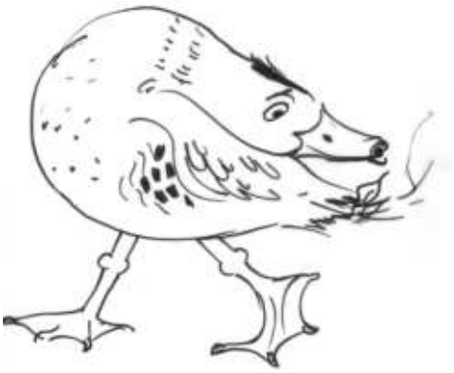
Fire is a natural phenomenon in many habitats, and wetlands are no exception. Although the ground is wet, the vegetation can dry out. Decay of vegetation produces gases, such as methane, which can accumulate and catch fire. These swamp gases sometimes ignite spontaneously, burning with a relatively cool flame. Probably this phenomenon provides the basis for stories of duppies or ghosts in some wetlands. Many wetland fires are started by lightning. This type of fire occurs in herbaceous or grassy swamps. It is very rare in mangroves.

Most fires in West Indian wetlands are started by people for many reasons, including:

- To burn off hard vegetation and promote growth of fresh young sprouts for cattle to graze;
- To drive fish out of small streams in the wetland into fish traps;
- To get better access to remote areas for fishing;
- To create or clear agricultural land;
- By accident (a cigarette thrown from a car or a bonfire or cooking fire that got out of control); and
- Just for fun.

In a habitat that is naturally adapted to burning, fires spread quickly, singeing off the grassy plants, without damaging the soil. Some plants have seeds that only germinate after they have been exposed to fire. Most types of herbaceous wetlands recover quickly after burning, especially if (it is) followed by rain. This is because the fire releases nutrients back into the soil, and makes them available for plant growthHowever, every time a site is burned, other nutrients are lost in the smoke and run off. If soil is exposed, it may wash or blow away after the fire. Too frequent burning depletes the soil. Also, because the water levels in many Caribbean wetlands are artificially low (as a result of water extraction for domestic uses and agriculture), there is always a risk that the peat itself will catch fire, resulting in serious damage to the root systems of plants.

Mangrove and swamp forest plants do not tolerate fire well and wetland fires can spread to farmland and residential areas, causing loss of property and crops. In most cases, wildlife can move to safety. However, birds, such as West Indian Whistling-Ducks that nest on the ground among grassy plants, could lose their nests. Fires can improve wildlife habitat by creating a patchwork of different types of habitats, which offer a variety of food and shelter.



Procedure

1. Discussion: Use the information in the introduction to lead a discussion about fires in wetlands. Introduce the positive and negative factors and list them on the board in two columns.

2. Discussion: Why do fires start? List ideas on the board. Are there any alternatives to the use of fire? What precautions could be taken to reduce the chances of fires in wetlands?

3. The following is the first verse of a song, which can be sung as a round to the tune of "London's Burning." Many students are familiar with the tune.

Wetland's burning! wetland's burning!
All the sedges! All the mangroves!
Fire, fire! Fire, fire!
Save the wetlands, save the wildlife!

The students should try out the first verse, to ensure that anyone who does not know the tune can learn it. Then they can work together to write two or three more verses (some positive, some negative and sing the song as a round.

Evaluation/Assessment
Students could write an essay entitled "Fire and wetlands" or draw a picture of a wetland fire and its consequences.

Source Concept adapted from Project Wild.

Activity 4-D

MAKING DIFFICULT DECISIONS

Tourism, the wetland environment and you

Summary

Students will discuss some of the practical environmental issues facing individuals, corporations and government agencies that are directly or indirectly involved in wetland management and tourism.

Learning Objectives

Students will:

- Appreciate difficulties faced by decision-makers
- Apply their knowledge of threats to the environment to specific issues.

Subject Areas Social Studies, Geography, English Language.

Time About 30-60 minutes

Age Levels 11 +

Materials

Copies of Issue Cards (one card per group plus a master sheet for the teacher)

Background

Politicians, government officials, directors of large companies and other decision-makers, are often blamed for making bad choices. However, they are often faced with very complex situations, in which the costs and benefits are measured in different ways and accrue to different groups in society. The process is complicated by corruption, the need to make decisions quickly and by pressure from voters and political factions.This activity places students in the position of the decision-makers, and challenges them to make up their own minds about what to do.

Preparation

Prepare copies of the Issue Cards. You may modify them for your island or add others that are clearly based on topical issues.

Procedure

1. Explain that the following activity is based on some real issues, which arose in a Caribbean island in 1999-2000. Each Issue Card includes a brief summary of the issue and some of the possible outcomes. The students will work in groups to make up their minds about what should have been done.

2. Divide the class into groups. There should be the same number of groups as cards.

3. Place the Issue Cards face down on the desk.

4. A representative of each group should pick up an Issue Card.

5. Tell the groups that they will have about 5 minutes to discuss their Issue Card. Stress there are no correct answers to these problems and encourage the students to develop other solutions that may not be on the sheets. Each group should select someone who will be responsible for presenting the findings to the class.

6. At the end of 5 minutes, the first representative should explain his/her group's findings. The class should discuss the findings before going on to the next group.

Alternate Procedure

This activity can also be done as a role play; each person playing the part of a different stakeholder in the community (e.g., prime minister or mayor, developer, local resident, fisherman, environmentalist, etc.) and presenting their viewpoint in a town hall meeting.

Evaluation

Students should write up their discussions.

Source Adapted from Project Wild.

ISSUE CARD 1

You are the director of a large international hotel chain. Your company has bought a prime beachfront site for a new hotel. The environmental impact assessment shows that the site is of great ecological importance, containing some rare wetland plants, some of which are found only in that area. It recommends that parts of the site should be conserved. However, your plans may have to be modified and it could delay the project.

Should you:

- Bulldoze the site as quickly as possible and cover it with several feet of marl before starting construction
- Commission a group of architects and ecologists to modify the design to include the rare plants as a feature of the new hotel and integrate conservation with the hotel
- Build on an adjacent site which has already been destroyed and protect the wetland in the original site
- Other?

ISSUE CARD 2

You are the director of a large international hotel chain. Your company has bought a prime beachfront site for a new all-inclusive hotel. A study shows that the beach and wetland behind it form one of the few remaining areas available for local people to use. However it is polluted with litter and people use it as a toilet because there are no facilities.

Should you:

- Go ahead with the all-inclusive hotel and close off the beach to non-guests
- Have an all-inclusive hotel but allow locals to use the beach
- Set aside part of your beach for locals to use
- Clean up the pollution and turn the whole area into a public beach park
- Other?

ISSUE CARD 3

You are the Chief Minister of a small island. The economy is in shambles and you don't know how you are going to win the next election. A big international construction company wants to construct a new toll road across your country, creating thousands of jobs and improving communications. However, it could also disrupt plans for sustainable tourism, by destroying landscapes and important ecosystems. Your country has two major on-going planning initiatives, one for tourism and another for sustainable development of the undeveloped south coast. The proposed road development was planned without consulting either planning team.

Should you:

- Accept the offer immediately and announce it to the press
- Try to integrate the proposal with the other planning initiatives
- Commission a thorough environmental and tourism study before making a decision
- Other?

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ISSUE CARD 4

You are a villa owner in a small coastal community. Part of your property includes a wetland with rare plants. The community is in the first phase of tourism development and is growing rapidly. Environmental problems are starting to emerge, such as unplanned development, noise pollution, litter, harassment and coastal pollution.

Should you:

- Plan to sell your property for a large profit to a hotel developer and move to another site
- Establish a community planning group to try to bring development under control before the area is spoiled
- Get involved in environmental education
- Do nothing and hope for the best
- Try to make your own property as environmentally friendly as possible.
- Other?

ISSUE CARD 5

You are the Minister of the Environment for a Caribbean island on which no duck hunting has been allowed for 25 years. Many influential people, including some of your friends, are keen hunters. They note that the number of migratory ducks in North America has increased. People are hunting ducks illegally. The hunting lobby has asked you to open a season. They would like to hunt ducks legally and think that the revenue from hunters' licences will contribute to better enforcement. The conservation lobby is afraid of the impact of hunting on the globally threatened West Indian Whistling-Duck (found in the same habitats as migratory ducks). Tour operators are concerned that the proposed hunting season (January to March) is also the height of the tourist season. They think that hunting will mean fewer birds for tourists to see and that gunfire will frighten the tourists.

Should you:

- Declare an open season for hunting
- Announce that there will be no hunting season for ducks
- Suggest a limited trial season in a selected area
- Other?

ISSUE CARD 6

You are the director of a national environmental agency. You know that for hundreds of years a sugar factory has been dumping its waste into a sinkhole. From the sinkhole the waste flows into a river, which feeds a wetland, where it causes severe pollution. It kills the fish and shrimp on which people depend for their livelihoods, causes skin rashes when people use the water for bathing, and pollutes the sea. This part of the river is currently an important tourist attraction and its use could expand - if pollution can be controlled. New laws give you the power to take strong action against companies that pollute water. However, the sugar industry is in decline. Although a study suggests that the cost of recycling the waste as fertiliser could be recouped in two years, you are afraid that implementing environmental measures could make the factory so unprofitable that it would have to close and jobs would be lost.

Should you:

- Close down the factory immediately until they can dispose of their waste properly
- Negotiate with the factory owners to determine a timetable for improving their waste disposal methods
- Help the factory to find funds to carry out research into better methods of waste disposal
- Wait to see whether public pressure will cause the factory to improve its practices
- Do nothing
- Other?

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Activity 4-E

WHAT REALLY HAPPENED AT JOLLY HARBOUR?

Summary

A case study from Antigua illustrates the issues surrounding tourism development in West Indian wetlands.

Learning Objectives

Students will:

- Apply their knowledge of wetland ecology to a real situation to predict the outcome of a proposed tourist development; and
- Will compare their predictions with what actually happened.

Subject Areas English Language, Arts, Social Studies, Geography, Tourism, Science

Time About 30 minutes

Materials

- Chalk board or flip chart
- Chalk or pens

Age Levels 10 +

Preparation

1. Read the material below and think of some local examples to make the discussion more relevant to your island.
2. Before the activity, draw a table on the board with two columns. Label the table "JOLLY HARBOUR" and the columns "FOR" and "AGAINST".
3. Select two students who will record on the board the main points raised in the discussions.

Procedure

1. Explain:

The background

This is the story of a real event that took place in Antigua. Similar events have happened on almost every Caribbean island. Imagine it happening at a wetland near you.

The proposal

In 1988, a German developer asked the government of Antigua for permission to construct a huge new tourist resort at Jolly Hill near Bolans on the west coast of Antigua. If the government would give him about 20 hectares (53 acres) of mangrove swamp, he would build a marina complex with 1,500-2,000 rooms. This would supplement the facilities of the existing 500-room Jolly Beach Hotel at the same site.

The site

This was the Jolly Bay and Yorks salt ponds, and the beach at Mosquito Cove, part of a complex of highly productive mangrove wetlands, with coral reefs and sea grass beds nearby. The area was used by the residents of Bolans for fishing, hunting, recreation, bathing and grazing their animals. They valued it because it protected the village from storms.

How the site would be changed by the project

Preparation of the site would involve completely filling in the mangroves at Jolly Hill salt pond and some of the mangroves of the adjacent Yorks salt pond with dredge and other material. A channel would be cut across the nearby sandy beach at Mosquito Cove.

2. Discussion: What sort of social and economic arguments might have been made by the developers in support of this proposal?

For example:

- New jobs in construction (short-term)
- New jobs in the hotel and marina (long-term) leading to a major boost in the economy of Antigua in general and Bolans in particular.
- Expansion of the tourist industry with spin-offs for many local businesses.
- Other?

3. Discussion: What environmental arguments might have been made against the project?

For example:

Loss of mangroves leading to:

- Loss of coral reefs
- Loss of sea grass beds
- Decline in water quality (increased sediment, pollution)
- Increased vulnerability to hurricanes and floods (the Jolly Hill pond was an important flood regulator)
- Decline in fisheries production
- Loss of access to high quality beach
- Loss of wildlife (e.g. ducks, herons, shorebirds)

4. Discussion: What socio-economic arguments might be made against the project?

Inform the discussion by explaining that although the Jolly Beach Hotel was one of the biggest private employers in Antigua, it was not a major source of employment for Antiguans. This is because most Antiguans are not interested in unskilled work in hotels (e.g., as maids or gardeners). Therefore, many hotel workers are foreigners (e.g., from Dominican Republic).

For example:

- The local community would feel the costs of social disruption without the benefits of employment. There would be more tourists than locals in Bolans. The whole character of the village would change because of the influx of tourists and foreign workers.
- Loss of grazing land
- Loss of access to fishing beach
- Loss of hunting area
- Loss of food from coconuts
- Poor return on valuable land that should not have been sold to foreigners so cheaply.

5. Discussion: If there were benefits, who would be likely to reap them?

- The hotel developers
- The construction company
- The Antiguan government
- Some of the people of Bolans.

5. Discussion: If there were costs, who would be likely to feel them? The people of Bolans.

6. Discussion: What do the students think the villagers felt about these arguments?

7. Read or explain: What the villagers felt about the proposed project.

The residents of Bolans were not impressed with the proposal. Four hundred and eight community members, (90% of the population of Bolans) signed a petition opposing the project. In August 1988, they presented it to the Prime Minister.

8. Discussion: What do the students think the Prime Minister should have done in response to the petition?

9. Read or explain: What actually happened.

The Antiguan government approved the project. They sold the 53 acres of land to the developers for just US $100 - claiming the land was useless. The first phase of the project was preparation of the site by dredging a drainage channel to Mosquito Cove, and using the dredge and other material to completely fill the Jolly Hill salt pond and part of the adjacent Yorks salt pond.

10. Read or explain: How did this affect the environment?

Compare what actually happened with what the rapporteurs wrote on the board. Ask the rapporteurs to put a tick or a cross beside the predictions, as appropriate.

- Water visibility decreased due to large amounts of sand and mud particles in the water. This reduced the attractiveness of the area for divers.
- The dredging operation led to heavy siltation in Mosquito Cove and other bays down current.
- Sea grass beds in Mosquito Cove died because of the heavy siltation.
- Fish populations in Mosquito Cove declined.
- Sediments from the dredging operations killed most of the corals in Mosquito Cove.
- Hurricane Hugo stirred up the dredge material and made the sediment problems worse.
- The landscape was totally altered to look like a typical Florida marina complex.
- Mangroves, sea grapes and coconuts were bulldozed and burned, reducing coastal protection.
- Wildlife populations declined dramatically. Some species such as West Indian Whistling-Ducks, Blue-winged Teal, American Coot, Osprey and Bahama Pintail stopped using the site. Others such as shorebirds and herons declined in number.
- The villagers felt that the mangrove swamp used to buffer the village from the sea. They think that they would have suffered less damage from Hurricane Hugo if the swamp had not been destroyed.

11.What happened to the villagers?

- They lost the traditional place where young boys used to play in the mangroves and stalk birds with catapults.
- They lost the closest place to their village in which to fish for mullet, tarpon and other fish, or collect crabs and oysters.
- They lost access to the coconut trees which were a small but important source of food.
- They lost access to game birds, which are no longer present.
- They lost access to important grazing lands for goats and cattle, which have been restricted and posted
- They lost access to a high quality beach at Lignum Vitae Bay where water quality has declined.
- They lost access to the former village beach, at Jolly Beach. Although it is still theoretically a public beach, access is restricted by the fence around the hotel and the absence of an access road. In addition, many people object to the visitors' topless bathing habits.
- They lost a place to keep their fishing boats, which were displaced by dive boats, glass bottom boats and sailboats.

12. The un-jolly ending.

The project eventually failed. The expected benefits did not accrue to Antigua or the people of Bolans.

Assessment

Ask the students to draw pictures of how they imagine the area around Jolly Hill salt pond looked before and after the construction of Jolly Harbour.

Extensions

- Find out whether there have been any similar experiences in your country.
- Discuss what measures might have altered the outcome of this story.

Source Ann Sutton.

The information used in this activity came from:
Albuquerque, K. 1991. Conflicting claims on the Antigua Coastal Resources: The Case of the McKinnons and Jolly Hill Salt Ponds. Pp. 195-206, in Girvan, N. and Simmons, D. (Eds.) Caribbean Ecology and Economics Caribbean Conservation Association.

Activity 4-F

MIGRATION STORIES

Summary

Find out about migration and its importance to West Indian wetlands.

Learning Objectives

Students will:

- Understand the concept of migration
- Be able to differentiate between resident and migratory species
- List some common migrants that use Caribbean wetlands

Age Levels 6 +

Subject Areas Science, English, Geography

Time 1–3 hours

Materials

- Copies of the Copy Cat Pages: "Some Common Migrant and Resident Wetland Birds of the West Indies" and "Where do the BW Teal Come From?"
- Field guide to birds (see References)
- Paper and pencil

Background

Imagine having a summer home in North America and a winter home thousands of miles away in the Caribbean, enabling you to enjoy pleasant weather in the summer, but head south as soon as the weather started to get cold. Sounds good? Now imagine that you have to move between your two homes every year, without using any vehicle or map. Sounds impossible? For most people it would be, but many birds do this every year. One of the most impressive is the Blackpoll Warbler, (a bird which is not much bigger than a Bananaquit). It flies more than 7,000 km (5,000 miles) annually. In the summer, it takes advantage of warm weather and ample food supplies to breed in the boreal forests of northern Canada. By late August, it is stocking up for the 2,300+ mile journey across the Caribbean sea to its wintering grounds in South America. It manages this journey in just 80 hours non-stop! In spring, it flies back to its summer territory. Amazingly, it uses precisely the same winter and summer territories from year to year.

This phenomenon is called migration. Many animals migrate seasonally (e.g., salmon, caribou, monarch butterflies). North-south migration is most common, allowing birds to exploit good feeding conditions in North America during the breeding season, but then moving south when the weather gets cold and food becomes scarce. A few migrants (such as the Black-whiskered Vireo) do it the other way round. They breed in summer in the West Indies, then fly south to South America, to spend the rest of the year.

Many of our common West Indian wetland birds are migrants (in the Cayman Islands, up to 85% of the birds are migrants). Some migrants stay the whole winter, others use West Indian wetlands as staging posts (places to rest and feed) on the way to their final destinations. Other wetland birds are residents. They stay in the wetlands all year, and breed when conditions are right. A few examples of the more common resident and migrant wetland birds are listed on the Copy Cat Page "Some Common Migrant and Resident Wetland Birds of the West Indies."

Procedure

Find out about Blue-winged Teal

1. Explain that Blue-winged Teal are common migrants that visit wetlands in most islands in the winter. Where do they come from? The map and data in Copy Cat Page "Where do the Blue-winged Teal Come From?" show where Blue-winged Teal that were marked with numbered metal bands (banded) in North America and recovered in Jamaica came from. Hand out copies of the worksheet. .

2. The students should write the numbers in the appropriate states on the map of North America and the West Indies and determine the flyways used by the Blue-winged Teal using the information from the table.

3. Discuss: Where do most of the Blue-winged Teal that winter in Jamaica breed? Can the students find out what types of habitats they use and how many eggs they lay? What are the main threats to their survival? Do they visit your island? If so, answer the above questions. Where do they go?

Find out about other migratory birds

1. Find out whether any of the migratory birds listed in the Copy Cat Page "Some Common Migrant and Resident Wetland Birds of the West Indies" or any other migratory species come to your island.

2. Working in groups or individually, select a common wetland migrant bird species and try to discover where you might find this bird in your country. Where does it go in summer? What is its migration route? What threatens its survival?

Assessment

Write a real or fictional story about the life of a migratory bird. What problems does it face at each stage? What can people do to help?

Extensions

- Organize a field trip to watch migrant birds.
- Monitor a wetland near your home or school at least once a month for a year. What migrant birds can you see? When do they arrive? When do they leave?
- Invite an ornithologist (e.g., from you local bird club, protected area, or university) to come and talk to your school about migratory birds.

Whistler says...

Did you know that in some mountainous islands even resident birds migrate? Birds that breed in the high mountains in summer often spend the winter in the lowlands.

Some Common Migrant and Resident Wetland Birds of the West Indies*

	MIGRANTS	RESIDENTS
Pelicans		Brown Pelican
Frigatebirds		Magnificent Frigatebird
Herons and Egrets	Great Blue Heron	Great Egret Snowy Egret Little Blue Heron Tricolored Heron Cattle Egret Green Heron Yellow-crowned Night-Heron
Stilts		Black-necked Stilt
Ducks	Blue-winged Teal	West Indian Whistling-Duck White-cheeked Pintail
Plovers	Black-bellied Plover Semipalmated Plover	Wilson's Plover
Sandpipers	Spotted Sandpiper Greater Yellowlegs LesserYellowlegs Least Sandpiper Western Sandpiper Semipalmated Sandpiper	Willet
Swallows	Barn Swallow	Bahama Swallow (endemic to the Bahamas)
Martins	Purple Martin	Caribbean Martin (migratory on some islands)
Warblers	Northern Waterthrush American Redstart	Yellow Warbler

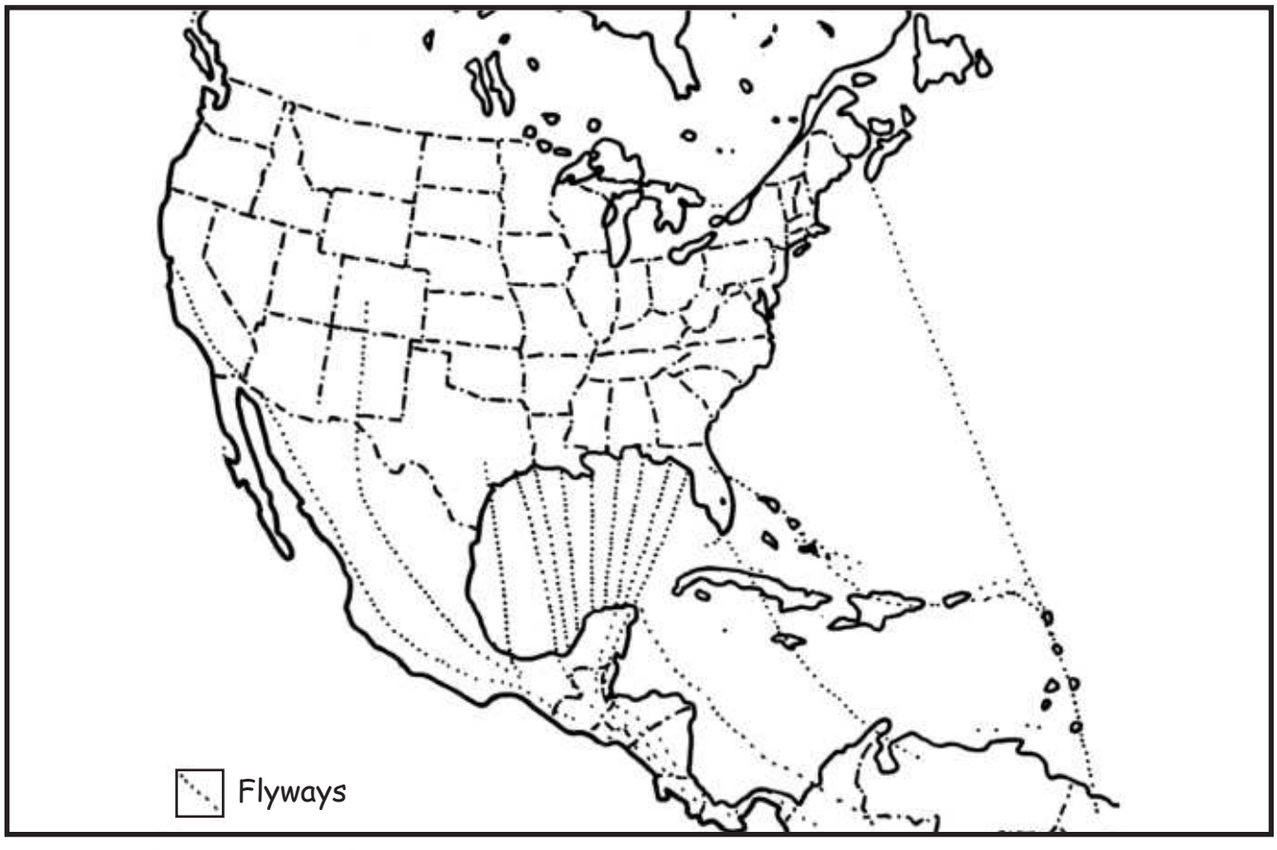
*The abundance of these species varies from island to island.

COPY CAT PAGE

Where do the Blue-winged Teal Come From?

Recoveries of Blue-winged Teal in Jamaica 1960-2000	
WHERE BANDED	NUMBER RECOVERED
Alberta	7
Cuba	1
Illinois	1
Iowa	1
Manitoba	10
Maryland	1
Massachusetts	1
Minnesota	5
Mississippi	3
Montana	1
North Dakota	3
New Brunswick	1
Nova Scotia	2
New York	4
Ohio	1
Ontario	4
Oregon	1
Rhode Island	1
Saskatchewan	5
Wisconsin	2
Data provided by Office of Migratory Bird Management, USFWS	

Major Flyways of North America and the West Indies



COPY CAT PAGE

Activity 4-G

MIGRATION HEADACHE

Summary
Students play a game illustrating how the loss of wetlands habitats affect the survival and reproductive success of migratory waterbirds.

Learning Objectives

Students will be able to:
- Describe the role of the West Indies for migrating birds
- List three factors that increase migration success
- List three factors that reduce migratory success
- Describe at least one action that will improve migration success

Age Levels 7 +

Subject Areas Science, Social Studies; also suitable for science clubs and youth groups

Time 2 consecutive lessons (30-45 minutes)

Materials
- One paper plate for every student or every two students, depending on class size
- Large outdoor area, such as a playing field, gymnasium, or basketball court.

Background

(See Copy Cat Page "Some Facts about Bird Migration")
Many factors influence the survival of migratory birds. One of the most important requirements is the availability of good habitat on both the wintering and breeding grounds as well as along the migration route. In some years, there will be enough food, water, shelter, and space to meet the habitat requirements of the birds. In other years, survival may be limited by a shortage of one or more of these elements.

Variation in conditions is a natural feature of any habitat. Natural variation in temperature and rainfall causes changes in the amount of available food and water within and between years. Population sizes fluctuate in response to this variation. In recent years, however, populations of many migratory birds declined steadily. These declines have been attributed to a loss of habitat, both on breeding and wintering grounds, and at stopover habitats along migration routes where birds rest and "refuel" for the next leg of the journey.

Procedure

Begin in the classroom with an introduction to migration. In this activity, the hazards of migration have been simplified and treated as though they mainly occur at the wintering or breeding grounds. In fact, many of the hazards are faced en route.

Remind the students that they represent the entire North American population of waterbirds (many hundreds of thousands of birds). The activity focuses on the factors that cause the death of thousands of birds, rather than factors (like predation) that act on a few individuals.

Note to the teacher
Be sure to create one or more "disaster" years to illustrate catastrophic loss of large areas of available habitat. The greatest long-term threats to the survival of populations of migratory shorebirds and waterfowl are the continuing losses and degradation of habitat. This activity should end with fewer areas of available habitat than can accommodate all the "birds."

Playing the game

1. Find a large playing area about 20 m (22 yards) long. Place the paper plates in two patches, one at each end of the playing field (see diagram).
2. Initially there should be one plate for every two students at each end of the field. When "wetlands" are in short supply only two "birds" will be allowed to a "wetland" (two students to a plate). Designate one end of the field "nesting habitat" (northern United States and Canada) and the other "wintering habitat" (the West Indies). Choose one or two students to remain at each end (wintering and nesting habitat). Explain that they are the referees and in charge of the paper plates. When you ask, they must remove or replace the paper plates. In the event of a fight between migrating birds as to whom got to the plate first, the referees will decide. Have one or two students keep a record on the blackboard of the number of birds at each round.

3. Explain to the students that they are wetland birds commonly found in the West Indies in the fall, winter, and spring, and that they will migrate between the two areas at your signal. Ask them to name a few species (ducks e.g., Blue-winged Teal; shorebirds e.g., Black-bellied Plover; seabirds, ospreys, kingfishers, warblers e.g., Northern Waterthrush).

4. Explain to the students that at your signal, they will migrate between the two areas. Explain that the plates represent suitable wetland habitat at each location and that by playing this game, they will learn about the consequences of habitat loss for migratory birds. Instruct the students that at the end of each journey, they will have to have one foot on a paper plate in order to continue, with no more than 2 students per plate. If they cannot get their foot on a plate, that means they have not found any suitable habitat. They "die" and have to retire to the sidelines and watch. During migration, the birds may want to "flap their wings," moving their arms like birds in flight.

5. Explain the Rules of the Game, below:

- "Birds" move (migrate) only on command, from one end of the field to a plate at the other end of the field.
- Referees judge which students arrive first to the plate. (Remember no more than 2 students to each plate).
- Referees remove and replace the plates (habitat) as told by the teacher.
- Any "bird" not reaching a plate is removed from the game.
- The winners are the "birds" still playing when the game ends.

6. Round One Begin the activity with all the students at the wintering habitat in the West Indies. Start the first migration. Let the children move slowly until they become familiar with the rules, then speed up. On the first try, all the birds will successfully migrate to the nesting habitat in North America. Explain that there has been no loss of available habitat. Thus, a successful nesting season is at hand.

7. Round Two Before the students migrate toward the wintering habitat, have the student referees remove two plates from the wintering region. Explain that a large wetland has been drained and used for condominiums and a golf course. Repeat the instruction to migrate, and send the birds to the wintering habitat. Have the three or four students that didn't make it stand on the sidelines. Tell the students that these birds have died as a result of loss of habitat. Remind any "dead birds" that they will have a chance to get back into the activity. They can come back as new, young birds born in the North American breeding grounds. Note: The next round will result in a large number of students waiting on the sidelines to re-enter the nesting habitat. Allow two to four young birds to join in Round Three.

8. Round Three Before the next migration to the nesting region, remove four plates in the nesting habitat. Tell the students that there has been a catastrophic habitat loss because a train derailed and spilled a toxic chemical into the wetland just as all the migrants were arriving. Instruct the students to migrate.

9. Round Four Repeat the process for eight or 10 migration cycles to illustrate how changes in habitat availability and conditions affect the survival and reproductive success of migratory birds. Remember that the activity should end with fewer areas of available habitat than can accommodate the birds. Try to think of some real life examples of wetland disasters from your own country or use some of the ideas listed below.

N.B. Choose the number of plates added or taken away according to the severity of the impact in such a way as to keep the game going. Remember to put back plates after something positive happens, and to allow players back into the game after a good breeding season.

- A severe drought in south-central Canada leads to a huge increase in grain prices and many wetlands drying up. Farmers respond by draining even more wetlands so that they can bring this land into agricultural production; remove some plates from the breeding grounds.

- Lots of rain during the fall in the West Indies. Plenty of wetland habitat and food available for wintering migrants this year; add some plates to the wintering grounds.

- The U.S. Fish and Wildlife Service purchases a degraded and polluted wetland along the East coast in the United States. They restore the habitat for migratory shorebirds. Very successful reproduction this year. Add some plates to the breeding grounds and a few individuals back into the game.

- Several Caribbean islands have open hunting seasons during the winter. There is little enforcement of hunting laws and many birds are shot. The amount of lead shot in wetlands increases, causing further mortality. Remove a few plates from wintering ground.

- Large country in the West Indies joins the Ramsar Convention on Wetlands (see Ch. 5). Wetlands are effectively protected. Add some plates to wintering ground.

- Disease spreads to waterbirds from captive birds in New York. Many die. Remove some plates from breeding grounds.

- Expansion of tourism throughout the West Indies results in hotels being built on many wetlands. Remove some plates from wintering grounds.

- Habitat restoration project recreates a large West Indian wetland. Add plates to wintering grounds.

Optional: A "hunter" can be introduced to the game. The hunter stands on the sidelines and tries to "kill" migrating birds by throwing a foam ball(s) at them. If hit, the "bird" has died and must come out of the game.

Discussion/Reflection

Review the information in Copy Cat Page "Some Facts about Bird Migration." Make a line graph showing the change in bird population size over time. What have the students learned from playing the game? Remind students that variation in conditions is a natural feature of any habitat, but that there has been huge-scale loss and degradation of habitat throughout the Americas.

Which changes are short-term? Which long term? Which are the birds more likely to recover from?

Which changes are gradual? Which are sudden and catastrophic? How are the effects of these changes different?

What can you do on your island to improve migratory success?

Evaluation/Assessment

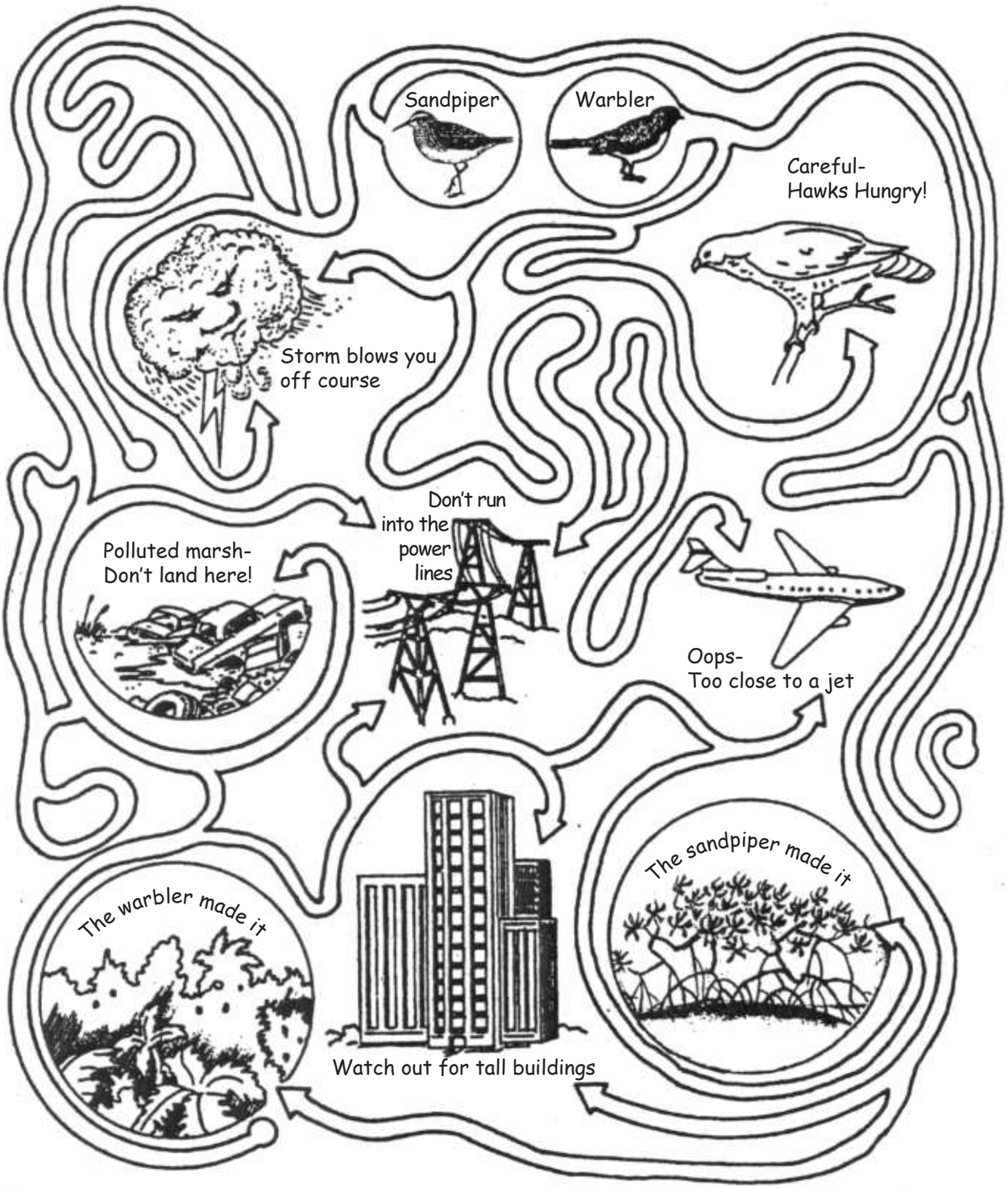
Students should write an essay about bird migration.

Extension

Ask students to do Migration Maze (see Copy Cat Page "Migration Maze") to reinforce their understanding of problems encountered by migrating birds.

Source Adapted from Aquatic Project Wild.

Migration Maze



COPY CAT PAGE

Some Facts about Bird Migration

Bird migration is an amazing natural phenomenon. Every autumn, after breeding, millions of birds leave their breeding grounds and head for their wintering grounds, often thousands of miles away. Of course it's not only birds that migrate. Can you think of other animals that migrate? Many fish (e.g, salmon snapper, eels), mammals (e.g., caribou, wildebeest, whales), and insects (e.g., Monarch butterflies).

Why do birds migrate?

To avoid the winter, and take advantage of better feeding conditions.

Where do they come from and where do they go?

Most of the migrants in the West Indies come from North America, following one of the major flyways. Many of them fly from Alaska to southern South America. They cannot complete the whole journey at once, so they make stops to rest and "refuel" on the way.

Major flyways of North America
See copy cat page 134

How do they find their way?

They may use landmarks, the sun, the stars and even the earth's magnetic field. However they do it, they manage to find their way with astonishing accuracy from point to point.

What types of birds migrate?

A huge variety of birds – ducks, geese, swans, cranes (some go to Cuba), ibises, herons, rails, egrets, gulls, terns, shorebirds, passerines, and birds of prey.

What is happening to migratory birds?

Some migratory species of waterbirds are in decline. Scientists think that the loss and degradation of wetlands caused by human activity (such as draining of wetlands, destruction of nesting cover, and pollution of water supplies) is one of the main reasons for the decline. When habitat is destroyed or disturbed, birds are likely to face shortages of water, shelter, and suitable habitat in their wintering and nesting areas, as well as at "refueling" and resting stops on the flyways. Of course, natural conditions such as drought, flood, storms, fire, disease and predators also affect their survival.

What factors encourage migration success?

- Effective preservation of wetlands
- High rainfall
- Restoration of habitat
- Dynamic balance with predators and diseases
- Wetland conservation measures such as habitat restoration, public education
- Effective regulation and control of hunting and harvesting of waterbirds, their eggs and young.

What factors reduce migration success?

- Drainage of wetlands
- Drought
- Pollution
- Expansion of towns into wetlands
- Conversion of wetlands into agricultural lands
- Conversion of rivers and streams into canals
- Illegal or uncontrolled hunting
- Lead shot in wetlands
- Disease
- Introduced predators and competitors.

COPY CAT PAGE

Activity 4-H

WHISTLERS' WHEEL OF TROUBLE

Summary

Students make a wheel that shows why the West Indian Whistling-Duck is threatened with extinction and will disappear unless immediate action is taken to conserve it.

Learning Objective

Students will understand

- Why some species of wildlife, such as the West Indian Whistling-Duck, are endangered.

Age Levels 7–14

Subject Areas Science, Social Studies

Time 40–60 minutes

Materials

- Pictures of West Indian Whistling-Ducks (from the West Indian Whistling Duck Colouring Book)
- Copies of Copy Cat Sheet "Whistlers' Wheel of Trouble" (one per student or pair of students)
- Copies of Copy Cat Sheet "Trouble for Whistlers" (optional, but if used one per student or pair of students)
- Lightweight paper plates at least 23 cm (9 in) in diameter (two per student or pair of students)
- Crayons or markers
- Scissors
- Glue
- Tape
- Paper fasteners (one per student or pair of students)
- Backing card

Background

Why are West Indian Whistling-Ducks (Whistlers) in trouble? The reasons include destruction of wetlands, unregulated hunting and poaching, pollution, and introduced species. Many other wetland species are in trouble, for the same reasons. Using the Whistling-Duck as an example, students can learn about the types of problems that affect many endangered species.

Preparation

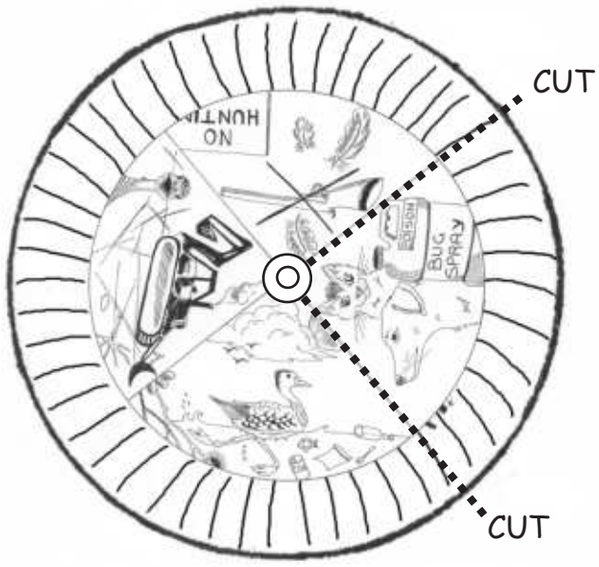
Before the class, make up enough pattern pieces to supply at least eight to every twenty five students. Make them as follows:

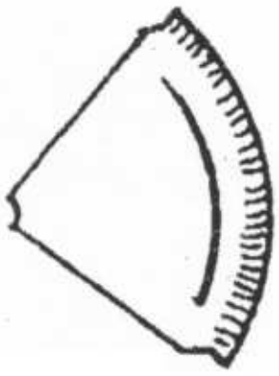
a) Take a copy of Copy Cat Page "Whistlers' Wheel of Trouble." Cut around the outer and inner circles, to make a doughnut shape with a hole in the centre. Then tape the paper ring lightly to the back of a paper plate (see below). Mark the plate into quadrants with a "hub" in the centre.

b) Cut out the four segments, as shown. Cut right to the edge of the plate but don't cut through the circle in the centre.

c) After cutting the plate into four segments, remove the original paper, which should now be in four pieces.

d) Use the pieces to cut out four more segments from another plate, and so on until you have enough for the class.





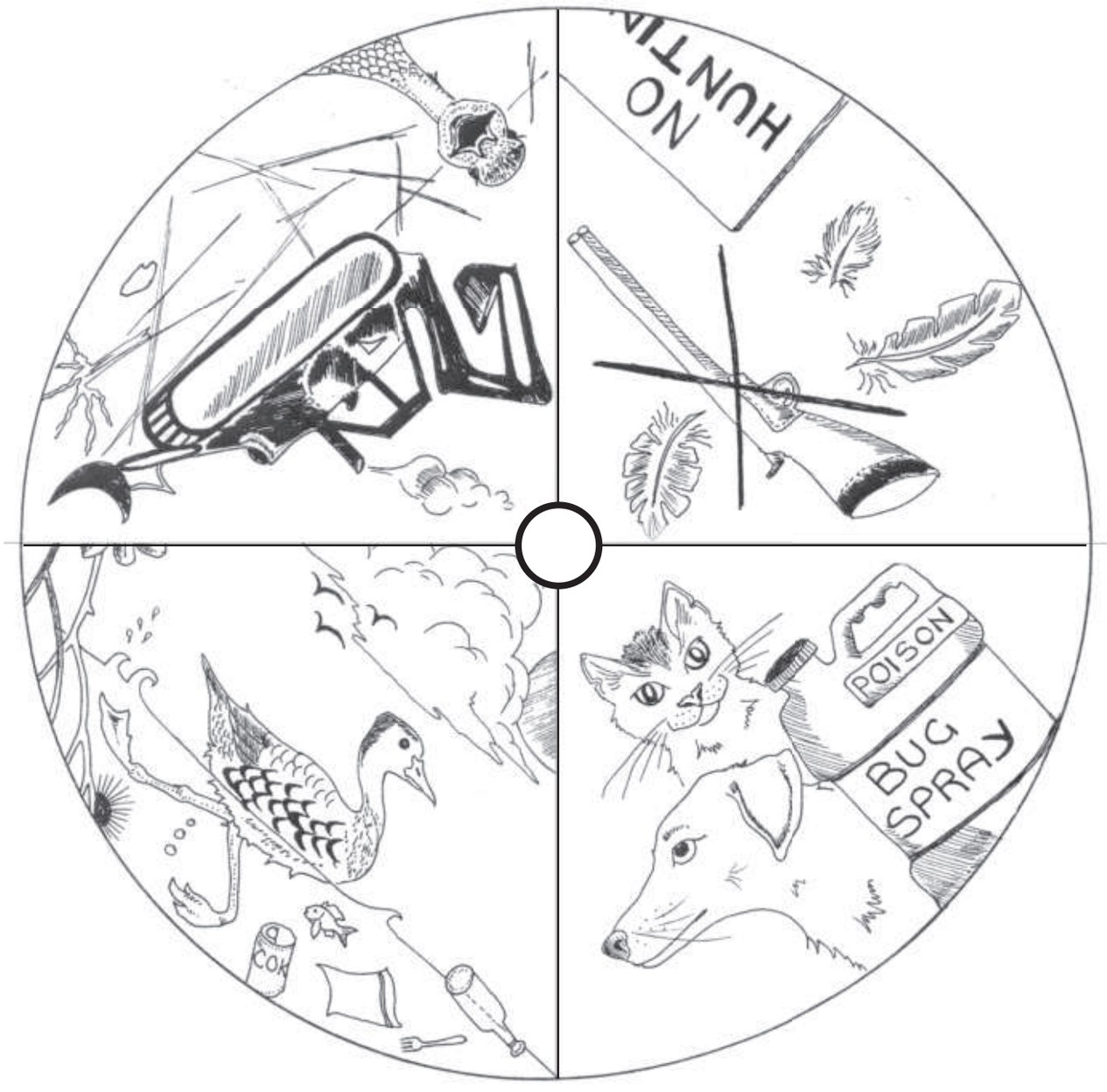
EACH PATTERN PIECE SHOULD LOOK LIKE THIS

Procedure

1. Show the class pictures of West Indian Whistling-Ducks and discuss their natural history.
2. Remind the students that Whistling-Ducks are endangered. Explain to the class that they will be learning why by making a "Wheel of Trouble".
3. Give each student a copy of Copy Cat Page "Whistlers' Wheel of Trouble" and two paper plates. They should also have scissors, glue, a paper fastener, and crayons or markers.
4. Hand out the triangular patterns and ask the students to share.
5. Tell the students to colour the pictures on the Copy Cat Page "Whistlers' Wheel of Trouble," then cut out the circle along the solid outer line.
6. Each student should then glue the circle onto the back of one of their paper plates. (Tell the students to use a thin layer of glue). They should set this plate aside.
7. Then they should place their triangular pattern on the front of the other paper plate so that the edge of the pattern meets the edge of the plate. Next they should trace and cut out one triangle shape. Trace the line for the other three patterns and color the three shapes different colors.
8. The next step is to ask the students to place the cutout plate on top of the plate with the pictures (back to back) and push a paper fastener through the centre of both plates.
9. As the students turn the top or bottom plate, each of the four pictures will appear in the cutout space.
10. Explain that these pictures illustrate the four major problems facing West Indian Whistling-Ducks.
11. The students can turn their wheels to picture A, then B, and so on, meanwhile you can use the information under "Trouble for Whistlers" to talk about each of the problems in turn.
12. After your discussion, ask the students to draw a picture of a West Indian Whistling-Duck on their top plate and write the title "Why West Indian Whistling-Ducks are in Trouble."
13. Discuss other threatened species (e.g., sea turtles, iguanas and parrots). Why do students think their populations are declining? Do the same four categories of threat apply?
14. Discuss how these threats can be addressed (see also Activity 4-J)

Source: Adapted from Ranger Rick's NatureScope: Endangered Species

Whistlers' Wheel of Trouble



COPY CAT PAGE

Trouble for Whistlers

A. Meat and eggs.

Unregulated hunting and poaching is a major problem for the West Indian Whistling-Duck. They are shot—often mistaken for other ducks—for food, and their eggs are also sometimes eaten. Overhunting has caused the West Indian Whistling-Duck to be eliminated from many islands where it was once plentiful.

B. Wetland Destruction.

In many places around the Caribbean, people have built homes, condos, marinas, hotels, roads, ports, power stations, tourist resorts, golf courses, and many other types of development where Whistlers nest and live. When mangrove wetlands are cut down and filled or drained for mosquito control, the duck's habitat may be completely destroyed.

C. Pollution.

Many wetlands have been (and still are) used as garbage dumps. This can harm Whistlers in many ways.

- Accumulation of toxins in the food chain occurs when pollutants and other toxic products (e.g. sewage, oil, pesticides, industrial waste) leak into the water and enter the food chain. Ultimately these toxins will kill the wildlife, including ducks.
- Destruction of habitat, as productive wetlands are filled by garbage.
- Pollution can also kill Whistlers directly. If birds feed in a place, such as a mudflat, where oil has been spilled, the oil may coat their feathers, preventing them from flying and ultimately killing them.

D. Introduced Species.

For many hundreds of years, the Whistler thrived in the absence of predators. When mongoose, raccoons, rats, cats, and dogs were introduced, Whistlers were preyed on, and having few defences, were especially vulnerable. These animals hunt and kill the Whistlers and eat their eggs and young.

COPY CAT PAGE

Activity 4-I

SURVIVAL!

Summary

In this activity students play a simple game, and learn about how some of the challenges facing West Indian Whistling-Ducks can be addressed.

Learning Objectives

Students will:

- Know the life history of the duck
- Understand the natural and man-made challenges facing the ducks
- Recognize that many of these challenges can be addressed
- Be able to identify some of the local, national and international actions that can help to conserve West Indian Whistling-Ducks

Materials

For each group of 2-6 players:

- Die or twister (see Copy Cat Page "How to Make a Twister")
- Copy of game board-Copy Cat Page "Survival"
- Coloured buttons or pieces of coloured card to use as counters (one for each player)
- Set of Challenges and Solutions cards in separate piles, prepared from Copy Cat Pages "Challenges and Solutions"

Age Levels 8 +

Subject Areas Science

Time About 10-20 minutes per game

Preparation

- Prepare the materials above.

Procedure

1. Begin with an introduction to West Indian Whistling-Duck's status, distribution and life history.
2. Explain that this game will help students to understand the challenges that West Indian Whistling-Ducks face, and some of the actions that are necessary to help them.
3. Divide the students into groups.
4. Players throw six to start.
5. If a player lands on a C square, s/he picks up a Challenge card, reads the instructions aloud, places the card at the bottom of the pile and moves as directed, picking up cards until s/he lands on a plain square.
6. If s/he lands on a S square s/he picks up a Solution card, reads it aloud and follows instructions. The player's turn ends when s/he lands on a plain square.
7. The first person to reach the end wins.

Extension

The Challenge and Solution cards can also be used to play a different game, described below.

Whistler Memory

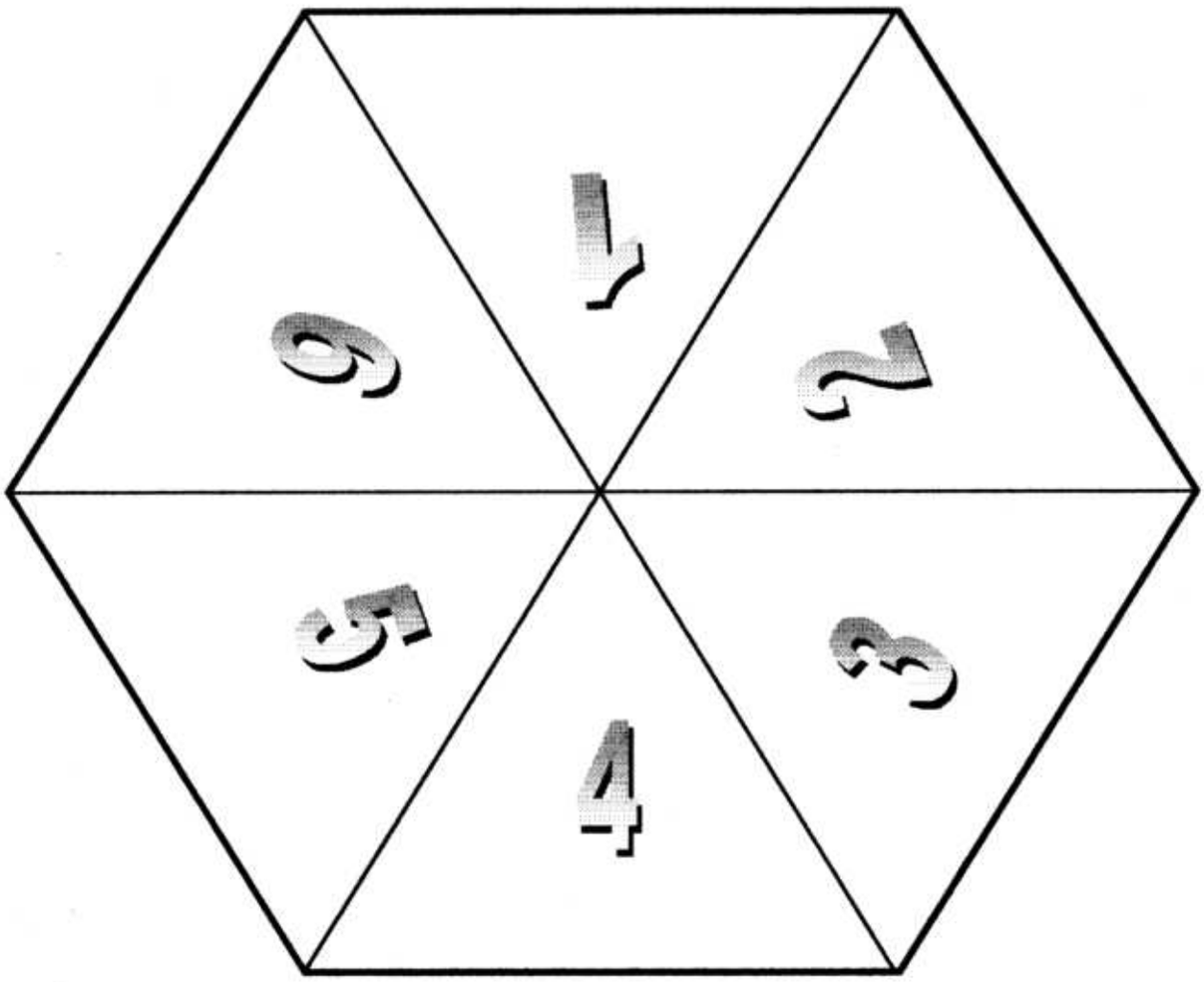
Preparation

Cut up the Challenge and Solutions cards and paste each onto a separate piece of stiff paper (e.g. file card)

Procedure

1. Place all the cards face down on table.
2. The first player turns over a card and reads what it says.
3. They then turn over another card and reads it. If the rest of the players agree that the two make a pair, i.e., a challenge and the appropriate solution, the player takes up the pair and tries again, until they fail to make a pair. Then the next player tries.
4. The person who collects the most pairs is the winner.

HOW TO MAKE A TWISTER



1. Stick the pattern to a piece of card
2. Cut out around the outside of the hexagon
3. Push a sharpened pencil through the centre of the card
4. Twist…

COPY CAT PAGE

Challenges and Solutions

Challenges	Solutions	Challenges	Solutions
Thatch fronds harvested – nest site disturbed. Go back 2.	New protected area includes thatch palms. Nesting success increases. Go forward 2	Mangroves converted into fish farm. Habitat lost. Go back to START.	Abandoned fish pond restored to wetland – new habitat created. Go forward 20
Tourists harass ducks to get a better view. They abandon area. Go back 10	Public education programme ensures people respect ducks and comply with laws. Go forward 10	Parent ducks shot illegally. Chicks die. Go back to START.	Wardens employed. Effective protection from hunting, duck population increases. Go forward 20
Chicks eaten by mongoose. Go back 6	Predator control programme reduces mongoose population – nesting success increases. Go back 6	Rats introduced. Eggs eaten. Go back 6	Predator control programme eradicates rats from island – nesting success increases. Go forward 6
Herbaceous marsh drained for agriculture. Go back 5	New protected area includes roosting habitat in herbaceous marsh. Go forward 5	Limestone forests felled for charcoal. Nowhere to breed. Go back 4	New protected area includes breeding habitat in limestone forest. Go forward 4
Mangroves converted into hotel. Nowhere to roost. Go back 5	New protected area includes mangroves. Go forward 5	Mudflats dredged to make beach. Less food available. Go back 3	New protected area includes feeding habitat on mudflats. Go forward 3

COPY CAT PAGE

Challenges	Solutions	Challenges	Solutions
Swamp forest trees cut for timber. Nest site destroyed. Go back 3	New protected area includes nesting habitat in swamp forest. Go forward 3	Fires lit in wetland – nests and feeding areas damaged. Go back 3	Fire control programme implemented – nests and feeding habitat saved. Go forward 3
People in boat come too close to nest – nest abandoned. Go back 2	Zoning system implemented in protected area – people excluded from key nesting habitat – nesting success increases. Go forward 3	Too much water taken from river for irrigation – wetlands dry up. Go back 5	Waters in wetland controlled by dykes, key habitats kept wet. Go forward 5
Adult and chicks run over by car on way from nest to water. Go back 6	Warning signs installed on roads – fewer ducks run over. Go forward 6	Forests near wetland cleared. Soils erode and fill wetland. Go back 5	Reforestation of hills – reduces flooding and erosion. Go forward 5
Dunder dumped in river – water polluted. Go back 4	Sugar factory recycles wastes – river pollution reduced. Go forward 4	Pesticides from vegetable farms run off into river. Water polluted. Plants and animals die. Chicks die of starvation. Go back 4	Public education and law enforcement improve the way people use pesticides. Go forward 4
Adult caught in trap. Go back 4	Public education and enforcement reduce illegal hunting. Go forward 4	Sea level rises from global warming – wetlands flooded. Duck habitat lost. Go back 2	Kyoto Treaty adopted (reducing global warming) and implemented. Sea level rise controlled. Go forward 2.

COPY CAT PAGE

Challenges	Solutions	Challenges	Solutions
Hurricane! Nest blown away. Go back 6	Wetland healthy and protected. Recovers quickly from hurricane damage. Go forward 6	Pig farm stops feeding ducks – birds starve. Go back 8	Feeding programme at pig farm – population increases. Go forward 8
Population so small that adult cannot find mate. Ducks die out. Go back to START.	Scientists reintroduce ducks from another island. Go forward 20	Global warming contributes to severe drought – chicks die of starvation. Go back 2	Your country joins effort to reduce global warming. Go forward 2
Disease spreads from domestic ducks to wild ducks. Many die. Go back 5	Quarantine regulations improved. Chance of introducing diseases reduced. Go forward 5	New coal-fired power station to be built in wetland. Habitat destroyed. Go back 8.	Wetland nominated as Ramsar site. Power station relocated. Go forward 8.

COPY CAT PAGE

SURVIVAL

START				C		S	S				C
		C				S	C		S		
S					C				C		S
			C				S		S		C
C											
						C	S				S
	S		S				C	C	C		S
S											
						C		S			
		C			S						
						C	S	C	S	C	
C					C						S
C											
S				C		S		C			You survived!

COPY CAT PAGE

Activity 4-J

WEST INDIES THREATENED WETLAND SPECIES POSTER

Summary

Many species of animals and plants throughout the Caribbean are endangered or threatened with extinction. This activity will make students aware of the causative factors.

Learning Objectives

Students will:

- Understand which wetland species are endangered regionally and locally
- Design a poster featuring an endangered wetland animal and its habitat(s), the threats and possible solutions.

Age Levels 8+

Subject Areas Science, Arts

Time Two or more class periods

Materials

- Copy of Copy Cat Page "Some West Indian Species at Risk"
- Drawing Paper
- Crayons, markers or coloured pencils
- Camera (optional)
- Postcards and/or photographs from magazines

Background

Clean air, safe drinking water, healthy crops – all of these depend on the protection and maintenance of our earth's biodiversity.

Biodiversity - short for biological diversity – is the extraordinary variety of life on earth, from genes and species to ecosystems and the valuable functions they perform.

- Genetic diversity, the genetic variation found within each species, is extremely important to the survival of species. It allows species to adapt to changing conditions and resist new diseases. It allows us to develop disease-resistant and high-yielding agricultural crops.

- Species diversity, the millions of plants, animals, and microorganisms that inhabit the earth, represents the range of evolutionary and ecological adaptations of species to particular environments. Species diversity supplies us with food, fiber, shelter, medicines, and countless other products. The many different kinds of plants and animals that occupy an area and their physical environment together make up an ecosystem.

- Ecosystem diversity - our forests, grasslands, coral reefs, deserts and wetlands - provides us with life sustaining "ecological services," such as keeping our air and water clean, controlling droughts and floods, moderating climate, and pollination of our crop plants.

All levels of biodiversity interact with and influence the others; they are connected in a "web of life." All are therefore necessary for the continued survival of species and natural communities, including humans. In addition to the many roles that biodiversity plays in sustaining human life, biodiversity also contributes to our quality of life. Nature inspires us with wonder, respect, and curiosity and is an unsurpassed source of relaxation, rejuvenation, beauty and peace.

The Caribbean islands have a rich heritage of biodiversity. They may not be as rich in total biodiversity as equivalent areas on the mainland, but they make up for this by their outstanding heritage of endemic species. (**Endemic** species are restricted to a single geographic area, for example, a Cuban endemic species would be found only on Cuba).

Scientists have become increasingly concerned over the rapid decline of the earth's biodiversity. Extinction is a natural process, but biologists estimate that human activities have increased the rate of extinction to several hundred times greater than the natural rate. Air and water pollution, invasive species, global climate change, deforestation, and urban sprawl and other land use changes are destroying and damaging habitats throughout the world and threatening ecosystems and species with extinction.

Habitat destruction is the leading cause of species extinctions around the world. The huge growth in human population (from 1 billion in 1850 to 2 billion in 1930 to 6 billion in 2000) has led to the conversion of wetlands and other habitat into land for homes, highways, businesses, industry and agriculture. As each habitat disappears, its unique plant and animal life also disappears.

Many species in the Caribbean have been classed as **extinct**, **endangered** or **vulnerable** by the World Conservation Union (IUCN) according to its ranking system, designed to determine global conservation priorities. **Endangered** species are species whose numbers have been reduced to the point that the survival of the species is unlikely, if present trends continue. **Vulnerable** species are those that may become **endangered** in the near future because their populations are decreasing in size throughout their range. **Extinct** species are no longer known to exist in the wild.

Island species are especially vulnerable because they have evolved with a limited number of competitors, predators, and diseases. When non-native species are introduced onto islands, they frequently outcompete or prey on the native species, which have not evolved any defenses against them. The introduction of rats, cats, dogs, raccoons, and mongoose has caused the decline of many species throughout the Caribbean, especially the birds and reptiles that are killed or lose their eggs through predation.

Preparation

Use the list of West Indian endangered species to develop a short list of animals that occur or used to occur on your island. Add others, if necessary.

Procedure

1. Using the Background material above, introduce the concept of biodiversity, explain why it is important, and the reasons for its decline.
2. Have each student select an endangered animal from the list provided on the Copy Cat Page.
3. Ask the students to do some research on the ecology of their chosen animals and the ways in which its existence is threatened.
4. Using what the students have learned about "their" creature, the students should create informative posters featuring their endangered species. The poster should show the name of the species, what it looks like, where it breeds, where it feeds, why it is important, threats to its survival and solutions to these threats. Encourage them to include colourful drawings and large text.
5. Have students share their research by giving a presentation on their chosen endangered species to the class, using their poster as a visual aid.

Extension

- Make a display of the posters in a central area of your school, public library or sports complex to create greater awareness of endangered species in your region.

Source Adapted from various sources by Lisa Sorenson and Martin Keeley.

Whistler says: **Endemic** species are species that are only found in one place. For example, a Barbudan endemic species, such as the Barbuda Warbler, is only found in Barbuda. West Indian Whistling-Ducks are West Indian endemics because they are only found in the West Indies. Some Caribbean islands (especially Cuba, Hispaniola and Jamaica) are ranked among the most important oceanic islands in the world for their high levels of endemism.

Some Examples of Threatened Species in the West Indies*

Birds

Bahamas Parrot (Bahamas)
Cayman Brac Parrot (Cayman Brac)
Cayman Parrot (Grand Cayman)
West Indian Flamingo (Caribbean)
West Indian Whistling-Duck (Caribbean)
Black-capped Petrel (Cuba, Dominican Republic, Haiti)
Zapata Rail (Cuba)
Barbuda Warbler
Bermuda Petrel (Bermuda)
Cuban Kite (Cuba)
Gundlack's Hawk (Cuba)
Ridgeway's Hawk (Hispaniola)
Trinidad Piping-guan (Trinidad)
Piping Plover (migratory, Caribbean)
Grey-headed Quail-dove (Cuba, Hispaniola)
Bay-breasted Cuckoo (Hispaniola)
Jamaican Blackbird (Jamaica)
Whistling Warbler (St. Vincent and the Grenadines)
Yellow-billed Parrot (Jamaica)

Reptiles

Turtles

Hawksbill Turtle (tropical seas)
Leatherback Turtle (tropical seas)
Green Turtle (tropical seas)
Loggerhead Turtle (tropical seas)

Crocodiles

American Crocodile (Greater Antilles)

Iguanas

Turks & Caicos Iguana (Turks and Caicos, Bahamas)
White Cay Iguana (Bahamas)
Exuma Island Iguana (Bahamas)
Anegada Island Iguana (British Virgin Is.)
Rhinoceros Iguana (Hispaniola)
Ricord's Iguana (Dominican Republic)
Mona Island Iguana (Puerto Rico)
Lesser Antillean Iguana (Lesser Antilles)
Little Caymans Iguana (Cayman Is.)
San Salvador Iguana (Bahamas)
Andros Island Iguana (Bahamas)
Cuban Iguana (Cuba)
Jamaican Iguana (Jamaica)

Snakes

Cuban Tree Boa (Cuba)

Mammals

West Indian Manatee (Caribbean)
Caribbean Monk Seal (Caribbean)

Molluscs

Queen Conch (Caribbean)

COPY CAT PAGE

*Visit BirdLife International's website to find information on Caribbean globally threatened birds: www.birdlife.org.uk/worldwide/regional/caribbean/biodiversity.html
For information on other threatened species visit: www.redlist.org/

Activity 4-K

THE ALIENS: ISLAND INVADERS

Summary

This exercise will introduce students to the idea that many of the animals and plants seen in Caribbean wetlands are native, while others are not and were introduced by people. Introductions can be deliberate or accidental, beneficial or harmful.

Learning Objectives

Students will appreciate that:

- Some familiar wetland plants and animals are not native.
- There are many reasons why plants and animals are introduced.
- Planned and unplanned introductions can have unexpected or negative effects.

Age Levels 9 +

Subject Areas Science, History, Geography

Time 30-60 minutes

Materials

- Pictures of the appropriate species from the Copy Cat Pages or field guide
- Pencils and paper
- Copies of Copy Cat Pages "Can You Spot the Aliens?" and "Some Introduced Species Found in Caribbean Wetlands."
- Some labels.
- Drawing pins.
- A few strands of coloured wool.

Preparation

Try to find out about introduced species in your country. Adapt the lists of plants and animals accordingly.

Background

Animals and plants spread naturally around the world, taking advantage of suitable conditions in new places. Once, their movements were limited by availability of suitable habitats and by natural geographic barriers (water, mountains, desert). Every place evolved a unique combination of native or indigenous plants (those that belonged). Some places also evolved their own endemic species. Changes happened slowly. However, human activity has altered this.

Species that do not naturally occur in a habitat but were brought there by people are called i**ntroduced, alien**, **exotic**, or **invasive species**. While many fare poorly when introduced to a new environment, some respond in exactly the opposite manner. Free from their native competitors, predators and diseases, some species thrive in their new home and their populations grow exponentially. Left unchecked, some introduced species (now called invasive), can transform entire ecosystems and out-compete or consume native species to the point of extinction.

The first introduced species arrived in the West Indies with the Arawaks, Tainos, Caribs and other early inhabitants of the Caribbean. They carried many of their favourite species of plant with them, such as sweet corn, cassava, guava, pawpaw, tobacco and avocado pear. Later the Spanish released goats, sheep, donkeys, horses and cattle wherever they went. These animals found ample food and no competition so they multiplied (at the expense of **native** species).

Other European and African settlers brought species that they thought might be useful like coconuts, breadfruit and mangoes. While people were bringing species that they wanted, pest species such as rats and mice were hitching rides. Cats followed the rats and once ashore, destroyed seabird colonies. Parasites (e.g., ticks) hitched rides on hosts (e.g., cattle). Urbanised species of mosquitoes arrived with plants and containers of water, introducing deadly diseases.

This process continues today. The increasing globalization of our economy, with its extensive travel and shipment of goods between continents, brings an ever-increasing number of new invasions. A recent example is the Pink Mealybug that was carried accidentally by travelers from the Far East to the Eastern Caribbean, where it wreaked havoc on plants on several islands. It was spread among islands by travelers who took fruits, plants and flowers with them. The Green Mussel came to the Caribbean from Australia by hitching a ride in bilge water. It was pumped out when the ships' tanks were emptied and cleaned and is spreading rapidly in our wetlands and displacing native species.

This movement is not all one way. A common Caribbean bird, the Ruddy Duck, was taken to England to be put on show in a large collection of waterfowl. They bred successfully in captivity and a few escaped. Their progeny are busily colonising Europe, where they are out-competing a native duck – the White-headed Duck.

When an invasive species begins to become a problem, people often try to control the problem by introducing natural predators from the place where the species originated. This can be effective. For example, Pink Mealybugs in the Eastern Caribbean have been controlled by the introduction of predatory wasps. However, introducing predators to control pests can backfire – remember the song about "She swallowed the spider to catch the fly"! In mid-eighteenth century in the Caribbean, introduced rats were a serious problem in sugar cane plantations. The Indian Mongoose was introduced to many Caribbean islands with the expectation that it would prey on the rats. Too late, people realized that the mongoose was active during the day, the rats at night. Just ten years after their introduction to Jamaica, mongoose were pests themselves, destroying domestic chickens and wiping out wild birds.

Invasive species represent an unprecedented world-wide ecological experiment and are one of the most serious global environmental challenges we face. Caribbean islands must take action to prevent new introductions and must control existing introduced species, in order to preserve their native plants and animals and most importantly their unique heritage of endemic species.

Some introduced species found in or near some Caribbean wetlands and their effects are listed in Copy Cat Page "Some Introduced Species found in Caribbean Wetlands."

Measures to control introduced species include:

- Eradication programmes. Eradication of rats on the offshore islands of Antigua has increased populations of the Antiguan Racer (a snake) and West Indian Whistling-Ducks.
- Carefully planned and managed introductions of predators or diseases.

Measures to prevent introduction of species include:

- Laws that prohibit importation of fresh fruits and vegetables (that could harbour pests).
- Laws that restrict importation of animals and their release into the wild.
- Strict quarantine and plant hygiene programmes at ports.

What you can do:

- Never carry fresh fruits, vegetables or plants when you travel between islands.
- If you have any introduced pets, make sure that they cannot escape (e.g., during a hurricane).
- Have your cat or dog sterilised to stop it from reproducing.

For more information on invasive species, visit these websites:

http://www.invasivespecies.gov/
http://www.invasive.org/
http://www.issg.org/
http://tncweeds.ucdavis.edu/index.html

Additional reading:

Invasive Species Threats in the Caribbean Region: Report to the Nature Conservancy. Prepared by M. Kairo, B. Ali, O. Cheesman, K Haysom and S. Murphy. CAB International.

Whistler says...

Introduced rats, cats and mongoose are one of the most important causes of the decline of West Indian Whistling-Ducks. The introduced animals prey on eggs, chicks and adults ands thus reduce nesting success. Whistling-Duck populations increase rapidly after the rats, cats and mongoose have been eliminated.

Source Ann Sutton and Lisa Sorenson

Procedure:

1. Explain that the purpose of this exercise is to introduce the idea that some wetland animals and plants are native, while others are non-native.

2. Distribute the Copy Cat Page "Can You Spot the Aliens?" list or write it on the board. Ask students to suggest which species are native, which introduced. Use Copy Cat Page "Introduced Species" to inform the discussion.

3. Discuss: Once the students have identified the introduced species, initiate a discussion about why and how species are introduced and spread. Cover both intentional and accidental introductions.

4. Demonstrate where animals and plants came from using Copy Cat Page "Some Introduced Species Found in Caribbean Wetlands." If students have copies of a world map, they should mark where the animals came from. Otherwise, place coloured pins on the class map (if available). Use wool to join the places to your island. Label each pin with the name of the species.

5. Explain that sometimes introductions go wrong and species become pests. These are known as invasive species. Why do some introduced species become problematic? Make up a table with three columns: the name of the species, positive effects and negative effects. Rank the effects in order of importance.

6. Discuss how introduction of species can be prevented. How can introduced species be controlled if they become pests?

Assessment

Imagine that a fish farmer has proposed introducing a foreign shrimp to your local wetland. Suggest at least five questions about its expected positive or negative effects that must be answered before the decision is made.

Extensions

Aliens Research:

Each student should choose an introduced animal or plant and write a short illustrated research paper, answering the following questions.

- Where did this species originate?
- How did it get to this island?
- Was it brought deliberately or accidentally?
- If brought deliberately, why?
- If brought accidentally, how?
- When was it brought?
- Is it a problem? If so, in what ways?
- Is anything being done to control it?
- Are the measures successful?

Aliens Quiz:

Each student should also make up 5 quiz questions about the species they have chosen. Each question should be on a separate piece of paper. Put all the questions into a bag.

Divide the class into teams of 4-6 students. The number of questions in the bag should be an exact multiple of the number of teams. Select a quiz master and a scorer. Let the teams sit together in groups. Decide the order in which teams will answer questions. The quiz master selects a question from the bag. Team members may consult about the answer. If they get it wrong another team may answer. The team with the most correct answers will win.

Reintroductions

Sometimes native species become so rare in the wild that the only hope of saving them is to breed them in captivity (e.g. in a zoo) and then reintroduce them to areas from which they have been wiped out. Is this the same as introducing introduced species? What are the risks? Find out more about programmes to reintroduce species.

Endemics

Find out more about the endemic species that are found on your island. Have they been affected by introduced species?

CAN YOU SPOT THE ALIENS?

Examples of introduced and native wetland species

PLANTS	MAMMALS	AMPHIBIANS AND REPTILES	BIRDS	FISH	INVERTEBRATES
Casuarina	Cow	Cane Toad	Bananaquit	Jack	Pink Mealybug
Red	Hutia	Anoline Lizard	Cattle Egret	Mosquito	Firefly
Mangrove	Mouse	Snake	Parrot	Fish	Spider
Water	Rat	Whistling Frog	Shiny Cowbird	Snook	Ticks
Hyacinth	Mongoose	Iguana	Bullfinch	Tarpon	Crabs
Water Lily	Bat	Crocodile	Yellow Warbler	Tilapia	Fire Ant
Mango	Manatee	Leatherback Turtle		Bonefish	Redclaw Crayfish
Royal Palm					

COPY CAT PAGE

Activity 4-L

A HUNTER'S TALE
To hunt or not to hunt?

Learning Objectives

To encourage students to:

- Consider the ethics of hunting, its effects on wildlife and the environment, and
- Examine their own attitudes towards hunting.

Subject Areas Social Studies, English, General Studies; also suitable for Youth Groups

Time About 45 minutes.

Materials The story included in this section.

Age Levels 8 +

Background

Since prehistoric times, Caribbean people have hunted native wild animals. Even though there is no need to do so, many people still hunt for food or sport. Wetland species, including ducks, doves and pigeons are popular targets. Mostly, hunting is regulated by the government. There are gun licences, hunting permits, regulations on open seasons, and lists of how many and which species may be taken. These laws were introduced to protect game species from over-exploitation, but they are not always well enforced.

To hunt or not to hunt? People who love hunting tend to feel strongly that they should be allowed to do so. Some say that they need the additional food. Others find it an enjoyable form of recreation, a great way to be outside in the wild with their friends. In many families there is a long tradition of hunting, and fathers love to teach their sons to hunt. To them, hunting is part of a time-honoured process, a link to the wild and the traditions of their fathers. . Hunters can help to protect wildlife in many ways. In some islands, especially the Bahamas, hunters have led the movement for protection of wildlife and their habitats, working closely with scientists and conservationists. Working together they have had great success, using the results of scientific research to enhance hunting while at the same time protecting wildlife.

In the Caribbean, as in North America and Europe, hunters established some of the first protected areas. Unfortunately, there are few properly managed hunting preserves in the Caribbean. Few islands, except Cuba and Puerto Rico, collect the baseline scientific information needed to make rational decisions about hunting, e.g., to set season dates or bag limits, and to decide which species can sustain hunting. Hunters' licence fees may provide funds for law enforcement and conservation. In Cuba hunting is a tourist attraction, but few islands have sufficient game for this to be sustainable. Most hunters respect the law, but a few who break the law give other hunters a bad reputation.

People who are opposed to hunting also have a wide range of opinions. Anti-hunters feel that it is simply wrong for people to kill animals, or that hunting animals causes unnecessary suffering and pain to animals. Non-hunters may not oppose hunting in principle, but may object in practice. They may think that specific decisions about hunting are not based on good science; that recommended hunting levels are not sustainable; that wildlife laws are not properly enforced; or that the taxpayer should not have to subsidise hunting. They may be concerned about the direct or indirect effects of hunting on endangered species, such as West Indian Whistling-Ducks. They may observe that ecotourism and hunting cannot work together in the same place, and that sometimes the former can bring more revenue to their island.

There are many different attitudes to hunting – but few people are indifferent. This is an opportunity to explore how and why people form strongly-held opinions about hunting and for students to explore their own positions.

Preparation

No special preparations are necessary, although it might be useful to obtain information about local hunting.

Procedure

1. Discuss the introductory material above. Each student should take about 5 minutes to write down a brief account of his or her own feelings about hunting.
2. Read the story aloud to the class.

A Hunter's Tale

It was a sunny September afternoon. The heat shimmered off the marsh. In the dappled light under the arching roots of a red mangrove, something strange was happening. For a month, a pair of West Indian Whistling-Ducks had tended their nest of sticks, lined with soft grasses. They had protected their precious milky-white eggs from sun and rain, and driven off predators, such as cats, rats and mongses. Now something was stirring. As the female turned the eggs, she heard a faint peeping call coming from one of them and noticed that one was cracked. Gradually a small beak poked out, the opening widened and a bedraggled brown chick emerged on its shaky legs. Within a few hours, the other chicks had hatched and there were twelve fluffy, stripy ducklings. Throughout the night, the adults tended the ducklings, taking turns to fly out to find food.

With the first light of morning, the female set off with her brood, walking across the swamp to a pool where they would find shelter and food while they grew into young adults. In single file, the day-old ducklings followed their mother, struggling through the dense grass and shrubs. At last they reached the water, and, driven by instinct, hopped straight in, swimming and splashing. There was another splash as a large pair of jaws closed. One chick would never be seen again – a morning snack for a hungry crocodile.

Fifty years ago, this marsh was full of West Indian Whistling-Ducks. Day and night, their wistful cries echoed across the open water and mangroves. Then men came with traps and guns. The ducks were juicy and sweet. Every evening the ducks flew out of their daytime roosts to visit their favourite feeding grounds on the mudflats by the sea. Every morning they flew back to the mangroves to idle away the day, squabbling and preening. Dawn and dusk the hunters were waiting, whilst other men destroyed the duck's habitat. They cut down the mangroves and built towns and resorts. There was less space and less food for whistlers. Their numbers declined.

Not far away, on that same September afternoon, someone else was celebrating a birthday. Just home from school, Dennis was thinking about his eighteenth birthday party. All his family and friends would be there. He wondered whether Kerisha, the prettiest girl in the school, would come. He also wondered what his parents would give him for his birthday. A new CD player perhaps, or those new name-brand sneakers he coveted?

It was after six o'clock when his father came home from work. There was still no sign of a present. Perhaps his parents thought he was too grown up for presents now?
"Dad, have you got me a birthday present?" he asked.
"Hold on Dennis," his father smiled, "You're nearly grown up now. Remember birthdays are not just for presents. As you get older you get new responsibilities too."
"My goodness," thought Dennis. "That's all I'm getting for my birthday – a lecture. I wish he'd give me a break."
"Yes, Dad," he said a bit sheepishly. He looked down. "I know."

When he looked up, his face changed. His father had produced, as if from nowhere, a long flat box, wrapped in shimmering paper and tied with ribbon.
"What can it be?" Dennis was intrigued. Certainly none of the things he'd asked for.
"This belonged to your grandfather. His father gave it to him when he was your age" his father said.
"Oh no," Dennis thought, "Something second-hand."
"Your mother and I have decided that you are old enough to have it now. This is something very precious. It can bring you much pleasure, but it also brings responsibility. We know you will look after it and use it responsibly."
What could it be? Carefully he opened the present and could not believe what he saw. In the box, gleamed an old shot gun, the faithful companion of his grandfather, through many a bird season. Trembling with excitement, he drew it out, and, careful not to point it at anyone, lifted it to his shoulder. There it nestled like an old friend.

He thought of all the times that he had accompanied his father and grandfather on hunting expeditions. The early morning departures, the long treks through muddy swamps to find the best pools for ducks, the long wait for birds to arrive, the excitement as the bird boys shouted "Mark" and the line of guns exploded. Afterwards, the tired tramp back to the club, the fellowship of exchanging the stories of the day, and finally the bird feast. Next time he would be among the proud men with their own guns.

As if he read his thoughts his father said, "We will have to apply for your gun licence and hunting permit as soon as possible, so that you are licensed for the coming season." Dennis could hardly speak, he was so happy.

Dennis thought the months to the opening of the season would never pass. One day his father took him to the skeet club to practice his marksmanship. They spent glorious days there together as his father taught him how to hit a moving target. These were very special times for Dennis and his father. Between sessions, they talked man-to-man of many things, but mostly of his father's special hunting memories. Dennis was fascinated by his father's stories, proud that his father was sharing his past with him. Whenever he could, he went to the skeet club to practice. When they had a competition, he entered. His father was delighted when Dennis won the junior cup. But always, in the back of Dennis' mind, there lurked the fear that no matter how good he was with skeet, he might not be able to manage a living target. He was anxious to prove that he was worthy of his father's love.

Meanwhile, in the swamp, the ducklings were flourishing. Protected by their parents in the sheltered pond, they gorged on fallen Royal Palm seeds and grew rapidly. After two months, they were nearly as big as their parents. No longer were they downy and insignificant, with webbed feet that looked several sizes too big. Now they strutted on their long legs, heads erect on their long necks, flaunting the elegant pattern of dark and light spots on their sides. One day they climbed to the top of a nearby tree and took their first flights on newly feathered wings. Now they were able to join their parents on their nocturnal trips to the feeding grounds.

Christmas holidays arrived. Dennis' family seemed to be thinking about nothing else. Bored by his mother's preoccupation with shopping and cooking, Dennis decided to wander down to the swamp.

"Just going out for a bit, Mum," he called to her as he left. She looked up at her almost-grown-up son, so tall and manly, and yet so young. He was already taller and broader than his father. She wondered what life had in store for him.

It was late afternoon as he took the trail down to the swamp. Dennis wasn't expecting what he saw. The pond below teemed with life. He recognized the dark-gray coots with the white bar from their beaks to their forehead (his father said it was called a frontal shield), and the brown jacanas, lily-trotting on their spindly green-yellow legs, hunting for snails.He noticed the bright red frontal shields of the charcoal-coloured moorhens. With a gasp of excitement, he saw what he was looking for. There was a raft of small ducks. The males had white crescent moons behind their bills; the females were brown and plain. Then the silence was broken by a loud, peeping chatter, made by a group of black and white birds with long red legs. Their calls alerted the ducks to his presence. As a group, the ducks rose from the water. They whirled and twisted and he saw bright blue patches in their wings as they turned away. One thousand ducks flying as one! It was impressive. They settled not too far away and he went on watching as the light faded over the hills and the sky was lit by pink and blue rays that caught the clouds, fringing them with gold.

Then he heard something he had never heard before. Far away, he heard a faint whistling cry, the echoing calls of some wild and beautiful creatures. And they were getting closer. As he watched, the West Indian Whistling-Ducks flew out of the sunset. To his amazement they landed, very quietly in the water in front of him. Awestruck, he watched them. He was astounded by their size and grace, their elegant colours, their proud walk. He watched and watched as night fell, and he could hardly find his way back home in the dark.

He might have known his mother would be cross. She had been worried; didn't know what was happening; he might have been eaten by a crocodile; everyone had been kept waiting; dinner was spoiled. However, Dennis' heart was full of the vision of seven birds arriving as if by magic, on the sunset swamp. He was sorry to upset his mother, but something else was bothering him more.

Next day it was still bothering him. He gathered up his courage and asked his father about it. He wanted to know what sort of birds he had seen the night before. "Oh, they must have been West Indian Whistling-Ducks," his father replied.
"Dad," he asked, "When we go shooting, we won't be shooting them, will we?"
"No. It's illegal," his father replied, "but accidents sometimes happen."
Dennis read everything he could about West Indian Whistling-Ducks. He found out that they are only found on the Greater Antillean islands and a few of the northern Lesser Antilles and nowhere else in the world. Once they were plentiful. Now there are probably fewer than 10,000 left. Hunting and destruction of wetlands contributed to their decline.

He found himself drawn back to the swamp. One day he came across a pair of old binoculars at the back of a cupboard. Now he could see the birds much more clearly. He saw several new birds that he had never noticed before. The next day he went to the library and borrowed a field guide. With its help he found out that the ducks with the white crescents were Blue-winged Teal and the noisy, long-legged black and white birds were Black-necked Stilts.

He studied the pages on ducks. Blue-winged Teal were the most common. To his amazement, Dennis read that they bred in the far north of America, in the small marshes called prairie potholes, in the northern Great Plains. Every winter they flew south, every spring they formed pairs and flew north to breed.

One day, he was amazed to see a duck with a bright blue bill, swimming across the pond. It had a white patch on its cheek and a strange tail that stuck straight up in the air. When the duck reached the dense floating plants on the edge of the water he seemed to settle down into the water. As Dennis watched this Ruddy MaskedDuck drake, he suddenly became aware that the drake was not alone. He was surrounded by the brown striped faces of the female and her five youngsters. They had been there all the time but were so still, and so well camouflaged that they were almost invisible.

The more he watched, the more Dennis learned, and the more excited he became. His friends laughed at him for spending all his time in the swamp, but he couldn't resist going back, again and again. The birds of the swamp became his friends. But the West Indian Whistling-Ducks were always his favourites.

The hunting season was getting closer. He was excited but not as excited as before. Shyly he asked his father about hunting. When did he start? Why did he enjoy it so much? Would shooting the Blue-winged Teal disturb the other birds? What happened to a bird that was maimed but not killed? Was he sure that hunting birds was right, if you didn't really need the meat?

His father was alarmed.
"You're not turning into one of those bunny-huggers are you? To think that a son of mine would ask such questions!"
Dennis' mother took his side. "Leave the boy alone. Let him make up his own mind."

At last the long-awaited day came. The opening of the hunting season. For weeks, Dennis' father had been planning where to go. Guns had been taken out and cleaned, ammunition checked. Hunting jackets were washed and pressed, pockets filled with all the favourite gadgets. A picnic basket was packed. Before dawn they loaded up the truck and set off, accompanied by some of his father's friends. Dennis had never felt so grown up. He laughed at their jokes, but something inside was a little unsure.

To his horror, Dennis realised that they were heading straight for his favourite spot - the place where he knew almost every bird by name, where his beloved family of whistlers would be roosting. Dennis remembered the experiences of the summer, his awakening to the beauty of nature. He hardly heeded the preparations going on around him.
"Going to be a great day. There's plenty of ducks and we're downwind. Should be easy to get our bags."
Dennis' father mistook his distraction for tiredness.
"Wake up son!" he chucked him on the shoulder.
"This is your big day!"
Dennis sensed that his father was very proud to have a son to carry on the family hunting tradition. He mustn't let him down. He mustn't.

As if in a dream, Dennis found himself on the edge of the swamp, standing beside his father. His precious gun was in his hand. The shoot was about to begin. A thousand things ran through his mind. His hours of practice at the skeet club had paid off and Dennis knew he was one of the best marksmen in the club. How would he fare against the challenge of a living target? The excitement was almost too much to bear. How impressed everyone would be when he shot his first bird. Then he thought of the wonder of the living ducks. He wondered why he was about to shoot things that gave him so much pleasure when they were alive. They had come so far, and survived the winter, now he would put an end to their lives. After all, he wasn't even hungry. This was just for fun. Just for fun. He panicked. What if he made a mistake and shot a whistler by mistake? And there to his horror, he glimpsed the head of one of the whistlers nearby in the reeds. He prayed that the others hadn't seen it.

Still he was aware of the power of the gun in his arms. He wanted to be one of the men. His heart thrilled at man's power over nature. He felt part of an ancient and noble tradition of hunters, going back to the first man who had killed to provide his family with food. This was how it had always been.

Through his sights, he saw that the teal were getting closer.
"Remember - don't shoot until they fly" his father whispered in his ear.
Dennis still didn't know what he was going to do.

"It can't be wrong. People have always hunted," he thought. But the doubt remained. He released the safety catch. As he did so, the men beside him drew breath as one, raising their guns as the flock of teal rose from the water, the blue on their wings bright in the sunlight. He heard the rush of air through their extended wings, the splash of webbed feet, and watched as shining drops of water sparkled and fell back into the water, rippling the calm surface. In that fraction of a second, as the ducks soared and then wheeled towards the hunters, Dennis made up his mind. He would…

After reading the story

1. Ask each student to write how he or she thinks the story ends.

2. Discuss the possible endings for the story. How does Dennis feel? What would the students have felt and done if they were in his position? Stress that there is no right or wrong ending. Students must make up their own minds on the issue of hunting.

Evaluation/Assessment

- Students should write an essay about the arguments for and against hunting. In it they should express and justify their own personal opinions. Alternatively, have a formal debate on the moot "Sport hunting makes an important contribution to conservation in (your island)."

Extensions

- Ask students to do some research into hunting. Find out which agencies are responsible for administering hunting, law enforcement and liaison with hunters. Ask representatives from these agencies to come and give talks in your school.

- Find out which species can legally be hunted. Are any wetland species (e.g. ducks, coots, moorhen, White-crowned Pigeon)? What are the season dates, the bag limits? How much does a hunter's license cost and how old do you have to be to get one?

- What do the various interest groups feel about hunting? Ask representatives of hunters' clubs, non-government agencies, protected area managers, tourist interests to come to talk to the class.

Source Concept adapted from Project Wild.

Activity 4-M

AWAY WITH WASTE

Summary

Students will listen to a story and learn that the waste we "wash away" does not disappear, but later on can have harmful effects. Very few people ever think about what happens to waste-water after it goes down the drain.

Learning Objectives

Students will learn that:

- Every day waste can end up polluting our waterways
- To cut down on pollution we should all take responsibility for our actions

Materials

- Copy Cat Page "Away on the Bay" and copies of the "Water Pollution Fact Sheets"
- Drawing paper and markers
- Construction paper (optional)
- Stapler (optional)
- Glue (optional)

Age Levels 7 +

Subject Areas Language Arts; Science; also suitable for Science Clubs and Youth Clubs

Time 30–60 minutes

Preparation

Copy fact sheets and story pages (optional).

Background

In our everyday lives, we have developed various ways of getting rid of household items ranging from shampoo to laundry detergent, from car oil to drain cleaners. Very few people actually think about what ultimately happens to these domestically used pollutants that we dump down the sink or into the road. The Copy Cat Pages "Water Pollution Fact Sheets", together with the poem Copy Cat Page "Away on the Bay" clearly show what happens to this waste, and what we can do to help prevent it.

Procedure

1. Before reading the story, ask the students to name some of the ways they use water (e.g. for drinking, bathing, brushing teeth, cleaning clothes and dishes). Ask what they think happens to the waste water. Explain that many people never think about household waste water or the water that runs off their streets and yards.

2. Now tell the students that you will read them a story about a town called "Away," where people polluted the water in the nearby bay without realising what was happening. Ask the students to listen carefully to the story to find out just how the water in the bay became polluted. Also, tell them to listen for the word "away." Each time they hear it they should gesture with their thumb over their shoulder to represent something going away.

3. After you've read the story, discuss it with the students. Ask them if the waste from Away simply disappeared. *No.* What happened to the waste? *It ended up in the bay.* Then go over the verses in the first half of the story, to make sure the students understood what was happening in each one.

4. What would have happened if there was a wetland between the town and the bay?

5. Discuss what new measures Away must have put in place to deal with the waste that was no longer dumped in the bay. Include discussion of various methods of sewage treatment.

Assessment/Evaluation

- Ask the students to draw a picture of the story. Alternatively, some students might act out the words while others chant the rhyme.

- If you are working with older students, they may create their own picture book of the story. Pass out copies of Copy Cat Page "Away on the Bay". The students draw a picture for each verse, then glue the pictures on sheets of construction paper, copy the words of each verse onto the pages, and bind the pages.

Extension

- Have the students do their own "Home Enquiry" research project about how much water they use each day. At the next class, use the answers to generate a discussion on where the water goes in their houses.

- Could Away be on your island? Does your town have a central sewage system? How do people treat their sewage? Where is the dump? Do people dump garbage anywhere else? Does it enter the sea or rivers? What effects does it have?

Source Adapted from Ranger Rick's NatureScope: Pollution—Problems & Solutions.

Away on the Bay

This is the tale of a town called **Away**—
A town that was built on the shore of a bay.
A town where the folks didn't think much about
What they dumped in their water, day in and day out.

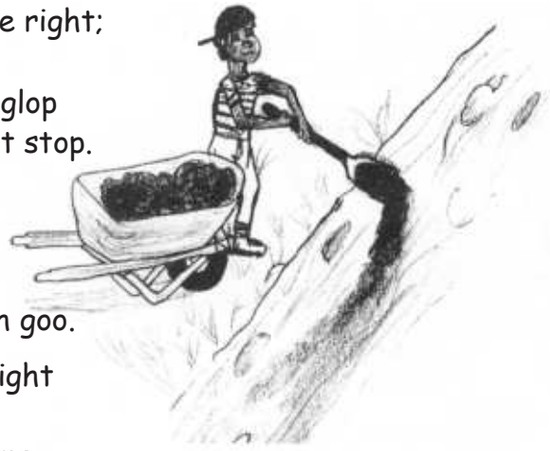
For one thing, a sink was an excellent place
To get rid of messes and leave not a trace.
Cleansers and cleaners and yesterday's lunch
Went **away** down the drain with a gurgly crunch.

At everyone's house there was laundry to do.
Day after day, how those laundry piles grew!
Load after load was washed, rinsed, and spun
And **away** went the water when each load was done.

On Main Street each day there were sidewalks to sweep.
The litter and dirt were swept into the street.
And then when it rained, everything washed **away**
Into drains in the road that dumped into the bay.

A mill there made "stuff" for the townfolk to use,
But a pipe from the mill churned out oodles of ooze.
And the ooze, well, it goozed from a pipe to the bay
Where it bubbled and glubbed as it drifted **away**.

Because the weather was warm, it was always a treat
To sail on the bay and bring picnics to eat.
But when folks were finished, they'd toss all their trash
Overboard and **away** with a plop and a splash.



Then folks started seeing that things weren't quite right;
The bay had become an unbearable sight.
Beaches and mangroves covered with garbage and glop
That rolled in with the waves—and the waves didn't stop.

The fish in the bay seemed all sluggish and sick,
The algae was everywhere—slimy and thick.
The birds near **Away** were all suffering too,
'Cause the fish they were eating were covered with goo.

The reefs where the coral was once pretty and bright
Began to turn white—a horrible sight.
And the tourists and divers who came all of the time,
Went **away** somewhere else, where things were just fine.

So a meeting was called to discuss the sick bay
And townspeople came from all parts of **Away**.
And during the meeting one person proclaimed,
"I know who's at fault: We all should be blamed."

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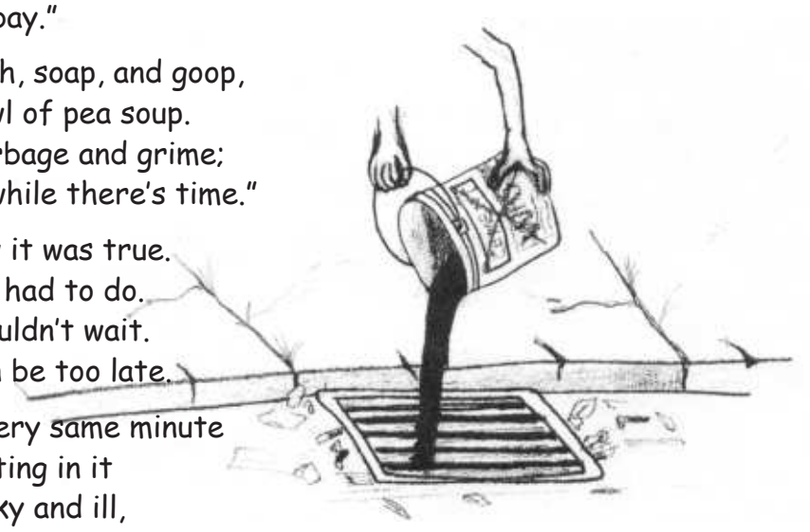
"For years we've washed chemicals, dirt, and debris
Down our sinks, off our streets, and out pipes—so you see,
Although we all thought that our waste went **away**,
It all ended up going down into the bay."

"Now the bay is a mess—full of trash, soap, and goop,
The water's turned green, like a bowl of pea soup.
And our wildlife is sick from the garbage and grime;
The bay needs our help, right now, while there's time."

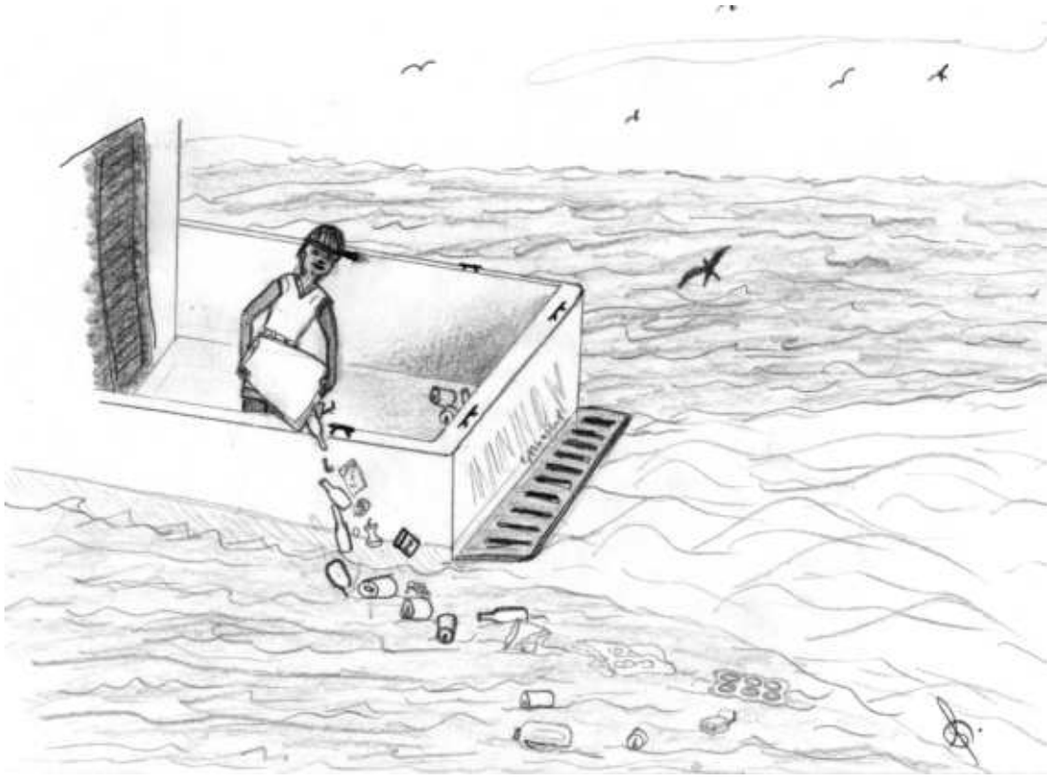


The folks were all silent—they knew it was true.
And they realised now what they all had to do.
It was time to get busy—the bay couldn't wait.
If they didn't act now, it might soon be too late.

So they signed an agreement that very same minute
To care for the bay and to stop putting in it
The stuff that had made the bay icky and ill,
Like soaps that pollute and the ooze from the mill.

They also agreed to stop dumping their trash
Overboard and **away** with a plop and a splash.
And all of the efforts have been a success;
Today the bay's clean and no longer a mess.

And that is the tale of the town called **Away**—
A town where the people, to this very day,
Remember a saying that's simple and plain:
Nothing just goes **away** when it's washed down the drain.



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WATER POLLUTION FACT SHEET

What are the main types of water pollution?

Water pollutants can be classified as chemical, biological or physical.

Chemical pollutants are water-soluble substances. Chemical substances can enter water sources through natural processes such as the leaching of minerals from soil, rocks, and mineral deposits. They can also enter water sources as a by-product of manufacturing processes and power generation, or through home use of chemicals. Organic chemical pollutants include oil and dyes, synthetic detergents, chlorinated hydrocarbons (DDT, PCBs), refined hydrocarbons, phenols and carboxylic acids. Inorganic chemical pollutants include acids, bicarbonates (acid salts), alkalis, chlorine, metallic salts, nitrates, phosphates, sulphates, hydrogen sulphide, and radioactive isotopes.

Biological pollutants include pathogens and aquatic plants and animals. It is obvious why pathogens (which are disease- causing organisms, such as bacteria, viruses, protozoans, fungi, algae, and parasitic worms) are pollutants. How can a plant or animal be a pollutant? The answer lies in the changes caused by human activities. For example, algae may be present naturally, but nutrients added by people can cause excess algal growth. They cover the surface of the water, block up canals and waterways and kill corals by growing over them. Once they have used up all the nutrients, the algae die and sink to the bottom, where bacteria feed on them. The bacterial populations increase and use up most of the oxygen in the water, and once the free oxygen is gone, many aquatic animals die. This process is called **eutrophication**. High nutrient levels can also result in blooms (called red tides) of toxic microorganisms or of jellyfish. Red tides often kill large numbers of fish. Jellyfish kill fish eggs and larvae.

Physical pollution

Physical water pollution includes solid matter – from tiny particles of soil suspended in water, to carcasses of animals and cars, dumped in waterways and wetlands. They may be washed into waterways by natural means or dumped by people. If they are present in larger quantities than nature can handle and purify, they are pollutants. Some examples include:

- Floating matter: foam and scum, wood and leaves
- Suspended matter: silt, sand, gravel, metal pieces, cinders, rubber, plastic, wood chips, paper, pulp, solid sewage material, animal carcasses.
- Thermal pollution: hot water or other substances, for example cooling water from power stations.

Where does water pollution go?

Remember that all the water in the world is linked. Sooner or later, it will all flow together – spreading its pollution. For convenience, however, we can look at two types of water, both carry pollutants into wetlands:

Surface water is easy to see: it's the water that flows in rivers and streams, that fills lakes, bays, oceans, and wetlands everywhere.

Groundwater is hidden from view. It fills the spaces between soil particles and rocks underground—a bit like the way water fills a sponge. Most groundwater comes from rain that has soaked into the ground, and sometimes it feeds lakes, springs, wetlands, and other surface water. Groundwater is stored in **aquifers** and fills underground reservoirs called freshwater lenses.

Many Caribbean people rely on groundwater for their drinking water (others use water from rivers, catch and store rainwater in cisterns for drinking, or get water from desalination plants). Groundwater is also one of the most important sources of irrigation water. Unfortunately, on nearly every island, some groundwater has become tainted with pollutants. In some large cities, such as Kingston, Jamaica, most of the wells have had to be abandoned because they are contaminated with nitrates from poor sewage disposal. Scientists expect that more and more groundwater will become unsafe for drinking as toxic chemicals dumped on the ground during the past several decades make their way into it.

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What does water pollution do?

The main types of pollution and their effects are summarised in the table below.

Effects of some pollutants on surface water and wetlands

TYPE OF POLLUTANT	SOURCE	EFFECTS
Chemical pollution – inorganic		
Pesticides (Insecticides, Herbicides, Fungicides) – include toxic and carcinogenic chemicals	Used on farms, gardens, golf courses, homes, factories, etc. to control unwanted plants and animals	Irrigation, groundwater flow, and natural run-off bring these toxic substances to rivers, streams, wetlands, and oceans, where they may accumulate in the food chain, kill beneficial plants and animals or cause cancer and other diseases.
Fertilisers – contain substances that promote plant growth, especially nitrogen and phosphorous	Applied to farms and gardens, the surplus gets washed away into surface and groundwater.	Nitrogen and phosphorus can cause blooms of algae, other microorganisms and jellyfish, as well as eutrophication, which contributes to reduced levels of oxygen in water. Conditions become unsuitable for many animals and plants.
Acid rain	Rain becomes acidic when sulphur dioxide produced by burning dissolves in it.	Some terrestrial plants and aquatic animals cannot tolerate abnormally acidic conditions.
Detergents, caustic wastes from bauxite processing, and many other synthetic industrial chemicals	These are often simply released to waterways, with no attempt to treat or contain them. They often come from mining and manufacturing industries, oilfield operations, agriculture, and natural sources.	Many of these substances are toxic to fish and harmful to humans. Some make drinking water unpleasant to drink. Some dissolve in water and are very poisonous at low concentrations. Others corrode water-treatment equipment. Some interfere with natural stream and wetland purification.
Chemical Pollutants – Organic substances		
Petroleum Products Oil and other petroleum products like gasoline and kerosene	From ships, oil refineries, power plants, gas stations, and streets. Fuel oil, gasoline, and kerosene may leak into groundwater through damaged underground storage tanks or enter aquifers after accidental spills	Oil spills kill aquatic life (fish, birds, shellfish and mangrove trees, coral) by physical damage, poisoning or suffocation. Beach tar may make sand so hard that burrowing animals like worms, molluscs, can no longer live there.
Organic wastes	Domestic sewage-treatment plants, sugar factories, rum distilleries, food-processing plants, paper mills, and leather-tanning factories release organic wastes that bacteria consume.	If too much waste is released, the bacterial populations increase and use up the oxygen in the water. Aquatic creatures, especially fish, die, if too much oxygen is consumed by decomposing organic matter.

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Effects of some pollutants on surface water and wetlands

TYPE OF POLLUTANT	SOURCE	EFFECTS
Biological pollutants		
Human and animal wastes contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery and other forms of diarrhea, hepatitis, flu, and the common cold are examples of diseases caused by water-born bacteria and viruses and spread in contaminated water.	Sewage seeps into the water where there are no treatment facilities. Many coastal towns in the Caribbean lack central sewage systems. They depend on property owners to treat their own sewage, using septic pits, or other systems. Many people cannot afford elaborate waste treatment systems. They use simple soakaways. If a soakaway pit is close to a river or the sea, there will probably be pollution. Catastrophes such as hurricanes, earthquakes and floods cause sewage treatment systems to break down, resulting in sudden severe pollution.	These diseases spread rapidly when sewage that has not been effectively contained or treated gets into ground or surface water. People and animals that swim or bathe in it get ill.
Physical Pollutants		
Sediments – Particles of soil, sand, silt, clay, and minerals wash from land and paved areas into streams, wetlands, and oceans. In large, unnatural quantities these natural materials can be considered a pollutant	Activities that increase sediments in run-off include: • Construction projects • Clear-cutting forests • Poor agricultural practices • Fires on hillsides and in wetlands.	Sediments may fill stream wetlands, converting them into less productive dry land. They may fill channels and harbours that later require dredging—and the dredging itself will stir up the same sediments. These sediments suffocate fish and shellfish populations by covering fish spawning areas and clogging the gills of bottom fish and shellfish. They also cloud the water and prevent sunlight from reaching wetland plants, sea grass and corals, causing their death.
Heat – Electric power plants and desalination plants use up large quantities of water as coolant in their steam turbines.	Heat reduces the ability of water to dissolve oxygen. The heated water is often returned to streams, lagoons, reservoirs, or the ocean. Desalination plants also produce large quantities of very saline water, which can damage the areas where it is discharged.	The loss of oxygen in the water harms fish, corals and other aquatic life. The same impact occurs with desalination plants, which heat up the water during the reverse-osmosis process, and then discharge it into the ocean.

COPY CAT PAGE

Activity 4-N

THE WATER CRIMINALS? – Guilty or innocent?

Summary

In this activity, students will learn to recognise some of the ways citizens pollute the water in their communities.

Learning Objectives

Students will be able to:

- Describe some common forms of domestic pollution
- Identify their effects
- Suggest what citizens can do to reduce them

Age Levels 9 +

Subject Areas Science, English Language.

Time 30-60 minutes.

Materials

At least one copy per student or pair of students of the following Copy Cat Pages:

- "The Water Criminals? The Accused"
- "The Water Criminals? Their Crimes"

Optional:

- "The Water Criminals? How They Were Reformed"
- "Water Pollution Fact Sheets" (from Activity 4-M)
- Chalkboard or flip chart
- Writing materials

Preparation

If your class has not already done Activity 4-M, you may wish to provide the Copy Cat Pages "Water Pollution Fact Sheets" from that activity to your students, to read (e.g., as homework) in preparation for this activity.

Procedure

1. Introduce the activity by discussing what water pollution is, where it comes from, how it spreads, and its effects.
2. Ask students to list some common types of water pollution that affect their communities. Write the suggestions on the board.
3. Explain that in the following activity they are going to try to find out whether some people from the community of Sand Island are "water criminals." Hand out the Copy Cat Page "Water Criminals? The Accused." The people described on the sheets have been accused by the community of being water criminals. They all think that they are innocent, but the students will have to be judge and jury. Hand out Copy Cat Page "Water Criminals? The Crimes." Tell the students to use the information on this sheet to identify which of the crimes each of the accused has committed. Then they should decide whether each one is guilty or innocent of a "Crime against Water."
4. Remind the students that many individual acts of pollution are very small but together they add up to a serious problem. This is what happens in many Caribbean communities.
5. Once the students have judged the accused, the next step is to pass sentences. The best sentence is to require the criminals to clean up their pollution and to refrain from polluting in the future. Lead a discussion about what crimes each of the criminals committed, how their activities affected the environment, and what each of the criminals could do in future to minimize the amount of pollution they produce. What the criminals did following their convictions is described in "The Water Criminals? How They Were Reformed."
6. This activity can also be done as a role play by holding a mock court trial. Divide the class into small groups. One group member plays the part of one of the water criminal characters. Other group members act as the judge, prosecutor and defense attorney. Each group presents their skit in turn, with the judge ruling on the case and handing out a sentence to reform. Encourage the students to use the information on pages 172 and 173 to present their case.

Extensions

Ask students to consider how they contribute to water pollution and suggest ways that they could reduce them.

Source Adapted from Ranger Rick's NatureScope: Pollution—Problems & Solutions.

Water Criminals? The Accused

NAME: JOE RAMOS

ADDRESS: Big Joe's Fruit Stand, River View Road, Sand Island

ACCUSED OF: Crimes against water

ABOUT JOE: Big Joe Ramos owns the largest farm on Sand Island. On the flat, fertile land beside the Sand River, he produces tomatoes, cucumbers, lettuce and cabbage. He also grows oranges and pineapples, and many other fruits and vegetables. People come from miles away to buy produce from him. Everyone knows that his produce is always perfect – never any sign of insect damage. Beside his farm he has a feed lot, where he keeps his pigs and beef cattle.

DO YOU FIND THE ACCUSED GUILTY OR INNOCENT?_____
WHAT CRIMES DID HE COMMIT?_____

NAME: LEILA KHALIL

ADDRESS: 34 River Bank Avenue, Sand Island

ACCUSED OF: Crimes against water

ABOUT LEILA: Leila Khalil is a student at the Sand Island College. A year ago she used all her savings from her summer job to buy a very old car, which is her pride and joy. She had to fix it up herself, replacing the battery and lots of engine parts, as well as respraying the body. Now she is proud that she can maintain it herself. She changes the oil regularly (disposing of the old engine oil by pouring it into the ditch beside the house), and washes the car every time she uses it. Despite all her work the car still drips a little oil, so she hoses down her parents' drive regularly. She tosses the old parts (including the battery), paint and oil tins over the hedge into the open lot next door. "The plants will soon grow and cover them up!" she says.

DO YOU FIND THE ACCUSED GUILTY OR INNOCENT?_____
WHAT CRIMES DID SHE COMMIT?_____

NAME: CONRAD SCOTT

ADDRESS: River View Apartments, Sand Island

ACCUSED OF: Crimes against water

ABOUT CONRAD: When he started his landscaping and golf course maintenance business about five years ago, Conrad had no idea how successful it would be. Now all the hotels around go to him, because the properties he maintains have the greenest lawns and gardens. In a recent interview, Conrad said, "I must be the biggest customer that "AgriChem" has in the island. I always use plenty of their fertilisers and weedkillers. I do not know how I would manage without them." Conrad is also a keen fisherman. "I used to love to go fishing in the pond on the golf course," he says, "but recently all the fish seem to have disappeared. I cannot imagine what has happened."

DO YOU FIND THE ACCUSED GUILTY OR INNOCENT?_____
WHAT CRIMES DID HE COMMIT?_____

COPY CAT PAGE

NAME: MARTHA JACKSON

ADDRESS: Martha's Gas Station, Main Street, Sand Island

ACCUSED OF: Crimes against water.

ABOUT MARTHA: Martha Jackson's small gas station, which she took over when her husband, Billy, died, is near the centre of town and has become a landmark. Every day Martha is there, selling gas, candy, sodas and other groceries. She loves to tell visitors about how she and Billy built the gas station when there was nothing else in Sand Island, except Big Joe's farm. Proudly, she points to where she and Billy carved their initials and the year "1958" into the wet concrete sidewalk above the underground storage tank. She does not show people the dump in the backyard, where there is an ugly pile of wrecked cars, car parts, oily rags and oil tins.

DO YOU FIND THE ACCUSED GUILTY OR INNOCENT?_____
WHAT CRIMES DID SHE COMMIT?_____

NAME: SABRINA RANKINE

ADDRESS: 24 River View Road,
Sand Island

ACCUSED OF: Crimes against water

ABOUT SABRINA: Sabrina is a full-time housewife with five children. On weekends, Sabrina watches her children play cricket or basketball. Between games, she spends a lot of time washing their dirty sports clothes and school uniforms! The clerk at the local store teases Sabrina about the huge amount of heavy-duty laundry detergent she buys. "Only the best for my boys!" Sabrina replies, "I don't economise on cleanliness."

Sabrina's house is close to the creek. It has five bathrooms. Although she has lived in the house for more than 20 years, she has never had to call a cesspit operator to empty the pit. "It must be a bottomless pit!" she jokes.

Sabrina has noticed that the creek is not the same as it used to be. "It used to be so clean and pretty," she says, "These days it is green, slimy and smelly. And just last week one of my boys got running belly after playing down there. Something must be wrong."

DO YOU FIND THE ACCUSED GUILTY OR INNOCENT?_____
WHAT CRIMES DID SHE COMMIT?_____

COPY CAT PAGE

Water Criminals? Their Crimes

1. **Polluting surface water.** When rain falls, some of the rain runs off over the surface and flows into storm drains, rivers and streams, which carry it to ponds, lakes, wetlands and the sea. If it flows over garbage, wastes, car fluids, or land that has been treated with fertilisers or pesticides, they will be washed into the water body too. Therefore, people should be very careful about where they dispose of wastes.

2. **Polluting groundwater.** When rain falls, some of the water soaks into the ground, where it joins the groundwater, carrying pollutants with it. Underground leaks in containers of dangerous chemicals, such as oil storage tanks and pipelines, may contaminate groundwater for years before anyone notices. Underground gasoline storage tanks often develop leaks after about 20 years.

3. **Careless disposal of sewage.** Sewage contains high levels of nutrients, bacteria, viruses and parasites. Effective sewage treatment is essential to ensure human health. In towns, the best solution is often a central sewage system. All the sewage is collected through a system of pipes and channeled to a sewage treatment plant. Sewage treatment plants provide varying levels of treatment. The simplest form is primary treatment, which simply removes the solids and the most dangerous organisms. Secondary treatment removes some of the nutrients, while after tertiary treatment water can be used for drinking. Few West Indian towns have central sewage systems, and even fewer have tertiary treatment. Instead, sewage is treated on a house-by-house basis, with various systems. Some of these can be quite effective, but if they are not properly maintained there may be serious problems. If sewage gets into the water, for example from a leaking cesspit, it causes eutrophication and disease.

4. **Excessive use of agricultural chemicals.** Thick, green lawns often get that way by being treated with chemical fertilisers and pesticides. These can be very dangerous to the environment. Excess fertilizer runs off into the surface water, causing eutrophication. Pesticides and herbicides can wash into waterways and poison fish and other creatures. All agricultural chemicals must be chosen and used carefully to avoid unnecessary damage to other living things.

5. **Careless disposal of oil.** Oil spreads over the surface of water, forming a barrier that stops oxygen from getting in. When the oxygen runs out, living things die. Old engine oil also contains many toxic chemicals.

6. **Careless disposal of solid wastes.** Old cars, car parts, paints and batteries contain many toxic chemicals. If they are dumped carelessly, these chemicals will pollute the soil and water.

7. **Excessive use of detergent and bleach.** Many detergents contain phosphates, which are nutrients that promote plant growth. Water in the Caribbean is naturally low in phosphates, so if water containing detergent (e.g., from washing) gets into it, plants, such as algae grow excessively.

8. **Excessive use of pesticides.** Crops grown with a lot of pesticides often look "perfect." When consumers demand that fruit and vegetables show no sign of insect damage, they encourage growers to use excessive amounts of pesticides.

9. **Careless disposal of animal wastes.** When a feedlot is placed close to a river and no measures are put in place to contain the wastes, the animal wastes will run into the water, and contribute to eutrophication.

COPY CAT PAGE

Water Criminals? How They were Reformed

What did the criminals do?	What effects did their actions have?	How did they mend their ways?
JOE: - Used too much pesticide on his produce in order to make his fruit look perfect. - Washed the empty containers in the river, adding to the pollution. - Located his feedlot too close to the river. - Did not dispose of the animal wastes properly.	The pesticides: - Killed the natural predators of the pests, so he had to use more and more pesticides. - The pesticides washed into the river where they killed the aquatic plants and insects. - The animal wastes from the feedlot enriched the water in the river (see below).	Following his conviction, Joe - Converted to organic farming. - Stopped using chemical pesticides. - Used natural predators to control pests. - Set up a biogas generator to use the feedlot wastes, and provide cooking gas. - Used the residues from biogas production as fertiliser. *Now his produce is even more popular, and his farm more profitable!*
LEILA: - Disposed of the oily wastes and old battery from her car badly. - Allowed oil to drip out of her car.	- Leila's waste engine oil washed into the river where it spread over the surface and killed fish over several hundred metres. - The lead from her battery got into the food chain and killed animals.	Following her conviction, Leila - Started to take all her old oil and batteries to an approved centre for recycling. - Placed a container under her car to catch any drips that she could not fix. *Leila's parents are happy because she uses less water to wash her car and their drive, so their water bills are lower.*
CONRAD: - Used too much fertiliser and pesticides on the golf courses and other properties that he looked after.	- The agrochemicals soaked into the ground water and ran off into the river. - The fertilisers enriched the water causing algae to grow which blocked out the sunlight. - The pesticides killed fish and other animals.	Following his conviction, Conrad - Cut his use of pesticides and fertilisers to a minimum. - Lobbied the local council to construct a secondary sewage treatment plant. Then he got a permit to use the treated effluent to fertilise the golf course. - Left a strip of natural woodland along the edge of the river. *His clients were delighted because he was able to reduce his costs and the grounds looked even better. He is happy because the fish are starting to come back in the pond on the golf course, and he is looking forward to fishing again.*
MARTHA: - Allowed her gas storage tank to get old and leaky. - Dumped the wastes from her garage in the backyard.	- The oil and other chemicals from the tank and the wastes soaked into ground and polluted the groundwater. - Washed over the surface into the river where they killed fish.	Following her conviction, Martha - Had her storage tank dug up and repaired. - Hired a skip and took all the waste in her backyard to the approved landfill. She made her yard into a garden where her clients could sit and enjoy their sodas. *Now her gas station is even more popular than before.*
SABRINA: -Used too much washing powder - Used washing powder that contained large amounts of phosphates - Did not realise that her septic tank was leaking.	- The phosphates from Sabrina's washing ended up in local waterways, and the nutrients from her sewage soaked into the river contributing to the growth of algae. - Germs and parasites from her cesspit leaked out too and made the water in the creek unhealthy.	Following her conviction, Sabrina • Started to buy phosphate-free soap powder. • Cut her use of soap powder to a minimum. • Had her cesspit repaired. • Lobbied the local council to put in a central sewage system. *Now her bill for soap powder is less. And she can let her boys play by the creek, without worrying that they will get ill.*

COPY CAT PAGE

Activity 4-O

THE TROUBLE WITH OIL

Summary

Three simple experiments and a discussion help to illustrate the danger to wetlands and wildlife from oil.

Learning Objectives

Students will be able to:

- Identify how oil gets into coastal waters, such as wetlands
- Describe the effects of oil on wetland plants, fish and other wildlife
- Suggest ways to reduce the amount of oil that gets into wetlands
- Suggest ways to reduce the impacts of oil

Age Levels 8 +

Subject Areas General Science, Mathematics, Chemistry

Time 30-60 minutes

Materials

See Experiments 1-3 below.

Background

Some of the most important and busy sea-lanes pass through the Caribbean. There is a serious risk of oil spills affecting valuable ecosystems and economically important beaches. This activity includes three experiments which enable students to investigate some of the effects of oil on the environment.

Experiment 1: How oil spreads over water

Materials

- Small quantity of oil (e.g. used engine oil, diesel or gasoline; alternatively, try vegetable oil)
- Water
- Ruler
- Calculator
- Measuring cylinder
- Large shallow glass dish (preferably rectangular)
- Dropper or pipette
- Sheet of graph paper

Procedure

1. Introduce the activity by reminding the students how much our lives depend on oil. However, also remind students that oil waste contains dangerous chemical pollutants as well as oil.

2. Tell the students that they are going to estimate how large an area can be affected by an oil spill.

3. Investigate how oil spreads on water as follows:

- Place about 2.5 cm (1 inch) of water in the large shallow dish that is positioned over a sheet of graph paper. Allow the water to become still, then add one drop of oil to the dish. Watch it spread out over the surface of the water.
- Count how many drops are needed to cover the whole surface.
- Use the graph paper to measure how large an area is covered by one drop of oil cover.
- Measure how many drops make up one cubic centimetre of oil.
- Work out what area one cubic centimetre of oil would cover.

4. Ask the students to use the information from the experiment to solve the following problems.

- When a mechanic changes the oil in a car, he uses about 2.5 litres of oil. If he tips it down the drain, and it gets into a wetland with open water, what area would it cover?
- An oil tanker holds about 40,000 litres (8,000 gallons). If it overturns in a road accident and the oil spills out into a mangrove swamp, how much water would it pollute?
- A super-tanker holds 400,000,000 litres (80,000,000 gallons). If it runs on a coral reef in a hurricane, how big an area of sea could it pollute?

5. Discuss: Have the students ever observed the effects of an oil spill on plants and animals and their habitats? What effects did they notice?
- *The oil coats plants and animals.*
- *Birds that are oiled cannot fly.*
- *No one wants to swim on a beach that is polluted by oil.*
  Remind the students that oil is carcinogenic.
- How does oil affect plants and animals? See Copy Cat Page "The Trouble with Oil."

EXPERIMENT 2: HOW OIL AFFECTS EGGS

Materials
- Three hard-boiled egg(s)
- Small quantity of oil
- Glass jar or beaker big enough to hold all three eggs
- Clock, timer or watch
- Paper towel

Background
See Copy Cat Page "The Trouble with Oil."

Procedure
1. Tell the students that many birds, including coots and moorhens, nest in mangrove roots, or on the banks of rivers and streams in wetlands. The following experiment will demonstrate what happens when a bird egg is exposed to oil.

2. Investigate the effects of oil on eggs as follows:
- Place 3 hard-boiled eggs in a small container.
- Cover them with oil.
- After 5 minutes: remove one egg from the container and examine it. What does the surface of the egg look like?
- Clean off the excess oil. Peel the egg. What does the shell look like? What does the egg look like?
- Repeat with the second and third eggs after 10 and fifteen minutes respectively. Describe what happened.

3. Discuss: If oil from a spill affected a bird nest close to the water, what effects would it have on the eggs?

EXPERIMENT 3: HOW OIL AFFECTS FEATHERS

Materials
- Feathers
- Glass jars or beakers containing oil
- Glass jars or beakers containing water
- Hand lens/magnifying glasses
- A bottle of washing up liquid
- Copy Cat Page "Parts of a Feather"
- Copy Cat Page "The Trouble with Oil"

Background
See Copy Cat Page " The Trouble with Oil"

Procedure

1. Introduce the experiment with a discussion. Many birds feed on fish and aquatic plants and animals. What happens when a bird gets into water polluted with oil? *It gets covered with oil and cannot fly.* Tell the students that you are going to do an experiment to discover why birds that have been oiled cannot fly.

2. Give the students feathers to examine.

3. Help them to identify the main parts of the feather (rachis, barbs, barbules) using Copy Cat Page "Parts of a Feather."

4. Now investigate how water and oil affect feathers, as follows.
   a) Tell the students to dip their feathers in water for one or two minutes.
   b) They should then take the feathers out and re-examine them, make a second sketch and compare it to the dry feather.
   c) Now they should place the feathers in oil for one or two minutes.
   d) Tell them to examine the feather again, and make a third sketch.
   e) What changes do they observe?
   f) What could be used to remove oil from bird feathers? *Detergent.*
   g) Distribute some detergent. The students should clean the feather with some of it, then rinse and dry them, then re-examine, them sketch them and compare the sketches with the previous ones.

5. Discuss: How would these changes affect birds? *Detergent is sometimes used to clean oiled seabirds. Unfortunately, very few cleaned birds survive, so unless the affected birds are very rare, it is not worth the effort.*

6. Discuss: (See Copy Cat Page "The Trouble with Oil" for some answers to these questions.)

- What can be done to reduce the amount of oil getting into the environment?
- What can individuals do to reduce oil pollution?
- What can companies do?
- What can governments do?
- Do we have to depend on oil as much as we do? What are the alternatives? What can individuals, companies and governments do to encourage people to use less harmful forms of energy such as solar?

Assessment

The students should write up the three experiments separately, describing methods, results, and conclusions for each experiment.

Extension

- Students could do some research into oil spills that have affected your island. When was the last major spill? What happened? How was it cleaned up?
- Students could do some research into alternative sources of energy including solar, wind energy, geothermal energy and wave energy. What are the environmental advantages and disadvantages of each?

Source Adapted from Project Wild.

The Trouble with Oil

Some of the main sources of oil pollution in Caribbean waters and wetlands include:

- Accidents with oil tankers at sea. Remind the students that there are so many ships moving about in the Caribbean that the chance of an accident is very high.
- Oil spills and fuel leaks on the roads and railways.
- Fuel leaks from undersea and underground pipelines, refineries, storage tanks, ships, oil wells and gas stations
- Bilge water released at sea illegally by ships cleaning out their tanks
- Waste oil from engines and industrial processes that is dumped in rivers, sinkholes and ponds.
- Oil sprayed on dust or marl roads to control dust.
- Oil that leaks out of transformers used by electricity companies, if they are not properly disposed of when they fail.
- Oil sprayed on wetlands, to help control mosquitoes.

How does oil affect plants and animals and their habitats?

Oil floats on the surface of water where it forms a barrier to oxygen. Soon there is not enough oxygen for animals such as fish and corals to breathe and they die.

Oil also coats plants and animals. When mangrove roots are coated with oil, they cannot breathe and the trees may die. The animals that live on and around the roots are also likely to be coated with oil and die. This undermines the mangrove food chain. Mangroves can take more than ten years to recover from an oil spill. Similarly, oil coats the gills of fish and they cannot breathe.

What can individuals do to reduce oil pollution?

- Take care to avoid spilling oil.
- Take waste oil to an approved site for recycling. Never pour waste oil down the drain, in the gutter, or into a river or wetland.
- If you own or operate boats, be careful not to spill any oil or gasoline into the water.

What can companies do to reduce oil pollution?

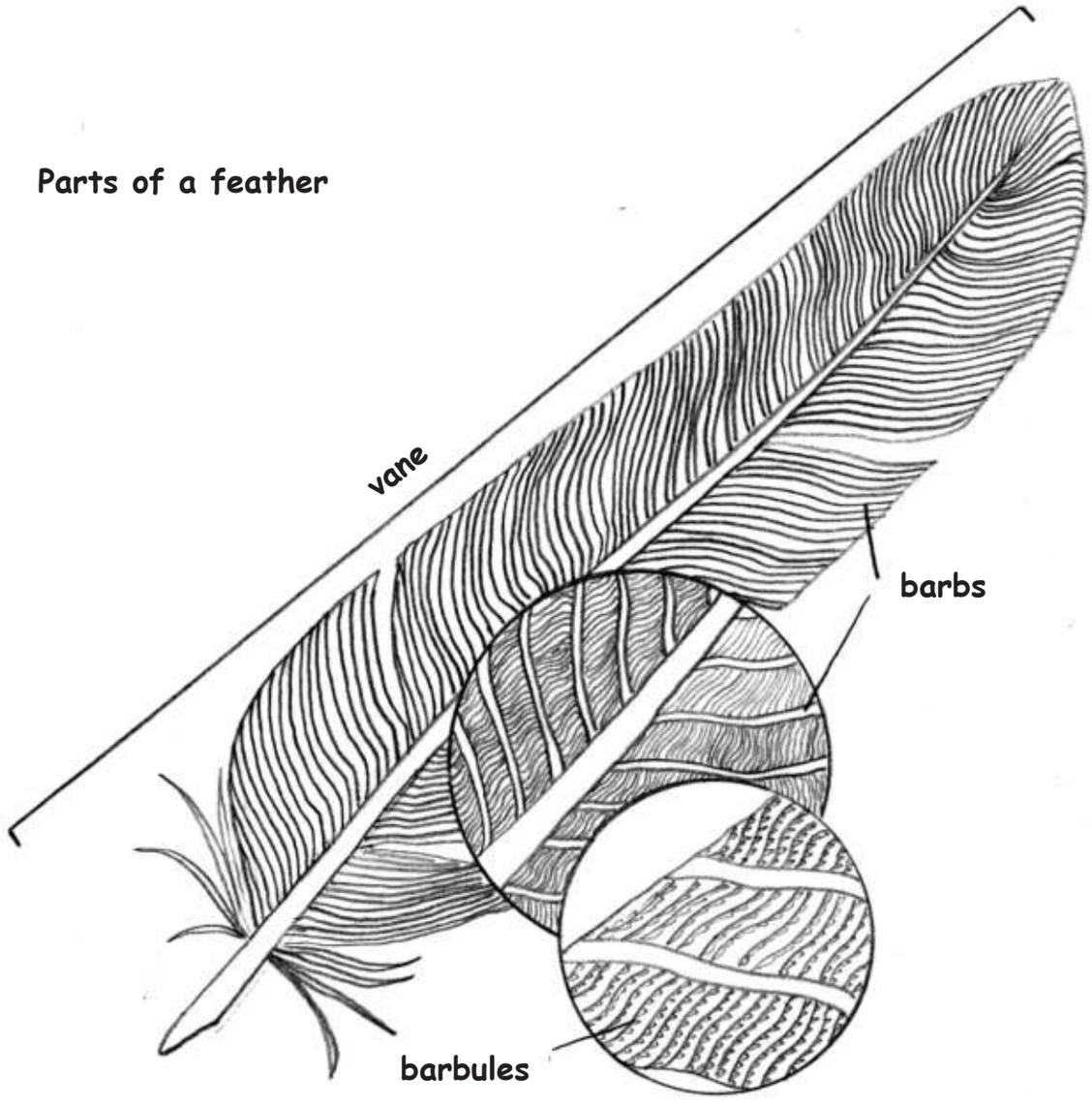
- Ensure that their employees take care when handling oil.
- Ensure that waste oil, oily water, bilge water (from ships) and all machinery containing oil is disposed of at an approved site.
- Take precautions to avoid accidental spills (e.g., ensuring that tankers are properly maintained and operated).

What can governments do to reduce oil pollution?

- Provide places for people to dispose of waste oil.
- Provide incentives for recycling oil.
- Educate people about the dangers of disposing of waste oil by pouring it down the drain.
- Prosecute ships that discharge oil into their territorial waters.
- Make sure that there is a national plan to deal with oil spills, including equipment to contain spills, chemicals to clean up and disposal sites for the oily waste that is removed from the site of the spill.
- Reduce dependence on oil by encouraging energy conservation, use of fuel-efficient cars and mass transit, and use of solar and wind power.

FEATHERS

Parts of a feather



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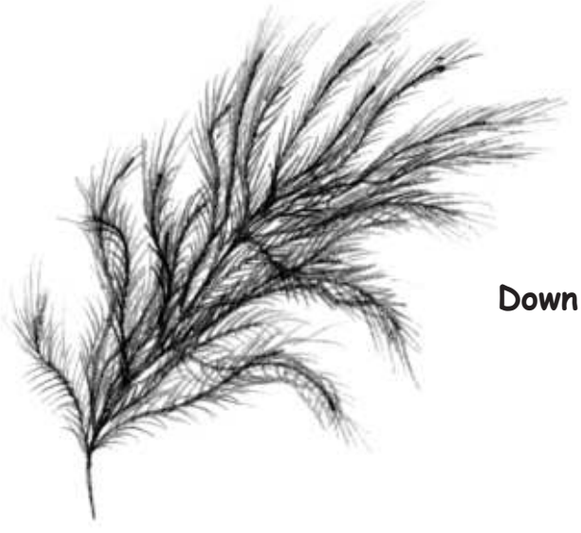
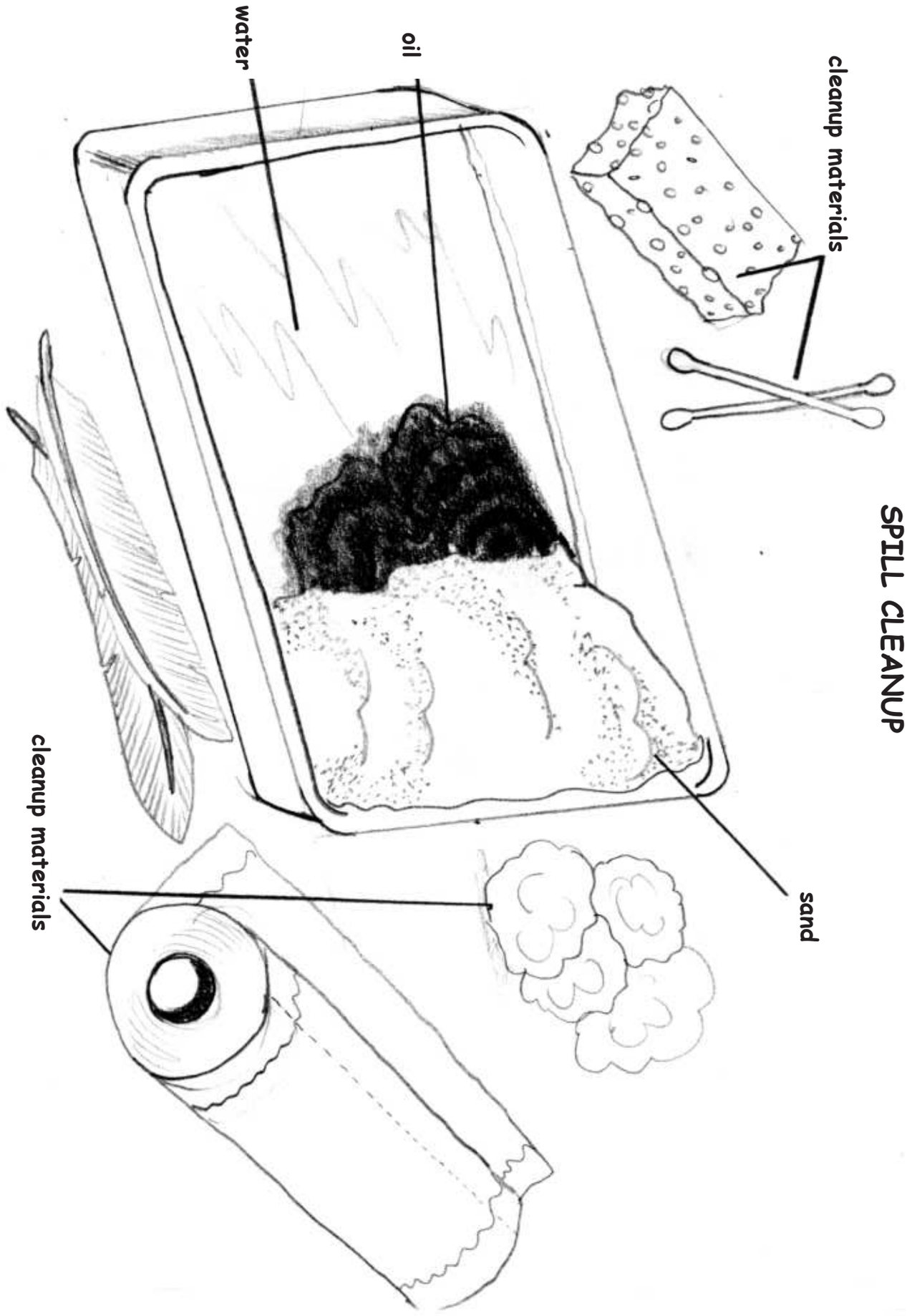


Down feather



SPILL CLEANUP

COPY CAT PAGE

Activity 4-P

DEADLY LINKS

Summary

Students play a game that illustrates how pollutants accumulate as they are passed up the food chain until they affect predators at the top of the chain.

Learning Objectives

Students will be able to:

- Give examples of ways in which pollutants, such as pesticides used in gardening, agriculture and pest control, enter the food chain
- Understand the concept of bio-accumulation and how it affects living things, including man

Age Levels 9 +

Subject Area Science (e.g., as follow-up to food chain activities in Chapter 2)

Time 30–60 minutes

Materials

- A package of multi-coloured drinking straws, green, yellow, red, and blue, cut in lengths of approximately 6 cm (2 in) so you have a total of about 100, roughly 25 of each colour (or in a ratio of 30 per student). If coloured straws are not available, you could use different coloured dried beans, multi-coloured cat kibble, or circles of coloured paper, made with a paper punch.
- Eighteen envelopes (or one-third the number of students in the class) or small paper cups
- Eight coloured arm bands (improvise), bibs or hats
- Whistle or bell
- Pictures (from the copy cat sheets) of an Osprey, Amphipod, and Mangrove Snapper.
- Copies of Copy Cat Page "Deadly Links"

Background

During the past century, the use of chemical pesticides has increased enormously. Some of these pesticides contain poisons - toxic chemicals that do not break down into harmless components in the environment. Rain and irrigation water may wash the toxic chemicals into a wetland or the ocean where they eventually enter the food chain.

The toxins are taken up and concentrated in aquatic plants and animals in a process known as bioaccumulation. Plants take up the toxins from the water. Then bottom-dwelling organisms such as amphipods siphon the detritus from the water and can easily take up toxins with the plants or attached to pieces of soil that have settled. These toxins, when ingested, remain inside the bodies of the amphipods. They are passed on when the amphipods are eaten by small fish that are then eaten by large fish. Thus, the toxins are passed through the food chain. If a person eats the fish, he or she may get a large dose of the toxic chemical.

This is how bioaccumulation works: If an Amphipod ingests one piece of detritus containing 10 units of toxin, then it will retain 10 units of toxin (1 x 10 = 10). If a Mangrove Snapper eats 10 Amphipods, each containing 10 units of toxin, then the Mangrove Snapper will retain 100 units of toxin (10 x 10 = 100). If an Osprey eats 10 Mangrove Snappers, each containing 100 units of toxin, then the Osprey will retain 1000 units of toxin (10 x 100 = 1000), and so on.

In this very active game students will become "Detritus", primary and secondary consumers like "Amphipods" and "Mangrove Snappers", and predators like "Ospreys" to illustrate how toxins accumulate in the food chain.

Preparation

- Prepare the straws.
- Review the rules of the game.
- Ideally the students should already be familiar with the concept of food chains (see Chapter 2).

Procedure

1. Remind the students about food chains, how they work, and why they are important. Discuss a few wetland examples.

2. Tell the students this activity is about food chains: for example, Amphipods eat by filtering detritus, Mangrove Snappers eat Amphipods, and Ospreys eat Mangrove Snappers.

3. Tell them a little about these animals, what they eat and where they live.

4. Divide the students as follows: at least three times as many Mangrove Snappers as Ospreys, and at least three times as many Amphipods as Mangrove Snappers. (In a class of 26, this would give 2 Ospreys, 6 Mangrove Snappers, and 18 Amphipods).

5. Each Amphipod is given an envelope, to represent the Amphipod's "stomach" in which to collect its food (detritus/straws). The Mangrove Snappers and the Ospreys are given different-coloured armbands, bibs or hats so they can be easily identified.

6. Ask the students to close their eyes while you spread the food (detritus, represented by the straws) around a playing field, an open area, or a large floor area in the classroom.

7. Give instructions (times indicated are for classroom space; make it a little longer if played outside):
    a. The Amphipods will go out looking for food, which they each place in their stomach (envelope). The Osprey and Mangrove Snappers remain quietly on the sidelines, acting as predators do when watching their prey. After 20 seconds, signal (or whistle) for the Amphipods to stop feeding.

    b. The Mangrove Snappers are now allowed to hunt the Amphipods, while the Ospreys still remain on the sidelines. When a Mangrove Snapper catches an Amphipod by tagging, the Amphipod must give up its food envelope to the Mangrove Snapper and move to "Amphipod heaven" at the side. Allow 15 to 20 seconds, enough time for each Mangrove Snapper to catch one or more Amphipods. Give another signal (two whistles).

    c. The Osprey are now introduced and given 15 to 20 seconds to hunt the Mangrove Snappers. When the Osprey tag the Mangrove Snappers and retrieve the food envelopes, the Mangrove Snappers go to "Mangrove Snapper heaven" at the side.

    Note: Any Mangrove Snappers still alive may continue to hunt Amphipods, and Amphipods still alive may continue to eat detritus.

8. Give a signal (three whistles) to end all the action. Have the remaining "live" Ospreys, Mangrove Snappers, and Amphipods stand in view, with the "consumed" wildlife sitting on the floor a few feet away. Ask the "consumed" students who they were and who consumed them. Ask the "live" Osprey, Mangrove Snappers, and Amphipods to count the number of food pieces (straws) in their envelopes, putting them on the floor as they do (don't let the students mix their straws with those of other students).

9. Inform the students that the following contaminants have been introduced into the food chain by farmers and gardeners to improve their crop, or by government agencies to destroy pests like mosquitoes.
    - Insecticides—red straws
    - Herbicides—yellow straws.

    Unfortunately, the people who administered the chemicals did not read or follow the instructions on the labels of the products.

10. As a result, the products got into the water.
    - All of the Amphipods who were not eaten by the Mangrove Snappers may now be considered dead if they have any yellow or red straws in their food supply.
    - Any Mangrove Snappers that have more than half their food supply contaminated—yellow or red straws—are now dead.
    - The Osprey with the highest quantity of yellow and red straws will not die at this time; however, it has accumulated so many pesticides in its body that the eggs produced by it and its mate during the next season will not hatch successfully. The other Osprey is not visibly affected at this time.
    - Hand out Copy Cat Page "Deadly Links" and explain how bioaccumulation works.

11. Try the activity again, choosing other colours of straws and different toxins—e.g., blue straws for fungicides and green straws for rodenticides.

12. Explain that this example is based on what actually happened around the world in the 1950s-1960s, when an insecticide called DDT accumulated in food chains and killed many wild animals, especially birds of prey, including Ospreys (see Case Study 1).

- What are the advantages and disadvantages to the farmer, gardener or householder of using pesticides?
- What are some alternatives to the use of toxins? *Some farmers are successfully using organic or non-toxic substances along with crop rotation, companion planting, biological controls, and genetic approaches in efforts to minimize damage to their crops.*
- What precautions should they take before and after using any herbicides or pesticides?
- What are other possible sources of toxic chemicals that could enter the food chain?

Extensions

Below are two case studies, one documented, one anecdotal, of declines in bird populations due to the ingestion of toxins that entered food chains. Interview family members, particularly grandparents, and document similar declines. Ask them, for example, if they remember more of a particular species when they were children than they see now.

Case Study #1

The Osprey is a common winter visiting bird throughout the Caribbean. It can often be seen hunting throughout the region. It is one of the top predators in the wetland food chain. Its prey is mostly fish, though it occasionally hunts egrets at some local airports. Not too many years ago (the 1950s and 1960s), the Osprey almost became extinct because its prey had absorbed DDT (a very popular insecticide) from agricultural run-off and mosquito control programmes. The DDT accumulated in the Osprey's tissues where it affected reproduction—the eggs often had thin shells that cracked before the chick was ready to hatch. The Osprey also suffered from illegal shooting (people thought it caught too many fish) and habitat loss. However, the 1972 ban on the use of DDT, plus other factors, have enabled this magnificent bird to make a comeback.

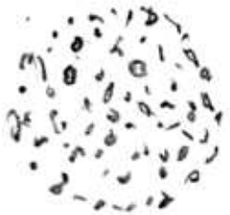
Case Study #2

There has reportedly been a drastic decline in the number of Barn Owls in the Cayman Islands. While there is no documented proof, there are many reports of a noticeable decline in numbers in recent years. The owls' primary foods are rats and mice, which in turn feed on plants, fruits, and nuts. The owls also eat lizards, bats, and other, smaller bird species like Bananaquits. The decline in the number of owls may be due to the increase in the amount of multi-dose poisons (some of which are known to be toxic to birds) which are being used to kill rats and mice. The owls eat the poisoned animals, and absorb the toxins. The toxins accumulate in their bodies and may eventually kill them.

Source Adapted from Project Wild.

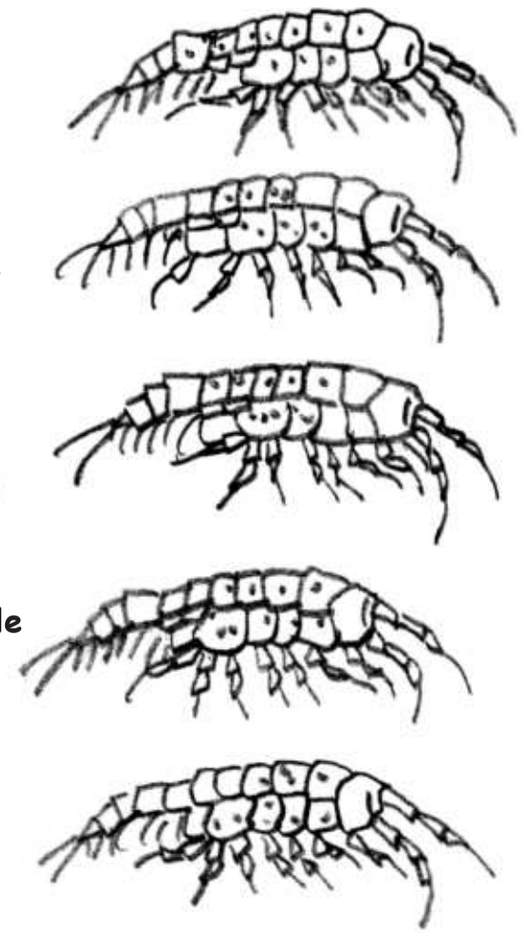
DEADLY LINKS

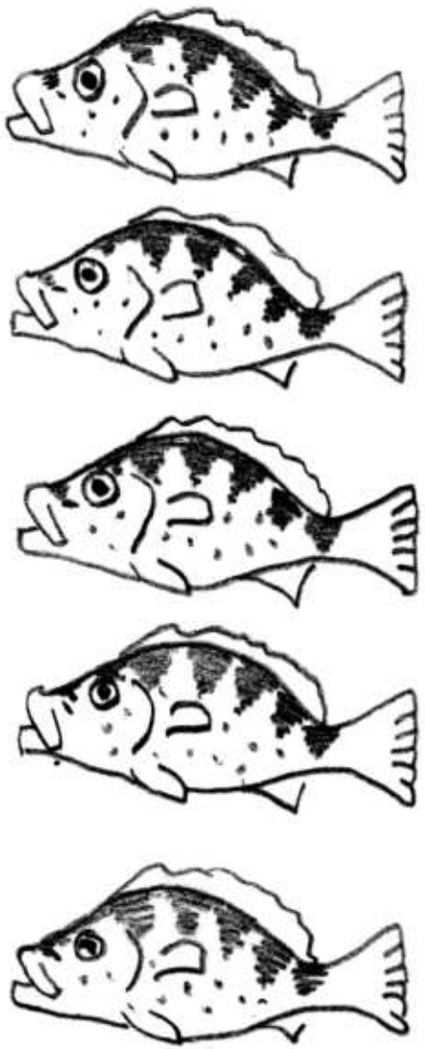
decaying plants



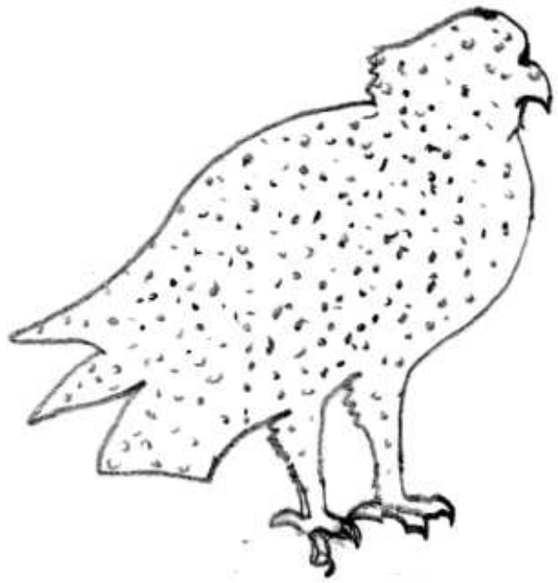
detritus particle with toxin attached

1 x 10 = 10
amphipods ingest detritus and bacteria and retain toxins





10 x 10 = 100
mangrove snappers eat amphipods and retain toxins



10 x 100 = 1000
ospreys eat mangrove snappers and retain toxins

SOME INTRODUCED SPECIES FOUND IN CARIBBEAN WETLANDS

COMMON NAME	SCIENTIFIC NAME	WHERE DID IT COME FROM?	HOW DID IT GET THERE?	EFFECTS
PLANTS				
Water Hyacinth	*Eichhornia crassipes*	Brazil	Ornamental water plant, escaped accidentally	Serious pest in rivers – blocks waterways
Canadian Pondweed	*Elodea canadensis*	Canada	Ornamental water plant, escaped accidentally	Serious pest in rivers – blocks waterways
Coconut	*Cocos nucifera*	Indian Ocean and West Africa	Originally brought by man, then spread naturally	Very useful as food and coastal protection
Casuarina	*Casuarina equisetifolia*	Australia	Ornamental	Pest on some coastlines, where they displace native species.
Mango	*Mangifera indica*	SE Asia	Introduced from India as food	Spreads widely in disturbed areas and along roads and rivers
MAMMALS				
Indian Mongoose	*Herpestes auropunctatus*	India	Brought to control rats in sugar	Prey on native birds and small mammals
Raccoon	*Procyon lotor*	North America	Introduced to Bahamas and some French islands	Prey on native birds, their eggs and young
Rats	*Rattus rattus* *Rattus norvegicus.*	Europe	Stowed away on ships	Destroys native bird nests (e.g. West Indian Whistling -Duck)
Mice	*Mus musculus*	Europe	Stowed away on ships	House pest, may prey on some species
Cats	*Felis catus*	Europe	Brought to control rats	Cats are a serious pest of birds and their eggs
Cattle	*Bos taurus*	Europe	Brought as food	Damages wetlands by grazing
BIRDS				
Cattle Egret	*Bubulcus ibis*	Africa	Spread naturally, following disturbed land	May compete with native egrets for nest sites and nesting materials
Shiny Cowbird	*Molothrus bonairensis*	Central America	Spread naturally, following disturbed land	Threatens native species by laying its eggs in their nests.
House Sparrow	*Passer domesticus*	Europe	Deliberately introduced to the US, spread naturally	Outcompetes native birds for nest sites
AMPHIBIANS				
Cane Toad	*Bufo marinus*	Central America	Deliberately introduced to control pests	Preys on and competes with native amphibians
Bullfrog	*Rana catesbiana*	USA	Deliberately introduced as potential economic resource (frogs legs)	Competes with native frogs
Whistling Frog	*Eleutherodactylus johnstonei*	Guadeloupe	Deliberately introduced because people liked calls	Annoying calls. Effects on native species not known.
FISH				
Mosquito Fish	*Gambusia affinis*	USA	Deliberately introduced to control mosquitoes by eating larvae.	Controls mosquitoes, but can affect ecological balance in rivers and ponds
Tilapia	*Tilapia nilotica*	Africa	Deliberately introduced as food fish	Competes with native fish, alters ecological balance
MOLLUSCS				
Green Mussel	*Perna viridis*	Australia	Accidentally brought in bilge water of ships	Competes with native oysters
INSECTS				
Mosquito	*Aedes aegypti*	Africa	Accidentally brought	Carrier of Yellow and Dengue Fever
Pink Mealybug	*Macronellicoccus hirsutus*	Asia	Accidentally brought and spread among islands on fruit and flowers	No natural predators. Destroys many native, horticultural and agricultural plants
Red Imported Fire Ant	*Solenopsis invicta*	South America	Accidentally introduced and spreading rapidly throughout the West Indies	Aggressive nature, powerful sting – serious threat to biodiversity, human health and agriculture, outcompetes native fire ants
CRUSTACEANS				
Redclaw Crayfish	*Cherax quadricarinatus*	Australia	Escaped from commercial shrimp farms	Not known

COPY CAT PAGE

WONDROUS WEST INDIAN

WETLANDS

"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed it's the only thing that ever does."

- Margaret Mead

Chapter 5

SAVE THE WETLANDS – SAVE THE WORLD!

We can make a difference

Learning Objectives for Chapter 5

Students should:

- Know that throughout the West Indies international agencies, governments, communities and individuals are working together to protect and conserve wetlands
- Find out what is being done in their own islands
- Identify some actions they can take themselves

#	TITLE	SUMMARY	SUBJECT	PAGE
5-A	Reduce, Reuse, Recycle	Learn about earth's water distribution and actions you can take to prevent pollution and conserve water	Science, Mathematics Social Studies, Arts	190
5-B	Be An Activist	Plan and carry out a project to help the environment	Science, English Language, Social Studies	194
5-C	Wondrous Wetlands	Celebrate wetlands in poetry	English Language	195
5-D	Mangrove Controversy	Participate in decision-making about a local wetland	English Language Arts, Social Studies, Science	197
5-E	Bouncing Back	Find out about some Caribbean wetland species that are increasing	Science	202
5-F	Marine Debris	Organise a beach clean up	Science Mathematics	207
5-G	Wet Work	Find out about careers in wetlands	English Language	213

What are the Alternatives to Wetland Loss?

Many uses of wetlands can be sustainable. Projects in St. Lucia have demonstrated how timber and charcoal can be sustainably harvested from mangrove wetlands. Too often, however, the mangroves are simply destroyed.

Whistler says... Wetlands can be used sustainably for tourism, especially when they are conserved in protected areas. If properly managed, boat tours, board walks, sport fishing and bird watching can be carried out in wetlands without seriously damaging them. Many wetland resources including fish, shrimp, oysters and game birds can be harvested sustainably, so long as the harvest is not excessive and critical habitats are protected. Mangroves produce excellent honey and bee keeping can be a profitable activity. If properly managed, wetlands can soak up nutrients and purify water.

Wetland restoration

We can learn from the experiences of other countries. For example, until about twenty years ago, there was little control of wetland development in the United States. Small wetlands, medium-sized wetlands, even the vast he Florida Everglades were drained in the name of progress and development As the consequences of wetland loss became apparent, governments introduced new policies to protect them. Many wetlands were included in national parks and protected areas, and inventories made to identify which were most important. Conservation agencies sometimes buy important wetlands, or enhance existing wetlands through management and they even create new wetlands. Any developer who damages a wetland must restore it or create a replacement. This is called **mitigation**. In the USA, a billion dollars is now being spent by the federal government to restore parts of the Florida Everglades.

SUSTAINABLE USES OF WETLANDS

Conservation	⇒ Setting aside wetlands for **conservation** (wise use), protects wildlife and their habitats and their natural functions and values.
Sustainable fisheries	⇒ Increased prosperity in coastal areas, if fish, fish habitats, and fishers are effectively managed
Sustainable hunting	⇒ With effective protected areas and regulations, some game can be hunted sustainably, contributing to the local economy
Sustainable harvest of timber and charcoal	⇒ Improved quality of life for rural people
Use of specially constructed and managed wetlands for some types of sewage treatment	⇒ Better quality effluent and cheaper, more easily maintained sewage plants
Properly managed tourism	⇒ Increased job opportunities ⇒ Improved wildlife habitat ⇒ Increased income from tourism locally and nationally
Sustainable harvest of mangrove resources	⇒ Improved craft industry ⇒ Conservation of traditional life styles
Production of honey	⇒ Increased income
Coastal and inland flood damage protection	⇒ Just leaving wetlands alone can significantly reduce impacts of storms and hurricanes

What can be done to ensure that West Indian Wetlands are used sustainably?

Throughout the Caribbean, individuals and agencies are working together to conserve wetlands and their wildlife. Although much has been lost - every small gain is important. Some wetland species are even increasing in numbers on certain islands (See Activity 5-E).

What types of initiatives are currently making a difference to Caribbean Wetlands?

Conservation starts at many levels – international, national, local and individual. Some positive developments are discussed briefly below. It is up to you to find out more!

- International initiatives to protect wetlands

The Ramsar Convention on Wetlands, established in Ramsar, Iran, (1971), is an intergovernmental treaty, providing the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. Countries that sign the Convention are required to designate at least one site for inclusion in the List of Wetlands of International Importance (the Ramsar List), and to protect these sites. The list is the basis for an international network of wetlands to conserve global biological diversity and for sustaining human life through the ecological and hydrological functions they perform. Currently the Convention has 141 Contracting Parties, with 1397 wetland sites, totaling 122,691,471 hectares, designated for inclusion in the Ramsar List. Several countries in the Caribbean have already joined this important convention. Do you have a Ramsar site near you?

Ramsar Sites in the Insular Caribbean

COUNTRY AND SITE	TOTAL HECTARES OF SITE	DATE OF DESIGNATION	ADMINISTRATIVE AUTHORITY
BAHAMAS			Bahamas Environment, Science and Technology Commission, Nassau
*Inagua National Park, Great Inagua	32,600	2/7/97	
CUBA			Ministério de Ciencia, Technología y Medio Ambiente, La Habana
*Buenavista	313,500	11/18/02	
*Ciénaga de Lanier y Sur de la Isla de la Juventud	126,200	11/18/02	
*Ciénaga de Zapata	452,000	4/12/02	
*Gran Humedal del Norte de Ciego de Ávila	226,875	11/18/02	
*Humedal Delta del Cauto	47,836	11/18/02	
*Humedal Río Máximo-Cagüey	22,000	11/18/02	
DOMINICAN REPUBLIC			Director Nacional de Vida Silvestre y Biodiversidad, Santo Domingo
*Lago Enriquillo	20,000	5/15/02	
JAMAICA			Natural Resources Conservation Authority, Kingston
*Black River Lower Morass, St. Elizabeth	5,700	10/7/97	
NETHERLANDS (Aruba)			Dept. of International Nature Management, 'S-Gravenhage
*Het Spaans Lagoen	70	6/23/80	
NETHERLANDS ANTILLES (Bonaire)			Dept. of International Nature Management, 'S-Gravenhage
*De Slagbaai	90	5/23/80	
*Het Gotomeer	150	5/23/80	
*Het Lac	700	5/23/80	
*Het Pekelmeer	400	5/23/80	
*Klein Bonaire Island & adjacent seas	600	5/23/80	
SAINT LUCIA			Ministry of Agriculture, Forestry and Fisheries, Castries
*Mankoté Mangrove	60	2/19/02	
*Savannes Bay	25	2/19/02	
TRINIDAD AND TOBAGO			Ministry of Agriculture, Lands and Marine Resources, Port of Spain, Trinidad
*Nariva Swamp	6,234	12/21/92	
UNITED KINGDOM			International Designations Team, European Wildlife Division, Dept. for Environment, Food, and Rural Affairs, Bristol, UK
(Bermuda)			
*Hungry Bay Mangrove Swamp	2	5/11/99	
*Lover's Lake Nature Reserve	2	5/11/99	
*Paget Marsh	11	5/11/99	
*Pembroke Marsh East	8	5/11/99	
*Somerset Long Bay Pond	1	5/11/99	
*Spittal Pond	10	5/11/99	
*Warwick Pond	2	5/11/99	
(British Virgin Islands)			
*Western Salt Ponds of Anegada	1,071	5/11/99	
(Cayman Islands)			
*Booby Pond & Rookery	82	9/21/94	
(Turks & Caicos Islands)			
*North, Middle & East Caicos Islands	58,617	6/27/90	

International initiatives to protect species

The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), (1975), is *the* global treaty protecting important plant and animal species (including wetland species such as the Greater Flamingo and West Indian Whistling-Duck) from unregulated international trade. Species threatened with extinction are protected from all international commercial trade; trade in species that are not threatened but which may become threatened if trade becomes unregulated is monitored and regulated; and countries have the option of listing native species already protected within their own borders. Countries implement the treaty by passing laws that allow police, customs officers and other government agents to arrest and prosecute individuals possessing or trading in CITES-listed species.

- **The Protocol on Specially Protected Areas and Wildlife of the Cartagena Convention (SPAW)** came into force in 1999, under the auspices of the United Nations Environment Programme. It requires countries to protect and manage selected coastal plants and animals and their habitats, including mangroves, conch and West Indian Whistling-Ducks.

Belted Kingfisher

National initiatives to conserve and protect wetlands

Wetland Policies: Some islands (e.g. Cayman Islands, Turks and Caicos Islands, Jamaica, Bahamas, Trinidad and Tobago) are in the process of developing national wetland policies that will serve as guidelines for decision-makers and developers. Trinidad and Tobago currently has a wetland policy that is a subset of their National Environmental Policy. Examples of highly successful wetland policies in the U.S. include: 1) the Clean Water Act (1972) to eliminate the discharge of pollutants into surface waters and achieve water quality that will protect fish, shellfish and wildlife and allow recreation in and on the water; and 2) the "no net loss" wetlands policy (1988) which states that damages to protected wetland habitats are to be avoided or mitigated.

Protected Areas: Examples include Humacao Nature Reserve in Puerto Rico, Lucayan National Park in Grand Bahama, the Pointe-a-Pierre Wildfowl Trust in Trinidad, Parque Jaragua in the Dominican Republic, Zapata Swamp in Cuba, and proposed protected areas in Jamaica. However, just calling an area a "National Park" or "Wildlife Reserve" is not enough; resources are needed for monitoring and management. Sometimes it is necessary to buy land in order to set it aside for conservation.

Legislation: Legislation requiring wetlands to be zoned for protection, permits for developing wetlands and environmental impact assessments for all projects that affect wetlands, is needed. Some countries have some of these regulations. Few have all.

Research: Research is being carried out into the status of wetlands and their importance. For example, the Environmental Awareness Group of Antigua and Barbuda recently assessed all the wetlands in their country. The West Indian Whistling-Duck Working Group of the Society for the Conservation and Study of Caribbean Birds is working on several islands to promote studies of whistling ducks. More research is needed.

Monitoring: There are very few monitoring programmes in the region, though we need them to track long-term changes. Antigua and Barbuda recently designed some excellent protocols for monitoring selected wetlands, while Cuba and Jamaica have started to monitor their populations of Whistling-Ducks.

Education and Public Awareness: Very few people in the Caribbean appreciate the actual and potential values of their wetlands. Public education and awareness are essential to generate the necessary level of public support. This manual is part of the effort of the West Indian Whistling-Duck Working Group of the Society for the Conservation and Study of Caribbean Birds attempts to increase public awareness about wetlands.

Local initiatives to protect wetlands and wetland species

Local effort can make a huge difference in the fight to conserve wetlands. For example, in the 1980s, the citizens of Negril (Jamaica) challenged a proposal by government and international business to mine peat from the biggest wetlands in the country. The peat was to be burned in power stations. People worried this would damage the environment and harm tourism. They held meetings, protested in the media and won international support - the project was abandoned. In New Providence, Bahamas, local citizens undertook the restoration of a large mangrove wetland called Adelaide Creek (See Activity 5-E "The Adelaide

Creek Restoration Project"). By working together the community ensured that today the Adelaide Creek wetland is teeming with birds and other wildlife. So what can you do? (See Activity 5-B for suggestions).

Individual initiatives to protect wetlands and wetland species

Change your behaviour; think about your ethical position. Assess your own and your family's lifestyle and think about what you can do differently to live sustainably and help build a better world. (See Activities 5-A, 5-B and 5-F).

Get to know your wetlands and their wildlife. Local people often notice changes before experts. Study a wetland near you and you will soon know more about it than anyone else in the world (See Chapter 6).

Monitor what is happening in your area. If you find out that a wetland is being damaged, try to determine what is happening, who is doing it, and whether there are any alternatives. If necessary, start a movement to protect it (see Activity 5-B).

Join an environmental group, support conservation of wetlands and wildlife and your own local protected area. Let everyone know that you care about the environment and don't want to see it destroyed. Many protected areas have support groups and volunteer programmes. Why not contact your local natural resource agency or conservation group to see if you can help make a difference? Groups are much more powerful than individuals. If necessary, start one. Some international groups are willing to fund projects carried out by local conservation groups.

Check it out!

Whistler says... The Society for the Conservation and Study of Caribbean Birds, through its West Indian Whistling-Duck Working Group, has been working to conserve West Indian Whistling-Ducks and their habitats throughout their range. Members of the group (including biologists and conservationists from every island in the duck's range, with their partners from North America) are working together to carry out basic research into the status and distribution of the species, to design and implement education programmes and to protect and manage wetland habitats. Achievements so far include:

- Production and dissemination of wetland education materials including a slide show, puppet show, duck identification cards for hunters, wetland bird identification cards, this book
- Provision of basic equipment including slide projectors and binoculars to educational institutions throughout the region
- Workshops on wetlands education for teachers in ten Caribbean countries
- Surveys of West Indian Whistling Ducks in Cuba, Jamaica, Turks and Caicos Islands, Cayman Islands and Barbuda
- Design and construction of "watchable wildlife ponds" including boardworks and interpretive signage, e.g. in the Cayman Islands.

Activity 5-A
REDUCE, REUSE, RECYCLE!

Summary
Students learn how to conserve water.

Learning Objectives

Students will understand:
- How water is wasted in the home; and
- Some simple things that they can do to conserve water.

Age Levels 10 +

Subject Areas Science, Mathematics

Time Part One: about 30 minutes; Part Two about 30 minutes.

PART ONE: WATER RESOURCES AND HOW WE WASTE THEM

Background

Water is a resource that has many uses. It is also essential for all forms of life and affects our health, lifestyle, and economic well being. As individuals, we use water for many purposes and in some places we pay for the public water utilities that provide water. Examples of the amount of water used by an individual during everyday activities are shown below

Flushing a toilet

20 to 30 litres (5 to 7 gallons)

Running a dishwasher

60 to 100 litres (15 to 25 gallons)

Washing dishes by hand

80 litres (20 gallons)

Taking a shower

100 to 190 litres (25 to 50 gallons)

Taking a bath

190 litres (50 gallons)

Washing a small load of clothes in a washing machine

130 litres (35 gallons)

Brush teeth (running water continuously)

10 to 20 litres (2 to 5 gallons)

Watering a small lawn

130 litres (35 gallons)

Although more than three quarters of the earth's surface is made up of water, only 2.8% of the Earth's water is available for human consumption. The other 97.2 % is in the oceans; however, this water is too salty to use for domestic purposes, and the salt is very costly to remove. Most of the earth's fresh water is frozen in polar ice caps, icebergs, and glaciers. Fresh water shortages can be especially acute on some Caribbean islands with limited groundwater or riverine supplies. On these islands, fresh water must be brought in by barge, obtained expensively from desalination plants, or rainwater must be captured and stored in cisterns.

Preventing water pollution and conserving water are essential to assure a continuing abundance of water that is safe to use for ourselves and future generations. Pollutants such as herbicides, pesticides, fertilisers and hazardous chemicals can make their way into our wetlands and water supplies. Physical pollutants such as trash, silt, sand, metal, sewage, and plastic can also harm water quality and degrade wetlands (see Copy Cat Page "Water Pollution Fact Sheets" Chapter 4). Contaminated water supplies threaten human, animal, and plant health. Purification is very expensive.

Each individual can really help the environment. Part 1 of this activity is designed to raise students' awareness about the amount of fresh water available on earth. Part 2 will help students think of ways they can protect water from pollution and conserve it by reducing the amount they use.

Materials

- Copies of Copy Cat Pages "Water Pollution Fact Sheets" and "Water Use Worksheet"
- One 1,000-millilitre (ml) graduated cylinder (or beaker)
- Five 100-ml or 50-ml graduated cylinders (or beakers) or one graduated cylinder and four small clear containers
- One medicine dropper
- Food colouring

Procedure

1. Ask the students to guess whether there is more salt water or fresh water in the world. Can they guess how much fresh water is available on Earth? Where does it come from? Write their suggestions on the chalkboard. Explain that you are going to demonstrate the actual distribution of the Earth's fresh water. The distribution is shown in the table below.

How much water is there in the world?

	Per cent of total	Represented by:
Saltwater (Ocean)	97.2	972 ml
Freshwater	2.8	28 ml
Where is the Freshwater?		
Icecaps and glaciers	82.1	23 drops
Groundwater	14.3	4 drops
Surface Water	2.4	2 drops
Water in air and soil	1.2	1 drop

2. Fill the large cylinder with colored water to the 1,000-ml line. Tell the students this represents the Earth's entire water supply.

3. Pour out 28 ml of the water from the large cylinder into a 100-ml graduated cylinder. This represents the Earth's total fresh water supply. The water remaining in the first cylinder (972 ml) represents salt water that we cannot drink without a costly procedure to remove the salt.

4. Divide the 28 ml of fresh water into four smaller containers. Use the amounts shown in the table above.

5. Ask the students whether they can guess which container represents the fresh water on Earth that is found in icecaps and glaciers. *The cylinderwith 23 drops.* Ask whether they think humans commonly use this source of fresh water.

6. Explain that most drinking water in the world comes from surface water (lakes, streams) and groundwater (**aquifers**), which together comprise only 16.7% of the Earth's freshwater. Illustrate this by showing them the relevant container (you may also draw a pie chart). Ask the students where they think most of the drinking water on your island comes from and then tell them the correct answers (this may require a little research on your part).

7. Are the students using water wisely? Each student should use Copy Cat Page "Water Use Worksheet" to estimate the amount of water their family used in the past week. Pool the results. Work out which activities used the most water. What is the average water use for families in your area?

8. After the students have discussed how ordinary citizens use water, ask them to identify water uses outside the home and school (e.g. agriculture, irrigation, livestock watering, fishing, industrial uses such as paper manufacturing, mining, power generation, and transportation). Explain to the students that in order to assure water is safe to use for ourselves and future generations, we must conserve fresh water by using it wisely and by preventing water pollution. (See "Water Pollution Fact Sheets" in Chapter 4).

PART 2 – Doing It Right

Materials

- Copy Cat Pages "Water Pollution Fact Sheets"
- Art materials
- Paper, cards or cartridge paper to make discussion cards

Procedure

1. Students work in small groups to compile a list of activities that they, their friends, families or neighbours may have done, that may waste or pollute water or damage wetlands.

   Here are some examples:
   - Letting the water run while brushing your teeth, washing your face, shaving, or washing dishes by hand. *Do not leave the water running, rinse all your dishes at once by using a dishrack placed in the sink.*
   - Taking baths. *Take showers instead of baths, they use 1/3 less water.*
   - Letting the water from your hose run continuously while washing your car or watering your plants. *Use a spray nozzle at the end of your hose to control the amount of water used.*
   - Running the dishwasher or washing machine when they are not full. *Do full loads of laundry or dishes only.*
   - Leaving soil exposed in a garden or cultivation. *Soil run-off may pollute water sources, more frequent watering will be necessary.*
   - Using chemical fertilisers and pesticides on your lawn or garden. *Use organic alternatives, plant native plants instead of traditional grass to avoid the use of herbicides, pesticides and fertilisers.*
   - Washing cars in or near rivers, streams or wetlands. *Run-off of soap scum, dirt and sediments will pollute wetlands.*
   - Dumping garbage and old household appliances in wetlands. *Degrades the wetland, harms wildlife, creates an unsightly mess.*
   - Throwing in the trash, pouring down the drain or dumping on the ground used motor oil, antifreeze, paint, paint thinner and other household hazardous wastes. *These can be washed into your water source or local wetland.*
   - Using toxic household cleaning products such as chlorine bleach. *Use non-toxic alternatives such as baking soda, club soda, vinegar, lemon juice and salt.*
   - Using laundry detergent containing phosphate*s. Use non-phosphate detergents.*
   - Using a hose to clean your garage or driveway. *Use a broom instead, do not sweep debris into the street or storm sewer.*
   - Leaving waste from your pet on the ground in town. C*lean up waste products while walking your pet.*
   - Using a pit latrine that is very close to a river.
   - Buying drinks and food in disposable containers. *Buy recycled as often as possible – this diverts waste from landfills into useful purposes and saves energy and resources.*
   - Using throwaway plastic table ware. *Use cloth napkins and plates, cups and utensils that can be washed and re-used.*
   - Setting fires in wetlands and hills. *When vegetation is removed by burning, soil erosion is likely to increase, killing corals and filling up wetlands.*
   - Clear-cutting forests. *Erosion and sediment run-off will pollute water sources and wetlands.*
   - Buying and using charcoal made from mangroves and other woodlands that are not managed for sustainability.
   - Buying and using sticks and poles cut from mangroves.
   - Others…
2. Have the students list these activities on cards. Collect the cards.
3. Redistribute the cards to each group of students. Each group should choose one or more of the activities and report on a discussion, paint a mural, do a skit, write a poem, or make up a dance hall song or rap song to illustrate:
   - What is happening?
   - How does it waste or pollute water or harm wetlands?
   - Why is the person doing it?
   - Are there any alternatives, which would meet the needs of the person, without doing any damage?

Evaluation/Assessment

Students could write an essay or draw a picture entitled "How I can help save water (or wetlands)."

Extensions

Students make up a list "Ten Simple Things I Can Do to Help Protect the Environment" and take a pledge to try and follow this list in their daily lives. Creating the list and taking the pledge would be a particularly good activity for a Science Club or Youth Group.

Remember: Reduce, Reuse, Recycle!

WATER USE WORKSHEET

Where does your household water come from?

Well _____
Tank or cistern (rainwater) _____
River, stream or pond _____
Municipal supply (town water) _____
Other _____

How much water do you use?

Ways you used water	Number of times last week (a)	Average amount of water used by this activity (litres) (b)	Approximate amount of water you use (a x b) (litres)
Brushed teeth		15	
Flushed toilet		25	
Washed dishes by hand		80	
Ran a dishwasher		80	
Took shower		150	
Used washing machine		130	
Washed by hand		70	
Washed car using hose		100	
Watered garden		70	
Other		(Estimate these)	
TOTAL			

Which of your activities used the most water?

How could you reduce the amount of water that you use?

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Activity 5-B

BE AN ACTIVIST

Summary

Students will learn the types of actions they can take to help the environment.

Learning Objectives

Students will learn:

- How to find out about real issues that confront their communities
- How to organise themselves to deal with issues

Age Levels 8 +

Subject Areas English Language, Social Studies, Science. Especially suitable for Science Clubs and Youth Groups.

Time Variable, depends on project

Materials

- Writing materials
- Books, magazines, maps, reports and other background information
- Depends on the issue, but probably art supplies, paper, and access to printer and photocopy machine

Background

Too often, people are faced with changes that they do not like in their environment, but they feel helpless about them. In many cases, people can make a difference - if they really want to! This activity will encourage students to take the initiative, use a little creativity and do some hard work—the rewards will probably be well worth the effort. Students will learn valuable lessons in leadership and organisation, make a positive change in their community, and develop pride in their role as stewards of the environment.

Procedure

1. Help students in your class, youth group or science club to identify an environmental problem in your school or community. For example, unsightly trash in an area, graffiti, lack of a recycling programme for paper, glass, aluminum, and plastic, pollution of a wetland, a proposed development in a natural area, destruction of wildlife or habitat, lack of nesting habitat for an endangered species on your island, logging or clearing of native vegetation, and wasting of energy, water or other natural resources. Review the Copy Cat Page "Water Pollution Fact Sheets" (see Activity 4-M) and the background information in Activity 5-A for additional ideas. For younger students or a group just starting out, it might be wise to take on a project that will have a high likelihood of success and a measurable result (e.g., neighborhood or beach clean up).
2. Find out the facts. Meet the people involved and discuss what is happening. If necessary, get help or the information you need by contacting experts (e.g., local environmental group or National Trust, natural resource department staff of your local government) or conducting research at the library or on the Internet.
3. Brainstorm some possible solutions to the problem (e.g. neighborhood/school clean-up, habitat improvement project such as replanting of native trees, putting up nest boxes, planting a butterfly/pollinator-friendly garden using a wide variety of native flowering plants, etc.). Discuss the various solutions, decide which ones are feasible, vote on the best idea, and come up with an Action Plan (the steps you will take to carry out your project). If manpower is needed, recruit help from family, friends, neighbours, and classmates. See if you can get local businesses to donate any needed materials, supplies, and specialised labour and equipment. Invent a catchy name for your campaign and decide how you are going to publicise it (e.g. through articles or letters in local newspapers, spots on local radio and television stations, handing out flyers and going door-to-door). The publicity should describe: 1) the problem, 2) why it is important, 3) proposed solutions or alternatives, and 4) how people can help. If government action is called for, write letters to government leaders asking for help and/or present your case at town meetings.
4. Carry out your Action Plan. Make sure all the necessary steps are in place to make the plan a success. If your plan calls for volunteer help on a certain date (e.g., clean-up or tree planting date), publicise it well. Don't forget to thank your volunteers and sponsors. Document your campaign and its results with data (e.g. number of bags/pounds of trash picked up) and photographs (e.g. before and after) and publicise them in your local newspaper and television. Be creative, enthusiastic in your leadership, and committed to making some kind of positive change. You'll be amazed at what grassroots efforts can accomplish!

Source Lisa Sorenson and Ann Sutton

Activity 5-C

WONDROUS WETLANDS

Summary

Field trips to mangroves and wetlands are often inspirational and always fun! Students will write poems about these experiences.

Learning Objectives

Students will:

- Experience the inspirational value of wetlands
- Write a poem about their experience

Age Levels 8 +

Subject Area Language Arts; also suitable as a follow-up to a field trip

Time 30–60 minutes

Materials

- Copies of vertical-poem and haiku forms (Copy Cat Page "Wetland Poems")

Background

Wetlands are important because they provide a place for people to observe and enjoy nature, relax, find peace and solitude, and recharge the soul. Witnessing the beautiful, haunting call of a flock of whistling-ducks as they alight on a still pond at sunset, or marveling at the serenity of wetland scenery are experiences that cannot be replaced by any of our modern technologies. Writing a poem about an experience in nature can help one appreciate the aesthetic value of wild places. It can be read again and again to rekindle the feelings of wonder, peace, or enjoyment. For this activity, students should take a field trip to a wetland or other natural habitat, taking notes on their observations. The notes will remind them of their experiences when writing the poems back in the classroom.

Procedure

As a follow-up to a field trip

1. During a visit to a wetland send all students away to be on their own, at least 20 m from other students. They should sit or stand quietly, listening and looking, focusing on a plant or animal, or an aspect of the environment. They should imagine that they have become the thing they focused on and make notes on what they hear, see, smell, and feel.

   If a field trip is not possible
   Take the students on an imaginary field trip (See Activity 3-A "Mangrove Metaphors," for instructions on how to do this), a walk in the school grounds or instruct them to visit a park in their neighborhood. There are plants and animals to observe and enjoy even in our cities and urban areas.

2. After the field trip (real or imaginary) or walk, ask them to write a short poem about what they observed and how they felt. The following handout can be used for writing poems about mangroves. It can be adapted for other observations.

Extensions

- Read and discuss the following quotation from a poem called "Inversnaid" by Gerard Manley Hopkins.

  "What would the world be, once bereft
  Of wet and wildness? Let them be left,
  O let them be left, wildness and wet;
  Long live the weeds and the wilderness yet."

- Read aloud to the class one or more of the "Just So Stories" by Rudyard Kipling. Ask the students to make up new titles (for example, "How the Whistler got its Whistle") and write and illustrate their stories.

- Illustrate your poems and stories with pictures and collages.

Source Adapted from Project Wild.

WETLAND POEMS

Vertical Poem

Choose a word that captures your feelings, and use the first letter of the word to begin the line of your poem. For example:

M _____
A _____
N _____
G _____
R _____
O _____
V _____
E _____
S _____

Haiku

Japanese haiku is a form of poetry with only three lines. The first line contains five syllables, the second has seven, and the third line, with five syllables, expresses surprise of discovery. For example:

In the mangrove swamp
Fish swim, crabs crawl, herons stalk
Waves and salt water.

Try writing a haiku about your own exploration experience.

Cinquain

Cinquains have five lines, which follow a set formula.

Line 1: The title in two syllables (or two words)
Line 2: The description of the title in four syllables (or four words)
Line 3: A description of an action related to the title (six syllables or six words)
Line 4: A description of feelings (eight syllables or eight words)
Line 5: Another word for the title in syllables or two words.

For example:

Whistling-Duck
Brown, spotted, wetland bird
Call echoing, lonely across the marsh
You appear from the reeds while I watch,
Please stay.

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Activity 5-D
MANGROVE CONTROVERSY
Town hall meeting

Summary

Development and ill-advised land-use decisions are destroying mangroves throughout the West Indies. In this activity students get a chance to participate in the decision-making process by creating a local council that makes planning decisions, and a cast of characters both for and against the proposal.

Learning Objectives

Students will be able to:

- Recognise the many viewpoints in land-use issues
- Understand the process of land-use planning and decision-making

Age Levels 10 +

Subject Areas Social Studies, Language, Arts

Time 2–4 lessons, or more

Materials

- Costume materials and props, e.g., hats, ties, hunting vests, glasses, jewelry, binoculars, etc.
- Paper and pencils
- Copies of Copy Cat Pages "Guest Speakers Character Worksheet," and "Mayor and City Council Members Character Worksheet."
- Name cards for city council members

Background

In this exercise, students will role-play the characters listed below to enact a town hall, city council, planning board, or similar meeting. This kind of forum may not be the way land-use decisions are made on your Caribbean island; however, on many islands an opportunity is given for public comment on such issues. The exercise will expose students to a variety of views. If the forum for land-use decisions on your island is different, adjust the scene as necessary. The attitudes are probably going to be very similar!

Preparation

To begin this activity, choose a mangrove wetland to use as an example. If you are aware of a real case, base your exercise on the issues surrounding the use of that specific wetland. Otherwise, use a real wetland in your area as the topic, pretending that it is under development pressure.

The plot: Some (fictitious) people in your town have been meeting surreptitiously to express their dismay about the "stink pond" in the community—the local wetland. They call themselves Citizens Opposed to Mangroves (COM), argue that the wetland is of no real value, and should be converted to other uses. In particular, a developer thinks it would make a wonderful marina. Another faction (also fictitious) has heard about COM and has joined together to defend this natural area. Using the motto "Save Our Mangroves" (SOM), these citizens feel the wetland is valuable and should be preserved at all costs.

The mayor, upon hearing of the growing dispute between COM and SOM—not to mention the $50 million marina proposal—has called a special city council meeting to discuss the matter. A decision will be made at the end of the meeting to determine the fate of the wetland.

The characters and a brief description are listed below:

Characters

Mayor Justus B. Faire
Mayor Faire is a wise person who wants to make the best possible decision for the city and the island—especially because this year is an election year.

City/Parish Council Members (6)

1. Simon Sense
2. Bertha Broadmind
3. Harry Reason
4. Iris Wise
5. Phil Osopher
6. Kitty Prettycity

All council members are elected officials who also have other jobs. They must weigh the evidence and decide the fate of the local wetland.

Guest Speakers (12)

1. **Phil Swamp:** Phil is a carpenter who builds homes. He knows that if the wetland were filled in, homes could be built in the area, providing more jobs for carpenters.
2. **Wanda Drejanbuild:** Wanda has already built a small marina on a neighbouring island, and sees this mangrove swamp as the perfect opportunity to enter the big leagues of developers.
3. **Marsha Plenty:** Marsha lives in a house near the tidal floodplain. She knows how important wetlands are and is concerned about her home.
4. **Duane DeMarsh:** Duane is a farmer who has filled in a marsh on his property and thinks all marshes should be filled in for better uses.
5. **Ima Heron:** Ima is a long-time resident of the city and grew up near the wetland. She thinks the wetland is beautiful and wants her grandchildren to be able to enjoy it too.
6. **Will Huntmore:** Will loves to hunt, and helps to feed his family through hunting. He realises how important wetlands are for ducks and other animals.
7. **Candy Velop:** Candy is another developer who would like to build condominiums around Wanda's marina, and provide them all with "ocean views."
8. **Amos Keetow:** Amos detests pests. He lives near the mangroves and feels they are the source of the insects that ruin his life in his expensive new home.
9. **Crystal Clearwater:** Crystal is the director of the water authority that provides water for the city and the island. She is concerned because she knows that wetlands are important areas for water purification and flood control.
10. **Dr. Pete Bog:** Dr. Bog is a scientist with a Ph.D. in wetland science from the University of Away. He has studied wetlands and knows how valuable they are to people.
11. **Fly Fish:** Fly is a local fisherman who knows the importance of mangrove wetlands as a nursery for many of the fish and conch from which he makes a living. He is concerned that dredging the mangroves will destroy the fishery.
12. **Tee Ball:** Tee is an avid golfer who just won the lottery. He has plans for a new golf course right next to the marina and the condominiums.

Procedure

1. Students will role play the scene at a local planning meeting. The task will be to decide the fate of the local mangrove wetlands. Should the council preserve it, convert it to use for something else, or make some sort of compromise? (A **compromise** is a method of reaching agreement in a dispute, by which each side gives up something that it wants.)

2. Remember that each citizen in a democracy has the responsibility to participate in the decision-making process by expressing their views to their elected representatives. You may express your views by voting, writing letters, speaking at town hall meetings, and so on.

3. Read the background information for this exercise carefully.

4. Assign students to the following roles.
   - Select one person as the Mayor. This person will be the facilitator of the meeting.
   - Appoint six city council members who will listen to the testimony and ask questions of the public.
   - Divide the remainder of the class into 12 groups. One student from each group will be the spokesperson.
5. Each character should have a character worksheet (either "Guest Speakers Character Worksheet" or "Mayor and City Council Members Character Worksheet"); one for each city council member and the Mayor, and one for each group represented by a guest speaker. Take time to answer the questions. The guest speakers each get a piece of paper with their character description, and members of the group should work together to answer the questions for their character.

Important: Remind students that the characters they are playing may not necessarily think the way they do. They are to put themselves in the shoes of their characters and say what those persons might say, according to the character descriptions.

6. Arrange seven desks in the front of the classroom for the city council members. Put name cards on the desks for each member. The mayor in the middle.

7. After everyone has filled out a character worksheet, students put on any costume or prop materials that are appropriate for their role, simply to add to the interest of the exercise (ties, glasses, straw hat, hunting vest, etc.).

8. Have the Mayor officially open the meeting and introduce himself or herself to the audience. Have the city council members introduce themselves. The Mayor should briefly introduce the situation and then invite public testimony from the guest speakers.

9. Each guest (spokesperson) is to stand up before the council to express his or her viewpoint, using the character worksheet for reference. When making their statements, guest speakers should introduce themselves, describe what they do, and anything else relevant about themselves, and say what they feel about wetlands and about this specific question.

   Example: "I am Dr. Peat Bog, you know I was raised on this island, and I went to the University of Away to study wetland biology. When I married Betty Bog I returned home to raise my family. Having spent years and years studying every tiny thing about mangroves, I have come to the conclusion that they are so important for us that I think it is criminal to destroy them."

10. After all the guest speakers have had their say, it is time for the council to ask questions and challenge the viewpoints of the guest speakers in order to clarify the issue. This will be a time for creative thinking. For example, someone might ask Candy why she cannot build her condos somewhere else, or, alternatively, why Marsha needs to live near a tidal floodplain.

11. After all the questions have been asked, the Mayor will decide it is time to make a decision and will call for a vote:
    All in favour of preserving the wetland?
    All in favour of converting the wetland to _____?
    All in favour of some sort of compromise?

12. After the vote, the Mayor makes a declaration about the fate of the wetland, and the meeting is adjourned.

13. Discussion
- If you yourself were voting on this decision, how would you vote?
- How should decisions like this be made?
- Should all people be involved in making the decision?
- Should laws be written to protect mangroves?
- What kind of laws would you make to protect mangroves?

Extensions

- Students could visit a local town hall meeting to see how decisions are made.
- If there is a threat to a local wetland, the students could follow the debate, make up their minds about their positions and perhaps even get involved by gathering data, giving testimony, or lobbying.
- Perform the West Indian Whistling-Duck Puppet Show (See section on Resources for where to obtain a copy)

Source: Adapted from Project Wild.

GUEST SPEAKERS CHARACTER WORKSHEET

Name_____

What do you do?

_____

Describe yourself.

_____
_____
_____

How do you feel about mangroves?

_____
_____
_____
_____
_____

What do you think should happen to this mangrove area?
Circle one: Preserve it Destroy it Compromise

Why?_____
_____
_____
_____

Important: Put yourself in the position of your character, and try to think what they might say, according to the character descriptions.

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MAYOR AND CITY COUNCIL MEMBERS CHARACTER WORKSHEET

Name_____

What do you do?

_____

Describe yourself.

_____

_____

How do you feel about mangroves?

_____

_____

_____

Write down reasons why people would want to save mangroves.

_____

_____

_____

Write down reasons why people would want to destroy mangroves.

_____

_____

_____

You will be making an important decision about the mangroves in your community. Therefore, you will want to know everything you can about the situation so you can make the best decision. Keep an open mind. Think of questions to ask the guest speakers about why they feel the way they do.

Important: Put yourself in the position of your character, and try to think what they might say, according to the character descriptions.

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Activity 5-E

BOUNCING BACK

Summary

These success stories illustrate how some endangered species have been brought back from the brink of extinction.

Learning Objectives

Students will:

- Learn the names of some species that have 'bounced back;' and
- Discuss some of the problems and solutions facing these species.

Subject Areas Science, Social Studies

Time 30–60 minutes

Age Levels 5–10

Materials

- Pictures of flamingos, osprey, crocodiles, West Indian Whistling-Ducks (add other species as desired).

Background

Some positive things have happened to endangered species. For example, the populations of raptors such as Ospreys are much healthier now than they were a few years ago. So are flamingos in the Bahamas and British Virgin Islands, Sooty Terns in Jamaica, and West Indian Whistling-Ducks in the Cayman Islands. Thanks to recovery efforts, Eastern Caribbean Leatherback Turtles are also doing better.

Cayman Island Whistlers (West Indian Whistling-Ducks)

Before the 1960s West Indian Whistling Ducks were very common throughout the Cayman Islands. By the 1980s however, they had declined catastrophically on Grand Cayman and Little Cayman (less than 200 ducks)and they stopped breeding on Cayman Brac. The species was not protected. Decline was attributed to unregulated hunting.

In the late 1980s, the National Trust of the Cayman Islands, and RARE Centre organised a public awareness and education programme in the Cayman Islands to explain the importance of saving the duck. The Cayman Islands government introduced a new law protecting whistling-ducks. Meanwhile, a local farmer began feeding ducks on his farm, which bred successfully and gradually spread to the surrounding wetlands. This prompt action has encouraged the whistling-duck population of the Cayman Islands to expand to around 1000, despite the loss of some wetlands. Since hunting stopped, the ducks have learned to use new habitats, including golf courses and farms.

Bahamian Flamingoes

See "Inagua National Park – A Conservation Success Story" opposite.

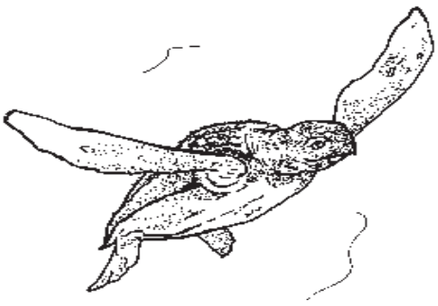
Ospreys

Ospreys were once common in wetlands of Europe and the Americas, including the West Indies. In the mid-1950s, however, owing to DDT that accumulated in their food chain, their populations declined markedly.

Jamaican Sooty Terns

In the twentieth century, populations of Sooty Terns on the Jamaica cays declined from more than 600,000 pairs in the late 1920s, to fewer than 60,000 pairs in the early 1980s. This was largely the result of unregulated egg collection. In 1992, the Jamaican government established a seasonal wildlife reserve on one of the cays.

Eastern Caribbean Leatherback Turtles



Leatherback Turtles are huge marine turtles that feed mainly on jellyfish. Most of their lives are spent in the open waters of the North Atlantic but they migrate south to breed on the sandy shores of the Caribbean. Once common, their numbers have been drastically reduced by hunting for meat and eggs, as well as the destruction of nesting beaches for hotel and marina development. Many also die after eating plastic bags, (mistaken for jellyfish), or after becoming entangled in fishing gear. Careful protection of beaches in the Virgin Islands and Trinidad and Tobago has been rewarded by an increase in nesting populations in some places. This may be a sign that the Caribbean populations of Leatherbacks will recover.

Adelaide Mangroves

See 'The Adelaide Creek Wetland Restoration Project" below.

Preparation

Try to find out from your local conservation agencies whether the populations of any wetland animals or plants on your island are recovering following conservation efforts. Add more verses to the rhyme for any local species that are making a comeback.

Procedure

1. Show students pictures of the animals you are going to discuss.
2. Discuss each of the species mentioned in the song "They're Bouncing Back." Use the information provided to briefly go over the problems each species has faced and how the animal has been helped through conservation efforts. What conservation measures are effective?
3. Have the students stand and form a circle.
4. Rehearse the chant, and then have the students "perform" it twice as they march around the circle.

Inagua National Park – A Conservation Success Story

by Lynn Gape

Inagua National Park, near Matthew Town, covers 287 square miles (almost half) of Great Inagua. Bird life dominates the park and the flamingo, the national bird of the Bahamas, is the star. The Park is home to some 50,000 West Indian Flamingos, the biggest breeding colony in the world. After 40 years the birds are back from the edge of extinction.

In 1905, at the first annual meeting of the National Audubon Society, a plea was made to the Bahamas government for the establishment of legal protection for the flamingo. Almost immediately the Wild Birds Protection Act was passed. In 1922, the Bahamas set aside a flamingo reserve on Andros Island and Audubon sent a patrol boat to help the wardens patrol the reserve. Flamingos continued to nest in Andros until World War II when Royal Air Force pilots buzzed the bird colonies for fun.

Flamingos were not only hunted for food, but also for their exquisite plumage. Indiscriminate hunting led to the disappearance of the flamingos in Florida Bay - last seen there in 1903.

By the 1950's, a close working relationship had been established between the National Audubon Society and the Bahamas. Concerned with the sudden decline in the flamingo population during the early years of that decade, Audubon sent Bob Allen, its research director, to investigate the situation. All of the places where flamingos were rumored to nest in the Caribbean—Cuba, Haiti, and the Dominican Republic—were searched. Owing to pressure from an expanding human population,

fifteen colonies had been abandoned in the Caribbean in the last 35 years. However, stories persisted about a great colony in the inhospitable wilds of Great Inagua.

Together, Bob Allen and Sam Nixon, a local hunter, found more than a thousand flamingos "commulating." The birds massed in a riotous courtship ritual of head turning, wing flicking, and exaggerated strutting - "the Flamingo Quadrille." This population might one day replenish the long-abandoned colonies elsewhere in the Caribbean. The Society for the Protection of the Flamingo in the Bahamas was formed by a number of American and Bahamian Conservationists. Sam Nixon became the first flamingo warden on Great Inagua, with the National Audubon Society providing money for his salary and equipment. On a subsequent trip in 1956, Bob Allen wrote a Monograph that is the basis of much of our knowledge of the "Caribbean" flamingo's natural history. By an odd twist of fate, it is not direct human persecution that is a major threat to Great Inagua's flamingos, but the marauding wild pigs that were introduced by early settlers and feed on the birds' eggs and the young. Constant vigilance and careful wardening has done much to neutralise the threat.

Another positive step was the creation of the Bahamas National Trust by an Act of Parliament in 1959. As the official organisation responsible for wildlife protection and National Park management, the Trust took over the work of the old Society of the Protection of the Flamingo. By working closely with Morton Salt (a local business enterprise), various government agencies and the National Audubon Society in a mutual aid partnership, the Trust has helped the resident flamingo population grow from several thousand birds in 1952, to over 50,000 birds today.

Morton Salt produces salt by solar evaporation in the vast flat saltpans that traverse the Inagua landscape. The process takes two years for seawater to be circulated from pan to pan. In time, algae, fertilised by the flamingo droppings grows in the water and darkens it. This hastens evaporation by absorbing more sunlight. Then the tiny brine shrimp begin feeding on algae cleaning the water. And the flamingos feed on the shrimp until the salt is ready for harvesting, leaving both the flamingos and people tickled pink! —A wonderful example of how private enterprise and Mother Nature can join forces. Furthermore, Morton assists the Trust by providing a vehicle for the wardens, keeping the dike roads passable and other infrastructure in good condition. Having learnt a lesson from the disappearance of the flamingos from Andros, the Trust has made the air space above the Inagua National Park a restricted area, banning flights below 2,000 feet.

The success of the Inagua National Park is evident in the restocking of other Caribbean islands by the Inagua flamingo population. Scientists are aware of the link between healthy flamingo populations in Inagua and Cuba, as well as between Inagua and the Turks and Caicos Islands, Grand Cayman, Crooked Island and Acklins Island.

The Adelaide Creek Wetland Restoration Project

By Pericles Maillis, Lynn Gape and Eric Carey

Throughout the Bahamas and Caribbean region, wetlands destruction is rampant. Wetlands have been drained to create agricultural lands. The fear of malaria or yellow fever caused wetlands to be hated. Anywhere there was a blue hole-flushed lake it was drained for salt production This destruction has provided us with many challenges and opportunities.

This is the story of a marvelous little restoration project that was carried out in 1990, and continues today. It is known as the Adelaide Creek Restoration Project, and covers an area of some 2 sq. miles of tidal creek, associated wetland and drainage areas on the island of New Providence (Bahamas).

Historically, the creek had two entrances, but in 1926, during a hurricane, a ship was wrecked, permanently blocking the main entrance. The Creek ran for about two miles along the inside of a beach ridge with a branch through a narrow channel inland to Corry Sound – forming a lake fed and drained by a tidal creek. Over time, the creek were reclaimed for farmland and cut up by causeways; in 1989, the mouth was sealed off by a coastal groin. The flow of water was restricted, the fish population was in decline. Garbage was being dumped by beach visitors and also by residents of the local village (founded in 1832, by freed slaves).

In late 1989, Mr. Maillis, a member of the Wildlife Committee of the Bahamas National Trust, proposed the restoration of the creek as a grass roots project for the committee. The proposal was approved and very quickly, the Adelaide Creek Wetland Restoration Project Committee was formed with Mr. Maillis as chair. The Committee, composed of local dignitaries, engineers, hydrologists and other experts, made the first site visit. A project letter was drafted recounting the history of the deterioration and appealing for public support. A schedule of works was organised. A public meeting to launch the project was held in the Adelaide Village School. At this meeting, the Director of Fisheries (Bahamas), Mr. Colin Higgs, spoke to the importance of tidal creeks, the detritus cycle and the importance of mangroves as a marine nursery. Barbara Curtis lectured on health education because the Committee had decided also to carry out a major cleanup of Adelaide Village and

the Creek edges and start regular garbage collection.

While the engineering and physical works were being initiated, more than 30 tons of garbage and 70 abandoned vehicles were removed from the Village and creek edges. Local residents of all ages and walks of life joined in the clean-up.

The project next needed heavy earth-moving machinery, but the Committee had no funding and the work was being done by hand by volunteers. Adelaide villagers, College of the Bahamas students and Bahamas National Trust Junior Members, removed the Cory Sound Causeway reuniting the waters of the upper creek with the main creek. The main bridge site was cleared. The committee had very favourable media attention and a strong groundswell of popular support. Politicians visited, including Senator Alma Adams (Government party). The local Member of Parliament - the Honorable Frank Watson - now Deputy Prime Minister – helped remove rocks from another interval causeway.

Soon, a local chicken farm lent a mechanical backhoe to excavate a channel. Fundraising efforts continued. A distinguished local lawyer and a lumber company donated heavy timber to replace the bridge over the causeway channel, and a local marine engineering firm provided carpenters to build the bridge. The Committee specialists supervised the works - Mr. Tony Hing Cheong (retired Surveyor General) and local villagers did excellent voluntary work on building the bridge ramparts. Adults and children from all walks of life worked together to save the Creek.

Then the fundraising efforts bore fruit dramatically - two associated insurance companies donated $5,000.00 because the project was so inspiring. The Bahamas Marine Construction Company donated machinery and concrete for the main bridge. A private engineer, George Cox, drew the structural plans for the bridge in consultation with other Ministry of Works engineers; the Commissioner of Police granted permission to block the main road across the Creek to the Beach; the Water and Sewerage authorities agreed to disconnect water flow while construction was underway.

At the mouth of the Creek, the beach ridge was removed and hundreds of casuarinas (an alien species) were felled. The groin (600 feet long) had to be cut and partly pushed on to land and partly turned into an island. The Ministry of Health donated a large backhoe, another company lent us a bobcat and the Ministry of Works donated gabions. During the day, spectators gathered, but towards evening drifted away and only the workers remained. A dramatic moment occurred when sea water met Creek water again – the tide came up and water came rushing in. By evening, the creek was flowing like the Mississippi River.

A ceremony to mark the completion of works was held and the Prime Minister released marine life into the renewed system. Within days, crabs were using the Creek, within weeks, fry of many fish species were evident. Later, a puppy tiger shark was seen. Today, children play and fish in clear water and in winter many waterfowl, waders and shorebirds use the system. The mangroves are regenerating. The residents are very pleased. The project brought government and NGOs closer together and we hope that many more similar projects will take place.

THEY'RE BOUNCING BACK

They're bouncing back,
They're bouncing back,
The Cayman Whistlers are bouncing back!
Elegant birds of brown and white,
Their numbers now are out of sight!

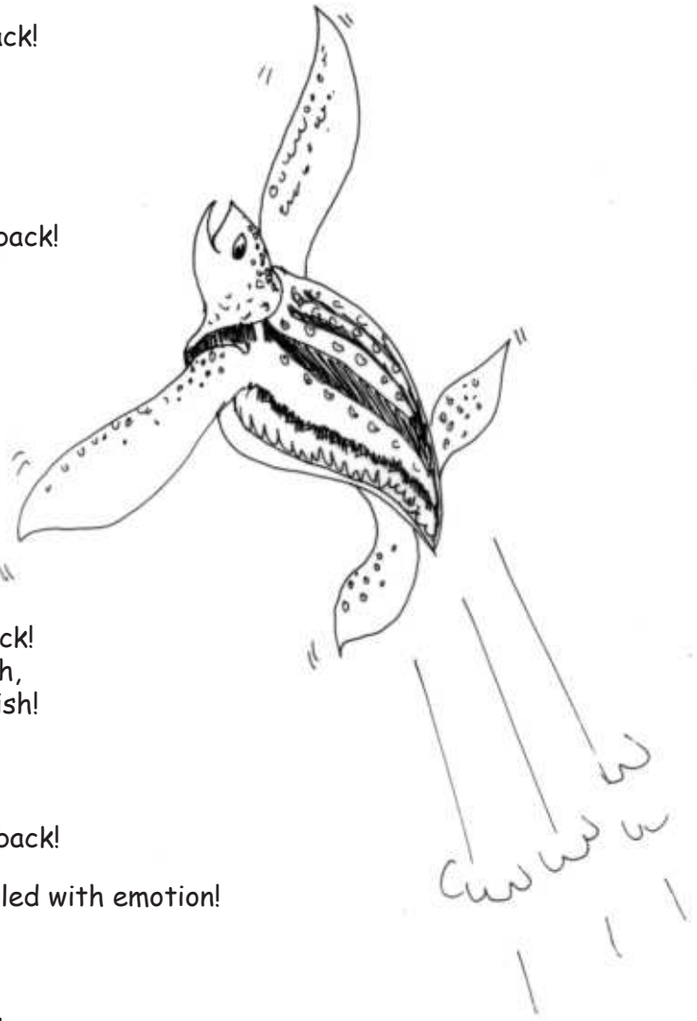
They're bouncing back,
They're bouncing back,
The Bahamian Flamingos are bouncing back!
Tall and graceful birds that dance,
Now they have another chance!

They're bouncing back,
They're bouncing back,
The Ospreys now are bouncing back!
Soaring over lake and bay,
Doing better every day.

They're bouncing back,
They're bouncing back,
Jamaican Sooty Terns are bouncing back!
Black and white birds, that feed on fish,
Let them keep increasing, that's our wish!

They're bouncing back,
They're bouncing back,
Caribbean Leatherbacks are bouncing back!
Giant turtles, that live in the ocean
Watch them lay their eggs, you'll be filled with emotion!

They're bouncing back,
They're bouncing back,
Adelaide mangroves are bouncing back!
As the mangroves recover, the fish move in,
Then crabs, shrimp, lobsters. Let everyone win!



Motions

- Flamingo: Slowly flap arms up and down and lift legs high with each step.
- Osprey: Hold arms out to your side and imitate the bird soaring.
- Whistling-Duck: Hold arms out to your side and sweep them up and down gracefully. Whistle.
- Sooty Terns: Use right hand to make a swooping motion, to show how the Sooty Tern dives to take fish from the surface of the sea. Repeat their call "Wide-awake! Wide-awake!"
- Leatherback Turtle: Make a rowing motion with the arms to show how the Leatherback pulls itself up the beach to lay its eggs.
- Mangroves: Take long arching steps, to imitate the way that red mangrove roots "walk' over water. Hold hands over head to imitate the branches of the mangrove trees.

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Source Adapted from Ranger Rick's NatureScope: Endangered Species.

Activity 5-F

MARINE DEBRIS
Collection and impact

Summary

Lots of garbage washes up on the West Indian coast. What it is and where it comes from will be determined in a series of field trips, research, and classroom activities.

Learning Objectives

Students will:

- Understand marine debris and its sources, and be able to describe its adverse effects on organisms
- Determine the distribution and predominant type of marine debris in their island/region
- Understand how long it takes various types of debris to break down in the environment
- List potential solutions to the problem.

Age Levels 8 +

Subject Areas Science, Social Studies

Time 2–4 lessons, or more

Materials

For field trip

- Trash bags (if recycling on island, two colours to separate recyclables from non-recyclables)
- Clipboards, pencils and forms for each group
- Gloves
- First aid kit
- Map of beach location to be cleaned (optional)
- Spring balance (optional)
- Small prizes (e.g., candy bar)
- Copies of Copy Cat Pages "Marine Debris Collection Worksheet 1"

Back in class

- "Marine Debris Collection Worksheet 2," "Marine Debris Time Line," "Marine Debris Collection Colouring Sheet."

Background

Every day tons of solid waste are washed ashore onto our beaches and into our mangroves. Much of this garbage comes from ships and fishing and recreational boats that dump their waste overboard. Marine debris also comes from beachgoers, improper disposal of trash on land, industrial facilities, offshore oil and gas platforms, and waste disposal activities. More than 90% of the garbage is plastic; the rest is glass, rubber, metal, paper, foamed plastic, wood and cloth. The ease with which the trash degrades dictates how long it remains in the marine environment. Not only is the litter unsightly, it is a serious threat to marine organisms. Each year millions of seaturtles, seabirds, marine mammals and fish die from ingesting plastic or becoming entangled in plastic, fishing lines and nets. For instance, sea turtles mistake plastic bags for jellyfish, swallow the bags and die.

Preparation

- Assemble equipment.
- Make arrangements with the local garbage-collection service for the bags of garbage to be picked up.

Procedure

Beach Clean Up

1. Divide the class into small groups. Each should have garbage bags, marine debris recording sheets and marine debris timeline sheets, pencils, clipboards, and gloves.

2. The students will gather the debris and analyse it for its type, source, time needed for decomposition, and potential threat to wildlife and the ecosystem.

3. Explain the importance of wearing gloves and what they should do in the event of finding a syringe or glass (*call the teacher and avoid picking it up themselves*).

4. Assign each group a specific area to be cleaned up (mark on map). A prize for the most unusual item found, as well as the most litter gathered. If items have labels on them, the students should write down the product type and name on the sheets. During the picking up, discuss the possible origin of the items of debris.

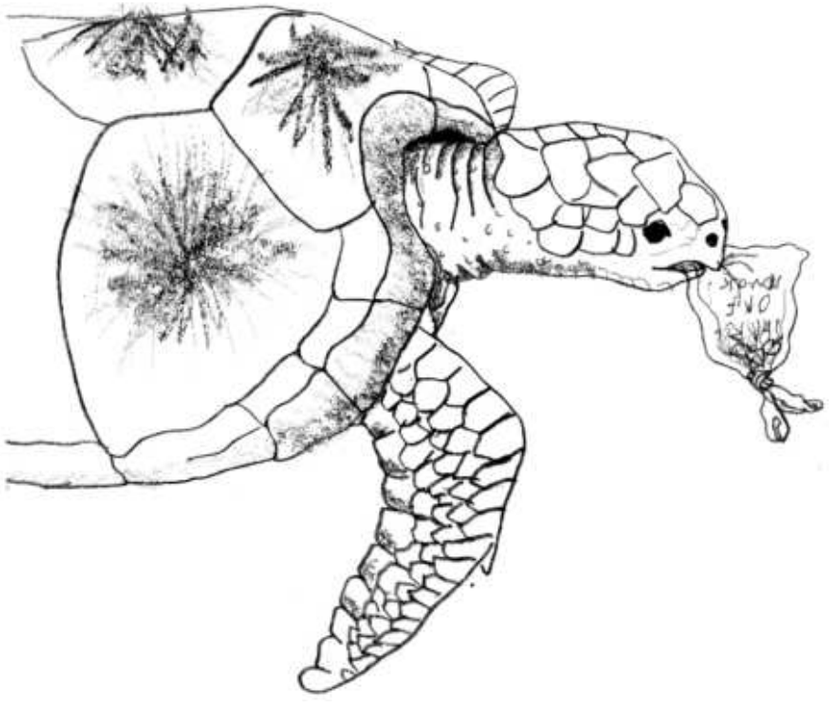
5. Complete the forms Copy Cat Page "Marine Debris Collection Worksheet 1" to make a record of the types, numbers and sources of items found.

Back in the classroom

- One group can analyse the data and create a report including the most common types of debris and its origins. Discuss how long various items can survive in the sea. The results can be filled in on "Marine Debris Collection Worksheet 2."
- Another group could investigate ways in which the debris can affect animal and plant life on the shoreline and in the water.
- **Discuss**: Where did most of the debris come from? How did it get into the sea? How might it affect wildlife? What measures are needed to reduce the amount of garbage in the sea?

Extensions

- The garbage may be displayed at a school Open House or science fair. For example, if they find an old fishing net, hang it between two or three poles and attach the debris to it in sections—each section representing 100 years—that illustrate how long it takes each type of debris to biodegrade.
- Younger students can create a Trash Monster by assembling all the pieces of garbage into a "Fishenstein".
- Younger students can colour the "Marine Debris Colouring Sheet."
- Visit the Environmental Protection Agency's websites on marine debris to learn more about the problem and solutions: www.epa.gov/owow/oceans/debris/
  www.epa.gov/owow/OCPD/Marine/contents.html



MARINE DEBRIS COLLECTION WORKSHEET 1

ITEM	TYPE	SOURCE

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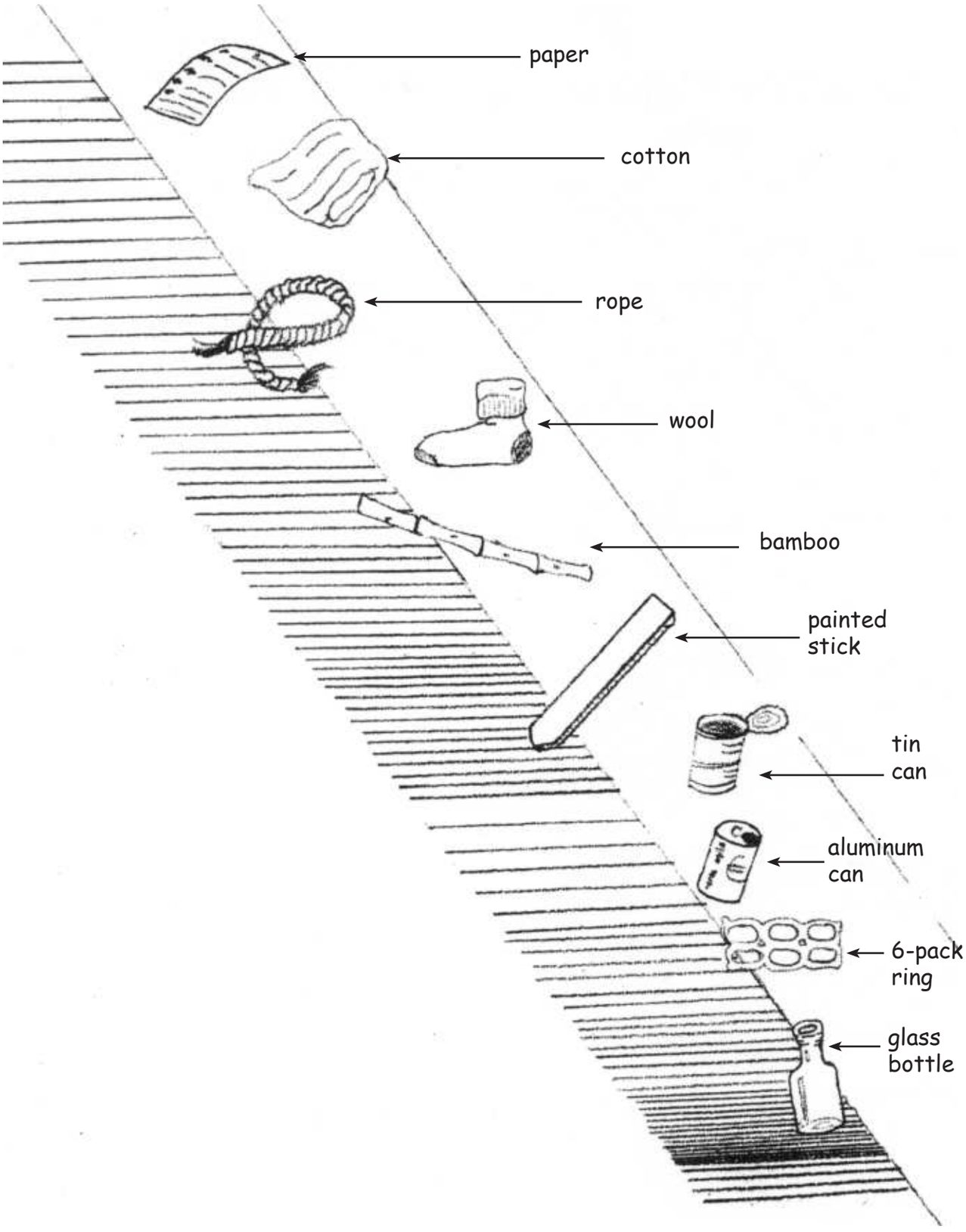
MARINE DEBRIS COLLECTION WORKSHEET 2

Summary of findings



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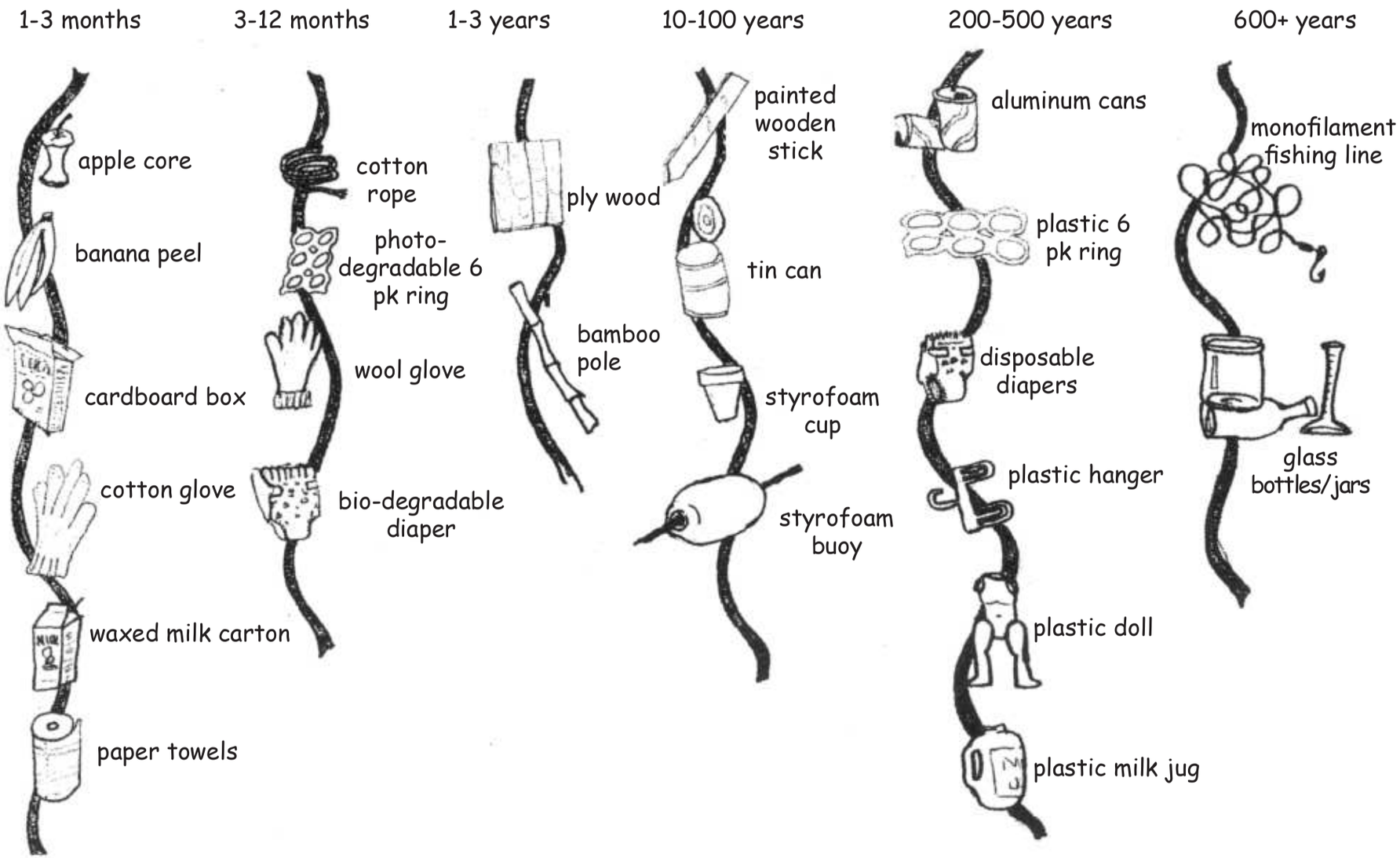
MARINE DEBRIS TIME LINE



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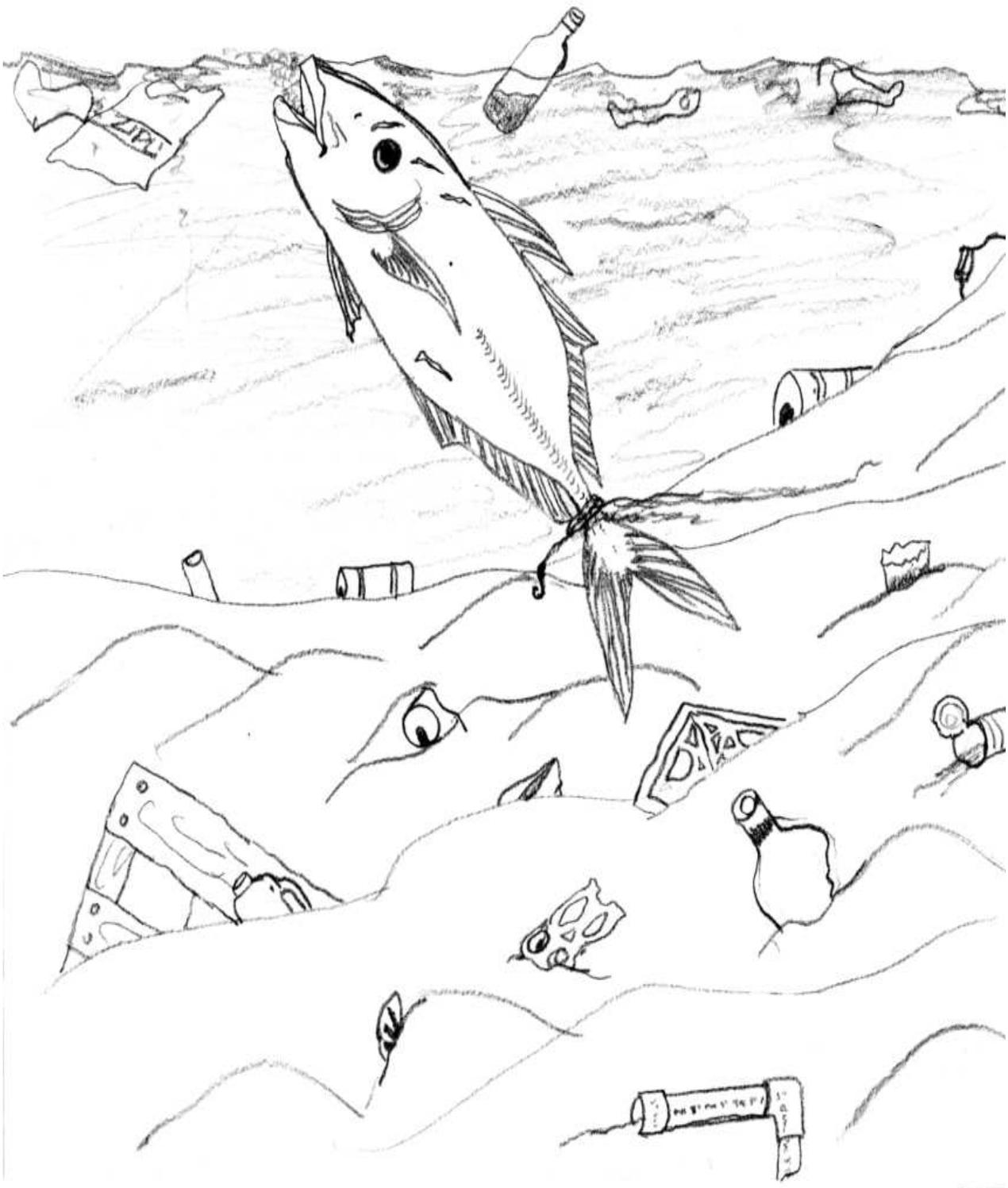
MARINE DEBRIS COLOURING PAGE



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Activity 5-G

WET WORK

Summary

Students will learn about employment in the environmental field.

Learning Objectives

Students should be able to:

- List careers that could involve working in wetlands
- Describe what some of these careers involve.

Age Levels All

Subject Areas Social studies, English language, Career Development

Time One lesson, plus time for lectures and visits

Background

Increasingly, governments and non-governmental organisations (NGOs) on Caribbean islands need people to work in wetlands, but the supply of trained people is inadequate. Some types of jobs that are available are described below.

1. Research

Universities and colleges employ lecturers and researchers. Their studies include research into the ecology and management of species or habitats, fisheries, climate change impacts, and how people depend on wetlands.

2. Management, law enforcement and interpretation

- Environmental NGOs, government agencies and other groups involved in managing wetlands employ rangers and wardens to monitor changes and enforce laws.
- Many nature centres and reserves employ interpreters to teach school children and visitors about ecology, wildlife, and wetlands.
- Tour guides are needed to inform the public about the natural history and ecology of an area, museum or aquarium.
- Scientists carry out surveys and develop and implement species and habitat recovery programmes.
- Social scientists work with communities around the wetlands to ensure that they use the resources in a sustainable way.
- Fish and shrimp farm managers.
- Artists, writers, videographers and photographers develop educational and promotional materials on nature.
- Lawyers develop wildlife laws or bring national legislation into line with international treaties (such as Ramsar and SPAW)
- Geographic Information Specialists map and assess natural resources.

3. Sustainable use

In some countries, rural people make their living in wetlands, burning charcoal, harvesting timber, fishing, working in salt factories or fish farms. Many of these traditional activities were sustainable so long as the number of people involved was small. There is a need to develop new technologies to use wetland resources sustainably.

4. Environmental Impact Assessment

Developers employ scientists to carry out environmental impact assessments, which are needed when they want to change the use of a wetland.

Materials

- Writing materials

Preparation

Find out the names and addresses of important environmental agencies in your island.

Procedure

1. Introduce the background materials.

2. Ask the students whether they have ever considered working with wildlife or in wetlands and what they think the advantages and disadvantages might be. What types of opportunities exist in your country? Make a list on the board based on the suggestions above, but using names of real organisations where possible. What qualifications are needed? Does any student know someone who works in wetlands or does other natural resource work?

3. If the class is large, divide the students into groups. Each group should pick a career from the list (not necessarily what they want to do themselves) and do a mime to illustrate it. The rest of the class should try to guess the occupation.

Extensions

Identify someone who is working in wetlands (or some other natural resource type of work) and invite them to come to talk to the class about their work. Before the talk ask the students to think of the sorts of questions that they might like to ask. For example:

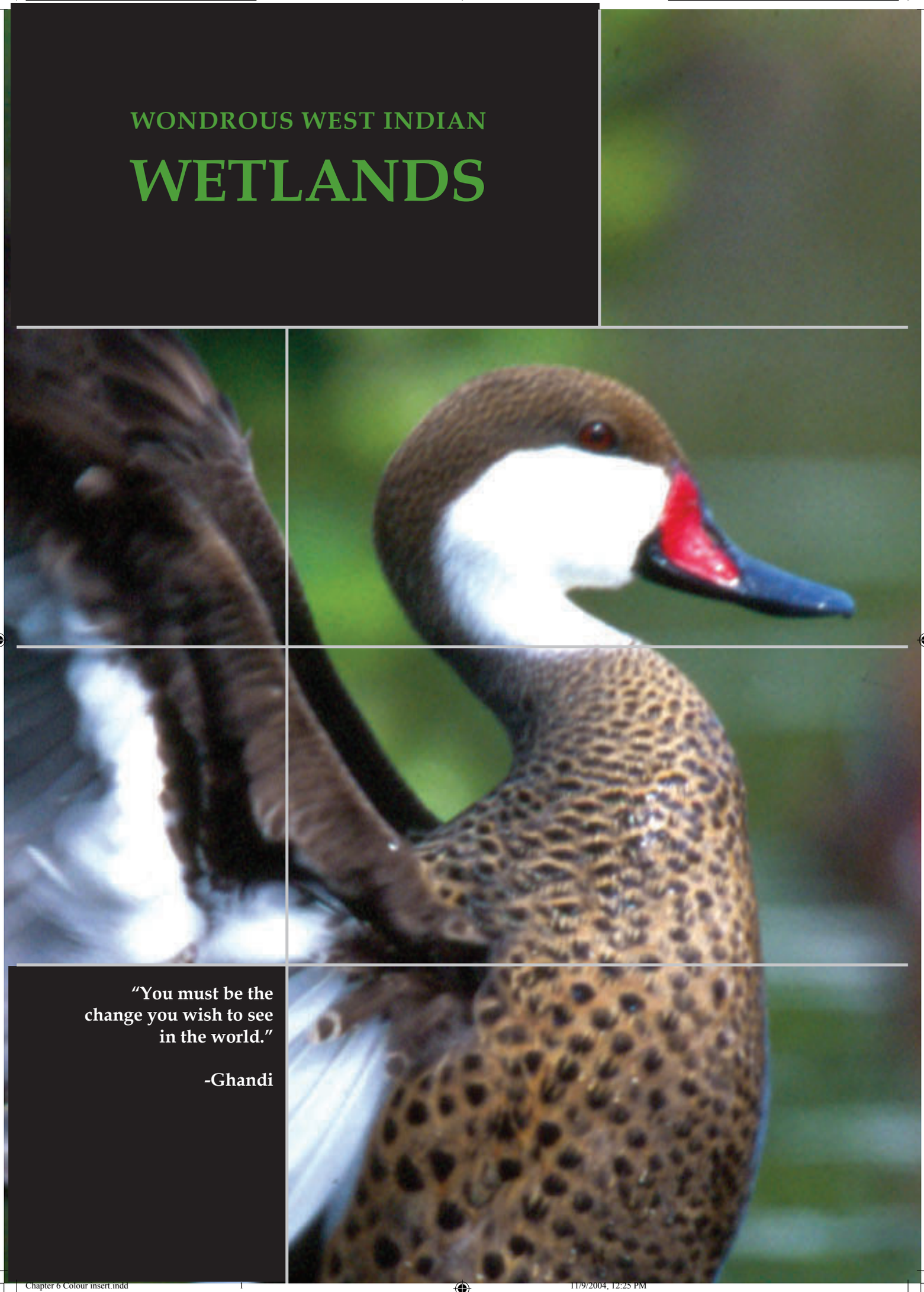
- Why did you choose your job?
- What sort of qualifications did you need to get it?
- How difficult was it to find a job in your field?
- Is it well paid?
- Do you think it is fun? Worthwhile?
- What do you like best about it?
- What do you like least?
- How much of your time do you spend working in the wetland?
- How much time do you spend working with people?

Alternatively, delegate students to write letters to selected people, asking them about their jobs. Read the replies to the class and discuss them.
OR
Arrange to visit a local organisation to find out first-hand how they work with wetlands.

Source Adapted from Project Wild

WONDROUS WEST INDIAN

WETLANDS



"You must be the change you wish to see in the world."

-Ghandi

Chapter 6

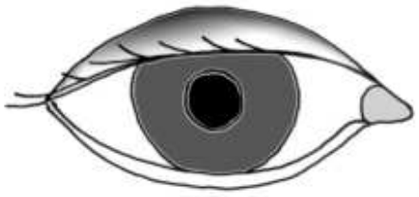
SEEING FOR YOURSELF
Wetland field trips

LEARNING OBJECTIVES FOR CHAPTER 6

Through visiting a wetland, students should:

- Learn how to behave in a natural environment
- Improve their observation skills
- Learn how to make and use simple field equipment
- Learn to identify and classify some common wetland animals and plants
- Learn some basic techniques used in ecological surveys

#	TITLE	SUMMARY	SUBJECT	PAGE
Getting prepared				
6-A	Planning Your Field Trip	Advice for the teacher on how to prepare for the field trip	N/A	216
6-B	Did You See That?	Learn the importance of careful observation	Science	221
6-C	Writing it Down	How to keep a field notebook	Science, English	223
6-D	Making your Own Equipment	Learn how to make useful field equipment, including nets, underwater viewer, sieve box	Science, English	225
6-E	Respect is Due: Wetlands Etiquette	Learn how to behave on a wetland field trip	Science, Social Studies	227
In the field				
6-F	Wetlands Pledge	Make a promise to respect wetland wildlife and its habitats	Science, Social Studies	230
6-G	Bird Watching	Learn how to use binoculars and keep a field record of birds	Science	231
6-H	Let's Play Bird Watching!	Learn how to watch birds using toy binoculars	Science, Art	234
6-I	Bird Behaviour Bingo	Find out more about behaviour of wetland birds	Science	236
6-J	Sounds Wild	Learn to use your ears to find out about wetlands	Science	238
6-K	Mangrove Scavenger Hunt	Find out which animals and plants live in the mangroves	Science	239
6-L	From the Sea to the Land – Transects	Use a transect to find out how mangrove communities change	Science	241
6-M	Adopt-a-Wetland	Carry out a long-term study of a wetland	Science Geography, Social Studies	245
6-N	How Many Whistlers?	Help scientists find out about these wonderful birds!	Science Geography Mathematics	249
6-O	Biodiversity Rap	Review what you have learned about wetlands!	Science English	251



Activity 6-A

PLANNING YOUR FIELD TRIP

No study of wetlands can be complete without a field trip. The sights, sounds, smells and sensations generated by close encounters with wetland plants, animals and mud are of immense educational value. Too often, the difficulty of organising a field trip discourages a teacher. Do not be discouraged! Your effort will be rewarded and your students will never forget the experiences they share with you in the wetland.

Careful planning is essential for success. This chapter guides you through every phase of running a field trip. The main stages are summarised in the checklists (see Copy Cat Pages).

1) AT LEAST ONE MONTH BEFORE

a) Decide the objectives of the field trip

Also decide how the trip fits into your various study programmes.

b) Select a site

Seek advice from someone who can help you to decide which wetland to visit. For example, ask conservation, forestry or fisheries agencies, national trusts, environmental non-government agencies, botanical garden staff, tour operators, local fishermen, hunters and local experts.

c) Decide where you are going to go

- A local nature reserve or protected area. If your school is local and you ask in advance, the protected area staff and wardens may provide a guided tour and may help you to design and implement your field activities
- A wetland-based tourist attraction. Wetland tourist attractions often feature boat tours and boardwalks. If you ask in advance, tour operators can sometimes be persuaded to offer special rates and tours for local school children
- Any other suitable wetland. Try to choose a wetland with a range of wetland habitats in a compact area, accessible by road, and close to your base

d) Select a date

If you have a choice of date, try to schedule the trip to take the following into account:

- The students should already have been exposed to some of the material in Chapters 1-5.
- Between September and May, North American migrant birds are more likely to be present and the field trip will be more interesting.
- In the northern Caribbean, where the influence of tides is greater than further south, it is better to visit wetlands during low tide. It may be wise to consult a tide table when planning your trip.
- If you are planning to visit a tourist attraction, try to avoid weekends and public holidays

e) Get help

The success of a field trip depends on good organisation. Try to have one adult for every five students.

f) Arrange reliable transport (commercial or private)

g) Get parental permission in advance

h) Make an advance trip to the site

Even if you are familiar with the site, visit it again to refresh your memory, and to plan in detail how your field trip will work. If there are staff on site, they may be able to suggest activities, supply worksheets and act as guides or teachers. Otherwise, make your own plans and adapt worksheets from this book.

i) Plan the trip in detail

Plan activities best suited to your group. Go through the list and make sure you know what equipment and which data sheets or field sheets you will need. Make up a detailed itinerary – and remember to include bathroom stops!

An example of a typical field trip:

0800 Bus arrives
0815 Hold a briefing meeting for assistants
0830 Collect permission slips and money (if necessary)
0900 Leave school compound
1000 Arrive at wetland
1005 Change clothes (if necessary)
1010 Wetlands Pledge
1030 First activity
1200 Lunch and swim (bathroom stop)
1300 Second activity
1500 Leave
1600 Arrive back at school. Put samples and specimens in refrigerator if necessary.

j) Brief your assistants

Your assistants will probably not be familiar with wetlands. Ideally, hold a planning meeting a few days before the trip, or brief the assistants shortly before the students arrive on the morning of the trip. At the briefing, explain the schedule, provide copies of the handouts, and make sure everyone understands what is expected of them.

k) Make equipment (see Activity 6-D)

l) Prepare the students (Activities 6-B, 6-D, 6-E, 6-F)

What to wear

Dress suitably - a field trip is not a fashion show! Old trousers and T-shirts, and worn out sneakers are best. If the field trip goes well, everyone will get wet and muddy, so participants should bring a change of clothes. If the trip includes a visit to a beach, a swim at lunchtime will be fun and educational (it will remind the students of the close links between wetlands and other marine ecosystems). If you plan to swim, make sure that the beach is a safe one, and that the students are properly supervised.

What to bring

There are no shops in wetlands, so students must bring food and water with them and a bag so that they can take home their own trash.

j) Prepare yourself

Make sure that you have checked the activities carefully and have all the necessary equipment. Many items on the list (below) are optional; the most important equipment needed for a successful field trip is your five senses!

2. ONE MONTH TO ONE WEEK BEFORE THE FIELD TRIP

a) How to behave on a field trip (Activity 6-E)

An important lesson the students will learn is how to behave in a natural environment. Students raised in urban environments can be overwhelmed by the new experiences and become unruly. It is very important to teach them how to look, listen and experience nature.

b) Introduction to mangroves and wetland ecosystems

Suitable activities can be found in Chapters 1-4.

c) The Dress Rehearsal

In order to get the most out of your field trip it may be necessary to rehearse it on the school compound.

3. ON THE DAY

Follow your itinerary as closely as possible, but if the children get over tired or over-heated, be flexible and adjust the schedule if necessary.

4. FOLLOWING UP

Teach the students that analysing data and writing up findings is as interesting and important as making the observations. Reports should be prepared as quickly as possible after the trip (perhaps as homework). To reinforce the lessons learned on the field trip try some of the following activities: Biodiversity Rap, Mangrove Food Chain Relay, Lost Identities, Living Web, Build or Paint a Mangrove, Touchy-Feely Bag, What's this Wetland Good For? Wetland Metaphors, and Knowing Our Wetlands.

TEACHERS PLANNING CHECKLIST

Approximate Date	Activities
At least two months in advance	❑ Contact resource persons ❑ Select site ❑ Search for background information about site ❑ Select date(s) ❑ Check with school to confirm suitability of date(s) ❑ Check with owner, manager or operator of site to get permission to use the site, and to confirm suitability of dates. ❑ If you need assistants, check their availability on selected dates ❑ Check cost of entry or tour (if any) ❑ Identify type of transport and contact owners to determine availability and cost and to make reservations. ❑ Determine whether school will subsidise trip ❑ If not, work out costs to students and ensure that they are reasonable
One month to one week in advance	❑ Prepare permission letters and circulate them to students ❑ Start collecting money from students (if necessary) ❑ Start or continue teaching from chapters 1-5 ❑ Make equipment (Activity 6-D)
One week in advance	❑ Circulate list of what to bring. ❑ Wetland Etiquette (Activity 6-E), print Wetland Field Trip Notebook*
On the day	❑ Ensure all the students have returned their signed permission slips ❑ Ensure all children have paid (if necessary) ❑ Double check that you have all the equipment on the checklist
On arriving at the site	❑ Wetland Pledge (Activity 6-G) N.B. adults accompanying trip must join in ❑ Implement selected activities (e.g., Activities 6-F to 6-O)
Back at school	❑ Examine and preserve specimens ❑ Write up reports ❑ Do follow-up activities (Activity 6-P and activities from Chapters 1-5)

* Wetland Field Trip Notebook can be downloaded at: www.whistlingduck.org/downloads.html

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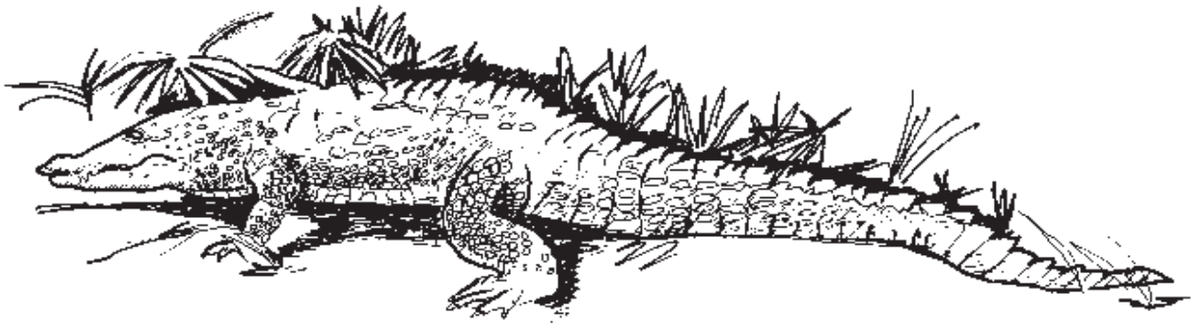

STUDENT'S CHECKLIST

Clothing and equipment

Clothes to wear in the wetland	❑ Old T-shirt ❑ Old jeans or other long trousers ❑ Spare pair of old socks ❑ Old trainers, sneakers, water boots or tennis shoes ❑ Hat ❑ Swim suit and towel (if necessary)
Clothes to change into after trip	❑ As necessary
Equipment to be brought by each student	❑ Pencils ❑ Paper or field notebook ❑ Clipboard (can be improvised from a sheet of cardboard and a bulldog clip) ❑ Water bottle (full of drinking water - a recycled plastic bottle is ideal) ❑ Packed lunch ❑ Trash bag ❑ Plastic bags (e.g., recycled carrier bags from the supermarket) for storing monsters and plants ❑ Recycled jam jars with covers ❑ Sun screen ❑ Insect repellent Not essential but useful, if parents are willing to lend them: ❑ Kitchen sieve or strainer ❑ Plastic tape measure ❑ Plastic ruler

COPY CAT PAGE

TEACHER'S CHECKLIST
Equipment and supplies to bring on the day

- ❑ Pencils
- ❑ Field sheets
- ❑ Worksheets (as necessary)
- ❑ Copy Cat pages showing common wetland animals and plants
- ❑ Wetland Field Trip Notebook*
- ❑ Field guides to plants, birds, amphibians and reptiles, butterflies, shells or fish (if available)
- ❑ Equipment: e.g.
    - Dip nets
    - Butterfly nets
    - Sweep nets
    - Plastic film cases
    - Pieces of paper cut up for use as labels
    - Underwater viewing glass
    - Sieve box or other bottom samplers
    - String for transect and stakes to anchor string
    - First aid kit
    - Measuring tape and/or yard/metre stick

IF AVAILABLE:

- ❑ Plastic buckets
- ❑ Kitchen strainers or sieves
- ❑ Thermometer
- ❑ Eye droppers/pipettes
- ❑ Core sampler
- ❑ Secchi disk
- ❑ Binoculars
- ❑ Telescope and tripod
- ❑ Camera
- ❑ Toilet roll binoculars
- ❑ Magnifying boxes
- ❑ Recycled plastic containers with lids (e.g., margarine tub)
- ❑ Recycled plastic shopping bags

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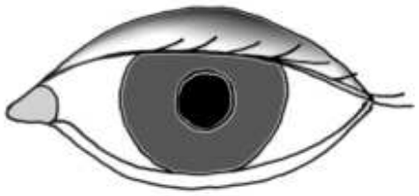
* Wetland Field Trip Notebook can be downloaded at: www.whistlingduck.org/downloads.html



Activity 6-B

DID YOU SEE THAT?

Object lesson in observation

Summary

Good observations are essential in field biology and can be improved with practice.

Learning Objectives

Students will understand:

- How important careful observation can be
- How selective people can be when they observe and remember
- How powers of observation can be improved with practice

Time About 30 minutes

Materials needed

- A tray with about 10-20 assorted items on it. They should include a range of colours, sizes and shapes
- A cloth to cover the tray
- Paper and pencils

Age Levels 8 +

Subject Areas Science

Preparation

Assemble the tray of objects and ensure that it is set up on the front desk when the students arrive in the classroom.

Procedure

1. When students arrive in the classroom, the tray and objects should already be on show.

2. Begin by discussing the importance and pleasure of good observation. Remind students that good observation must be combined with good powers of analysis.

3. Tell the students the following joke:

Sherlock Holmes and the Great Outdoors

by Richard Feeney

Sherlock Holmes and Dr. Watson go on a camping trip. They set up their tent and fall asleep. Some hours later, Holmes wakes his faithful friend.

"Watson, look up at the sky and tell me what you see," says Holmes.

Watson replies, "I see millions of stars."

"What does that tell you?" asks Holmes.

Watson ponders for a minute, then replies "Astronomically speaking, it tells me that there are millions of galaxies and potentially billions of planets… Astrologically speaking, it tells me that Saturn is in Leo. Timewise, it appears to be a quarter past three… Theologically, it's evident that the Lord is all powerful and we are small and insignificant…Meteorologically, it seems that we will have a beautiful day tomorrow."

After a pause, he says testily, "And ….what does it tell you, Holmes?"

Holmes is silent for a moment, then speaks.

"Watson, you idiot, someone has stolen our tent!"

4. Cover the tray with a cloth, and ask each student to make a list of the tray's contents. Allow about five minutes.

5. Remove the items from under the cloth one by one. Show each in turn to the class. Ask the students who wrote them on their lists to raise their hands. Count how many people remembered each item. Ask someone to list the items on the board, count how many people remembered each, and write the number in the appropriate place.

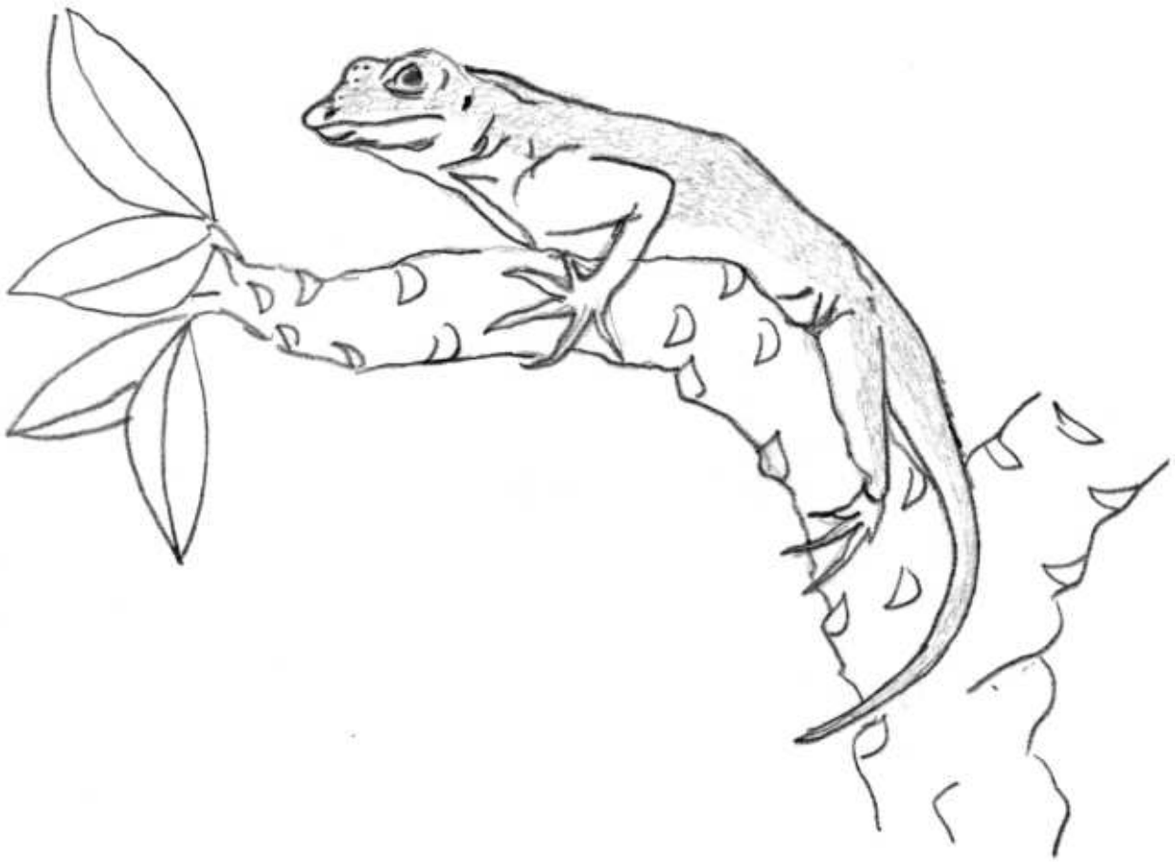
6. Classify the types of objects that they remembered *(generally, large, colourful or unusual)* and compare them with the ones they missed *(small, dull, and things they could not identify*).

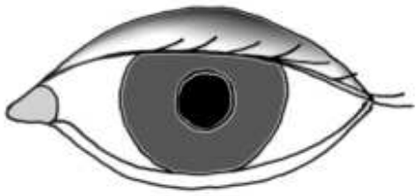
Discussion/Assessment

What does this exercise tell us about observation skills? *They tend to be selective.*

How can people improve their powers of observation? *Practice*

Source Ann Sutton.





Activity 6-C

WRITING IT DOWN
The field notebook

Summary

Keeping good field notes is an important skill that every naturalist should develop.

Learning Objectives

Students will learn how to keep detailed and accurate field notes.

Age Levels 8 +

Subject Areas Science, English Language

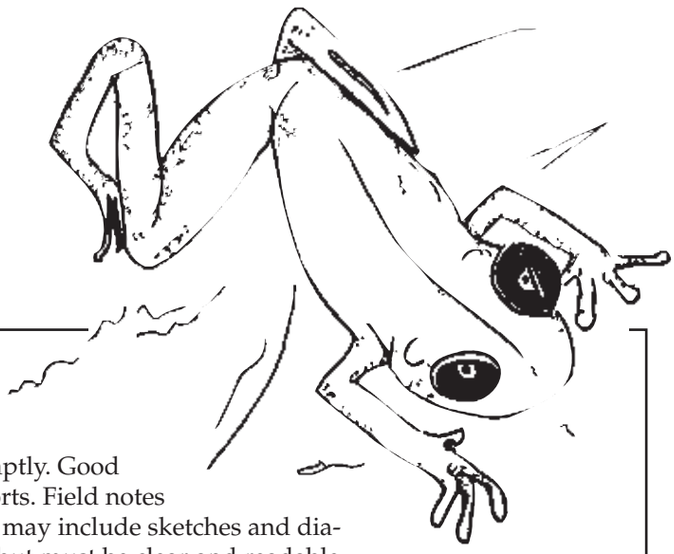
Time About 10-30 minutes

Background

A field notebook is an essential part of any naturalist's equipment. It should be kept clean and dry in a plastic bag, together with pencils and a small ruler.

Materials

Students should supply their own field packet, including a small, hardcover notebook, sharp pencils and a ruler in a plastic bag.



Procedure

1. Memory is selective so the only way to remember accurately is to write it down promptly. Good observation => good field notes => good reports. Field notes should be clearly written and systematic, and may include sketches and diagrams. They will not always be tidy or clean, but must be clear and readable.

   All good naturalists keep field notebooks. Even if the students are not going to be professional biologists, this habit will add greatly to their enjoyment of field experiences.

   Field notes should include:
   - Date
   - Time
   - Location (and notes on how to find the site again if necessary)
   - General description of the weather (e.g., sunny, no wind); see codes for sky condition and wind speed on page 224
   - Name of species under observation (if known) or detailed notes if not known
   - For animals, notes on interesting behaviour e.g., what it was doing, where it was doing it, and how long it spent on each activity
   - Notes on habitat
   - Measurements or counts, where possible

2. Take the students out into the school grounds or campus to practice observing and recording (or do this for homework).

   Students should choose an animal or plant to observe. They should note:

   - What is it called? (If they do not know, make up a name and try to find out the correct name later)
   - What does it look like?
   - Where does it live?
   - How many were seen?
   - Any other interesting observations?

Discussion/evaluation

When you get back to class ask students to share their observations.

Extension

Remind students that making collections can be a very interesting way to learn about natural history. They might collect shells, insects, pressed plant specimens, fossils or bird observations. The objects they collect should be clearly labeled and noted in their field notebooks. It is best not to collect live creatures (instead, catch and release). Be sure that you have permission from the park/landowner to collect fossils and other items. To minimize impact on the wetland, a class collection is preferable to individual collections.

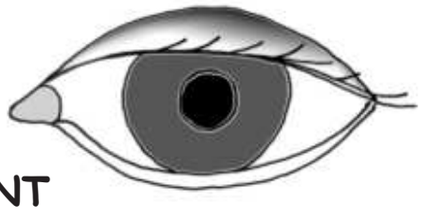
Source Ann Sutton.

Sky and Wind Codes

Sky codes: 0 = clear or a few clouds 1 = partly cloudy/variable 2=cloudy/overcast 3 = fog 4 = drizzle 5 = showers 6 = rain
Wind codes: 0 = calm 1 = 1-3 mph 2 = 4-7 mph 3 = 8-12 mph 4 = 13-18 mph 5 = 19-24 mph 6 = 25-31 mph (see Beaufort Wind Scale)

Beaufort Wind Scale

Force No.	Description	Signs	KPH	MPH
0	Calm	Smoke rises	0-2	0-1
1	Light air	Smoke drifts but no wind-vane movement	3-5	1-3
2	Slight breeze	Wind felt on face, leaves rustle	6-11	3-7
3	Gentle breeze	Leaves and small twigs in constant motion, wind extends a light flag	12-20	7-12
4	Moderate breeze	Dust and loose paper are raised, small branches are moved	21-29	12-18
5	Fresh breeze	Small trees in leaf begin to sway	30-39	18-24
6	Strong breeze	Large branches in motion, whistling in wires	40-50	24-31
7	High wind	Whole tree in motion	51-61	31-38



Activity 6-D

MAKING YOUR OWN EQUIPMENT

Summary

In the West Indies, scientific equipment can be difficult to obtain and expensive, so students will learn how to improvise. The equipment is simple and can be made quite quickly from easily available materials. You will find directions for making:

- Dip nets, sweep nets and butterfly nets
- Underwater Viewer
- Sieve Box

Learning Objectives

Students will:

- Learn how to follow instructions and make simple sampling equipment

Age Levels 8 +

Subject Areas Science, Social Studies, Industrial Arts

Time About 1-2 lessons per item (or divide the class into groups to make different items, or set as homework).

MAKING A VIEW GLASS

Materials

- Large plastic containers, such as old bleach bottles
- Clear, heavy-duty kitchen wrap
- Several pairs of scissors
- Large rubber bands or duct tape

Procedure

1. Cut off the top and bottom of the large plastic containers.
2. Stretch a sheet of clear plastic kitchen wrap across the bottom end and hold it tightly in place with large rubber bands or secure it with duct tape.

MAKING A NET

Materials

- Metal coat hangers or lengths of washing line wire
- Wooden broom handles or stout sticks (one per net)
- Needle and thread (one set per group)
- Scissors
- Duct tape, string or cable ties
- Material to make bag e.g.,

  Insect net (to collect flying insects): About 0.5 m (0.5 yd) chiffon
  Dip net (to dip animals and plants out of water): About 0.5 m (0.5 yd) nylon mosquito mesh
  Sweep net (to sweep insects out of vegetation): 0.5 m (0.5 yd) calico

Procedure

1. Bend the wire hanger to form a circle about 20-30 cm (8–12 in) in diameter, with a straight handle at each end.
2. Cut the material into a suitable shape for the type of net you plan to make (see page 226).
3. Bind the broom handle to the straight wire handles, using duct tape or string.

MAKING A SIEVE BOX

Background

The sieve box enables students to sample animals and plants that live in mud on the bottom. Students catch the invertebrates by dragging the sieve box through the wetland and then sieving the mud and water. Any animals or plants they find should be placed in plastic containers with covers. Store the specimens carefully (in a cooler or shady place) until ready to take them back to the classroom for further examination or return them to the wetland. Minimize the stirring up of sediments by having groups of students share sieve boxes (one per group).

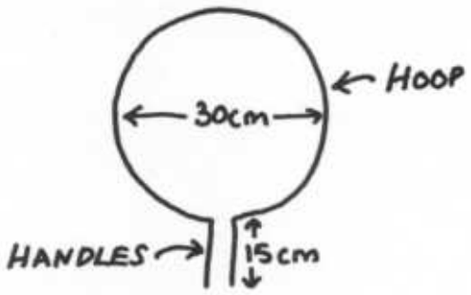
Procedure

1. Cut off the top of a large plastic container, leaving the handle (if any) attached.
2. Punch small holes (about half a centimetre across) into the bottom of the plastic container.
3. Attach the string or rope to the handle (see page 226).

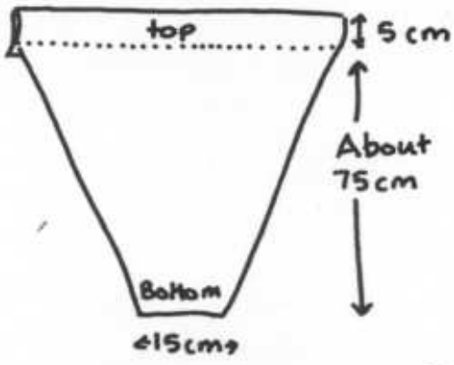
Source Adapted from various sources by Martin Keeley.

HOW TO MAKE A NET

1. TAKE A PIECE OF WIRE ABOUT 250 cm LONG.
2. BEND IT TO FORM A HOOP WITH HANDLES.



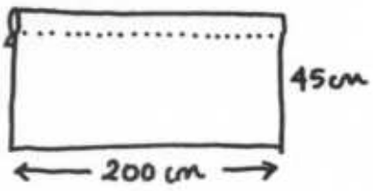
3. TO MAKE A BUTTERFLY NET



- CUT OUT SHAPE IN LIGHT FABRIC SUCH AS CHIFFON OR MUSLIN.
- SEW ROCKET AT TOP TO HOLD WIRE.
- SEW SIDES AND BOTTOM TO FORM NET.
- THREAD WIRE INTO POCKET AND BIND HANDLES ONTO STICK USING TAPE OR STRING

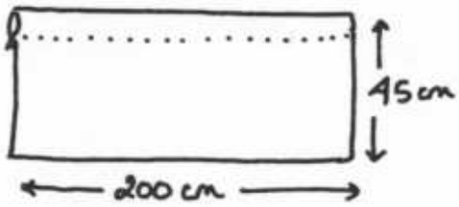
4. TO MAKE A DIP NET

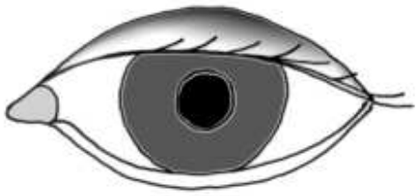
- USE MOSQUITO MESH



5. TO MAKE A SWEEP NET

- USE CALICO





Activity 6-E

RESPECT IS DUE
Wetlands etiquette

Summary

Students learn how to behave when they visit a wetland and discuss why this is important.

Learning Objectives

- See summary above

Materials

Copies of the Copy Cat Pages "Wetland Dos" and "Wetland Don'ts"

Age Levels 6 +

Subject Areas Science, Social Studies

Time About 30 minutes

Background

Students from urban environments often have little experience of being outdoors in natural places and therefore may need some guidance.

Procedure

1. Remind students that the wetland is home to many animals and plants. How should one behave when one visits a stranger's home? *Respect their habits, don't wake them up when they are asleep, don't damage their property or make a mess.* What does this suggest about how we should behave in a wetland? Discuss the material in the Copy Cat Pages.

2. Circulate the Copy Cat Pages "Wetland Dos" and "Wetland Don'ts."

Evaluation/Assessment

Older students could write an essay about the importance of appropriate field behaviour. Younger children could draw pictures of wetland etiquette.

Source Adapted from various sources by Martin Keeley.

WETLAND DOs

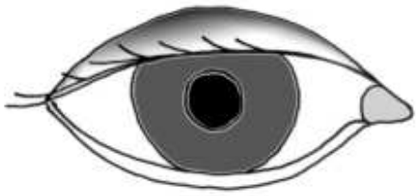
THINGS TO DO	WHY SHOULD YOU DO THESE THINGS?
DO use your eyes. **DO** use your nose. **DO** use your ears.	There are many new experiences waiting for you in the wetland - it is up to you to find them.
DO record what you see, smell or hear by making notes, making drawings or taking photographs. **DO** start your own field notebook or diary.	Record experiences to ensure that you remember them accurately. It's an excellent habit.
DO handle animals carefully and put them back where you found them.	Animals are different from people. We cannot tell how they can be hurt and they cannot tell us when we are hurting them.
DO roll over logs and stones to see what may be living underneath – but always put the logs and stones back where you found them	Many interesting creatures lurk under stones and logs. They may die if they are exposed to light, heat and air.
DO watch where you are putting your feet.	Some birds (like Least Terns and Killdeer) nest on the ground near swamps and beaches. Remember that their nests are camouflaged to protect them from predators. It is easy to tread on a nest by mistake. Many plants and animals (such as algae and corals) can be destroyed by walking on them.
DO be very quiet and move slowly. DO stay on trails and paths.	Many animals hide when they sense that people are coming. The quieter you are, the more you will see. It is easier to be quiet on a path than off it.
DO listen to what the animals are telling you.	Animals often tell you when they are disturbed - if you can understand their language. For example, as you get too close to a bird it may: • Raise its head and look at you. • Start to get skittish. • Peck/preen or wipe its bill repeatedly. • Give a loud alarm call. • Do a distraction display (e.g., pretend its wing is broken). • Fly off.
DO wash your hands before eating after you have been in the swamp.	Some wetlands are polluted. You might be poisoned or catch a disease.

COPY CAT PAGE

WETLAND DON'Ts

ACTIONS TO AVOID	WHY YOU SHOULD AVOID DOING THESE THINGS
DON'T be noisy, run, yell, shout or fight.	Romping in the swamp disturbs animals. You won't see anything if you are noisy, your behaviour will drive animals away, so neither will anyone else see anything. Some animals may abandon their nests or young if they are disturbed. Wetland paths can be slippery. You might fall into a hole or sprain an ankle.
DON'T collect or kill animals unless your teacher tells you to do so as part of a specific activity.	It is very tempting to take animals and plants home as pets. Away from the special conditions of the wetland they suffer and die.
DON'T throw garbage in the swamp. Carry a trash bag with you and put all your waste paper (including toilet paper if necessary) in it.	Garbage is ugly and dangerous. For example, sea turtles may eat clear plastic bags, because they mistake them for jellyfish.
DON'T move animals from one part of a wetland to another.	Many wetland animals are very particular about where they live. For example, a fish or mollusk that lives in the sea probably won't survive in a pond.
DON'T chase, harass or flush animals.	If an animal is sitting still, it is very tempting to try to get it to move, by rushing up to it, or throwing a stone at it. Some people even drive at animals in cars, boats, jet skis or all-terrain vehicles. This can disturb or kill the animals, or destroy their habitats. Such behaviour is illegal in some islands. Remember it is much more fun to watch quietly.
DON'T go close to an active bird's nest.	If you find an active nest (i.e. one that is being built, or has eggs or chicks), don't disturb it. Repeated disturbance can cause the parents to abandon the nest.. Move away from the nest quietly.
DON'T play music on your radio, CD or car sound system.	Your music will disturb animals and other people who want to listen to nature.

COPY CAT PAGE



Activity 6-F
WETLANDS PLEDGE

Summary

Encourage students to settle down and behave properly in the natural environment.

Learning Objectives

The purpose of this activity is:

- To remind students going on a field trip how they should behave
- To get students settled before beginning the activities

Materials

Copy of pledge

Age Levels 5 +

Subject Areas Science

Time About 10 minutes

Procedure

1. When the students arrive at the site of the field trip, take a moment to pause, settle down and do the initial briefing.

2. Remind students that they are visitors and should behave appropriately. Explain the importance of each point, then tell the students they are going to promise to behave properly in the wetland.

3. Ask the students to raise their right hands in the air, (as in a court of law) and repeat each sentence after you.

THE WETLANDS PLEDGE

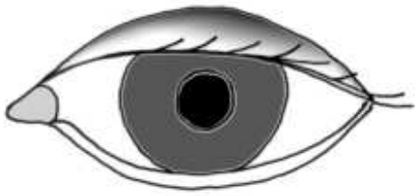
- When I am in the wetland, I will remember that I am a guest
- I will respect the wetland creatures and their habitats
- I will move slowly and speak quietly
- If I disturb anything, I will put it back where I found it
- I will not chase or scare animals
- I will take all my litter home with me
- I will try to reduce water pollution and to protect wetlands

4. Once the students have taken the pledge, remind them of the plans for the day, then issue equipment and worksheets for the first activity.

Extension

You may wish to conclude this activity with an appropriate prayer.

Source Martin Keeley.



Activity 6-G

BIRD WATCHING

Summary

Students will learn about bird watching, first in the classroom, then in the school grounds or on a field trip

Learning Objectives

Students will learn:

- How to use and care for binoculars
- How to use a field guide to identify birds

Age Levels 8 +

Subject Area Science

Time Variable, at least 10–20 minutes

Materials

- Wetland Birds of the Caribbean identification cards OR copies of general copy cat pages of birds.
- Field guides to birds (if available, one per team)
- Pencils
- Copies of Copy Cat Page "Field Records of Birds" form or Wetland Field Trip Notebook
- Binoculars. The West Indian Whistling-Duck Working Group has supplied binoculars to selected agencies in various islands. These are available for loan to schools and bird groups.
- "West Indian Whistling-Duck and Wetlands Conservation Slide Show" (optional)

Background

Bird watching (birding) is an ideal way to encourage students to develop an understanding of wildlife and the world of nature, and to sharpen their observation skills. They will learn the basics of bird identification, using size, shape, sound, behaviour, and **field marks** (unusual markings) to tell the difference between species and groups of species. Taking students birding and instilling a basic understanding of nature will help build a new generation of stewards for our environment.

Preparation

- If there is a National Trust office, birding club or protected area near your school, ask if they have any binoculars you can borrow. A member of staff may be willing to give a presentation to your class (e.g., slide show), or even take you out birding.

- Improve your knowledge of wetland birds (review Chapter 2) concentrating on the parts about birds. Also, study field guides and the Wetland Birds of the Caribbean identification card.

Procedure

1. Tell the students that around the world, there are more than 70 million birders. Many visitors to the Caribbean come to see birds. Some birders keep "Life Lists" of all species of birds that they have seen. However, nobody has seen all of the more than 9,000 bird species in the world. Through watching birds, we can learn a great deal about the world around us. Birding can also be a source of income, as there are possibilities for jobs leading bird tours, studying and conserving birds.

2. Learning to identify birds requires patience and careful observation. You will teach the students how to use binoculars to identify birds. First, remind the students that binoculars are fragile. They should be treated with respect, never wet them, drop them or touch the lenses with fingers. Show them the parts of the binoculars, especially the focusing wheel and explain how to use it.

3. Divide the students into groups, each including an *observer* (with binoculars), an *identifier* (with pictures or field guide) and a *recorder* (with pencil and recording form). All the other students in the group will be *spotters*. The *observer* identifies **field marks** such as colour ("I see a red spot on its chest"), size ("It has longer legs than the other birds") or shape ("It is the same shape as a chicken"). The *identifier* looks at the field guide and suggests the name. Remind students to use the Copy Cat Page to record their observations. Take turns.

4. Explain that birds are afraid of people so be quiet, move silently and "stalk" them. The best way to see a lot of birds is to remain in one place, preferably hidden behind a bush or tree. The birds will assume you are part of the neighbourhood and will come close, so that you can see them better.

Evaluation/Assessment

Back in the classroom, students should list the birds they saw. They could follow up this activity by drawing the birds and their habitats, and trying to find out more about their ecology and behaviour.

Extensions

- Slide presentations and colour photographs are effective tools to help students learn about the birds they might see in a wetland. The "**West Indian Whistling-Duck and Wetlands Conservation Slide Show**" should be available on your island. Consider presenting this slide show to your students either to prepare them for a field trip to a wetland or to reinforce what they have learned afterwards.

- Explain that the types of birds one can see in a given area change according to the time of year, the fruiting and flowering patterns of the plants and the behaviour patterns of the birds. Although the ideal observation period is at least a year, this is not practical for most schools. Instead, you might choose a shorter period, for example, September-October (when migrants arrive from North America) or April-May (when migrants leave the West Indies to breed in North America). Encourage the students to choose a suitable site and visit it regularly to observe the birds. Keep records on the worksheet, look for changes in species composition, numbers of birds and bird behaviour.

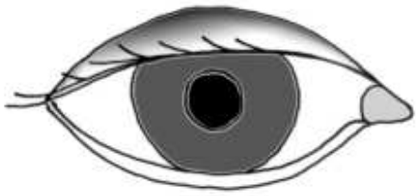
Source Adapted from Martin Keeley.

FIELD RECORD OF BIRDS

Date: **Start time:**
Location: **End time:**

	COMMON NAME	NOTES ON HABITAT AND BEHAVIOUR	NUMBER SEEN
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			

COPY CAT PAGE



Activity 6-H

LET'S PLAY BIRD WATCHING

Summary

This is a simple and inexpensive way to introduce young children to the joys of bird watching.

Learning Objectives

Students will be introduced to bird watching. They will learn:

- How to behave when they go birding
- What to look for

Age Levels 6 - 9

Subject Area Science

Time About 30 minutes

Materials

- Empty toilet rolls (2 per student) OR empty kitchen towel rolls (1 per student)
- Masking tape
- String to hold the binoculars (enough for each student)
- Paper punch
- Paper and crayons
- Copy Cat page "Bills and Feet"

Background

Bird watching is a great way to learn about the environment and to learn observational skills.

Preparation

Assemble the equipment.

Procedure

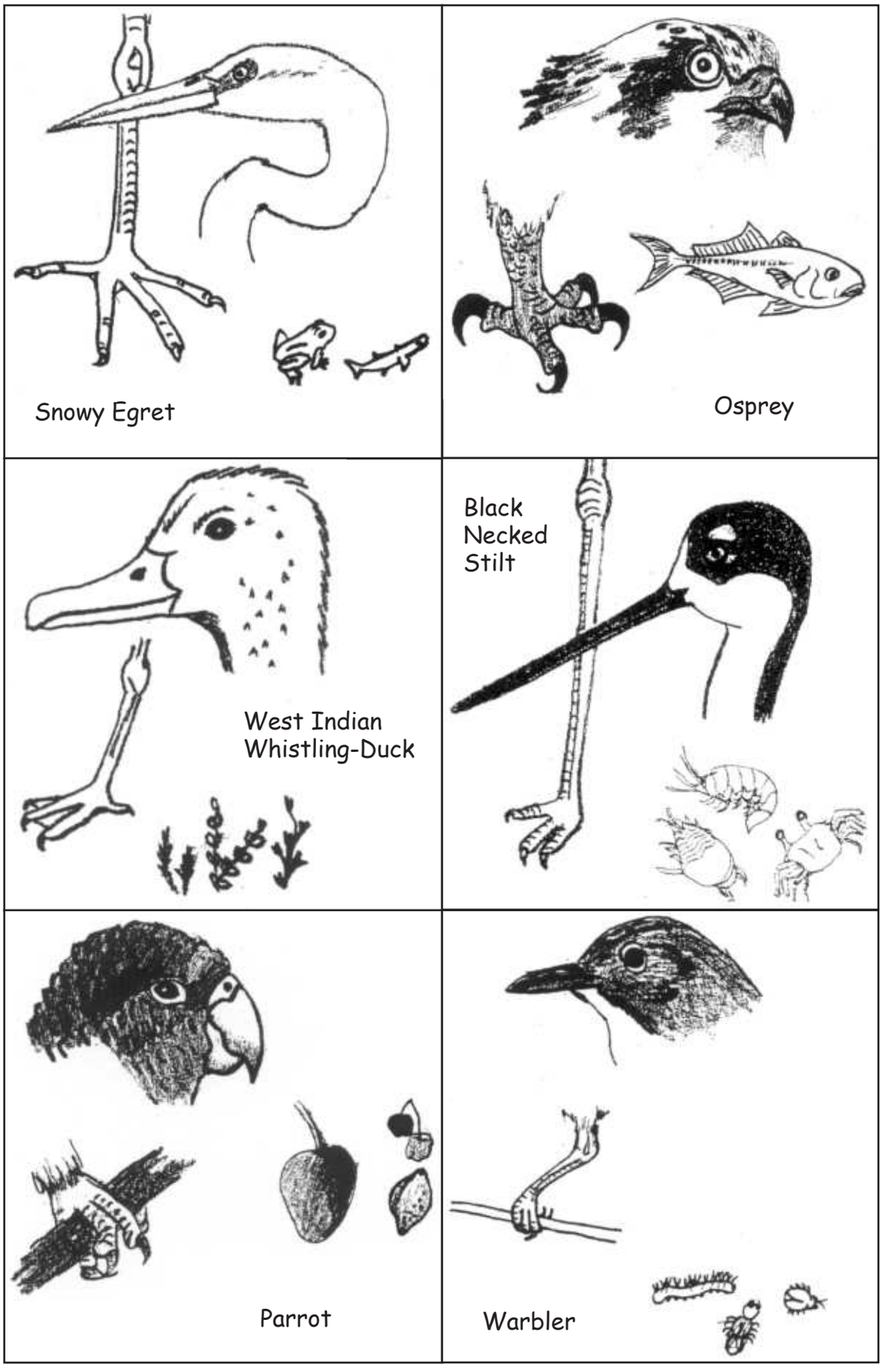
1. Introduce this activity by asking two students to stand up so that everyone can see them. Do they look exactly the same? *No.* In what ways are they the same? *Two arms, two legs, same school uniform, etc.* How are they different? *For example: height, glasses, sex, hair style, shape.*
2. Now discuss the birds that live in your neighborhood. How does one bird differ from another? *Size, shape, colour, bill shape, type of feet, etc.*
3. If we look closely at birds we can see that there are many differences among them. Show them Copy Cat page "Bills and Feet." Explain that one way we can look closely at birds is to go on a bird-watching walk, using binoculars.
4. The students will make toy binoculars, as follows:
   - Place two toilet rolls together and use a loop of masking tape to hold them in place.
   - Punch two holes at the top to hold the string.
   - Tie a piece of string through the holes.
5. Go for a practice walk, or wait for the field trip.
6. When the students are outside, encourage them to spot birds, then study them through the binoculars. Of course, the binoculars will not really magnify the birds, but they will help focus the children's attention.
7. Explain that they must be very quiet if they want to study birds.
8. Encourage them to look for birds of different shapes, sizes and colours.

Assessment

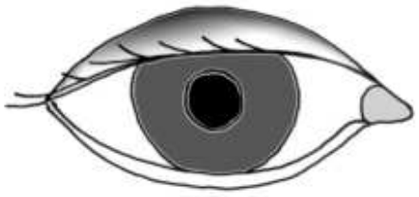
When you get back into the classroom, make a list of the birds that you saw. Ask the children to draw them, and identify the bird if you can. Display the drawings.

Source Adapted from Peek-a-Zoo, Office of Education, National Zoological Park, Smithsonian Institution.

BILLS AND FEET



COPY CAT PAGE



Activity 6-I

BIRD BEHAVIOUR BINGO

Summary

Students will play a game and practice observing and recording bird behaviour.

Learning Objective

Students will learn to observe birds and the ways they behave.

Age Levels 8 +

Subject Area Science

Time 15–30 minutes

Materials

- Copy Cat Page "Bird Behaviour Bingo Worksheet," one per pair of students, or page 4 in Wetland Field Trip Notebook
- Pencil or crayon (one per pair)

Background

Wetlands are wonderful places to observe bird behaviour. There are many large, conspicuous species, which can easily be seen nesting, feeding and interacting with each other and the environment.

Procedure

1. Remind the students about the activities that all living things do (feed, excrete, breathe, reproduce, move, sense things, grow). Which of these activities are they likely to observe in the wetland? Tell them that an animal's behaviour is adapted to the place where it lives.

2. Explain that the students will visit a wetland, where they will work in pairs to observe bird behaviour. (See "Bird Behaviour Bingo Worksheet").

3. Equip each pair of students with a "Bird Behaviour Bingo Worksheet" and a crayon.

4. Briefly review the types of behaviour listed on the sheet and make sure that all the students know what they are looking for and how to record what they see.

5. Before setting out, remind the students to remain silent during the walk, except during organised discussions. Agree on some hand signals to be used if someone wants to point out something interesting. Stress that even if students observe all the types of behaviour listed on the bingo sheet, they stay together and remain quiet until the end of the activity.

6. When everyone has finished, or when you are close to your destination, assemble the group. What was the most interesting bird behaviour? Did anyone see examples of all of the types of behaviour on the sheet?

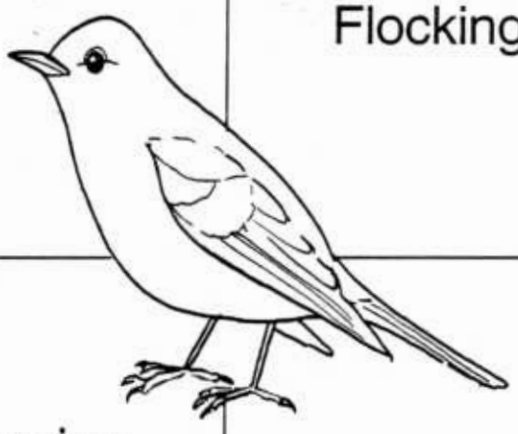
Evaluation/Assessment

Students should draw a picture showing one or more of the types of behaviour they observed.

Source Adapted from Ranger Rick's NatureScope: "Birds, Birds, Birds"

BIRD BEHAVIOUR BINGO WORKSHEET

check off the ones you observe

Hunting for Food in Branches	Resting 	Flocking
Hunting for Food While Flying	Preening	Camouflaged
Hunting for Food on the Ground	Alarm Call 	Aggressive Behavior
Not Camouflaged	Singing	Approaching or Leaving a Nest

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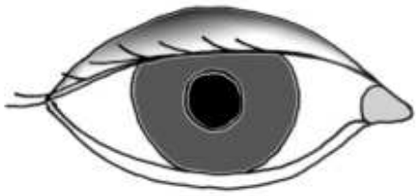


Activity 6-J

SOUNDS WILD
Sound mapping

Summary

Students will listen for and describe sounds that they hear in the wetlands, and make a sound map.

Learning Objectives

Students will learn:
- To use their ears while outdoors
- That hearing is an important observational tool

Time 10–20 minutes

Materials

One 3 x 5 inch index card and one crayon or pencil per person, or page 3 in Wetland Field Trip Notebook

Age Levels 8 +

Subject Area Science

Background

Most of us spend so much of our time in very noisy urban environments that we forget how to listen to simple sounds. When we are quiet, we hear more. Monitor the class, and stop when restlessness starts to interfere with concentration.

Procedure

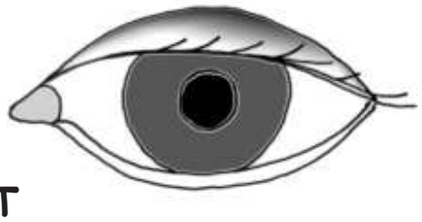
1. Show the group a 3 x 5 inch card with an X drawn in the centre. Tell the students that the card is a map, and the X shows where they are sitting.
2. When they hear a sound, they should make a mark on the card that represents the sound—for example, wavy lines might mean the wind. The mark's location should indicate as exactly as possible the direction and distance of the sound. Tell them to close their eyes while they listen.
3. Have the students spread out and find their "listening place" quickly. Stress that once they find it, they are to be quiet and remain seated so as not to disturb the others.
4. Call the group back with a natural sound such as a bird call.

Discussion

When they are all back, have the students share their maps with a partner.

- How many different sounds did they hear?
- Which sounds did they like best?
- Which sounds did they like least?
- Were there sounds they had never heard before?

Source Adapted from Project Wild.



Activity 6-K

MANGROVE SCAVENGER HUNT

Summary

Students will use observation skills to find different organisms and objects in mangroves.

Learning Objective

Students will:

- Learn to use all their senses to find and identify wetland animals and plants

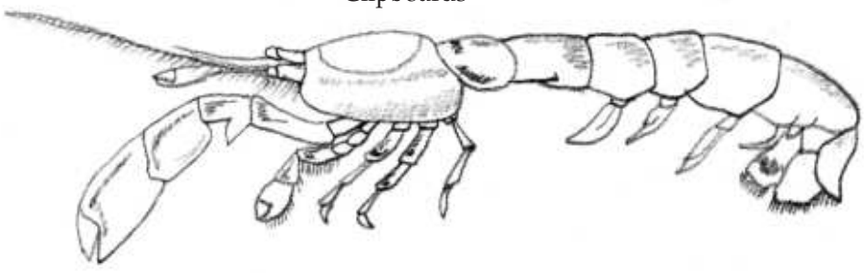
Materials

- Copy of Copycat Page " Mangrove Scavenger Hunt" or page 18 in Wetland Field Trip Notebook
- Pencils
- Clipboards

Age Levels 6 +

Subject Area Science

Time 15–30 minutes



Background

Use the information in Chapters One and Two to prepare background information suitable for your class.

Procedure

1. Give each student a copy of Copy Cat Page "Mangrove Scavenger Hunt" or a copy of the Wetland Field Trip Notebook
2. Explain that they have 15 minutes (but be flexible) to gather information outlined in the sheet.
3. Lead them in finding and identifying things.
4. When you are sure everyone has had enough time, gather the students together and compare results. Get each student to report his or her findings. See how many different items they have discovered.

Discussion/Reflection

- Talk about how each item fits into the food chain.
- Help the students to design a food chain based on the evidence they have found.
- Tell the students to illustrate and label typical animals or plants (e.g., they might draw a Fiddler Crab and label its shell and types of legs).
- List any signs of human influence in the wetland and discuss how people have altered the ecosystem.

Extensions

This activity can be easily adapted for any environment, such as a freshwater wetland ecosystem.

MANGROVE SCAVENGER HUNT

It is your task to discover each of these items during your exploration. Remember to use all of your senses, and put things back **exactly** where they were found. If you don't know the name of what you find, tell what you observed about it to the class.

Three kinds of birds:

Three kinds of plants:

Three kinds of aquatic creatures:

Two signs of humans:

Three kinds of animals (or animal signs such as tracks, scat or bones):

Something that feels:

smooth

rough

sharp

wet

dry

What have you seen that might be food for a:

Heron?

Crab?

Stilt?

Something whose smell you:

Liked

Did not like

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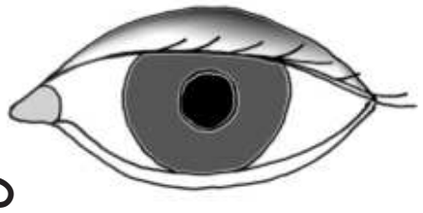


Activity 6-L

FROM THE SEA TO THE LAND
Conducting a transect

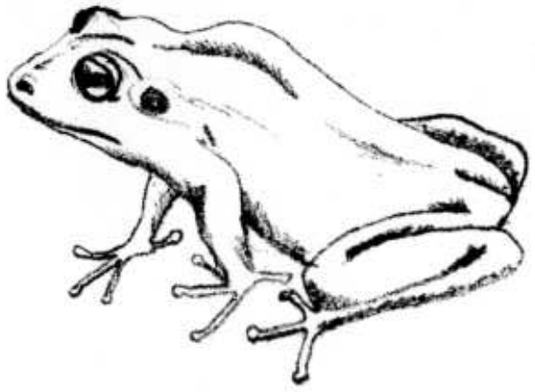
Summary

Students will use a transect to create a profile showing the zonation of wetland vegetation.

Learning Objective

Students will learn through observation that:

- Vegetation and animal communities change along physical gradients



Age Levels 12 +

Subject Area Science, also suitable for Science Clubs or Fairs

Time 30–60 minutes

Materials

- Copies of Copy Cat Pages "Transect Worksheet" and "From the Sea to the Land Worksheet" or page 15 in Wetland Field Trip Notebook
- Copies of pictures of wetland plants from general copy cat pages
- Field guides (optional)
- About 30-50 m (90-450 ft) of heavy string or rope
- Two stakes or lengths of PVC pipe, each 1-2 m (3-6 ft) long, with waterproof marks every 2 ft (or equivalent in centimetres); leave enough room below the mark at ground level for the stake to be inserted into the ground (optional)
- Long measuring tape (20 m or more, if available)
- Ball of coloured string or yarn
- Tape measure or metre rule
- Several hand lenses (optional)
- A notebook or science journal to record observations and diagrams of plants
- An inventory of plants found in the wetland (if available) from your country's Department of Resources or Environment, a local university, or the National Trust
- Clipboards
- A camera (optional)

Background

Wetlands are zones of transition, from the land to the sea or open water. In a coastal wetland, the change from the open sea to the hard land results in changes in wetness, salinity, soil types, exposure to wind, waves, sea spray, storms, and to freshwater run off from the land. These changes affect the vegetation and the communities of animals that live in it.

Procedure

1. Using the stakes and rope, the students should lay out a transect line perpendicular to the shoreline (see diagram). Ideally the transect line should extend from a point in the water (stake A) where underwater plants can be seen, to another point (stake B) where dry land vegetation is present. The distance will vary depending on the nature of the wetland. (In large wetlands, it may not be practical to lay out string over the whole distance.) Push the stakes in firmly. Lay the measuring tape along the transect or use a metre rule or tape measure to mark 1 m increments along the rope with the coloured yarn.

2. Starting at the beginning of the line in the sea, (0 m) identify each plant or group of plants that intersects the line (can be above or below the line) and also note how far the plant stretches along (i.e., the distance of the start and end points from the start of the string). Make sure that you note where the edge of the water occurs, and which plants are under water. Note the height of each plant, the type of soil and whether there is any standing water.

3. Your records should look something like this:

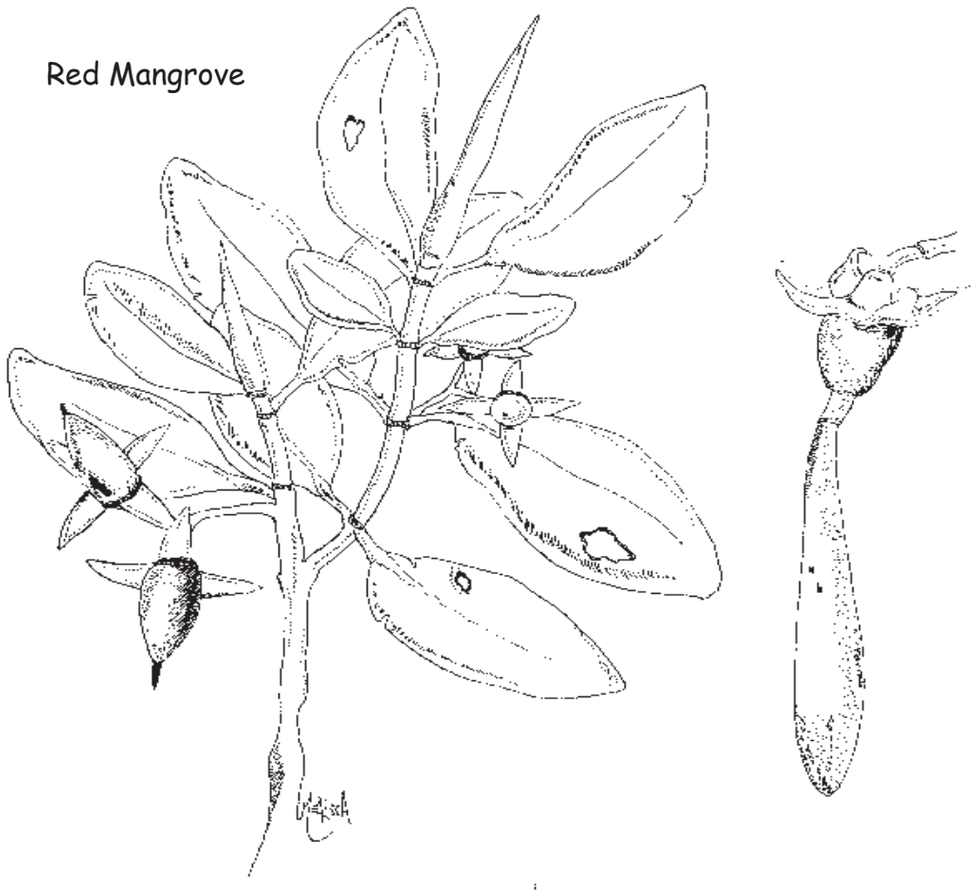
SPECIES	FROM (M)	TO (M)	HEIGHT (M)	SOIL	NOTES E.G., ANIMALS OBSERVED
Sea Grass	0.0	0.11	0.10 m	Wet mud	Below sea surface
Red Mangrove	1.1	10.3	2 m	Peat	Some standing water Fiddler and Mangrove crabs abundant Sand flies rare
Black Mangrove	10.3	45	1.5 m		Yellow Warbler nest

4. When you get home use graph or construction paper to draw a scale diagram of the horizontal and vertical zonation. Design and select symbols for each species of mangrove. Place arrows under your diagram for increasing or decreasing salinity, wetness and other gradients that you think may affect the plants.

5. Discuss:
- Where are the different species of mangroves found?
- Where are the various species of animals found?
- What do these animals eat? Draw a simple food web incorporating the animals and plants you observed
- What limiting factors affect the distribution of plants and animals in the mangroves?

Source Adapted from various sources by Martin Keeley

Red Mangrove



FROM THE SEA TO THE LAND WORKSHEET

SPECIES	FROM (M)	TO (M)	HEIGHT (M)	SOIL	NOTES ON WATER LEVELS AND ANIMALS OBSERVED

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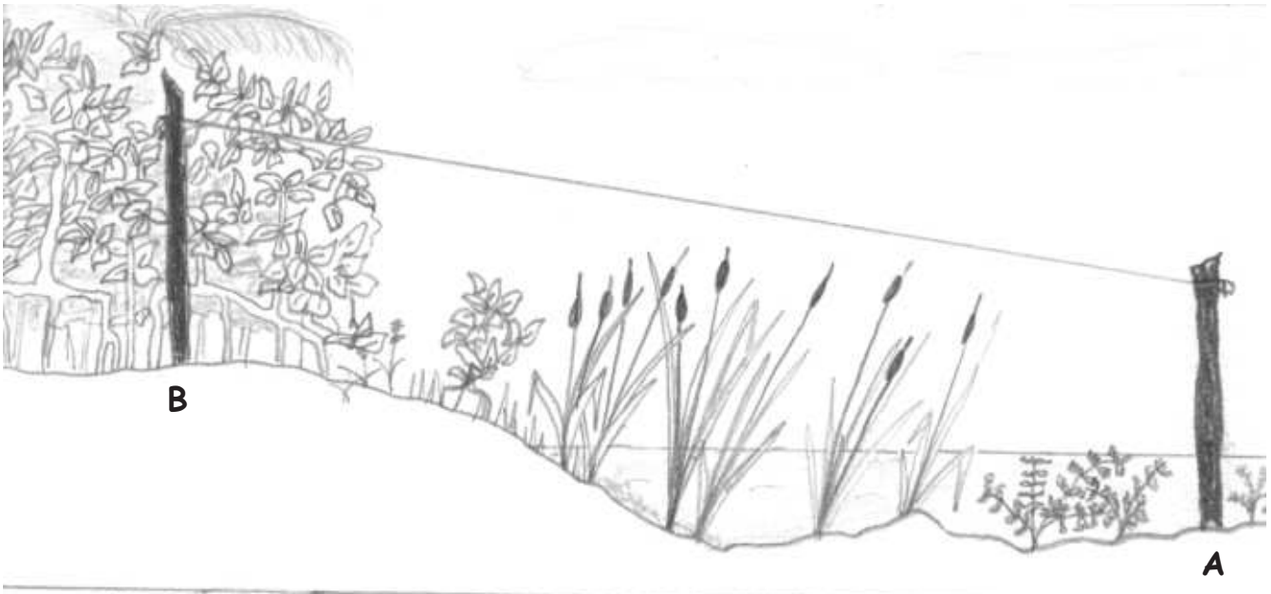
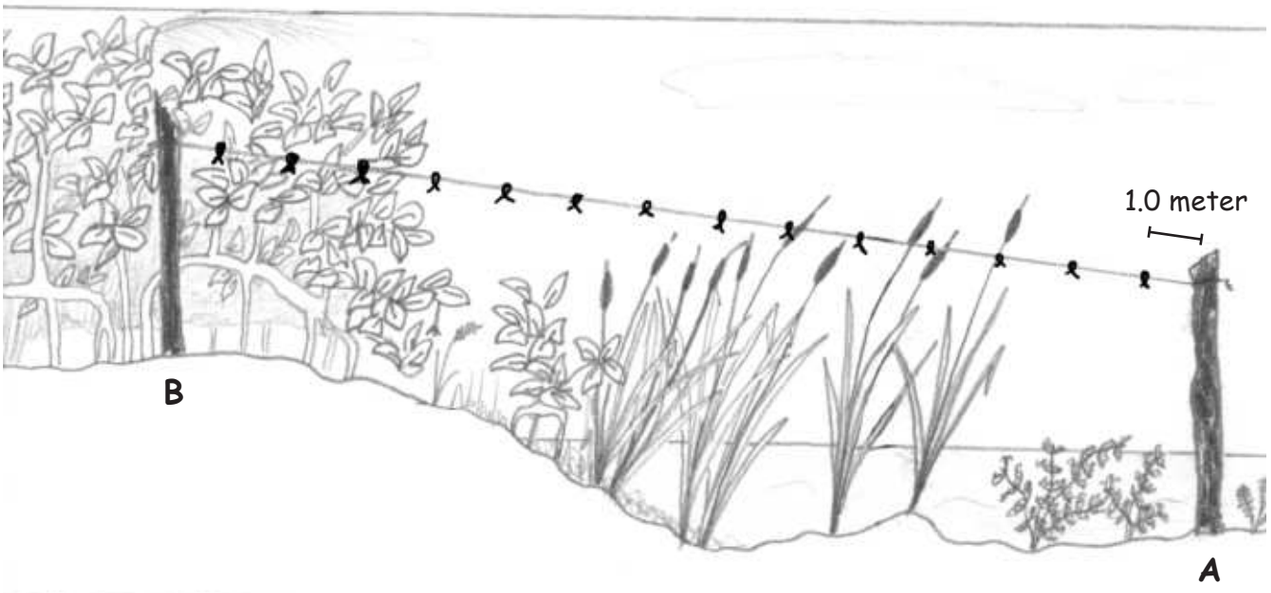
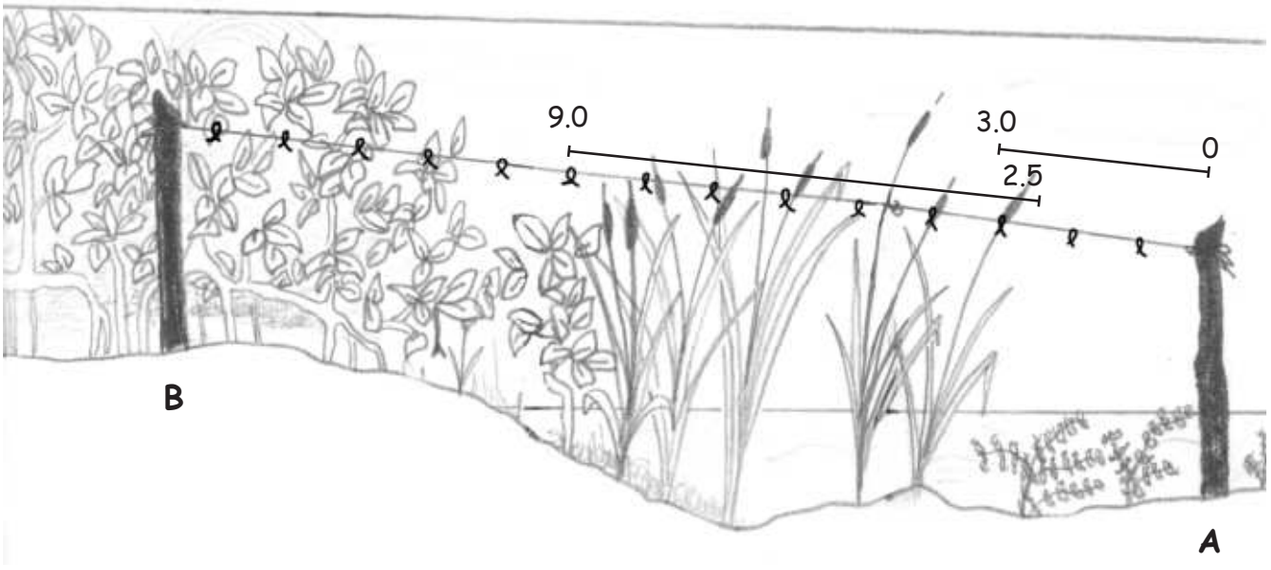
TRANSECT WORKSHEET







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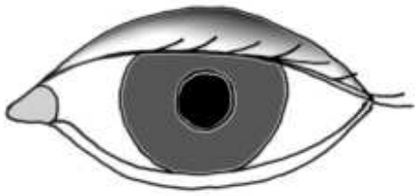

Activity 6-M

ADOPT-A-WETLAND

Summary

There is very little information about the current status of most Caribbean wetlands. Students can make an important contribution to science and conservation if they visit a selected wetland regularly and make systematic observations.

Learning Objectives

Students will:

- Improve their observational skills
- Learn more about seasonal and long-term changes in wetlands
- Gain practical experience of wetland conservation

Age Levels 10 +

Subject Areas Science; also suitable for Science Clubs or Fairs

Time Variable

Materials

Variable, depending on availability and objectives, but might include:

- Field forms (e.g., Copy Cat Page "Wetland Monitoring Field Sheet") and pencils
- Clip boards
- Binoculars and spotting scope if available.
- Camera (optional)

Preparation

Any wetland field trip could stimulate interest in this activity.

Procedure

Working with the students, decide what things they can monitor and how often they will visit the wetland. What is the best time of day? As far as possible the observations should be standardised. A sample monitoring form is provided, but the students may want to design their own. Photographs taken from a standard point at regular intervals provide an excellent way to track long-term changes in wetlands.

Evaluation/Assessment

Make a special scrapbook for your observations and field forms. Write a report on your wetland at least once a year, and send it to your local conservation agency. Include:

- Name of Wetland
- Location
- Description
- Common plants
- Common animals
- Threatened or rare species
- Changes you have observed in the wetland
- Threats to the wetlands
- Recommendations for conservation or sustainable use

Extensions

Monitoring your wetland might lead to many other things:

- If you find out that it is threatened by development, you might want to try to save it. The data you have collected would be invaluable.

- If the wetland has potential for education you might want to interpret it. You could develop a nature trail and encourage visitors to come to it .

- If the wetland has interesting or threatened species, you might want to get it conserved. You could lobby your government to designate it a protected area.

- More detailed data collection
  Select and mark trees that you will monitor long term, with paint or metal tags.
  Measure their diameter at breast height (mark the position) at least once a year.
  Measure or estimate their height at least once a year.
  Use a **quadrat.** A quadrat is a standard square sample plot used for sampling vegetation by counting the number of plants or species or the area covered by each species.

Quadrat size

Different sizes of **quadrat** are appropriate for different kinds of vegetation. The optimum size depends on:
- the size of the individual plants
- the number of species distributed more or less homogenously
- species present

The following are suitable areas:
- Small-plant communities (e.g. mosses, surface of red mangrove roots): 10 x 10 cm to 25 x 25 cm
- Grassland (pasture and short grass): 25 x 25 cm to 100cm x 100 cm
- High grass, scrub or low woodland: 5 x 5 m
- Forest: 10 x 10 m to 50 x 50 m

White Mangrove

WETLAND MONITORING FIELD SHEET

PLACE:	
DATE:	TIME:
OBSERVERS:	
PHOTOGRAPH: Yes/No	
WEATHER CONDITIONS:	
WATER LEVELS (circle): High Normal Low No water	
SALINITY OF WATER AT SURFACE (Determine this by tasting a tiny drop **IF** you are sure the wetland is not polluted, then (circle): Salty Brackish Fresh	
NOTES ON CONDITION OF PLANTS: (e.g., Flowering, fruiting, defoliated by hurricane) Red Mangroves White Mangroves Black Mangroves Buttonwood Others	
WHAT BIRDS WERE PRESENT? (count or estimate). This is a summary but if you can identify the species do so on a separate sheet.	

TYPES	NUMBERS IN GROUP TOTAL
Ducks	
Grebes	
Coots	
Herons	
Egrets	
Sandpipers	
Plovers	
Terns	
Pelicans	
Frigatebirds	
Raptors	
Perching birds	
Other	
OBSERVATIONS OF OTHER ANIMALS	
Crabs	
Other?	

COPY CAT PAGE

NOTES ON HUMAN IMPACTS	
Garbage	
Wood cutting	
Charcoal burning	
Hunting	
Agriculture	
OTHER OBSERVATIONS	

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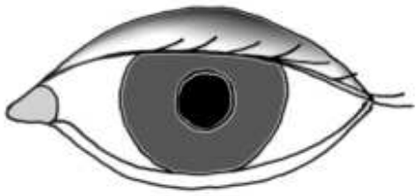

Activity 6-N

HOW MANY WHISTLERS?

Summary

Students assist scientists to collect data on a globally threatened species.

Learning Objectives

Students will:

- Learn about West Indian Whistling-Ducks and their ecology

Age Levels 10 +

Subject Areas Science, Geography, Mathematics

Time About 2 hours per observation period

Materials

For each group of students

- Field forms
- Clipboard
- Pencils
- Conservation Slide Show (if available)
- Flashlight
- Watch
- West Indian Whistling-Duck and Wetlands
- Tape recorder and tape of calls (if available)
- Compass (if available)

Background

West Indian Whistling-Ducks are among the rarest ducks in the world. Very little is known about their ecology. Students can make an important contribution to science by collecting data.

Preparation

- Copy Copy Cat Page "West Indian Whistling-Duck Count Worksheet"
- Talk to local naturalists, hunters and residents and try to identify accessible spots in the wetlands where West Indian Whistling-Ducks can be seen regularly flying over at dusk. These will be your survey points

Procedure

1. Show the students the West Indian Whistling-Duck and Wetlands Conservation Slide Show.
2. Explain the purpose of the survey and what they will be expected to do. Ensure the students can identify Whistlers by sight and sound. Synchronise watches.
3. Arrange for teams of 2-3 students to wait at the pre-selected survey spots from just before sunset to about one hour after sunset and use a standard form to record observations of the Whistlers. Under the headings "Flying from:" and "Flying to:" students may write short descriptions (e.g., "1 km N of Codrington") or compass bearings or both as appropriate. The more detail, the better.
4. Repeat observations once per month if possible.
5. Collate observations regularly on maps.
6. Analyse data to:
   - Estimate numbers
   - Locate probable roosting grounds
   - Locate probable feeding grounds

Assessment

- Discuss where the ducks might be going to or coming from. How do they use these habitats? Where do they usually feed? Where do they spend the days? Where do they spend the nights? Where do they breed?
- What threats do the ducks face in your area?
- Write a report on your observations. Send copies to your local conservation organisation and to the West Indian Whistling-Duck Working Group

Source Ann Sutton.

WEST INDIAN WHISTLING-DUCK COUNT WORKSHEET

Date			Observers		
Start time			End Time		
Location					
TIME	NUMBER SEEN	NUMBER HEARD (ESTIMATED)	FLYING FROM:	FLYING TO:	NOTES

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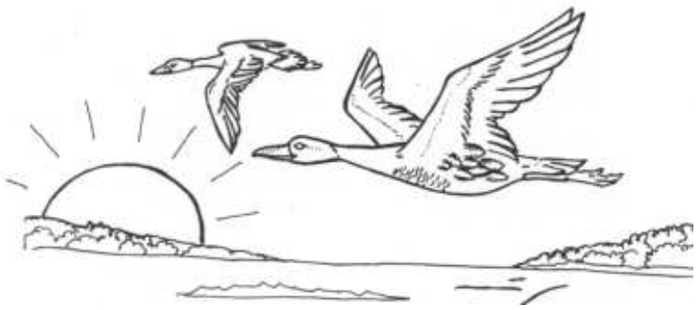

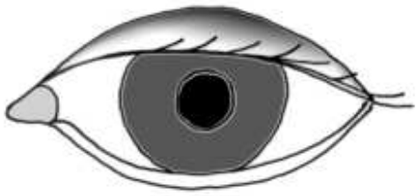

Activity 6-O

BIODIVERSITY RAP

Summary

A rap is used to reinforce the things that were learned during a nature walk or field trip.

Learning Objectives

The students will:

- Understand the concept of biodiversity
- Remember what they observed on the class field trip
- Have an opportunity to share their experience with others

Age Levels 6 +

Subject Areas

Science, English Language, suitable for a concert, science club, youth group, or as follow-up activity for field trip

Time About 30 minutes

Materials

Teacher's copy of outline rap (below)

Procedure

1. Towards the end of a field trip, on the bus going home, or the following day, tell the class they are going to write and perform a rap.

2. Use the outline below as a guide, but base your lyrics on the things that were seen during the trip.

We wanna tell you about our field trip,
Bet you didn't know that mangroves are hip!
All of the creatures from A to Zee
Because this rap's all about variety.

A - ant, aphid
B - bat, bee, butterfly, beetle, bug, beenybud,

C - crab, cricket, "croaker", coot, conch, crocodile
D - dragonfly,

E - egret
F - fiddler, frigatebird, fish

G - grasshopper, grassquit
H - heron, hummingbird

I - insect
J - John crow

K - kestrel, kingbird, killdeer, kingfisher
L - lizard, lobster

M - mosquito, mongoose, manatee
N - night heron, neotropical migrants

O - osprey
P - pigeon, parrot, plover

Q - "quits", "quoks"
R - ratbat,

S - spider, snook, snails, sea hare, sandpipers
T - toad, tarpon

U - upside-down jellyfish
V - vervain

W - West Indian Whistling-Duck, wasp, worm
X - eggs of many birds

Y - 'Y" did we see so much litter?
Z - zooplankton, zebra butterfly

Living things all around
High in the sky, buried in the ground
We've shown you the creatures and variety
And what does that spell?

BIO-DIVER-SITY!

Extensions

This rap could be chanted by older children. Young children could act the animals as they chant them. The rap could also be illustrated.

Source Adapted from "Second Nature" Royal Society for the Protection of Birds, UK

Sesuvium

Some Selected Sources of Further Information

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Wetlands

Wetlands International – non-profit organisation dedicated solely to the crucial work of wetland conservation and sustainable management of wetlands. URL: http://www.wetlands.org/

The Ramsar Convention on Wetlands – dedicated to the conservation and wise use of wetlands by national action and international cooperation as a means to achieving sustainable development throughout the world. URL: http://www.ramsar.org/

Ducks Unlimited – working to fulfill the annual life cycle needs of North American waterfowl by protecting, enhancing, restoring and managing important wetlands and uplands. URL: http://www.ducks.org/

National Wildlife Federation – Includes government legislation, latest news and developments, a wetlands library, educational materials and more. URL: http://www.nwf.org/wetlands/

Global Environment and Endangered Species

IUCN, The World Conservation Union – striving to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. URL: http://www.iucn.org/

United Nations Environment Programme - advocacy of environmental concerns within the international systems; working to implement an environmental agenda that is integrated strategically with the goals of economic development and social well-being - an agenda for sustainable development. URL: http://www.unep.org/

Birds

American Bird Conservancy – conserving wild birds and their habitats throughout the Americas. URL: http://www.abcbirds.org/

Birdlife International – a global alliance of conservation organisations with a focus on birds that works together on shared priorities, policies and programmes of conservation action, exchanging skills, achievements and information, growing in ability, authority and influence. URL: http://www.wing-wbsj.or.jp/birdlife/

Cornell Lab of Ornithology – interpreting and conserving the earth's biological diversity through research, education, and citizen science focused on birds. URL: http://www. birds.cornell.edu/

Partners in Flight - Cooperative partnership focusing resources on the improvement of monitoring and inventory, research, management, and education programs involving birds and their habitats. URL: http://www.partnersinflight.org/

Royal Society for the Protection of Birds - working to secure a healthy environment for birds and wildlife, helping to create a better world for us all. URL: http://www.rspb.org.uk/

Society for the Conservation and Study of Caribbean Birds – working to promote the scientific study and conservation of Caribbean birds and their habitats. URL: http://www.nmnh.si.edu/BIRDNET/SCSCB/

GLOSSARY

abiotic factors environmental influences produced other than by living organisms, for example, temperature, humidity, pH, and other physical and chemical influences. Contrast **biotic factors**.

acid rain rainfall which has become more acid than usual, due to contamination with pollutants in the air, e.g., sulphur dioxide, (produced by heavy industry and burning of fossil fuels).

aerenchyma plant tissue with large air-filled intercellular spaces, usually found in roots and stems of aquatic and marsh plants. Aerenchyma make it easier for oxygen and carbon dioxide to move through the plant. This is an **adaptation** to growing in wet places.

aerial root a root, some or all of which is in the air. Found in some species of mangroves.

adaptation a genetically determined characteristic (behavioural, morphological or physiological) that improves an organism's ability to survive and reproduce in a particular habitat. For example, ducks have webbed feet that help them to swim and feed in water.

algae (singular: *alga*) simple plants, lacking stems and leaves. There are two main types; **phytoplankton**, which are **unicellular** and float freely in water, and benthic algae (seaweeds), which are usually larger, and are attached to the bottom.

alien species see **introduced species, invasive species**

amphipod a type of aquatic **crustacean**, that somewhat resembles a shrimp, found in water of pond or mangroves.

anaerobic without oxygen.

anoxic oxygen-poor

aquifer an underground layer of permeable material that can store, transmit, and supply water.

arthropods invertebrate animals including **crustaceans** (such as crabs), insects (such as beetles and flies), arachnids (such as spiders), millipedes and centipedes. All arthropods have their skeletons on the outside (exoskeletons), jointed legs and segmented bodies

ascomycetes a type of fungi, often found in decaying leaves.

atoll ring-shaped coral reef that encloses or almost encloses a lagoon and is surrounded by open sea.

bacteria very small, **unicellular** living things. They cannot be seen with the naked eye but are very important in nature, as they cause decay. Some bacteria break down organic matter in water and use up the oxygen. Others cause diseases such as diarrhoea and cholera.

bag limit the number of birds a hunter is allowed to shoot in a session.

banding (also called ringing) placing small, individually numbered metal or plastic rings on wild birds' legs. When a banded bird is recaptured, the number is recorded and information on national or international databases can be used to determine when and where it was banded. This information may be used to determine **migration** routes.

basin a shallow depression.

bedrock layer of rock beneath the soil.

berm a narrow ledge or path as at the top or bottom of a slope, along a beach.

bioaccumulation concentration of toxic chemicals as they pass up the **food chain**.

biodegradable capable of being broken down into simpler components by living organisms (such as **bacteria)**.

biodiversity (shorthand for **biological diversity)** the diversity of living things found in the natural world. The concept usually refers to the different species but also includes ecosystems and the genetic diversity within a given species.

biomass weight of living material, usually expressed as dry weight per unit area.

biotic factors environmental influences caused by living organisms. Contrast **abiotic factors**.

bloom a proliferation of **algae** or other simple aquatic living things increase in response to a change in their **environment** (such as an increase of **nutrients** due to **pollution**). Blooms often produce such high densities of algae that they change the colour of the water.

bog wetland characterized by an accumulation of peat, acid conditions, and dominance of sphagnum moss.

brackish water that contains some salt, but is less salty than seawater.

buttresses tree roots and trunks that extend sideways and help to support the tree in wet or muddy or other unstable conditions.

camouflage body colours, shapes or behaviour that help animals to blend into their backgrounds and hide from their predators or prey.

carbon sinks ecosystems capable of absorbing and storing carbon (e.g., forests, some wetlands); preservation of these ecosystems is of prime importance for reducing the human-caused increasing levels of carbon dioxide in the atmosphere which contribute to **global warming**.

carnivore an animal that eats other animals.

carrying capacity the number of animals or plants that can be supported by the resources of a particular habitat.

catchment area the area which supplies water to a particular river or stream.

cell the basic unit of living things.
chlorophyll pigment found in green plants. It absorbs light energy for **photosynthesis**.
clutch the number of eggs laid in a nest.
community a group of living organisms in a given area that interact with each other; the living components of an **ecosystem**.
competition the interaction that occurs when organisms of the same or different species use a common resource that is in short supply or when they harm one another when seeking a common resource.
condensation occurs when a vapour (such as steam) cools and turns into a liquid (such as water).
conservation the protection, management, and wise use of natural resources (including plants and animals and their habitats) as well as cultural and human resources.
convection the movement of heat through liquids and gases.
coral bleaching the loss of colour from a coral as it expels its **zooxanthellae**—usually a stress response (e.g., warming water temperatures from **global warming**, pollution).
critical habitats habitats that are essential for the survival of species (e.g. woodpeckers need trees for feeding and nesting).
currents movements of water (in oceans or lakes) created by winds, tides, differences in salinity or temperature between water bodies.
decomposer living things such as **bacteria**, that break down dead organic matter into simpler substances.
denitrification breakdown of nitrates and nitrites into nitrogen gas by microorganisms, in the absence of oxygen.
detrivore an animal that feeds on detritus.
detritus material formed when dead organic matter decomposes.
diatoms microscopic aquatic **algae**, an important part of **phytoplankton**.
dissolved oxygen oxygen gas dissolved in water.
down soft fluffy feathers.
dredge to remove sand, sediments, mangroves, etc. from the bottom using a scoop or shovel-like device or large suction pipe.
ebb tide occurs when the tide moves water away from shore.
ecosystem a community of living things, interacting with each other and the environment in which they live (soil, water, air, light) as a system (e.g. a pond, a forest, a wetland).
ecotourism tourism based principally on natural and archaeological/historical resources such as birds and other wildlife, scenic areas, reefs, caves, fossil sites, archaeological sites, wetlands and areas of rare or endangered species.
effluents a thing that flows out or forth, e.g., the outflow of a sewer or septic tank.
endangered species species whose total population is declining to low levels throughout its range, such that, if the trend continues, will result in extinction. Many West Indian species including some birds, turtles, and iguanas are endangered in the West Indies.
endemic a species found only in a particular region.
environment all the conditions or influences within a particular ecosystem that affect its organisms.
erosion the process in which soil particles are carried away by wind or water, resulting in the wearing away of land or beaches. Erosion can occur naturally, but is generally made worse by clearing plants from beaches, cutting forests, road building, construction and farming.
estuary a bay open to the ocean at one end that receives freshwater from a river at the other. Hence, mixing of fresh- and saltwater occurs (the water appears **brackish**).
eutrophication enrichment of water by excess nutrients, mainly phosphorous and nitrogen compounds, which promote the growth of algae and other water aquatic plants at the surface. Deep water has little or no dissolved oxygen.
evaporation the process by which a liquid (such as water) turns into a gas or vapour (such as steam).
evapotranspiration loss of water from the soil both by evaporation and by transpiration from the plants growing thereon.
exoskeleton an external skeleton, such as the shell of a mollusc or **arthropod**.
exotic species see **introduced species, invasive species**.
extinct species species no longer represented by living individuals.
fauna animals.
field marks the characteristics of a bird that may be used to identify it (e.g., its colour, size, shape, behaviour).
filter-feeding getting food from water by filtering particles out of it
flora all the plants living in a particular place.
food chain the movement of energy and nutrients from one feeding group of organisms to another in a series that begins with producers (plants) and ends with **carnivores**, **detrivores** and **decomposers**.
food web interlocking patterns formed by a series of and interconnecting **food chains**.
fossil fuels coal, oil, and natural gas formed millions of years ago from the remains of plants and animals. Use of fossil fuel is a major cause of pollution.

fringe edge.
fry fish **larvae**.
gastropod a snail, limpet, sea hare, sea butterfly or sea slug.
global climate change a change in the Earth's climate caused by increasing concentrations of **greenhouse gases** in the atmosphere from human activities (burning of fossil fuels and deforestation). The effects of global climate change include warming temperatures, altered weather patterns (e.g., changes in the frequency and intensity of precipitation events) and rising sea levels. See also **global warming** and **greenhouse effect**.
global warming term used to describe the gradual increase in the global average surface temperature of the earth from an enhanced **greenhouse effect**, which results from the accumulation of additional **greenhouse gases** in the atmosphere from human activities.
greenhouse effect the trapping of heat by gases, such as carbon dioxide, in the Earth's atmosphere. This is a natural phenomenon, without which life as we know it would not be possible.
greenhouse gases gases in the atmosphere that absorb infrared energy and contribute to the air temperature.. These gases are like a heat blanket and are important in insulating Earth's surface. They include carbon dioxide, water vapour, methane, nitrous oxide, and chloroflourocarbons and other halocarbons.
groundwater water from rain, springs and rivers that is stored in natural reservoirs in the **bedrock** and soil below the earth's surface.
habitat place where a plant or animal lives.
herbaceous an adjective describing non-woody plants (herbs).
herbivore an animal that eats only plants.
hydric (of soils) permanently wet.
hydrology the study of water.
hydrophyte any plant that is adapted to living in water or very wet conditions.
hypersaline more salty than seawater.
indigenous species see **native species**.
ingest to eat.
insect arthropod with three pairs of legs.
insectivore an animal that eats **insects**.
introduced species a species that has been brought into a geographical area where it never lived before. For example, the mongoose was brought into parts of the West Indies to kill rats. Introduced species often compete with or prey on **native species** and may become **invasive**.
invasive species those plants, animals, and microbes not native to a region which, when introduced either accidentally or intentionally, out-compete native species for available resources, reproduce prolifically, and dominate regions and ecosystems. Invasive species cause enormous ecological and economic damage around the world and are the second leading cause of species endangerment (habitat destruction is first).
invertebrate an animal without a backbone (e.g. worms, snails, starfish, insects and crabs).
lagoon shallow lake or pond, especially one connected with a larger body of water; area of water enclosed by a circular coral reef, or atoll; an area of shallow salt water separated from the sea by sand dunes. The term means different things on different islands.
larva (plural *larvae*) a young animal that hatches from an egg in a form that is different from the adult (e.g., a caterpillar is the larva of a butterfly). Larvae and adults often use different habitats.
leaching the removal by water of **soluble** materials from soil or waste tipped on land. Leaching of toxic chemicals from dumps may contaminate **groundwater**. Leaching can also remove useful nutrients from soils.
lenticels small raised opening on bark of a woody plant, used in respiration.
limiting factor factor primarily responsible for limiting the growth and/or reproduction of an organism or a population (e.g., temperature, light, competing species, the availability of particular **nutrients**).
mangrove tropical and sub-tropical trees that grow in saltwater.
marsh a wetland with **herbaceous** plants.
metabolism energy changes that sustain life within an organism.
metamorphosis a change in form an animal undergoes as it develops from egg to adult.
mitigation measures taken to reduce or offset the environmental impacts of a development.
molluscs invertebrates such as gastropods (conch and snails), bivalves (clams) and cephalopods (squid and octopus).
montane of the mountains.
migration seasonal movement of animals from one region to another and back. For example, many birds, including warblers, migrate annually from North America to the West Indies for the winter, returning to breed in the summer.
mucous a slimy secretion containing protein, which serves to moisten and lubricate membranes; is often used by filter- and suspension-feeders to trap food particles.
native species a species that occurs naturally in an area (also called **indigenous** species).
nutrients substances such as nitrogen and phosphorous that promote the growth of plants or animals.
omnivore an animal that eats both plants and animals.
ornithology the study of birds. An ornithologist is a scientist who studies birds.

osmosis movement of water from a concentrated solution to a less concentrated one across a semi-permeable membrane.

overgrazing the phenomenon of animals (e.g., cattle, sheep, goats) grazing in greater numbers or for longer than the land can support in the long run. There may be a temporary economic gain in the short run, but the land is destroyed, and its ability to support life in the long run is vastly diminished. Overgrazing often results in soil **erosion**.

organism any living thing, including plants and animals.

pathogens organisms that cause diseases, including some **bacteria**, viruses and worms.

permeable allows substances to move through (or **pervious).**

pervious see **permeable**.

pesticides any chemical used for killing pest insects, weeds, etc.

photosynthesis synthesis, with the aid of **chlorophyll** and with light as the energy source, of carbohydrates (simple sugars) from carbon dioxide and water, with oxygen as a byproduct.

phytoplankton small, floating plant life in aquatic ecosystems.

plankton microscopic plants (**phytoplankton**) and animals (**zooplankton**) that are found drifting in freshwater and marine ecosystems. They form the basis of aquatic food webs.

plantlet young plant.

pneumatophore an erect respiratory root that protrudes above waterlogged soils; typical of bald cypress and mangroves.

poach to hunt, kill, or collect a plant or animal illegally.

point source pollution pollution that comes from a particular source, such as from a factory or a sewage treatment plant. Distinguished from non-point source pollution, which does not come from a single identifiable source but includes materials that wash off streets, yards, farms, and other surfaces.

pollutant any natural or artificial substance that enters the ecosystem in such quantities that it does harm to the ecosystem; any introduced substance that makes a resource unfit for a specific purpose.

pollution contamination of air, water, or soil with undesirable amounts of material or heat. The material may be a natural substance, such as phosphate, in excessive quantities, or it may be in very small quantities of a synthetic compound, such as dioxin, that is exceedingly toxic.

polyp coral animal.

precipitation rain, sleet, snow and hail.

predator a carnivorous animal. Its victim is called the *prey*.

primary consumers the lowest consumers in the **food chain**, i.e., **herbivores** that feed on green plants and their products (e.g., nuts, seeds).

primary producers the lowest link in the **food chain**, (i.e. green plants).

prop root root that supports a **mangrove** tree.

propagule plantlet that develops from a seed while it is still attached to its parent tree.

radula the file-like tongue of many snails, used for rasping their food.

rare species a species that has a small number of individuals and/or has a limited distribution.

reef an underwater ridge of coral or rocks formed from corals.

rhizome in plants, a horizontal stem on or under the ground that produces stems and roots; in animals, a horizontal outgrowth that gives rise to new individuals.

riverine on a river bank.

roost a place where birds rest at night, often in large numbers.

run-off water from floods or irrigation that flows over land towards the sea, wetland, ponds or rivers.

salinity a measure of the saltiness of water, usually measured in parts per thousand.

salt marsh an area of soft, wet land with grass-like or herbaceous plants, periodically flooded by salt water.

salt wedge layer of salty water below the fresh water, a common phenomenon in coastal rivers in the Caribbean.

scavenger animal that feeds on dead or dying organisms.

school a group of fish swimming together.

sea squirt see **tunicate**.

secondary consumer animal that eats animals that eat plants.

sedge grass-like wetland plant.

sediment soil particles (sand, silt and clay) which are washed from the land into the water and settle to the bottom.

silt fine particles of soil that are carried along by flowing water and eventually settle to the bottom of a waterway.

sound a wide channel or strait linking two large bodies of water or separating an island from the mainland.

species (plural *species*) organisms forming a natural population or group of populations that transmit specific characteristics from parent to offspring; a group of organisms reproductively isolated from similar organisms and usually producing infertile offspring when crossed with them.

spray zone zone above the high tide line that is regularly wet by the salt spray of the surf.

spring tide tide of maximum range occurring at the new and full moon.

subtropical nearly tropical in location and climate.

subspecies a geographical unit of a species population, distinguishable by morphological, behavioral or physiological characteristics.

succession The gradual, or sometimes rapid, change in species that occupy a given area, with some species invading and becoming more numerous while others decline in population and disappear, often progresses to a stable climax community (e.g., a saltwater pond surrounded by mangroves may gradually fill itself in and become a woodland). Succession is caused by a change in one or more **abiotic** or **biotic** factors benefiting some species but at the expense of others.

surface water water bodies above ground (e.g., in wetlands, lakes and rivers).

suspended solids eroded soil particles (including sand, soil and silt) that are washed off the land, usually after rain, or are stirred up by wave action.

suspension feeding feeding upon particles in water, such as **plankton** or **detritus**.

sustainable development development that provides people with a better life without sacrificing or depleting resources or causing environmental impacts that will undercut future generations.

swamp wetland with trees and shrubs.

territory the space an animal defends from intrusion by other animals (mainly the same species) for mating or feeding.

thorax chest, or, in invertebrates, the region of the body between the head and abdomen.

threatened species a species whose numbers are low or declining. A threatened species is not in immediate danger of extinction, but is likely to become endangered if it is not protected. The Nassau Grouper is a threatened species, as is the West Indian Whistling-Duck.

tidal range the difference in height between consecutive high and low tides. Tidal ranges decrease towards the equator, and are smaller in the southern Caribbean than in the north.

tidal wave tsunami, or a huge sea wave caused by an oceanic disturbance.

tide the twice-daily ebb and flow of ocean waters caused by the gravitational pull between the Earth and the moon and the Earth and the sun.

tidepool depression in a rock (or created by rocks)within the intertidal zone that traps water as the tide recedes.

tissue cells of similar structure that are grouped together and perform a specific function.

toxic poisonous.

transpiration loss of water vapour from the leaves of plants.

tropics the region between the Tropic of Cancer (23° 26' north) and the Tropic of Capricorn (23° 26' south); parallels of latitude on either side of the earth's equator that correspond to the astronomical tropics.

tsunami see **tidal wave**.

tunicates small tube-like sedentary filter-feeding animals whose larvae superficially resemble tadpoles, and which have many features that link them to the vertebrates. Commonly called **sea squirts**.

turbidity a measure of the amount of suspended matter in water.

unicellular an animal or plant or other living thing whose whole body is just one cell.

vertebrates animals with backbones (including fish, birds, amphibians, reptiles, and mammals).

vulnerable species species that may become endangered in the near future because their populations are decreasing in size throughout their range.

water cycle the process by which seawater evaporates, forms rain which falls on the land, forming rivers, and flowing back to the sea.

watershed the total area of land that drains directly or indirectly into a particular stream or river. The watershed is usually named for the stream or river into which it drains.

wetland areas that are at least seasonally wet and are flooded at more or less regular intervals. Also, marshy areas along coasts that are regularly flooded by tide.

zonation arrangement in zones or bands, as in the distribution of plants or animals in a habitat.

zooplankton the animal community, predominantly single-celled animals, that floats free in marine and freshwater environments, moving passively with the currents.

zooxanthellae one-celled dinoflagellates and other algae that live as symbionts within coral.

Scientific Names of Plants and Animals Mentioned in the Text and Illustrated in the Copy Cat Pages

PLANTS

Monocotyledons (grasses, sedges and palm)

Bulrush *Typha domingensis* (Note: In North America, the common name of *Typha domingensis* is cattails, while bulrush is the common name for different species of *Scirpus*)
Caribbean Sedge *Cyperus planifolius*
Common Reed *Phragmites communis*
Casuarina *Casuarina equisetifolia*
Cat-tails - see Bulrush
Manatee Grass *Syringodium filiforme*
Puerto Rico Royal Palm *Roystonea borinquena*
Reed - various species of *Eleocharis*
Royal Palms - various species of *Roystonea*
Sea Grass - see Manatee Grass, Turtle Grass
Swamp Cabbage *Roystonea princeps* (see also Water Lettuce)
Turtle Grass *Thalassia testudinum*

Dicotyledons

Beach Morning Glory *Ipomoea pes-caprae*
Beach Pea *Canavalia maritima*
Beach Mahoe *Thespesia populnea*
Black Mangrove *Avicennia germinans*
Buttonwood Mangrove (Button Mangrove, Buttonwood) *Conocarpus erectus*
Hippomane *Hippomane mancinella*
Mango *Mangifera indica*
Red Mangrove *Rhizophora mangle*
Sea Grape *Coccoloba uvifera*
Sea Lavender *Argusia gnaphalodes*
Swamp Bloodwood *Pterocarpus officinalis*
Swamp Cabbage - see Water Lettuce (also used for Royal Palm, see above)
Water Hyacinth *Eichhornia crassipes*
Water Lettuce *Pistia stratiotes*
Water Lilies - various species of *Nymphaea*
White Mangrove *Laguncularia racemosa*

Ferns

Giant Swamp Fern *Acrostichum aureum*

ANIMALS

Chordates

Mammals

Bat - sometimes called Ratbat. Various species in the Chiroptera
Caribbean Monk Seal *Monarchus tropicalis*
Hutia - also called Coney. *Geocapbromys* spp. There are endemic species on many islands.
Indian Mongoose *Herpestes auropunctatus*. An introduced species and a pest.
Manatee - see West Indian Manatee
Mouse *Mus muscularis*

Raccoon *Procyon lotor*
Rat *Rattus rattus* or *Rattus norvegicus*
West Indian Manatee *Trichechus manatus*

Birds

Antillean Nighthawk *Chordeiles gundlachii*
American Coot *Fulica americana*
Bahama Parrot - see Rose-throated Parrot
Bahama Pintail *Anas bahamensis*
Bahama Swallow *Tachycineta cyaneoviridis*
Baldpate - see White-crowned Pigeon
Bananaquit *Coereba flaveola*
Barbuda Warbler *Dendroica subita*
Barn Owl *Tyto alba*
Barn Swallow *Hirundo rustica*
Belted Kingfisher *Ceryle alcyon*
Beenybud - see Bananaquit
Black-bellied Plover *Pluvialis squatarola*
Blackpoll Warbler *Dendroica striata*
Black-capped Petrel *Pterodroma hasitata*
Black-crowned Night-Heron *Nycticorax nycticorax*
Black-whiskered Vireo *Vireo altiloquus*
Black-Necked Stilt *Himantopus mexicanus*
Blue-winged Teal *Anas discors*
Brown Booby *Sula leucogaster*
Brown Pelican *Pelicanus occidentalis*
Bullfinch - see Greater Antillean Bullfinch and Lesser Antillean Bullfinch.
Bunting - small, seed-eating bird
Caribbean Martin *Progne dominicensis*
Carib Grackle *Quiscalus lugubris*
Cattle Egret *Bubulcus egretta*
Cayman Brac Parrot - see Cuban Parrot
Common Ground Dove *Columbina passerina*
Common Snipe *Gallinago gallinago*
Crane - see Sandhill Crane. This term is sometimes used as a common name for some large herons or egrets.
Cuban Parrot - see Rose-throated Parrot
Egret - various e.g. Cattle Egret
Finch - various species of seed-eating birds
Flamingo - see Greater Flamingo
Frigatebird - see Magnificent Frigatebird
Glossy Ibis *Plegadis falcinellus*
Greater Antillean Bullfinch *Loxigilla violacea*
Greater Flamingo *Phoenicopterus ruber*
Great Blue Heron *Ardea herodias*
Grebe - see Least Grebe or Pied-billed Grebe
Grackle - see Carib Grackle or Greater Antillean Grackle
Grassquit - various species of small, seed-eating birds
Gray Kingbird *Tyrannus dominicensis*
Greater Yellowlegs *Tringa melanoleuca*
Ground Dove - see Common Ground Dove
Gull - various species of seabird, see Laughing Gull

Heron - various species of long-legged, fish-eating birds
Hummingbirds - various species of nectivorous birds
Ibises - two species are common - see Glossy Ibis and White Ibis
Jacana - see Northern Jacana
Jamaican Oriole *Icterus leucopteryx*
Laughing Gull *Larus atricilla*
Least Grebe *Tachybaptus dominicus*
Lesser Antillean Bullfinch *Loxigilla noctis*
Lesser Yellowlegs *Tringa flavipes*
Kingbirds - various species of insect-eating birds, see Gray Kingbird
Magnificent Frigatebird *Fregata magnificens*
Nighthawk - see Antillean Nighthawk
Night Heron - see Black-crowned and Yellow-crowned Night-Herons
Northern Jacana *Jacana spinosa*
Northern Potoo *Nyctibius jamaicensis*
Northern Waterthrush *Seiurus novaborensis*
Osprey *Pandion haliaetus*
Owl - various species of night bird, some endemic to certain islands
Parrot - various species of *Amazona*, many endemic to certain islands
Pied-billed Grebe *Podylymbus podiceps*
Pelican - see Brown Pelican
Peregrine Falcon *Falco peregrinus*
Pigeon - various species, see White-crowned Pigeon
Plover - various species of small waterbirds with short bills
Potoo - see Northern Potoo
Purple Martin - *Progne subis*
Rail - various species of small waterbirds, that live in dense, wet vegetation
Rose-throated Parrot *Amazona leucocephala.* Sub-species include Cayman Parrot *Amazona leucocephala caymanensis;* Cayman Brac Parrot - *Amazona leucocephala hesterna.*
Ruddy Duck *Oxyura jamaicensis*
Ruddy Turnstone *Arenaris interpres*
Sandhill Crane *Grus canadensis*
Sandpipers - various species of waterbirds with longer bills than plovers
Semipalmated Plover *Charadrius semipalmatus*
Semipalmated Sandpiper *Caldris pusilla*
Shiny Cowbird *Molothrus bonairensis*
Shorebirds - plovers and sandpipers
Sooty Tern *Sterna fuscata*
Sparrow - small seed-eating bird
Spotted Sandpiper *Actitis macularia*
Snipe - see Common Snipe
Stilt - see Black-necked Stilt
Swift - various species of insectivorous birds
Swallow - various species of insectivorous birds
Swan - various species of large aquatic birds
Tern - various species of seabirds
Turkey Vulture *Cathartes aura*
Vireo - various species of small birds that eat insects and fruit
Warbler - various species of small birds that eat insects and fruit
West Indian Flamingo - see Greater Flamingo
West Indian Whistling-Duck *Dendrocygna arborea*

Western Sandpiper *Calidris mauri*
Whistlers see West Indian Whistling-Duck
White Ibis *Eudocimus albus*
White-crowned Pigeon *Columba leucocephala*
White-headed Duck *Oxyura leucocephala*
White-winged Dove *Zenaida asiatica*
Willet *Catoptrophorus semipalmatus*
Wilson's Plover *Charadrius wilsonia*
Woodpecker - various species
Vervain Hummingbird - *Mellisuga minima*
Yellow Warbler *Dendroica petechia*
Yellow-crowned Night-Heron *Nyctanassa violacea*
Yellowlegs - see Greater and Lesser Yellowlegs
Zapata Rail *Cyanolimnas cerverai*
Zenaida Dove *Zenaida aurita*

Reptiles

Acklins Iguana *Cyclura rileyi nuchalis*
Allen's Cay Iguana *Cyclura cychlura inornata*
Bartsch's Iguana *Cyclura carinata bartschi*
American Crocodile *Crocodylus acutus*
Anegada Island Iguana *Cyclura pinguis*
Andros Island Iguana *Cyclura cychlura cychlura*
Anoline Lizard - various species of *Anolis*
Crocodile - see American Crocodile and Cuban Crocodile
Croaking Lizard - see Gecko
Cuban Crocodile *Crocodylus rhombifer*
Cuban Iguana *Cyclura nubila nubila*
Cuban Tree Boa *Epicrates angulifer*
Exuma Island Iguana *Cyclura cychlura figginisi*
Freshwater Turtle (genus *Trachemys*): species found in Hispaniola, Cuba, Cayman, Bahamas, Puerto Rico Bank, Jamaica and introduced Lesser Antilles
Gecko - various species of *Aristelliger* and similar species
Grand Cayman Iguana *Cyclura nubila lewisi*
Hawksbill Turtle *Eretmochelys imbricata*
Green Turtle *Chelonia mydas*
Jamaican Iguana *Cyclura collei*
Leatherback Turtle *Dermochelys coriacea*
Lesser Antillean Iguana *Iguana delicatissima*
Lesser Caymans Iguana *Cyclura nubila caymanensis*
Loggerhead Turtle *Caretta caretta*
Mona Island Iguana *Cyclura cornuta stejnegeri*
Rhinoceros Iguana *Cyclura cornuta cornuta*
Ricord's Iguana *Cyclura ricordi*
San Salvador Iguana *Cyclura rileyi rileyi*
Turks and Caicos Iguana *Cyclura carinata carinata*
White Cay Iguana *Cyclura rileyi cristata*

Amphibians

Bullfrog *Rana catesbiana*
Cane Toad *Bufo marinus*
Tree Frog - various species
Toad - see Cane Toad

Fish

Barracuda - see Great Barracuda
Damselfish - various species of Pomacentridae
Eel - various species of Muraenidae
Great Barracuda *Sphyraena guachancho*
Jack see Jack Fish
Jack Fish - various species of *Caranx*
Junefish (or Jewfish) *Epinephelus itajara*
Mangrove Snapper *Lutjanus griseus*
Mojharra - various species of *Eucinostomus*
Mosquito Fish - various species of *Gambusia*
Mullet - various species of *Mugil*
Nassau Grouper *Epinephalus striatus*
Parrot Fish - various species of *Scarus*
Pipefish - various species of *Cosmocampus*
Salmon *Salmo salar*
Sea Horse - various species of *Hippocampus*
Sergeant Major *Abudefduf saxatilis*
Snapper - various species of *Lutjanus*
Snook *Centropomus undecimalis*
Tarpon *Megalops atlanticus*
Tilapia *Tilapia nilotica*

Tunicates

Sea Squirt - various species

Invertebrates

Poriferans - sponges

Coelenterates - corals, sea anemones and jellyfish

Brain Coral - various species of *Diploria*
Red Fire Coral - a species of *Millepora*
Sea Anemones - various anthozoans
Sea Fan - various species of *Gorgonia*
Staghorn Coral *Acropora cervicornis*
Upside-down Jellyfish *Cassiopeia xamachana*

Echinoderms - sea eggs, starfish

Brittle Star - various species in the Ophiuroidea
Sea Egg (Sea Urchins) - various species in the Echinoidea
Starfish - various species in the Asteriodes

Mollusks - snails, oysters and squid

Conch - see Queen Conch
Donax - various species of *Donax*
Green Mussel - *Perna viridis*
Mangrove Oyster *Crassostrea rhizophorae*
Sea Hare - type of Gastropod
Snail - type of Gastropod
Queen Conch *Strombus gigas*
West Indian Murex *Chicoreus brevifrons*

Arthropods

Crustaceans - crabs, lobsters and shrimp
Amphipod - members of the Amphipoda
Barnacle - various species of *Balanus*
Brine Shrimp *Artemia* sp.
Crayfish - various species of *Macrobrachium*
Copepod - members of the Copepoda
Fiddler Crab - various species of *Uca*
Goose Barnacle - various species of *Lepas*
Hermit Crab - members of the Diogeniidae
Ivory Barnacle *Balanus eburnus*
Land Crab - various species of *Gecarcinus*
Lobster see Spiny Lobster
Mangrove Crab - various species of *Aratus*
Red Claw - commercial variety of large shrimp
Snapping Shrimp - various species of *Alphaeus*
Spiny Lobster *Palinurus argus*
Swimming Crab - various species of *Callinectes*

Insects

Bee *Apis melifera*
Beetles - members of Coleoptera
Caddisflies - members of Trichoptera
Caterpillars larvae of Lepidoptera
Diving Beetle - various species of *Dytiscus*
Dragonflies - members of Odonata
Fireflies - members of Lampyridae
Grasshoppers - members of Orthoptera
Monarch Butterfly - various species of *Danaus*
Mosquitoes - members of Culicidae
Pink Meallybug - *Maconellicoccus hirsutus*
Water Boatman - various species of *Notonecta*
Water Strider - various species of *Gerris*
Zebra Butterfly *Heliconius charitonius*

Arachnids - spiders, mites and ticks

American Bird Conservancy

Bahamas National Trust

U.S. Fish & Wildlife Service

MacArthur
The John D. and Catherine T. MacArthur Foundation

Oak Hammock Marsh Interpretive Centre

BirdLife International

GEF

UNEP

RSPB

Foreign & Commonwealth Office

Ducks Unlimited Canada

RARE Centre for Tropical Conservation