







# MARINE ENVIRONMENTAL EDUCATION DRAFT MANUAL

FOR SCHOOLS AROUND WATAMU MARINE NATIONAL PARK AND RESERVE

 ${\scriptstyle (\! C \!\!\! C \!\!\! )}$  A Rocha Kenya, Local Ocean Trust: Watamu Turtle Watch and Africa Billfish Foundation | 2016







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# Oceans

# Objectives

By the end of the topic, the learner should be able to:

- 1. Define an ocean.
- 2. Identify major oceans on earth.
- 3. Swim safely in an ocean.
- 4. State the importance of oceans.
- 5. Appreciate the presence of all living organisms in the ocean.

# Introduction

Oceans are large bodies of salt water. They cover 71% of earth's surface and contain almost 98% of all waters on earth. There are four major oceans on earth: the Pacific, the Atlantic, the Indian and The Arctic. They are not separated by real borders, water flows freely between them. Smaller parts of these oceans are called seas, gulfs, bays and creeks. The coastline of Kenya is washed by the Indian Ocean.

# Importance of oceans

- 1. **Source of food**. The oceans provide habitats for a variety of marine life. These are in turn harvested as a source of protein for the many people who live adjacent to the Indian Ocean. Along the Watamu coastline, fish and crustaceans are harvested for food.
- 2. **Shipping routes**. The oceans provide convenient transport routes. In fact most of all trade between countries is carried by ships. The cargo transported includes: food, fuel, chemicals, electronics and household goods
- 3. **Tourism and Recreation**. The oceans and associated beaches attract numerous tourists both local and international. In Watamu, the white sandy beach associated with the Indian Ocean attracts many tourists who engage in various recreational activities ranging from swimming, water sports (such as kite surfing), rock pooling, beach games and sun bathing. These in turn earn foreign exchange for the country.
- 4. **Habitat**. The oceans provide a home for a wide range of biodiversity. For instance in the ocean around Watamu, the biodiversity of the ocean includes: crustaceans, molluscs, echinoderms, fish, sea grass, sea weeds, turtles etc. They all have their homes in the ocean.
- 5. **Employment.** Ocean tourism, recreation and living resources create jobs for thousands of people around Watamu. These range from the tour and boat operators to the hoteliers and fishers.
- 6. **The air we breathe.** Oceans are a critical player in the basic elements we need to survive. Ocean plants produce half of the world's oxygen and these amazing waters absorb nearly one-third of human-caused carbon dioxide emissions.
- 7. **Regulate the weather**. Oceans also regulate our weather and form the clouds that bring us fresh water.
- 8. A shared resource: While many of us enjoy the spectacular recreational activities that oceans offer, for some people oceans are a lifeline for survival. Keeping oceans healthy keeps people healthy, and we each have a personal responsibility to protect our oceans.

# Threats

- 1. **Pollution.** Raw sewage, chemicals, fertilizers, plastics and any form of waste on land eventually find their way to the ocean where they cause all manner of destruction to the ocean and the marine life.
- 2. **Inadequate protection**. Ocean life is conserved and managed through creation of marine parks and reserves. However, only a small percentage of the oceans have been protected therefore allowing all sorts of unregulated activities to be carried out in the ocean leading to overexploitation and destruction of the associated resources.
- 3. Unsustainable fishing methods. Most communities living adjacent to the ocean engage in fishing methods that are not favorable to fish populations. This often means specific







habitats being continuously fished or the use of methods (such as use of ring nets) that do not promote regeneration of the fish populations. This then leads to dwindling fish species diversity and availability.

- 4. **Tourism and Development**. Although this is a lucrative and beneficial economic activity, it poses a great threat to the ocean by the construction of hotels and residential homes, which encourage erosion of the existing beach and destruction of habitats found near the beach of an ocean. Recreational activities conducted by tourists also cause threats to the ocean. For instance in Watamu Marine Park, the reef that is the coral gardens has been heavily affected by the boating and snorkeling activities conducted in that area.
- 5. **Shipping**. The oceans offer a transport route for all sorts of ships, which in turn either dump waste in the ocean or spill oil, in the case of accidents involving ships carrying oil.
- 6. **Oil and gas exploration**. Oceans contain buried deposits of oil and gas and the activities associated with exploration and mining of the oil and gas pose a great threat to the ocean.
- 7. **Climate change**. Global warming which leads to climate change has brought about coral bleaching, rising ocean levels and changing species distribution, posing a great threat to the oceans.

# Solutions

- 1. Education and awareness raising for schools and the communities on the importance of the ocean and the threats posed to the ocean, especially human-caused threats.
- 2. Enforcement of existing laws regarding the ocean by the government agencies such as EMCA Act (1999) and Wildlife Conservation and Management Act (2013).
- 3. Development and implementation of management plan for protected areas such as Watamu Marine National Park that will designate areas for conducting recreation activities, fishing spots, beach activities, education and research.
- 4. Better waste management and adoption of recycling of waste
- 5. Establishment of high fine charges for ships responsible for ocean pollution.
- 6. Working with fishing communities to enable them understand the need to use sustainable fishing methods and promote the adoption of alternative sources of livelihood.

#### Activities

3.

- 1. Drawing (e.g.) drawing living organisms found in the ocean like corals, starfish, giant clamp, sea grass, sea weeds, sea shore etc.
- 2. Singing a song about conservation.

#### Mazingira song

i. Eeh kiumbe kipenzi chake Mwenyezi, uliyeumbwa kapewa na ufahamu,

Kapewa na utawala dunia yote, uilinde uitunze kwa faida yako x2 Chorus

Kwa upendo na kwa roho moja, twazipaza sauti kwa hamasa

Na mwenge wa sauti zetu hizi, uwafike enyi walimwengu x2

ii. Tujiepushe na ukataji miti ovyo, huko ni kuharibu mazingira,

Tujiepushe na utupaji taka ovyo, huko ni kuharibu mazingira,

Mazingira bora ni kwa faida yetu, tuyatunze kwa maisha salama x2

iii. Tujiepushe na uchafuaji bahari, huko ni kuharibu mazingira,

Kumbuka viumbe vilivyo baharini, jukumu letu kuviweka salama,

Mungu alitupa uwezo kuvitunza, vitufae kuboresha maisha yetu x2 Modelling e.g. modeling ocean/sea creatures







- 4. Nature walk to the ocean to identify the creatures found in the rock pools and on the sea shore.
- 5. Swimming.
- 6. Riddles: e.g.
  - I am an animal, I lay my eggs on land and feed under water, who am I?
  - We are marine invertebrates living in clusters under water and feed on planktons and other small creatures, who are we?
- 7. Quizzes e.g.
  - Name three physical features found in the ocean.
  - Name two mammals found in the ocean.
  - Give at least two plants that can survive in salty water.

#### Marine Protected Areas

# Objectives

By the end of the topic, the learner should be able to:

- 1. Define marine protected areas (MPA).
- 2. Identify and explain the major types of marine protected areas.
- 3. Name the marine parks and reserves found in the locality.
- 4. Describe the importance of national parks and reserves.
- 5. State the threats to marine national parks and national reserves.

# Introduction

Marine protected areas are areas that, due to human activities have been placed under some restrictions for conservation and management purposes.

There are two major types:

- 1. National Marine Park. An area where there is no taking of fish or other sea creatures, including corals. <u>It is a NO TAKE ZONE</u>. This gives full protection to the marine environment and ensures that all marine life remains untouched. Along the Kenyan coastline these parks include:
  - (a) Malindi Marine National Park
  - (b) Watamu Marine National Park
  - (c) Mombasa Marine National Park
  - (d) Kisite National Park
- 2. National Reserve. An area which is a partial take zone. Here carefully monitored, limited traditional fishing and sustainable use of resources is allowed. Along the Kenyan coastline these reserves include:
  - (a) Kiunga Marine National Reserve
  - (b) Malindi and Watamu National Reserve
  - (c) Mombasa Marine National Reserve
  - (d) Diani National Reserve
  - (e) Mpunguti National Reserve

#### Watamu Marine National Park

This is one of the four fully protected marine areas in Kenya and has been managed by Kenya Wildlife Service as part of Kenya's world famous national park system. It was gazetted in 1968 making it one of the oldest marine protected areas in Africa and the world. It is found within the larger Malindi-Watamu Marine National Reserve, which was declared a UNESCO (in full) biosphere reserve in 1979. Its creation has resulted in huge benefit for the conservation of the local flora and fauna compared to the nearby unprotected areas.







The above protected area has resulted in the protection of:

- (a) Coral reefs (f) Sea grass and sea weeds
- (b) Intertidal and sub tidal rock (g) Countless invertebrates and crustaceans
- (c) Beach and riparian areas
- (d) Sand
- (e) Endangered species

# Watamu Marine National Reserve

This was established together with the marine park in 1968 becoming the first in the county and the third in the world. It is part of the larger Malindi-Watamu Marine National Reserve and covers an area of 32 (sq. Km). It is characterized by the presence of mangroves which form a critical habitat for most indigenous and migratory bird species. Its creation has led to the protection of lower invertebrates, molluscs, crustaceans, fish breeding and nursery grounds, mangroves and birds.

#### Importance

- 1. There is a large area for marine life to flourish, forage and breed, hence increasing their abundance.
- 2. There are good nursery sites for some species.
- 3. There is eventually a beneficial spillover effect to the unprotected area.
- 4. Improved fish stocks.
- 5. Increased biodiversity of marine life.
- 6. Revenue from tourism activities, hence enhanced quality of life for residents of the area.
- 7. Marine recreation like diving, snorkeling, dolphin watching are easily conducted.

#### Threats

- 1. Pollution.
- 2. Over congestion of tourism activities in the marine protected area.
- 3. Overexploitation of marine resources.
- 4. Beach development affecting nesting areas, especially of turtles.
- 5. Poaching of fish and other endangered species.
- 6. Stepping and anchoring on corals.
- 7. Activities that promote harvesting of some species for sale to tourists.

#### Solutions

- 1. Educating people on the importance of establishing and respecting the marine protected area.
- 2. Tourists being advised to avoid buying products harvested from the marine protected area.
- 3. Not allowing fishing or commercial activities in the marine protected area.
- 4. Keeping the marine protected area clear, without pollution, i.e. proper waste management.
- 5. Users of the protected area being advised not to touch, walk or stand on live coral. In addition boat operators should not anchor on the coral reef, instead they should use buoys.

#### Activities

- 1. Visiting marine parks and reserves for snorkeling activities which involve watching the creatures found in the ocean.
- 2. Drawing the marine life (e.g.) coral reefs, crabs, mangroves, sea grass, seaweeds etc.
- 3. Beach cleanup activities to avoid pollution.
- 4. Modeling sea creatures using the sand at the shore.
- 5. Visiting the ocean during low tides for rock pooling activities.







# Questions

- 1. What are Marine Protected Areas?
- 2. Give two major types of Marine Protected Areas.
- 3. Name the organisms that are protected in Marine National Parks and Reserves.
- 4. State the importance of Marine Protected Areas.
- 5. What are the threats to Marine Protected Areas?
- 6. Give the possible solutions to threats to Marine Protected Areas.

# Intertidal Zone

# Objectives

By the end of the topic the learners should be able to:

- 1. Define an intertidal zone.
- 2. List the uses of intertidal areas
- 3. Name the threats facing intertidal habitats.
- 4. Define tides.
- 5. State the causes of tides.

# Introduction

This is a zone of the oceans ecosystems which is periodically exposed or submerged dependent on the tides. It is exposed during low tide and submerged during high tide. This zone comprises different forms of habitats such as rocky shores, sandy beaches, mudflats and even mangrove forests. Tides and waves are important factors that influence anything that takes place in the intertidal habitats.

There are many species that live in the intertidal area, both resident and transient species. These species use the areas as breeding, nursery and resting grounds and therefore their occurrence usually depends on the tide regime. Examples of such species are shorebirds, sharks and turtles. An important factor among intertidal species is the inter-dependence on each other for food, shelter and support. For example, crab plovers feed on crabs and other invertebrates.

#### INTERTIDAL ROCKY SHORES

Rocky shores are intertidal areas that consist of hard substrate as granite rock or degraded reef (limestone). Due to continual periods of erosion, rocky shores may form pools, crevices, cracks and other forms of microhabitats for many types of animals. These are adapted to the harsh conditions making the area very rich and diverse.







#### Beaches

A beach can be defined as habitat formed by deposition of sediments of various sizes from sand to boulders. Although a beach sometimes may seem bare there are many species that live in between the sand grains, some so small that they cannot be seen by the naked eye. Beaches, experience a lot of human activities because of their beauty and easy accessibility and are therefore more likely to be affected by excess human use.

# Importance of intertidal habitats

1. Provide unique habitats for huge variety of animals and plants such as sea stars, fish, molluscs, crustaceans, seaweeds and sea grass, corals etc.



- 2. Feeding areas for wading birds during low tides
- 3. Nursery ground for organisms such as crustaceans and fish, some of which will spend their adult life in different marine habitats.
- 4. Sites for recreational tourist activities such as rock pooling and sun bathing.
- 5. Appropriate habitats to study marine ecosystems and their processes due to their easy accessibility.

#### Threats

- 1. Pollution such as plastic debris, domestic waste run off and spills from boats that anchor in these areas.
- 2. Trampling as people walk through the areas.







- 3. Over extraction of resources such as shells for souvenirs, aquarium species, sand and boulders for building.
- 4. Mishandling of organisms such as poking giant sea clams and moray eels.
- 5. Coastal development that alters the shoreline.

#### Solutions

- 1. Education and awareness of communities and users on their importance and good use.
- 2. Restriction of extractive activities such as shell collection within the areas.
- 3. Enforcement of regulations designed to protect and manage these areas

#### **Tides and Tides Cycle**

#### Tides

Tides are the rise and fall of the sea level. Tides originates from the ocean and move towards the shoreline. Simply tides are very long-period waves that move through the ocean. When the highest part of the wave reaches a particular area, it is high tide while low tide is when the lowest part of the wave reaches that area. Tides are caused by gravitational pull of the moon and the sun. The vertical difference between high tide and the succeeding low tide is called **Tidal range**.



Some shorelines experience two nearly equally high and low tides each day. This is a **semi-diurnal tide**. Other shorelines have one low and high tide each day called **Diurnal tide** while other locations have uneven tides or sometimes one low and one high each day. This is **mixed tide**. Tides in Kenya are mostly semi-diurnal.

#### Spring and Neap tides

When the moon and the sun are either together in the sky or in the opposite directions (new moon and full moon) there is a greater gravitational force from both the moon and the sun that pulls the water further, therefore creating a **spring tide**. During spring tides the water recedes further during low tide and comes further to the shoreline during high tide. The highest tidal range is experienced.

During the two quarters of the moon, when the moon and the sun are at right angles the gravitational pull of the moon and the sun cancel each other and forms **neap tides**. During neap tides the lowest tidal range is experienced.

The spring and neap tides alternate approximately every week.







Tides are very important for intertidal habitats; they influence the distribution of species within the habitats and even the activities that are carried out in the area.

# Questions

- 1. Define intertidal zones.
- 2. Name the forms of intertidal habitats.
- 3. List the uses of intertidal areas.
- 4. What are rocky shores?
- 5. Give the other names of degraded reef.
- 6. Explain the importance of intertidal habitats.
- 7. Name the threats to intertidal habitats.
- 8. Define tides.
- 9. What causes tides?
- 10. What is the name given to the vertical difference between high tides and succeeding low tide?
- 11. When are spring tides experienced?
- 12. When do the spring and neap tides alternate?

#### Activities

1. Experimentation- use pun nets to count crabs along the intertidal zone.

2. Observation- go to observe when the ocean has tides or high tides.

#### **Mangrove Forests**

# Objectives

By the end of the topic the pupils should be able to:

- 1. Name the eight species of mangroves found at Mida Creek in either their scientific or Kiswahili names.
- 2. Outline the adaptations of mangroves to their environment.
- 3. State the role of mangroves in the ecosystem.
- 4. Give threats facing mangroves.
- 5. Outline solutions to the threats facing mangroves.







# Introduction

Mangroves are salt tolerant evergreen trees found in locations where salt water and fresh water meet. The mixture of fresh and salt water is called brackish water. Such locations include creeks like Mida Creek, deltas like Tana Delta and estuaries e.g. Sabaki River estuary.

There are nine species of mangroves in East Africa, eight of which are found at Mida Creek, which is part of the Watamu Marine National Reserve. These nine species include;

- 1. *Rhizophora mucronata*(mkoko)
- 2. Ceriops tagal (mkandaa)
- 3. Avicenia marina (mchu)
- 4. Bruguiera gymnorrhiza (mshinzi)
- 5. Xylocarpus granatum (mkomafi)
- 6. Sonneratia alba (mpira)
- 7. Lumnitzera racemosa (mkandaa dume)
- **8.** *Heritiera littoralis* (mkungu)

# Adaptations of Mangroves to Their Environment

1. Mangroves have developed aerial roots, called pneumatophores that rise from the soil into the air above the low tide level to obtain oxygen from the air.



- 2. Mangroves also have small openings (lenticels) in their bark that allow oxygen to diffuse into the plant and down into its underground roots.
- 3. To anchor themselves, many mangrove species have prop roots that arch out from the tree into the soil, helping the plant to withstand strong coastal waves.







- 4. Some species of mangroves have developed salt glands, salt-filtering roots, or salt-excreting leaves or branches in order to prevent the buildup of high salt concentrations inside the plant. For example *Avicenia marina*.
- 5. All Kenyan mangrove trees except *Sonneratia* are viviparous. Unlike most plants, mangrove seeds germinate before dropping.



#### **Importance of Mangroves**

- 1. Mangrove trees are an important habitat for birds, mammals, crustaceans and fish by providing feeding, breeding and shelter.
- 2. Mangroves are filters: they improve water quality by filtering out pollutants.
- 3. Mangroves protect the shore by stabilizing and improving the soil and therefore protecting shorelines from erosion.
- 4. Mangroves are an important part of the food chain for a number of animals.
- 5. Mangroves are rich in resources such as fish, crabs, shellfish, prawns and bees that produce honey which is considered the best available.
- 6. Many traditional medicines are made from mangroves, including those for treating skin disorders, headaches, rheumatism, snake bite, ulcers and many more.
- 7. Some mangrove trees are prized for their hard wood which may be used for construction.







# **Threats Facing Mangroves**

- 1. Development: Increase in tourists has led to increasing demand for mangroves for construction of restaurants, hotels and resorts as well as space for residential houses and agriculture.
- 2. Deforestation: Mangrove trees are overharvested to be used for firewood, construction wood and charcoal production. While harvesting has taken place for centuries, in some parts of the world it is no longer sustainable and threatens the future of the forests.
- 3. Pollution: Pollution from industries, agriculture, sewage and oil spills slows the growth and distribution of mangroves.
- 4. Climate change: Mangrove forests require stable sea levels for long-term survival. They are therefore extremely sensitive to current rising sea levels caused by global warming and climate change.
- 5. Natural factors: Diseases, biological pests and parasites e.g. barnacles, leaf eating crabs and caterpillars are threats facing mangroves.

#### Activities

- 1. Nature walk to identify the different species of mangroves and their adaptive features.
- 2. Sand art-modeling mangroves.

#### Questions

- 1. Explain four adaptations of mangroves to their environment.
- 2. Outline four important features of mangroves
- 3. Outline four threats facing mangroves.
- 4. State solutions for the threats facing mangroves.

# **Corals and Coral Reefs**

#### Objectives

By the end of the lesson learners should be able to:

- Define what coral is and how a coral reef is formed.
- Describe what corals are and how they feed, grow and reproduce.
- Appreciate the importance of coral reefs.
- Explain the threats facing coral reefs and suggest possible solutions.

#### Introduction

Corals are marine invertebrates that typically live in compact identical individuals called polyps. Each polyp has six or eight tentacles.

A coral reef on the other hand, is a habitat built by very small animals called coral polyps. An individual coral is known as a polyp; it is a very small and simple organism consisting mostly of a stomach topped by a tentacle-bearing mouth. The polyps extend their tentacles at night to sting and ingest tiny organisms called plankton and other small creatures.

Thousands of identical polyps live together and form a coral colony. Each polyp excretes a calcium carbonate exoskeleton beneath it and, over long periods of time, the skeletons of many coral colonies add up to build the structure of a coral reef. Many other species – fish, invertebrates, algae and microorganisms – make their homes on and around this reef.

Corals get food in two ways.

- Through small zooplankton being captured by stinging cells on the tentacles. These are then brought into the polyp where they are digested.
- Coral also get food from their symbiotic algae, the zooxanthellae, which live in their tissue. Corals get 80% of their food through this way. These microscopic algae are also responsible for the different colors that corals have.



Coral reefs are found all around the world in tropical and subtropical oceans. They are usually found in shallow areas at a depth of less than 150 feet. However, some corals extend much deeper, up to about 450 feet deep. In Watamu Marine National Park, the coral gardens are merely 300 meters from the shore and are home to a vast number of fish (over 400 species) and other weird and wonderful sea-creatures.

There are several reef patches in Watamu Marine National Park, including the Turtle reef, Bennet reef, Coral gardens, Uyombo reef, Lambis reef and Ladder reef.



Corals are mainly classified into two major categories: Hard/stony corals and soft corals

# Soft Coral

Soft corals have a flexible skeleton made from protein and therefore they are not as rigid as hard corals and are swayed by waves. Unlike hard corals, soft corals have eight tentacles. Soft corals do not have the microscopic algae found in hard corals hence they obtain food through their tentacles. Soft corals are also brightly colored but their colors are not caused by the microscopic algae as in hard corals but by colour pigments found in their cells.









# Hard Corals

Hard corals, as their name suggests, are hard or stony and look like rocks because of their rigid skeleton made from a hard substance called calcium carbonate. Hard corals have six tentacles. Hard corals live in symbiosis with microscopic algae that give them their colors. There are a variety of these microscopic algae, hence the variation in the colour of different coral types. Most hard corals obtain their energy and nutrients from the photosynthetic activities of these algae and therefore require light for their survival and thus grow in clear shallow water. Hard corals have different growth forms such as branching and massive.

Hard corals are very important marine animals because they are the main builders of coral reefs that are home to very many organisms found in the ocean. Particles of calcium carbonate are produced by the polyps of corals and then glued together by other substances produced by various other organisms living in the ocean and build up a bigger and hard structure that is called a coral reef.

# **Coral growth forms**

Corals grow in a variety of ways forming different shapes and patterns in the marine environment. These growth forms include:

#### **Branching corals**

Often found in areas of high wave action, and have branches as well secondary branches that appear like horns.



# Columnar corals

These appear as pillar or finger-like corals. Columnar corals do not have the secondary branches seen in the branching coral growth type.







# **Encrusting corals**

These are lichen-like in their form and are low spreading. They cling on to rock surfaces.



# **Massive corals**

These corals grow slowly to form large, ball-shaped boulders. This shape gives them stability and as such they are not easily damaged by waves.



# Laminar corals

These have a flat upper surface which gives them a table-like structure. Due to their table-like shape, laminar coral are often referred to as table corals.









# Foliaceous corals

These are scroll-like in their appearance.



# Solitary coral

Some polyps may be referred to as free-living if they grow as isolated individuals. They survive as singular structures without big colonies. Most of the solitary corals appear as mushrooms and are either circular or oval shaped.



#### **Importance of Coral Reefs**

- Coral reefs protect the shore by breaking the power of waves.
- Coral reefs form the nurseries for about a quarter of the ocean's fish, and thus provide revenue for local communities as well as national and international fishing fleets.
- Coral reefs form beautiful tourist attraction sites thereby generating income.
- Coral reefs are feeding grounds, nursery grounds and shelter for many creatures.
- Coral reefs are a source of medicine.
- Coral reefs are a great educational tool, giving opportunities for various learning activities.

#### Threats Facing Coral Reefs

- Destructive fishing practices such as bottom trawling.
- Overfishing which affects the ecological balance of coral reef communities.







- Careless tourism: Careless boating, diving, snorkeling, and fishing happens around the world, with people touching reefs, stirring up sediment, collecting coral, and dropping anchors on reefs.
- Pollution: Urban and industrial waste, sewage, agrochemicals, and oil pollution are poisoning reefs. These toxins increase the level of nitrogen in seawater, causing an overgrowth of algae, which 'smothers' reefs by cutting off their sunlight.
- Sedimentation: Erosion caused by construction, mining, logging, and farming is leading to increased sediment in rivers. This ends up in the ocean, where it can 'smother' corals by depriving them of the light needed to survive.
- Coral mining: Live coral is removed from reefs for use as bricks, road-fill, or cement for new buildings.
- Climate change: Corals cannot survive if the water temperature is too high. Global warming has already led to increased levels of coral bleaching.

# Solutions

- Keeping the environment clean and without pollution.
- Educating people on the wonders of the coral reef so as to improve awareness of it.
- Protecting the soil from erosion especially along riverbanks to avoid siltation.
- Not walking on or touching live corals and using bouys instead of anchoring on coral reefs.

# Activities /game

# Activity one: Egg carton coral activity

Egg cartons can be used to construct models of coral colonies showing many aspects of the coral's natural history – including the structure of coral polyps and the coral colony's colonial life style. **Materials:** Egg cartons, paper, tape, scissors, markers (especially green)

### To make the model:

**1.** Begin by cutting the top half and the closing flap off an egg carton, leaving just the section with the twelve eggcups. Place this upside down on a table and punch a hole in the bottom of each eggcup with scissors. To shorten the activity, cut the eggcup tray into thirds, giving each student a section of 4 eggcups rather than all twelve.

**2.** Cut 2 sheets of paper into four strips horizontally. Each strip will become a coral polyp. Roll each strip into a tube about the diameter of your finger. Tape the tube to keep it from unrolling and tape the bottom of the tube shut.

**3.** To make the tentacles of the polyp, make several cuts from the top of the tube, <sup>3</sup>/<sub>4</sub> of the way to the bottom of the tube. Get the tentacles to bend/curl by running each fringe over the blade of a scissor or a metal ruler.

**4.** Insert one polyp tube in each eggcup, pulling it partway through the hole. Tentacles should be on the top of the egg carton.

5. Using markers you can add small dots on the polyp to symbolize the zooxanthellae.

# Using the models:

You can talk about many aspects of coral as you construct the models with students. Some important concepts include:

- How a coral reef is built.
- The two ways in which corals get their food.
- How corals behave at night and during the day- tentacles.

#### Activity two: What words can you find in the word zooxanthellae?

# Questions

1. Name two types of corals.







- 2. State the two ways in which corals get their food.
- 3. How is a coral reef formed?
- 4. State the importance of coral reef habitats.
- 5. What are the threats facing coral reefs?
- 6. Give solutions to the threats facing coral reefs.

# Marine Mega Fauna

Marine mega fauna are large marine creatures such as sharks, dolphins, sea birds, sea turtles and billfishes. Most of these are top predators in the oceans.

#### Sharks and Rays

# Objectives

By the end of the topic the learners should be able to:

- 1. Name the types of sharks and rays.
- 2. List the importance of sharks and rays.
- 3. Name three threats facing sharks and rays and give possible solutions to these threats.
- 4. Draw pictures of sharks and rays.

Sharks and Rays are a special group of ancient fish that do not have bones in their skeleton. Instead their skeleton is made of cartilage which unlike bones is soft and lighter enabling them to bend even in tight corners.







There are nearly 500 species of sharks and over 490 different kinds of rays in the world. There are about 50 species of sharks and 30 species of rays that occur in the Western Indian Ocean (WIO) region. Within the Watamu Marine National Park and Reserve there are almost 10 species of sharks and rays. Contrary to the many myths that portray sharks as vicious and dangerous "man-eaters", the majority of sharks are completely harmless. Some of the more dangerous shark species are great white shark, tiger shark and bull shark. Most shark attacks are usually as a result of mistaken identity or the sharks feeling threatened hence acting in self-defense. The pygmy shark is the smallest shark and can only grow up to just 15cm,

#### Importance

- 1. Sharks are major predators in the oceans and are important in keeping the oceans healthy by controlling populations of their prey and removing sick animals from the ecosystem hence preventing the spread of diseases.
- 2. Sharks have a role in supporting the marine tourism industry as snorkelers and scuba divers want to experience sightings of these animals.

#### Threats

- 1. Many sharks and rays are endangered due to overfishing for food.
- 2. Thousands of sharks and rays are accidentally caught in fishers' nets as by-catch.



- 3. Degradation of their habitats such as coral reefs by human activities such as pollution and dredging. This disrupts feeding and reproduction for sharks and rays.
- 4. Due to their slow reproduction rate neither sharks nor rays can sustain the fishing pressure they are subjected to. For example, millions of sharks are killed annually for their fins which are used to make soup and for their teeth and jaws which are used to make jewelry.



#### Solutions

- 1. Creation of awareness and education in schools and communities of the importance of sharks and rays in the marine ecosystem.
- 2. Returning sharks and rays that are accidentally caught in fishermen's nets back to the ocean.
- 3. Restriction of shark and ray fishing and exploitation.







# Activities

- 1. Drawing.
- 2. Modelling.
- 3. Sandart.
- 4. Paper cutouts.

# Questions

- 1. Name the types of sharks and rays.
- 2. List the importance of sharks and rays.
- 3. List the threats facing sharks and rays.
- 4. Give the possible solutions to threats facing sharks and rays.

# **Billfish Species**

# Objectives

By the end of the topic learners should be able to:

- 1. Define the species of billfish.
- 2. State the growth and maturity of billfish.
- 3. Give the economic importance of billfish.
- 4. State the threats facing billfish and suggest possible solutions to them.

# Introduction

Just as eagles have done in the sky, billfish have dominated the seas as apex predators for years, yet we know relatively little about them. There are eight species of Billfish in the world and all eight of them are found in Indian Ocean. (only 7 included in this list and one of these – White Marlin - only lives in the Atlantic Ocean and Caribbean and Mediterranean Seas). Billfish include Marlin, Sailfish, Swordfish and Spearfish. Billfish are best known for their elongated nasal bones that form their 'bill'. Like tuna their bodies are made for the endurance and speed needed to travel thousands of miles in search of food.

#### Growth and Maturity

- Billfish reach sexual maturity at the age of two to four years; males reach sexual maturity at a weight of 35- 44 kg, females 47- 61.
- Females may spawn as many as four times a season. They often release over seven million eggs at once, each approximately one millimeter in size.
- The young drift freely in the oceans pelagic zones.

# **Diet and Feeding**

- Billfish feed on a wide variety of organism near the surface. (These organisms are biotic, or living, part of the environment).
- Billfish use their bills to stun, injure or kill prey while knifing through a school of prey before returning to eat.
- The larvae feed upon a variety of zooplankton along with drifting fish eggs and other larvae. They progress to feeding on a wide range of fish such as mackerel, tuna, squid etc.

#### **Economic Importance**

- Billfish meat has a commercial value throughout the world; because of their rarity beauty and sporting quality, they are considered one of the most prestigious catches a recreational fisherman can make







- Billfish fishing is a multi-million dollar industry, which includes hundreds of companies and thousands of jobs for boat operators, boat builders, dealers and fishing tackle manufacturers.

### Threats

- Over fishing.
- Pollution.
- Destructive fishing methods.

# Species

# **Blue Marlin**

Blue Marlin are found in all of the world's oceans. They are one of the largest billfish species. Their bodies are blue black on top with a white silvery underside. Blue Marlin undergo rapid growth during the first or the second year of their lives, however it typically takes 30 years or them to reach 454 kilos. Females can grow up to four times the weight of the male. They are known for making long distance migrations; a billfish recorded by ABF was tagged in Pemba-Tanzania and was recaptured in Iran, having travelled a distance of approximately 2620 miles in 248 days.



# Black Marlin

Black Marlin are found in the Indian and Pacific Oceans. Like blue marlin, black marlin are known for making long distance migrations. One tagged in Kenya was re-captured in Yemen after 159 days, having travelled a distance of 1880 miles.



# **Striped Marlin**

Striped Marlin are found throughout the Pacific and Indian oceans, and occasionally in the Atlantic Ocean. These Marlin are known for coming to the surface during strong winds and waves, where they swim in the direction of the wind. They are also known for making long distance migrations. A Striped Marlin tagged in Kenya was recaptured in Perth, Australia having travelled a distance of 5250 miles in 195 days.









# White Marlin

White Marlin are found in the Atlantic Ocean and in the Caribbean and Mediterranean seas. They are among the smallest of the Marlin; typically only reaching weights of 25 kilos and a length of 5.5 feet (1.5 m) Individuals have been known to reach sizes of 2.3 m and weights 82 kilos though. This species is mostly caught along the eastern coast of the US.

# Sailfish

Sailfish are best known for their huge 'sail like' dorsal fins. This fin can be up to twice the height of the body of the fish. They are the most commonly encountered of all the Billfish. Sailfish are the fastest fish in the ocean and they can swim up to 110 km/h. A sailfish tagged in Watamu Kenya was recaptured in Aden Yemen after 175 days having travelled a distance of 1880 N.M.



# Spearfish

Though spearfish, the smallest of the Billfish, are found in all the worlds' oceans, they are rarely encountered in much of the world. They have the shortest bills of the Billfish. Very little is known about these animals, although it is believed that they have the shortest lifespan of the Billfish, maturing at two years and living no more than five years.



#### Swordfish

Swordfish were the first species of billfish to be described by humans. One of the most pronounced features of a Swordfish is its very large eyes which allow it to take in more light and therefore to see better in low light. Swordfish have also evolved a type of heating system that warms their eyes and brain; this area can be warmed up to 10-15 degrees Celsius above the surrounding water temperature. This heat warms the blood passing through the muscle on its way to the brain and eyes, which improves their vision significantly. Swordfish are found in all of the world's oceans. They are easily identified by their flattened bills, shaped like the blade of a sword. Another distinguishing feature is the dorsal fin on their back, which is very high and sickle shaped. A







broadbill (Swordfish?) tagged in Kenya was recaptured at Port Elizabeth in South Africa, having travelled a distance of approx. 2400 miles in 369 days.

# Questions;

1. Billfish include (i)\_\_\_\_\_

(ii)	
(iii)_	
(iv)	

- 2. \_\_\_\_\_\_is the fastest fish in the ocean, they can swim up to 110 km/h.
- 3. \_\_\_\_\_ have the shortest bills of the Billfish.
- 4. \_\_\_\_\_have very large eyes which allows them to take in more light and therefore to see better in low light.
- 5. Billfish mature at the age of \_\_\_\_\_ years.
- 6. What is the weight of a mature billfish?
  - a. Male
  - b. Female
- 7. How many eggs does a billfish release at once?
- 8. What does a billfish use the bill for?
- 9. State two economic importances of billfish.
- 10. State three threats facing billfish.

#### Activities

- 1. Drawing different types of billfish species.
- 2. Watching video clips on different species of billfish
- 3. Visiting the beach to watch billfish fishing equipment being used.

#### Sea Grasses

# Objectives

By the end of the topic learners should be able to:

- 1. Differentiate between sea grass and seaweeds.
- 2. State characteristics of sea grasses.
- 3. State the importance of sea grasses.
- 4. Explain three conditions necessary for the healthy growth of sea grass.
- 5. Give at least four uses of seaweeds.

#### Introduction

Sea grasses are flowering plants that grow in marine environments (salty water in oceans and seas). Most grow in large groups that look like grasslands inside the water.







#### Characteristics

- They are green plants and have seeds, roots and flowers.
- They make their own food (photosynthesis).
- Are found in areas that have adequate light.
- Occur in shallow water.
- Occur in areas with soft sediment such as sand or mud so that the roots can anchor.

#### Importance

- Sea grass beds are important habitats for fish and other marine organisms e.g. Molluscs.
- Sea grasses are eaten by many marine herbivores e.g. Turtles, fish, crabs, dugongs.
- Sea grasses trap sediments in water, this helps in protecting coral habitats.
- Through photosynthesis, they provide oxygen in marine systems.
- Sea grasses stabilize the ocean floor and protect areas from coastal erosion.

#### Threats to Sea Grasses

- Disturbance or destruction of habitats, caused by propeller/motor boats being driven over shallow sea grass beds whilst dredging the sea floor for minerals or oil.
- Overfishing of big fish in the ocean. This causes an abundance of small crustaceans e.g. Prawns and krill that overgraze in the sea grass beds.
- Over enrichment of marine water from bad agricultural practice in the uplands. (Over enrichment causes an increase in algae growth in marine areas, which flats and block out sunlight. This limits photosynthesis in the sea grass causing them to die.)

#### Solutions

- Stopping overfishing in marine water.
- Protecting sea grass habitats by stopping destructive human activities in sensitive marine areas.

#### Seaweed







Seaweeds are simple plants (algae) that are found in the marine environment. There are three groups.

# Red algae

These seaweeds appear red in colour.



# Brown algae

These are brownish in colour. They are the largest seaweeds.



**Green algae** They are green in colour.









# Conditions necessary for growth of seaweeds

- 1. Sunlight.
- 2. Salty water.
- 3. Adequate nutrients.

# Importance

- 1. Some seaweeds are edible and are eaten as delicacies.
- 2. Used as additives for different foods and beverages.
- 3. Used in wound dressing as it has medicinal properties.
- 4. Seaweed contains iodine that is used to prevent goitre.
- 5. Used for filtration as seaweeds have the ability to remove unwanted nutrients from water such as nitrogen and phosphorus through their strong photosynthetic ability.

# Questions

- 6. What is sea grass?
- 7. State four characteristics of sea grasses.
- 8. State four importance uses of sea grasses.
- 9. What is the major threat facing sea grass?
- 10. State three conditions necessary for the healthy growth of sea grass.
- 11. State at least four uses of seaweeds.

#### Activities

- 1. Visiting the beach to see the different species of seaweeds.
- 2. Watching video clips on marine ecosystems.
- 3. Drawing pictures of marine ecosystems showing different organisms that depend on sea grass.

#### **Marine Mammals**

### Aim

Help pupils gain knowledge about marine mammals and realize the importance of their conservation as part of the ecosystem.

#### Objectives

By the end of the topic pupils should be able to:

- 1. Give characteristics of marine mammals.
- 2. Name the different species of whale sand dolphins and identify some of their characteristics/adaptations.
- 3. Name some threats facing marine mammals.
- 4. Give some solutions to the threats facing marine mammals.

#### Introduction

Mammals are warm blooded animals, breath through lungs, give birth and suckle their young ones and have a fat layer called blubber under their skin to maintain body temperatures.

#### **Species of Marine Mammals**

- Whales: Blue Whale, Humpback Whale, South Right Whale, Mink Whale, Sperm Whale
- Dolphins (Spinner Dolphin, Bottle Nose Dolphin, Spotted Dolphin, Humpback Dolphin.
- Dugongs

#### Blue whale

The largest animal on earth, reaching 24-27 meters in length and weighing up to 170,000 kilograms. Blue grey body colour with spotted appearance and huge blowhole splashguard with 9m high blow. Status: endangered.







# Humpback whale

Black or dark grey upper side with long white or black flippers, low blunt fin with hump. Large body (13 to 14m). Matures at 5 years. Status: endangered.

# Southern Right Whale

Large head, broad back with no fin, strongly arched mouth line, dark and round body, large paddleshaped flippers. Highly acrobatic, inquisitive and approachable. Length: 11-18m. Status: endangered.

# Mink Whale

The smallest of the whales. 7 to 10m in length, sharply pointed snout, curved dorsal fin, low, indistinct blow. A fast swimmer. Status: common (though hunted commercially).

# Sperm whale

Huge, square head, low hump instead of fin, single, slit-like blowhole, dark body with wrinkled skin. Is often motionless at surface. Length: 11-18m. Status: vulnerable.

#### **Common Dolphin**

Dark body with "V" under fin, white under and lower sides, yellowish patch on sides, dark line from flipper to beak. Highly active. Length: 2m. Status: common.

#### Humpback Dolphin

Robust body, elongated hump on back with small fin, long beak, difficult to approach. Length: 2.5 m. Status: common.

# Spinner Dolphin

Performs high, spinning leaps. Has a long, thin body and beak, tall, erect fin and sloping forehead. Three toned colour pattern. Lives in large schools. Length: 1.5 - 2 m. Status: common.

## **Spotted Dolphin**

Dark grey colour, heavily spotted. Dark line from flipper to beak, tall, curved dorsal fin, elongated body with long, narrow beak. Very active at water surface. Length: 1.5 – 2.5 m. Status: common.

#### **Bottlenose Dolphin**

Robust head and body, rounded forehead, short beak. Usually lives in small groups. Length: 2 - 4 m. Status: common.

#### Dugong or "Sea-cow<u>"</u>

Has front flippers and fluke like tail used for propulsion and snout for grazing. Mature males have tusks. Diet: herbivorous (sea grass). Lives up to 70 years. Length: ? - 3.5m. Weight: 400kg. Low rate of reproduction, (one calf at a time,) and only a few in a lifetime.

#### Activities

- Song related to marine mammals in the introduction
- Drawing and coloring pictures of marine mammals

#### The king whale story

I am king whale, the biggest animal on land and in the ocean. My worst enemy is mankind because he hunts me for meat and blubber, which is used to light the lamps of humans.

One day as I was swimming in the ocean off the shores of Joppa during a very rough storm, I saw some light from lamps on a ship which was being tossed by the raging waves like a rag doll and I heard men call out the name 'Jonah'. To my surprise I saw the men toss Jonah, one of their kind, into the stormy ocean and I wondered why men are so cruel to all creatures, even their own kind.







I quickly swam to where they had thrown Jonah and with a gulp full of ocean water took him into my mouth. I blew all the water out through my blowhole, leaving Jonah dry in my mouth. I decided to save him and for three days and three nights I carried him in my mouth and then deposited him safely on the shores of Nineveh. He patted my head, thanked me and asked that the living Lord would bless me. I later learnt that what I had done was part of God's plan to bring Jonah to Nineveh to pray for the people of that city. I was very proud to have helped to save them from the wrath of God. By Jim Joe

# **Dolphin story**

My name is Peter. I am a deep sea diver and a researcher on marine life. One day as I was diving, a dolphin came up to me and started making sounds while pushing me with her beak. I did not understand what she was trying to say, but she would swim a short distance away then come back and start pushing me as if urging me to follow her.

I followed her until we came to her calf (young one), who had been pierced by a freely drifting ghost long line. I tried to remove the hook from its back, but it had stuck too deep inside and the harpoon would not come off. I had to use my penknife to make a long, deep cut in the calf to remove the hook.

I knew that the chances of survival for the calf were minimal since blood was oozing from the open wound and there were many predators around. As the mother and calf swam away, the mother gently nudged me to say "thank you".

About one year later I was deep sea diving in another part of the ocean when one of my mates fell from our boat during a heavy storm. We were not able to go after him to save him and we watched helplessly as he was swallowed up by the raging waves and disappeared. We had lost him.

As I stood by the rails of the boat, mourning my mate, I suddenly saw the back of a dolphin appear from the depths of the ocean. As it lifted its back next to our boat, I saw that it was lifting our comrade so that we could pick him up. As my other friends were reviving him on the deck, I looked overboard and saw two dolphins swimming alongside the boat. One was an adult and the other one a calf - and guess what? The calf had a long scar on its back. A dollar for a penny! By Jim Joe

# **Marine Turtles**

#### Aim

Help pupils identify the different species of turtles, understand their lifestyle and appreciate the importance of conserving them as part of the ecosystem.

#### Objectives

By the end of the topic pupils should be able to:

- 1. Name the species of turtle found in Watamu and give their characteristics.
- 2. Tell the life story of a turtle from hatching to adulthood and nesting.
- 3. Name four threats facing marine turtles on land and in the ocean.
- 4. Give some solutions to the threats facing marine turtles.

#### Introduction

Marine turtles are reptiles related to the tortoises that live on land. Turtles live most of their lives in the ocean. They feed under water but come to the surface to breath. Female turtles return to the land, to the specific place where they were born, to lay their eggs.

There are seven species of turtle in the world, five of which are found in Kenyan waters. The five species found in Kenya include:

- 1. Leatherback- the largest at 3m long. It feeds on jelly fish.
- 2. Loggerhead, which feeds on crustaceans and molluscs.
- 3. Olive Ridley, which feeds on crustaceans and molluscs.





- 4. Hawksbill, which feeds on soft coral and sponges.
- 5. Green Turtle, which feeds on sea grass and algae.

The turtles nesting in Watamu include the Green Hawksbill and Olive Ridley Turtles. The Olive Ridley species is rare but occasionally comes to the nesting site. Leatherback Turtles do not nest in Watamu or Malindi but they pass through nearby waters during their migration. There is also a turtle-breeding beach immediately adjacent to the Kenya Wildlife Service Marine HQ where visitors can see young turtles tentatively emerging into the evening light and streaming down to the ocean.

ROCHA

Turtles migrate thousands of kilometers to return to the beach they hatched from, to breed and nest there. Females mate with several males. Sperm is stored inside female turtles and is used to fertilize each batch of eggs produced. Females come to the beach at certain high tides and dig a nest to lay their eggs which they then cover. An average of.120 eggs are laid in each nest. The female may not return to nest again for another 3-5 years. When she does, she will return to the same place on the same beach.

The baby sea turtles emerge after 60 days and are known as hatchlings. The tiny turtle hatchlings scramble out of their eggshells and crawl towards the sea. They will live in the sea until they are old enough to have young of their own at about 30 years of age. The sad truth is that the ratio for the survival of turtles is 1/1000.

# Threats Facing Marine Turtles

- Pollution. Sea turtles get entangled in marine debris such as plastic bags.
- Global warming. When sea turtle eggs are incubating, the surrounding temperature affects the sex of the hatchlings, with higher temperatures producing more females. As sand becomes warmer due to climate change, the ratio of females to males becomes out of balance, affecting breeding activities when they reach adulthood.
- Loss of nesting habitat due to development.
- Increased human presence. Residential and tourist use of beaches can result in disturbance to nesting turtles, especially at night.
- Poaching. Unfortunately for sea turtles, their eggs are still considered highly desirable for a number of reasons, mostly for food.
- Artificial Lighting. Baby turtles find their way to the sea by the light reflected off the ocean. Artificial lighting from buildings, streetlights, and beachfront properties has a disorienting effect on little turtles. This also affects adult turtles.
- Predators. Turtle eggs are particularly vulnerable to predators. Hatchlings must escape the clutches of animals such as foxes and gulls as they try to reach the water; even when they reach the ocean, predators such as sharks await them.

#### Solutions

- Education and awareness in schools and in the community.
- Nest protection.
- Working with fishing communities to promote sustainable fishing methods and alternative income generating activities.
- Reporting incidences of illegal turtle trade.
- Not driving or building on the beaches.
- Not littering! If you throw away a plastic bag, it could reach the sea and kill a turtle.

#### Turtle friends' story



Katana is an old man from my village. Everyone believed he was crazy because at certain periods of the year he started raking the beach and then wielding his rake against beach revelers, driving them away from certain areas on the beach.

One day as I was walking from school I decided to visit the beach and sure enough I found old Katana busy with his rake, cleaning the beach. I went to him and asked why he was doing this and he informed me that his friends were coming from the ocean. He asked me to join him that night on the beach to see them. Curiosity got the better of me and I went to join him and wait for his friends, imagining that they would come sailing in on a boat.

As we waited and watched we saw dolphins swimming on the waves and I asked him if these were his friends. He said yes, but they were not the ones he was expecting. We both went to sleep having promised one another that the following night we'd meet again to welcome Katana's friends.

The following night I went down to the beach and out of the ocean came the billfish, gliding on the waves and I asked him whether they were his friends. He answered yes, but they were not the ones he was expecting. He said that he was sad and worried that his friends would not be coming that year because of what humans were doing to the beaches. We both went to sleep having promised one another that we would meet again the following night to welcome his friends.

On the third night, out of the ocean and floating to the land was a boulder like animal which wobbled to the beach, dug a hole for nesting, laid its eggs then buried them and wobbled back into the ocean. I asked him if that was his friend and he said yes that was a scout turtle, which had come to see if it was safe for others on the beach. We went to sleep with the promise that I'd join him again the following night.

On the fourth night, hundreds then thousands of turtles came out of the waves to roost. They wobbled across the beach, dug holes, laid their eggs and buried them. Then they wobbled back into the ocean. Old Katana told me to come back after some days. From that day on the old man started wielding his rake against any person strolling near the nests.

After some days I took my friends Charo, Kadzo, Juma, Eliza, Baraka and Wanjiru to the beach. We watched awed by the hundreds of thousands of nestlings (young turtles) emerge from the holes and move towards the ocean. Old Katana informed us that out of every one thousand nestlings only one would reach maturity. This made us very sad.

Since that time, whenever old Katana starts to clean up the beach, my friends and I join him with our rakes to prepare for the coming of our friends, the turtles. We have since formed a group called "TURTLE FRIENDS" which now has many children and adult members.

# Fishing

# Objectives

By the end of the topic pupils should be able to:

- 1. Define fishing.
- 2. State the major types of fishing methods.
- 3. Explain the passive and active fishing methods.
- 4. Give the difference between destructive and non-destructive methods of fishing.

#### Introduction

This is one of the major activities conducted in the ocean. It is defined as an activity that involves catching fish, but it also applies to catching other aquatic animals such as molluscs, cephalopods, crustaceans and echinoderms. There are two major types of fishing method, passive and active; me either method may be destructive or non-destructive. The methods that are commonly used around the Watamu area are as follows:

#### Non-Destructive

1. **Line** (*uvuvi wa mshipi*). Line fishing is a very passive method of fishing (the fish coming to the fisherman). Line fishermen catch larger fish than other fishing methods and research







has shown that in Mida Creek line fishermen catch more fish per person than net fishermen! Local people usually fish with a couple of lines with one or two hooks on, some set on floats.

- 2. Local Long line (maskadi). As the name suggests this is a very long main line with numerous smaller lines and hooks branching off it. Local fishermen use it at sea for large pelagic species and sharks and some creek fishermen also use it at certain times of the year. Long lines in this local area may have 10-50 hooks.
- 3. **Static net of legal size** (*uvuvi wa nyavu na jarife*). This is also a passive method of fishing using nets of varying mesh size to entangle passing fish. Only nets above 2.5 inches are legal and non-destructive. Some nets are set for a few hours, others are set for periods up to 12 hours. 'Jarife' nets are large mesh size nets made of strong netting used to catch big fish species like tuna and shark. Unfortunately these nets also frequently catch and drown sea turtles, especially when left unmanned for long periods.
- 4. **Throwing net** (*kimia*). A more 'active' fishing method which involves chasing the fish using a small hand held net to throw out over sighted schools of fish, or blindly in the hope of catching passing fish. Is often used in Mida Creek, often with undersize mesh which is only legal for seasonal sardine fishing.
- 5. **Sport fishing** Watamu is an internationally famous site for sport fishing, using the rod and line method to catch large pelagic fish species from boats. Lines are usually towed behind a boat called 'trawling'.
- 6. **Spear** (*uvuvi wa fumo*). Wading or snorkelling fishermen use spears to stab slow moving fish and octopus.
- 7. **Hand fishing** (*uvuvi wa uvamizi*). This refers mostly to fishermen using snorkelling gear to collect by hand shellfish, octopus and lobster. Some fishermen also illegally catch turtles in their sleeping places by this method.
- 8. Fish trapping fences (*uzio*). These are structures used in the shallows that allow fish to enter on a rising tide, so that when the tide falls the fish are left stranded in a small enclosure within the fence. It is one of the oldest traditional fishing methods in this area and the structures are made from thin branches. It is a passive and sustainable fishing method that can catch large quantities of fish and prawns. Its use is in decline as the youth are not prepared to learn the skills or take time to prepare the fences.
- 9. **Baited fish trap** (malema). These portable home-made hexagonal traps, up to 1.5m in diameter, attract fish in through a one-way cone shaped entrance and are used both in the ocean and creeks at varying depths. They are made with wooden strips lashed together and are baited with seaweed and the intestines of fish. They are often put out in groups and used at varying depths. This traditional and effective method is also on the decline amongst the local youth for the same reasons as above.

# Destructive

- 1. **Drift net** (*uvuvi wa kukokota nyavu*). Drift netting means allowing nets, of varying mesh size, to drift freely in the current catching anything in its path. The nets are left uncontrolled and so can cause great damage by getting caught on coral reefs, or, even worse lost, so that they carry on catching and killing fish for years ('ghost fishing'). Set nets can also get lost in rough seas, or broken sections may be carelessly discarded; this causes as much damage as ghost nets. Drift netting is illegal in Kenya.
- 2. Undersize Static net (*uvuvi wa nyavu*). Static nets are illegal and damaging if undersize mesh is used, which in Kenya means less than 2.5 inches. Undersize mesh nets catch very small fish, mostly juveniles, which damages fish populations and eventually means lower catches for local people. Many undersize mesh nets are used in this area, some people even use mosquito netting!







- 3. **Seine netting** *(juya)*. This netting method can be used either from the beach or boat. The net is very large and usually of undersize mesh, or incorporating sections of undersize mesh net. A beach seine is laid in a semi-circle out from the beach and then dragged in, the weights on the bottom destroying coral. When used from a boat a smaller boat takes the net out in a circle back to a larger carrying boat, the net is then dragged in enclosing the fish, with weights at the net bottom damaging the sea floor. In the case of the 'purse' seine net, the bottom of the encircling net is roped closed by divers and then lifted up. As seine nets usually use undersize mesh, many juvenile fish are caught and killed. Seine netting is illegal in Kenya.
- Trawling. Arguably the most destructive fishing method. It involves towing a long huge 4. bag of netting behind a powerful boat, with heavy wooden or steel beams used to keep the net mouth open. This net catches everything in its path. In this region trawlers target mostly prawns which means they drag the net along the sea floor (where prawns live) using heavy steel balls on the net mouth to maintain momentum. These heavy weights crush and destroy important sea floor dwelling animal life, including thousand year-old corals and sponges. Another very destructive feature of prawn trawling is that it is indiscriminate in terms of what it catches, so that many other species are caught. In fact research has shown that between 70 and 90% of the catch is often NOT prawns (this is called by-catch) and much of this has no commercial value and is discarded dead to the sea. Endangered species like sea turtles are often killed by trawl nets. This method of fishing is disgracefully wasteful, killing many important species in the food chain as well as juveniles of commercial species. In Kenya trawlers are now required by law to use Turtle Excluder Devices (TEDs), a device that allows large non-target species like turtles, sharks and rays to escape the trawl. However, despite the law trawlers rarely use TEDs.
- 5. **Commercial Long line** (*maskadi*). Commercial long lines are lines several kilometres long with hundreds of hooks. Such commercial long lines are considered dangerous to wildlife, as non-target species like seabirds and turtles are also caught.
- 6. **Poison fishing** (*uvuvi wa sumu*). Fishermen use poisons, with neurotoxin or suffocating effects, to collect fish from rock pools and small semi enclosed shallow areas. These poisons are extracted from the bark of certain local plant species (Mtupa). Locals believe that if the fish is cooked quickly and properly the consumer will not get sick, but food poisoning cases have been reported locally as a result of eating poisoned fish. Poisons are of course indiscriminate with corals, eggs and many other sea creatures killed by the poison.
- 7. **Spear gun** (*uvuvi wa bunduki*). Spear guns are mainly used by snorkelers, but occasionally by scuba fishermen around coral reefs. Most spear guns are homemade and are illegal in Kenya. Spear gun fishermen don't always make a kill that is collected, wounding a fish that escapes and later dies, with no benefit to fishermen

#### Questions

- 1. What is fishing?
- 2. Name five types of non-destructive fishing methods.
- 3. Name five types of destructive fishing methods.

#### Activities

Introduction skit on fishing using different methods.

#### Tourism

# Objectives

By the end of the topic pupils should be able to:

1. Define tourism.







- 2. Name tourist attraction sites around Watamu Marine Park and Reserve.
- 3. Mention ten tourist related activities that they know.
- 4. State the positive impacts of tourism.
- 5. State the negative impacts of tourism.
- 6. Give ways in which tourism can be done better.

### Introduction

Tourism is travel for recreation, leisure, religious, family or business purposes, usually for a limited duration. Tourism in Kenya is the second largest source of foreign exchange revenue following agriculture. The Kenya Tourism Board is responsible for maintaining information pertaining to tourism in Kenya.

# Tourism Attractions Sites In and Around Watamu Marine Park and Reserve

- Arabuko-Sokoke Forest.
- Sandy beaches.
- Mida Creek.
- Gede Ruins.
- Watamu Marine Park

# Tourist Related Activities

- Tour guiding.
- Snorkeling.
- Boat riding.
- Selling curios and ornaments.
- Hotel operations.
- Camping and picnicing.
- Nature walks.
- Traditional dances and plays.
- Canoe riding.
- Selling local products.

# Positive Impacts of Tourism

- Creates employment.
- Promotion of education.
- Improved social amenities.
- Improved livelihood.
- Funding.
- Creativity and innovation.
- Boosts the economy of the country.

#### Negative Impacts of Tourism

- Drug abuse.
- Prostitution.
- Youth dropping out of school.
- Damage to ecosystems.
- Pollution.

# Solutions

- Responsible tourism.
- Environmental education.
- Capacity building.
- Review and enforcement of laws and regulations.







# Activities

Introduction skit on selling local products.

# Questions

- 1) Name three tourist attraction sites found in and around Watamu Marine Park and Reserve.
- 2) Name different tourist related activities.
- 3) Give four positive impacts of tourism.
- 4) Name three negative impacts of tourism.
- 5) Name two solutions to the negative impacts of tourism.

# Marine Waste and Pollution

# Objectives

By the end of the topic pupils should be able to:

- 1. Name the types of waste found along the coastline.
- 2. Name the sources of marine waste.
- 3. State the threats facing marine life and the coast through pollution.
- 4. Give ways to curb the problem of marine pollution.

# Introduction

This topic looks at the ways in which the natural environment is being contaminated with harmful substances (either intentionally or accidentally) as a consequence of human activities.

# Type of waste found along the coast:

- a. Plastics.
- b. Car tyres.
- c. Flip-flops.
- d. Nets.
- e. Old drums.
- f. Bottles.
- g. Ropes.

# Sources of Marine Waste:

- 1) People leaving rubbish on the beach.
- 2) Wind blowing from nearby areas.
- 3) Ships dumping their rubbish overboard when at sea.
- 4) Oil spills from ships and tankers.
- 5) Fishing boats throwing old nets and ropes overboard.
- 6) Storm water drains. These collect rubbish as well as water from city streets which eventually flows into the sea.
- 7) Some factories allow their toxic industrial waste to flow along rivers and through storm water drains into the sea.
- 8) Rubbish that is dumped in rivers or collects there eventually flows into the sea.

# Threats

To marine life:

- Marine life get caught in old fishing lines and ropes.
- Marine animals mistake plastic bags for food.
- Oil harms and kills marine birds and animals.
- Chemical from industrial effluent is harmful to marine life.
- More than a million sea birds die every year because of ingestion, choking or entanglement in plastic.







To the coast

- Beaches become unhealthy and unsafe, hence a drop in the number of tourists visiting.
- Unattractive looking landscape.

### Solutions

- 1. Carry your own bag for shopping to avoid over use of plastic bags.
- 2. Carry your own water bottle and refill with clean water when necessary, rather than continually buying new bottles of water.
- 3. Pick up plastic waste whenever you walk on the beach, so that it doesn't wash back into the sea.
- 4. Organize a regular beach or river clean up with your community.
- 5. Educate and raise awareness of the issue with communities living near the ocean.
- 6. Practice the 3 R's: Reduce, Re-use, Recycle.

#### Questions

- 1) What is pollution?
- 2) Name five types of waste found along the coastline.
- 3) State five sources of marine waste.
- 4) Name three threats facing marine life.
- 5) Name two threats facing the coast.
- 6) State five solutions to the threats facing marine life and the coast.

#### Activities

- 1) Drawing types of waste found along the coastline.
- 2) Digging a litter pit for proper disposal of waste in the school.
- 3) Collection and disposal of waste in the school compound.

# **Coastal Forests**

#### Objectives

By the end of the topic pupils should be able to:

- 1. Name coastal forests found in Kenya.
- 2. State the three vegetation types found in Arabuko Sokoke Forest and mention one of the most dominant tree species in each zonation.
- 3. Name the Sokoke Six.
- 4. State the importance of Arabuko Sokoke forest.
- 5. State the threats facing Arabuko Sokoke forest.
- 6. Give some of the solutions to the threats facing Arabuko Sokoke forest.

#### Introduction

The coastal forests are a chain of broken patches of forest that stretch along the East African coastline. They used to extend from Somalia to Mozambique as an extensive forest where different vegetation types such as woodland, scrub and dry forest existed. In Kenya the coastal forests include: Arabuko Sokoke Forest (420 sq.km), Shimba Hills Forest (63 sq. km), Tana River Forest/Woodland, Boni-Dododri Forest, Dakatcha Woodland and approximately 53 tiny patches of forests known as the *Kayas*, found in Kwale, Mombasa and Kilifi Counties.

#### Arabuko- Sokoke Forest

Arabuko Sokoke Forest is the largest single block of indigenous coastal forest remaining in East Africa. The forest was originally declared as Crown Forest in 1932 and was gazetted as a forest reserve in 1943. An additional 2,675 ha at Kararacha in the South East was added in 1968. Within the forest area about 4,300 ha was designated as a strict Nature Reserve in 1977. The forest has rich biodiversity, including a concentration of endemic and endangered flora and fauna. It has been







ranked as the second most important forest for conservation of threatened bird species in mainland Africa.

# Flora

Approximately 600 species of plants are known at Arabuko Sokoke Forest. The vegetation has been classified into three types as follows:

**Mixed Forest**: This is a dense forest type which extends to about 7,000 ha on wetter coastal sands in the east of Arabuko Sokoke. It has diverse tree species including, *Afzelia quanzensis* (mbambakofi/mwamba), Hymenaea verrucosa, Combretum schumannii, Manilkara sansibarensis and the cycad Encephalartos hildebrandtii.

**Brachystegia Forest:** This is a more open forest covering about 7,700 ha. It is dominated by *Brachystegia spiciformis (mrihi)* growing on drier and infertile white sands through the centre of the forest.

**Cynometra Forest:** This is a dense forest or thicket on the north-west side of Arabuko-Sokoke. It is dominated by the trees *Cynometra webberi* and *Manilkara sulcata*, and the euphorbia species *Euphorbia candelabrum*, but with reducing numbers. *Brachylaena huillensis* also used to be abundant in this zone, but its numbers have been severely reduced by extraction of minerals.

# Fauna

# Mammals

There are thought to be 52 mammal species in Arabuko Sokoke Forest. Several are of particularly high conservation concern. Three species, the Golden-rumped Sengi formerly known as Golden-rumped Elephant-Shrew (*Rhynchocyon chrysopygus*), Ader's Duiker (*Cephalophus adersi*) and the Sokoke Bushy-tailed Mongoose (*Bdeogale (crassicauda) omnivora*) are endemic to the forest and globally threatened. Ninety percent of the world's population of the Golden-rumped Elephant Sengi is found in the forest.

#### Birds

Arabuko-Sokoke Forest has been ranked as the second most important forest for the conservation of threatened bird species on the mainland of Africa. The 270 bird species known from it include six globally threatened commonly known as the Sokoke Six which include Clarke's Weaver, Sokoke Scops Owl, Sokoke Pipit, Amani Sunbird, Spotted Ground Thrush and East Coast Akalat. Clarke's Weaver is an endemic while the Sokoke Scops Owl, the Sokoke Pipit and Amani Sunbird are near-endemics. Important populations of the Spotted Ground Thrush and the East Coast Akalat also occur in the Forest.

#### **Reptiles and amphibians**

Arabuko-Sokoke Forest holds at least 41 species of snake, 21 lizards and 2 tortoises. As well as this richness in reptiles, the amphibian fauna includes rarer species. Among the 25 amphibian species are Bunty's Dwarf Toad (*Mertensophryne micranotis*), a coastal endemic and Ornate Tree Frog (*Leptopelis flavomaculatus*), which is near endemic.

#### Invertebrates

This group comprises the largest number of species, although (with the exception of butterflies) it is the least studied. Just over half of the 263 butterfly species known from the Kenyan coast have been recorded in the forest, of which *Acraea matuapa, Charaxes blanda kenyae, Baliochila latimarginata* and *Baliochila stygia* are endemic. Dragonflies are also an important invertebrate group, of which there are a number of rare and unusual species in Arabuko-Sokoke Forest.











#### **Importance of the forests**

1. The forests are **high in biodiversity**. For instance, the largest of the forests (Arabuko Sokoke Forest) has a biodiversity which includes:

Species	Numbers
Plants	600
Birds	52
Butterflies	270
Mammals	263
Snakes	41
Lizards	21
Tortoises	2
Frogs/Toads	25

2. The forests are a source of different types of natural resources such as building material, fruits and food products, fuel for cooking, and medicines. Unlike indigenous forests such as Arabuko Sokoke Forest, commercially planted forests such as those commonly observed planted with *Casuarina and Eucalyptus spiecies*, consist of one plant species only and the animal species associated with the same are low. These non indigenous forests basically serve one purpose only, the production of poles.







- 3. **The forests create employment**. The forest provides long term jobs through government agencies and non-governmental organizations which manage and conserve the forests for tourism, bee keeping, butterfly farming, mushroom farming, *Aloe vera* farming and herbal medicine.
- 4. The forests are needed for human survival and health. Trees trap and store carbon which in turn controls the earth's temperature, provides oxygen for us to breathe and supplies us with water through the process of transpiration.
- 5. The forests are a source of rain. Trees draw up water from beneath the ground through their roots and stems, which through transpiration, is released from the leaves into the air as water vapour. When the temperature drops, the water vapour condenses into water droplets which gather as clouds and provide rain.
- 6. The forests control soil erosion. Forests catch the rain droplets in the branches, slow their speed down and allow rainwater to drip gently onto the leaf litter on the forest floor and into the soil. The water which goes into the soil joins underground streams that supply the surface land with water in the form of lakes, streams and springs. Farmers depend on this water for watering their crops. Eventually, this clear water finds its way to the sea. This in turns joins the sea water keeping that clean and good so that corals can thrive. Without the forests there would be much erosion and consequently far muddier water. This in turn would have a bad effect on farmers, towns, sea water and corals.
- 7. **The forests have high endemism**. This means the species in question occurs in that particular area. For instance in Arabuko Sokoke Forest, there is the Golden Rumped Sengi (formerly Golden Rumped Elephant Shrew), the Ader's Duiker (small antelope), and the Sokoke Scops Owl (Africa's smallest owl).
- 8. Other importance of forests include:
  - As habitats (homes) for biodiversity.
  - As wind breakers.
  - As cleaners of dirty soil and air.
  - As reducers of noise pollution.
  - As places for recreational purposes such as walking and biking through the nature trails.

# Threats to the forests

Only 10% of the original area of forest is left. The threats to this include:

- 1. A rapidly **increasing population** which requires:
  - (a) More land to grow food, which results in clearing of the forest.
  - (b) More demand for building poles.
  - (c) More reliance on wood for fuel.
  - (d) More demand for bush meat.
- 2. **Poaching**. Most of the species of mammals found in the forest, including the rare ones, are being hunted for various reasons such as for food or trade, (eg elephant tusks).
- 3. **Charcoal making**. In Kenya 80% of the urban dwellers rely on charcoal as their source of energy. This creates a demand that leads to large scale felling of forest trees for charcoal production. This is seriously impacting Arabuko-Sokoke Forest.
- 4. **High demand and overreliance on timber as a raw material for building.** Construction has increased, especially with the growth of the tourism sector along the coast and this has led to many hotel operators acquiring timber illegally from the forest.
- 5. Wood carving. Tourism has also promoted the market for wood carvings. This has in turn had devastating effects on the forest hardwood species such as *Brachylaena huillensis* (muhuhu).
- 6. Others threats include:







- Poor farming practices outside the forest that lead to exposing the soil resulting in erosion.
- Laxity in terms of management and conservation of the forest by both the national and county governments.
- Conflicting laws and policies governing these forests.
- Lack of full community involvement in management and conservation of the coastal forests so that adjacent communities feel alienated from their own forests and in turn continue to access the forests illegally in order to harvest trees, make carvings and trap wildlife.

# Solutions

- 1. **Environmental education and awareness**. Environmental education lessons should be conducted in schools and wildlife clubs, and the general community should be made aware of the importance of conserving their adjacent forest.
- 2. Government (National and County) Prioritization. Coastal forest reserves are few, therefore they should be increased. Protected ones are understaffed and often inefficiently managed either due to poor funding or laxity.
- 3. **Community empowerment and involvement**. Communities need to be empowered through Community Forest Associations (CFAs) in order to be directly involved in the management and conservation of the forest under the Forest Act. This will help them to develop a sense of ownership. (Examples of CFAs in ASF)
- 4. **Community centered alternative income generating activities**. These can reduce pressure on the forest due to reduced overreliance on forest products, such as poultry keeping, farming, bee keeping, butterfly farming etc.
- 5. It is important to start **educating people on the need to have small families**. The Kenyan population is increasing by 1 million every year, exerting immense pressure on the already scarce natural resources, including coastal forests.
- 6. There should be a **review of policies and laws** so as they are well coordinated and not contradictory.

#### Questions

- 1) What are coastal forests?
- 2) Name the coastal forests found in Kenya.
- 3) When was Arabuko Sokoke Forest gazette as a forest reserve?
- 4) Name the types of vegetation found in Arabuko Sokoke Forest.
- 5) Name the globally endangered mammal species found in Arabuko Sokoke Forest.
- 6) Name the Sokoke Six.
- 7) Name the butterfly species found in Arabuko Sokoke Forest.
- 8) State the importance of Arabuko Sokoke Forest.
- 9) What are the problems facing Arabuko Sokoke Forest?
- 10) State five solutions to the problems facing Arabuko Sokoke Forest.

#### Sea Birds

# Objectives

By the end of the topic the pupils should be able to:

- 1. Name the three types of marine birds and give the difference between them.
- 2. Outline the adaptations of sea birds to their environment.
- 3. Describe the role played by sea birds in the ecosystem.
- 4. State the threats facing sea birds.
- 5. Give solutions to the threats facing sea birds.







# Introduction

Sea birds are also known as marine birds; they are birds that have adapted to life within the marine environment. In Watamu they are found on the shores, the sand or the exposed reef at low tides, all of which offer feeding grounds for many bird species especially the waders. They are also found on the open ocean and isolated islands. In addition, they occur on the sandbars and mangroves of Mida Creek.

- 1. The ones that occur in the open ocean are generally known as **sea birds** since they rarely venture or approach to settle at the shore. The ones found in Watamu include: Terns, Long-tailed Cormorant and Brown Noody.
- 2. The ones that occur on the shores are known as **shorebirds**. Examples of some found in Watamu include: Herons, Egrets, Storks, Ibis and even Flamingoes.
- 3. The **waders** that are present at bays around Watamu and on the mudflats of Mida Creek include: Plovers, Sandpipers, Little Stints and Whimbrels.

# Sea Birds Adaptations

Seabirds are well adapted to life in a marine environment; they also have several physical adaptations that give them an advantage for life on the high seas. Knowing these adaptations can help birders instantly recognize if they are looking at a seabird.

- **Plumage Coloration**: Most seabirds have drab <u>plumage</u> that is dark above and light below. This offers camouflage from aerial predators and hides the bird from potential prey beneath them.
- **Feathers:** Seabirds have more feathers relative to their body size than other birds, which give them superior waterproofing and insulation.
- **Feet:** Most seabirds have flexible webbed feet that help them be powerful swimmers or help propel them across the water to gain speed for takeoff.
- Wing Shape: Seabirds' wings are specially shaped for their unique flight needs. Longer, more tapered wings allow seabirds to soar for hours with very little effort, allowing them to remain aloft far from land. In some species, shorter wings give the bird better control and agility for flight right at the surface of the water.
- Salt Glands: Many seabirds have specialized salt glands that extract salt from the birds' food and water, allowing them to eat and drink without dehydration from too much salt. Excess salt is then excreted, typically near the birds' nostrils.
- **Head Structure**: Seabirds that hunt deeper in the water through plunge diving, such as gannets, have specialized adaptations in their head structure to withstand high-speed impacts with the water, such as strong, tapered bills, air sacs and thicker bones.
- **Diet:** Because of where they live, seabirds subsist on a diet of primarily fish, squid and crustaceans.
- **Breeding**: Unlike the solitary breeding preferences of many bird species, seabirds are <u>colonial</u> nesters and a breeding colony may grow to thousands of birds.
- Lifespan: While a typical songbird may live just a handful of years and a bird older than 10 is unusual, seabirds have much longer lifespans, mostly ranging 20-40 years.

#### Importance

- 1. They are part of the marine ecology.
- 2. They help promote tourism through encouraging birdwatchers from different countries to visit the Kenyan coast. This in turn creates employment and boosts the economy. This is highly evident at Mida Creek where there is a boardwalk and bird hide that offers a good view of the birds.
- 3. They are highly significant for education and research: many different scholars and scientists have been able to study them, in order to promote their conservation.







4. They are traditionally used as indicators of fish shoals.

# Threats Facing Sea Birds

- 1. Commercial development of the shoreline, mudflats, creeks and isolated islands that provide favorable habitats for the birds.
- 2. Becoming entangled in fish nets or hooked in fishing lines.
- 3. Litter. Floating trash can be very tempting for foraging seabirds, but because it is indigestible material, plastic clogs the birds' digestive tracts and can cause starvation. Sharp pieces can also cause internal lacerations, and chunks can cause choking. <u>Balloons</u> are a particular hazard because they resemble jellyfish or other prey.



- 4. Fishing. Many oceanic fishing practices can be hazardous to seabirds. Thousands of birds get tangled in nets or long lines each year and are either injured or drown. Overfishing of productive areas also depletes food sources available for seabirds.
- 5. Invasive Predators. Seabirds may stay at sea for months at a time, but they are particularly vulnerable when they come to land for nesting. Invasive predators on islands or coastlines where seabirds nest, can decimate colonies by preying on adults and chicks, eating eggs, damaging nesting habitats or destroying nest burrows.
- 6. Pollution. Oil spills while obviously damaging are only one type of pollution hazardous to seabirds. Other fuel spills as well as runoff waste from excess use of fertilizers, herbicides or other chemicals can contaminate water supplies and threaten seabirds.

#### **Solutions**

- 1. Proper waste management near the oceans.
- 2. Enforcement of laws prohibiting commercial development of sea bird habitats.
- 3. Inclusion of sea bird habitats into marine protected area systems.
- 4. Educating communities on the need to practice sustainable fishing methods and the importance of sea birds.

#### Activities

- 1. Sand art-modeling seabirds.
- 2. Nature walk along the beach to identify the different sea birds.
- 3. Drawing, coloring and naming sea birds.

#### Questions

- 1. Name the three categories of sea birds and give two examples in each category.
- 2. Explain three adaptations of sea birds to their environment.
- 3. Outline three importance of sea birds.
- 4. Give four threats facing sea birds.