Endangered Caribbean Sea Turtles: An Educator's Handbook

Sera Harold
Karen Eckert

WIDECAST Technical Report No. 3
2005

"In the end, we will conserve only what we love, we will love only what we understand, we will understand only what we are taught."

-Baba Dieum

Front Cover: Photo by Scott Eckert. *Note*: This picture is of a researcher releasing hatchlings on a nesting beach, after the hatchlings had become entangled in beach vines. If you see hatchlings, please allow them to reach the water on their own, handling them (with hands free of insect repellent or sunscreen) only when such handling is neccessary for their survival.

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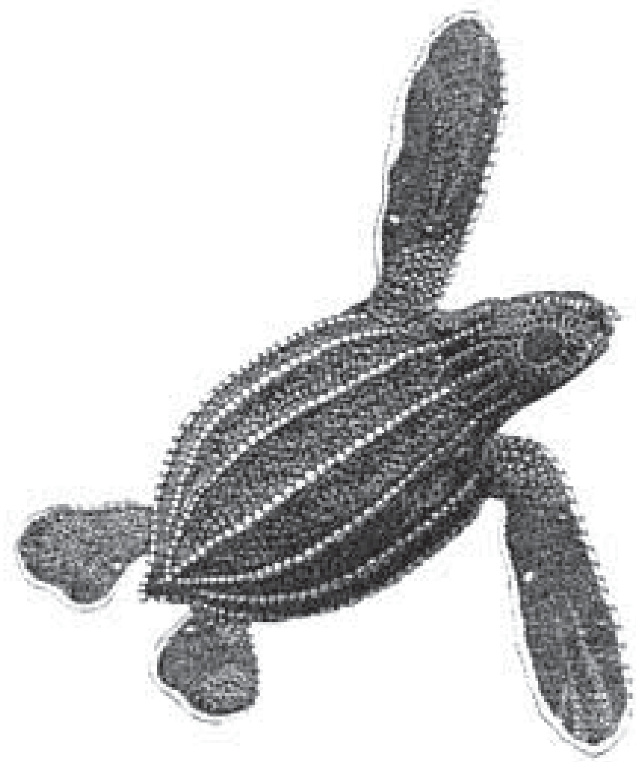
Endangered Caribbean Sea Turtles



An Educator's Handbook

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Karen Eckert
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WIDECAST
Wider Caribbean Sea Turtle Conservation Network

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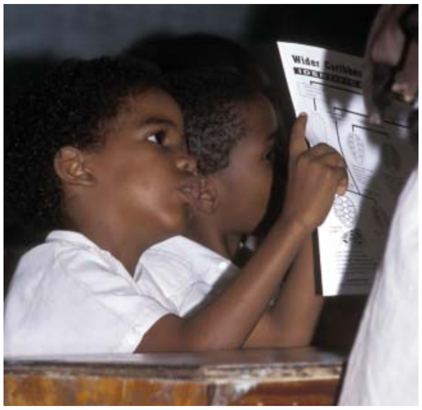


Introduction to the Handbook

Overview

This Handbook is intended to provide a science-based outreach tool that is both Caribbean-focused and aimed at a broad public audience. The Handbook features cross-cutting conservation issues associated with six species of endangered sea turtles, emphasises classroom activities and curriculum units, and provides a unique education tool for conservation and youth groups, park and protected area officers, dive and tour operators, museums and cultural societies, and public awareness programs associated with Fisheries and Forestry departments throughout the region.

The Handbook is designed to assist educators by using standard layouts developed for classroom use, including lesson plans, analytical exercises, fact sheets and work sheets, contests and team-building assignments, field and conservation exercises, and suggestions for "enrichment" activities that encourage students to think more deeply about the issues. A Glossary is provided, as well as useful Internet sites and basic literature references.

We hope that through direct participation, students will become familiar with sea turtle biology, including ecological roles, patterns of behavior, and survival needs (food, shelter, nesting beaches); management tools and conservation strategies, including laws and treaties, best practices and policy options (e.g. protected areas, time and area closures, alternative fishing gear technologies); and how to become involved in local management issues, including beachfront lighting, beach clean-ups, coastal care (e.g. bonfires, beach-driving), reporting violations, and basic 'etiquette' (e.g. what to do when you encounter a sea turtle).

The Handbook has been peer-reviewed and field tested by expert colleagues from around the Caribbean (see Awknowledgements).

Why is it important to know something about sea turtles?

The Caribbean Sea once supported populations of sea turtles that numbered in the uncounted millions. Seventeenth and eighteenth century mariner records document flotillas of turtles so dense and so vast that net fishing was impossible, even the movement of ships was curtailed. Their teeming numbers were a dominant force in the ecology of coral reefs and seagrass meadows, and in the economies of man. Today sea turtle populations are severely reduced from historical levels, and some of the largest breeding populations the world has ever known (for example, the green sea turtles, *Chelonia mydas*, of the Cayman Islands) have all but vanished.

In addition to a minimally regulated harvest that has spanned centuries, sea turtles are accidentally captured in active or abandoned fishing gear, resulting in death to uncounted thousands of turtles each year.

Sea turtles are still killed for meat and eggs (subsistence and commercial markets), shell (used in crafting jewelry and ornaments, generally for a tourist clientele), oil (typically used medicinally), and skin (fashioned into leather products). Much of the harvest is illegal.

Coral reef and seagrass degradation, pollution and marine debris, high density coastal development, and an increase in ocean-based tourism have damaged or eliminated many Caribbean nesting beaches and feeding areas. International trade in sea turtle products has also contributed to the demise of some species.

Today all Caribbean sea turtle species are classified as "Endangered" or "Critically Endangered" (for details, visit the IUCN Red List of Threatened Species at http://www.redlist.org).

Mobilising citizens and governments in dozens of nations and territories is required to effectively manage and conserve Caribbean sea turtles. Because sea turtles are among the most migratory of all Caribbean fauna, what appears as a decline in a local population may be a direct consequence of the activities of peoples many hundreds or thousands of kilometers away. While local conservation is crucial, coordinated action among range states is also important.

For sea turtles to survive, everyone must work together!

How will using this Handbook help?

In order for people to take action, accurate information is needed at a regional scale. An informed citizenry is essential to maintaining a healthy marine environment, which translates into the conservation of biodiversity, the sustainable use of subsistence and commercial resources, and the protection of critical coastal habitats upon which we all, directly or indirectly, depend.

A major concern is the lack of Caribbean-based information tools for use in the classroom, and suitable for teaching basic curriculum concepts (science/biology, comprehension, reading/writing, critical thinking).

This Handbook provides tools designed to enhance the understanding and use of science in decision-making. It builds the capacity of Caribbean educators to explore and use a marine conservation curriculum based on a familiar flagship species, the sea turtle, and provides learning tools that promote conservation action on behalf of sea turtles and their imperiled coastal habitats, including seagrass, coral reefs, and sandy beaches.

The challenge is to keep the issue of sea turtle survival (which, by definition, requires sustained conservation action over long periods of time) alive and in the public eye by integrating basic concepts into schools and other learning environments, throughout the region. On behalf of the more than 40 nations and territories that participate in the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), we hope that you enjoy this new Handbook and that you let us know how we can improve it! For more information relevant to educators, please visit www.widecast.org/educators.

Karen Eckert, Ph.D.
Executive Director
WIDECAST
2005

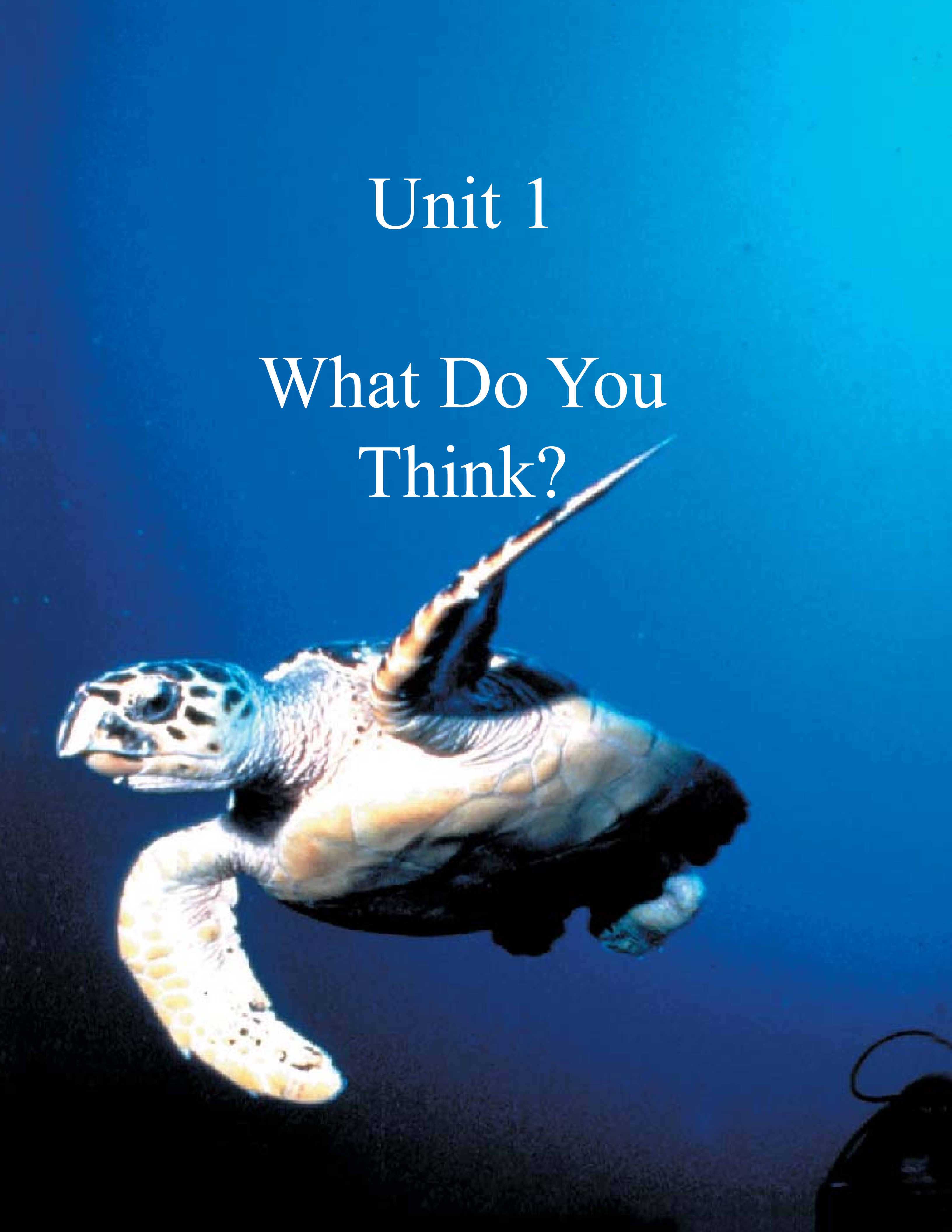
How To Use This Book

- The activities are written with 12-15 year olds in mind; however, some activities will be too difficult for this age range and some will be too easy. Each activity is easily adaptable for most age ranges.
- Most units can be used independently, meaning that the teacher does not need to complete the whole book. We wanted to supply the teacher with possibilities, and didn't intend for an educator to be intimidated by the size of the Handbook.
- Each activity is designed to stand alone.
- Almost everything you need is included in the Handbook! No fancy equipment is needed for any of the activities. Most can be completed using photocopies and a pencil.
- There is no formal evaluation included in the form of tests, except in a few instances. The use of Sea Turtle Portfolios is a good evaluation tool in most cases. Have students keep their work in a folder. Let this collection of work be your evaluation tool.
- Vocabulary words appear in boldface throughout the text of the Handbook. A Glossary of terms is included at the end of the book.
- The Subject Index and Skills Index at the back of the book should make it easier to find exactly the right activity for your learning objective!
- The Handbook is designed to be as interactive and dynamic for students as possible. Each activity suggests that the background information be a reading assignment. This is only a suggestion. The teacher should deliver this information in any way that proves most useful.
- The Handbook is designed primarily for formal school settings, and for children, but we have used many of these activities with adults in different circumstances and we encourage non-traditional educators to use this book, as well.

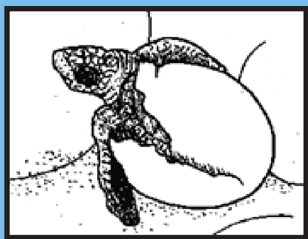
(Most of all, we hope that you and your students enjoy the Handbook!)

Unit 1

What Do You Think?



What Do You Think? 1A



Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
45 minutes
- **Enrichment**
60 minutes

Materials Needed:
- 3 Copies of provided Questionnaire for each student
- Pencil and paper
- Calculator

Setting:
Classroom

Subject Areas:
Culture, Ecology, Social Studies, Mathematics

Skills:
Analysis, Discussion, Scientific Writing, Public Speaking, Report Drafting, Statistical Analysis

Vocabulary:
frequency
opinion
percentage
policy
questionnaire
survey

▼ Summary
Students take a survey using a prepared questionnaire, tabulate their results as a class, modify the questionnaire and survey a family member.

▼ Objectives

Students will:
- State their own opinions about sea turtle conservation, and the opinions of their peers, family and elders.
- Discuss the importance of changing attitudes in **policy**-making.

▼ Why Is It Important?

Students and teachers alike often encounter wildlife-related interests and issues in their community. Planners frequently use information about public **opinion** in making **policy**; sometimes this information is collected through **surveys**. Conducting a survey helps students discover what is happening in their community, how people think and feel about what is happening, and how survey results can be used to help make decisions. Students will explore how the opinions of family and community members might differ among generations and how those differences might affect wildlife-related **policy** in a country.

▼ Background Information

One way to obtain information about people's thoughts and actions regarding an issue is through a survey. In this activity, students will conduct **surveys** using an interview/questionnaire method. Interviewing is the process of **surveying** viewpoints by verbal questions. **Surveys** can be used to solicit facts from people and to determine people's opinions about a topic. Opinions include personal beliefs, attitudes, and values. Facts include background information such as age, education, experience, and place of employment.

Surveys often provide information helpful to solving a problem or answering a question. The purpose of the survey is often expressed as a research question. Research questions should be clearly written, should be reasonable in scope, and should provide insight into the purpose of the survey. Examples of research questions include:

"How many people in this area fish or have fished for sea turtles?"

"Are there more or fewer turtles here now than there used to be?"

After the survey has been completed, the collected data need to be interpreted. One of the simplest procedures is to tally responses and calculate frequencies. For example, if 20 people were asked if they fished for turtle, 12 people might say yes and 8 say no. In this example the results could be reported as: 60% of the respondents have fished for turtles and 40% have not.

$$\frac{\text{12 said “yes”}}{\text{20 people surveyed}} = 0.6 = 60\%$$

The sum of all proportions should equal 100%. Further analysis would involve the use of simple statistics including finding the mean, standard deviation, and a measurement of bias or error.

▼ Procedure

Warm Up

1. Have each student complete the included **questionnaire entitled, "Sea Turtle Survey**." Don't worry about the blank questions yet.

2. Have the students tally the results of the **questionnaire** in class and calculate **percentages** for each response. Keep the results to compare with family responses obtained later.

▼ The Activity

1. Divide the class into small groups. Using the "Survey Development" page and the included **questionnaire**, have the students design extra questions for use in **surveying** a family member. Remember that the research question is: "How do different generations feel about sea turtles?" The students should agree as a class which of the new questions will be written into the two blanks in each section and used as part of the **questionnaire**.

2. Have each student administer the survey to a parent and a grandparent or other family members representing these different generations.

3. Upon completion of the survey, have the students analyze the data in the same way as the initial classroom survey. They may calculate a mean, median and standard deviation for each response.

4. Ask each group to prepare a report of their results. Advise them to find a snappy title that incorporates or relates to the research question, and to include any background information explaining the issue, a description of how the survey was conducted, results (tables, charts, and graphs make results more visually appealing), and conclusions. They can also explain any difficulties they had with the survey process.

5. Have the groups present and discuss the survey and its results. Were the results what they expected? What are the differences between generations? Where is the greatest difference, the least? Based on your interviews, does public **opinion** change with time? If so, why do you think this is so? How do you suppose that these changes in public **opinion** influence **policy** making?

▼ Enrichment

1. Choose a question from the **questionnaire** about which the different generations had differing opinions. Divide the class into three groups. Draw a line across the classroom from one wall to another. Choose one wall as "strongly disagree" and the other wall as "strongly agree". Read the question aloud and have the students arrange themselves along the line representing one of three generations (students, parents, grandparents). Have the three groups present their generation's view to the class and how the view relates to "their" generation's experience.

Survey Development:
Using a Questionnaire

Who will you talk to?

As a safety precaution, students should poll only people they know. Students will sample family members for this activity. For a more sophisticated study, students may consider collecting a random sample, or sampling only fishermen or market vendors.

How will you conduct the survey?

Mailed **questionnaire**s, face-to-face interviews, and phone calls are a few of the options a student might use to collect information. Discuss the pros and cons of each. For example, phone interviews provide immediate results; however, people may be more likely to participate if the interview were conducted face-to-face. Cost (stamps, travel), time (sitting through an interview), and willingness to participate are all things to consider.

What questions will you ask?

Using the research question: "How do different generations feel about sea turtles?" students should create a list of questions they would like to ask, choose from these questions as a class, and add them in the blank spaces of the **questionnaire** before **surveying** family members.

Have students consider whether they will be collecting facts, **opinion**s, or both. Write several examples of each on the board and discuss the difference between facts and **opinion**s (see examples below).

Facts

- How many turtles do you see each week?
- Do you still hunt turtles?
- What is the price of a kilo of turtle meat?

Opinions

- Is it important to conserve turtles?
- Should people be able to fish for turtles?
- Do people take too many?

Encourage groups to test the questions for clarity and to make sure they are not biased. The survey can be tested by asking a friend to listen to each question. Does the question provide information that helps answer the overall research question? Does the question make sense? Did the question make the person feel he or she should answer a certain way (in other words, was the tone of the question condescending or "leading"?)

How will the results of the survey be analyzed?

Close-form items (e.g., yes/no, agree/disagree) are easier to analyze than open-form items. Open-form items are those to which the participant responds in his or her own words. Examples include the following: How do you feel about marine pollution? Is sea turtle conservation important?

Analyzing open-form responses involves carefully studying (listening to, reading, reviewing) all responses and looking for common messages that can be used to summarize the statements.

For close-form questions, students can report the **frequency** of responses by tallying the number of people who responded to each answer category. Students can also calculate the group average or what **percent** of the sample answered in a certain way. For ease of analysis, this activity features the use of close-form questions only.

Sea Turtle Survey:
How Do Different Generations Feel About Sea Turtles?

Interviewer Information:

Name(s): Date: Location:

Introduce yourself to the interviewee. Explain that you are carrying out a survey as part of a class assignment to learn more about how opinions on wildlife related issues might differ among generations in your community. The questions focus on how important sea turtles are, and were, to the culture and everyday lives of the people of your country. Explain that as a student it is important to find out about this historical relationship because many traditions are lost as a country becomes more developed. Explain that the results of the **surveys** will be shared with your class and that the names of people interviewed will not be used.

Interviewee Information

Occupation: Relationship:

Sex: Area of Residence:

Age: 0-20 21-40 41-60 61-80 80+

Section 1- Turtles, General Information (circle one)

1. How many different species of sea turtle can you name?
   0 1 2 3 4 5 6

2. How many different species of sea turtle have you seen?
   0 1 2 3 4 5 6

3. How many species of sea turtle are classified internationally as "Endangered" in the Caribbean?
   0 1 2 3 4 5 6

4. Have you ever seen a turtle laying her eggs?
   0 1
   No Yes

5. Can you name the most important sea turtle nesting beach in your country?
   0 1
   No Yes

6.* ____

0 1 2 3 4 5 6

7. ____

0 1 2 3 4 5 6

* If the answer is not a numerical response (0-6), then each number should be associated with an answer. For example, 0=no, 1=yes, 2=unsure.

Section 2- Turtles, Past Uses

Note:
< = "less than"
> = "more than"

8. When I was a young person, sea turtles were most valued for:

0	1	2	3	4	5	6
no value	meat	eggs	shell	oil	eco-tourism	don't know

9. When I was a young person I ate turtle meat or eggs:

0	1	2	3	4	5	6
never	< once monthly	once monthly	>once monthly	daily	special occasions	don't know

10. When I was a young person sea turtles were most often caught by:

0	1	2	3	4	5	6
never caught	nets at sea	hand at sea	spear at sea	accidently at sea	during nesting	don't know

11. When I was a young person I believe that most people thought sea turtles were:

0	1	2	3	4
extinct	rare	common	abundant	don't know

12.*____

0 1 2 3 4 5 6

13. ____

0 1 2 3 4 5 6

*Notice that questions 12 and 13 should "match" questions 18 and 19.

Section 3- Turtles, Present Uses

14. Today, sea turtles are most valued for:

0	1	2	3	4	5	6
no value	meat	eggs	shell	oil	eco-tourism	don't know

15. Today I eat turtle meat or eggs:

0	1	2	3	4	5	6
never	< once monthly	once monthly	> once monthly	daily	special occasions	don't know

16. Today sea turtles are most often caught by:

0	1	2	3	4	5	6
never	nets at sea	hand at sea	spear at sea	accidently at sea	during nesting	don't know

17. Today I believe that most people think sea turtles are:

0	1	2	3	4
extinct	rare	common	abundant	don't know

18. ____

0 1 2 3 4 5 6

19. ____

0 1 2 3 4 5 6

Section 4- Turtles, Future Options

20. Sea turtles will continue to exist here no matter what we do.

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

21. People should be able to fish for turtles and collect eggs without restriction.

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

22. I would be sad if turtles were extinct and there were none for my children to see.

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

23. Generating community income from turtles through tourism (like a "turtle watch") is a good idea.

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

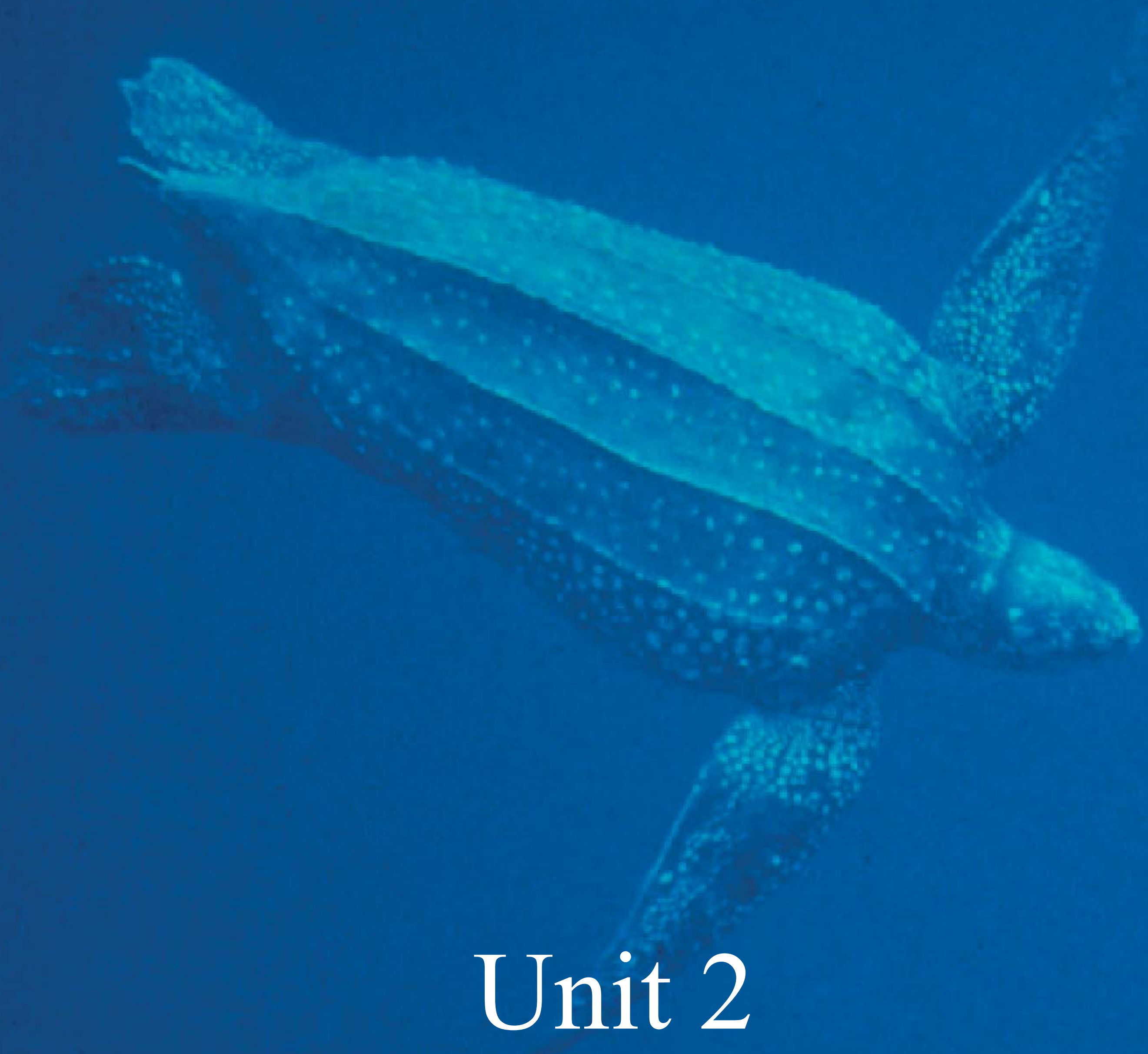
24. ____

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

25. ____

1	2	3	4	5
strongly disagree	disagree	no opinion	agree	strongly agree

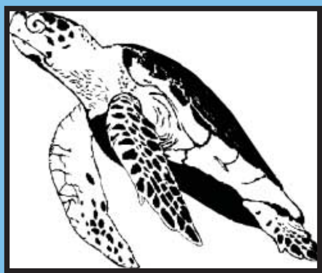
Be sure to thank the interviewee for participating!



Unit 2

Amazing Sea Turtles

Life Underwater 2A



■ **Preparation Time:**
10 minutes

■ **Activity Time:**
• **Warm up**
30-45 minutes
• **Activity**
45 minutes
• **Enrichment** (optional)
30 minutes

■ **Materials Needed:**
• Copies of provided Background Information TurtleCam Diary
• Pencil

■ **Setting:**
Classroom

■ **Subject Areas:**
Ecology, Anatomy, Language Arts

■ **Skills:**
Observation, Analysis, Field Skills

■ **Vocabulary:**
adaptation
marine
propulsion
salinity
tear ducts
terrestrial
thermoregulation
viscous

▼ Summary

Students will learn how sea turtles are adapted to live in the ocean, and how those **adaptations** affect the behavior of the sea turtle.

▼ Objectives

Students will:

- Identify three **adaptations** sea turtles have for living underwater.
- Identify three behaviors sea turtles need for their survival.

▼ Why Is It Important?

We cannot see through a turtle's eyes or go with them on their dives underwater. Sea turtles live under the ocean's surface, a place we can only visit briefly. Because of this, it is difficult to understand how turtles eat, see, breathe, and hear. Through detailed study of the anatomy of turtles, and study of similar animals, scientists have been able to get an idea of what a turtle's life is like underwater. This information is important because if we do not know the basic biology of these animals, it can be challenging to protect or manage them effectively.

▼ Background Information

Water is eight hundred times denser than air, water is a more effective heat conductor than air, and sea water contains dissolved salts. Animals living in this environment are exposed to different pressure, temperature, and **salinity** than animals on land; so most **marine** animals have unique **adaptations** (fins, gills, etc). that could never exist (and would not be very useful!) in a **terrestrial** environment.

Like the dolphin and the seal, sea turtles represent animals that originally were adapted for a **terrestrial** existence and later, over the course of millions of years, returned to a life in the ocean. As a result, several **adaptations** had to occur in order to get sea turtles ready for life underwater. For example:

Breathing: Sea turtles are not fish, they <u>must</u> come to the surface to breathe. Sea turtles have shells so they cannot expand and contract the rib cage to breathe like we do. Instead they use flipper muscles and the movement of swimming to pump air into and out of the lungs. Deep diving sea turtles store relatively large amounts of oxygen in their blood and muscle, rather than in their lungs.

Swimming: Sea turtles' front flippers have become modified into paddle-like limbs to move the turtle quickly through the water. But these same flippers make the turtle very clumsy on land! Young sea turtles also use their back flippers for **propulsion**, while adults use them only for steering (and nest digging).

Drinking: All animals need freshwater to survive. A sea turtle's body is less salty than the ocean, and must stay that way. The shell and scaly skin help to keep salt water out, but a lot of salt is taken in during feeding. To get rid of the extra salt, sea turtles have special "salt glands" (similar to our **tear ducts**), located near the eyes, which pump extra salt out of the body in thick "tears". The tears that people see in nesting turtles are actually salt secretions from these glands. Sea turtles "cry" all the time, not just during nesting.

Temperature Regulation: Sea turtles are **ectothermic** ("cold-blooded", meaning they maintain body temperature by, for example, absorbing heat from the environment), and so they sometimes "bask" or float at the surface to warm themselves.

Many species will migrate to warmer waters when temperatures in winter drop below 15 degrees Centigrade. Leatherbacks are a special case. Due to their large size and exceptional heat capacity, they can live in very cold water, even venturing into subarctic zones to feed on jellyfish and other delicacies.

Reproduction: Sea turtles must come ashore to lay their eggs. If the eggs are laid at sea, the embryos will drown. The female turtle crawls up onto a sandy beach, carefully digs a hole, deposits her eggs, and buries them in the sand before returning to the sea. The eggs can stay warm and the developing embryos can get oxygen while they incubate in the sand.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Discuss ectothermy and endothermy. What is your body temperature? If students don't know, use a thermometer to find out. What is the temperature outside? Are the two different? Are humans endothermic or ectothermic? Sea turtles, like all reptiles, control their body temperature through behavioral means. Are sea turtles endothermic or ectothermic?

▼ The Activity

1. Copy and distribute the TurtleCam Diary page. Have the students read through the diary or read it aloud in class.

2. Have the students underline or circle any thing the turtle does that they can explain using the Background Information. For example, if the turtle is described surfacing and sticking its head out of the water, the students would state that the turtle is breathing.

3. The students should write their explanations for the behaviors on the lines provided. Have students report their results to the class.

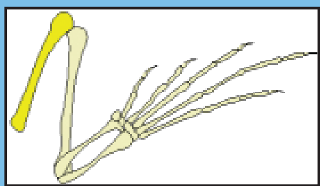
▼ Enrichment

1. If you have access to the internet, you can show videos of actual turtle cams. One place to access these videos is listed below:
http://www.seaturtle.org/turtle_cam/

TurtleCam Diary

The camera is activated just as green turtle #thr567 is leaving the beach after nesting. The front edge of her flippers come into the frame, I can hear them hit the sand and she moves a few centimeters forward. After 2 minutes she pauses, lifts her head, and I can hear what sounds like a breath. There are big viscous tears coming out of her eyes. She continues down the beach and into the water. Once she is swimming, she moves fast. I can see her flippers come into the frame every second or so, both of them at the sides. They seem to be almost vertical before she brings them powerfully downwards. The ocean floor is moving by quickly. After 3 minutes she starts towards the surface. The camera breaks the surface of the water and her head points upwards, she inhales. She puts her head back underwater but the camera is still above the waves. For 65 minutes the camera shows open ocean, and even turns around to show the beach the turtle just came from! Then suddenly, she dives down to the ocean floor and starts throwing sand and mud with her flippers. The camera stopped filming 83 minutes after it started.

Adaptation Laboratory 2B



Preparation Time:
10 minutes

Activity Time:
- **Warm up**
15-20 minutes
- **Activity**
70 minutes
- **Enrichment** (optional)
30 minutes

Materials Needed:
- Copies of provided Background Information
One copy of Lab Cards
- Pencil & paper

Setting:
Classroom

Subject Areas:
Ecology, Anatomy

Skills:
Observation, Analysis, Field Skills

Vocabulary:
analogous
camouflage
caudal
homologous
generation
natural selection
predator
prey

▼ Summary

Students will learn how sea turtles adapted to live in the ocean, and how those changes affect the behavior of the sea turtle.

▼ Objectives

Students will:
- List three adaptations that sea turtles have for living underwater.
- Identify sea turtle behavior and its causes.
- Identify several **analogous** and **homologous** structures.

▼ Why Is It Important?

Why does a sea turtle look the way it does? Why does it lay its eggs on land? One way to answer these questions is to see how turtles are different from other animals and to see what purpose these differences might serve. In this activity students will ask and answer some "why" questions.

▼ Background Information

The special characteristics that allow plants and animals to be successful in a particular environment are called adaptations. The process of adaptation generally occurs over a long time period.

Let's imagine a land turtle that is competing for food with lots of other animals on land. He finds some food in the water and there is less competition for this food so he may become more successful than the other land turtles. Eating different food, in this case, is a useful adaptation. Now let's imagine, many **generations** later a turtle is born with webbed feet. Now this turtle can be even more successful getting food in the water. Enjoying plenty of food and less competition for it, more young web-footed turtles survive to reproductive age, producing more young than the other turtles. Webbed feet are a successful adaptation for turtles who feed in the water. If a land turtle who did not feed in the water was born with webbed feet, the feet would not be an advantage, and might even be a disadvantage. Why might webbed feet be a poor adaptation to living completely on land?

Slight changes in body shape, retained and specialized over time, can give an animal advantages. In this case our turtle species becomes adapted to living even more completely in the water. This process goes on and on, and the most successful plant or animal species becomes very well suited to its environment!

The process of adaptation is also called **natural selection**, which means that only those changes that help an animal (or do no harm) are likely to remain. Particular changes that hurt an animal or place it at a disadvantage (like the webbed feet on the land turtle) will most likely disappear over time because animals with those characteristics are likely to be less competitive and leave behind fewer offspring.

Camouflage is a good example of an adaptation. Why is a hawksbill turtle's shell so beautiful and why is it different from the other sea turtles? The basic rule of adaptation is that natural selection acts on the endless natural variation among individuals in such a way as to favor reproduction in those best suited to their environments. So the best question is: how is the hawksbill's environment different from other sea turtles and why would it favor a shell like that? Hawksbill sea turtles spend much of their time near coral reefs. Coral reefs are more colorful and varied than most other ocean environments, so for the hawksbill to blend in and avoid detection, you could argue that it would be advantageous to look like the coral reef!

Homology is the idea that different body parts are made of similar bones. For example, a turtle's flipper is **homologous** to a human's arm. They have the same bones and basic structure, even though the arm and flipper do very different things.

Analogy is the idea that two body parts have the same function, no matter what the structure. For example a bird wing is **analogous** to a butterfly wing. Both serve as wings for flying, but while a bird wing has bones (like our arms), a butterfly wing has no bones at all!

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Discuss analogy and homology to make sure the students understand the concepts before beginning the activity.

3. Begin with an example: Think of a dog's paw, a human hand and an elephant's trunk. Have the students say what each is used for, and point to the part of their own body that is analogous or homologous to the example given (for the elephant trunk, they would point to their nose). Are these **analogous**? **Homologous**?

▼ The Activity

1. Divide the class up into teams of 3-4 students. One team member should be responsible for writing down responses. Give one copy of the Adaptation Lab Worksheet to each team.

2. Make one copy of the Lab Cards. Designate four tables or desks in the room, and tape the cards to the tables. Put all of the Group 1 Lab Cards on one table and so on so that there is one table for each group of Lab Cards. (If the class is larger than 30 students you may want to make two duplicate sets of tables and Lab Cards.)

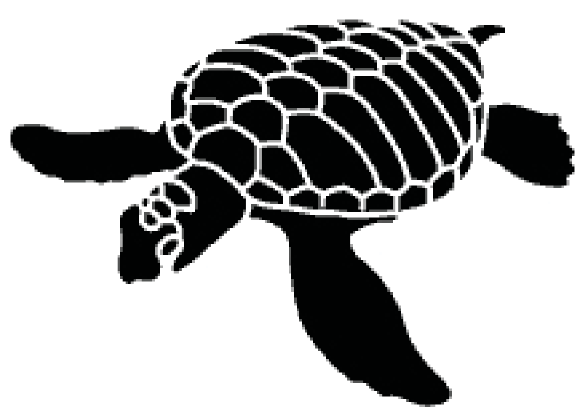
3. Start the groups off at different tables and have them answer the questions on the worksheet. Try not to help too much, because their own analytical thinking is the important part!

4. After all of the groups have had a chance to answer all of the questions at all of the tables, have each group stand at one of the tables. They should choose a representative to read their answers to the class and explain the answers. If other students disagree, guide a discussion.

▼ Enrichment

1. If you have not already done them, the students can complete activities 1 and 3 in the Natural History of Sea Turtles.

2. Students can choose another animal and either observe that animal or find a picture of it. Have them list adaptations they see and what environmental factor might have caused that adaptation.



Adaptation Lab Worksheet

Group 1:

1. Define the term **analogous**. Which two structures in group 1 are **analogous**?
2. Are there any structures in group 1 that have no bone structure?
3. What differences do you see between the bat wing bone structure and the turtle flipper bone structure? Why do you think they are this way?
4. How are the turtle and human forelimbs similar? How are they different?

Group 2:

5. Define **homologous**. Are there **homologous** structures in group 2?
6. Are there any structures without bones? If so, what do they have instead of bones?
7. What activities are these four structures used for?
8. How are the turtle and human limbs similar? How are they different?

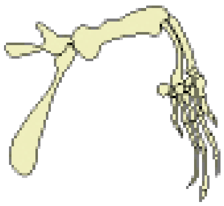
Group 3:

9. What is one thing you can think of that all four of these structures are used for?
10. Are the human rib cage and the turtle carapace **homologous**? Are the crab shell and sea urchin spine?
11. If you could pick out one of group 3 that was different from the others, which would it be?
12. Which of the two animals represented by the parts in group 3 do you think are most closely related?

Group 4:

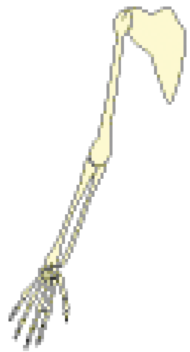
13. A shark's fins do not have bone structure. Why do you think this is true?
14. How many of these structures are **analogous**? **Homologous**? Which ones?
15. Name the function(s) of the tail for each of the four animals in group 4.
16. Can you think of animals that have different uses for their tail than those above?

Lab Cards



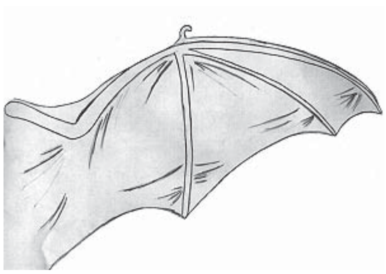
Group 1

Sea Turtle Front Flipper



Group 1

Human Arm

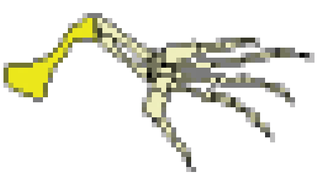


Group 1

Bat Wing

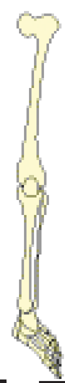
Group 1

Butterfly Wing



Group 2

Sea Turtle Rear Flipper



Group 2

Human Leg

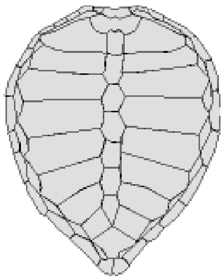
Group 2

Crab Claw

Group 2

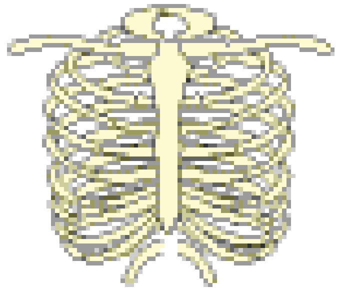
Fish Caudal Fin

Lab Cards



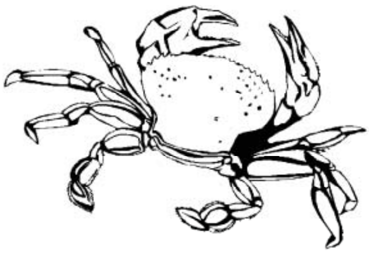
Group 3

Sea Turtle Carapace



Group 3

Human Rib Cage

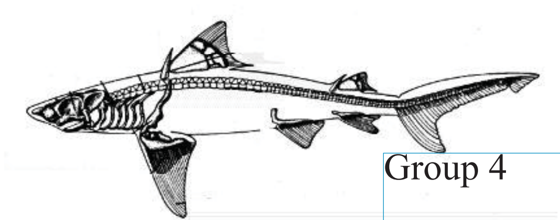


Group 3

Crab Shell

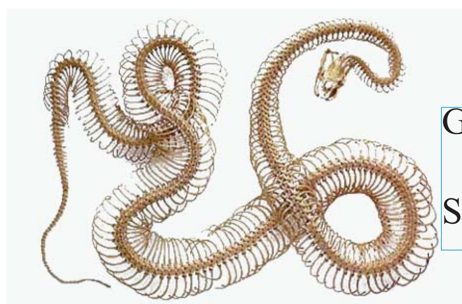
Group 3

Sea Urchin Spines



Group 4

Shark "tail" or Caudal Fin



Group 4

Snake Tail

Group 4

Sea Turtle Tail

Group 4

Dog Tail

Turtle Nest Box 2C

Preparation Time:
30 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
45 minutes
- **Enrichment** (optional)
30 minutes

Materials Needed:
- Copies of provided
Background Information
Turtle Tracks page
Sex Determination Page
Arribada Page
- Pencil

Enrichment:
- Styrofoam cooler
- About 50 Styrofoam balls or balls of paper
- Sand colored paint
- Clear plastic sheet ("Saran" or cooking wrap) or Plexiglas

Setting:
Classroom

Subject Areas:
Ecology, Fine Arts

Skills:
Observation, Analysis, Field Skills

Vocabulary:
aggregated
clutch
embryo
gait
overburden

Summary

Students will learn how sea turtles use special behaviors to nest on the beach, and will learn what a nest looks like by building one.

Objectives

Students will:
- Identify five different sea turtle tracks.
- Define an "arribada".
- Determine the probable sex of sea turtle hatchlings.
- Reproduce a sea turtle nest.

Why Is It Important?

We rarely get to see sea turtles when they are in the water, but when they come to the beach to nest, we have more contact with them. We understand much more about sea turtles' nesting behavior than their underwater behavior. For example, scientists discovered that sea turtles normally return to nest on the beach where they hatched. This tells us that if a beach is used this year by turtles for nesting, it will be used in 30 years, and is an important part of the turtle's survival. Understanding the nesting behavior of turtles helps us to protect them.

Background Information

As a turtle comes ashore, its flippers change from being used to swim and steer, to pulling its heavy body up the beach. In doing so the turtle leaves behind a clear track which can be used to identify her species. Leatherback and green turtles move their foreflippers forward together. They leave behind a symmetrical track. Hawksbills, loggerheads and ridleys alternate their **gait**. One front flipper moves forward at the same time as the hind flipper on the opposite side, leaving behind a track with offset flipper marks. The width of the track can also help to identify the species. A larger turtle leaves a wider track.

Females generally nest during seasons that are warm and dry. They will deposit from 1 to 12 **clutch**es of eggs per nesting season, with an average of 3 to 6 **clutch**es. Most sea turtles show strong nest site fidelity, often returning to the exact same nesting beach for many consecutive nestings.

The sand color, composition, and compaction are some of the factors important in determining how moist the nest will remain over time. Moisture in the nest is critical in keeping a steady temperature.

Unlike chicken eggs, in sea turtle eggs the **embryo** attaches itself to the inside of the egg shell and breathes directly through the shell.

Leatherbacks lay many infertile, often smaller "barrier" eggs in each nest, usually last, so they are at the top of the nest. These eggs may serve to seal the nest, preventing sand from sifting in between the larger eggs below. They may also humidify the nest as they lose moisture over time.

All sea turtles practice solitary nesting, but Kemp's ridleys in the Caribbean, as well as olive ridleys in the Pacific, exhibit

aggregated nesting known as an arribada. Often the mass nesting appears to happen with certain moon or tidal phases. Why do you think sea turtles would nest this way? Perhaps for the same reason that birds fly in flocks, for protection from predators. Remember that while adult sea turtles have few predators in the water, on land the sea turtles, and especially the hatchlings, are very vulnerable. By nesting in an arribada the sea turtle ensures that millions of hatchlings will emerge from the sand together, thus increasing their chances of survival.

Unlike some other animals (like humans), a sea turtle's sex is not determined at the time of conception, but is influenced by the temperature of the sand in the nest. In general, warmer temperatures produce females and cooler temperatures produce males. Eggs in the center of the nest receive more heat and may be more likely to be females! Humans can change beach temperatures by cutting down shade vegetation, or by planting it!

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Write the following steps of nesting on the board and have the students put them in order.

   - laying eggs
   - crawling to a suitable nest site
   - digging the egg chamber
   - burying and disguising the nest
   - crawling up on to the beach

   You can then ask the students to draw the series of events.

▼ The Activity

1. Copy and distribute the Turtle Tracks page.

2. Have the students work in pairs to try to match the turtle with its track. Have them refer back to the description of the tracks in the Background Information.

3. Copy and distribute the Sex Determination page. Have the students work individually to color in the eggs they believe will be female and leave the eggs white that they believe will be male.

4. Create a model sea turtle nest to show the school.

   - Cut the front panel out of a Styrofoam cooler
   - cut a plastic sheet (Plexiglas is best) so that it will fit the front panel and secure with tape or staples.
   - make sure your Styrofoam balls or other substitute are the size of table tennis (ping pong) balls, and an appropriate color.
   - paint the inside of the plastic with sand colored paint to resemble a nest chamber in the sand.
   - Let the paint dry
   - Assemble the nest by filling the cooler with "eggs". Remember that there will be around 10cm at the top of the nest with no eggs where the turtle will fill in sand to bury the eggs (the **overburden**).
   - Label the parts of the nest with paper tags, and put some facts about turtle nesting on the cooler so that other students can learn what you know about sea turtle nesting!

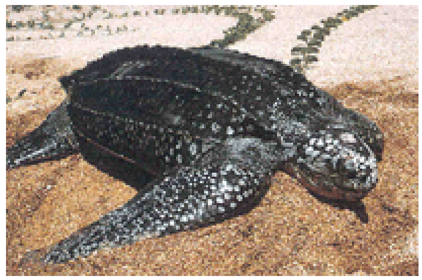
▼ Enrichment

1. Have students read the Arribada page, an excerpt from Archie Carr's book *So Excellent a Fishe.* Have the students draw the arribada. This section probably has a lot of new vocabulary; the students should be prepared to use the glossary often.

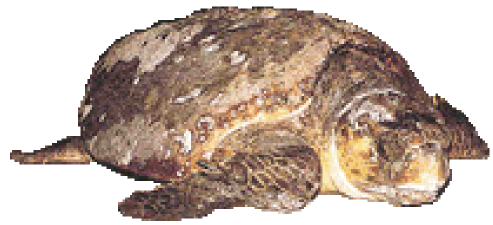
Turtle Tracks

hawksbill

leatherback



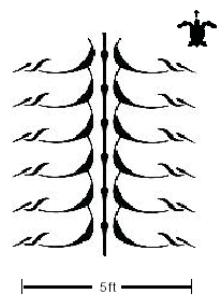
loggerhead

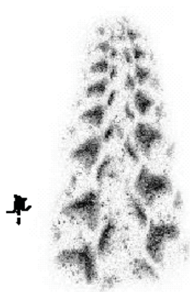


A. Parallel flipper marks as from a "butterfly-stroke" crawling pattern

B. Ridged track center with a thin, straight, and well-defined tail-drag mark that is punctuated by tail- point marks

C. Extensive marking from front flippers at the margins of the track And extending the total track width to 5 - 6 feet or greater

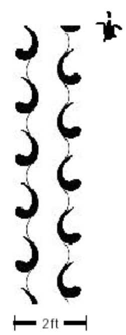


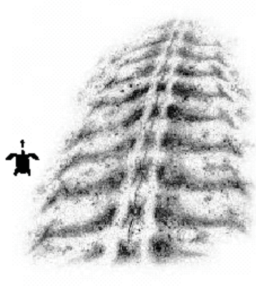


A. Alternating comma-shaped flipper marks

B. Wavy and smoothed track center with no thin, straight, and well-defined tail-drag mark

C. No regular marking from front flippers at the margins of the track

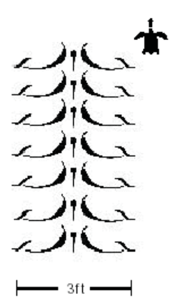




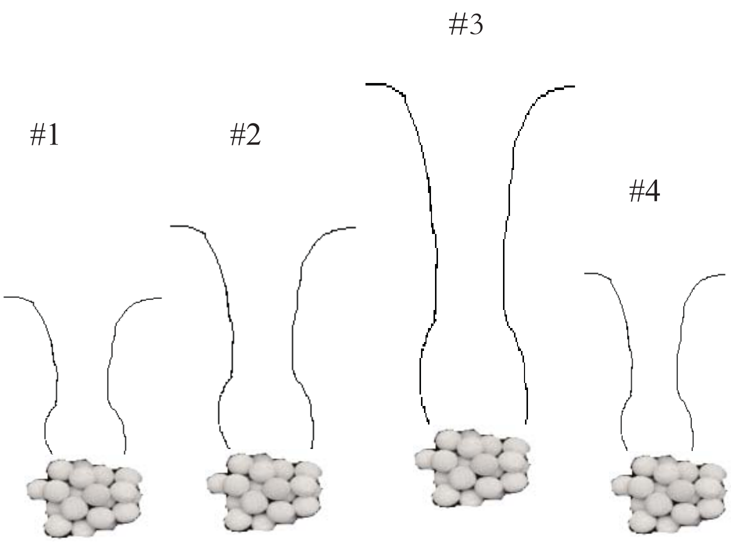
A. Parallel flipper marks as from a "butterfly-stroke" crawling pattern

B. Ridged track center with a thin, straight, and well-defined tail-drag mark that is punctuated by tail-point marks

C. Regular marking from front flippers at the margins of the track



Sex Determination



The Average Temperature is collected with "probes" or thermometers in each nest which record the daily average temperature (in degrees Celsius, ^{O}C). These values are used to calculate an Average Temperature over the length of the two-month incubation. Each species has a characteristic "pivotal temperature", which may vary slightly with latitude. The pivotal temperature is that temperature at which an equal number of male and female hatchlings are produced in the nest. If the average incubation temperature rises above the pivotal, females are likely to dominate.

Nest #	**Species (pivotal temperature)**	**Average Temperature**	**Predominant Sex of Hatchlings?**
1	Hawksbill (29.32 ^{O}C)	30.2 ^{O}C	
2	Green (28.26 ^{O}C)	29.6 ^{O}C	
3	Leatherback (28.47 ^{O}C)	27.6 ^{O}C	
4	Loggerhead (28.47 ^{O}C)	26.9 ^{O}C	

Arribada from "So Excellent a Fishe" by Archie Carr

The lights went out. A switch snapped and the screen lit up with an aerial view of a long, straight beach, bordered by broad surf, like lace between the ivory sand and the deep blue of a wind-whipped sea.

Then the scene changed and an airplane stood on the beach, and another was coming in for a landing. When the second plane stopped a man got out, walked a short distance, then began to dig up turtle eggs. Some more men appeared from somewhere and joined him beside a monumental heap of turtle eggs they had dug out of the sand.

It was the most turtle eggs I ever saw in one place. They were little eggs, obviously not those of a green turtle or a loggerhead and the next scene showed why, because suddenly a turtle was there busy with her work of digging a nest. The turtle was an Atlantic ridley. She not only was *Lepidochelys kempi*, which some people said didn't lay eggs at all, but she was out there in the full sunlight of a brilliant Mexican morning, violating the inflexible sea turtle custom of nesting after dark. So the turtle on the screen was not only the first Atlantic ridley I had ever seen digging any beach, but she was doing it by day, as if this were the only proper time for a sea turtle to lay her eggs.

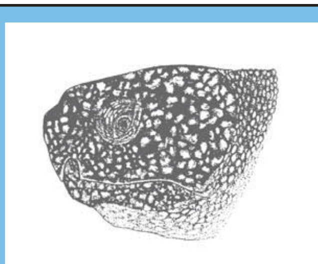
The scene on the screen cut to another turtle digging, then to a pair digging side by side; then to a turtle scraping sand to fill a finished nest. Then there came some **exasperating** footage of a man standing on a turtle to ride; and another man started catching eggs in his hands as a laying turtle dropped them into the nest. For some reason, people who watch sea turtles nest seem always bound to do those two things: catch eggs as they are dropped, and ride on the back of a turtle. I wasn't surprised when those men did it, but I was pretty impatient for them to get it over with. Every thing those turtles did was to my eyes a marvel; every slight **mannerism** was the material of dreams. The playful attitude of the Mexicans seemed **irresponsible**.

They kept at it though, for quite a few feet of precious film. Several more turtles came up from the surf together, and other men tried to stand on them. Finally, when I was ready to **rend** my garments, the cameraman tired of the horseplay. He turned his lens down the shore. And there it was, the arribada as the Mexicans call it – the arrival – the incredible crowning **culmination** of the ridley mystery. Out there, suddenly in clear view, was a solid mile of ridleys.

I don't know how many turtles the film actually showed. Dr. Henry Hildebrand, who found the film I am telling about, made a careful estimate of their numbers and decided there were ten thousand turtles on shore. Counting those clearly in view on the beach, and **reckoning** the average time it took a female to finish nesting, and the length of time there were turtles out on the beach that day, Henry calculated that the whole arribada had forty thousand ridleys in it. I have not gone through the sort of calculations he did, but just looking at the film I see no reason to think he overestimated. The **customary metaphor** to use in telling of great **abundance** of beasts is to say that one might have walked across a lake (or stream or plain) on their backs, or could have walked a mile without touching the earth. In the film you could have done this, literally, with no metaphoric license at all. You could have run a whole mile down the beach on the backs of turtles and never have set foot on the sand. And because sand was flying, and because ridleys are frisky, **petulant** nesters, as compared with green turtles, the scene was charged with feverish activity. The ridleys seemed more like **overwrought** creatures searching for something lost than like turtles about the business of **procreation**.

One male turtle in the film, for instance, was so taken up with the spirit of the occasion that he followed a female - one out of the ten thousand females – far up the beach, making **fervid**, unwelcome, and **futile** efforts to mount her all the way. Sea turtle mating normally occurs only in the water. Seeing it in the film like that heightened the air of unreality of the mad, **unprecedented** scene.

Navigation Obstacle Course 2D



Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
45 minutes
- **Enrichment** (optional)
30 minutes

Materials Needed:
- Copies of provided Background Information
- Pencil
- Compasses
- Tape measures

Setting:
Classroom, field or playground

Subject Areas:
Ecology, Anatomy, Language Arts

Skills:
Observation, Field Skills
Group Building

Vocabulary:
imprint
migrate
navigate

Summary

Students will learn how sea turtles navigate across oceans underwater and try to navigate an obstacle course just like a turtle would.

Objectives

Students will:
- Discuss two theories on how turtles **navigate** underwater.
- Use a compass and directions to **navigate**.

Why Is It Important?

Navigation like that performed by sea turtles and birds and other migrating animals continues to baffle science. As humans drastically alter the oceans, it is important to understand how turtles **navigate** in order to protect their migration pathways.

Background Information

Many theories have been suggested to explain the ability of some sea turtles to **migrate** through thousands of miles of open ocean, from feeding areas to nesting grounds. Evidence suggests that adult sea turtles will return to lay their eggs on or near the same beaches they emerged from as hatchlings. Some say that hatchlings taste the water upon first entering the sea, creating a unique memory of the chemical "fingerprint" of their birth beach which they then use 20 or so years later to find their way "home."

Another idea is that turtles "**imprint**" on the unique magnetic field of their home beach and use this information to **navigate** back. Still others think that turtles **navigate** by the stars or the sun, temperatures or currents.

Sea turtles have a substance called magnetite in small amounts in their brains; this same substance has been found in the brains of homing animals like pigeons and may explain how turtles can sense the earth's magnetic field.

The earth acts like a large magnet. It has a magnetic force that varies over the surface of the earth. This magnetic field is how we can tell "north" on a compass. The compass needle is magnetized and will always point north.

How turtles **navigate** such long distances in the open ocean is most likely a combination of several methods. Scientists are continuing to study sea turtles to find out how they do it!

The leatherback holds the record for migrations in the open sea. Adults swim about 16,000 kilometers a year, that's almost half way around the world!

Adult leatherbacks have a light patch of skin on their heads directly above the brain. It is thought that this "pink spot" may be a window into the brain, allowing the turtle to calculate day length and time of year. The pineal gland is the part of the brain sensitive to light, and therefore it plays a role in migration. Humans have a pineal gland, too, but it is buried deep within our brains!

Wild animals **migrate** for different reasons. They **migrate** to escape cold weather, to find food, to find mates, and to nest on tropical beaches.

All sea turtles **migrate**, but none as far as the leatherback. Hawksbill turtles, for example feed in the coral reef and so they rarely leave tropical waters. All sea turtles, however, seem to return to their home beach to nest, making very precise navigation necessary.

▼ Procedure

Warm Up

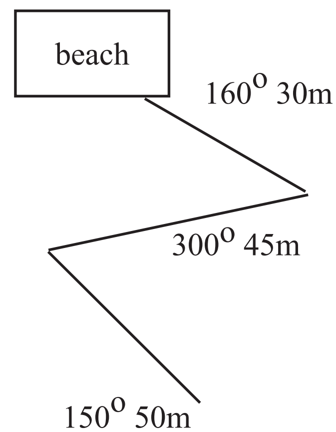
1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Can the students think of any other animals that **migrate**? Are there any birds that are present part of the year and then leave? Are there fish that swim through at a certain time of year? This "coming and going" may involve long distance migrations. Why do each of these animals **migrate**? Are they chasing food? Escaping cold? Reproducing?

▼ The Activity

1. Have the students work in pairs for this activity. Each student should pick an object on the playground or field to serve as the "home beach". Have the student start at the land mark and make a trail with several different straight sections in different directions leading away from the beach. The student should keep track of the compass heading and distance in each straight section of the trail. The student should reverse the compass directions 180 degrees so that the trail leads to the beach, not away from it. The student should write each section down as a compass heading and a distance.

2. Have each student give their trail information to the other student in the pair. They should try to use the compass and tape measure to find their "home beach". This is what it might be like to use magnetic cues to **navigate**! If compasses are not available, use landmarks (trees, buildings) as if they were stars. Instead of compass



headings, use landmark directions like: stand halfway between the two trees and walk 10 meters forward. This is (a little bit) like using the moon and stars for navigation!

3. What other information would the student need if he/she were going to find the "home beach" from very far away? How would you get that information?

▼ Enrichment

1. If you have access to the Internet, you can view the migrations of actual sea turtles. Compare the leatherbacks to other turtles. How far did they go? One place to access these tracks is http://www.cccturtle.org/sat1.htm

2. Have students read Longest Migration, the included article about arctic terns, which have the longest migration in the world! Compare and contrast tern and turtle migrations. How are they different? Similar? What cues do the birds rely upon?

Longest Migration (Enrichment)

One Good Tern Deserves Another

(Arctic, That Is)

The Arctic Tern is a small bird that is about 12-15" in length and weighs under 2 pounds. However, this little avian wonder can claim the "Longest Migration Award," travelling from the far northern polar regions down to Antarctica!

Terns are in the *Laridae* family, along with Jaegers and Gulls. The Arctic Tern *Sterna paradisaea,* is medium-sized, as terns go, white body with a black smooth and rounded head, short legs, and a slender short bright orange beak that will turn to red during breeding season. Its long tail is deeply forked while its wings have a dark trailing edge to them. An Arctic Tern's feet are small and webbed. Both male and females are similar in appearance, attaining full adult plumage in their third year.

During breeding season, these terns are throughout the polar regions above the 50th parallel in the Arctic Circle, forming colonies from 50 to thousands of pairs of birds. One to two small eggs are laid in the grass or sand, incubated by both the male and female. The chicks, which hatch after about 22 days, are fed shrimp, insects and small fish caught by their parents. The terns will aggressively defend their young and nesting areas from other birds as well as people. In around 25 days, the young terns have fledged and are able to fly.

Arctic Terns spend much of their life in the air. Catching fish, they will hover in the air and then dive to the water surface, grabbing their meal. Insects are caught as they gracefully swoop through the air. They may even feed their young while hovering.

Arctic Terns **migrate** over the sea and are rarely seen from land except during breeding season. It is said that their migration path is over 22,000 miles (35,000 km) each year and may be the longest avian migration. Because of their migration timetable, Arctic Terns are thought to be in daylight longer than other birds. As the late summer days get shorter, the Arctic Terns begin their migration south, leaving their breeding area only around 90 days from the time they arrived in the Arctic. From North America, they will travel across the Atlantic Ocean to southern Europe, down the coast of Africa to the Antarctic or sometimes back to South American and then south down to the Antarctic regions where it is summer and food is plentiful.

Taken from:

Tarski, Christine (2002) http://birding.about.com/library/weekly/aa020700a.htm

Sea Turtle Diving Profiles 2E

Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
45 minutes
- **Enrichment**(optional)
30 minutes

Materials Needed:
- Copies of provided
Background Information
Dive Data
Graph Paper
- Pencil

Enrichment:
- Eye dropper
- Plastic soda bottle
- Cup

Setting:
Classroom

Subject Areas:
Ecology, Anatomy, Language Arts

Skills:
Observation, Analysis, Field Skills, Statistical Analysis, Report Drafting

Vocabulary:
correlation
pressure
trend

Summary

Students will learn how and why sea turtles dive to extreme depths, and plot the diving profile of two leatherback turtles.

Objectives

Students will:
- Describe two adaptations that help a sea turtle dive.
- List two reasons why sea turtles dive, and what makes the various turtles different.
- Plot diving data on a graph.

Why Is It Important?

As with navigation in the previous activity, sea turtles can dive to depths, and for lengths of time unthinkable to human beings. Most of our deep-diving equipment can't venture as deep as a leatherback sea turtle! By learning a little bit more about turtles - what they eat, where they live, and how they live - we also learn a little bit about ourselves and we can study the differences between humans and turtles. Let's say that fisheries managers want to stop the accidental catch of sea turtles in fishing nets. The managers want to know what time of day the turtle is most likely to be shallow, and what time of day the turtle is most likely to be deep. With this information, he/she can make more effective rules about fishing. Studying diving behavior can help answer these questions.

Background Information

Even before we had sophisticated equipment that allows us to track the dives of turtles in the ocean, scientists suspected deep diving capabilities, especially in leatherbacks. Stomach contents showed that leatherbacks ate deep water jellyfish and siphonophores (a close relative of the jellyfish). Leatherbacks also have skeletal similarities to deep diving marine mammals like whales and some seals.

While all sea turtles dive to get food, escape predators and perhaps regulate their body temperature, leatherbacks are particularly impressive divers. Adult females are known to reach depths exceeding 1000m in the Caribbean.

Shallow diving, air-breathing organisms, like humans, usually inhale before a dive and store most of the oxygen for that dive within their lungs. Before you dive underwater what do you do? Where do you keep the air you will use underwater?

In contrast, the leatherback sea turtle is adapted to store much of the oxygen it needs for deep-diving within its blood and other tissues. Loggerhead sea turtles can hold 25% more oxygen in their lungs than leatherbacks can, but hold less than half as much oxygen in their blood and tissue as a leatherback.

One of the limitations for humans (and most animals) during deep diving is the increasing **pressure** as you go deeper. At the surface of the ocean, the **pressure** felt on your body is 1.05 kg/cm. This is the **pressure** you feel everyday on land, but as you go deeper underwater the **pressure** increases. At shallow depths this **pressure** is what causes your ears to pop!

At 1000 meters, close to a leatherback's deepest recorded dive, the **pressure** is 105 kg/cm, 100 times the **pressure** you feel above the water. Imagine 100 kg lying on top of you. That is what the **pressure** is like at 1000m.

A leatherback is specially designed for these depths both because of its oxygen storage and because it does not have a hard shell. The leatherback's shell compresses as it dives, keeping the turtle from being crushed by the **pressure**. The reason for the leatherback's flexibility is that its ribs are not fused together to form a hard bony shell.

It is commonly thought that leatherbacks are following their food when they dive. Why else might diving be a good idea for the relatively soft-bodied leatherbacks?

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Have the students think about the last time they went swimming. Have you ever been diving underwater? What happened? If you were wearing a mask, did it press against your face? Why? Did your ears pop? Why?

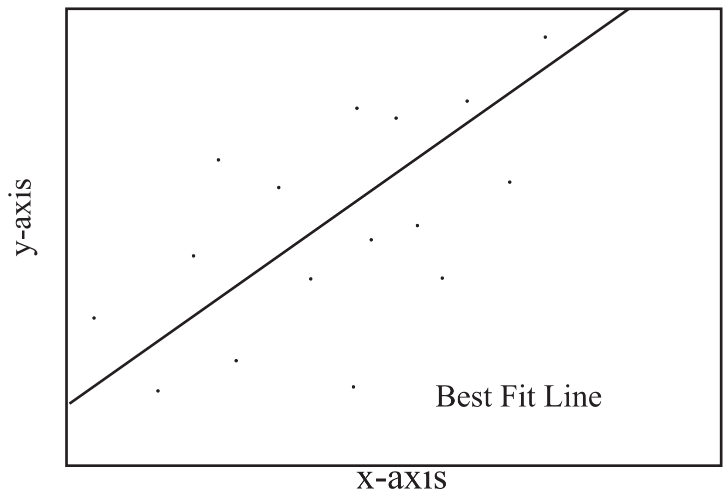
3. Have you prepared to go underwater by taking quick shallow breaths before you took a big breath to go under? What purpose do you think this serves? Why would a deep diving animal not want to store oxygen in its lungs? Why do humans rely so heavily on lungs for oxygen storage?

The Activity

1. Copy and distribute the Dive Data page and the Graph Paper page to each student. Have the students work individually for this activity.

2. Have the students set up their graph paper as follows:
   - A title at the top
   - An X-axis title at the bottom (dive depth)
   - A Y-axis title along the left hand side (dive time)
   - The X-axis should start at the shallowest depth recorded for both turtles and end at the deepest depth recorded. The meters should be evenly divided between the squares on the graph paper.
   - The Y-axis should be set up the same way for dive time.

3. Use the Dive Data sheet to plot the depth of each dive v. the dive time. Try to draw a "best fit" line through the dots that shows the **trend**. Do this for both turtles on one sheet, using a different color for each one. Answer the questions on the data sheet.



Enrichment

1. If you have access to eye droppers, a plastic soda bottle, a cup and water, you can simulate how animals and submarines dive.
2. Fill the plastic bottle and the glass almost to the top with water.
3. Fill the dropper with enough water by squeezing the bulb so that the top of the bulb floats at the surface of the water.
4. Now place the full dropper in the plastic soda bottle and attach the top
5. Ask the students to predict what will happen when the soda bottle is squeezed. When it is released?
6. Squeeze the soda bottle and watch what happens to the eye dropper.
7. Discuss what changes the squeezing caused that made the dropper move.

Dive Data

Turtle 1 = night time

Dive #	Dive Depth (m)	Dive Time (min)	Surface Time (min)
1	46.3	8.9	4.0
2	62.7	10.4	4.7
3	36.5	6.7	4.7
4	119.8	15.9	14.0
5	152.1	17.2	39.9
6	152.5	16.6	10.3
7	130.1	15.4	9.8
8	121.2	15.2	8.6
9	103.7	13.3	7.2
10	113.2	13.4	5.0

Turtle 2

Dive #	Dive Depth (m)	Dive Time (min)	Surface Time (min)
1	57.1	10.2	3.6
2	51.4	11.2	2.8
3	28.1	5.6	11.5
4	30.4	4.0	11.2
5	64.0	14.3	8.1
6	81.1	10.7	19.0
7	125.2	12.2	14.6
8	123.3	12.4	27.5
9	123.6	12.8	21.3
10	131.4	12.9	11.0

Source: Eckert, S., D. W. Nellis, K. L. Eckert, and G. L. Kooyman.1986. Diving Patterns of Two Leatherback Sea Turtles During Internesting Intervals at Sandy Point, St. Croix, US Virgin Islands. Herpetologica 42(3):381-386.

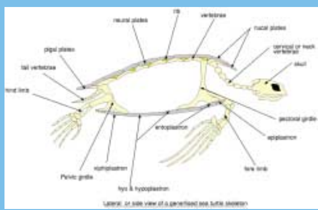
Questions:

1. Does it seem that the longer the dive, the deeper the dive from your graph? Just by looking at the data above, do leatherbacks seem to dive deeper during the day or the night? Can you guess why?

2. Does the **trend line** seem to be a good fit? Are there many points far away from the line? The closer the data points are to the line you've drawn, the better the "fit". If there is a lot of scatter around the line, the relationship between the information represented along the x-axis and the y-axis is harder to predict.

3. Is there a **correlation** between dive time and surface time? Can you guess why (or why not)?

Turtle Quiz Show 2F



This activity can be used at any time, simply change the questions!

■ **Preparation Time:**
30 minutes

■ **Activity Time:**
• **Warm up**
30-45 minutes
• **Activity**
45 minutes

■ **Materials Needed:**
None

■ **Setting:**
Classroom

■ **Subject Areas:**
Ecology, Anatomy

■ **Skills:**
Group Building, Comprehension

Summary

Students will recall sea turtle knowledge by playing the Sea Turtle Quiz Show.

Objectives

Students will:

- Recall important sea turtle facts from earlier lessons

Procedure

Warm Up

1. Make five columns on the blackboard titled: Adaptations, Diving, Navigation, Nesting, and Life Underwater. Make six rows so that there are six squares in each column. Label the six rows with point values.

2. The questions are included on the pages labeled Quiz Show Questions. These are for the instructor to use so she/he can read the questions to the class.

The Activity

1. Reproduce the table below on the blackboard or a large piece of paper in the front of the classroom. Split the class into three teams and have each team stand in a line facing the board.

2. Give the three students in front three different objects to make noise with (a coin hitting a can, etc.) so they can "ring in".

3. The three students in the front of the line play first. They choose a category and value. The instructor reads the question. The first student to ring in must answer the question, to earn the points. If he/she cannot answer the question the second to ring in can have a chance to answer it. The students cannot get help from their teammates. Ask the other students to keep the answers to themselves. After all the students have played, the highest scoring team wins.

Adaptations	Diving	Navigation	Life Underwater	Nesting
100	**100**	**100**	**100**	**100**
200	**200**	**200**	**200**	**200**
300	**300**	**300**	**300**	**300**
400	**400**	**400**	**400**	**400**
500	**500**	**500**	**500**	**500**
600	**600**	**600**	**600**	**600**

Quiz Show Questions

Adaptations:

100 – Sea turtles have special adaptations in order to live where?
- underwater

200 – Name two adaptations sea turtles have for swimming.
- example: flippers, flattened shell, streamlined form, enlarged chest muscles, breath-holding

300 – Are sea turtles more closely related to tortoises or to whales?
- tortoises (whales are mammals, not reptiles)

400 – Adaptations help an organism to do what?
- survive and reproduce in a particular environment

500 – A hawksbill's shell pattern helps to hide the turtle. This is known as what?
- camouflage

600 – Are a bird's wing and a butterfly's wing analogous or homologous?
- analogous

Diving:

100 – Which is the deepest diving sea turtle?
- leatherback

200 – What food items are leatherbacks chasing when they dive?
- jellyfish (or related animals such as siphonophores)

300 – Name two adaptations that leatherback sea turtles have for diving.
- ability to store oxygen in the blood and tissues (to avoid the bends), powerful flippers, flexible carapace, streamlined body form

400 – Do leatherbacks dive deeper at night or during the day?
- day

500 – How deep can leatherbacks dive?
- at least 1000 meters

600 – Is there a correlation between dive time and surface time with the leatherback data you analyzed?
- yes

Nesting:

100 – Do all sea turtles walk with the same "gait" on land?
- no

200 – What are two ways to tell turtle tracks apart?
- the size (width), and whether the flipper marks are symmetrical or not

300 – What determines the sex of a baby sea turtle?
- temperature during nest incubation

400 – How can humans affect the balance of sexes in sea turtle populations?
- cut down vegetation or otherwise alter beach temperatures

500 – What is the name of the mass nestings of some turtles?
- arribada, Spanish for "arrival"

600 – Which sea turtles nest in an arribada?
- the ridleys: Kemp's ridley and olive ridley

Navigation:

100 – Do sea turtles navigate well or poorly?
- well

200 – Name two areas that sea turtles might migrate between.
- feeding grounds and nesting grounds, mating grounds and nesting grounds

300 – Name two ways that turtles might navigate.
- stars and moon, magnetic compass, wave compass, current patterns

400 – True or False, sea turtles nest on a different beach every year.
- false

500 – What is the name of the gland under the "pink spot" that leatherbacks may use to assess day length and helps in navigation?
- pineal gland

600 – Which sea turtle species has the longest migration?
- leatherback

Life Underwater:

100 – Do sea turtles have gills or lungs?

- lungs

200 – Do adult sea turtles use their back flippers for moving forward?

- no, they use them to steer and to dig nest holes

300 – How do sea turtles get rid of the salt from the water they drink?

- it is excreted in "tears" from tear ducts in the eyes

400 – Are sea turtles endothermic or ectothermic?

- ectothermic

500 – What makes sea turtles ectothermic?

- they use behavioral means (like basking) to regulate body temperature

600 – The word that describes the amount of salt in sea water is what?

- salinity

Unit 1 and 2 References

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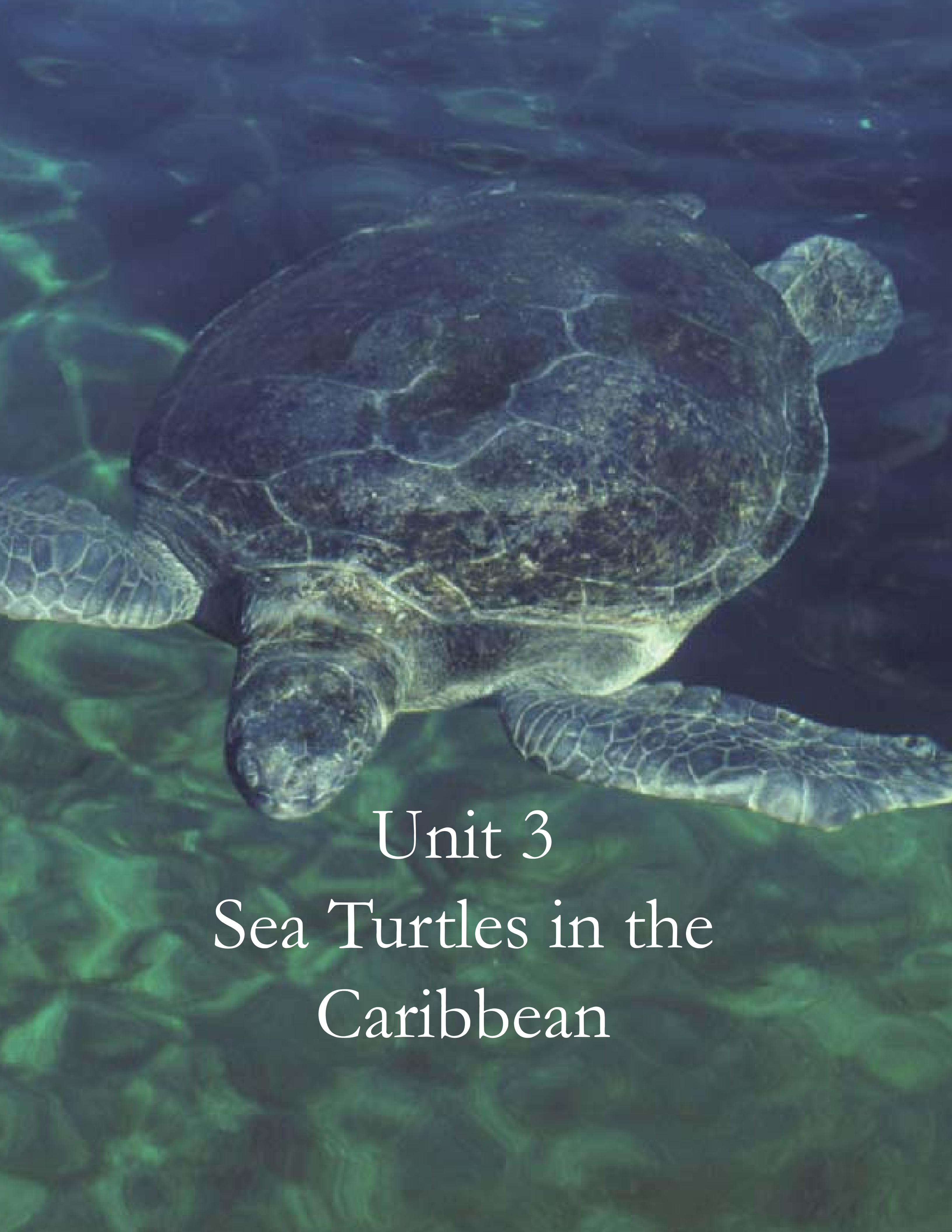
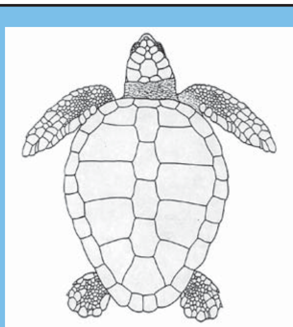


Unit 3
Sea Turtles in the Caribbean

Natural History of Sea Turtles 3A



■**Preparation Time**:
10 minutes

■**Activity Time**:
• Warm up
30-45 minutes
• Activity
45 minutes
• Enrichment (optional)
60 minutes

■**Materials Needed**:
• Copies of provided
Background Information
"Leatherback Picture"
"Life cycle Cutouts"
"Adaptation Cards"
• Pencil and scissors

■**Setting:**
Classroom

■**Subject Areas:**
Caribbean History, Literature, Ecology

■**Skills:**
Research Skills, Analysis, Scientific Writing, Comprehension, Public Speaking

■**Vocabulary:**
ectothermic
recruit

▼ Summary

Students will recreate the life cycle of a sea turtle and discover the origins and adaptations unique to sea turtles.

▼ Objectives

Students will:
- Compare sea turtles to other reptiles.
- List 3 adaptations sea turtles have for living underwater.
- Be able to correctly construct a sea turtle's life cycle.

▼ Why Is It Important?

One of the reasons that sea turtles are difficult to manage and protect is because scientists know so little about them. If scientists do not know how many hatchlings are needed to maintain a breeding population, how can he or she know what nest conservation steps to take? Taking care of these animals means understanding them, including how they are similar to other animals and how they are different. These activities will provide a basic understanding of the natural history of sea turtles.

▼ Background Information

Turtles first appeared on land more than 200 million years ago. The oldest sea turtle fossil dates back about 112 million years. By around 65 million years ago, four distinct families of sea turtle roamed the world's seas.

All turtles, including sea turtles, are reptiles. Reptiles are a part of the Animal Kingdom and are generally **ectothermic**, or cold-blooded. Other marine reptiles include saltwater crocodiles, marine iguanas and sea snakes.

Each type of reptile has adapted to its habitat. Sea turtles have flippers in order to swim in the ocean while tortoises are land turtles with thick legs for body support and walking. Freshwater turtles have webbed feet for walking and for swimming in lakes and streams.

Turtle ancestors developed a hard shell as a type of armor to protect them against the predators that existed millions of years ago. When turtles developed a shell, it meant a loss of flexibility in the body. The advantage, however, was that the large domed shell created room for pulling the head and limbs inside the shell, thereby protecting the turtle. To return to the ocean, several modifications or adaptations were necessary. For example, the large boxy shell needed to be streamlined. But there was a trade-off: the streamlined shell means that sea turtles are unable to pull their head and limbs inside their shell.

Sea turtle eggs, however, never adapted to life underwater, so the females have to return to land in order to lay eggs. But now the sea turtle's body is not built to move on land! Sea turtles are slow and vulnerable when they are on the beach and so they often nest at night when it is safer.

Sea turtles start their lives on land as tiny hatchlings protected by a leathery egg. After the hatchlings emerge from the nest and make it to the water, male sea turtles will never return to land, while females will return many times in their adult lives to lay their own eggs.

"Life history" is the history of changes in an organism's life, from birth to its natural death. It turns out that sea turtle life history is pretty consistent across species. In all cases, eggs are laid in a cavity dug in the warm sand of a suitable nesting beach. Incubation typically lasts 55 to 70 days, at which time the hatchlings move cooperatively toward the surface, emerge from the sand, and scramble to the sea. There is no parental care, meaning that the female does not stay with the eggs or hatchlings to care for them.

Once at sea, the hatchlings gain nourishment (food) from a yolk sac within. They do not stop to feed, but instead they undertake a "swim frenzy" that lasts several days and is designed to take them past nearshore predators and into the open sea. It is there that they spend the first several years of their lives, seeking shelter in floating seaweeds and other flotsam, before returning to nearshore waters as young juveniles, about the size of a dinner plate. Most species are highly mobile during the decades spent as a juvenile and subadult, moving freely among the waters of many Caribbean nations.

At sexual maturity the sea turtle will **recruit** into the adult population and eventually migrate to mating and nesting areas. Evidence suggests that, after mating, the egg-laden female returns to the general coastal area where she was born. Most return to the same beach! The female digs a nest cavity and the cycle starts anew. When she has finished egg-laying, nesting as many as 12 (but more likely 3-6) times during the nesting season, she will return to her "adult habitat", which is her preferred feeding area. Her adult habitat might be hundreds or thousands of miles/km from her nesting beach. She will make this migration every 2-5 years for the rest of her life.

▼ Procedure

Warm Up

1. Pass out copies of the Background Information as a reading assignment, or read it aloud.

2. Discuss adaptation. What adaptations do you have that help you to live on the land? The same way that humans have a lower metabolism when we are asleep, sea turtles can slow their metabolism. This helps them stay underwater for long periods of time.

3. Scientists have recorded green sea turtles holding their breath for up to 5 hours. How long can the students hold their breath? Why can't humans hold their breath for 5 hours?

▼ The Activity

1. Copy the Turtle Adaptation cards and cut them along the dotted lines to make 20 cards. If more are needed, make multiple copies of each card. Keep a copy of the cards so that you can give hints to the students as they do the activity. Shuffle the cards and give each student one card. Tell the students that they each have a description of a turtle adaptation on their card. Some cards describe a sea turtle and the others describe a terrestrial box turtle.

2. Students are to find, and stand next to, others whose cards are describing the same turtle (box turtles stand next to box turtles, sea turtles stand next to sea turtles).

3. Students cannot show their cards to anyone, but must read the information to another student when requested. Give the students a time limit such as three minutes to perform this task. In the end there will be two groups. Have each group present their turtle to the other group.

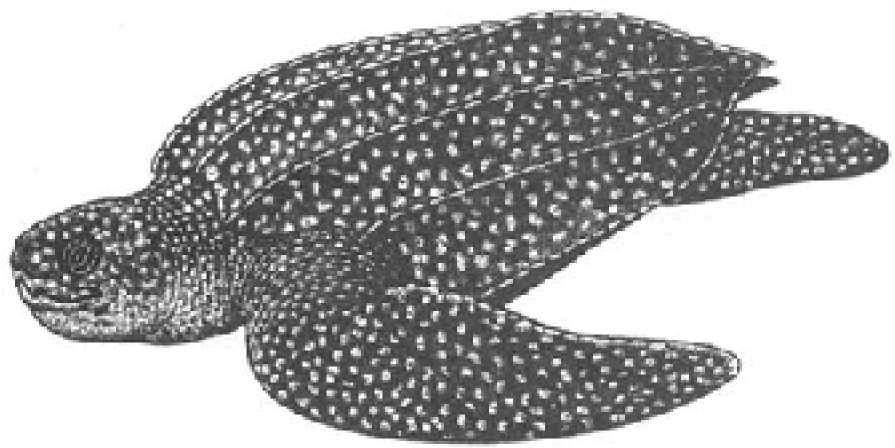
4. Copy the Life cycle Cutouts page and have the students cut out the eight pieces of the life cycle. Students can work in pairs to try to fit the life cycle of a sea turtle together. An answer key is provided.

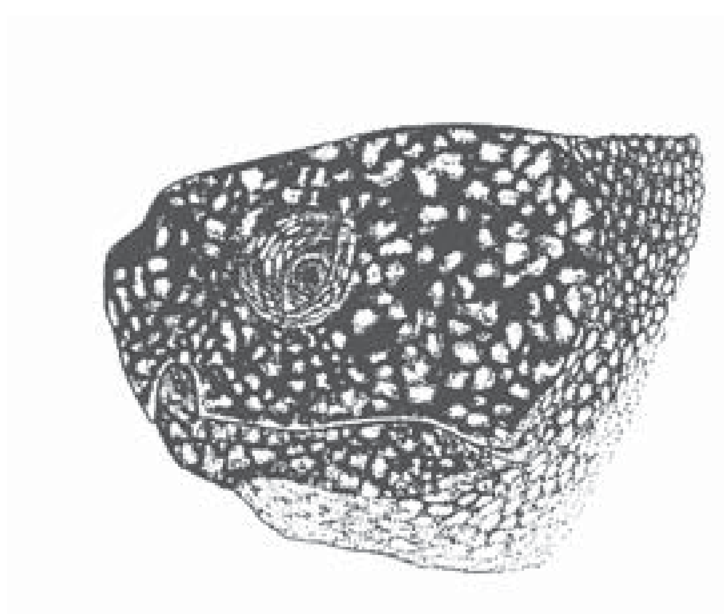
▼ Enrichment

1. Have each student write a short essay that identifies and discusses any 5 adaptations that sea turtles have that make them different from land turtles, or able to live in the water.

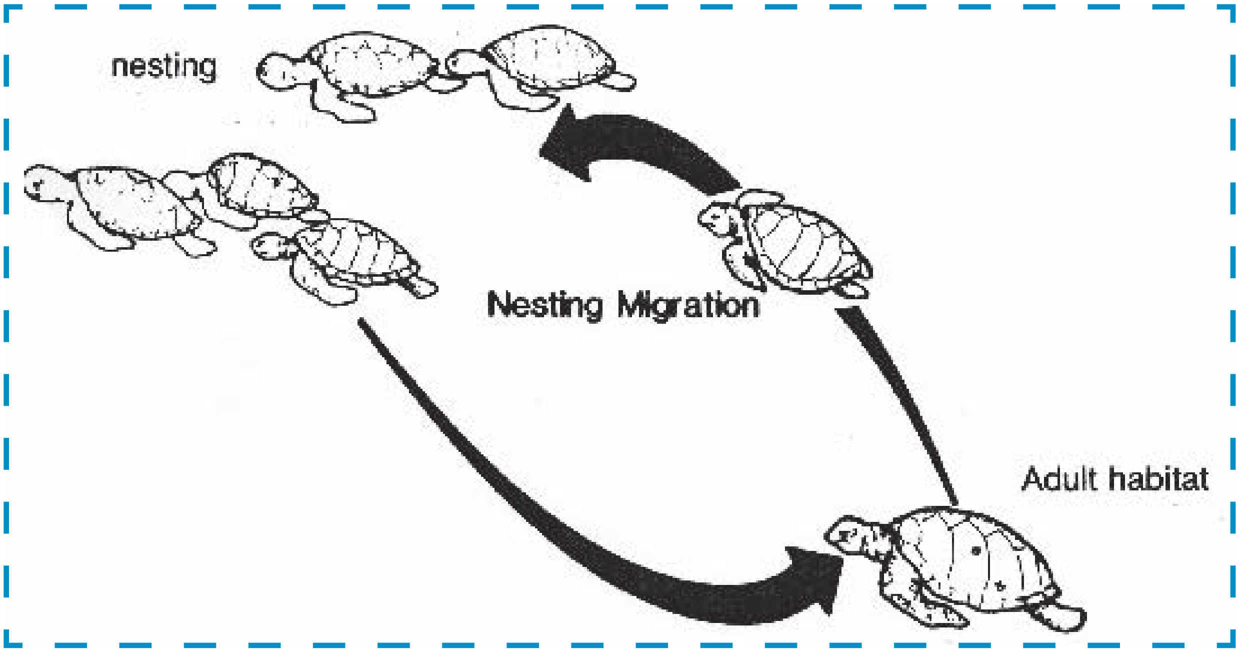
2. Have the students study the Leatherback Picture Have them describe the turtle out loud and name adaptations they see. Why does the shell have ridges? Why are the rear flippers smaller than the front flippers? Why is the jaw notched?

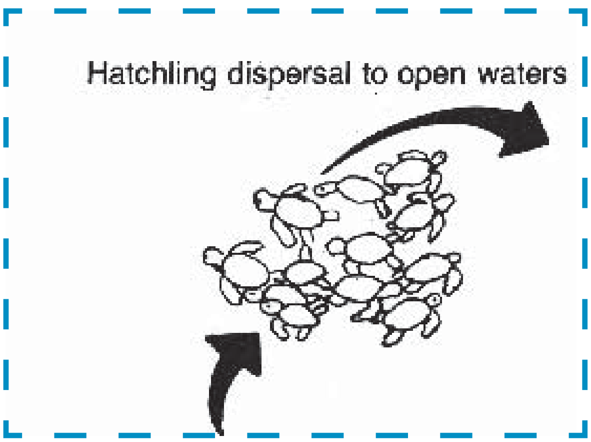
Leatherback Picture

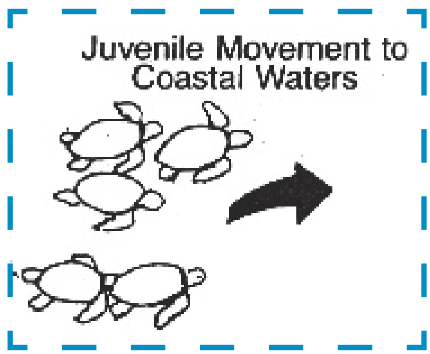


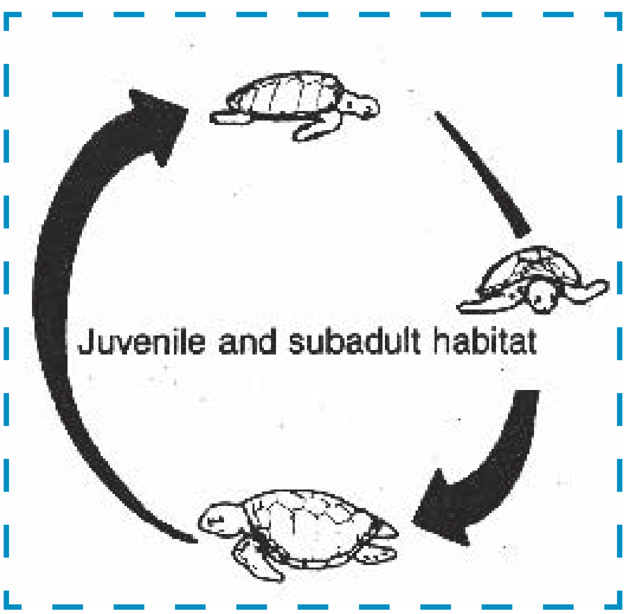


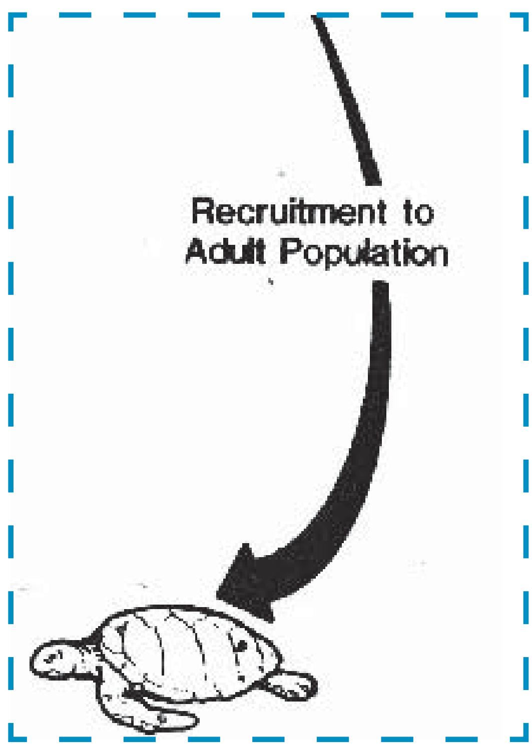
Life cycle Cutouts











Turtle Adaptation Cards (sea turtle)

As an adult my average weight is around 160kg and I am usually over 1 meter long. My large size deters most predators and helps retain my body heat.

I am cold blooded, which means I depend on outside sources of heat to maintain my body temperature. This is one reason I am normally found in tropical water.

The top part of my shell is somewhat flattened to help me swim. Scutes cover my shell. The rear edge of my shell is particularly thick, which may offer some protection from sharks.

Even though I spend most of my life in the water, I do not have gills. I have lungs. I can hold my breath for several hours. During long periods underwater my metabolism slows down and my heart beats as little as one beat every nine minutes.

Four flippers power me through the water and help me crawl on land. I use my long front flippers to propel myself, and my short rear ones to steer and change directions. I also use my rear ones for digging.

As adults we spend our entire lives in the water except in the summer months when females of our species crawl onto the beach to lay eggs. Males of my species almost never come out of the water.

Females lay soft, leathery eggs that look like table tennis balls. The leather shell prevents breakage and allows oxygen into and out of the egg. This is important because when we finish laying the eggs, we bury them with sand!

I get all my water through the foods I eat and the salt water I swallow. I have special glands that remove and store excess salt. I periodically excrete excess salt from these glands through tear ducts. It makes it look like I am crying.

I do not have any teeth. Instead I have a sharp-edged jaw with a beak at the tip. This allows me to crush shelled animals and pick out the meat with my beak.

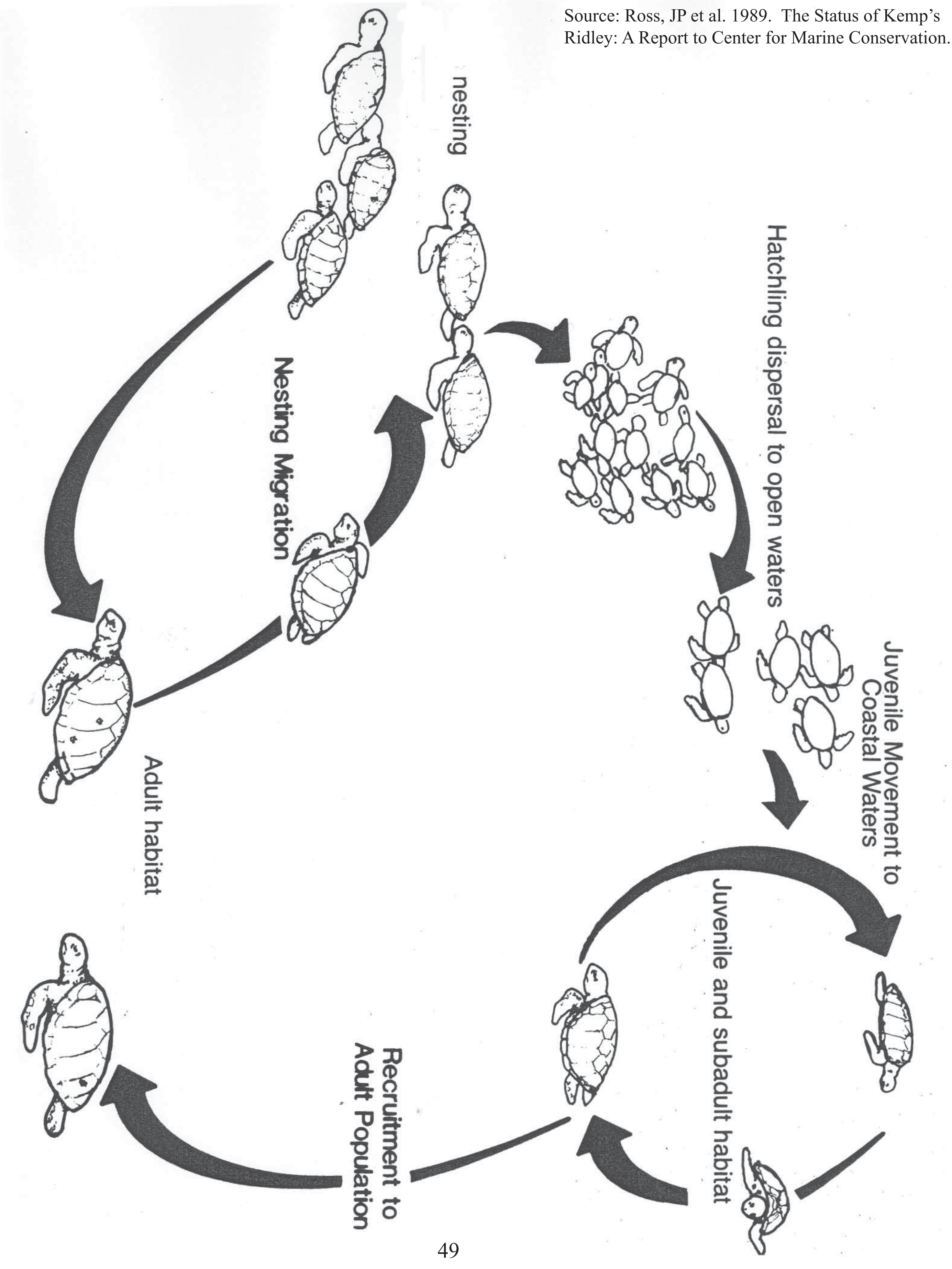
As a hatchling, I escaped from ghost crabs, dogs and people. So far I have managed to avoid sharks, large fish, boats, pollution and other dangers. It is estimated that fewer than one out of 1,000 of my kind survives to adulthood.

Turtle Adaptation Cards (box turtle)

Young of my species are about the size of a quarter and are vulnerable to predators, such as snakes and dogs, until their shells develop at four years of age	I do not have teeth. Instead, I have a sharp-edged jaw that is tipped with a beak. This allows me to feed on a wide variety of plants and animals that live in the forest
When cold weather sets in, I bury myself about two feet under loose soil and leaves to hibernate. This eliminates the need for me to travel long distances in search of warmth.	Most animals must seek shelter or maintain a burrow, nest or other form of shelter. Not me, I carry mine on my back! This is one reason I am able to stay on the move. I do not have to worry about shelter, just food.
Flowers depend on me to disperse the seeds from their fruit which I eat.	I am omnivorous, which means I eat both plants and animals. My diet includes snails, slugs, beetles, worms, spiders, berries, fruit, fungi and mushrooms.
Males of my species have hind claws that are shorter, stockier and more curved that the females' claws. Males also have longer thicker tails and a shallow depression on their **plastron**. Males usually have red eyes, while females' eyes are brown.	A long time ago, native people killed my species for food and used our shells for rattles. Some even buried us with the dead!
Females of my species dig a nest in the forest soil and lay a clutch of three to eight soft, leathery eggs. Up to three clutches may be laid in a season, from the months of May through July.	As an adult I am 4 to 6.5 inches in length. My small size and camouflage make it hard for predators to detect me.

Sea Turtle Life Cycle Answer Key

Source: Ross, JP et al. 1989. The Status of Kemp's Ridley: A Report to Center for Marine Conservation.



Caribbean Sea Turtle History 3B

Preparation Time:
10 minutes

Activity Time:
- Warm up
30-45 minutes
- Activity
45 minutes
- Enrichment (optional)
60 minutes

Materials Needed:
- Copies of provided
"Background Information"
"Columbus' Logs"
"Make a Log Book"
- Pencil, paper

Setting:
Classroom

Subject Areas:
Caribbean History, Literature, Ecology

Skills:
Research Skills, Analysis, Scientific Writing, Comprehension

Vocabulary:
delicacy
exploitation
natural resource
pre-Columbus
renewable
rookery

Summary

Students will become familiar with the history of sea turtles in the Caribbean region, and interpret primary sources.

Objectives

Students will:
- Describe historical numbers of sea turtles in the Caribbean.
- Compare historical accounts.
- Interpret historical logs.
- Write creatively about the history of the Caribbean.

Why Is It Important?

Turtles were and continue to be an important resource for humans living in the Caribbean, but what did the region look like before now? Were there more turtles or fewer? Only by finding out about the past can we learn to interpret the present. Historical information broadens our understanding of the status, value and potential of **renewable** resources.

Background Information

History shows that Caribbean marine ecosystems were extremely degraded by the early 1900s. The green turtle, hawksbill turtle, manatee and (now extinct) Caribbean monk seal were dramatically reduced by about 1800.

Estimates of **pre-Columbus** human populations in the Caribbean vary, but the populations of Jamaica and Cuba are estimated to have been in the hundreds of thousands of people. These early native people were reduced by conquest, slavery and disease to only a few thousand by 1600, and European settlement was slow. Interestingly, we can deduce that the actual population of the area was low during the period in which the most sea turtles may have been hunted and killed.

Sea turtles were once abundant in the waters of the Caribbean. In 1503, on his fourth and last voyage to the Caribbean, Christopher Columbus reported that his ship came "…in sight of two very small and low islands, full of tortoises, as was all the sea about, insomuch that they looked like little rocks, for which reason those islands were called Tortugas." These islands, later renamed the Cayman Islands, were once the site of one of the largest green turtle nesting colonies (rookeries) in the world.

The Taino and Carib natives who lived in the Caribbean islands at the arrival of European explorers used sea turtles for food, but seem only to have hunted enough for food, household items, and some trade between their small populations. Middens, or trash piles from more than 1000 years ago in the Caribbean, contain turtle bones.

Much of the early activity by Europeans in the Caribbean was dependent in some way on turtles. The meat and eggs provided a seemingly endless supply of protein, and turtles could be kept alive on ships for long voyages. Turtle oil was used for cooking, lamp fuel and as a lubricant. Turtles were shipped to Europe, particularly England where the meat was considered a **delicacy** and the gelatinous "calipee" found along the lower shell was made into soup. By 1878, an estimated 15,000 turtles a year were being shipped to England from the Caribbean. By 1940 the populations were much reduced, with once enormous rookeries, such as in the Caymans, destroyed.

Sea turtles seem to have been extremely common and widespread throughout the Caribbean region before European trade began in the 1500s. Based on evidence of sea grass cover, some published estimates of the numbers of green sea turtles that lived in the Caribbean **pre-Columbus** range up to 660,000,000!

▼ Procedure

Warm Up

1. Copy and introduce the Background Information as a reading assignment or read it aloud in class.

▼ The Activity

1. Use the Make A Log Book instructions page to have each student turn a piece of paper into an explorer's log. Have each student write their name on the front, title it, and decorate it as they wish. The students will use these log books to record the rest of the activities.

2. Read Columbus' logs and answer the following questions in the log book. Have students label the page appropriately:
   In the first voyage entry, the log says that the turtles are doing what?

   - What time of year is it?
   - On the first voyage, Columbus mentions sirens. What did he think they were? What do you suppose they actually were?
   - On the second voyage what does Columbus describe the turtles doing? How does the native fisherman catch a sea turtle?
   - On the second voyage, on the 11th of June, what kind of turtle do you think Columbus is describing, and where are they?
   - What creature do you think the explorers saw and were mystified by in the last entry? What did Columbus think that the sighting meant?

3. Each student should choose a plant or animal to "discover" for the class. Have each student, while looking at their plant or animal, write as if they are documenting it for their country for the first time today! Have them describe what they hear, see, smell and feel. Have them describe the plant or animal thoroughly, including where it was discovered and what it was doing.

   The "discovery" should be recorded in a separate labeled section in the log. Have the students pretend to be an explorer when they write and include drawings if they wish. They must also name their plant or animal! (Many explorers named new plants and animals after themselves, the expedition sponsor, or the place the species was first found!)

4. Students should read their logs aloud to the class.

▼ Enrichment

1. Have the students write a short essay that tells the full story of sea turtles in the Caribbean. Include facts, descriptions and quotes from the activity.

2. Have each student write a description or draw a picture of what their country would be like if there were millions of sea turtles in the water. What would be different. Would it cause any problems? Would the numbers stay that way for long?

Columbus' Logs

1st Voyage 1492-1493 Thursday, 10 January 1493

At midnight I raised sails with the wind SE and sailed to the ENE. I reached a point exactly east of Monte Cristi [in Cuba] some 45 miles. In the shelter of this point I anchored at 3 o'clock in the afternoon. I dared not depart from there at night because of the many reefs. The water inside is very deep and forms a secure anchorage against all winds.

In this country there are many [sea turtles]; the sailors captured some of them that had come ashore to lay their eggs at Monte Cristi. They are large, like great wooden shields. Yesterday, when I was going to the Rio del Oro, I saw three sirens that came up very high out of the sea. They are not as beautiful as they are painted, since in some ways they have a face like a man.

2nd Voyage 1493-1496

…On other islets, they saw a great number of turtles and turtle eggs which are like hen's eggs, though their shells are not very hard. The turtles lay these eggs in holes which they make in the sand. These they cover and leave until the heat of the sun hatches the young turtles, which grow with time to the size of a buckler and some to the size of a large shield. In one of the channels they saw a canoe, with Indian fishermen who remained calm and…signed to them to wait a little until they had finished their fishing. Their method was this: they tie thin cord to the tails of certain fishes which we call "remora" and send these after the other fish. These remora have a rough patch on their heads which extends down the spine and attaches itself to any other fish that comes near. Our men saw these fisherman bring out a turtle to whose neck this fish had attached itself.

For the next day, which was 11 June, in order to bring the ship from one channel into another deeper one, the Admiral had to have it towed with ropes over a sandbank where there was not a fathom of water and which was two shop-lengths wide. Drawing closer to Cuba in this way they saw turtles three to four feet long in such vast numbers that they covered the sea.

As they continued on their voyage, the Admiral and his men saw a fish in the sea as big as a whale. It had a large shell on its back, like that of a turtle, and kept its head, which was the size of a barrel, out of the water. It had a tail like that of a tunny fish, very long with a large fin on either side. By the presence of this fish and by other signs, the Admiral judged that the weather was about to change, and began to look for a harbour in which to take refuge.

From:

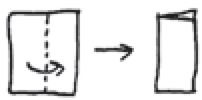
Columbus, Christopher. *Christopher Columbus: The Four Voyages*. Translated by J.M. Cohen (1969). Penguin Classics, New York.

Columbus, Christopher. *The Log of Christopher Columbus*. Translated by Robert Fuson (1987). McGraw-Hill. New York.

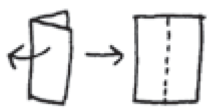
Make a Log Book

Follow the directions below to make a small log book to record your activities.

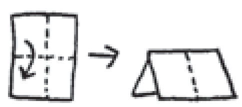
1. Fold the paper in half the long way, like a hot dog.



2. Open the paper.

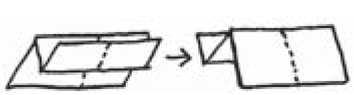


3. Fold the paper in half the short way.

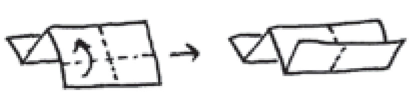


4. On one side, fold the edge of the paper back to meet the fold.

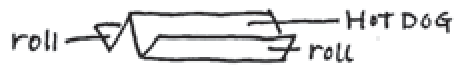
5. Turn the paper over.



6. Fold the edge of the paper back to meet the fold.



7. Place the paper on the table so that you see a W when you look at the end. You can also think of it as a hot dog in a roll.



8. Cut the hot dog in half along the center fold. You'll be cutting through two layers of paper and stopping at the cross fold.

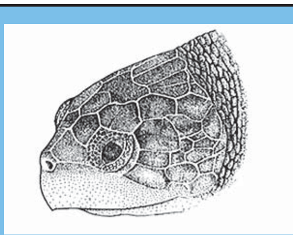
9. With your wrists above your fingers, hold the two halves of the hot dog from the top.

10. Turn your wrists to the sides.

11. You will have an open book with four sections.

12. Bring three of the sections together. Fold the last section on top of the other three so that you have a flat book.

Turtle Key 3C



Preparation Time:
10 minutes

Activity Time:
• Warm up
30-45 minutes
• Activity
45 minutes
• Enrichment
60 minutes

Materials Needed:
• Copies of provided
"Background Information"
"Sea Turtle ID"
"Turtle Key"
" Turtle Characteristics"
"Sea Turtle Picture Cards"
• Pencil

Setting:
Classroom

Subject Areas:
Ecology, Anatomy

Skills:
Observation, Field Skills, Public Speaking

Vocabulary:
carapace
dichotomous key
organism
plastron
scutes
taxonomy

Summary

Students use anatomical drawings and **dichotomous keys** to identify Caribbean sea turtle species.

Objectives

Students will:
- Define **taxonomy**
- Identify three types of **scutes** used to classify sea turtle species.
- Locate all of the **scutes** and shell parts.
- Use a **dichotomous key** to identify 6 sea turtle species.

Why Is It Important?

The science of **taxonomy** deals with the classification of **organisms** into established categories. Keys are widely used by taxonomists to identify species and classify new species.

Although sea turtles may look similar, each one eats a different diet and serves a different purpose in the ecosystem. The ability to identify each species of turtle is fundamental to knowing about them and understanding their various adaptations.

Background Information

The word "**taxonomy**" comes form the Greek words meaning arrangement and law. By following certain rules of **taxonomy**, biologists have arranged known **organisms** into related groups. Biologists carefully observe an **organism**'s anatomy, ecology, and distribution before placing it into a specific category or group.

All **organisms** are first divided into large groups known as Kingdoms. There are five widely-recognized Kingdoms: Monera, Protista, Fungi, Plantae, and Animalia. Each Kingdom is then split into smaller and smaller groupings, with species (or subspecies) being the smallest taxonomic grouping.

A key is an essential tool in the science of **taxonomy**. Biologists, students and others use these keys to help them identify unknown **organisms**. A key is an ordered list of characteristics that describe **organisms**. Keys often specialize in a particular type of **organism** such as flowering plants, freshwater fish, or sea turtles. Keys usually contain pictures and drawings, as well as written descriptions, to guide the reader to the correct name for the unknown **organism**.

Most keys are "dichotomous", meaning dividing or branching into two parts. At each level of a **dichotomous key**, the reader must choose from two descriptions. The reader carefully observes the unknown **organism** and then chooses the description in the key that best matches the **organism**. One choice leads to another until finally the reader reaches the name of the **organism**!

Before using the Turtle Key, you must be familiar with the terms that describe sea turtle anatomy. The "Sea Turtle Identification" illustration shows and defines the key characteristics you must know in order to identify sea turtles.

When you understand the words **plastron**, **carapace**, and scute, you are ready to begin reading at the top of the Turtle Key.

Study one of the included Sea Turtle Cards. read the two statements labeled "1" at the top of the Turtle Key. If your turtle picture matches 1A, you can write Leatherback on the card. If your turtle picture matches 1B, you go to "2" or the second level of the key. You will then read 2A and 2B and decide which description best fits your picture. Your choice at level 2 will send you to either level 3 or level 4. Keep reading the key until you arrive at the name of a turtle.

As you work your way through the key, you may want to take notes by listing your choices at each level on the back of the turtle card. This will help you later if you need to find places in the key where you may have made the wrong choice and that may have led you to the incorrect name for your turtle.

▼ Procedure

Warm Up

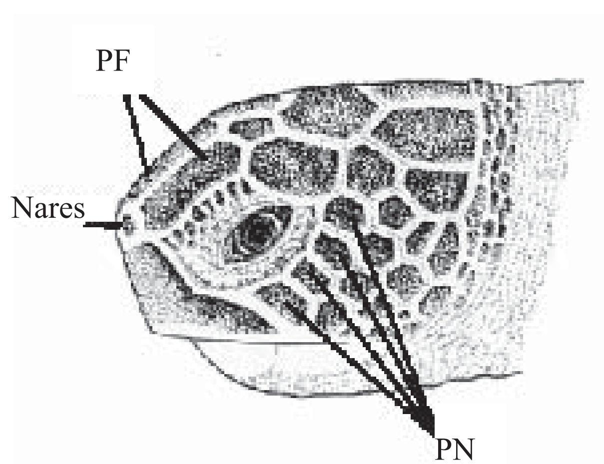
1. Divide the students into teams of two for this activity. Hand out copies of the Background Information, the Sea Turtle Key, Picture Cards, and Identification page. Have the students read the Background Information and study the accompanying diagram of sea turtle external anatomy. They should also preview the Sea Turtle Key by skimming for new vocabulary words. The teacher should use the sea turtle diagram on the Sea Turtle Identification sheet to give a step-by-step demonstration of how to read the Sea Turtle Key. (Hint: This diagram depicts a loggerhead sea turtle.)

▼ The Activity

1. Ask each team of students to cut the Turtle Picture Cards on the dotted lines. They will work together to identify the sea turtle species shown on each card. Students should write the name of the sea turtle on the front of each card. On the back of each card, they should write their choices at each level of the key.
2. As the teams complete their identification, give them the Sea Turtle Characteristics sheet. They should use this sheet and the Turtle Key to decide if they correctly identified their turtle cards. The teacher should review the correct answers and discuss the use of the key. Was the key easy to use? What caused the greatest difficulty in using the key?
3. Combine students into six groups to give a summary of the external anatomy of each of the six sea turtle species found in the Caribbean. Each group should describe to the class what makes their turtle species unique. If their turtle were found crawling on the beach, what characteristics would they observe in order to identify it quickly and correctly?

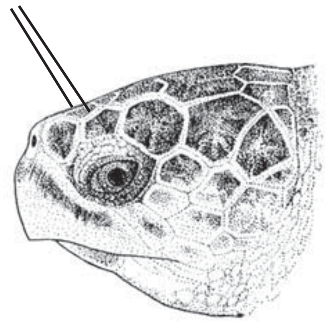
▼ Enrichment

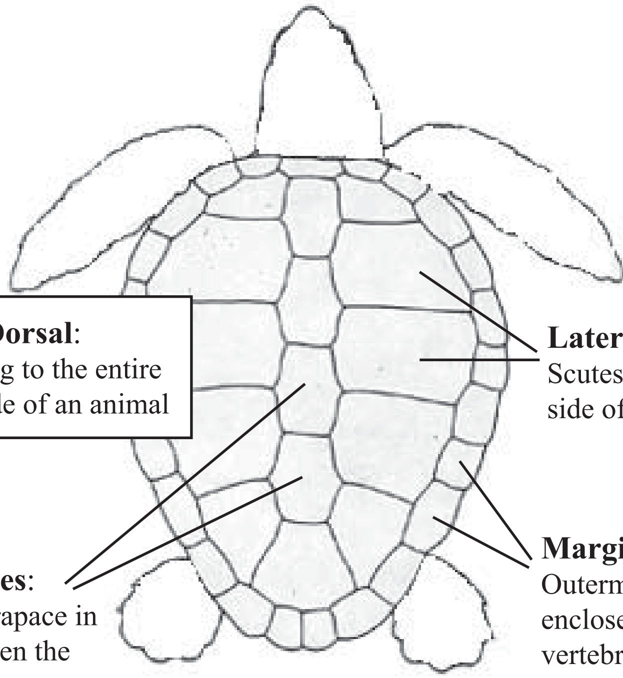
1. Have the students write their own **dichotomous keys**. They could write a **dichotomous key** for their classmates, for pieces of fruit or for a group of animals. They should choose something simple and practice writing a detailed and exact **dichotomous key**. Have the students trade keys and talk about which keys were most easily used.
2. Cut out copies of the Turtle Cards and tape one to each student's shirt. Have the students approach each other and try to identify the turtle on each other's shirts as quickly as possible. Which species is the easiest to consistently identify and why?



Sea Turtle Identification

Prefrontal Scales:
Scales located between the eyes





Dorsal:
Referring to the entire upper side of an animal

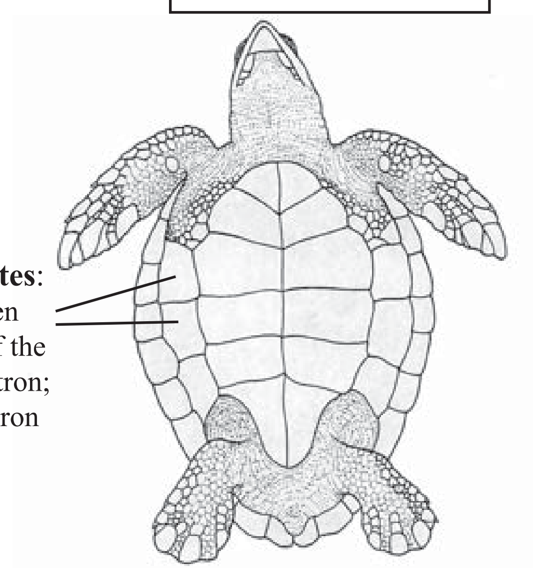
Lateral Scutes:
Scutes located on either side of the vertebral scutes

Marginal Scutes:
Outermost scutes, they enclose the lateral and vertebral scutes

Vertebral Scutes:
Scutes on the carapace in the center, between the lateral scutes

Carapace:
Top or dorsal part of the turtle's shell

Ventral:
Referring to the entire underside of an animal



Inframarginal Scutes:
Scutes located between the marginal scutes of the carapace and the plastron; they connect the plastron to the carapace

Plastron:
Bottom or ventral part of the turtle's shell

Turtle Key

You can use this key to identify the six Sea Turtle Picture Cards.
You can also use this key to identify dead turtles you find at the beach.
Remember not to disturb a nesting turtle!

1A. Carapacewith five raised ridges extending the length of the leathery "shell"; no carapace scutes.........**Leatherback**

1B. Carapace scutes present...Go to 2

2A. Five vertebral and four lateral scutes..............................Go to 3

2B. Five vertebral and five lateral scutes...............................Go to 4

3A. One pair of prefrontal scales..**Green**

3B. Two pairs of prefrontal scales..**Hawksbill**

4A. Three inframarginal scutes; head very wide...................**Loggerhead**

4B. Four inframarginal scutes; carapace nearly as wide as it is long...Go to 5

5A. Five pairs of lateral scutes..**Kemp's Ridley**

5B. Six or more pairs of lateral scutes.................................**Olive Ridley**

Sea Turtle Characteristics

After you have identified the sea turtles, write their names in the blanks.

Species A ____________________

- two pair prefrontal scales
- **carapace scutes** overlap each other
- four pairs of lateral **scutes**
- two claws on each front flipper
- habitat- tropical, worldwide
- distinct "overbite" in jaw

Species B ____________________

- **carapace** with five longitudinal ridges
- no **scutes** on head or **carapace**
- "soft" **carapace** black with light spots
- largest reptile in the world-weighs 500kg or more
- feeds mainly on jellyfish, including Portuguese man-o-war
- habitat – tropical, temperate, and subarctic

Species C ____________________

- more than one pair of prefrontal scales between the eyes
- **carapace** often encrusted with barnacles
- three inframarginal scutes
- five pairs of lateral **scutes**
- very large head, strong crushing jaws
- habitat - tropical to temperate

Species D ____________________

- one pair of prefrontal scales
- one claw on each front flipper
- large-may weigh 300kg or more
- four pairs of lateral **scutes**
- only sea turtle with tiny tooth-like projections on edge of lower jaw
- habitat – tropical, worldwide

Species E ____________________

- **carapace** grayish, nearly as wide as it is long
- five pairs of lateral **scutes**
- four inframarginal **scutes** that have small pores at their base
- more than one pair of prefrontal scales
- small for a sea turtle, up to 50kg
- nests in large groups, often during the daytime
- habitat – tropical, temperate

Species F ____________________

- six or more pairs of lateral **scutes**
- four pairs of inframarginal **scutes** that have small pores at their base
- omnivorous, eating shrimp, jellyfish, crabs, snails, fish, algae, and sea grasses
- nests in large groups, often during the daytime
- habitat – tropical

Sea Turtle Characteristics (Answers)

Species A Hawksbill sea turtle

Species B Leatherback sea turtle

Species C Loggerhead sea turtle

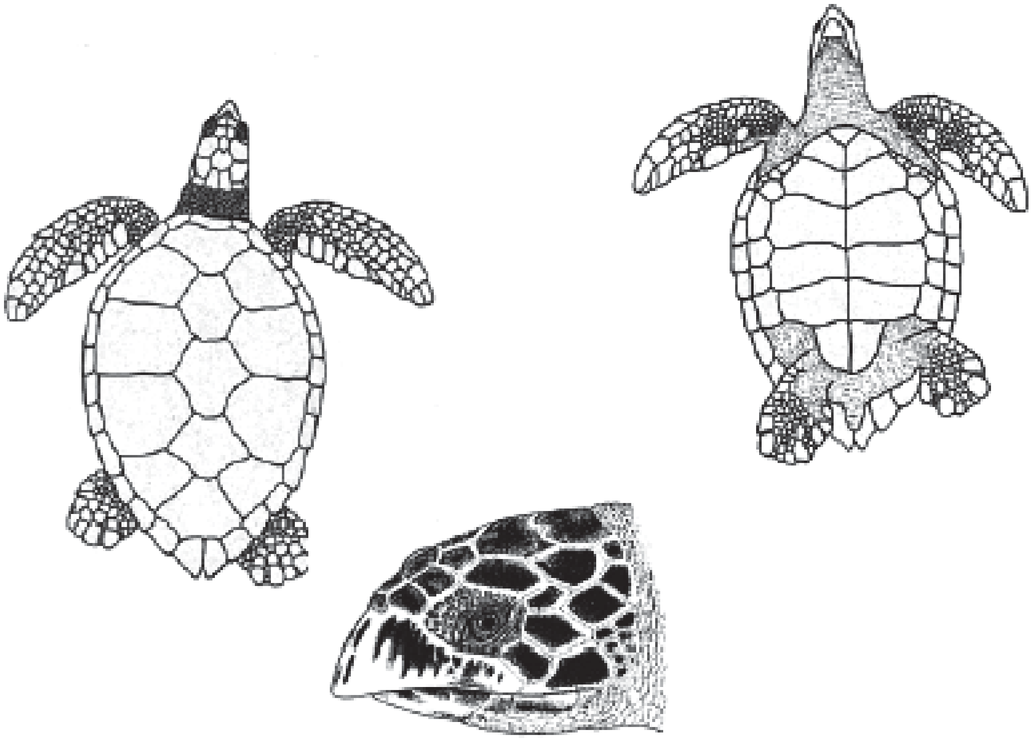
Species D Green sea turtle

Species E Kemp's Ridley sea turtle

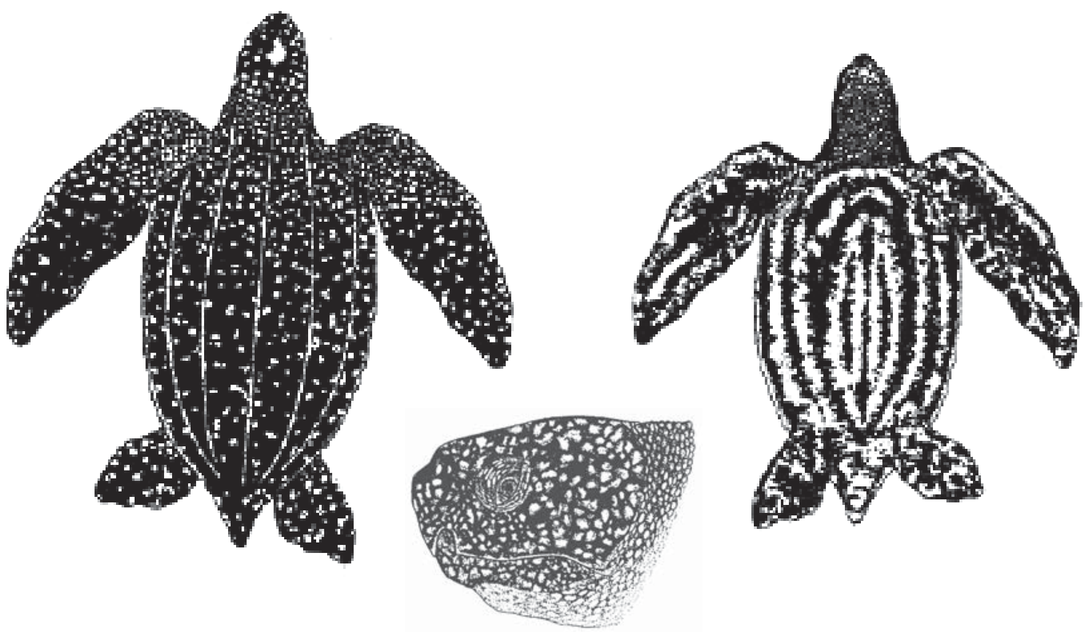
Species F Olive Ridley sea turtle

Sea Turtle Picture Cards

A

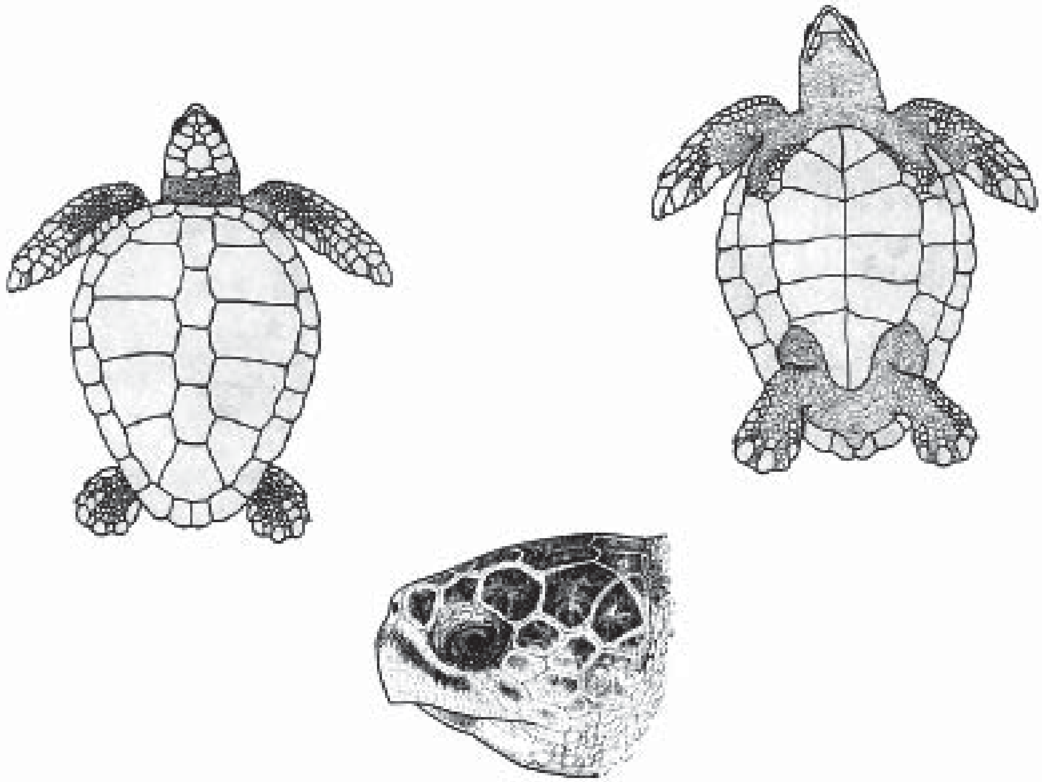


B

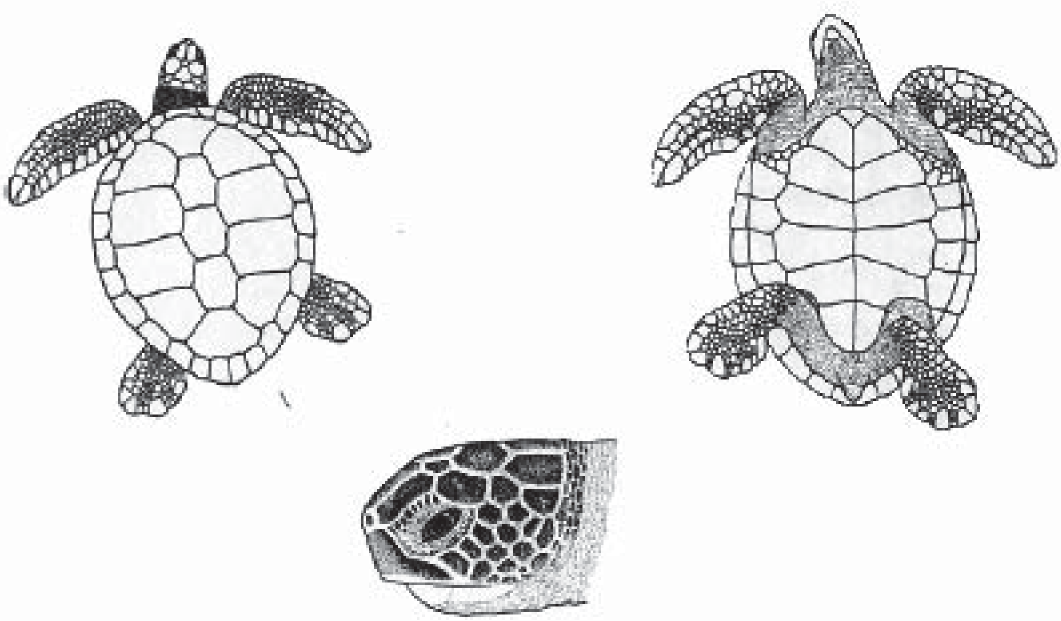


Sea Turtle Picture Cards

C

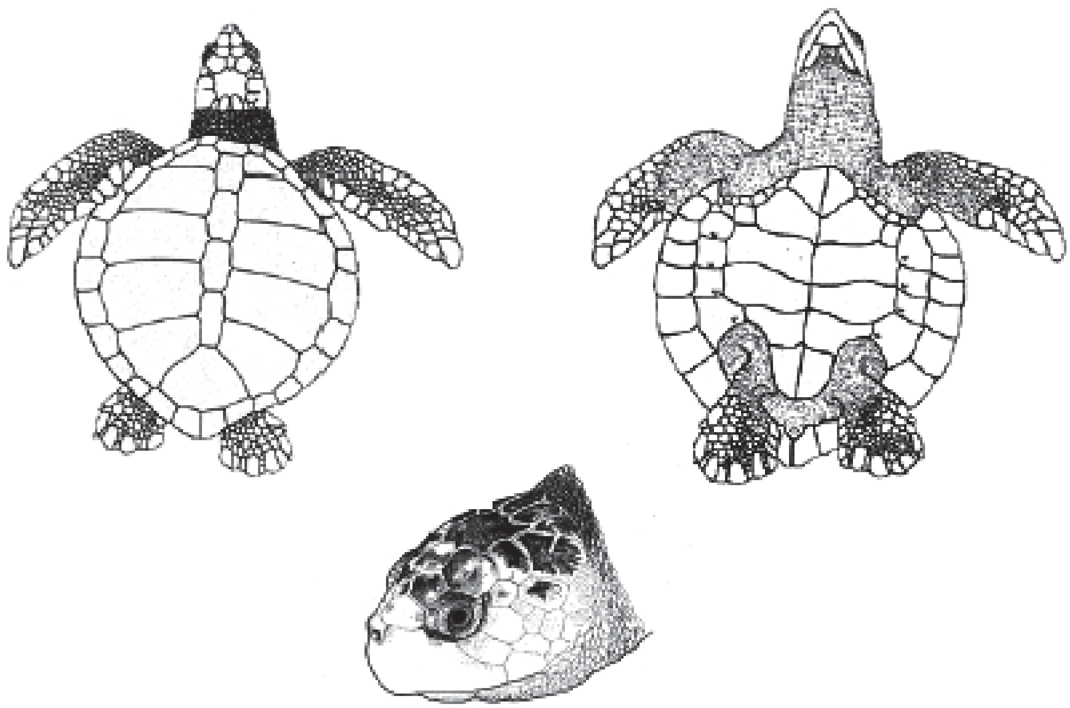


D

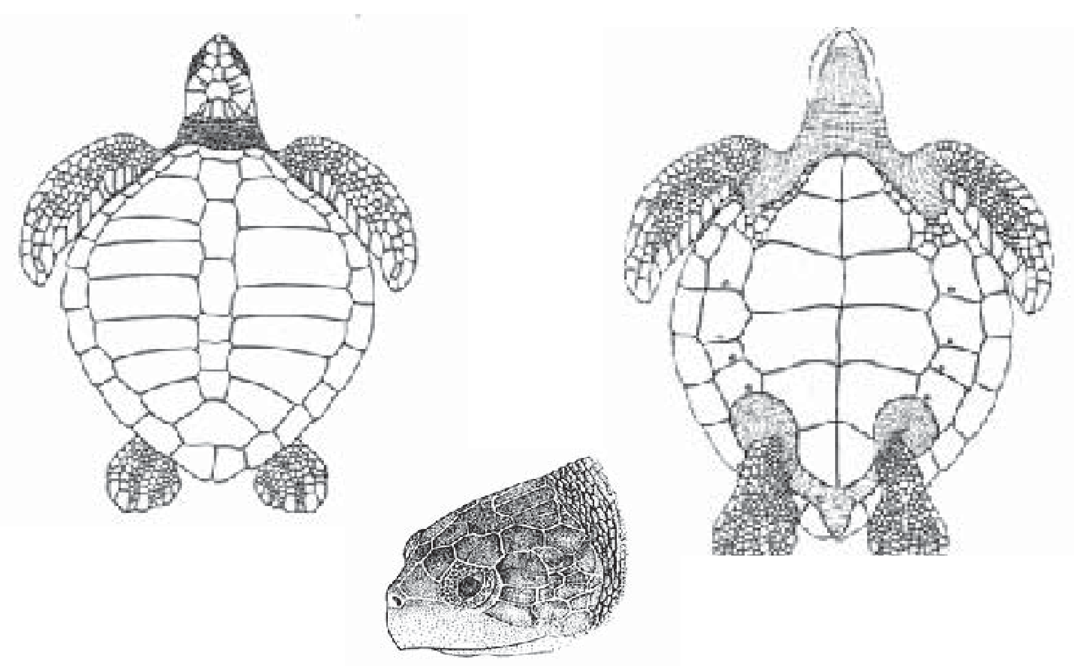


Sea Turtle Picture Cards

E



F



Trade in Sea Turtles 3D

■ **Preparation Time:**
20 minutes

■ **Activity Time:**
- **Warm up**
  30 minutes
- **Activity**
  40 minutes
- **Enrichment**
  45 minutes

■ **Materials Needed:**
- Copies of provided
"Trade Data"
"Sea Turtle Trade Worksheet"
"Interpretation Key"
- Calculator, pencil

■ **Setting:**
Classroom

■ **Subject Areas:**
Culture, Ecology, Social Studies, Mathematics

■ **Skills:**
Analysis, Discussion, Statistical Analysis, Scientific Writing, Report Drafting, Decision-Making

■ **Vocabulary:**
ecosystem
exploitation
extinction
import/export
incidental
indigenous
over-harvesting
sustainable

▼ Summary

Students will discover the impact of trade in endangered species, learn laws controlling international trade, and will study data from the Caribbean in order to form an opinion about trade in sea turtles.

▼ Objectives

Students will:
- Learn the impact of trade on sea turtles.
- Find out what trade goes on in the Caribbean.
- Form an opinion about trade in sea turtle products.

▼ Why Is It Important?

The world's wildlife resources are **import**ant to all people, providing us with food, medicines, clothing and other products. Many of the products we use in the developed world are actually derived from wild animals and plants - whether it is fish served in a restaurant, drugs derived from medicinal plants, or furniture made from timber extracted from the rain-forest.

There is no doubt that over-**exploitation** of wildlife is closely linked to and plays an **import**ant part in species depletion and even **extinction**. The **over-harvesting**, un**sustainable** use, and illegal trade of some species is threatening not only their continued survival but also the survival of **ecosystem**s, communities and local economies that depend upon these species for food, medicine and ecological services.

▼ Background Information

The global wildlife trade is huge, with annual profits estimated at billions of dollars and involving hundreds of millions of individual plants and animals.

Laws that regulate the use of wild plants and animals are usually specific to one country and are enforced in that country only. But some laws apply internationally and we call these laws "treaties" or "conventions".

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into force in 1975 and over 150 countries have signed it, thereby promising to abide by its rules. The treaty was established to protect endangered species from over-**exploitation** by means of a system of **import** and **export** permits.

CITES protects more than 30,000 plant and animal species, including all species of sea turtle. The member countries act together to control international trade in sea turtles and other endangered plants and animals. These species are divided into three "appendices", Appendix 1 lists the most critically endangered. For this reason, species listed on Appendix 1 are prohibited from entering into international trade.

In the case of sea turtles, it is often not the entire animal being traded. For example, the scutes (the colourful plates, often called "tortoiseshell") that cover a hawksbill sea turtle's shell are widely valued for their beauty and are crafted into jewelry and ornaments. Japanese imports of these scutes between 1970 and 1989 totaled 713,850 kg, representing more than 670,000 turtles, with more than half (368,318 kg) originating from the Caribbean and Latin America. Customs data show that in 1988 alone, Japan imported tortoiseshell from nearly 12,000 adult hawksbills, all killed and exported from the Caribbean Sea. In total, during the period 1970 to June 1989, more than a quarter-million Caribbean hawksbills were killed for the shell trade with Japan. Other countries participated in this trade, as well, so these figures represent only part of the trade volume. (Note: Japan ended its hawksbill trade by formally withdrawing, in 1994, the "reservation" it held under CITES that allowed Japan to continue to trade in the Appendix I listed hawksbill turtle.)

CITES allows trade when the proper permits are legally obtained, and only when it can be shown that trade will not endanger the animal. At the end of this activity you will find data on the legal trade in sea turtles and sea turtle products in the Caribbean. The illegal trade in these species is still common in some places but of course no official records of it exists.

▼ Procedure

Warm Up

1. Pass out copies of the Reported Trade in Caribbean Sea Turtles data and copies of the interpretation key. These are reported trades for which import permits were obtained. Have students look over the listings of legal trade in sea turtles and answer the following questions:
   - Which species is most commonly traded?
   - Which countries are usually the **import**ers?
   - The **export**ers?

▼ The Activity

1. Pass out copies of the International Trade Worksheet. Have the students work in groups to complete the worksheet.
2. Have the groups prepare a short report to share with the class on their question.

▼ Enrichment

1. Have each student complete all of the group questions on the worksheet.
2. Discuss with the class how the hawksbill trade takes place. Who is involved? (Hint: Consider the fisherman, the buyer/ "middleman", the exporter, the government officers who grant the import and export permits, the importer, the artisan in Japan, the final consumer of the jewelry, etc.) Who makes the most money? The least?
3. Divide the class into small groups. Ask them to discuss what information a fisheries manager would need to determine whether the continued killing of hawksbills was sustainable over time. What happens to local hawksbill populations if the commercial harvest is sustainable? What happens if it's unsustainable?

Sea Turtle Trade Worksheet

Instructions:
Use the Trade Data to answer the following questions. Use the interpretation key to understand the data, and wait for your teacher to assign questions to your group.

1. In 1973 Japan began stockpiling bekko, concerned that it would become illegal to trade it once the CITES treaty came into force. Find evidence of the stockpiling effort.

____

2. 1 ton = 907 kg. After 1979, Japan restricted its imports to 30 tons per year. How many kg is that?

____

3. If the Caribbean provided 50% of Japan's bekko in 1979, how many kg of bekko did the Caribbean export to Japan in 1979? How many turtles is this?

____

4. What explanations can you give for the generally decreasing amount of bekko exported to Japan from Panama between 1970 and 1979?

____

5. Using 1.3 kilogram of bekko per turtle, how many hawksbills were killed in Cuba for trade to Japan in 1976?

____

6. In 1974, the Caribbean provided what percent of the world's bekko to Japan? Using the number of kg and the percentage, find out how many kg Japan imported that year from around the world.

____

7. Calculate the total kg of bekko imported from Nicaragua over the 10 years sampled. How many turtles does that represent?

____

8. Which countries exported the largest amount of bekko between 1970-1979?

____

9. Can you list a Caribbean country that did not trade bekko with Japan in this time period?

____

Interpretation Key for Trade Data

Species

Eretmochelys imbricata = hawksbill sea turtle

Quantities

All quantities listed are in kilograms (kg).

Definitions

Bekko is raw unworked hawksbill shell, also called tortoiseshell.

Turtle conversion rate

It is estimated that a single Caribbean hawksbill turtle provides approximately 1.3 kg of bekko.

Trade Data

Japanese Imports of Bekko 1970-1979 from the Caribbean

	Year										
Country	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total
Panama	10,744	11,981	8,389	8,990	9,350	9,313	5,885	4,450	6,505	4,810	
Cuba	5,435	5,946	5,100	8,100	6,245	6,100	6,975	3,984	6,600	3,725	
Caymans	0	0	78	936	963	1,083	3,096	3,863	6,321	6,110	
Haiti	1,415	1,415	1,303	2,390	678	831	1,094	1,173	959	1,689	
Nicaragua	798	1,060	1,316	994	2,646	1,632	1,446	1,573	1,014	949	
Jamaica	600	943	1,852	2,521	222	286	343	683	128	559	
Honduras	0	0	0	316	0	38	0	71	9	9	
Bahamas	127	109	1,474	580	218	449	532	922	1,018	1,886	
Belize	97	82	0	28	276	0	12	40	0	314	
Dominican Republic	0	0	62	4	11	31	113	507	0	219	
Puerto Rico	974	700	498	341	45	165	262	264	0	18	
St. Lucia	0	0	0	345	288	332	0	489	349	152	
Costa Rica	360	189	387	265	175	515	170	260	47	89	
St. Vincent	0	0	0	243	250	191	130	230	144	0	
Barbados	398	338	337	344	310	31	13	0	23	0	
French W. Indies	266	0	0	0	0	122	152	198	276	123	
Trinidad & Tobago	0	0	0	0	0	0	0	0	0	0	
Dominica	0	0	0	6	0	0	126	0	0	114	
Antigua & Barbuda	0	0	0	0	0	0	0	0	0	0	
Grenada	0	0	0	499	0	132	0	59	0	0	
Turks & Caicos	149	85	0	0	0	0	0	0	0	0	
Venezuela	0	0	0	171	0	0	0	0	0	0	
Colombia	0	26	0	37	58	45	0	0	0	0	
Mexico	0	0	0	8	0	0	0	0	0	0	
Total	21,476	22,874	20,796	27,118	21,735	21,296	20,349	18,766	23,393	20,766	
% of world-wide total	58.1	64.3	49.8	37	63.5	59.1	49.2	42.9	57.7	32.7	

Source: Milliken and Tokunaga, 1987

Sea Turtle Tracking 3E

■**Preparation Time**:
10 minutes

■**Activity Time**:
■Warm up
20 minutes
■Activity
50 minutes
■Enrichment (optional)
60 minutes

■**Materials Needed**:
- Ruler
- Pencil
- Calculator
- Provided "Background Information"

■**Setting:**
Classroom

■**Subject Areas:**
Geography, Trigonometry, Ecology

■**Skills:**
Analysis, Discussion, Field Skills, Comprehension, Decision-Making

■**Vocabulary:**
barnacle
carapace
endangered species
latitude
longitude
nautical miles
range
resource management

▼ Summary

Students use turtle tracking data to calculate the range, speed and direction of the animal's migrations.

▼ Objectives

Students will:
- Know the names and locations of five Caribbean countries and cities within those countries.
- List two methods used to tag turtles.
- Correctly identify **longitude**s and **latitude**s on a map.
- Calculate distances using a map scale.

▼ Why Is It Important?

To develop better **resource management** plans, we need to know as much about a sea turtle's life history as possible. Since sea turtles spend virtually all their lives in the ocean, they are very hard to observe and study directly. One method used to obtain information on sea turtle population numbers and their **range** is by tagging. If another researcher finds a tagged turtle, he or she will report the information on the tag. The data collected on each turtle can be used to determine how far that particular turtle traveled, how long it took, and sometimes the condition of the turtle during its travels. Modern technologies, including satellites, can also tell us swim speed, dive depth and other behavioral data.

▼ Background Information

All species have a natural **range**. **Range** is defined as the area in the world where a particular plant or animal is normally found. For example, the **range** of the hawksbill turtle includes tropical waters worldwide. Hawksbill sea turtles may travel 20 – 40km per day during migration, but they normally stay within their "tropical" **range**. Leatherback sea turtles, on the other hand, **range** from tropical to subarctic waters and migrate many thousands of kilometers between feeding and nesting grounds.

Historically, tagging has been the single-most valuable activity in advancing our understanding of sea turtles and their conservation needs in relation to complex life cycles, migrations, and growth rates. In many cases, a commitment to years of systematic tagging may be necessary to achieve certain objectives. However, in some instances the tagging of even a few turtles, particularly at nesting beaches where tagging has never been conducted, can yield valuable insight into migrations and the locations of non-nesting feeding areas.

Turtles may be tagged several ways. Many researchers attach a metal tag to the front or rear flipper. Turtles may also be tagged using internal tags which are injected under the skin using a special needle. These tags are then read with an electronic "scanner"; each tag has a unique number. These internal tags, called Passive Integrated Transponder or PIT tags, are not lost as frequently as the metal flipper tags. Turtles may also be identified by natural characteristics, like injuries or **barnacle** patterns on the **carapace**. In these cases photographs are taken in order to identify the turtle later.

Researchers can also attach a tracking device to the turtle. A satellite tracking device sends a great deal of information to a special satellite in orbit around the Earth, and the researcher can then retrieve that information. Satellite tracking provides excellent data, but is very expensive.

In the following activity you will analyze data collected from a hawksbill sea turtle satellite-tagged in Antigua. You will explore sea turtle migration routes and discover why it is so difficult to protect and manage sea turtles.

▼ Procedure

Warm Up

1. Pass out copies of the Background Information as a reading assignment or read it aloud in class.

2. Pass out copies of the turtle tracking map. Have the students locate where they live on the map. The numbers shown on the map are north **latitude** (numbers along the side) and west **longitude** (numbers along the top). Notice the scale bar at the bottom of the map. Have the students find the **latitude** and **longitude** of their home. Next, have them pick another location and calculate the distance between the two sites using a ruler and a calculator if necessary.

▼ The Activity

1. Pass out copies of the Statistics Card.

2. Review the concepts of **latitude** and **longitude,** if necessary:

   Latitude refers to the lines that run horizontally across maps or globes. **Latitude** is measured in degrees from the equator. All **latitude** lines above the equator are north **latitude**s.

   Longitude refers to the lines that run vertically on a map or globe. **Longitude** is measured in degrees from Greenwich, England. The **longitude** lines west of Greenwich are west **longitude**s.

3. To practice using the map, perform the following example with the students.

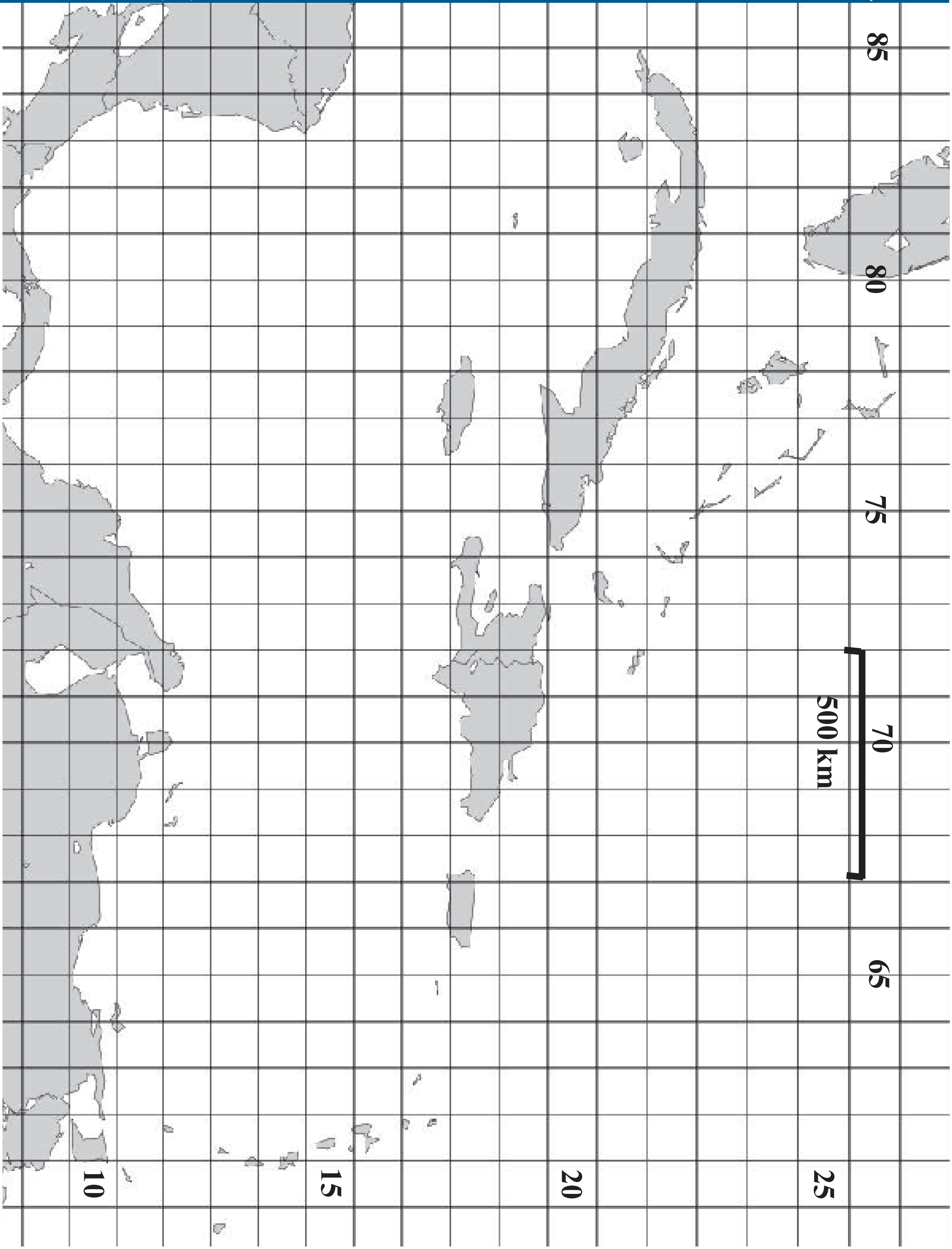
   A turtle was recorded at the following coordinates: 14 degrees north **latitude** and 62 degrees west **longitude**. First locate where these two coordinates meet (just west of the island of St. Lucia). Mark this point on the map with a pencil. The next coordinate is 16 degrees north, 65 degrees west. Mark this point on the map. Calculate the distance and direction of the turtle's movement, assuming the turtle swims swam a straight line.

4. Distribute the Sea Turtle Worksheet. The students can work individually or in teams to answer the questions on the worksheet.

▼ Enrichment

1. Request information on 10 to 15 sea turtles that have been tagged. Be sure to get information on different species. You will need to login to access the data, this is a free service. The address is: http://www.seaturtle.org/tracking/teachers/data.shtml, Repeat the Warm Up procedure with other turtle data.

2. Emphasize creative writing by asking the students to make a journal about one of the turtle's travels, first from the turtle's point of view and then from a human's point of view, from a boat following the turtle.


85
80
75
70
65
500 km
10
15
20
25

Sea Turtle Statistics Card

Species: Hawksbill – *Eretmochelys imbricata*

Sex: Female

Date Tagged: August 16, 2003

Location Tagged: 17.1N -61.7W

Tag Number: NNW 2349

Method Used To Tag: satellite transmitter

Carapace Length: 87cm **Carapace Width:** 60cm

Locations Since Tagging:

Date	**Location**		
August 16, 2003	(nesting location)	17.1 N	-61.7 W
August 18, 2003		16.7 N	-61.5W
August 21, 2003		16.3 N	-62.1W
August 28, 2003		14.1N	-62.6W
September 5, 2003		13.4N	-60.7W
September 14, 2003		11.0N	-60.4W

Sea Turtle Tracking Worksheet

Instructions:
Use the Sea Turtle Tracking Chart and Sea Turtle Statistics Card to answer the questions below.

1. What were the latitude and longitude where the turtle nested on August 16, 2003?

   ____

   Mark this point on the tracking map.

2. Find the turtle's latitude and longitude on August 18. Circle this point on your chart. How many nautical miles did the turtle travel from its last known point? (Assume the turtle swam in a straight line.)

   ____

3. What city is just west of the turtle on the 18th?

   ____

4. Find the turtle's latitude and longitude on August 21st. Circle this point on your chart. How many nautical miles did the turtle travel from its last known point?

   ____

5. What is the name of the island that is east of the turtle's location on the 21st?

   ____

6. Find the turtle's latitude and longitude on August 28th. Circle this point on your chart. How many nautical miles did the turtle travel from its last known point?

   ____

7. Find the turtle's latitude and longitude on September 5th. Circle this point on your chart. How far did the turtle travel from its last known point?

   ____

8. What is the name of the island that is southeast of the turtle's location on the 5th?

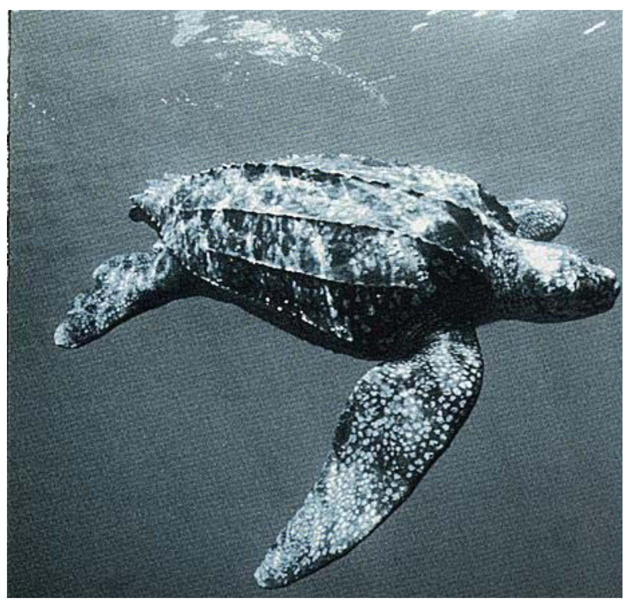
   ____

9. Find the turtle's latitude and longitude on September 14th. Circle this point on your chart. How far did the turtle travel from its last known point?

   ____

10. What is the name of the island that is just east of the turtle's location on the 14th?

    ____



11. How many nautical miles did the turtle travel from the time it was tagged to the last known location on September 14, 2003?

____

12. How many nautical miles per day did the turtle travel from the time it was tagged to the 14th?

____

13. If the turtle were recorded at Puerto Rico, what would be the latitude and longitude?

____

14. What is the name of the island just west of Puerto Rico?

____

15. On September 21, 2003 this turtle was caught in a fishing net in Barbados. Circle this point on your chart. How many nautical miles did the turtle travel from its last known point (in a straight line)?

____

Bonus Question:

Convert all nautical miles answers to kilometers. (there are 1.85 km in each nautical mile.)

Question #2 ________________

Question #4 ________________

Question #6 ________________

Question #7 ________________

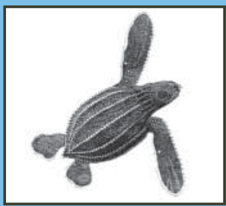
Question #9 ________________

Question #11 ________________

Question #12 ________________

Question #15 ________________

A Leatherback's International Journey 3F



■ **Preparation Time**:
10 minutes

■ **Activity Time**:
• Warm up
30-45 minutes
• Activity
45 minutes
• Enrichment
60 minutes

■ **Materials Needed**:
• Copies of provided
"Tracking Map"
"Tracking Worksheet"
"Sea Turtle Statistics Card"
"Table of Laws"
•Pencil, colored marker

■ **Setting:**
Classroom

■ **Subject Areas:**
Culture, Ecology, Social Studies, Mathematics

■ **Skills:**
Analysis, Discussion, Field Skills, Comprehension, Decision-Making.

■ **Vocabulary:**
conservation
currents
Exclusive Economic Zone
migration
territorial seas

▼ Summary

Students use leatherback tracking data to explore the international nature of these animals and the threats they face due to **migration**s.

▼ Objectives:

Students will:

- Learn about leatherback **migrations**.
- Learn the differences in laws between different countries.

▼ Why Is It Important?

Unlike most of the wildlife we encounter, sea turtles almost never "belong" to a single nation. We protect (or hunt) sea turtles in our own country and then they feed or nest in another country, under different laws. This is particularly true in the Caribbean region where the boundaries of more than 40 nations and territories come into close contact with each other. This is why cooperation is the best way to effectively manage our marine resources!

▼ Background Information

The sea is a special environment where links established by **currents**, species and **migration**s can extend thousands of kilometers. Consequently, marine **conservation** issues, especially those relating to far-ranging species such as sea turtles, must be addressed at a multinational level.

If a species travels widely among many different nations' waters, then **conservation** effort in one country may be compromised due to activities (such as harvest) in a neighboring country. Therefore, successful management programs must rise above political boundaries! When countries share a common marine resource, they also share the common challenge of conserving that resource.

Several international agreements exist that relate to the international management and use of sea turtles. You have already learned about CITES, which regulates inter-national trade in endangered species. Of special importance in our region is UNEP's Caribbean Environment Programme (CEP). The CEP provides valuable assistance to all Caribbean governments in implementing the "Convention on the Protection and Development of the Marine Environment in the Wider Caribbean Region". This treaty strongly encourages collaboration among member nations. For more information, visit www.cep.unep.org.

The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) is an international scientific network comprised of volunteer Country Coordinators (sea turtle experts, natural resource professionals, and community-based **conservation**ists), an international Board of Scientific Advisors, and Partner Organizations in more than 40 Caribbean States and territories. Each Coordinator works closely with a national coalition of stakeholders to ensure that everyone has access to the dialogue, as well as to the unique products and services of the network. WIDECAST is a partner organization of the CEP, helping to ensure that the biology of sea turtles is taken into account during international decision-making.

Leatherbacks travel the greatest distances of all the sea turtles. Not only does a leatherback cross through many countries' EEZs in the Caribbean during its **migration**, it often visits Canada and the countries of Africa as well.

Each country is surrounded by a Territorial Sea which extends about 20 kilometers, or 12 nautical miles offshore.

Each country also has an **Exclusive Economic Zone** (EEZ) extending to 200 nautical miles (around 320km) offshore. For most countries in the Caribbean Region, the EEZ does not extend 200 nm because it soon joins the border of the EEZ of another country. The map below shows that in most cases a line is drawn half way between two countries' territorial sea boundary.

Laws of a country apply within the EEZ. Any resources found in the EEZ of a country, including fish and animals, may be exploited and must be managed by that country. Landlocked nations have no EEZs and therefore no rights to coastal ocean resources (unless they negotiate these rights with a friendly maritime country).

▼ Procedure

Warm Up

1. Pass out the Background Information as a reading assignment or read it aloud in class.

2. Give a copy of the Tracking Map to each student.

3. Have students use the map scale on their tracking maps to estimate 12 nautical miles and trace the Territorial Sea of his/her country. How big would the EEZ (200nm) be if it was not restricted by other countries' EEZs?

▼ The Activity

1. Pass out copies of the Sea Turtle Statistics Card with information about a leatherback's locations and copies of the Table of Laws.

2. Have the students plot the journey of the leatherback from beginning to end. Make sure that each point is labeled with the date.

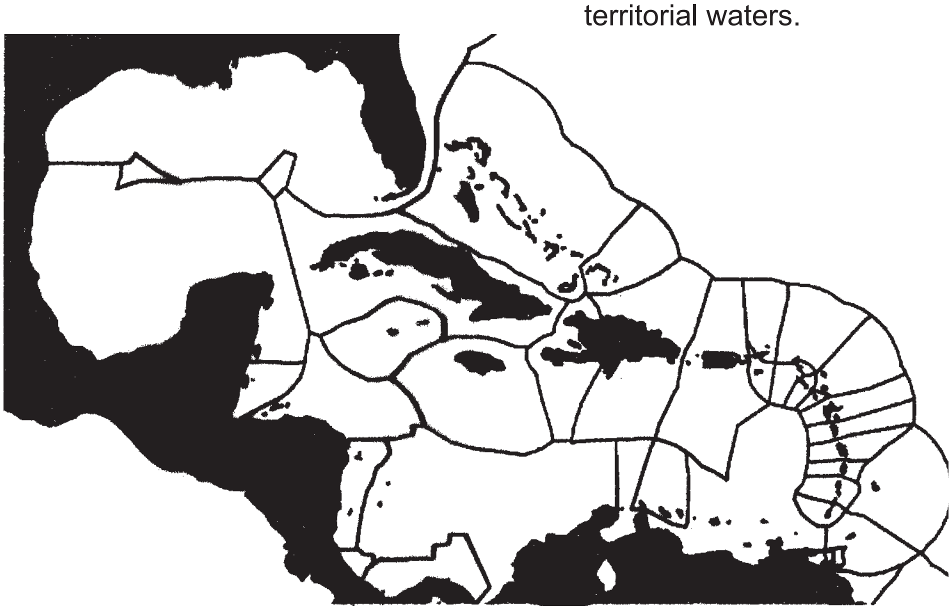
3. Review the table of protections for sea turtles in different countries in the Caribbean. Did the turtle pass through any waters where it was protected? Did the turtle pass through waters where it could have been hunted?

4. Where did the turtle nest? Was it protected at its nesting beach? Have the students color the protected portions of the turtle's track black and the unprotected parts of the journey red.

▼ Enrichment

1. Have the students form small groups and come up with several ideas to help Caribbean countries coordinate effectively in terms of sea turtle management.

2. Have the groups represent different countries and draft an international "agreement" allowing the safe passage of sea turtles through territorial waters.



Are Eggs or Adult Turtles Protected Here?

Laws change constantly and some countries may have revised their sea turtle regulations since this table was created.

		Are all Turtles Protected?			
Country	Eggs Protected?	*Caretta caretta*	*Eretmochelys imbricata*	*Chelonia mydas*	*Dermochelys coriacea*
Antigua &Barbuda	YES	NO*	NO*	NO*	NO*
Bahamas	YES	NO*	YES	NO*	not specified
Belize	YES	YES	YES	YES	YES
British Virgin Islands	YES	NO*	NO*	NO*	NO*
Cayman Islands	YES	NO*	NO*	NO*	not specified
Colombia	I	I	YES	I	I
Costa Rica	YES[t]	YES	YES	YES	YES
Cuba	YES	NO*	NO*	NO*	YES
Guatemala	I	YES	YES	YES	YES
Grenada	YES	NO*	NO*	NO*	YES
Haiti	YES	NO	NO	NO	not specified
Honduras	I	I	I	I	I
Montserrat	YES	NO*	NO*	NO*	NO*
Nicaragua	I	YES	YES	I	YES
St. Kitts & Nevis	YES	NO*	NO*	NO*	NO*
St. Vincent & Grenadines	YES	NO*	NO*	NO*	NO*
Suriname	I	YES	YES	YES	YES
Trinidad & Tobago	YES	NO*	NO*	NO*	NO*
Turks & Caicos	YES	NO*	NO*	NO*	NO*

I = Indigenous and/or subsistence take only

*= Only juveniles are protected

t = Eggs are collected only in the village of Ostional (Pacific Coast).

Sea Turtle Statistics Card

Species: Leatherback – *Dermochelys coriacea*

Sex: Female

Date Tagged: June 10, 2003

Location of Nest: 10.1N -61.3W

Tag Number: 6854-9853-59834

Method Used To Tag: satellite transmitter

Carapace Length: 136cm **Carapace Width:** 100cm

Locations Since Tagging:

Date		**Location**	
June 10, 2003	(Nesting location)	10.1 N	-61.3 W
June 18, 2003		11.3 N	-64.1 W
June 21, 2003		12.2 N	-62.1 W
June 28, 2003		17.7 N	-65.8 W
July 5, 2003		18.1 N	-74.5 W
July 14, 2003		23.6 N	-76.3 W

International Tracking Worksheet

Begin by plotting the leatherback's journey on the tracking map using the Sea Turtle Statistics card. Remember that the turtle was tagged when she nested.

Answer the following questions:

1. In which country did the turtle nest? Are those eggs protected by law in that country?

2. Is the female turtle protected by law in the country where she nested?

3. List the countries the turtle passed through on its journey where it could have been hunted.

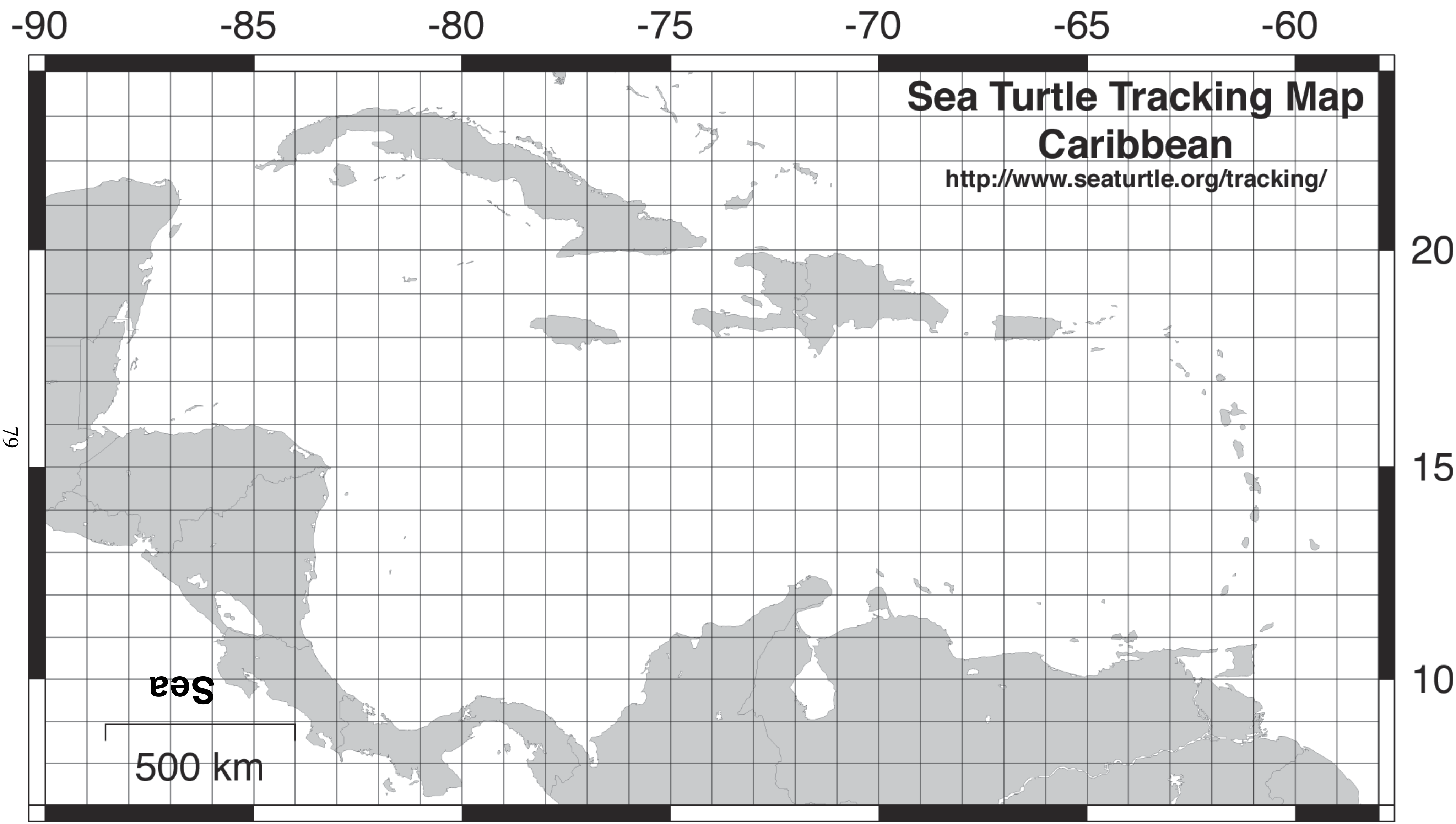
4. List the countries that the turtle passed through on its journey where it was protected.

5. Is the leatherback sea turtle protected in more or fewer countries than the green sea turtle?

6. Use a colored marker to color the dangerous parts of the turtle's journey.

Bonus:

7. Even in EEZ's where leatherbacks are protected, list three things that might kill the migrating turtle.


Sea Turtle Tracking Map
Caribbean
http://www.seaturtle.org/tracking/
-90
-85
-80
-75
-70
-65
-60
20
15
10
Sea
500 km

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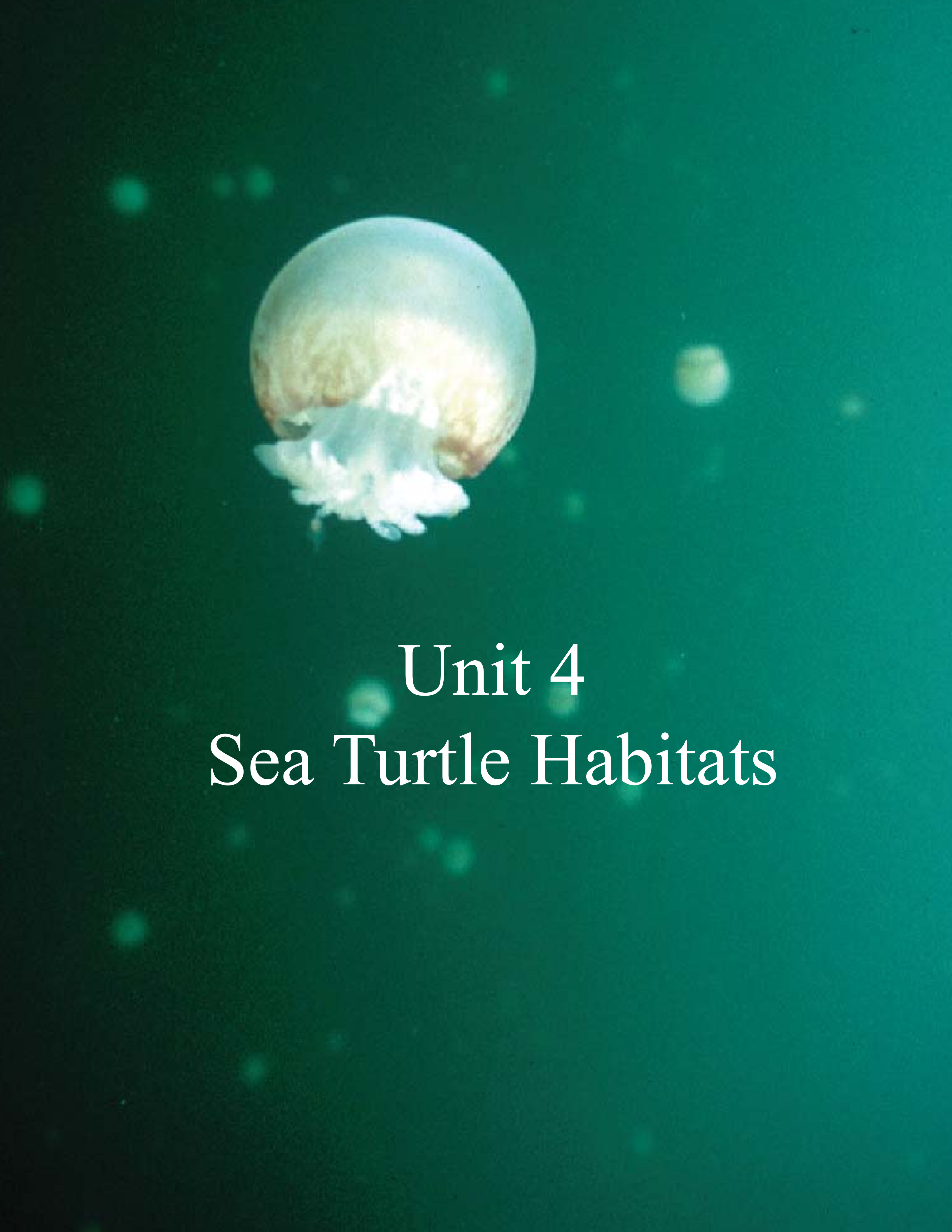
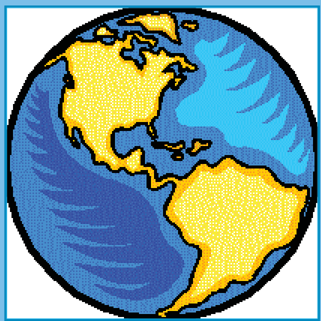


Unit 4
Sea Turtle Habitats

Why is Biodiversity Important? 4A



Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
70 minutes

Materials Needed:
- Copies of provided Background Information
- One copy of food web tags
- Colored sticks or straws
- Large ball of string

Setting:
Classroom

Subject Areas:
Ecology, Geography

Skills:
Observing, analyzing, Comprehension, Group-Building

Vocabulary:
abiotic
biodiversity
biotic
ecosystem
food chain
food web
stability

▼ Summary

Look at the roles that different plants and animals have in marine **ecosystems** by building a representation.

▼ Objectives

Students will:
- Show what a **food web** is.
- Show that **biodiversity** helps create **ecosystem stability**.
- Identify human actions that can have effects on **ecosystems**.
- Show the interconnectedness of **biotic** and **abiotic** factors in an **ecosystem**.

▼ Why Is It Important?

The natural environment is the source of all our resources for life — providing us with air to breathe, water to drink and food to eat, as well as materials to use in our daily lives (petroleum for fuel; fertilizer; silicon for computer chips) and natural beauty to enjoy.

Complex **ecosystems** with a wide variety of plants and animals tend to be more stable. A highly diverse **ecosystem** is often a sign of a healthy **ecosystem**. Some might argue that species have become extinct with no effect on the environment, but the Earth's systems are so complex that we are still learning about environmental processes and the roles species play.

Preservation of **biodiversity** is not necessarily about preserving everything currently in existence. It's more a question of 'walking lightly' on the Earth — a balance of respecting the natural changes that occur and of protecting species and environments from human-caused destruction and extinction.

▼ Background Information

The word '**biodiversity**' is a combination of two words: *biological* and *diversity*. It refers to the variety of life on Earth. **Biodiversity** includes all the living things that exist in the air, on land or in water: plants, humans and other animals, microorganisms, fungi. The area considered may be as small as your backyard — or as big as our whole planet.

Animals and plants don't exist in isolation. All living things are connected to other living things and to their non-living environment (such as rocks and rivers). If one tiny species in an **ecosystem** becomes extinct, *we* may not notice or think it's important. But the **biodiversity** of that **ecosystem** will be altered, and in fact all of the **ecosystems** that the species belonged to will be affected.

There are two elements or "factors" that make up an **ecosystem**. The plants, animals, fungi and other living things make up the **biotic** or "living" factors. The rocks, minerals, soil, air, and water make up the **abiotic** or "non-living" factors. The **biotic** factors in an **ecosystem** cannot survive without the **abiotic** factors. They are connected. What would a fish do without water, or a tree without sunlight and soil? What would humans do without oxygen?

An **ecosystem** has many "layers". **Abiotic** factors make up the base of the **ecosystem**. Next are the producers. Producers are organisms, so they are a **biotic** factor. They are special because they make their own food from sunlight and carbon dioxide. Plants and trees on land are all producers. In the ocean most producers are tiny plants known as phytoplankton.

Next up the **food chain** are the consumers. Consumers cannot make their own food and must get it from eating other organisms. When a green sea turtle feeds on seagrass, it is acting as a consumer. The grass is the producer. **Food webs** are a good way to visualize **biodiversity**. Think of a food "web" as the sum of many inter-related **food chains**. You will make a **food web** in this activity.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

▼ The Activity

1. **<u>Food Web:</u>** Cut out the **Food Web** Tags and give one to each student. If there are too many, leave some tags out. If there are not enough, make a second copy. If the group is large, consider dividing the class in two and doing two **food webs**. Have each student attach the tag to his/her shirt and have the students stand in a circle.

   First give the ball of string to a producer (seagrass, green algae, or phytoplankton). Have the student hold the end of the string and pass the ball on to an organism that is a predator or prey for him/her. The seagrass might pass the ball to a sea turtle. The sea turtle would then hold on to the string and pass the ball to a tiger shark (predator) or sponge (prey). Have the students continue until everyone has hold of the string, or until there are no more connections. This is a **food web**. See how it looks like a spider's web?

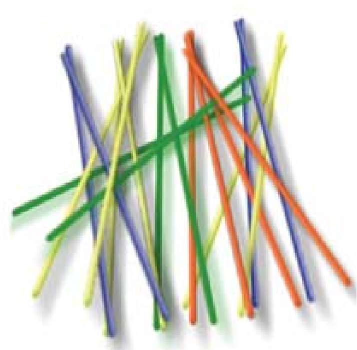
   Now have the students imagine what would happen if sea turtles disappeared. Have the sea turtle drop his/her piece of string. The plants and animals connected to the turtles in the **food web** might disappear, too. Then the connections to all of the dropped strings will have to drop the string as well. Have this continue until all the students have had to drop the string.

2. **<u>Biodiversity:</u>** Divide the class up into teams of four. Pass out a collection (10-20) of colored sticks or straws (you can use almost any stick and color one end with a marker) to each team. Ideally you should have 4 colors. One color will represent the **abiotic** factors, and will be a rock. Another color will represent producers, and will be seagrass. A third color will represent a primary consumer, and will be a sea turtle. The fourth color will be the secondary consumers, and will be a tiger shark.

   Drop the sticks into a pile. Try to remove the sticks one by one. Each person can have a try. They must take their stick without moving or shaking the pile. If the other sticks move, they lose their turn.

   Try it with half as many sticks. Is this more or less stable? Is it easier or harder to remove sticks? Is this true in an **ecosystem**? Do more connections mean more **stability**?

   Was it easy or even possible to remove seagrass from the pile without disturbing the other factors? How is this like a real **ecosystem**? Are the factors dependent on each other? What is an example of something humans do that might upset your **ecosystem**?



Food Web Tags

Use the food web diagram on the following page to help construct the food web.

Phytoplankton

Seagrass

Sea turtle

Tiger shark

Jellyfish

Coral (A producer *and* consumer)

Clam

Sponge

Sea Anemone

Butterflyfish

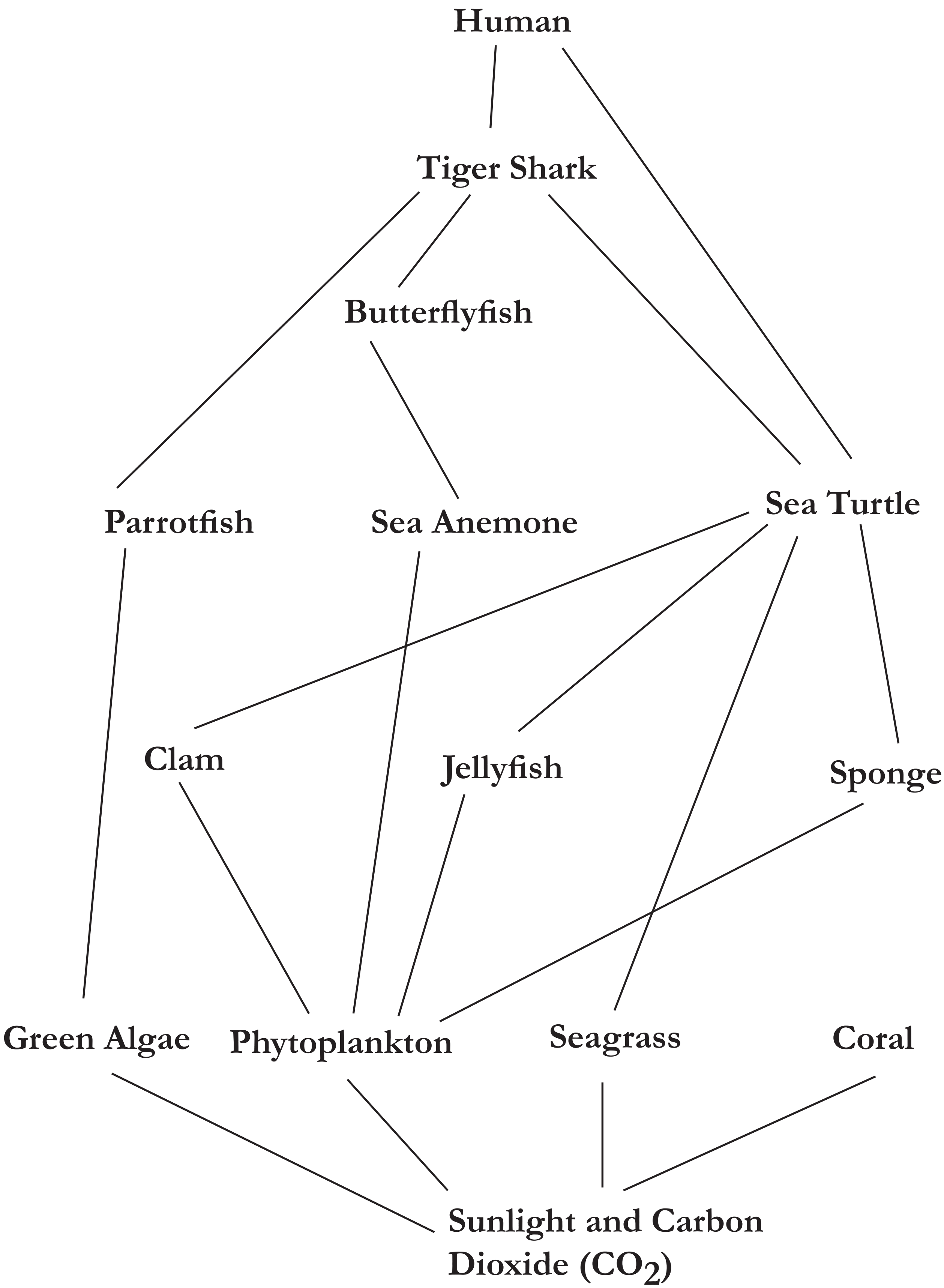
Human

Green algae

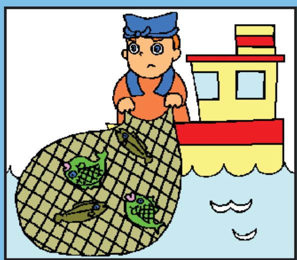
Parrotfish

Sunlight + Carbon Dioxide gas

Sample Food Web



Fishy Problems 4B



Preparation Time:
10 minutes

Activity Time:
- **Warm up**
10 minutes
- **Activity**
70 minutes
- **Enrichment**
30 minutes

Materials Needed:
- Copies of provided:
- Background Information
- Fishy Problems Worksheet
- Pencil

Setting:
Classroom

Subject Areas:
Ecology, Mathematics

Skills:
Statistical Analysis

Vocabulary:
bycatch
commercial
hand line
longline
trawl

Summary
Students will gain a greater understanding of the problems facing ocean habitats and coastal people by calculating the answers to fisheries questions.

Objectives

Students will:
- List 3 human-caused threats to the ocean.
- Identify 3 ocean organisms that are affected by fisheries.
- Discuss the impact of over-fishing on the oceans.

Why Is It Important?

Close to half of the world's fisheries are in a state of collapse. Most of the ocean's **commercial**ly important fish are in danger of extinction and the causes are largely man-made. The solution cannot be to put fishermen out of business, but other solutions must be found if the world's fishermen are to have anything to fish 100 years from now. The first step towards a solution is for each citizen of the planet to understand the problem we face. This activity is designed not only to exercise important math and reading skills, but to give each student an idea of the crisis in the oceans.

Background Information

Bottom **trawl**s are large nets which are used to catch fish and crustacean species. **Commercial** bottom **trawl**s are one of the most destructive fishing gear types because they directly threaten species richness and biodiversity, and they catch a variety of non-target species. Non-target species, or **bycatch**, are typically discarded overboard, often either dead or dying. In some fisheries the **bycatch** can be large, with several kilos of **bycatch** caught and discarded back into the water for every 1 kilo of target species. **Trawl**s often kill sea turtles, whales and dolphins who are caught in the nets and unable to get free. Bottom **trawl**s can also cause severe habitat damage, including deep sea corals and sponges.

Longline fishing consists of baited hooks on lines up to 80 miles long. Each **longline** can be baited with several thousand hooks at a time. These may catch swordfish, tuna and sharks, as well as non-target birds and turtles.

Other destructive fishing practices include using sodium cyanide which is applied to coral reef crevices where fish hide. Although the practice has been outlawed in most countries, and many importers refuse cyanide-tainted fish, widespread use of cyanide continues. In some parts of the Caribbean Sea, fishermen still illegally use chlorine bleach to stun and capture fish or lobster.

Blast fishing catches food fish in a flash, but it's dangerous to fishermen, devastating to fishes and coral reefs, and even though prohibited in most countries, still used on coral reefs in Asia, Africa, the South Pacific, and even the Caribbean. A single blast can destroy thousands of years of coral growth and kill many species that are not used or brought to market.

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Discuss fishing in your area. What kinds of fishing do you see? How many students have family members that fish? How important is fish to the students' diets? Are fish becoming more scarce? More expensive?

The Activity

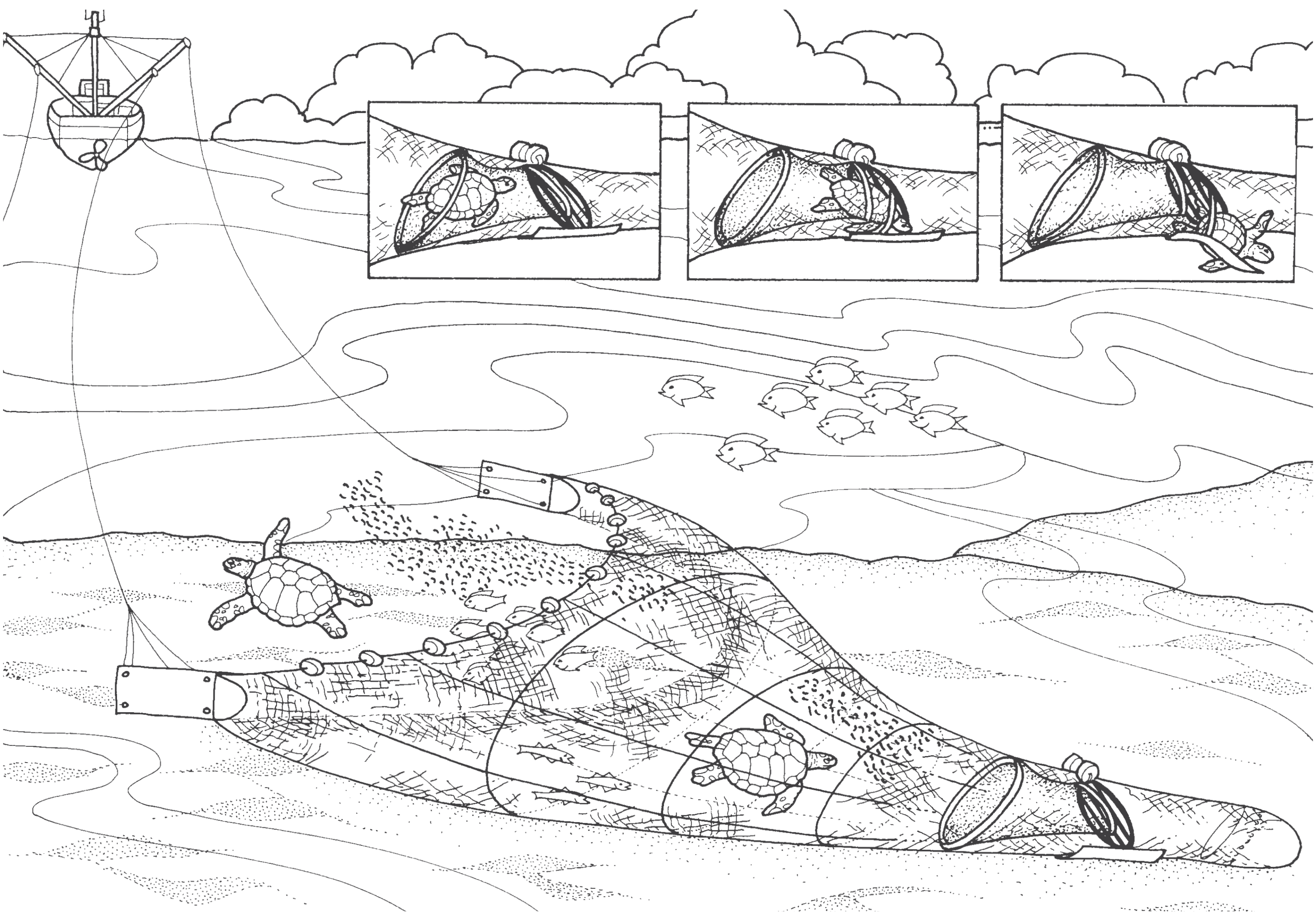
1. Copy and distribute the Fisheries Problems page and have students in pairs match the fishery to the effect.

2. Copy and distribute the Fisheries Worksheet and have the students work in pairs or small groups to complete the problems.

3. Have students work in teams of 3-4 to come up with solutions for the capture and drowning of sea turtles in the different fisheries. Assign a fishery to each team and ask them to come up with different solutions, for example: changes in laws, changes in fishing gear or technique, changes in education, changes in the way we eat fish, etc.

Enrichment

1. Ask students to consider the following Fisheries Solutions: marine protected areas, fish size limits, fishing gear restrictions, fishing seasons and public awareness. Ask them to briefly define their solution and discuss the impacts it would have on fisheries, local livelihoods, and possible sea turtle **bycatch**.



Fisheries Worksheet

Answer the following questions on a sheet of paper.

Equivalents
1kg = 2.2 pounds
1 metric ton = 2,204.6 pounds
1km = .621 miles
1 mile = 5,280 feet

1. The world's oceans are fished by over one million large fishing ships and two million smaller ones. Around the world, 12.5 million people make their living catching fish, and another 150 million people are employed in on-shore operations or the processing of fish.

a) How many ships fish the world's oceans?

b) For every single fishing boat, how many people are needed, on average to catch fish?

c) For every singe fishing boat, how many people are needed, on average to handle on-shore processing and operations?

2. Almost all tuna stocks worldwide are in peril from overfishing, with the Atlantic bluefin tuna declining 90% in the last 2 decades, from 225,000 in 1970 to only __________in 1990.

3. If one year, shrimpers off the southern coast of the United States caught 48,000 endangered sea turtles, and it is estimated that one quarter of these are killed in shrimp nets, how many turtles were killed in shrimp nets during this year?

4. In a coral reef area observers recorded 6 dynamite fishing explosions per hour, with an estimated catch of 1800 kg of fish per day. Surveys indicated that more than half the corals in the area have been decimated by blasting.

a) Assuming there are eight hours in the fishing day, how many dynamite explosions occurred in one day?

b) How many kg of fish on the average would have been caught after each explosion?

c) How many pounds of fish would have been caught in one day?

d) How many pounds caught in one hour?

5. A coral reef was destroyed, which caused increased erosion of the beach and loss of sand. This could have the disastrous effect of increasing the loss of life and property during storms, decreasing income from tourism, and harming wildlife habitat. As a result, the government spent $12 million for 1km of seawall to secure the shore end and replace the destroyed reef.

a) How many feet long was the seawall?

b) What was the cost per foot to build it?

6. It is important to consider the economic value, both short term and long term, or environmental conservation. However, often this is not done. For example, a logging concession was expected to yield $13 million from cutting down the rainforest over a 10-year period. The resulting environmental problems, such as erosion and siltation, would have severely damaged the down stream coral reefs where fishing was done. If this happened, it was estimated that up to $75 million in fishing revenue would have been lost. If this logging concession had been granted, what would have been the net loss of revenue to the nation?

7. It is estimated that 1 square kilometer of coral reef in poor condition produces only 5 metric tons of fish per year, just enough to feed 100 people. A healthy reef, however, can feed between 400 and 700 people per year.

a) How many metric tons of fish would be produced by a healthy reef?

b) How many pounds of fish would that equal?

8. At a conservative estimate, coral reef destruction has meant a loss of 37% in fish production each year, or 150,000 metric tons.

a) If the coral reefs were healthy and fish production was at 100%, how many metric tons of fish would be produced?

b) This 37% loss means that 3 million people now get no seafood protein, or 6 million people get only half the protein they would otherwise have. How may pounds of fish does each of these people now eat in a year?

Source: Coral Forest Teacher's Guide. Coral Forest, 400 Montgomery Street, Suite 1040, San Francisco, California 94104 Tel: (415)788-REEF Fax: (415)398-0385 e-mail: coral@igc.apc.org

Fisheries Worksheet Answer Key

1
- a. 3 million
- b. 4
- c. 50

2 22,500

3 12,000

4
- a. 48
- b. 37.5kg
- c. 3969 lbs.
- d. 496 lbs.

5
- a. 3279 ft.
- b. $3,600/ft.

6 $62 million

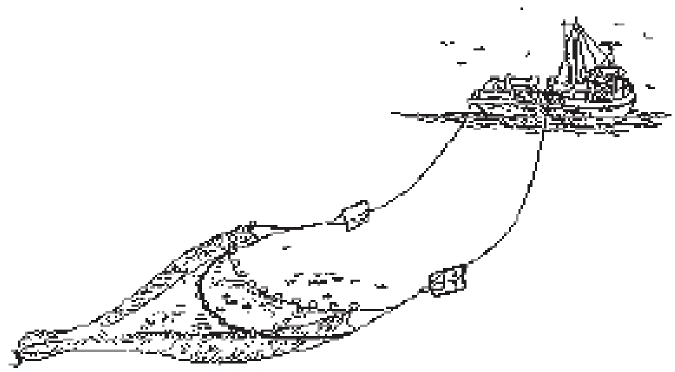
7
- a. between 20 and 35 metric tons
- b. 3 million people eat 0 lbs of fish, 6 million people eat 58.42 lbs/person.

8
- a. 405,405.4 metric tons
- b. 110.23 pounds

Fisheries Problems

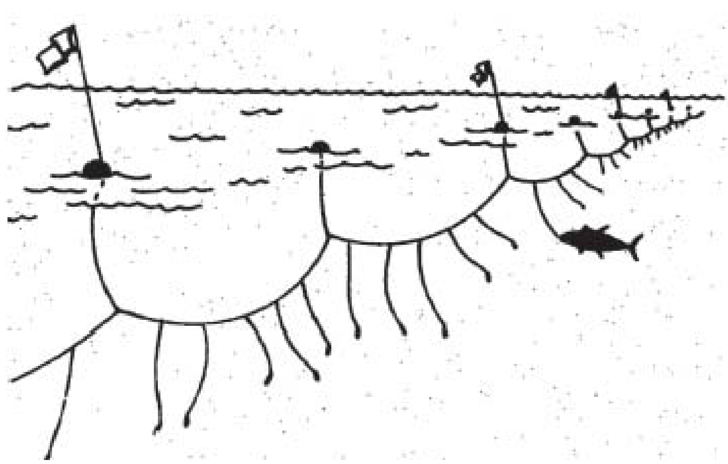
blast fishing

dead coral



commercial bottom **trawl**ing

turtle caught on line



long-lining

coral rubble

Coral Reef Community 4C

Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
70 minutes
- **Enrichment**(optional)
30 minutes

Materials Needed:
- Copies of provided Background Information and coral cards
- Pencil & paper
- Egg cartons
- Tape
- Scissors
- Markers

Setting:
Classroom

Subject Areas:
Ecology, Anatomy

Skills:
Research Skills, Group-Building, Observation

Vocabulary:
bleaching
coral reef
polyps
symbiotic
zooxanthellae

Summary
Students will learn about corals and coral reef communities, and the important roles they play in the oceans.

Objectives

Students will:
- Show knowledge of coral anatomy and structure.
- List coral reef inhabitants and identify their habitat.
- Discuss the importance of the coral reef to sea turtles.

Why Is It Important?

Coral reefs are one of the most important natural resource in the Caribbean Sea. In general, people are not aware of their tremendous economic and ecological value and the many ways in which they contribute to the livelihoods of Caribbean people. As an example, the thriving tourism industry depends on healthy **coral reefs** for white sandy beaches, clear water, diving and sport fishing. Similarly, the region's nearshore and artisanal fishers rely on healthy **coral reefs** as nursery grounds for fish. About 70% of the world's coral is either dead, or threatened due to human activities such as pollution, overfishing, boating and sedimentation.

Background Information

Many people do not realize that corals are animals. They are soft-bodied and easily damaged. The "rocks" we think of when we think of corals, are really the skeletons of these soft animals. **Coral reefs** are among the most diverse and productive communities on Earth. They are mostly found in the warm, clear, shallow waters of tropical oceans. Reefs have functions ranging from providing food and shelter to fish and invertebrates to protecting the shore from erosion. Through symbiosis with simple algae called **zooxanthellae**, reef-building corals are capable of producing their own food just like plants! Compounds produced by reef dwelling organisms possess antimicrobial and antiviral activity. These compounds may be important sources for drugs and medicines. In addition, revenue from tourists attracted to the beauty of **coral reefs** can be a significant source of income for human communities in these areas.

Reefs are formed by calcium carbonate produced by tiny coral **polyps**. While corals are the chief builders of reef structure, they are not the only ones. Some algae, tube worms and molluscs donate their hard skeletons. Together these organisms construct many different types of reefs. Reefs are important land builders in tropical areas, forming islands and altering shorelines. Barrier reefs like those seen surrounding most islands in the Caribbean are the island's main protection in hurricanes.

A coral colony may consist of thousands of **polyps**. **Polyps** are typically carnivorous, feeding on small particles floating in the water. However, **symbiotic** algae living inside the tissue of the **polyps** also provide important sources of nutrition to corals. An entire colony many meters in diameter can start out as a single polyp. Many hard corals can take hundreds of years to grow, increasing only one or two centimeters per year!

Because many **coral reef** organisms can tolerate only a narrow range of environmental conditions, reefs are sensitive to damage from environmental changes. Corals are susceptible to diseases and **bleaching**. Natural events such as hurricanes can damage **coral reef**s. However, most damage to reefs is human-caused, such as by anchors, fish pots, plastic bags, and pollution.

Because corals depend on algae living inside the bodies of the coral **polyps**, corals require clear, warm water. The algae need light to produce food. When waters become clouded by pollution, or become too warm, the corals can bleach or die. When a coral bleaches, the **zooxanthellae (algae)** actually leave the polyp. This is why the coral loses its color and appears an unnatural, bleached white.

Coral **polyps** are in the same family as jellyfish. Imagine a tiny upside-down jellyfish and this is what a coral polyp looks like. A coral colony may contain many thousands of individual **polyps**. All of these **polyps** share a stomach, so in some ways each coral colony (or reef) is one large animal! Just like jellyfish, some corals have stinging cells in their tentacles. If you have ever touched a "fire coral", you know first hand about the stinging ability of some corals. Each coral polyp creates another layer of the skeleton out of calcium carbonate; in this way, the coral colony gets larger with each generation of **polyps**.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

▼ The Activity

Egg Carton Coral

1. Collect egg cartons, tape, paper, markers and scissors. Divide the class into groups of three or four. Each group should get an egg carton and 4 sheets of paper (colored paper is fun!).

2. Cut a sheet of paper into three strips horizontally. Each strip will become a coral polyp. Roll each strip into a tube about the diameter of your finger. Tape the bottom of the tube to keep it from unrolling. To make the tentacles of the polyp, make several cuts from the top of the tube, ¾ of the way to the bottom of the tube. Get the tentacles to curl by running the blade of the scissors along the paper.

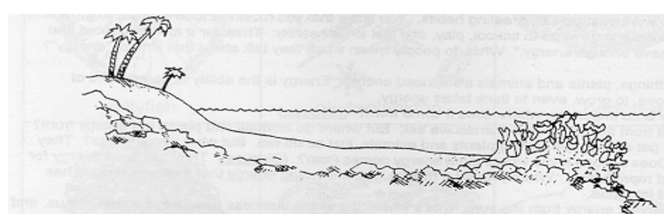
3. To make the coral colony, remove the top of an egg carton, leaving only the section with the 12 egg cups. Turn this upside down, and poke a hole in each cup with the scissors. Push the bottom of the polyp through one of the holes, leaving the tentacles exposed. Repeat this for all 12 cups.

4. Using markers you can add small dots on the polyp to symbolize the **zooxanthellae**. **Zooxanthellae** can have a variety of pigments giving them different overall colors. It is the **zooxanthellae** that give corals their color.

5. Have each group present their model to the class, pointing out all of the parts of the coral and the **zooxanthellae**. Where is the mouth? Point out the colony, an individual polyp. Where are the stinging cells?

The Coral Reef Community

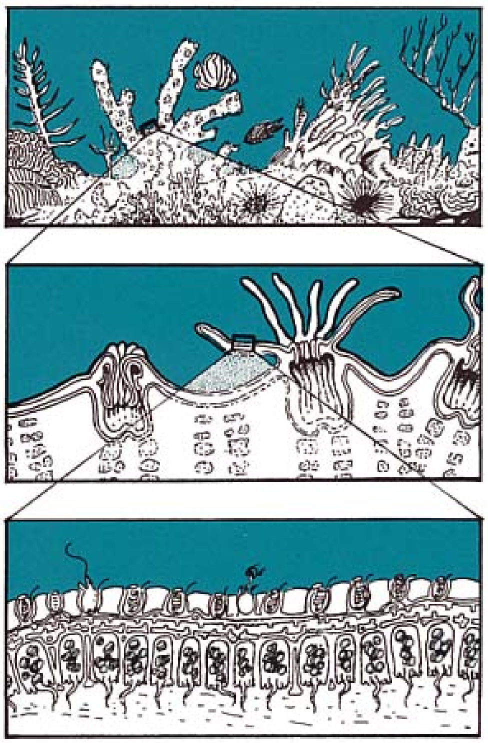
6. Draw the basic outline of a **coral reef** (see below) on the blackboard or on a large piece of paper. Also write the three categories: **Carnivores**, **Herbivores**, **Omnivores**. Have students identify the beach, water, shallow area, and reef. Distribute one Coral Card to each student. Give them a few minutes to read the card, and ask each student to approach the drawing and write the name of their animal under the correct category heading, and tape the animal description in the correct habitat on the drawing. Each student should present his/her animal by reading the card to the class and explaining the placement.



▼ Enrichment

1. Have the students create a model **coral reef** community using the egg carton corals they created, and the coral animals. They should draw pictures of the animals they have on the cards, and mount them on the wall behind the model reef.

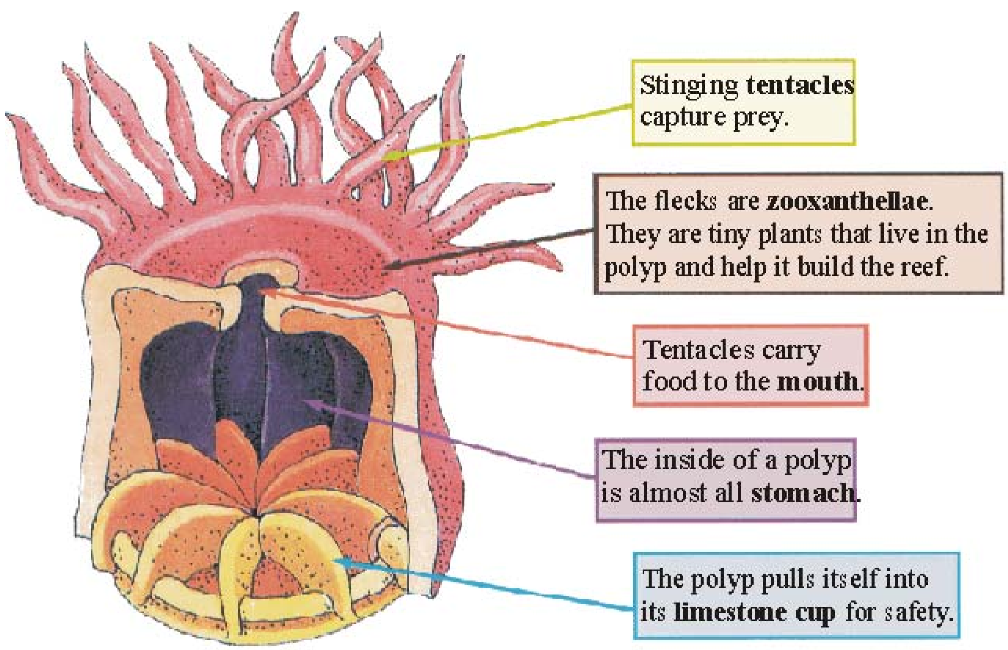
Coral Reef Anatomy



The individual coral polyp is a hollow, cylindrical animal. The mouth is surrounded by tentacles armed with stinging cells for capturing plankton. During the day these tentacles are folded in the digestive sac.

Microscopic single-celled algae (zooxanthellae) that give the coral its green, blue or brown colour are located in the tissue of the living coral. These symbiotic algae process the wastes produced by the polyps. They use the nitrates, phosphates and carbon dioxide produced in the polyp. Through photosynthesis they generate oxygen and organic compounds which the polyps themselves can use. They may also help the polyp lay down calcium carbonate.

In addition to their role as primary producers, the other algae coating much of the reef's surfaces also produce substantial amounts of calcium carbonate. Algae are so important to reef life that it has been suggested that "coral-algal reefs" is a



Coral Cards

I live in a hard tube that I build for myself I have fine, thin gills on my head. They filter my food, tiny animals called zooplankton. I am a type of worm with bristles. I am a FEATHER DUSTER WORM	I have a circular body outline I swim on the surface of the ocean My stinging tentacles catch fish, which I eat I am almost clear and transparent I am a MOON JELLYFISH
I am a whole colony of animals, all alike I grow into a fan-shaped creature that waves back and forth in the water. I am a type of coral, feeding on zooplankton I am a SEA FAN	I possess neither a shell or a backbone. I crawl along the ocean bottom and hide in holes in the reef. I eat clams and snails I am an OCTOPUS
I crawl around the reef and eat coral polyps I am a type of worm with stinging bristles on my back I am a FIREWORM	I visit the coral reef and seagrass beds. I eat sponges and seagrasses I have four flippers for swimming I am endangered I am a GREEN SEA TURTLE
I have a hard outer shell for a skeleton. I eat small fish, and other things I find on the sea bottom. I especially like urchins and snails I am a CORAL CRAB	I have scales and fins, and big eyes, I am red. I hide under corals. I eat shrimp and small fish, but grouper and eels eat me. I am a SQUIRREL FISH or POPEYE ANTI
I am an individual in a colony of animals like me. I eat zooplankton Parrotfish and butterfly fish eat me I am a CORAL POLYP	I live in a beautiful shell I move along the bottom eating algae I am a LAMBI or QUEEN CONCH
I am a spiny star-shaped animal. I eat algae and bits of dead plants and animals on the reef. I hide in cracks and holes in the reef. I am a BRITTLE STARFISH	I don't eat because I make food from the sun. I grow on the sandy bottom between the reef and land. Turtles eat me. I am TURTLE GRASS

I have fins and scales and sharp teeth. I eat small fish I am a BARRACUDA	I have a tube-shaped body with tentacles. I grow attached to rocks or shells. My tentacles catch small fish. I am a SEA ANEMONE
I have ten long arms. Two of my arms catch small fish for me to eat. I can change color quickly. I am a SQUID	I belong to a group of tiny animals. Trillions of my kind drift through a reef's waters. I eat algae or other members of my group! I am a ZOOPLANKTON
I have fins and scales and two spots near my tail that look like eyes. I eat zooplankton, corals and worms. I am a FOUREYE BUTTERFLY FISH	I have a hard outer skeleton and ten legs I eat snails, worms and crabs. People catch me so my species is in trouble. I am a SPINY LOBSTER
I am a spiny skinned animal with a circular body. My spines protect me. I eat algae on the reef and sea floor. I am a LONG-SPINED SEA URCHIN or SEA EGG	I have fins and scales and a sort of beak. I am brightly colored and eat algae I am one of the biggest reef fish I am a PARROTFISH
I have fins, and am large, I breathe air. I visit the outer edge of the reef from the deep ocean. I eat tuna, and other fish in schools. I am a DOLPHIN or PORPOISE	I have fins and scales and a soft skeleton. I lie on the sandy bottom eating snails crabs and clams. My tail has a nasty sting. I am a STINGRAY
I have fins and scales, a big mouth, stripes and spots. I eat small fish like squirrelfish. I usually stay very still in reef waters. I am a GROUPER	I live on land and breathe air. I eat almost everything in the ocean. I use coral to decorate my body. I am a HUMAN BEING
I have gills and fins and fierce jaws I eat octopuses, fish, and sometimes, careless divers. I am long and snake-like. I am a MORAY EEL	I am a tiny plant that drifts in the water without being seen. I need only sunlight and water to live. Lots of fish eat me. I am PHYTOPLANKTON

Seagrass Beds 4D

Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
70 minutes
- **Enrichment** (optional)
30 minutes

Materials Needed:
- Copies of provided Background Information and Seagrass Memory cards
- Scissors

Setting:
Classroom

Subject Areas:
Ecology, Anatomy

Skills:
Observation, Comprehension

Vocabulary:
photosynthesis
producer
salinity
seagrass
sediment
turbidity

Summary

Students will learn about seagrass and its important role in the Caribbean Sea.

Objectives

Students will:
- Identify the three main seagrass types (species).
- List three organisms that rely on seagrass beds for survival.
- Discuss why seagrass is important to sea turtles.

Why Is It Important?

Seagrass beds cover a large portion of the tropical ocean floor. These beds are rich in biodiversity and are an important food source in the oceans. Just like on land, "producers" (organisms that can make food from sunlight) are critical to the health of the habitat and form the basis of the food chain. The seagrass beds and coral reefs exist together and if one disappears, the other is sure to follow it.

Background Information

There are three types of seagrass found throughout the Caribbean. These are Turtle Grass (*Thalassia testudinum*), Manatee Grass (*Syringodium filiforme*) and Shoal Grass (*Halodule wrightii*). Manatee, once common Caribbean herbivores, have been hunted nearly to extinction.

Just like grass and other land plants, seagrass requires sunlight for **photosynthesis**, therefore it is most often found in shallow, clear waters. Seagrass beds are among the most productive marine habitats in the world, supporting a myriad of other plants and animals, large and small.

With root-like stems, which extend horizontally under the sea bottom, seagrasses act to stabilize the soft sediment. These sediments (which might otherwise settle on coral and block out sunlight) tend to accumulate and become trapped in the seagrass.

Turtle grass, the most common type of Caribbean seagrass, thrives in areas that are protected from heavy current and waves. The broad leaves of turtle grass act as filters, removing particles from the water and depositing them as fine sediment. These sediments contribute to the high productivity of this habitat and help to maintain clear water.

The highly productive seagrass habitat attracts various species of fish, conch, lobster, sea turtles, and manatees for feeding, breeding and shelter.

Numerous species of reef fish use seagrass as a protective nursery, hiding from predators amid the grass. Moreover, adult fish that hide in the coral reef during the day and venture out at night to feed, take advantage of the rich source of food that exists in the seagrass.

Currently, there are several threats facing seagrass beds. Due to the fact that seagrasses depend on factors such as **salinity**, water temperature, and low **turbidity**, this ecosystem is particularly sensitive to agricultural, industrial, and domestic pollution. With increased agricultural activity, a major threat to seagrass is run-off of herbicides. Indiscriminate anchoring is also a serious threat.

Turtle grass is the main food of the green sea turtle. The vast beds of seagrasses found throughout the tropics serve as pastures for green turtles. Because mature seagrass is high in fiber and low in nitrogen, green turtles maintain "grazing plots" of young leaves by feeding repeatedly in the same area. By eating young plants in the grazing plots, green turtles can avoid older leaves that are higher in fiber, and thus increase the percentage of nitrogen in their diet. Queen conchs and sea urchins are common residents of seagrass beds, and both also feed on the grasses.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

▼ The Activity

1. Divide the class into teams of two, and give each student a set of the Seagrass Memory Cards. The two students in each team will mix their sets together to form the game.

2. Each team should shuffle the cards so that they are not in any order. The cards should be spread out, face down on the table. One student starts, he/she turns over one of the cards. The student then tries to turn over a matching card. A matching card can be a true match, or can be the written name match to a picture, or a picture match to the written name. For instance, if the first student turns over a picture of turtle grass, a match would be another picture of turtle grass, or a card with "Turtle Grass" written on it.

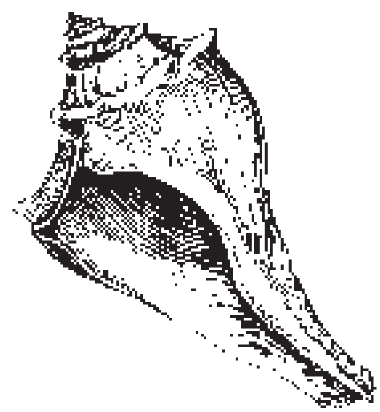
3. If a match is made, the second student collects both cards and keeps them. The student with the most cards at the end wins. The students should continue to play until they are comfortable with the names and identities of all of the seagrass inhabitants.

▼ Enrichment

1. Have the students take a trip on a glass-bottomed boat, or snorkel to a seagrass bed nearby. Students should keep track of all species they observe (such as in a journal or dive slate). What was each species doing? Which species were more likely to be frightened by the students' presence? Why? How many species of sea grass can be identified?

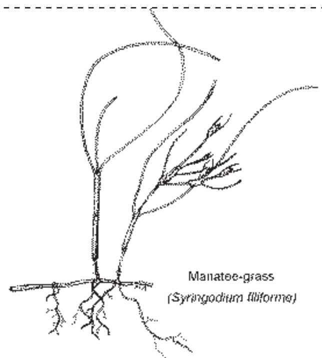
2. Invite a local seagrass biologist or fisheries officer to speak to the class about the biological and economic importance of seagrass. What is the historical range of seagrass in the nation's coastal waters. Is seagrass more or less abundant now? Why?

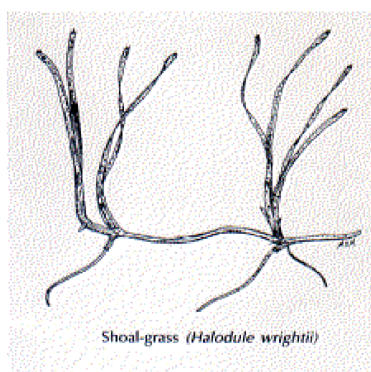
3. Working in small groups, have each group of students research an aspect of seagrass ecology and present it to the class. Possible subjects include: oxygen production, sediment stabilization, inhabitants, predators, prey, and importance to local fisheries.

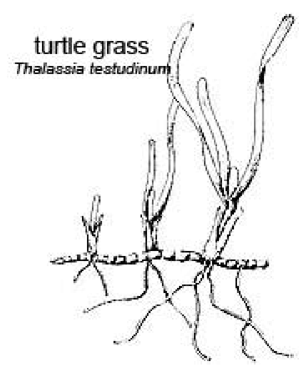


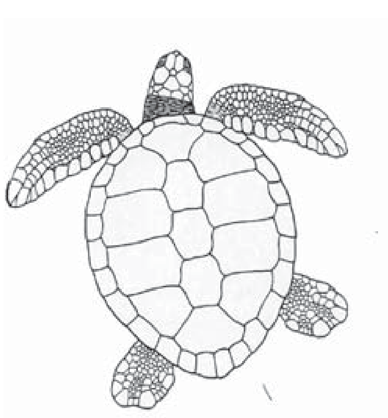
Seagrass Memory Cards

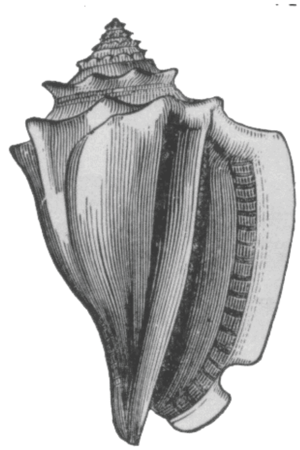
Turtle Grass	Manatee Grass	Shoal Grass
Green Sea Turtle	Conch	Sea Urchin



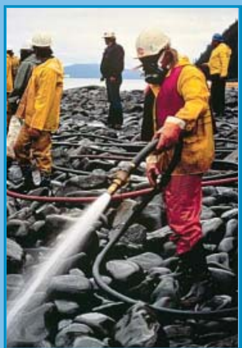








An Oil Spill Story 4E



Preparation Time:
10 minutes

Activity Time:
- **Warm up** 30-45 minutes
- **Activity** 70 minutes
- **Enrichment** (optional) 30 minutes

Materials Needed:
- Copies of provided Background Information
- Pencil & paper
- Cooking Oil
- Powdered Cocoa (optional)
- Bowl, hot and cold water

Setting:
Classroom

Subject Areas:
Ecology, Anatomy, Conservation

Skills:
Field Skills

Summary

Students will learn how oil spills affect the ocean and the animals that live in the ocean.

Objectives

Students will:
- List two reasons for oil spills, and three effects they have on the ocean.
- Demonstrate the protocol for rescuing sea turtles after an oil spill.

Why Is It Important?

The world depends on oil for many of our energy and manufacturing needs. Sometimes that oil is spilled from ships, from tanks on land, or from automobiles, and the animals in the ocean are affected. Animals who use the surface of the sea, like turtles, birds, seals, otters, penguins, dolphins and whales, can become covered in oil and associated toxic chemicals.

Background Information

When we talk about oil spills, how much oil are we talking about? Often quite a lot:

- The world uses nearly 3 billion gallons each day.
- One of the most famous oil spills was the Exxon Valdez spill into Prince William Sound, Alaska, in March 1989. An oil tanker ran aground to cause this spill of almost 11 million gallons of crude oil. While this was a big spill, it was actually only a small fraction-less than 1 percent-- of what the world uses in 1 day!

These big numbers are hard to relate to everyday life, so let's make some comparisons. For example, the approximate amount of oil spilled from the Exxon Valdez would have filled up 9 school gyms or 430 classrooms. The average school classroom would be filled by 25,000 gallons of oil.

What do we use all this oil for? You may not be aware of all the ways we use oil. We use it:

- to fuel our cars, trucks, and buses, and sometimes to heat our houses.
- to lubricate machinery large and small, such as bicycles or printing presses.
- to make the asphalt we use to pave our roads.
- to make plastics, such as the toys we play with and the portable radios or CDs we listen to.
- to make medicines, ink, fertilizers, pesticides, paints, varnishes, and to fuel the power plants that make electricity!

Oil spills into rivers, bays, and the ocean are caused by accidents involving tankers, barges, pipelines, refineries, and storage facilities, usually while the oil is being transported to us, its users.

Oil floats on salt water (the ocean) and usually spreads out rapidly across the water surface to form a thin layer that we call an oil slick. As the spreading process continues, the layer becomes thinner and thinner, finally becoming a very thin layer called a sheen, which often looks like a rainbow. (You may have seen sheens on roads or parking lots after a rain or in marina waters filled with boat engines).

Depending on the circumstances, oil spills can be very harmful to marine birds and mammals, and also can harm fish and shellfish. You may have seen dramatic pictures of oiled birds, sea otters and baby turtles that have been affected by oil spills. Oil destroys the insulating ability of fur-bearing mammals, such as sea otters, and the water-repelling abilities of a bird's feathers, thus exposing these creatures to the harsh elements. Many birds and animals also ingest (swallow) oil when they try to clean themselves, which can poison them. Depending on just where and when a spill happens, many thousands of birds and mammals might be killed or injured. Once oil has spilled, various local and international agencies, as well as volunteer organizations, may be needed to respond to the incident.

Although oil spills are the most dramatic sources of oil pollution in the oceans, an estimated 85% of the oil that enters the Atlantic Ocean comes from land sources. Everyday, leaky automobiles drop enough oil to cause an oil slick larger than the Exxon Valdez spill. Most of this oil eventually ends up in the ocean. Simple car tune-ups can prevent this pollution, and this is especially true on Caribbean islands where, as we know, everything washes to the sea!

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Collect the materials you will need including bowls (one for each team), hot and cold water, and dish washing soap (*Dawn* works well if it is available).

▼ The Activity

1. Divide the class into teams of 3-4 students. One team member should be responsible for writing down responses. If there is a student who does not want to get wet, he/she can record. Each team should have a set of materials.

2. Fill the bowl with water (cold or warm). Fill the cap of the cooking oil bottle with oil, and turn it over in the bowl of water. You can add powdered cocoa to the oil to make it more visible and resemble crude oil. Add two caps (or about 3 tablespoons) to the water. Have the students observe the oil spill and report how the oil spreads: how quickly, evenly or in clumps, how thin?

3. To simulate a turtle caught in an oil spill, have students place their hand in the bowl. When the hand is covered in oil, put the hand in cold water and try to get the oil off. Then have them try the warm water. Finally, add dish washing liquid to the warm water and try again. Have the students report the results. Alternatively, students can use pieces of wood, stones, table tennis balls or cotton balls to simulate the turtles. (Caution: Soap should never be used around an animal's eyes or mouth.)

4. Your fingernails are similar to the turtle's shell, your skin is similar to the turtle's skin, which was hardest to clean? How would this have been different if you were a turtle? If the cooking oil was crude oil? If you had swallowed the oil? If no one had rescued you or taken the time to cleanse you?

▼ Enrichment

1. Visit the web page http://response.restoration.noaa.gov/photos/mearns/mearns.html Have students in groups of 2 complete the Mearns Rock exercise. This exercise lets students graph the changes in marine life following the Exxon Valdez oil spill.

2. Have students mix oil and water either in a jar, or in a bowl, and observe what happens. Have the students, in their groups from the activity, write down three possible methods for cleaning up an oil spill.

Sea Turtle Survivor 4F

Preparation Time:
10 minutes

Activity Time:
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment**(optional)
30 minutes

Materials Needed:
• Copies of provided Background Information
5-10 copies of Sea Turtle Survivor Board
5-10 copies of Turtle Tip Cards
• Dice (or coins)

Setting:
Classroom

Subject Areas:
Ecology

Skills:
Comprehension, Group-Building

Vocabulary:
flotsam
lifecycle
pollution

▼ Summary

Students will learn the threats that face sea turtles on their journeys in the water and on land.

▼ Objectives

Students will:

- Describe the general **life cycle** of sea turtles.
- Explain the low rate of hatchling survival to adulthood.
- List three natural threats to sea turtle survival.
- List three human-created threats to sea turtle survival.

▼ Why Is It Important?

Sea turtles have been in existence for over 100 million years, yet in recent times their numbers have rapidly declined. This decline is a result of human activities that have affected and continue to affect turtle populations, such as development along the coast which reduces suitable nesting habitat, **pollution** of our oceans, and the excessive taking of turtles for food, jewelry and souvenirs. This activity will help students to understand how these threats affect the lives of Caribbean sea turtles.

▼ Background Information

Sea turtles are reptiles that spend almost their entire **life cycle**s in the ocean. There are seven species worldwide, and six in the Caribbean. Sea turtles have special characteristics and adaptations that enable them to survive in their ocean environment. For example, they consume the salty sea water that surrounds them and rid themselves of excess salt by tearing. Instead of having feet for crawling, like the smaller fresh-water turtles that we sometimes see on land, they have flippers for swimming. Sea turtles, like all reptiles, have lungs instead of gills so they cannot breathe underwater. They can, however, stay underwater for several hours - even sleeping underwater!

Unlike other turtles, sea turtles cannot pull their limbs inside of their shells for protection. Their head and flippers stay extended, making them vulnerable to predators like sharks. To escape predators, sea turtles are strong and agile swimmers and some species are very deep divers.

Sea turtles are omnivores, which means that they eat both plants and other animals. Some of the things they eat include jellyfish, crabs, and sea weed. Sea turtles don't have teeth. Instead they have horny beaks.

When it is time for a female turtle to nest she migrates to her nesting beach and crawls ashore to lay her eggs. She usually crawls beyond the reach of high tide and digs a deep hole in the sand. She then deposits, on average, about 100 eggs. She covers the hole with sand and crawls back to the ocean.

After about 60 days, the eggs hatch, the hatchlings make their way to the surface, and then emerge from the sand. The temperature of the sand will largely determine whether the turtles turn out as males or females. Lower sand temperatures generally produce males and warm temperatures, females. Hatchlings orient themselves toward the lowest, brightest light which, under natural circumstances, is the open horizon of the ocean. If there are artificial lights shining on the beach, turtles often crawl in the wrong direction and never make it to the water.

Once the hatchlings emerge from the nest, they have to get past the ghost crabs that live on the beach, as well as seagulls and other birds that might try to eat them. Emerging at night helps to keep the baby turtles safe.

Sea turtles spend the early years of their lives at the surface of the water, floating in and camouflaged by clumps of seaweed and other **flotsam**. The seaweed provides them with food and shelter. Because they are so small when first hatched, they are vulnerable to predators, and many don't reach adulthood. In fact, researchers believe that fewer than 1 in 1,000 eggs laid will produce a turtle that reaches maturity.

While hatchlings weigh only 17g - 45g, adult sea turtles range from less than 50kg to the giant leatherback which can exceed 900kg!

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

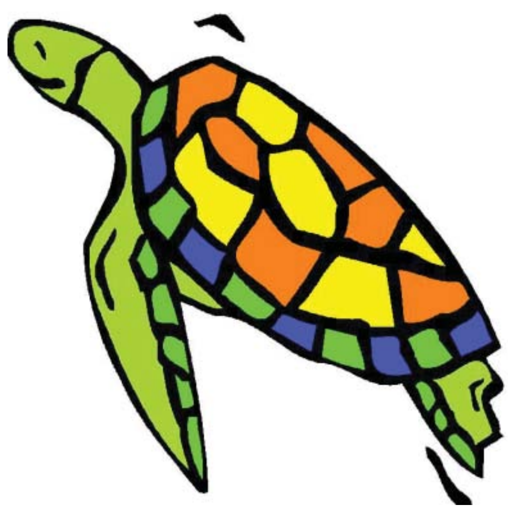
2. Divide the class into teams of 5 and give each group a copy of the Tokens, game board, Turtle Tip cards, and a die. If you don't have dice, use two coins. If the coins both land "head" up, that is 1, mixed is 2, and both landing on "tails" is 3. This should be fine for the purposes of the game.

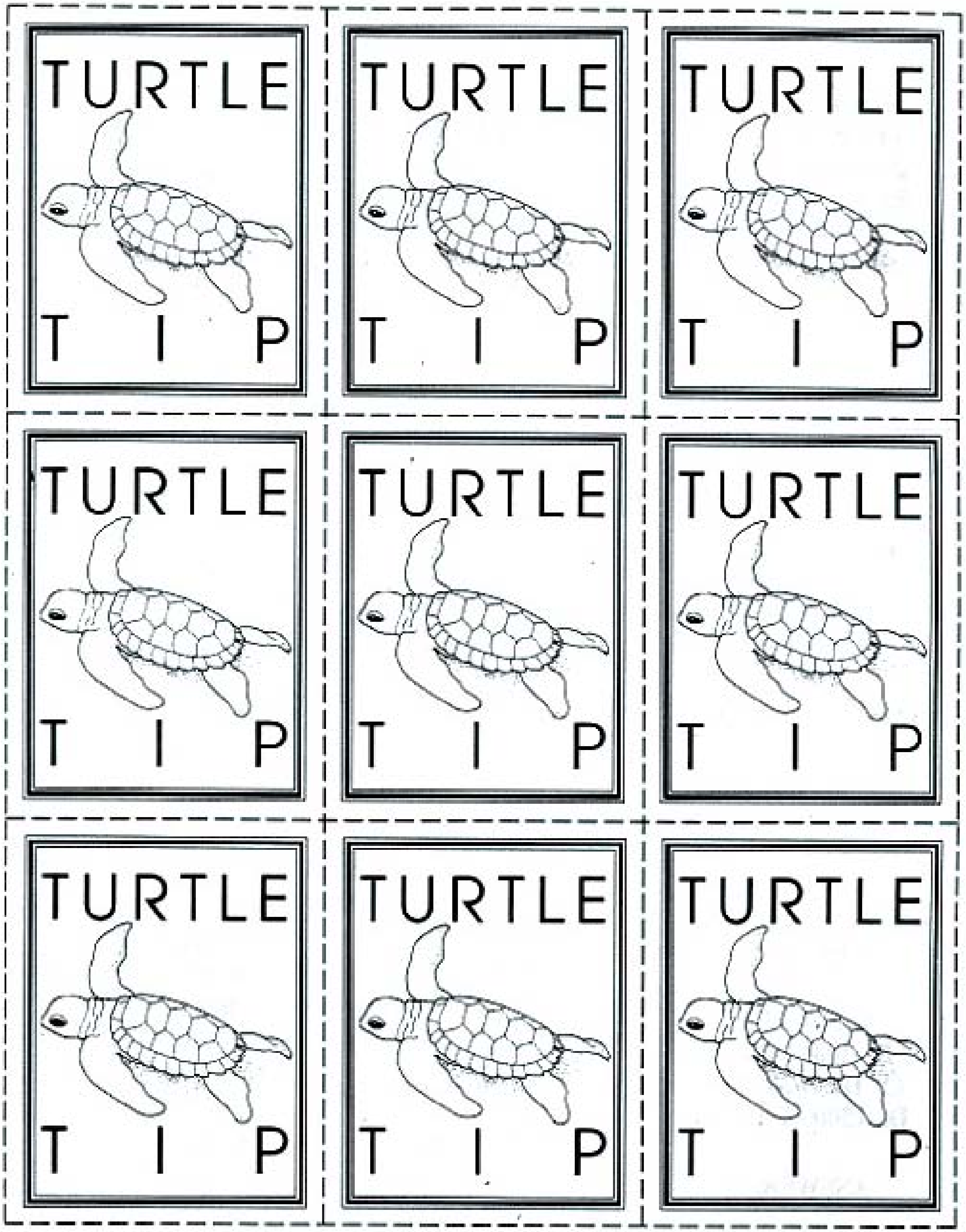
3. Make a copy of the Turtle Tip Cards and questions for each team. If two-sided copies cannot be made, glue the questions to the cards. Cut the Cards out and stack them near the board.

▼ The Activity

1. Explain the following rules to the students.
   - Everyone should roll the dice to decide who goes first. The highest roll goes first, the game proceeds clockwise.
   - Each player should put a token on the "start" space.
   - The first player rolls a die and moves the token the number of spaces the die indicates. When a player lands on a space, he/she must follow the instructions on that space.
   - If the space is a Turtle Tip, the player is asked a question from the Turtle Tip Cards. Another player draws the top card and reads it aloud. If the player answers correctly, he/she rolls again, if incorrect, he/she remains in place, and the die is passed to the next player.
   - Play until one player reaches the end and correctly answers the Turtle Tip question.

2. After the students have played the game, lead a discussion about how difficult it is for hatchling sea turtles to survive. Have the students list the man-made and natural threats that they encountered during the game. Which do you think are most important survival threats where you live?

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Sea Turtles lay their eggs on:
A. Rocky Shores
B. Sandy Beaches
C. Coral Reefs
D. Fishing Piers
Answer: B

Sea turtle eggs usually hatch after approximately:
A. 2 days
B. 10 days
C. 60 days
D. 1 year
Answer: C

What determines whether a sea turtle will hatch out as a male or female?
Answer: Temperature of the sand during incubation.

True or False: Female sea turtles remain with the nest to incubate their eggs.
Answer: False

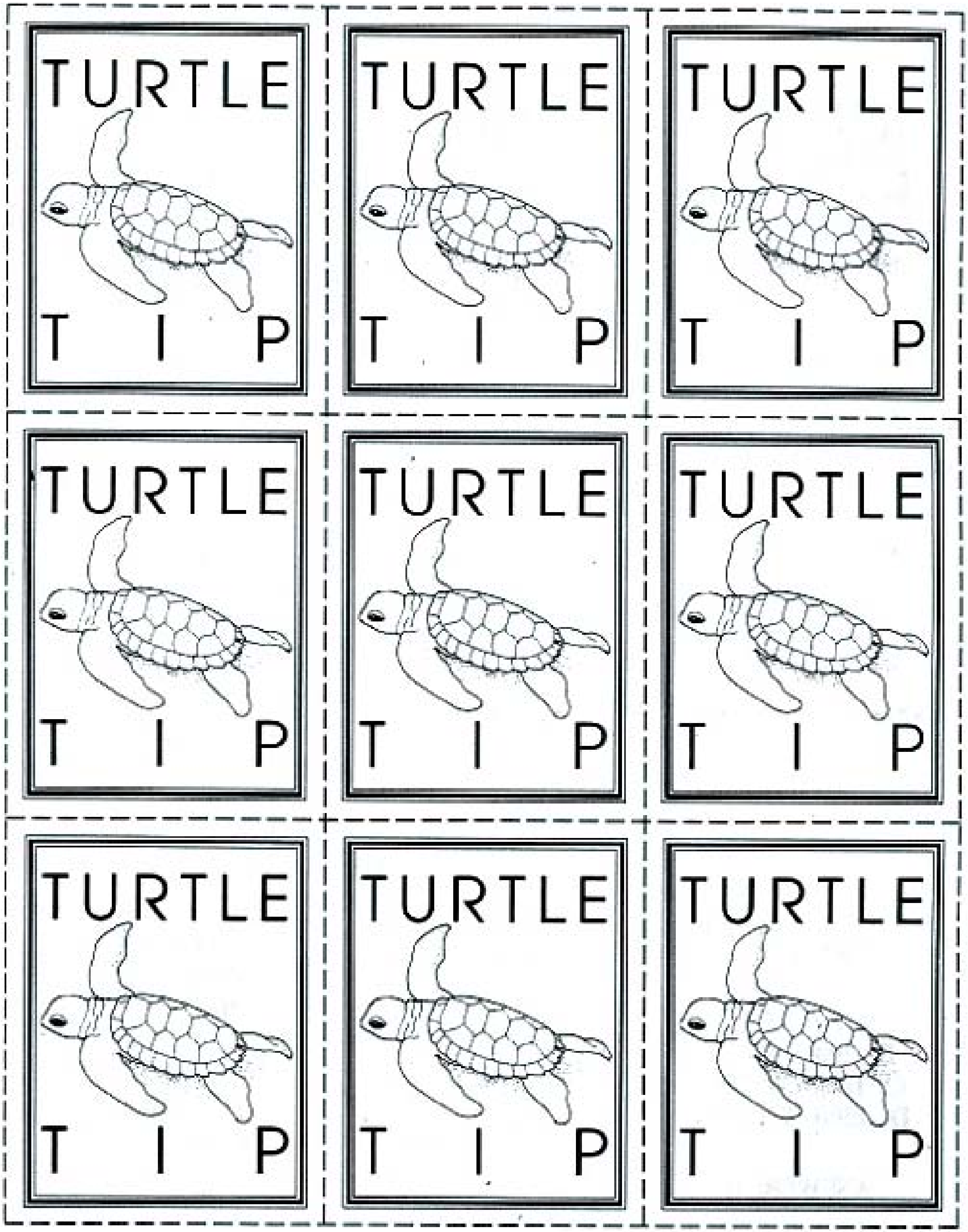
Could lights shining on the beach cause hatchling sea turtles to crawl in the wrong direction, away from the ocean?
Answer: Yes

Does the bright open horizon over the sea attract sea turtle hatchlings to the ocean?
Answer: Yes

Where is it thought hatchling sea turtles spend the first years of their life?
A. Floating in seaweed mats at the ocean surface
B. Buried under the mud on the ocean floor
C. In the sand dunes
Answer: A

Approximately how many sea turtle hatchlings make it to adulthood?
A. Every one
B. One in ten
C. One in one hundred
D. One in one thousand
Answer: D

Can residential and commercial development along the coast reduce good nesting habitat?
Answer: Yes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True or False: A sea turtle can pull its head into its shell for protection.
Answer: False

Where do sea turtles sleep?
A. On the beach
B. In reefs or "sleeping holes" on the ocean floor, or floating at the surface
C. In the forest behind the beach
D. In the "Turtle View" Condominiums
Answer: B

Instead of teeth, sea turtles have:
A. Gums
B. Incisors and molars
C. Canines
D. A sharp beak
Answer: D

Green sea turtles are:
A. Herbivores (eat mainly plants)
B. Carnivores (eat mainly animals)
C. Omnivores (eat both plants and animals)
Answer: A

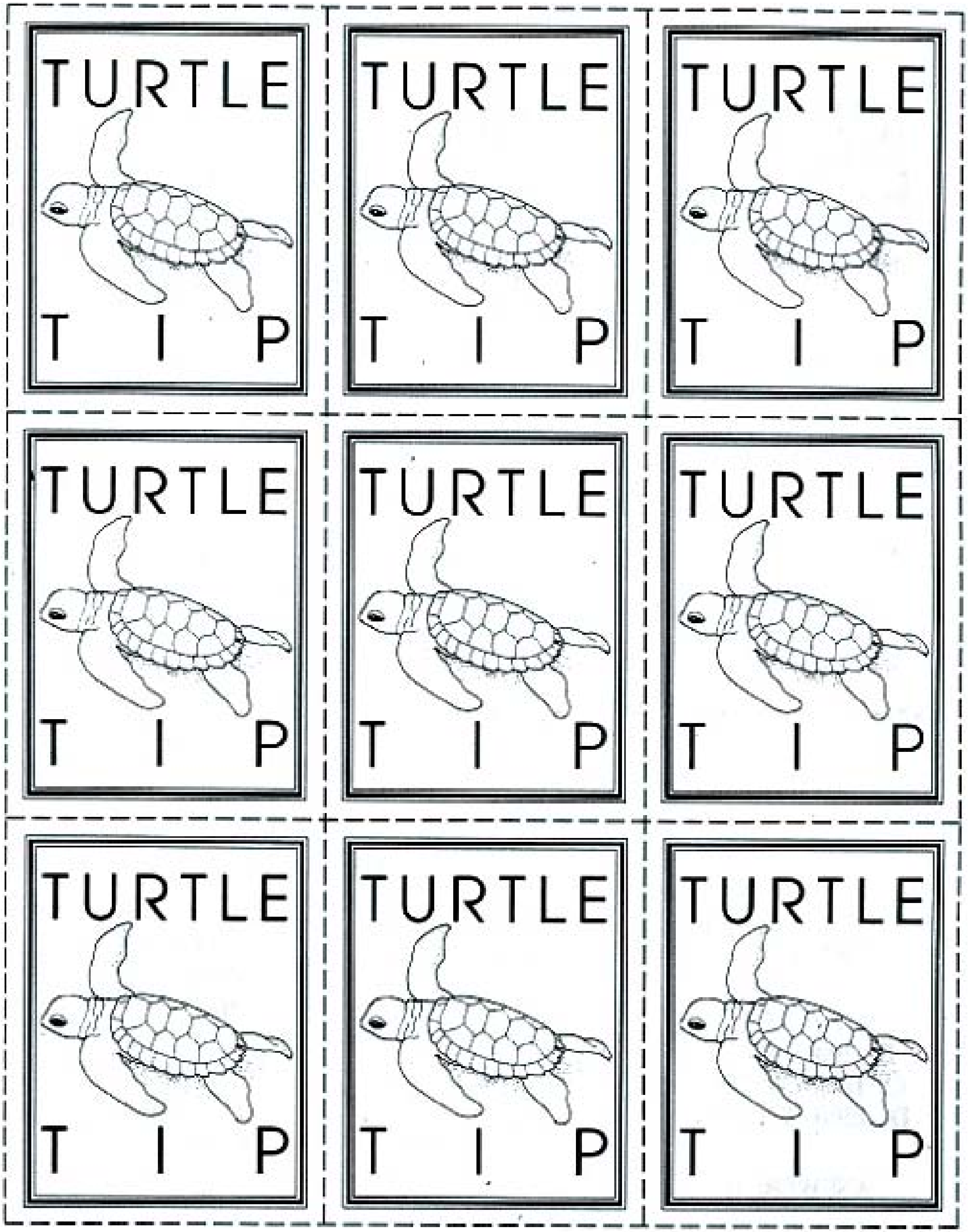
Which of the following is NOT a food source for sea turtles?
A. Jellyfish
B. Coconuts
C. Seaweed
D. Small crabs
Answer: B

Which of the following is NOT a predator of sea turtles?
A. Ghost crabs
B. Humans
C. Sponges
D. Sharks
E. Sea gulls
Answer: C

True or False: Sea turtles cry only during nesting.
Answer: False

When do hawksbill sea turtles nest?
A. At night
B. During the day
C. Only during the full moon
D. Only after a storm
Answer: A

True or False: A female sea turtle will lay, on average, about 100 eggs per nest.
Answer: True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How many species of sea turtles are possibly found in the Caribbean Sea?
Answer: 6

What sea turtle is the most endangered (has the smallest population) of all the turtles in the Caribbean Sea?
Answer: Kemp's Ridley

Adult female leatherback sea turtles weigh about:

A. 20-40kg
B. 100-200kg
C. 350-550kg
D. 700-1000kg

Answer: C

What is the largest sea turtle in the Caribbean Sea?
Answer: Leatherback

A sea turtle is a(n):

A. Insect
B. Amphibian
C. Reptile
D. Mammal

Answer: C

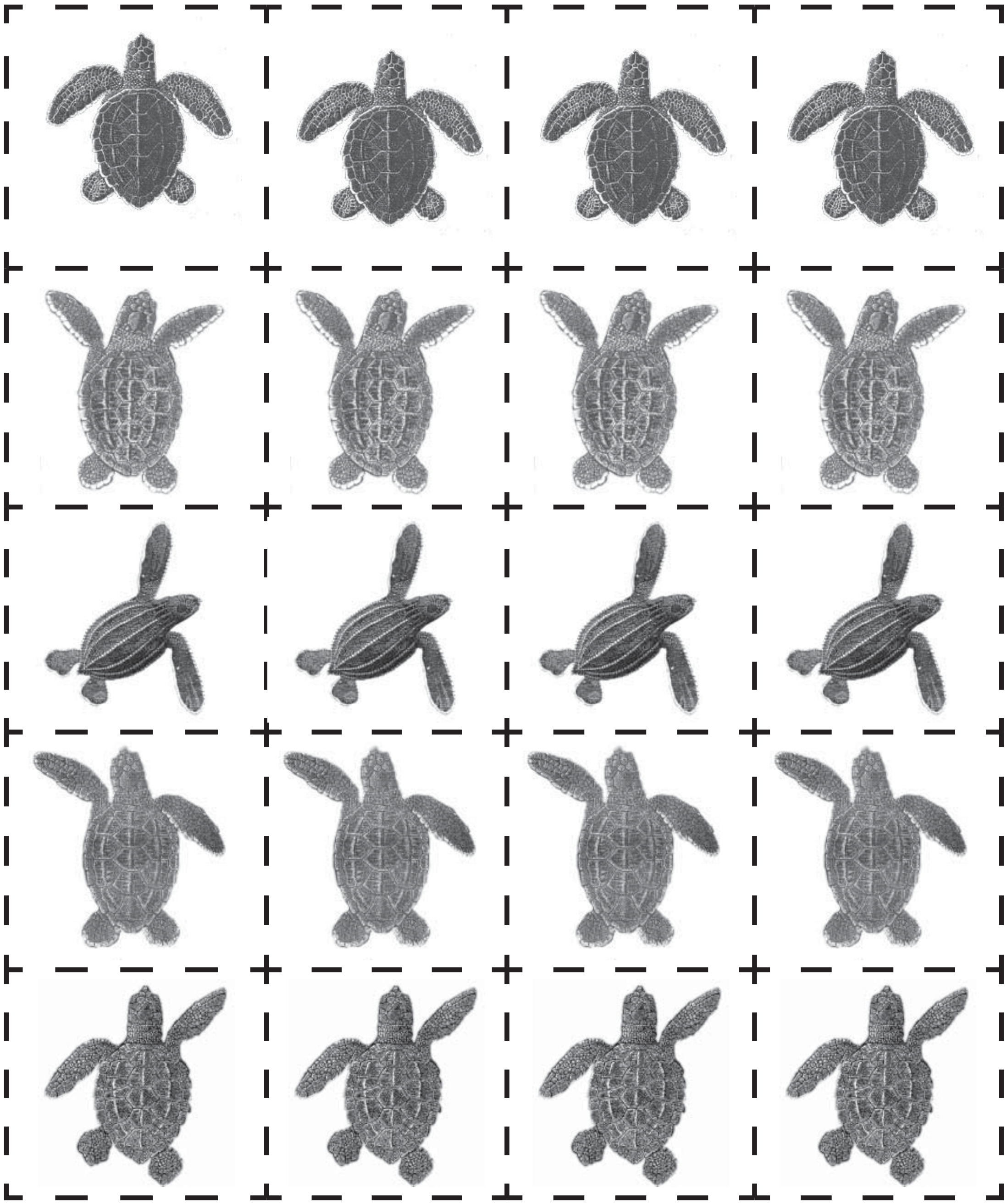
True of False: Sea turtles can breathe underwater.
Answer: False

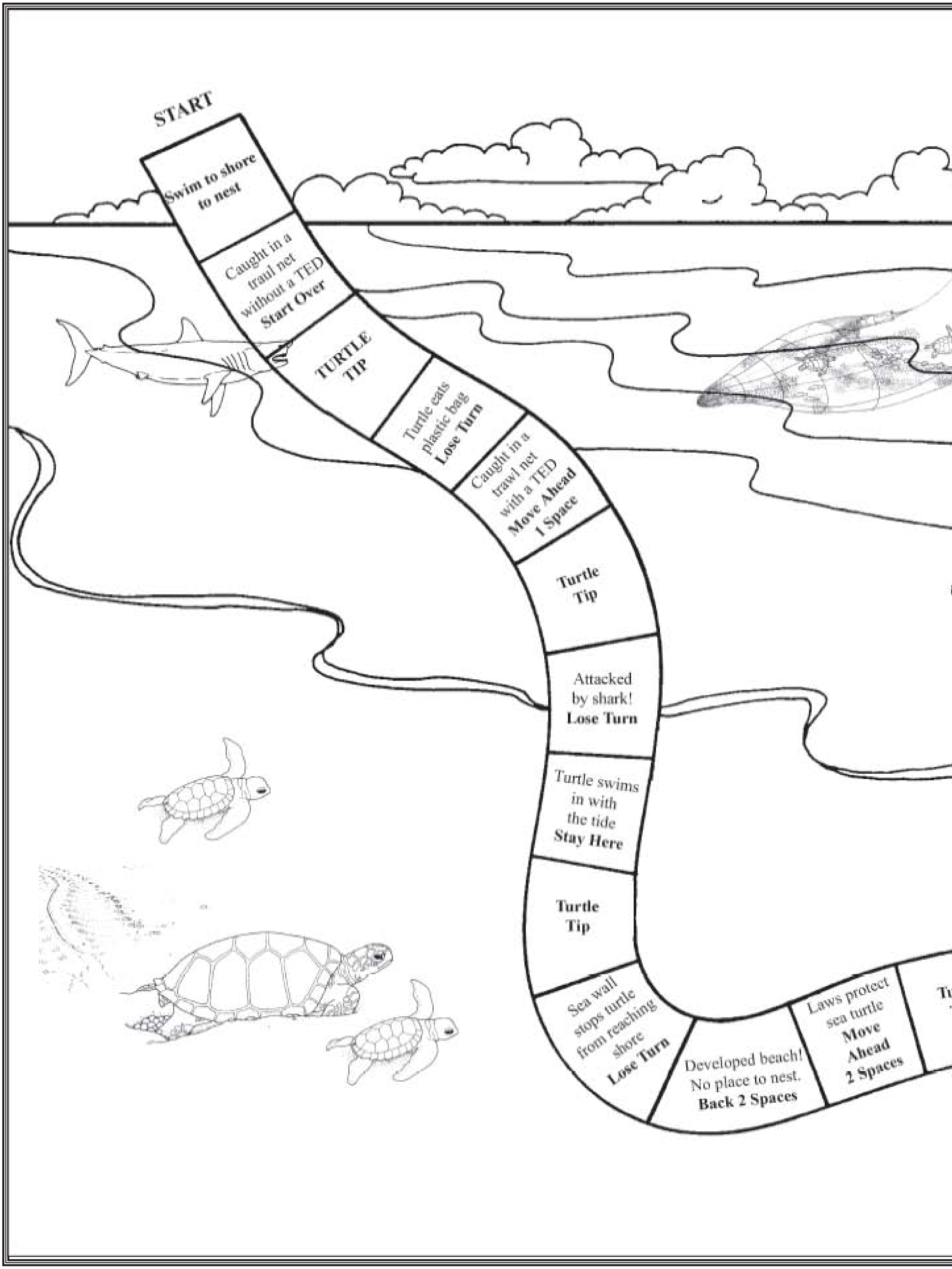
Do sea turtles have gills or lungs?
Answer: Lungs

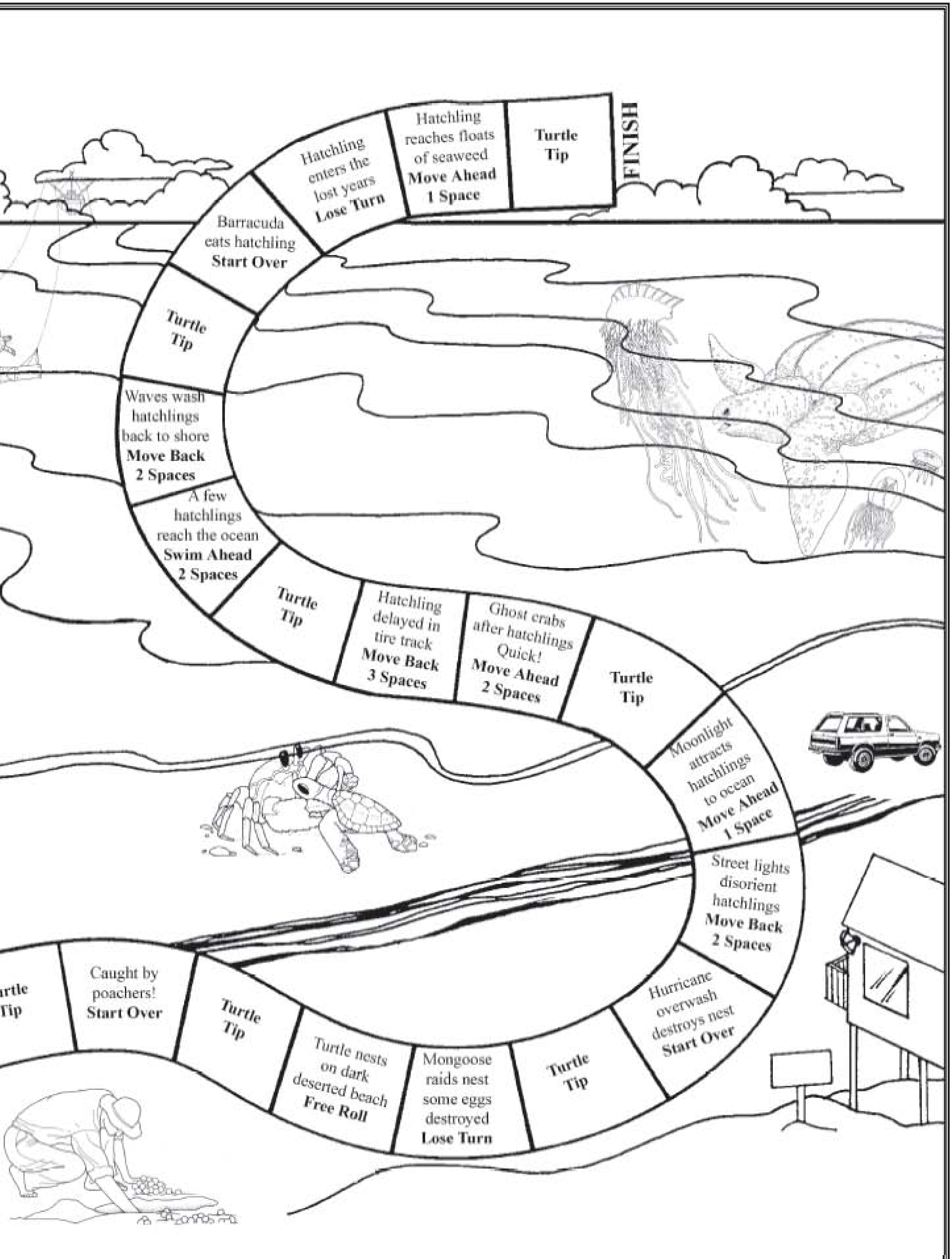
What do sea turtles drink?
Answer: Sea water

How do sea turtles rid themselves of excess salt in their bodies?
Answer: By shedding tears

Tokens




START
Swim to shore to nest
Caught in a traul net without a TED Start Over
TURTLE TIP
Turtle eats plastic bag Lose Turn
Caught in a trawl net with a TED Move Ahead 1 Space
Turtle Tip
Attacked by shark! Lose Turn
Turtle swims in with the tide Stay Here
Turtle Tip
Sea wall stops turtle from reaching shore Lose Turn
Developed beach! No place to nest. Back 2 Spaces
Laws protect sea turtle Move Ahead 2 Spaces


rtle Tip
Caught by poachers! Start Over
Turtle Tip
Turtle nests on dark deserted beach Free Roll
Mongoose raids nest some eggs destroyed Lose Turn
Turtle Tip
Hurricane overwash destroys nest Start Over
Street lights disorient hatchlings Move Back 2 Spaces
Moonlight attracts hatchlings to ocean Move Ahead 1 Space
Turtle Tip
Ghost crabs after hatchlings Quick! Move Ahead 2 Spaces
Hatchling delayed in tire track Move Back 3 Spaces
Turtle Tip
A few hatchlings reach the ocean Swim Ahead 2 Spaces
Waves wash hatchlings back to shore Move Back 2 Spaces
Turtle Tip
Barracuda eats hatchling Start Over
Hatchling enters the lost years Lose Turn
Hatchling reaches floats of seaweed Move Ahead 1 Space
Turtle Tip
FINISH

Unit 4 References

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Unit 5

Hatchlings

Turtle Hurdles 5A

Preparation Time:
10 minutes

Activity Time:
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment**
30 minutes

Materials Needed:
• Copies of provided Background Information
• Rope or chalk
• Coins, cards, etc.

Setting:
Outdoors or large indoor space

Subject Areas:
Ecology, Math, Physical Education

Skills:
Comprehension, Group-Building

Vocabulary:
critically endangered
endangered
hatchling
maturity
survival
threat

Summary

Students will simulate the mortality rate of hatchlings as they leave the nest and grow up in the ocean.

Objectives

Students will:

- List 4 limiting factors for sea turtle **survival**.
- Name safe areas, where young turtles hide.
- Discuss the odds of a **hatchling** surviving to adulthood.

Why Is It Important?

Many of the limiting factors to sea turtle **survival** are human-influenced. We make changes to the beaches and oceans, often without realizing that it has a negative impact on the animals that live there. This activity will help students to understand sea turtle mortality by having them act it out!

Background Information

A **hatchling**'s journey across the beach is usually accompanied by predatory crabs, mammals, herons and stray dogs, with gulls and frigate birds joining in. Once hatched, only about one out of one thousand of the turtles survive the first year. In the sea, the turtles must mature for more than a decade before returning to nesting sites as a natural part of their life cycle. Biologists are uncertain how long sea turtles reproduce and live, but it is well known that they are prey for fish, sharks, killer whales and humans.

The motives for human predation are based on products that are outlawed in many countries. Jewelry, leather, oil and food are the primary uses. Turtle eggs are seen by some as a boost to longevity and vigor; tens of thousands of eggs are illegally harvested in the Caribbean Sea every year. Evidence suggests that a serious human **threat** to the turtles is poaching.

Also damaging is commercial and private construction (homes, hotels etc.) along the coastline. This may create a barricade that prevents the turtles from reaching their traditional nesting sites or even eliminates nest sites altogether. Along with coastal development comes beach driving, which can crush incubating eggs hidden in the sand.

Entanglement in discarded fishing gear and plastic garbage cast into the oceans is a serous hazard, killing or injuring many sea turtles each year. Turtles also fall victim to the nets of large fishing trawlers; once caught in the nets, they drown. One of the turtle's favorite foods is jellyfish. Turtles mistake the human-produced litter of floating plastic bags for this food. The result is that their digestive tracts become blocked with the discarded plastic and they die.

All six Caribbean sea turtle species are officially designated either **Endangered** or **Critically Endangered** internationally.

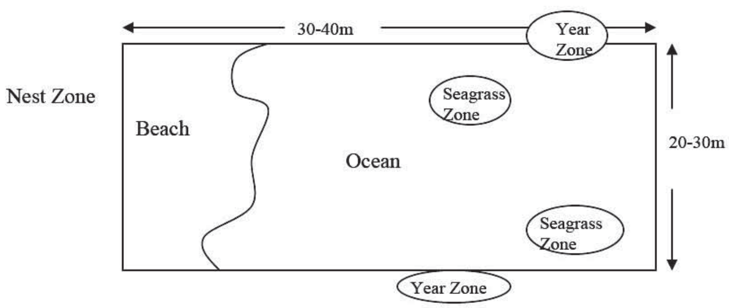
A species is **Critically Endangered** when scientists determine that its global population has been reduced by 80% or more over 3 generations; in the case of **Endangered**, there needs to have been a 50% or more reduction. To see the lists of **endangered** and **critically endangered** species, see this web page: http://www.iucn.org/redlist/2000/

Besides the human-caused **threat**s to **hatchling**s, there are also natural (and not-so natural) **threat**s to the turtles. Mongoose are often predators on **hatchling**s and eggs. The mongoose was introduced to the Caribbean from India in the 1600's to kill rats in the cane fields. Even though the mongoose is "natural", its presence in the Caribbean is not. Ghost crabs also prey on **hatchling**s, as do many shore birds. The yellow-crowned night heron is especially dangerous to **hatchling**s since it hunts at night when the **hatchling**s make their run for the water. Once the **hatchling**s get into the water they can be eaten by any number of large fish!

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.



2. Have the students list four things on the beach and four things in the water that could kill an egg or **hatchling**.

3. Set up the playing area as pictured with rope or chalk or cones.

The Activity

1. Ask the students to act as **hatchling**s and stand around a couple of nests in the nest zone. About 6 students should be taken out of the nest zone and designated as "limiting factors". Three should be on land and three in the ocean. Have the students designate the factors they represent. For example: beachfront lighting, mongoose, crabs, sharks, tuna, fishing nets, beach fires, illegal killing, keeping turtles as pets, or oil spills.

2. Turtles must hatch all at once and start making their way down the beach. If the **hatchling** makes it to the ocean, it needs to spend 25-40 years there before it returns to nest. The coins or cards or beans (anything will work) should be in the year zones. Each year card represents 5 years, so each **hatchling** needs to get 5 cards (25 years) before it can go back to the beach.

3. The seagrass zones are safe. That is where the young turtles will hide from predators, no predator can get the turtles in the seagrass zones. Only one year card can be picked up at any one time. After one is picked up, the next one must be from the other year zone (on the opposite side of the playing field or classroom).

4. If a **hatchling** is caught, it turns into a hotel. All of the tagged **hatchling**s should stand between the beach zone and nest zone with their arms out to their sides, forming a barrier across the beach. Once a **hatchling** has all five year cards and goes back to try to nest, it can only go up the beach where there are no hotels. How many **hatchling**s made it?

5. Discuss the results of the game. Now why do you suppose sea turtles lay so many eggs? If the mother turtle took care of the eggs and young, would she need to lay as many? Was it better to be in a big group or alone? What was the safe place? What percentage of the students survived? Remember how few real **hatchling**s live past the first year.

Enrichment

1. Repeat the game, only this time remove the "factors" that were human-caused. Now how many students survived?

2. Repeat the game, only change the ratios of predators to **hatchling**s. What happens if there is an increase in ghost crab populations one year?

Hatchling Development 5B

■ **Preparation Time**:
10 minutes

■ **Activity Time**:
• **Warm up**
30-45 minutes
• **Activity**
30 minutes
• **Enrichment**
30 minutes

■ **Materials Needed**:
• Copies of provided Background Information Development Worksheet
• Pencil

■ **Setting:**
Outdoors or large indoor space

■ **Subject Areas:**
Ecology, Anatomy

■ **Skills:**
Comprehension, Observation

■ **Vocabulary:**
clutch
commensalism
egg tooth
embryo
incubation
mutualism
parasitism
protocooperation
symbiotic

▼ Summary

Students will learn about the life of a sea turtle in the egg and the complex behavior exhibited during their crawl towards the sand's surface.

▼ Objectives

Students will:
- Define vocabulary words after reading a discussion of nest biology.
- Show how sea turtle hatchlings compete for resources, and how they cooperate.

▼ Why Is It Important?

Animals often develop special relationships with each other to help each other survive. In many species, parents help their young to grow up. Some animals, like honey bees and ants, spend their lives helping one of their relatives to have offspring, and never have any of their own. These relationships are important to understand and fun to learn about! Sea turtles show several kinds of cooperation both with other species and with other turtles.

▼ Background Information

Sea turtle eggs are deposited in a large **clutch** in a nest excavated in a sandy beach by the female. The developing **embryo** is dependent on the beach for oxygen, water and heat. During **incubation**, the **embryo** grows inside the egg from a few cells in the beginning, to a self-sufficient organism at hatching some 50 to 80 days later. The yolk, provided by the mother, inside the egg and provides energy for the growth of the **embryo**.

The eggs must incubate within a precise range of temperatures and, as we explored in Unit 2, the exact temperature has an effect on the gender of the hatchlings. A warmer **incubation** period produces more females than a cooler **incubation** period. The temperature can also affect the **incubation** time. Warmer nests tend to hatch sooner than cooler nests.

Embryos get water for growth from the yolk and also from the surrounding sand. The eggs have to be porous enough to allow water vapor to pass through. Just like human beings, developing sea turtle **embryo**s need to take in oxygen and get rid of carbon dioxide. These gases pass through the egg shell. Obviously the state of the beach will determine how well this happens. (What if a turtle lays her eggs in an area of the beach that is underwater half of the day due to tidal cycles?)

When it is time, hatchlings use a specialized **egg tooth** (a hard tip on their nose) to break the egg shell. The egg tooth disappears shortly after hatching. Once the hatchling is free of the shell, it begins the long process of digging its way to the surface. Movement caused by breaking free of the shell causes neighboring eggs to hatch. As each egg hatches, the fluids drain away, creating air space in the nest.

The hatchlings, aware of which way is "up", wiggle and dig towards the surface in a rare example of cooperation among individuals known as "**protocooperation**". The hatchlings move upwards in a group through the sand and the majority of the turtles reach the surface together. The climb to the surface may take several days to complete. Once there, the hatchlings wait unseen, just below the surface, until the sand cools (signaling night time) and then emerge quickly and together from the nest. This behaviour increases the chance that a turtle will make it to the water. With so many hatchlings in one place, it would take a lot of predators to get them all! Once in the water, the hatchlings are once again solitary animals and will compete for food and shelter.

By cooperating together, the hatchlings help one another to survive. When cooperation occurs between different species, it's called **mutualism**, which is a form of **symbiosis**. **Symbiotic** relationships can also be harmful to one of the participants. There are three different kinds of **symbiotic** relationships. In **mutualism**, both animals benefit from the exchange. When bees drink nectar from flowers and in turn pollinate the flower, both the plant and bee win. In **commensalism**, one animal benefits while the other is neither harmed nor helped. Some vines use trees to reach light and for support, but do not harm the tree. In **parasitism** one animal gains, and the other is harmed. For example, Cuckoo birds lay their eggs in other birds' nests. When the chicks hatch, the larger cuckoo chick pushes the other chicks out of the nest.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Let them know that it will be important that they remember it for the worksheet later. Have the students read the information or read it aloud in class.

2. Discuss the three kinds of symbiosis. Have students think of examples from their own experience of **mutualism**, **commensalism** and **parasitism**.

▼ The Activity

1. Have students complete the Development Worksheet by filling in the blanks. They should not look back at the Background Information, but try to remember the answers.

2. Cut out squares of colored paper (or white paper and make a colored mark on them) in blue, yellow and green. Provide 3 of each color to each student. You can also use candies, poker chips, or any other pieces.

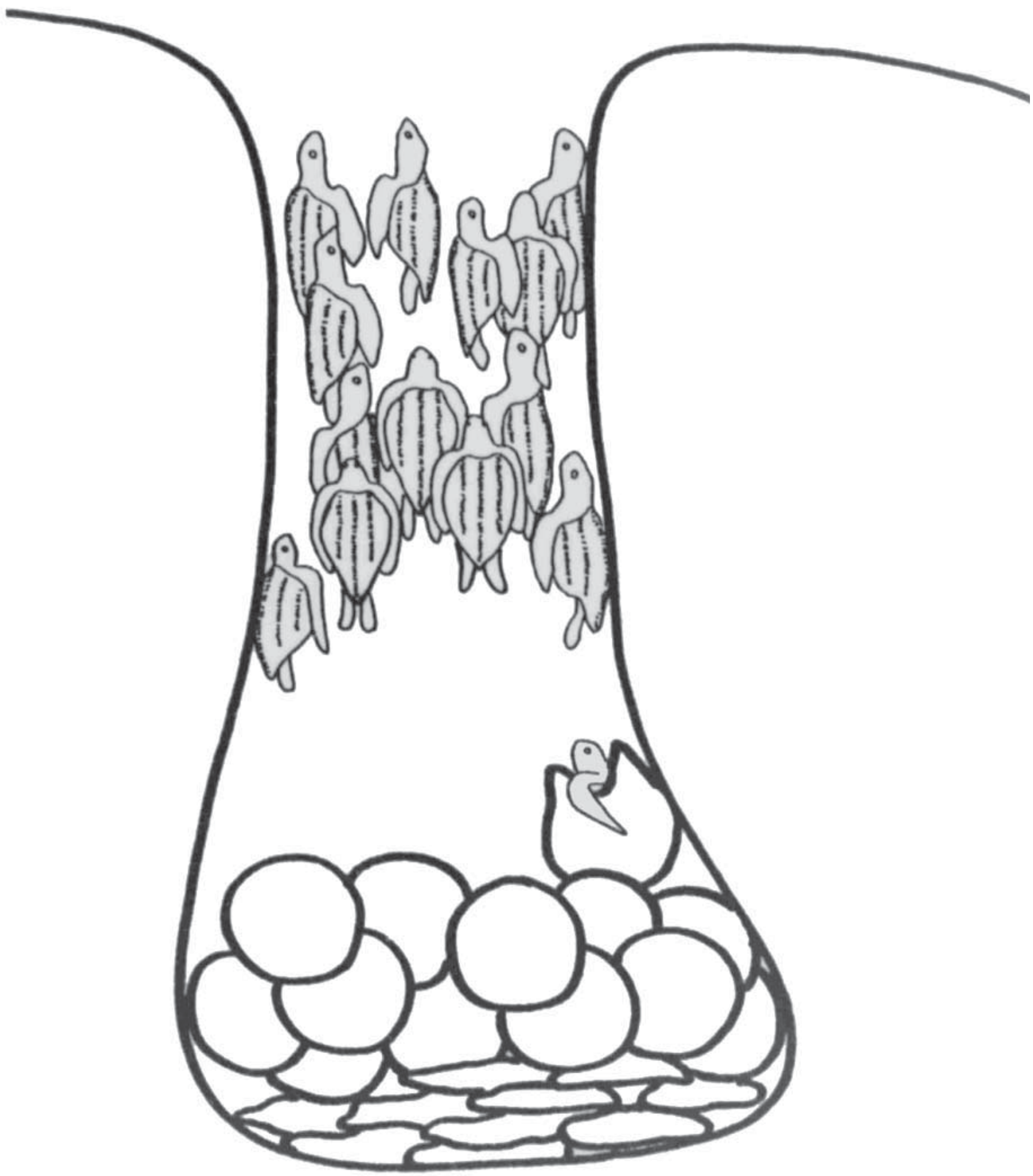
3. Have each student represent an egg in a nest and arrange themselves arm's length from each other in a circle. Once the students are in place, they cannot move their feet. The blue cards represent water, the yellow cards represent heat and the green cards represent oxygen. Scatter the cards among the students evenly, including inside and outside the circle. Indicate that they may begin, and that each egg should try to get as many resources as possible.

4. Only those eggs that receive at least one heat, one water, and one oxygen will survive. Any egg with more than two heat cards will be female. Repeat the game twice more and discuss the results. Was it easier if you were close to other students, or far away? Were you cooperating or competing with your nest-mates?

▼ Enrichment

1. Repeat the game above, but limit some of the nutrients. Make extra rules. For instance, if an egg gets 3 waters, it drowns. Try a rule that says that eggs can supply excess nutrients (or heat) to neighboring eggs. Does this require communication?

2. Have all of the students close their eyes. Have them spin a couple of times and all grab the same rope or piece of string, or even a stick. Now tell the students that they should all try to move together to get somewhere (towards the sun, or towards a noise you make). Since hatchlings don't open their eyes until they are out of the nest, what senses do you think they use to get to the surface of the sand?



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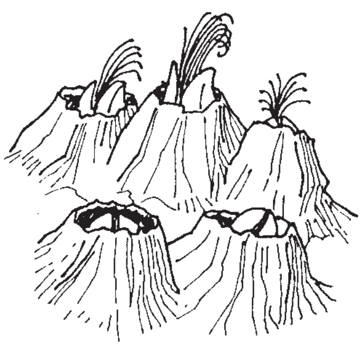
(Adapted from Gulko and Eckert, 2004)

Development Worksheet

Fill in the blanks.

In this photo, fish are picking seaweed off of the turtle's shell. The fish eat the seaweed and the turtle is helped because it can swim faster without the "drag" caused by the seaweed. This kind of **symbiotic** relationship is known as:
________________________________.

Many sea turtles are hosts to barnacles. These animals build casings on the shells of sea turtles. The sea turtle is neither benefited nor harmed by most of these barnacles, but the barnacles benefit by filter feeding as the turtle moves, getting them more food. This relationship is known as:
________________________________.



Leaches attach to the skin of sea turtles and feed on the turtle's blood. Although the leech is helped by the relationship, the turtle may be harmed. This is called ______________________.

Sea turtles emerging from their nest are all the same species but, even so, cooperation is rare. The kind of cooperation sea turtle hatchlings use to reach the surface of the beach from deep inside the nest is called ________________________________.

What might the consequence be if hatchlings did not cooperate when leaving the nest?

____

Name two advantages to hatchlings waiting until early evening, or nightfall, to emerge from the nests and scramble for the sea?

____

Finding the Sea 5C

Preparation Time:
10 minutes

Activity Time:
- **Warm up** 30-45 minutes
- **Activity** 45 minutes
- **Enrichment** 15 minutes

Materials Needed:
- Copies of provided Background Information Student copies of the Word Search and Hatchling Maze
- Pencil & paper

Setting:
Classroom or outdoors

Subject Areas:
Ecology, Anatomy

Skills:
Analysis, Research Skills

Vocabulary:
"Lost years"
obstacle
wave compass

Summary

Students will learn how hatchlings find the ocean from their nests, where they go, and why so many don't get there.

Objectives

Students will:
- Describe the ways that hatchlings reach the ocean.
- Discuss the difficulties in navigating by senses.
- Explain the human-caused factors that make the trek to the sea so difficult.

Why Is It Important?

On average, between 50% and 90% of sea turtle hatchlings make it out of the nest. It is the next 10 or 20 meters between the nest and the ocean that starts to take a toll on the numbers of hatchlings. The predators on the beach are discussed in the Turtle Hurdles activity in this unit. Here we will explore non-living (abiotic) threats, and learn how hatchlings are able to emerge from the egg and within a week or two, find distant off-shore feeding grounds.

Background Information

A hatchling's trek to the sea is not as easy as you might think. To a hatchling, a single person's footprint on the beach can be a serious **obstacle** in its journey to the ocean. Vehicle tracks, boats, logs, trash and even sunbathing tourists can be huge barriers. In addition, lights on a beach where hatchlings are emerging can disorient and misdirect the young turtles, preventing them from reaching the sea. Hatchlings are very sensitive to the brightness of the open ocean horizon (as opposed to the relatively dark beach vegetation). This sensitivity gives the newborns their strongest clue as to the location of their destination- the sea.

Visual cues (what the hatchlings actually see with their eyes) guide hatchlings from the nest to the ocean's edge. When they first enter the water they rely on an unusual ability scientists refer to as a "**wave compass**", moving directly against the incoming waves so that they head straight out to sea. Those that survive the predator-rich nearshore waters begin to navigate much like their mother did to find the beach. They use a "magnetic compass" in order to maintain their seaward direction.

When the hatchlings first reach the water, their beach crawl is replaced by "dog paddling". They may be thrown back ashore by strong waves more than once, but soon the hatchlings are running for their lives past hungry fish and birds. This "swim frenzy" may last for several days and is designed to carry the hatchlings into open ocean currents that serve as nursery grounds.

The years the hatchling will spend in these nursery grounds are called "**lost years**" because the very youngest sea turtles were not seen by early sea turtle researchers. Today, scientists know that the "**lost years**" are sometimes more like a lost decade. The years are spent traveling in ocean currents where the young turtles are feeding mainly in floating seaweed (flotsam) and debris that offer protection.

While at sea, baby turtles sleep or rest at the surface with their front flippers tucked up over their backs; this decreases their visibility to predators and limits how exposed their flippers are to fish looking for a snack. When they complete their years in the open sea, most young turtles (now the size of dinner plates) return to nearshore waters. These animals travel widely among coastal feeding areas, where they live until they are adults. This is a very mobile time of a turtle's life and these feeding and developmental areas may include the waters of dozens of countries. This period of life may last 15-40 years, making turtles quite old when they first start to reproduce.

▼ Procedure

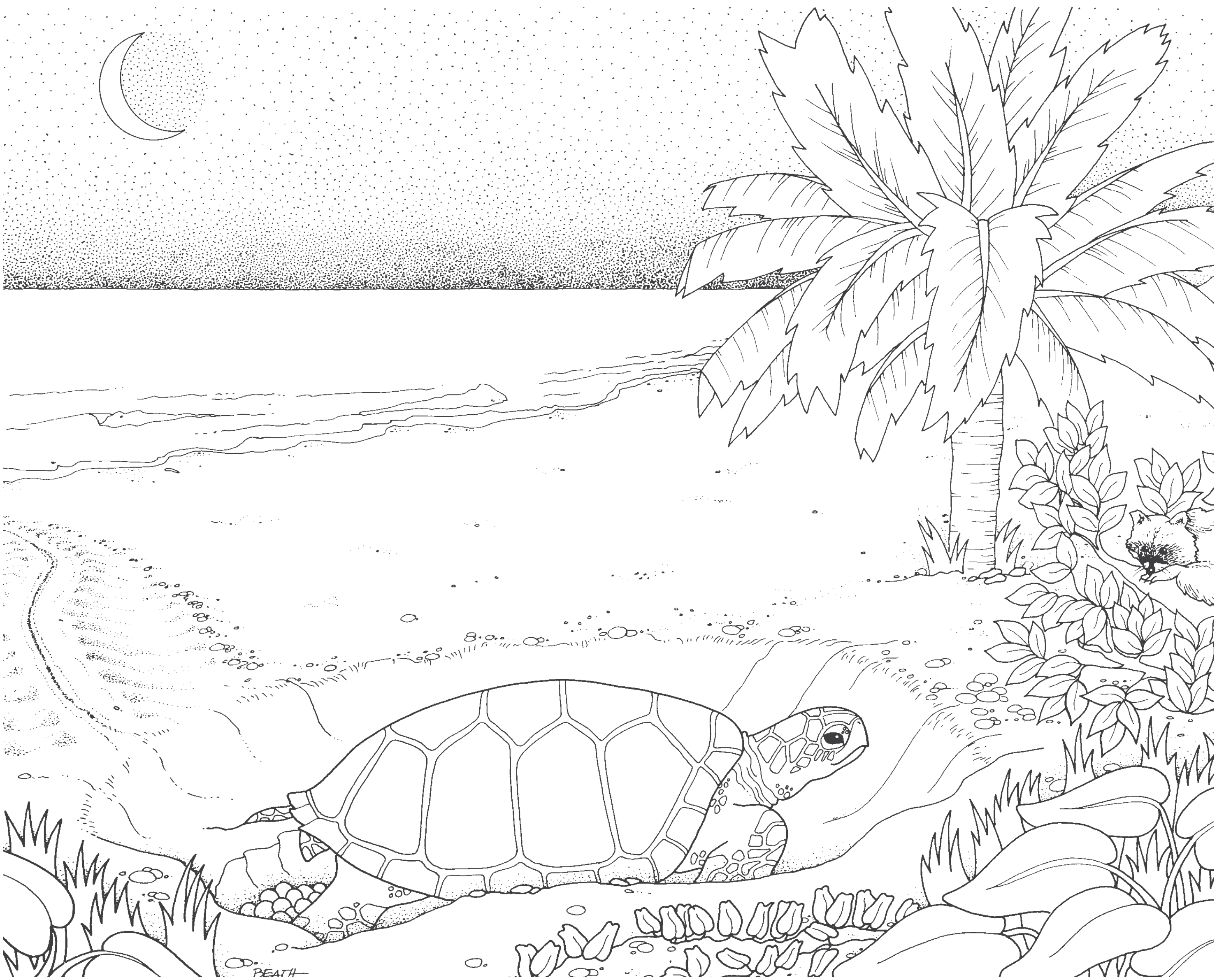
Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

▼ The Activity

1. Have each student work individually to complete the **Lost Years** Word Search and the **Lost Years** Maze.

2. Have each student create a word search featuring words that describe the first 10 years of their lives. Are there any words in common between the students' Early Years Word Search and the Turtles' Lost Years? Why or why not?

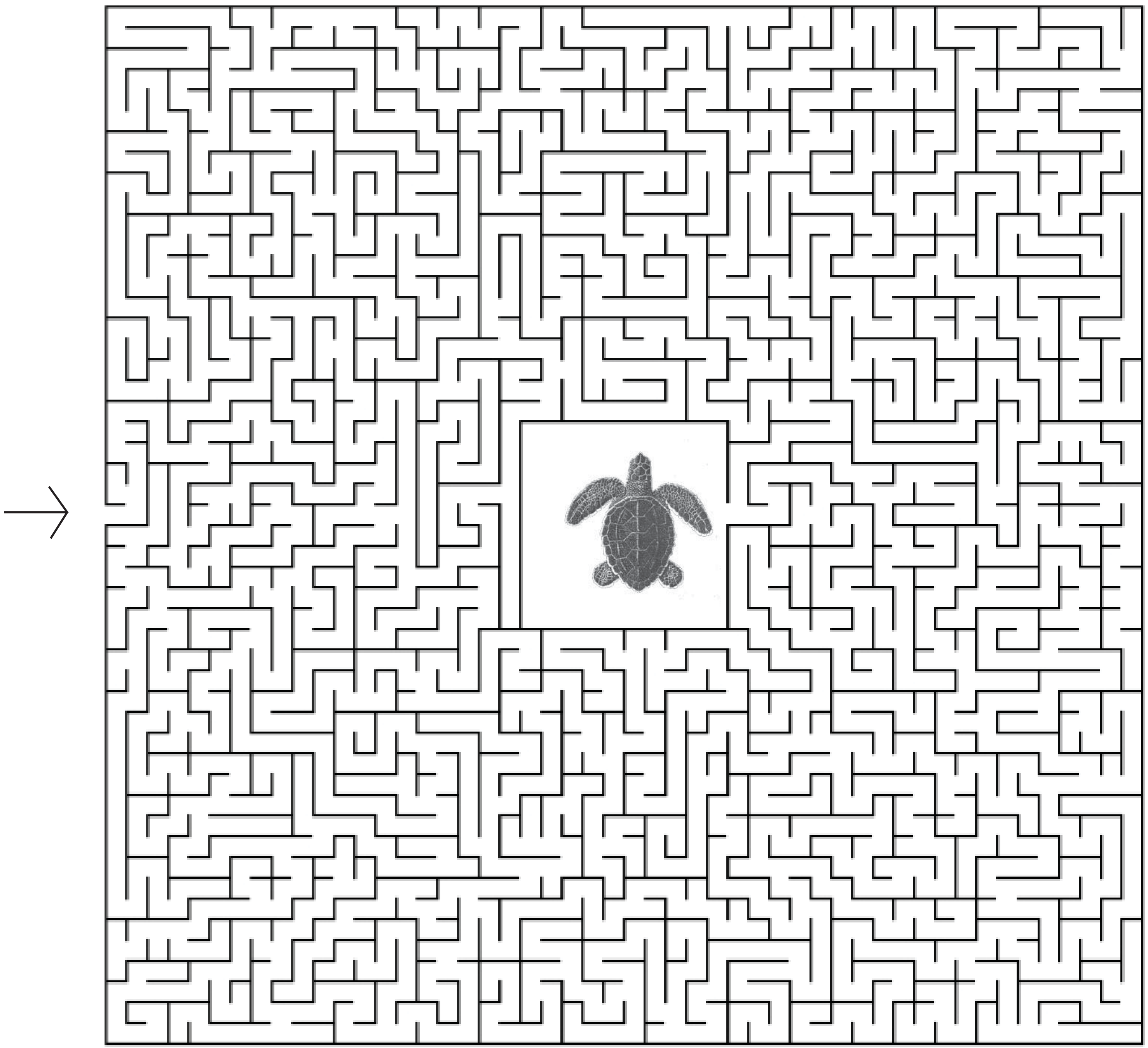


Lost Years Word Search

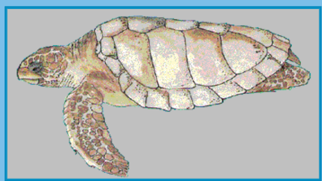
A	D	G	Y	N	Y	N	S	A	K	J	J	J	I	T	R	C	T	Q	W	C	F	J	O	M	T
L	B	H	G	D	G	U	U	P	V	H	V	C	O	P	E	S	H	W	L	C	C	P	O	M	V
R	L	R	T	Q	K	S	H	L	Y	J	N	I	V	O	P	V	A	P	A	R	A	S	I	T	E
U	V	I	E	H	E	R	V	O	N	H	H	W	D	D	P	Y	N	M	Q	R	Q	W	L	D	U
S	H	M	B	A	G	O	O	I	Y	O	H	E	R	B	I	V	O	R	E	T	A	W	I	R	H
W	D	L	A	S	M	R	X	W	O	R	Z	M	M	C	L	U	T	C	H	V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

CARBON DIOXIDE
CLUTCH
EGG
FLIPPER
GROWTH
HATCHLING
HAWKSBILL
HERBIVORE
IMPRINT
LEATHERBACK
NEST
ORIENTATION
OXYGEN
PARASITE
PREDATOR
PROTOCOOPERATION
SEAWEED
SYMBIOSIS
WATER

Hatchling Maze



Sea Turtle Growth 5D



Preparation Time:
10 minutes

Activity Time:
- **Warm up** 30-45 minutes
- **Activity** 70 minutes
- **Enrichment** 30 minutes

Materials Needed:
- Copies of provided Background Information, Hawksbill Size Classes Worksheet, Hawksbill Re-Capture Data Sheet, and graph paper (provided)
- Pencil, calculator

Setting:
Classroom

Subject Areas:
Ecology, mathematics

Skills:
Analysis, Report Drafting, Statistical Analysis

Vocabulary:
cohort
skeletochronology

Summary

Students will learn about the growth rate of sea turtles through data interpretation and graphing exercises.

Objectives

Students will:
- Read and interpret field data.
- Apply data to graphs.
- Interpret results.
- Discuss sea turtle growth.

Why Is It Important?

We know that sea turtles are remarkably long-lived animals, but no one knows exactly how many years make up a "long" time. Guesses range from 60 to more than 100 years. For some species such as the giant leatherback, no one knows exactly how long it takes for a hatchling to become an adult, ready to lay eggs of her own. Questions like "How many years will a female continue to lay eggs?" and "How many eggs will survive?" seem basic, and a necessary piece of information for managing sea turtles.

Background Information

Many sea turtle populations are declining due to overfishing and the disappearance of nesting and feeding grounds. When population numbers, which are generally based on nesting female counts, are studied, they fluctuate widely. How can we know whether a population is really at risk or whether the population is stable, with different numbers of adult females coming to the nesting beaches each year? The growth of sea turtles and their recruitment into the adult population has to be understood more completely. Perhaps hurricanes or food shortages cause fluctuations in the recruitment and survival over time.

A **cohort** is a group of hatchlings of the same age, born in the same year or nesting season. When there is a bad year for sea turtle eggs, then 25-40 years later we should expect a bad year for nesting females, as those hatchlings become breeding adults. It is important to be able to tell short-term (year-to-year) fluctuations from a long-term decline or rise in population levels.

One of the most popular methods for measuring individual growth rates, as well as population-level mortality rates, is known as "capture-recapture". As the title suggests, turtles, whether they are taken from the water or found nesting on the beach, are tagged with individual numbers. Measurements are taken, and sometimes the weight and sex of the turtle. When this animal is captured again, the same measurements are taken. Because food quality and quantity may affect growth rate, using size to estimate age is inexact.

Another method, still being perfected, is called **skeletochronology-** reading the chronology of the skeleton. A tree can be aged by counting the growth rings in its trunk. A similar procedure is used on sea turtles. Some bones will display growth rings that can be used to approximate the age of the turtle. Bones sometimes reabsorb rings too, so the technique is complicated. Scientists continue to develop new techniques to estimate sea turtle age from **skeletochronology**. One obvious drawback to the procedure is that it is more costly (and requires a dead turtle) than the tagging of live turtles.

This activity will deal with hawksbill turtles captured and released in Puerto Rico (see photo). Students will examine data to determine the ages of turtles.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Copy and distribute the Hawksbill Size Classes Worksheet. Ask each student to answer the questions below the graph.

▼ The Activity

1. Divide the students into groups of 3-4. Copy and distribute the Hawksbill Capture Data Sheet (one for each group) and the prepared graph paper.

2. Have the students answer the questions below the data.

3. Each group should prepare a graph like that on the Hawksbill Size Classes Worksheet, using the data set provided on the Hawksbill Capture Data Sheet. One member of the group will present the completed graph to the class.

4. Discuss the conclusions: How much error do is in the answers? How would the students conduct the study differently in order to reduce the error?

▼ Enrichment

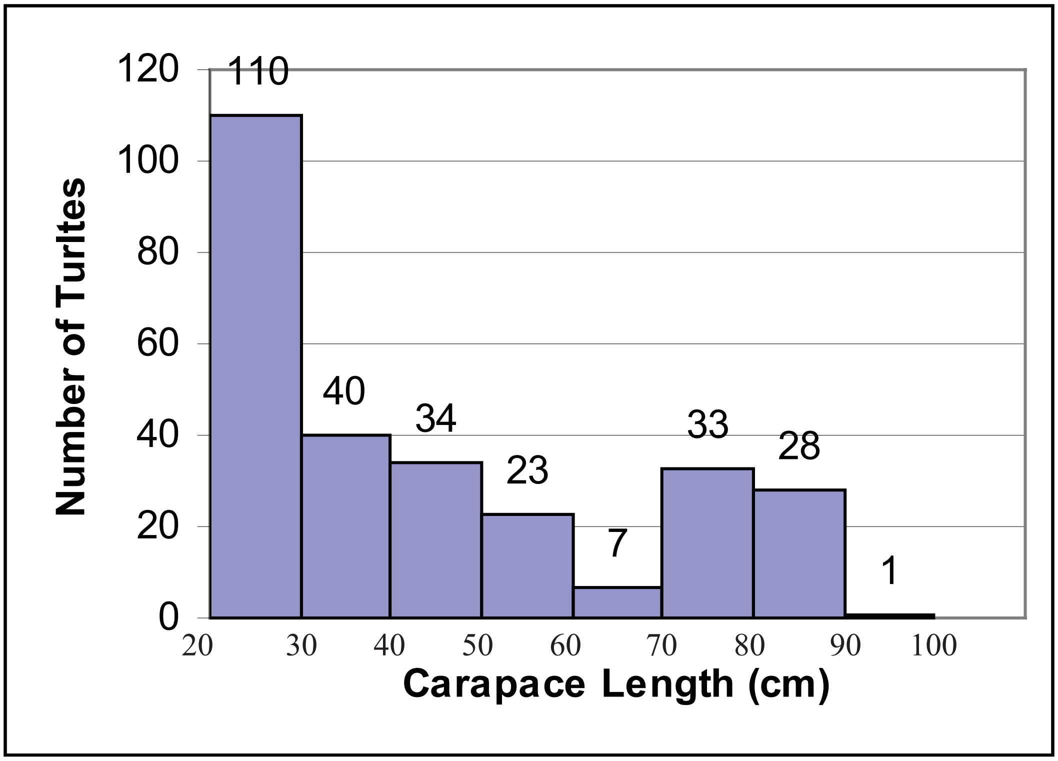
1. Measure the height of each student in the class, at the beginning of the school year.

2. Create a student size class worksheet.

3. Eight months later, re-meausre the height of each student. Create a re-capture data sheet where "tag" is student name and "length" is height.

4. Calculate the individual and class average growth rates. Do students grow faster or slower than turtles? Why?

Hawksbill Size Classes Worksheet



Questions:

1. What size class has the greatest number of turtles? Can you guess why?

2. What size class has the fewest number of turtles? Why?

3. Think of possible reasons why the graph fluctuates. Why does it increase again in the 70cm and 80cm size classes?

Hawksbill Re-Capture Data Sheet

Tag	Capture Date1	Length1	Recapture Date2	Length2	Growth (cm)	Months	Growth Rate (cm/month)
AAD620	3/13/1992	31.6	5/7/1993	33.8		13.8	
AAD341	3/14/1992	36.4	5/17/1997	51.1		62.1	
AAD890	1/14/1992	29.4	2/24/1994	35.5		25.4	
ABD214	11/27/1993	39.3	11/26/1994	42.0		12.0	
AAD256	2/1/1995	52.5	3/12/1998	67.1		37.3	
AAB903	12/14/1995	57.3	2/21/1998	68.9		26.3	
AAB538	6/3/1986	42.1	5/12/1988	47.9		23.3	
ABD751	6/24/1982	34.9	7/20/1983	39.2		12.9	
ABD759	7/20/1983	39.2	6/14/1984	40.4		10.8	
AAD620	5/7/1993	33.8	4/15/1995	35.3		23.7	
AAD341	5/17/1997	51.1	12/5/1998	53.8		18.4	
AAD890	2/24/1994	35.5	3/14/1995	40.6		12.6	
ABD214	11/26/1994	42.0	12/10/1997	55.7		36.3	
AAD256	3/12/1998	67.1	1/18/2000	75.2		22.1	
AAB903	2/21/1998	68.9	4/30/2000	71.7		26.1	
AAB538	5/12/1988	47.9	3/18/1992	56.9		46.2	
ABD751	7/20/1983	39.2	10/4/1985	43.8		26.3	
ABD759	6/14/1984	40.4	4/13/1986	47.7		22.0	

Source: Mona Island Hawksbill Research Project, adapted from data collected by Dr. Robert van Dam and Carlos Diez (1983-2000)

1. Calculate the growth from Date 1 to Date 2 for each turtle. Write it in the table.

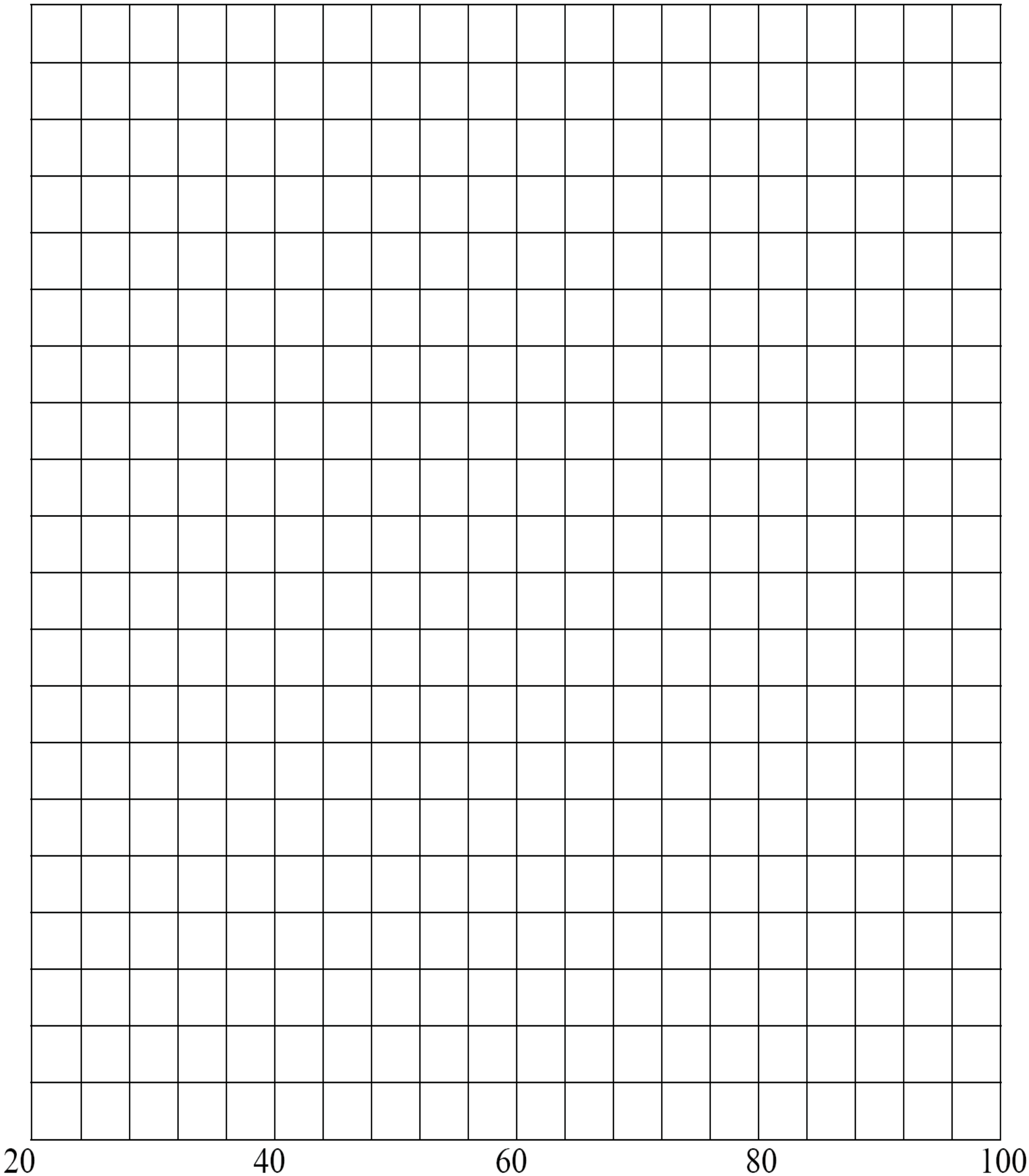
2. Now divide the growth by the number of months that passed to find the growth rate. Write it in the growth rate box of the table for each turtle.

3. When was the second time that turtle ABD759 was captured? How long (shell length) was the turtle?

4. Make a graph using the graph paper below. You need to fill in the growth rate. Find the lowest and highest growth rates in the turtles above and divide the squares up evenly so that each square represents the same amount. Plot each of the captures and try to draw a "best fit" line, or a line that shows the trend (if any) in the points.

Turtle Carapace Length and Growth Rate

Growth Rate (cm/month)



Carapace Length (cm)

Where's My Beach? 5E

■**Preparation Time**:
10 minutes

■**Activity Time**:
• **Warm up**
30-45 minutes
• **Activity**
45 minutes
• **Enrichment**
30 minutes

■**Materials Needed**:
• Copies of provided Background Information, Gel Electrophoresis Sheet, Genetics Worksheet, Build Me a DNA Sheet
• Pencil & paper

■**Setting:**
Classroom

■**Subject Areas:**
Ecology, Anatomy, Genetics

■**Skills:**
Comprehension, Analysis

■**Vocabulary:**
cell
DNA
gel electrophoresis
genetics
inheritance
mitochondrion

▼ Summary

Students will learn how sea turtles return to the beach they were born on, and how scientists used **genetics** to figure it out.

▼ Objectives

Students will:

- List the four component bases of **DNA**.
- Explain how a sea turtle finds its natal beach.
- Read a **DNA** electrophoresis gel.

▼ Why Is It Important?

Our growing knowledge of **genetics** makes exciting things possible. Not only can **genetics** help us to understand and manage wildlife, but it may also help us cure human diseases and develop better medicines. In sea turtles, scientists have figured out ways to discover things about the turtles' lives, using genetic techniques, that could never have been known using direct observation alone.

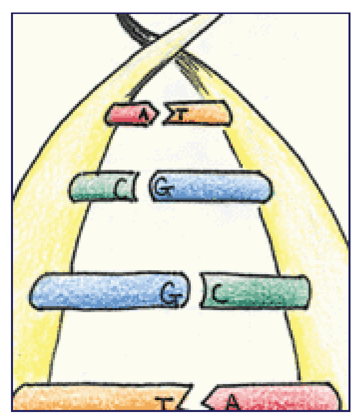
▼ Background Information

The science of **Genetics** is the study of **inheritance**. Why are you the height you are? Why do you have your mother's nose or your father's ears? This is **inheritance**. Each **cell** in your body contains a complete set of your **DNA** (Deoxiribonucleic Acid). Your **DNA** is a mix of your mother's and father's **DNA**.

DNA is a long molecule that holds a "code" for you, your body, and what each **cell** will do in your body. A sea turtle is no different. It has a different number of **DNA** molecules, but they function in the same way.

Each **DNA** molecule has two strands, joined at the "bases". There are only four bases: Adenine always joins with Thymine, and Cytosine always joins with Guanine. This means that for any joint in the **DNA**, there are four possibilities. There can be any of the four bases, and the other strand has the complement. If a section of **DNA** bases reads GGCTA, the opposite, complimentary strand would read CCGAT. **DNA** continues on for billions of base pairs. If you stretched out the **DNA** in one of your **cell**s, it would be over 3 meters long! This **DNA** is a "map" for your body.

There is a special section of **DNA** located in the **mitochondrion** of each **cell**. This **DNA** is only received from your mother. The same is true for sea turtles. By looking at mitochondrial **DNA**, scientists can draw conclusions about who the mother was.



Scientists use a process called **gel electrophoresis** to read the sequences of base pairs in **DNA**. You will practice reading some gels from the mitochondrial **DNA** of sea turtles. Why do scientists do this?

It all starts with a simple question: "Do female turtles return to nest on the beaches where they hatched?" Evidence for a long time suggested that they did, but modern **DNA** evidence can prove it!

How could we test this question? We could tag the hatchlings, but this has proven impossible so far. Because most hatchlings do not survive, tagging them is expensive and you may have to wait 30 years to get returned tags! But, what if all of the turtles nesting on a beach had similar mitochondrial **DNA**; in other words, they were all related through their mothers? If all the turtles nesting and hatched in Antigua had similar **DNA**, but it was statistically different from the **DNA** found in nesting females and hatchlings in other countries, we could conclude that turtles do indeed return to their hatching beach (what scientists call their "natal beach") to nest as adults. In this activity you will compare **DNA** tests from several sea turtle populations.

When scientists need a **DNA** sample from a sea turtle, the first step is to take a sample of blood from the animal. The blood **cell**s contain the same **DNA** as the rest of the **cell**s in the animal. The **DNA** is then separated from the **cell** in the laboratory, and it is "amplified" (copied) so that there are many **DNA** molecules. These **DNA** molecules are broken apart or "lysed" by special enzymes and the resulting mixture is put onto a **gel electrophoresis** plate.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Write the following sequence on the board: ATCCGAATGGGATCCTG. Have the students each write the complementary strand, remembering that A pairs with T, and C pairs with G.

▼ The Activity

1. Divide the class up into pairs. Give each pair a copy of the **Gel Electrophoresis** page and a copy of the **Genetics** Worksheet.

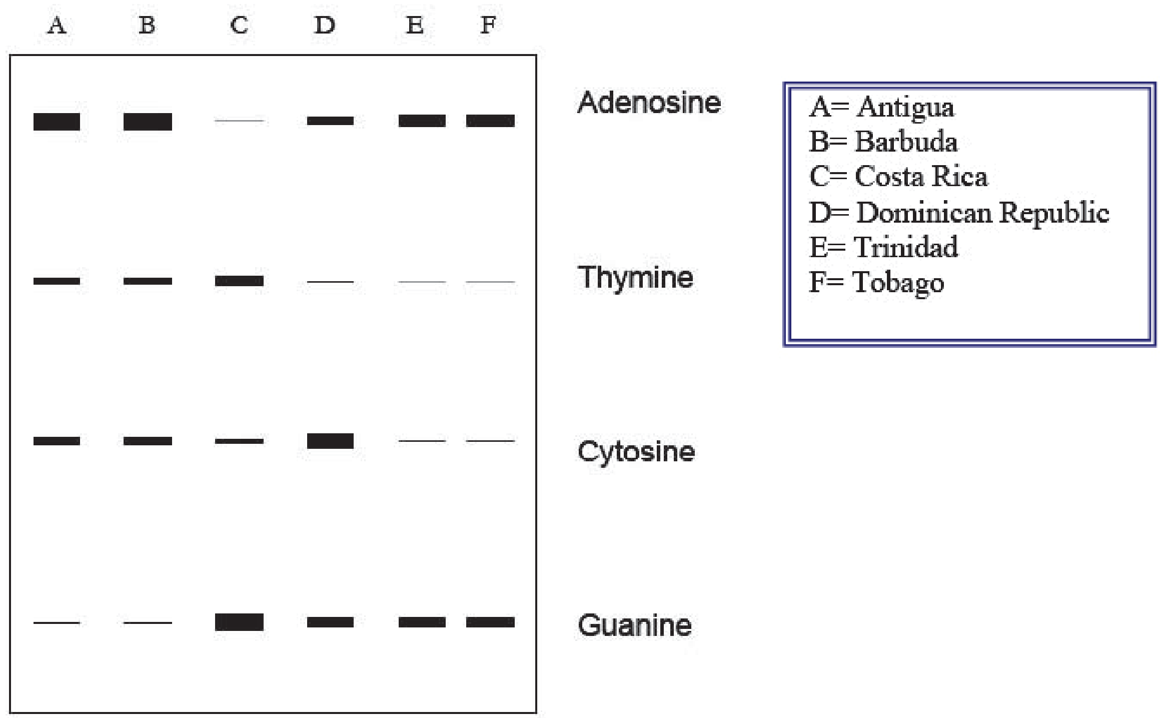
2. Have each pair complete the worksheet. When everyone is finished, have each pair present one or two of their answers to the class and explain how they figured it out.

▼ Enrichment

1. Have the students work in pairs or small groups and pick one of the **DNA** sequences from the **Gel Electrophoresis** page. They should use the Build Me a **DNA** page to construct a model of part of this sequence.

2. In pairs or small groups, have the students discuss other ways in which scientists might determine whether or not sea turtles return to birth beaches to lay eggs on their own. Ask each group to share their idea with the class.

Gel Electrophoresis



The **DNA** is placed in the gel (in the box) near the top. It is then forced to move through the gel towards the other end. In this example, Adenosine is very large and so it barely moves. Therefore Adenosine gathers in a group near the top. Guanine is smallest and travels the farthest so it collects near the bottom. Turtles from the Dominican Republic in this example have more cytosine in their **DNA** than turtles from other regions.

Here is an actual example of what a green sea turtle's mitochondrial **DNA** sequence would look like.

```
  1 AATAAAAGTG TCCACACAAA CTAACTACCT AAATTCTCTG CCGTGCCCAA
 51 CAGAACAATA CCCGCAATAC CTATCTATGT ATTATCGTGC ATCTACTTAT
101 TTACCAATAG CATATGACCA GTAATGTTAA CAGTTGATTT GGCCCTAAAC
151 ATAAAAAATC ATTGAATTTA CATAAATATT TTAACAACAT GAATATTAAG
201 CAGAGGATTA AAAGTGAAAT GACATAGGAC ATAAAATTAA ACCATTATAC
251 TCAACCATGA ATATCGTCAC AGTAATGGGT TATTTCCTAA ATAGCTATTC
301 ACGAGAAATA AGCAACCCTT GTTAGTAAGA TACAACATTA CCAGTTTCAA
351 GCCCATTCGA TCTGTGGCGT ACATAATTTG ATCTATTCTG GCCTCTGGTT
401 AGCTTTTCAG GCACATACAA GTAGCAACGT TCATTCGTTC CCCTTTAAAA
451 GGCCTTTGGT TGAATGAGTT CTATACATTA AATTTA
```

Genetics Worksheet

Answer the following questions about the **Gel Electrophoresis** page.

1. Are there any areas that appear to have turtles from the same population, sharing the mother's **DNA**? What areas are these?

2. Can you explain why? Does this prove the theory wrong of returning to the hatching beach? Hint: Where are those islands?

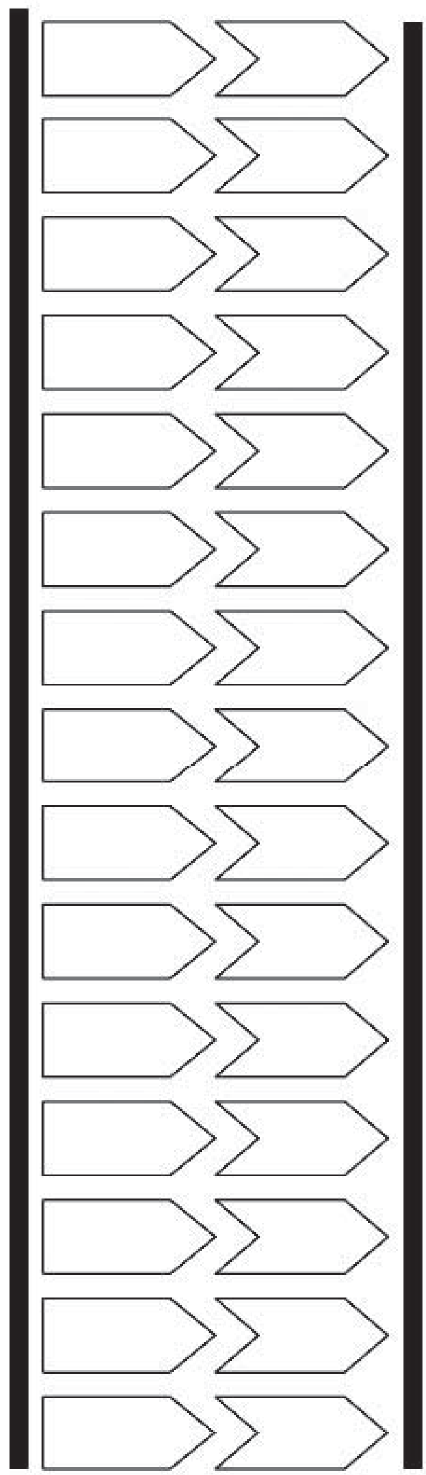
3. How can you tell that Costa Rica and the Dominican Republic have different populations of turtles (that is, turtles hatched in Costa Rica do not mature and return to nest in the Dominican Republic)?

4. In the Dominican Republic turtles, what is the most common base in the **DNA**?

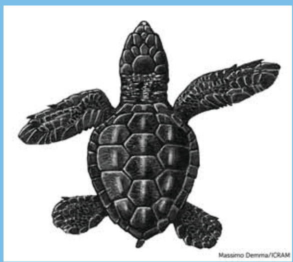
5. In Costa Rica, what would be the most common base in this **DNA**'s **complementary** strand?

Build Me a DNA

Write in the bases from a real **DNA** sequence (from the green turtle sequences at the bottom of the **Gel Electrophoresis** Page) on the left hand side, and then fill in the complementary bases on the right hand side. You have made a turtle's **DNA** molecule!



Hatchling Conservation 5F



Preparation Time:
10 minutes

Activity Time:
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment**
30 minutes

Materials Needed:
• Copies of provided Background Information
• Pencil, paper

Setting:
Classroom

Subject Areas:
Ecology, Government

Skills:
Observation, Discussion, Public Speaking, Decision-Making

Vocabulary:
keystone species

Summary

Students will express what they want their island to look like, and what should be done to help their vision become reality.

Objectives

Students will:

- Show their ideal and nightmare homes.
- Show what they want for sea turtles.
- List what sea turtles need.
- Draft laws to provide a safe "home" for the turtles.

Why Is It Important?

Whether we work for the government as a wildlife officer, for a private organization protecting wildlife, or just live in a community, or city, we are affected by the natural world and the animals in it, and we affect them. We all have a stake in the world we live in and we can help to shape the way our communities and governments manage the environment. But first we have to know what we want! There may never be millions of sea turtles again, like there were before so many people lived here, so how many turtles do we want? What habitats are available for nesting? These are important questions that you will explore in this activity.

Background Information

Sea turtles are important to the marine environment. They are a **keystone species**. Just like the lion on the African savannah, the sea turtle has a complex and significant influence on its surroundings. **Keystone species** very often don't have many predators. Certainly when they are young sea turtles have predators, but as adults, they have very few.

We as humans rely on the marine environment. Almost all of us eat seafood, and even if we do not eat seafood there are seafood products in many things we eat. The ocean helps to absorb the carbon dioxide that is building up in the atmosphere, ocean plants called phytoplankton provide most of our oxygen, and it is in the oceans where life on earth began!

Humans have drastically changed the environment. We also have the ability to design our environment. If we need more shade we plant trees, if we need to cool off we may build a pool. Can you think of other examples? It is important that people living in a community agree about what they want that community to look like. What if half the community wants more shade and the other half doesn't want the noise from birds? How many trees should you plant and where? These are issues dealt with in the next unit.

The efforts to conserve adult sea turtles and the efforts to conserve their nests or hatchlings may be very different. Often the greatest threats to adults happen in the ocean and include overfishing and pollution. Often the greatest threats to eggs and hatchlings happen on land and include human consumption, and habitat loss. In order to figure out what we should do to conserve hatchlings and adults, we first have to understand what they need, and how we have to change the way in which we live and behave.

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Have students make a list of the things that animals need to survive. What about sea turtles? Think about things like water, food and shelter. What else is needed?

The Activity

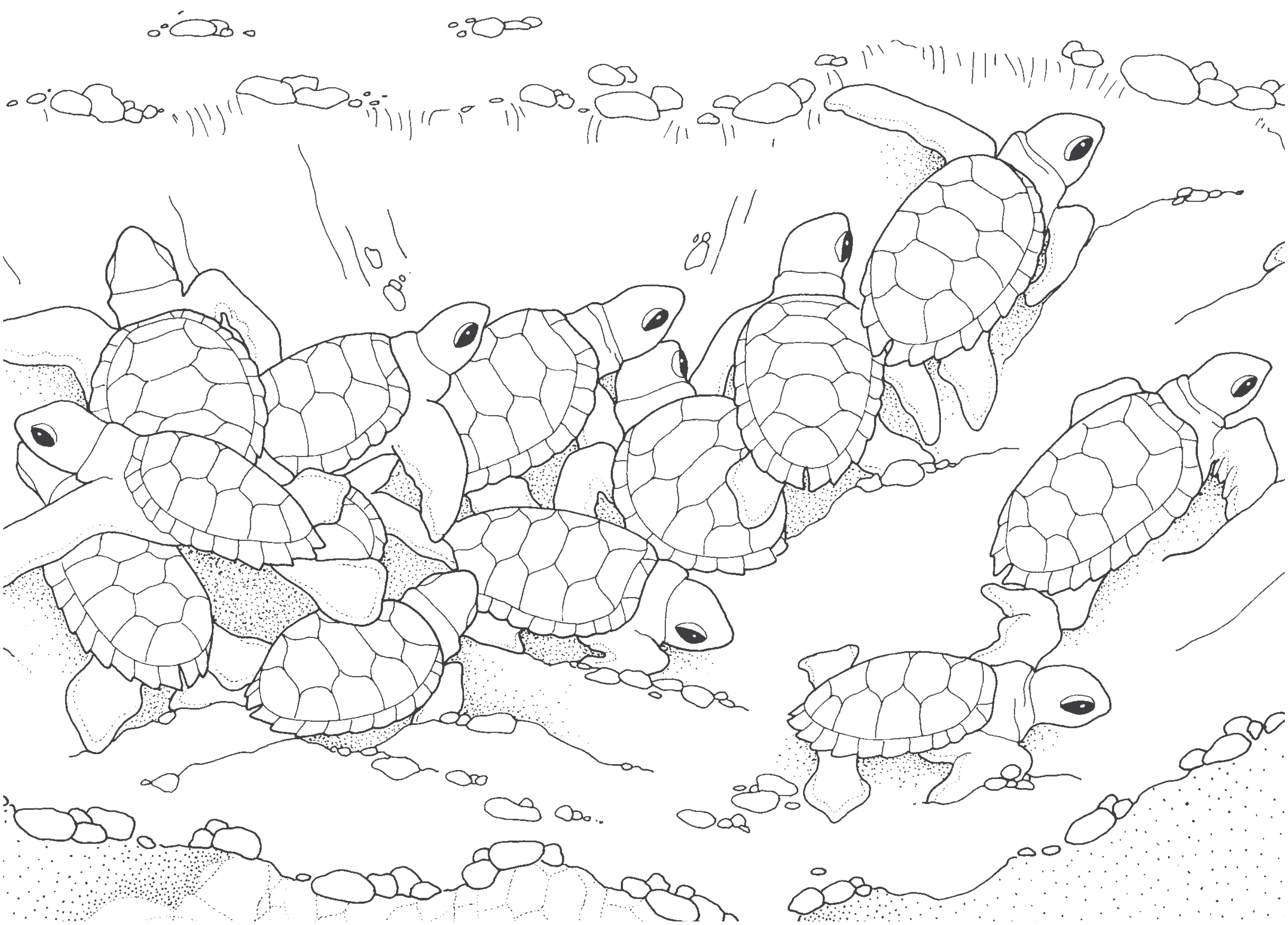
1. Have each student label one side of a piece of paper "Ideal Beach", and the other side of the paper, "Nightmare Beach".

2. Give the students 20 minutes or so to draw their Ideal Beach world and their Nightmare Beach world.

3. Ask each student to present their two worlds. After the presentations, discuss what was similar about the students' visions and what was different. Which one, Ideal or Nightmare is better for sea turtles? Why?

4. Have the students work in pairs to list five things they would need to do to create an "ideal" beach from their Nightmare Beach.

5. Have the students write one law or regulation for each of the five things they listed. Present these to the class. What might be the social and political obstacles to getting the law(s) passed? Are there some problems that cannot be solved by laws alone? Why?



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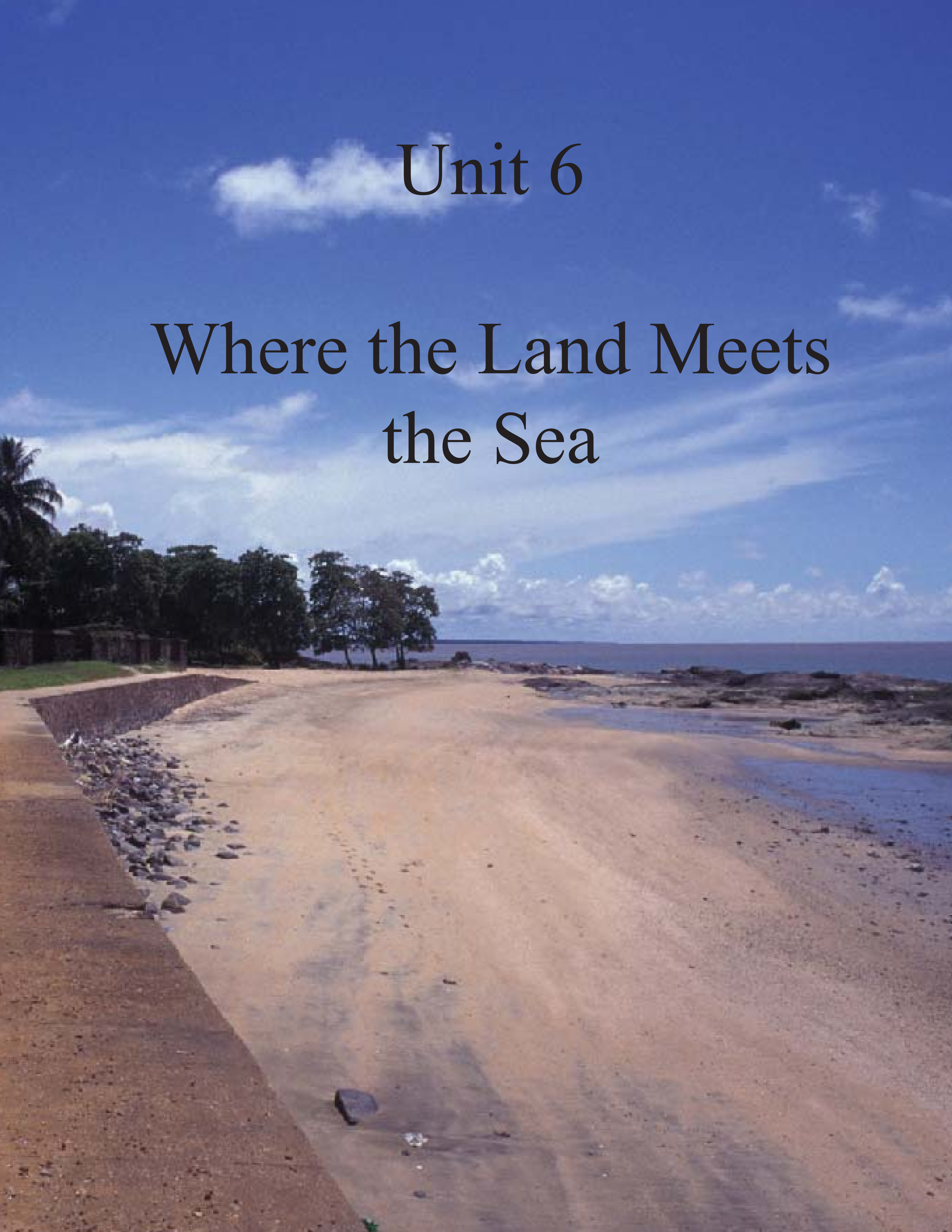
Unit 6

Where the Land Meets the Sea



Land Use Planning 6A

■**Preparation Time**:
10 minutes

■**Activity Time**:
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment**(optional)
30 minutes

■**Materials Needed**:
• Copies of provided Background Information, Island Map and Land Use Cutouts
• Pencil

■**Setting:**
Classroom

■**Subject Areas:**
Ecology, Mathematics, Government, Social Studies

■**Skills:**
Group Building, Decision Making, Discussion, Analysis

■**Vocabulary:**
balance
energy
runoff
zoning

▼ Summary

Students will learn about land use planning and will decide on uses for land on an island.

▼ Objectives

Students will:
- Read and interpret field data.
- Graph data.
- Calculate results.

▼ Why Is It Important?

Every human use of land has a positive or negative effect on the water in our rivers, bays, mangroves and oceans. What we do with land is a reflection of our priorities and lifestyles. Choices born of convenience sometimes produce mixed results for plants, animals, water quality, and people. Some people see natural resources as nothing more than raw materials for human use, while others believe that the natural world should be preserved without regard to human needs. Differences of opinion about these issues are present in every community and can be difficult to resolve.

▼ Background Information

At the center of land use issues is the idea of growth. In the natural world, growth has limits set by a **balance** of **energy** between all parts of the system. An increase in the number of predators is accompanied by a decrease in the number of prey. **Energy** is expected to remain constant, even though the plants and animals change.

Human activities often go beyond the natural limits of a setting. Humans have the ability to import **energy**, and exceed the **energy** limits of the natural world. For example, people can dam a river to provide power, drinking water and irrigation. Water from the river can be used in factories, mills, sewage treatment and other industry.

Because humans have the ability to throw the natural system out of **balance**, we have to be careful about what we do. Land use planning involves the designation of land for a specific purpose. Do you live in a neighborhood that is all houses and no stores? It is probably because the land in your neighborhood is "zoned" or designated only for houses.

Land use planning is an activity, generally conducted by a local government, that provides land use recommendations consistent with a community's wants and needs. This plan is generally used to guide decisions on **zoning**.

The placement of things like airports and schools is decided by land use planning. Someone has to decide what the area should look like. For example, we probably don't want the landfill right next to the school. These issues are important in designing natural areas, as well. If a natural area is designed to protect certain species of animal or plant, then that area should protect the habitat necessary for the species' survival.

Most of the pollution that affects coastal waters comes from on land in the form of **runoff**. **Runoff** comes from our farms, cars, houses, landfills and roads. The use of land can affect the animals and plants that live in the ocean.

Good land use planning can keep pollution from becoming a serious problem.

Would you place a road close to a major river? Would you place an elementary school on a busy road? These are questions that face land use planners, and that you will answer in this activity.

In many places, there has been no land use planning. Communities and cities are built one piece at a time, and have a history of bad (or no) planning. This can make it difficult to have natural areas and can also make living there unpleasant. Have you visited a community too close to the airport, or a community with no sidewalks? Land use planning helps people, as well as wildlife!

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Divide the class up into groups of three or four.

3. Copy and distribute the Island Map and Land Use Cutouts (1 to each group).

▼ The Activity

1. Assign an interest to each group of students. Use the following: Residents (people who want to live there), Farmers, Businesses, State Park Manager, Factory Owner, School Representative, Local Government.

2. Have the group cut out the Land Use Cutouts. The cutouts can be cut into smaller pieces, but all of each cutout must go on the map. The cutouts cannot overlap. Remind the students to keep in mind what each cutout represents and needs. A store needs a road, a factory may need water, etc.

3. Each group should work long enough to really discuss the issues about where to place different facilities.

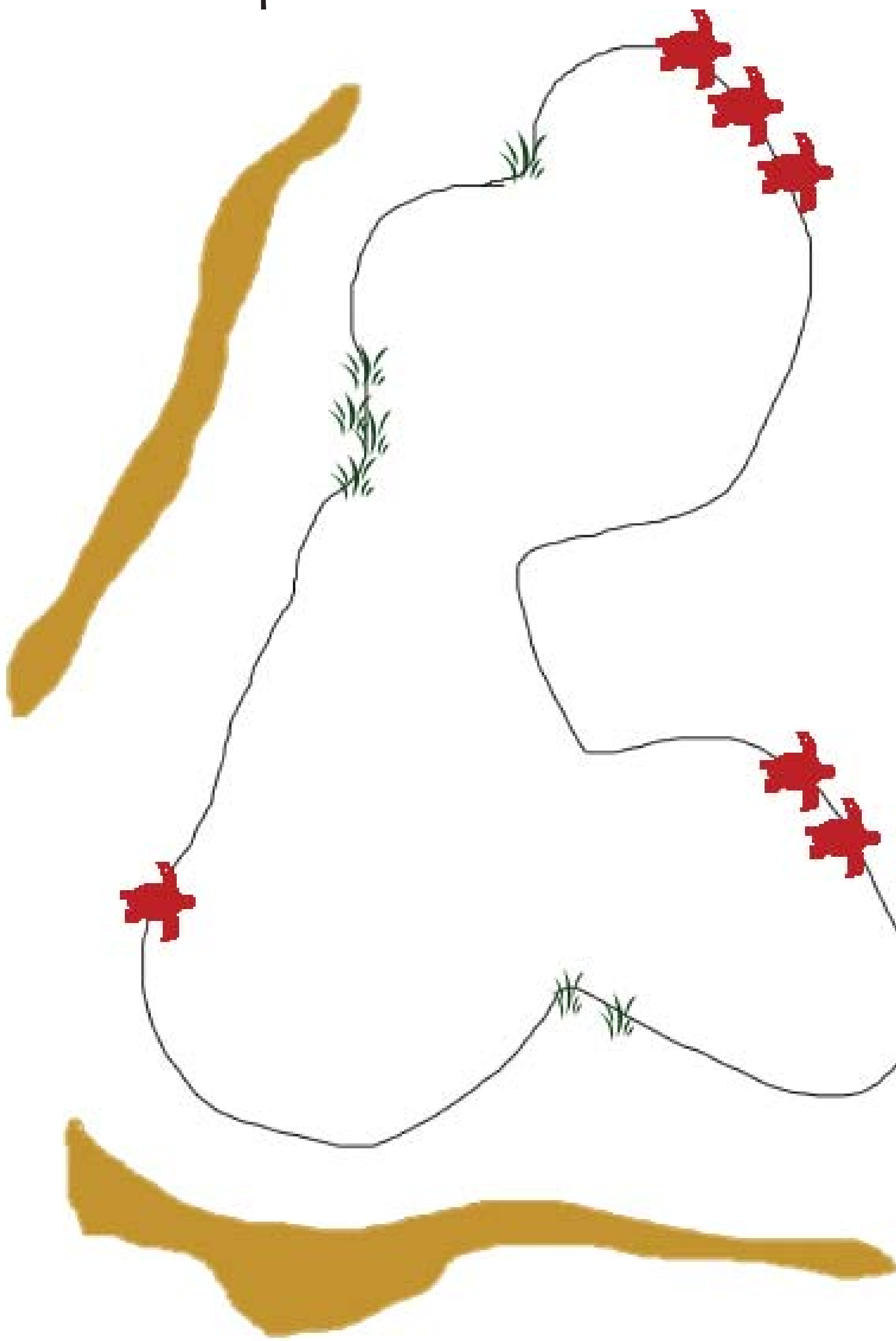
4. Have the groups present their maps and explain their choices. Still representing different interest groups, have the other students explain how the proposed land use plan would affect them- positively or negatively.

▼ Enrichment

1. Call your local government agency to find out if a representative can talk to the class about land use issues where you live.

2. Make a land use map of your area. Map the school, houses, stores, parks, beaches etc. Are there things that you would have placed differently? Are there things that are missing? How do "mistakes" (too much of this, too little of that) get made?

Island Map



Land Use Cutouts

Legend

 = sea turtle nesting site

 = coral reef

 = mangroves

Road

Land Park

School

Farm

Landfill

Hospital

Stores

Waste water Treatment

Factory

Gas Station

Marine Park

Beach Management 6B

■**Preparation Time:**
10 minutes

■**Activity Time:**
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment** (optional)
30 minutes

■**Materials Needed:**
• Copies of provided Background Information, "What's the Score?" and Beach Graph
• Pencil, calculator

■**Setting:**
Classroom

■**Subject Areas:**
Ecology, Mathematics, Social Studies, Government

■**Skills:**
Group Building, Decision Making, Discussion, Comprehension, Public Speaking, Analysis

■**Vocabulary:**
benefit
cost
management
multiple use
objective
subjective

▼ Summary

Students will role-play as managers of a 400-acre beach in order to understand the complex decisions that have to be made by managers.

▼ Objectives

Students will:

- Calculate monetary values of environmental issues.
- Balance economic gain with environmental concerns.
- Make decisions about land **management**.
- Show how a decision is made.

▼ Why Is It Important?

Beaches and coastal areas make up a large part of the places we live in the Caribbean region. Those coastal areas provide habitats for many species of plant and animal, as well as providing important resources for people. People use coastal areas in many ways such as for fishing, homes, recreation, business, industry, and shipping. Most areas cannot be managed only for use by animals, or only for use by humans. There must be a mix. Most countries do set aside areas such as parks and reserves that are for use by animals (or at least these areas are managed to take the needs of animals into account), but most of the land and sea is shared.

▼ Background Information

Many governmental decisions are made in terms of direct **cost**s and **benefit**s. A manager must also consider indirect effects on the coast's recreation, water, soil and wildlife even though the **cost**s and **benefit**s of these effects are much more difficult to measure. One way to estimate the value of a beach for recreational use would be to compare the **cost**s and **benefit**s of changing the beach. For example, the **cost** of developing a campground versus the possible income the campground would generate from fees. Another way to estimate the recreational value of a beach would be to calculate the number of visitors that will use the beach recreationally in a year. Giving money value to a sea turtle nest, or a family's ability to swim in clean water, can sometimes help a manager to make decisions.

One way to estimate the value of wildlife is to measure its contribution to the beach's economic value. Calculate this value by identifying the different animals that live in the coastal area. If those animals are hunted or fished, determine the income generated from fishers through licenses, bait, equipment, and travel. An animal's economic value might also include income from other uses such as photography, bird watches, or turtle watches.

Another way to estimate the value of wildlife is to realize that it has value other than economic value. With this approach, managers view the forest as a complex ecosystem in which every part of the system is important to every other part. If managers maintain each component of the ecosystem, the result will be healthy and assorted wildlife and plant communities. To figure out how a specific action might affect these communities, forest managers look at the effects of an action on several wildlife species with different needs. Sometimes the decline of a certain species can indicate that the whole system is at risk.

Imagine that you and your classmates are managers of a beach that has been donated to your school. The beach and surrounding coastal area contains 400 acres (162 hectares). A hectare is 10,000 square meters.

The area currently has no roads or trails, so few people use or visit the land. The coast, however, is alive with wildlife like sea turtles, deer, crabs, snapper, lobster and octopus. Your job is to develop a **management** plan for the area. You may decide to do more than one thing on the same piece of land, or you may want to divide the area and do different things in different areas. (Managers call this **multiple use**) Your goal is to find the best balance between money (income vs. cost), plant and animal species, and visitor enjoyment. Here are several actions you might take in the area: create hiking trails, create a wildlife preserve, start turtle watches, allow hunting and fishing, or allow timber harvest.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Copy and distribute the Beach Graph and the What's the Score pages.

3. Have students list activities that may happen on beaches and in surrounding coastal areas. Are there any activities that cost money? Are there activities that earn money? What activities affect wildlife?

▼ The Activity

1. Have the students work in groups of 3-4. Each team should first decide what is most important to them, and how they want to manage the beach. Do they want to preserve wildlife, make money, or both? They should use the Beach Graph to visually represent how many acres should be devoted to each activity they choose. See the "What's the Score" pages to see what activities can be used. There are 400 squares on the grid, one for each acre of land to be managed. If 10 acres are for hiking trails, 10 boxes should be colored in, and labeled for hiking trails.

2. Once the team has agreed on the **management** scheme, they should fill out the What's the Score pages to see the **cost**s and **benefit**s of their **management** plan.

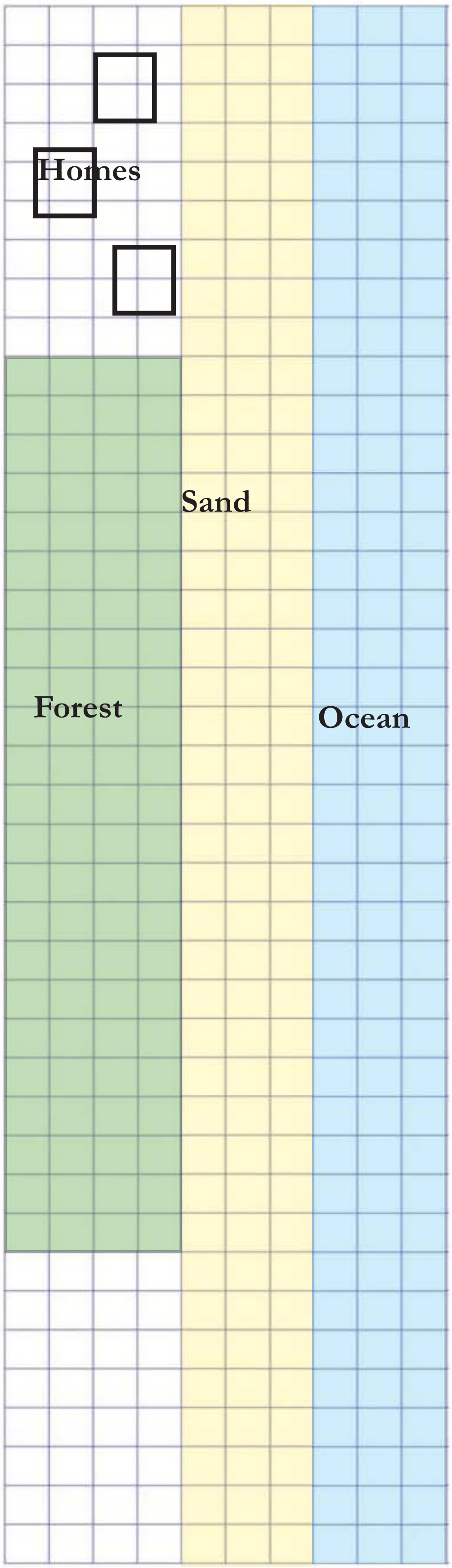
3. Each team should discuss the strong parts and weak parts of their plan, and present it to the class, explaining why each choice was made.

4. Each Beach Grid can be hung in the classroom and the different management plans can be compared. Can the class elect one of the management plans that they like the best?

▼ Enrichment

1. Discuss which parts of beach **management** are **subjective** (require value judgements), and which parts of beach **management** are **objective** (require no value judgements)? Is it easier for a community to reach agreement on **subjective** or **objective** land use decisions? Why?

Beach Graph



Key:

☐ = Wildlife Preserve

☐ = Hiking Trail/Dirt Road/Paved Road

☐ = Turtle Watches

☐ = Fishing/Hunting

What's the Score?

1

After your team has made a management plan, count the number of acres you have set aside for each action. Write those numbers in the "Action" spaces on the following chart. If your team decides not to include one of the actions in your management plan, leave that row blank and do not add it in at the end.

Estimated Costs/Benefits

Money cost (-) or profit (+)

-$100 per acre of hiking trail
-$600 per acre of dirt road
-$1000 per acre of paved road
-$100 per acre of wildlife preserve (for management)
-$250 per acre for turtle watches
-$150 per acre of fishing
+$5 per visitor
+$10 per nest sold
+$10 per turtle watcher
+$25 per fisherman

2

Add (or if negative, subtract) the numbers in each column to estimate the costs and benefits in terms of money, turtle nests, wildlife and visitors of your management plan.

Turtle Nests + or –

150 nests per acre

Wildlife + or –

25 lobster per acre
2 turtles per acre
1 snapper per acre

3

Multiply the number of acres by the estimated cost or benefit given to you in each box.

What's the Score?

Action	Money	Wildlife	Visitors/year
Wildlife Preserve # of acres __________	_____ * (-)$ 100 (# acres) (mgt.) = (-)$ _____ ___5____ * $ 2 (# visitors) = (+)$ _______	_____ * (+) 25/acre (# acres) = ______ lobster _____ * (+) 2/acre (# acres) = ______ turtles ______ * (+) 1/acre (# acres) = _______ snapper	_______ * (+)5 (# acres) = (+) _____visitors
Hiking Trail/Dirt Road/Paved Road # of acres __________	_____*(-) $100/600/1000 (# acres) (trail) = $ (-) ______ 10/20/50___* $ (+)5 (# visitors) = (+) $_______	_____ * - 1 (per acre) (# acres) = -_____ snapper _____ * - 25 (per acre) (# acres) = -______ lobster	______*(+)10/20/50 (# acres) = (+) ____visitors
Turtle Watches # of acres __________	_____ * (-) $250 (# acres) = $ (-) ______ ___50__* $ (+)25 (# watchers) = $ (+) _______	No Change	________ * (+) 25 (# acres) = (+) _____ turtle watchers

What's the Score?

Action	Money	Wildlife	Visitors/year
Fishing # of acres __________	____ * (-)$ 150 (# acres) (mgt.) = (-)$ _____ ___25___ * $ 25 (# visitors) = (+)$ _______	_____ * (-) 25/acre (# acres) = ______ lobster _____ * (1) 1/acre (# acres) = ______ turtles ______ * (-) 1/acre (# acres) = _______ snapper	_______ * (+)25 (# acres) = (+) _____visitors
Add columns Total Managed Area # acres=	Add columns Total $ (+/-)_______	Add columns Total ______turtles ______lobster ______snapper	Add columns Total _______visitors

I Beg To Differ 6C

■**Preparation Time**:
10 minutes

■**Activity Time**:
• **Warm up**
30-45 minutes
• **Activity**
70 minutes
• **Enrichment**(optional)
30 minutes

■**Materials Needed**:
• Copies of provided Background Information, Dilemma Cards
• Pencil

■**Setting:**
Classroom

■**Subject Areas:**
Ecology, Language Arts, Government

■**Skills:**
Analysis, Discussion, Public Speaking, Comprehension

■**Vocabulary:**
affirmative
debate
moot
negative
rebuttal

▼ Summary

Students will learn the basic rules of debate and practice a formal debate about beach recreation issues.

▼ Objectives

Students will:
- Organize **debate** teams.
- Structure an argument.
- Present their argument in **debate** style.
- Express personal opinions about issues.

▼ Why Is It Important?

People confront problems daily. You may have weighed the pros and cons of completing a homework assignment versus taking the time to visit with friends. You may also be familiar with beach use issues such as fishing regulations, public access to beaches, and wildlife protection. As you investigate problems involving people and beaches, you will see that much of it depends on personal opinion and values.

▼ Background Information

A dilemma is a problem situation that requires a person to choose from two or more alternatives, each of which can produce wanted and/or unwanted outcomes. Managing beaches and shorelines often creates dilemmas. These dilemmas or conflicts are often between what we want to do versus what we think should be done. For example, throwing soda cans and garbage on the beach or in the water is easier than disposing of them properly, but the consequence is litter, filth, and harm to natural resources and human health.

People use various ways to determine the action to be taken in a dilemma. These range from flipping a coin to conducting research and going to meetings. A **debate** can be a casual conversation between two people with differing ideas, or a **debate** can be a very formal process of discussion. You have probably already conducted a **debate** today. Can you think of one time today when you have disagreed with a parent, classmate or teacher and have discussed all sides of the problem? You conducted an informal **debate**.

Formal debating is not about having an argument. There are rules, and a real debate involves research, preparation, teamwork, speaking skills, and persuasion. There are rules for the way the **debate** is organised, and the kind of arguments you may use.

A **debate** features a topic, usually called the **moot**. The **moot** is a claim that something is true. For example:

- People should be refused access to turtle nesting beaches.
- People who throw trash on a beach should be fined.

Typically, there are two teams with three speakers each. One team agrees with the **moot** (the **Affirmative**) and the other team disagrees (the **Negative**).

Usually you are given the topic and told whether your team is **affirmative** or **negative**. This means that you may be debating a position with which you personally disagree. This is the skill of debating, and it helps you understand that there are two sides to most questions.

Each team divides up the job of researching the evidence and preparing the case. Each team member writes speech notes. The first people to speak use their notes more, while the later speakers are more likely to be answering what their opponents have said (**rebuttal**).

The teams speak in this order:

1. **Affirmative** leader 2. **Negative** leader	Define **moot**, introduction
3. **Affirmative** second speaker 4. **Negative** second speaker	Further arguments, **rebuttal**
5. **Affirmative** third speaker 6. **Negative** third speaker	Mostly **rebuttal**
7. **Negative** leader 8. **Affirmative** leader	Summary (no new arguments)

What is the point of the **debate**? Each team is trying to win by doing the best job of arguing their case. This does not mean that one team must be right and the other one wrong. There are two sides to any **debate**, and either side could win.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Copy and cut out the Dilemma Cards for later.

▼ The Activity

1. Have the students work in teams of 3 (4 if necessary).

2. Have each team decide how they will divide up the **debate**. Each team needs a "leader", a "second speaker" and a "third speaker". If there is a fourth student, the leader's duties can be shared.

3. Each team should be given a dilemma card which tells them the statement (**moot)**, and whether they are to argue the **affirmative** or **negative**. The teams should spend 10 minutes discussing the argument they want to make. They should also think about what the opposite team will say, and consider **rebuttal**s.

4. The teams with opposite arguments should sit facing each other in front of the class. They should follow the **debate** order as shown in the Background Information.

5. At the end of the **debate** the class will vote on which side presented the better argument.

Dilemma Cards

Moot: All sea turtle nests should be protected from any kind of collecting, and there should be a fine for the sale of turtle eggs. Position: **Affirmative** (agree)	**Moot**: All sea turtle nests should be protected from any kind of collecting, and there should be a fine for the sale of turtle eggs. Position: **Negative** (disagree)
Moot: People should be able to build their houses right on the beach and restrict public access to "their" beach. Position: **Affirmative** (agree)	**Moot**: People should be able to build their houses right on the beach and restrict public access to "their" beach. Position: **Negative** (disagree)
Moot: The government should pay people to patrol the beaches to reduce crime. Position: **Affirmative** (agree)	**Moot**: The government should pay people to patrol the beaches to reduce crime. Position: **Negative** (disagree)
Moot: Homeowners on sea turtle nesting beaches should be required to turn off all of their lights after dark every night, during the nesting season. Position: **Affirmative** (agree)	**Moot**: Homeowners on sea turtle nesting beaches should be required to turn off all of their lights after dark every night during the nesting season. Position: **Negative** (disagree)
Moot: Allowing tourists to pay money to see sea turtles nest here is a good idea. Position: **Affirmative** (agree)	**Moot**: Allowing tourists to pay money to see sea turtles nest here is a good idea. Position: **Negative** (disagree)

The Sandy Shore 6D

Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
70 minutes
- **Enrichment**(optional)
30 minutes

Materials Needed:
- Copies of provided Background Information,
- Pencil, paper
- small sea shells
- glass jar with lid
- water, sand

Setting:
Classroom

Subject Areas:
Ecology, Fine Arts

Skills:
Observation

Vocabulary:
calcareous
calcium carbonate
Halimeda
protists

Summary
Students will learn about Caribbean sand and the shifting shoreline by building a model of a beach.

Objectives

Students will:
- Identify sand's components.
- Make sand.
- Build a model of a shoreline.
- Observe how the shoreline changes with wave action.

Why Is It Important?

Beaches are vitally important to the Caribbean. They support numerous animals and plants that we value, and they are a source of income, recreation and shoreline protection. The beach is also a very difficult place for plants and animals to live. It is hot, it is constantly moving, and is scoured by wind and water on a daily basis. Yet many creatures make their homes here. The properties of the sand are important to the plants and animals that live there. Sea turtle nests, for example, will survive or not depending on the movement of water and oxygen through the sand.

Background Information

One of the most impressive feats of nature is the erosion of massive mountains into sand by the powerful forces of wind and water. Individual sand grains are the size of table salt grains (less than one millimeter in diameter), and resemble miniature gemstones when magnified. Sand from granite mountains is often made of angular pieces of quartz, feldspar and mica.

But not all sand grains are made of quartz and feldspar. The brilliant snow-white dunes of White Sands (New Mexico, USA) are composed of gypsum, and the spectacular black sand beaches of Costa Rica are made of fine volcanic particles.

Gleaming white sands of Caribbean coral beaches and atolls are the most beautiful of all. High magnification of the grains reveals a glistening, microscopic assortment of reef animals, including wave-worn fragments of brightly-colored corals, shells of minute one-celled **protists** called foraminiferans, fragments of seashells and shiny, star-shaped sponge spicules.

A large percentage of the sand grains of some tropical beaches (such as in Belize) come from minute fragments of **calcareous** green algae, including **Halimeda**. At least nine species of **Halimeda** are known in Caribbean waters, often growing among turtle grass meadows on sandy bottoms or among luxuriant coral reefs. The upright branches of this unusual green alga are composed of segmented **calcareous** plates which become dusted with sediments. The segments superficially resemble a string of tiny wing nuts. The body (thallus) of this alga is firmly attached to mud, sand or rocky bottoms by a large holdfast. Microscopic jointed plates of dead **Halimeda** get washed ashore and become a significant portion of the **calcium carbonate** sand on tropical shores.

The famous sand of the Caribbean is made up not of rock or lava, but out of the skeletons of plants and animals that live on the reefs. Once again, we can see how the coral reef is a vital part of the Caribbean.

Without the shells of tiny snails and **protists**, without the hard parts of sea plants, the Caribbean would have very little sand. The **calcium carbonate** in these plants and animals is what makes up most of the sand. Below is a picture of sand from the British Virgin Islands under a microscope. The star shaped spikes are from a sponge, what else can you see?

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. A couple of days before the activity, a mix of dirt or sand and water (enough to make a thick mud) should be piled on one side of a wide jar as shown in Diagram 1, and left to dry.

The Activity

1. Give each student or group of students some small sea shells and a paper towel, or piece of newspaper. Have the students crush the shells thoroughly and write down their observations. What do the fragments look like? How do they suppose it happens on the beach?

2. Using the prepared jar with a dried slope, pour 2-3 cm of sand or dirt in the bottom, where it is not already covered. Pour 2-3 cm of water on top of that. Put the top on and make waves in the water, small at first.

3. Each student should continue his/her observations. Have them observe the type of wave or disturbance, and what happens to the loose sand at the bottom. What happens to the dried sand piled up? What happens to the water?

4. Discuss the observations and how they might be different or similar to the real ocean.

5. What are the potential consequences of sand erosion to a sea turtle nesting beach?

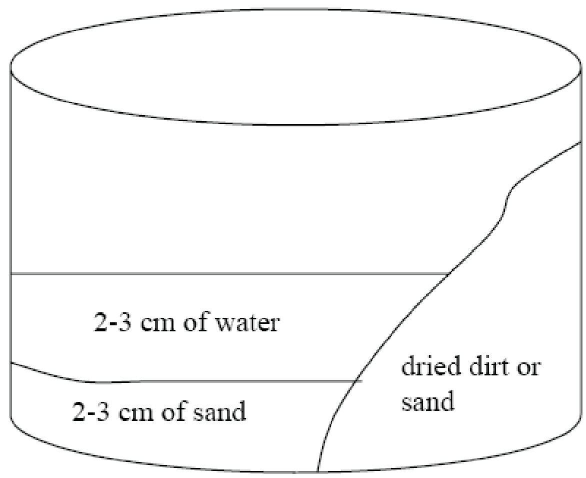


Diagram 1.

Shoreline Creatures 6E

■**Preparation Time:**
10 minutes

■**Activity Time:**
- **Warm up**
30-45 minutes
- **Activity**
70 minutes
- **Enrichment**(optional)
30 minutes

■**Materials Needed:**
- Copies of provided Background Information, Shoreline Creature Cards

■**Setting:**
Classroom

■**Subject Areas:**
Ecology, Fine Arts

■**Skills:**
Analysis, Discussion, Public Speaking, Comprehension

■**Vocabulary:**
intertidal
nutrients

Summary

Students will learn about the animals that live in the intertidal zone at the edge of the sea.

Objectives

Students will:
- List four animals that live in the **intertidal** zone.
- Define the 4 habitats within the **intertidal** zone.
- Identify the preferred habitat of three **intertidal** animals.

Why Is It Important?

Life's not easy in the **intertidal** zone! Organisms there must be adapted to life in a place that is constantly changing. All of the organisms that live in the **intertidal** zone have adaptations that help them to survive in this constantly changing environment. Arthropods (crabs) and mollusks (clams and mussels) have shells that protect them from drying out and from being smashed on the rocks by waves. Organisms like limpets, starfish and seaweed attach themselves to rocks so they don't wash out with the tides. Crabs, mollusks, sea urchins and even bacteria often burrow under the sand when the tide is low.

Background Information

The **intertidal** (or littoral) zone is the area of shoreline between the high tide and the low tide. For part of the day it is covered in water and for part of the day it is dry, or partially dry. In addition to changes in water levels, the **intertidal** zone can see great changes in humidity, temperature and wave pressure during the course of a day.

The **intertidal** zone is rich with **nutrient**s. As the tide comes in, it carries plankton, detritus and pieces of dead plants and animals. Animals including crabs, barnacles, starfish, anemones, shorebirds and small fish feed on the food the waves bring in.

Lots of the animals that burrow under the sand when the tide is out, come out to hunt for food when the tide returns. Hermit crabs scurry along the shore looking for food. Sea worms stick their heads out of the sand and trap food as it comes by. Clams and mussels extend feeding tubes or siphons and draw in food.

When the tide is out, the sea birds hit the beach looking for food. Curlews, sandpipers and red knots use their sharp bills to poke in the sand for worms and other invertebrates. American oyster catchers use their strong bills to crack open mussels and cockles. Gulls scour the beach searching for crabs, small fish and hatchling turtles.

The **intertidal** zone isn't all the same. It has four separate regions with unique features and challenges for the organisms that live in them.

The <u>spray zone</u> is the farthest from the ocean and it is the driest zone. Usually this zone is just reached by the ocean's spray. Think of it as the desert of the **intertidal** zone. Barnacles, limpets, whelks, algae and periwinkles can often be found on the rocks in this zone. Other animals like crabs and sea stars are not as common in this area because it gets so little sea water.

Next is the <u>high-tide zone</u>. It is exposed to some water during high tide when waves wash over it. Organisms that live in this zone must be able to survive in both wet and dry environments. They also must be able to survive pounding waves! Barnacles, limpets, whelks and mussels that live in this zone attach themselves to rocks so they aren't washed away by the waves. Tidepools often form in this region when water is trapped in depressions in rocks and the sand. Some animals live in tidepools for their whole life, others wash in and out with the tides. Organisms that live in tide pools have to adjust to changes in water temperature, and salt and oxygen levels during the course of a day.

The mid-tide zone is completely covered and uncovered twice each day by the tides. Plants and animals in this zone must be able to live in air and water. Some animals, including mussels and anemones, hold moisture by "closing up" when the tide goes out. Seaweeds that grow here can withstand drying until the tide returns.

If the spray zone is the desert of the **intertidal** zone, the low-tide zone is the rainforest. It is usually covered by water for most of the day. It is only exposed to air during unusually low tides. Because there is less change, life is easier for the organisms in this zone and there are typically more species here than in the other zones. Many species of seaweed, crabs, sea urchins, star fish, anemones and small fish are common here.

▼ Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

2. Copy and separate Shoreline Creature Cards.

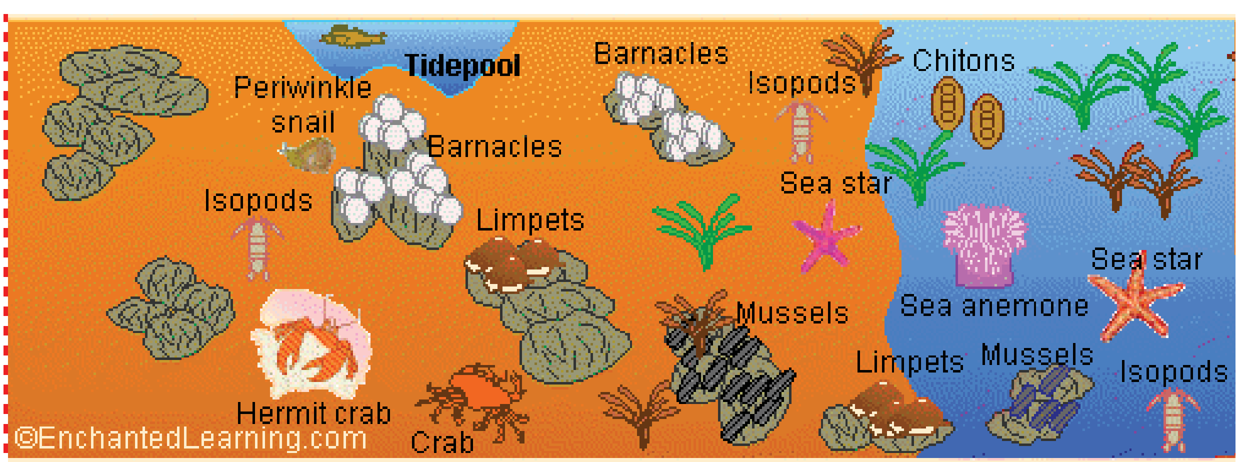
▼ The Activity

1. Draw a simple diagram on the blackboard or on a large sheet of paper like the one below showing only the four zones. Do not add any animals yet.

2. Call on each student to come to the board and introduce the animal card by name, description, and the zone that the animal lives in. The animal card should be left taped to the board in its zone.

3. Call on students to name the four zones, and to list several animals that inhabit each zone. Discuss why an animal lives in a particular zone. Call on students to name the four zones. Are some animals adapted to more than one zone? How?

Intertidal Zone Organisms

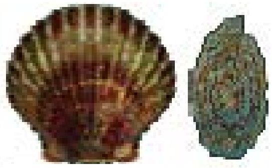


Spray Zone (Usually Dry) | High-Tide Zone (Wet during high tide) | Mid-Tide Zone (Wet and dry) | Low-Tide Zone (Usually wet)

Shoreline Creature Cards

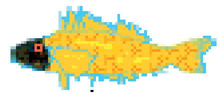
Anemone, Sea

The sea anemone is a predatory animal that looks like a flower and lives on the ocean floor.



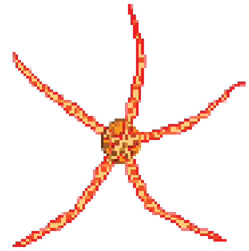
Bivalves

Bivalves are soft-bodied animals that are protected by two hard shells, hinged together. Scallops, oysters and clams are bivalves.



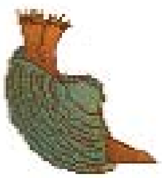
Black-Faced Blenny

A small fish with a three-part dorsal fin. Many blennies live in littoral zones.



Brittle Star

A bottom-dwelling marine invertebrate with long, spiny arms.



Clam

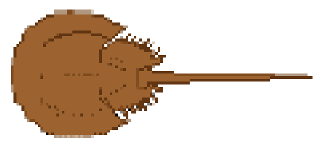
Burrowing bivalves with a soft body.

Crab

A crab is an animal with a shell. It has eyes on stalks on its head.

Hermit Crab

Hermit crabs are crabs that lack a hard shell; they use a discarded shell for protection.

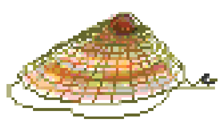


Horseshoe Crab

The horseshoe crab is a hard-shelled animal that lives in warm coastal waters on the sea floor.

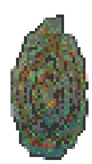
Krill

Small crustaceans that are eaten by many animals, including baleen whales.



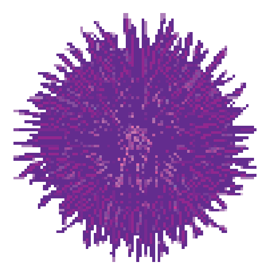
Limpet

The limpet is a marine invertebrate (a gastropod) with a flattened, cone-shaped shell.



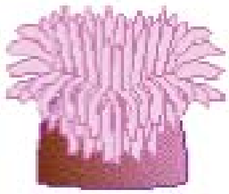
Oyster

The oyster is a bivalve, a soft-bodied marine animal that is protected by two hard shells.



Purple Sea Urchin

A spiny, globular animal that lives on the ocean floor off the western coast of North America.

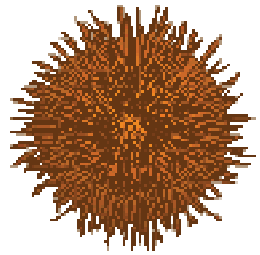


Sea Anemone

A predatory animal that looks like a flower and lives on the ocean floor.

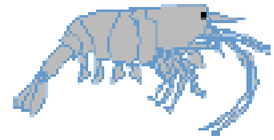
Sea Star

Sea stars, another name for starfish, are animals that live on the ocean floor.



Sea Urchin

A spiny, globular animal that lives on the ocean floor.



Shrimp

Shrimp are small, bottom-dwelling crustaceans with a translucent exoskeleton.

Snail

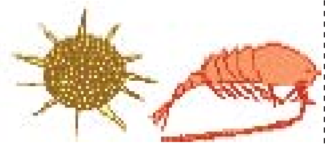
A soft-bodied animal with a hard, protective shell. Many snails live in the littoral zone.

Starfish

Sea stars, another name for starfish, are animals that live on the ocean floor.

Whelk

Whelks are predatory marine invertebrates with a spiral shell.



Zooplankton

Zooplankton are tiny animals that float in the seas and other bodies of water.

Law of the Beach 6F

Preparation Time:
10 minutes

Activity Time:
- **Warm up**
30-45 minutes
- **Activity**
70 minutes
- **Enrichment**
30 minutes

Materials Needed:
- Copies of provided Background Information, Law Maker's Worksheet, and Student Law pages
- Pencil

Setting:
Classroom

Subject Areas:
Ecology, Social Studies, Government

Skills:
Analysis, Discussion, Decision Making, Comprehension

Summary

Students will learn about public policy making by identifying problems and drafting rules for the use of sandy beaches.

Objectives

Students will:
- Define policy.
- List three problems on local beaches nearby and identify solutions.
- Draft rules to solve problems.
- List conflicts in beach use.

Why Is It Important?

Different towns, islands and countries have different laws about beaches. These laws might govern who can go to the beach, when you can go to the beach, what you can do there, and what you can take from or leave at the beach. Sometimes we can identify laws that are not working well, or laws we dislike, and we can work to change them. The process of writing a law involves taking people's needs and wants into account. In a democracy, citizens have a say in policy-making.

Background Information

Think of the beaches near where you live. Are there any beaches you are not allowed to go to? Can you build fires on the beach? Can you fish from the beach? Could you build a house there? All of the things we can and cannot do at the beach are controlled by laws. Some places make all beaches public property so that you can go to any beach any time you want to. Other places allow private ownership of parts or all of the beach. Protected beaches might require a trained guide or a fee.

When you go to the beach is there anything you don't like about it? Is there too much trash? Are there too few tables or restrooms? Are there too many dogs? Too many hotels?

In this activity you and your classmates will pretend that you have been chosen to make new rules governing the beaches where you live. You will need to first identify the problems that you want to fix and then come up with solutions.

Policies are guiding principles. That all beaches should be public and accessible is a policy. A law is more specific. A law might be that every beach must have a parking lot with at least 10 parking spaces and a path leading to the sand.

Procedure

Warm Up

1. Copy and distribute the Background Information to each student. Have the students read the information or read it aloud in class.

The Activity

1. Have the students work in groups of 3-4. Copy and distribute the Law Maker's Worksheet and the Student Law page.

2. Ask each group to identify a problem they would like to solve having to do with beaches. They should then fill out the rest of the worksheet according to the example.

3. After the worksheet is complete, have the groups write three laws into the Student Law page. These should be presented to the class, and can be displayed for the rest of the school to see.

▼ Enrichment

1. Call your local government or contact a local law maker in your community. Have a speaker come in to talk to the class about the process of making laws. The students should have some specific questions about beach laws after completing the activity.

Law Maker's Worksheet

1 List of Beach Problems:

1. I can't get to the beach
2.
3.
4.
5.
6.

1 Chosen Problem to address:
(Select one from your list)

1.
2.
3.
4.
5.
6.

1 List causes of the problem:

1. The hotel has fenced the property
2.
3.
4.
5.
6.

1 Potential solutions for the problem:

1.
2.
3.
4.
5.
6.

Student Law

The students of ______________________ , on the day of ____________,

20____ enact the following laws concerning the coastal areas of

________________ in order to address the following problem:

____.

1.

2.

3.

Signed on this date by the law's authors:

____

____

____

____

Unit 6 References

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Skills Index

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Natural History of Sea Turtles	43	•				•	•
Caribbean Sea Turtle History	50	•				•	•
Turtle Key	54			•	•		•
Trade in Sea Turtles	63	•	•			•	
Sea Turtle Tracking	68	•	•		•		
A Leatherback's International Journey	74	•	•		•		
Why is Biodiversity Important?	82	•		•			
Fishy Problems	86						
Coral Reef Community	92			•			
Seagrass Beds	97			•			
An Oil Spill Story	100				•		
Sea Turtle Survivor	103						
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Hatchling Development	118			•			
Finding the Sea	122	•					
Sea Turtle Growth	126	•					
Where's My Beach?	131	•					
Hatchling Conservation	136		•	•			•
Land Use Planning	140	•	•				
Beach Management	144	•	•				•
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Glossary of Terms

adapted from Word Central's Student Dictionary

abiotic
non-living

abundance
a large quantity

adaptation
the adjustments that occur in animals with respect to their environments

affirmative
positive; asserting that the fact is so

aggregated
to collect or gather into a mass or whole

analogous
related features in animals which have developed separately in response to similar ways of life. The wings of birds and insects are analogous.

balance (of nature)
the fine state of balance in a natural ecosystem due to the effects of the living and nonliving parts of the environment on each other species of plants or animals sometimes die out when human beings upset the balance of nature

barnacle
any of numerous small saltwater shellfish that are crustaceans, are free-swimming as larvae, and as adults fasten themselves to rocks, wharves, and the bottoms of ships

biodiversity
biological variety in an environment as indicated by numbers of different species of plants and animals

biotic
living

bleaching
to grow white : lose color; in corals the polyps lose their color by losing their zooxanthellae

bycatch
the animals that are caught accidentally by fishermen and often thrown away; non-target species

calcareous
consisting of or containing calcium carbonate; also : containing calcium

calcium carbonate
a solid substance found in nature as limestone and marble and in plant ashes, bones, and shells and used especially in making lime and portland cement

camouflage
the hiding or disguising of something by covering it up or changing the way it looks

carapace
a bony or horny case or shield covering all or part of the back of an animal (as a turtle)

caudal
having to do with the tail

cell
one of the tiny units that are the basic building blocks of living things, that carry on the basic functions of life either alone or in groups, and that include a nucleus and are surrounded by a membrane

clutch
all the eggs deposited in a nest during laying

cohort
a group of individuals of the same age

commensalism
a relation between two kinds of plants or animals in which one obtains a benefit (as food) from the other without damaging or benefiting it

commercial
designed mainly for profit; especially : designed for mass appeal <the commercial theater>

conservation
a careful preservation and protection of something; especially : planned management of a natural resource to prevent exploitation, pollution, destruction, or neglect

coral reef
a reef made up of corals, other organic substances, and limestone

correlation
the state of being correlated; especially : a mutual relation discovered to exist between things

critically endangered
animals in critical danger of extinction and whose survival is unlikely if the causal factors continue operating

culmination
to reach the highest point

currents
the part of a fluid body moving continuously in a certain direction

customary
commonly done, observed or used

debate
a regulated discussion of a problem between two matched sides

delicacy
something pleasing to eat because it is rare or a luxury

dichotomous key
a series of pairs of phrases or descriptions which are used to classify a group of living things by making choices between the sets of traits and characters described in each pair

DNA
any of various nucleic acids that are located especially in cell nuclei and are the chemical basis of heredity

ecosystem
a system made up of an ecological community and its environment, especially under natural conditions

ectothermic
maintaining body temperature through behavior, like seeking shade or sun

embryo
an animal in the early stages of development that are marked by cleavage, the laying down of the basic tissues, and the formation of primitive organs and organ systems

endangered
animals in danger of extinction and whose survival is unlikely if the causal factors continue

endangered species
a group or taxa of animals that is endangered

energy
the capacity (as of heat, light, or running water) for doing work

exasperating
to make angry; annoy; irritate

exclusive economic zone
zone seaward of the shore and state zone with an outer boundary that may be up to 200 miles out. Within this a coastal state controls the use of the oceanic resources

exploitation
to harvest or kill; to get value or use from

export
to carry or send abroad especially for sale in another country

extinction
an act of extinguishing or an instance of being extinguished

fervid
extremely excited

flotsam
floating refuse or debris

food chain
a series of organisms in which each uses the next usually lower member of the series as a food source

food web
the whole group of interacting food chains in an ecological community

frequency
how often something happens : rate of repetition

futile
useless; having no result or effect

gait
manner of moving on foot; also : a particular style of such movement

gel electrophoresis
the movement in an electric field of charged particles within a gel; The rate of movement varies with the charge, size and shape of the particle

generation
a group of individuals born and living at the same time

genetics
a branch of biology that deals with the inherited traits and variation of organisms

halimeda
calcareous green algae found in the tropics and responsible for the formation of a great deal of sand

hand line
fishing gear including line and hook

hatchling
a recently hatched animal

homologous
two similar structures resulting from descent from a common ancestor

import
to bring (as goods) into a country usually for selling

imprint
to fix firmly, as on the memory

incidental
happening by chance; of minor importance

incubation
the process of hatching eggs by warmth

inheritance
something that is or may be received by genetic transmission

intertidal
of, relating to, or being in the area that is above the low-tide mark but exposed to flooding by the tide

irresponsible
having or showing no sense of responsibility

indigenous
living naturally in a particular region or environment

keystone species
a species of animal whose presence and numbers can be used to measure the health of the entire ecosystem

latitude
distance north or south from the equator measured in degrees

lifecycle
the series of stages of form and activity through which a living thing passes from a beginning stage in one individual to the same stage in its offspring

long line
fishing practice using very long fishing lines with thousands of baited hooks

longitude
distance measured by degrees or time east or west from the prime meridian

lost years
a sea turtle juvenile period that lasts about 3-7 years; from the time that the hatchlings enter the water to the time that the turtles show up on beaches to nest, it is unknown exactly where the turtles go or what they're feeding upon.

mannerism
a characteristic and often unconscious way of acting

marine
of or relating to the sea

maturity
a condition of full development or growth

metaphor
a figure of speech in which a word or phrase meaning one kind of object or idea is used in place of another to suggest a similarity between them

migration, migrate
passing from one region or climate to another usually on a regular schedule for feeding or breeding

mitochondrion
one of the round or long bodies found in cells that are rich in fats, proteins, and enzymes and are important centers of metabolic processes (as the breakdown and manufacture of carbohydrates, fats, and amino acids)

moot
open to question or discussion

mutualism
association between different kinds of organisms that benefits both

natural resource
something (as a mineral, waterpower source, forest, or kind of animal) that is found in nature and is valuable to humans

natural selection
a natural process in which individuals or groups best adapted to the conditions under which they live survive and poorly adapted forms are eliminated

nautical mile
a unit of distance equal to 6076.115 feet (1852 meters)

navigate
to control the course of; to steer

negative
marked by denial or refusal

nutrient
a nutrient substance or ingredient

objective
dealing with facts without letting one's feelings interfere with them

obstacle
something that stands in the way or opposes

opinion
a belief based on experience and on seeing certain facts but falling short of positive knowledge

organism
an individual living thing that carries on the activities of life by means of organs which have separate functions but are dependent on each other : a living person, plant, or animal

overburden
the amount of sand covering the eggs in a sea turtle nest

over-harvesting
to gather too many individuals; continued overharvest my result in extinction

overwrought
extremely excited

parasitism
a close association between living things of two or more kinds of which one is a parasite and obtains benefits from the other which is a host and is usually harmed in some way

percentage
a part of a whole expressed in hundredths

petulant
marked by displays of rudeness or ill temper

photosynthesis
the process by which plants that contain chlorophyll make carbohydrates from water and from carbon dioxide in the air in the presence of light

plastron
the shell on the under-side of a turtle

policy
a course of action chosen in order to guide people in making decisions

pollution
contamination; spoiled, dirty

polyp
an invertebrate animal (as a sea anemone or a coral) that is a coelenterate having a hollow cylinder-shaped body closed and attached at one end and opening at the other by a central mouth surrounded by tentacles armed with minute stinging organs

pre-Columbus
the era before 1492, before the voyages of Columbus to the New World

predator
an animal that lives by killing and eating other animals

pressure (atmospheric)
the pressure resulting from the weight of the atmosphere

prey
an animal hunted or killed by another animal for food

procreation
to take as a mate

producer
a living thing (as a green plant) that makes its food from simple inorganic substances

propulsion
a force, resulting in the forward motion of a body

protists
a Kingdom of one-celled, colonial, or many-celled organisms that resemble plants or animals or both and that include the protozoans, algae, and some lower fungi (as slime molds)

protocooperation
to act, work, or associate with other individuals so as to get something done

questionnaire
a set of questions to be asked of a number of persons usually in order to gather information (as on opinions)

range
the place where a certain kind of animal or plant naturally lives

recruit
to increase the number of by enlisting new members

rebuttal
opposition by argument

reckoning
to estimate by calculating

rend
to tear as a sign of anger, grief, or despair

renewable
capable of being replaced by natural ecological cycles or sound management procedures

resource management
act of making decisions about the use of natural resources

rookery
the place where a group of animals breed, nest, or raise their young

runoff
water traveling across the ground surface, caused by heavy rains or irrigation. surface runoff can wash dirt and garden chemicals into the water

salinity
amount of salt dissolved in water; measured in parts per thousand

scutes
"scales" covering the bony shell of a turtle

seagrass
an aquatic plant that acts as a primary producer in marine ecosystems

sediments
material (as stones and sand) deposited by water, wind, or glaciers

skeletochronology
the study of aging animals using growth rings in bone

stability
the condition of being not easily changed or affected

subjective
dealing with facts in a personal, or biased way

survey
a series of questions designed to gather information

survival
remaining alive

sustainable
able to be maintained; capable of supporting need

symbiotic
the living together in close association of two different kinds of organisms

taxonomy
orderly classification of plants and animals according to their presumed natural relationships

tear ducts
a tube or vessel carrying a bodily fluid to the eye (as the secretion of a gland)

terrestrial
of or relating to land as distinct from air or water; living on or in or growing from land

territorial seas
soil air and water not exceeding 12 nautical miles seaward of the shoreline

thermoregulation
regulation of body temperatures in animals

threat
something that can do harm

trawl
a large cone-shaped net dragged along the sea bottom in fishing

trend
to show a tendency

turbidity
the degree to which water is clouded or discolored by sediment

unprecedented
not done or experienced before

viscous
having the characteristic of stickiness

wave compass
a turtle's sense that allows them to swim directly against the oncoming wave surge in nearshore water

zoning
laws passed by local governments regulating the size, type, structure, nature and use of land or buildings

zooxanthellae
tiny plants that live in a symbiotic relationship with certain corals, clams, and some sponges; they receive nutrients from their host and provide a food source in return; it is the zooxanthellae that are responsible for the brilliant green, yellow, and blue colors in corals and clams

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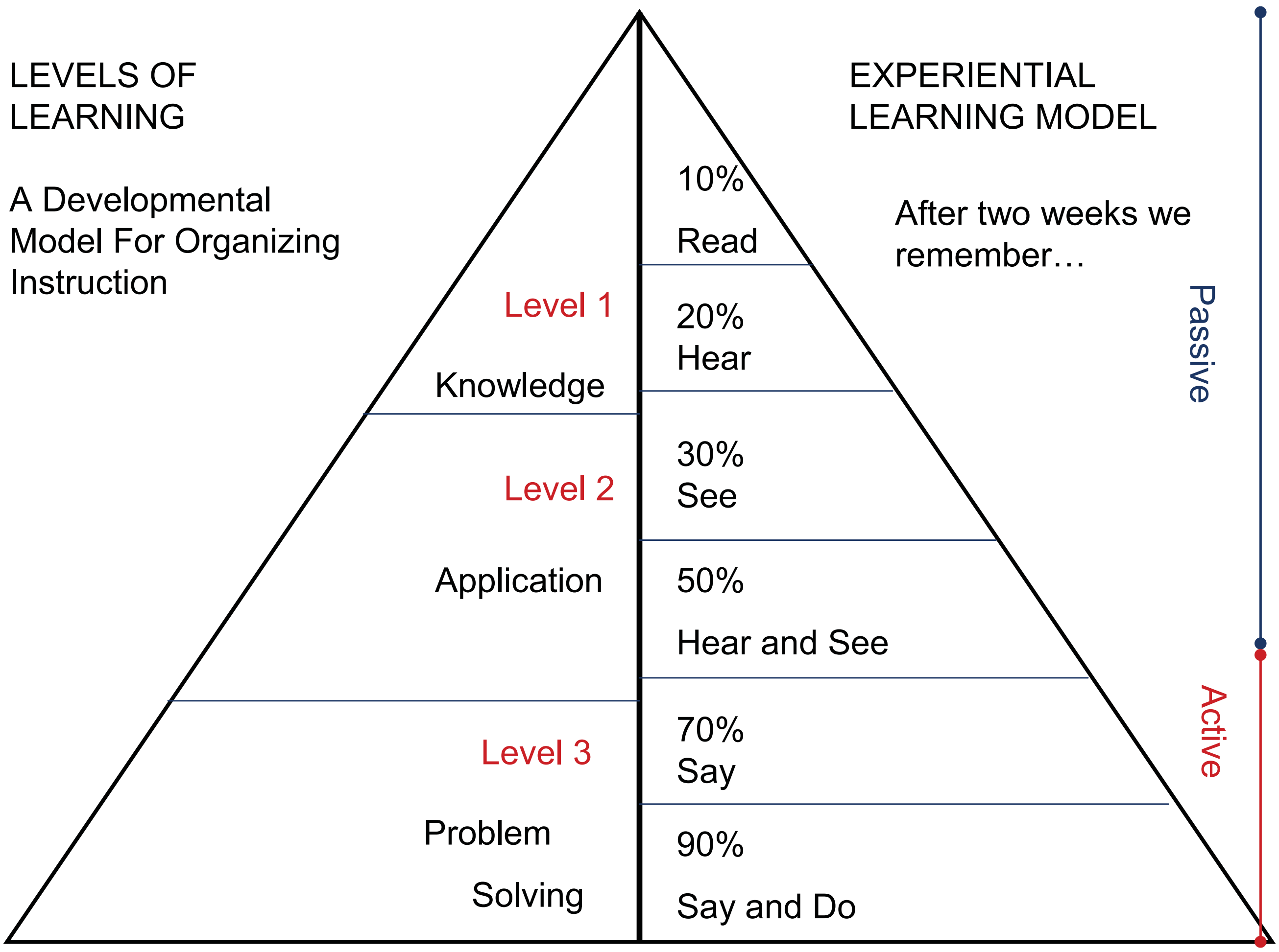
Authors' Note: Educational Philosophy of the Handbook



Levels of Learning:

Each activity contains at least one objective for each level of learning. The third level, which includes creative problem solving, is the most important step for creating an ecologically literate society. These third level objectives are often met in the Enrichment section.

Experiential Learning:

Each activity is designed to keep the learners active. This increases interest level and learning ability! Enjoy!

What is WIDECAST?

The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) is a volunteer expert network and Partner Organization to the U.N. Environment Programme's Caribbean Environment Programme (CEP), based in Kingston, Jamaica. Emphasising information exchange and training, the network promotes strong linkages between science, policy, and public participation in the design and implementation of conservation actions. WIDECAST develops pilot projects, provides technical assistance, and supports initiatives that build capacity within participating countries and institutions.

WIDECAST, chartered in the Dominican Republic in 1981, is committed to the idea that conservation must be nurtured from within, it cannot be commanded from outside. With Country Coordinators and partner organizations in more than 40 Caribbean States and territories, the network has been instrumental in promoting best practices, training and institution strengthening, harmonising legislation, encouraging community involvement, and raising public awareness of the endangered status of the region's six species of migratory sea turtles. This Handbook is a natural extension of the network's emphasis on the development of Caribbean-based materials suitable for local audiences.

WIDECAST focuses on bringing the best available science to bear on sea turtle management and conservation, empowering stakeholders to make effective use of that science in the policy-making process, and providing a mechanism and a framework for cooperation at all levels, both within and among nations. By involving stakeholders at all levels and encouraging policy-oriented research, WIDECAST puts science to practical use in conserving biodiversity and advocates for grassroots involvement in decision-making and project implementation. We hope that this Handbook will encourage students throughout the Caribbean region to put their new knowledge to use by, for example, participating meaningfully in public debate and policy.

WIDECAST is uniquely designed to address both national and regional priorities, both for sea turtles and the habitats upon which they depend. The network is all about partnerships – building bridges to the future that facilitate and strengthen conservation action, encourage inclusive management planning, and help to ensure that utilization practices, whether consumptive or non-consumptive, do not undermine sea turtle survival over the long term.

In joining together to protect future options with regard to the use of sea turtles, participants in the WIDECAST network recognize essential linkages between a healthy Caribbean ecosystem and economic prosperity for Caribbean people. A thriving biodiversity base brings economic choices, economic diversity, and economic wealth over the long term, whereas a depleted resource base is far more likely to invite economic dependence, restricted choices, and poverty. We hope that you enjoy learning about sea turtles through the activities featured in this Handbook!