

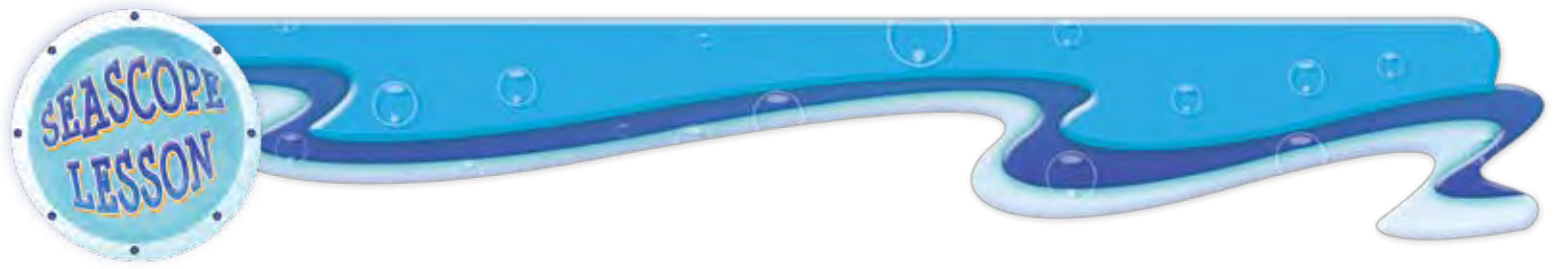


SeaScope

Lesson Plans and Teacher's Guide



Based upon the 2-disc SeaScope DVD set



SeaScope

Lesson Plans and Teacher's Guide



Based upon the 2-disc Seascope DVD set



WWW.OCEANFUTURES.ORG



Dear Educators, Parents and Students of all ages,

My team and I have created a series of 52 five-minute shows that depict the wonder and value of the ocean. We have traveled the world to acquire these images and fascinating stories. Our goal is to help people appreciate the incredible diversity of life in the sea and also the variety of ways humans benefit from and interact with the sea. Stories range from the behavior of fish that act as doctors on coral reefs-to the value of shipwrecks, and how humans explore the underwater world. I am sure people of all ages will find these stories educational and entertaining.



In order to enhance the educational value of these stories, we offer a series of lessons and activities that will help students of all ages better understand the message of these episodes and also appreciate the many connections between the sea and our own lives.



We live on a water planet, actually an ocean planet. The oceans control and regulate climate, they provide us with valuable resources, and they are a source of spiritual enrichment. Protecting the ocean is protecting ourselves.

**- Jean-Michel Cousteau
President
Ocean Futures Society**



Dear Educator,

We are pleased to offer a series of activities and lessons that will enhance the educational value of our Sea Scope shows. They are organized according to subject area, sometimes with several Sea Scope stories combined into a single lesson. In other cases a lesson may relate to only a single Sea Scope episode.

We have created a diversity of stories with the intent of their serving as a point of departure where you, the educator, can expand upon the subject matter to other academic areas. We have learned that the sea excites people's imaginations and we want to take advantage of this interest to broaden students' awareness of the interconnectedness of all things, from oceanography and marine biology to scientific research to human benefits from the sea to economics and on to culture, geography and even history. We address all of these subject areas in the Sea Scopes and hope that you can use these glimpses into the diverse world of the ocean to intrigue and connect students to all academic subject areas.



We have had the pleasure of working with Linda Freeman, Science Teacher, Tower Heights Middle School, Centerville, Ohio, and Bridget Lewin, Lecturer, Environmental Studies Program, University of California, Santa Barbara, who created these lessons. Both are experienced educators and members of our team who have taught and participated in our Ambassadors of the Environment programs around the world. In developing these plans, Bridget and Linda have integrated current best practice with the National Science Education Standards. We applaud their commitment and creativity in this endeavor.



The beautiful design of these lessons is thanks to Susan Freeman (Vice President of Design), Carol Thompson (Art Director), Molly Scanlon (Designer) and their colleagues at GGS Book Services, PMG Design & World Languages. Their creativity has made these lessons come alive as elegant works of art. We are extremely appreciative of their hard work.

We would appreciate any feedback you may care to offer and suggest you visit the [Ocean Futures Society website](#) to explore other educational resources and opportunities we offer. Specifically, I suggest you visit the web pages on our *Ambassadors of the Environment* program. Please [become a member of Ocean Futures Society](#); it's free, and you will be entitled to receive updates on our upcoming PBS documentaries and the many activities of Jean-Michel Cousteau and his team.

We applaud your commitment to the next generation and hope these resources can help you inspire your students to contribute towards creating a more sustainable world for all.



Sincerely,

- Richard Murphy, Ph.D.
Director, Science and Education
Ocean Futures Society
rmurphsurf@gmail.com





SeaScope Program Line-Up

Episodes 1-52

episode

1

Rainforests of the Sea

Coral reefs are to the sea what rainforests are to the land. Reefs occupy only 1/10th of one percent of the ocean bottom, yet 99% of all the species in the sea make their home there.

episode

2

Whale Wishers

Before they start on their long migration north, the friendly whales of San Ignacio Lagoon in Mexico get a warm send-off from people in boats who are thrilled by the up-close encounters.

episode

3

Sand City

The ocean bottom looks empty, but is filled with strange critters like cuttlefish that squirt ink, urchins that pick up hitchhikers, and fish that play possum – you just have to know where to look.

episode

4

Cleaning Station

Do you stand on your head when you go to the doctor's office? No? Well, some fish do. When fish need a checkup, they go to a cleaning station where "doctors" are waiting to nip off their pesky parasites and dead skin. It's a win-win situation: the doctors get an easy meal and the patients get a health boost!

episode

5

Clownfish / Anemone

The anemone has a carpet of stinging tentacles, but the clownfish feels right at home: it is immune to the stingers and uses them to protect itself and its eggs from predators. In return, it protects the anemone from certain species of fish that like to munch on tentacles.

episode

6

Destroyer at Peace

Not too many people get to ride a sinking ship to the bottom of the sea – but Jean-Michel Cousteau does. He then watches as fish move into their new home.

episode

7

Different Strokes

Everyone in the ocean swims in a different way. Knowing why can tell you a lot about what they eat and what eats them.

episode

8

Jelly Fish Lake

Some jellyfish sting, but in Palau's Jellyfish Lake, you can dive in a whole sea of jellies without getting hurt – if you know which ones you're dealing with.

PROGRAM LINE-UP

episode
9

continued

Reef Recyclers

Nothing is wasted on a coral reef. Sea cucumbers feed on waste, turning it into clean sand, and sponges do the same with water. Both the sea cucumber and sponge remove waste leaving the reef clear and clean, so we call them 'recyclers' of the sea.

episode
10

Molly the Manta

Molly the manta ray lives in the Cayman Islands. She looks a little scary, but she's really friendly, and lets people touch her when she comes near their lights to feed on plankton at night.

episode
11

Dinosaurs of the Deep

The nautilus was around before the dinosaurs, and it's still here. Like a scuba diver, it can handle different depths and pressures. Close cousins of the nautilus, the cuttlefish are also living fossils.

episode
12

Bedtime Stories

Everyone needs to sleep, even in the sea. Some fish bury themselves in the sand to take a snooze, while the octopus settles into a little rocky crevice and changes color so it won't be disturbed.

episode
13

Undersea Forests

In California, giant kelp form beautiful forests filled with animals. Sea lions frolic through the underwater forest, and each leaf-like structure or frond is home to snails, crabs, and other tiny creatures.

episode
14

Urchin & the Damsel fish

Old McDonald was a damselfish: these little fish farm small gardens of algae on coral reefs. They make their homes in dens excavated by sea urchins who like to eat algae, but the damsel fish doesn't like to share so they chase or carry the hungry urchins off the farm.

episode
15

False Advertising

The ocean is full of phonies, liars, and con artists - but there's a good reason. Fish have to be tricky to both find a meal and to avoid being eaten, so many resort to false advertising and camouflage.

episode
16

Sixth Sense

Fish actually like to be in school. Resembling an expert drill team, they shoot through the water in very beautiful patterns. They even stay in formation at night! How is this possible? They have a sixth sense. Using something called a lateral line, they feel the vibrations that go through the water as their friends move, and they use that information to stay in formation.

PROGRAM LINE-UP

episode
17

continued

Reef Killers

Polluted water stress corals out. Even things as simple as sediments and nutrients can cause corals to die. The crown-of-thorns seastar is beautiful, but when there is pollution in the water they have a baby boom. This sudden explosion creates a big problem for reefs because this seastar eats coral. When there are too many crown of thorns seastars, they can devour and destroy a whole reef.

episode
18

Spotted Dolphins

Spotted dolphins use a sonar buzz to stun tiny fish that live in the sand, and then they dig them up for dinner. When bottlenose dolphins come to join the dinner party, they seem to be welcome guests at first, but then they are chased away in no uncertain terms.

episode
19

Value of a Fish

The people of the Cayman Islands have realized that many fish are more valuable alive than dead on a dinner plate. Underwater celebrities like Freddy the grouper, the tarpons of Tarpon Alley, and the stingrays of Stingray City attract many divers and generate a lot of money for this island economy.

episode
20

Pharma-sea

Many sea creatures produce chemicals to protect themselves from disease and predators, and some scientists are using these chemicals to create cures for some human ailments as well.

episode
21

Jointed Footed Things

Crabs walk sideways, lobsters walk straight, and shrimp do it all. What do they have in common? They are the joint-footed creatures. They have exoskeletons, legs, and pinchers, and they are destined to walk in a world where most everyone else can swim.

episode
22

Mystery Ship

Deep on the bottom of the ocean, a sunken ship is still leaking oil from its coral encrusted hull 50 years after it went down. Jean-Michel Cousteau explores this wreck. Inside there is no life, only spooky catwalks, passageways and a monster deep down in the engine room.

episode
23

Filming Leopard Sharks

When large numbers of leopard sharks gather in the shallow waters off Catalina Island, scientists have an opportunity to locate and observe tagged sharks. Jean-Michel and his team are on hand to capture the action. But the camera-shy sharks pose a filming challenge, so remote cameras and even disguises are used to assist in getting the elusive close-ups.

PROGRAM LINE-UP

episode

24

continued

Mating Dances

Gorgonians, sea fans and worms don't make babies like some other animals – they just release millions of sperm and eggs into the water at the same time and rely on the currents to mix it all together. It's called spawning, and what's amazing is that it all happens on one or two special nights a year. Other undersea creatures like turtles take the more traditional approach to reproduction.

episode

25

Aqua-culture

Today, turtles and giant clams are endangered, but some people are helping by raising baby turtles and clams in underwater farms and then releasing them into the wild.

episode

26

Wrecking Crew

The earth is under constant transformation and these wrecking crews are some of the reasons why: On land, water can carve beautiful caverns out of solid rock. Underwater, animals like the parrotfish and sea urchin excavate the reef, grinding rock and old coral skeletons into sand that eventually helps form beaches. But the slow moving chiton may be the star of this show as it is actually one of the geological forces behind the fanciful “mushroom” islands of Palau.

episode

27

Dive Buddies

Just like people, sea creatures have buddies that they like to hang out with. Sometimes the relationship is mutually beneficial to both, as in the classic relationship between the clownfish and the anemone. However, often one of the partners reaps all of the rewards, as in the case of the shark and the hitchhiking remora.

episode

28

Form & Function

Fish come in all different shapes and sizes. That's because they all have different survival strategies. We'll find out how these different forms function to benefit their survival.

episode

29

Spiny Things

If you lived on the bottom of the sea and wanted to protect yourself but you couldn't walk any faster than a crawl and couldn't swim at all, what would you do? You could use spines to protect yourself like the echinoderms! In fact, echinoderm means spiny (echino) skin (derm).

episode

30

Plankton

You can see right through some creatures in the ocean, because they are made almost completely of water. Many of these creatures are called plankton. They drift through the ocean like spaceships and make colorful patterns of light.

PROGRAM LINE-UP

episode
31

continued

Standing Guard

In the sea, some creatures offer their offspring no parental care and could seem to care less about a stable home, but others are fiercely protective of their young and their territory.

episode
32

Destroyer at Peace - One Year Later

One year after its sinking, the Destroyer at Peace is hardly recognizable. The Crow's nest has collapsed and the sea has begun transforming the ship to a reef in earnest. The sunken vessel is now home to many creatures, including a sergeant major guarding its nest of eggs.

episode
33

Evolution in the Galapagos

Evolution has been described as inspired design producing perfection. A closer look leads one to wonder how such strange creatures could have been produced from the evolutionary process since they seem more like weird science fiction than perfection.

episode
34

All Dressed Up

Have you ever gotten all dressed up in some really weird things just for fun? And have you ever changed your outfit from one to another? Many fish appear to be doing the same thing, but in fact, there probably is a reason for them to be all dressed up.

episode
35

Growing Up

Some fish look just like their parents, while others go through lots of changes before they're grown up. Many change color, some change shape, and a few even change sex!

episode
36

Weirdos of Indonesia

In the rich waters of Indonesia, where two oceans meet, evolution is in overdrive. In this almost perfect environment, sea creatures have come up with some mind-boggling designs. That specialization helps animals like the stargazer, the pygmy seahorse, and the mimic octopus survive in diverse habitats.

episode
37

Keiko - Learning to be Wild

Keiko the orca is being untrained. That's right, in preparation for his release to freedom, his trainers are teaching him how to be wild by getting him physically and mentally fit for life at sea.

episode
38

Manatees

Manatees, or sea cows, spend most of their lives eating plants - up to 100 pounds in a day. A manatee's life may sound boring, but it can be dangerous with boats nearby. Luckily, a series of refuges now protects about a thousand of these once plentiful marine mammals from poachers and propellers.

PROGRAM LINE-UP

episode

39

continued

Eels

They look like they belong in a horror show, but eels are just fish whose slinky shape helps them survive in rocky and sandy habitats. Seeing them hunt is pretty scary, but one diver finds out that they can be as cuddly as kittens - when they've had enough to eat.

episode

40

Elephant Seals

Elephant seals are champion divers that go nearly a mile deep in search of food. But it's on land that they play out an important part of their social life, the males fighting over beach territory to win a harem of females.

episode

41

Mangroves

A tree that grows in the sea? Well, sort of. Mangrove seedlings travel long distances to settle in estuaries and on beaches where they grow a complicated aboveground root system. Due to ignorance, people sometimes cut them down, but mangroves are a useful habitat for young fish and a good way to keep beaches from washing away.

episode

42

Friendly Monk

Monk seals were once hunted for their fur, so they are usually shy. But off of Hawaii, one monk seal loves to swim with people and nobody knows why. Was he in a zoo? Was he somebody's pet? Now the seal has returned to his own wild world, but the mystery lingers.

episode

43

Battleships on the Bottom

Where once a furious battle raged, sunken ships now litter the bottom. The smoke has cleared, but danger lurks around every corner as Jean-Michel Cousteau explores tangled wrecks filled with live ammunition.

episode

44

Marine Mammal Rescue

Twenty years ago, Peter Howorth caught sea lions for marine parks. Now he catches them for their own good. Peter's Santa Barbara Marine Mammal Rescue Center helps stranded, injured, and entangled creatures recover and gives them the ultimate gift - their freedom.

episode

45

Food Web

Some sea creatures eat plants and some eat other animals, but all are processing the same thing: solar energy. The sun is the source of energy that keeps the entire marine food web going.

PROGRAM LINE-UP

continued

episode
46

Warm Blood in the Sea

Millions of years ago, the ancestors of marine mammals walked on land. Today, whales, dolphins and pinnipeds rule the sea. From blubber to blowholes, a series of ingenious adaptations help these warm-blooded creatures flourish in a cold-water world.

episode
47

SeaScience

In order to protect the sea, people have to understand it, and that means studying things like coral reefs and fish populations up close. But how do you perform science underwater when it's hard enough in the lab? Scientists always find a way.

episode
48

Polarized

You wouldn't expect to find much life in the arctic, but it's actually teeming with animals. How do they survive? Many fish species have antifreeze in their veins, while marine mammals thrive on a combination of blubber and brains.

episode
49

Deeper & Longer

People have long wanted to swim free underwater like fish and marine mammals, but only in the last 150 years did they invent the gear to help them do just that. Now there are new frontiers to explore as the quest to go deeper and stay longer continues in a new generation with space-age technology.

episode
50

The Ever Changing Arctic

In the arctic, animals have come up with some impressive adaptations to keep up with their ever-changing environment. Polar bears can travel on land or in the water. That's what makes them champs of the adaptation game.

episode
51

No Bones

Most people are afraid of sharks, but only about a dozen of the world's 400 species of sharks and 500 species rays are dangerous. All of them are fascinating, having risen to the top of the marine food chain without having a single bone in their bodies.

episode
52

Keiko - Homeward Bound

For over 18 years, Keiko the killer whale performed tricks for marine park audiences. Now he's working up to the greatest trick of all - returning home to the wild waters off Iceland. He has lots of help, including trainers, scientists, and even the U.S. Air Force!



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SEASCOPE LESSON



Episodes 33, 36

This activity allows students to observe how physical adaptations influence an organism's ability to compete for a limited resource. Students will be able to create a simulated adaptation of an organism.

episode 33

episode 36

Evolution

Evolution in the Galapagos

Evolution has been described as inspired design producing perfection. A closer look leads one to wonder how such strange creatures could have been produced from the evolutionary process since they seem more like weird science fiction than perfection.



Weirdos of Indonesia

In the rich waters of Indonesia, where two oceans meet, evolution is in overdrive. In this almost perfect environment, sea creatures have come up with some mind-boggling designs. That specialization helps animals like the stargazer, the pygmy seahorse, and the mimic octopus survive in diverse habitats.



Introduction:

Ambassadors of the Environment Principles:

Everything is Connected: All Species depend on Others

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Content Standard C Diversity and Adaptation* by describing how species acquire many of their unique characteristics through biological adaptation.

Background Information:

Biodiversity or biological diversity is defined by the United Nations Convention on Biological Diversity as:

“The variability among living organisms from all sources...this includes diversity within species, between species and of ecosystems.”

There are 3 distinct levels of biodiversity:

- **Species diversity:** diversity among species present in different ecosystems. This is the diversity of populations of organisms and species and the way they interact.

More info on Biodiversity:
<http://marinebio.org/Oceans/Conservation/biodiversity.asp>





continued

- **Genetic diversity:** diversity of genes within a species and processes such as mutations, gene exchanges, and genome dynamics that occur at the DNA level and generate evolution.
- **Ecosystem diversity:** genetic, species, and ecosystem diversity of a given region. This is the diversity of species interactions and their immediate environment.

Today's biodiversity is the result of billions of years of evolution, natural processes, and in more recent years, human activity. Before the advent of *Homo sapiens*, the Earth's biodiversity was much greater than it is today. Human activity has had a tremendous impact on biodiversity due to use of Earth's resources and exponential human population growth.

The total number of species on Earth today is estimated around 10 million, but some believe it is low as 2 million while others believe it may be as high as 100 million. New species are discovered frequently, and many that have been discovered have not yet been classified. The richest sources of biodiversity on Earth are found in rainforests and the coral reefs. These ecosystems and their many inhabitants are responsible for a number of important functions, including:

- Capture and store energy
- Produce organic material
- Help regulate climate and atmospheric gases
- Decompose organic material
- Cycle water and nutrients
- Control erosion or pests

Biodiversity is important economically in terms of:

- **Biomedical research:** coral reefs are home to thousands of species that may be developed into pharmaceuticals to maintain human health and to treat and cure disease
- **Food resources:** agriculture, livestock, fish and seafood
- **Industry:** textiles, building materials, cosmetics, etc.
- **Tourism and recreation:** beaches, forests, parks, ecotourism

Human's have an ethical responsibility to protect biodiversity. Biodiversity is important to science because it helps humans understand how life evolved and continues to evolve, and it provides an understanding on how ecosystems work and how we can help maintain them. Some of the basic threats to biodiversity include:

- Increasing human populations out of balance with the scale of natural resources





continued

- Heavy consumption and excessive exploitation of natural resources
- Lack of sufficient knowledge and understanding of species and ecosystems
- Destruction of ecosystems and habitats due to increased land use, urbanization, and pollution
- Underestimating the value of nature and its resources
- Global climate change
- Ecological disasters such as large-scale fires and floods

Before viewing the episodes:

1 Explain to students that in this lesson, they will be answering the following questions:

- What is biodiversity?
- Why is biodiversity important?

2 As a class, locate the Galapagos Islands and Indonesia on the map. Have pairs of students brainstorm a list of characteristics of marine ecosystems. After five minutes, have student pairs share their answers with the class and record the list on the board or on chart paper.

While viewing the episodes:

Show students the *SeaScope* video clips. Students should focus on the types of mouths the fish have in these episodes. Ask students to take notes and make drawings of the various examples in the film.

After viewing the episodes:

Materials

- Toothpicks
- Small paper cups
- Bamboo skewers
- Poster board
- Pennies
- Corn, Soybeans
- Gravel
- Paperclips
- Clock
- Pliers
- Forceps, tweezers, tongs
- Rice
- Eye droppers
- Beakers w/water and pepper
- Small size fish nets





continued

1 Set up six stations, each one representing a different food source. (The list below is an example and your stations may vary depending on what you have available.)

- a. tray with rice
- b. tray with gravel
- c. tray of paper clips
- d. tray of toothpicks
- e. container of water with pepper scattered on top
- f. bowl of pennies
- g. Bowl of corn or soybeans

2 From the collection of different instruments on the tray, have students choose a tool that will be their fish mouth. Try to have a variety of tools at each table of students. Each student will also have a paper cup that will represent their mouth. Their goal is to gather as many food items as possible in the allotted time (30 seconds or 1 minute). Have students calculate how much food each gathers and return the food items to the table.

3 Have students rotate stations and repeat the feeding process.

4 After each group has visited all stations, ask students "which mouth was best adapted for each food source?"

Questions to Consider:

- a. How do the different feeding mechanisms in this activity resemble the actual adaptations fish have in the wild?
- b. Given the trials, which mechanism resembles a successful feeding adaptation?
- c. If this were a natural environment, which type of fish would benefit from the process of natural selection?

Resources:

Coral Reef Connections - web activity: <http://www.pbs.org/wgbh/evolution/survival/coral/index.html>

Flashy Fish - web activity: <http://www.pbs.org/wgbh/evolution/educators/lessons/lesson4/act2.html>

The Mating Game - web activity: http://www.pbs.org/wgbh/evolution/sex/mating/ed_pop.html

Origin Of Species - (The Galapagos Finch): <http://www.pbs.org/wgbh/evolution/darwin/origin/>



Episode 4 demonstrates one of the most intriguing partnerships on coral reefs. It emphasizes the parasitic symbiosis between isopods, bacteria, and fungi on fish and the mutualistic symbiosis between the cleaners and their patients. This episode would also complement **Episodes 27** (Dive Buddies) and **5** (Clownfish/Anemone) which both address mutual and commensal symbiosis.

Coral Reef Cleaning Stations

episode
4

Cleaning Station

Do you stand on your head when you go to the doctor's office? No? Well, some fish do. When fish need a checkup, they go to a cleaning station where "doctors" are waiting to nip off their pesky parasites and dead skin. It's a win-win situation: the doctors get an easy meal and the patients get a health boost!



Introduction:

Ambassadors of the Environment Principles:

Everything Runs on Energy: Stars, Cities, Machines, and People

There is No Waste in Nature: Nature recycles everything

Biodiversity is Good: The more variety the better

Everything is Connected: All species depend on others

National Science Education Standard Connection:

This episode addresses *National Science Standard C: Regulation and Behavior* by describing the behaviors of various coral reef fish and how they interact with their respective cleaner fish and cleaner shrimp. It also addresses Population and Ecosystems by showing how various individuals within a population affect other organisms within a coral reef ecosystem, and *Diversity and Adaptations* by showing that the relationships between reef fish and cleaners have evolved over time. It demonstrates that these species have acquired many of their unique characteristics through biological adaptation of behavior, structure, and physiology.



continued

Background Information:

Just about all living things are seen as a meal by some other life form. Not all predators, though, eat all their prey; some just nibble. This limited predation strategy insures the availability of future meals. Many parasites and diseases that infect animals are nibblers of sorts. Generally, these disease organisms do not kill their hosts but just extract some energy to survive and reproduce. Hosts, on the other hand, are not particularly happy about this since these nibblers create all kinds of trouble and suffering.

The fish that live on coral reefs are vulnerable to predators, parasites, and diseases. They are parasitized by isopods, copepods, worms, and other creatures. Fish are also vulnerable to infections caused by bacteria and fungi.

On coral reefs they are called 'cleaners'— wrasses, gobies, and shrimp—that 'clean' their hosts of external parasites. Fish often line up, waiting their turn to be cleaned, and some cleaners may see as many as 2,300 patients in one day.

"Fish travel for considerable distances to attend these 'cleaning stations' where the tiny cleaner wrasse or shrimp swim and hop in and out of their mouths and gill slits removing growths and parasites. The amazing thing about this relationship is that often these fish are predatory and would normally eat smaller fish and crustaceans like the cleaners. At the cleaning stations however there is no risk of predation, as the fish patiently wait for the cleaning to be completed. This is because fish evolved to know "cleaners" are better left alive than eaten, because without regular cleanings the fish would get sick. In some areas where the cleaning stations were experimentally removed, there were sudden drops in general biodiversity in the area. The remaining fish often have fungal growths or bad parasitic infections. This is another form of mutualism on the reef that does not require the pair to be biologically joined like the coral and the zooxanthellae but rather provides a mutual service that benefits both, the cleaners get to eat and the fish avoid parasitic infestations."

From *Coral Reefs: Cities under the Sea* by Dr. Richard Murphy (2002): <http://www.oceanfutures.org/store/books-dvds-and-games>

From website: http://www.reef.edu.au/asp_pages/secc.asp?formno=6





Before viewing the episode:

Viewing Guide Activity

Teacher will preview with students, the discussion questions from the **Coral Reef Cleaning Stations** viewing guide (see attached student sheet).

While viewing the episode:

1 Students will answer questions on the **Coral Reef Cleaning Stations** viewing guide.

2 If necessary, students can watch the episode a second time to complete the “Environmental Principles: **Coral Reef Cleaning Stations** student sheet.

After viewing the episode:

1 Teacher will lead a discussion using the **Coral Reef Cleaning Stations** viewing guide.

2 Students will describe how all four of the Ambassadors of the Environment Principles are demonstrated at coral reef cleaning stations (see student sheet, **Environmental Principles: Coral Reef Cleaning Stations**. For further information about these environmental principles see attached answer key.

Extensions:

1. Students, in groups of three, will use the student sheet, **WebQuest: Cleaner Wrasses: Take Them or Leave Them?** to assist them in researching the issue about whether or not cleaner wrasses should be taken from their coral reef habitats for salt water tanks.
2. Each group will prepare a persuasive presentation about whether or not wrasses should be removed from coral reefs. Each team member can collect information from one of the listed websites. Then, all group members can work together to develop and write a convincing persuasive essay/presentation.





Resources:

1. *Coral Reefs: Cities under the Sea* (Murphy, 2002): <http://www.oceanfutures.org/store/books-dvds-and-games>
2. Information about coral reef cleaning stations: <http://aquaviews.net/reef-cleaning-stations-meet-the-cleaners/>
3. Ambassadors of the Environment website: <http://www.oceanfutures.org/learning/ambassadors-environment>
4. Websites associated with the issue of whether or not cleaner wrasses should be removed from their coral reef habitats for home salt water aquariums:
 - a. Cleaners—friend or foe: http://www.forthefishes.org/Aquarium_Hobby_Impacts.html
 - b. Dr. Jungle's Animal-World: <http://animal-world.com/encyclo/marine/wrasses/information/CleanerWrassesInTheAquarium.php>
 - c. Education Network: http://www.reef.edu.au/contents/bc/fr_living.html





Coral Reef Cleaning Stations

1. This process of cleaning is fascinating! Write down 2 or 3 parts of this episode that you thought were particularly interesting.

2. What are the types of coral reef organisms that clean parasites off fish?

3. How do the cleaners (“doctors”) use coloring and behavior to show they are “open and ready for business?” How do the other fish (“patients”) behave to let the cleaners know they would like to be cleaned?

4. Describe how each of the following are benefited by this process of cleaning:
 - a. the “patients” (the fish that are cleaned):

 - b. the “doctors” (the cleaners):

 - c. the rest of the coral reef ecosystem:





Coral Reef Cleaning Stations



1. This process of cleaning is fascinating! Write down 2 or 3 parts of this episode that you thought were particularly interesting.

Answers will vary depending on students' personal interests.

2. What are the types of coral reef organisms that clean parasites off fish?

Cleaner fish: wrasses and gobies remove dangerous bacteria and parasites

3. How do the cleaners ("doctors") use coloring and behavior to show they are "open and ready for business?" How do the other fish ("patients") behave to let the cleaners know they would like to be cleaned?

The doctors have flashy blue and black stripes that make it easier to see them on the busy reef. Sometimes colors aren't enough. The cleaner fish have to perform a dance to get attention. This episode shows a wrasse bobbing up and down to let the patients know "the doctor is in." Patients also advertise. They swim into the general area and act differently. Some hang upside down, others go vertical. Some open their mouths wide and flex their fins. The Hogfish extends its mouthparts.

4. Describe how each of the following are benefited by this process of cleaning:

a. the "patients" (the fish that are cleaned):

get rid of harmful parasites

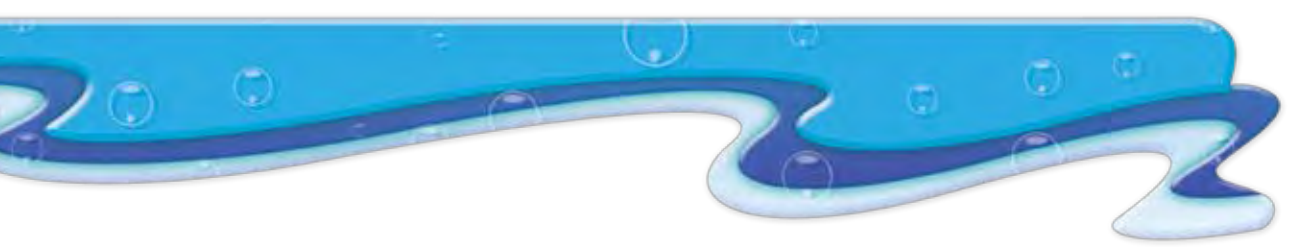
b. the "doctors" (the cleaners):

get a tasty meal

c. the rest of the coral reef ecosystem:

keeps disease under control





Environmental Principles: Coral Reef Cleaning Stations

Directions: At the cleaning stations we see examples of the four Ambassadors of the Environment Principles. Explain how these principles are demonstrated at the cleaning stations. For further explanations of these principles, go to <http://www.oceanfutures.org/learning/ambassadors-environment>

Ambassadors of the Environment Principles

1. Everything Runs on Energy: Stars, Cities, Machines, and People

2. There is No Waste in Nature: Nature Recycles Everything





continued

Ambassadors of the Environment Principles

3. Biodiversity is Good: The More Variety the Better

4. Everything is Connected: All Species Depend on Others





Environmental Principles: Coral Reef Cleaning Stations

Directions: At the cleaning stations we see examples of the four Ambassadors of the Environment Principles. Explain how these principles are demonstrated at the cleaning stations. For further explanations of these principles, go to <http://www.oceanfutures.org/learning/ambassadors-environment>

Ambassadors of the Environment Principles

1. Everything Runs on Energy: Stars, Cities, Machines, and People

Energy flows through the food web from primary producers to cleaners. Algae convert solar energy into chemical energy stored in their tissue. They are preyed upon by herbivorous fish and invertebrates, which are eventually preyed upon by fish that are infected with disease or parasites. These pathogens derive their nutrition from their host. And they are in turn preyed upon by cleaners. So cleaners derive their energy through a food web involving parasites that is ultimately based on solar energy.

The larger perspective of the Energy principle is that all food webs are dependent on energy, mostly from the sun. The energy from ecosystems millions of years ago is now stored in what we call petroleum, the cooked remains of those ecosystems. That energy is used in power plants to provide electricity to run toasters and light bulbs, and myriads of other appliances. The sun heats the earth and causes wind to blow and ocean currents, enabling both to redistribute heat from the tropics to higher latitudes. The sun evaporates water that eventually rains on mountains and flows back to the sea. Ocean currents, wind power and hydropower are all forms of solar energy.

2. There is No Waste in Nature: Nature Recycles Everything

The No Waste in Nature principle applies to cleaning symbiosis through the parasites and the waste of them and their hosts. When parasites, generally considered bad, are removed from their hosts they are not really wasted because they are valuable food for the cleaners. In addition the parasites metabolize the tissue of their host and have their own biological "waste" as do the host individuals themselves. This biological "waste" is really a resource that is broken down by microbes into fertilizer ready for uptake by algae to promote their growth.

This principle applies equally to terrestrial systems. When microbes, fly larvae (maggots), and fungi convert a dead bird into raw materials it becomes fertilizer for plants. A dead leaf is not a wasted leaf but valuable material to enrich the soil. If we were to follow nature's model we would compost all garbage into valuable topsoil. We would also make sure to recycle almost everything after we use it and also make sure to only produce things that can be reused.





continued



Ambassadors of the Environment Principles

3. Biodiversity is Good: The More Variety the Better

The Biodiversity principle relates very clearly to cleaning since the diversity of fish and shrimp and their lifestyles has resulted in certain species (cleaners) becoming adapted to prey on diseased tissue and parasites living on fish. The job of cleaners is to rid their "patients" of disease and promote their well being.

The value of biodiversity is seen at all levels of biological organization. Each creature has a job that it performs and the work of all species together create a healthy ecosystem. This is just like our human communities where doctors, bus drivers, sanitation engineers and grocery store owners provide valuable services that keep our communities running well. Species need to be protected to ensure the valuable work they perform continues to help the entire community.

4. Everything is Connected: All Species Depend on Others

Cleaning is a perfect example of the principle of Connections. The health of many reef fish is dependent on there being a healthy population of cleaners. There is a very important connection between biodiversity on the reef and the health of reef creatures.

In all ecosystems plants make food, animals eat food, and microbes convert waste into raw materials for plants to use again. Plants make oxygen and take up carbon dioxide; animals release carbon dioxide and take up oxygen. Reef doctors keep the reef healthy. Grazing parrotfish control algae and help corals survive by eliminating their competitors. People release carbon dioxide from energy use and cause corals thousands of miles away to die from warm water. Everything is connected!





WebQuest

Cleaner Wrasses: Take Them or Leave Them?

Environmental Issue:

In the past, wrasses have been removed from coral reefs to sell to pet-store customers who have salt-water tanks at home. More recently, people are reconsidering whether or not this removal of wrasses is environmentally responsible. Using the Internet, check out the following websites to substantiate your group's persuasive argument about whether or not you think this should happen. Be prepared to make a persuasive argument with supporting scientific evidence. Include how the removal of wrasses affects the wrasses themselves, reef diversity, and the health of other reef fish.

Here are some helpful websites with information on this environmental issue:

1. For the fishes:
http://www.forthefishes.org/Aquarium_Hobby_Impacts.html
2. Dr. Jungle's Animal World:
<http://animal-world.com/encyclo/marine/wrasses/information/CleanerWrassesInTheAquarium.php>
3. Reef Education Network:
http://www.reef.edu.au/contents/bc/fr_living.html



In this lesson, students will observe manatees and determine some rules people should follow to better protect manatees from boats, tourists, and habitat loss.

Manatee Manners

Manatees

Manatees, or sea cows, spend most of their lives eating plants – up to 100 pounds in a day. A manatee’s life sounds boring, but boats pose a serious threat to the survival of these slow-moving animals. Luckily, a series of refuges now protects about a thousand of these once plentiful marine mammals from poachers and propellers.

Photo Credit: © Herve Prigent for 3D Entertainment Distribution Ltd.



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Science as a Human Endeavor Content Standard G : Nature and History of Science* by showing how we as humans have scientifically studied the needs of manatees and used what we have learned to develop a way to coexist with them in a way that improves our personal and community health.

Background Information:

Around the world, there are four kinds of manatees, which are also known as dugongs or sirenians (after the “sirens,” or mermaids, of ancient lore). A fifth species, the Stellar’s sea cow, used to live off the coast of Alaska, but it was hunted to extinction in 1768, less than 20 years after it was first described by shipwrecked Russian explorers.

The Stellar’s sea cow was easy to kill because it lived in shallow waters, and was slow and fearless—just like its modern-day Florida cousin. Indeed, people can often paddle right up to a manatee, especially when the creatures gather by the hundreds each winter in a few Florida springs, such as the Crystal River.

Unfortunately, the manatees, which like to swim just below the water’s surface, are vulnerable to fast-moving boaters, who often

From *Nature: Springs Eternal- Florida’s Fountain of Youth*





continued

run over the animals without realizing what has happened. And the gentle creatures are also threatened by water pollution, which is causing Florida's once transparent spring waters to become increasingly cloudy. Much of the pollution is in the form of excess nutrients, such as nitrogen fertilizer from lawns and farms, which can trigger unwanted blooms of algae and tiny toxic organisms. These blooms sometimes form a deadly event known as a "red tide." In the winter of 1995, for instance, nearly 400 Florida manatees (about 20 percent of the population) died from exposure to red tide.

Luckily, people are taking steps to protect manatees. Florida is attempting to educate boaters to slow down in areas inhabited by manatees. And the federal government has established several manatee refuges, where the animals can winter without worry of disturbance. The refuges have also proved a boon to researchers. They have learned, for instance, that though manatees may look ungainly, they can sprint short distances at speeds of up to 15 miles per hour, though they usually paddle along at about 4 miles per hour. Scientists have also shown that manatees have well-developed eyes: in clear water, they can detect objects more than 50 feet away. And they have been able to collect data that suggests that manatees can live 60 or more years.





Before viewing the episode:

Adapted from [National Geographic Xpeditions](#)

- ▶ **1** Have students look at the manatee pictures at one or both of these Web sites: [Manatee Photographs](#) and [West Indian Manatees](#)

- ▶ **2** Ask them to describe their first impressions of these animals. Have they ever seen anything like a manatee before? Do manatees remind them of any other animals? What words come to mind when they see these pictures?

- ▶ **3** Tell the class that early explorers in Florida thought manatees were either mermaids or monsters. As they will learn, these explorers were not very well informed!

- ▶ **4** Ask one or more students to point out Florida on a United States map. Explain that most of the manatees in the United States live along the coast of Florida and in Florida's lakes and rivers that are connected to the ocean.

- ▶ **5** Tell the class the manatee is an endangered species. What does endangered mean? What does extinct mean? What is a sanctuary?

- ▶ **6** Ask why is the manatee endangered? Why would a manatee need a sanctuary?

- ▶ **7** Print out the article "[Manatees Edure Deadliest Year on Record](#)" and ask students to read it.





continued

▶ **8** Share with students the [Manatee Mortality Statistics from Florida Fish and Wildlife Conservation](#).

▶ **9** Explain to the class that manatees face some problems that are caused by human activities. In particular, people who drive their boats carelessly or too fast might hit manatees. Manatees might also become tangled up in fishing lines. Fortunately, many people are working hard to protect manatees, even some boaters and fishermen who care about this interesting species.

Share this information with the class

- Manatees swim close to the water's surface.
- Manatees are slow swimmers.
- Manatees are very gentle animals and do not attack people.

Hand out **Manatee Manners Guide** and ask students to complete first part. Ask students to describe how the characteristics above might play a role in the manatees' problems with boaters and other people in Florida's busy waters.

While viewing the episode:

▶ **1** As they watch the film ask students to jot down additional facts they hear and observe about manatees.





After viewing the episode:

1 For Part 3 on the worksheet, encourage students to brainstorm solutions to preventing human-caused manatee deaths. (They might need to do additional research.) Students should develop some rules that humans need to follow that would help humans and manatees coexist without detriment to either.

2 *Boating with Manatees*, created by Larry Coomer, Dayton Public Schools, Dayton, Ohio.

Equipment (based on 3 teams)

- 3 nine piece manatee puzzles (see resource list)
- 3 tricycles, scooters, or skateboards
- 4 large cones
- 16 small cones
- table (for Care Station)
- balloons

Teacher says: “Today we are going to focus on one of the manatees major threats—boats. You are going to guide your boats (tricycles, scooters, or skateboards) around the river course. You are going to pass manatee sanctuaries. Stay out of the sanctuaries and travel carefully. After you finish your lap, hand your boat over to the next person and collect a puzzle piece. The game is over when one team finishes their puzzle first. If you strike a manatee even slightly, you must park your boat and bring the manatee to the care station before you can finish your lap. If you enter a sanctuary you cannot collect a puzzle piece for that lap.”





continued

Guidelines

1. Students are boaters. They must circle the river course avoiding manatees (balloons).
2. From the marina, the first student on each team will board his/her boat (tricycle, scooter or skateboard).
3. On the signal they travel around the course clockwise, staying on the outside of the large cones.
4. As they complete their lap they pass the boat on to the next student and collect a puzzle piece. The game is over when one team completes their puzzle.

Rules and Sacrifices

5.
 - a. As the boaters travel around the gym, they will pass 4 manatee sanctuaries (10-15 balloons in between 4 small cones). During the race the manatees (balloons) will start to stray from their sanctuaries because air currents, caused by the scooters, etc. racing around the track, pull the balloons out of the sanctuary.
 - b. If a manatee is struck by a boat, the boater must pull over and bring the manatee to the care station (table or other convenient object). They then may continue their lap.
 - c. Any boater who enters a sanctuary may not collect a puzzle piece at the completion of their lap.
6. Closing: Count the number of manatees struck. This number represents injuries or deaths. Discuss how this affects their population. What would happen if this trend continues? As boaters, how can we minimize these losses? As students, what can we do to help protect the manatee?





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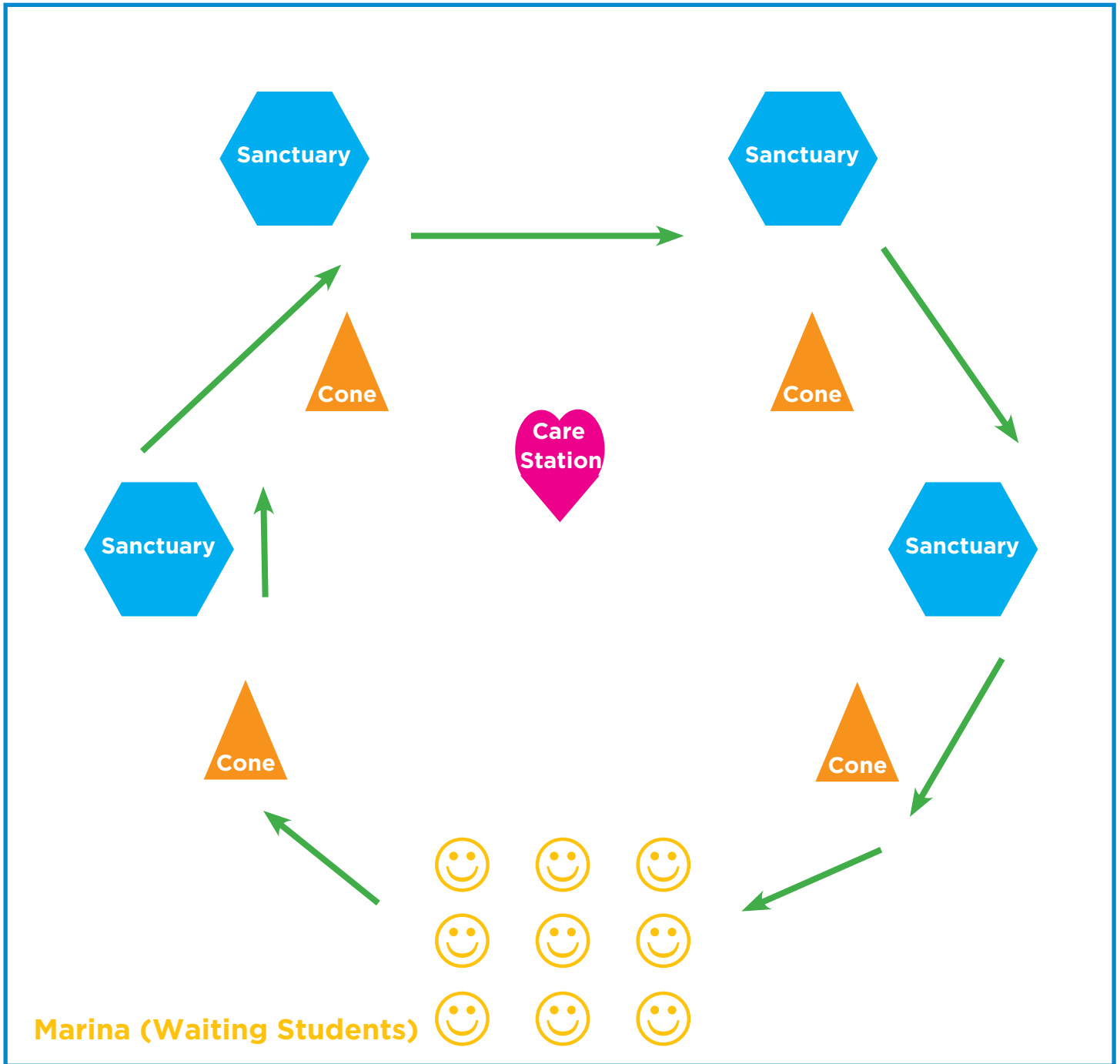
Variations

1. Older students could collect manatee facts instead of puzzle pieces.
2. When students take their manatee to the care station, ask them to “treat” the animal in some way or “pay” in some way (ie. sing a song) for its rehabilitation.
3. Have students run the game a second time but this time with speed zones when they come close to the sanctuaries. Let students decide where the speed zones will be and how fast they should go. Does this make a difference in the outcome of the second game?





Boating with Manatees Playing Field





Extensions:

Ask students to consider the impact sanctuaries and rules will have on different user groups like fishermen, boaters, dive shops, tourists, and local businesses that cater to tourists that come to see the manatees. Students could then debate the various points and hopefully come to a compromise similar to what has been done in Crystal River, Florida in making sanctuaries and manatee encounter rules.

Challenge students to develop guidelines for manatee sanctuaries and interacting with manatees. For more information see:

http://www.fws.gov/southeast/hotissues/manatee_FAQ.pdf

<http://www.savethemanatee.org/Tips.htm>

Resources:

Manatee Educators Guide:

<http://www.savethemanatee.org/EdGuideSm.pdf>

Manatee Coloring Book:

<http://www.savethemanatee.org/Coloring%20Book.pdf>

Manatee Music:

http://www.savethemanatee.org/coolstuff_music.htm

Manatee Brochures:

<http://www.savethemanatee.org/manatee.materials.htm>

Manatee Mortality Article:

“Manatees Edure Deadliest Year on Record”

Manatee Mortality Summary:

http://research.myfwc.com/manatees/search_summary.asp

U.S. Fish and Wildlife Service Article:

<http://www.fws.gov/northflorida/Releases-07/001-07-Joint-FWS-FWC-manatee-harassment-031207.htm>





Manatee Manners Guide

Directions: In the first two boxes, write down your ideas that might explain why manatees are endangered. Include manatee facts, behaviors and characteristics, as well as human facts and behaviors that might contribute to the problem.

Before viewing the episode:

While viewing the episode:

After viewing the episode: What are some solutions to preventing human caused manatee deaths? (do a little research) Develop some rules that humans should follow that would help humans and manatees coexist without detriment to either.





Manatee Manners Guide

Directions: In the first two boxes, write down your ideas that might explain why manatees are endangered. Include manatee facts, behaviors and characteristics, as well as human facts and behaviors that might contribute to the problem.

Before viewing the episode: some examples might be:

- Manatees swim close to the water's surface.
- Manatees are slow swimmers.
- Manatees are very gentle animals and do not attack people.
- Manatees have to come to the surface to breathe.
- More people are moving to Florida every day. This increases habitat destruction.
- Many people vacation in Florida, many use boats.
- Boaters like to go fast. Too fast for manatees to react.

While viewing the episode:

- Move slow, so not easy to get out of the way
- Broad flat tail for propulsion and steering
- Flippers for paddling and eating
- Plant eater
- Large lungs near backbone that are punctured when boats hit manatee
- People boating too fast in manatee habitat

After viewing the episode: What are some solutions to preventing human caused manatee deaths? (do a little research) Develop some rules that humans should follow that would help humans and manatees coexist without detriment to either.

- According to the FWS guidelines, if you are swimming, diving or boating when manatees are present:
- Operate boats at idle and slow speed where posted speed zones are in effect.
 - Do not enter designated manatee sanctuaries for any reason. Sanctuaries are in effect Nov. 15 - March 31.
 - Observe manatees from the surface of the water and at a distance. Manatees on the bottom are likely to be resting or feeding.
 - Never ride, chase, poke or surround manatees.
 - Never separate a mother and calf or an individual from the group.
 - Avoid excessive noise and splashing that could disturb bottom-resting manatees.
 - Use snorkel gear when attempting to watch manatees. The sound of scuba gear may cause them to leave the area.
 - Do not feed manatees or give them water.



SEASCOPE LESSON



Episode 20

Oceans and sea creatures, as scientists are finding out, are helping humanity cure diseases. Costs of medical treatment, lost work productivity, and emergence of drug-resistant diseases all point to the need for new and more effective treatments, making it all the more important to protect our underwater “phamasea.”

episode 20

Pharma-sea

Pharma-sea

Many sea creatures produce chemicals to protect themselves from disease and predators, and some scientists are using these chemicals to create cures for some human ailments as well.



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Content Standard F: Science in Personal and Social Perspectives* by showing how coral reef organisms are being used to improve personal and community health.

Background Information:

Most drugs in use today come from nature. Aspirin, for example, was originally isolated from the willow tree. Morphine is extracted from the opium poppy. Penicillin was discovered from common bread mold.

To date, most of the drugs derived from natural sources come from terrestrial organisms. But recently, systematic searches for new drugs have shown that marine invertebrates produce more antibiotic, anti-cancer, and anti-inflammatory substances than any group of terrestrial organisms. Particularly promising invertebrate groups include sponges, tunicates, ascidians, bryozoans, octocorals, and some molluscs, annelids, and echinoderms.

Information from NOAA:
<http://oceanexplorer.noaa.gov>





continued

The list of drugs derived from marine invertebrates includes:

- **Ecteinascidin** - Extracted from tunicates; being tested in humans for treatment of breast and ovarian cancers and other solid tumors
- **Topsentin** - Extracted from the sponges *Topsentia genitrix*, *Hexadella* sp., and *Spongisorites* sp.; anti-inflammatory agent
- **Discodermalide** - Extracted from deep-sea sponges belonging to the genus *Discodermia*; anti-tumor agent
- **Lasonolide** - Extracted from the sponge *Forcepia* sp.; anti-tumor agent
- **Bryostatin** - Extracted from the bryozoan *Bugula neritina*; potential treatment for leukemia and melanoma
- **Pseudopterosins** - Extracted from the octocoral (sea whip) *Pseudopterogorgia elisabethae*; anti-inflammatory and analgesic agents that reduce swelling and skin irritation and accelerate wound healing
- **Conotoxin MVIIA** - Extracted from the cone snail, *Conus magus*; potent pain-killer





Before viewing the episode:

World Splash Activity

1 The teacher creates a **Word Splash** (see attached) for students using the following words:

- Jellyfish
- Blue-green Algae
- Sea Squirt
- Anemone
- Corals
- Shark
- Pufferfish
- Gorgonian
- Sponges

2 The teacher directs students to predict how some of these sea creatures help the field of medicine, writing their answers on the Word Splash page.

While viewing the episode:

1 In groups of 2 or 3, students pick one of the creatures listed in the Word Splash activity and collect the correct information from the film about that creature.

After viewing the episode:

1 Student groups using the creature they chose above, gather more information via internet or books about the research currently going on in the medical community.

2 Students prepare a multimedia presentation about their findings in the form of a Public Service Announcement or Advertisement.

3 During whole class presentation of projects students complete a **Gathering Grid** (see attached) with the correct information about each creature.

Resources:

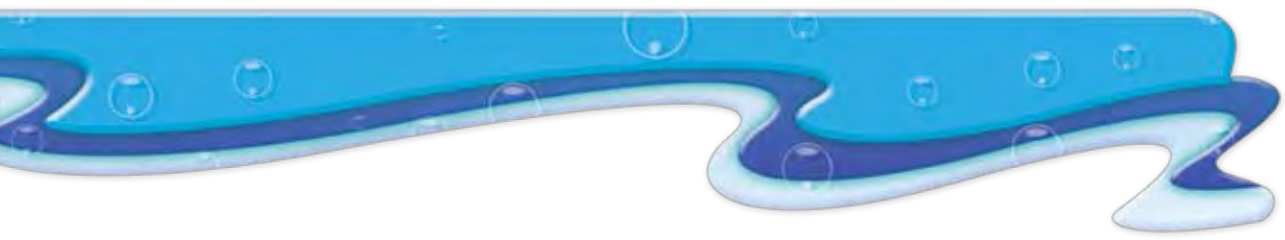
Biotechnology for the 21ST Century: New Horizons <http://www.nurp.noaa.gov/Biotech.htm>

Kerr, Russell, Ph.D., "Drugs from the sea: will the next penicillin come from a sponge?" lib.hebust.edu.cn/ywyfzsk/zsk/hyyw2/10.pdf

Medicines from the Deep Sea: Exploration of the Gulf of Mexico: <http://oceanexplorer.noaa.gov/explorations/O3windows/welcome.html>

Wilson, Elizabeth K., Plumbing the Ocean Depths for Drugs: <http://pubs.acs.org/cen/science/8103/8103sci2.html>





Word Splash





Pharmasea Creature Gathering Grid

Sea Creature	Medicinal Research or Use
Jellyfish	
Sponge	
Shark	
Blue-green Algae	
Gorgonian	
Anemone	
Pufferfish	
Coral	
Sea Squirt	



SEASCOPE LESSON



Episode 2

Students trace the migration route of a gray whale and discover the gray whale's natural history. Students will be able to state when, where and why gray whales migrate, plot data of two migrating whales on a map, and describe the ecosystems to and from which gray whales travel.

episode 2

Whale Wishers

Whale Wishers

Before they start on their long migration north, the friendly whales of San Ignacio Lagoon in Mexico get a warm send-off from people in boats who are thrilled by the up-close encounters.



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This episode addresses *Life Science Content Standard C : Regulation and Behavior* by describing the gray whale migration route, reasons for the migration, and showing the reasons for declining gray whale population. It also addresses *Unifying Concepts and Processes: Evidence, models and explanations, Form and function and Content Standard A: Understanding about scientific inquiry.*

Background Information:

Gray whales (*Eschrichtius robustus*) has the longest single migration of any other marine mammal. They journey between feeding and breeding grounds and cross national and international boundaries. California gray whales live off the western coast of North America.

California Gray whales spend the summers eating marine worms and amphipods (shrimp-like animals). They strain huge amounts of food from the muddy bottoms of the Bering and Chukchi seas. Most gray whales migrate south in the fall when the Arctic ice pack forms. They swim along the North American coastline to Baja California, Mexico—a distance of more than 6,000 miles (9,656 km).

Information from PBS *Jean-Michel Cousteau's Ocean Adventures*: <http://www.pbs.org/kqed/oceanadventures/educators/pdf/OceanAdv-OnTheMove.pdf>





continued

In Baja, the whales give birth and mate in the shallow waters of Laguna Ojo de Liebre (Scammon's Lagoon), Laguna San Ignacio and Magdalena Bay. After two or three months, the gray whales travel back up north to the Alaskan Arctic.

In the 19th and early 20th centuries, whalers hunted gray whales to the brink of extinction. After a ban in 1946 on hunting the whales, the population of California gray whales began to recover. Scientists believe that the current population is close to pre-whaling numbers.

In 1994, the gray whale was the first marine mammal removed from the U.S. Endangered Species List.

Before viewing the episode:

1 Look at the **World Map** (see attached). Discuss the values for latitude (horizontal lines) and longitude (vertical lines). What are the latitudes at the poles and the equator? Between which latitudes is the Pacific Coast of North America found? Is this region north or south of the equator?

2 Distribute the blank **North American Pacific Coast Map** (see attached) to students and have them label the countries or continents, the ocean basins, the seas, the coastal states, Hawaii, and Baja California, Mexico. Identify where San Ignacio Lagoon is located.

While viewing the episode:

1 Answer the questions on the attached **Whale Wishers Viewing Questions** diagram.





continued

After viewing the episode:

1 Distribute the **Gray Whales Migration Data** sheet showing the dates, latitudes and longitudes for two gray whales migrating along the coast. Distribute the **Gray Whales Migration Map** to the students. Have students plot the migration data on their maps using a different color for each whale. Place arrows or other symbols along the migration path to indicate when whales travel south, travel north or are in the area in which they give birth and mate. To complete the map, add a map key and a compass rose and give the map a title.

2 As a class or as individuals, use the maps completed in class, the migration data, the diagram completed during film viewing, an atlas and the provided online sources to answer the questions on the **Gray Whales Migration Data Questions** sheet. (See the teacher page for answers.) If students cannot answer in class let them work on the questions as a homework assignment, using the Internet or library to look up more information on gray whales and humpback whales.

3 Discussion: The next day, discuss the answers. Other topics for discussion: In what ways is the ocean environment different near Alaska than it is near Mexico? Why do gray whales and humpback whales migrate? How do they find their way over such a long distance? What other animals migrate? Do humans migrate?

Extensions:

1. Complete "Can Crittercam Help Protect Humpbacks?" lesson plan on humpback migration.
2. Play the **Gray Whale Observer Game**. Track migrating whales and try to catch their adaptive behaviors on film. Use the accompanying lesson plan at: <http://www.pbs.org/kqed/oceanadventures/educators/whales/> to enhance the educational value of the activity.

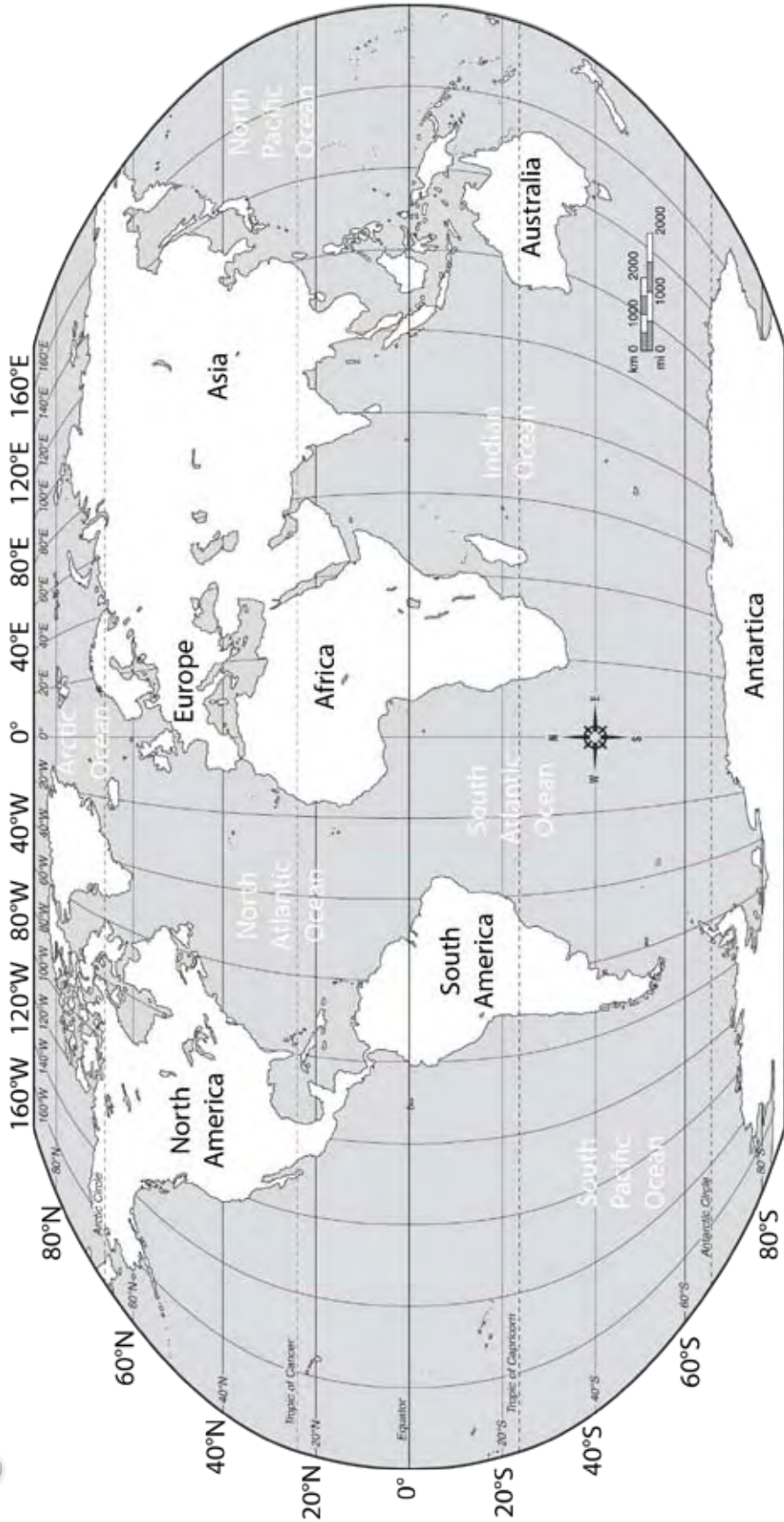
Web Resources:

Can Crittercam Help Protect Humpbacks?: <http://www.nationalgeographic.com/xpeditions/lessons/18/g68/cchumpback.html>

Gray Whale Observer Game: <http://www.pbs.org/kqed/oceanadventures/funandgames/games.html>



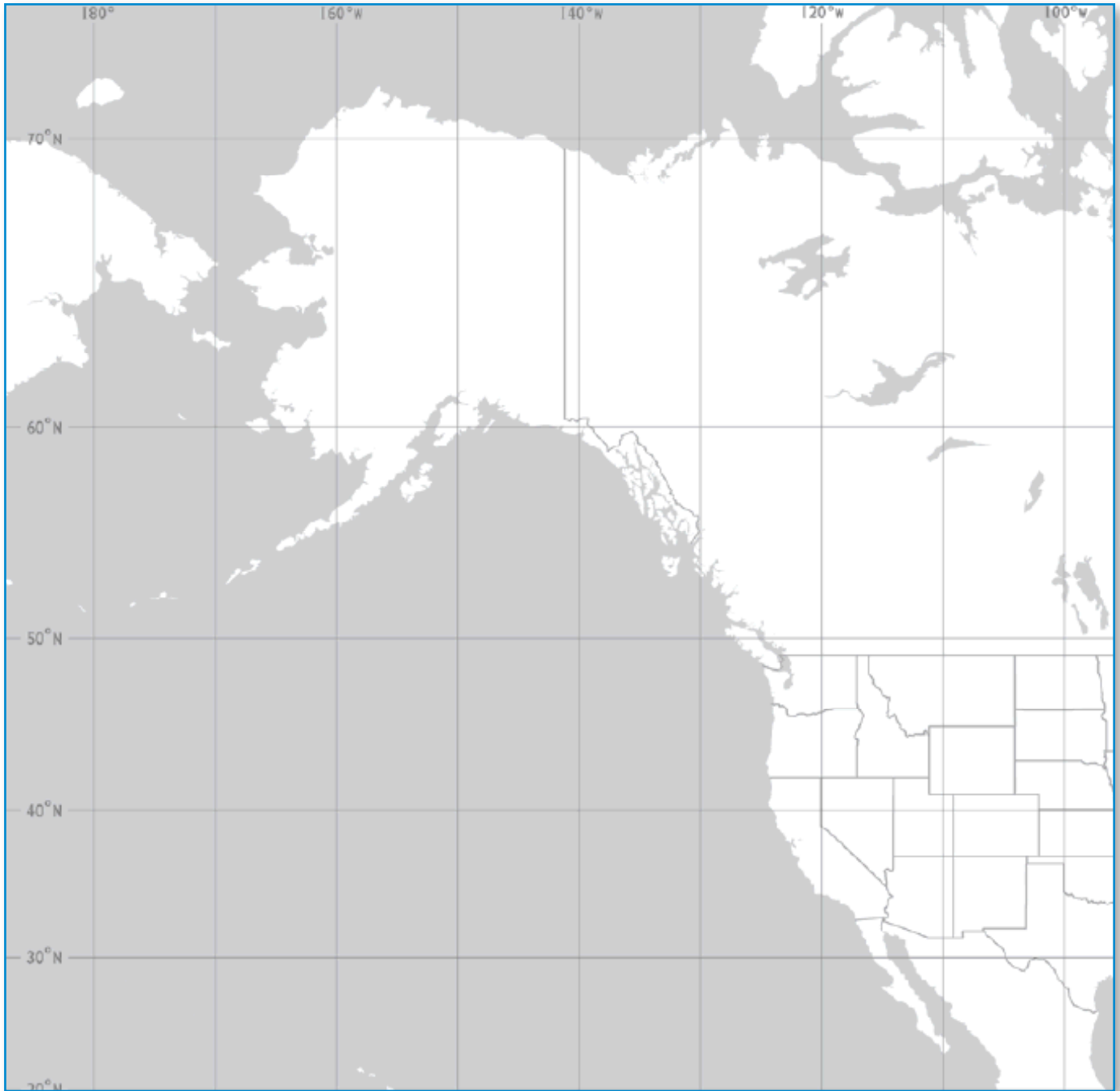
World Map





North American Pacific Coast

Directions: On this map write the names of ocean basins, seas, countries or continents, and states. Also indicate Hawaii, Baja California, Mexico, and Mexico.





Whale Wishers Viewing Questions

1. Why do gray whales migrate each year from Alaska to Baja California, Mexico?

2. What behaviors/habits made gray whales an “easy” catch for 19th- and 20th- century whalers?

3. Name and describe 2 specific behaviors that the whales do in San Ignacio Lagoon.

4. Do you think that humans interacting with whales in the Lagoon is a good thing? Why or why not?





Gray Whales Migration Data

Whale 1: Pregnant Female			Whale 2: Mature Male		
Date	Latitude (N)	Longitude (W)	Date	Latitude (N)	Longitude (W)
Oct. 20	60°N	170°W	Oct. 30	67.5°N	170°W
Oct. 30	55°N	165°W	Nov. 19	55°N	165°W
Nov. 19	57.5°N	150°W	Nov. 29	57.5°N	140°W
Nov. 29	50°N	130°W	Dec. 9	45°N	125°W
Dec. 19	35°N	122.5°W	Dec. 19	35°N	122.5°W
Jan. 8	25°N	112.5°W	Jan. 18	25°N	112.5°W
Feb. 17	25°N	112.5°W	Feb. 17	25°N	112.5°W
Mar. 10	25°N	112.5°W	Feb. 27	40°N	125°W
Mar. 26	40°N	125°W	Mar. 10	50°N	130°W
Apr. 15	55°N	135°W	Mar. 26	57.5°N	150°W
May 5	57.5°N	140°W	Apr. 15	55°N	165°W
May 30	55°N	170°W	May 5	67.5°N	170°W





Gray Whale Migration

Directions: Plot the migration of gray whales on this map.





Gray Whales Migration Data Questions

1. Why do gray whales migrate each year from Alaska to Baja California, Mexico?
2. Whale 1 reached Baja California, Mexico, earlier than Whale 2 and stayed there longer. What is a possible reason for this?
3. To which breeding lagoon in Baja California, Mexico, have these two whales migrated? To which sea in the Alaskan Arctic has each whale traveled in the summer?
4. What behaviors/habits made gray whales an “easy” catch for 19th- and 20th-century whalers?
5. Another whale that migrates in the eastern North Pacific Ocean is the humpback whale. Where do these populations of humpbacks spend the summer months? Where do they spend the winter months?
6. Gray whales and humpback whales travel through different coastal areas. Are any of these ecosystems protected? How could unprotected areas (those open to shipping and fishing) affect the migration and lives of the whales?





Gray Whales Migration Data Questions



1. Why do gray whales migrate each year from Alaska to Baja California, Mexico?

The Alaskan Arctic has large amounts of food (amphipods) for gray whales. Baja California has protected lagoons (calm waters, protected from killer whales), so it is a relatively safe place for the females to raise their calves.

2. Whale 1 reached Baja California, Mexico, earlier than Whale 2 and stayed there longer. What is a possible reason for this?

Whale 1 gave birth and stayed longer in the breeding lagoon to care for her calf.

3. To which breeding lagoon in Baja California, Mexico, have these two whales migrated? To which sea in the Alaskan Arctic has each whale traveled in the summer?

Both whales migrated to Magdalena Bay. Whale 1 migrated to feeding grounds in the Bering Sea; Whale 2 migrated to the Chukchi Sea.

4. What behaviors/habits made gray whales an “easy” catch for 19th- and 20th-century whalers?

Gray whales were easy to find because of their behavior of staying close to the Pacific coastline during migration. Also, their habit of gathering in lagoons to breed and give birth made it much easier for whalers to locate and catch large numbers of gray whales.

5. Another whale that migrates in the eastern North Pacific Ocean is the humpback whale. Where do these populations of humpbacks spend the summer months?

Where do they spend the winter months? Humpback whales in the eastern North Pacific Ocean spend the summer months feeding in the waters off the coast of Alaska, Canada and down to central California. Breeding populations of humpbacks in the eastern North Pacific migrate to the waters of Hawaii and the western coast of Mexico during the winter months (including the tip of Baja California, Mexico, and the Gulf of California).

6. Gray whales and humpback whales travel through different coastal areas. Are any of these ecosystems protected? How could unprotected areas (those open to shipping and fishing) affect the migration and lives of the whales?

See some of the listed Web sites for information on U.S. National Marine Sanctuaries and threats that are facing the whales.



SEASCOPE LESSON

key concept

Episodes 7, 15, 16, 28, 34, 35

An adaptation is a characteristic or behavior that allows an animal to survive in its environment. Animals look and behave the way they do for a reason: it helps them survive. Behavioral and physical features are adaptations to the environment that help an animal catch food, avoid predators and reproduce successfully.

Adaptations

episode
7

Different Strokes

Everyone in the ocean swims in a different way. Knowing why can tell you a lot about what they eat and what eats them.



episode
15

False Advertising

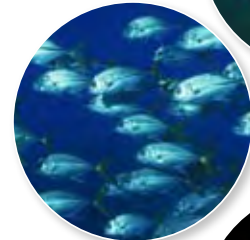
The ocean is full of phonies, liars, and con artists – but there's a good reason. Fish have to be tricky to both find a meal and to avoid being eaten, so many resort to false advertising and camouflage.



episode
16

Sixth Sense

Fish actually like to be in school. Resembling an expert drill team, they shoot through the water in very beautiful patterns. They even stay in formation at night! How is this possible? They have a sixth sense. Using something called a lateral line, they feel the vibrations that go through the water as their friends move, and they use that information to stay in formation.



episode
28

Form & Function

Fish come in all different shapes and sizes. That's because they all have different survival strategies. We'll find out how these different forms function to benefit their survival.



episode
34

All Dressed Up

Have you ever gotten all dressed up in some really weird things just for fun? And have you ever changed your outfit from one to another? Many fish appear to be doing the same thing, but in fact, there probably is a reason for them to be all dressed up.



episode
35

Growing Up

Some fish look just like their parents, while others go through lots of changes before they're grown up. Many change color, some change shape, and a few even change sex!





Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Diversity and Adaptations of Organisms* by showing that coral reef organisms acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include structures, behaviors, or physiology that enhances survival and reproductive success in a particular environment.

Background Information:

In order to survive and thrive, animal species (along with plants and other organisms) have developed a host of amazing characteristics that help them find food, protect themselves, communicate, reproduce and move about in their environment. Some of these are physical characteristics — like camouflage and body shapes. Others are behavioral. These include communicating with one another and advertising as a means of finding food. Adaptations can be physiological as well. For example, many species of fish have the capability of changing gender.

An adaptation doesn't happen overnight; it is a slow, gradual change that can take hundreds of thousands of years to evolve. If an animal has a particular physical characteristic or behavior that enables it to survive when others in its species are less likely to, that trait gets passed on to its offspring and to future generations.

Understanding adaptation can be a particularly troublesome concept. Many students think adaptation means if the environment changes, individual organisms deliberately adapt.

Be sure to emphasize that, in reality, variation among individuals occurs naturally and randomly. The individuals best suited for their environment are more likely to survive, reproduce, and pass on their genes, and over generations this leads to an adaptation.





Before viewing the episodes:

- 1 Find out what your students know about the concept of animal adaptation. Ask students to toss out examples and keep a running list. Always ask, *How does this feature benefit the species (that is, help it survive or reproduce)?* You may need to grease the wheels with an example (e.g., a hummingbird's long, thin beak can reach into flowers to get nectar).
- 2 Students may mainly suggest physical adaptations. Explain that adaptations can be a behavior that helps a species survive or reproduce (e.g., many animals "dance" to prepare for mating, and squirrels build nests high off the ground). It can also be a physiological characteristic such as the shape of a beak and the ability to change gender.

While viewing the episodes:

- 1 Divide students into 6 groups. Each group will be responsible for viewing and collecting adaptation information about one of the following SeaScope Episodes: **7, 15, 16, 28, 34, and 35.**
- 2 Discuss with students the terms listed on the top of the **Gathering Grid** to make sure everyone is in agreement as to the word meanings.
- 3 Direct students to fill out the **Gathering Grid** while viewing the film. (Since the films are quick, the teacher may want to provide examples from the attached answer sheets, fill-in parts of the charts ahead of time and /or allow teams to watch the films more than once.)
- 4 Students should turn in one chart per group for the teacher to check over prior to going on to the next step.





After viewing the episodes:

1 Post 5 sheets of chart paper around the room. Each should be labeled with one of these headings: Reproduction, Communication, Protection, Feeding, and Locomotion.

2 Ask students to select and post organisms from their **Gathering Grids** whose adaptations fit these categories. (Not all movies cover all categories, so don't expect an entry on each page from all groups.)

3 Students will create a "Little Book" about adaptations that will contain at least 6 pages. (It should include a cover and 5 content pages—one for each of the categories listed in Step 1.)

4 Discuss as a whole class the entries made on each sheet, asking that each group explain the adaptation, description and purpose of their organisms adaptations. Students will take notes in the "Little Books" they made, listing at least 3 examples for each category.

5 Using the "Little Books" have students write "A Day in the Life" story for selected reef dwellers. Have them describe each animal's appearance, its home, its meals, and any escapes from predators or other reef adventures using adaptations they have learned about in this activity.

Extensions:

(from www.oceanfutures.org/exploration/equipment and www.pbs.org/kqed/oceanadventures/educators/oceancareers/)

1. Humans are adapted for life on land, not in the water. What equipment do scuba divers use to adapt to the underwater environment? How does this equipment work? Compare the adaptations of a scuba diver with the adaptations of a fish and/or dolphin.

Resources:

Seabird Survival Adaptation Card Game: www.pbs.org/kqed/oceanadventures/educators/pdf/OceanAdv-Seabird.pdf

EcoKids Adaptations Game: http://www.ecokids.ca/pub/eco_info/topics/climate/adaptations/index.cfm



Animal Adaptations Gathering Grid



Episode Title: 7: Different Strokes

Animal	Adaption	Description	Purpose
Flatworm	Whole body ripples	Uses whole boneless body	Locomotion in open water
Eel	Fin length of body moves like a wave	Wiggles into nooks and crannies	Locomotion; Maneuverability advantages
Sea Snake	Oar-like tailfin	Uses it as a paddle for swimming	Locomotion in open water
Jacks	Rigid body	Strong tail movements	Locomotion and Speed
Flounder	Flat	Lies on its side	Hide from predators
Remora	Can attach to sharks	Suction-like pad on dorsal surface	Locomotion and feeding
Shark	"S" shaped movement	Tail pushes against the water	Speed and locomotion
Diver	Fins	Moves legs up and down	Speed and locomotion
Puffer	Pectoral fins move back and forth	Move in little waves	Locomotion; Maneuverability in tight spaces
Seahorse	Fast moving pectoral fins	Hovers like a helicopter	Ability to stay hovering in one place
Parrotfish	Oar-like pectoral fins	Rows like a boatman	Locomotion and maneuverability
Ray	Big pectoral fins	Soars across the reef	Locomotion over great distances





Animal Adaptations Gathering Grid



Episode Title: 15: False Advertising

Animal	Adaption	Description	Purpose
Stonefish	Camouflage	Looks like a rock	Catch a meal
Crocodile Fish	Camouflage	Blends in with Coral	Catch a meal
Lionfish	Camouflage	Looks like coral	Catch a meal
Butterflyfish	False Eyespot	Confuse predator when attacking	Protection from Predators
Butterflyfish	Bar through Eye	Confuse Predators	Protection from Predators
Goatfish	Color Change	Blends in with surroundings	Avoid predators
Flounder	Lies on side, both eyes on top	Blends in with surroundings	Avoid predators





Animal Adaptations Gathering Grid



Episode Title: 16: Sixth Sense

Animal	Adaption	Description	Purpose
Grouper	Nostril	Hole in front of eye for sense of smell	Find prey
Goatfish	Whiskers (barbels)	Touches/tastes food	Find prey and shelter
Sergeant Major Fish	Hearing or vocalization	Detect sounds or make sounds	Avoid danger or give warning
Bonito and others	Lateral Line	Canal with tiny hairs which are sensitive to	Detect predators and prey





Animal Adaptations Gathering Grid



Episode Title: 28: Form & Function

Animal	Adaption	Description	Purpose
Grouper	Big head with a big, wide mouth	Sucks in big gulp of water with prey	Feeding
Sweetlips	Sensitive lips	Create seal on rocks to suck out prey	Feeding
Goatfish	Finds shrimp with barbels	Digs and tastes food before eating	Feeding
Queen Trigger	Can voluntarily raise big pointy spine on back	Makes it too big and too painful to swallow	Protection from predators
Trumpetfish	Shape imitates sponges and soft corals	Holds perfectly still	Grabs prey when they come close
Yellow Trumpet	Changes color	Blends into surroundings	Feeding
Boxfish	Pointed snout	Blows away sand to expose its intended meal	Feeding
Jack	Body built for speed	Bursts of speed help catch a meal and avoid predators	Better predator and escape from predators
Barracuda	Long and sleek like a torpedo and sharp teeth	Shoot through water and catch prey with teeth	Speed to escape and catch prey
Barracuda School	Silver color	In a school, color makes them hard to single out and catch	Protection from predators
Flatfish	Mouth at tip of head	Can nip creatures shooting up from the sand	Feeding
Ray	Wing-like fins and strong jaws	Uncovers buried shellfish and crushes in jaws	Finding prey and eating
Lionfish	Venomous striped fins	Stripes help blend and spines ward off enemies	Protection from predators
Bumphead Parrotfish (and others)	Various unusual characteristics	Created by evolution	Unknown





Animal Adaptations Gathering Grid



Episode Title: 34: All Dressed Up

Animal	Adaption	Description	Purpose
Camouflaged Fish	Camouflage	Blends into the background	Protection from predators by hiding
Lionfish	Colorful bright bars	Warning	Protection
Grey Angelfish	Characteristic colors	Advertises to other Angelfish	Communication with species
Butterfly Fish	Color and color patterns	Recognition and Identification	Maintain communication between pairs
Striped Fish	Stripes	Confuses predators	Protection from predators
Rock Beauty	Bright, obvious colors	Flashy	Warning to protect territory
Barracuda	Changes stripe color pattern	Changes from drab to bright stripes	Possible warning Communication
Soldier Fish	Bright red coloration	Appears dark and drab in deeper water	Protection from predators
Batfish	Red lips	Unknown	May scare off predators
Colorful Fish	Unknown	Fun to view	Mating, warning, camouflage, etc..





Animal Adaptations Gathering Grid



Episode Title: 35: Growing Up

Animal	Adaption	Description	Purpose
Juvenile Jackknife Fish	Large fins, small body	Grows into fins as an adult	Makes little fish look like a big fish
Cleaner Wrasse	Bright color, bouncing behavior	Attracting patients since so small may not be noticed	Advertising to get food
Mother salp and babies	Babies attached to mother then detach when larger	Break away and carried by current to take up life on their own	Dispersal of species
Baby Garibaldi	Orange color with spots	Avoid attacks by adults since don't look like adults	Less harassment from adults
Fairy basslets	Sex change	If male dies, 1 female changes to male	Survival of species
Sheephead	Color change, sex change	As fish matures changes sex and color	Identifies life stage to possible mates



SEASCOPE
LESSON

key concept



Episode 27

Students will learn that there are several types of symbiotic relationships between organisms. They will first focus on relationships between organisms they know, and then through watching this episode, they will identify symbiotic relationships between organisms living in a coral reef ecosystem.

episode
27

Dive Buddies

Dive Buddies

Just like people, sea creatures have buddies that they like to hang out with. Sometimes the relationship is mutually beneficial to both as in the classic relationship between the clownfish and the anemone. But often one of the partners is reaping all of the rewards as in the case of the shark and the hitchhiking remora.



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This episode addresses *Life Science Content Standard C: Regulation and Behavior* by describing behaviors of various marine animals and how they can help (mutual symbiosis), or have no effect (commensal symbiosis) on other organisms within the coral reef ecosystem. It also addresses *Populations and Ecosystems* by showing how various individuals in a community affect other organisms within a coral reef ecosystem.

Background Information:

Episode 27 focuses on two symbiotic relationships within the coral reef ecosystem: mutualism and commensalism. You may also want to teach your students about parasitism, the third type of symbiosis, using **Episode 4** because it shows and describes how cleaning fish act like “doctors” on the reef by removing parasites from other fish. In addition, **Episode 5** discusses the mutually symbiotic relationship between clownfish and anemones. Both **Episode 4** and **Episode 5** would complement **Episode 27**, for a more complete study of symbiosis on coral reefs.

Animals that live together within the coral reef ecosystem have close relationships that exist beyond direct feeding relationships. These relationships are categorized based on how the organisms



continued

are affected by the interaction. For example, if both organisms benefit from the relationship, it would be called mutual symbiosis. If one benefits but the other is unharmed, it is considered a commensal symbiosis. If one benefits at the expense of the other organism, it is considered a parasitic relationship, such as parasitic bacteria living on a fish. This video describes and shows examples of two of these types of symbioses, mutual and commensal relationships.

Before viewing the episode:

- 1 Teacher will review, with students, symbiotic relationships between living organisms using the chart, **Symbiotic Relationships Between Living Things**. If necessary, teachers can use the definitions for “symbiotic relationships” and “host” located at the bottom of the transparency. This will begin the students’ recognition of the variety of ways that organisms interact.
- 2 Using a similar chart, have students think of relationships between living things within the ecosystems in which they live. Have them analyze the relationships by identifying the organisms and how they are affected. The teacher could use the attached chart as a transparency, **How Do Living Things Relate in Your Neighborhood?** for this data.
- 3 Through this process, the teacher can introduce the scientific vocabulary that describes these relationships. Based on how the two organisms are affected, have the students identify which relationships are **mutual** (both organisms benefit), **commensal** (one is benefited while the other is neither helped nor harmed), or **parasitic** (one is benefited while the other is harmed).





While viewing the episode:

- 1 Introduce **Episode 27** by explaining that this clip will show some of the mutual and commensal relationships between animals found in a coral reef ecosystem.
- 2 Students will use a graphic organizer (see attached: **How Do Living Things Relate on a Coral Reef**) to assist them in taking notes, while watching the movie. First they will list whether or not an organism is helped, harmed, or neither helped nor harmed and then analyze the relationship to determine the type of symbiotic relationship. See Relationships of Organisms Living in a Coral Reef Ecosystem where the organisms described in the episode are already entered into the charts.

After viewing the episode:

As a class, or in small groups, discuss:

- 1 the relationships recorded on the **How Do Living Things Relate on a Coral Reef**. Fill in all of the blanks and make comments where appropriate.
- 2 the episode using the **Discussion Questions For Dive Buddies** (see attached) and fill in the answers.





Extensions:

1. Reproduce decks of cards with card pairs showing symbiotic relationships. Distribute a card to each student and have all students find their “buddy.” Then have the pairs of buddies do research to find out why they are buddies, answering the following questions: Why do we live together? What advantages and disadvantages do we provide one another? What would happen if one of us weren’t here? Pairs of buddies could then give short reports to the class, telling about their relationship. Afterwards, this pack of cards can be used by students in a card game similar to *Go Fish!* where seven cards are handed out to the players and on each turn each player requests a card from another player to try to make a pair. The pairs would be symbiotic relationships between two animals. (Adapted from *Project Wild Good Buddy* activity, 1992)
2. Using what you have learned about mutualism and commensalism with animals that live in and around coral reefs, describe how you interact with your family and friends. What can we learn from these animals that can help us become more aware of the relationships we have with other people? Based on what you have discovered about your own relationships, might you choose to change how you interact with others at home, school, or with your friends? Explain.
3. Using either relationships from the *SeaScope* episodes or ones found in other resources, have students play the following game of **Coral Reef Charades**. Teachers can create their own cards (see Resources below), or have students create them based on their research.
 - a. Divide the class into 2 teams—Team A and Team B—(with even numbers on each team). Have students within the teams pair up as “Performance Partners.”
 - b. Use **Charade Cards** to direct the performance of each pair. Have a Performance Partner Pair from “Team A” choose a Card and present their paired charade to their team. If you need to, the teacher can give a time limit. If the audience from Team A correctly guesses the relationship type—





Extensions continued:

partnership (mutual and commensal), **predation**, or **competition** (for space, food, shelter, or mates)—they receive one point; if they also guess the organisms, they receive two points. Do the same with a Performance Partner Pair from Team B. The team that ends the game with the most points, wins.







Resources:

1. Predator/Prey Relationships:
<http://www.pbs.org/wgbh/evolution/survival/coral/predators.html>
2. Competitor Relationships:
<http://www.pbs.org/wgbh/evolution/survival/coral/competitors.html>
3. Partnership Relationships:
<http://www.pbs.org/wgbh/evolution/survival/coral/partners.html>





Symbiotic Relationships* Between Living Things

Host**	Other Organism	Description of the Symbiotic Relationship*
 Benefits	 Benefits	Mutual The host and the other organism both benefit. Example: anemone and clownfish
 Neither is Harmed Nor Benefited	 Benefits	Commensal The host neither benefits nor is harmed, while the other organism benefits. Example: remora on a shark
 Harmed	 Benefits	Parasitic The host is harmed, while the other organism benefits. Example: flea on a dog

***Symbiotic Relationship:** organisms (especially of different species) living together but not necessarily in a relationship beneficial to each

****Host:** The animal or plant on which or in which another organism lives

Definitions from <http://en.wikipedia.org/wiki/Symbiotic>.



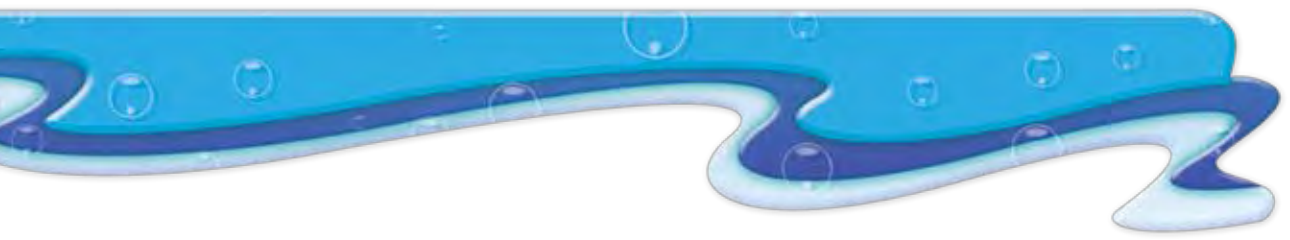


How Do Living Things Relate Around My Neighborhood?

As a class, think about some of the relationships you have seen between living things in your neighborhood. Write in the name of the host, the other organism, if they are helped (☺), unharmed (☹), or harmed (☹). Then write in the type of symbiotic relationship they share. Do not include predator/prey relationships.

Host**	Other Organism	Type of Symbiotic Relationship	Comments
Cottonwood Tree ☹	Robin ☺	Commensal	Since the bird is helped, but the tree is unharmed, this would be considered a commensal relationship.
Sycamore Tree ☹	Mistletoe ☺	Parasitic	Since the mistletoe is a plant that takes nutrients from the sycamore tree, it is benefiting at the expense of the tree and is therefore considered a parasite.





continued

Host**	Other Organism	Type of Symbiotic Relationship	Comments





How Do Living Things Relate on a Coral Reef?

As you watch Episode 27, write down how each of the following organisms are affected within the relationships: harmed (☹), helped (😊), unharmed (☺). Then, after the film, write in the organisms' type of relationship. Comment as you choose.

Host**	Other Organism	Type of Symbiotic Relationship	Comments
Shark ☹	Remora 😊	Commensal	Remora gets a free ride. It gets free food when the shark eats. The shark is not harmed or helped.
Anemone 😊	Clownfish 😊	Mutual	
Shrimp	Goby		
Diver (his finger)	Cleaner Shrimp		
Anemone	Purple Cleaner Shrimp		





continued

Host**	Other Organism	Type of Symbiotic Relationship	Comments
Ray	Jack		
Triggerfish	Jack		
Jellyfish	Young Jack		
Shark	Jack		
Shark, Whale Shark, Diver, Turtle	Remora		
Grouper	Trumpetfish		





How Do Living Things Relate on a Coral Reef?



As you watch Episode 27, write down how each of the following organisms are affected within the relationships: harmed (☹), helped (😊), unharmed (☺). Then, after the film, write in the organisms' type of relationship. Comment as you choose.











Host**	Other Organism	Type of Symbiotic Relationship	Comments
Shark ☹	Remora 😊	Commensal	Remora gets a free ride. It gets free food when the shark eats. The shark is not harmed or helped.
Anemone 😊	Clownfish 😊	Mutual	Clownfish aggressively protect their anemone home from predators. Female clownfish lay their eggs under an individual anemone and then fiercely protect their developing young.*
Shrimp ☹	Goby 😊	Mutual	A shrimp digs out holes in the sand where both it and the Goby will live. The Goby keeps a lookout for predators.
Diver (his finger) ☹	Cleaner Shrimp 😊	Mutual	The diver is receiving a nice manicure from the purple cleaner shrimp who feeds on dead skin.
Anemone ☹	Purple Cleaner Shrimp 😊	Commensal	Purple cleaner shrimp rely on the anemone for protection. They're immune from the venom of the anemone's stinging tentacles. The anemone protects the shrimp but gets nothing in return.

*The clownfish bodies are covered by mucus that protects them from the anemone's lethal stinging capsules. The clownfish is protected from predators by the anemone nematocysts (stinging capsules).



continued



Host**	Other Organism	Type of Symbiotic Relationship	Comments
Ray 	Jack 	Commensal	Jacks like to stay with the rays. As the rays dig up the sediments in search of shrimp and shellfish, they disturb fish, and the jacks are right there to score an easy meal. This does not seem to bother the rays.
Triggerfish 	Jack 	Commensal	The jack hides behind the queen triggerfish as she swims along. The jack hopes a fish only see the harmless trigger and not notice her shadow the jack. When the strategy works it's another easy meal for the jack.
Jellyfish 	Young Jack 	Commensal	Young jacks learn early in life to hide inside the jellyfish for protection. The jellyfish is neither harmed nor benefited from this interaction.
Shark 	Jack 	Commensal	Older jacks rub themselves on the sharks' scratchy skin. Nobody knows why they do it, but as long as the sharks don't mind, the jacks will get away with it.
Shark, Whale Shark, Diver, Turtle 	Remora 	Commensal	The remora takes free rides on all of these organisms. They are known as "champion hitchhikers."
Grouper	Trumpetfish	Commensal	The trumpet fish is using the grouper as a "hunting blind." The trumpet fish is always ready to zoom out and snare a snack.





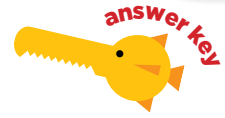
Discussion Questions for Dive Buddies

1. Which animals were benefited, harmed, or unharmed, and therefore which relationships were examples of mutualism, parasitism, or commensalism? Use the charts you filled out during the episode to verbally discuss these relationships.
2. How is the relationship between the shrimp and goby similar to the relationship between the anemone and the clownfish? Explain.
3. How is the relationship between the shrimp and anemone similar to the relationship between the remora and the whale shark? Explain.
4. Describe one of your own friendships that is like mutual symbiosis, in that both of you benefit from the relationship.
5. Describe the relationship between you and one of your pets. Would you define your relationship as mutualistic or commensal? Explain. (If you do not have a pet, choose the relationship between a friend or family member regarding their pet.)
6. Describe how the relationship between the remora and the turtle is unlike the relationship between the clownfish and the anemone.
7. What are some of the problems associated with collectors taking clownfish to sell to pet stores? How is the anemone harmed without the protection of the clownfish?





Discussion Questions for Dive Buddies



1. Which animals were benefited, harmed, or unharmed, and therefore which relationships were examples of mutualism, parasitism, or commensalism? Use the charts you filled out during the episode to verbally discuss these relationships.

(See above charts)

2. How is the relationship between the shrimp and goby similar to the relationship between the anemone and the clownfish? Explain.

Both of these symbiotic relationships are mutually beneficial to the two organisms in the relationship. With the shrimp and goby, the shrimp makes the "home" while the goby acts as a sentinel to warn when predators approach. With the anemone, it provides the home and protection for the clownfish (with its stinging capsules) while the clownfish also protects the anemone from predators.

3. How is the relationship between the shrimp and anemone similar to the relationship between the remora and the whale shark? Explain.

Both of these relationships are commensal where one organism in the pair benefits while the other is neither helped nor harmed. The shrimp gets protection from the anemone's stinging capsules (since it is immune to the stings). The anemone doesn't receive any benefit from the shrimp, neither is it harmed. With the remora and whale shark, the remora gets a free ride and feeds on the plankton blooms that the whale shark finds to eat. While the whale shark is neither harmed nor benefited by the remora sticking onto it as it swims through the water.

4. Describe one of your own friendships that is like mutual symbiosis, in that both of you benefit from the relationship.

This answer will of course vary—however, in general a healthy friendship involves both friends finding the friendship to be meaningful, interesting, and one that include both giving and receiving. It is a "win-win" relationship where both friends benefit from the relationship and are better for it.

5. Describe the relationship between you and one of your pets. Would you define your relationship as mutualistic or commensal? Explain. (If you do not have a pet, choose the relationship between a friend or family member regarding their pet.)

Most students will define their relationship with their pet as either commensal or mutualistic. Accept all reasonable answers. If commensal, they need to explain how one of the partners (either themselves or their pet) benefits while the other is unharmed. With mutualistic, they need to explain how both benefit.

6. Describe how the relationship between the remora and the turtle is unlike the relationship between the clownfish and the anemone.

The relationship between the remora and the turtle is commensal. The remora benefits from being able to stick to the turtle with its oval-shaped suction disc on its head. The remora benefits by protection from predators travel over great distances, and possibly being able to share in the meal of its host. This relationship is different than that the clownfish and the anemone because with these two organisms, they both benefit. The clownfish is able to hide in the sea anemone for protection. It also lays its eggs on rocks underneath the anemone and therefore receives protection for its young hatchlings. The anemone benefits from the aggressive protection of the clownfish. This type of relationship, where both organisms benefit, is called mutualism.

7. What are some of the problems associated with collectors taking clownfish to sell to pet stores? How is the anemone harmed without the protection of the clownfish?

According to www.pbs.org/wgbh/evolution/survival/coral/partners.html#clownfish and www.pbs.org/wgbh/evolution/survival/coral/predators.html#butterflyfish clownfish protect their sea anemone partners from predators such as the anemone-eating Saddled Butterfly fish. In addition, they have also been seen dragging food to their anemone host. If pet stores remove clownfish, they take away an important partner of the anemone and expose it to greater danger, since it is left without added protection from the clownfish. This would eventually result in more anemones being eaten by predators. With less anemones reproducing on the reef, there would be a reduction in the population of anemones. With fewer anemones, there would less nesting sanctuaries for clownfish and less places for clownfish to live and protect themselves from their predators, so eventually this could result in a reduction of clownfish found on the reef.





Examples of Charade Cards

<p>Damselfish and Sea Urchin <i>competing</i> for the same patch of algae.</p>	<p>Cleaner wrasse bob up and down to advertise that their “doctor’s office” is open for business.</p>
<p>Clownfish <i>partners</i> with a Sea Anemone for protection of eggs.</p>	



SEASCOPE LESSON



Episodes 8, 11, 21, 29, 39, 46, 51

Scientific classification groups all plants and animals on the basis of certain characteristics they have in common.

episode 8

episode 11

episode 21

episode 29

episode 39

episode 46

episode 51

Diversity of Marine Life

Jelly Fish Lake

Some jellyfish sting, but in Palau's Jellyfish Lake, you can dive in a whole sea of jellies without getting hurt - if you know which ones you're dealing with.



Dinosaurs of the Deep

The nautilus was around before the dinosaurs, and it's still here. Like a scuba diver, it can handle different depths and pressures. Close cousins of the nautilus, the cuttlefish are also living fossils.



Jointed Footed Things

Crabs walk sideways, lobsters walk straight, and shrimp do it all. What do they have in common? They are the joint-footed creatures. They have exoskeletons, legs, and pinchers, and they are destined to walk in a world where most everyone else can swim.



Spiny Things

If you lived on the bottom of the sea and wanted to protect yourself but you couldn't walk any faster than a crawl and couldn't swim at all, what would you do? You could use spines to protect yourself like the echinoderms! In fact, echinoderm means spiny (echino) skin (derm).



Eels

They look like they belong in a horror show, but eels are just fish whose slinky shape helps them survive in rocky and sandy habitats. Seeing them hunt is pretty scary, but one diver finds out that they can be as cuddly as kittens - when they've had enough to eat.



Warm Blood in the Sea

Millions of years ago, the ancestors of marine mammal walked on land. Today, whales, dolphins and pinnipeds rule the sea. From blubber to blowholes, a series of ingenious adaptations help these warm-blooded creatures flourish in a cold-water world.



No Bones

Most people are afraid of sharks, but only about a dozen of the world's 400 species of sharks and 500 species rays are dangerous. All of them are fascinating, having risen to the top of the marine food chain without having a single bone in their bodies.





Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

These episodes address *Content Standard C—Diversity and Adaptations* by exploring the diversity of species and their many unique characteristics.

Background Information:

Most people can tell if an object is living or not by looking at whether it moves, grows or reproduces. Biologists have decided that an object is living if it carries out the following 8 functions:

- uses energy
- reacts to stimulus
- adapts
- has cells
- grows
- moves
- reproduces
- has levels of cellular organization

Information on each invertebrate and vertebrate phyla can be accessed at the *Sea and Sky* website: <http://www.seasky.org/reeflife/sea2.html>

Biologists sort organisms into groups to make sense of the tremendous variety of life that is present on Earth. The groups are organized in a hierarchical system that shows how the organisms are related to each other from simple to complex.

There are more than 30 phyla of invertebrate organisms (organisms that lack a spine). They encompass a wide variety of body form and size. Included among them are:

- sponges
- worms
- sea stars
- jellyfish
- mollusks (snails, shellfish, slugs)
- arthropods (insects, spiders, millipedes, crustaceans)

While there are many phyla of invertebrates, all vertebrates (organisms with a spine) belong to Phylum Chordata. This phylum is broken into just 5 classes based on features of their body structure, mode of reproduction and internal physiology.





Before viewing the episodes:

Stations Lab Activity

Review the characteristics of all living things by setting up eight stations with the following items (vary as needed):

Teacher Demo Station - Organization

- dictionary
- ruler
- day planner
- calendar page
- thermometer

Station 1 - Use Energy

- a dry cell
- animal food
- solar calculator

Station 2 - Cells

- a whole egg
- comic strip
- microscope with slide of cells
- piece of honeycomb

Station 3 - Reproduction

- seeds
- bird nest
- photo and a photocopy of that photo

Station 4 - Reaction to Stimulus

- biodegradable packing pellets made of cornstarch with a beaker of water
- pH paper and a weak acid or base
- mood ring
- "fortune telling cellophane fish" or memory foam

Station 5 - Growth

- balloons of three different sizes
- snake skin
- crystals

Station 6 - Movement

- wind-up toy
- pinwheel
- slinky
- directional compass

Station 7 - Adaptation

- different types of marking pens (permanent, overhead, non-toxic, fine point)
- different types of eating utensils
- different types of glue (glue stick, Elmer's glue, rubber cement)
- different kinds of tools (Phillips-head screwdriver, flat-head screwdriver, pliers, wrench)





continued

- ▶ **1** Divide students into seven different groups, one per station.

- ▶ **2** Students will identify and write down on the **Stations Lab** worksheet what all the items at that station have in common *without* being told that they are characteristics of living things (see attachment). Teacher demonstrates using materials from Teacher Demo Station. Teacher may coach students in the right direction, but not give them answers.

- ▶ **3** Student groups move through all stations. Give students about two to three minutes per station.

- ▶ **4** When the rotation is complete, review their answers in whole class discussion. In the discussion, the teacher reveals the correct answers and then asks the students to write the summary answer to, "What do all of the stations have in common?" (*They all represent characteristics of all living things.*)

- ▶ **5** After discussing what all living things have in common, ask "How are they different?" Divide up the class into seven groups, one per *SeaScope* episode. The phyla represented in these episodes are:
 - Crustaceans
 - Echinoderms
 - Mollusks
 - Cnidaria (coral, anemones, jellyfish)
 - Chordates (Classes: Cartilaginous Fish (sharks and rays), Bony Fish and Mammals)

- ▶ **6** Students could do research/readings on the phyla or use the film as an introduction to their phyla research.





Stations Lab

Directions: You will be visiting seven different stations. At each station, list the items and then assign one or two words that identify what all of the objects have in common.

For example, at the station where there is a dictionary, ruler, day planner, calendar page, and a thermometer, discuss in your group what the characteristic is that all items have in common. _____

Station	Items	Descriptive Word

Conclusion: What do all of these stations have in common?





Stations Lab



Directions: You will be visiting seven different stations. At each station, list the items and then assign one or two words that identify what all of the objects have in common.

For example, at the station where there is a dictionary, ruler, day planner, calendar page, and a thermometer, discuss in your group what the characteristic is that all items have in common. Organization

Station	Items	Descriptive Word
1	a dry cell, animal food, solar calculator	Use Energy
2	a whole egg, comic strip, microscope with slide of cells, piece of honeycomb	Cells
3	seeds, bird nest, photo and a photocopy of that photo	Reproduction
4	dissolvable packing peanuts (made of corn starch) with a beaker of water, pH paper and a weak acid or base, mood ring, "fortune telling cellophane fish," or memory foam	Reaction to Stimulus
5	balloons of three different sizes, snake skin, crystals	Growth
6	wind-up toy, pinwheel, slinky, directional compass	Movement
7	different types of marking pens (permanent, overhead, non-toxic, fine point), different types of eating utensils, different types of glue (glue stick, Elmer's glue, rubber cement), different kinds of tools (phillips head screwdriver, flat-head screwdriver, pliers, wrench)	Adaptation

Conclusion: What do all of these stations have in common?

All are characteristics of living things.



While viewing the episodes:

1 Use attached **Lotus Diagram**. Have students take notes on the identifying characteristics for their phyla listed on the diagram.

After viewing the episodes:

1 Students do additional research to complete their diagram. Students will turn in one diagram per group for the teacher to check. Teacher will photocopy diagrams so that each group has a packet containing all phyla.

2 Each student group will make a booklet (ie. entitled, "Journal of Marine Phyla"). Each person in the group will be responsible for creating one to two pages for the booklet using the notes from the diagram packet. (See samples of student work at the end of this document.)

3 Teachers and students may choose how to organize the content within the booklet. For instance students could describe:

- a. what they saw on an expedition to various coral reef sites like a scientist would in a field journal.
- b. in postcards or letters home to family/friends what they learned and saw while away on vacation.
- c. what they saw and learned on a field trip to an aquarium.
- d. what a day in the life of a critter like "Nemo" might be like.

See attached examples.

Extensions:

1. "Exploring the Reef with Jean-Michel, Nemo and Dori": write a short essay on some of the threats facing coral reefs and how humans are apart of the solution in protecting the ocean's coral reefs. <http://www.oceanfutures.org/learning/kids-cove/jean-michel-finds-nemo>





Lotus Diagram

Essential Characteristics of the Phylum _____

Reproduction	Critter Picture	Growth
Fun Fact	Phylum Name	Fun Fact
Movement	Body Covering	Symmetry



SEASCOPE LESSON

7/15/07

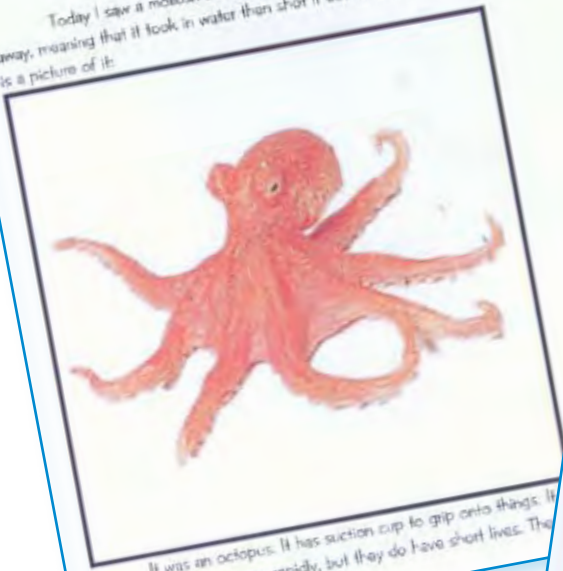
Today I found a marine animal that looked like this:



It has an exoskeleton. It is symmetrical and it has jointed legs to move around. They reproduce sexually and they grow by having their shell crack and then there would be a new one under it. I'm guessing that this belongs to the phylum Arthropods.

7/15/07

Today I saw a mollusk being chased by a cat shark. The mollusk used jet propulsion to get away, meaning that it took in water then shot it out to get around. I was not symmetrical at all. Here is a picture of it:



It was an octopus. It has suction cup to grip onto things. It is a Cephalopoda. They grow rapidly, but they do have short lives. They die when they are old.

7/17/07

Today I saw a shark. That's right, a real live shark. Sharks have skin, but not covered in scales. From above, they are symmetrical. They use fins and a tail to get around. They do not have bones. They continuously grow until mature. They belong to the phylum Chordata. They reproduce by having the female lay some eggs on the ground and having the male fertilize the eggs by squirting sperm on them. The ray is the cousin of the shark and there are many species of shark. There are over 350! Here's a picture of one:



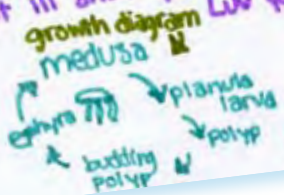
7/18/07

Today I swam around a bunch of jellyfish. I didn't get stung, though. They belong to the Cnidaria phylum with coral, anemones, etc. They go through these stages in their life: larva, polyps, budding polyp, ephyra, and medusa. They can still sting when they are dead. One of my research clients learned that from experience. They are radially symmetrical. They move by jet propulsion, which you know because I explained it earlier. They can swim or float freely and use a nerve net to control their movement. They are coated with transparent gelatin-like stuff, shaped like a cup or a ball. Their mouth functions as both a mouth and an anus. They reproduce sexually and asexually. When the sperm develops, it is released into the stomach and out through the mouth. The sperm



Dear Family

We made a trip down onto the shore. My friend was about to pick up a jelly fish and then.... the jelly fish was dead so she picked it up and it stung her hand. Owww! They have no bones so it looked like a circle, very symmetrical. They just float in the water (i wish i could do that) and their see through. I got to go learn more but ill show you the diagram of growth. Luv you, bye.



Luv,
Erin

DAY 1

Sea Teacher

When I went on my field trip to Florida and I went swimming in the Ocean and saw some pretty cool things. Like squid, octopus, nautilus, and cuttlefish which are in the phylum of mollusca. Since I learned about them I want to see them live and rapid growth. They don't die. They also have short lives and rapid growth. They don't die. They also have short lives and rapid growth. They don't die. They also have short lives and rapid growth.

Their movement is by using their water vascular system. They can change shape and color. None of them are symmetrical. Another Phylum is Echinodermata which are sea stars, sea urchins, sand dollars, and sea cucumbers.

Their growth is continuously as specimen grows, older and stops when they are dead. Their body structure is in a circle.

By not knowing sea creatures I had to use the Echinodermata. Their reproduction is that:

- female lays egg
- male spouts sperm from their tails and fish
- they fertilize them
- they grow up into a larva and then grow into an adult.

I also found out that in what I learned.

Field Journal

Day 1

My journey begins in Australia. It has many reefs that contain the animals in Phylum Echinodermata. What are the animals, you ask? They are star fish, sea urchins, sand dollars and sea cucumbers.

Day 2

I go down in the water in my scuba. I come across a sea star. It has a five part body structure just like the rest of the animals in the phylum. It moves around using the water vascular system.

Day 3

I see a large sea urchin. It releases sperm into the water to fertilize the eggs. This process is called external fertilization. Next to the urchin I see eggs. The egg will be fertilized then hatch into a larva, then grow into an adult, with a hard exoskeleton.

Day 4

I see a sea cucumber. Part of its body was ripped off, but it's no problem because any animal in the phylum can grow back parts. My trip ends at the sea cucumber spouts out goo to protect itself.

SEASCOPE
LESSON

key concept

Episode 30

Plankton are the ocean's drifters. They travel through the ocean in waves and currents. Most are microscopic, but some are larger than a diver. Plant plankton is called phytoplankton, while animal plankton is called zooplankton. These creatures provide the first two levels of the marine food chain.

Plankton

Plankton

You can see right through some plankton because they are made almost completely of water. They drift through the ocean like spaceships and make colorful patterns of light.



Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Populations and Ecosystems* by examining organisms in their environment and by comparing populations, resources and environments. It also relates to *Diversity and Adaptations of Organisms* because it shows that there are many types of microorganisms alive today. This lesson also addresses *Earth Science Content Standard D: Structure of the Earth System* by showing that living organisms have played many roles in the earth system, including affecting the composition of the atmosphere.

Background Information:

Plankton are the plants and animals that drift around on the oceans' currents. They are abundant in the surface waters where sunlight and nutrients are readily available.

Phytoplankton are the microscopic plants that convert sunlight and nutrients to carbohydrates, amino acids and other forms of organic matter. Not only does phytoplankton form the base of the oceans' food chain, it also produces over 50% of the oxygen that we breathe. Among the animal plankton (zooplankton), common are eggs, larvae, and juvenile forms of invertebrates and fishes. Copepods (related to crabs and shrimp) are the most abundant and widely distributed zooplankton.


episode
30




continued

All forms of life in the open ocean depend either directly or indirectly upon plankton for food. Phytoplankton supports most of the pelagic herbivores of the sea. As the oceans' primary producer, phytoplankton trap and store the energy contained in sunlight. In the process of photosynthesis, the phytoplankton use carbon dioxide and water to produce food. Because they need sunlight to photosynthesize, phytoplankton are generally found near the surface of the ocean. Phytoplankton, algae and plants produce oxygen in proportion to the amount of carbon dioxide that they use. Over a few billion years these producers converted the atmosphere of the planet from being anaerobic, lacking oxygen, to aerobic, enabling all animals to survive.

Preparation:

 If possible, purchase a freshwater or saltwater plankton sample with high diversity: *Fisher Scientific Catalog* #S244867, *VWR Catalog* #WL3911A-19, *Carolina Biological Supply Company* #WW-13-2050. If not possible, obtain and maintain a sample from a local body of water, or make a sample from a hay infusion (see <http://www.bodelin.com/files/proscope/docs/Microbes.pdf> for an sample recipe).

Before viewing the episode:

 Since students love gross and discrepant events, show them a bottle of water (the sample containing the plankton) and ask if anyone would drink it. Determine if they believe anything is in the bottle. The teacher can have some fun with the responses, but the point is to generate interest. (**Note:** Do NOT let a student drink the water containing the plankton sample!)

Adapted from "Visit to an Ocean Planet": <http://sealevel.jpl.nasa.gov/education/activities/ts3ssac3.pdf> and Lesson Plan: Discovering Plankton by Douglas Weittenhiller II: http://www.uwm.edu/~caberg/maclinks/Attach/16-Plankton_LC.doc





continued

2 The students will work in pairs and look at the water sample under the microscope. A dissecting microscope is suggested to begin with to see if larger plankton are present. Also view samples under an objective microscope at 100X and 400X. The students will be actively engaged in looking at the “stuff swimming in the water.” They will be challenged to use the microscope to focus on and observe plankton as well as to draw what they see onto paper. They will consult with their partner on what they see.

3 Use an eye dropper to collect a few drops of the sample and place in a petri dish. Observe the sample with a compound microscope to view the smaller types of plankton. Since the plankton can move up and down in the drop, you will need to refocus your microscope to see plankton at different levels.

4 Questions to ask: What do you see? What is that little “stuff”? Is it moving? Is it alive? How many creatures do you see? Why can't you see them without the microscope?

While viewing the episode:

Tell students they will now watch a film about the diversity of plankton in the ocean. Students make notes on the attached **Plankton Viewers Guide**.

After viewing the episode:

1 Students will then return to their plankton samples to complete the **Plankton Scavenger Hunt** to distinguish different plankton types, so you may wish to discuss how to differentiate ocean plants from animals. Will they have different colors? Structure? Behavior? You may want to alert them that distinguishing characteristics for land-based plants and animals are usually much different than those for plankton.





continued

- 2 Some possible questions to ask:
- What did you see in the clear water? Would you still drink it?
 - How are the zooplankton/phytoplankton similar? Different?
 - What characteristics of plankton indicate if they are producers? Consumers?
 - What do you think would happen if the phytoplankton were unable to carry out photosynthesis?
 - What effect would an alga bloom have on the phytoplankton? On zooplankton? On animals that feed on plankton?
 - How would this affect other life forms in the ocean and on land?
 - How does photosynthesis carried out by phytoplankton benefit fish, animals and humans?
 - Are all planktonic animals tiny? Think of what we saw in the video.

- 3 Students will create their own plankton on the attached sheet, **Create Some Plankton**. Characteristics of the drawing should match items circled in margins of chart.

Extensions:

Phyto- v. Zoo- Plankton and How Plankton Prevent Sinking from:

<http://www.msc.ucla.edu/oceanglobe/pdf/PlanktonPDFs/PlanktonEntirePackage.pdf>

Filter Feeding Experiment:

http://marinediscovery.arizona.edu/lessonsFOO/sea_cucumbers/2.html

Resources:

Plankton Identification Charts - Bigelow Laboratory for Ocean Sciences:

http://er.jsc.nasa.gov/seh/Ocean_Planet/activities/ts3ssac3.pdf

More Plankton Identification Charts:

<http://www.marine.usf.edu/pjocean/packets/f01/f01u6p2.pdf>





Plankton Viewers Guide

1. A “flying snail” has no shell and uses its foot as a wing to fly through water. The technical name for it is _____.
2. Describe 2 ways a jellyfish catches its prey.
 - a.
 - b.
3. Describe how comb jellies and salps move differently.
 - a. comb jellies -
 - b. salps -
4. Our closest relative without backbones are the _____.
5. Plankton in Greek means _____.
6. Name 5 organisms that eat plankton:
 - a.
 - b.
 - c.
 - d.
 - e.
7. Manta rays have _____ in their gills to help collect plankton.
8. The largest fish in the sea is _____.





Plankton Viewers Guide

1. A "flying snail" has no shell and uses its foot as a wing to fly through water. The technical name for it is heteropod.
2. Describe 2 ways a jellyfish catches its prey.
 - a. long stringy tentacles with stinging capsules
 - b. cast sticky nets with stinging capsule
3. Describe how comb jellies and salps move differently.
 - a. comb jellies - use tiny paddles
 - b. salps - use jet propulsion to pulse through water
4. Our closest relative without backbones are the salps.
5. Plankton in Greek means wandering or drifting.
6. Name 5 organisms that eat plankton:
 - a. soft corals
 - b. sea fans
 - c. anemones
 - d. clams
 - e. worms, also barnacles, manta ray, whale shark
7. Manta rays have gill rakers in their gills to help collect plankton.
8. The largest fish in the sea is whale shark.





Plankton Scavenger Hunt

1. What are the most abundant organisms? _____
Draw some.

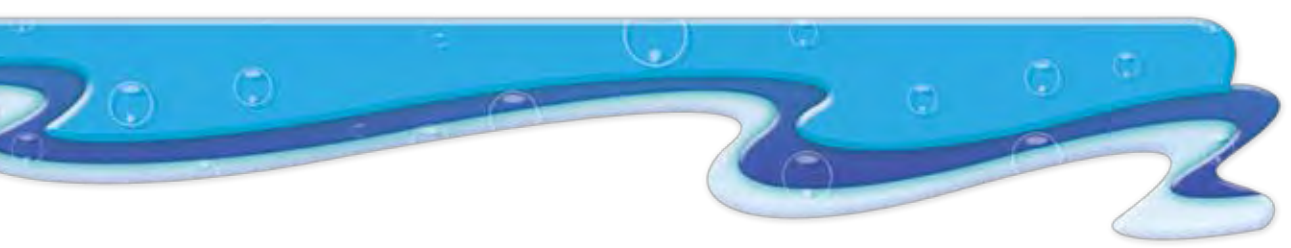
2. Describe some variations in shape, color, and swimming ability of plankton.

3. What are some types of appendages seen on your plankton? Draw them.

4. Find eggs and draw them.

5. Can you find larval and juvenile forms of crustaceans and fish? Draw them.





continued

6. Select the most common organisms from your sample. On your data sheet below, draw and identify each specimen.
7. Repeat this procedure with as many different organisms as time permits. Make sure that you have at least:
 - a. two different kinds of phytoplankton (plants)
 - b. four different kinds of zooplankton (animals)
 - c. one diatom, one dinoflagellate, and one form of permanent zooplankton



Create Some Plankton

START BY DRAWING A SHAPE IN THE CIRCLE

HOW WILL IT EAT?

IT WILL MAKE FOOD FROM THE SUN
COLOR YOUR SHAPE GREEN

OR

IT WILL CATCH OTHER PLANKTON
GIVE IT A MOUTH

HOW WILL IT MOVE?

IT WILL SWIM
DRAW SHORT HAIRS CALLED "CILIA" OR LONG HAIRS CALLED "FLAGELLA" TO HELP IT SWIM

OR

IT WILL ENTANGLE THEM IN LONG STRINGS
DRAW LONG STRINGS WITH SHORT STINGING HAIRS

OR

IT WILL CHASE THEM AND CATCH THEM
DRAW ARMS, LEGS, EYES OF CATCHERS

IT WILL FLOAT WITH THE CURRENTS
DRAW WINGS, HAIRS, LEGS OR FLAPS TO HELP IT FLOAT

OR

IT WILL SPEND ITS ENTIRE LIFE FLOATING AS A PLANKTON

OR

IT WILL GROW LARGER AND DROP TO THE BOTTOM LIKE CRABS AND CLAMS

CHECK ONE BOX

NAME OF YOUR PLANKTON: _____

YOUR NAME _____



SEASCOPE
LESSONkey concept


Episodes 9, 26

Matter cycles through ecosystems with the help of many organisms.

Reef Recyclers to the Rescue!

Reef Recyclers

Nothing is wasted on a coral reef. Sea cucumbers feed on waste, turning it into clean sand, and sponges do the same with water. Both the sea cucumber and sponge remove waste leaving the reef clear and clean, so we call them 'recyclers' of the sea.



Wrecking Crew

The earth is under constant transformation and these wrecking crews are some of the reasons why: On land, water can carve beautiful caverns out of solid rock. Underwater, animals like the parrotfish and sea urchin excavate the reef, grinding rock and old coral skeletons into sand that eventually helps form beaches. But the slow moving chiton may be the star of this show as it is actually one of the geological forces behind the fanciful "mushroom" islands of Palau.



Introduction:

Ambassadors of the Environment Principles:

There Is No Waste In Nature: Nature Recycles Everything

Everything is Connected: All Species depend on Others

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C-Populations and Ecosystems* by showing animals can be categorized by the function they serve in an ecosystem.

Background Information:

Many sea cucumbers crawl along the bottom, ingesting huge quantities of sand. From this sediment they extract detritus, which is waste organic matter such as feces, parts of dead organisms, and mucus. In this process they perform an important ecological function. By making use of what could be considered waste products, they increase the ecological efficiency of the entire ecosystem by more fully utilizing its food resources. They also clean up the reef by releasing back to the reef sediment cleaner than it was before it passed through their digestive tracts.

Information from *Cities Under the Sea* by Dr. Richard C. Murphy, 2002

episode
9episode
26



continued

According to scientists who have calculated the amount of sand passed through the bodies of sea cucumbers, the impact of sea cucumbers on the reef is not trivial. In the South Pacific relatively dense populations of sea cucumbers of more than 40 per square meter, can take in and release about 34 pounds of sediment per square yard per year. This means that for a coral reef 1000 meters by 100 meters wide, these sea cucumbers are processing more than 1000 tons of sand a year equal to more than 75 full 12-ton dump trucks!

Sponges, clams and sea squirts filter sea water through their bodies, extracting food (including plankton, organic particles and even dissolved organic matter), and returning to the reef ecosystem water that is cleaner than when it arrived. By filtering the water for their own benefit they also contribute to the reef's health and vitality. Organic matter and drifting organisms that would otherwise be carried away by currents are kept within the reef ecosystem by these filter-feeders. Many water purifiers live in rubble and in hidden spaces deep within the reef. Through their feeding currents, they ventilate the reef by bringing in oxygen and keeping the reef's recesses from becoming stagnant. This helps bacteria digest the last bits of organic matter and facilitates the return of their nutrient byproducts to the surface for algae to use as fertilizer for producing more food.

The amount of work done by these purifiers is incredible. Some sponges, for example, can remove as much as 99 percent of the bacteria from the water they filter, and some can filter their own volume of water in less than 30 seconds. In the reef area mentioned above (1000m by 100m) at 10 meters in depth, a population of sponges consisting of one half liter of tissue per square meter could filter 38 million gallons of water every day, and the entire volume of that reef four times per day!





Before viewing the episodes:

- 1 Teacher asks students to think about the organisms that perform the job of recyclers in their own backyard. Possible answers might include earthworms, bacteria, fungi, and some insects (sowbugs, millipedes).
- 2 Explain to the students that they are going to watch two short films about recyclers in the ocean. As they watch the films students should fill out the **Reef Recyclers Gathering Grid** (see attached).

While viewing the episodes:

Students fill out **Gathering Grid**.

After viewing the episodes:

Discuss student answers, and then challenge them to think of an organism that would be a terrestrial counterpart doing a similar job in their local community.

Extensions:

1. Direct students to do Internet research about human uses for reef recyclers. Two examples can be found below in Resources. For example, how do humans use sea cucumbers and sponges?
2. Vermicomposting: The purpose of the following activity is to study the recycling of waste by worms by creating a worm bin to both recycle wastes and produce organic fertilizer.





Vermicomposting

Materials

- Empty tennis ball containers with plastic lids (one per worm hotel)
- Spray bottle filled with water
- Soil
- Dry leaves
- Newspaper torn into half-inch strips
- Separate tubs to hold the soil, leaves, and newspaper
- Newspaper to cover student work areas

1 Engage:

- a. Discuss what worms eat and how they help the soil. Worms eat organic matter and recycle nutrients back into the soil, and therefore to plants.
- b. Have students assist teacher in creating a list of the value of earthworms. This could be listed on the board or on the overhead projector. Possible ideas: worm burrows keep the soil loose, letting water and nutrients in and allowing plant roots to spread through the soil, they aerate soil bringing oxygen to the roots, mix soil by bringing subsoil up to the surface of the topsoil, recycle fruit and vegetable refuse, recycle nutrients back to the soil, etc. In addition, they are prey to various predators within their ecosystem.

2 Explore: Obtain worms from a vermicomposting store (composting with worms). Keep the worms in damp soil and feed them composting scraps.

Cover student work areas with newspaper. Each work area should have a clear tennis ball container for each of 3-4 students, a lid with slits cut into it for each student, a large container of damp, but not wet, soil, a large container of dry leaves, and a large container of newspaper torn into long strips, black construction paper to wrap containers with after they are completed, a white crayon to label the worm hotels.





continued

- a. Students create individual “worm hotels” to begin their study of worm composting. This initial experience can begin with students using magnifying glasses to observe worms (**Safety:** discuss the value of the worms and the importance of being respectful of living things).
- b. Draw and label a picture of their worm. Label anterior, posterior, mouth, anus, clitellum, and segments. Write a description of worm behavior and anything else they observe: size, are they dry or moist, how do they move, etc.
- c. After the students have observed their worm, they can create their worm hotels by putting the following substrates into their tennis ball container. They should begin with 1-2 inches of soil, add a 2 inch layer of leaves, and add a 2 inch layer of small, loosely packed strips of newspaper. Between each layer, the students should spray 10-15 squirts of water from a spray bottle filled with pure water. They should repeat this layering until approximately 2 inches from the top of the container. Students can then top off their worm hotels with small bits of compost scraps and then put in five worms. Then they can put the lid (with slits or holes) onto the container; wrap it in black paper and tape. Then use the white crayon to write their names and dates.
- d. Ask students to predict what will happen in their containers over time. Teacher or students may wish to record student predictions.
- e. For comparison with the students’ containers, label two control containers: “Container 1” and “Container 2.” Use dry soil in Container 1 and damp soil in Container 2. Ask students to predict the difference over time between the three types of containers based on what was discussed in the Engagement section. Containers 1 & 2 will act as controls for the students’ worm hotels so that they can make more accurate comparisons with what is happening in their containers.
- f. Clean up work areas.





continued

3 Explain:

- a. The teacher could then use any one of a variety of methods to explain more about worms and how they can be useful in reducing the amount of food wastes while simultaneously creating soil amendments through recycling.
- b. The teacher can then give students time to explore the Internet to find out more about worms.

4 Elaborate:

- a. Students can then maintain the “worm hotels’ for the next few weeks and record what happens. They can slip off the black paper covers to observe the worms and record changes throughout this time period. The worms will transform the leaves, newspaper, and compost into soil. (Be watchful that the soil stays damp but not soggy.)
- b. Discuss the difference between student containers with worms and the controls: Control Containers 1 and 2 without worms. The soil in the worm-filled student containers should be dark and rich. The soil in Container 1 (unwatered, without worms) should look dry with dry compost materials; the soil in Container 2 (watered, without worms) should look wet with moldy compost that has not broken down.
- c. Over time (after 3-4 weeks) the students will notice new cocoons and small young worms.
- d. Students should draw what happened in each container. Students can label the drawings and note which compost scraps the worms ate. Vocabulary words might be useful here.

5 Evaluation:

- a. Based on the students’ data, and records, they could create a “user-friendly” guide to creating and maintaining a worm hotel or worm bin.





continued

b. Students could work alone or with a partner to design a poster that shows worms below the soil surface. Students could draw and label the poster. They could also write on the poster useful things the worm does for the soil.

6 Create a Class Worm Bin:

- a.** After the class has finished observing the containers, the worms could be put into a worm bin (see websites for how to make). Students could then use the worm bin to recycle their produce waste from their lunches.
- b.** Students could take this experience back to their own homes. They could create a worm bin for their home recycling and record how it is working.
- c.** Take a field trip to a composting facility to see nutrient recycling in action.

Resources:

Warty sea cucumber: <http://www.montereybayaquarium.org/animals/AnimalDetails.aspx?enc=COqbp1fPxQ8FNQEnNPdLww>

Murphy, Dr. Richard C.,
Cities Under the Sea, 2002:
<http://www.oceanfutures.org/store/books-dvds-and-games>

Shalaway, Scott, "Nature's Recyclers Perform Key Work":
http://www.redorbit.com/news/science/729814/the_wild_side_natures_recyclers_perform_key_work/index.html?source=r_science

The Adventures of Herman the Worm: www.urbanext.uiuc.edu/worms/index.html

Worm World: <http://yucky.discovery.com/flash/worm/>





Reef Recyclers Gathering Grid

Who	What do they do?	How do they help recycle?
Sea cucumber		
Chiton		
Snails		
Sea Urchins		
Parrotfish		
Triggerfish		
Sponges		
Serpulid worms (Christmas tree worms)		





Reef Recyclers Gathering Grid



Who	What do they do?	How do they help recycle?
Sea cucumber	Ingests sand	Makes sand cleaner by digesting detritus
Chiton	Eat algae on reefs, erodes reef in the process	Converts coral into sand
Snails	Eat algae and erodes reef in the process	Converts coral into sand
Sea Urchins	Beak with 5 teeth to eat algae	Excavates holes in reef and excretes sand
Parrotfish	Teeth scrape the reef to get algae	Grinds up bits of reef and excretes sand
Triggerfish	Teeth bite the reef to get worms and clams	Excavates the reef
Sponges	Use chemicals to etch out a spot on the reef Filter food from water	Chemically erodes holes in reef Cleans water in the process
Serpulid worms (Christmas tree worms)	Use chemicals to etch out a hole in the reef	Chemically makes holes in reef



SEASCOPE
LESSON

key concept

Episodes 4, 5, 14, 24, 31

Students will view a variety of episodes that show footage of the various types of relationships between organisms that keep coral reefs healthy. These relationships include partnerships (mutualism and commensalism), predation, competition, and parasitism. Students benefit from being able to observe and analyze true-life examples of these relationships.

It's All About Relationships

episode

4

Cleaning Station

Do you stand on your head when you go to the doctor's office? No? Well, some fish do. When fish need a checkup, they go to a cleaning station where "doctors" are waiting to nip off their pesky parasites and dead skin. It's a win-win situation: the doctors get an easy meal and the patients get a health boost!



episode

5

Clownfish / Anemone

The anemone has a carpet of stinging tentacles, but the clownfish feels right at home: it is immune to the stingers and uses them to protect itself and its eggs from predators. In return, it protects the anemone from certain species of fish that like to munch on tentacles.



episode

14

Urchin and the Damselfish

Old McDonald was a damselfish: these little fish farm small gardens of algae on coral reefs. They make their homes in dens excavated by sea urchins who like to eat algae, but the damsel fish doesn't like to share so they chase or carry the hungry urchins off the farm.



episode

24

Mating Dances

Gorgonians, sea fans and worms don't make babies like some other animals - they just release millions of sperm and eggs into the water at the same time and rely on the currents to mix it all together. It's called spawning, and what's amazing is that it all happens on one or two special nights a year. Other undersea creatures like turtles take the more traditional approach to reproduction.



episode

31

Standing Guard

In the sea, some creatures offer their offspring no parental care and could seem to care less about a stable home, but others are fiercely protective of their young and their territory.





Introduction:

Ambassadors of the Environment Principles:

Everything is Connected: All Species Depend on Others

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Reproduction and Heredity* by teaching that reproduction is a characteristic of all living things and is essential to the continuation of every species. This lesson focuses on sexual reproduction. It also addresses *Life Science Content Standard C: Structure and Function* as students study how marine organisms are adapted to protect themselves, their offspring, and their food resources. Additionally, it addresses *Life Science Content Standard C: Populations and Ecosystems* by showing how organisms interact through competition, partnership, predation, and parasitism to keep the coral reef a sustainable ecosystem.

Background Information:

In coral reef ecosystems, predatory, competitive and cooperative behaviors are important relationships in maintaining a sustainable reef. In these episodes, competition is portrayed by various organisms “standing guard” over food sources (e.g. the Damselfish protecting its algae gardens from sea urchins). Other examples show fishes protecting their eggs, nests, and offspring; still others, such as clown fish and wrasses exhibit intraspecies competition when protecting their home territories.

Other species develop complex symbiotic partnerships that result in mutual, commensal or parasitic relationships. One of the best known mutual relationships is that of the clownfish and the giant sea anemone. In this relationship, the stinging tentacles of the sea anemone do not harm the clownfish due to the fish’s protective covering of mucus. The clownfish lives among the anemones tentacles, safe from predators. In return for its safe home, the clownfish defends the anemone from predators. The relationship between the clownfish and the anemone is





continued

therefore mutually beneficial; the clownfish gets a safe place to live while the anemone gets a bodyguard. This type of symbiotic relationship is called mutualism.

There are many other examples of symbiotic relationships on the reef. Along with mutualism (where both parties benefit), there are commensalism (where one party benefits while the other is not affected) and parasitism (where one party benefits at another's expense). The relationship between damselfish and pencil sea urchins can be considered commensal because the damselfish benefits from the holes the urchins excavate in the reef, while the urchins do not benefit nor are they harmed. However, the relationship could also be considered a competitive one, because the two animals compete for the same food source, algae.

Also common on coral reefs are predator-prey relationships. Predator-prey relationships are the easiest to spot, and your students will probably notice these first. Encourage them to think about interspecies relationships in more creative ways to pick out other forms for symbiosis.





Before viewing the episode:

Cards Activity

- 1 Duplicate enough sets of cards such that each 2-3 students have a complete set.
- 2 Have each group of students sort the cards to match up a term to its correct definition, and examples.
- 3 Teachers should give guidance, when appropriate, without giving away answers.
- 4 As a class, review the correct matches and have students write down the definitions of the types of relationships, with examples.

While viewing the episode:

Using the **It's All About Relationships** student sheet, have students list the relationships under the appropriate column as they watch the episodes. Teacher may choose to divide class into four groups and have each group watch a different film.





After viewing the episode:

1. Learn about other examples of relationships on a coral reef.
2. Using either relationships from the episodes or ones found in other resources, have students play the following game of “Coral Reef Charades.” Teachers can create their own cards (see Resources below), or have students create them based on their research.
 - a. Divide the class into 2 teams—Team A and Team B—(with even numbers on each team). Have students within the team pair up as “Performance Partners.”
 - b. Use **Charade Cards** to direct the performance of each pair. Have a Performance Partner Pair from Team A choose a Card and present their paired charade to their team. If you need to, the teacher can give a time limit. If the audience from Team A correctly guesses the relationship type—**partnership** (mutual and commensal), **predation**, or **competition** (for space, food, shelter, or mates)—they receive one point; if they also guess the organisms, they receive two points. Do the same with a Performance Partner Pair from Team B. The team that ends the game with the most points wins.

Extensions:

See *SeaScope* lesson plan for **Episode 27** entitled, **Dive Buddies** for another activity focused on partnerships.

Resources:

Predator/Prey Relationships:

<http://www.pbs.org/wgbh/evolution/survival/coral/predators.html>

Competitor Relationships:

<http://www.pbs.org/wgbh/evolution/survival/coral/competitors.html>

Partnership Relationships:

<http://www.pbs.org/wgbh/evolution/survival/coral/partners.html>

General:

<http://oceanworld.tamu.edu/students/coral/>





Cards Activity

Predation	Living thing that catches, kills, and eats other living things
Competition	Organisms struggle with one another to obtain resources - Can occur within a species or between species
Partnership - Mutualism	Both organisms benefit
Parasitism	One organism benefits, other harmed
Partnership - Commensalism	Only one organism benefits, other one is neither hurt or benefits





It's All About Relationships

Directions: List the organisms that relate to one another. Then, put an "X" in the appropriate box for the way they are relating to one another.

- Predator/Prey
- Competition (for food, shelter, space, or mate)
- Partnership (Mutualism or Commensalism) M= Mutualism,
C= Commensalism
- Parasitism

Pairs of Organisms	Predator Prey	Competition	Partnership	Parasitism





It's All About Relationships

Directions: List the organisms that relate to one another. Then, put an “X” in the appropriate box for the way they are relating to one another.

- Predator/Prey
- Competition (for food, shelter, space, or mate)
- Partnership (Mutualism or Commensalism) M= Mutualism, C= Commensalism
- Parasitism

Pairs of Organisms	Predator Prey	Competition	Partnership	Parasitism
Hogfish/Wrasse			M	
Parasites/Hogfish				X
Parasites/Cleaner Wrasse	X			
Fang Blenny/Fish wanting cleaned	X			
Basslets in a school			M safety in numbers	
Clownfish/Anemone			M	
Urchin/Algae	X			
Urchin/Damselfish		X fight for algae		
Leatherfish/Urchin			C	
Urchin/Damselfish			C holes for eggs	
Damselfish/other fish		X guards nest		
Triggerfish/other fish Cleanerfish/ other fish Grunts / other fish		defends nest defends food defends space		





Example of Charade Cards

<p>Damselfish and Sea Urchin competing for the same patch of algae.</p>	<p>Cleaner wrasse bob up and down to advertise that their “doctor’s office” is open for business.</p>
<p>Clownfish partners with a Sea Anemone for protection of eggs.</p>	





Sharks and rays are incredibly diverse, embracing an astonishing variety of forms and lifestyles.

Sharks and Rays

Molly the Manta

Molly the manta ray lives in the Cayman Islands. She looks a little scary, but she's really friendly, and lets people touch her when she comes near their lights to feed on plankton at night.



Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Diversity and Adaptation* as it compares and contrasts the traits of mantas and sharks.

Background Information:

Sharks and rays are fish. Like other fish, sharks and rays have a backbone, live in water, and breathe by means of gills. Rays descended from sharks about 200 million years ago.

The banded guitarfish illustrates the close relationship between sharks and rays because it looks like a perfect blend between a typical-looking shark and a typical-looking ray. It is found in coastal waters, from shallow bays to about 70 feet deep, from Panama to Newport Beach. The banded guitarfish is, in fact, a close relative of both sharks and rays.

Sharks and rays have many traits in common:

- A skeleton made of cartilage (the material in your ears and the end of your nose)—it is strong, flexible, less dense than bone, and favors maneuverability
- Specialized jaws and teeth for a variety of feeding strategies
- Scales made of denticles—small tooth-like structures covering the skin - armor protecting against predators and abrasion
- 5-7 gill openings—a trait retained from ancient ancestors
- Sharks and rays reproduce by laying eggs or bearing live young. All use internal fertilization.

Information From San Diego Natural History Museum:
<http://www.sdnhm.org/kids/sharks/index.html>

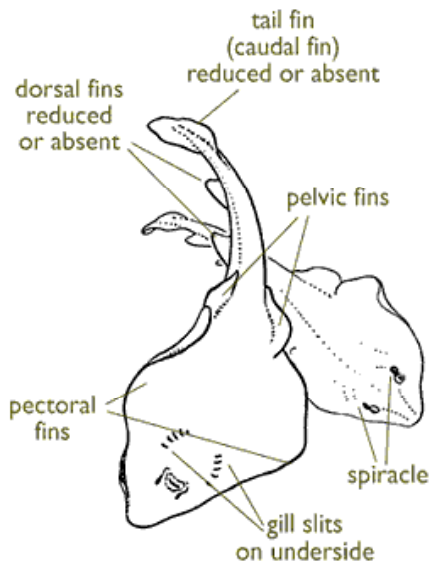
So, how *do* you tell the difference between a shark and a ray?

Body form

- Many but not all sharks have long slender bodies.
- Rays have much more flattened bodies. This shape is well-suited to the habitat occupied by most rays, the ocean-bottom.

Use of pectoral fins

- Sharks' pectoral fins are used for lift and steering.
- Rays use their large pectoral fins to swim, either by flapping them like wings or fluttering them in a wave-like motion from the front to the back of the fins.



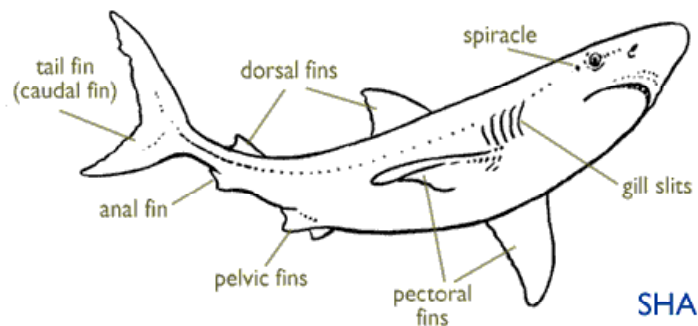
RAY

Use of the tail

- Sharks swim by undulating their muscular bodies and sweeping their tails from side to side. The longer upper lobe of the shark's tail fin is a distinctive trait found in most species.
- Rays move their pectoral fins up and down and generally do not use their tails for propulsion.
- Most rays have narrow tails, some lacking fins. Ray tails may be used for balance or steering. Many ray tails sport a sharp barb for protection.

Placement of gill openings

- Sharks' gill openings are on their sides in front of their pectoral fins.
- Rays' gill openings are found on the underside of their head because the pectoral fins are attached to the head over and in front of the gill openings.



SHARK





Before viewing the episode:

- 1 Show students a photo of a Shovelnose Guitarfish and ask them if they think it is a shark or a ray.
- 2 Discuss the differences between sharks and rays. Teacher may start a chart on the chalkboard or on poster paper listing student's ideas.

While viewing the episode:

As students watch the film, they should fill out the attached chart that compares and contrasts sharks and rays.

After viewing the episode:

After class discussion of the chart, direct small groups of students to create a play to be acted out in front of the class that will demonstrate their knowledge of the differences between sharks and rays. In the play, students should use the shark and ray characteristics to make an analogy to modern-day things (For example: Gill-rakers on a ray are similar to pouring orange juice through a strainer to remove the pulp).

Extensions:

1. Not all sharks eat fish and not all rays eat plankton. Ask students to investigate a cartilaginous fish of their choice to find out more information on the diversity of these organisms. Students may make presentations, write a report, or create a public service announcement, poster or advertisement to show what they have learned.
2. Students investigate the facts and myths about rays and sharks. San Diego Natural History Museum Shark School - web activity: <http://www.sdnhm.org/kids/sharks/games/index.html>

Resources:

Biology of Sharks and Rays: http://www.elasmo-research.org/education/evolution/evol_s_predator.htm

Animals Online: <http://www.wildanimalsonline.com/fish/mantaray.php>

Sea World Sharks and Rays Index: <http://www.seaworld.org/animal-info/info-books/sharks-&-rays/index.htm>





Comparison of Sharks and Rays

Characteristic	Sharks	Manta Rays
Family group (Class)		
Bones		
Tail		
Fins		
Teeth		
Food		
Skin		
Movement		





Comparison of Sharks and Rays



Characteristic	Sharks	Manta Rays
Family group (Class)	Shark (class Chondrichthyes)	Shark (class Chondrichthyes)
Bones	No bones, Cartilage only	No bones, Cartilage only
Tail	Big	Small
Fins	Small	Big
Teeth	Yes, but see exception below.*	Mantas have special adaptations in their gills called "gill rakers" that filter plankton from the water.**
Food	Fish, shellfish and plankton*	Shellfish and plankton**
Skin	Feels like sandpaper when rubbed the wrong way	Feels like sandpaper when rubbed the wrong way
Movement	Tail fin moves back and forth	Pectoral fins move up and down

answers continue ->





* The whale shark (*Rhincodon typus*) and basking shark (*Cetorhinus maximus*), resemble the baleen whales in feeding mode as well as in size. They feed exclusively or chiefly on minute passively drifting organisms (plankton). To remove these from the water and concentrate them, each of these species is equipped with a special straining apparatus analogous to baleen in whales. The basking shark has modified gill rakers, the whale shark elaborate spongy tissue called dermal denticles supported by the gill arches. The whale shark also eats small, schooling fishes. (http://whaleshark.freeservers.com/whale_shark.html)

** Unlike the manta, a stingray's diet consists of worms, carrion, squid and crustaceans. The stingrays' mouth is on it's underside of its body, which enables it to dig crabs and shrimp out of the sea bed. Its wide jaws have a collection of blunt, broad teeth aligned in several rows. The stingray's teeth are primarily used for cracking the shells of its protected prey. (<http://www.miamisci.org/oceans/coralreef/predators/8stingray.html>)





Shovelnose Guitarfish



SEASCOPE LESSON



Episodes 6, 32

These two episodes showcase the ecological event called primary succession. Primary succession occurs in an environment where there appears a substrate (such as lava flow or sunken ship) devoid of vegetation and usually lacking soil. Pioneer species then colonize the new space and create conditions that will eventually support a community of many species. Pioneer species are gradually replaced by others that are better suited to the new conditions, ultimately creating a mature ecosystem.

episode

6

An Artificial Reef

Destroyer at Peace

Not too many people get to ride a sinking ship to the bottom of the sea - but Jean-Michel Cousteau does. He then watches as fish move into their new home.



episode

32

Destroyer at Peace -One Year Later

One year after its sinking, the Destroyer at Peace is hardly recognizable. The Crow's nest has collapsed and the sea has begun transforming the ship to a reef in earnest. The sunken vessel is now home to many creatures, including a sergeant major guarding its nest of eggs.



Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Populations and Ecosystems* by showing how the number of organisms present in a coral reef ecosystem depends on the resources available and abiotic factors such as temperature and light level. Lack of resources and other factors, such as predation and climate, limit the growth of populations in specific niches in the ecosystem.

Background Information:

Man can participate (with significant help from nature) in the creation of additional, or "artificial," reefs to enhance recreational fishing and sport diving opportunities in coastal waters, and to increase the amount of productive hard-bottom habitat available overall. This is accomplished by placing suitable long-lived, stable and environmentally safe materials (usually steel or concrete) on a selected area of ocean bottom. Once the material is in

Information on *Sea Science* can be accessed at: <http://www.dnr.sc.gov/marine/pub/seascience/artreef.html>





continued

place it acts in the same way that naturally occurring rock outcroppings do in providing hard substrate necessary in the basic formation of a live-bottom reef community.

In theory, man-made reefs can be equally as productive as naturally occurring hard-bottom habitats and are limited only by the life span of the materials utilized. Artificial reefs enhance saltwater fishing opportunities for recreational anglers and provide additional locations of interest for the growing number of sport divers. They also add to the amount of highly productive hard-bottom coastal habitat as well as potentially enhance their associated fish stocks. With these attractions, fishermen and divers generate millions of dollars in total economic benefit to nearby communities each year. While not the primary reason for building the marine artificial reefs, this economic benefit from their existence adds significant weight to the overall cost-effectiveness of the efforts involved in maintaining a reef system.

An additional benefit of a reef program is the fact that many artificial reefs are constructed from materials that would otherwise go to a landfill. Many materials such as concrete pipe, concrete pilings, steel highway bridges and a variety of other bulky structures have no other practical use at the end of their service life. Utilizing these materials as substrate in the construction of artificial reefs not only saves limited landfill space, but it allows the structures to continue to serve in a productive capacity for hundreds of years past their originally intended use.

Using a process called mineral accretion can accelerate the rate at which artificial surfaces can be "grown". In mineral accretion, a low voltage current is applied to a metallic structure to cause limestone to accrete or build on the surface, upon which coral larvae (planulae) can attach and grow. The voltage is low enough that it can be generated by floating solar panels or from wave motion. A coalition of scientists known as the Global Coral Reef Alliance (GCRA) has been developing a technique called the Biorock® Process using mineral accretion for reef restoration, mariculture, and shore protection.





Before viewing the episodes:

- 1 Pose this question to the class: “Can human-made objects, such as sunken ships or oil rigs, provide good habitats for marine animals?” Ask students to think about the question for a minute, and spend about five minutes discussing their initial ideas.
- 2 Make sure the students know that coral reefs are barriers and ridges created by the limestone remains of tiny coral polyps, and that they attract a wide variety of marine animals.
- 3 Define the term “artificial reef” as a human-made structure in the ocean or sea.
- 4 Explain that, like coral reefs, artificial reefs frequently attract marine animals from the surrounding ocean areas.
- 5 Show *SeaScope Episode 6*.

After viewing the episodes:

- 1 Ask students to make a “pros and cons” chart that hypothesizes the positive and negative impacts of artificial reefs on the marine ecosystem. They can make their charts individually, in small groups, or as a class, but be sure to discuss the charts as a class.
- 2 Students read the *National Geographic News* article, “Artificial Reefs: Trash to Treasure”, either individually or as a class. Ask them to answer the following questions as they read:
 - Why are marine organisms attracted to a sunken ship?





continued

- When a ship sinks and turns into an artificial reef, does it matter how it is shaped or what it is made of? Why?
- Over time, do artificial reefs become very similar to or very different from natural reefs?
- How might a sunken ship help a nearby natural coral reef?



Show *SeaScope Episode 32*.



Students make a revised "pros and cons" list based on the information they have gathered.



Discuss students' new lists as a class. Overall, do they think artificial reefs are a good idea? Under what circumstances might they be more damaging than beneficial?





Extensions:

Present students with this scenario:

In 1997, the country of Denmark signed the Kyoto Agreement, agreeing to reduce its carbon dioxide emissions. This is good news for air quality, global warming, and many animal and plant species. In the process of reducing emissions, Denmark has built sea-based windmill parks to harness energy from the wind. The question remains as to how these windmill structures, which rise out of the sea, will affect the marine ecosystem. Will seals and porpoises be disturbed by these structures? How might these windmills affect other parts of the marine ecosystem, and how might impacts on invertebrates and fish affect marine mammals?

Ask students to write paragraphs predicting the effects of the Danish windmills on the marine ecosystem. They should base their predictions on what they have already learned about artificial reefs and on additional research into artificial reefs and the behaviors and habitats of seals and porpoises (see Wind Farm articles below).

Resources:

This activity has been adapted from *Pros and Cons of Artificial Reefs* which can be found at:

<http://www.nationalgeographic.com/xpeditions/lessons/08/g912/artificialreefs.html>

Articles that support the wind farm extension activity:

“Denmark’s wind power blows to sea”

www.alternative-energy-news.info/technology/wind-power/wind-farms/

“Positive attitudes towards offshore wind farms”

http://www.awea.org/faq/wwt_offshore.html

<http://www.sciencedaily.com/releases/2007/12/071212201424.htm>

<http://www.pge.com/waveconnect/>



SEASCOPE LESSON

key concept



Episodes 22, 43

Scientists have the opportunity to research, explore, and teach others about their discoveries. To become an *Ocean Explorer*, one needs both academic and technical education and training. Jean-Michel Cousteau is a role model whose life's work includes educating others, especially the young people of the world, to foster a conservation ethic for our water planet. Students can use their creativity to imagine, draw, write about, and produce a video describing how they could become an *Ocean Explorer* who, like Jean-Michel Cousteau, makes a positive impact in our society.

Ocean Exploration

episode

22

Mystery Ship

Deep on the bottom of the ocean, a sunken ship is still leaking oil from its coral encrusted hull 50 years after it went down. Jean-Michel Cousteau explores this wreck. Inside there is no life; only spooky catwalks, passageways and a monster deep down in the engine room.



episode

43

Battleships on the Bottom

Where once a furious battle raged, sunken ships now litter the bottom. The smoke has cleared, but danger lurks around every corner as Jean-Michel Cousteau explores tangled wrecks filled with live ammunition.



Introduction:

Ambassadors of the Environment Principles:

Everything is Connected: All Species Depend on Others

There is No Waste in Nature: Nature Recycles Everything

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson refers to *Content Standard F: Science in Personal and Social Perspectives - Science, Technology, and Society*. It shows how the study and practice of science and technology can be integrated by scientific explorers for the betterment of society.

Background Information:

Jean-Michel Cousteau and his family have inspired millions of people to become ocean explorers. Whether people have taken up snorkeling or scuba diving as a hobby or chosen career paths to become divers, marine

Information on Coral Reef Information System can be accessed on NOAA's Coral Reef Information System (CoRIS): http://coris.noaa.gov/exchanges/coral_rainforest/





continued

biologists, or oceanographers, they have all learned more about our oceans and therefore care more deeply about the sea and its inhabitants. Jean-Michel and his family have demonstrated a consistent commitment to both reveal the wonders of the underwater world and provide ways to understand how to protect and maintain these ocean environments through more sustainable practices. In these two *SeaScope* episodes, Jean-Michel explores two ship wrecks. Students can see, through his investigations, how the ocean ecosystem transforms these ships into habitats suitable for life. Viewers see that in the sea, nothing stays the same for very long. Change is a natural part of the cycle of life. Even war, which inflicts many wounds on people and the environment, yields to a healing peace; and the greatest machines of destruction give way to the beauty of creation.

Jean-Michel Cousteau is the founder and president of a non-profit organization called Ocean Futures Society. The mission of Ocean Futures Society is to explore our global ocean, inspiring and educating people throughout the world to act responsibly for its protection, documenting the critical connection between humanity and nature, and celebrating the ocean's vital importance to the survival of all life on our planet.

Before viewing the episodes:

Teachers can introduce these episodes by asking questions such as:

- 1 • Why do we research ship wrecks?
 - What do ocean explorers expect to find?
 - Is it dangerous to explore ship wrecks?
 - How might the changes within the ocean environment transform these wrecks into new ecosystems?
- 2 • Who is Jean-Michel Cousteau and what is the mission of his organization, [Ocean Futures Society](#)? What may have influenced Jean-Michel's commitment to caring about and educating others about the ocean?





While viewing the episodes:

1 Have students consider these same questions as they view the episodes and make notes accordingly.

After viewing the episodes:

1 Discuss the students' observations and answers. In addition, consider how Jean-Michel Cousteau has helped to reveal underwater mysteries to others and how this helps people learn about and care more deeply about the oceans and its inhabitants. What does it take to become an *Ocean Explorer*? If you wanted to do what Jean-Michel does, what type of education, training, and experiences would you need? Use the suggested websites to discover answers to these questions and more.

2 To become an *Ocean Explorer*, one would need to be both knowledgeable about the ocean and a diver. What type of educational and technical degrees would be required? Have students do internet research to become more aware and knowledgeable about what education and training is required to become an *Ocean Explorer*. Some questions that might spark their research could be:

- a. What academic education is required to become a marine scientist?
- b. What schools could one attend to obtain a degree in ocean science?
- c. What is required to become a deep sea diver?
- d. What training programs are there that train deep sea divers?
- e. Once someone has this education and training, what can he/she do to benefit and improve the oceans, ocean inhabitants, and people? This can include diving, educating others, recreational leaders, acting, artistry, etc.

3 Then, have students imagine that they have these skills and write an imaginative description of who they are, what they are working on, and how their work as an *Ocean Explorer* is benefiting the oceans, marine life, and people. They can also draw a picture of themselves in this capacity.





Extensions:

Using their descriptions and drawing of themselves as Ocean Explorers, have students create a video product. Have students choose what this might be. However, have them, in their own creative way, describe to the viewers:

1. Who they are
2. What they did to get to where they are (through education and training),
3. What are some of their prior accomplishments, what projects are they currently working on, and possibly what their plans are for the future.
4. A hopeful message to their viewers relating to what they are working on and what the viewers can do, related to their current project, to help sustain healthy ocean ecosystems.

Resources:

Jean-Michel Cousteau's Biography:

<http://www.oceanfutures.org/about/jean-michel-cousteau>

Jean-Michel Cousteau's speech transcripts, messages to the community, honors and awards: <http://www.oceanfutures.org/blog>

Jean-Michel Cousteau Ocean Adventures:

<http://www.pbs.org/kqed/oceanadventures/>

Jean-Michel Cousteau's Children:

<http://www.oceanfutures.org/about/cousteau-family/fabien-cousteau>

<http://www.oceanfutures.org/about/cousteau-family/celine-cousteau>

Diving Technology:

<http://www.oceanfutures.org/exploration/equipment>

Ocean Careers Exploration: <http://www.pbs.org/kqed/oceanadventures/educators/oceancareers/>

Ocean Exploration Timeline: 1800 to

Present: <http://www.seasky.org/oceanxp/sea5a3.html>

NOAA's Office of Ocean Exploration:

<http://www.research.noaa.gov/>

Ocean Diving Training:

<http://www.oceandiving.com/training.html>

Monitor National Marine Sanctuary:

<http://www.pbs.org/kqed/oceanadventures/episodes/treasures/guide/monitor.html>

Thunder Bay National Marine Sanctuary:

<http://www.pbs.org/kqed/oceanadventures/episodes/treasures/guide/thunder-bay.html>

Books:

Explore the National Marine Sanctuaries with Jean-Michel Cousteau by Ocean Futures Society (2010).

The Silent World by Jacques Cousteau (1953).

SEASCOPE
LESSONkey concept


Episodes 3, 12, 13, 32, 41, 48, 50

Students will investigate the complex interactions of marine organisms and community structure in diverse and productive marine ecosystems.

Ecosystem Extravaganza!

episode
3

Sand City

The ocean bottom looks empty, but is filled with strange critters like cuttlefish that squirt ink, urchins that pick up hitchhikers, and fish that play possum – you just have to know where to look.

episode
12

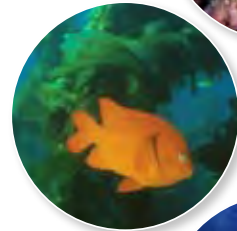
Bedtime Stories

Most everyone needs to sleep, even in the sea. Some fish bury themselves in the sand to take a snooze, while the octopus settles into a little rocky crevice and changes color so it won't be disturbed.

episode
13

Undersea Forests

In California, giant kelp form beautiful forests full of animals. Each frond (like a leaf) is home to snails, crabs and other tiny creatures, and sea lions frolic like monkeys through the underwater trees.

episode
32

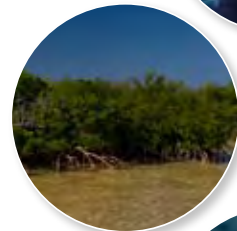
Destroyer at Peace—One Year Later

One year after it's sinking the Destroyer at Peace is hardly recognizable. The Crow's nest has collapsed and the sea has begun the transformation into a reef in earnest. The sunken vessel is now home to many creatures including a sergeant major guarding its nest of eggs.

episode
41

Mangroves

A tree that grows at sea? Well, sort of. Mangrove seedlings travel long distances and settle in estuaries and on beaches, where they erect a complicated above-ground root system. Due to ignorance, people sometimes cut them down, but mangroves are useful as a habitat for young fish and as a good way to keep beaches from washing away.

episode
48

Polarized

You wouldn't expect to find much life in the arctic, but it's actually teeming with animals. How do they survive? Many fish species have antifreeze in their bodies, while marine mammals thrive thanks to a combination of blubber and brains.

episode
50

The Ever Changing Arctic

In the arctic, animals have come up with some impressive adaptations to keep up with their ever-changing environment. Polar bears can live on land or in the water, and that makes them champs of the adaptation game.





Introduction:

Ambassadors of the Environment Principles:

Everything is Connected: All Species Depend on Others

Biodiversity is Good: the More the Variety the Better

Everything Runs on Energy: Stars, Cities, Machines and People

National Science Education Standard Connection:

This lesson thoroughly addresses *Content Standard C: Populations and Ecosystems*.

Background Information:

One of the most fascinating aspects of marine ecosystems is how the organisms meet challenges of survival and live together. A population consists of all individuals of a species that occur together at a given place and time. All populations living together and the physical factors with which they interact compose an ecosystem.

Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers—they make their own food. All animals, including humans, are consumers—they obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem.

For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transformed by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs.

The number of organisms an ecosystem can support depends on abiotic (non-living or physical) and biotic (living) factors. Abiotic factors include sunlight, temperature, water availability, salinity, soil conditions and nutrients. Biotic factors include available food, competitors, mutualist symbionts, predators and disease. Given appropriate levels of abiotic and biotic factors populations (including humans) can increase at rapid rates. Lack of resources and other negative factors, such as predation and climate, can limit the growth of populations in the ecosystem and even cause some populations to go extinct.

Information from *National Science Education Standards*, 1996: http://www.nap.edu/openbook.php?record_id=4962





Before viewing the episodes:

- 1 Hand out student sheet on the **Ecosystem Extravaganza** and introduce the lesson (see attached).
- 2 Separate students into groups of four. Have each group select one of the five ecosystem topics (kelp forest, arctic, sandy bottom, coral reef at night, artificial coral reef, mangroves) from the *SeaScope* episodes.
- 3 In their cooperative groups, have students choose their role (**Animal Expert, Plant Expert, Climate and Location Expert, Current Issues Expert**) and take the corresponding data sheets (see attached) to fill in while watching the episode.

While viewing the episodes:

Students will view their group's *SeaScope* episode and fill in the appropriate data on project worksheets (see attached).

After viewing the episodes:

- 1 Students use books and Internet resources to complete their data sheets.
- 2 Students work together in their groups to create a *PowerPoint*-type presentation of their ecosystem.
- 3 Students make their presentation to the class.

Extensions:

1. **Art Connection:** Have students create a 3-D diorama of their ecosystem, possibly using a cardboard box and clay.
2. Create a class CD of all of the student presentations to share with other classes or post online. Copies could also be given to each student for their own files and/or final assessment assistance.





Ecosystem Extravaganza!

Directions:

Congratulations! You have been selected to join a team of ecologists to study living things and how they interact in an ecosystem. The ecosystem your team has chosen is _____.

Your team must make a presentation to a convention of world-famous ecologists. They may have never visited your ecosystem before and it is your team's responsibility to explain to them everything you can about your assigned ecosystem.

Your task is to gather interesting information using *SeaScope* episodes, books, and the Internet to share at the convention. You must present this new information in a *PowerPoint* presentation that will inform the audience of the characteristics of your ecosystem. Have Fun!

The Process:

In this activity you will be working together with a team of four students in your class. Remember that when you work in a group, you must respect other student's opinions, be a good listener, ask questions, work cooperatively, and most of all have fun! It is your responsibility to cooperate as a team and learn as much about your ecosystem as possible.

1 Facts about Your Ecosystem

Your team should have some background information before you start to research in your roles. Before you begin, take the time to refresh your memory with some facts about ecosystems.

2 Exploring your Roles

Once you meet with your team, each member will select one area to study from the following topics. Since each member will have a different role, as a team you will become experts about the characteristics of your ecosystem. You are each accountable for thoroughly researching your part of the topic. Fill in your answers to the questions below using your **Data Collection** worksheet. Remember that your team is counting on you!





continued

Climate and Location Expert

1. Are there seasons in your ecosystem? Describe them.
2. What are the temperatures like in your ecosystem? Have a graph ready of annual temperature ranges to put in your presentation.
3. Does precipitation affect your ecosystem? If so, how much rainfall does your ecosystem get per year? Have a graph ready of annual rainfall to put in your presentation.
4. Where in the world can you find your ecosystem? Put a map in your presentation.

Plant Expert

1. Name and describe 4 types of plants that can be found in your ecosystem. Describe some characteristics and adaptations, for example, holdfasts on kelp, leaf/flower color, root types?
2. Why are the plants of your ecosystem important?
3. What would cause a decrease of plants in your ecosystem?
4. What would cause an increase of plants in your ecosystem?
5. Collaborate with the **Animal Expert** so the food chains, food webs, and symbiotic relationships you use include the organisms that you are both describing.

Animal Expert

1. Describe at least four animals that live in your ecosystem, include mammals, birds, fish, reptiles and invertebrates (try to choose a variety of types of organisms).
2. What kinds of food do the animals in your ecosystem eat?
3. Explain some ways in which each animal is adapted to this environment.
4. List a food web (or at least 2 food chains) that is part of your ecosystem, using as many organisms in the *SeaScope* films as possible.





continued

5. Name at least one symbiotic relationship in your ecosystem. Tell which kind of relationship it is (mutualism, commensalism, parasitism).
6. Collaborate with the **Plant Expert** so the food chains, food webs, and symbiotic relationships you use include the organisms that you are both describing.

Current Issues Expert

1. Are there any environmental threats to your ecosystem? If so, explain them. How might global warming affect your ecosystem?
2. What would an environmental solution to this threat be?
3. Describe some problems that contribute to the decline of your ecosystem.
4. Can you describe something dangerous that might happen to you in your ecosystem?

Putting it All Together

Now that each member has become an expert at their role, it's time to put it all together and share your findings. As a team of ecologists, it is your job to use information, pictures, facts and opinions from the *SeaScope* episode, books, and Web pages that you explored to put together a *PowerPoint* presentation. Remember that you are trying to inform other ecologists to the best of your ability about your ecosystem.

Hints for your *PowerPoint* presentation:

- Include a title slide
- Include at least 3-4 slides about your role's findings
- Include at least five images in your presentation (look at the sites you visited)
- Include a reference slide listing where you got your information.

Look on the **Evaluation** page to see the expectations for your presentation. You have worked so hard to find your information about your role, now impress the convention attendees with your presentation.





Data Collection

Animal Expert

Common and Scientific names	Food	Adaptations to ecosystem
Animal One		
Animal Two		
Animal Three		
Animal Four		





Data Collection

Animal Expert

Food Web	Symbiotic Relationship
2 Food Chains	Symbiotic relationship





Data Collection

Current Issues Expert

<p>Environmental Threats How might climate change affect your ecosystem?</p>	<p>Environmental Solutions to these threats</p>
<p>Problems that contribute to ecosystem decline</p>	<p>Something dangerous in your ecosystem</p>





Data Collection

Climate and Location Expert

<p>Evidence of Seasons</p>	<p>Temperature Range Make or find a graph for the presentations.</p>
<p>Rainfall Range Make or find a graph for the presentation.</p>	<p>Where in the world can you find your ecosystem? Include a map.</p>





Data Collection

Plant Expert

Common and Scientific name	Characteristics/Adaptations
Plant One	
Plant Two	
Plant Three	
Plant Four	





Data Collection Plant Expert

<p>Why are plants important here?</p>	<p>What would cause a decrease in plants here?</p>
<p>What would cause an increase in plants here?</p>	<p>What role do the plants play in your ecosystem?</p>





Rubric

Ecosystem: _____

PowerPoint

Group members _____

Title Slide

- _____ Names the Ecosystem
- _____ Presenter names

Climate Slides

- _____ Seasons
- _____ Temperature graphs, maps or charts
- _____ Rainfall graphs, maps or charts (if appropriate)
- _____ Where is ecosystem found - map or directions
- _____ Pictures

Plant Slides

- | | | | | |
|-----------------------------------|---|---|---|---|
| _____ 4 types of plants | 1 | 2 | 3 | 4 |
| _____ Characteristics/Adaptations | 1 | 2 | 3 | 4 |
| _____ Plant Importance | | | | |
| _____ Cause of Plant Decrease | | | | |
| _____ Cause of Plant Increase | | | | |
| _____ Pictures | | | | |

Animal Slides

- | | | | | |
|---|---|---|---|---|
| _____ 4 animals | 1 | 2 | 3 | 4 |
| _____ Variety of animals presented | | | | |
| _____ What the animals eat | 1 | 2 | 3 | 4 |
| _____ Adaptations | 1 | 2 | 3 | 4 |
| _____ Food web or at least 2 food chains | | | | |
| _____ Plant/Animal Interrelationships show collaboration | | | | |
| _____ Symbiotic Relationship | | | | |
| _____ Symbiotic Relationship identified (mutualism, commensalism, parasitism) | | | | |
| _____ Pictures | | | | |

Current Issues

- _____ Environmental Threats identified
- _____ Environmental Threat explanation
- _____ Environmental Solution
- _____ Ecosystem decline problems
- _____ Something dangerous in the ecosystem
- _____ Pictures

WOW Points:

- _____ Total



SEASCOPE
LESSON

key concept

Episode 1

Coral reefs make up only a small proportion of the ocean but are extremely important because of their high biodiversity.

episode
1

Rainforests of the Sea

Rainforests of the Sea

Coral reefs are to the sea what rainforests are to the land. Reefs occupy only 1/10th of one percent of the ocean bottom, yet 99% of all the species in the sea make their home there.



Introduction:

Ambassadors of the Environment Principle:

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Populations and Ecosystems* by examining organisms in their environment and by comparing populations, resources and environments.

Background Information:

The public generally perceives tropical rainforests as complex, diverse ecosystems that are threatened and worthy of conservation efforts, but a deeper understanding of the rainforest is not widespread. Public understanding of coral reefs tends to be even weaker. Therefore, on a fundamental level, the reef/rainforest analogy is relatively accurate and useful, and can raise public awareness about the importance of reefs. The analogy successfully conveys the basic message that both systems are highly diverse, are suffering from human impacts, and are worthy of protection and conservation.

From a more scientific point of view there are even deeper similarities. Coral reefs and rainforests have among the highest rates of primary productivity, the environments in which they exist (oceanic waters and soils) are depleted in nutrients, nutrient cycling

Information on Coral Reef Information System can be accessed on NOAA's Coral Reef Information System (CoRIS): http://coris.noaa.gov/exchanges/coral_rainforest/



continued

is efficient and rapid within both systems, biodiversity is very high, and species interactions are very high with mutualism of particular importance.

Large herbivores are very important in both systems. In the Amazon, manatees, turtles and herbivorous fish graze on aquatic vegetation. On coral reefs, parrotfish, turtles, surgeonfish and other species graze on algae. In each system the loss of these herbivores, from over harvest by humans, has caused extreme ecological disruption because the control of aquatic vegetation and algae is important to the health of other populations of species.

On the other hand, there are differences between the two ecosystems. For instance, tropical rainforests are richer in species and have higher canopies, while reefs have a greater diversity of large taxonomic groups, with 32 of the 34 presently known animal phyla. Rainforests support only 17 phyla.

Reproductively speaking, broadcast spawning on reefs ensures widespread dispersal of coral larvae. In a rainforest environment, however, successful seed dispersal and germination is dependent on a variety of species that pollinate and disperse seeds. Reefs and tropical rainforests differ significantly in taxonomy as well.

The following activity may be developed and expanded to meet the needs of the grade level you teach. Answers you get from the students will vary with their prior knowledge and experience. You may choose to focus on the similarities, the differences, student misconceptions, or have students explore individual topics (i.e. diversity, reproduction, taxonomy) in greater depth. This lesson could be used as a pre- and post-test assessment for an ecology unit, a cross-curriculum piece or a standalone activity.





Before viewing the episode:

- 1 Students are seated in groups of four.
- 2 The teacher introduces the title of the film and generates a brief discussion about what the title means.
- 3 Ask students working in groups to brainstorm a chart (see attached) on poster paper that lists ways they think coral reefs and rainforests might be alike and not alike.

While viewing the episode:

- 1 After the film, students revisit the chart they had filled out, and add, remove or correct the lists they have created.
- 2 The groups share their posters with their classmates.
- 3 In their groups, students write a cooperative story that accurately compares and contrasts rainforests and coral reefs.

Resources:

NOAA's Coral Reef Information System: http://coris.noaa.gov/exchanges/coral_rainforest/

Hawaii's Living Reef Program: http://www.hawaiireef.net/teachers/keiki_activity.shtml





Rainforests of the Sea: Coral Reefs and Rainforest Comparison

Coral Reefs and Rainforests are alike:

- A.
- B.
- C.
- D.
- E.
- F.
- G.
- H.

Coral Reefs and Rainforests are not alike:

- A.
- B.
- C.
- D.
- E.
- F.
- G.
- H.





Rainforests of the Sea: Coral Reefs and Rainforest Comparison



Coral Reefs and Rainforests are alike:

- A. Diversity — both have biodiversity as high as anywhere on the planet
- B. Productivity — both as high as any natural ecosystem on the planet
- C. Inorganic nutrients — low - nutrient poor environment
- D. Nutrients in biomass — nutrients held in biomass and efficiently recycled
- E. Predation — little on primary producers (few eat corals or trees directly)
- F. Detritus — this is an important way energy from primary producers gets into the food chain, as dead leaves and coral mucus etc rather than direct herbivory
- G. Mutualism — very important with examples of mycorrhizae and roots, zooxanthellae and corals, clownfish and anemones, orchids and their pollinators, gobies and shrimp living in the sand, and on and on
- H. Intense competition has resulted in specialization as contrasted to having a lot of generalists

Coral Reefs and Rainforests are not alike:

- A. Tropical rainforests are richer in species and have higher canopies
- B. Reefs have a greater diversity of large taxonomic groups, with 32 of the 34 presently known animal phyla. Rainforests support only 17 phyla.
- C. In a reef environment, broadcast spawning ensures widespread dispersal of coral larvae. In a rainforest environment, however, successful seed dispersal and germination is dependent on species of pollinators and seed dispersers.
- D. Reefs have a greater gross productivity.
- E. The structure of the forest is made by trees, on the reef it is coral animals that create the structure.
- F. Rainforests have many resident mammal species, reefs have few.
- G. Corals have created geological structures called reefs, trees are not as durable.



This activity will provide the students with the opportunity to place organisms in roles and see how these organisms function in their habitat. Students should identify at least 2 food chains and one food web.

Food Webs: You are what you eat!

Food Web

Some sea creatures eat plants and some eat other animals, but all are processing the same thing: solar energy. The sun is the source of energy that keeps the entire marine food web going.

Introduction:

Ambassadors of the Environment Principles:

Everything Runs on Energy: Stars, Cities, Machines and People

Everything is Connected: All Species depend on Others

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard C: Populations and Ecosystems* by showing organisms can be categorized by the function they serve in ecosystems...producers, consumers, decomposers. It also describes how the major source of energy for an ecosystem is sunlight. *The Physical Science Content Standard B: Transfer of Energy* can be integrated when addressing energy flow through food webs. Much of a plant's available energy is lost when it is eaten. That is why an herbivore must eat large volumes of plants. Also, when larger carnivores eat smaller animals, much of the energy is lost so they must also eat many smaller animals. Only about 10% of the total energy is passed from one organism to the next along a food chain.





continued

Background Information:

A food chain illustrates the sequence of who eats who in a particular ecosystem. It also shows how all species in an ecosystem are interconnected and depend on each other for survival. The food chain is a complex balance of life. If one animal's source of food disappears from events such as over fishing or hunting, many other animals in the food chain are impacted and may die.

Plants and other photosynthetic organisms are known as Producers. This is because they use the sun's energy to produce their own food. Consumers fall into categories based on their feeding strategies. The main groups consist of herbivores, carnivores and omnivores. Herbivores consume primary producers, which are mainly plants and chlorophyll containing bacteria. These are the vegetarians of the world. Carnivores eat flesh or meat, which usually means the other consumer species. Omnivores eat both plants and animals.

When organisms die what happens to their bodies? Decomposers take care of them. Decomposers are organisms that feed off of dead and decaying matter called detritus. For this reason they are also known as Detrivores. Like garden worms, decomposers help make healthy soil by putting into it the raw nutrients and chemicals leftover from their meals. They play an important role in cycling nutrients such as carbon, nitrogen, and phosphorus back into the environment for producers to use all over again.

Information from *Kidport Reference Library*: <http://www.kidport.com/RefLib/Science/FoodChain/FoodChain.htm> and *Food Chains and Food Webs: "What's for dinner?"*: <http://www.enchantedlearning.com/subjects/foodchain/>





Before viewing the episode:

Teacher will review key terms with students: consumer, producer and decomposer (see Background Information).

While viewing the episode:

- 1 Students will draw and label producers, consumers and decomposers in several food chains.
- 2 Students will draw and label producers, consumers and decomposers in a food web.

After viewing the episode:

- 1 Possible discussion questions:
 - What is the importance of producers and their role in our world?
 - How are consumers important?
 - Where does each of the decomposers live?
 - What type of food do they consume?
 - What would the world be like with no decomposers?
- 2 Students form teams of 2-3 to explore, in one to three class periods, the schoolyard for food chains and webs. Teacher should set some ground rules and possibly escort the students to point out boundaries for the activity. Students complete the attached sheet, **Schoolyard Ecology**. On completion of the activity, teacher may choose to revisit the questions above to relate them to schoolyard activity.





continued

3 This next activity is adapted from *Fish are Animals Too* which can be found at www.pbs.org/kqed/oceanadventures/educators/pdf/OceanAdv-Fish.pdf.

- a. Choose one of the ecosystems in the tables titled, **Ecosystem Food Webs**, that follow. Assign a student to each of the organisms (and one to the sun) within the ecosystem you have chosen. Provide each student with a cardboard sign with the corresponding name of their organism or the sun.
- b. Have the students form a large circle. Starting with the sun, have each student read out which other organism directly interacts, as listed (see teacher page), with the one the student represents. As each relationship is called, the student representing that organism holds on to the end of the string and passes the ball of string to the organism that was read out. When the entire table has been read, a “web” will have been created with string.
- c. Ask the students to carefully lay the string on the ground without disturbing the patterns. Discuss the results: Use these questions to conduct a discussion about the food web they created:
 - What is the importance of each individual species?
 - Why is it a web and not a chain?
 - What would occur if one element were removed?
 - What would occur if another species were introduced?
 - Is one part of a food web more important than another (e.g., large fish versus small fish)?
 - Are we as humans part of a food web?
 - Why is understanding food webs so important?

Extensions:

Choose one or more of the following activities to reinforce the concept of food webs and food chains:

Food Chain Game http://www.cns.uni.edu/LakeStudy/Education%20Pages/food_web_game.htm

Food Chain Hollywood Squares <http://teach.fcps.net/trt2/activities/Food%20Chain%20HollywoodSquares.ppt>

Chain Reaction Web Activity http://www.ecokidsonline.com/pub/eco_info/topics/frogs/chain_reaction/index.cfm#

Saved by a Shark Card Game <http://www.nationalgeographic.com/xpeditions/lessons/07/g68/noashark.html>





Schoolyard Ecology

Have you ever wondered what living things are in your backyard, the park, or around school? During this activity you will investigate our school grounds ecosystem and identify all of the creepy crawly, high flying, breeze blowing organisms that live here.

To be successful on the project you must complete the following steps:

1. Participate in the class discussion about energy in an ecosystem.
2. Visit different areas of our schoolyard. Identify and record organisms that you encounter in this ecosystem in the spaces below.
3. Create two food chains for the schoolyard ecosystem.
4. Combine your food chains with those of your group members to create a food web for our schoolyard. Display your food web on a large piece of paper.

Life in Our Schoolyard	
Producers:	
1.	6.
2.	7.
3.	8.
4.	9.
5.	10.





continued

Consumers: (List the consumers in the different groups that they belong in.)	
Herbivores:	Omnivores:
1.	1.
2.	2.
3.	Decomposers:
4.	1.
5.	2.
Carnivores:	
1.	3.
2.	4.

Using your list of organisms, construct two food chains in the space below.





Ecosystem Food Webs

Kelp Forest Ecosystem	Prey (Food Source)	Predator
Sun	n/a	n/a
Kelp	Sun (photosynthesis)	Sea urchins, small fish, humans
Sea urchins	Kelp	Sea otters
Sea lions	Small and large fish	Sharks
Sharks	Sea lions, small and large fish	Humans
Sea otters	Sea urchins, small and large fish	Humans
Plankton	Sun (photosynthesis)	Small fish
Small fish	Kelp, plankton	Large fish, sea otters, sea lions, sharks
Large fish	Small fish	Sea lions, sharks
Humans	Small fish, large fish, sharks, kelp	None





Ecosystem Food Webs

Coral Reef Ecosystem	Prey (Food Source)	Predator
Sun	n/a	n/a
Small fish	Algae, coral	Large fish, sharks
Crustaceans (crabs, lobsters, etc.)	Sea urchins, zooplankton	Eels, sharks
Coral polyps	Zooplankton	Snails, butterflyfish
Large fish	Small fish	Sharks
Sharks	Small and large fish, sea turtles	Humans
Phytoplankton	Sun (photosynthesis)	Zooplankton, jellyfish
Zooplankton, jellyfish	Phytoplankton	Coral, small fish
Eels	Small fish, crustaceans	Large fish, sharks
Sea turtles	Crustaceans, sea grass and algae, jellyfish	Sharks, humans



SEASCOPE LESSON



Episodes 37, 52

Keiko was an Orca whale that starred in the movie, *Free Willy*. When thousands of children petitioned for Keiko's release, the decision was made to "untrain" Keiko and get him ready to return to his home waters in Iceland. It took a great deal of time, resources, and commitment from many dedicated people to make this possible. These two SeaScope episodes explain how Keiko successfully made it back to Iceland.

Keiko: Learning to be Wild & Homeward Bound

episode 37

Keiko-Learning to be Wild

Keiko the orca is being untrained. That's right, in preparation for his release to freedom, his trainers are teaching him how to be wild by getting him physically and mentally fit for life at sea.



episode 52

Keiko-Homeward Bound

For over 18 years, Keiko the killer whale performed tricks for marine park audiences. Now he's working up to the greatest trick of all - returning home to the wild waters off Iceland. He has lots of help, including trainers, scientists, and even the U.S. Air Force!



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species depend on Others

National Science Education Standard Connection:

This lesson addresses Science as a Human Endeavor Content Standard G : Nature and History of Science by showing how difficult it is for scientific innovators to break through the accepted ideas of their time, and that sometimes it involves overcoming a challenge, giving us an opportunity to become heroes.

Background Information:

"Keiko was the star of the hit movie *Free Willy*. When a *Life* magazine story later revealed that Keiko was living in unhealthy conditions in an amusement park in Mexico City, millions of people expressed their concern. Thanks to this show of support, Keiko was nursed back to health in Oregon and returned to his original home in Iceland. Keiko then embarked on a careful training program to go back and live free in his native waters.



continued

“Keiko captured the hearts and minds of millions of children around the world when they learned that *Free Willy’s* happy Hollywood ending was a lie,” says *Ocean Futures Society* President Jean-Michel Cousteau. “Thanks to their outcry, Keiko learned to be a wild whale again.”

We often study “The Hero’s Journey” in relation to people. We admire heroes in literature and in our own lives. As an alternative, is it possible to see animals as heroes? In this case, Keiko’s life story fits the archetype description of a hero. He was separated from his home territory and pod, he was taken and cared for by humans in a new home, yet he went through challenging experiences as a captive whale. When it was revealed to children and others that he was in fact living in poor and unhealthy conditions (one might equate this with an “abyss”), he was guided back to health and wholeness. He was transferred to Oregon where his transformation began. Here, he was mentored and guided by professional scientists to re-learn how to live life in the open ocean. Initially, he was only able to stay underwater for a few minutes. Over time, he gradually improved to being able to stay underwater for up to 18 minutes. In addition, he began to re-discover how to catch and eat live prey. This transformation took a couple of years, but eventually he was ready to return to his native habitat. With a great deal of intention, resources, and follow-up care, Keiko’s return was successful. He continued to live his life off the coasts of Iceland, with other Orca whales, in peace.

This opportunity afforded us, as a human species, a challenge and an opportunity to become heroes. “Keiko’s journey inspired a massive educational effort around the world and formed the basis for several scientific studies.” (*US Human Society*, 2003) Throughout Keiko’s “hero’s journey,” he attracted many supporters. (In fact, you may find one of your students was one of them.) With an Internet quest, the students can discover how people were the key to Keiko’s success. As Keiko journeyed “home,” people were able to feel the challenge and courage required to re-train Keiko to live in the wild, the exultation of renewal and transformation that came with Keiko’s willingness to learn new behaviors, the anxiety that came with the wonderment of whether or not he would be successful, and the contentment with knowing he was peacefully living back in his home waters with other Orca whales. We, as humans, collectively took a hero’s journey to right a wrong that had been committed against an innocent creature.





Before viewing the episodes:

- 1 To introduce students to the episode, discuss the following questions:
 - a. What are Orca whales?
 - b. How many of you have been to a Marine Park and seen an Orca whale show?
 - c. Where do you think whales come from that are currently living in Marine Parks?
 - d. How do you think removing whales from the wild affects those individual whales as well as the pods from which they are taken?
 - e. Do you think it is okay to take marine mammals from the wild and put them in captivity, for:
 - Rehabilitation if they are sick or damaged
 - Scientific research
 - Education
 - Entertainment
 - f. Do you think it is possible to return animals that have been kept in captivity for long periods back into the wild?
 - g. How many of you has seen the movie, *Free Willy?* and/or know the story of Keiko the whale?

Then teacher says, "Today, we will view episodes that show how the Orca whale, Keiko, was retrained and returned to his home waters off the coast of Iceland."

- 2 Go to <http://www.keiko.com/faq.html> to read the answers to some frequently asked questions about Keiko.

- 3 You and your students can read authentic news articles written while Keiko was living, at <http://www.keiko.com/news.html>.





While viewing the episodes:

Have students answer the following questions on the **Keiko Worksheet** (see attachment) while viewing episodes 37 and 52. To differentiate instruction, teachers may decide to assign different questions to different student groups instead of having all students answer all questions.

After viewing the episodes:

The true story of Keiko's return to the wild can be used in a variety of ways in both formal and informal learning environments. It is a heroic true story that involved millions of people who contributed to bringing Keiko out of the confines of a Mexican amusement park to rehabilitation in Oregon and then to final freedom in the waters off the coast of Iceland. All those that contributed to saving Keiko's life were heroes in their own right. These heroes consisted of the children who collected money through bake sales, the scientists who worked long hours to "untrain" Keiko, the philanthropists who contributed money, the *Ocean Futures Society* staff and *Craig McCaw Foundation* that watched over Keiko's recovery, the United States Air Force that airlifted Keiko to Iceland, and the *Free Willy Keiko Foundation* and the *Humane Society of the United States*.

"The dictionary definition of a hero is "a person of distinguished courage or ability...admired for brave deeds and noble qualities...role model, ideal..." (excerpts, *Webster, Unabridged*, 2nd edition, 2001). This seems somewhat narrow and exclusive unless amplified. You may want to include the following characteristics in your description of a hero: integrity, compassion, helping those in need, moral courage and doing what you know is right." (Ann M. Hoffelder, Curriculum Consultant and Allyx Schiavone)

Have students study the timeline (teachers may print these out and distribute them to students instead of students needing to go online themselves) of Keiko's life from:

Keiko's Story: The Timeline <http://www.keiko.com/history.html> and
Timeline of Keiko's Journey <http://www.oceanfutures.org/action/marine-mammals/keiko>.

Complete the following **Lesson on Heroes** as a class.





Lesson on Heroes

1 Introduction

1. After viewing the Keiko **episodes 37** and **52** and reading some of the above online articles, ask, "What is a hero?". Have students respond with their ideas. Write their responses on the board or chart paper.
2. Ask the students to:
 - a. identify the heroes in this true life experience,
 - b. explain why he/she is a hero and why heroes are important.
(They may add to the descriptions of a hero at this point.)

2 Definition/Description

As a class, come up with a definition/description of a hero.

1. Write this summary definition/description on the board or chart paper.
2. You may want students to have this definition/description listed in their notebooks or in a folder on heroes.
3. A graphic organization with "hero" in the center circle and descriptions radiating from the circle is effective visually.

3 Identification/Naming of Heroes and Analysis

1. Using the archetype of *The Hero's Journey*, by Joseph Campbell and others, have students conceptualize how Keiko, in his journey from capture to being returned home follows the pattern of a hero.
http://myhero.com/myhero/go/teachersroom/teachersguide_whatareheroes.asp
2. Alternatively, have students make a list of all of the people who had a hand in Keiko's success story, and describe how they collectively acted as guides in Keiko's journey home. How were these people "heroic?"





Extensions:

1. Arrange the key term "hero" in the center circle. Surrounding the main circle, arrange several smaller circles with hero characteristics written inside. <http://www.webenglishteacher.com/hero.html>
2. Students can name heroes in their lives and express why those people are heroes to them.
3. Describe when they feel they have acted as a hero for another in their own life.
4. Use a computer to access the Internet, find and read stories on the My Hero website www.myhero.com. Examples from *Ocean Futures Society*, include: Jean-Michel Cousteau http://www.myhero.com/go/hero.asp?hero=Jean_Michel_Cousteau and Dr. Richard Murphy http://myhero.com/go/hero.asp?hero=Richard_Murphy_06.
5. Students can create their own "My Hero" webpage at myhero.com.

Resources:

Keiko: Wild Whale in Training: <http://www.oceanfutures.org/news/blog/keiko-wild-whale-training>

Keiko Gallery: http://www.keiko.com/photo_gallery.html

Keiko Died in Freedom, December 2003: <http://www.oceanfutures.org/news/blog/keiko-died-in-freedom>

More on Hero's Journeys:

<http://www.yourheroicjourney.com> - An excellent website that describes the Hero's journey in depth and detail.

Statement on Releasing Captive Orcas:

<http://www.oceanfutures.org/news/blog/statement-releasing-captive-orcas>

Hero Lesson modified from one created by Ann M. Hoffelder, Curriculum Consultant and Allyx Schiavone.





Keiko Worksheet

A. How were children involved with suggesting Keiko be freed to return to his original home waters?

B. Describe Keiko's rehabilitation process and who was involved in his care.

C. What precautions were taken to insure Keiko survived his transfer to Iceland?

D. How did the public in Oregon feel when Keiko flew to Iceland? Why were they both happy and sad?





Keiko Worksheet



A. How were children involved with suggesting Keiko be freed to return to his original home waters?

Children were actively involved in writing letters, communicating with various people who had control of Keiko's experience, visiting Keiko when he was in Oregon, and cheering him on when he was being transported to Iceland.

B. Describe Keiko's rehabilitation process and who was involved in his care.

Scientists and whale experts began Keiko's return to the wild by moving him to an Oregon aquarium to become "untrained." There, he got in shape by playing with specially designed toys, and being encouraged to develop his own games. Through these activities he became more independent. He had his teeth fixed, learned how to eat live fish, hold his breath up to 18 minutes, and gained a ton of weight. He also developed a more "wild" attitude.

The U.S. Air Force supplied the plane which flew Keiko to Iceland

C. What precautions were taken to insure Keiko survived his transfer to Iceland?

A special sling was made to transport Keiko from the aquarium
Special ointment was applied to keep him moist and protect his skin
While being transported, he was kept in the sling and constantly splashed with water.
The U. S. Air Force allowed him to fly in a special transport plane.
He was hoisted out of plane by a crane and put into a specially designed Bay Pen in the ocean with fresh, cold sea water

D. How did the public in Oregon feel when Keiko flew to Iceland? Why were they both happy and sad?

The people in Oregon that had watched Keiko's rehabilitation process became very attached to Keiko. So, when it was time to leave, they were both happy for him to be returning to his home, however at the same time they were sad to say "Good-bye" to him.



SEASCOPE LESSON

key concept

Episodes 2, 18, 38, 40

This lesson shows the structure, function and needs of marine mammals. It also demonstrates the human qualities required to study marine mammals in the wild.

Marine Mammal Biologists

episode
2

Whale Wishers

Before they start on their long migration north, the friendly whales of San Ignacio Lagoon in Mexico get a warm send-off from people who gently stroke the animals' heads.



episode
18

Spotted Dolphins

Spotted dolphins use a sonar buzz to stun tiny fish that live in the sand and then they dig them up for dinner. When bottlenose dolphins come to join the dinner party, they seem to be welcome guests at first, but then they are chased away in no uncertain terms.



episode
38

Manatees

Manatees or sea cows spend most of their lives eating plants—up to 100 pounds each day. A manatee's life sounds boring, but it can be dangerous when boats are nearby. Luckily, a series of refuges now protect about a thousand of these once plentiful marine mammals from poachers and propellers.



episode
40

Elephant Seals

Elephant seals are champion divers who go nearly a mile deep in search of food. But it's on land that they play out an important part of their social life, fighting over beach territory to win a harem of females.





Introduction:

Ambassadors of the Environment Principle:

Everything is connected: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Content Standard C: Structure and Function in Living Systems* by demonstrating the complimentary nature of structure and function in various marine mammals. It also addresses *Content Standard G: Science as a Human Endeavor* by showing that science requires different human qualities such as reasoning, insight, energy, skill and creativity.

Background Information:

Working with marine mammals is appealing because of strong public interest in these animals and because the work is personally rewarding. However, competition for positions is keen.

Marine mammal scientists are hired because of their skills as scientists, not because they like or want to work with marine mammals. A strong academic background in basic sciences, such as biology, chemistry, and physics, coupled with good training in mathematics and computers, is the best way to prepare for a career in marine mammal science. Persistence and diverse experiences make the most qualified individuals. Often developing a specialized scientific skill or technique, such as acoustics analysis, biostatistics, genetic analysis, or biomolecular analyses, provides a competitive edge.

It is important for marine mammal scientists to have a understanding of their marine mammal's physiology, behavior, habitat, interactions with humans, history, and conservation status in the world today. Therefore, these scientists must be well educated in their field. They must also be tuned in to world events regarding the various threats to their marine mammal's survival-- threats from global climate change to habitat loss and boat strikes.

Information on a marine mammal biologist can be accessed at: www.marinecareers.net/field_marinebiology.php





Before viewing the episode:

- 1 Students are applying for a job at the local natural history museum to study marine mammals—manatees, whales, dolphins, and elephant seals.
- 2 Students choose one of the 4 marine mammal stations set up by the teacher.
- 3 Students complete the first 2 parts (K and W) of the **K-W-L Chart** for that mammal (see attached).
- 4 Students need to be ready to explain why they want to work with marine mammals.

While viewing the episode:

- 1 View the *SeaScope* episode at the station completing the third part (L) of the **K-W-L Chart**. Pay special attention to habitat, feeding and behavior.

After viewing the episode:

- 1 Students, working in cooperative groups, will fill out individual job applications and complete the sample interview questions as a group (see attached).

Extensions:

Students have been hired as a field biologist; they must now design their research protocols that are appropriate for the animals they are studying and environmental conditions.

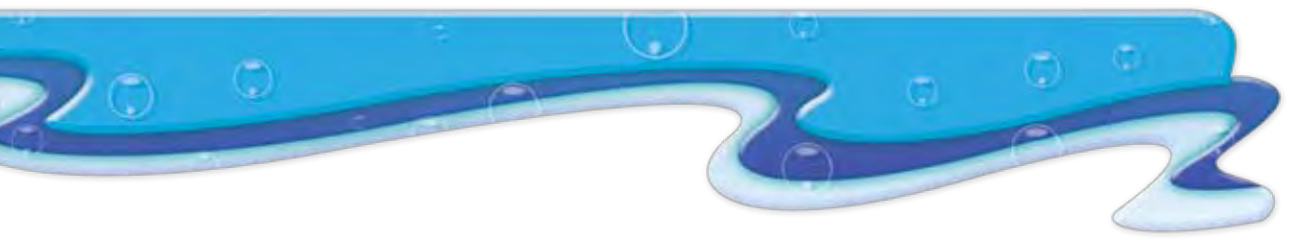
Resources:

Gray Whale Obstacle Course:
Jean-Michel Cousteau Ocean Adventures, PBS special: www.pbs.org/kqed/oceanadventures/episodes/whales/

Jean-Michel Cousteau Ocean Adventures lesson plans: Ocean Careers: <http://www.pbs.org/kqed/oceanadventures/educators/oceancareers/>

The Marine Mammal Center: www.marinemammalcenter.org/





K-W-L Chart

About: _____

What I KNOW	What I WANT to Know	What I LEARNED





Sample Interview Questions

Please explain why you want to research and study marine mammals?

Feeding

1. What does your marine mammal normally eat in the wild?
2. Does your marine mammal live in a group to feed or does it feed independently?
3. Does your marine mammal migrate to specific feeding grounds?

Behavior

1. What kind of behavior does your animal exhibit in the wild?

Educating others about your marine mammal

1. What are 5 of the most important things you have learned about your marine mammal?
2. What are the 3 essential things you would want to teach others about your marine mammal while researching them in the wild?

Habitat

1. Describe the natural habitat of your marine mammal.
2. Draw a detailed picture for an educational display about your marine mammal: general ecology and natural history.
3. If your marine mammal is dependent on a specific habitat for feeding, are there conservation measures in place to protect their critical habitat?



SEASCOPE LESSON

key concept

Episodes 23, 25, 42, 44, 47, 49

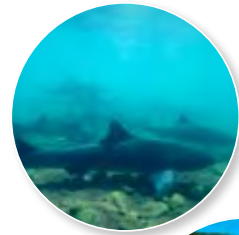
These six episodes show several examples of how science and technology are reciprocal. They give students an understanding of how technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable. They show how technology also provides tools for investigations, inquiry, and analysis.

Problem-Solving Marine Scientists

episode
23

Filming Leopard Sharks

When large numbers of leopard sharks gather in the shallow waters off Catalina Island, scientists have an opportunity to locate and observe tagged sharks. Jean-Michel and his team are on hand to capture the action. But the camera-shy sharks pose a filming challenge, so remote cameras and even disguises are used to assist in getting the elusive close-ups.



episode
25

Aqua-culture

Today turtles and giant clams are endangered, but some people are helping by raising baby turtles and clams in underwater farms and then releasing them into the wild.



episode
42

Friendly Monk

Monk seals were once hunted for their fur, so they are usually shy. But off Hawaii one monk seal loved to swim with people, and nobody knows why. Was he in a zoo? Was he somebody's pet? Now the seal has returned to his own wild world, but the mystery lingers.



episode
44

Marine Mammal Rescue

Twenty years ago, Peter Howorth caught sea lions for marine parks, now he catches them for their own good. Peter's Santa Barbara Marine Mammal Rescue Center helps stranded, injured and entangled creatures get healthy and then gives them the ultimate gift- their freedom.



episode
47

SeaScience

In order to protect the sea, people have to understand it, and that means studying things like coral reefs and fish populations up close. But how do you perform science underwater when it's hard enough in the lab? Scientists always find a way.



episode
49

Deeper & Longer

People have long wanted to swim free underwater, like fish and marine mammals, but only in the last 150 years did they invent the gear to help them do it. Now there are new frontiers, and the quest to go deeper and stay longer continues in a new generation of space-age technology.





Introduction:

Ambassadors of the Environment Principles:

Everything is Connected: All Species depend on Others

Biodiversity is Good: The More Variety the Better

National Science Education Standard Connection:

This lesson addresses *Content Standard E: Understandings about Science and Technology* by having students investigate six scientific problems that are currently being studied by marine biologists. It shows that technological solutions and designs have trade-offs and constraints. This lesson also shows that many different people in different cultures have made and continue to make contributions to science and technology.

Background Information:

Scientists need to be curious and passionate about what they are doing. They have respect for the truth and confidence that they are asking a good question and pursuing solutions with integrity. Much of the work of a scientist requires patience and stamina. There are many types of successful scientists. Qualities that can lead to a person becoming a good scientist, apart from a desire to do research, include intelligence, creativity, tenacity, and hard work. Students in school need to recognize and practice these qualities.





Before viewing the episodes:

- 1 Draw a Scientist:** In order for students to gain an understanding of their own preconceptions about science and scientists, have them draw a picture of a person doing science. Students should include what the scientist studies and what the scientist is doing in the drawing. Within the description, have the students focus on describing how the scientist approaches scientific problems. Collect and save these drawings/descriptions for later in the lesson
- 2 Students' Topic Selection:** Have students choose which episode they would like to watch and produce a presentation for. They can choose from studies related to (see descriptions above):
 - a. Leopard Sharks:** How would you go about studying sharks we don't know much about?
 - b. Aquaculture—Raising Turtles and Clams:** How would you replenish marine organisms that have been depleted due to over fishing?
 - c. Monk Seals, Sea Lions, and Seals:** How would you help marine organisms while still keeping them wild?
 - d. Marine Mammal Rescue:** How would you propose rescuing marine mammals, like sea lions and whales that have been caught in fishing nets?
 - e. Studying Coral Reefs and Fish Up Close:** How would you use the sea to study environmental changes?
 - f. Ways to Study the Underwater World:** How would you use and develop technology to enable marine scientists to dive deeper and stay underwater longer?
- 3** Group students according to their choices. Have each group brainstorm and write down their answers for their group's question. Encourage students to be as creative as possible with their suggestions.





While viewing the episodes:

Each group will view their episode and use the **Problem-solving Marine Scientists** sheet to fill in answers to their question.

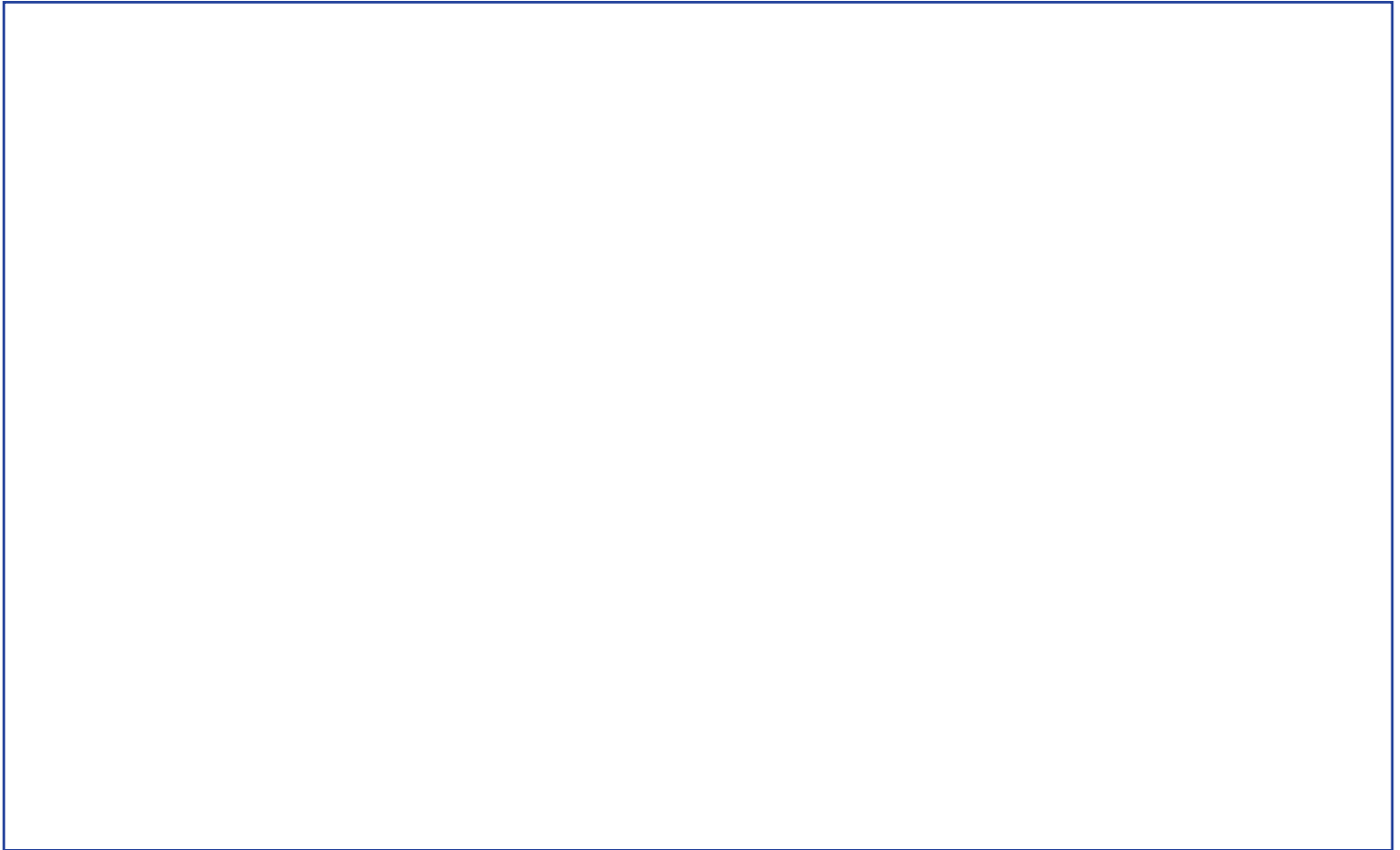
After viewing the episodes:

- 1 Students will continue to use the **Problem-solving Marine Scientists** sheet as they pursue answering their question using additional resources (i.e. Internet, books, interviews with scientists, etc.). Again, encourage students to be creative as they suggest solutions to their scientific problems.
- 2 Students, in their groups, create a 3-D “museum exhibit.” (Possibly using a tri-fold poster board for display.)
- 3 Students visit their peers’ “Museum” displays to identify ways that researchers are working to creatively solve marine problems. Teachers may choose the criteria that the students will use to complete the project.
- 4 As a class, discuss the various characteristics that all of these researchers have in common (e.g. curiosity, creativity, persistence, hard work, education, as well as using equipment, collecting data, analyzing, reporting results, asking questions, etc.). See *Becoming a Scientist* at <http://www.hhmi.org/becoming/> to learn how to become a scientist.
- 5 **Re-draw A Scientist:** Have students use a blank **Draw a Scientist** worksheet. Ask students compare their new drawings and descriptions with their previous ones. Do they see any changes in their perceptions of who scientists are, what they do, and how they approach scientific problems? If so, how are their perceptions different? Do their drawings represent a more diverse group of scientists?





Draw a Scientist

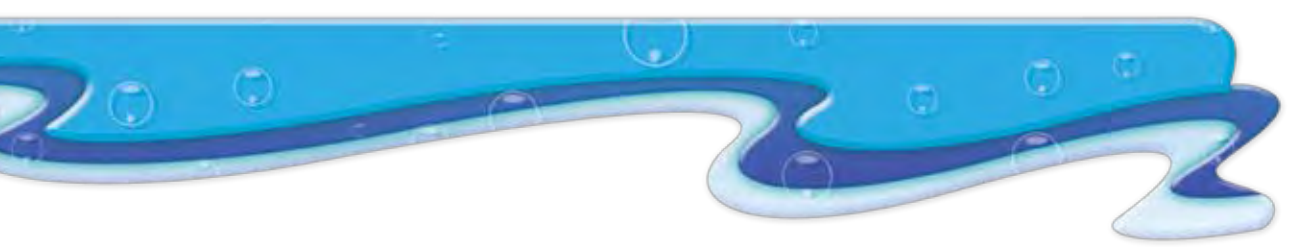


1. What is your scientist's name? _____

2. What does your scientist study? _____

3. Describe your scientist (in particular, describe how your scientist approaches scientific problems). _____





Problem-solving Marine Scientists

Scientific Problem: (write your scientific problem here)

New Vocabulary: (write down words that are new to you)

Background Information:

Hypothesis:

Procedure:

Expert Authority (resources):

Why does your group think this is a good solution?



The environment is becoming degraded as the human population increases. Causes of environmental degradation and resource depletion vary from region to region and from country to country, but pollution and environmental degradation even many miles from a reef can affect it because runoff connects land and sea.

Reef Killers

Reef Killers

Polluted water stresses corals. Even things as simple as sediments and nutrients can cause corals to die. The crown of thorns sea star is beautiful, but when there is pollution in the water, they have a baby boom. This sudden population explosion poses a big problem for reefs because crown of thorns eat coral. And when there are too many crown of thorns, they can devour and destroy a whole reef.

episode
17

Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Life Science Content Standard F: Science in Personal and Social Perspectives* by showing how the coral reef ecosystem may become unbalanced due to human activities such as resource acquisition, urban growth, land-use decisions, and waste disposal. Students should understand the risks associated with chemical hazards (pollutants in air, water, soil, and food).

Background Information:

While the coral reef is one of the most complex and diverse environments in the world, it is also one of the most delicate.

Moving water carries soil. The stronger the flows of water, the more soil it moves. Most of the soil settles out of the water as the motion of the water slows or stops. The heaviest particles settle first, the smallest particles stay in the water the longest. Shoreline development, agricultural expansion, and sewage runoff cause silt, sediments, and excess nutrients to wash into the sea. This runoff can cause major problems in tropical areas where delicate coral reefs border the coastline. Soil particles in water reduce the penetration of light that affects the algae (zooxanthellae) making food for the coral. Soil may

Information from National Aquarium in Baltimore:
<http://www.aqua.org/>



continued

smother corals or clog the gills of aquatic organisms.

Also, chemical fertilizer and pesticides from the soil on land can leach into the sea as runoff. These chemicals can stress or kill sensitive species like corals, crustaceans and fish. Particularly sensitive are the eggs and larvae of marine organisms. In addition to these threats, anchors from fishing boats, divers and snorkelers standing on corals or collecting from them harm coral reefs.

Before viewing the episode:

- 1 Find and share satellite photos of soil erosion and sediment plumes:
<http://celebrating200years.noaa.gov/visions/coral/image2.html>
<http://www.cinms.nos.noaa.gov/pcw2/seawif.html>
<http://archive.orr.noaa.gov/photos/exxon/17.html>
<http://www.sciencedaily.com/releases/2007/02/070227105400.htm>
http://disc.gsfc.nasa.gov/oceancolor/scifocus/classic_scenes/10_classics_rivers.shtml
- 2 Ask students, "What happens when soil erodes from the land and enters aquatic habitats?"
- 3 Ask students to brainstorm what might be in the sediment plumes besides soil. Discuss answers.
- 4 Direct students to look over the attached **Anticipation Guide** and jot down their best guess for the source and consequence for each threat to the coral reef in the rows marked, "Hypothesis".





While viewing the episode:

- 1 Students take notes on actual sources and consequences.

After viewing the episode:

- 1 Discuss the items on the **Anticipation Guide**.

- 2 Students test the effect of soil in water on the penetration of light. Prepare 4 labeled jars of water.

- one has just water
- one contains 2 spoonfuls of soil in water
- one contains 1/4 cup of soil in water
- one contains 1 cup of soil in water

- 3 Make a Secchi disk for the jars experiment using big painted metal washers. (See how to make a Secchi disk at <http://dipin.kent.edu/makedisk.htm>)

- 4 Lower Secchi disk into the water until it disappears when watching from above and record its depth in cm. Measure the turbidity of the water immediately after shaking and periodically afterward to measure the rate of settling. Graph the results.

- 5 Repeat experiment, changing size of soil particles as a different variable.

Resources:

Article: "Experts Tracking Coral Reef Killers:" <http://www.msnbc.msn.com/id/13281295/>

Article: "Scientists examine the decline of Florida Bay:" <http://www.flmnh.ufl.edu/Fish/southflorida/news/floridabay2004.html>

Don't Teach Your Trash to Swim – Reef Relief Poster: <http://reefrelieffounders.com/images/marine-debris-timeline-by-joel-biddle.jpg>

Household Guide to Coral Reef Protection: <http://reefrelieffounders.com/household-guide-to-coral-reef-protection.html>

Living in Water, Activity 16: Dirty Water, National Aquarium in Baltimore, 1997: www.aqua.org





Optional Activities:

- 1** Analyze the labels of plant fertilizers to discover what common plant nutrients are. Students should find compounds containing nitrogen, phosphate, and potassium. Many brands have a number of other chemicals as well. Students could research the purpose of these chemicals and their effects on living things in the ocean.
- 2** Identify a problem of soil erosion in your school playground or community that affects aquatic environments. You might call your local Soil Conservation District officer to ask about a local problem your class could study and propose a solution.





Reef Killers Anticipation Guide

Threat	Source	Consequence
Runoff	Hypothesis:	
	Actual:	
Pollution	Hypothesis:	
	Actual:	
Crown of Thorns Sea Star	Hypothesis:	
	Actual:	
Fertilizer	Hypothesis:	
	Actual:	
Fishermen	Hypothesis:	
	Actual:	





Reef Killers Anticipation Guide



Threat	Source	Consequence
Runoff	Hypothesis:	
	Actual: Trees are cut down and there is no longer a root network to hold soil in place.	Sediments cloud the water and settle on the reef. Covers coral and deprives it of sunlight and food.
Pollution	Hypothesis:	
	Actual: Sewage from pipes dumps into the ocean.	Nutrients from sewage act like fertilizer, causing algae to grow fast and cover up the reef.
Crown of Thorns Sea Star	Hypothesis:	
	Actual: Increased nutrients cause an algae bloom; young crown of thorn sea stars eat algae and therefore more survive and grow into adults.	Adults eat coral; too many crown of thorn sea stars, many coral destroyed
Fertilizer	Hypothesis:	
	Actual: Fertilizer runoff from farm fields also acts as fertilizer on marine algae.	Marine algae overgrow the reef, covering coral or eliminating habitat for young corals
Fishermen	Hypothesis:	
	Actual: Rely on reefs for food	If fish move away because coral die, fishermen will have less food.



Sometimes it's better to conserve fish than to eat them.

The Value of a Fish

Value of a Fish

The people of the Cayman Islands have realized that many fish are more valuable alive than dead on a dinner plate. Underwater celebrities like Freddy the grouper, the tarpons of Tarpon Alley, and the stingrays of Stingray City attract many divers and generate a lot of money for this island economy.



Introduction:

Ambassadors of the Environment Principle:

Everything is Connected: All Species Depend on Others

National Science Education Standard Connection:

This lesson addresses *Content Standard F: Science in Personal and Social Perspectives* by showing how coral reef organisms are being used to improve personal and community health.

Background Information:

Fish populations around the world are in serious decline. The *UN Food and Agriculture Organization* considers about 75 percent of all fish fully exploited, over-exploited or depleted. Catches are shrinking along with the average size of the fish. Just a few short decades ago the same fish averaged 300-400 pounds and could be caught close to shore with a harpoon. Biomass is another term for the size and weight of a fish. The biomass of large fish has declined by about 90 percent in the Pacific since 1950. Large fish in the sea are like lions and tigers on land. They control populations of their prey and thus have an important ecological role in the sea, without them ocean ecosystems become out of balance. Thus it is important to protect these ecologically important species.

Solutions to this problem include the creation of marine protected areas where either fish are not caught, or the number of fish caught and number of people catching fish are limited. Not only do these protected areas allow fish to flourish, but they also promote tourism. Tourists often travel great distances to experience nature, wild nature and even wild nature underwater. In marine parks where spear fishing is prohibited, fish soon learn not to fear people. Tourists who want



continued

to see fish up close and personal hire guides, go to reefs in boats, rent equipment, stay in hotels, and enjoy nice meals. All of this costs money and that money is paid to people and businesses in local communities. So if we calculate the amounts of money paid by tourists to enjoy seeing fish in their world and compare this to the amount of money an angler would receive for selling a fish in the market we are likely to find that fish are worth far more alive attracting tourists than dead. In the Cayman Islands just this has happened, people pay to swim with stingrays and the economy of the community has benefited greatly from protecting fish rather than killing them.

Before viewing the episode:

This activity is adapted from *Summarization in any Subject* by Rich Wormeli, 2005.

- 1 Teacher divides the class into 2 groups. One group will play the role of people from a developing country, the other group the role of people from a developed country.
- 2 Teacher creates a **P-M-I Chart** (see attached) where students are given a statement to consider from their groups point of view.
- 3 Ask students to record their response to the statement at the top of their **P-M-I Chart**. Then have them fill in the advantages of the idea in the pluses column, disadvantages or negatives in the minuses column, and those aspects of the idea that don't fall neatly into either category—plus or minus—in the interesting column. (First reflections should be done individually).





continued

▶ **4** When students finish, ask them to share their responses with a partner or small group, any ideas shared within the group can be added to any student's recorded ideas.

▶ **5** Show film.

After viewing the episode:

▶ **1** Create a large version of the chart in the front of the room. Students post their responses for each column on the chart using sentence strips, post-it notes or index cards.

▶ **2** Ask students to reflect on where the strongest arguments lie. Usually one column has the majority of arguments and they are often the most compelling. Students should respond purely on evidence and not just emotion. Students should reexamine their initial positions. Did they change?





Extensions:

Teacher may wish to extend this activity into a debate format. The websites listed below are examples of debates using different points of view.

Amazon Eco-tourism game: <http://www.eduweb.com/amazon.html>

In-Depth: Stakeholders - Sharing Our Waters by Kelly Whalen
<http://www.pbs.org/kqed/oceanadventures/episodes/treasures/stakeholders/>

Sustainable Tourism in Hawaii:
<http://www.hawaiianatolls.org/teachers/pdf/TownMeeting.pdf>

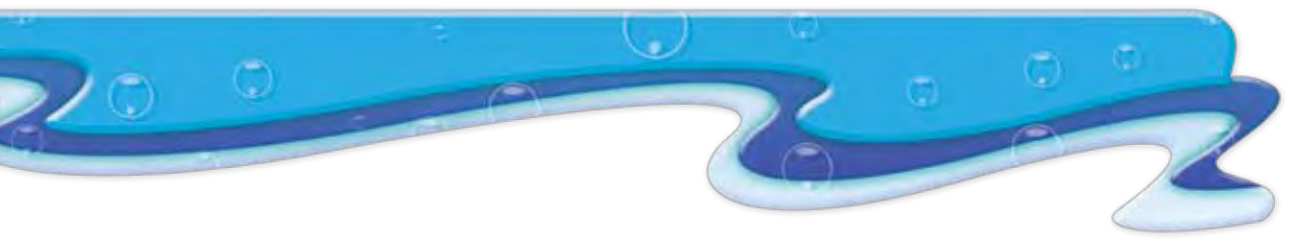
Resources:

Sustainable Tourism Resources:
<http://www.gdrc.org/uem/eco-tour/eco-tour.html>

Good Gone Wild by Eric Jaffe:
http://www.phschool.com/science/science_news/articles/good_gone_wild.html

National Geographic: Geo-friendly Travel:
<http://www.nationalgeographic.com/xpeditions/lessons/06/g68/geofriendly.html>





P-M-I Chart

Statement: In developing countries, fish are best used as food, not tourist attractions.

Student Response:

Pluses	Minuses	Interesting

