

# ECO GUIDE

*exploring aquatic ecosystems*

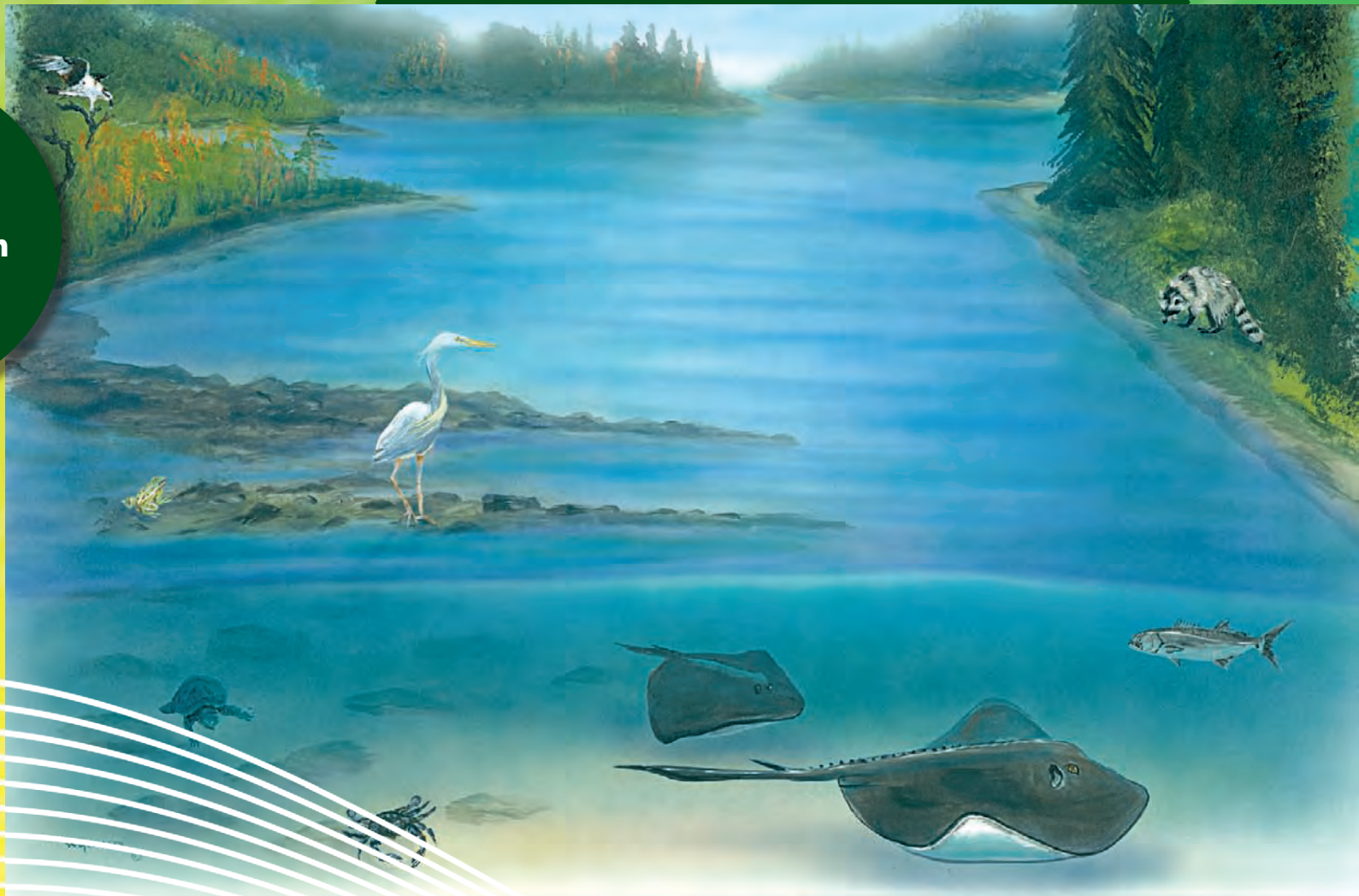
CLEAN WATER FOR THE 21<sup>ST</sup> CENTURY

# Estuaries

## WIN

A visit and  
painting lesson  
from Wyland!

See back page for details.



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# What are estuaries?

Estuaries are some of the most interesting—and complex—water habitats.

Estuaries are places where fresh water from rivers meets salt water from the ocean. These meeting places don't have sharp boundaries like the boundaries between states, however.

In an estuary, fresh and salt water mix in a variety of ways depending on the shape of the land, the strength of the flow of water in the river, and the force of tides from the ocean.

Estuaries usually are partly closed areas that slow down the river water, giving it time to mix with salt water and elements found in the land along the shore. The mixing creates a rich and complex environment that can support thousands of varieties of plant and marine life.

Bays, harbors, lagoons, sounds, and coves can all be estuaries. The Chesapeake Bay in Maryland, in fact, is the largest estuary in the United States. Estuaries also can be formed by coral reefs, sandbars, spits of land, or rock deposits that create sheltered areas along the ocean's shore can also form estuaries. They may also contain swamps, marshes, and various other wetland habitats.

Many shellfish, birds, and fish spend their whole lives in and around estuaries. Even many fish that live most of their lives in the ocean come to estuaries to lay eggs or give birth to young. An estuary is a safer and more protected environment for young animals. Spending their young lives in an estuary habitat gives them a better chance of surviving than they would have in the open ocean.

Estuaries are home to so many plant and animal species that many estuaries are among the most life-filled places on the planet.



## Estuaries

IN THE SUN SENTINEL

Estuaries are among the richest habitats in the world for wildlife and marine life. In the photos, stories, and ads in the *Sun Sentinel* or *Sun Sentinel Digital Edition*, find an animal, bird, fish, or amphibian that would live in an estuary. Write its name in the middle of a sheet of paper. Then create a "Web of Life" showing other plants, animals, or marine life that would be connected to your choice as either predators or prey. Finish by showing the connections between other kinds of wildlife in your estuary Web of Life.

### credits:

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### About the Sun Sentinel News In Education program:

Throughout the school year, the Sun Sentinel NIE program provides newspapers, both digital and print, to South Florida schools at no charge. Our goal has been to help teachers help their students, promote literacy, encourage hands-on learning using the newspaper, and help students stay up-to-date on the world around them. Another key focus of our program is providing curriculum materials, like **Wyland Estuaries**, to enhance lessons in the classroom across all subject areas. These complimentary booklets are aligned with the Sunshine State Standards

For more information about Sun Sentinel News in Education and to download educational materials, such as an expanded Estuaries curriculum, visit our website at: [www.SunSentinel.com/nie](http://www.SunSentinel.com/nie) Click on the Teacher tab, then Free Curricula!





There are 102 major estuaries in the United States, according to the U.S. Environmental Protection Agency. Of these, 28 have been designated by their states and the federal government to be of national importance.



## How are estuaries formed?

To understand how estuaries are formed, you need to first understand the different shapes that land takes along rivers and oceans.

The study of the way land is shaped is called topography.

Topography is one way that scientists put estuaries into categories so that people can better understand them.

Using topography, scientists divide estuaries into four main categories.

### Flooded, drowned, or coastal

The first type is known by several names: flooded river valley estuary, drowned river valley estuary, or coastal plain estuary. This type of estuary was generally formed at the end of the last ice age about 10,000 years ago. When the glaciers of the ice age melted, the level of seawater rose all around the world because water from melting glaciers went into the oceans. As the sea level rose, the areas where many rivers met the sea were covered by water. In these shallow areas, fresh and salt water mixed in an estuary.

### Bar-built

The second kind of estuary is a bar-built estuary. A sand bar is a place where

sand and sediment build up, creating an obstruction that forces water to flow around it. When a river meets the ocean, sediment sometimes falls out of the water as the river water slows down. At the same time, sand pushed toward the shore by the ocean builds up from the other side. When this sand or sediment forms bars that block the river from the ocean, a bar-built estuary is formed.

### Fjords

Fjord estuaries were formed by the movement of glaciers sliding over land. Fjords (pronounced FEE-ords) are narrow inlets bordered by steep cliffs that were created during the last ice age. When the Earth warmed and the ice melted, the ocean flowed into the steep fjord river valleys, mixing with fresh water to form fjord estuaries. One important feature of a fjord estuary is that many of them have a sill of rock formed from debris dropped by the glacier at the place where the fjord meets the open sea. As a result, fjord estuaries have shallow water at their entrance but very deep water inside.

### Tectonics

The last category scientists have created for estuaries is a tectonic estuary. The earth's outer layer, or crust, contains large sheets of rock, called tectonic plates, which can overlap or push against each other. When pressure and energy cause the plates to move in coastal areas, land near the plates sometimes drops or collapses, and sea water moves into the collapsed area. If there is a river flowing through this area, it mixes with sea water to form a tectonic estuary. The famous San Francisco Bay in California is a tectonic estuary.

## Activity

Research to discover which type(s) of estuaries are found in south Florida. Select one of these and become an expert. Using the *Sun Sentinel* or *Sun Sentinel Digital Edition* and other resources, prepare an oral or multi-media presentation to inform your class about your estuary. Be sure to site your references.



# WHAT IS A WATERSHED?

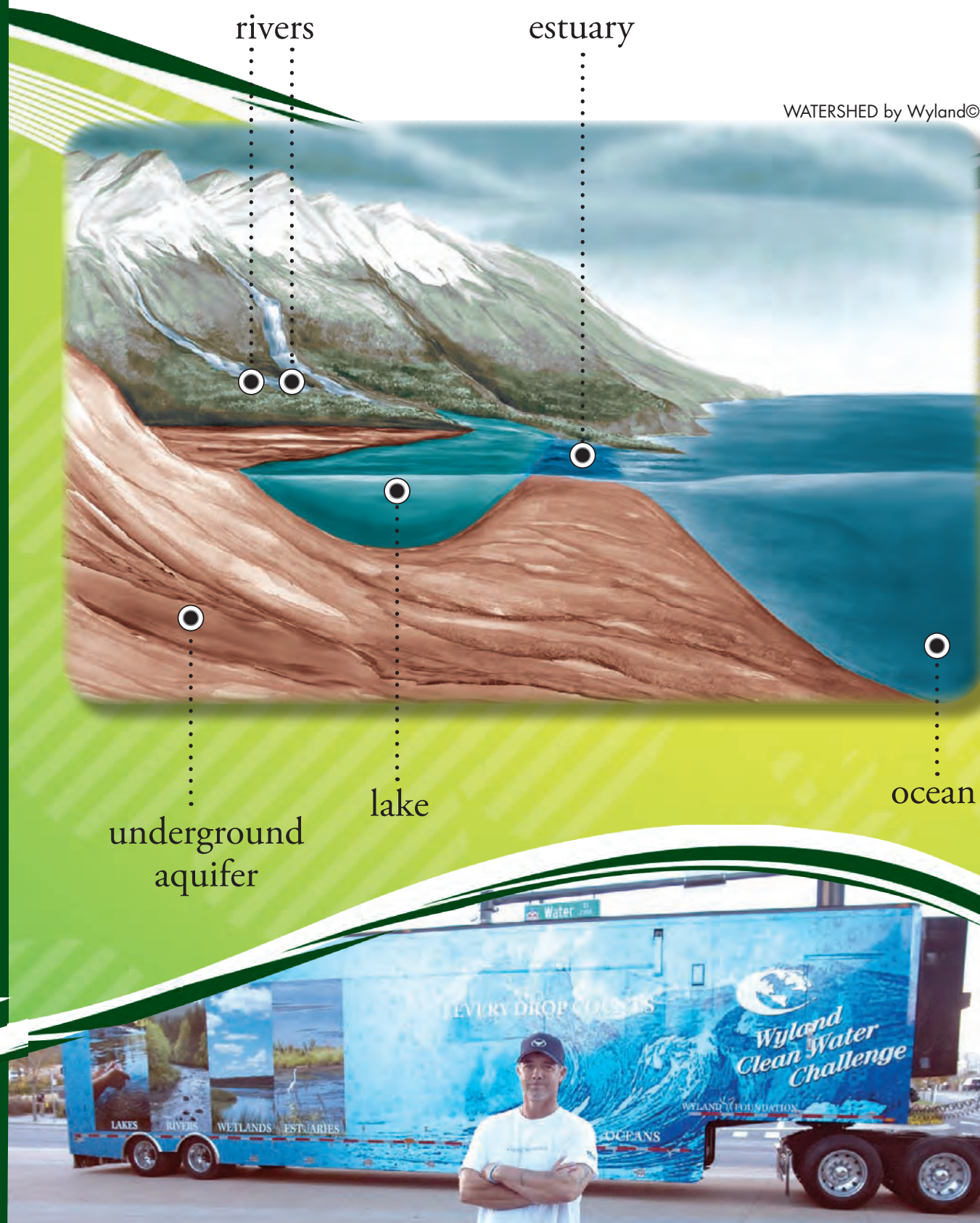
In every area of the Earth, the highest points of land form natural boundaries from which water runs downhill. Because of gravity, water always runs down from high points like mountains and hills to lower points in lakes, rivers, wetlands, and estuaries. Eventually, all water drains into the world's oceans.

In every area, the water flows into what is called a "watershed" because the water "sheds" from high areas and travels into the low areas.

The water in wetlands eventually evaporates, drains into rivers or lakes, and makes its way to the ocean. Or it seeps into the earth and runs through the ground as groundwater. Although this water moves more slowly than water on top of the earth, it eventually rejoins the flow of water through a watershed.

## KEY PARTS OF WATERSHEDS

Estuaries are where freshwater meets the salty water of the sea. Estuaries are somewhat protected from the open ocean, so the water flushes slowly out of estuaries. It is because of this slow movement and mixing of water that the health of an estuary can reflect the health of the whole watershed. Water tested here tells the story of what it picked up while traveling through the rest of the watershed.



# What kind of water is in an estuary?

## Activity Mix It Up

HERE'S AN EXPERIMENT YOU CAN DO TO SEE HOW SALT AND FRESH WATER MIX.

Get two cups of water. Add a tablespoon of salt to one cup and stir it around. Use food coloring and make this water blue.

In the second cup, keep the water fresh and add red food coloring.

Take 20 drops of water from the blue cup and put into the red fresh water cup.

Take 20 drops of water from the red freshwater cup and put them into the blue salt water cup. Wait five minutes. Do not bump or stir your cups.

Record what happens in each cup. You have just seen what happens in an estuary!

Some scientists divide estuaries into categories by the way the water moves in them, and the ways salt and fresh water mix. This approach is a kind of science called hydrodynamics. Scientists have three main ways to classify estuaries based on hydrodynamics.

### Salt and Tides

The properties of salt and fresh water, and the movement of tides, play a big role in the hydrodynamic categories of estuaries.

Because it contains the mineral salt, salt water is more dense than fresh water. Because it is more dense, salt water will sink beneath fresh water. As a result, fresh water and salt water interact in some very interesting ways in an estuary.

Tides are caused by the pull of gravity from the Earth's moon. Both the moon and the Earth have gravity, a force which pulls other objects toward it. The pull of the moon's gravity causes water in the oceans to rise and fall in every 24-hour period. If the tide rises and falls by many feet, areas experience strong tides. If the water does not rise and fall very much, areas have weak tides. Some places can experience both very strong and very weak tides, depending on the pull of the moon at different times of the month.

### Salt-Wedge Estuary

One category scientists have created based on hydrodynamics is the Salt-Wedge Estuary. In a salt-wedge estuary, the flow of a river is very strong, but the tides that change the level of the seawater are weak. The fresh water flows out of the river quickly, and moves over salty seawater in a wedge-like pattern. In salt-wedge estuaries the water close to the mouth of the river, at what is called head of the estuary, is mostly fresh water at all depths.

The farther you move from the head of the estuary, the thinner the layer of fresh water on top becomes and the greater the layer of salt water underneath. In the place where the estuary meets the open sea, there is just a thin layer of fresh water on top of the salt water.

### Partially Mixed Estuary

A second category based on hydrodynamics is the Partially Mixed Estuary.

In a partially mixed estuary, the river and the ocean water flow with similar strength.

Because of this, the fresh water cannot just flow out over the salt water as it does in a salt wedge estuary. In a partially mixed estuary the fresh and salt water are mixed together by the movement of the water caused by the meeting of two energetic flows. The water at the top will still be less salty, but it will grow saltier the closer it gets to the ocean.

### Well Mixed Estuary

In a Well Mixed Estuary the tides cause ocean water to flow with more strength than the river water. As a result, the salt water has a chance to mix thoroughly with the fresh water, even though it is heavier. Well mixed estuaries are often shallow. As the salt water is pushed forward and back by strong tides in this shallow bit of water, it mixes completely with the fresh water. The water in a well mixed estuary is equally salty from top to bottom. The mixed water flows very slowly toward the sea.

Be aware that in some estuaries fresh and salt water may not mix at all times. Sometimes during a dry season fresh water may not flow into an estuary, and sometimes tides may be so low that ocean water does not reach the estuary.

Explore your impact on our ocean, lakes, rivers, streams and wetlands in the Wyland "Water's Extreme Journey Maze", a fascinating interactive labyrinth that tests your knowledge and your sense of direction. Can you find your way out to the clean ocean?



# FOODweb

In the natural world, everything is connected. Some people call these connections the web of life, others refer to them as the food web. The food web is easy to understand - every living thing in an ecosystem is connected. Larger animals feed on smaller animals, or animals feed on plants. At every point of the web, animals need healthy plants or healthy smaller animals to feed on.



Go online and look for pictures of estuaries taken from space or from planes. This bird's eye view will give you a good idea of how estuaries are sheltered from the ocean. Then choose a type of estuary and draw your own bird's eye view which includes the river, the place where fresh and salt water mix, the ocean, and the land that shelters the estuary.

# Get Involved!



## 5 Ways YOU CAN HELP

1. Get a Seafood Watch card. The card will tell you what kind of seafood is over-fished so you can make an educated choice about what you eat. Monterey Bay Aquarium has cards you can print out and put in your pocket or wallet. [www.montereybayaquarium.org/cr/cr\\_seafoodwatch/download.aspx](http://www.montereybayaquarium.org/cr/cr_seafoodwatch/download.aspx)
2. If you have a yard, use only natural fertilizers for your lawn and plants to help keep chemicals out of the watershed. Leaving grass clippings on the lawn will fertilize it better than store-bought chemicals, doesn't cost a thing, and won't get into the watershed!
3. Don't litter and be sure to recycle whatever you can. Keeping plastics out of watersheds and landfills solves a lot of problems.
4. Find out about an estuary in your area and, if you can, plan a visit. Many estuaries have visitor centers that welcome volunteers to help with projects like cleanups, counting animals, or planting.
5. Create a newsletter or website about your local estuary and share it with friends, parents, and neighbors. They may not realize how amazing estuaries can be!



Harshit Agrawal, Age 12  
New Delhi, India

New Delhi is full of ancient traditions and monuments. But for Harshit Agrawal, the capital city of India holds the key to his country's environmental future. As a founding member of "Little Eco Friends," Harshit is working with his friends and family to improve the environment in India and around the planet. From performing street plays and organizing marches to hanging posters and forming human chains, Harshit encourages others to get involved in making change happen.

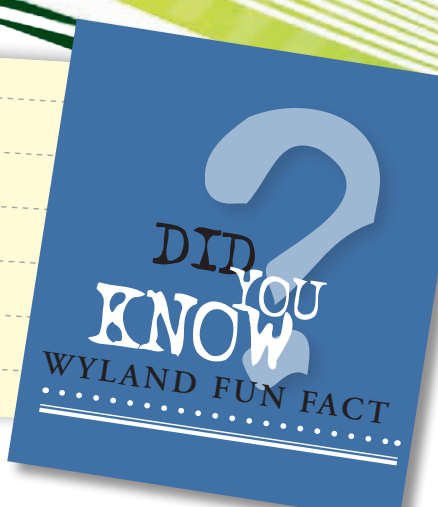
He has organized successful campaigns for the conservation of safe water and against plastic bags. His current project, "Don't Waste Waste," is raising awareness about how useful waste can be. Harshit is also busy attending environmental conferences all over the globe spreading his message, vowing to "help Mother Earth become cleaner and greener."

## Water

### IN THE SUN SENTINEL

Pollution can affect all bodies of water, not just estuaries. Look through the *Sun Sentinel* or *Sun Sentinel Digital Edition* and find a story or photo involving waterways or estuaries in your area. Write an essay describing ways water pollution could affect the area involved and the wildlife that lives in it. Then write a second paragraph describing how to correct water pollution if it exists or prevent it if it does not exist.

On many shoreline areas of the Chesapeake Bay, you can find ancient fossilized shark teeth. A single shark can go through as many as 50,000 teeth in its lifetime.







Learn about the Wyland Living Green Fair at [www.LivingGreenFair.com](http://www.LivingGreenFair.com)

November 5th, 6th and 7th at Mizner Park in Boca Raton.

# Wyland Living green fair

## Free Event!

**Students:** Discover more about Living Green at the Wyland Living Green Fair. This event is full of fun and includes hands on activities!

- Paint a 50-foot mural with marine artist Wyland.
- Transform into a drop of water and find your way to the ocean at the Water's Extreme Journey Maze.
- Become a water change agent at the Wyland Clean Water Mobile Learning Center.
- See how the Grand Canyon was formed.
- Watch popcorn being made from the sun.
- Take photos with Spouty the Whale.
- Learn about the latest electric hybrid cars.
- Preview organic fashions.
- Sample organic food.
- Visit the Gumbo Limbo Nature exhibit at the Kids Eco-Zone and more!

## Fashion Show and Concert!

Learn more about Living Green at an Eco-Friendly Fashion Show, Saturday, November 6th, at the Mizner Park Amphitheater hosted by Zeke and Luther's Ryan Newman. Anna Margaret and Disney's newest performer, Jasmine will be in concert!

**For more information visit:**  
[www.LivingGreenFair.com](http://www.LivingGreenFair.com)

### resources:

For more information on the Chesapeake Bay:

<http://www.vims.edu/resources/>  
<http://www.chesapeakebay.net>

<http://noaa.chesapeakebay.net>  
<http://www.bayeducation.net/>

For more information on estuaries:

<http://www.estuaries.gov>  
<http://nerrs.noaa.gov>

To learn more about

Dr. Eugenie Clark:  
<http://www.sharklady.com>

## Win a painting lesson from Wyland!

**One Class will win:  
A visit and painting lesson from Wyland!**

**One Student will win:  
A signed print from Wyland!**

1. Complete this entry form.
2. Bring this form to the Wyland Living Green Fair on either Saturday, Nov. 6 or Sunday, Nov 7th.
3. Drop off the form at the "Kohler Discovery Center" in Mizner Park.

Student's Name \_\_\_\_\_

School \_\_\_\_\_

Teacher's Name \_\_\_\_\_

Teacher's Email \_\_\_\_\_

*No purchase required. The winners will be selected by random drawing. The winners will be announced on Nov. 15th. Wyland will visit the winning class during the current school year. Dates to be determined. The signed print will be mailed to the individual winner by Nov 30th.*

## Teachers

Download the free teacher's guide with 18 art and science activities, organism activity cards, and loads of fun extras!

[www.wylandoceanchallenge.com](http://www.wylandoceanchallenge.com)

