2017

Future Water Stewardship and Fact-Based Water Policy: An Aquatic Science Education Pathway Model

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Future water stewardship and fact-based water policy: An aquatic science education pathway

By

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Presented at the

IWRA XVIth World Water Congress
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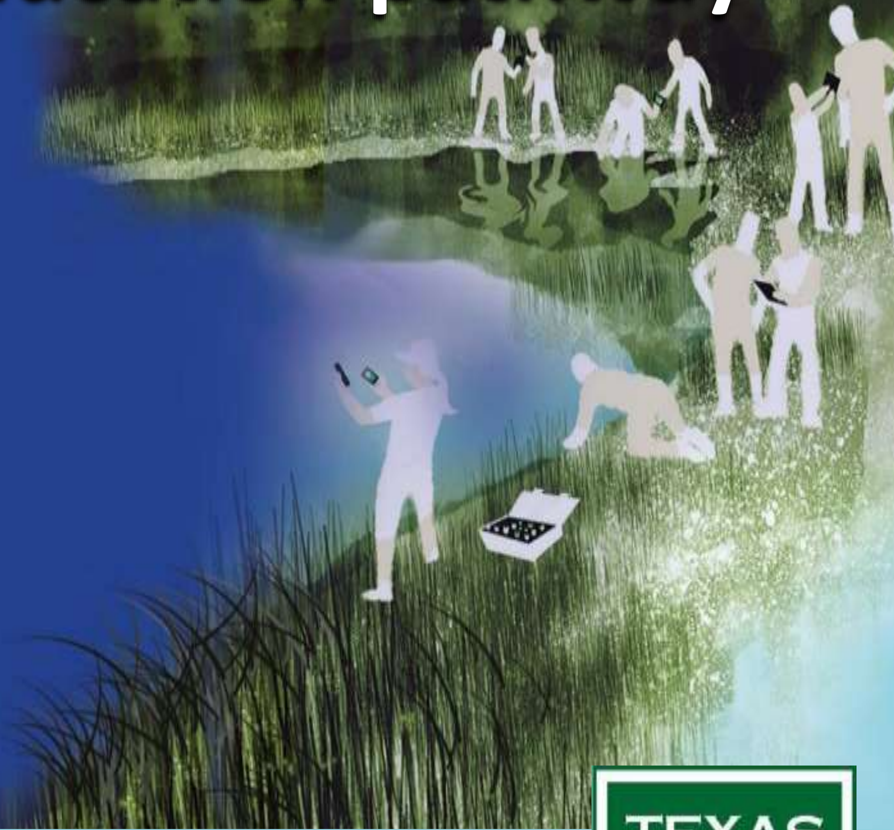

The Meadows Center for Water and the Environment

CE3SAR

Texas A&M University Corpus Christi | Harte Research Institute for Gulf of Mexico Studies

Texas A&M University San Antonio

Texas Parks & Wildlife

From headwaters to the ocean, H2O has developed methods and technology enhancements to help today's students become tomorrow's engaged citizens who understand and advocate the environmental, economic and societal values of water.

H2O

Headwaters to Ocean

Funded by a generous grant from the
Ewing Hasell Foundation

The Meadows Center for Water and the Environment
Texas State University

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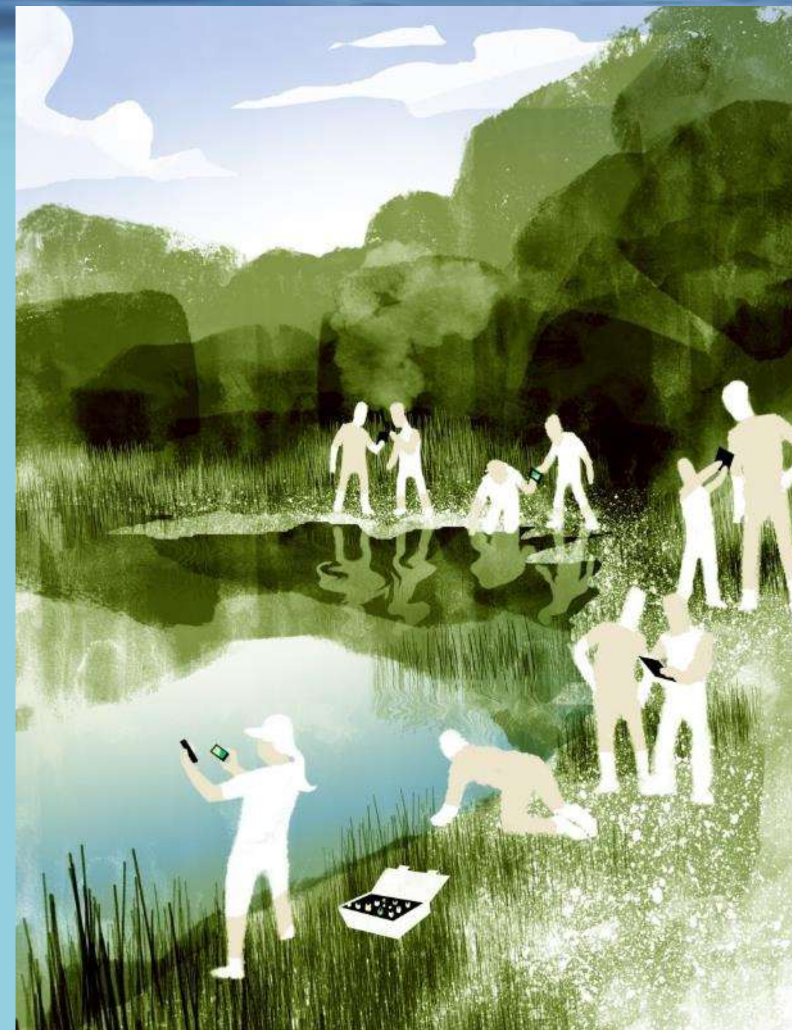
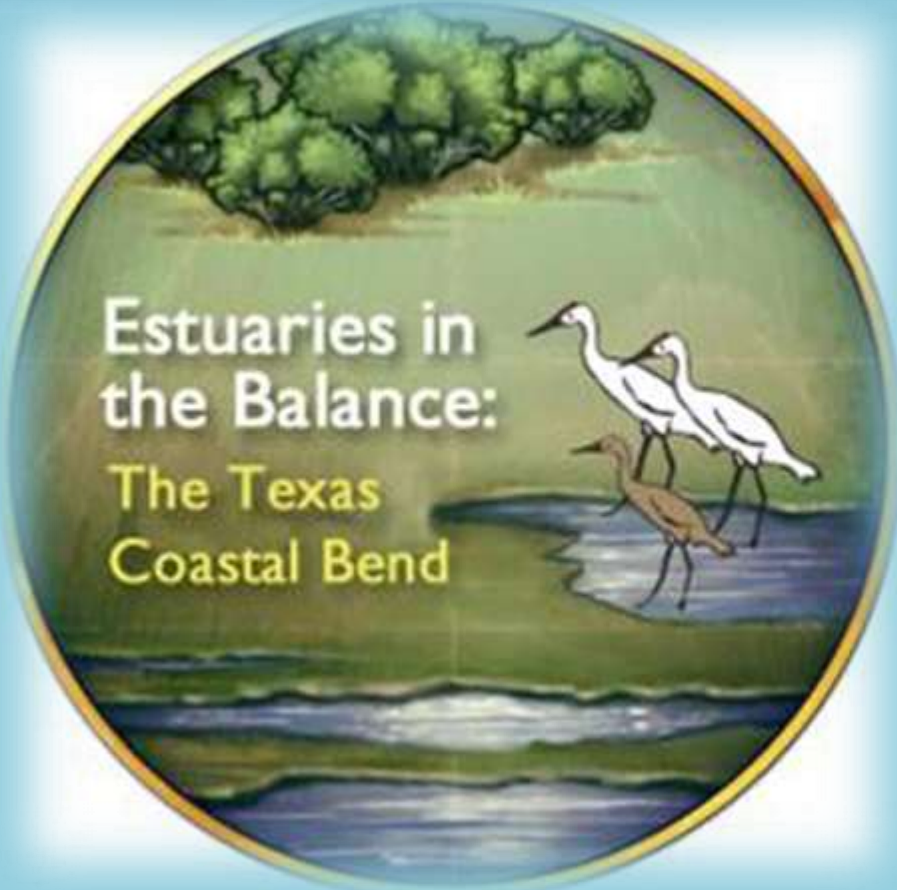
- **Virtual Water Experience**
- **Tech Equipped Bay and Estuary Experience**
- **Watershed Technology Safari**



TEXASAQUATICSCIENCE.ORG

Web-Based Interactive Learning



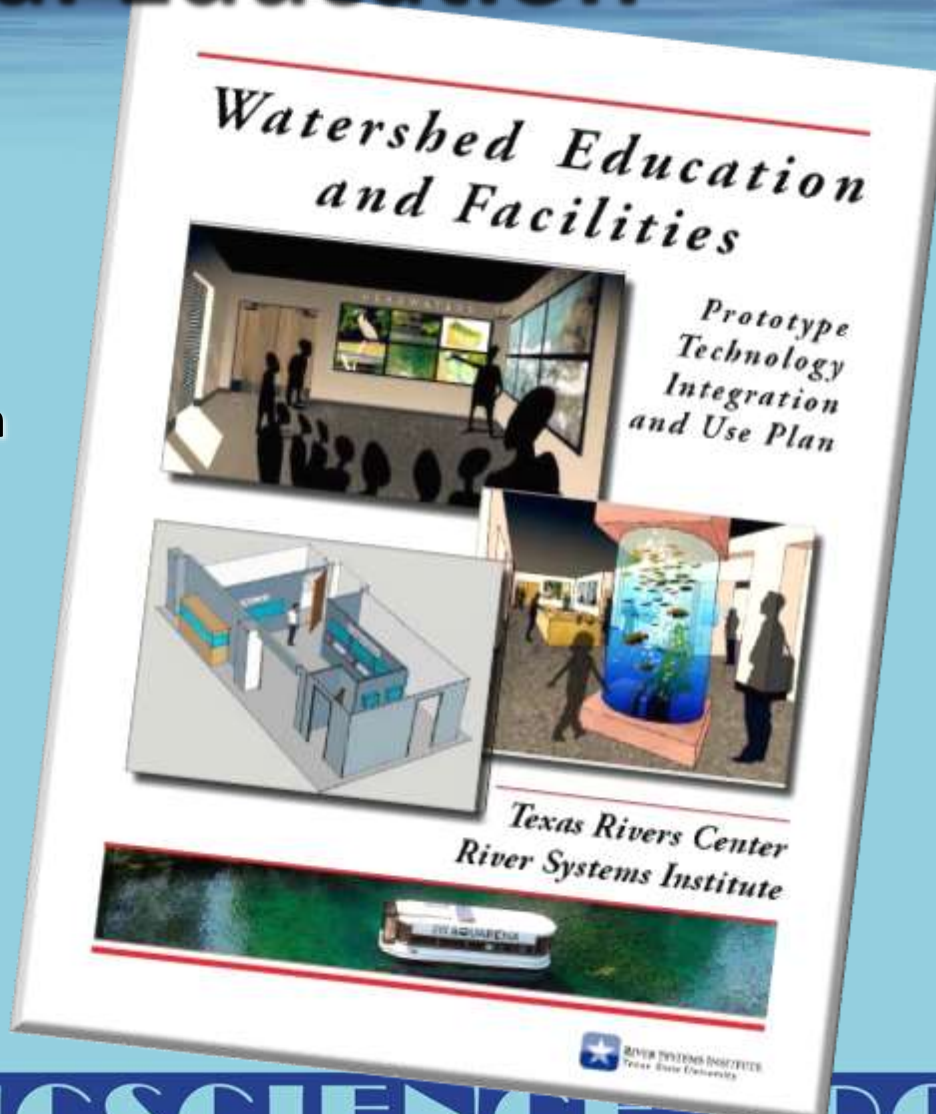
ESTUARIES IN THE BALANCE: THE TEXAS COASTAL BEND

- Interactive multimedia focused on estuary ecosystems
- Games, videos, dynamic visualizations.

High-Tech Integration in Experiential Education

Prototype Technology Integration and Use

- Technology integration and research test bed
- Accommodate :
  - 25,000 K-12 students in class groups
  - 125,000 children and adults unguided



High-Tech Integration in Experiential Education

Experiential Learning Laboratory - Technology Test Bed

- Multi-media, multi-screen array
- Linked 22-screen array
- Outdoor Wi-Fi network
- Interactive touch table
- Interactive kiosks
- Low-cost design
- DEMO OUTDOOR CTRS
- EASILY EXPORTED

High-Tech Integration in Experiential Education

- iPad – iPhone for outdoor aquatic science instruction
  - Species ID Key
  - GPS Photo Scavenger Hunt
  - Journaling
  - Social-Networking
  - Games
  - Teacher-Friendly
  - QR Code Scanner
  - Documents
  - Videos
  - Photos
  - Links

Adaptable for outdoor learning ctrs

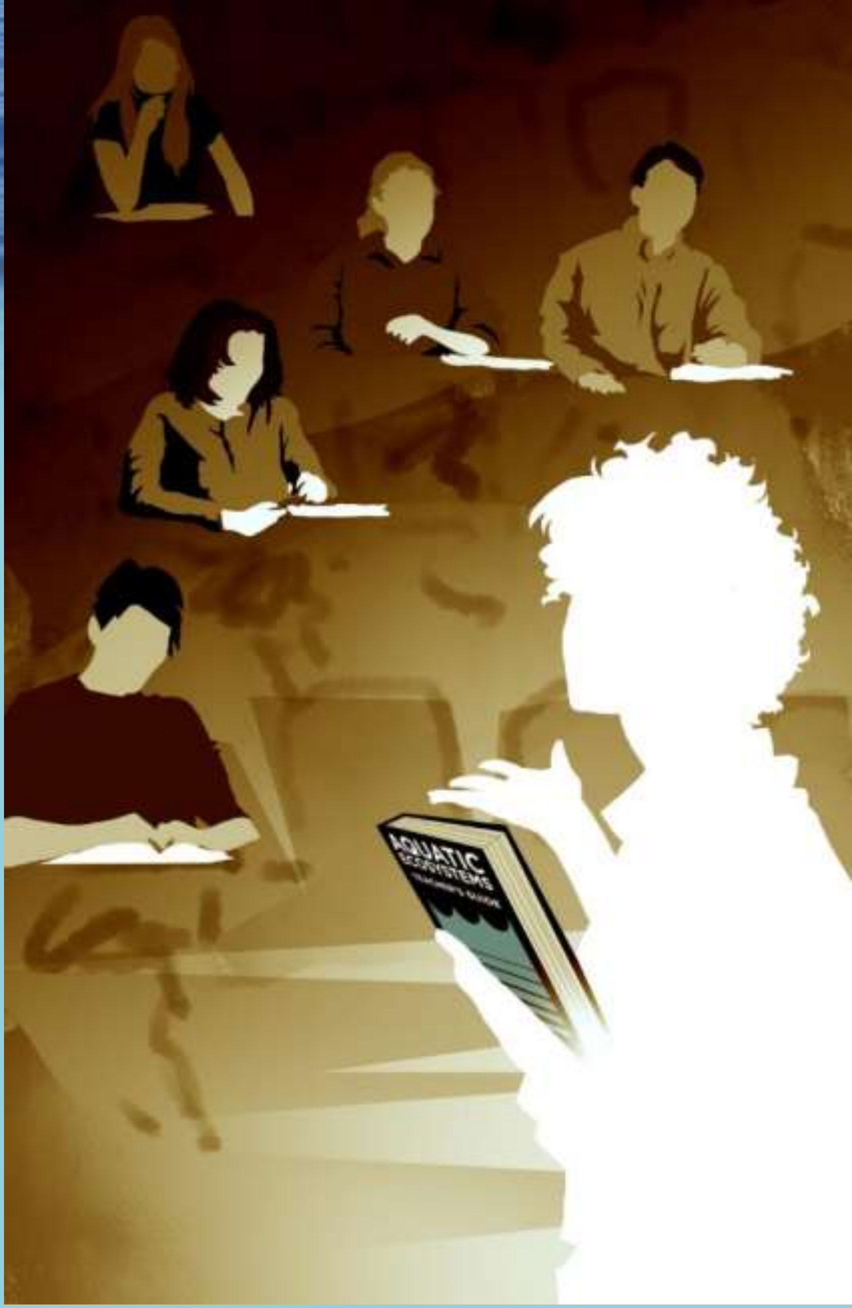
Opps!

- Cool apps, games, interactives and even bigger ideas……….all with no context for use by teachers.
- **Loser! Loser!**

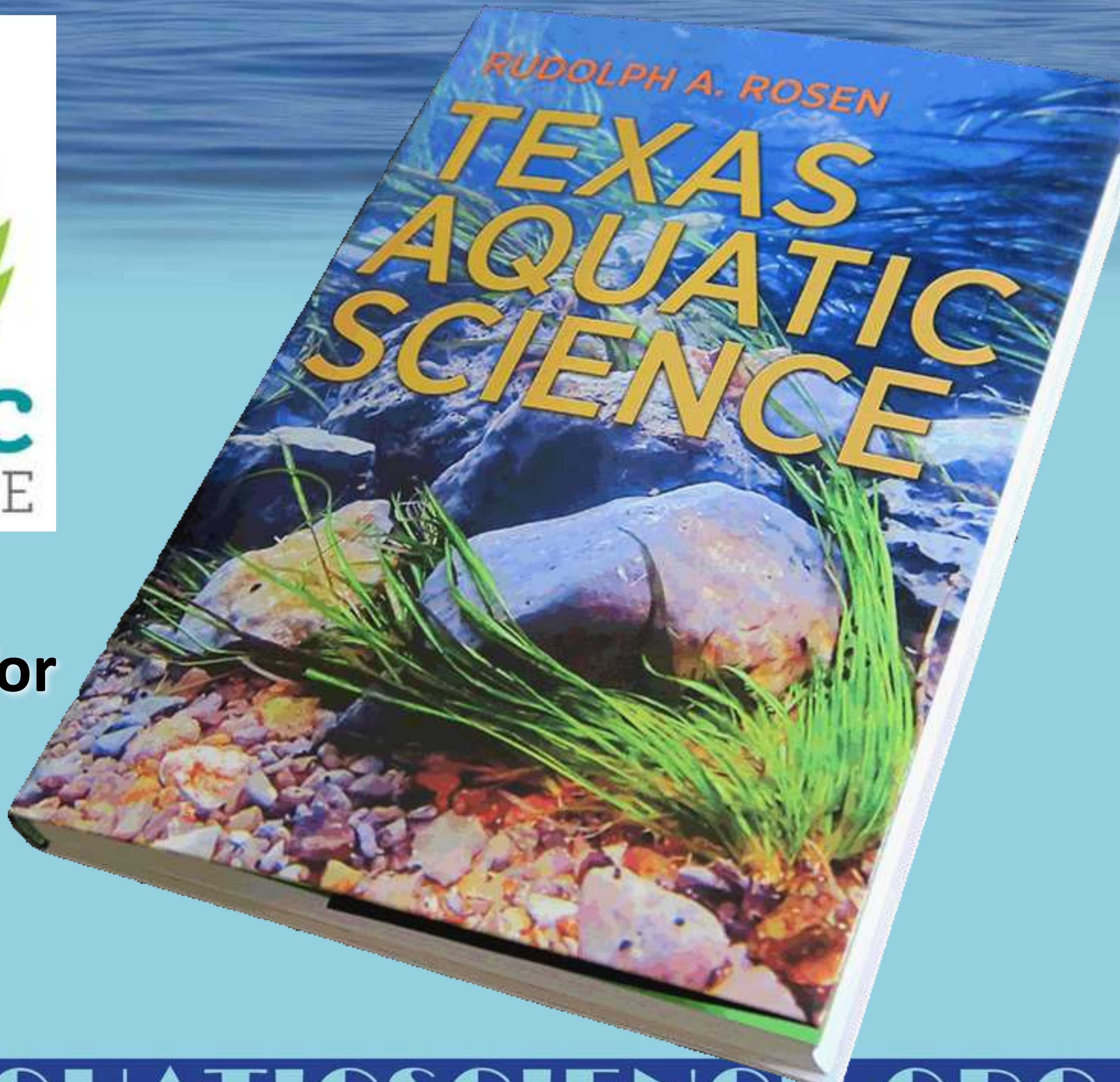
Effective Pathway for Water Curricula

Texas Aquatic Science

- Texas' first comprehensive curricula in Aquatic Science for middle and high schools students
- Meeting all state standards for education
- #1 Internet ranked curriculum for aquatic science



Texas
AQUATIC
SCIENCE



Foundation for Instruction

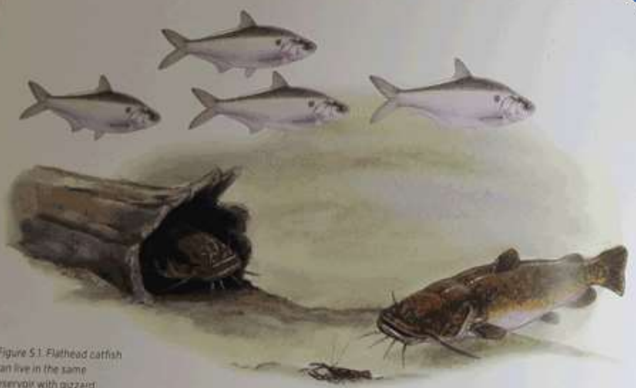


Figure 5.1. Flathead catfish can live in the same reservoir with gizzard shad because they do not compete for the same niche. Gizzard shad eat plankton and spawn over gravel and grass. They broadcast their eggs, which sink and adhere to any underwater substrate. When they are small, flathead catfish eat invertebrates, such as worms, insects, and crayfish. But once the flatheads grow large enough, they begin to prey on live fish. They spawn in sheltered areas on the lake bottom, such as cavities in logs, undercut banks, and rocks. Flathead catfish males guard the eggs. Once hatched, the fry remain on the nest for about a week, still guarded by the male. Illustrations courtesy of Missouri Department of Conservation and Texas Parks and Wildlife Department; modified by Rudolph Rosen.

for a short period of time when bass are very young. There are sufficient food resources for both species to survive over time because the bass and the shad occupy different niches in the same environment by eating different foods.

Largemouth bass and gizzard shad also have very different places and ways to breed. Largemouth bass spawning begins in the spring when water temperatures reach about 60 °F (15 °C). Depending on location in Texas, this can be as early as February or as late as May. Male bass build a circular nest about twice as far across as the bass is long. Nests are usually in water about two to eight feet deep. Once a female largemouth bass lays its eggs in the nest (between 2,000 and 43,000 eggs!), she is chased away by the male, who then guards the eggs. The young hatch in about 5 to 10 days. The newly hatched fish, or **fry**, remain in a group or "school" near the nest and under the male's watch for several days after hatching before swimming off on their own.

Gizzard shad also spawn in shallow water in spring when water temperature reaches about 60 °F (15 °C), but that is where the similarity with bass ends. To reproduce, gizzard shad males and females school together, releasing **milt** and eggs simultaneously near the surface, where the eggs are fertilized. Once fertilized, the eggs become sticky. The eggs are carried by water currents, and they adhere to underwater objects as they slowly sink to the bottom. A single female can release as many as 400,000 eggs. These hatch in about four days. Immediately after hatching, the fry form schools and swim away. Gizzard shad do not make nests or have any parental involvement. As the young gizzard shad hatch and mature, they become food for the young largemouth bass once they switch from a plankton to a fish diet.

This story is similar for other species where largemouth bass and gizzard shad live, such as the flathead catfish. Different species may have similar or even overlapping habitats, but no two species can occupy exactly the same niche in the same community for long without competition adversely affecting one or the other (fig. 5.1).

Competition and Survival

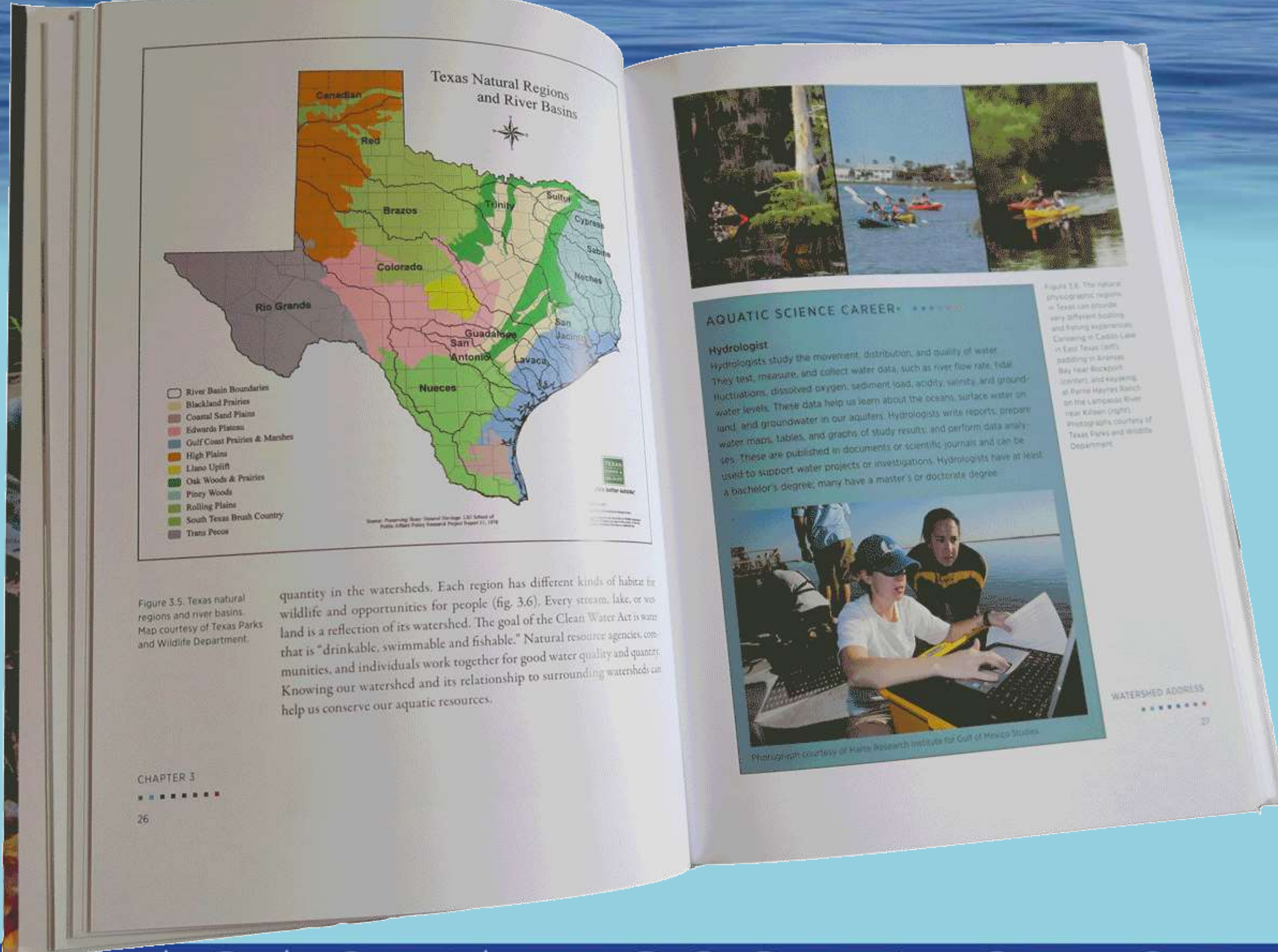
Living organisms have the capacity to produce populations of an unlimited size if they have unlimited food and other necessary resources, but this is a situation that never exists for very long. When there is not enough of something to go around, individuals must compete for whatever becomes scarce. If it is something necessary for survival or desirable to the individuals of any one species, some or perhaps all individuals can be adversely affected.

Individual bluegills in a pond compete with one another for food. Populations of species within a community may compete against one another as well. Bluegills in a pond compete with green sunfish, since both species are similar and feed on the same prey. This spells trouble for both species when food is scarce.

The amount, extent, or quality of biotic (living) and abiotic (nonliving) resources needed by a species in any one place determines the environment's **carrying capacity**. Carrying capacity is the maximum number of individuals in a particular population that an environment can support. When there are more resources than a particular population can use, the population is below carrying capacity for that particular environment. When this happens, individuals can continue to grow and reproduce.

When there are more individuals in a population than the environment can support, the population is above carrying capacity. Populations usually do not stay above carrying capacity for long. Once a population exceeds the habitat's carrying capacity, individuals may starve, get sick, or be forced to move to a place that can support them. Some examples of resource limits in aquatic habitats are the availability of food and cover (fig. 5.2).

Figure 5.2. When a population exceeds the carrying capacity of its environment, starvation and disease may result. Illustration courtesy of Missouri Department of Conservation.



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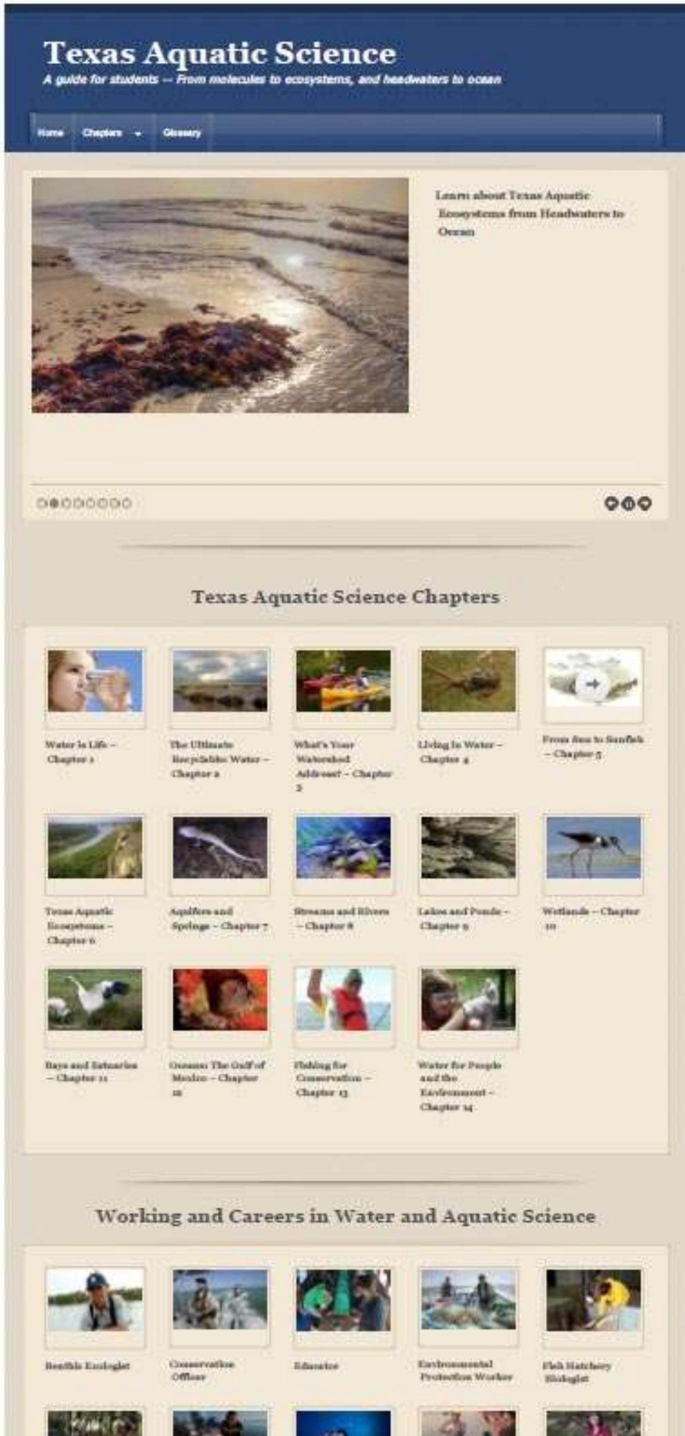
THE CONNECTION BETWEEN SEAWEED, JELLYFISH, AND BEACH TRASH IN TEXAS

Beachgoers in Texas often remember encounters with seaweed, jellyfish, and trash found on the beach. Believe it or not, all three are frequent features of Gulf Coast beaches for the same reason. All are carried along by currents and winds that push them onto Texas beaches. Massive currents swirl about in the giant basin that is the Gulf. As happens when you stir liquid contents in a big bowl, the water in the Gulf moves in a definite direction. This water movement, or current, carries along with it whatever floats in the water. Currents in the Gulf move toward Texas from both the north and south. The currents combine with winds that blow toward Texas. This helps push animal passengers as well as any floating trash or seaweed onto our beaches.

At times Texas beaches may contain a large amount of sargassum, a brown seaweed. Although it may look and smell yucky, this seaweed actually helps build up the beach by acting to hold sand in place. Jellyfish are another passenger in the currents' continuous journey because they are free-floating animals. While some species of jellyfish can give swimmers an unpleasant sting, trash gives everyone an unpleasant experience.

Jellyfish and seaweed are a natural part of the Gulf ecosystem, but the trash is not. Where does trash come from? It comes from all over the Gulf, from other states, from Mexico, from storm sewers that empty into the Gulf, and from the rivers draining into the Gulf, such as the Mississippi River. It comes from ships and oil and gas platforms far out in Gulf waters. It floats northward to Texas from Mexico and southward from Louisiana. The amount of trash that washes to shore is enormous. Sometimes sea turtles and other species that eat jellyfish mistake clear plastic bags or other trash in the water for food and eat the trash. This can cause injury or death because the plastic clogs up the animals' stomachs and intestines.

Every year more than 1,000 people volunteer to pick up over 150 tons of trash on Padre Island. Volunteers also clean up other beaches. When you go to the beach, remember to pick up your own trash. You may also want to join others at your favorite beach on volunteer cleanup days or just do it yourself.



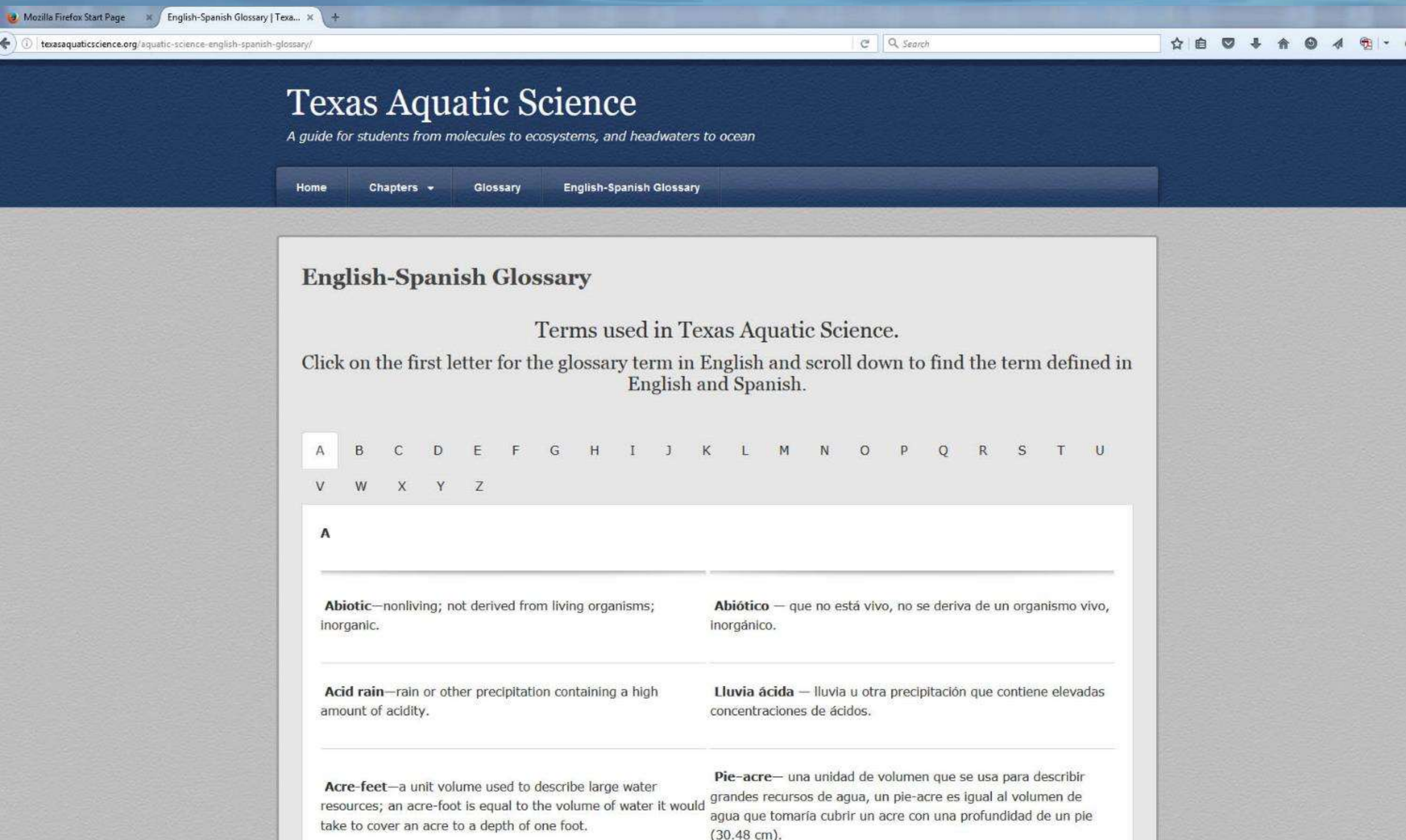
Texas Aquatic Science Online

- texasaquaticscience.org
- Textbook 100% and FREE
- Chapters
- Videos
- Career Promotions
- Science stories
- How to help
- TEKS Aligned

UATICSCIENCE.ORG

Texas Aquatic Science

Spanish – Glossary & Chapt. Videos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Search

Texas Aquatic Science

A guide for students from molecules to ecosystems, and headwaters to ocean

Home | Chapters | Glossary | English-Spanish Glossary

English-Spanish Glossary

Terms used in Texas Aquatic Science.

Click on the first letter for the glossary term in English and scroll down to find the term defined in English and Spanish.

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

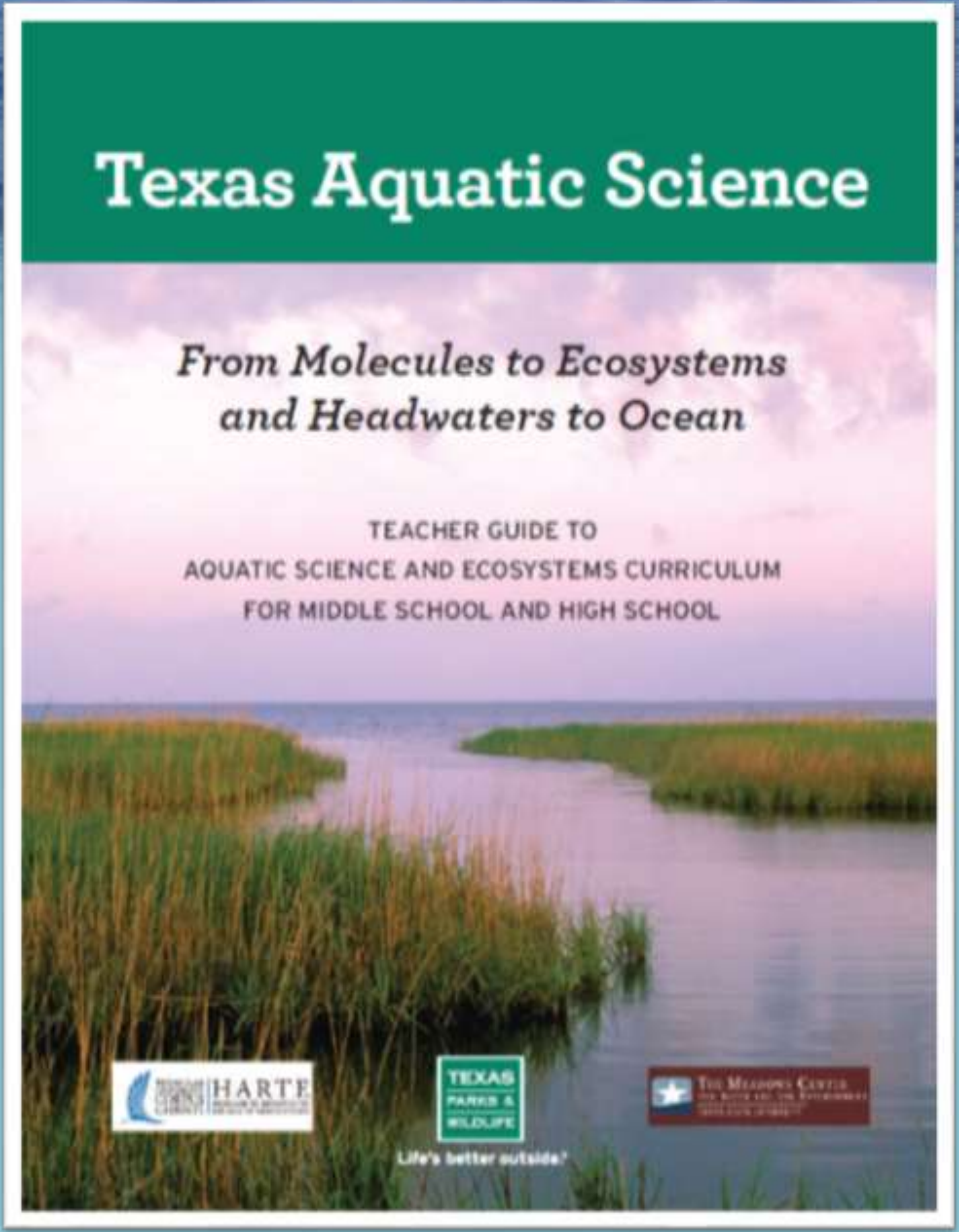
A

Abiotic—nonliving; not derived from living organisms; inorganic.	**Abiótico** — que no está vivo, no se deriva de un organismo vivo, inorgánico.
Acid rain—rain or other precipitation containing a high amount of acidity.	**Lluvia ácida** — lluvia u otra precipitación que contiene elevadas concentraciones de ácidos.
Acre-feet—a unit volume used to describe large water resources; an acre-foot is equal to the volume of water it would take to cover an acre to a depth of one foot.	**Pie–acre**— una unidad de volumen que se usa para describir grandes recursos de agua, un pie-acre es igual al volumen de agua que tomaría cubrir un acre con una profundidad de un pie (30.48 cm).

Texas Aquatic Science

Teacher Guide

- Science investigations, games, cooperative learning activities, Internet projects, readings, videos, science journals, field based student research projects, tests and assessments.



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Texas Aquatic Science Videos

America's Sea: The Gulf of Mexico

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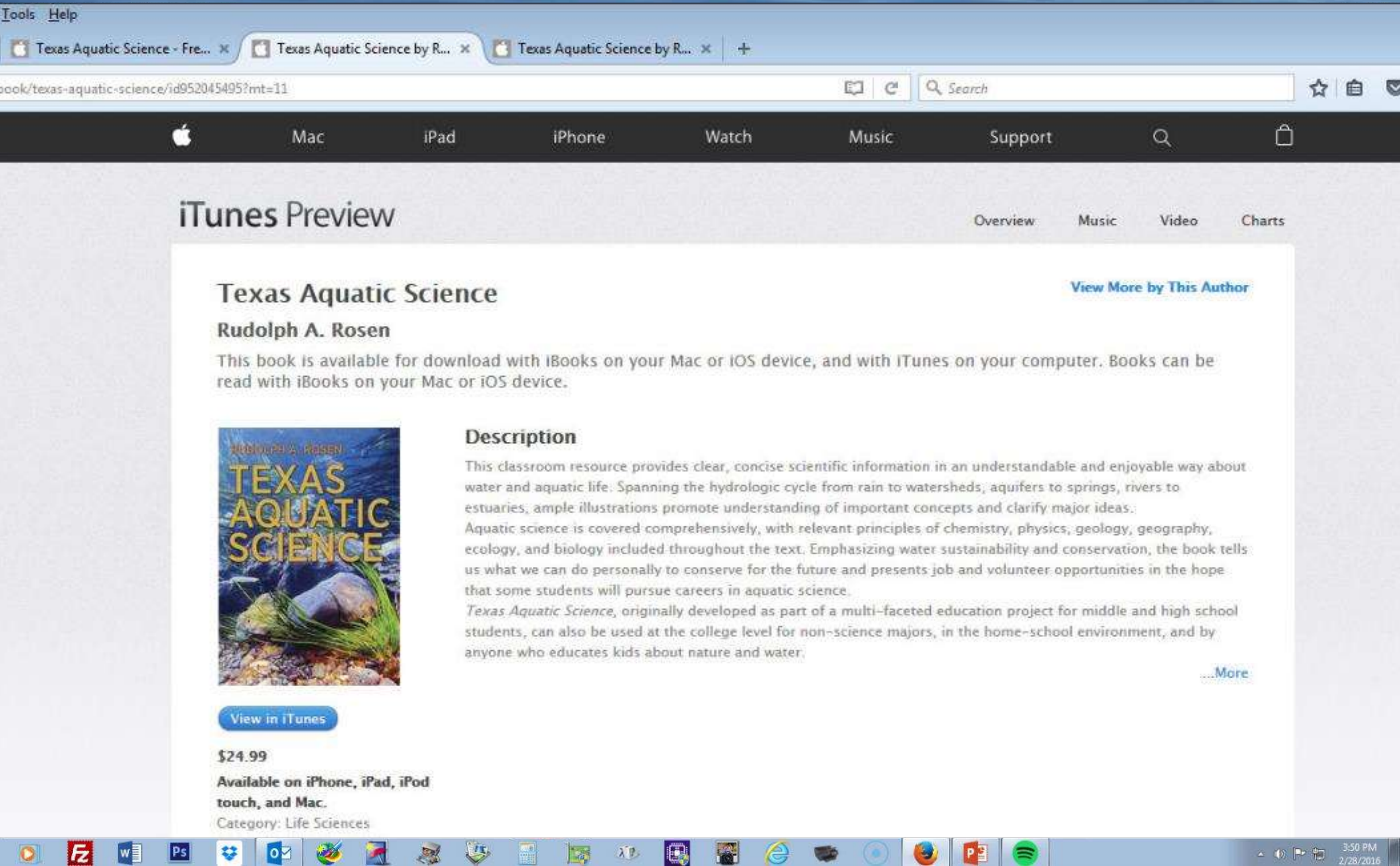
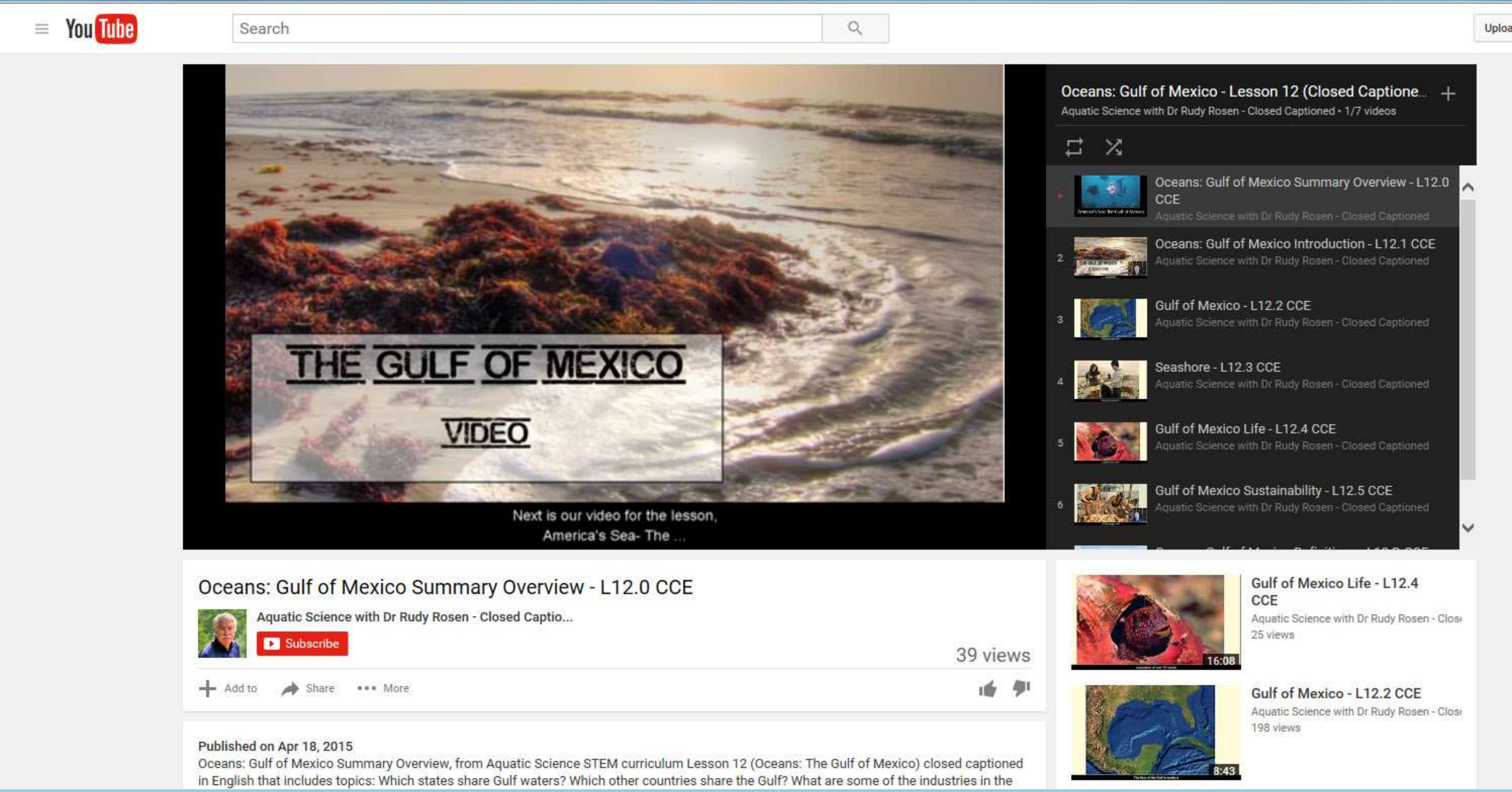
Texas Aquatic Science Online

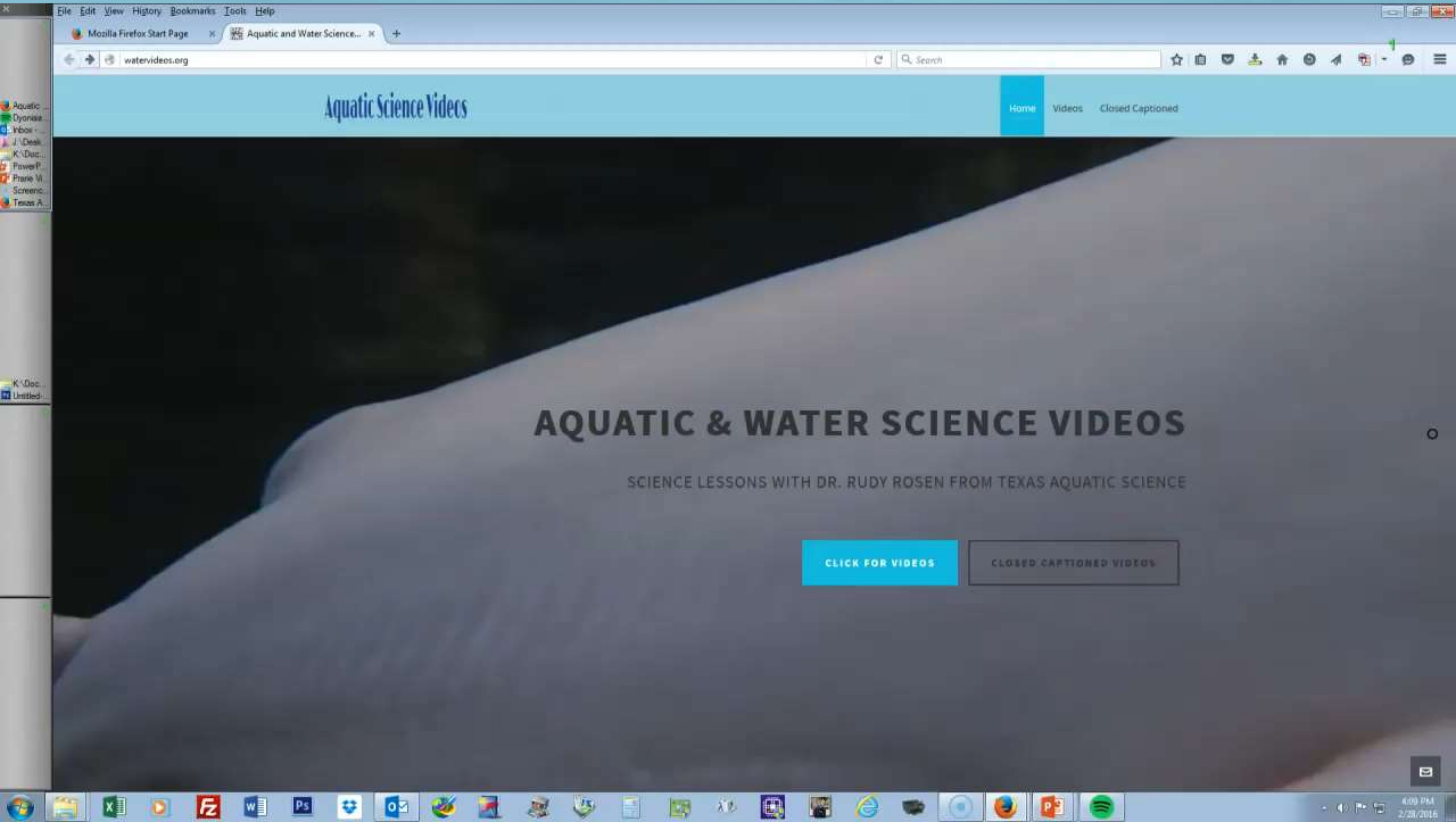


Texas Aquatic Science
Online Course lessons

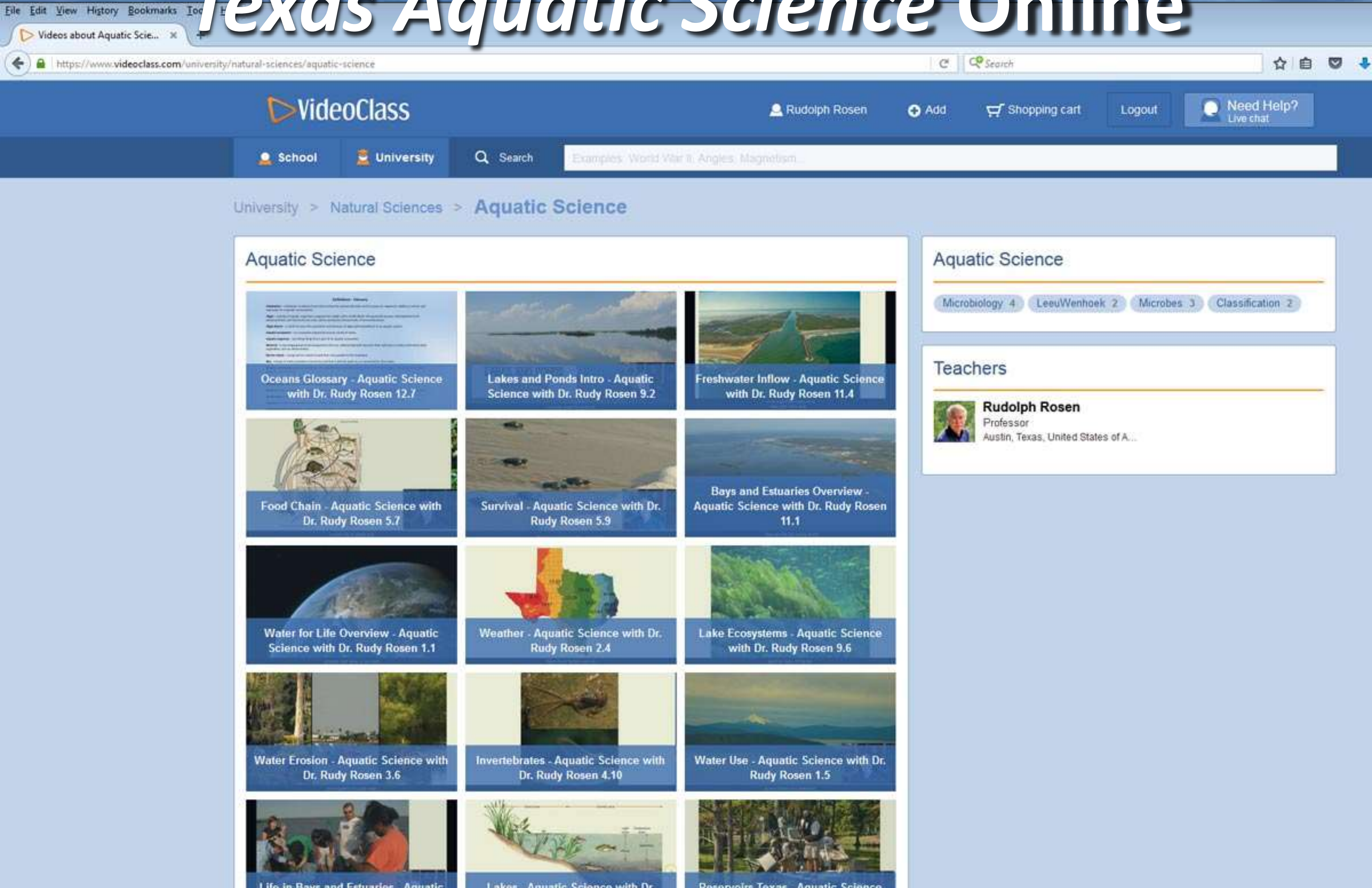


TEXASAQUATICSCIENCE.ORG

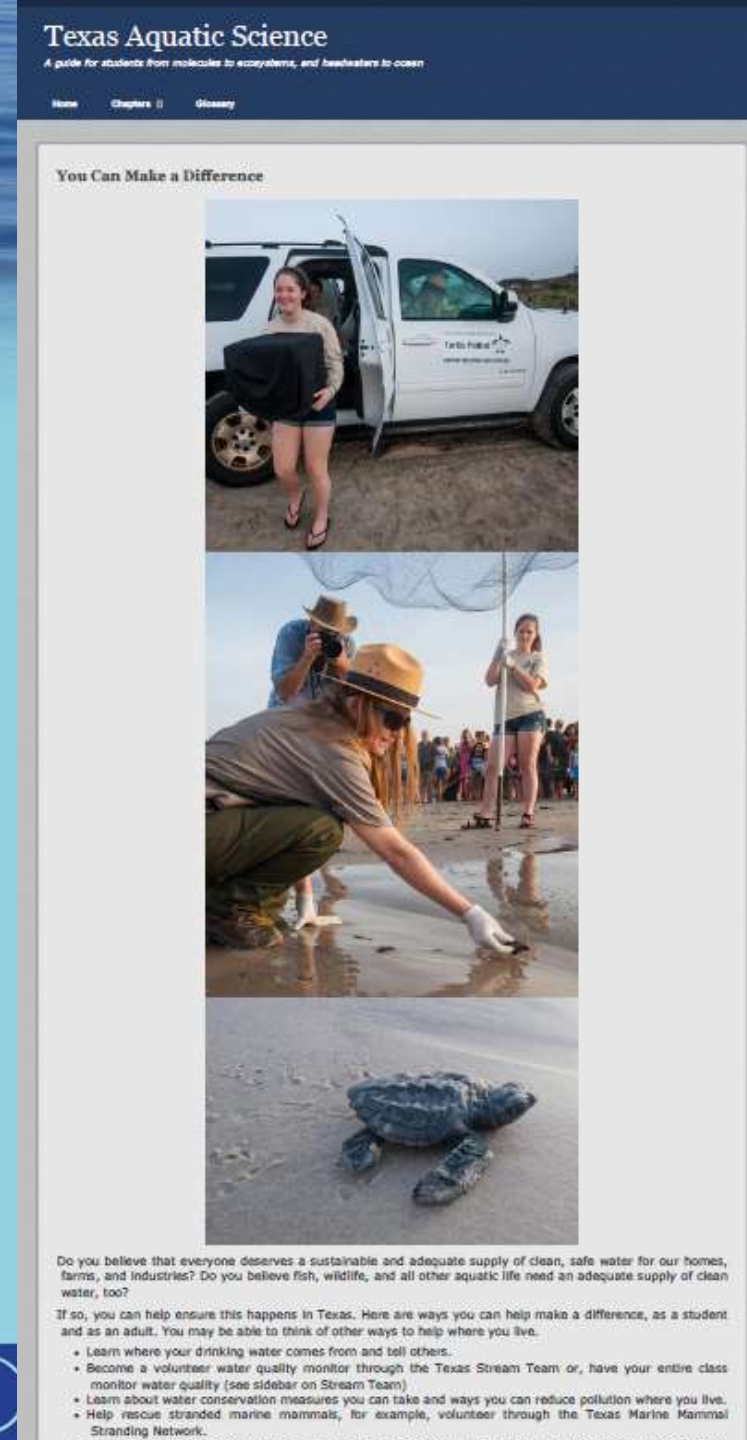
Texas Aquatic Science
Online Lessons
225 videos – Closed Captioned



Texas Aquatic Science Online



Interconnected Curriculum


Texas Aquatic Science

A guide for students from molecules to ecosystems, and headwaters to ocean

Home Chapters Glossary

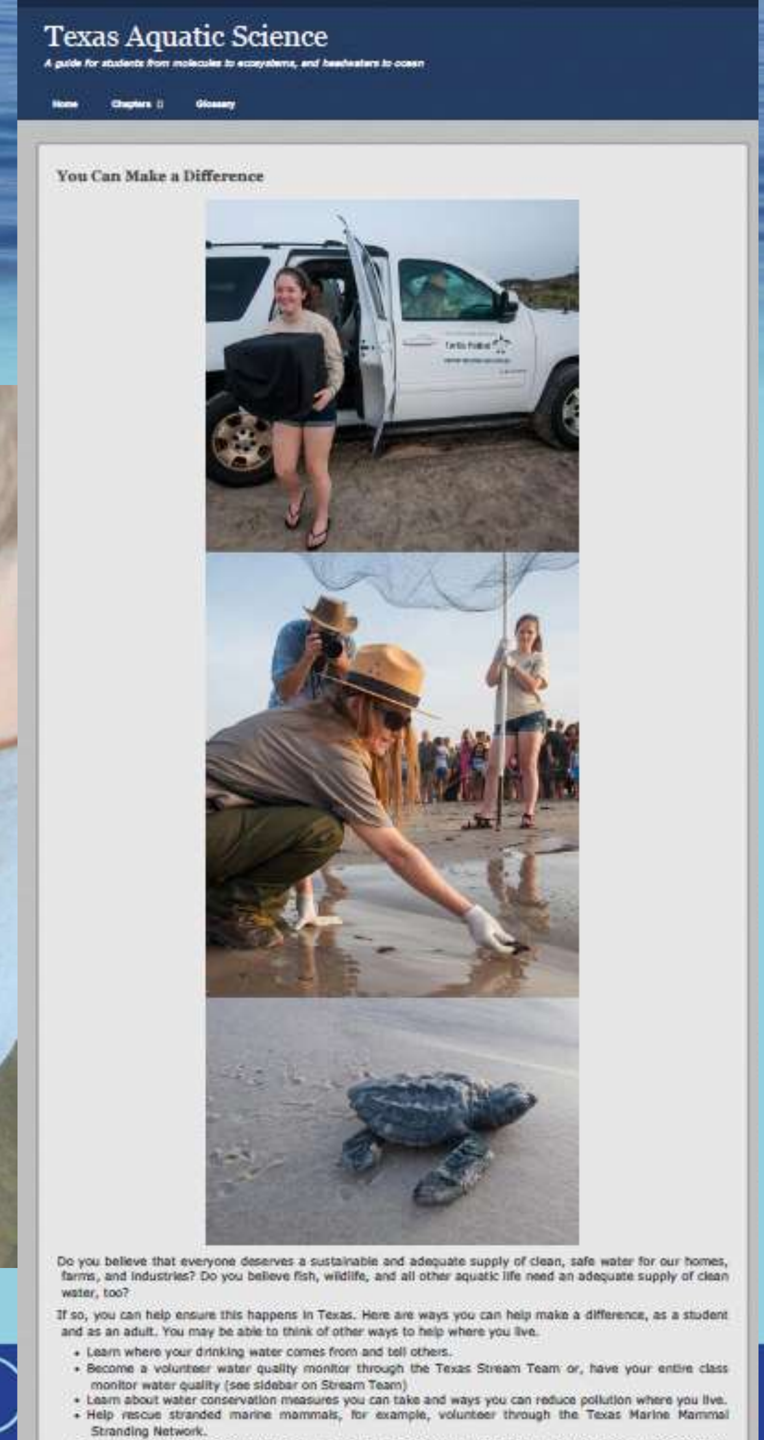
You Can Make a Difference

Do you believe that everyone deserves a sustainable and adequate supply of clean, safe water for our homes, farms, and industries? Do you believe fish, wildlife, and all other aquatic life need an adequate supply of clean water, too?

If so, you can help ensure this happens in Texas. Here are ways you can help make a difference, as a student and as an adult. You may be able to think of other ways to help where you live.

- Learn where your drinking water comes from and tell others.
- Become a volunteer water quality monitor through the Texas Stream Team or, have your entire class monitor water quality (see sidebar on Stream Team)
- Learn about water conservation measures you can take and ways you can reduce pollution where you live.
- Help rescue stranded marine mammals, for example, volunteer through the Texas Marine Mammal Stranding Network.

Interconnected Curriculum



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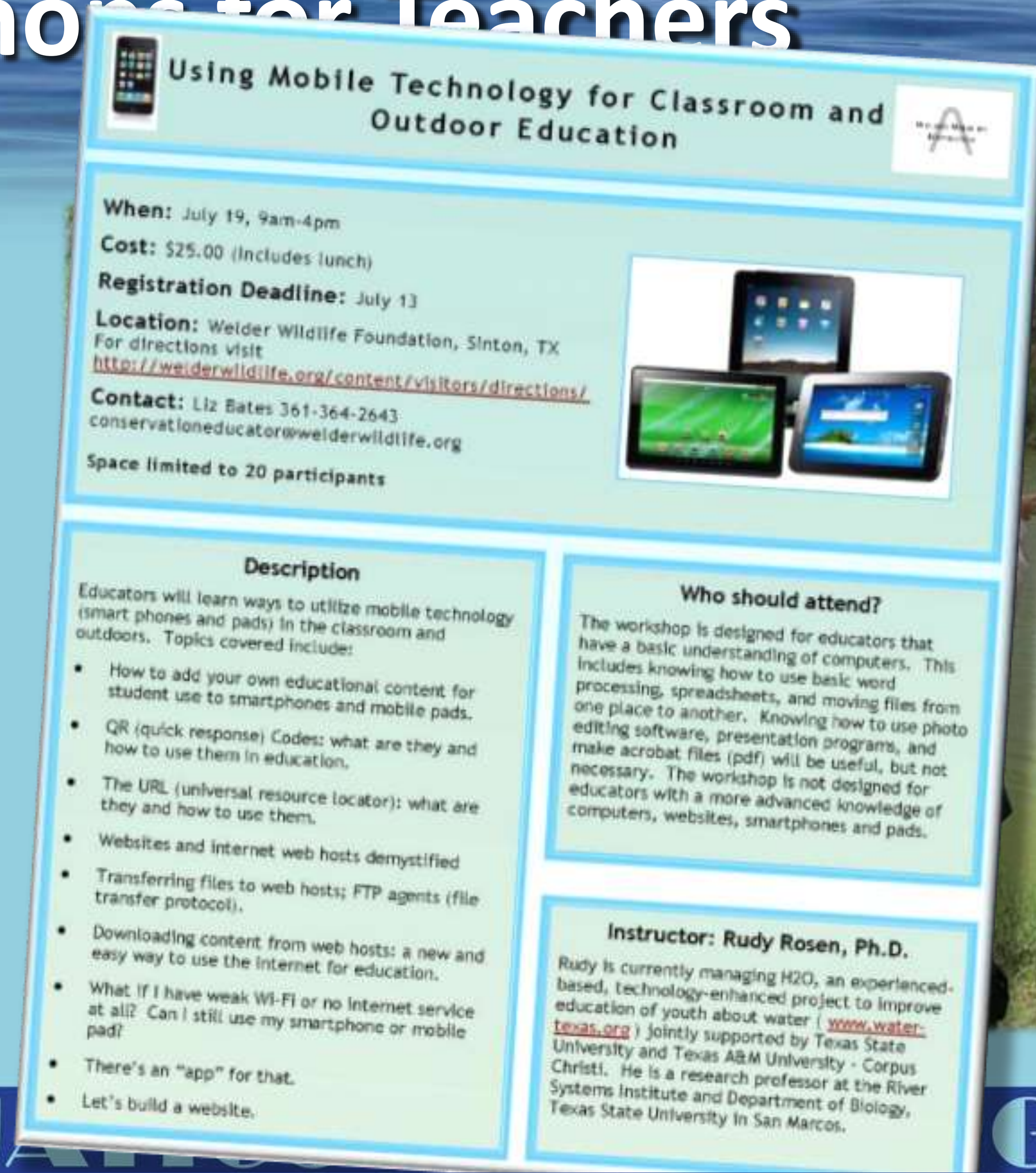
TEXASAQUATICSC

Workshops for Teachers

- Instruction for teachers on how to use Texas Aquatic Science:
  - Teachers Guide
  - Exercises
  - Integrating new mobile technology into outdoor and classroom education



Using Mobile Technology for Classroom and Outdoor Education

When: July 19, 9am-4pm

Cost: $25.00 (includes lunch)

Registration Deadline: July 13

Location: Welder Wildlife Foundation, Sinton, TX
For directions visit
http://welderwildlife.org/content/visitors/directions/

Contact: Liz Bates 361-364-2643
conservationeducator@welderwildlife.org

Space limited to 20 participants

Description

Educators will learn ways to utilize mobile technology (smart phones and pads) in the classroom and outdoors. Topics covered include:

- How to add your own educational content for student use to smartphones and mobile pads.
- QR (quick response) Codes: what are they and how to use them in education.
- The URL (universal resource locator): what are they and how to use them.
- Websites and internet web hosts demystified
- Transferring files to web hosts; FTP agents (file transfer protocol).
- Downloading content from web hosts: a new and easy way to use the internet for education.
- What if I have weak Wi-Fi or no internet service at all? Can I still use my smartphone or mobile pad?
- There's an "app" for that.
- Let's build a website.

Who should attend?

The workshop is designed for educators that have a basic understanding of computers. This includes knowing how to use basic word processing, spreadsheets, and moving files from one place to another. Knowing how to use photo editing software, presentation programs, and make acrobat files (pdf) will be useful, but not necessary. The workshop is not designed for educators with a more advanced knowledge of computers, websites, smartphones and pads.

Instructor: Rudy Rosen, Ph.D.

Rudy is currently managing H2O, an experienced-based, technology-enhanced project to improve education of youth about water (www.water-texas.org) jointly supported by Texas State University and Texas A&M University - Corpus Christi. He is a research professor at the River Systems Institute and Department of Biology, Texas State University in San Marcos.

Texas Aquatic Science
Certified Field Sites

- **Connect students to aquatic science with experiential learning outdoors**
- **65 sites (so far)**

Effectiveness Research

- 2015-16 School Year
- 160 Teachers Trained for Pilot
- 4,500 Students in Pilot Study
- 39 Schools
- State-wide

Effectiveness Research - Results

- **Teachers heavily rely on materials for instruction…**
  - strong preference for using combination of printed and online
  - high percentage indicated effective curriculum
  - effective in enhancing student learning about water

Effectiveness Research - Results

- **Statistics show patterns of website use:**
  - heavy use when class is in session
- **About 220,000 unique individuals were using the website in the 2015-16 school year, the first full year of classroom use.**

Teacher Survey on Experiential Water Education Outdoors

- **Students' understanding of water increased**
- **Teachers' understanding of teaching about water and awareness about water increased**
- **4 out of 5 teachers say they will seek opportunities to engage students in issues related to water and the environment using technology after experiencing outdoors learning**

Research – Ph.D. Dissertation

Conclusions

- Experiential water education can be enhanced by:
  - interactive technology
  - direct contact with water
  - linking a water experience in one location to other water locations

Points of Discussion

1. "Apps" and games alone may not be effective
2. Teachers need context to teach
3. Experiential place-based education works to improve understanding about water
4. It's no simple matter
    1. Time and Money
    2. Diverse APPLIED Skills

Partners and Support

- Meadows Center for Water and the Environment
- Harte Research Institute for Gulf of Mexico Studies
- Institute for Water Resources Science and Technology
- Ewing Halsell Foundation
- Texas Parks and Wildlife Department
- USFWS - Sport Fish Restoration Program
- National Science Foundation
- Texas State High Performance Computing Team
- The Meadows Foundation
- Research Coordination Network on Climate, Energy, Environment, and Engagement in Semiarid Regions
- Gilbert M. Grosvenor Center for Geographic Education
- Hamline Univ. Ctr. for Global Environmental Education
- Texas State Aquarium
- Texas Pioneer Foundation
- International Crane Foundation
- Gary Jobs Corps
- Welder Wildlife Foundation
- Texas Stream Team

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