
Aquatic Science Education Pathway from Headwaters to Ocean is a Model for Place-Based Experiential Learning for Protecting and Stewarding Gulf States' Freshwater and Marine Resources

Rudolph A. Rosen¹, Erin Scanlon², and Johnnie Smith³

¹Texas A&M University–San Antonio, One University Way, San Antonio, Texas 78224

²Texas State University, 601 University Dr., San Marcos, Texas 78666

³Texas Parks and Wildlife Department, 4200 Smith School Rd., Austin, Texas 78744

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http://www.gcags.org/exploreanddiscover/2016/00034_rosen_et_al.pdf

Posted September 13, 2016.

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ABSTRACT

Teachers, students and parents today have a bewildering and fast-moving array of technology innovations that purportedly will help students learn and teachers teach. Unfortunately, it is hard for anyone to grasp what works, let alone what works best. Texas Aquatic Science has become a model for enhanced water education that has rapidly risen to the top of search engine rankings for aquatic science. The project was conceived in the course of developing means to integrate use of various new mobile and interactive technologies into middle and high school curricula about water from headwaters to the Gulf of Mexico. The researchers heard that to effectively use new technology and materials regularly, there needed to be a context for their use.

Led by educators and researchers from the Meadows Center for Water and the Environment (Texas State University), Harte Research Institute for Gulf of Mexico Studies (Texas A&M University–Corpus Christi), and Texas Parks and Wildlife Department, the initiative expanded through support from over 20 partners and multiple funders to develop that context. This resulted in a comprehensive STEM pathway to engage learners from middle school through adulthood on an educational journey to create water-savvy citizens of tomorrow who will ensure effective stewardship of water in the Gulf states and beyond.

Project partners published a comprehensive textbook available in print and on-line versions, assembled a teacher guide with instructional and assessment materials that allowed integration of technology enhancements, produced videos and enhancement materials, and developed a field site program connecting aquatic science in the classroom with educators and outdoor place-based experiential learning in the field. This provided a comprehensive context for instruction of middle and high school students and served as a basis for aquatic science instruction at the college level for non-science majors, in the home-school environment, and to anyone wanting to learn about nature

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and water. Curricula met Texas teaching standards for relevant principles of geology, geography, chemistry, physics, ecology, and biology in the text and associated teaching materials. Experience and results of research to-date demonstrate integrating education enhancements into comprehensive curricula enhance student learning and teacher ability to provide meaningful instruction. We believe the model can be used for developing science education curricula in other areas of environmental sustainability, such as for watershed science, land conservation, or coastal areas management.

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By

Rudolph Rosen

Texas A&M University San Antonio

Erin Scanlon

Texas State University

Johnnie Smith

Texas Parks and Wildlife Department

September 20, 2016



THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT



CE³SAR



TEXAS A&M
UNIVERSITY
CORPUS
CHRISTI

HARTE
RESEARCH INSTITUTE
FOR GULF OF MEXICO STUDIES

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



TEXAS A&M
UNIVERSITY
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CHRISTI

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RESEARCH INSTITUTE
FOR GULF OF MEXICO STUDIES

Tech Enhanced Water Education: A Report and Plan

- Report and proposal to the Ewing Halsell Foundation
- Enhanced water education and technology integration
- Plan to bring a Texas network of water educators to life
- 4 year, \$3.4 million project



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



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



Headwaters to Ocean

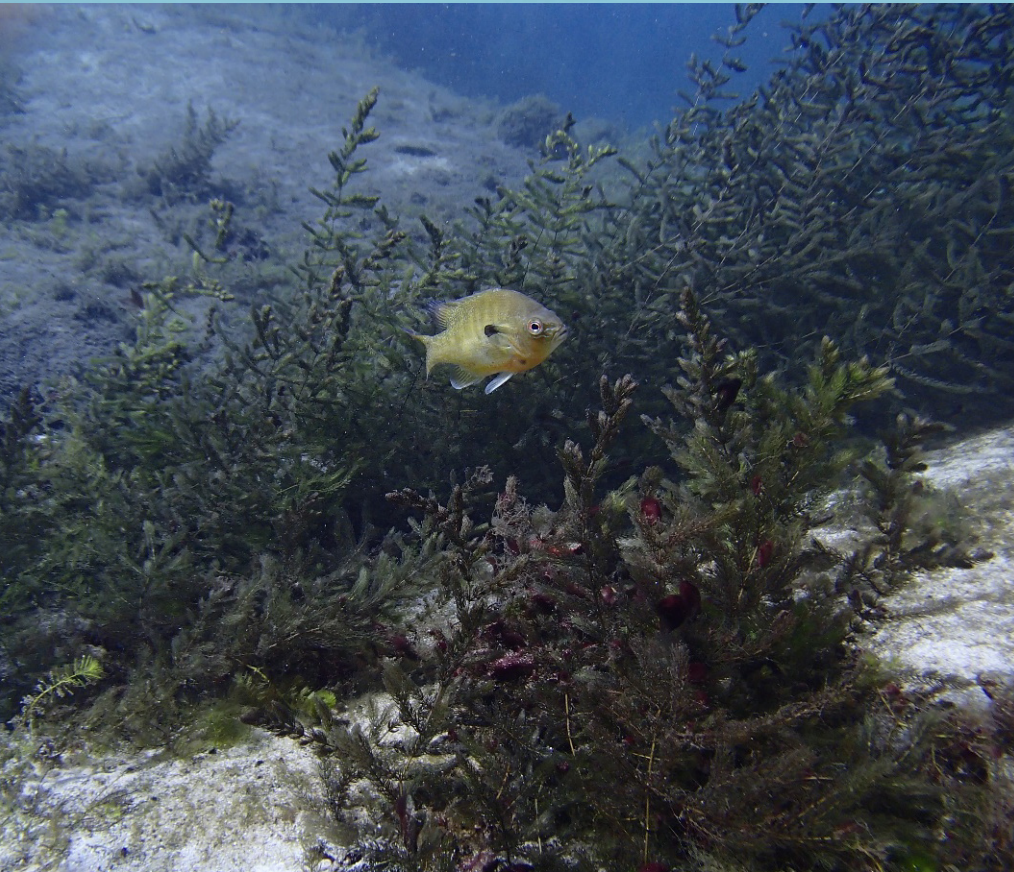
- Headwaters Exploration
- Underwater Experience
- Wetlands Discovery



- Headwaters Exploration
- Underwater Experience
- Wetlands Discovery



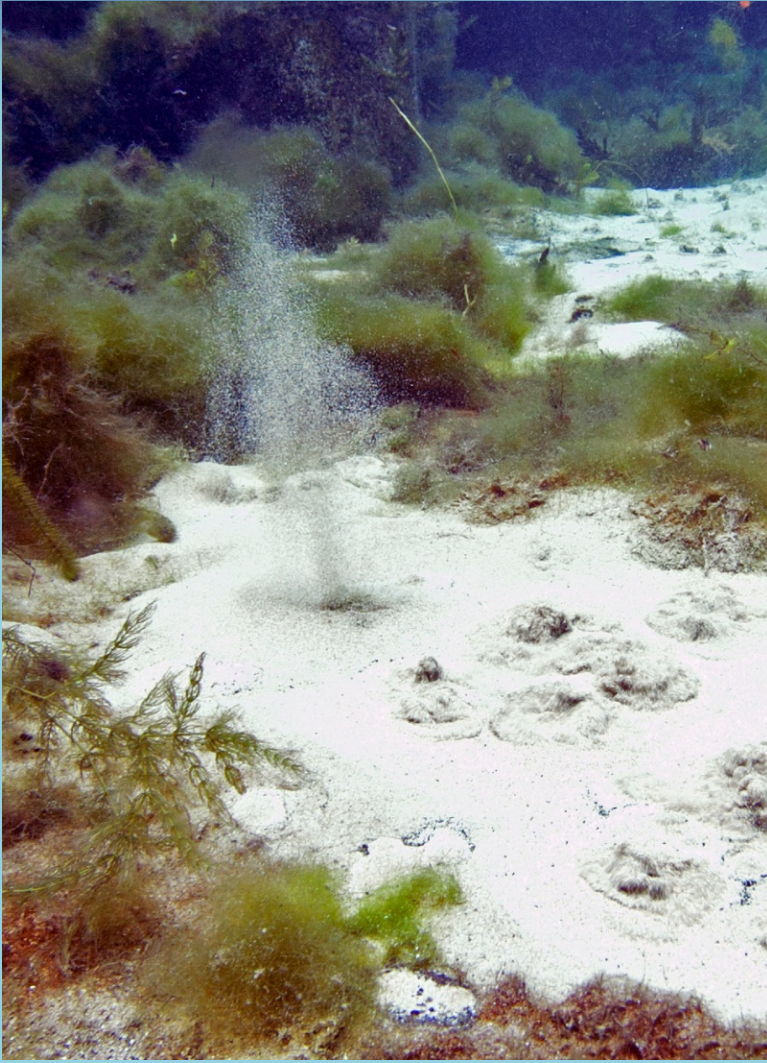
- Headwaters Exploration
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- Wetlands Discovery



H2O

Headwaters to Ocean

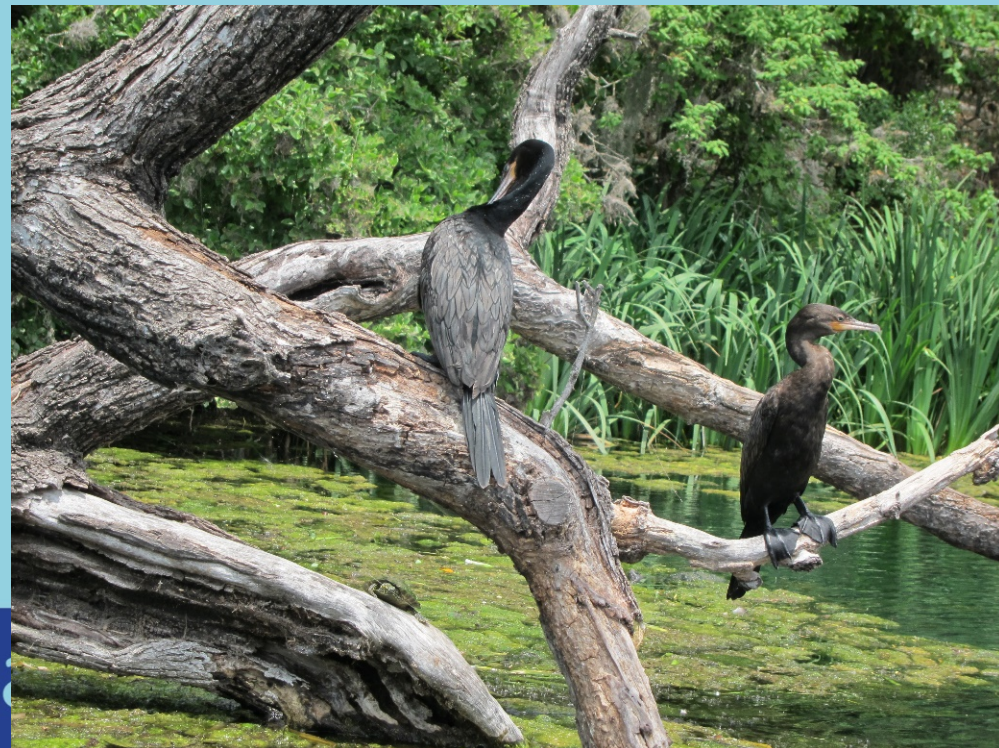
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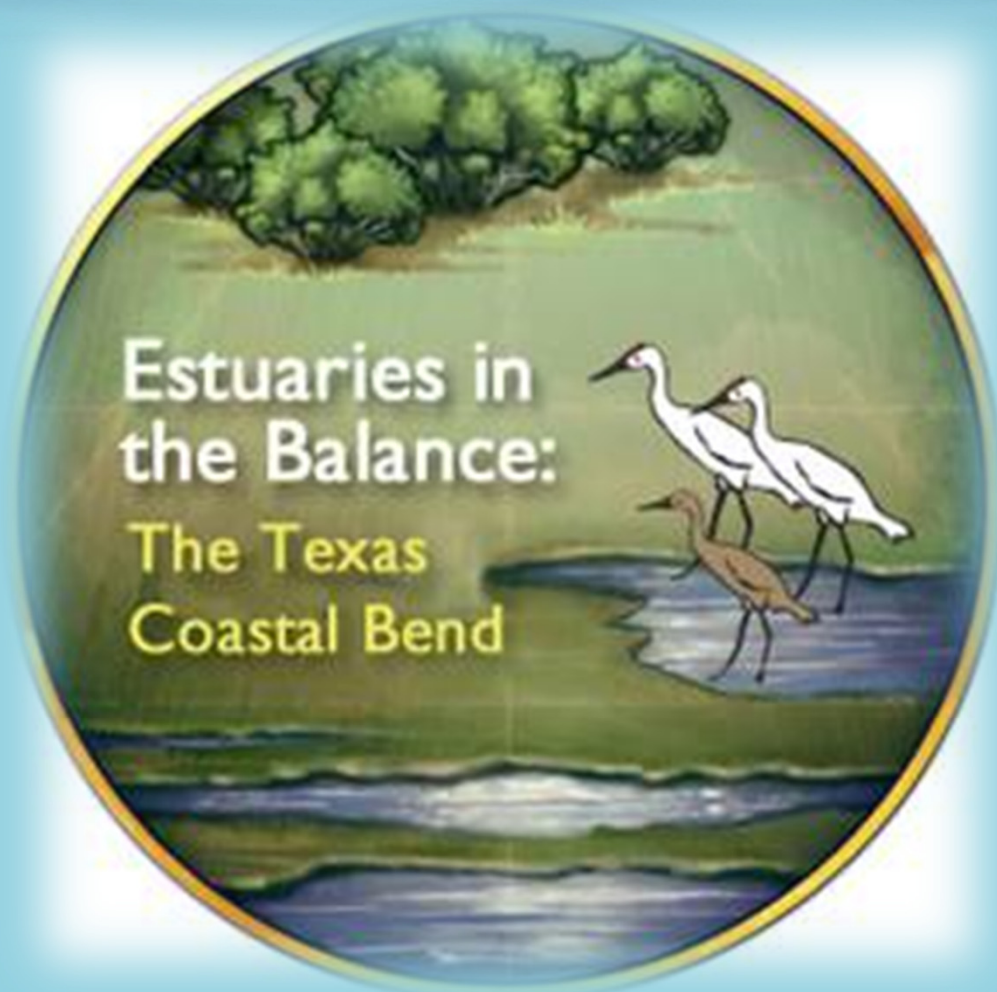


- Headwaters Exploration
- Underwater Experience
- Wetlands Discovery





Web-Based Interactive Learning



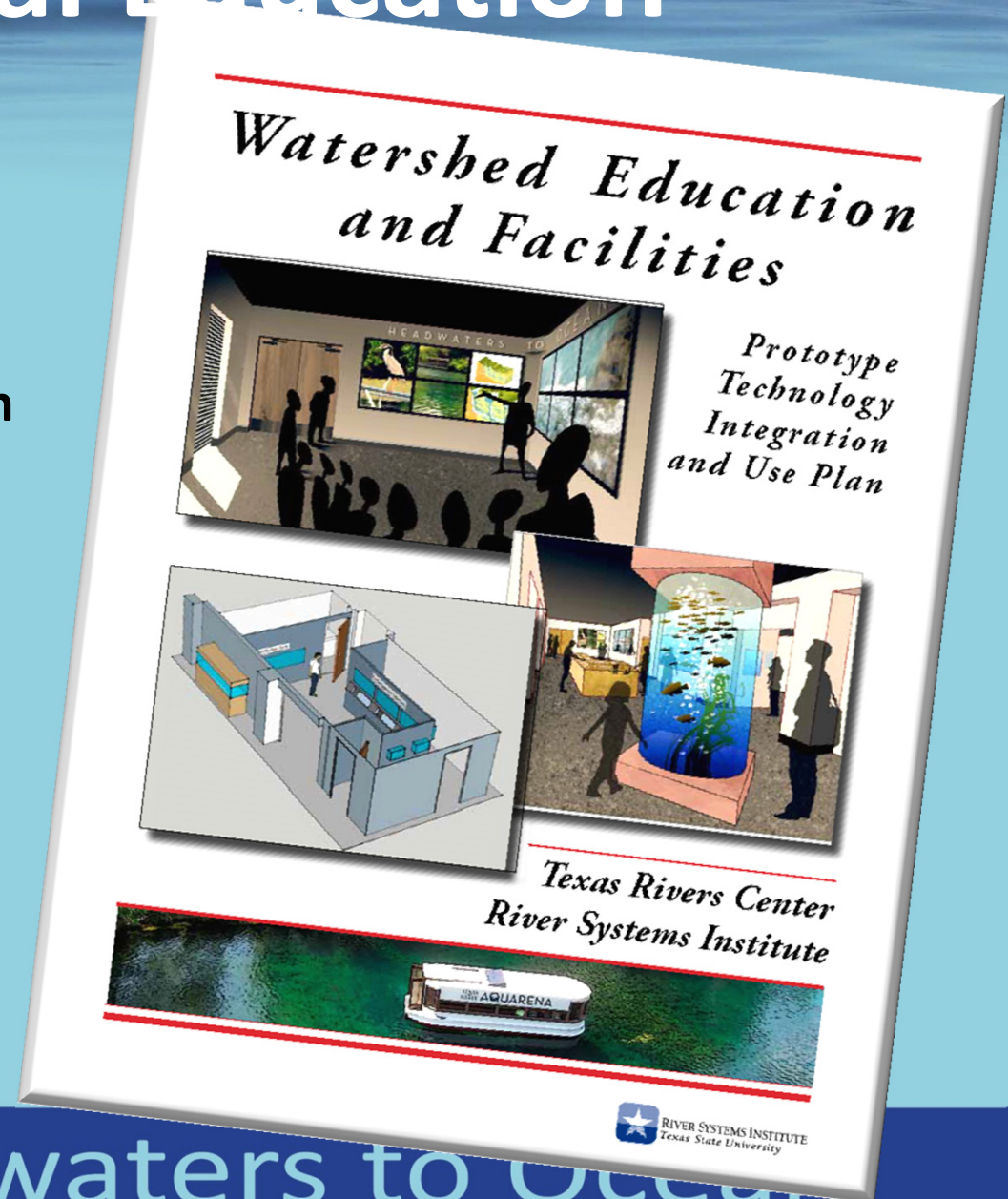
ESTUARIES IN THE BALANCE: THE TEXAS COASTAL BEND

- Interactive multimedia “mega-module” focused on estuary ecosystems
- Four key species: blue crabs, oysters, redfish, and whooping cranes.
- Games, videos, dynamic visualizations, Google Earth Tours.
- Partners: HRI, Hamline University Ctr for Global Environmental Education, International Crane Foundation

High-Tech Integration in Experiential Education

Prototype Technology Integration and Use

- Technology integration and research test bed
- Accommodate :
 - 17,500 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
- Low-tech programming
- **DEMO OUTDOOR CTRS**
- **EASILY EXPORTED**
- **RESEARCH PLATFORM**



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High-Tech Integration in Experiential Education

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

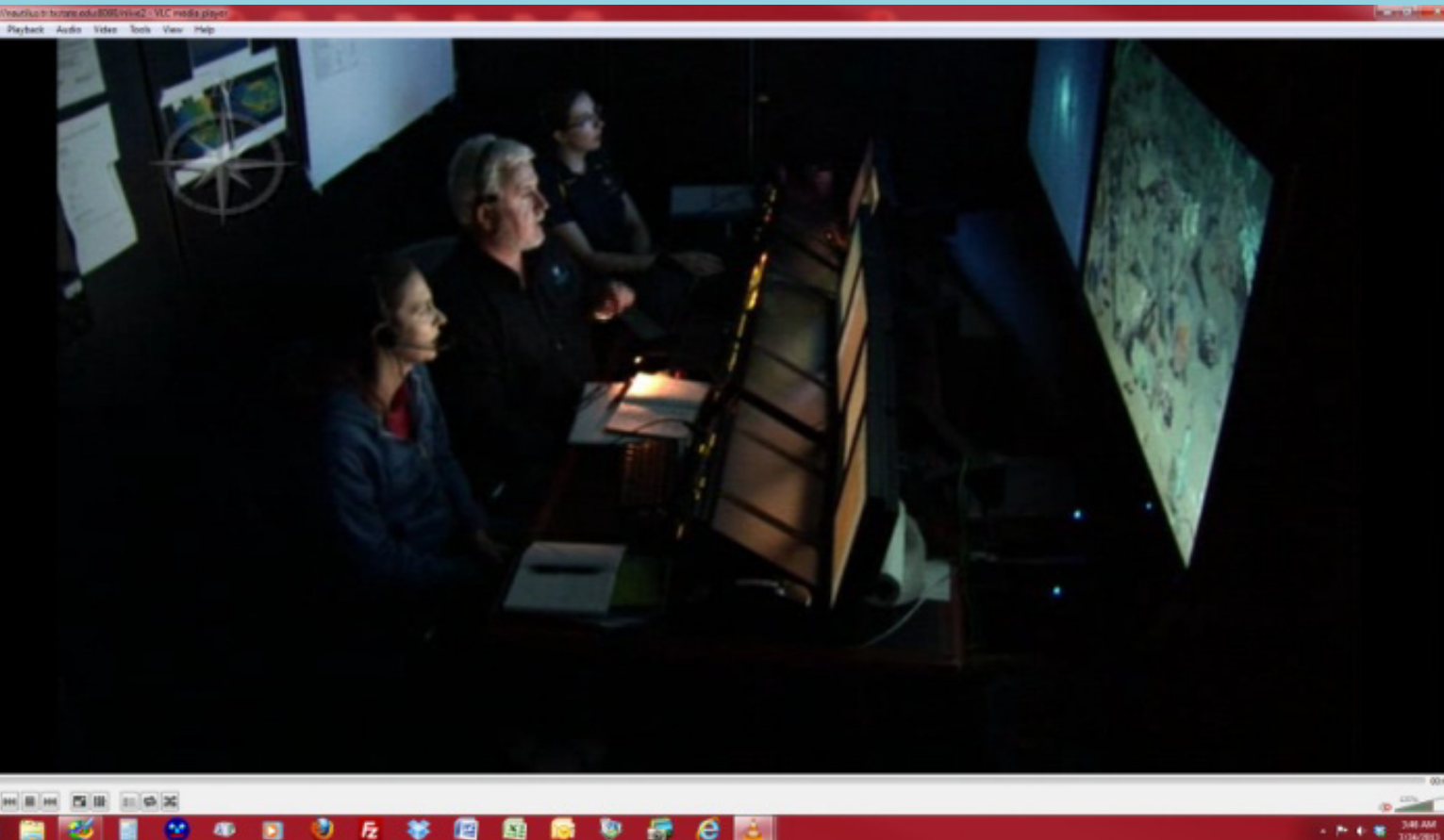
Adaptable for outdoor learning ctrs



High-Tech Integration in Experiential Education

Multi-Media “Command Center”

- View and participate in real-time expeditions at sea and on land
- Communicate directly with explorers
- Scientists participate in scientific explorations remotely





Texas State scientists explore shipwrecks

Texas State University scientists are part of a command center watching live underwater cameras exploring four shipwrecks sunken in the Gulf of Mexico.

This is an active video link.
Please click anywhere on this
image to activate media link.

SAN MARCOS, Texas (KXAN) — Scientists from Texas State University are part of a command center watching **live underwater cameras** exploring four shipwrecks sunken in the Gulf of Mexico.

First of Kind Water Education – STEM Corps

Jobs Corps Student Instruction

- Technician jobs in water, technology training (H2O iPad) and math skill instruction
- Largest Job Corps training center in the nation



Headwaters to Ocean

Research – Ph.D. Dissertation



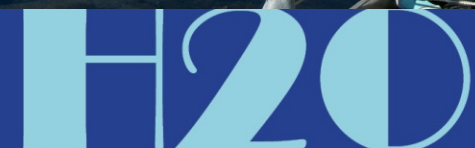
- **Conclusions after having experienced experiential tech enhanced water education:**
 - Significant increases in:
 - student understanding of importance of water
 - teacher interest in instruction about water
 - 100% of teachers agreed they accumulated a deeper appreciation for water and water education

Research – Ph.D. Dissertation

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Headwaters to Ocean

Research – Ph.D. Dissertation

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 - Experiential education can be enhanced by:
 - interactive technology
 - direct contact with water
 - a water “testing” activity
 - linking the experience in one location to other locations familiar to students



Research – Ph.D. Dissertation

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Oops!

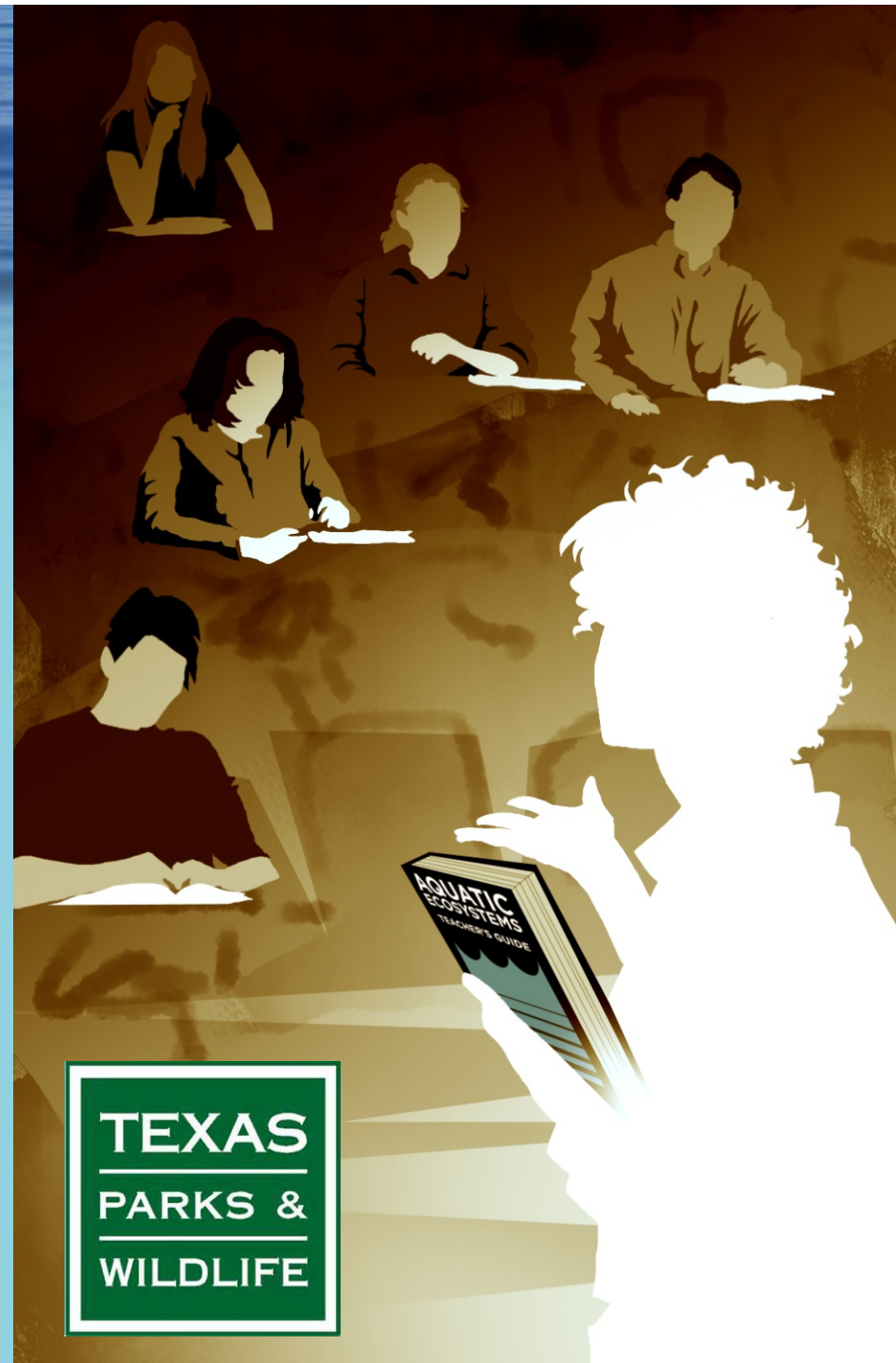


- Cool apps, games, interactives and even bigger ideas.....all with no context for use by teachers.
- **Loser! Loser!**

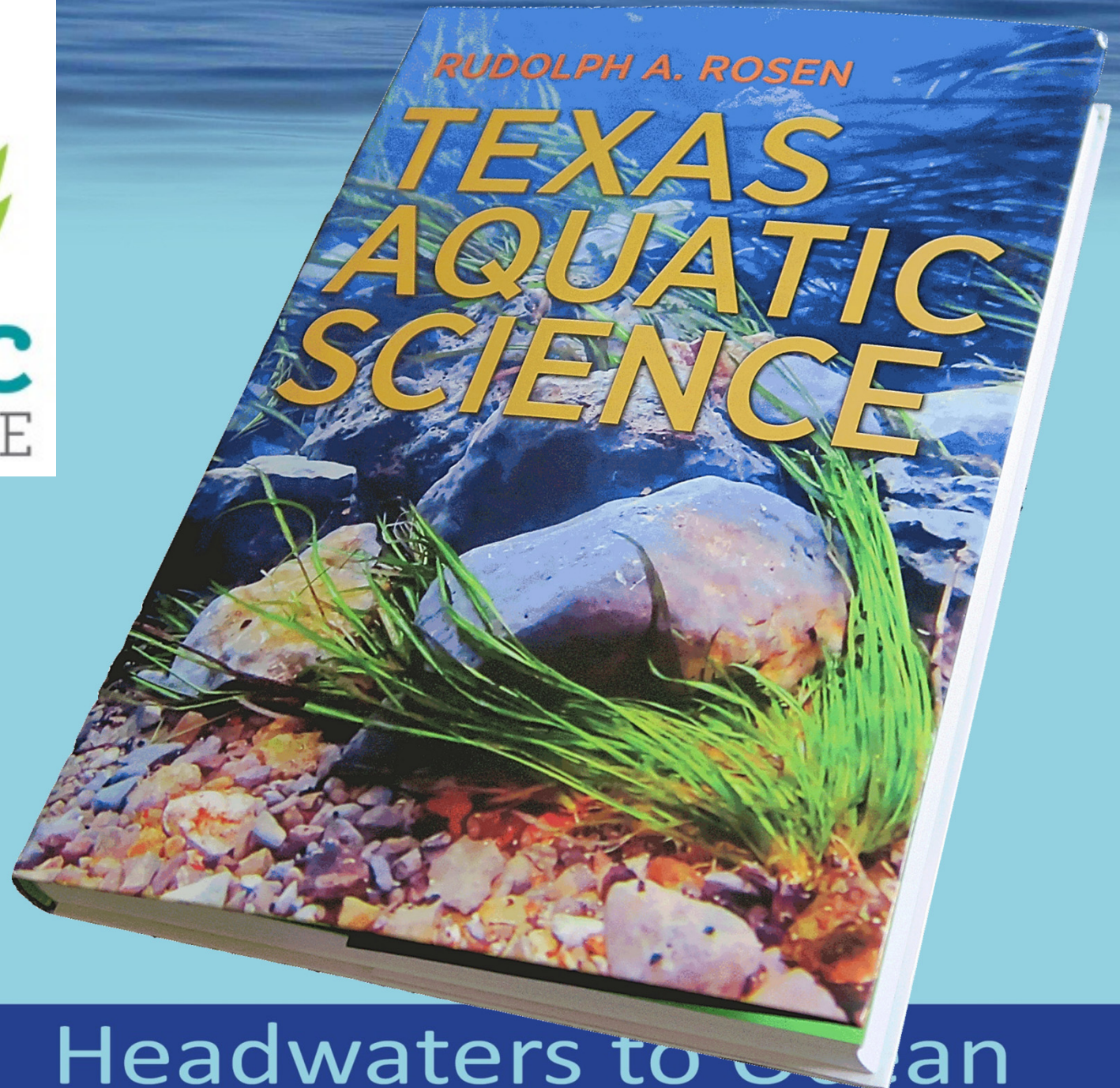
Effective Pathway for Water Curricula

Texas Aquatic Science

- Texas' first comprehensive curricula in Aquatic Science for middle and high schools students
- Meeting all state standards for education and concurrence with TEKS
- Partner with Texas Parks and Wildlife
- Most extensive curricula of its kind in the nation
- Invited review by all Tx Science Teachers as developed



Headwaters to Ocean



H2O

Headwaters to Ocean

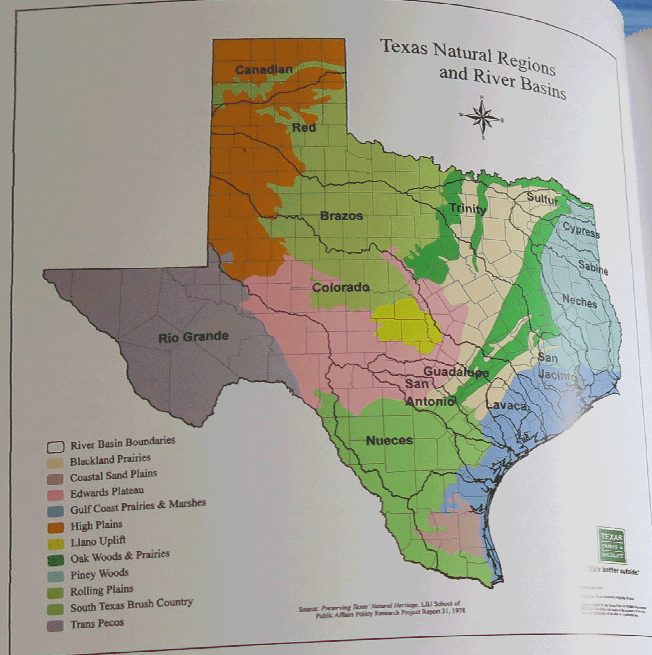


Figure 3.5. Texas natural regions and river basins. Map courtesy of Texas Parks and Wildlife Department.

quantity in the watersheds. Each region has different kinds of habitat for wildlife and opportunities for people (fig. 3.6). Every stream, lake, or wetland is a reflection of its watershed. The goal of the Clean Water Act is water that is "drinkable, swimmable and fishable." Natural resource agencies, communities, and individuals work together for good water quality and quantity. Knowing our watershed and its relationship to surrounding watersheds can help us conserve our aquatic resources.

CHAPTER 3

26

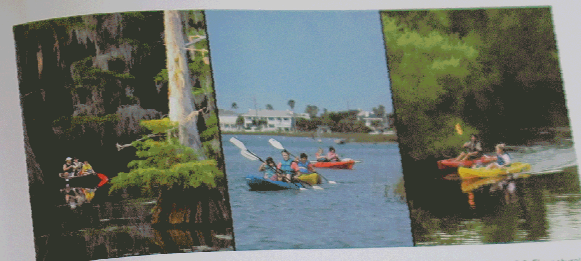
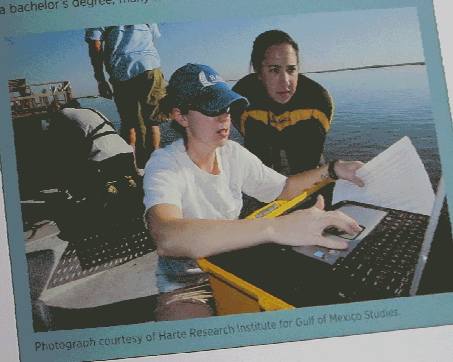


Figure 3.6. The natural physiographic regions in Texas can provide very different boating and fishing experiences. Canoeing in Carlos Lake in East Texas (left), paddling to Aransas Bay near Rockport (center), and kayaking at Parrie Haynes Ranch on the Lampasas River near Killeen (right). Photographs courtesy of Texas Parks and Wildlife Department.

AQUATIC SCIENCE CAREER

Hydrologist

Hydrologists study the movement, distribution, and quality of water. They test, measure, and collect water data, such as river flow rate, tidal fluctuations, dissolved oxygen, sediment load, acidity, salinity, and groundwater levels. These data help us learn about the oceans, surface water on land, and groundwater in our aquifers. Hydrologists write reports, prepare water maps, tables, and graphs of study results, and perform data analyses. These are published in documents or scientific journals and can be used to support water projects or investigations. Hydrologists have at least a bachelor's degree; many have a master's or doctorate degree.



Photograph courtesy of Harte Research Institute for Gulf of Mexico Studies.

WATERSHED ADDRESS

27

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 seaweed, 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.



Map courtesy of Texas Research Institute for Gulf of Mexico Studies and modified by Rudolph Wassen (top); photograph by Rudolph Wassen (middle); photograph courtesy of Corbis Outdoors (bottom)



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.

TEXAS AQUATIC SCIENCE

*From Molecules to Ecosystems,
and Headwaters to Ocean*

Teacher Guide to Aquatic Science and Ecosystems Curriculum
for Middle School and High School

A joint project
Texas Parks and Wildlife Department
The Meadows Center for Water and the Environment, Texas State University
Harte Research Institute for Gulf of Mexico Studies, Texas A&M University - Corpus Christi



Headwaters to Ocean

Texas Aquatic Science Videos

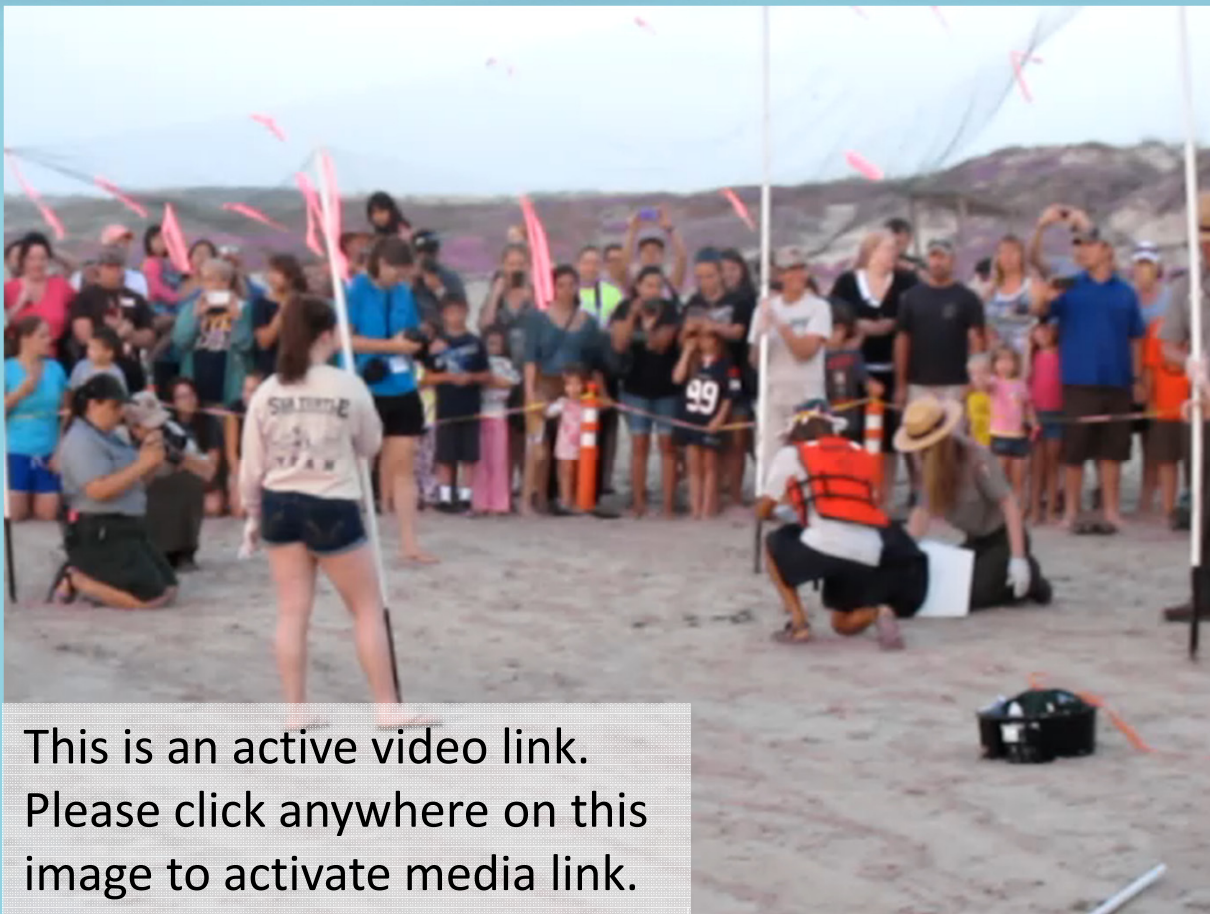


America's Sea: The Gulf of Mexico



Headwaters to Ocean

Interconnected Curriculum



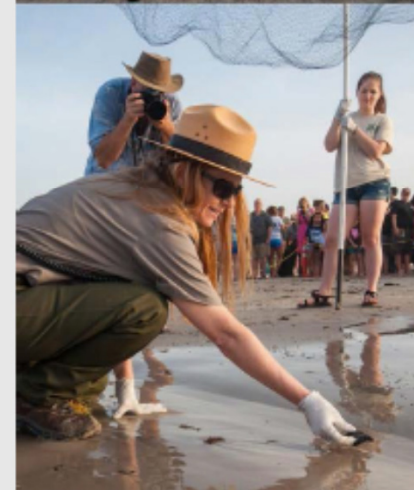
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Texas Aquatic Science

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.

Tech-Driven Teacher Training

Teaching with the Stars

- Watersheds
- Tidewaters: Bays and Estuaries
- Partnership with the Gilbert M. Grosvenor Center for Geographic Education



Headwaters to Ocean

Workshops for Teachers

- **Instruction for teachers on how to use Texas Aquatic Science:**
 - Teachers Guide
 - Exercises
 - Water quality monitoring as an outdoor educational experience
 - Integrating new mobile technology into outdoor and classroom education



Workshops for Teachers

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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.

Water Education Website

- <http://water-texas.org>
- H2O – Headwaters to Ocean
- Over 90 papers, announcements, technology hints for teachers, updates, and more....



H2O Headwaters to Ocean

Texas Aquatic Science

A guide for students -- From molecules to ecosystems, and headwaters to ocean

Home Chapters ▾ Glossary



Learn about Texas Aquatic Ecosystems from Headwaters to Ocean

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Texas Aquatic Science Chapters



Water Is Life – Chapter 1



The Ultimate Recyclable: Water – Chapter 2



What's Your Watershed Address? – Chapter 3



Living in Water – Chapter 4



From Sun to Sunfish – Chapter 5



Texas Aquatic Ecosystems – Chapter 6



Aquifers and Springs – Chapter 7



Streams and Rivers – Chapter 8



Lakes and Ponds – Chapter 9



Wetlands – Chapter 10



Bays and Estuaries – Chapter 11



Oceans: The Gulf of Mexico – Chapter 12



Fishing for Conservation – Chapter 13



Water for People and the Environment – Chapter 14

Working and Careers in Water and Aquatic Science



Beetle Ecologist



Conservation Officer



Educator



Environmental Protection Worker



Fish Hatchery Biologist

Texas Aquatic Science Online

• texasaquaticscience.org

• Chapters

• Videos

• Career Promotions

• Science stories

• How to help

headwaters to Ocean

Texas Aquatic Science Online University Course



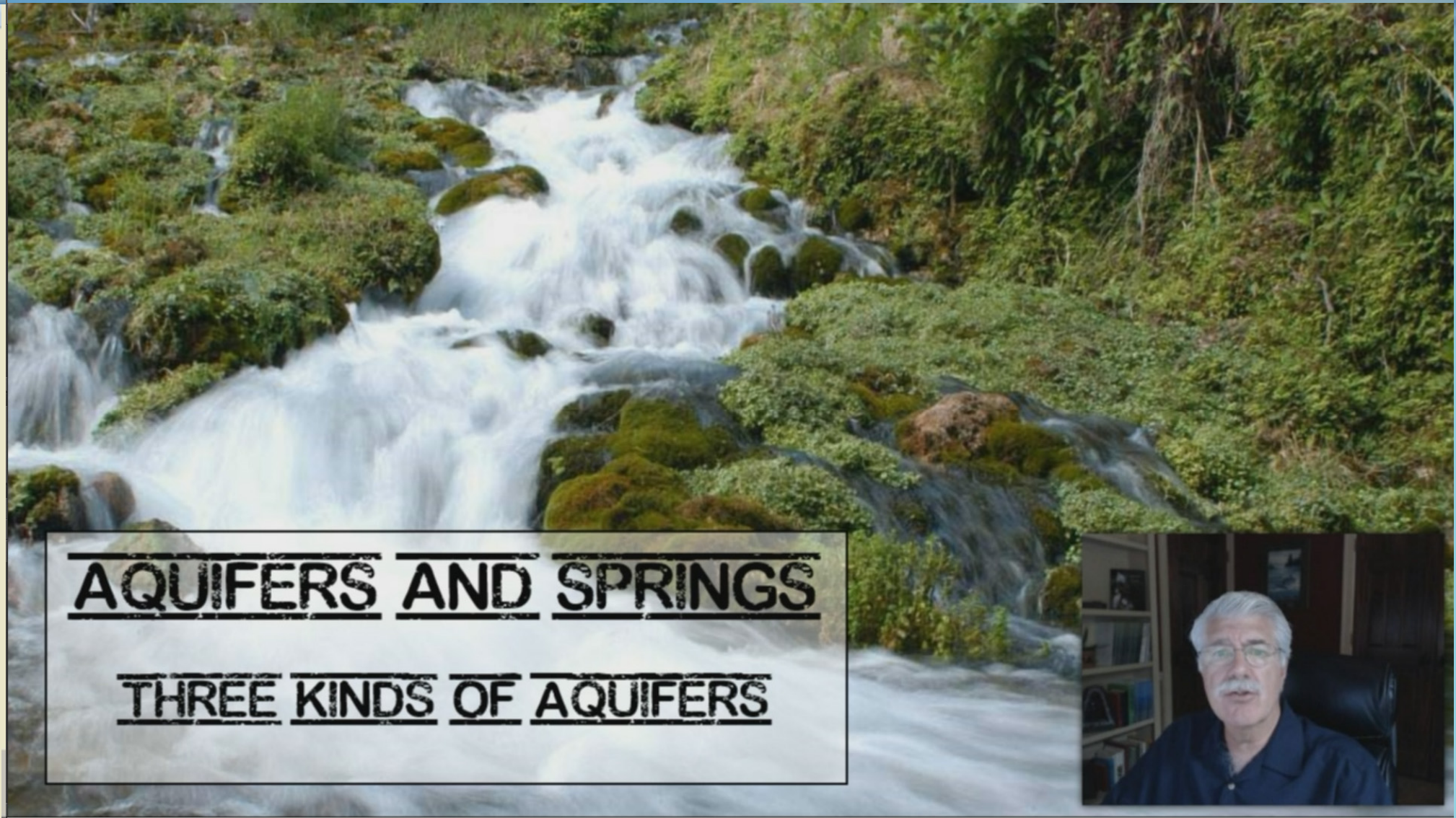
AQUATIC COMMUNITIES

INTRODUCTION



Headwaters to Ocean

Texas Aquatic Science Online University Course



AQUIFERS AND SPRINGS

THREE KINDS OF AQUIFERS



Headwaters to Ocean

Texas Aquatic Science Online University Course



Headwaters to Ocean

Texas Aquatic Science Online University Course

Questions to Consider

- What is an aquifer? What is groundwater?
- How are aquifers similar? How do they differ?
- How do aquifers recharge?
- What is a playa lake? What role does it play in Texas?
- What kinds of aquatic ecosystems exist in groundwater? What adaptations enable aquatic life to exist underground?
- What is a spring? What are headwaters?
- How have springs influenced Texas' history?
- How can we help conserve groundwater?

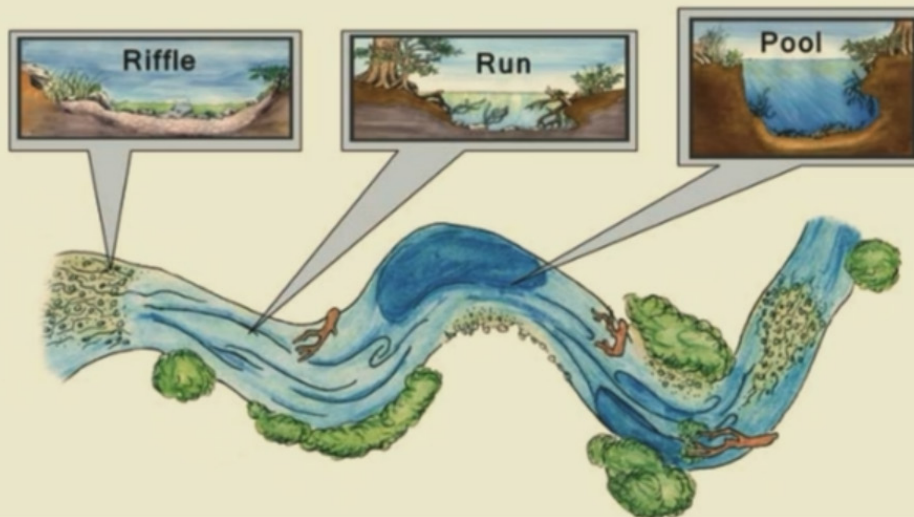
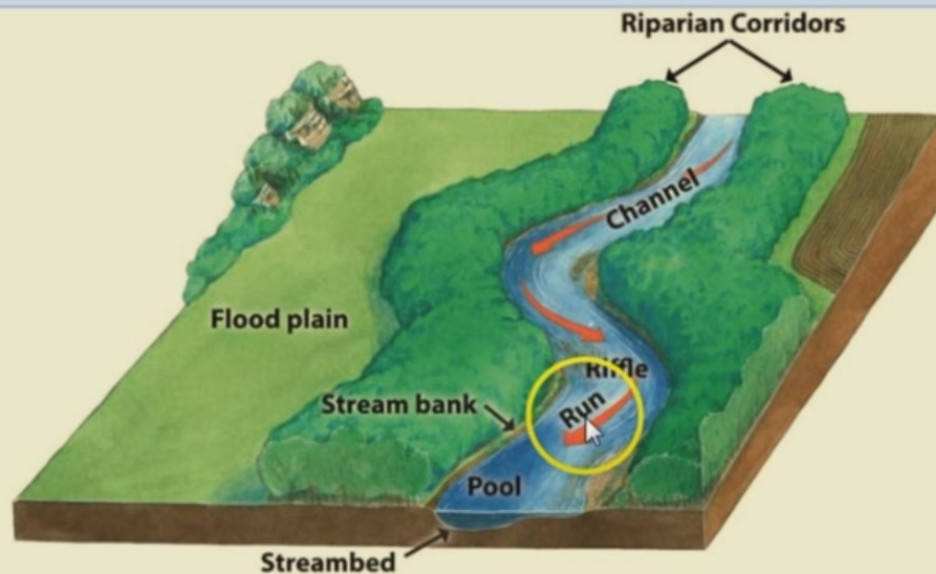
Challenge Questions

- How is your life connected to aquifers?
- Which aquifer provides groundwater where you live?
- How is your groundwater being used? Is it being conserved or is it being depleted?



Headwaters to Ocean

Texas Aquatic Science Online University Course



Texas Aquatic Science Online University Course

AQUATIC ECOSYSTEMS

OVERVIEW



Headwaters to Ocean

Praise for *Texas Aquatic Science*

These materials will benefit hundreds of thousands of students and teachers each year. --Brenda Templeton, Sr. Community Liaison, WaterWorks Education Center, Humble

This is a magnificent contribution. I have shared this new resource with my team.... to use it across the state. --Pamela Plotkin, Director, Texas Sea Grant College Program, College Station

What a great piece of work! I've forwarded ...the new materials to my education list as well as my son's Aquatic Science teacher and the TMEA network. --Kelly L. Drinnen, Education & Outreach Specialist, Flower Garden Banks National Marine Sanctuary, Galveston

I am copying our Nature Center Director and the principal of our new Elementary Environmental Science academy. --Susan Simpson, Superintendent, Grand Prairie ISD, Grand Prairie

The curriculum truly addresses TEKS. I have shared it with many teachers in the Dallas area. --Jana Harter, Executive Director, Healthy Habitats Program

This new curriculum and teaching guide are innovative and of great value in our outdoor, science based community and childrens programs.

--Tom Ryan, Board President, RavenStar Outdoor Education, New Braunfels



Headwaters to Ocean

Texas Aquatic Science Online

File Edit View History Bookmarks Tools Help

Mozilla Firefox Start Page x Aquatic and Water Science... x +

watervideos.org

Aquatic Science Videos

Home Videos Closed Captioned

AQUATIC & WATER SCIENCE VIDEOS

SCIENCE LESSONS WITH DR. RUDY ROSEN FROM TEXAS AQUATIC SCIENCE

CLICK FOR VIDEOS

CLOSED CAPTIONED VIDEOS

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Please click anywhere on this
image to activate media link.

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2/28/2016

Texas Aquatic Science Online

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Texas Aquatic Science

by Texas Parks and Wildlife

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Free

Category: [Ecology](#)
Language: English
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Description

The Texas Aquatic Science series explores our state's ecosystems from headwaters to ocean. Find teaching materials and more resources at <http://texasaquaticscience.org/>. For grades 6-12.

	Name	Description	Released	Price	
1	Chapter 1. Water is Life	Water has properties t...	11/6/2013	Free	View In iTunes
2	Chapter 2. The Ultima...	The earth's water is on...	11/6/2013	Free	View In iTunes
3	Chapter 3. What's You...	Everyone lives in a wat...	11/6/2013	Free	View In iTunes
4	Chapter 4. Living in W...	All aquatic species, inc...	11/6/2013	Free	View In iTunes
5	Chapter 5. From Sun t...	Aquatic habitats are c...	11/6/2013	Free	View In iTunes
6	Chapter 6. Texas Aqu...	Ecosystems are compl...	11/6/2013	Free	View In iTunes
7	Chapter 7. Aquifers a...	Springs have attracted...	11/6/2013	Free	View In iTunes
8	Chapter 8. Streams an...	Texas streams and riv...	11/6/2013	Free	View In iTunes
9	Chapter 9. Lakes and ...	Lakes and ponds provi...	11/6/2013	Free	View In iTunes
10	Chapter 10. Wetlands	Wetlands are among t...	11/6/2013	Free	View In iTunes
11	Chapter 11. Estuaries ...	Texas bays and estuar...	11/6/2013	Free	View In iTunes
12	Chapter 12. Oceans: T...	The Gulf of Mexico is ...	11/6/2013	Free	View In iTunes
13	Chapter 13. Fishing fo...	Understanding fish an...	11/6/2013	Free	View In iTunes
14	Chapter 14. Water for ...	One of the greatest ch...	11/6/2013	Free	View In iTunes

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Examples: World War II, Angles, Magnetism...

University > Natural Sciences > Aquatic Science

Aquatic Science

Oceans Glossary - Aquatic Science with Dr. Rudy Rosen 12.7

Food Chain - Aquatic Science with Dr. Rudy Rosen 5.7

Water for Life Overview - Aquatic Science with Dr. Rudy Rosen 1.1

Water Erosion - Aquatic Science with Dr. Rudy Rosen 3.6

Water Use - Aquatic Science with Dr. Rudy Rosen 1.5

Lakes and Ponds Intro - Aquatic Science with Dr. Rudy Rosen 9.2

Survival - Aquatic Science with Dr. Rudy Rosen 5.9

Weather - Aquatic Science with Dr. Rudy Rosen 2.4

Invertebrates - Aquatic Science with Dr. Rudy Rosen 4.10

Water Use - Aquatic Science with Dr. Rudy Rosen 1.5

Freshwater Inflow - Aquatic Science with Dr. Rudy Rosen 11.4

Bays and Estuaries Overview - Aquatic Science with Dr. Rudy Rosen 11.1

Lake Ecosystems - Aquatic Science with Dr. Rudy Rosen 9.6

Water Use - Aquatic Science with Dr. Rudy Rosen 1.5

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Aquatic Science

Microbiology 4

Leeuwenhoek 2

Microbes 3

Classification 2

Teachers

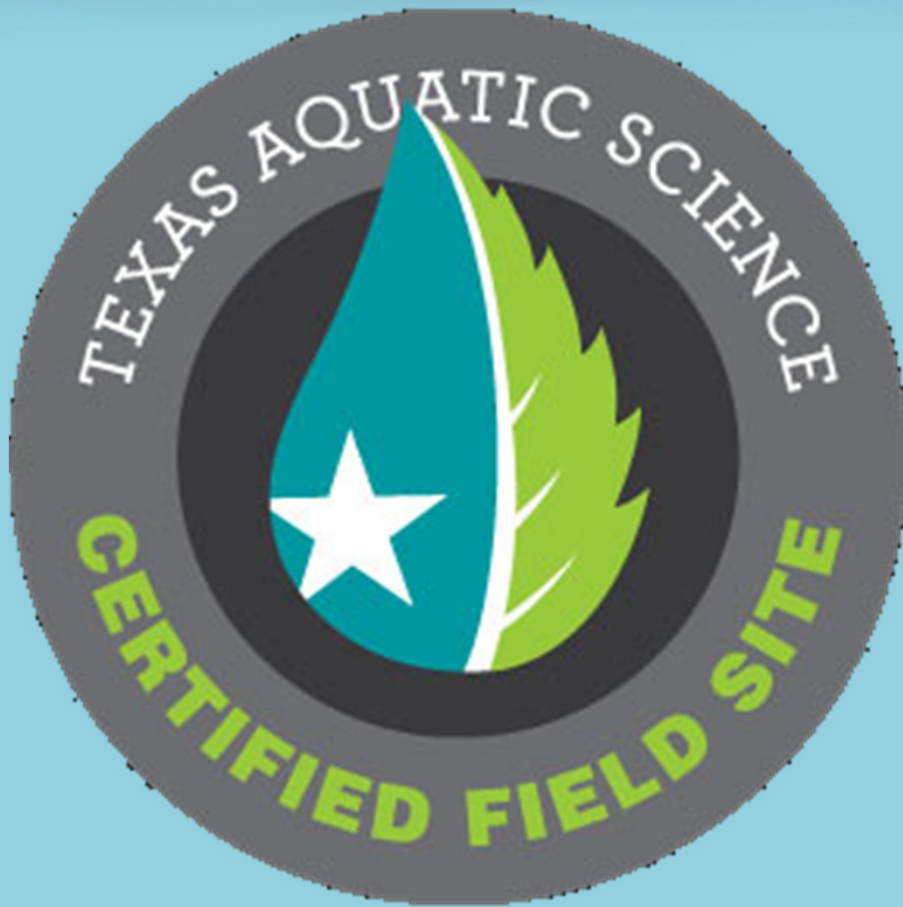


Rudolph Rosen

Professor

Austin, Texas, United States of A...

Texas Aquatic Science Certified Field Sites



- **Connect aquatic science in the classroom with educators and outdoors learning**
- **62 sites (so far)**
 - Austin Area
 - Corpus Christi Area
 - East Texas
 - West Texas
 - Fort Worth/Dallas Area
 - Houston Area
 - San Antonio Area
 - Waco Area

Effectiveness Research



- **Ph.D. Student Project**
 - **2015-16 School Year**
- **160 Teachers Trained for Pilot**
- **4,500 Students in Pilot Study**
- **39 Schools**
 - **San Antonio, Austin, Dallas, East Texas, Houston, Rio Grande Valley**
- **Student & Teacher Assessments**
- **Grant Funded: \$130,000**

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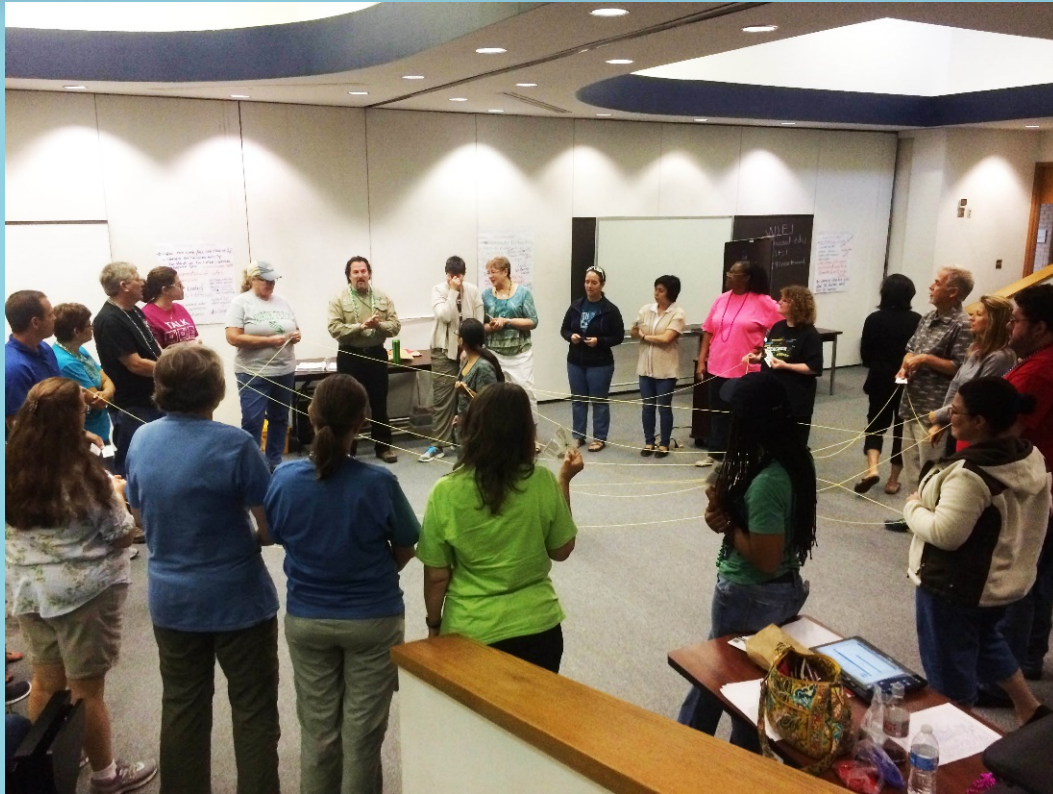
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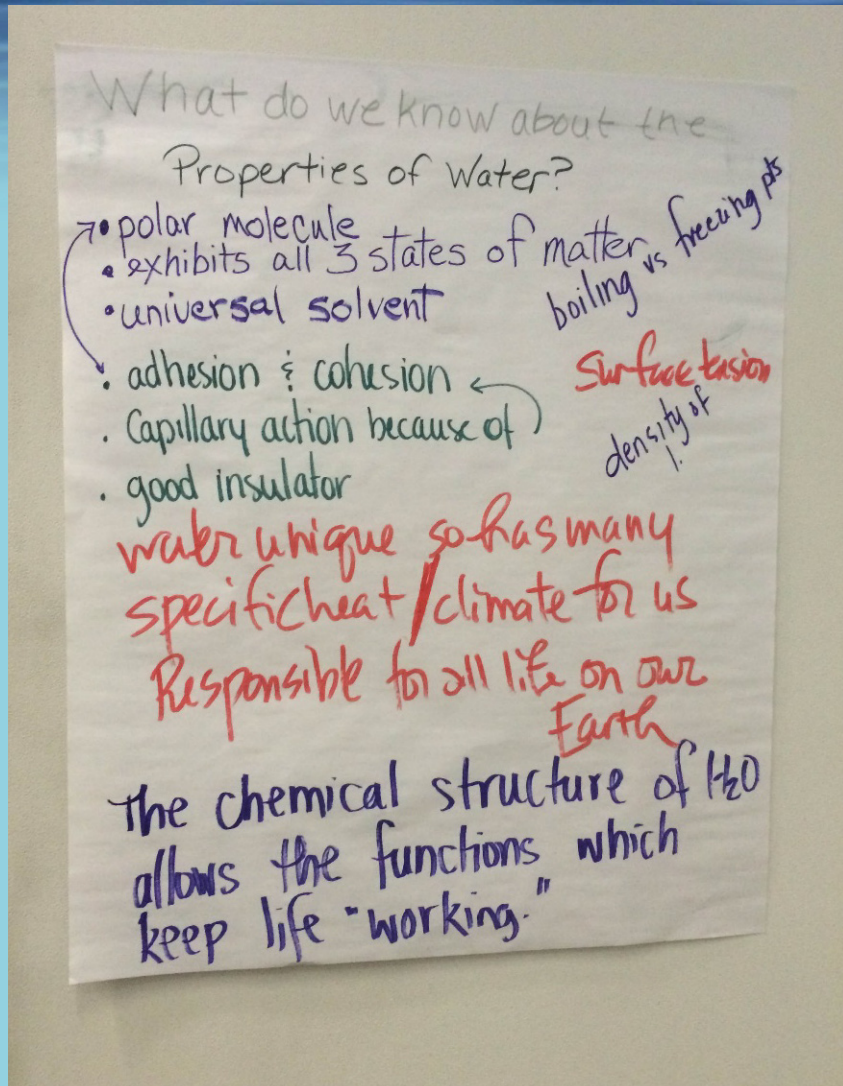
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1. Measure impact on students' understanding of aquatic science concepts, as well as impact on students' attitudes and beliefs
2. Implementation:
 - a. how much and which parts of the curriculum teachers implement
 - b. in what ways
3. Suggestions for future improvement

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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
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- **Statistics show patterns of website use:**
 - heavy use during weekdays when class is in session
 - summer usage on day-by-day basis about 75% less than during the school year
- **About 220,000 unique individuals visited the website in the 2015-16 school year, the first full year of classroom use.**



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Partners and Support

- The Meadows Center for Water and the Environment
- Harte Research Institute for Gulf of Mexico Studies
- Ewing Halsell Foundation, San Antonio
- Texas Parks and Wildlife Department
- USFWS - Sport Fish Restoration Program
- National Science Foundation
- The Meadows Foundation
- Texas State High Performance Computing Team
- 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

