The Spring Lake Dive Authorization Course

Course Overview

Course Overview

Thank you for your participation in this course and helping us to preserve and protect Spring Lake, one of the true treasures of Central Texas.

This course has been developed to impart to you the importance and fragility of this unique environment and to make sure that you always conduct yourself in the safest possible manner when SCUBA diving in Spring Lake.

Course Structure

The Spring Lake Dive Authorization Course is divided into 4 take home Academic Modules and assessment quizzes that are to be ***completed by each student <u>prior</u> to the class start***.

Students will meet for one full day at Spring Lake where the assessment quizzes will be reviewed, diving skills will be assessed, a tour of the Springs will be given and common volunteer tasks will be demonstrated.

Course Structure

The Four Academic Modules will cover:

- The Hydrology of the Edwards Aquifer;
- The History and Archaeology of Spring Lake;
- The Biology of Spring Lake;
- Safety Procedures and Protocols for Diving in Spring Lake

Plan to spend @4 hours going over the modules and answering the quiz questions.

Quizzes may be taken with open notes and the course slides.

Course Structure

The Diving Assessment will cover:

- Buoyancy Control;
- Situational Awareness;
- General Diving Skills;

Among other things, divers will be required to swim through an underwater obstacle course consisting of several 4’ x 4’ PVC squares placed at variable depths to demonstrate proper buoyancy control on ascents and descents.

Proper buoyancy control and situational awareness are two of the most essential skills to ensure the protection of the environment and diver safety.

Anyone that feels that their buoyancy control is not adequate should seek additional training before the start of this course.

Course Structure

This course is a PASS/FAIL course.

Students must score at least 70% on each of the assessment quizzes and demonstrate that they are competent divers (good buoyancy control and situational awareness) in order to pass this course.

Students who do not successfully complete the course the first time will have the opportunity to make up the failed portions 2 more times. After that, they will be required to start the course over again.

Student Requirements

Students who wish to take this course must:

- Show proof of a Full Open Water SCUBA Certification through a major Dive Training Agency (at this time Junior Open Water Certifications are not being accepted);
- Show proof of a minimum of 20 logged dives ***beyond*** their training dives;
- Provide their own equipment including tanks and weights.
- Pay the Course fee of $230
- Complete and turn in all required paperwork.

Please Remember!

Diving in Spring Lake is a privilege. As stewards of this precious resource we depend upon you to act with the utmost respect towards the environment and rich cultural history that you are helping us to maintain and protect.

Special Thanks

Distinguished filmmaker and environmentalist Ron Coley founded the Volunteer Diving Program at The Meadows Center for Water and the Environment, at Texas State University in 1996. Ron's passion for scuba diving and commitment to the preservation of the San Marcos Springs has been an inspiration to the many volunteers, dive masters and colleagues who have participated in this unique underwater stewardship opportunity.

The course material presented to you was originally written and developed by Ron Coley and Deborah Lane. It is a compilation of scientific and educational documents from the U.S. Fish & Wildlife Service, Edwards Aquifer Authority, Texas Parks & Wildlife Department, Texas Historical Commission, Hays County Historical Commission, Edwards Aquifer Research and Data Center/Texas State University, Center for Archaeological Studies/Texas State University, and the Meadows Center for Water and the Environment/Texas State University.

The Volunteer Diving Program has been fortunate to have the enthusiastic and dedicated support from many contributors and volunteers who have been diligent in their efforts to promote the conservation and preservation of this amazing natural resource. Special thanks and acknowledgement goes to Eric Peterson, Don Dibble, Joseph M. Owen, Bridget Lewin, Katherine Chapman, Erica Meier, Anlo Sepulveda, Paul Collins, Yakona.org and Jennifer Idol.

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The Meadows Center for Water and the Environment
Texas State University

Spring Lake Dive Authorization Course

Module 1
Water, and the Hydrology of the Edwards Aquifer

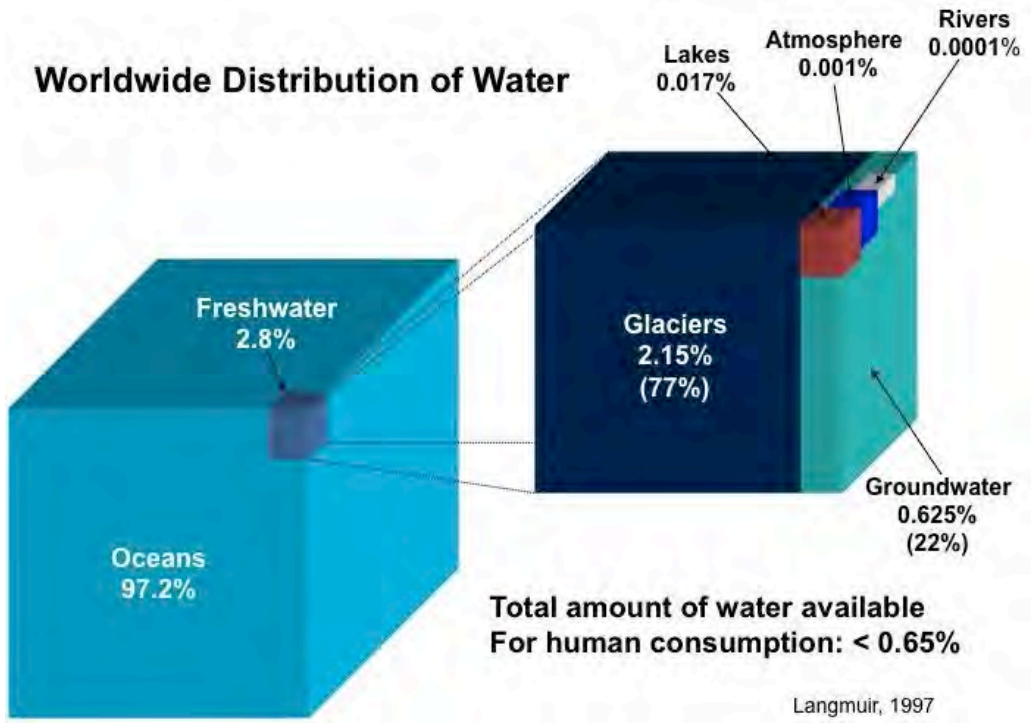
Topics

- Water in a Global Context
- Water issues in Texas
- The Hydrology of the Edwards Aquifer
- Spring Lakes Place in the Aquifer

Water in a Global Context

THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

- Water is essential to almost all life; past, present and future. It is a nexus for economic development, energy production, and human and environmental health.
- While water covers nearly three-quarters of the planet, 99% of it is in oceans or glaciers, or is otherwise inaccessible.
- All terrestrial life is dependent upon less than 0.65% of the world's water supply.
- Where that 0.65% is clean and accessible there is an opportunity for commerce, culture, and coexisting human and natural communities.



Water in a Global Context

THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

NASA

In its 2000 Millenium Declaration, the United Nations directly related a lack of access to clean water to poverty and poor health.

Freshwater is a finite resource. Its sustainability requires judicious management, particularly as pressures rise from agriculture, energy production, industrial uses, and human consumption.

Over the past century the world population has tripled and the demand for water has grown sixfold.

- 1.1 billion people live without access to good clean drinking water
- 2.6 billion people live without proper sanitation
- 90% of sewage in the developing world is left untreated
- 70% of industrial waste in the developing world is left untreated
- 80% of the diseases in the developing world are water borne
- 5 Million deaths, mostly among children and the elderly, occur each year as a result.

Water in Texas

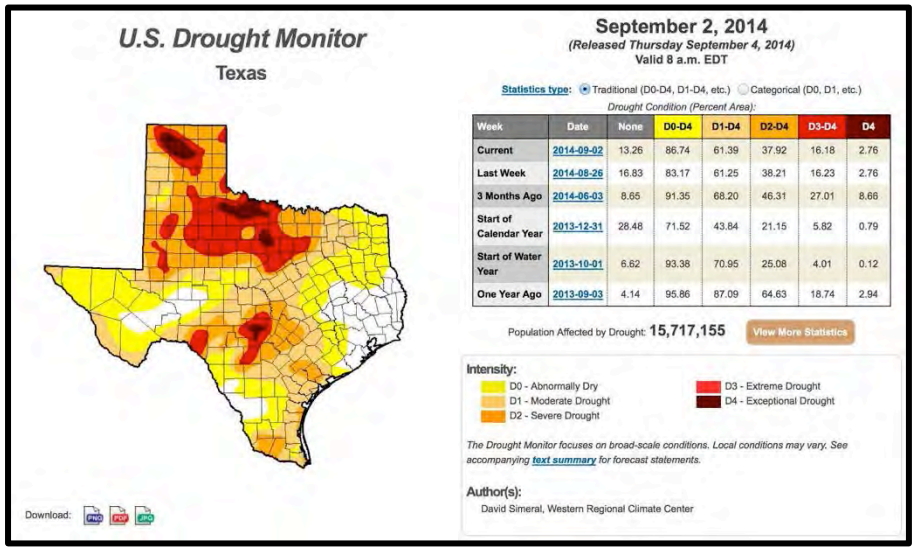
THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

2011 was the driest year on record for Texas and cost the agricultural industry $7.62 billion.

In Texas from 2010 to 2060:

- The population is expected to grow by 82%
- Water demand is expected to grow by 22%
- Existing Water supplies are expected to drop by 10%
- Failure to meet water needs could result in more than a million lost jobs and an annual income loss of $115 billion.

As many as 900 Texas cities may not have enough water by 2050.



Week	Date	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	2014-09-02	13.26	86.74	61.39	37.92	16.18	2.76
Last Week	2014-08-26	16.83	83.17	61.25	38.21	16.23	2.76
3 Months Ago	2014-06-03	8.65	91.35	68.20	46.31	27.01	8.66
Start of Calendar Year	2013-12-31	28.48	71.52	43.84	21.15	5.82	0.79
Start of Water Year	2013-10-01	6.62	93.38	70.95	25.08	4.01	0.12
One Year Ago	2013-09-03	4.14	95.86	87.09	64.63	18.74	2.94

http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?TX

The Edwards Aquifer

Cave Passageway in the Edwards Aquifer
Photo © Jennifer Idol The Underwater Designer

The Edwards Aquifer is a karst (limestone) aquifer 300-700 feet thick, formed from the carbonate minerals deposited 144 to 65 million years ago during the Cretaceous period when this area was an inland sea.

The Balcones Fault Zone was created by a series of earthquakes which started 27 million years ago and lasted about 15 million years. This seismic activity helped to form a system of fractures, faults, open channels, sinkholes, and caves through which water flows.

The Edwards Aquifer

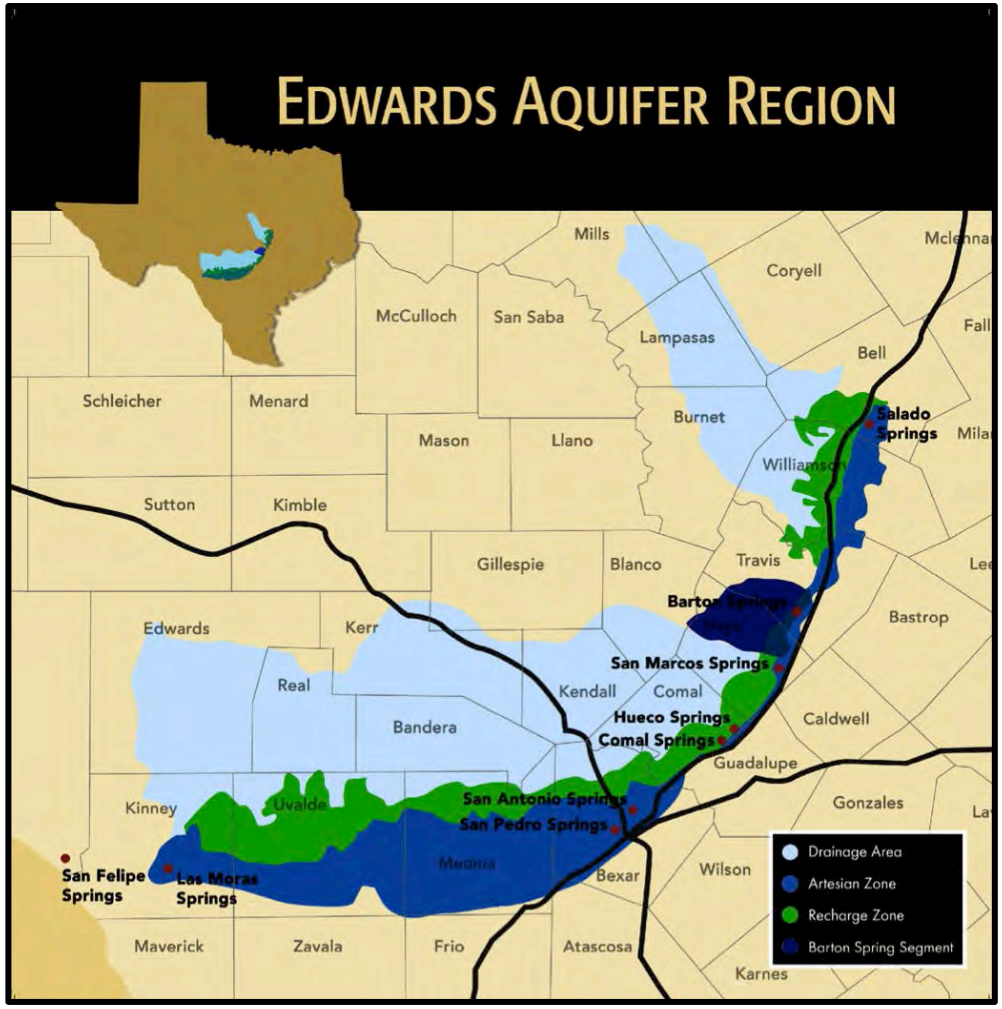
The Meadows Center for Water and the Environment
Texas State University

The aquifer has three segments: the ***Northern Segment***, *the* ***Barton Springs Segment***, and the ***Southern or San Antonio Segments***.

The San Antonio Segment of the Edwards Aquifer extends 176 miles, from Brackettville in the west, to Kyle in the East. Spring Lake is in this segment.

Each segment has three zones, the ***Drainage Zone***, *the* ***Recharge Zone***, *and the* ***Artesian Zone***.

The *Drainage Zone* consists of the watershed area. It covers the largest geographic area of the Edwards Aquifer.



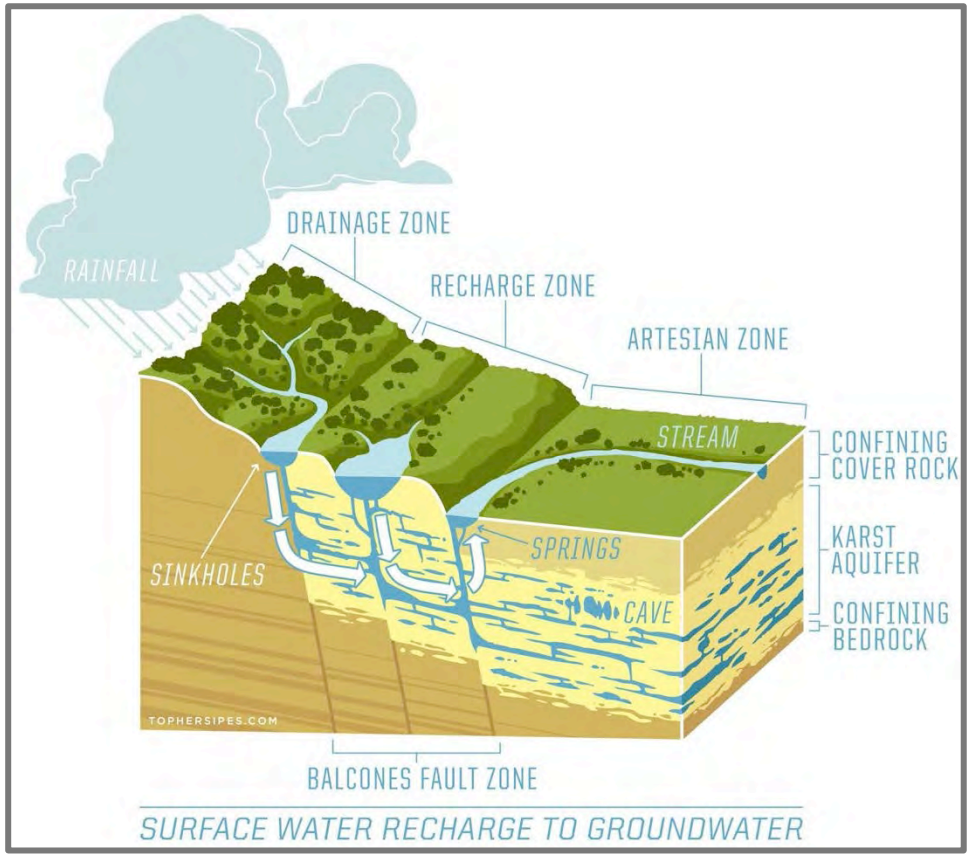
The Edwards Aquifer

The ***Drainage Area*** occurs on the Edwards Plateau (the Texas Hill Country). The drainage zone collects rainfall which in turn flows into streams that run across the Recharge Zone.

In the ***Recharge Zone*** the porous Edwards limestone is exposed to the surface, allowing rainfall and stream flows to plunge directly into the caves and channels that make up the aquifer. The recharge zone is where any pollutants and contaminants are able to enter the aquifer. Contaminants are very difficult to trace back to their source and eliminate.

The ***Artesian Zone*** is the aquifer's underground reservoir. The water held in these spaces is under its own pressure because of the weight of the water above it. The artesian zone is trapped between two relatively impermeable layers.

Artesian springs occur when ***faults*** or ***fractures*** in the overlying impervious layer allow water under its own pressure to flow upward.



The Edwards Aquifer

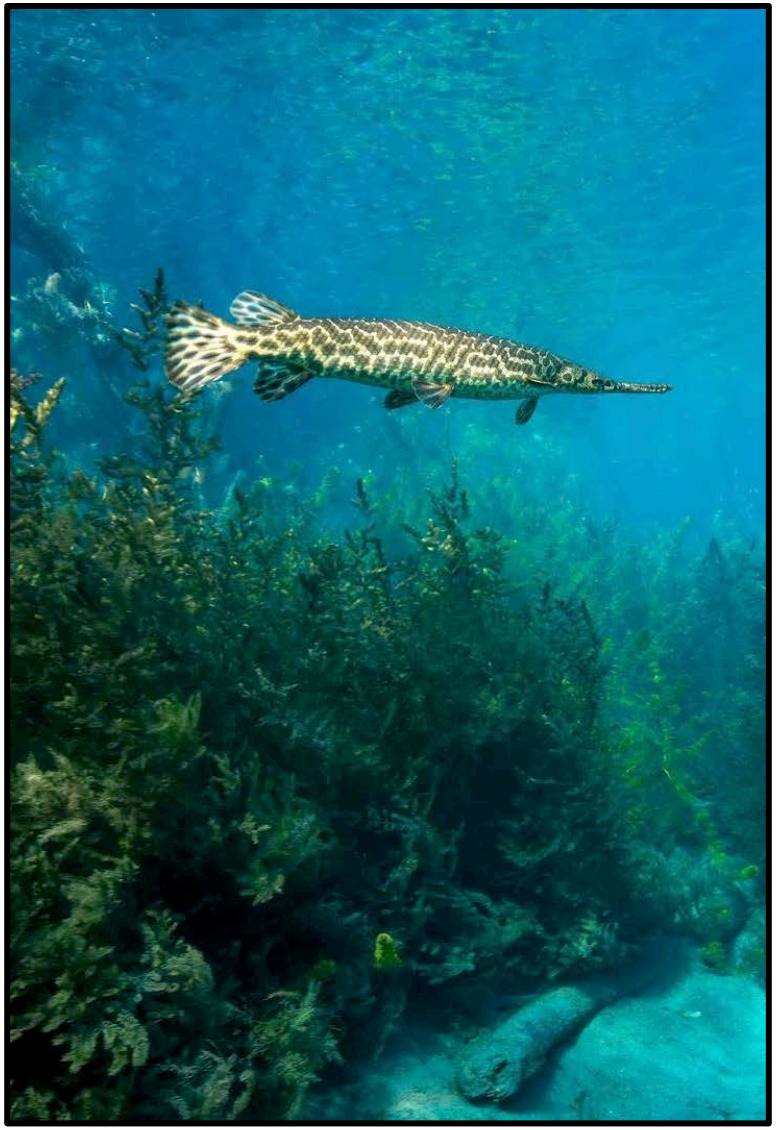
The ***Edwards Aquifer*** is a limited resource. This was first realized in the 1950s with the increased pumping from wells within the aquifer region and a seven year drought that drastically lowered water levels causing many springs and streams to cease flowing altogether.

Water is essential to most forms of life, and the Edwards Aquifer serves the diverse agricultural, industrial, recreational, and domestic needs for over 2 million people.

As local population grows, more and more water is drawn from the Aquifer, demand on the Aquifer increases and the water level decreases.

Barton Springs Austin, Texas
Photo © Jennifer Idol The Underwater Designer

Spring Lakes Place in the Aquifer



Spotted Gar, Spring Lake
Photo © Jennifer Idol The Underwater Designer

Spring Lake is a man-made, artesian spring fed lake located along the Balcones Fault. The San Marcos Springs that feed the lake are the headwaters of the San Marcos River that flows into the Blanco River which in turn flows into the Guadalupe River and then on to the Gulf of Mexico. On the west side of the lake is the beginning of the Texas Hill Country, to the east is the beginning of the Coastal Plain which extends all the way to the Gulf of Mexico.

Human interaction with the San Marcos Springs has been continuous since its discovery. Spring systems have unique characteristics that provide relatively isolated, island like, ecosystems that are highly endemic.

In an area subject to cyclical droughts, the San Marcos Springs have never stopped flowing in recorded history. Spring Lake helps us not only demonstrate the fragility, beauty and importance of the aquifer, but also monitor it for any effects we may cause.

Key words in Hydrology

Aquifer: a geological formation below the earth that stores, transmits, and yields water in sufficient quantities for human use.

Artesian: groundwater confined under pressure that will rise above the level of the aquifer when penetrated by a well.

Acre-foot: the amount of water needed to cover one acre of surface area to the depth of one foot (@ 325,000 gallons).

Balcones Fault Zone: area along the south-eastern border of the Edwards Plateau containing extensive faults and fractures that formed from the movement of the Earth's crust.

Cretaceous Period: the last geological time period in the Mesozoic Era, approximately 65 to 135 million years ago.

Edwards Formation: a designated layer of limestone whose sediments were deposited during the Cretaceous Period.

Hydrology: the study of water.

Impermeable: material that does not permit liquid (water) to flow through.

Permeable: material that permits liquid (water) to flow through.

Recharge: the process by which water enters the aquifer.

Spring: a place where water flows from the soil or rock.

Troglobite: a cave dweller.

Water table: the part of the aquifer or zone of saturation nearest to the surface.

The Big Question...

THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

How do we manage our water for the health of our communities, the vitality of our commerce and culture, and the sustainability of our environment?

Guadalupe State Park

Spring Lake Dive Authorization Course

Module 2
The Archaeology and History of Spring Lake

Topics

- What is Archaeology?
- Texas Archaeology
- Spring Lake History
- Spring Lake Archaeology
- The Texas Historic Commission
- The Texas Antiquities Code
- Violations

What is Archaeology?

Anthropology is the study of human culture. Archaeology is a sub-discipline of anthropology. It is the study of past peoples and cultures through the excavation and examination of material remains.

Archaeologists use controlled recovery and preservation methods to propose and test hypotheses, perform scientific analyses, and put forth theories about the past. During and after examination, artifacts and findings are relocated to a local university or museum to be part of a collection, where archaeologists can conserve them and perform more studies for years to come.

Surface Excavation at Spring Lake directed by the Center for Archaeological Studies

One day someone will stand where we now live and wonder who we were.

What is Archaeology?

Or should we say, “What archaeology is not”?

The distinction between archaeologist and collector or, worse, a treasure hunter, is an important one. While collectors are legally allowed to pick up artifacts on their own land, ***it is against the law to collect artifacts on state or federal lands***.

Furthermore, collectors need to be aware that much more information would be learned from an artifact if an archaeological excavation was performed and the entire context of the site was taken into account.

Spring Lake is state land, including the parts that are underwater!

The legal custodian of all cultural resources, historic and prehistoric, on all Texas State University Property, including the Meadows Center is the State of Texas.

<u>Collecting</u> arrowheads and potsherds is NOT archaeology!

Core sample being extracted from Spring Lake

An artifact is *<u>any</u>* object used or made by man that is over 50 years old.

What is Archaeology?

Looters, collectors, and vandals alike damage archaeological sites in order to obtain relics of the past for their own personal gain.

Beyond physical damage to the site itself, ***looters and vandals deprive archaeologists of the possibility of studying the site and testing important theories about Texas' history***.

While some looters claim they are saving artifacts from imminent destruction, the fact is that any uncontrolled digging sacrifices contextual information that is crucial to reconstructing the lifestyles of past peoples.

Texas Archaeology

Scattered across Texas are clues to a story that began approximately 13,000 years ago.

Currently, about 65,000 archaeological sites have been discovered, with ***thousands left unknown***. Each site tells the story of over 500 generations of Texans, from ancient hunters in the San Marcos area, to missionaries in San Antonio.

These sites are historically and scientifically important to our state because they contain the tangible remains of our history.

How many more archaeological sites are yet to be found in Texas?

Texas Archaeology

Submerged Sites

Millions of sites are scattered throughout the plains of north Texas, the rolling Hill Country, and the desert mountains in the south. However, human occupation did not stop at the shores of the Gulf or the banks of the rivers and streams.

Over the last thousand years, the gradual rise in sea levels and more recent reclamation projects have submerged important sites like the San Marcos Springs.

With over 5,200 square miles of total water area, the possibility of finding an archaeological site increases significantly. These sites still lie preserved under layers of protective sediment and are accessible to underwater archaeologists.

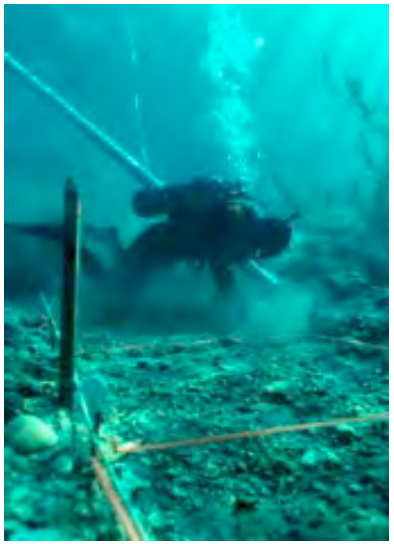


Photo courtesy of Ron Coley

Photo courtesy of Ron Coley

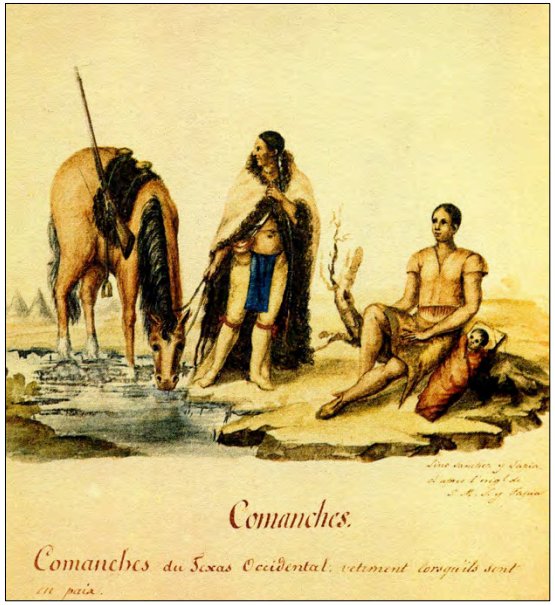
Underwater Archaeology conducted in Spring Lake

Spring Lake History

Prehistoric and Historic Background of the San Marcos Springs

The area surrounding the San Marcos Springs has been inhabited during every known period of human habitation in Central Texas, from Paleo-Indian through the Historic period. **The springs and rich assortment of aquatic and terrestrial plant and animal life that flourish at the springs were and continue to be a strong attraction to people.** Paleo-Indian artifacts have been recovered in excavations in and around the headwaters of the San Marcos Springs and from underwater excavations in Spring Lake conducted by Dr. Joel Shiner starting in the 1970's. Shiner proposed that Paleo-Indian groups were semi sedentary and lived for long periods of time at the springs. Because Paleo-Indian sites are few and their geological content is often mixed, this period is poorly understood within Texas. The oldest artifacts from this period date back over 12,000 years ago and belonged to the Clovis culture. (Bousman and Nickels, 2003)

Early hunters and gatherers migrated into the Americas over 13,000 years ago

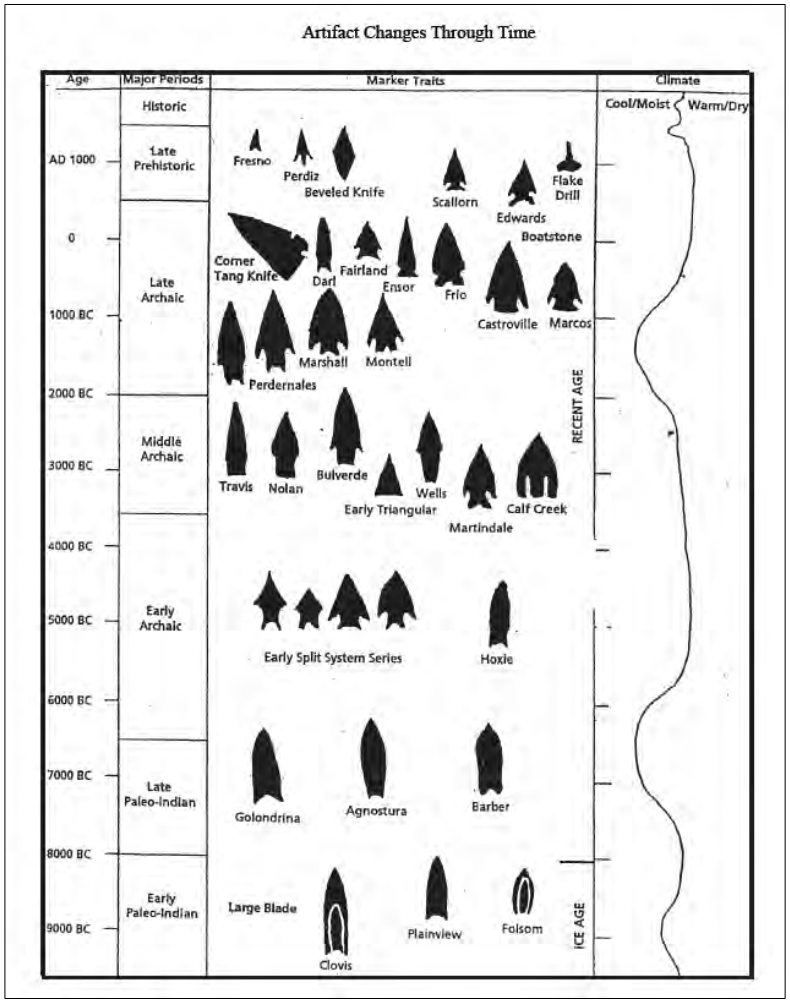


Watercolor of Comanche Indians by Lino Sánchez y Tapla

Spring Lake History

The Archaic Period 7,000 B.C. – A.D. 800

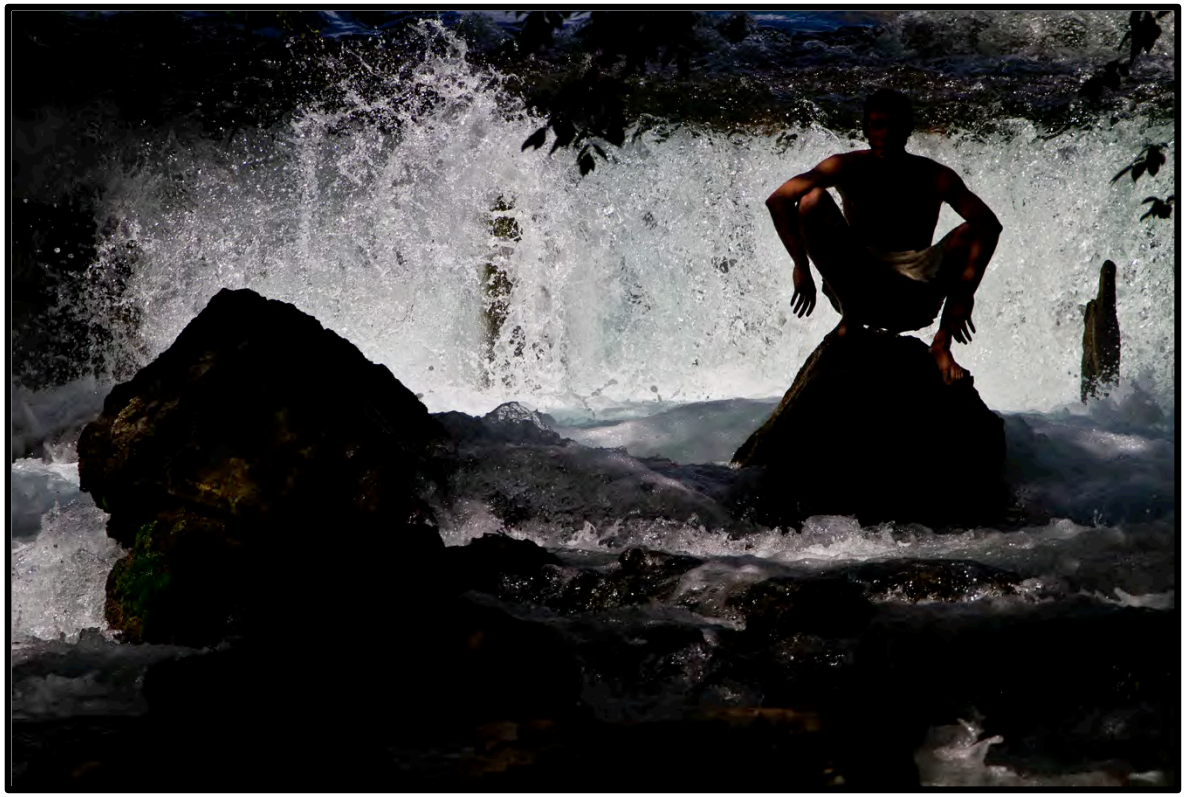
Surveys and excavations along the San Marcos River, Blanco River, Sink Creek and Purgatory Creek reveal abundant occupations during this period. Projectile points become more refined, cemeteries appear and hunting shifts from deer to bison. During this era the inhabitants of the area existed through specialized hunting and gathering and eventually established “seasonal regions” in which they found specific food resources at particular locales at specific times of the year. They made a wide variety of chipped stone tools such as spear points, stones and grinders. They also made tools and ornaments of bone and shell. Population increased significantly during this period as evidenced by a growing number of burial sites (Bousman/Nickles 2001).



Spring Lake History

The Late Prehistoric A.D. 800 – Historic Times, A.D. 1500

This period witnessed several changes such as the introduction of clay pottery and the bow and arrow. Hunting and gathering continues. Agriculture was not practiced in this part of Texas. Villages increase in size perhaps for defensive purposes as the period is characterized by movements of different tribal groups through the region.



Yakona.org

Spring Lake History

Protohistoric Period

The period between the earliest European contact and permanent settlement is called the Protohistoric period. In the 1500's, Spanish explorers came to the region and by 1697 they had completed the "Camino Real" the King's Highway from Natichotoches, Louisiana, through San Antonio and into Mexico passing near San Marcos.

"In June of 1691 the Domingo Teran de los Rios expedition camped at the San Marcos Springs for a few days in route to East Texas and they recorded the Cantona Indian name for the San Marcos Springs. This name, ***Canocanayestatetlo***, means "hot water." (Bousman, Nickels 2010)

During this time period, various groups lived near the San Marcos Springs some living permanently while others came seasonally on bison hunts. (Newcomb 1993). Later groups such as the Tonkawa, Lipan Apache, and Comanche migrated south from Oklahoma and the Plains and replaced the former groups through warfare, diseases and settlement. As the Spanish presence increased, their direct and indirect contact with the Native American inhabitants had a dramatic and negative effect that lead to a dramatic decline in population through disease and internal turmoil .

Watercolor of Tonkawa Indians by Lino Sánchez y Tapia in Jean Louis Berlandier, *The Indians of Texas in 1830* (1969).Texas Collection Library

Spring Lake History

Historic Period

Beginning in the 1700's into the early 1800's, military posts, missions and settlements appeared in the area.

Spanish Settlement in Central Texas first occurred in San Antonio with the establishment of the Alamo. The first Spanish settlement in San Marcos wasn't until 1755. Historic records indicate there were several missions in the San Marcos area for the Tonkawa Indians. However their exact locations are not known.

The mission in San Marcos was eventually abandoned for numerous reasons, including drought, immoral, unhealthy conditions and attacks by the Apache. The first permanent Spanish settlement near San Marcos was along the San Marcos River, near Westerfield Crossing. Founded on April 1, 1808, it was named San Marcos de Neve. The small village was abandoned in 1812 due to Tonkawa and Comanche Indian harassment and severe flooding.

By 1836, Texas had gained Independence from Mexico and permanent communities began to appear in Central Texas.

Map of San Marcos c. 1881


Marker for the Kings Highway near San Marcos

Spring Lake History

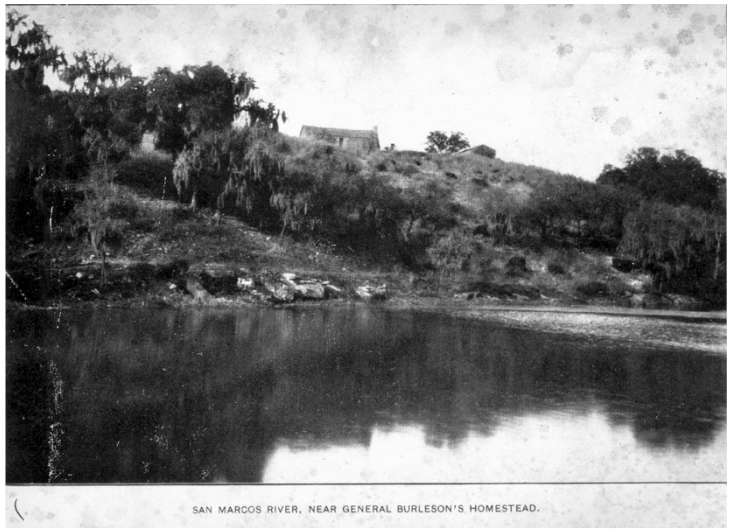
The Settling of San Marcos

In 1831, Juan Veramendi, a native of San Antonio received a land grant of two leagues of land in the area that is now San Marcos. In 1845, General Edward Burleson and Dr. Eli Merriman bought a portion of that land including the headwaters and springs of the San Marcos River.

In 1846 Burleson joined with William Lindsey and Dr. Eli Merriman to found the town of San Marcos. The town was officially established in 1851. From the time that Burleson purchased the land around the headwaters and the springs became associated with him.

In 1848 Burleson built a cabin on the hillside overlooking the headwaters of the San Marcos River. He also built the first schoolhouse in San Marcos and the first dam across the San Marcos River. Built in 1849, the dam ran a gristmill and a sawmill at the end of Spring Lake.

General Edward Burleson



The Burleson Homestead on Spring Lake

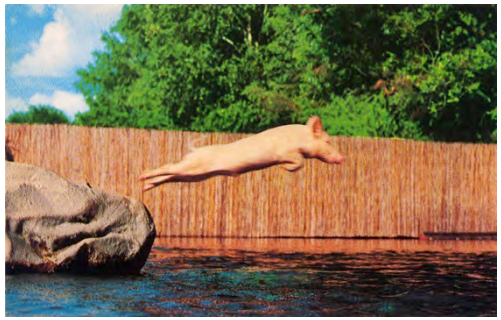
Spring Lake History

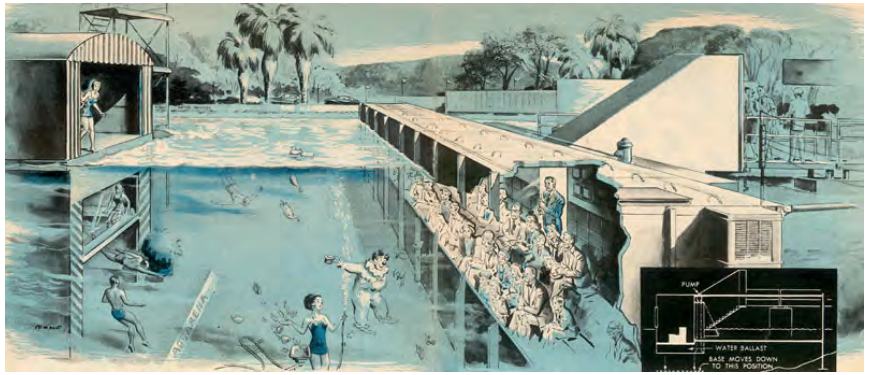
Aquarena Springs

A.B. Rogers purchased the land around the headwaters in 1926 and built the Spring Lake Hotel, which opened its doors in 1929. In 1949, Paul Rogers bought the land from his parents for $20,000. He rigged a paddle boat with a glass bottom and began to take family and friends out to see the bubbling springs, plants and animals that thrived in the clear waters of Spring Lake.

He went on to the develop the Aquarena Springs theme park using glass bottom boats as its main attraction. Rogers continued to add buildings and attractions to the park including a submarine theatre, sky ride, space needle, pioneer village, restaurant and hillside trails. Aquarena Springs became a favorite tourist destination throughout the 1960's, 70's and 80's.

It was best known for a swimming pig named 'Ralph' who began each underwater show by diving into the lake to drink from a milk bottle that a trainer held. In 1985 the Paul J. Rogers Trust sold Aquarena Springs to a development company. In 1994, Southwest Texas State University (now Texas State University) purchased the land.





Spring Lake History

Today

Texas State University-San Marcos established **The Meadows Center for Water and the Environment**, formerly the River Systems Institute, as a leadership initiative to coordinate and further university-wide efforts in the field of aquatic resource management. The Meadows Center started out as International Institute for Sustainable Water Resources in January 2002, and was renamed the River Systems Institute in 2005.

Following a large gift from the Meadows Foundation in August, 2012, The Meadows Center will continue the mission to develop and promote programs and techniques for ensuring sustainable water resources for human needs, ecosystem health and economic development. The Meadows Center aims to promote a holistic approach to the management of natural systems where key principles of sustainability and equitable use guide sound water policy.

Over 125,000 visitors come each year to Spring Lake to learn and marvel in its enduring beauty.

Spring Lake Archaeology

When General Edward Burleson built his earthen dam across the San Marcos River to power a Gristmill and sawmill, he unwittingly created an underwater archaeological preserve.

As the waters rose, most of the archaeological artifacts left by the inhabitants disappeared beneath the surface of the lake.

Over one hundred years later, archaeologists realized the importance of this site and began to perform underwater excavations.

Thousands of artifacts dating back to the Clovis period (about 13,000 – 9,000 years ago) were recorded from Spring Lake.

Dr. Joel Shiner was the pioneer of underwater archaeology at Spring Lake and his site can still be viewed above and below the water.

Dr. Joel Shiner at Work in Spring Lake
Photo courtesy of Ron Coley

Spring Lake Archaeology

Today, Spring Lake and the Burleson Dam are owned and operated by Texas State University.

Since 1982, Texas State University has been involved in the systematic investigation of the prehistoric inhabitants of the San Marcos area, uncovering hundreds of thousands of artifacts. Underwater research conducted by Joel L. Shiner established over 12,000 years of continuous human habitation of the area in and around the headwaters of the San Marcos River and Spring Lake.

Burleson Dam c. 1921/
www.edwardsaquifer.net

Spring Lake Archaeology

People have depended on the the San Marcos Springs for the necessities of life since the region was first inhabited. Much like today, harsh droughts plagued the region every few decades, resulting in severe food and water loss.

Unlike any other springs in the area, history does not record a time where the San Marcos Springs ceased to flow.

This information, coupled with archaeological surface digs in and around Spring Lake, leads us to believe that the area around the headwaters is one of the oldest continually inhabited regions in the United States and was crucial to the survival of ancient peoples in Texas.

Prof. Britt Bousman displays an artifact recovered by Spring Lake

Artifacts recovered from surface excavations near Spring Lake.

Photos courtesy of Ron Coley

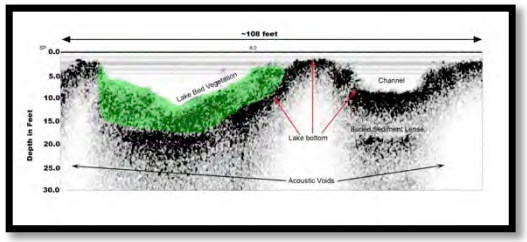
Spring Lake Archaeology

Underwater Archaeology Continues in Spring Lake

Since 2010, the Meadows Center's Chief Underwater Archaeologist, Frederick Hanselmann, has begun new efforts to better understand the submerged portion of the springs' archaeological record. The data recovered will provide further information on the paleoenvironment of the San Marcos Springs and will assist in selecting sites within the springs for future excavation

Results to date

- Completion of two geophysical surveys using both high and low frequency echosounders in order to read into the lakebed and provide potential locations for core samples
- Cores were extracted using a diver-operated system consisting of a pneumatic driver, segments of aluminum pipe, and a chain hoist.
- Initial sediment analysis of the cores indicate at least one water level highstand or lake' existed in prehistory due to either a log jam, beaver dam, or possibly anthropogenic activity and combined with previous core sample data, that Spring Lake Peninsula formed beginning in the Late Pleistocene as a result of the continuous presence of water from the springs combined with the intermittent availability of moisture upstream.



Future efforts

- More in-depth core sampling to include terrestrial cores
- Initiate long-term excavation on selected areas of the lakebed
- Develop a permanent exhibit of Spring Lake archaeology
- Install a historic marker underwater near the Shiner excavation site

The Texas Historical Commission

TEXAS HISTORICAL COMMISSION
real places telling real stories

The mission of the Texas Historical Commission (THC) is to protect and preserve the state's historic and prehistoric resources for the use, education, economic benefit, and enjoyment of present and future generations.

In 1953 the Texas State Legislature established the Texas State Historical Survey Committee with the task to identify important historic sites across the state.

The Texas Legislature changed the agency's name to the Texas Historical Commission in 1973. Along with the name change came more protective powers, an expanded leadership role and broader educational responsibilities.

Antiquities Code of Texas

During the late 1960s, treasure hunters plundered a sunken Spanish treasure ship that was lost in a storm off the Texas coast in 1554. Many artifacts were taken from the wreck with no regard for proper archeological controls, and the public realized that significant historical information was being lost. This incident prompted the 1969 passage of the Antiquities Code of Texas to protect historic buildings and archeological sites on public land. The Texas Historical Commission (THC) is charged with ensuring compliance under the Antiquities Code.

The Antiquities Code of Texas requires that the Texas Historical Commission staff review any action that has the potential to disturb historic and archeological sites on public land. Actions that need review under the Antiquities Code of Texas include any construction program that takes place on land owned or controlled by a state agency or a state political subdivision, such as a city or a county.

Projects that require review include:

- Reservoirs constructed by river authorities and water districts;
- Construction of recreational parks or the expansion of existing facilitates by city governments;
- Energy exploration by private companies on public land;
- Construction by a city or county government that exceeds 5 acres or 5,000 cubic yards, whichever comes first. If the activity occurs inside a designated historic district or affects a recorded archeological site, it needs to be reviewed, regardless of project size.

Violations of the Antiquities Code of Texas

As provided by the Antiquities Code, **all sites, or items of archaeological, scientific, or historical interest that are found on land belonging to the State of Texas, belong to the state** and may not be taken, altered, damaged, destroyed, salvaged or excavated without a permit from the THC.

A person violating provisions of the code is guilty of a misdemeanor, and on conviction can be punished by a fine of not less than $50 and not more than $1,000 and or by confinement in jail up to but not more than 30 days.

An artifact is *<u>any</u>* object used or made by man that is over 50 years old.

Our Collective Responsibility

Each of us is responsible for the legacy of Texas. Whether you have a strong desire to learn more about Texas archaeology, an interest to help describe Texas' history to others, or simply a love of underwater exploration, you play an integral role in preserving the past. While our Texas heritage is usually a focus on past events, practices, and people, it can also be a consideration on the future of our culture. As you continue to dive at the Meadows Center, please be reminded of the importance of Spring Lake, the archaeological sites found here, and all of our roles in its preservation for years to come.

Never remove or disturb any artifacts above or below the water!
Doing so on State or Federal Land is against the law!

IF YOU ENCOUNTER ARCHAEOLOGICAL REMAINS OR ARTIFACTS ABOVE OR BELOW THE SURFACE AT SPRING LAKE, DO NOT DISTURB THEM, MARK THEIR LOCATION AND NOTIFY MEADOWS CENTER STAFF.

Thank you for your help!

Spring Lake Dive Authorization Course

Module 3
The San Marcos Springs Ecosystem

Topics

- Introduction to the San Marcos Aquatic Ecosystem
- Reasons for Biodiversity
- Important Terms
- The Endangered Species Act of 1973
- Endangered and Threatened Species of the San Marcos Springs
- Major Threats to Our Endangered/Threatened Species
- Aquatic Plants of Spring Lake
- The Spring Lake Management Plan and Habitat Conservation Plan

Introduction to the San Marcos Springs Ecosystem

The upper San Marcos River is one of the most biologically diverse aquatic ecosystems in the southwestern United States and has a number of endemic (they exist no where else in the world) species that are found in the upper 4.5 miles of the river. The U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department now list **eight of these species as threatened or endangered.**

Ecologists are interested in all the organisms in an ecosystem and how they are affected by the physical environment that surrounds them, and their interactions with each other.

The protected status given to these eight species results from the isolated nature of the spring run and the high potential for habitat destruction. Divers in Spring Lake and the river need to be aware of these species and their special habitat requirements so that diving activities do not negatively impact them.

Texas Blind Salamander

Introduction to the San Marcos Springs Ecosystem

Developing an understanding of this unique ecosystem will enhance your diving experience and increase your value as a volunteer diver.

Your skills and awareness as a diver are just as important as your knowledge of the species in Spring Lake and where they live.

The San Marcos River was impounded in 1849 forming Spring Lake. From there the river flows for 4.5 miles through an urban setting to its confluence with the Blanco River. It then flows about 75 miles to its confluence with the Guadalupe River and continues for a total of 264 miles to the San Antonio Bay in the Gulf of Mexico.

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Reasons for Biodiversity

Why are Spring Lake and the Upper San Marcos River such a biologically diverse ecosystem?

There are a number of factors that make Spring Lake such a biologically diverse aquatic ecosystem. They are:

- Low seasonality as a result of:
  - Constant Flow
  - Constant Temperature
- Water Clarity
- Water Chemistry
- An Abundance of Aquatic Plant Species
- Endemism associated with Caves and Spring Systems

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Reasons for Biodiversity

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Low Seasonality

Unlike most river systems that are subject to seasonal changes in weather, where sources of food become limited and extremes in temperature restrict activity, **the water flow and temperature** in the upper San Marcos River vary only slightly. These constants decrease seasonality and provides and excellent environment for animals to feed and reproduce year round.

The unique and diverse plants and animals in the San Marcos River likely result from long term stability of physical and chemical factors of the upper river. The headwaters of the San Marcos River begin from a series of over two hundred spring orifices that flow from the artesian zone of the Edwards Aquifer.

Reasons for Biodiversity

Constant Flow

The rate of flow of a creek, stream or river is measured by quantity over time. This is often referred to as **discharge**, or *the rate at which a volume of water passes a given point in a given amount of time.* A common unit used to describe this flow is **cubic feet per second (cfs)**. The discharge of water from the San Marcos Springs has been remarkably stable over time, having never stopped flowing in recorded history. Over the last 15 years the average daily flow has been 187 cfs (EAA). The lowest flow ever recorded was 45 cfs during the long drought of the 1950's and the highest recorded was 452 cfs in the flood of 1992.

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Constant Temperatures

Water discharging from the springs remains a constant temperature of about 22 C (70F) year round because of its long-term contact with the stable sub-surface temperatures found in the Edwards Aquifer. It takes a significant amount of energy to change the temperature of water and so a large volume of water will remain fairly constant in temperature for several miles downstream before ambient air temperature and solar radiation begin to affect it. These stable temperatures are limited to the spring run above the confluence of the Blanco river.

Photo © Jennifer Idol, The Underwater Designer

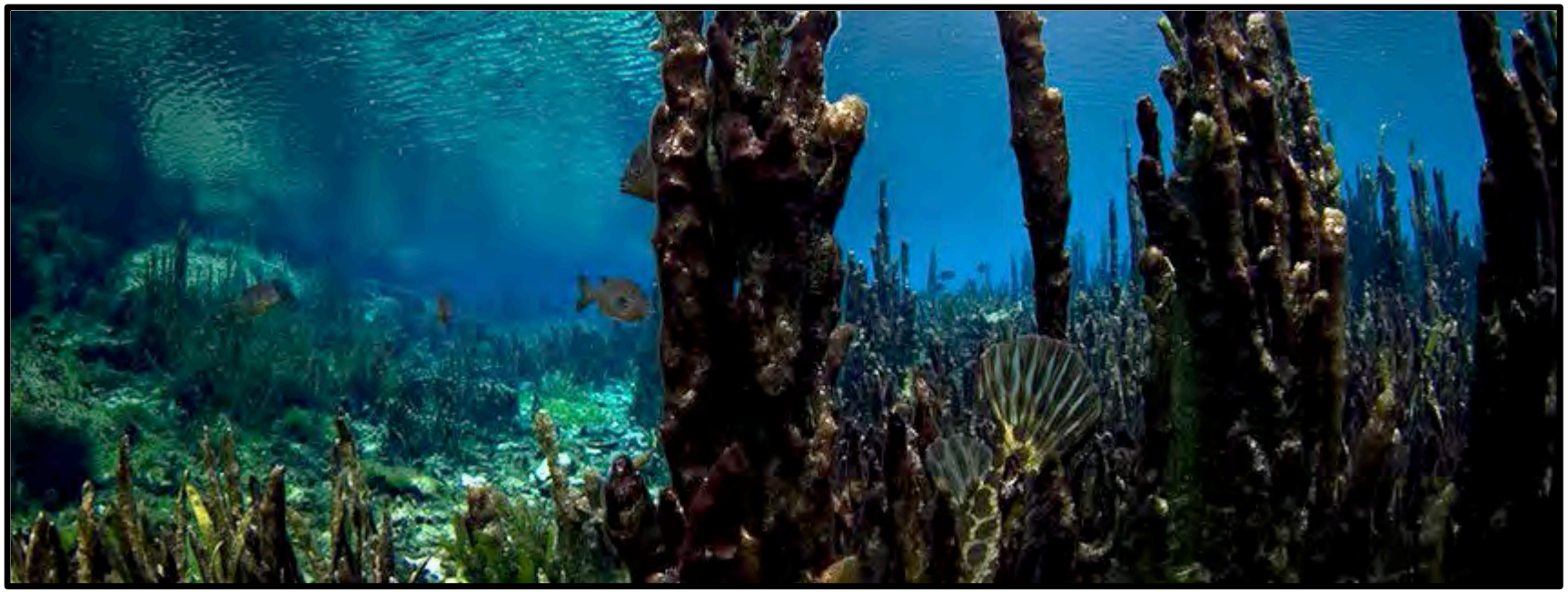
Reasons for Biodiversity

Water Clarity

Water clarity plays an important role in determining the depth to which various spectra of light can penetrate and therefore, the depth to which photosynthesis can occur. Suspended particles, dissolved organic and inorganic compounds, and phytoplankton production affect water clarity. Since rivers are erosional in nature, suspended particulate matter is responsible for reduced water clarity. Spring Lake and the upper San Marcos River are somewhat buffered from the effects of severe flooding and erosion. As a consequence the water clarity remains exceptional.

Water Chemistry

The Edwards Aquifer is comprised of limestone. Rivers draining through limestone and emerging from limestone aquifers are "hard water" systems. Such systems are naturally high in calcium carbonate, dissolved calcium and other mineral compounds. Where springs emerge from limestone aquifers, free carbon dioxide is generally high at the source but is rapidly removed upon exposure to atmospheric air. This has resulted in an excellent source of carbon for the abundant aquatic plants found in Spring Lake.



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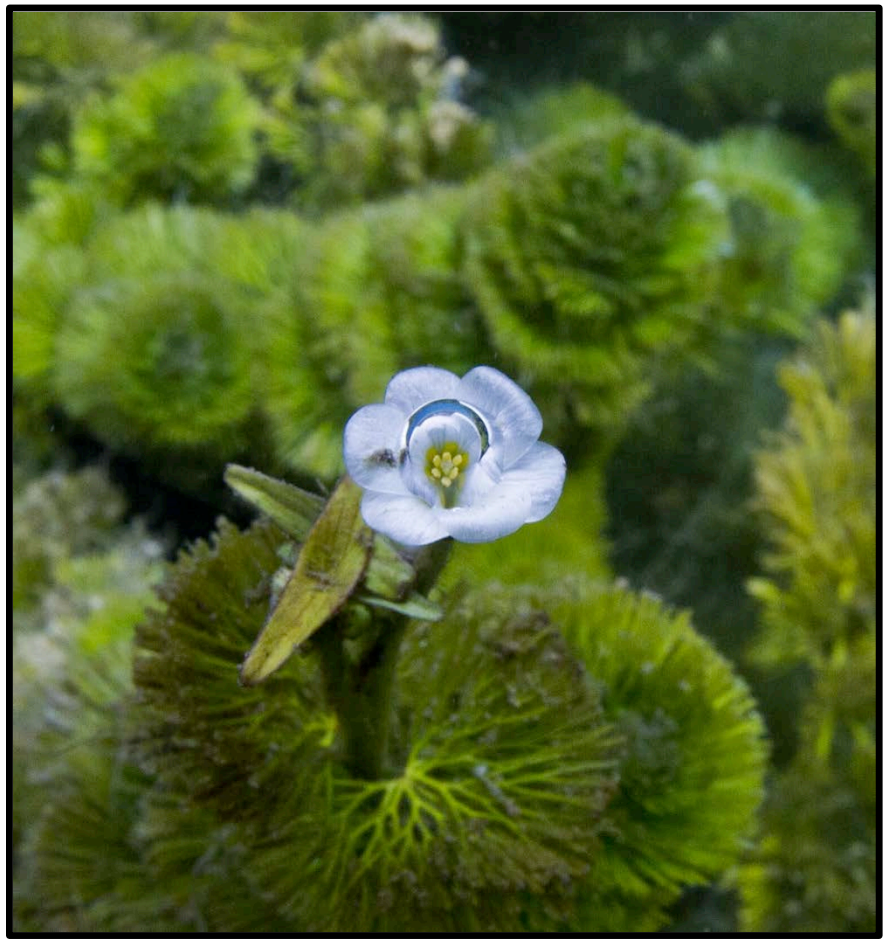
Reasons for Biodiversity

Abundant Aquatic Plant Species

The headwaters of the San Marcos, Spring Lake and upper San Marcos River are characterized by stable flow and temperature, high water clarity and hard water. These conditions are ideal for the growth of aquatic plants. There are 55 native aquatic species and 13 introduced species found in the upper 4.5 miles of the river. (Williams 2010). These plants provide cover and protection to many animals in the river. There also exists many algal species that serve as the base of the food chain in the river.



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Endemism of Caves and Spring Systems

An **endemic species** is one that is limited in its distribution to a specific geographical area. Caves and spring systems are noted for a high degree of endemism because the species that inhabit them became isolated over time and adapted to their unique environments in order to survive. The result of this adaptation is the evolution of new species.

Important Terms

Critical Habitat refers to a particular geographical area that at the time of listing contains all of the physical, chemical, and biological attributes needed for the continued success of an endangered plant or animal and that may require special efforts for management and protection.

Take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Incidental Take is take that occurs during an otherwise legal activity providing that it is not the purpose of the activity. As we embark on major habitat restoration efforts, some individuals might be impacted. However, efforts must be made to minimize the impact of such take. For the most part, you will be covered under incidental take rules in the activities you are involved in.

Collection of Individuals of an endangered species is a form of take that is limited to scientific and zoological research, stocking of refugia facilities and educational display such as those we have in The Discovery Hall collection requires very specific permits assigned to limited entities. As a volunteer diver at Spring Lake, you are not covered under any such permit.

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Do not under any circumstance, collect individuals of endangered or threatened species, as you will be in violation of federal law!

The Endangered Species Act of 1973

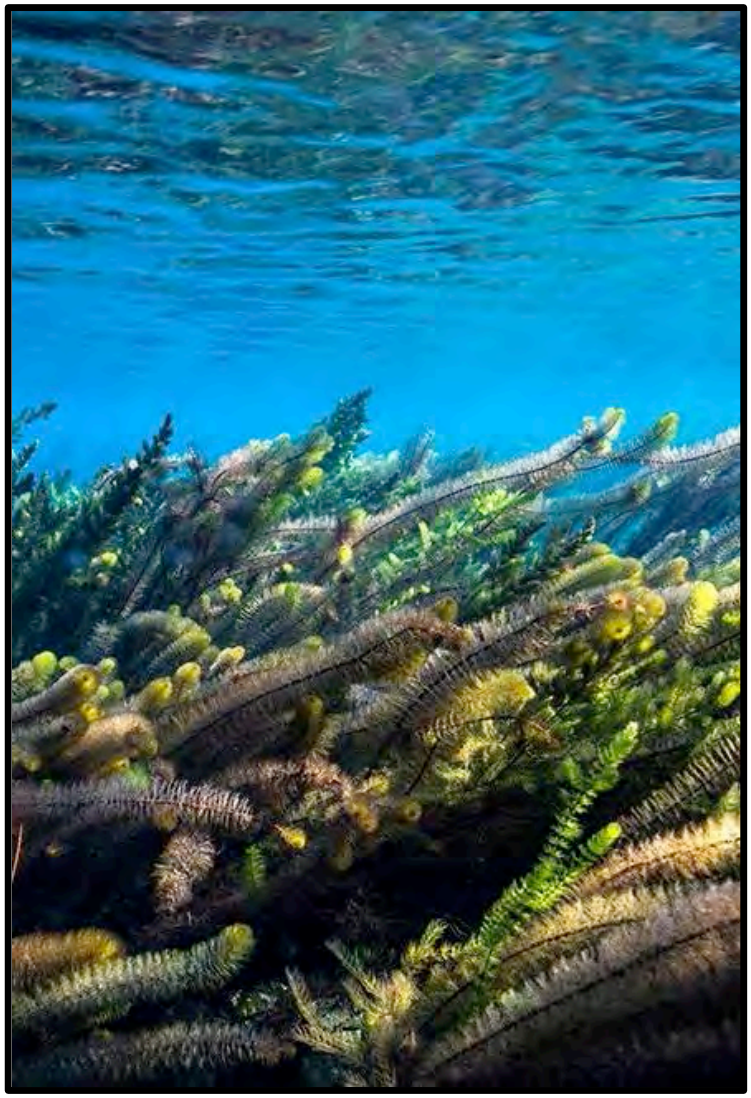


Photo © Jennifer Idol The Underwater Designer

The **Endangered Species Act** (ESA) was passed by Congress in 1973 and was our nation's response to global concerns about the reduction of biological diversity by extinction.

Most of our federal laws and international agreements that especially affect the natural environment were conceived and approved during the mid 1960's and early 1970's. International agreements include treaties with a variety of nations concerning migratory birds, international fisheries and trade in endangered species.

The ESA allows the listing of only native species as endangered or threatened based on declining numbers or loss of habitat.

The law required the preservation of the habitats of listed species and included land acquisition for this purpose. The ESA is one of many laws designed to protect the natural environment from damage by human activity.

The act is not a static law and must be reviewed, revised and re-approved every five years.

The Endangered Species Act of 1973

While it is not important that you make an exhaustive study of the Endangered Species Act, it is critical that you understand how this law affects everyone involved in the operation of The Meadows Center including our volunteer divers.

Because Texas State University is a state university and receives federal moneys, our activities in Spring Lake must be in strict compliance with the provisions of the law.

A variety of activities occur legally in Spring Lake and the river that can affect those species listed as threatened or endangered.

These include biological investigations, archaeological investigations, water quality sampling, habitat restoration, recreation, collection of individuals for scientific or educational purposes, manipulating lake levels, maintenance of underwater points of interest and removal of exotic species.

Photo © Jennifer Idol The Underwater Designer

Penalties for Violating the Endangered Species Act

The goal of the Spring Lake Dive Authorization Course at The Meadows Center is to help in the preservation and conservation of this ecologically sensitive area through continuing education. All those that are involved in any aspect of this operation are bound by law to proceed in a manner to help us meet this goal.

Substantial civil and criminal penalties including fines and imprisonment may be levied against persons who "knowingly" violate the provisions of the ESA.

Violations range from $10,000 and up to one year in jail for each violation. Completion of the Spring Lake Dive Authorization Course at The Meadows Center requires that you demonstrate knowledge of the endangered and threatened species, their habitat requirements and the law.

Therefore the term "knowingly" has more important implications for you. Essentially, you forfeit a legal defense of ignorance if you violate any provision of the act.

To protect yourself and The Meadows Center it is important that you follow approved work plans under staff supervision.

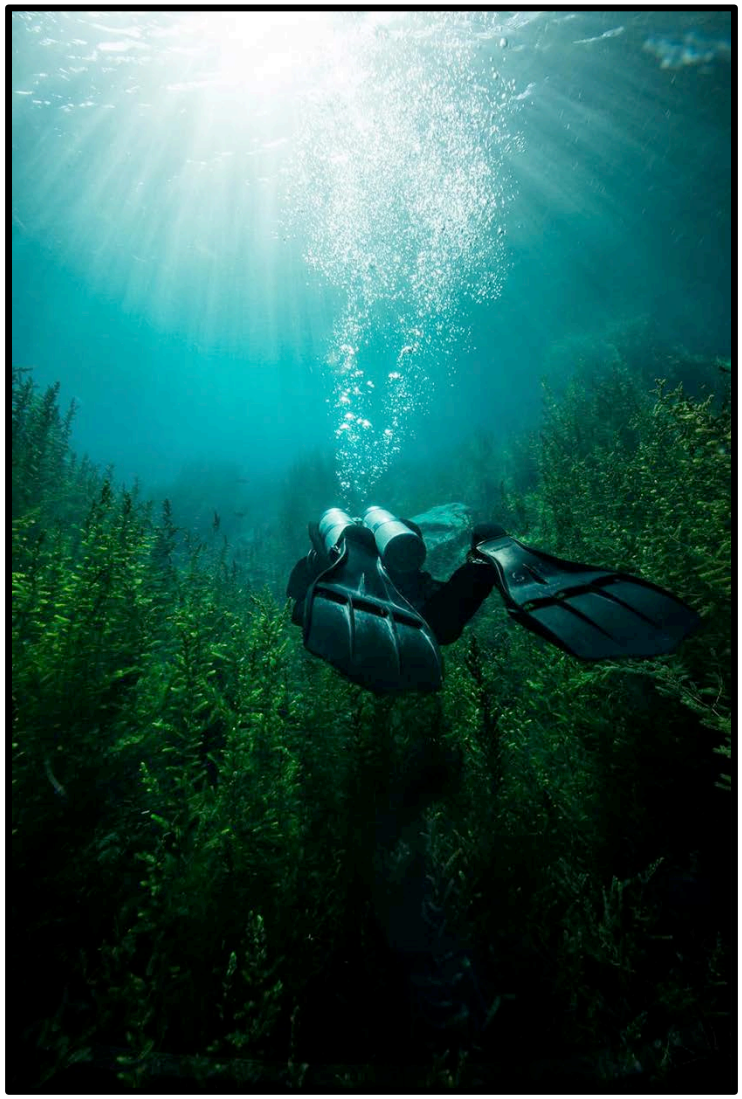


Photo © Jennifer Idol The Underwater Designer

Endangered And Threatened Species of the San Marcos Springs

The U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department presently recognize **seven endangered species and one threatened species in the San Marcos Springs**.

Species are listed as threatened or endangered based on declining numbers or loss of their critical habitat.

Texas Blind Salamandar, yakona.org

Endangered And Threatened Species of the San Marcos Springs

The eight species found in the San Marcos Springs that are listed as endangered or threatened are:

- Texas Blind Salamander (E)
- San Marcos Salamander (T)
- San Marcos Gambusia (E)
- Fountain Darter (E)
- Dryopid Beetle (E)
- Peck's Cave Amphipod (E)
- Comal Springs Riffle Beetle (E)
- Texas Wild Rice (E)

(E) = Endangered (T) = Threatened

Endangered And Threatened Species of the San Marcos Springs

Range and Habitat

Range and habitat are two terms that you are going to need to become familiar with in order to successfully dive in Spring Lake without disturbing the endangered and native species that live here.

Range refers to the geographic area where a species can be found (i.e. North America, Galapagos Islands).

Habitat refers to the area within a range where a species lives. (i.e. forest, desert etc.)

For example, the American bald eagle has a range of North America and a habitat of forests.

Texas Blind Salamander (*Eurycea rathbuni)*
Status: Endangered

Description: The Texas Blind Salamander is smooth and unpigmented, appearing white. Their skin is translucent and the larger organs are visible through the sides and belly. The head is large and broad; eyes are reduced, visible as 2 dark spots deep beneath the skin representing vestigial eyes. The limbs are slender and long with four toes occurring on the fore legs and 5 toes occurring on the hind legs. The Texas blind salamander is of considerable scientific interest due to its uniqueness. It is the most advanced troglobitic salamander known in the world today, displaying many adaptations toward total life in a cave. It may prove to be considerable value in gauging water quality changes in the Edwards Aquifer.

Size: Three to four inches in length

Range: The Edwards Aquifer in Hays County. All collections of Texas blind salamanders have occurred in Hays County and according to the USFW distribution of this species may be limited to the Edward Aquifer beneath and near the City of San Marcos and an area as small as 25.9 square miles (USFW 1996).

Habitat: Caves, springs and well discharges of the San Marcos region of the Edwards Aquifer. They have been observed in caves with access to the water table, traveling along submerged ledges within the aquifer. It is likely that they are sensitive to changes in water temperatures, preferring the thermally constant temperatures of the Edwards Aquifer.

photo courtesy of Ron Coley

San Marcos Salamander *(Eurycea nana)*

Status: Threatened


photo courtesy of Miranda Wait

Description: The San Marcos Salamander is small, slender and light brown in color with yellowish flecks. The salamander is capable of altering its dorsal coloration from light tan to dark brown to match the color of the substrate. They have large eyes with a dark ring around the lens, well developed and high pigmented external gills, moderately short and slender limbs, four toes on the fore feet and five on the hind feet and a well developed dorsal fin. The San Marcos Salamander is a member of the lungless salamander family. During the adult sexually mature stage of the life cycle, it still retains its juvenile form including features such as gills. The gills expand and appear bright red from increased blood flow due to the cool temperature and low oxygen content of the water in which it lives. In addition, it does not leave the water to metamorphose into a terrestrial form but becomes sexually mature and breeds in the water

Size: Up to 2.3 inches long.

Range: The headwaters of San Marcos River, Spring Lake

Habitat: The San Marcos salamander is restricted to the headwaters of the San Marcos River, and 450 feet downstream of the dam. They are primarily located on limestone shelves in the shallow rocky spring areas of Spring Lake. The salamander requires clean, clear and thermally constant flowing waters in areas of sand, gravel and rock substrate with filamentous algae or vegetation cover, in areas with little mud or detritus. In addition, the area preferred by the salamander must provide an adequate food supply of small insect larvae, insect pupae and small aquatic snails.

San Marcos Gambusia *(Gambusia goergei)*

Status: Endangered

photo courtesy of Ron Coley

Description: The San Marcos Gambusia is usually plainly marked with lemon yellow, bright yellowish orange, or bluish coloring. Like other members of the Gambusia family it produces live offspring. Listed as endangered, this species has not been seen in the wild since 1983; therefore either very few San Marcos Gambusia exist or they may already be extinct.

Size: Range in size from 1.0 - 1.5 inches with adult females being larger than males.

Range: Historically, the San Marcos Gambusia has been found in the upper portion of the San Marcos River.

Habitat: The San Marcos Gambusia prefers the quiet shallow thermally constant waters of the San Marcos River. Reduction in population size is likely resulting from habitat compression as elephant ears (invasive plant) invaded and altered suitable habitats. As population size diminished and habitat reduction occurred, hybridization with other Gambusia species has likely destroyed the genetic integrity of this species.

Fountain Darter *(Etheostoma fonticola)*

Status: **Endangered**

Description: The Fountain Darter is mottled brown in color for camouflage, with dark markings along its sides and dark spots at the base of the tail, opercule, dorsal fin and around the eye. A spawning male will show more attractive markings. They lack a swim bladder, which is how the majority of fish control their buoyancy, so are found at the bottom of the lake, hiding under macrophytes, mainly filamentous algae. Like all darters, the Fountain Darter is actually a member of the family Percidae, the perches. The fountain darter was reintroduced to the Comal River from the San Marcos River population after they had become extinct in the Comal Springs during the drought of the 1950's when the Comal Springs stopped flowing.

Photo courtesy of Ron Coley

Size: Usually less than an inch in length but can reach up to two inches in length.

Range: The headwaters of the San Marcos River, the San Marcos River up until the confluence with the Blanco River, and the Comal River.

Habitat: Fountain Darters require clear, clean, flowing waters of a constant temperature, adequate food supply, undisturbed sand and gravel substrates, rock outcrops and areas of submerged vegetation for cover.

Comal Springs Riffle Beetle
(Heterelmis comalensis)

Status: **Endangered**

Description: The Comal Springs riffle beetle is a small, flightless surface aquatic beetle. Both larva and adult riffle beetles are entirely aquatic with the adults feeding mainly on the algae and detritus scraped from submerged weeds and rocks (Brown 1987). Water flow is important to respiration and survival of this species, therefore a severe reduction in spring flow leading to drying of the spring run will limit their range and may be a limiting factor to their survival.

Size: Adult beetles are approximately one-eighth inch long, with females slightly larger than males.

Range: Comal Springs and San Marcos Spring.

Habitat: These beetles are generally found near spring orifices, in flowing, uncontaminated water ranging from 1-4 inches deep and have also been found in the spring runs and in spring upwellings below the surface of Landa Lake (BIO-WEST2002).

photo © Jean Krejca

Comal Springs Dryopid Beetle *(Stygoparnus comallensis)*

Status: **Endangered**

photo © Jean Krejca

Description: A subterranean aquatic insect species from the family Dryopidae. Adult beetles are slightly pigmented with translucent skin and vestigial (non functioning) eye. On their underside, a mass of small, unwettable hairs can be found which hold a thin air bubble, allowing for gas exchange to occur during respiration (Chapman 1982). As spring flows decrease, dissolved oxygen levels decrease as well preventing the beetle from effectively using this form of respiration.

Size: Approximately one-eighth inch long

Range: The Comal Springs and San Marcos Spring.

Habitat: Due to their inability to swim Comal Springs Dryopid beetles appear to be restricted to headwaters of springs and spring runs. Because of the process it uses to exchange gas, the dryopid beetle requires flowing, uncontaminated waters for survival.

Peck's Cave Amphipod *(Stygobromus pecki)*

Status: **Endangered**

Description: The Peck's Cave Amphipod is eyeless and lacking pigment. ***The Comal Springs Riffle Beetle, Peck's Cave Amphipod, and the Comal Springs Dryopid beetle were first found in the headwaters of the San Marcos River following high flow from flooding in 2007*** which resulted in the US Fish & Wildlife Service listing the San Marcos Springs as critical habitat for them.

Size: Approximately one-eighth of an inch.

Range: San Marcos Springs, Comal Springs, Hueco Springs and the Panther Monitoring Well that is drilled into the Edwards Aquifer.

Habitat: San Marcos and Comal Springs aquatic ecosystem. Primary habitat lies within the aquifer in permanent darkness. When found outside of the aquifer, Peck's Cave amphipod are typically found in the crevices of rocks and in gravel near spring orifices.

photo © Jean Krejca

Texas Wild-Rice *(Zizania texana)*

Status: **Endangered**

Description: Texas Wild-Rice is an aquatic grass that is endemic to a small segment of the San Marcos River. Texas Wild-Rice does not occur naturally in any other springs and was on its way to extinction until a researcher began a restoration project on the species. Wild-rice plants form large masses firmly rooted in the gravel bottom of the river. Stalks and leaves are completely immersed in the swift current. Flowering plants are rarely seen and when present their stalks do not extend very far above the surface. This plant is heavily impacted by recreational uses of the river and floods, which may uproot the plant or strip off its leaves and flowers. Low flows make the plant vulnerable to herbivores or may cause the plant to be exposed and dry out.

Size: Average plant length varies between 3.3 to 6.6 feet with linear leaves that are up to 3.3 feet long and .05 inch wide

Range: The San Marcos River, approximately 2.7 miles down river from Burleson's Dam.

Habitat: Texas Wild-rice requires thermally constant temperatures, clear water, undisturbed stream bottom habitat, protection from floods and unimpeded light for reproduction. The plant grows in swift currents, shallow areas near the middle of the river in water to 6.5-9.8 feet deep.

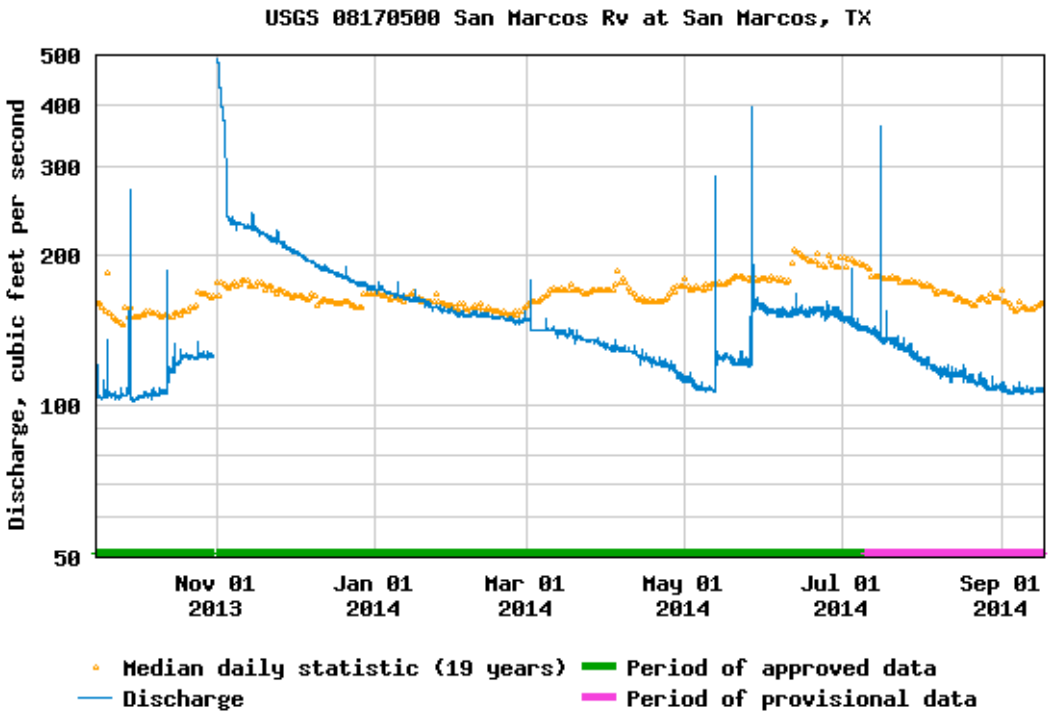
photo courtesy of Ron Coley

Major Threats to our Endangered Species

A variety of factors threaten the listed species. Local threats to each of the species as well as broader, regional threats to the ecosystems' continued integrity are related to both quality and quantity of water available in the spring systems and in the aquifer.

Threats include:

- Diminishing spring flows
- Pollution of the Aquifer and Surface Waters
- Habitat Modification
- Introduction of non-native species



USGS, http://nwis.waterdata.usgs.gov

Discharge in cfm for Spring Lake, from October 2013 - September 2014 shows it to be below the 19 year average

Major Threats to our Endangered Species

Diminished Spring Flow

Reduction in spring flow can occur quickly when drought conditions are present and pumping demands are high. Diminished spring flow reduces the amount of habitat available for our endangered/threatened species.

Pollution of the Aquifer and Surface Water

Water in the aquifer may become polluted through long-term effects of non-point source pollution or catastrophic spills of hazardous materials in environmentally sensitive recharge zones. Surface water can become polluted from local run-off containing pesticides, fertilizers, motor oil, and other contaminants.

Introduction of Non Native Species

Non-native species have been introduced to Spring Lake and the San Marcos River through ignorance and misunderstanding of the impact they would have on native species. In some cases they have taken over habitat, competed with or predated native species (e.g. the giant ramshorn snail, elephant ear, tilapia, nutria etc.).

Habitat Modification

Human modifications to the natural river channels (bank stabilization, dams, road maintenance and construction) have significantly altered natural configurations and drainage in the San Marcos River system. Recreational activities can have direct impacts as well. Bottom disturbances, vegetation control, increased compaction, erosion and litter all can have negative impacts. Increased urbanization increases flooding and erosion, pollution and siltation.

Aquatic Plants of Spring Lake

Aquatic plant identification is a necessary skill for Volunteer Divers in order to perform underwater gardening in Spring Lake. Non-native aquatic plants that were introduced to Spring Lake may compete with native plants for food and space. Because introduced species lack natural enemies in their new environment, they can multiply and spread at an alarming rate, affecting water quality, causing native plants to be forced out of the habitat, interfering with boat traffic and a wide range of other problems.

55 native plants and 15 introduced plants have been documented in the lake.

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Aquatic Plants of Spring Lake

The dominant species found in Spring Lake include native and introduced species. Underwater gardening includes both the removal of invasive species and planting of natives.

A success story attributed to this work was the removal of *Hydrilla verticillata*. Hydrilla was the predominant plant 10 years ago but was successfully decreased through the efforts of our volunteers who were able to remove it and transplant cabomba and arrowhead to replace it.

Several plants look alike so it is imperative to be able to tell the difference between them.

yakona.org

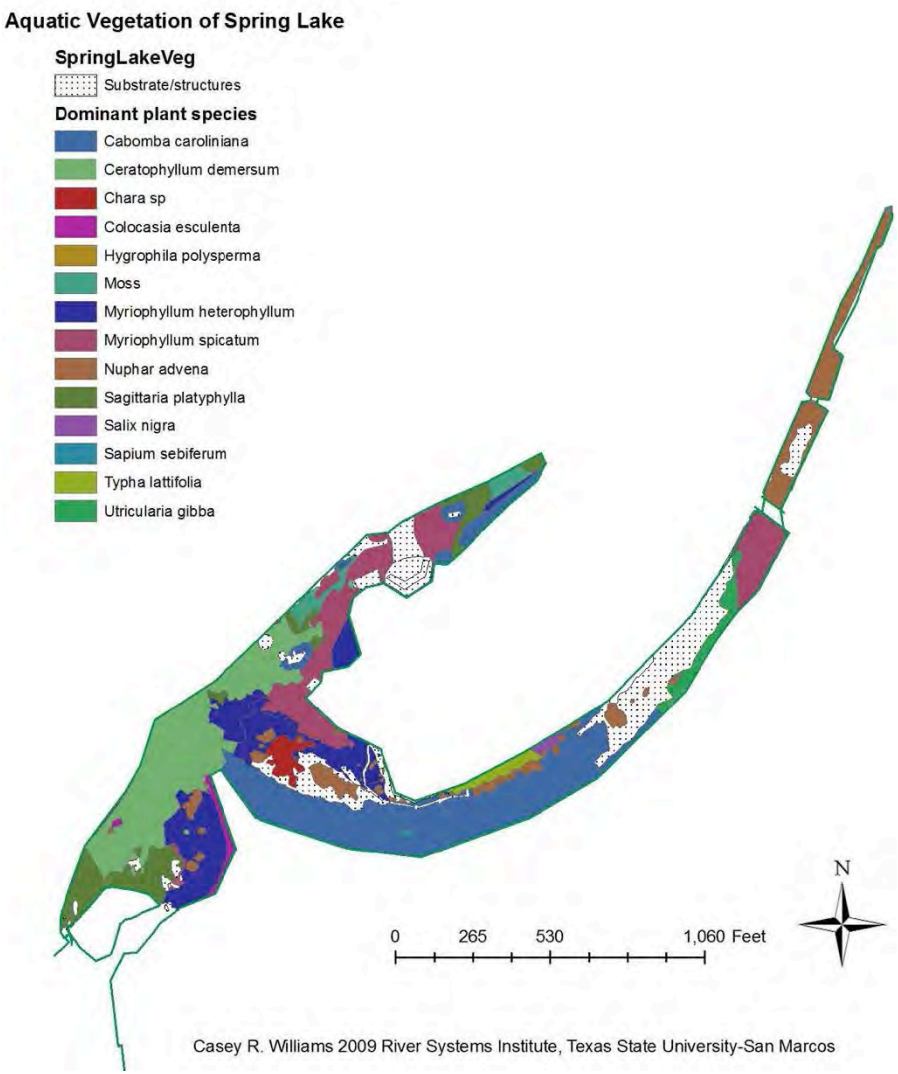
Aquatic Plants of Spring Lake

The native species most commonly seen are:

- **Cabomba** *(Cabomba caroliniana)*
- **Coontail aka Hornwort***(Ceratophyllum demersum)*
- **Stonewort** *(Chara sp muckgrass)*
- **Two Leaved Water Milfoil** *(Myriophyllum heterophyllum)*
- **Red Leaf Ludwigia** *(Ludwigia repens)*
- **Arrowhead** *(Sagittaria platyphylla)*
- **Eel grass** *(Vallisneria americana)*
- **Bladderwort** *(Ultricularia gibbi)*
- **Texas Wild Rice** *(Zizania texana)*

The most commonly seen introduced species include:

- **Elephant ear** *(Colocasia esculenta)*
- **Hydrilla** *(Hydrilla verticillata)*
- **Water Hyacinth** *(Eichhornia crassipes)*
- **Indian Swampweed** *(Hygrophila polysperma)*
- **Eurasian Water Milfoil** (*Myriophyllum spicatum)*



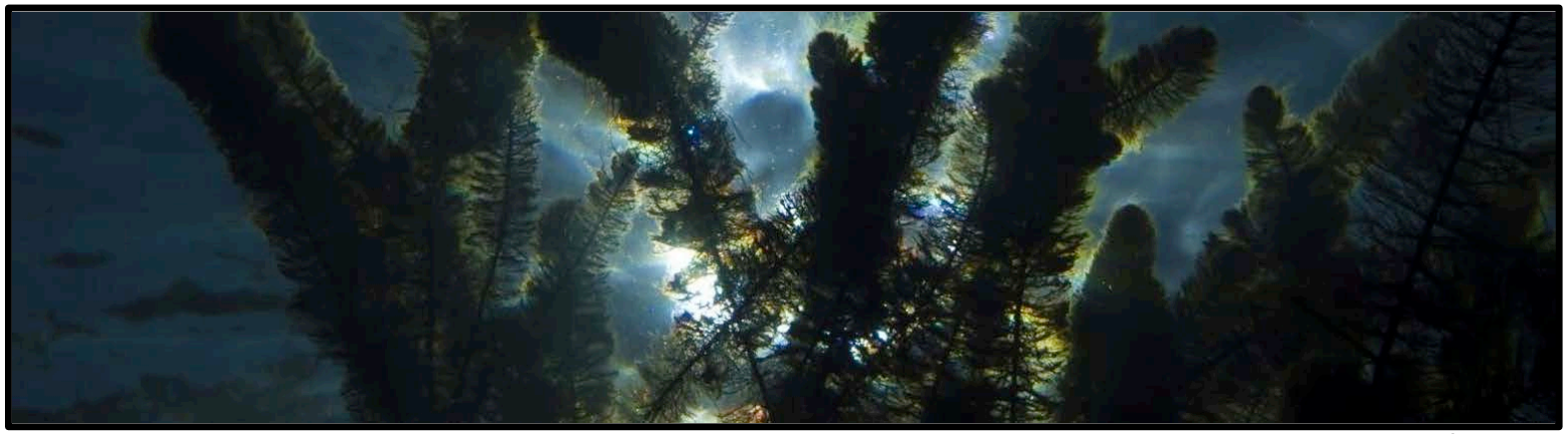
Aquatic Plants of Spring Lake

While this list includes emergent, floating and submerged plants, y**ou will only need to be familiar with the submerged plants as a volunteer diver**.

Following are descriptions of those most common plants associated with underwater maintenance.

Of added importance is the recognition that many of these plants are often habitat and/or a food source for native and endangered species.

Handling of these plants must be with extreme care so as not to injure or “take” an endangered or threatened species.



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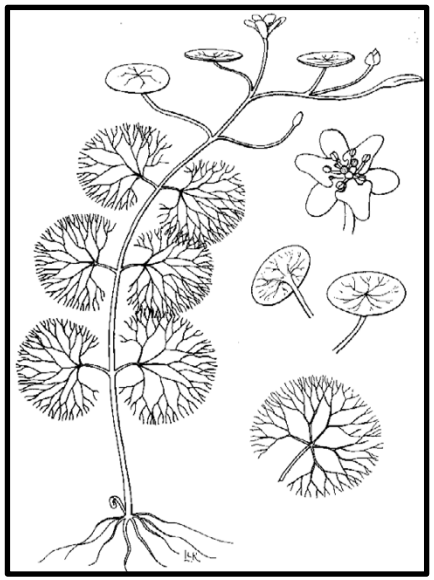
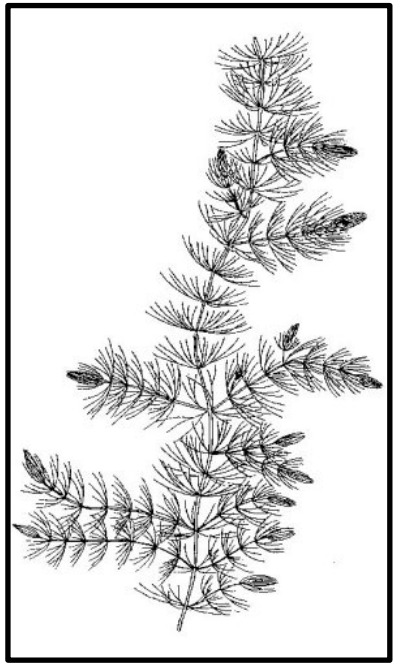


Cabomba *(Cabomba caroliniana)*
Cabomba is one of the most common native submerged aquatic plants in Spring Lake. Its dark green foliage growing from short rhizomes with fibrous roots that produce emergent flowers can help identify it. Individual leaves are arranged oppositely along the stem and are highly divided and fan shaped. Stems may grow up to thirty feet in length. Submerged leaves are one to two inches across, with petioles opposite on the stem. Leaves are finely dissected into thin, flat segments that give each leaf the appearance of an ornate fan. Flowers are solitary and white, with three sepals and are typically about a half-inch wide.



Coontail - Hornwort *(Ceratophyllum demersum)*
Coontail is the only submerged plant in Spring Lake that does not produce roots. It can anchor itself to the bottom with specialized hooks or is commonly seen floating on top of the water. Coontail is easily recognizable by the teeth on each highly divided leaf. The leaf segments are flat, linear, and coarsely toothed, spreading to curving upward, and more crowded toward the branch tips to give the “coontail” appearance. Retaining its stiffness when removed from the water also recognizes this plant. Thin submerged leaves and large surface to weight ratios make it an important habitat species for many aquatic invertebrates.


photo courtesy of Florida/IFAS

Stonewort/Muckgrass *(Chara sp)*

Although it may look like a plant, *Chara* is actually a well developed macro algae. On first inspection it is very similar to coontail forming stiff structures that retain their shape when removed from the water. Muskgrasses are green or gray-green colored. Individuals can vary greatly in size, ranging from 5 cm to 1 m in length. The main "stem" of muskgrasses bear whorls of branchlets, clustered at regularly spaced joints. These algae are identifiable by their strong skunk-like or garlic odor, especially evident when crushed. Muskgrass provides very important habitat to aquatic invertebrates where other vegetation is not available.


photo courtesy of Justin Payne

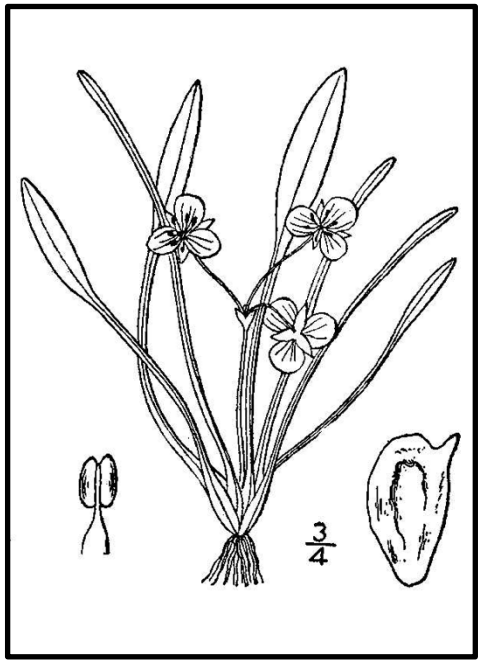
Two Leaved Watermilfoil *(Myriophyllum heterophyllum)*

Two leaved milfoil is one of two species of milfoil found in Spring Lake. This species is mostly limited to the slough and wetland side, although it can be found in patches on the spring side of the lake. Two leaved milfoil is recognized by the red stem with whorls of four to six feathery leaves. At certain times of the year it will produce emergent stems with leaves resembling *Hydrilla*. Blooms are held at the tips of these structures.

photo courtesy of Aaron Wallendorf

Red Ludwigia *(Ludwigia repens)*

At first glance Red Ludwigia seems to be similiar to the invasive Hygrophila, but has more rounded leaves with a red tinge on the leaf underside. Red Ludwigia grows mostly in the shallow areas of Spring Lake around the Wetlands but can grow in deeper areas. Red Ludwigia is usually found in clumps. Some species of Ludwigia produce chemicals that inhibit growth of other plants but it has not been determined if this is the case for this species of Ludwigia.



Arrowhead *(Sagittaria subulata)*

Arrowhead is fully adapted to life under water. Submersed leaves are ribbon-like, not differentiated into petiole and blade. Before flowering, the floating leaves appear on thin petioles with blades that are 25 to 50 mm in length, oval, or rarely arrow-shaped. The flowers develop on very thin, long, light-green stalks that are equally as long or perhaps up to three times longer than the blade. Submerged portions provide habitats for many micro and macro invertebrates. These invertebrates in turn are used as food by fish and other wildlife species (e.g. amphibians, reptiles, ducks, etc.) Arrowhead is also a favorite food of several species of turtles living in Spring Lake.

photo courtesy of Justin Payne

Hydrilla *(Hydrilla verticillata)* **INVASIVE**

Hydrilla is an extremely invasive plant. It can grow in conditions that are less ideal for native plants allowing it to crowd out native plants. A native to South America, Hydrilla was believed to have been introduced through the aquarium trade. Spring Lake was once heavily infested with this plant but the Volunteer Diving program was able to remove most of it and keep it in check. Distinguishing features include a toothed mid-vein on the bottom of each leaf causing a rough feeling when drawn through the fingers. Five to six leaves are arranged in a whorl around the stem.

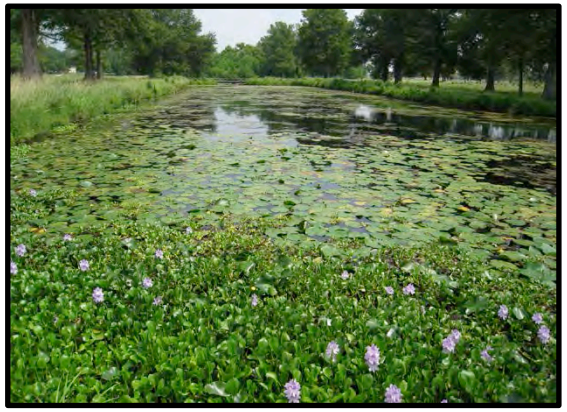


photo courtesy of MCWE

Water Hyacinth *(Eichhornia crassipes)* **INVASIVE**

The broadly elliptic leaves with enlarged bases easily identify water hyacinth. These bases form the floating structure which holds the plant above the water. Floating mats block sunlight from entering the water and prevent submersed plants from growing. When in bloom they produce some of the most beautiful flowers of any plant. It is a pest around Spring Lake and is thought to have influenced the loss of habitat for the San Marcos gambusia that have not been seen in the wild for over 35 years. Efforts to remove this invasive are constant but extremely difficult due to its deeply embedded root system.

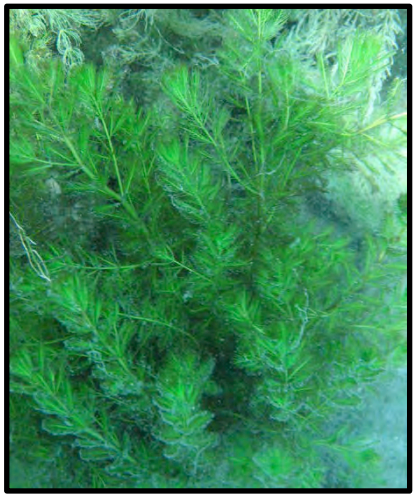


photo courtesy of Justin Payne

Eurasian Watermilfoil *(Myriophyllum spicatum)* **INVASIVE**
One of two species of Watermilfoil that can be found in Spring Lake. Eurasian watermilfoil is found in the deeper areas and can be easily reconized by its feathery foliage. Leaves are arranged in a whorl of four around the stem. This plant thrives in areas of the lake that have previously been disturbed. In some areas of the lake it can be completely covered with algae giving it a brown reddish color. Watermilfoil produces fragments easily. Divers should be cautious to prevent fragmentation and further spread of this plant in Spring Lake.

photo courtesy of Justin Payne

Indian Swampweed *(Hygrophila polysperma)* **INVASIVE**
Hygrophila is an extremely common introduced plant in Spring Lake. It is mostly found around the perimeter and tends to avoid growing in the deeper areas around the spring orifices. It can be recognized by elongated leaves growing opposite along the stem. New growth is noticeably tinged red which makes it easy to confuse with Red Ludwigia. Stems are square and roots along the stem are common. Blooms are blue and found at the base of mature leaves throughout the year.

The Spring Lake Management Plan and Habitat Conservation Plan

The Meadows Center for Water and the Environment at Texas State University is committed to the protection and careful management of Spring Lake. The **Spring Lake Management Plan** was created to insure that Spring Lake and the surrounding habitat will be managed in accordance with the university's mission. Review of this plan is recommended prior to requesting access to Spring Lake in order to fully understand the rules and laws governing Spring Lake and University policies and procedures.

A **Habitat Conservation Plan** (HCP) for Spring Lake was created to minimize threats to the listed Endangered Species and protect their critical habitat. Anyone who dives in Spring Lake is strongly encouraged to become familiar with these plans.

Copies of the Spring Lake Management Plan and the Spring Lake Habitat Conservation plan may be obtained by emailing the Diving Coordinator (divecoordinator@txstate.edu).

The Importance of Good Diving Skills

Since more half of our endangered species live on and in the substrate of the lake, divers need to stay off of the bottom of the lake.

Good buoyancy control and situational awareness are very important skills for volunteer divers to possess.

Volunteers diving in Spring Lake will see fountain darters, the San Marcos salamanders and possibly Texas Wild Rice. It is unlikely that you will ever see the San Marcos Gambusia as it may have already become extinct.

The other listed species are predominantly found in the underground aquifer or spring orifices and would be very unusual to observe as a diver in Spring Lake.

Photo © Jennifer Idol The Underwater Designer

The Spring Lake Dive Authorization Course

Module 4
Diving Safety and Procedures for Spring Lake

Topics

- Diving Safety in Spring Lake
- Maintenance Tasks in Spring Lake
- Gear Wash Procedure
- Maintaining Status as a Volunteer Diver

Diving Safety in Spring Lake

General Rules for Diving

- Procedures
- Volunteer Tasks
- Limits
- Required Dive Gear
- Skills and Technique
- Prohibited Activities

Hazards

- Entry and Exit
- Heat/Sun Exposure
- Wildlife
- Underwater Caves
- Weather
- Boats
- Out of Gas Situations

The Spring Lake Dive Accident Management Plan

Procedures for Diving

Scheduling a Dive:

To schedule a dive, e-mail the Dive Coordinator (divecoordinator@txstate.edu) with the date(s), time(s), and name(s) of each volunteer diver in the dive group. The Dive Coordinator will respond with an approval form. You must bring this form with you when you check in at the Ticket Booth. If you need a dive buddy, the Dive Coordinator can assist in finding one for you.

Checking In the Day of your Dive:

Upon arrival report to the Ticket Booth. Check-in with the Person In Charge (PIC). The PIC will sign off on your approval form and assign you your task. The PIC will also advise all boat drivers of where you will be diving.

- Carts are available at the dive yard for transferring your gear to the dive entry points. (A valid drivers license is required as a deposit to use the carts).
- Yellow dive suits are also available at the dive yard.
- Vehicles, tents, and chairs are not permitted on the Peninsula beyond the paved parking lot.

All volunteer dives must be scheduled at least 72 hours in advance of the day you wish to dive.

Procedures for Diving

Parking:

If volunteering during the week, you will need to purchase a visitors parking pass in the main parking lot in front of the Ticket Booth and display it on your front dash. Failure to do so may result in a parking ticket. Please park in the designated area for divers and please do not block the bus turnaround. THe cost of a parking ticket is $3 per day. ***The ticket machine only accepts credit cards***.
PARKING PASSES are not required on weekends.

Gearing Up for your Dive:

Please assemble gear in the parking lot and use carts to transfer gear to your dive entry point. Please stay on the designated pathways and keep the area around your vehicle tidy. Please use the fenced in dive yard next to the Ticket Booth to change, remembering that we have many visitors, mostly school children, that visit the Spring on any given day. **You are part of what they are here to see**. Please act responsibly and respectfully. Many people have never seen dive gear before and may be curious to learn more what you are doing.

Diving Entry Points:

If diving the Training Area, Cream of Wheat, Ossified Forest, Riverbed, or Catfish Hotel enter the water from the floating dock located at the Training Area. If diving Deep Hole or Arch Site please enter at the gravel beach (kayak launch) next to Deep Hole.

Volunteer Tasks in Spring Lake

Once you have successfully completed the Dive Authorization Course, you will be able to schedule Volunteer Dives through the Spring Lake Diving Coordinator. The following protocols need to be followed to ensure diver safety.

PROTOCOLS

1. All tasks are assigned before entry into Spring Lake; Tasks will be sent to you by the Dive Coordinator when you receive confirmation for your dive request.
2. All divers must sign in and notify the person in charge (PIC) upon arrival.
3. Before getting in the water, update the dry erase board in the dive yard to include the names of divers, entry point (Deep Hole or Training Area), the location where you will be diving, and the time you plan to enter and exit the water. When you are done diving, please remove your name from the board.
4. Push carts and yellow dive suits are available in the dive yard, please return them to the place you found them when done diving.
5. Enter and exit the lake by way of the proper entry point as described in the previous slide.
6. Dive your plan and stay in your assigned area. DO NOT dive areas you have not been assigned!
7. Remember that the boats may incorporate you into their tour. The visitors love to see divers, so wave hello as they pass overhead. Be careful about fin placement and visibility! Do not do anything that would compromise your safety when boats pass over.
8. Always be aware of boat traffic. You can ask the PIC how many boat tours will be going out during your time underwater.

Volunteer Tasks in Spring Lake

PROCEDURES

1.) When performing volunteer tasks always work in a zigzag pattern, from upstream to down. Performing your task well requires that you know exactly where you are in the lake at all times!

2.) **Hand Fanning:** Remove all plant matter, detritus, and algae off the spring openings by gently fanning with your hand(s). Detritus is the black accumulation on top of the springs. The goal of this task is to lift it up from the spring with a little momentum and continue to move it off to the side. Use your hand to carefully remove detritus, and green and filamentous algae from the springs.

3.) **Plucking:** Gently pluck coon's tail and other plant material (exception is Hydrilla) from the spring openings. Be sure to shake out the roots to make sure that no animals are caught before creating a ball and floating plants to surface.

4.) **Floating:** Use your alternate air source or your exhaled breath from your primary regulator to float plants to the surface.

5.) **Transplanting:** Carefully transplant native plants (i.e... Cabomba) in place of exotics with hands.

Volunteer Tasks in Spring Lake by Location

1. **Training Area/ Diversion**
   - Clean buoys (remove algae growth from fabric, handrails, inner storage hold/ cup with scour pads or stiff bristle brush)
   - Clean PVC squares on the obstacle course.
   - Clean gravel bottom (especially under and around dive platforms)
   - Remove plants from pea gravel areas of the Training Area
   - Remove algae growth from exit ramp and exit ladder of the floating dock
   - Clean and remove plant and algae growth on an around the ADA submersible lift

2. **Cream of Wheat**
   - Enter and exit from the Training Area
   - Hand Fanning in a zigzag pattern (working back and forth, from east to west and then west to east) from upstream to downstream
   - Clean algae and detritus from the surface of the sandy bottom
   - Remove algae carefully from the sand
   - Remove algae and coontail from the spring entrances
   - Do not remove mosses; leave in place

3. **Ossified Forest**
   - Enter and exit from the Training Area (make sure to plan your gas consumption accordingly)
   - Hand Fanning in a zigzag pattern lightly on the floor of the channel, from upstream to downstream
   - Remove coontail by bagging or floating, when specifically requested
   - Remove algae and coon's tail from the spring percolations
   - Do not remove mosses; leave in place

4. **Riverbed**
   - Enter and exit from the Training Area (make sure to plan your gas consumption accordingly)
   - Hand Fanning in a zigzag pattern, beginning at the upstream end, working the algae off the bottom in a downstream direction
   - Floating or bagging, when specifically requested
   - Remove algae and coontail from the spring percolations
   - Do not remove mosses; leave in place

Volunteer Tasks in Spring Lake by Location

5. **Catfish Hotel**
- Enter and exit from the Training Area (make sure to plan your gas consumption accordingly)
- Hand Fanning in a zigzag pattern, beginning at the upstream end to expose the white, sandy springs below the algae
- Remove algae and coontail from the spring percolations
- Remove coontail from the logs and boulders
- Remove algae and coontail from the spring percolations
- Do not remove mosses; leave in place

6. **Deep Hole**
- Enter and exit from the Kayak launch point (make sure to plan your gas consumption accordingly)
- Hand Fanning in a zigzag pattern from north to south, from the flat, rocky plain to the main spring opening
- Move down the fault line, removing plants and algae so that it is clearly visible from the boats
- Floating or bagging, when specifically requested
- Remove algae and coontail from the spring percolations
- Do not remove mosses; leave in place

7. **Archaeology Site**
- Enter and exit from the Kayak launch point (make sure to plan your gas consumption accordingly)
- Hand Fanning in a zigzag pattern, floating, and/or bagging, depending on what is required
- Remove algae and coontail from the spring percolations
- Do not remove mosses; leave in place
- **Please LEAVE any artifacts where they lie, even if they have been disrupted by cleaning!**

*** Notice that the progression of your tasks follows the current of the river! This process of cleaning has been set up so that we are not just wasting our time! Please follow your assigned tasks

Limits for Volunteer Diving in Spring Lake

As stated in the Habitat Conservation Plan, only six Volunteer Divers are allowed beyond the Training Area in Spring Lake at a time for a maximum of 2 hours. No more than 12 Volunteer Divers can enter Spring Lake (beyond the training area) in a day.

These numbers may change depending on spring flow. When the flow rate of the San Marcos Springs is 100 cfs, The Meadows Center will implement a **Diving Drought Protocol** in accordance with the Habitat Conservation Plan. The protocol requires limiting the number of volunteers submerged in Spring Lake. Only two to three volunteer scuba divers may be submerged at a given spring location at the same time. Unfortunately, this might affect convenience of dive times, where scheduling will be on a first come first dive basis. However, the purpose of the Diving Drought Protocol is to preserve the unique aquatic ecosystem as well as to protect the safety of volunteer scuba divers. At 100 cfs, volunteers will find themselves in closer proximity to glass bottom boat traffic as the water level of Spring Lake will continue to drop in response to the declining spring flow. ***At 75 cfs, the Diving Drought Protocol requires all scuba diving activities to be suspended in Spring Lake.*** The Diving Drought Protocol is necessary to protect the unique ecosystem in Spring Lake as well as the safety of all volunteers.

Our projects are structured to minimize contact with listed species in an effort to ensure protection of listed species and their habitat.

The Diving Coordinator coordinates and supervises all volunteer diving to ensure that these limits are respected.

Required Dive Gear for Diving in Spring Lake

On every dive at Spring Lake, you as a diver, are responsible for having a complete, well-maintained, and reliable set of equipment with which you are familiar. You are also responsible for inspecting it for proper fit and function prior to each dive.

As a ***minimum*** a complete set of SCUBA gear ***must*** include:

- A buoyancy control device
- A low-pressure buoyancy control inflation system
- Suitable thermal protection for 70˚ water with appropriate weights
- A first stage and primary second stage
- An alternate second stage (octopus, necklace)
- A submersible pressure gauge
- A depth gauge
- A timing device
- A tank which has both a current annual inspection sticker and hydro test with enough breathing gas to accomplish accomplish your task and safely return two divers to the point of entry should there be an out of gas situation.
- Mask and fins (snorkels are optional)
- Dive planning/monitoring device (bottom timer, dive computer, dive tables)

All volunteer divers are required to wear a provided <u>Yellow Dive Suit</u> to increase visibility for boats and so that they are clearly identifiable to the Meadows Center Staff and University Police.

Diving Skills and Techniques

SCUBA diving is sport that requires time to develop good skills and techniques. Working as a Volunteer Diver in Spring Lake is an ideal opportunity for you to practice and improve these skills. Two of the most important skills to help ensure diver safety and protection of the environment are:

Buoyancy Control

- Neutral Buoyancy while performing tasks
  - Avoid touching the bottom
  - If you need to stabilize, do so gently with one finger preferably on a rock
- Controlled Descents
  - Do not crash into the bottom, make sure you are properly weighted
  - Add gas to your buoyancy control device while descending
- Controlled Ascents
  - Maintain contact with your buddies at all times
  - Ascend slowly from every dive
  - Dump gas from your buoyancy control device while ascending

Situational Awareness

- Awareness of yourself
  - e.g. If you do not feel up for diving do not dive, if something does not feel right, it probably is not.
- Awareness of your Equipment
  - Keep it maintained, keep it streamlined (do not let it drag on the bottom)
- Awareness of your team
  - Be aware of where you are in relation to your team at all times.
- Awareness of the Environment
  - Be aware of wildlife, the weather, boat traffic

Prohibited Diving Activities in Spring Lake

The Following Diving Activities are Prohibited in Spring Lake:

- Solo Diving
- Stage diving
- Rebreather Diving
- Cave Diving (unless approved by the Diving Safety Officer)
- Scooter Diving (unless approved by the Diving Safety Officer)

Divers that plan to dive in **sidemount** or **doubles** configurations need to provide proof that they have received training in these techniques or may be required to show competency by redoing the diving skills circuit.

Hazards in Spring Lake

Entry and Exit

Please take care when entering and exiting the water so as to avoid injuring yourself. Common injuries are strains, sprains and breaks caused by falling or tripping when carrying heavy dive gear. Help each other get gear to the entry point, use our hand carts to transport gear to the entry, use handrails where provided, make sure you can see where you are stepping.

Heat and Sun Exposure

As we all well know, Texas Summers can get quite hot. Please make sure to avoid overheating while gearing up for your dive. Stay in the shade as much as possible, be sure to hydrate, and do not fully don your thermal protection until you are ready to enter the water. Once in the water cool off at the surface. **If you feel overheated, sit down in the shade, remove excessive thermal protection and hydrate.** If following these steps does not improve your condition, seek medical attention immediately. Please make sure to protect yourself from the harmful effects of the sun by wearing adequate protection.

Wildlife

Be aware of harmful animals and plants both at the surface and underwater. At the surface there are fire ants, snakes and poison ivy. Use designated pathways, do not bring food out to the entry points and always look before putting something down. Underwater there are snapping turtles. Do not reach into thick underwater vegetation without first looking to see if there is anything there. Do not harass or chase any wildlife at the surface or underwater.

Hazards in Spring Lake

Underwater Caves

There are a couple of small, restricted underwater cave entrances in Spring Lake. Under no circumstances should any diver, even those with cave diving certifications, ever attempt to enter them.

Weather

The Meadows Center for Water and the Environment follows the Texas State University protocols and procedures for severe weather. If inclement weather is expected on the day of your dive, it is best to call ahead to the ticket booth to see if diving activities have been cancelled. You can also call the Texas State University news hotline at (512) 245-2424 for up to date information.

- **Lightning**

  Texas State University utilizes a dangerous lightning prediction warning system. The system uses a horn array and a strobe-light warning mechanism to alert the campus of approaching weather systems that have the potential to produce dangerous lightning. If this occurs, the horn array will sound two times for 15 seconds and strobes will be activated throughout the alert. **There is a warning system array near Spring Lake between the Ticket Booth and the golf course.** If the Texas State Warning System is activated, you are advised to seek shelter in the nearest available open building, away from windows, or in any low lying area until the all clear alarm has been sounded. The all clear alert will be three five-second sirens.

Hazards in Spring Lake

The Glass Bottom Boats

Spring Lake is one of very few dive sites where boats actually seek out divers. The boat captains will be advised as to where you will be diving, and may stop above you so that our visitors can see you at work.

To ensure your safety it it is critical that all divers adhere to the following guidelines while diving:

- To increase your visibility to the boats, always wear the yellow dive suit on every dive outside of the training area.
- Learn to listen for the 'whir' of the boat motors (they are electric).
- Before ascending and transiting shallow areas, make sure to look both ways and make sure there is no boat traffic.
- Transit shallow areas as quickly as possible, staying close to the west side of the Spring and hugging the bottom.
- Be sure to vent gas from your BCD when ascending into shallow areas to avoid popping to the surface.
- Do not go outside of the areas you have been assigned to dive.
- **PLEASE AVOID SURFACING** in Spring Lake when outside of the Training Area.

Out of Gas Situations and Dive Planning

Because surfacing outside of the Training Area is extremely hazardous due to the Glass Bottom Boat traffic, all divers are expected to follow proper planning and management of their breathing gas to ensure that **two divers** may safely **return to the nearest, safe exit point** while breathing from the same source (tank) without breaking the surface.

If you must surface in Spring Lake please move to the closest shoreline and away from boat lanes. Make sure to check for boat traffic before ascending.

We strongly recommend the use of a long hose (minimum 5 foot length) in order to safely pass single file or side by side through shallow areas while sharing gas.

Minimum starting pressure (assuming you are using a single 80 ft^3 aluminum tank) is 2000 psi.

Please surface with at least 500 psi in your tank at the end of the dive.

The Spring Lake Gear Wash Procedure

To help protect our waters from the threat of invasive species, please take the time to prepare your equipment for your dive in Spring Lake. By washing at home you will save time and avoid donning wet gear on your dive day. This simple procedure will not only extend the life of costly equipment but help protect the aquatic habitats we enjoy.

Underwater housings, dry suits, cylinders, manifolds, regulators, and any other specialty equipment that cannot or should not be submerged in a vinegar solution should be cleaned to manufacturer's specifications with an appropriate cleanser, thoroughly rinsed, and dried prior to use in Spring Lake.

Gear that has been used exclusively in Spring Lake, a chlorinated pool, or a saltwater environment does not require decontamination prior to access at this time.

1. Visually inspect all equipment for plant, animal, or foreign material of any kind. Remember to check pockets, folds, and tread of shoes, any velcro and booties.
2. Create a solution of 20% vinegar and 80% water in a sizable container.
3. Submerge gear in vinegar solution for 20 minutes. Use a weight belt to hold down buoyant gear. Be sure to get solution inside your BCD by opening dump valves while submerged in the solution.
4. After soaking your gear for 20 minutes, remove gear from solution and rinse thoroughly with fresh water.
5. Hang gear and allow it to fully air dry.

We depend on ALL DIVERS to follow these protocols to ensure the health of the Spring Lake aquatic system and the longevity of SCUBA diving activities in this delicate environment. Failure to follow these protocols may result in damage to the environment and the termination of all recreational diving instruction by outside entities in Spring Lake.

The Spring Lake Gear Wash Procedure

What are invasive species?
(for more information please visit: http://www.texasinvasives.org)

An "invasive species" is defined as a species that is non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. (Executive Order 13112).

An invasive species grows/reproduces and spreads rapidly, establishes over large areas, and persists. Species that become invasive succeed due to favorable environmental conditions and lack of natural predators, competitors and diseases that normally regulate their populations.

This includes a wide variety of plants, insects and animals from exotic places. As invasive species spread and take over ecosystems, they decrease biodiversity by threatening the survival of native plants and animals. In fact, invasive species are a significant threat to almost half of the native U.S. species currently listed as federally endangered.

In addition to negatively impacting ecosystems, invasive species are also costly. It is very expensive to prevent, monitor and control the spread of invasives, not to mention the damage to crops, fisheries, forests, and other resources.

Invasives cost the United States @S $137 billion annually. Some of the most harmful species cost in excess of $100 million annually.

The Spring Lake Dive Accident Management Plan

All Volunteer Divers are required to read and be familiar with the Spring Lake Dive Accident Management Plan, and understand how to activate the Emergency Medical System in case of a diving emergency. The diving accident management plan is part of every Volunteer Divers student packet.

It is highly recommended that you keep a copy of the Spring Lake Dive Accident Management Plan in your vehicle or dive bag.

We will review the Spring Lake Dive Accident Management Plan during your class.

Maintaining your Volunteer Status

To maintain a current "Authorized Volunteer" status you must:

- Log at least four hours of volunteer work a year.
- Adhere to the rules and protocols set forth in the Spring Lake Diving Authorization Course, the Spring Lake Management Plan and the Habitat Conservation Plan.

Remember:

All volunteer divers are **required to wear yellow suits** over their wet suits for visibility purposes. These suits also help identify authorized divers to our park staff. This policy is a result of an increase in the trade of illegal antiquities, diving and boating safety regulations and risk assessments provided by the Attorney General's Office and the University Police. Failure to wear the yellow suits could result in the loss of authorization to dive in Spring Lake. Additionally, all divers are required to follow the Spring Lake Gear Wash Procedures to prevent the spread of invasive species in Spring Lake.

Last Word on Safety

For all of us at the Meadows Center for Water and the Environment, your safety is of the utmost importance to us. Please feel free to let us know if you have any doubts or questions about what you have learned in this module.

By diving safely, you can ensure that access to Spring Lake will remain open for diving activities.

We appreciate your having taken this course and your commitment to help us preserve and protect Spring Lake and the San Marcos Springs.

Dive Safely!