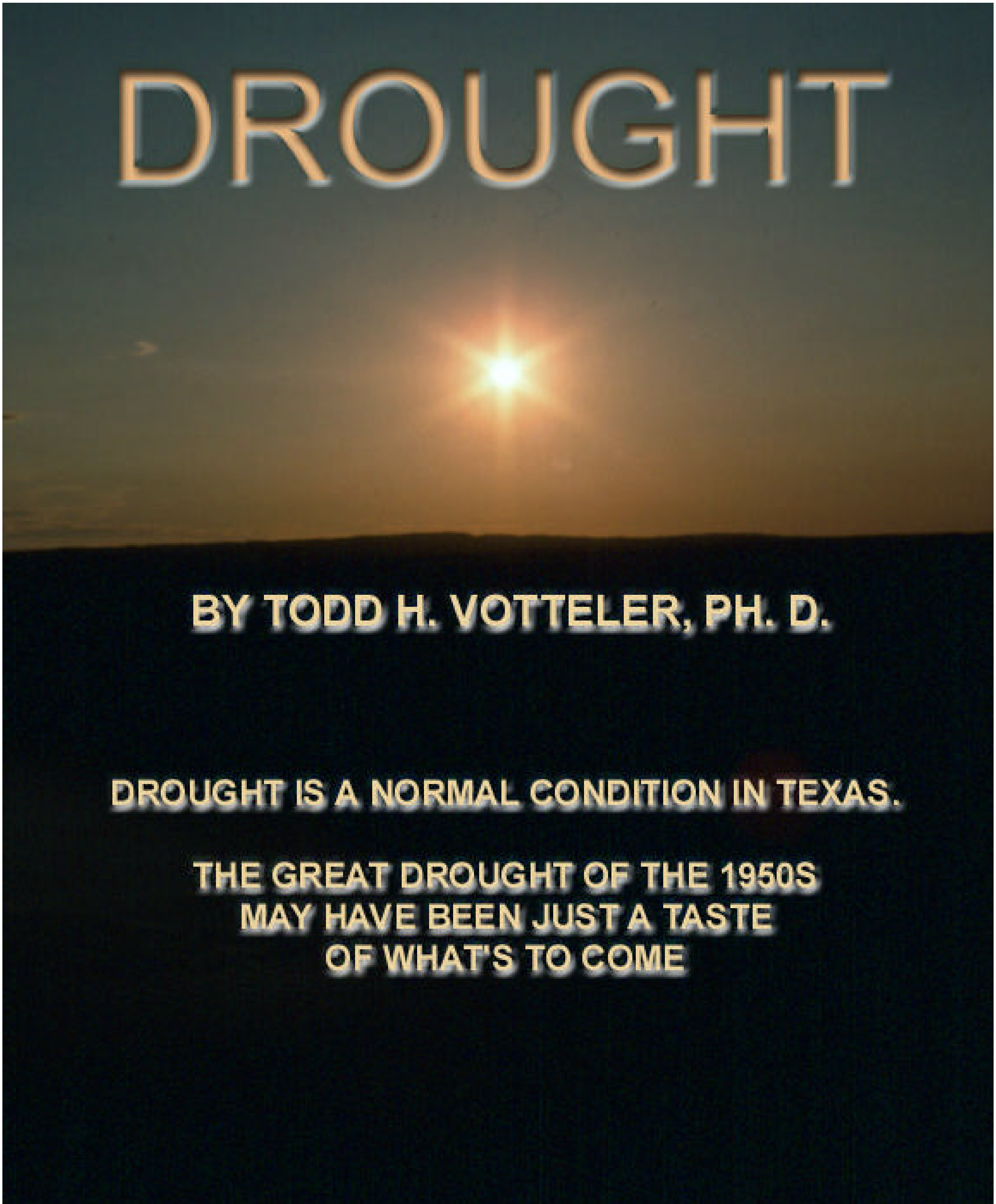

DROUGHT
BY TODD H. VOTTELER, PH. D.
DROUGHT IS A NORMAL CONDITION IN TEXAS.
THE GREAT DROUGHT OF THE 1950S
MAY HAVE BEEN JUST A TASTE
OF WHAT'S TO COME

[WATER DEFINES TEXAS. IT IS OUR MOST VITAL NATURAL RESOURCE. ITS PRESENCE – OR ABSENCE – HAS MOLDED OUR STATE'S HISTORY AND PEOPLE. OFTEN, IT SEEMS THAT TEXAS EITHER IS COPING WITH TOO MUCH WATER OR TOO LITTLE. RECENTLY, IT HAS BEEN TOO LITTLE; RAINFALL HAS BEEN SCARCE FOR MORE THAN A YEAR NOW IN MUCH OF THE STATE. DROUGHT HAS RETURNED TO TEXAS, SPREADING NORTHWARD ACROSS THE RIO GRANDE FROM THE CHIHUAHUAN DESERT IN NORTHERN MEXICO, AS IT DID IN THE 1950S. BUT WAS IT EVER VERY FAR AWAY?]

Drought is the most complex, and least understood, of all natural hazards, affecting more people than do other natural hazards, but differing from them in important ways. Unlike earthquakes, hurricanes and tornadoes, drought unfolds at an almost imperceptible pace, with beginning and ending times that are difficult to determine, and with effects that are spread over vast regions.

Drought is the most costly of all natural disasters and, because of the famines it causes, it is the most deadly. In the 25 years preceding the 1990s, drought throughout the world affected 1.4 billion of of the 2.8 million people who suffered from weather-related disasters, resulting in 1.6 million deaths. In Texas, agricultural losses from the 1996 drought are estimated at $2 billion, and losses from the 1998 drought reached $2.1 billion, with some estimates much higher. Estimates of overall state losses from both droughts exceed $11 billion.

[**These two views of the Pecos River show how dramatic water fluctuations can be. A Texas Water Commission study found that a drought of six months to a year is more likely to occur somewhere in Texas than average precipitation during the same time period.**]

WHAT IS DROUGHT?

Drought, or the more Texan "drough", or "drout," is a normal feature of nearly all climates. Drought generally means a period of serious moisture deficiency that persists from one year into the next. Anything less than a year is usually called a "dry spell," which also can cause serious hardship. There are several major categories of drought: meteorological, which refers to a deficit of precipitation; hydrologic, which refers to the effects of reduced precipitation, springflow and streamflow; socioeconomic, for example, less water during a drought resulting in a shortfall in available hydroelectric power; and agricultural, which refers to reduced soil moisture. Hydrologic drought shows how complicated drought science can be. Even with average or above-average rainfall, reservoirs and aquifers can be at critically low levels if rain does not fall in the right place and at the right rate.

Drought is a normal condition in Texas. A Texas Water Commission study found that a drought of six months to a year is more likely to occur somewhere in Texas than average precipitation during the same time period. A three-month drought is likely to occur in some part of the state every nine months. Droughts lasting six months or longer will likely occur once every 16 months, and year-long droughts are likely somewhere in the state once every three years.

WHY SO MANY DROUGHTS?

Texas experiences so many droughts in part because of its location along 30 degrees north latitude, a climate transition zone called the Great American Desert. This is the latitude where many of the earth's deserts are found, including the Sahara. It is not uncommon for portions of Texas to be suffering a drought while other parts are experiencing heavy rainfall. Annual rainfall varies from eight inches in El Paso to 56 inches along the Texas-Louisiana border.

Texas receives most of its moisture from the Gulf of Mexico, with lesser amounts from the Pacific Ocean. Precipitation across the state varies seasonally. April, May and June are normally the wettest months because of thunderstorm activity provoked by cold and warm fronts. A secondary rainfall peak occurs in September and October, caused by tropical cyclones (depressions, storms, and hurricanes) originating in the Gulf of Mexico, the Caribbean Sea and the Atlantic Ocean. These major storms occasionally provide the rainfall needed to quench serious droughts. Droughts in Texas occur primarily when the Bermuda High, a zone of high pressure in the atmosphere, becomes fixed over the southern United States.

Brief, but severe, statewide droughts occurred in 1996 and 1998, but portions of South and West Texas have been in a long-term drought for years. There is growing speculation among climatologists that, during the next few decades, Texas could see even more frequent droughts, of longer duration, than the ones it has experienced since the great drought of the 1950s.

GLOBAL FACTORS CONTRIBUTE

Droughts vary in intensity and length because of differences in how the atmosphere and oceans interact, which can alter precipitation patterns over decades and centuries. Global factors such as El Niño and La Niña are being studied as potential influences on droughts in Texas.

El Niño is a warming of sea surface temperatures in the Pacific Ocean west of Peru and Ecuador. Since 1950, it has occurred about every three years. Some studies conclude that a strong El Niño causes wetter than average winters and springs in Texas, because it can shift the jet stream farther south into Texas, bringing with it the west-east path along which storms move across the country. Conversely, El Niño appears to suppress tropical cyclone activity.

In contrast, La Niña is a cooling of the sea surface temperatures in the Pacific Ocean west of Peru and Ecuador. Over the last 50 years La Niña has occurred about every four years. La Niña generally contributes to drier than average conditions in Texas by shifting the jet stream north, taking the west-east track of storm with it. Yet, La Niña appears to enhance tropical cyclone activity. Both 1999 and 2000 have been La Niña years.

As most of us are aware by now, global climate change, also called the "greenhouse effect," is the potential for an

increase in world temperatures due to an increase in gases in the atmosphere such as water vapor and carbon dioxide, as well as other factors. Some of the computer programs designed to simulate the effects of global climate change indicate warmer and drier conditions for Texas. While global climate change might make the Texas climate warmer and drier, droughts will continue to occur with or without it.

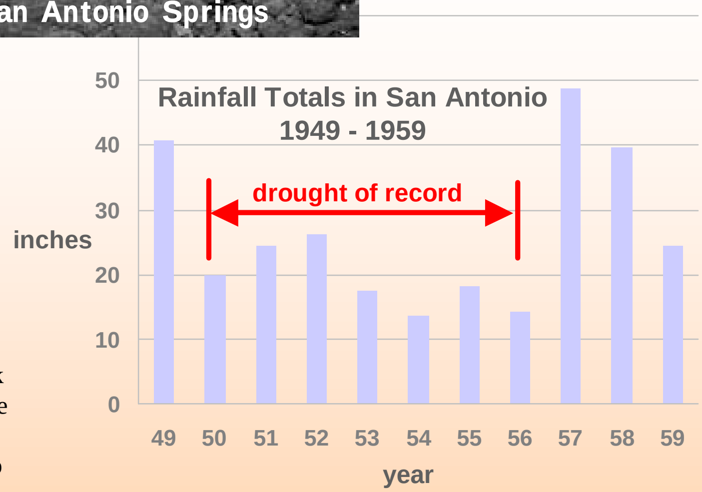
Finally, the 22-year sunspot cycle also is being studied as an influence on droughts. The sun drives circulation in the atmosphere and oceans, causing weather. There are dark spots that appear on the surface of the sun, called sunspots, which wax and wane in cycles that last roughly 11 years each. Sunspots are relatively cool areas that appear as dark blemishes on the face of the sun, formed when the magnetic field just below the sun's surface is twisted and thrusts to the surface. Some researchers believe that there may be a connection between the sunspot cycle and a 22-year drought pattern over much of the American West. During peaks, or maximums, of the sunspot cycle, droughts have occurred in Texas, including the Dust Bowl in the early 1930s and the record drought in the mid-1950s. The last maximum occurred around 1989, and the next is predicted for this year. Some supporters of the theory predict that the next few years in the West will be dry, followed by flooding along the Mississippi River in 2004 or 2005.

THE DROUGHT OF RECORD

The drought of record generally refers to the worst drought that has occurred in a region since the beginning of detailed record-keeping. For Texas as a whole, the drought of record lasted from 1950 to 1957, although it may have begun in parts of the state in the 1940s. What may have been the most devastating feature of this drought is that it was uninterrupted by a single "wet" year. By the end of 1956, 244 of Texas' 254 counties were classified as disaster areas. The Panhandle was blanketed by dust storms of dry topsoil that some people said were worse than those during the 1930s. The dust piled up on the highways in drifts, requiring snowplows and bulldozers to remove it. Wells that survived previous droughts went dry, as did creeks, rivers and springs. Comal Springs, the largest springs in the southwestern United States, dried up for almost five months in 1956. Partially as a result of the lack of flow from these springs, the Guadalupe River dwindled, allowing salt-water to flow up the river from the Gulf of Mexico and into water intakes. An inflatable dam now guards the Guadalupe against future saltwater invasions. Dams were placed on the Trinity and Neches rivers after salt-water invasions. Ranchers used butane-fueled "pear burners" to singe the spines off prickly pear cactus so their cattle would have something to eat. Ranch debt climbed above $3 billion and 143 counties in Texas experienced a reduction in population as the drought accelerated rural migration. The water supplies of some cities, including Llano and Royce City, were exhausted, requiring water to be hauled in by trucks. A few cities actually lowered their water rates to east the cost of increased consumption, which aggravated the crisis as cheaper water led to more use. As an emergency measure, Dallas built a pipeline from Lake Texoma to supplement its dwindling water supply, but the water proved too salty. The drought ended in 1957, with a flood that saturated the ground, returning soil moisture conditions to normal and replenishing depleted surface water reservoirs and aquifers.

"The most recent research indicates that a drought similar to the drought of record can be expected to occur in Texas once every 50 to 100 years over the long-term," says Malcolm Cleaveland, a professor at the University of Arkansas. He is a recognized authority in restructuring past climates, or paleoclimates, in the Southwest at the University of Arkansas Tree Ring Laboratory. Cleaveland believes that the science of reconstructing past droughts has improved considerably in recent years. In addition to using tree rings, scientists also are combining information from lake sediments, packrat nests, pollen, historical documents and archeological evidence in an effort to help us understand past droughts.


San Antonio River
just below San Antonio Springs



MEGADROUGHTS

A growing body of research indicates that 20th century droughts paled in severity, extent and duration to droughts that occurred centuries ago. Droughts over the last 400 years have occurred on a scale of seasons to years, while droughts from A.D. 1 to A.D. 1600 appear to have occurred on a scale of one or more decades, a scale that is difficult to imagine. Some suggest this may portend future droughts that may last longer and be more severe than those experienced since 1600, which could result in natural disasters on a scale unknown during the last century. "These mega-droughts will eventually return, but we don't know when," says Cleaveland.

In fact, one megadrought in the 16th century appears to have been the most widespread and severe of the last 500 years. New research by Cleaveland indicates that "for portions of the Southwest, the 16th century drought lasted a minimum of 20 years to a maximum of 50 years." Some of the attributable effects include mass human migrations as pueblos were abandoned in the Southwest and the disappearance of Sir Walter Raleigh's English colony on Roanoke Island in North Carolina when the drought spread to the East Coast.

WATER, DROUGHT, AND POLITICS

As rainfall decreases and a drought develops, water supplies shrink from the lack of replenishment as well as from increased watering of lawns and gardens. As the Texas economy and population continue to grow, without an increase in the water supply or more efficient water use, the water supply becomes tighter. The detrimental effects of the droughts of record probably would be far greater today, primarily because of growth in the state's population and the size of the economy. Additional factors contribute to increasing vulnerability to water shortages in Texas:

- Depletion of groundwater continues;
- Most of the good reservoir sites have been developed, and it is increasingly difficult to build new reservoirs;

Agricultural losses from droughts are severe, climbing into the billions of dollars. Drought is the most costly of all natural disasters.

- Increasing legal and regulatory requirements concerning environmental issues will reduce water available for other needs; and
- The high costs of new water supplies result in communities taking greater risks that their current supplies will get them through future droughts.

The battle against drought is usually won or lost before the drought begins. Preparation is crucial. With this in mind the Drought Preparedness Council (DPC) was created by the 76th Texas Legislature. It is part of the Texas Department of Public Safety's Division of Emergency Management. Tom Millwee, chair, describes the DPC as "a coalition of state and federal agencies sharing information to address problems associated with drought before a drought begins." The council promotes education and awareness of drought issues and coordinates its efforts with regional water planning efforts under Senate Bill 1, major water planning legislation. "The public has a critical role to play in mitigating the effects of drought through water conservation and wildfire prevention," Millwee states.

Texas water law has evolved within a pattern of key litigation and legislation following major droughts. For example, after the 1996 drought, the Texas Legislature passed Senate Bill 1 in 1997.

The Texas Water Development Board is the agency leading the effort to plan for future water supply needs of the state in line with this legislation. Across Texas, regional water planning groups are undertaking the challenging task of developing a blueprint for how each part of the state will meet its future water needs.

The Texas Water Development Board is involved with the current drought by monitoring drought conditions and providing ready access to this information. Also, we are providing technical assistance in drought response programs. The TWDB is also looking into the future as part of the state water planning process established by Senate Bill 1, 75th Texas Legislature. Any longterm solutions to meet the future water needs, including during times of drought, will need to evaluate environmental impacts in addition to cost, quantity and quality aspects of solutions.

Bill Madden, Chairman of the Texas Water Development Board

OVER THE HORIZON

Almost half the United States was in drought at the beginning of 2000. The winter of 1999-2000 was the warmest since records have been kept. As for Texas, at the beginning of 2000, reservoirs across the state were at 23-year lows, with levels continuing to fall. Since the 1960s, much of the state has experienced a wet period with occasional droughts of relatively short duration. Generous rainfall might be responsible, in part, for a slowdown in the development of new water resources, since the need has not been as apparent. In recent years, conservation has been the preferred method of stretching the water supply. While conservation is critical, it ultimately will not be able to meet all of the needs for additional water, given the projected growth in Texas. To obtain new supplies, perhaps by building a new reservoir, may require 20 years or more before the water actually flows from your tap. "When the next megadrought returns, limiting car washing, lawn watering and restricting restaurants from serving water will not be enough to make a difference. With water resources you must take the long-term view to prepare for drought," says Cleaveland.

Droughts worse than the drought of record have occurred in the past and will happen again. Should such a drought occur in Texas in the near future, it will affect a state that has seen its population more than double since the drought of record, while the development of new water supplies has not kept pace. The key to living drought is preparation, even if you've been reaching for your umbrella lately. *

Analyzing Ancient Droughts

Historical documents contain observations of weather and climatic changes in farmers' logs, travelers' diaries, newspapers and other written records.

Tree ring widths, as trees generally produce one ring a year, provide a record of each year's climate. Some trees can grow to be a few thousand years old, providing a lengthy historical record.

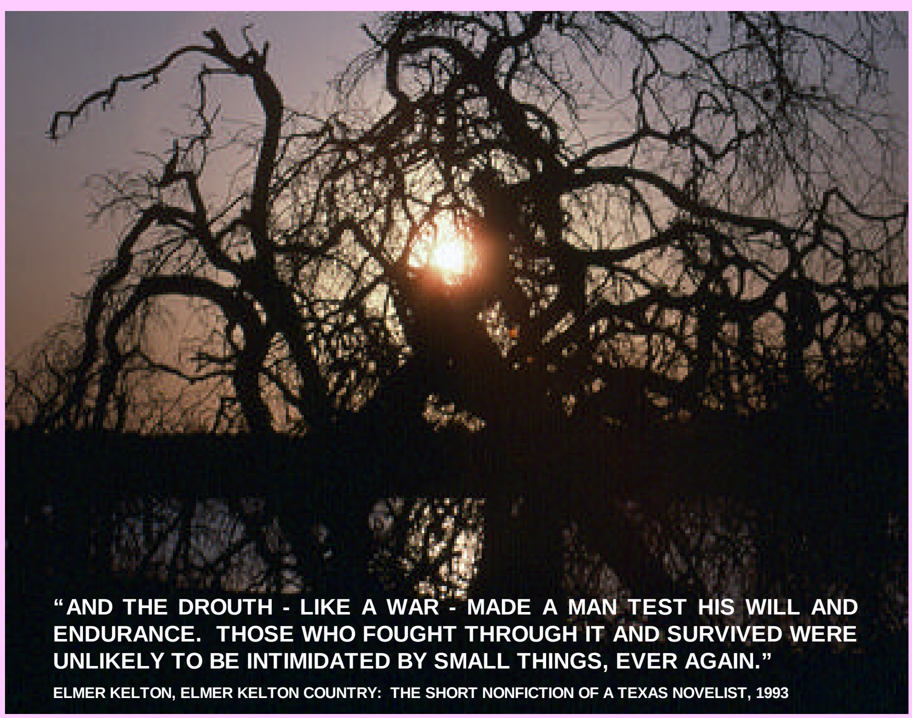
Corals build their hard skeletons from calcium carbonate, a mineral extracted from seawater. The carbonate contains oxygen and trace metals that can be used to determine water temperatures in which the coral grew. These temperature recording can provide an indicator to climate.

Fossil pollen grains are well preserved in the sediment layers that form in lakes or oceans, showing what kinds of plants were growing when the sediment was deposited, which reflects the climate of the time.

Ice cores from glaciers and polar ice caps have accumulated from snowfall over thousands of years. The ice contains dust and air bubbles that can be used to analyze the past climate of that area.

Sediments from ocean and lake floors in drilled cores consist of materials produced in the lake or ocean or washed in from nearby land. These materials include fossils and chemicals that can be used to interpret past climate.

Packrats collect plant parts, rocks, animal bones, insect parts, teeth and other small items. Some of these collections are tens of thousands of years old and are preserved by packrat urine – hardening into dark, crystalline-like "middens" that can be radiocarbon dated.



"AND THE DROUTH - LIKE A WAR - MADE A MAN TEST HIS WILL AND ENDURANCE. THOSE WHO FOUGHT THROUGH IT AND SURVIVED WERE UNLIKELY TO BE INTIMIDATED BY SMALL THINGS, EVER AGAIN."

ELMER KELTON, ELMER KELTON COUNTRY: THE SHORT NONFICTION OF A TEXAS NOVELIST, 1993

Wildlife and Droughts

Most of our native wildlife is adapted to drought conditions, although they are still affected by the resulting lack of water and forage. For example, animals can obtain water from food, particularly succulent plants like cacti. Some examples of the effect of drought on wildlife include:

- Low nesting success and survival rates for game birds;
- Sparse grass and ground cover, which means that wildlife nesting and escape sites may be lost;
- Diminished or curtailed flows of fresh water into the state's bays and estuaries, whch can cause steep declines in the reproduction of fish and shellfish in these coastal nurseries;
- Freshwater fish can die in ponds with low water levels as the oxygen level declines; and
- When animals do not consume a sufficient amount of food and water, their physical condition declines. While the impact usually is not fatal to adult animals, it can mean death for younger animals. Animals in poor condition generally produce fewer offspring, and fewer of the offspring that are born reach adulthood.

As water sources disappear, wildlife seek out secondary water sources and stay closer to them. This can put an even greater demand on the remaining water sources and on the vegetation nearby. Diseases sometimes spread among the weakened wildlife concentrated in these areas, and predation may increase at these oases. Today, many species of wildlife benefit from the construction of livesock watering troughs and farm ponds that can provide water in these areas that had historically had little water during previous droughts.