



Center for Environmental Research at Hornsby Bend



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- Hydrogeology of the Alluvial Aquifer
- Riparian Ecology and Restoration
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50 YEARS OF BIRDING

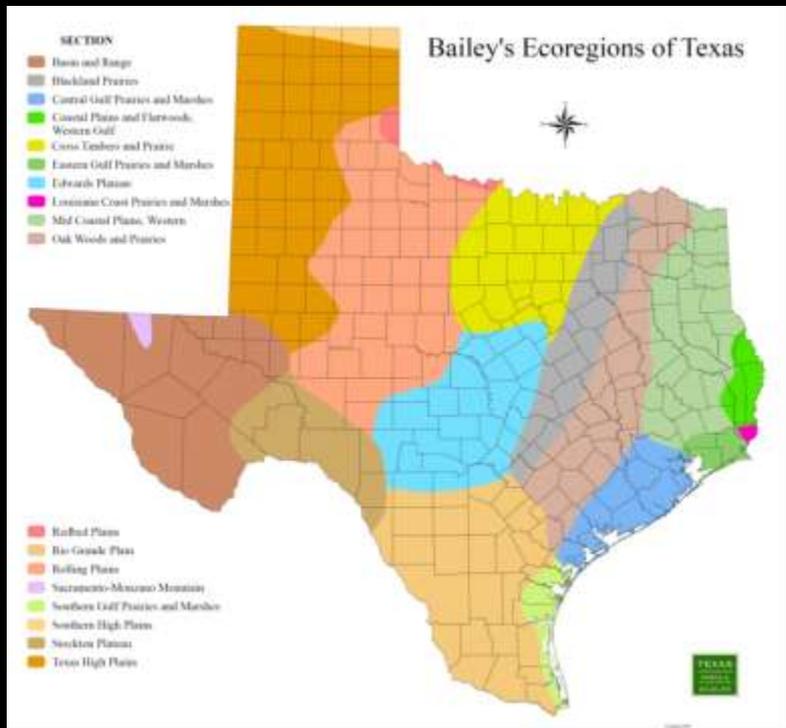


AUSTIN, TEXAS
Hornsby Bend
1959-2009

The Natural History of Texas: Biological Survey and Ecological Change

Kevin M. Anderson

Austin Water Center for Environmental Research



Natural History

Understanding whole organisms in context

Ecological understanding shaped by cultural contexts

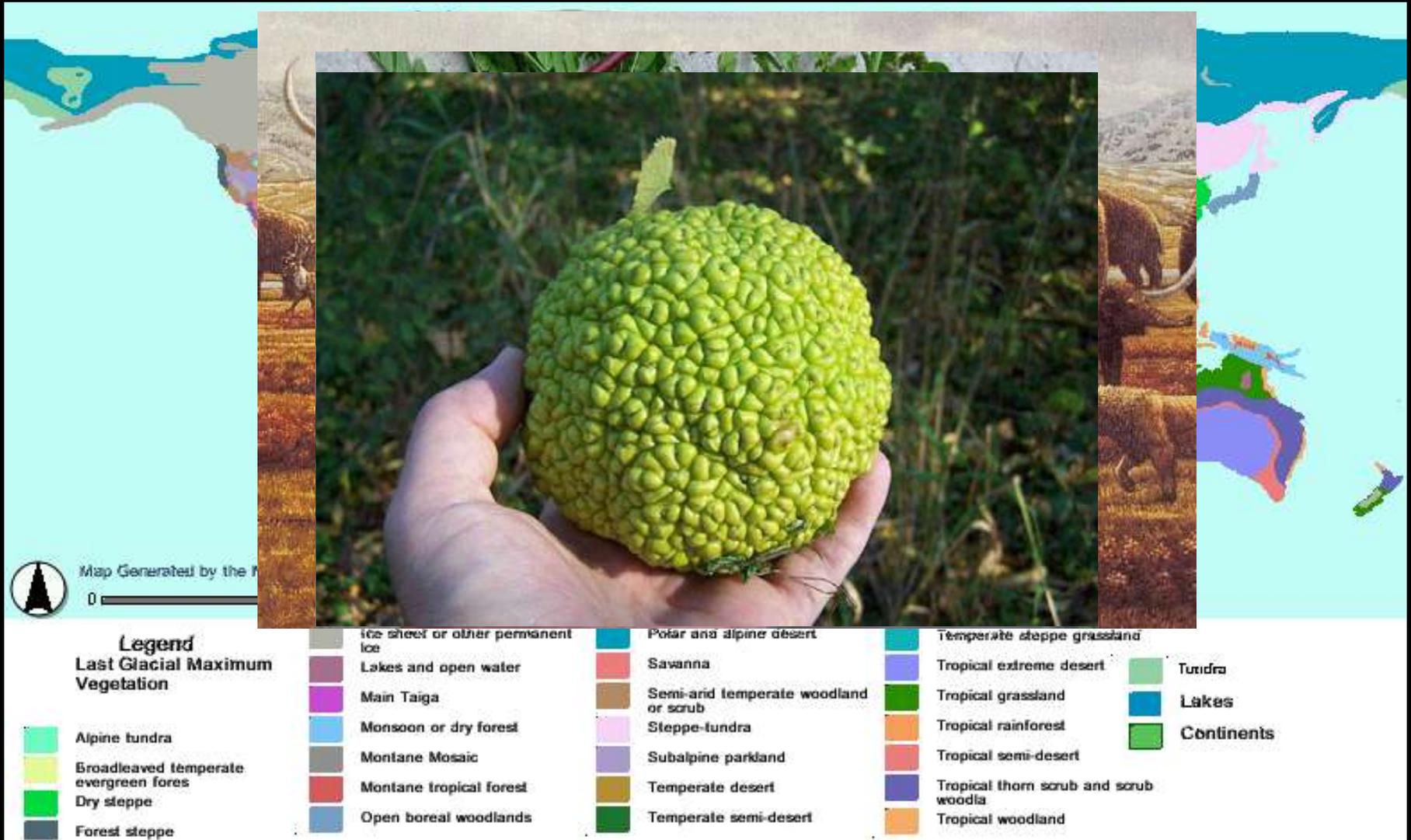
Cultural understanding shaped by ecological contexts



"The idea of nature contains, though often unnoticed, an extraordinary amount of human history."
Raymond Williams, "Ideas of Nature"

Which Natural History?

The Last Glacial Maximum (LGM) refers to a period in the Earth's climate history when ice sheets were at their maximum extension, between 26,500 and 19,000–20,000 years ago



Which Natural History?

At the peak of glacial expansion, vegetation and climate of Texas were much different than today.

As glaciers developed the climate of Texas became cooler and moisture effectiveness was greater which resulted in the presence of plant species that today typically occur in more mesic or cooler environments.

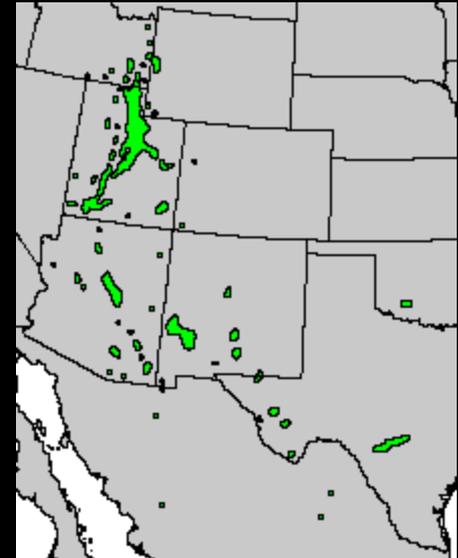
For example, the current distribution of many eastern forest species that extend into central and West Texas, such as bald cypress (*Taxodium disticum*), Chinkapin oak (*Quercus muhlenbergii*), redbud (*Cercis canadensis*) and many others, may have occurred during these more favorable glacial conditions.

Likewise, western species such as papershell pinon pine (*Pinus remota*), which was widespread across all of the current desert and arid grasslands of the Trans-Pecos region and onto the Edwards Plateau during the advance of the last glacier, bigtooth maple (*Acer grandidentatum*), madrone (*Arbutus xalapensis*) and other species that still exist in central Texas, may be persisting today on favorable sites but were more widespread during the glacial periods.

Also, boreal forest species, such as spruce (*Picea glauca*), are documented to have extended as far south as Texas.



“Lost Maples”



Recent Climate Change

Over the past 10,000 years most of the state of Texas has generally become progressively warmer and drier with, of course, various fluctuations through time.

During the most recent 1000 years there are some climatic variations that may be noteworthy relative to vegetation.

Beginning about 1000 years ago the earth's temperature became warmer up until about 600 years ago. This Medieval Warm Period is characterized by retreating mountain glaciers, and documented shifts in vegetation distributions in various parts of the world.

From 600 to 150 years ago the earth experience a cooling period known as the Little Ice Age. Many of the changes observed in the previous warm period were reversed.

From about 1850 to the present the earth has been in a warming mode.



Changing scene. Based on findings from pack rat middens, this artist's conception shows what Hueco Tanks may have looked like some 12,000 to 14,000 years ago (far left), some 9,300 years ago (middle) and as it appears today (right). Colorado pinyon needles found in the oldest middens imply that Hueco Tanks was cooler and wetter 14,000 years ago. By 9,000 years ago, the climate had become more arid and the pinyons disappeared, leaving a juniper-oak woodland. Today Hueco Tanks is dominated by xeric grasslands and desert scrubs.

Humanized Landscape – Buttermilk Creek Complex 15,000 years old

Researchers in Texas have discovered thousands of human artifacts in a layer of earth that lies directly beneath an assemblage of Clovis relics, expanding evidence that other cultures preceded the Clovis culture in North America.

This pre-Clovis toolkit appears to be between 13,200 and 15,500 years old and it includes biface and blade technology that may have later been adapted—and improved upon—by the Clovis culture.

The Clovis people, whose tools were known for their distinctive “fluted” points, were once thought to be the original settlers of North America about 13,000 years ago. Over the past few years, however, scattered evidence has hinted at several earlier cultures. But such evidence has often been disputed in part because so few artifacts have actually been recovered.

The new site in Texas, known as the Debra L. Friedkin site, documents a pre-Clovis settlement in the region and informs researchers about the transition to Clovis culture and technology, which is later seen across North and Central America (and also into northern South America). These new artifacts comprise what researchers are calling the **Buttermilk Creek Complex**, and details of its excavation are reported in the 25 March 2011 issue of *Science*.



To Have Viewed It Entire – John Graves

In recent decades it has become customary, and right I guess, and easy enough with hindsight, to damn the ancestral frame of mind that ravaged the world so fully and so soon. What I myself seem to damn mainly though, is just not having seen it. Without any virtuous hindsight I would likely have helped in the ravaging as did even most of those who loved it best.

But God! To have viewed it entire, the soul and guts of what we had and gone forever now, except in books and such poignant remnants as small swift birds that journey to and from the distant Argentine, and call at night in the sky.

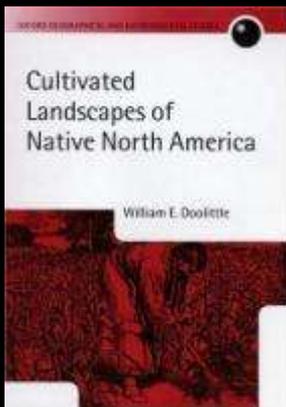
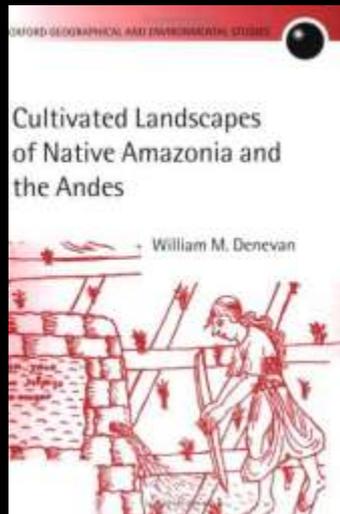
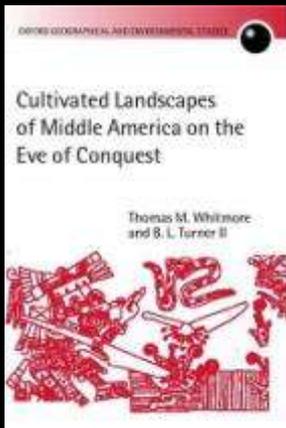
- From *Self Portrait, with Birds: Some Semi-Ornithological Recollections* (1991)





Cultivated Landscapes of the Americas – The Myth of Pristine Nature

The geographer William M. Denevan argued in 1976 that the American population in 1492 was around 55 million and that the population north of Mexico was under 4 million. These are among the lowest of modern estimates, but still dramatically higher than the nineteenth-century numbers.



The Pristine Myth: The Landscape of the Americas in 1492

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Abstract. The myth persists that in 1492 the Americas were a sparsely populated wilderness, "a world of barely perceptible human disturbance." There is substantial evidence, however, that the Native American landscape of the early sixteenth century was a humanized landscape almost everywhere. Populations were large. Forest composition had been modified, grasslands had been created, wildlife disrupted, and erosion was severe in places. Earthworks, roads, fields, and settlements were ubiquitous. With Indian depopulation in the wake of Old World disease, the environment recovered in many areas. A good argument can be made that the human presence was less visible in 1750 than it was in 1492.

Key Words: Pristine myth, 1492, Columbus, Native American settlement and demography, prehistoric New World, vegetation change, earthworks.

"This is the finest prairie . . ."

Engelke: A Tale of Acadie (Langfellow, 1847).

WHAT was the New World like at the time of Columbus—"Geography as it was," in the words of Carl Sauer (1971, xi). The Admiral himself spoke of a "Terrestrial Paradise," beautiful and green and fertile, teeming with birds, with naked people living there whom he called "Indians." But was the landscape encountered in the sixteenth century primarily pristine, virgin, a wilderness, nearly empty of people, or was it a humanized landscape, with the imprint of native Americans being dramatic and persistent? The former still seems to be the more common view, but the latter may be more accurate.

The pristine view is to a large extent an invention of nineteenth-century romanticist and

primitivist writers such as W.H. Hudson, Cooper, Thoreau, Longfellow, and Parkman, and painters such as Catlin and Church.¹ The wilderness image has since become part of the American heritage, associated "with a heroic pioneer past in need of preservation" (Pyne 1982, 17; also see Bowden 1992, 22). The pristine view was restated clearly in 1950 by John Bakeless in his book *The Eyes of Discovery*:

There were not really very many of these redskins . . . the land seemed empty to invaders who came from settled Europe . . . that ancient, primeval, undisturbed wilderness . . . the streams simply baked with fish . . . so much game . . . that one hunter counted a thousand animals near a single oak tree . . . the virgin wilderness of Kentucky . . . the fabled glory of primitive America (11, 201, 223, 314, 407).

But then he mentions that Indian "prairie fires . . . cause the often-mentioned oak openings . . . Great fields of corn spread in all directions . . . the Barrens . . . without forest," and that "Early Ohio settlers found that they could drive about through the forests with sleds and horses" (31, 304, 306, 314). A contradiction!

In the ensuing forty years, scholarship has shown that Indian populations in the Americas were substantial, that the forests had indeed been altered, that landscape change was commonplace. This message, however, seems not to have reached the public through texts, essays, or talks by both academics and popularizers who have a responsibility to know better.²

Kirkpatrick Sale in 1990, in his widely reported *Conquest of Paradise*, maintains that it was the Europeans who transformed nature, following a pattern set by Columbus. Although Sale's book has some merit and he is aware of large Indian numbers and their impacts, he nonetheless champions the widely-held dichotomy of the benign Indian landscape and

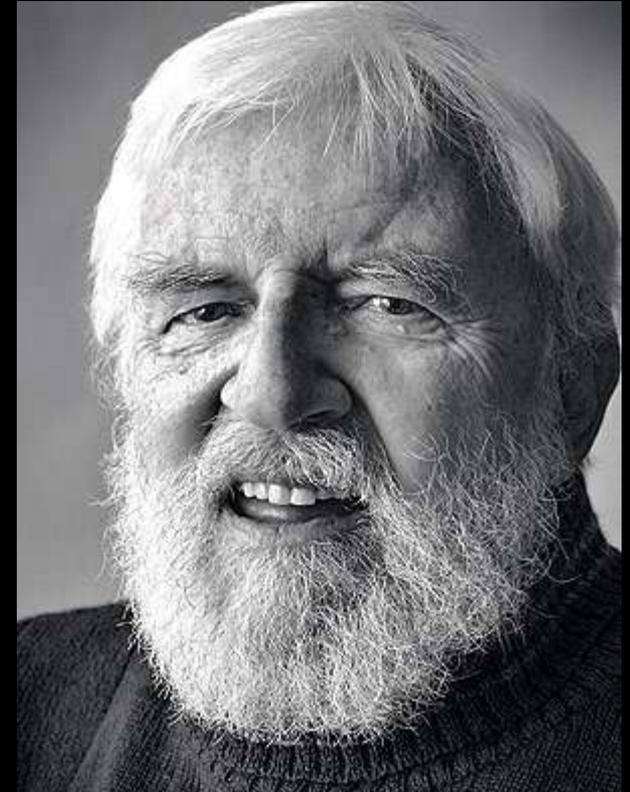
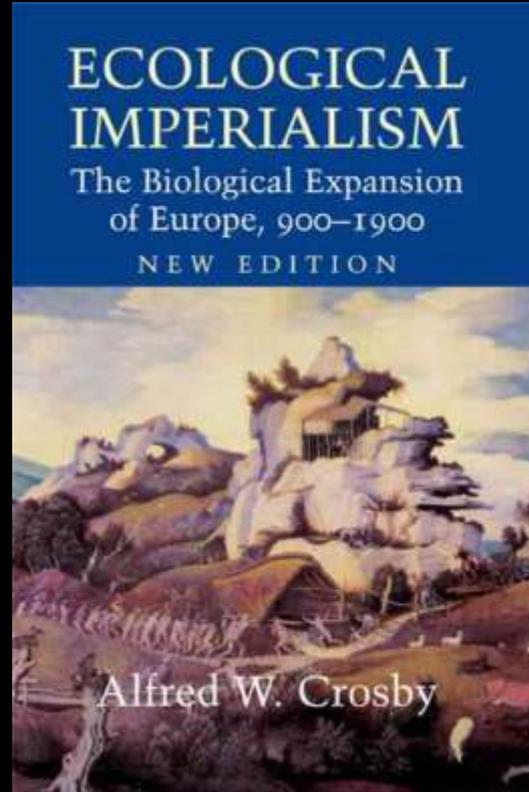
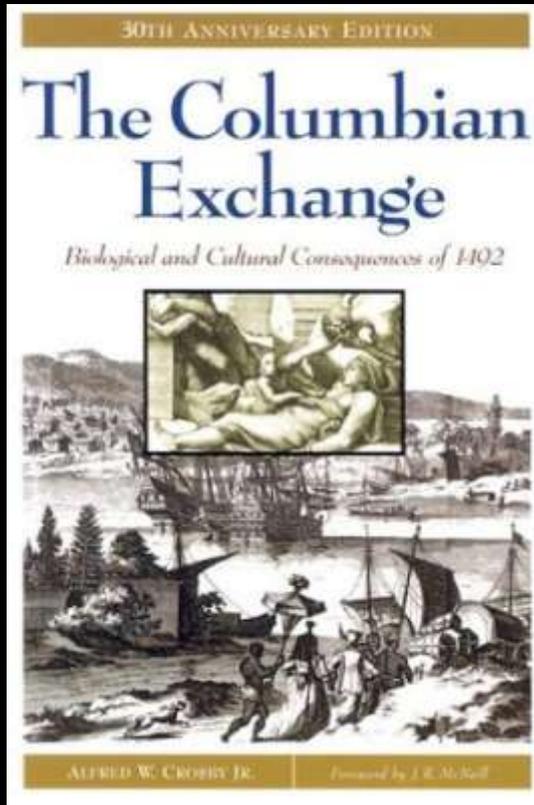
Journal of the Association of American Geographers, 2002, 106(4), pp. 588-591
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The Columbian Exchange and Ecological Imperialism



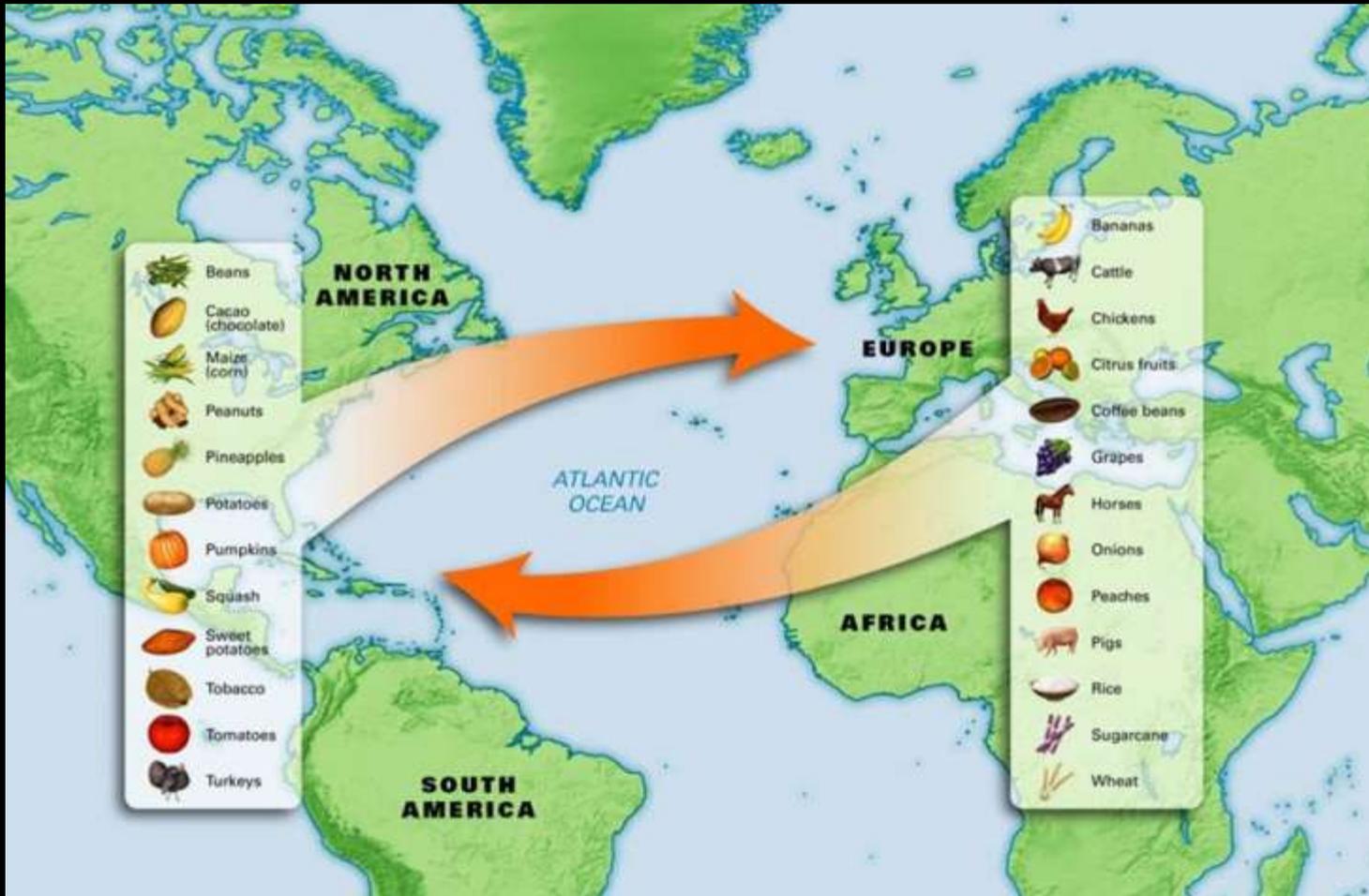
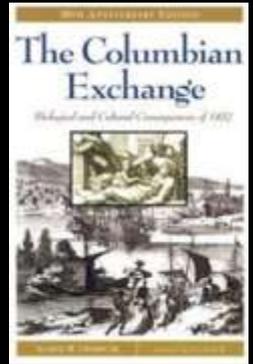
In 1972, Alfred Crosby described the near extinction of some tribes and the dramatic depopulation of others in *The Columbian Exchange* and the biological expansion of Europe in *Ecological Imperialism* published in 1986.



The Columbian Exchange

Until about 200 million years ago Eurasia and the Americas were a single landmass called Pangaea. It broke apart and for millions of years the parts had little communication. As Crosby put it, Columbus initiated the process of knitting back together the seams of Pangaea.

Ever since 1492, the hemispheres have become more and more alike, as people mix the world's organisms into a global stew through the Columbian Exchange.



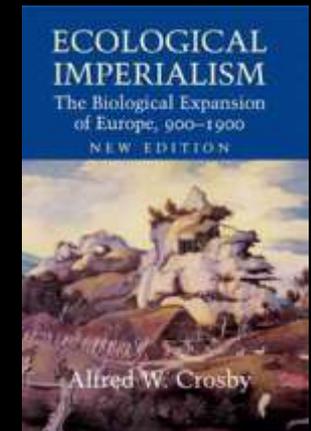
Ecological Imperialism

“Columbus set off an ecological explosion of a magnitude unseen since the Ice Ages.

Some species were shocked into decline (most prominent among them *Homo sapiens*, which in the century and a half after Columbus lost a fifth of its number, mainly to disease).

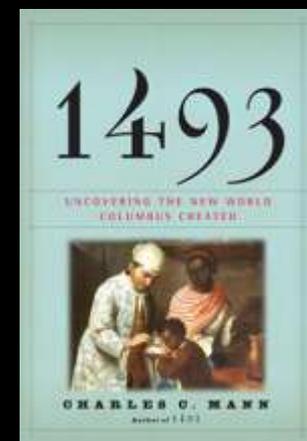
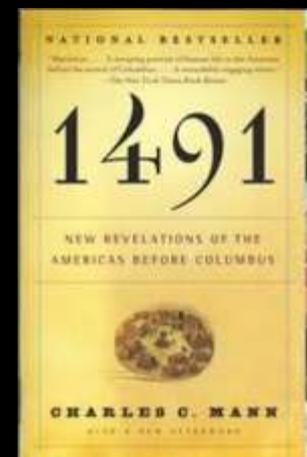
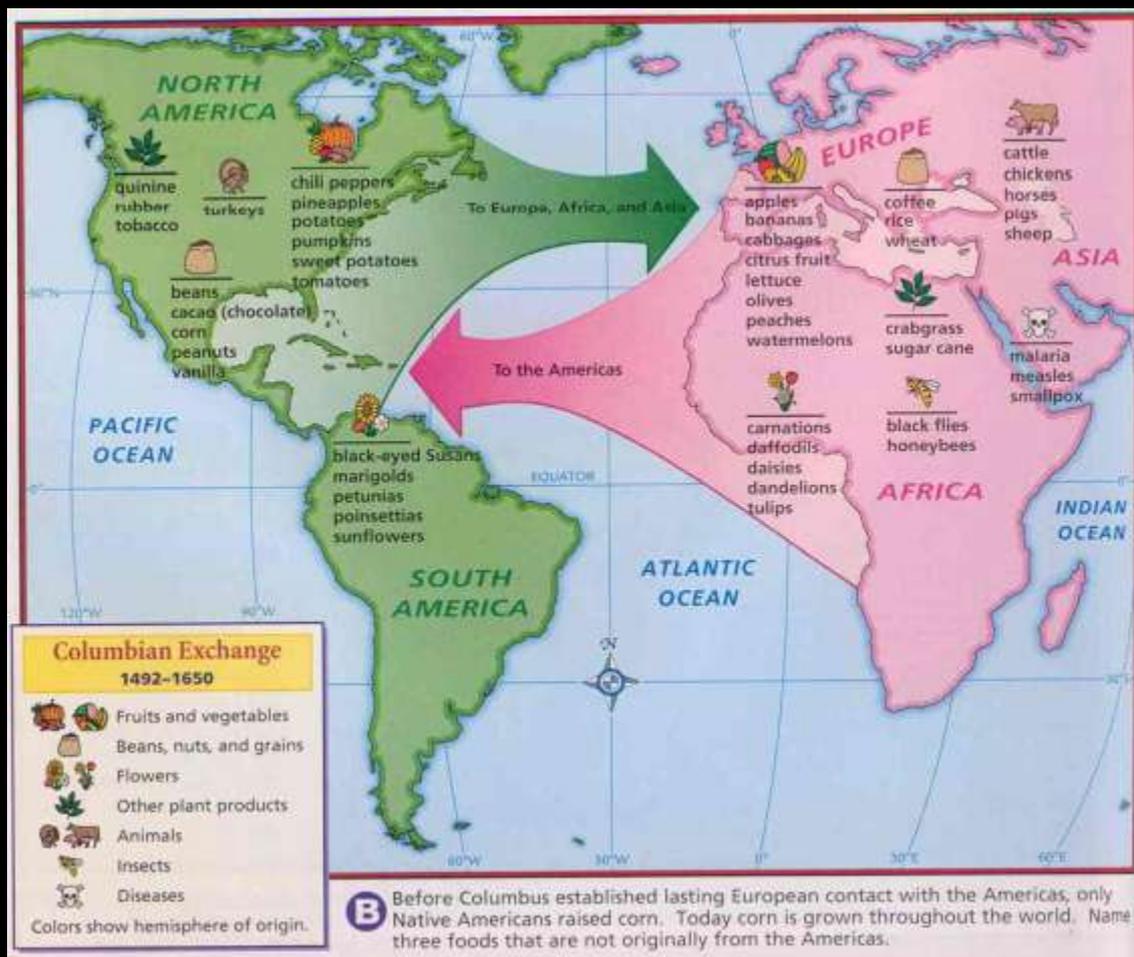
Others stumbled into new ecosystems and were transformed into environmental overlords: picture-book illustrations of what scientists call “ecological release.” Mann, 1491

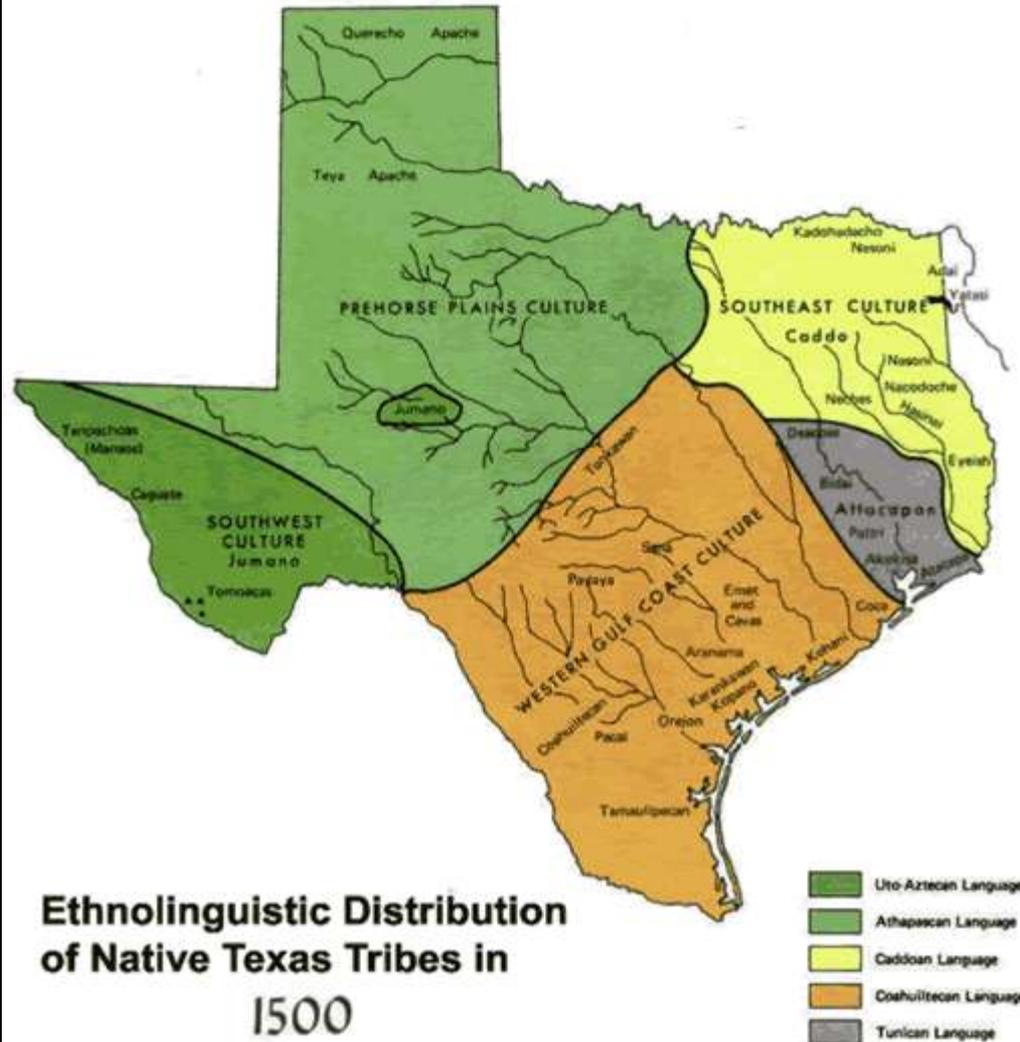
Not all released species will become invasive. Most released species that don't immediately die out tend to find a small niche in the local ecosystem. Ecological release occurs when a species expands its niche within its own habitat or into a new habitat where there is little competition for resources.



“Until Columbus, Indians were a keystone species in most of the hemisphere. Annually burning undergrowth, clearing and replanting forests, building canals and raising fields, hunting bison and netting salmon, growing maize, manioc, and the Eastern Agricultural Complex.

Native Americans had been managing their environment for thousands of years...But all of these efforts required close, continual oversight. In the sixteenth century, epidemics removed the boss...Not only did invading endive and rats beset them, but native species, too, burst and blasted, freed from constraints by the disappearance of Native Americans.” Mann, 1491



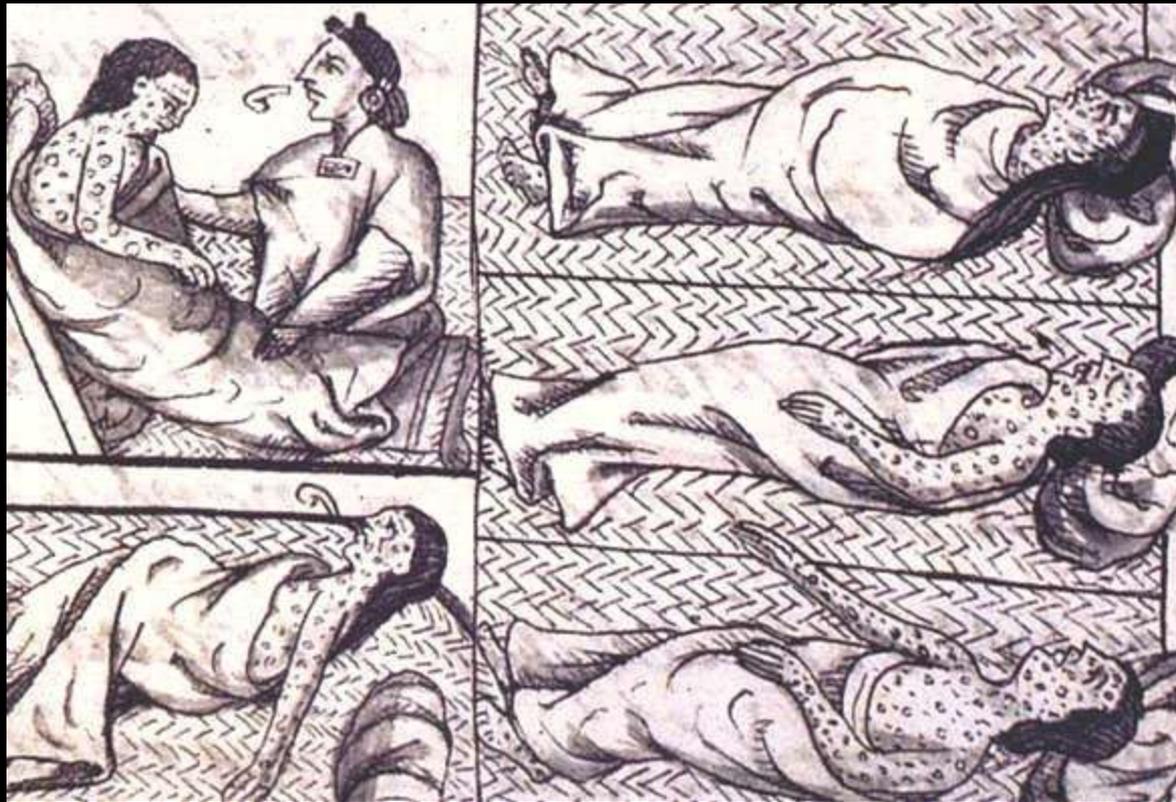


Ethnolinguistic Distribution of Native Texas Tribes in 1500

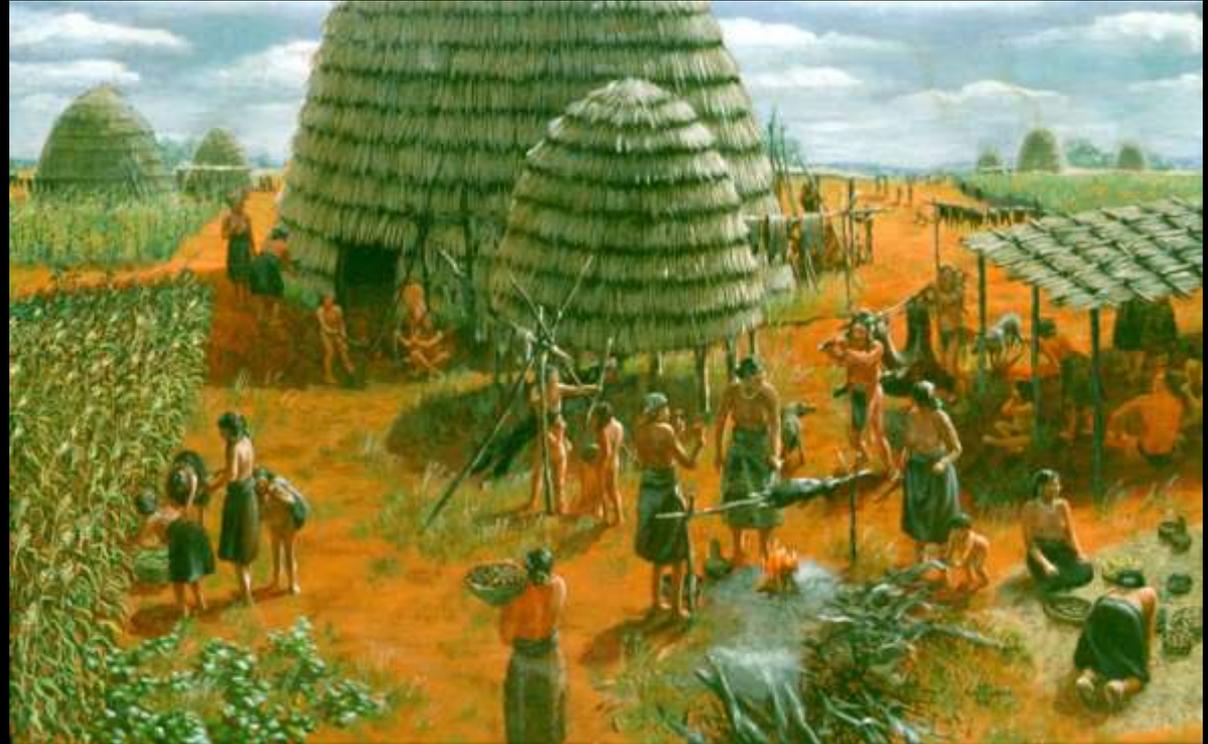
Source: Lydia L. M. Skewes, *An Ethnohistorical Survey of Texas Indians*,
Texas Historical Survey Committee, Office of the State Archeologist,
Report No. 22, Austin, 1972.

The Columbian Exchange and Ecological Imperialism

Disease and Depopulation



Caddoan Culture of East Texas



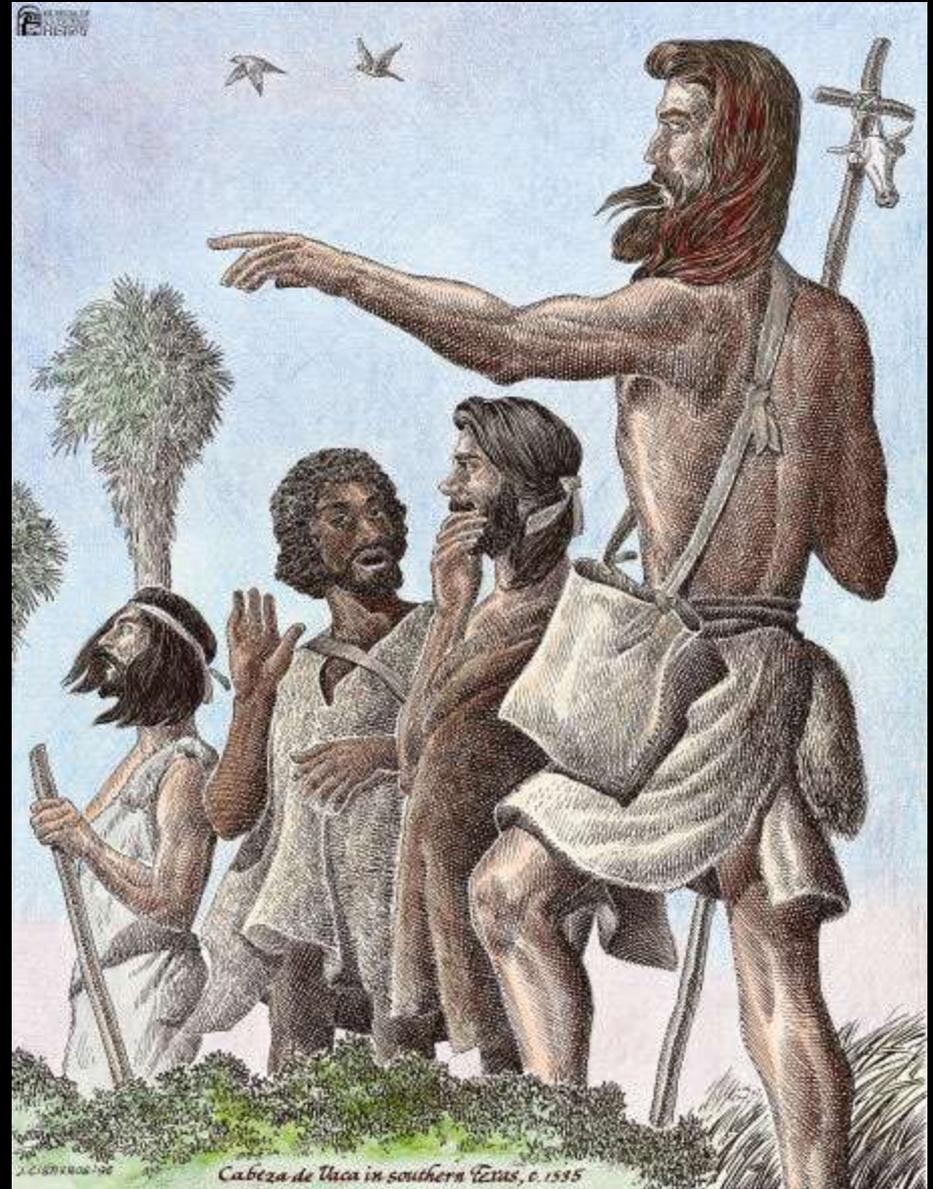
Sho-We-Tit (Billy Thomas), a Caddo man photographed by Joseph Dixon on June 21, 1913 at Anadarko, Oklahoma.

1500s Cabeza de Vaca

Shipwrecked off the coast of Texas in 1528, Spanish explorer Cabeza de Vaca and his companions traveled across south Texas and northeastern Mexico, living among native groups for several years.

These men walked from the shores near present-day Galveston to Mexico City in a journey of between 2,300 and 2,640 miles that, after they finally left south Texas in 1534, took them 14 months.

The accounts of this journey provide some of our richest insights into native life ways and the landscapes of South Texas.





1600s Dislocation

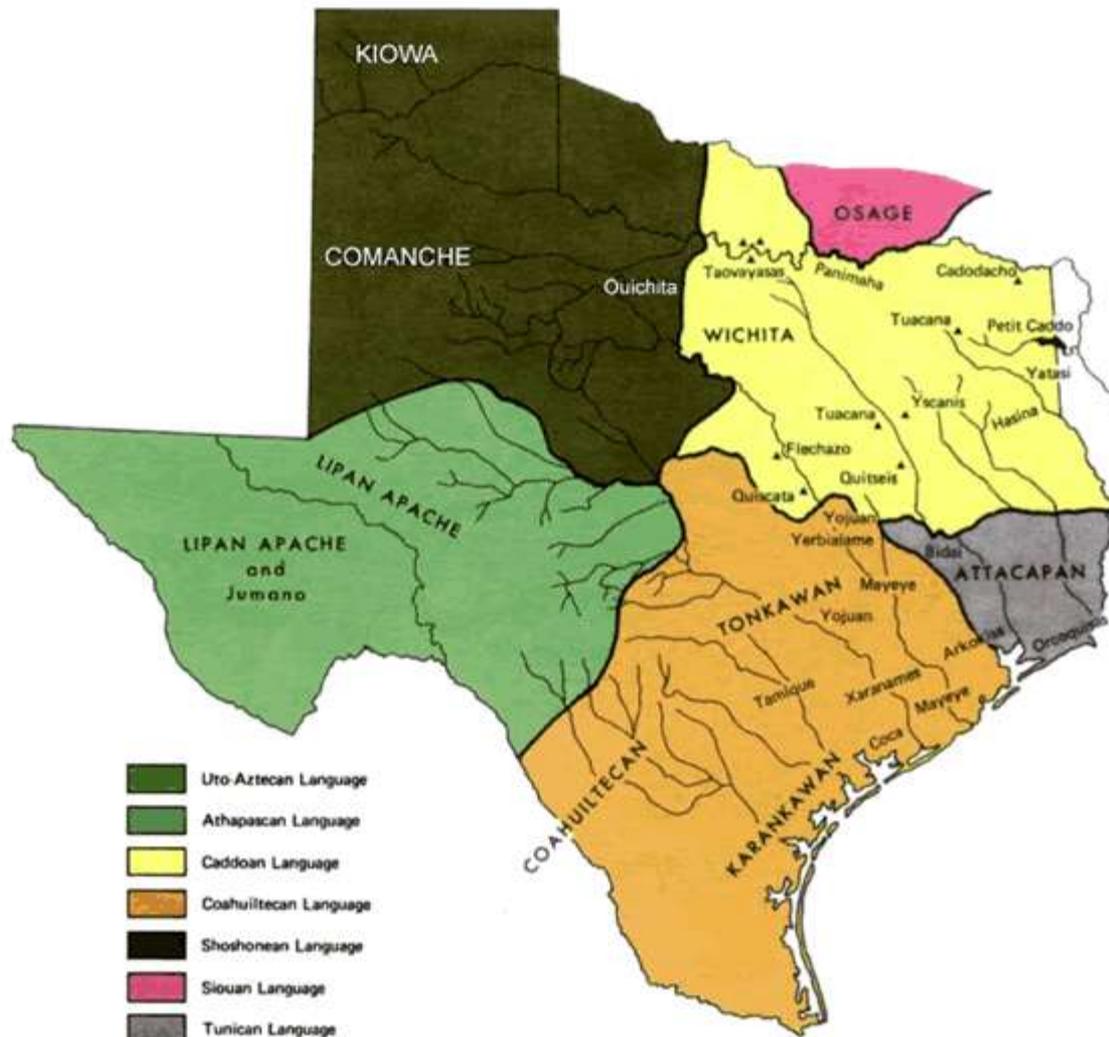
In late prehistoric times, the Lipan and Mescalero Apache lived in the Southern Plains of the United States.

By the late 1600s, they found their homelands threatened by the Comanches and by Spanish raids seeking slaves for the silver mines around Parral and Chihuahua City or for the large ranches of what is today northern Mexico.

To avoid those fates, they moved south and east, eventually reaching south-central Texas.

As the tumultuous times unfolded, some Apache attempted alliances with other native peoples, including the Jumano and Tonkawa, groups with whom they had had hostile relationships in the past.

Ethnolinguistic Distribution of Indians in Texas in 1776



Native Americans – Fire and Other Ecological Impacts

The widespread presence of burned rock middens suggests that fire was a significant tool utilized by Native Americans. While the record is not clear as to their use of fire as a vegetation and wildlife management tool, or as an ally in warfare, it can be reasonably surmised that purposeful and accidental wildfires would have occurred.

Early inhabitants, through their selective harvesting and use of various plants and hunting of animals probably had major influences on the local abundances of many species.

Likewise their local encampments produced disturbance patches of locally altered vegetation. Most of these early inhabitants were nomadic and hence served as effective dispersal agents for the reproductive propagules of many plant species.

The total extent and types of influences exerted by the early Native American is not completely understood



Horses and Cattle

As early as 1680, Indians on the Pecos River had acquired horses from the Spaniards. The horse exerted a profound effect on Indian culture. Their possessions of the horse prevented Anglo settlement of much of Texas for over 200 years.

The net result was the development of a very large horse population (including wild bands) in Texas well before settlers started moving onto the western rangelands.

This increase of horses, as well as cattle, significantly increased the grazing pressure and marked the beginning of what would be a considerable change in the vegetation composition and structure of Texas rangelands. In places heavy grazing by their feral animals had occurred for over 100 years before settlers arrived. There was a period after the Civil War when the settlers actively pursued these animals and for a short period substantially reduced these numbers.

That was a short-lived phenomenon. Since settlement, which began in earnest about 1870, grazing by free-roaming large native herbivores (such as bison and feral horses and cattle) changed to grazing by relatively free-roaming livestock and ultimately to confined livestock.



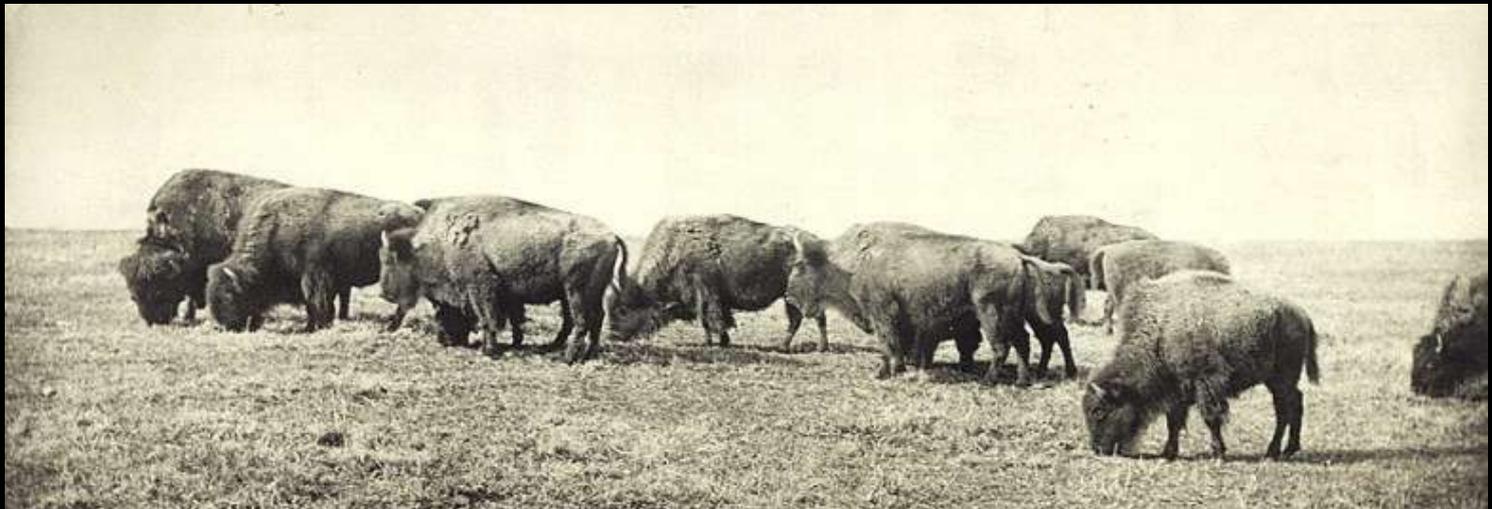
The occurrence of large numbers of herbivores such as bison would be expected to have had significant impacts on the composition and structure of the vegetation, however, since they were free-roaming they rarely and only locally produced destructive and long lasting impacts.

Most of the large herbivores were reduced or eliminated by the 1870's. This was also the time at which large numbers of free-ranging feral horses and cattle were rounded up and sent to slaughter houses on the Texas coast or driven to northern markets for sale or slaughter.

During the period between 1870 and 1885, before widespread stocking of the ranges by settlers and after the demise of the bison, the ranges were relatively free of grazing by large herbivores. This was also a period of favorable precipitation and is often referred to as the "Golden Period" of the Southwestern stockman.

The rangelands seemed capable of supplying unlimited amounts of forage for grazing animals. As a result there was rapid and severe overstocking of the rangelands .

Originally these animals grazed on free and open range, but soon with the advent of more settlers, the availability of barbed wire and windmills to provide water, the animals were confined, which led to destructive grazing of many rangelands.



The Myth of Superabundance

Europeans significantly and permanently changed the character of Texas native flora and fauna

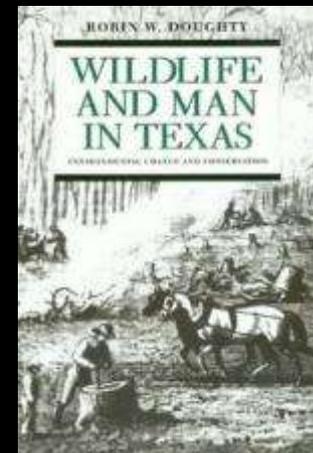
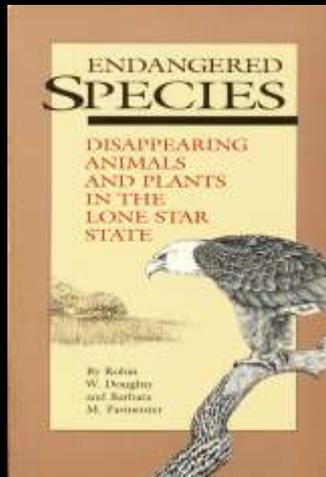
For example bears, which were common in Central Texas, were locally driven to extinction.

The bison, which was abundant and widespread, was hunted to local extinction across most of the state .

White-tailed deer were exceptionally abundant and were likewise eliminated from many parts of the state and later reintroduced.

Prairie dogs were largely eliminated as were their impacts on the ecosystem. A prairie dog colony stretched from San Angelo to Clarendon, an area 250 miles by 100 miles that was estimated to contain almost a half-billion prairie dogs.

Many predators were greatly reduced in numbers or essentially eliminated as were many birds and other species.



Nineteenth Century Natural History

“Before the Mexican province of Texas was opened to settlement by other nations, the West Indian botanist, Nicolas Antonie Monteil (1771-1833),³ opened botanical exploration of Texas by collections on the lower Trinity River, and in the neighborhood of Galveston Bay. This was in the year 1817. Three years later, the American naturalist, Dr. Edwin James,⁴ made botanical collections in the present Panhandle of Texas; and in 1828, botanical investigations began in earnest with the labors of Jean Louis Berlandier,⁵ a French-Swiss naturalist in the employ of the Mexican Government. Subsequently, in the frontier period, came a score or more of other naturalists: botanists and zoologists.”



Botany

Jean Louis Berlandier 1830s

Thomas Drummond 1830s

Ferdinand Lindheimer 1830s

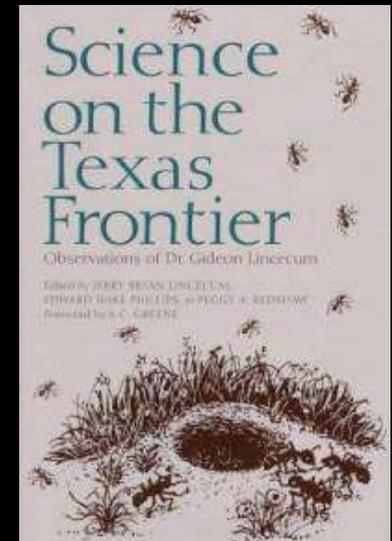
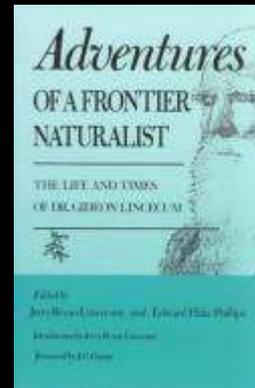
Ferdinand von Roemer 1840s

Frederick Law Olmsted – tours of Texas 1850s

Entomology

Otto Friedrich 1850s

Gideon Lincecum 1793-1874



Birds and Mammals – the Audubons in Texas

In April 1837, John James Audubon and his son John left New Orleans aboard the United States revenue cutter Campbell on an expedition along the Gulf Coast to the new Republic of Texas. They arrived at Galveston Bay toward the end of the month and were officially greeted there by the secretary of the Texas Navy, Samuel Rhoads Fisher.

They next visited the capitol at Houston, where they met with President Sam Houston in his dog-trot cabin.

While in Texas they observed a large number of previously known birds including blue-winged teals, black-necked stilts, least terns, roseate spoonbills, skimmers, ivory-billed woodpeckers, black-throated buntings, and varieties of sandpipers, ducks, and herons.

The Birds of North America (1827–1839) Viviparous Quadrupeds of North America (1845-48)

Quadrupeds contains more plates drawn from Texas specimens than does the Birds of America. In fact, apparently only one plate from *Birds of America*, the Texas Turtle Dove, fits this category. Among the Texas Quadrupeds drawn by John James Audubon are the Orange-bellied Squirrel, the Cotton Rat, the Collared Peccary, and the Black-Tailed Hare.

Many of the Quadruped specimens were obtained by John W. Audubon on his second trip to Texas in 1845–46. Although important parts of John James Audubon's journal, including information on his 1837 Texas trip, were lost, Samuel Wood Geiser attempted a reconstruction of the Texas trip from the Birds in "Naturalists of the Frontier" in the Southwest Review for 1930.

Samuel Wood Geiser. *Naturalists of the Frontier* (SMU Press, 1937)



Merriam's Life Zones and the National Biological Survey

C.Hart Merriam, at age sixteen, had accompanied Spencer Baird (the first secretary of the Smithsonian Institution) on the Hayden Survey (the first scientific expedition to Yellowstone) in 1872.

By 1883 Merriam formed the American Ornithological Union and became the U.S. Department of Agriculture's economic ornithologist in 1885.

By 1896 his office became the Division of Biological Survey, and in 1906 it became a bureau.

By 1910 the Biological Survey was forced to devote its time controlling noxious weeds and predatory animals and Merriam retired, realizing that his dream of a national biological survey would never come to pass.

Life zones were proposed by Alexander von Humboldt and others who emphasized plants. Around 1900 C. Hart Merriam, then chief of the U.S. Biological Survey, related life zones, as observed in the field, with broad climatic belts across the North American continent designed mainly to order the habitats of America's important animal groups.

The first-order differences between the zones, as reflected by their characteristic plants and animals, were related to temperature; moisture and other variables were considered secondary.



Biological Survey of Texas 1889-1905 – Merriam and Bailey

It has been over 100 years since the Biological Survey of Texas was completed. The field work for that survey was conducted from 1895-1898 under the direction of the US Bureau of Biological Survey and was led by Vernon Bailey. Bailey later (1905) published the results of these efforts as "The Biological Survey of Texas."

Vernon Bailey and his wife Florence Merriam Bailey are names almost unknown except by students of historical ecology, although there is a Vernon Bailey Mountain in Big Bend National Park.

In 1899 Bailey married Merriam's sister Florence Merriam, who had already become one of the most prominent ornithologists of the nation (and who later would publish the Birds of New Mexico in 1928.) She led the fight to declaring the killing of birds for feathers to be used in millinery and private egg collection, which led to the development of the Audubon Society.

Bailey was born in Minnesota in 1864. At age 11, Bailey received a shotgun and soon filled a room of his parents house with preserved specimens and taxonomic mounts. When he was 20 he contacted C. Hart Merriam.

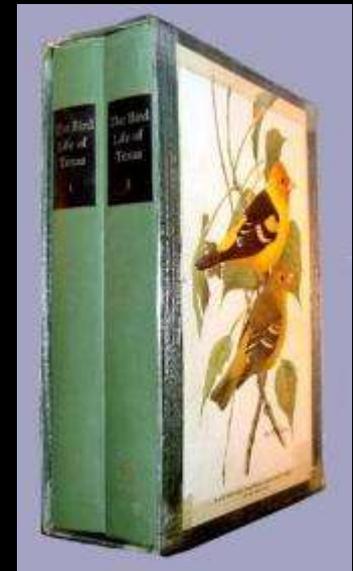
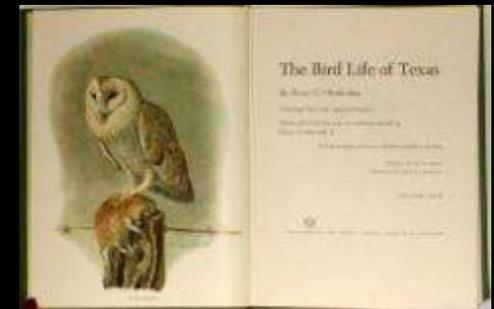


In 1889 Merriam sent Bailey to Texas.

He returned in 1892, 1899, 1900-1902, and 1904, publishing his results in 1905.

While in Texas, Bailey hired a number of naturalists to help him, most notably the renown artist Louis Agassiz Fuertes and H. P. Attwater who played an important role in developing wildlife laws in Texas in the 1920s.

Another naturalist to accompany Bailey was Harry Church Oberholser, whose *Bird Life of Texas*, was posthumously published in 1974 by his longtime editor Edgar B. Kincaid.

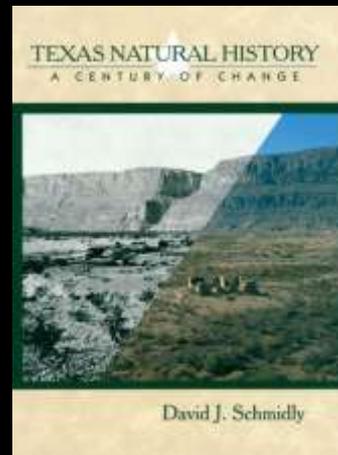


Bailey's work gives a baseline for understanding the changing distribution of animals in Texas over the last hundred years.

For example, he commented that opossums were not found west of San Angelo (and now they are found in New Mexico).

He also noted that javelina were found along the Pecos River into New Mexico and into the sand dunes near Monahans ("the center of their abundance"), and also along the Concho River as far north as San Angelo. Now they are found at least as far as Borden County and on the Llano Estacado as far north as Andrews. Bailey found none on top of the Llano Estacado.

During Bailey's time, mountain lions were hunted almost to extinction, and during his time were still found in the Big Thicket of east Texas and in the mountains of West Texas, and along the western edge of the Llano Estacado around the sand dune country. Now they are found in almost every county of the state.



Diversity in the two states has actually increased because of the changing landscape through brush growth and the emigration of species and because modern genetic studies have “discovered” new species.

New Mexico, with 151 mammalian species is second to California (162 mammals) and Texas is third (139.)

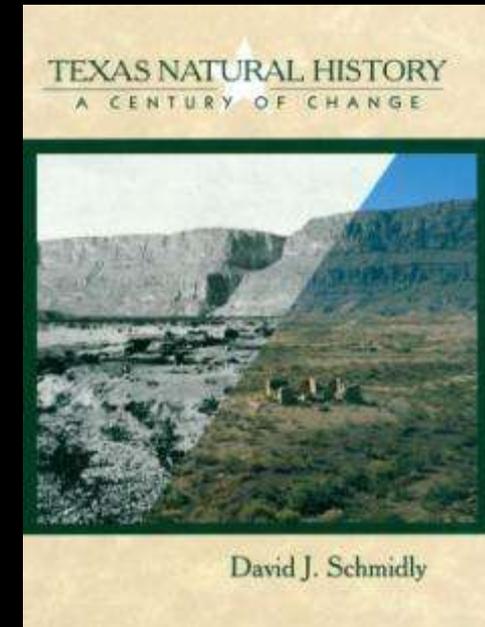
Texas has the most species of bats (a third of which are on “watch lists”) and carnivores.

71 species of “exotic” (mostly African) species of mammals have been introduced for hunting (mostly in the Hill Country and south Texas Plains.) Axis deer, fallow deer, sika deer, the nilgai, auodadad, and the black buck are now free-ranging beyond their original homes behind high-game fencing.

Feral hogs have also increased, and may be blamed for a decrease in armadillos, a relatively late newcomer to Texas in the 1850s.

All but one of the five species of skunks appear to be declining.

The arid southwestern third of Texas (west of the 100th meridian) is in the best shape.



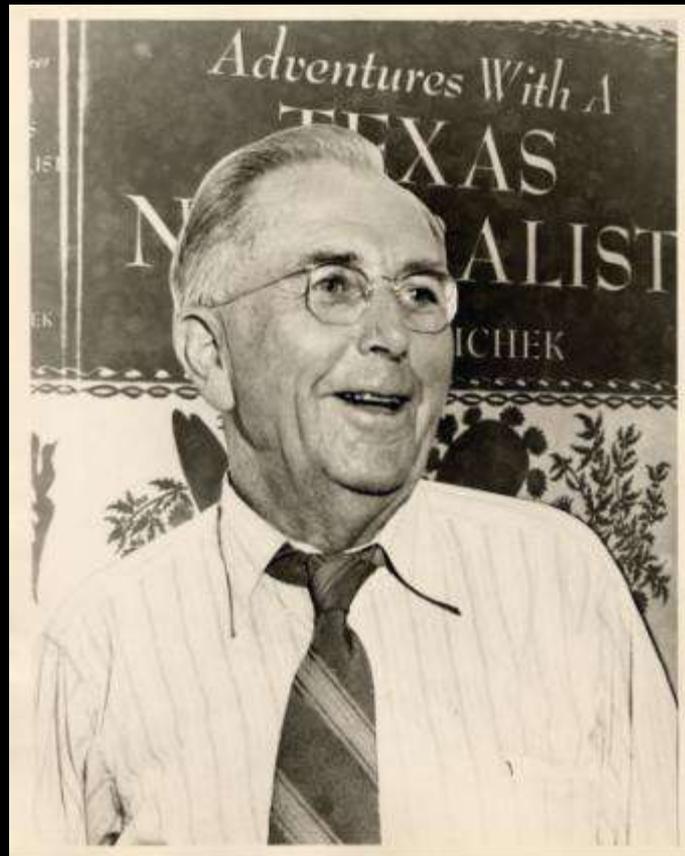
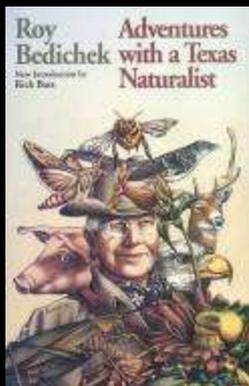
Roy Bedichek

Adventures with a Texas Naturalist (1947)

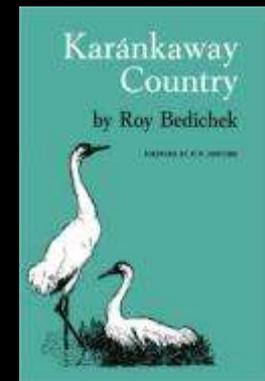
Karánkaway Country (1950)

posthumous *The Sense of Smell* (1960).

1947



1950



Texas Nature

Ignorance of the conservation function of brush has hung like a pall of smoke over popular thinking since remotest antiquity. Land stripped of forest or of grass seems to know that nakedness is sin. It hastily grabs up anything within reach with which to cover its shame. [Weeds, invading shrubs, vines]...Nature abhors an organic vacuum as much as she does an inorganic one.

In spite of its cinema reputation, Texas is not tough, that is, ecologically. It is really a tender land, and cannot stand the buffetings that certain other areas of the world have endured and still support a human population in health and vigor.



Bedichek and Ecological Change

“I have seen in my boyhood days the crown and upper slopes of gentle hills, on which the black soil is mixed with fragmented limestone, produce ninety bushels of oats to the acre.

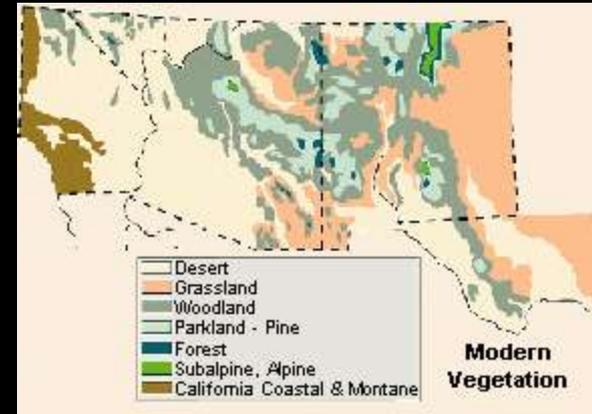
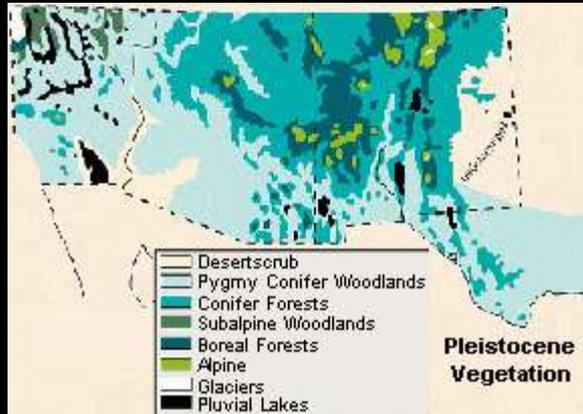
Now many of these slopes are all bleached out, pale as death, and really dead in so far as ability to support vegetable life is concerned. Many old-timers have seen bale-to-the-acre land in 1883 abandoned as worthless in 1903.”



In a 1931 automobile Bedichek drives 10,000 miles a year, sleeping out, cooking his meals over an open fire. When not on the move, he holes up in his Friday Mountain hermitage and writes about birds.



Landscape Dynamics in the Southwest



1950

1989

An isolated stand of Colorado pinyon (*Pinus edulis*) at Owl Canyon, north of Fort Collins, Colorado, represents the endpoint of its northward migration since the end of the last ice age.

This 5 km² stand was colonized by pinyon pine less than 500 years ago, possibly from accidental plantings by Cheyenne and Arapaho, who carried pinyon nuts in their "trail mix" on treks along the Front Range. The nearest potential source populations are 250 km to the south near Colorado Springs.

USGS Land Use History of North America
<http://biology.usgs.gov/luhna/index.html>

Landscape Dynamics in the Southwest



1940



1982

Since World War II, ground-water withdrawals have reduced wetlands and riparian vegetation in southwestern valleys. Mining of ground water in the Tucson Basin, for example, destroyed mesquite forests in the bottomlands of the San Xavier Indian Reservation between 1940 and 1982. Such wholesale conversions of floodplains makes recovery from arroyo-cutting impossible on century time scales.

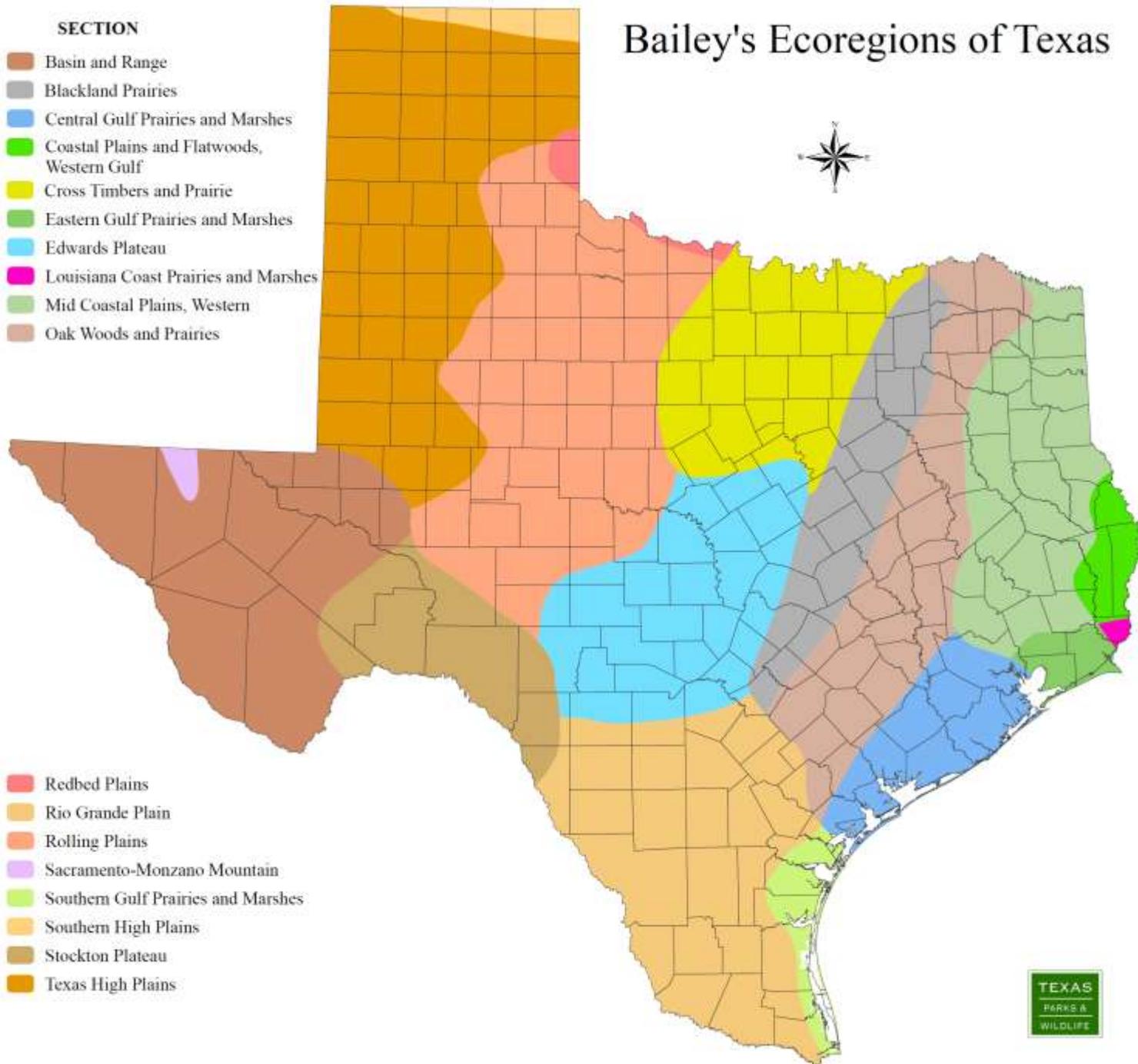
Bailey's Ecoregions of Texas



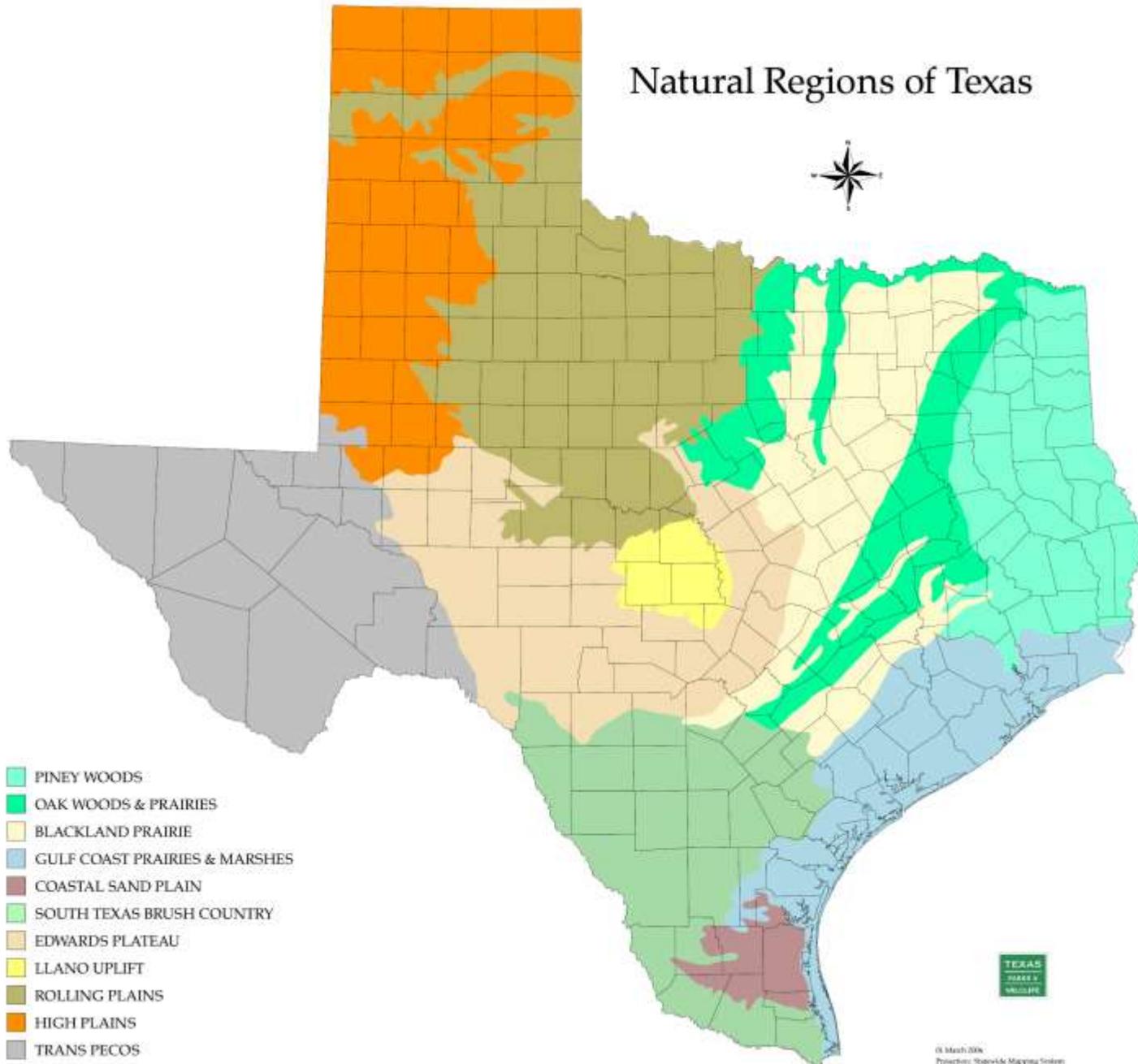
SECTION

- Basin and Range
- Blackland Prairies
- Central Gulf Prairies and Marshes
- Coastal Plains and Flatwoods, Western Gulf
- Cross Timbers and Prairie
- Eastern Gulf Prairies and Marshes
- Edwards Plateau
- Louisiana Coast Prairies and Marshes
- Mid Coastal Plains, Western
- Oak Woods and Prairies

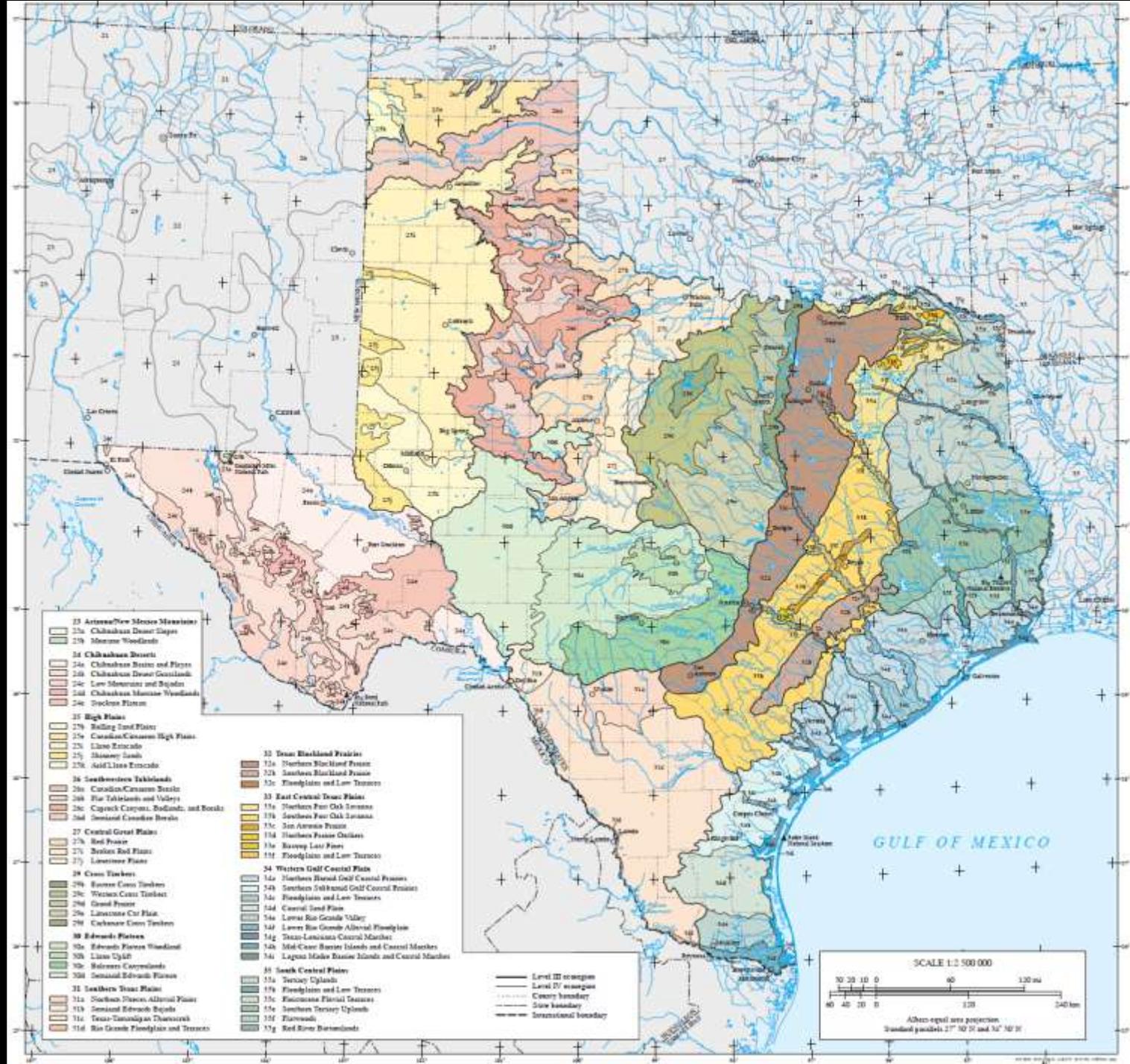
- Redbed Plains
- Rio Grande Plain
- Rolling Plains
- Sacramento-Monzano Mountain
- Southern Gulf Prairies and Marshes
- Southern High Plains
- Stockton Plateau
- Texas High Plains



Natural Regions of Texas



01 March 2006
Projection: Statewide Mapping System
Map compiled by the Texas Parks & Wildlife Department
GIS Lab. No claims are made for the accuracy of the data
or the suitability of the data for a particular use.



Natural History

Understanding whole organisms in context

Ecological understanding shaped by cultural contexts

Cultural understanding shaped by ecological contexts



"The idea of nature contains, though often unnoticed, an extraordinary amount of human history."
Raymond Williams, "Ideas of Nature"

Applause



Questions?

