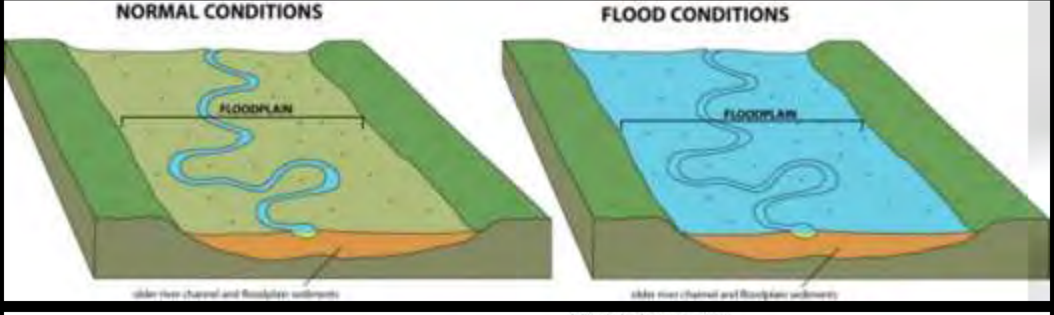
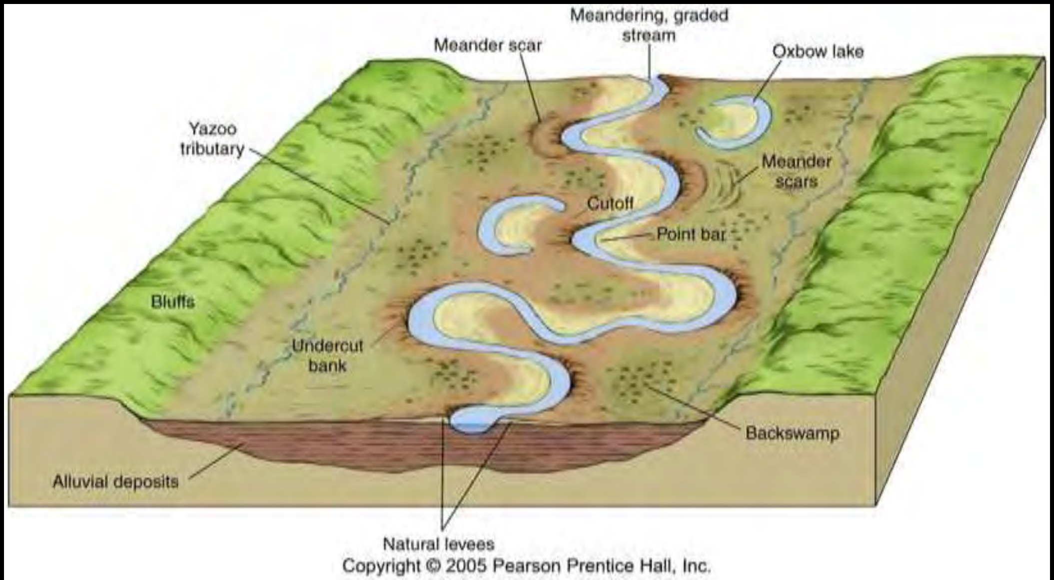
Center for Environmental Research at Hornsby Bend

Austin Water

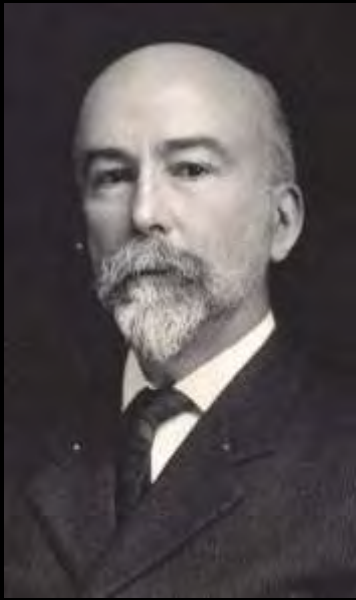
Bottomland: Life on the Floodplain

Kevin M. Anderson, Ph.D.
Austin Water – Center for Environmental Research





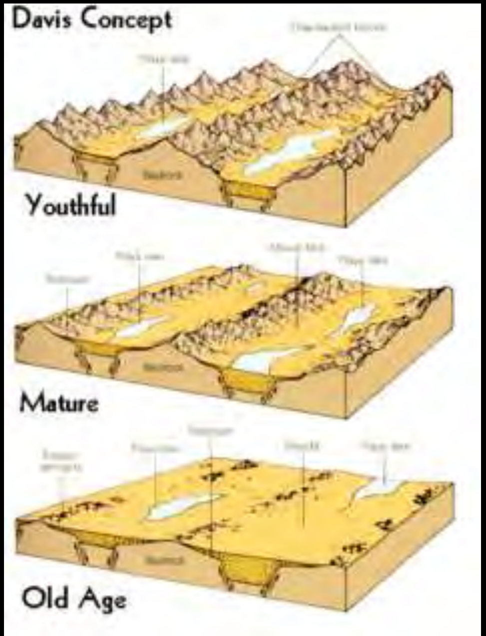
The Life of a River – William Morris Davis

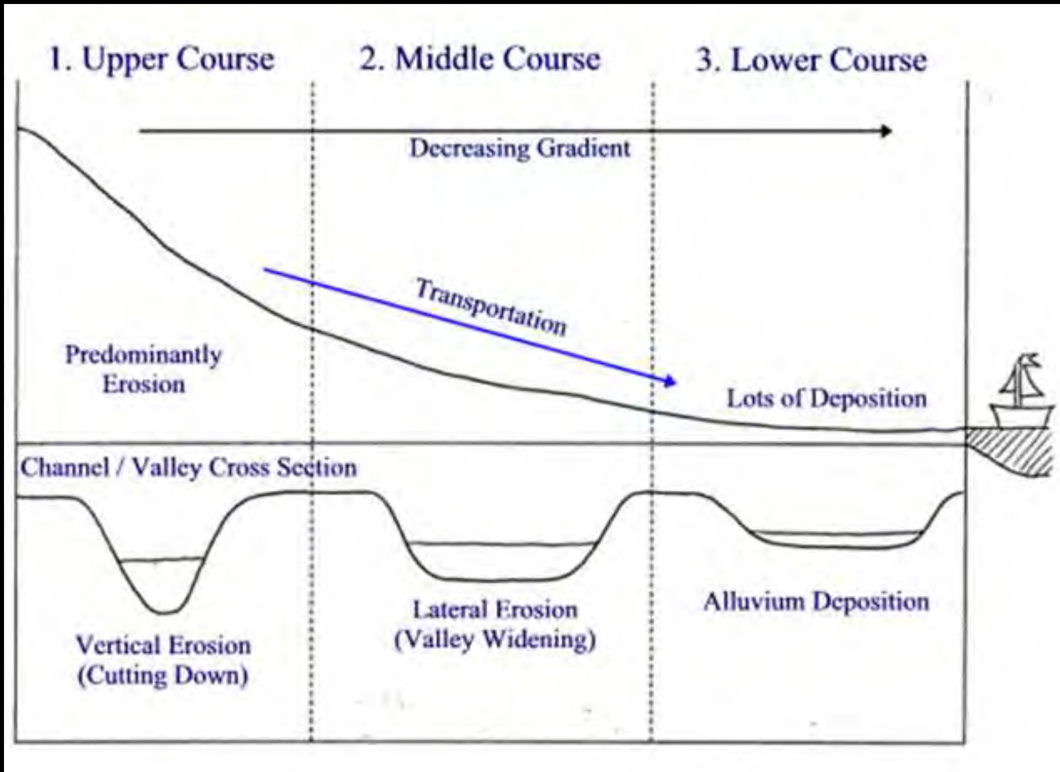


Davis "viewed the river system as having a life of its own.

- Its youthful headwaters are steep and rugged. It rushes toward the sea, eroding bed and bank on its way.
- In its central part, it is mature, winding sedately through wide valleys adjusted to its duty of transporting water and sediment.
- Near its mouth it has reached, in its old age, a nearly level plain through which it wanders in a somewhat aimless course toward final extinction as it joins the ocean that had provided the sustaining waters through its whole life span."

Luna Leopold "A Reverence for Rivers" 1977



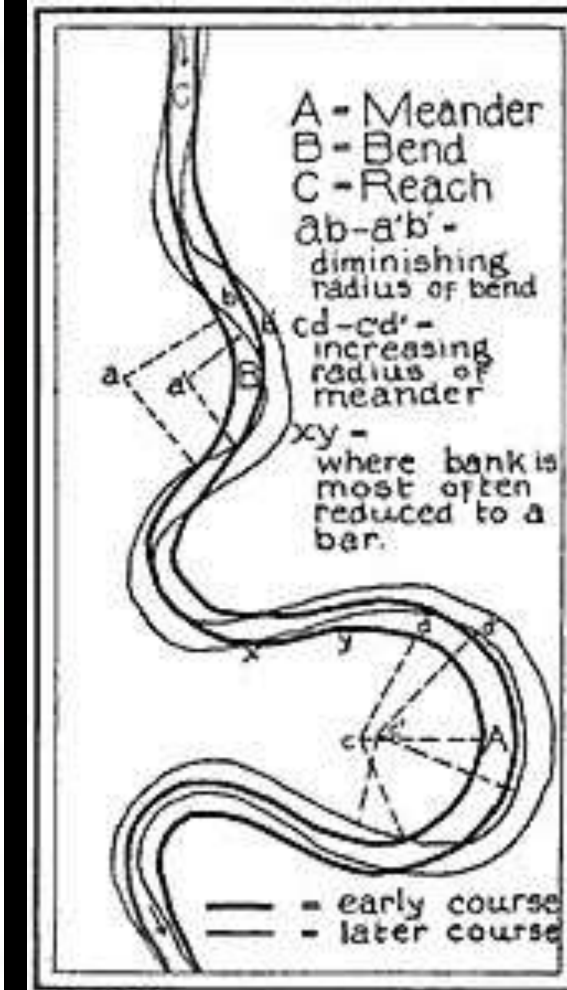


The Middle and Lower Course: Life in the Bottomland

Fluvial Process - Sinuosity is inversely proportional to slope

Bottomland Life, Floodplain Flooding

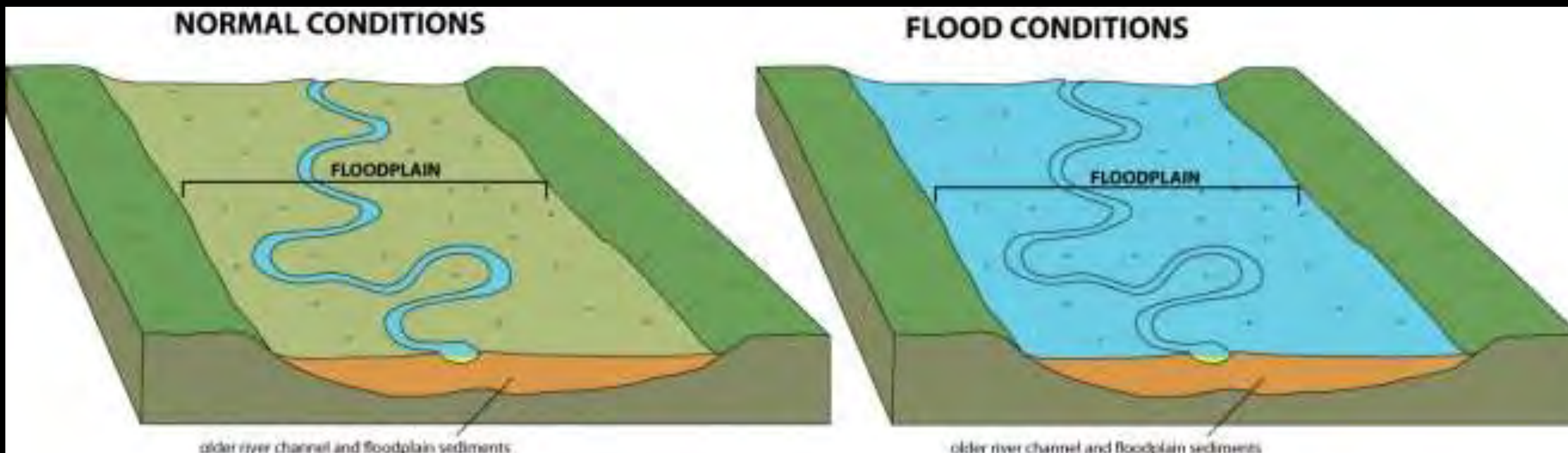
Course Stage	Upper Course Youth Stage	Middle Course Mature Stage	Lower Course Old Age Stage
Slope			
Main processes	Hydraulic Action Abrasion **Erosion**	**Erosion and Deposition**	**Deposition**
Valley shape			
Main features	V-shaped Valleys Interlocking Spurs Waterfalls	Meanders and Ox-Bow lakes	Deltas Levees Flood Plains (and m+ob lakes)

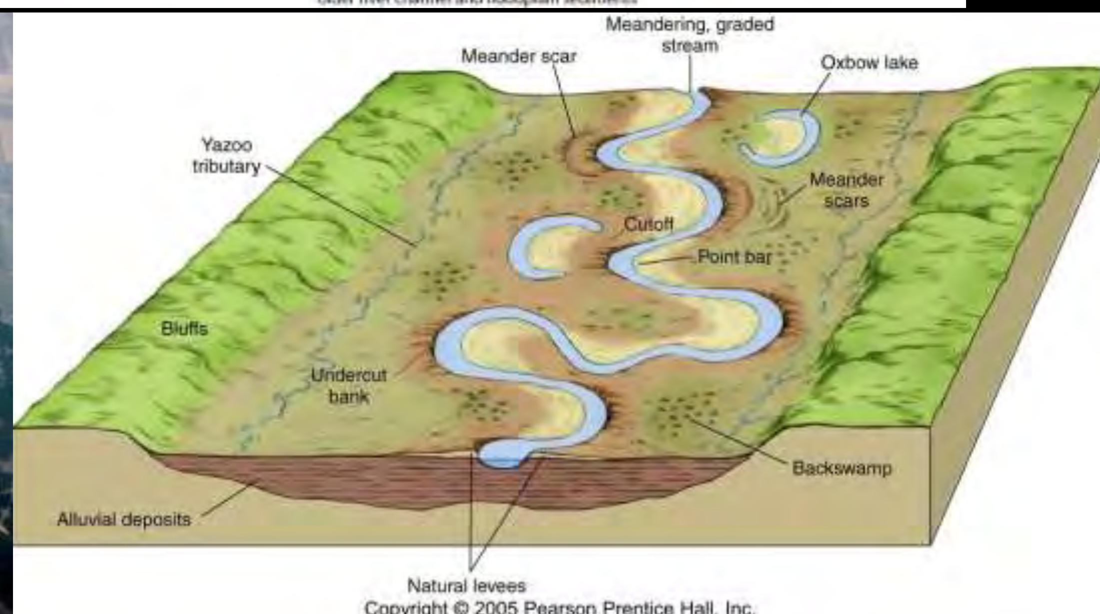


Floodplains and Levees

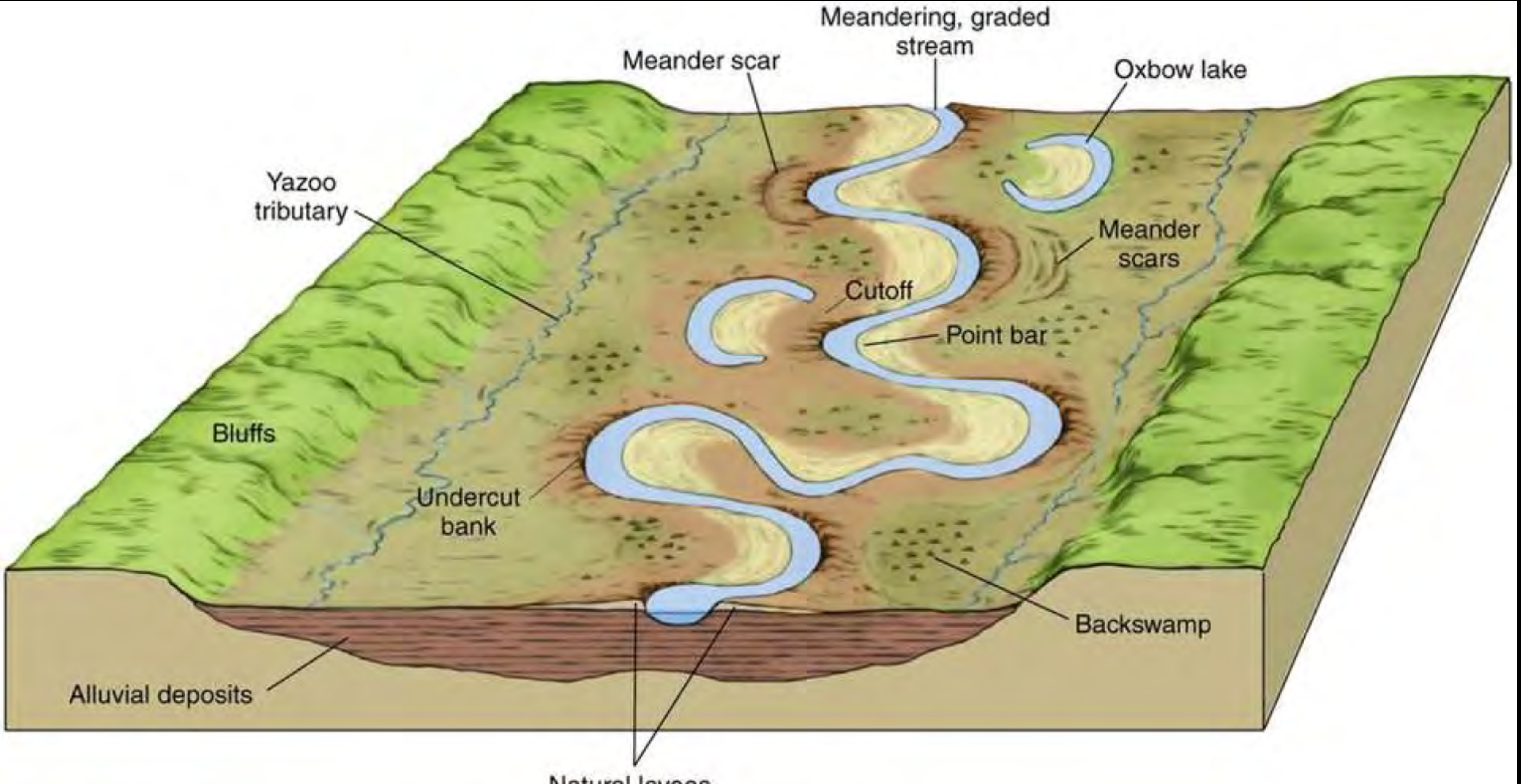
A floodplain is a low-lying plain on both sides of a river that has repeatedly overflowed its banks and flooded the surrounding areas.

When the floods subside, alluvium is deposited on the floodplain.





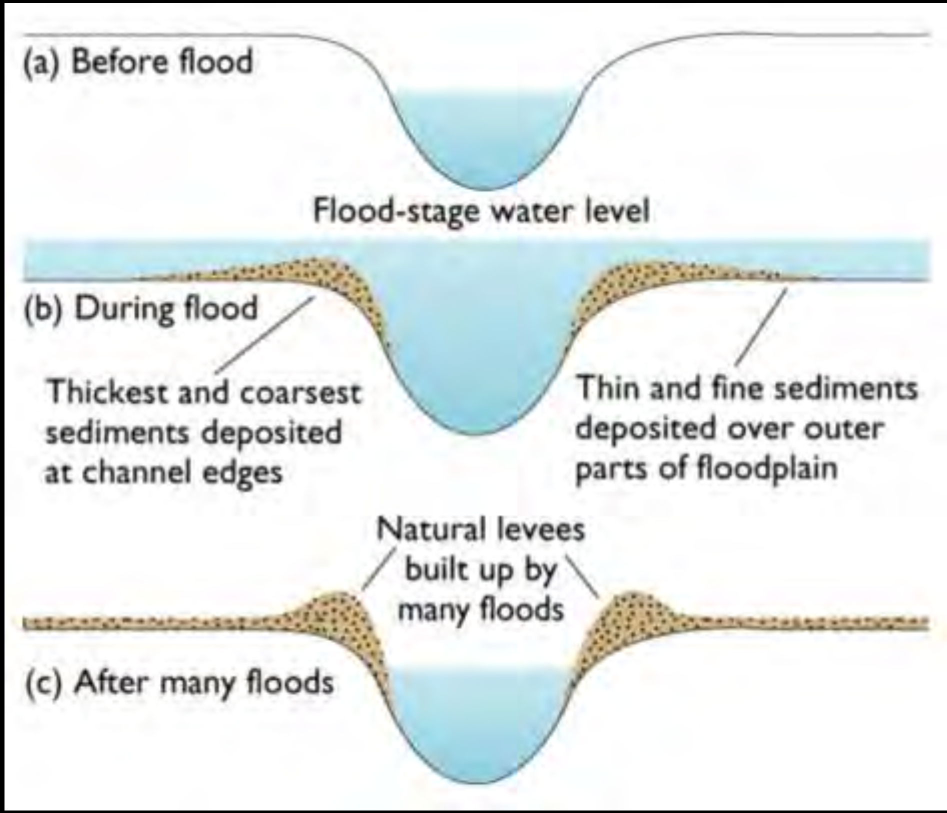
Floods shape the bottomland



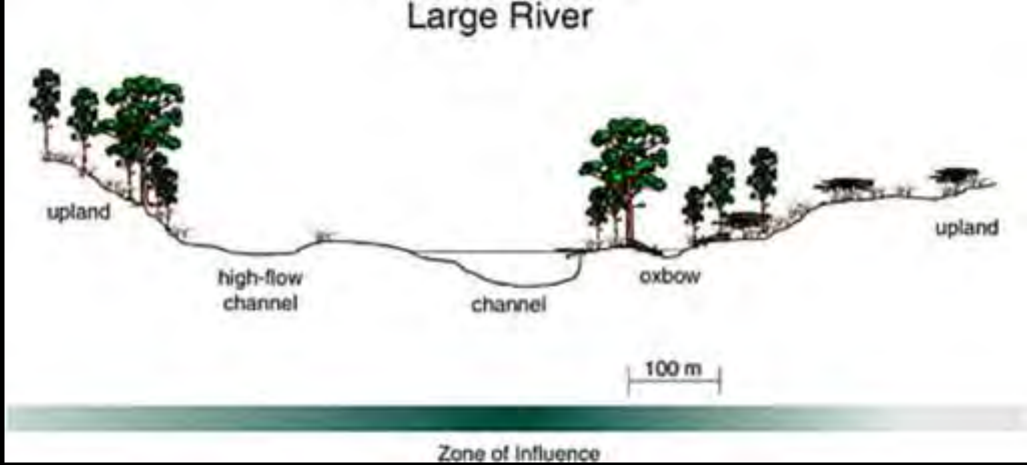
Floodplains and Natural Levees

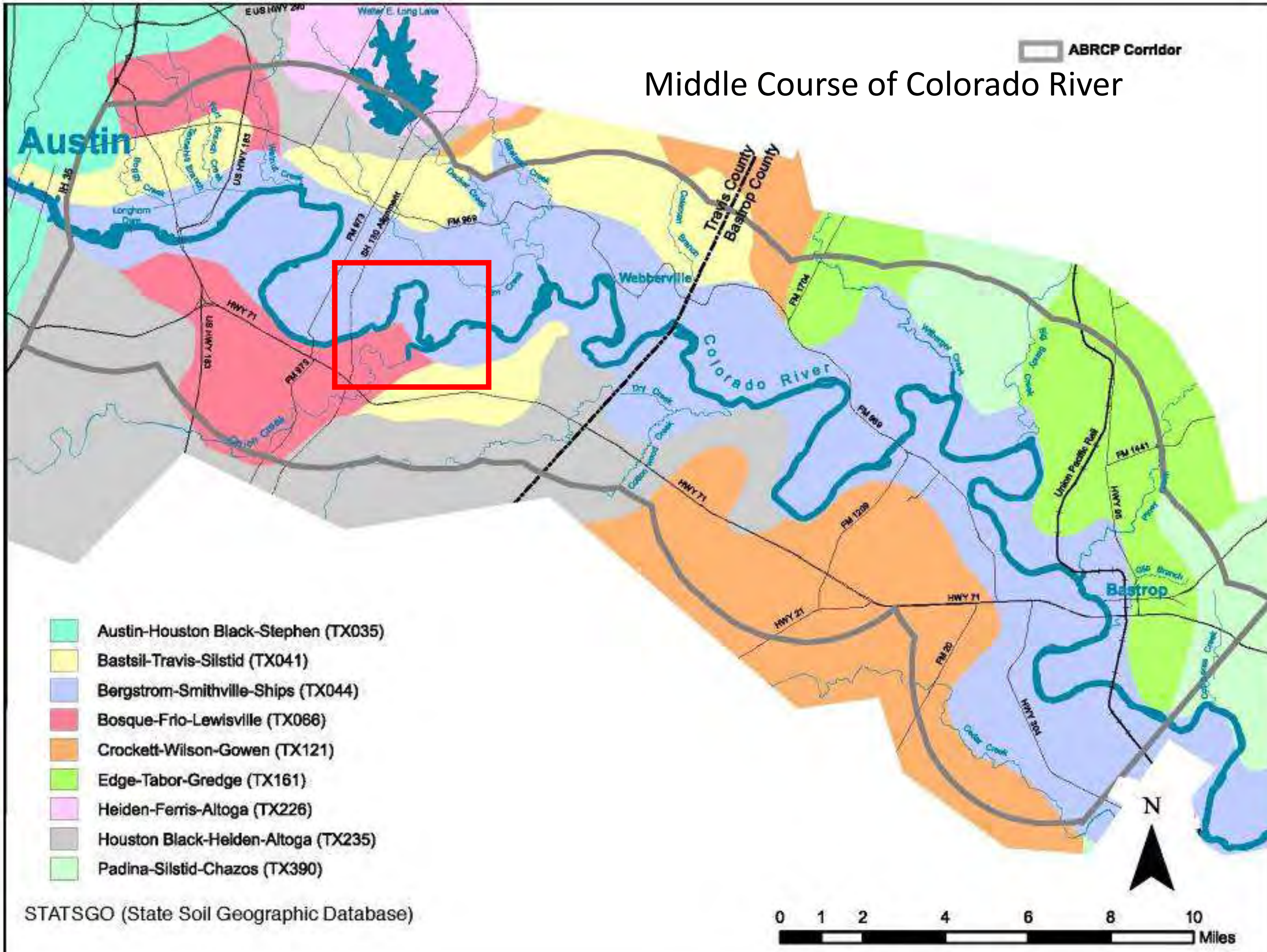
The larger suspended material, being heavier, is deposited at the river banks while the finer sediments are carried and deposited further away from the river.

The deposition at the river banks build up into embankments called levees.



High-flow Channels – Flood Scars





Middle Course of Colorado River
ABRCP Corridor
Austin
Webberville
Bastrop
Colorado River
Travis County
Bastrop County
Walter E. Long Lake
Longhorn Dam
Union Pacific Rail
HWY 71
HWY 21
HWY 95
HWY 304
US HWY 183
FM 969
FM 973
FM 1704
FM 1209
FM 1441
FM 20
IH 35
SH 130 Alignment
Dry Creek
Cedar Creek
Decker Creek
Wilbarger Creek
Gills Branch
Austin-Houston Black-Stephen (TX035)
Bastsil-Travis-Silstid (TX041)
Bergstrom-Smithville-Ships (TX044)
Bosque-Frio-Lewisville (TX066)
Crockett-Wilson-Gowen (TX121)
Edge-Tabor-Gredge (TX161)
Heiden-Ferris-Altoga (TX226)
Houston Black-Heiden-Altoga (TX235)
Padina-Silstid-Chazos (TX390)
STATSGO (State Soil Geographic Database)
N
0 1 2 4 6 8 10 Miles


2003

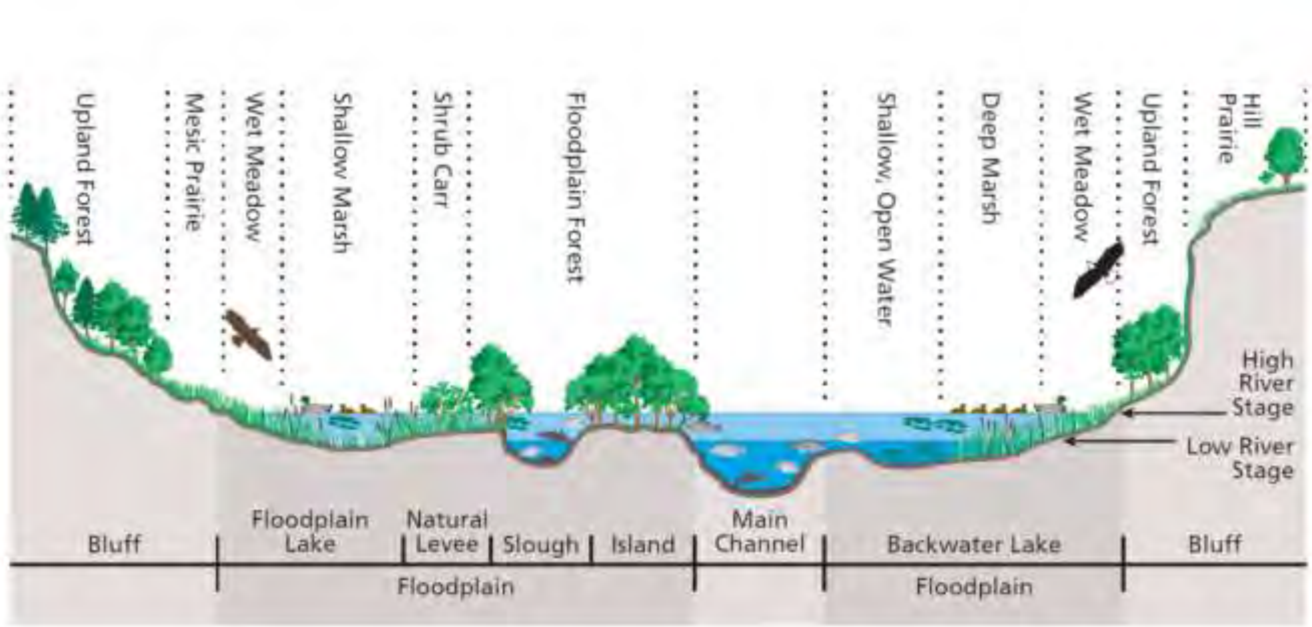

Old Mining Pit
2003

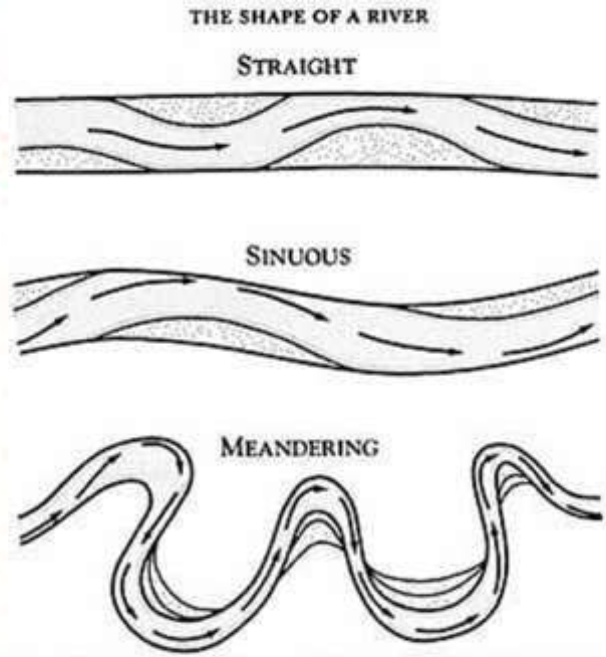

2006

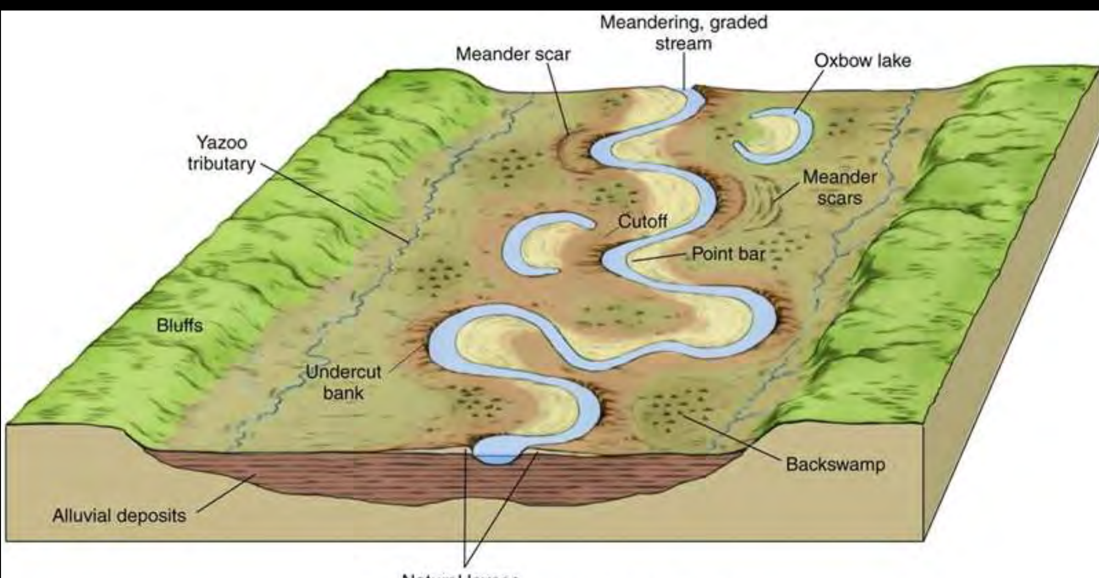

80 feet
130 feet
Breach
Mining Pit
2006

2018

The Meander Belt – Diverse and Dynamic Bottomland Habitat







Sloughs and Backwaters

Slough usually rhymes with shoe in the U.S. except in New England, where it usually rhymes with now, the preferred British pronunciation.

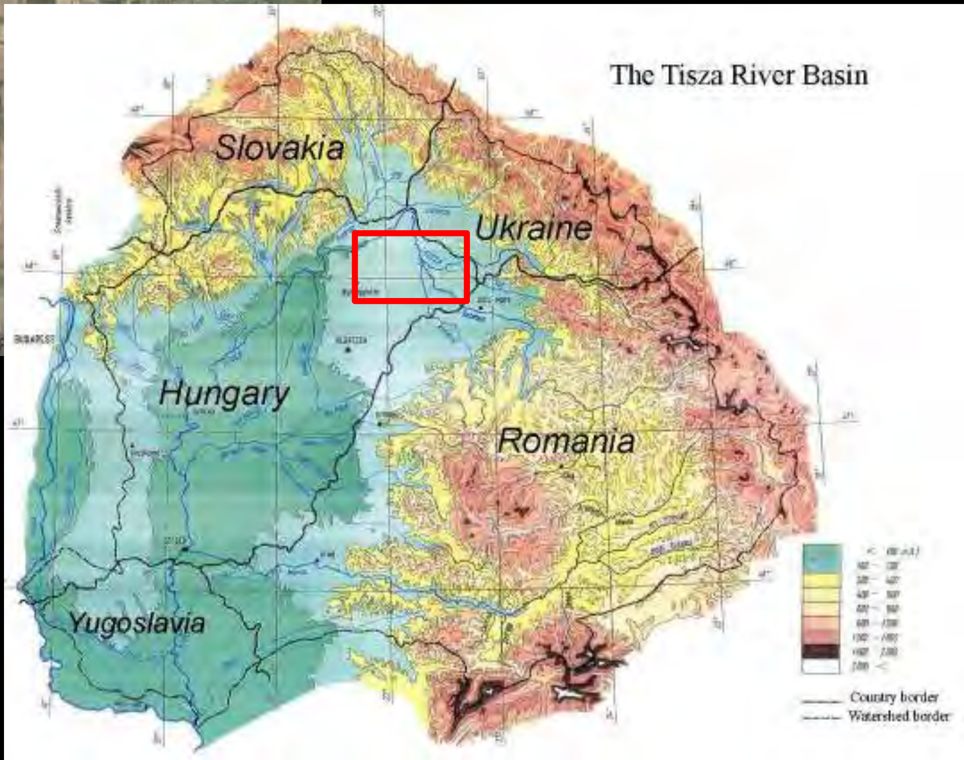
Slough may mean a place of deep mud or mire, a swamp, a river inlet or backwater, or a creek in a marsh or tide flat.

Marsh or Swamp

Marshes are nutrient-rich wetlands that support a variety of reeds and grasses, while swamps are defined by their ability to support woody plants and trees.

Oxbow Lake

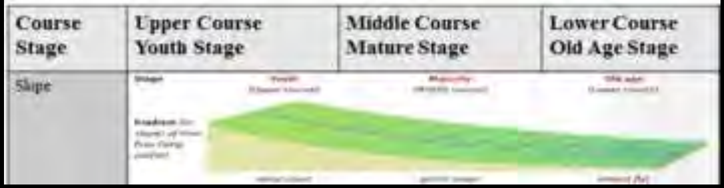
Oxbow Lakes and Meander Scars – The Bodrogköz
The Tisza and Bodrog Rivers – Northeastern Hungary



The Bodrogköz lowland region lies between the Bodrog and Tisza rivers. The southern part belongs to Hungary and the upper Bodrogköz is on the other side of the border in Slovakia.

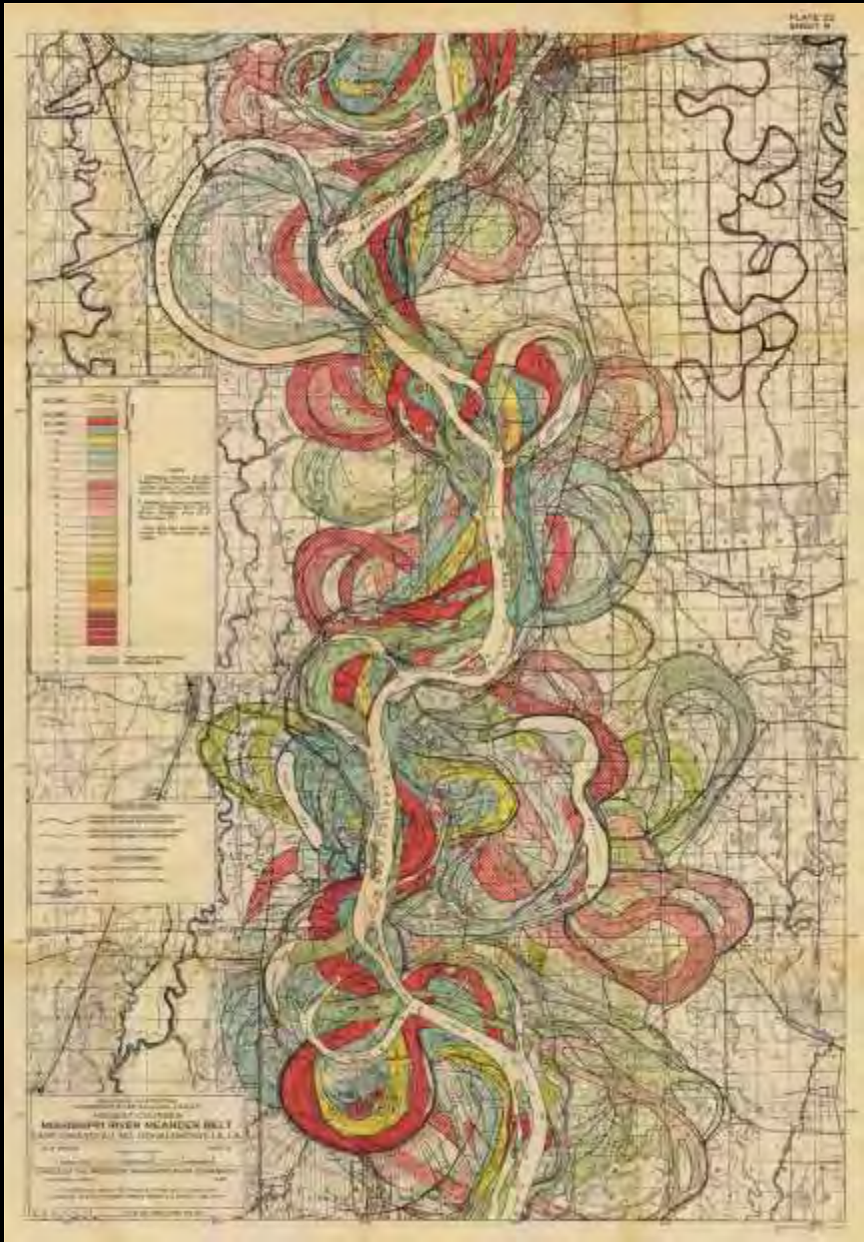
The Lower Course Geography

The Mississippi



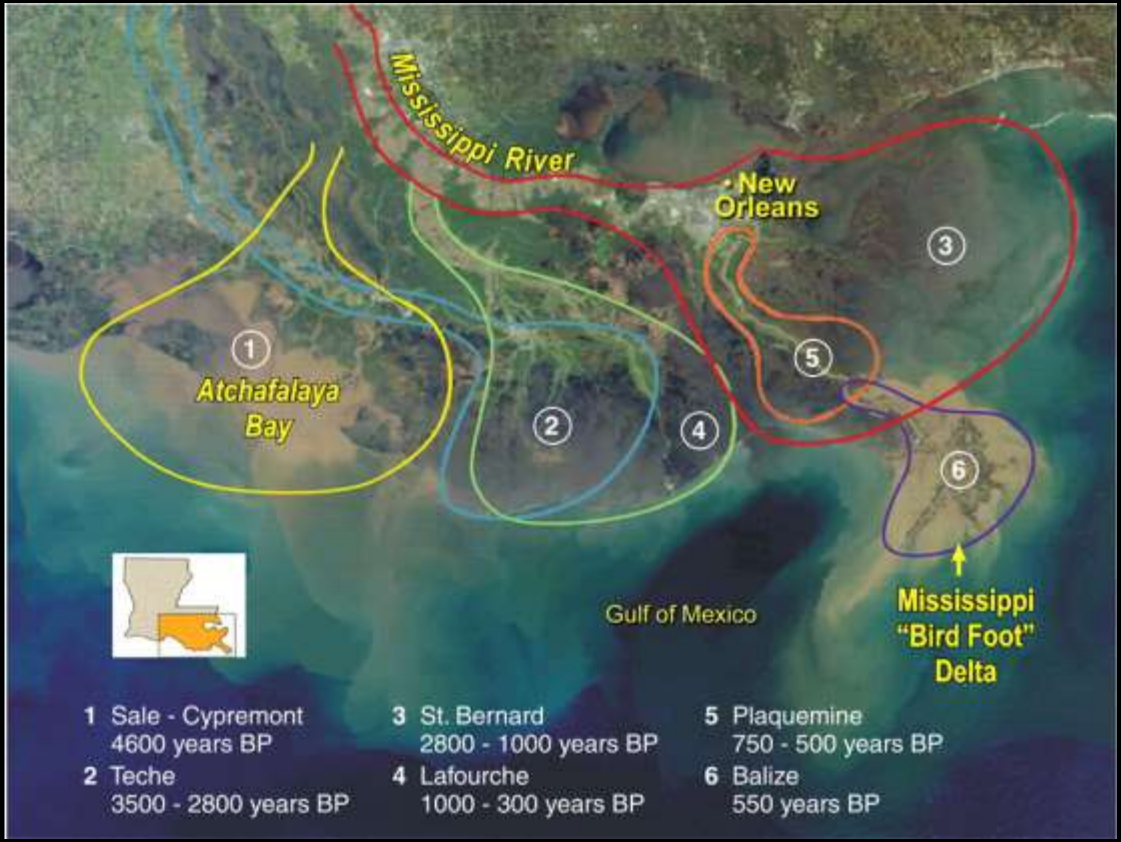
Course Stage	Upper Course Youth Stage	Middle Course Mature Stage	Lower Course Old Age Stage
Slope			

- Very large rivers are usually <u>low gradient and the main channel is very wide</u>, resulting in <u>negligible influence of riparian canopy</u> in terms of shading and leaf-litter input.
- Larger alluvial rivers in their natural state are <u>diverse habitats</u> with side channels, sand and gravel bars, and islands that are formed and reformed on a regular basis.



Avulsion - the rapid abandonment of a river channel and the formation of a new river channel

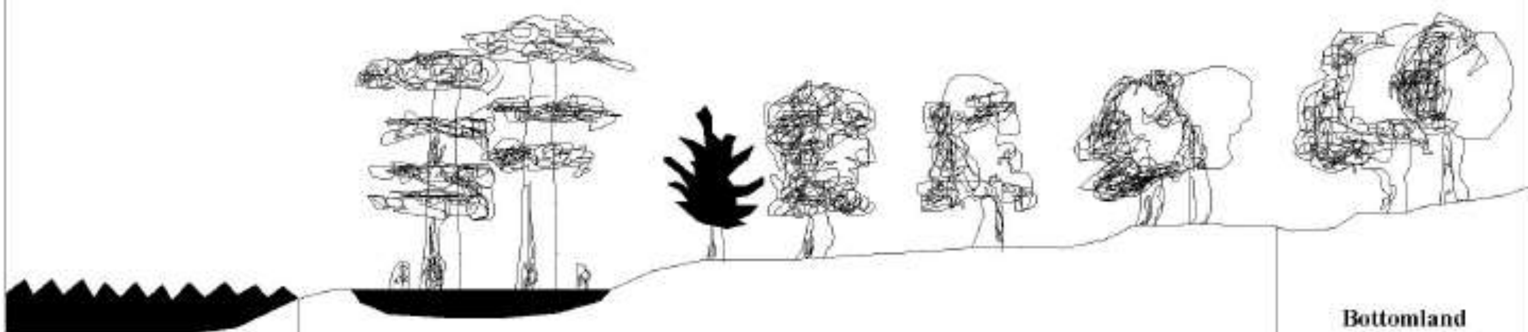
Avulsions are common in deltaic settings, where sediment deposits as the river enters the ocean and channel gradients are typically very small. This process of avulsion in deltaic settings is also known as delta switching. When this avulsion occurs, the new channel carries sediment out to the ocean, building a new deltaic lobe. The abandoned delta eventually subsides



Location of Mississippi River channels discharging water into the Gulf of Mexico over the past 5000 years. Notice the location changes from time to time, keeping all areas of the delta supplied with sediments that balance the natural sinking of the delta. Today, two-thirds of the flow are through the Bird Foot Delta (6) and one third through the Atchafalaya

Life on the Floodplain

Bottomland Vegetation

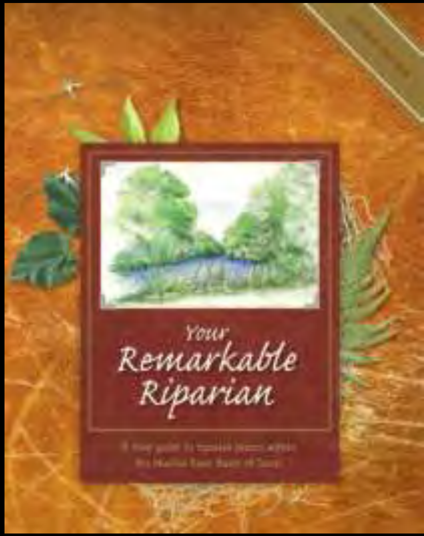


	Aquatic ecosystem	Bottomland hardwood ecosystem				Bottomland upland transition
Zone	I	II	III	IV	V	VI
Name	Open water	Swamp	Lower hardwood wetlands	Medium hardwood wetlands	Higher hardwood wetlands	Transition to uplands
Water modifier	Continuously flooded	Intermittently flooded	Semipermanently flooded	Seasonally flooded	Temporarily flooded	Intermittently flooded
Flooding frequency, % of year	100	~100	51 - 100	51 - 100	11 - 51	1 - 10
Flooding duration, % of growing season	100	~100	> 25	12.5 - 25	2 - 12.5	< 2

Bottomland Vegetation

Plant community structured by hydrology

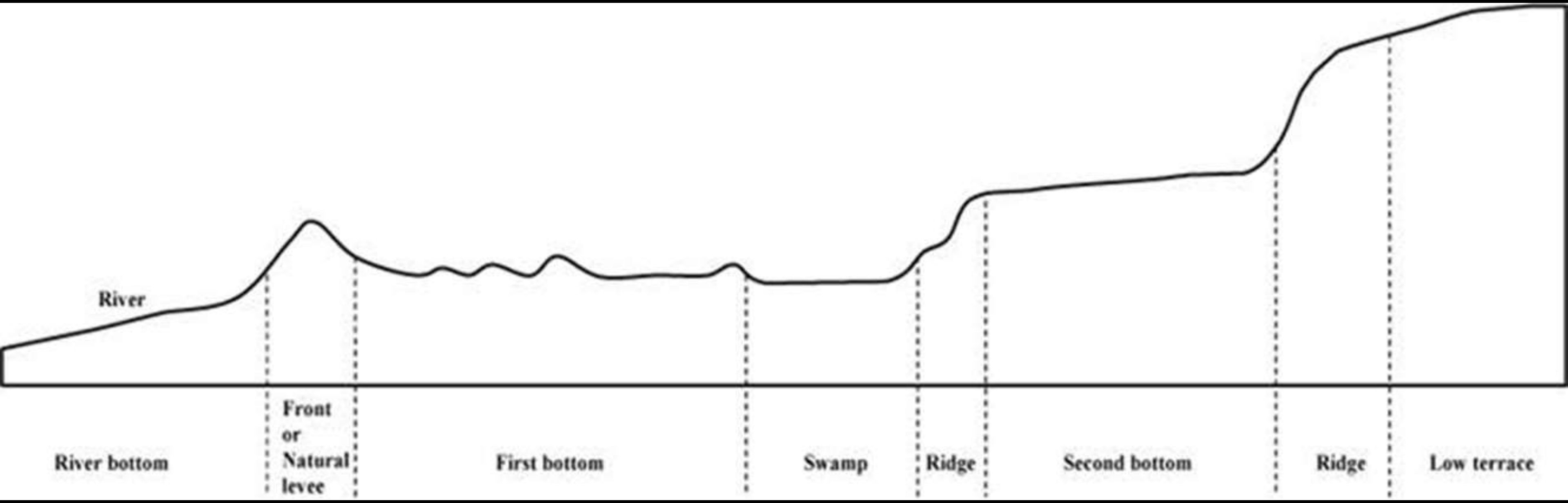
Hydric Soils



Bottomland Ecology

Elevation Changes Plant Communities

Habitat Richness = High Biodiversity

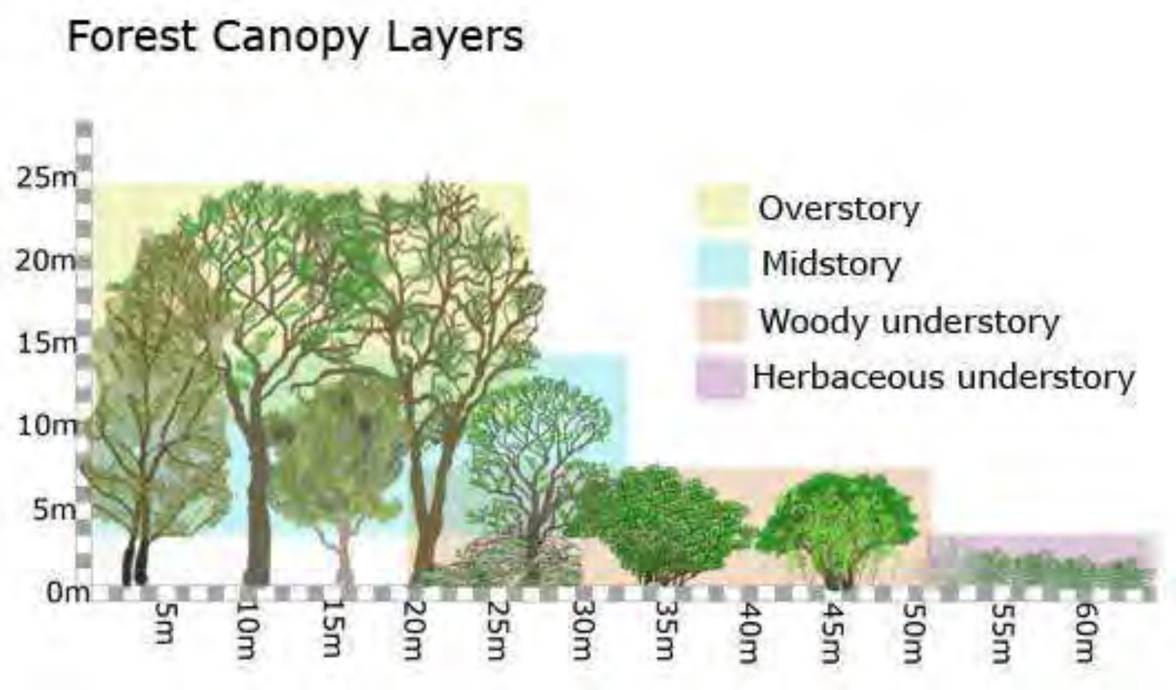


Riparian and Bottomland Forest

Open areas - “Bottomland prairies”

Above Permanent Waterline

American Elm	Hackberry
Honey Locust	Yaupon
Roughleaf dogwood	Cedar elm
Eve’s Necklace	Eastern gamagrass
Box elder	Big bluestem
Buttonbush	Indiangrass
Green ash	Little bluestem
Baccharis	Virginia wildrye
Black willow	Texas bluegrass
Western soapberry	Purpletop
Pecan	Inland sea-oats
Bur oak	Texas wintergrass
Cottonwood	Maximilian sunflower
Sycamore	Illinois bundleflower
Little walnut	Dogbane
False indigo	Mustang grape
Wafer ash (Hop tree)	Herbaceous mimosa
Live oak	Redbud
Mulberry	Gum Bumelia



Riparian and Bottomland Forest - Vertical structure

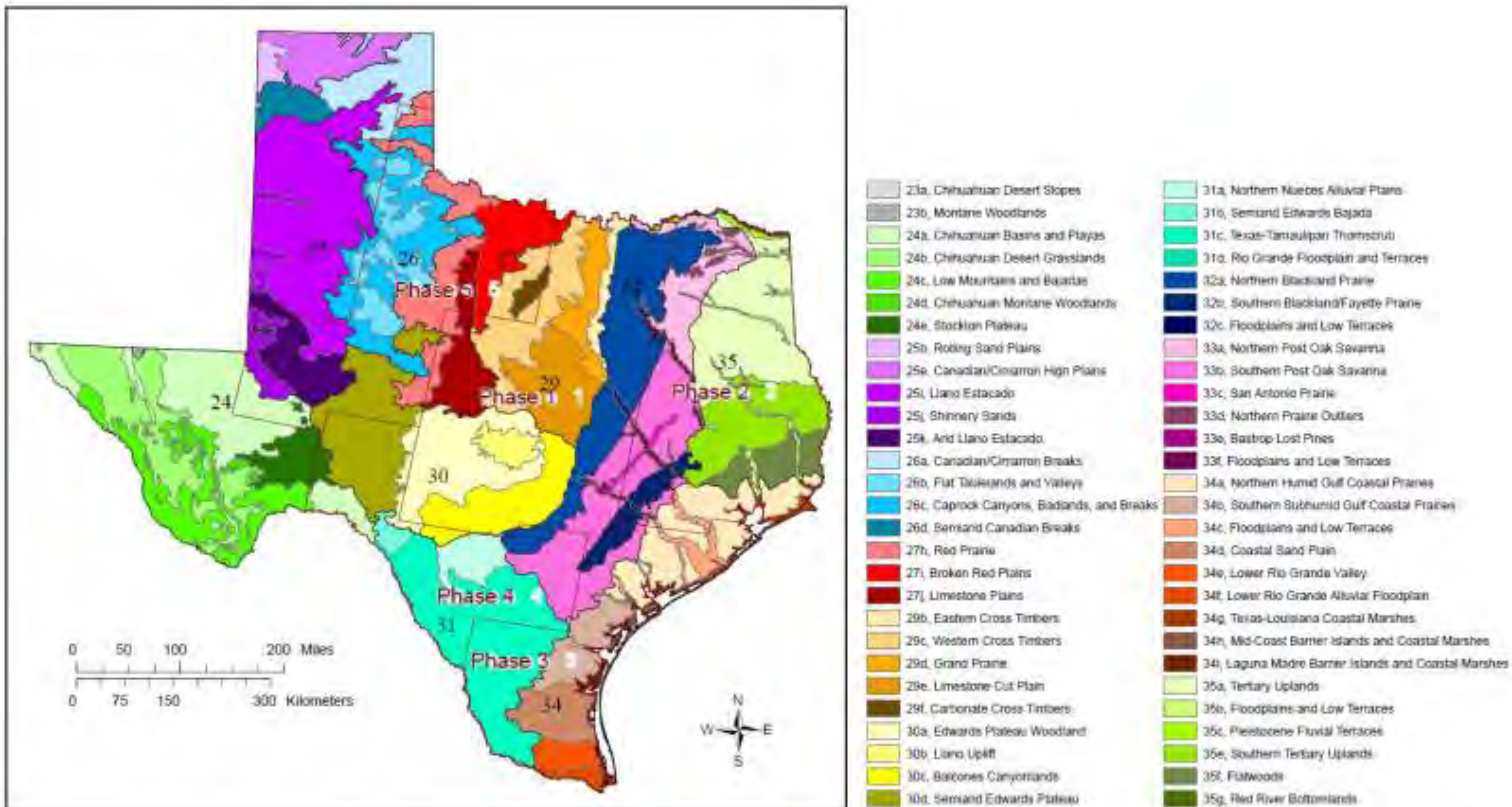


Figure 1. Texas Ecological Systems Mapping project phase map. Outlines of the phases correspond with the footprints of satellite scene data. The project will be completed in the early fall of 2012.

Contemporary Ecology of Texas - Texas Ecological Systems Project

The Texas Parks and Wildlife Department cooperated with private, state, and federal partners to produce a new land cover map for Texas, using an expansion and modification of the original NatureServe Ecological Systems Classification System.

The resulting Mapping Subsystems are essentially land cover types within more broadly-defined ecological systems, which represent groups of related plant communities affected by similar processes, and occurring together within larger landscapes.

Southeastern Great Plains Riparian Forest

- Central Texas: Riparian Juniper Forest
- Central Texas: Riparian Live Oak Forest
- Central Texas: Riparian Hardwood / Evergreen Forest
- Central Texas: Riparian Hardwood Forest
- Central Texas: Riparian Evergreen Shrubland
- Central Texas: Riparian Deciduous Shrubland
- Central Texas: Riparian Herbaceous Vegetation

Southeastern Great Plains Floodplain Forest

- Central Texas: Floodplain Juniper Forest
- Central Texas: Floodplain Live Oak Forest
- Central Texas: Floodplain Hardwood / Evergreen Forest
- Central Texas: Floodplain Hardwood Forest
- Central Texas: Floodplain Evergreen Shrubland
- Central Texas: Floodplain Deciduous Shrubland
- Central Texas: Floodplain Herbaceous Vegetation


Bottomland Faunal
Biodiversity

Table 1
PIF Physiographic Regions that Identify Bottomland Hardwoods and Forested Wetlands as Priority Habitats for Conservation with Associated Priority Bird Species[1]

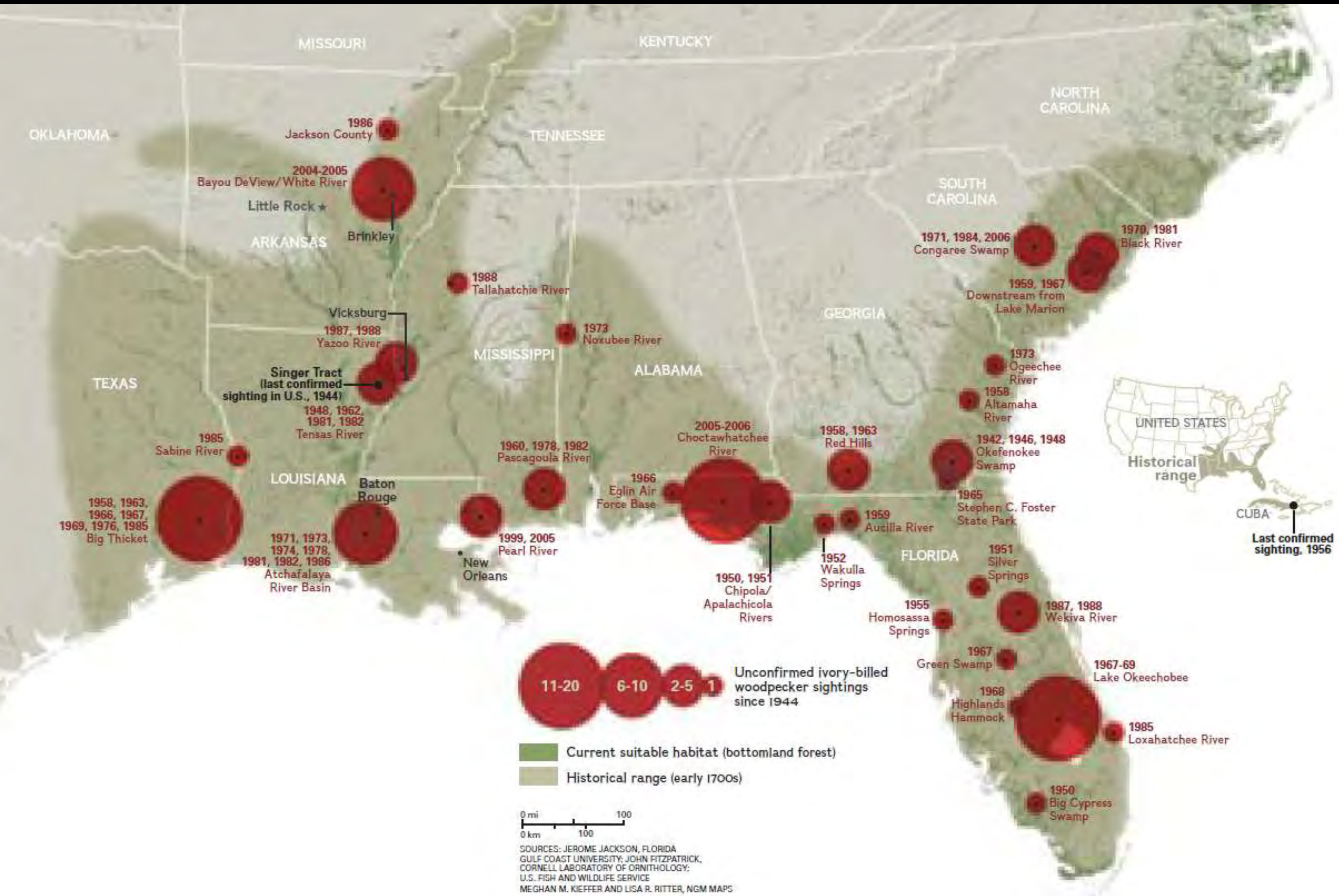
PIF Priority Species	Subtropical Florida (01)	Peninsular Florida (02)	South Atlantic Coastal Plain (03)	East Gulf Coastal Plain (04)	Mississippi Alluvial Valley (05)	Coastal Prairies (06)	Interior Low Plateaus (18)	Ozarks and Ouachitas (19)	West Gulf Coastal Plain (42)	Mid-Atlantic Coastal Plain (44)
Acadian Flycatcher							X	X		
American Redstart							X			
Black-throated Green Warbler[2]			X							
Blue-gray Gnatcatcher					X					
Carolina Chickadee					X			X		X
Cerulean Warbler			X	X	X		X	X	X	X
Chimney Swift				X						X
Great-crested Flycatcher								X		
Hooded Warbler			X						X	
Kentucky Warbler				X	X			X	X	X
Louisiana Waterthrush								X	X	
Northern Parula			X		X		X			
Ovenbird								X		
Pileated Woodpecker								X		
Prothonotary Warbler			X	X	X	X	X	X	X	X
Red-headed Woodpecker				X	X				X	
Ruby-throated Hummingbird					X					
Scarlet Tanager										X
Summer Tanager			X					X		
Swainson's Warbler			X	X	X	X	X	X	X	X
Swallow-tailed Kite	X	X	X	X	X	X			X	
Yellow-billed Cuckoo			X	X	X			X	X	
Yellow-throated Vireo			X							X
Yellow-throated Warbler							X	X		
Wood Thrush			X		X		X			X
Worm-eating Warbler			X	X	X			X	X	X

[1] The "X" denotes priority species identified by PIF within each physiographic region.
[2] Refers to a subspecies, Wayne's Black-throated Green Warbler (*Dendroica virens waynei*), that breeds along the Atlantic coast in cypress swamps.

MAKING DOLLARS AND SENSE IN
IVORY-BILL COUNTRY

While biologists figure out how to protect the ivory-billed woodpecker, local residents are turning the endangered bird into cash

Eastern Arkansas could teach pool tables a few things about being flat. Lying in the vast Mississippi River floodplain, the terrain on all sides stretches unimpeded to the most distant horizons. In such a level place, rivers find room to expand during flood season, enriching the soil and giving rise to bottomland-hardwood forests that, 200 years ago, covered 25 million acres.


MISSOURI
KENTUCKY
NORTH CAROLINA
OKLAHOMA
TENNESSEE
1986 Jackson County
2004-2005 Bayou DeView/White River
Little Rock
Brinkley
ARKANSAS
SOUTH CAROLINA
1971, 1984, 2006 Congaree Swamp
1970, 1981 Black River
1959, 1967 Downstream from Lake Marion
1988 Tallahatchie River
Vicksburg
1987, 1988 Yazoo River
GEORGIA
1973 Noxubee River
MISSISSIPPI
ALABAMA
TEXAS
Singer Tract (last confirmed sighting in U.S., 1944)
1948, 1962, 1981, 1982 Tensas River
1973 Ogeechee River
1958 Altamaha River
UNITED STATES
Historical range
1985 Sabine River
2005-2006 Choctawhatchee River
1958, 1963 Red Hills
1942, 1946, 1948 Okefenokee Swamp
1960, 1978, 1982 Pascagoula River
LOUISIANA
Baton Rouge
1966 Eglin Air Force Base
1965 Stephen C. Foster State Park
1958, 1963, 1966, 1967, 1969, 1976, 1985 Big Thicket
1971, 1973, 1974, 1978, 1981, 1982, 1986 Atchafalaya River Basin
1999, 2005 Pearl River
New Orleans
1959 Aucilla River
CUBA
Last confirmed sighting, 1956
1952 Wakulla Springs
FLORIDA
1951 Silver Springs
1950, 1951 Chipola/ Apalachicola Rivers
1955 Homosassa Springs
1987, 1988 Wekiva River
1967 Green Swamp
1967-69 Lake Okeechobee
11-20
6-10
2-5
1
Unconfirmed ivory-billed woodpecker sightings since 1944
1968 Highlands Hammock
1985 Loxahatchee River
Current suitable habitat (bottomland forest)
Historical range (early 1700s)
1950 Big Cypress Swamp
0 mi 100
0 km 100
SOURCES: JEROME JACKSON, FLORIDA GULF COAST UNIVERSITY; JOHN FITZPATRICK, CORNELL LABORATORY OF ORNITHOLOGY; U.S. FISH AND WILDLIFE SERVICE
MEGHAN M. KIEFFER AND LISA R. RITTER, NGM MAPS

Identifying Field Marks of an Ivory-billed Woodpecker and Similar Birds

In flight - view from below

Distinct Ivory-billed Woodpecker characteristics:

- White trailing edge of wing (vs. dark trailing edge of Pileated).
- Wing more slender than Pileated.
- Tail feathers longer and more pointed.
- Pale, ivory-white bill.

In flight - view from above

Distinct Ivory-billed Woodpecker characteristics:

- White trailing edge of wing (vs. dark trailing edge of Pileated).
- Two white stripes converge on lower back.
- Tail feathers longer and more pointed.
- Pale, ivory-white bill.

Illustrations: © David Allen Sibley

At rest

Distinct Ivory-billed Woodpecker characteristics:

- Two white stripes converge on lower back.
- Entirely white secondary feathers give appearance of white "saddle" on back.
- Largely dark face and dark chin (vs. white chin of Pileated).
- Pale, ivory-white bill.
- Crest is curved and pointed; male crest is red with black forehead (Pileated male crest is entirely red).

Female Head

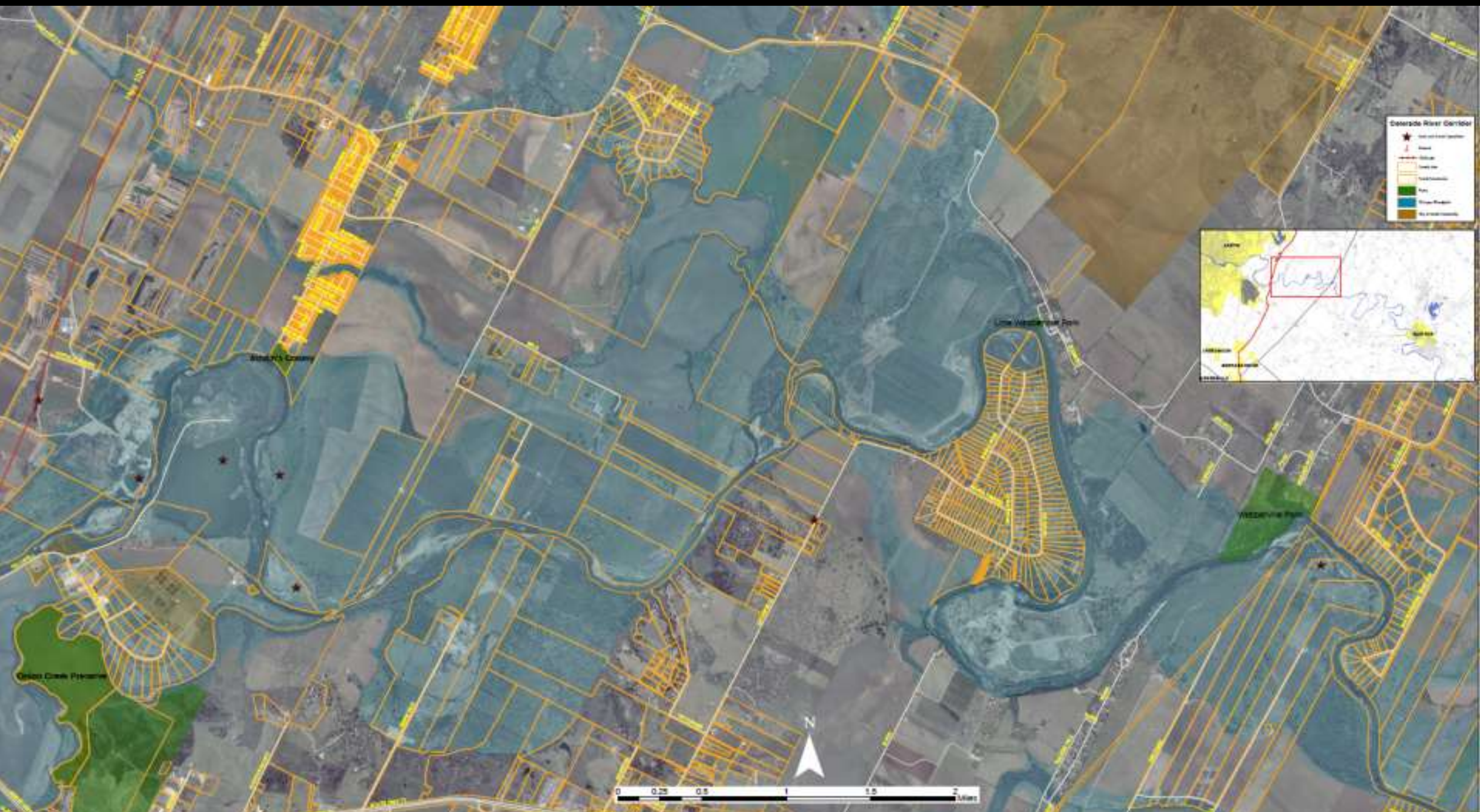
- Female Ivory-bill crest is entirely black (female Pileated crest resembles male ivory-billed red crest with black forehead – use chin color as distinguishing feature)

Bottomland Bird – Hornsby Bend

Black-bellied Whistling Duck

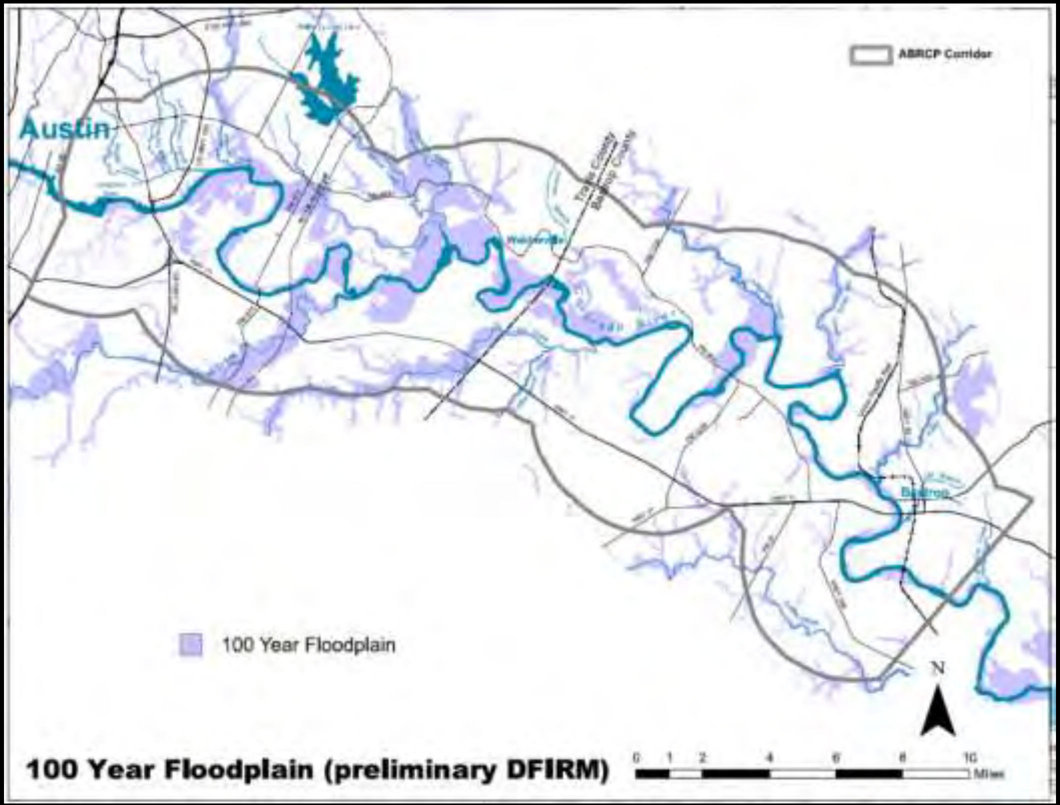
Life on the Floodplain

Humans settle in the bottomland



100-year floodplain

The 100-year floodplain is the land that is predicted to flood during a 100-year storm, which has a 1% chance of occurring in any given year. You may also hear the 100-year floodplain called the 1% annual chance floodplain or base flood. Areas within the 100-year floodplain may flood in much smaller storms as well.

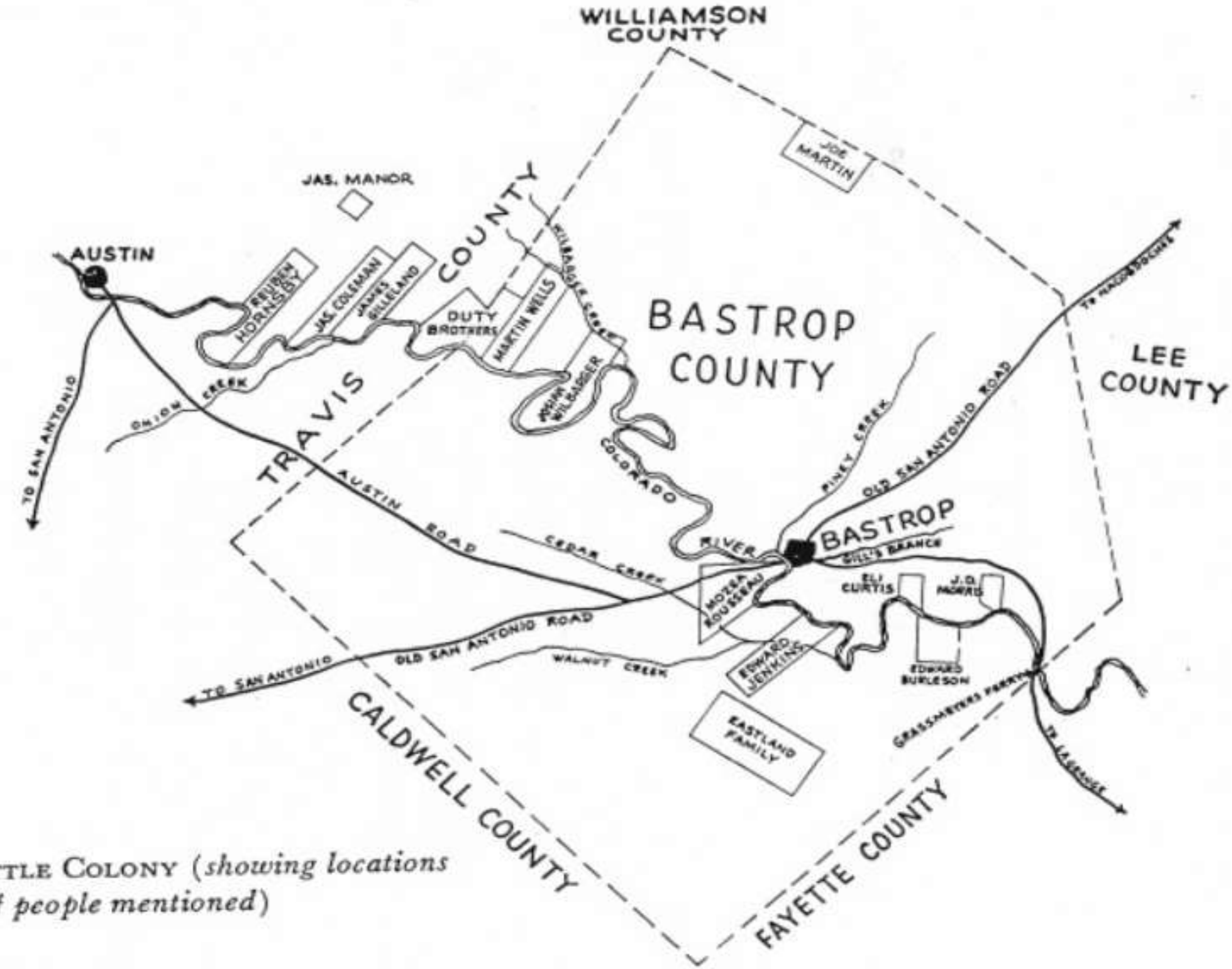


100-Year Storm

A 100-year storm is defined as an event that on average occurs once every 100 years or has a 1% chance of occurring annually.

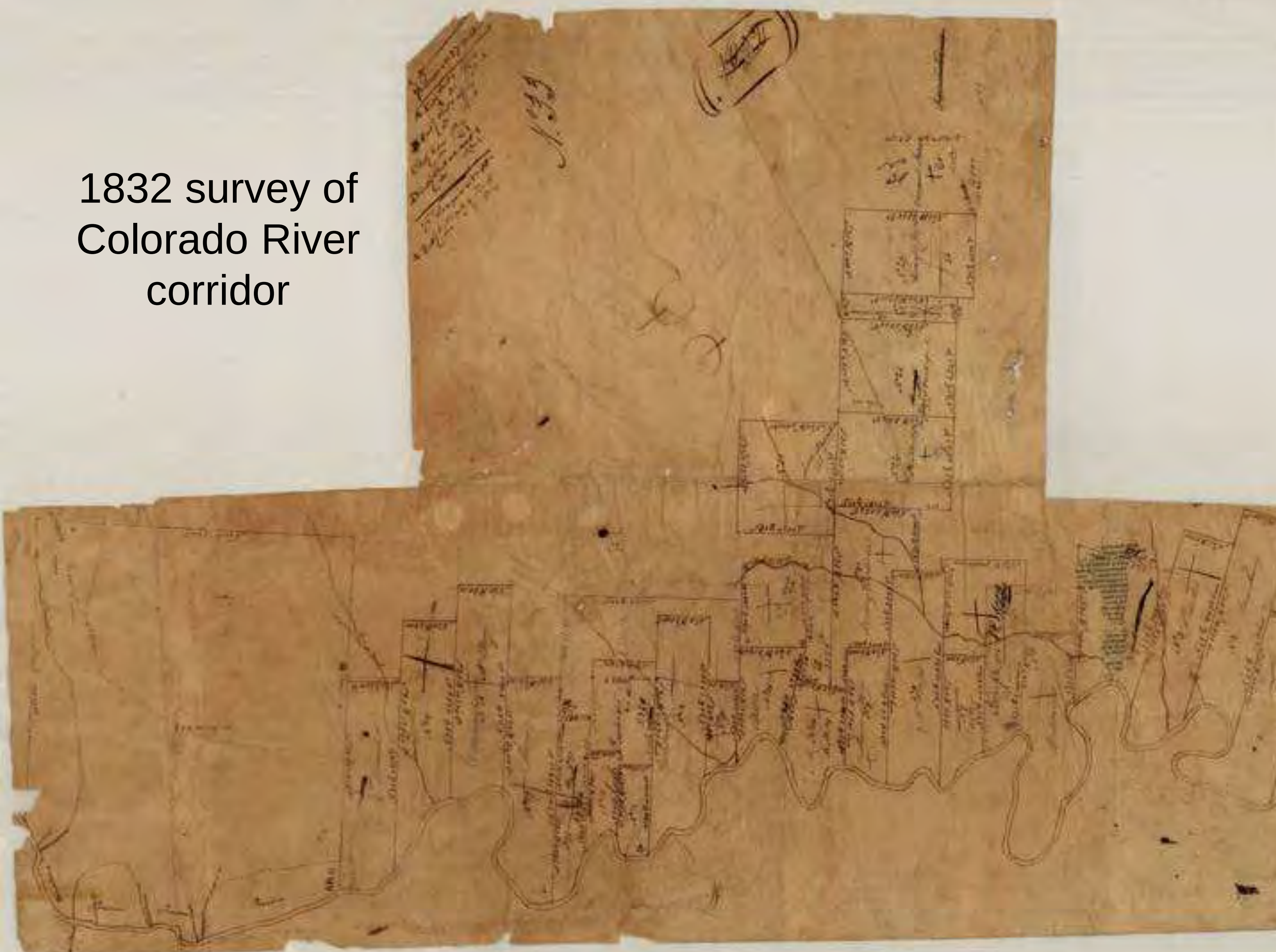
Up to last year, the 100-year storm for Austin was defined as 10 inches of rain in 24 hours.

Settlement begins 1820's along river corridor



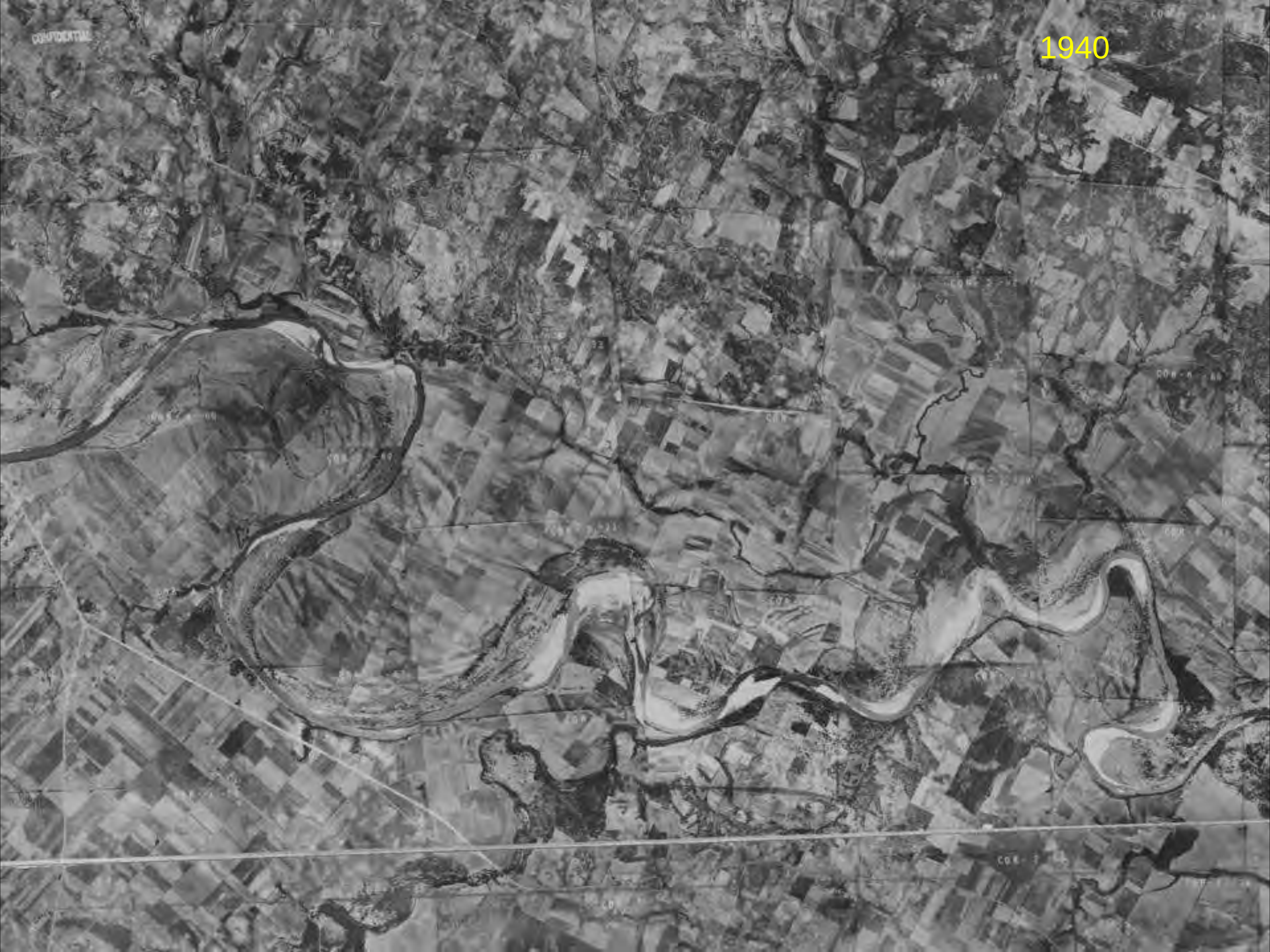
Austin's Little Colony (*showing locations of homes of people mentioned*)

1832 survey of Colorado River corridor

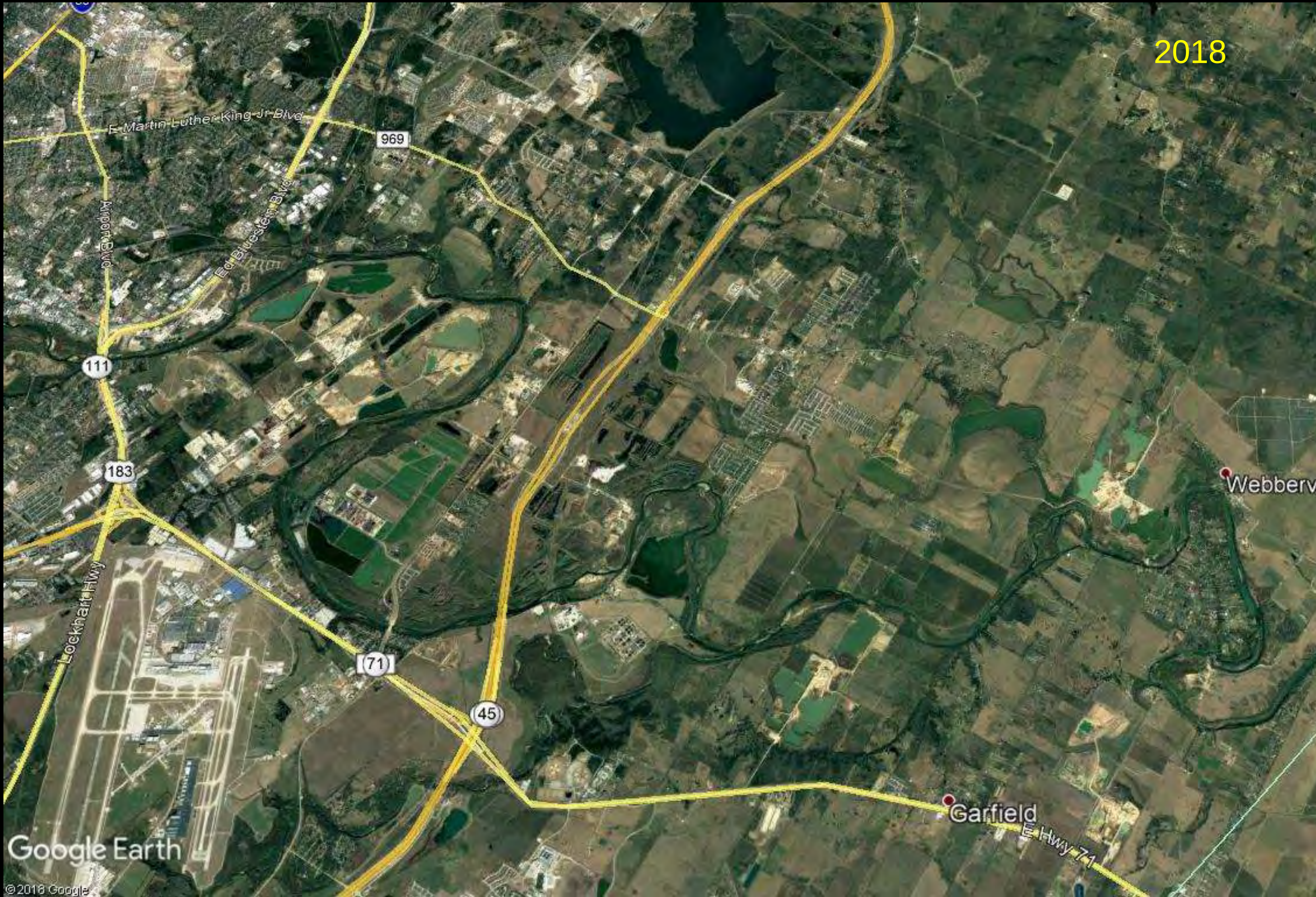


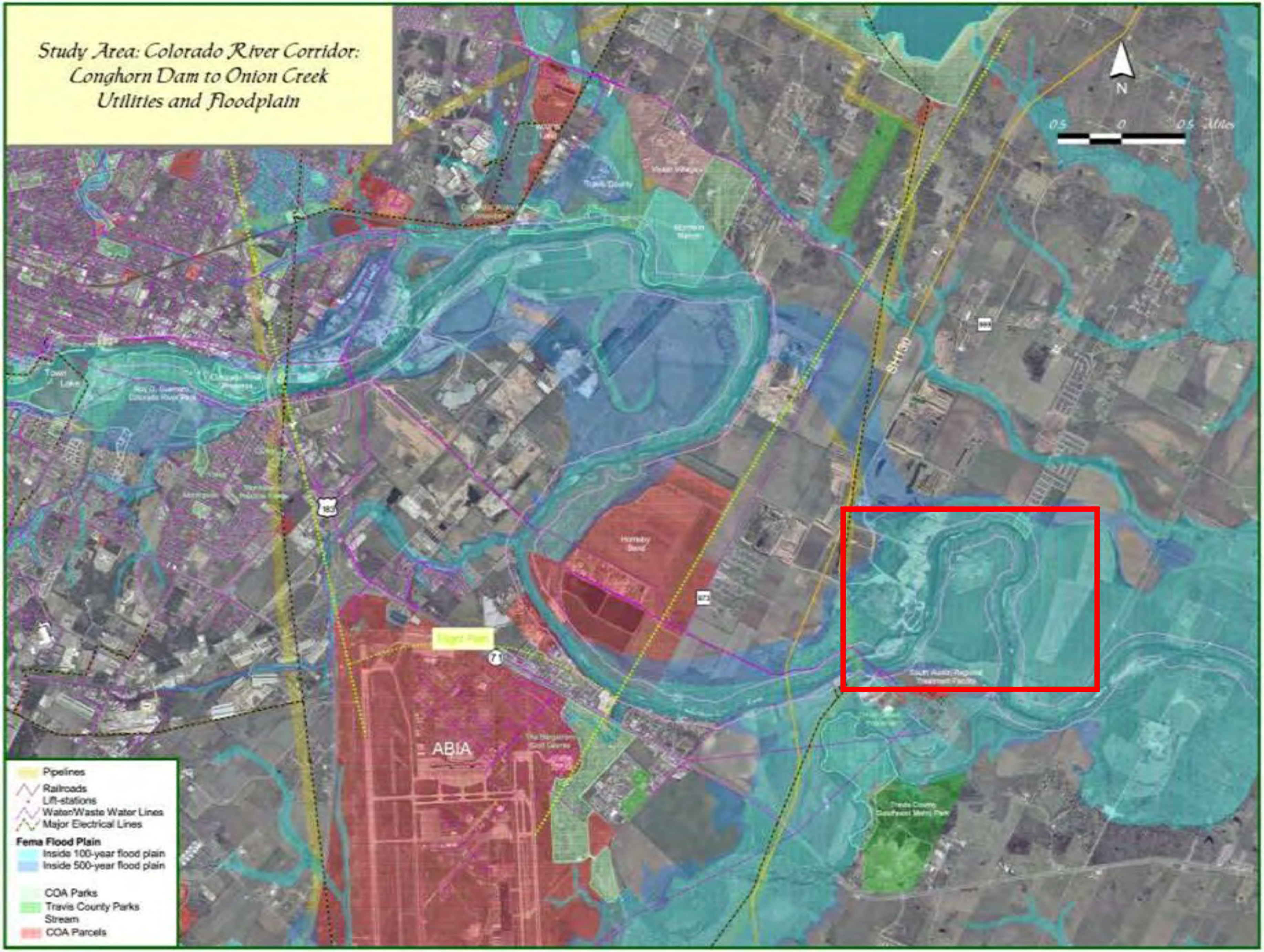
1901


AUSTIN
HOUSTON
TEXAS
AND
Boggy Creek
STONES FORD
Montopolis
Hornsby
Decker
Creek
Dunlap
Elm Creek
Webberville
THREE ISLAND FORD
COLORADO
RIVER
West Base
Delvalle
East Base
McKinney Falls
Creek
Garfield
Onion
Moore & Berry's Store
Elysium
Creek


1940
CONFIDENTIAL


2006


2018
E Martin Luther King Jr Blvd
969
Airport Blvd
Ed Bluestein Blvd
111
183
Lockhart Hwy
71
45
Webberv
Garfield
E Hwy 71
Google Earth
©2018 Google


Study Area: Colorado River Corridor:
Longhorn Dam to Onion Creek
Utilities and Floodplain
N
0.5 0 0.5 Miles
SH130
Hornsby Bend
ABIA
Pipelines
Railroads
Lift-stations
Water/Waste Water Lines
Major Electrical Lines
Fema Flood Plain
Inside 100-year flood plain
Inside 500-year flood plain
COA Parks
Travis County Parks
Stream
COA Parcels


4
1964

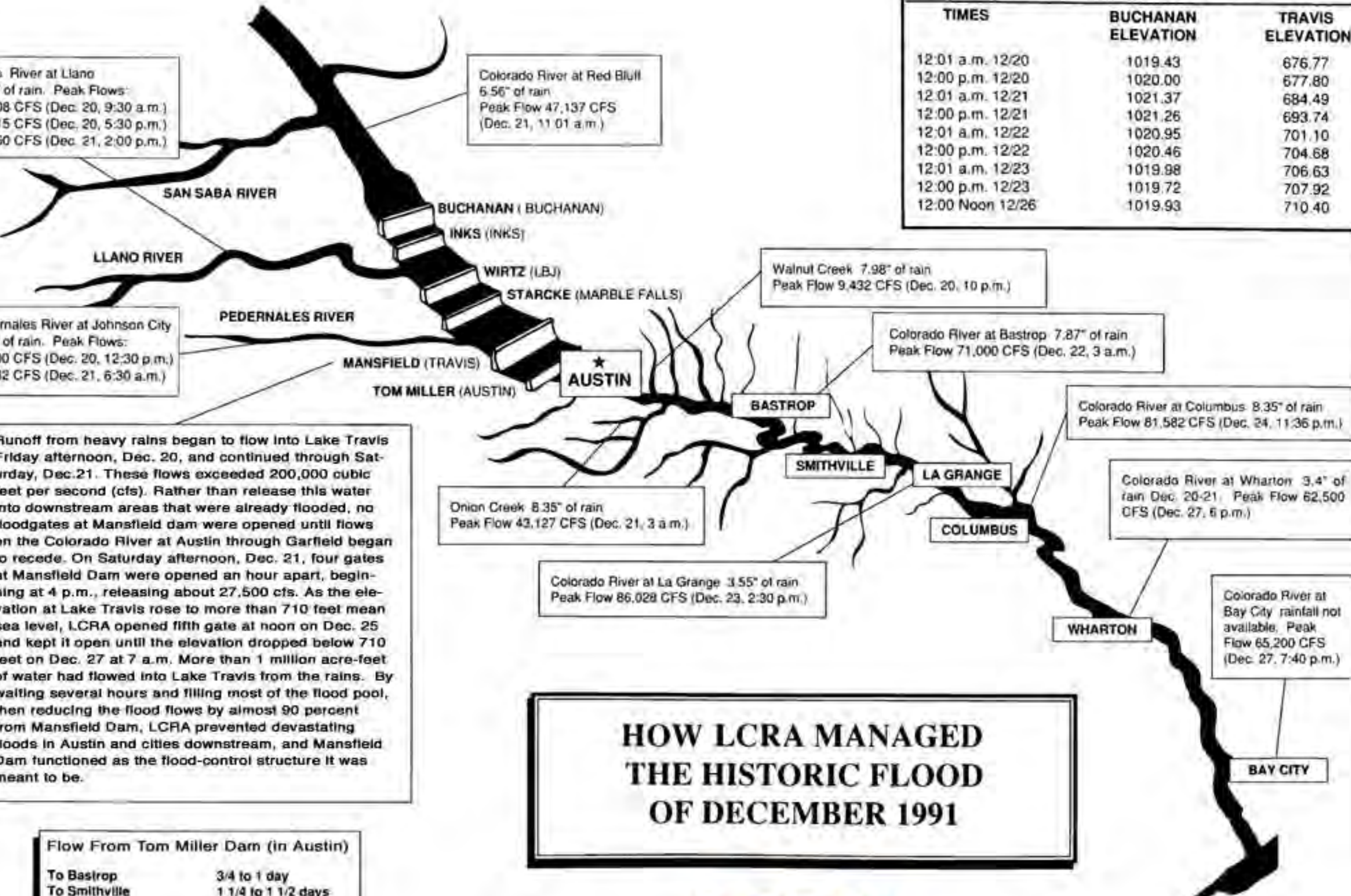

1983


1983

HOW LCRA MANAGED THE HISTORIC FLOOD OF DECEMBER 1991

Levels at Lakes Buchanan and Travis

TIMES	BUCHANAN ELEVATION	TRAVIS ELEVATION
12:01 a.m. 12/20	1019.43	676.77
12:00 p.m. 12/20	1020.00	677.80
12:01 a.m. 12/21	1021.37	684.49
12:00 p.m. 12/21	1021.26	693.74
12:01 a.m. 12/22	1020.95	701.10
12:00 p.m. 12/22	1020.46	704.68
12:01 a.m. 12/23	1019.98	706.63
12:00 p.m. 12/23	1019.72	707.92
12:00 Noon 12/26	1019.93	710.40



Runoff from heavy rains began to flow into Lake Travis Friday afternoon, Dec. 20, and continued through Saturday, Dec.21. These flows exceeded 200,000 cubic feet per second (cfs). Rather than release this water into downstream areas that were already flooded, no floodgates at Mansfield dam were opened until flows on the Colorado River at Austin through Garfield began to recede. On Saturday afternoon, Dec. 21, four gates at Mansfield Dam were opened an hour apart, beginning at 4 p.m., releasing about 27,500 cfs. As the elevation at Lake Travis rose to more than 710 feet mean sea level, LCRA opened fifth gate at noon on Dec. 25 and kept it open until the elevation dropped below 710 feet on Dec. 27 at 7 a.m. More than 1 million acre-feet of water had flowed into Lake Travis from the rains. By waiting several hours and filling most of the flood pool, then reducing the flood flows by almost 90 percent from Mansfield Dam, LCRA prevented devastating floods in Austin and cities downstream, and Mansfield Dam functioned as the flood-control structure it was meant to be.

Flow From Tom Miller Dam (in Austin)

To Bastrop	3/4 to 1 day
To Smithville	1 1/4 to 1 1/2 days
To La Grange	1 3/4 to 2 days
To Columbus	2 1/4 to 2 3/4 days
To Wharton	4 1/4 to 5 days
To Bay City	5 1/4 to 6 1/4 days

Rainfall amounts from Dec. 20, 1991,12:01 a.m. until Dec. 24, 1991, Noon.
Information on this document is taken from records as of Dec. 31, 1991.

LCRA
ENERGY • WATER • COMMUNITY SERVICES

Lower Colorado River Authority
P.O. Box 220
Austin, Texas 78767-0220

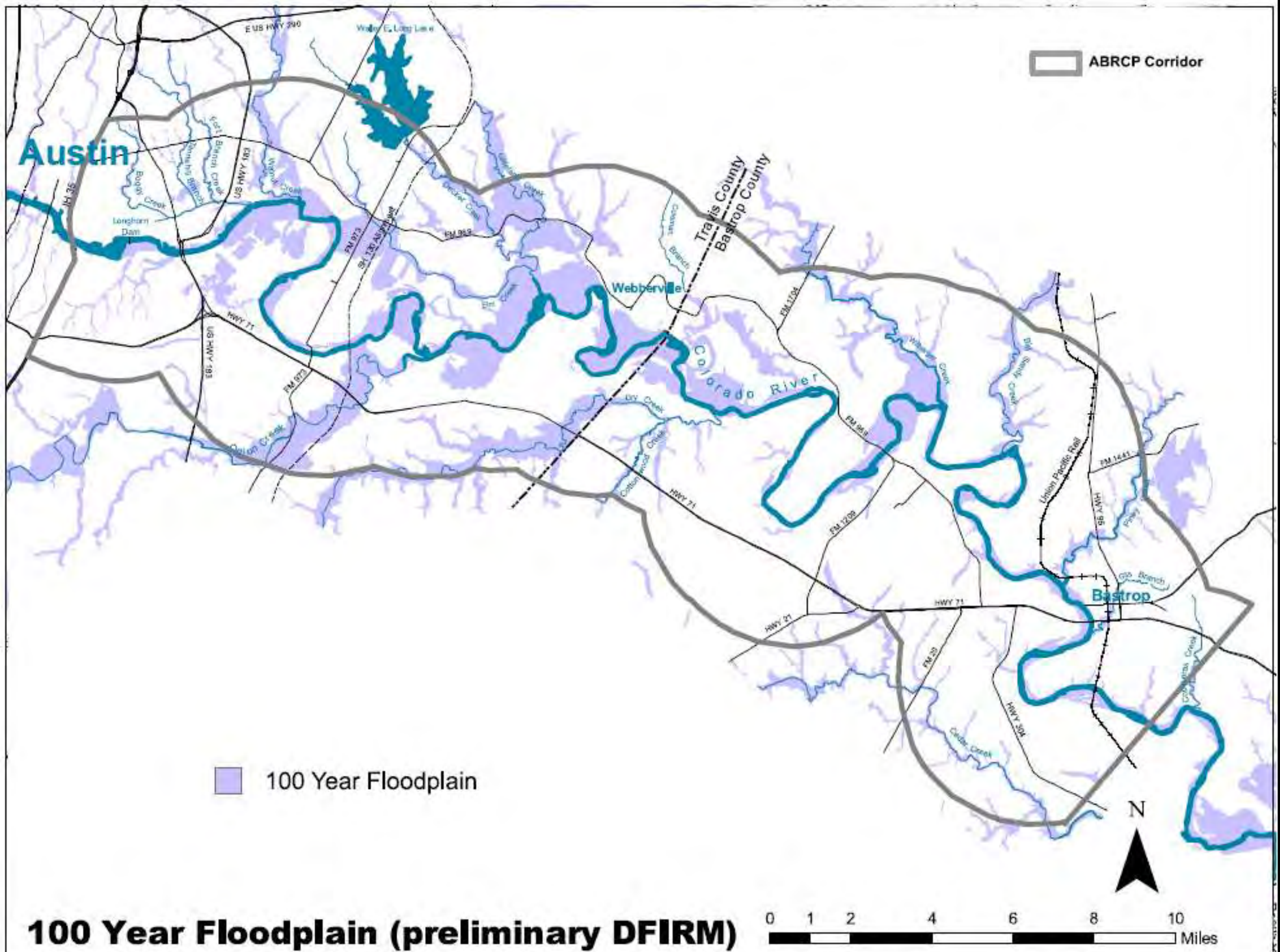
For recorded information on lake levels:
Call 1-800-776-5272, ask for lake levels: In Austin, 473-3333


Breach
1996


1996

2015

2018



100 Year Floodplain (preliminary DFIRM)

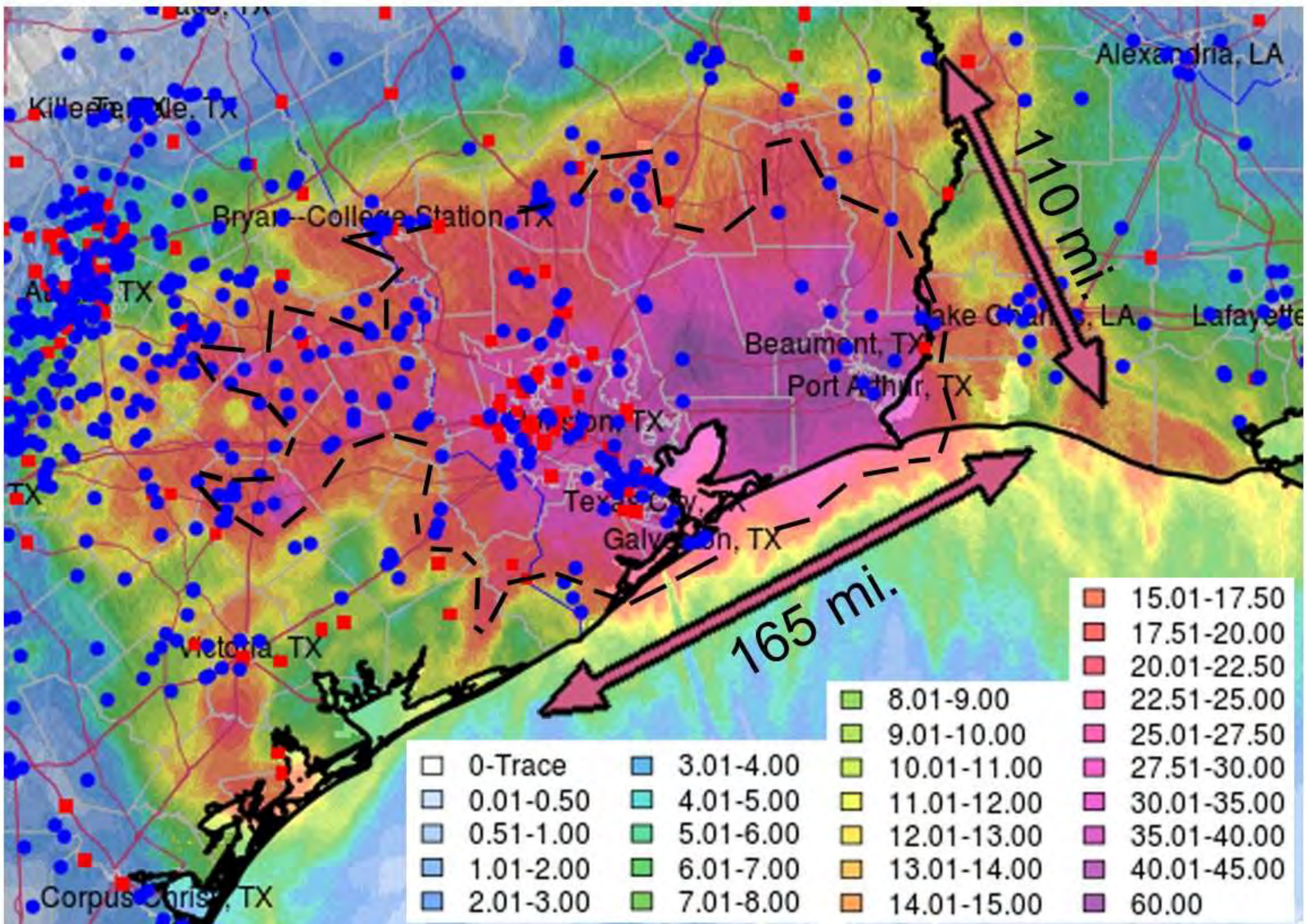
NOAA's Atlas 14: Texas

The 100-year Storm, Now the 25-year Storm

Hurricane Harvey Rainfall

August 25 to August 30, 2017

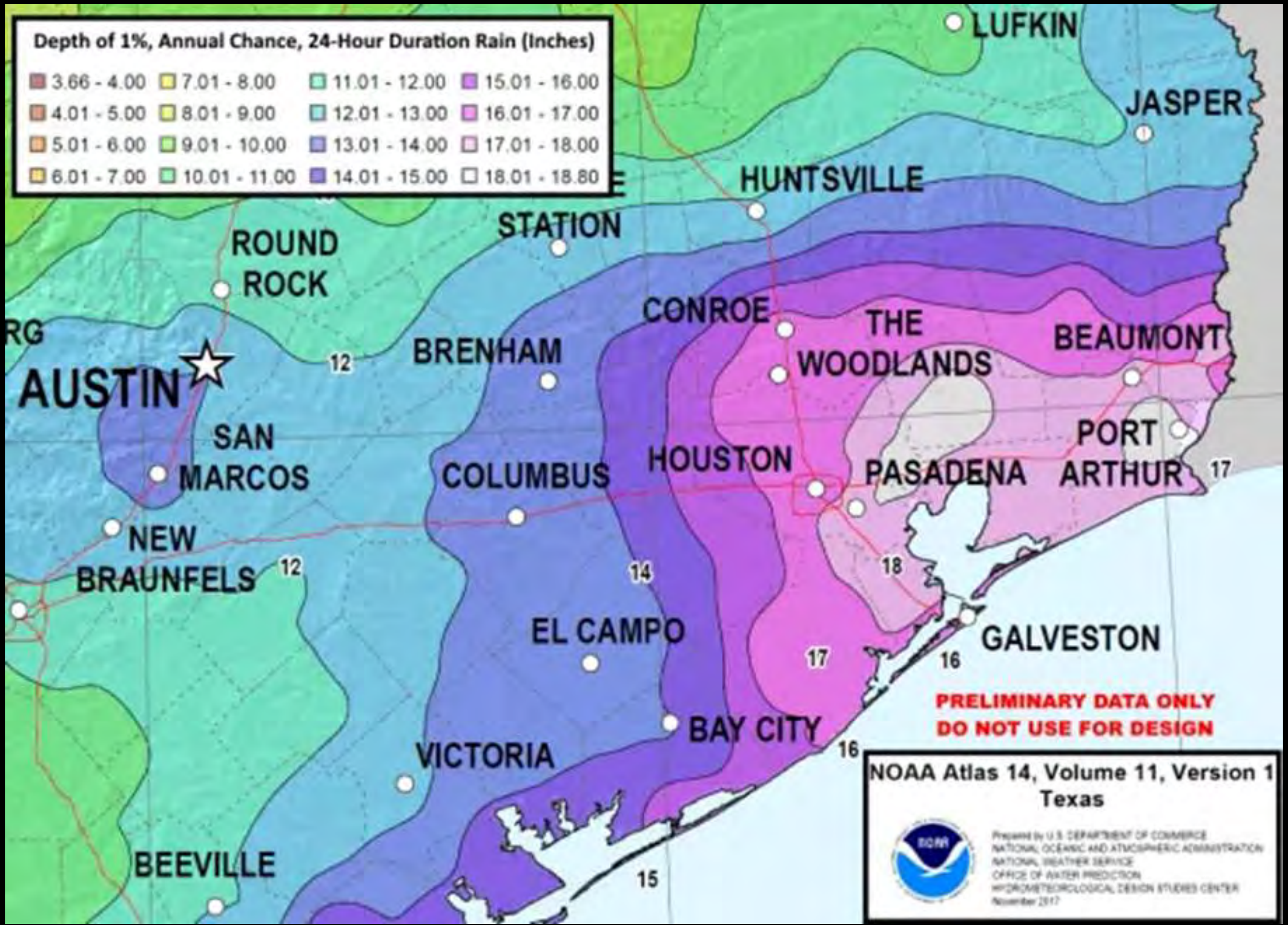
Dashed line is rainfall in excess of 20 to 27.5 inches



Atlas 14: Texas – The 100-year Storm is Now the 25-year Storm, Already

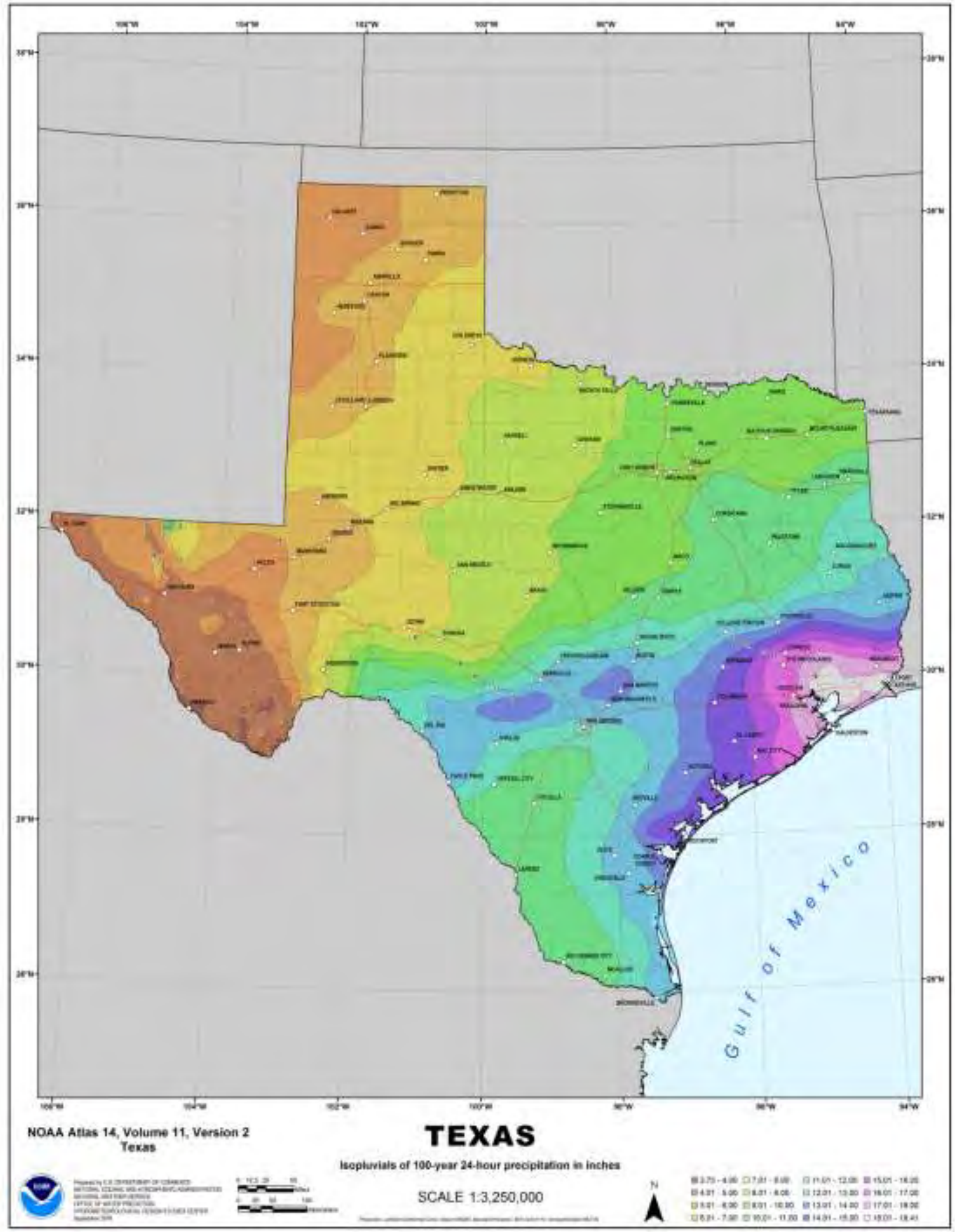
In Houston, the 100-year storm in our old climate was 12.5 inches in 24 hours. The new rainfall data analysis just released by NOAA shows the 25-year storm total is now 12.1 inches. The 100-year storm total has increased to 17.9 inches, an increase of 43 percent.

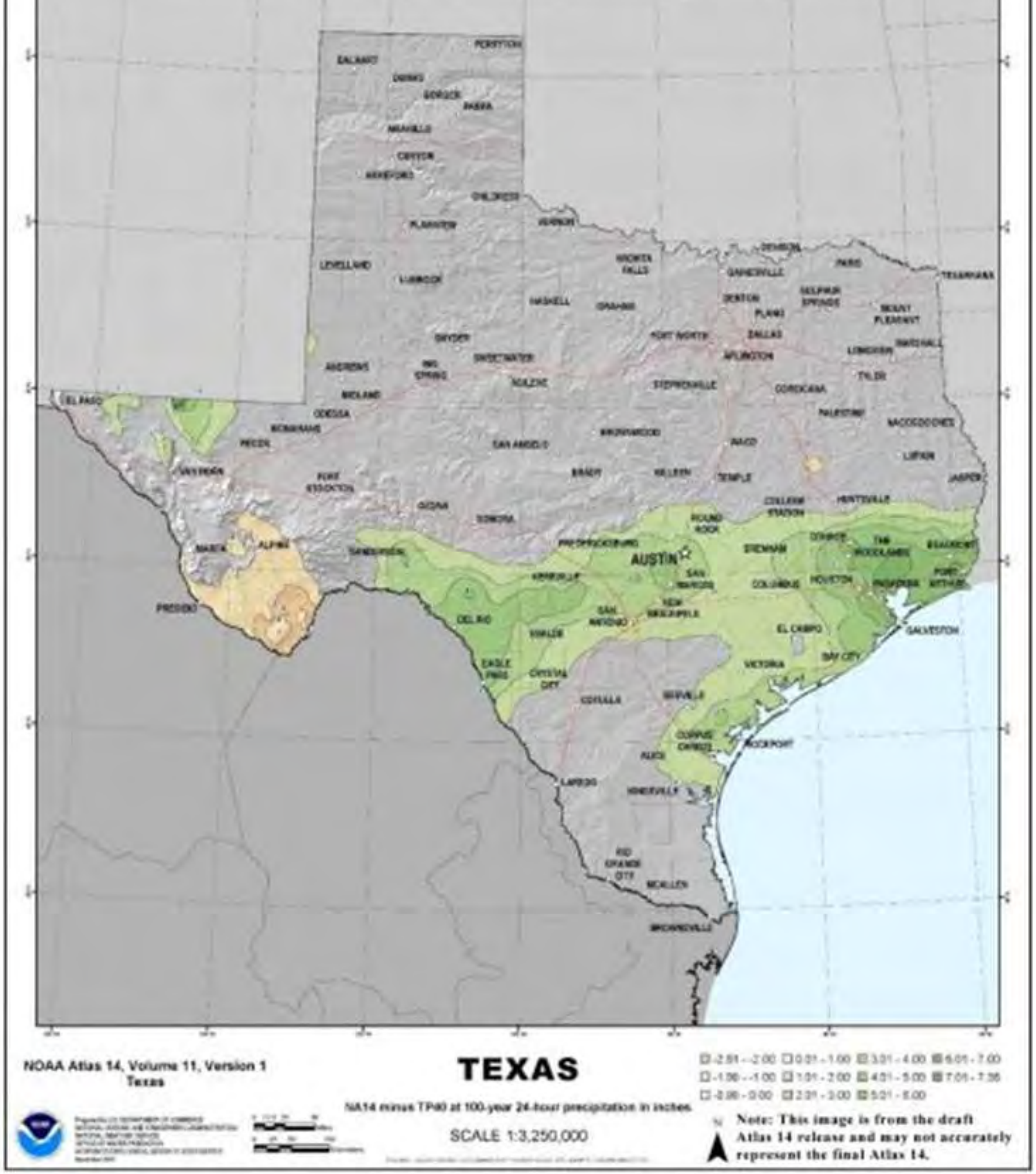
In Austin, the 100-year storm in our old climate was 10 inches in 24 hours. The new 100-year storm rainfall amount for 24 hours is 13 inches. The Austin 50-year storm is now 10.6 inches and the 25-year storm is 8.86 inches.



NOAA Atlas 14 rainfall values are used for infrastructure design and planning activities under federal, state and local regulations. They also help delineate flood risks, manage development in floodplains for FEMA's National Flood Insurance Program and are used to monitor precipitation observations and forecasts that can indicate flooding threats by NOAA's National Weather Service.

The updated values will supersede those currently available for Texas from the 1960s and 1970s. The new values are more accurate than estimates developed 40 to 50 years ago due to decades of additional rainfall data, an increase in the amount of available data, both in the number of stations and their record lengths, and improved methods used in the analysis.





This graphic shows where and how much rainfall has increased for the new NOAA Atlas 14 vs. the old NOAA evaluations from the 20th century.

Many areas have remain unchanged, but changes in others have been large.

This reflects fairly accurately the general rainfall projections under a warmer climate where inland areas will become drier and coastal areas will become wetter.

Only it's happening much ahead of schedule.

"These brand new numbers in Atlas 14 however, are biased low. The statistical analysis used by NOAA relies on long-term weather data to prove statistically that rainfall is increasing in intensity. Because the increase of extreme rainfall events we have been seeing lately in some areas has just begun over the last 10 or 15 years, the new statistical analysis averages them low. <u>So in reality, the extreme rainfall events we have been seeing are not well captured by NOAA's new work</u>.

<u>So Atlas 14 is a very useful tool</u>. It tells us that rainfall has indeed increased a lot already, it's not just our imaginations or natural cycles. But on a warmer world, a little more warming does not create a little more extremeness.

Thermodynamics are at play. <u>A little warming creates a lot more dynamic response, meaning that a little more warming does not create a little more extremeness, it creates a lot more</u>."

Bruce Melton - Climate Discovery and the Climate Change Now Initiative: https://climatediscovery.org/

The Middle and Lower Course: Life in the Bottomland

Fluvial Process - Sinuosity is inversely proportional to slope

Bottomland Life, Floodplain Flooding

Course Stage	Upper Course Youth Stage	Middle Course Mature Stage	Lower Course Old Age Stage
Slope			
Main processes	Hydraulic Action Abrasion **Erosion**	**Erosion and Deposition**	**Deposition**
Valley shape			
Main features	V-shaped Valleys Interlocking Spurs Waterfalls	Meanders and Ox-Bow lakes	Deltas Levees Flood Plains (and m+ob lakes)