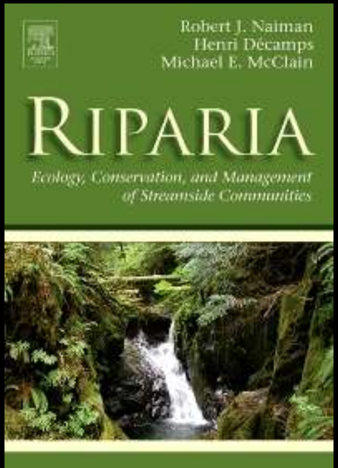
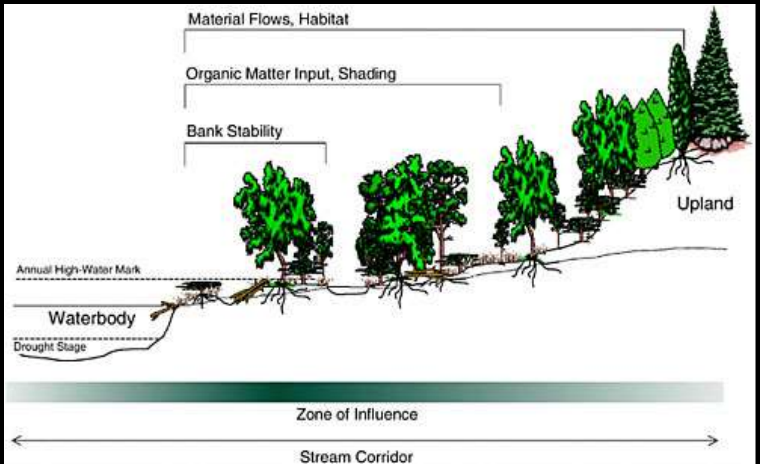
Center for Environmental Research at Hornsby Bend

Austin WATER

Riparia: Life at the Edge

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

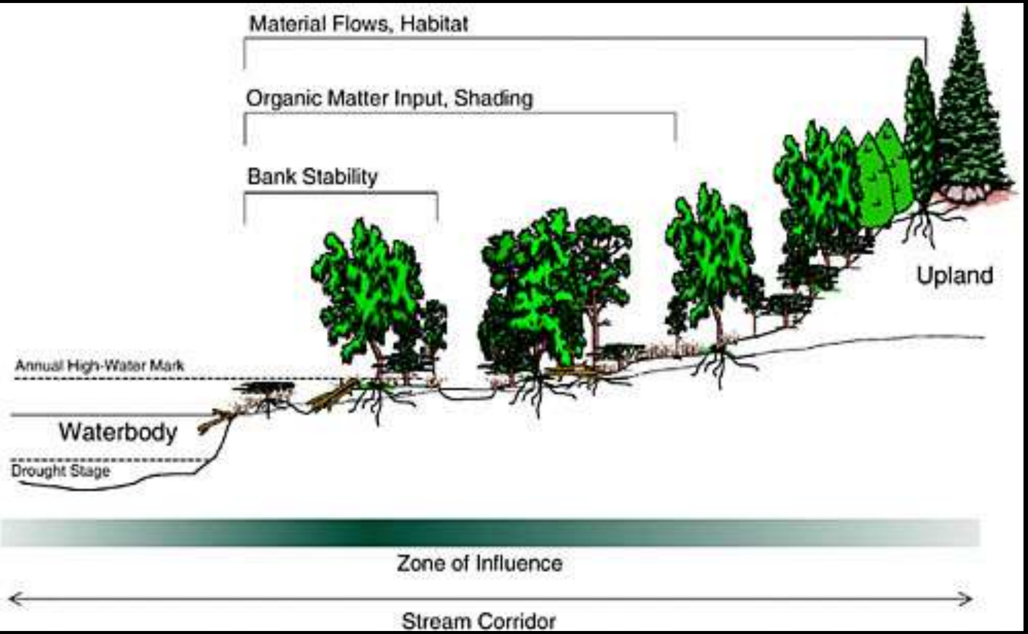


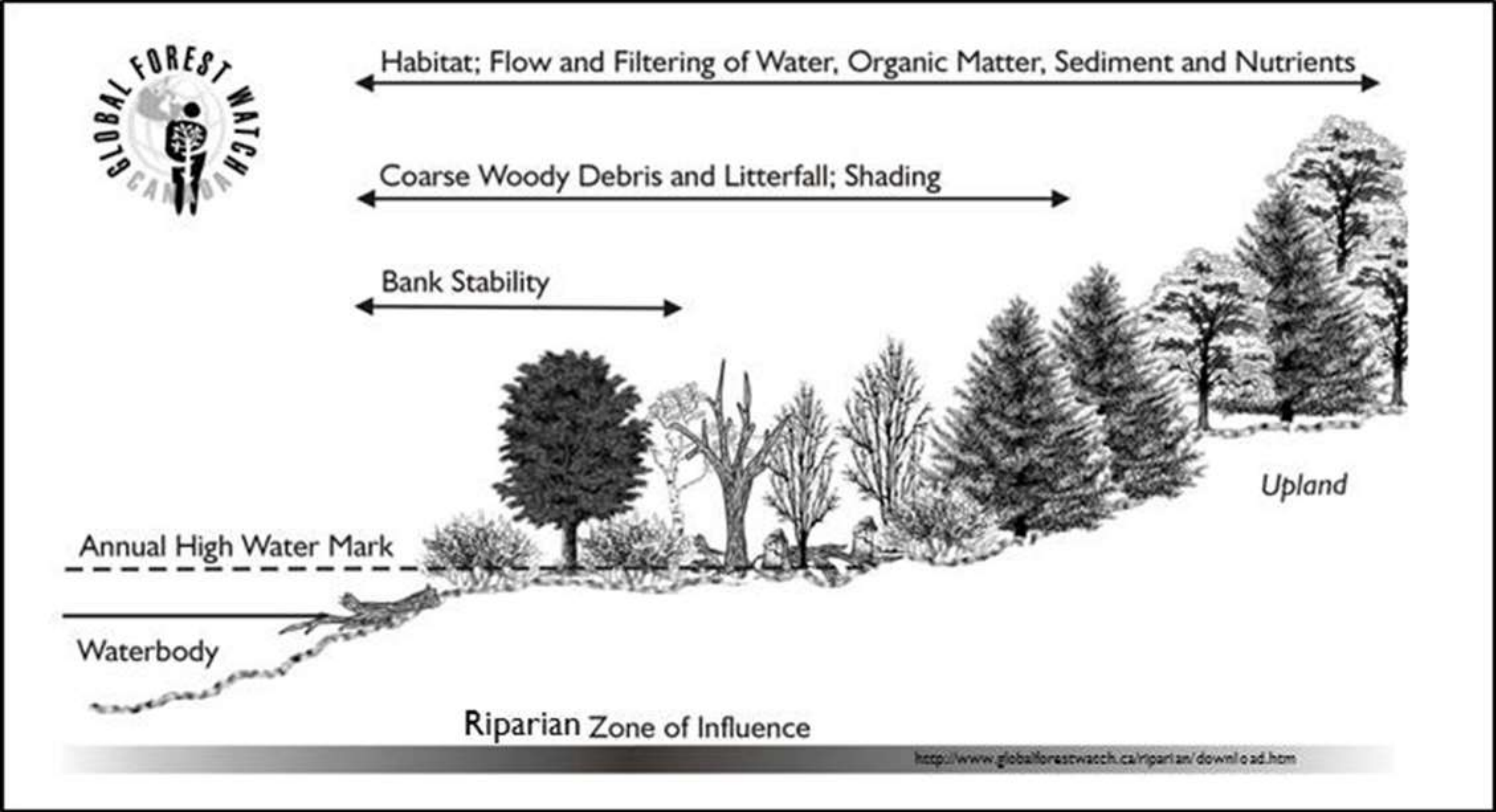


Riparian Zone = Waterway Margins

Riparian areas are transitional zones between terrestrial and aquatic ecosystems.

Vary in width depending on influence of water





Riparian zones include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems.

Hydric Soils

Subsurface Habitat – The Microbial Zone

Streams exchange water, nutrients, and organisms with surrounding aquifers.

The interstitial, water-filled space beneath river beds, where most active aquifer-river water exchange occurs and is an important habitat for a number of aquatic organisms and for fish spawning.

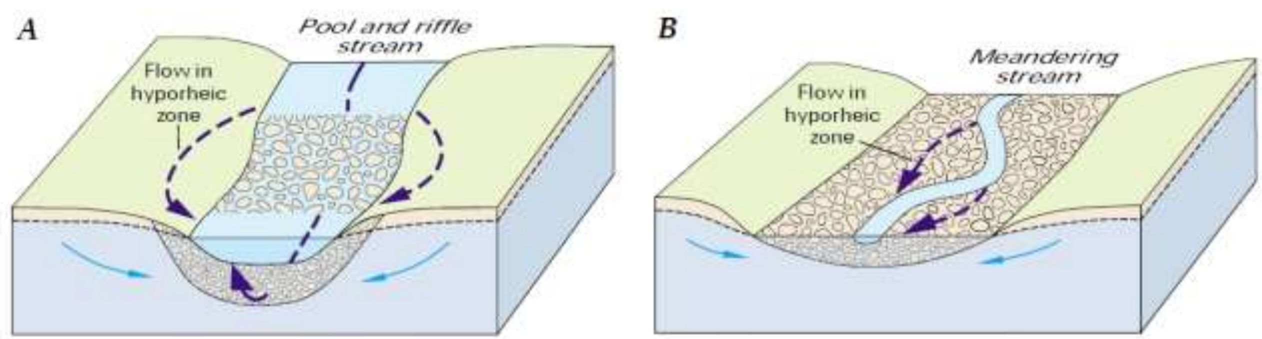
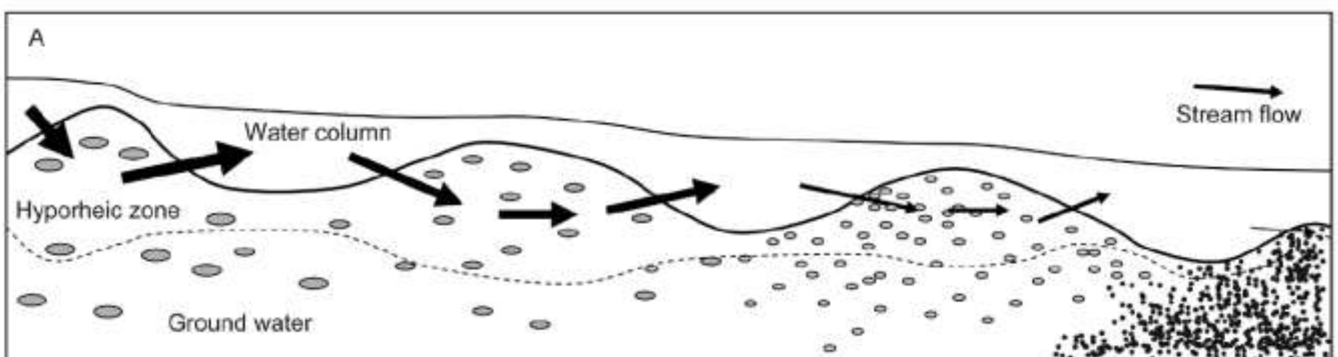
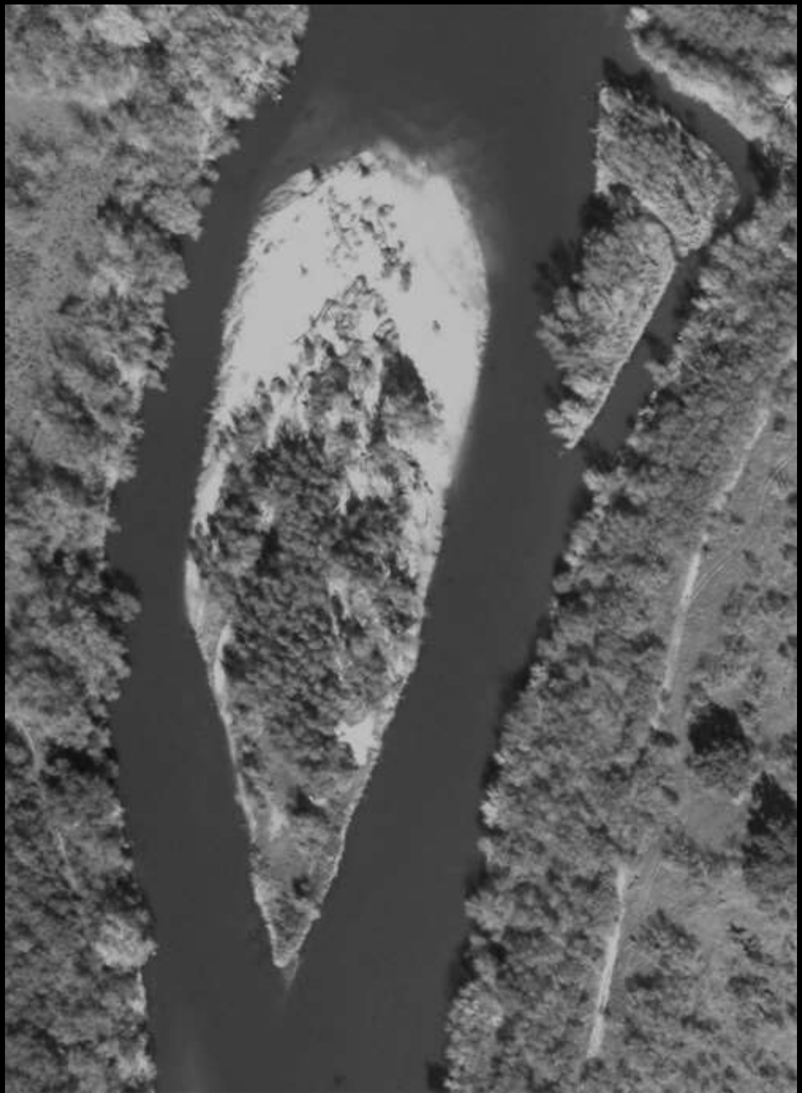


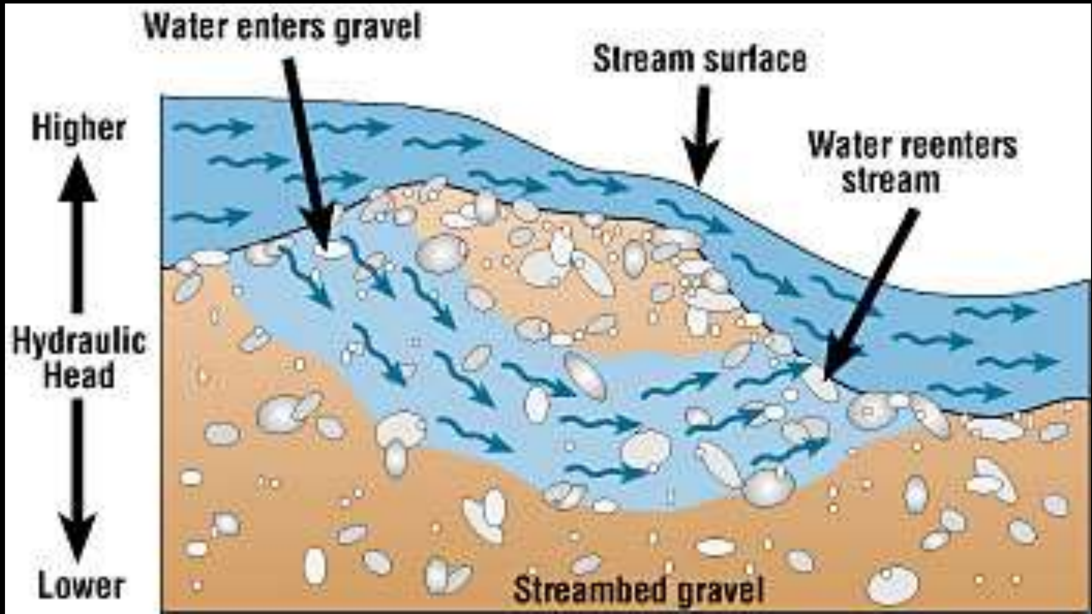
Figure 14. Surface-water exchange with ground water in the hyporheic zone is associated with abrupt changes in streambed slope (A) and with stream meanders (B).

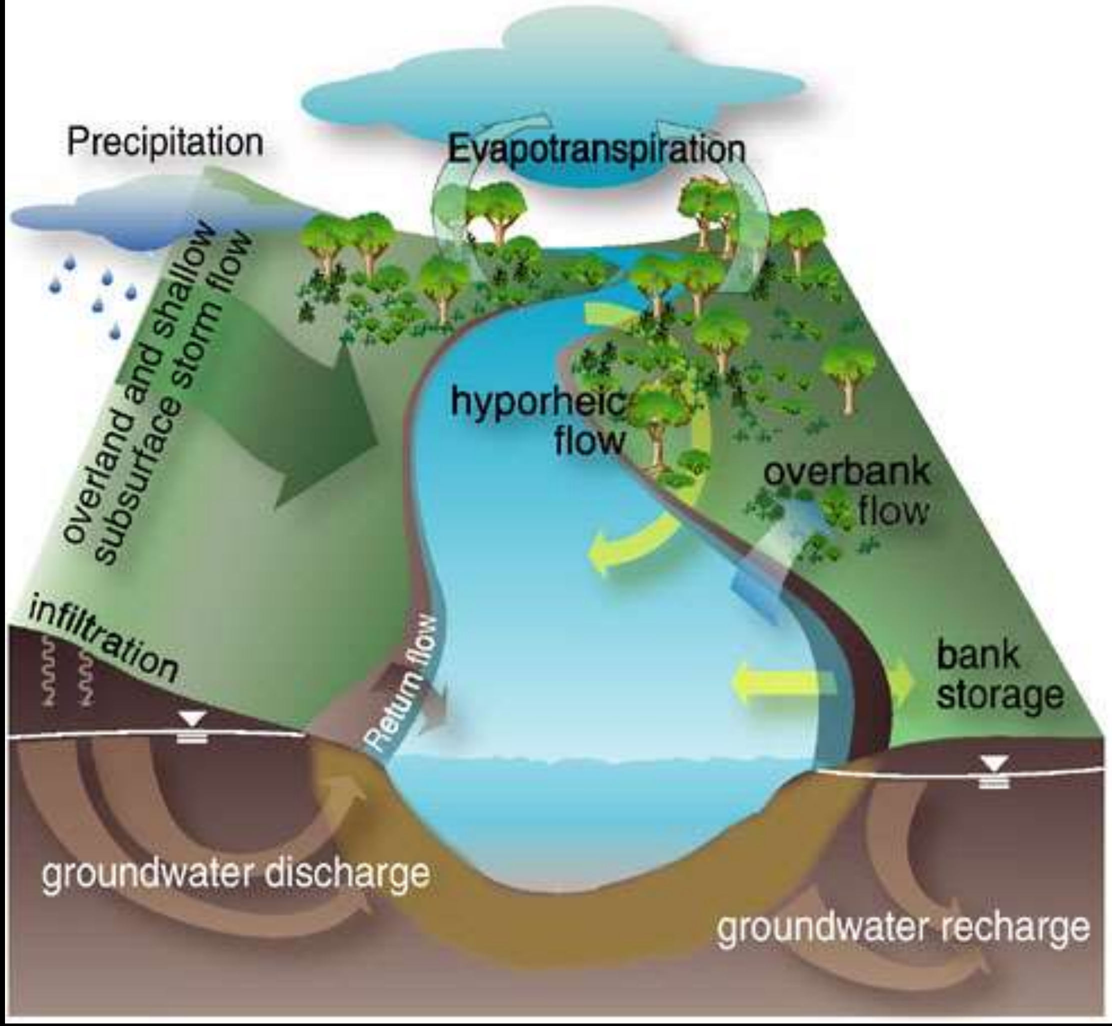


Beneath the Benthos

The Hyporheic Zone







Hydrogeology – Alluvial Aquifers and Hyporheic Flows

Hyporheic Flows
hypo (below) and rheos (flow)

They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands.

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Hydrogeology of the River The Alluvial Aquifer and Hyporheic Research 2007-23

Dr. Bayani Cardenas

WATER MANAGEMENT AND HYDROLOGICAL SCIENCE
TEXAS A&M UNIVERSITY

THE UNIVERSITY OF TEXAS AT AUSTIN
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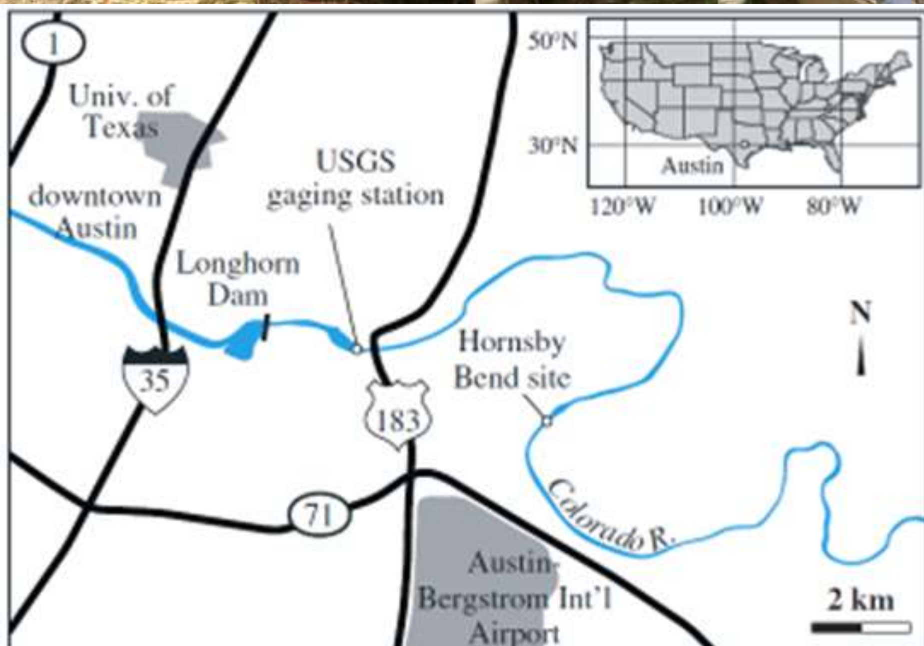


Figure 1. Location of study site on the Colorado River in relation to Austin, Texas, USA. USGS gaging station 08158000 is 2 km downstream from Longhorn dam, and the study site is another 13 km downstream

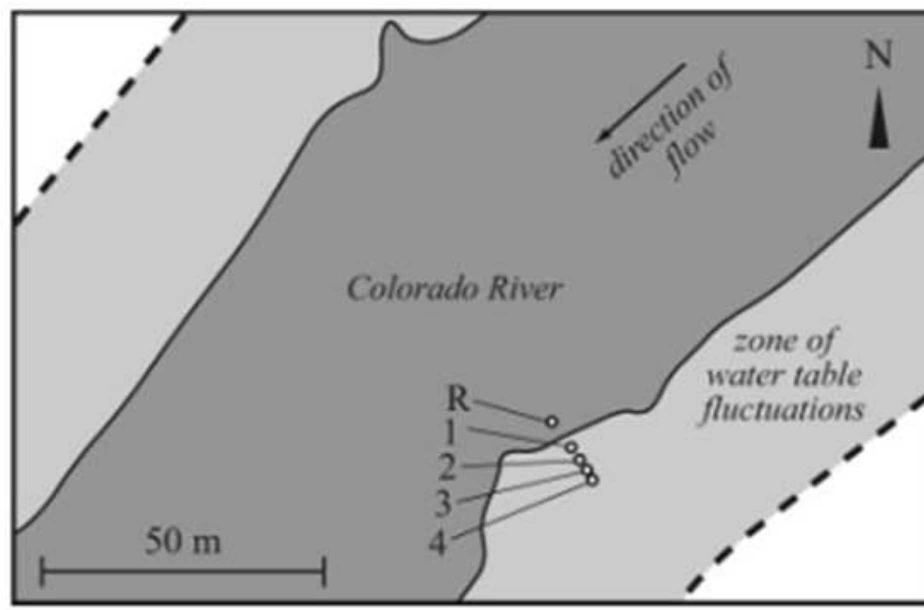
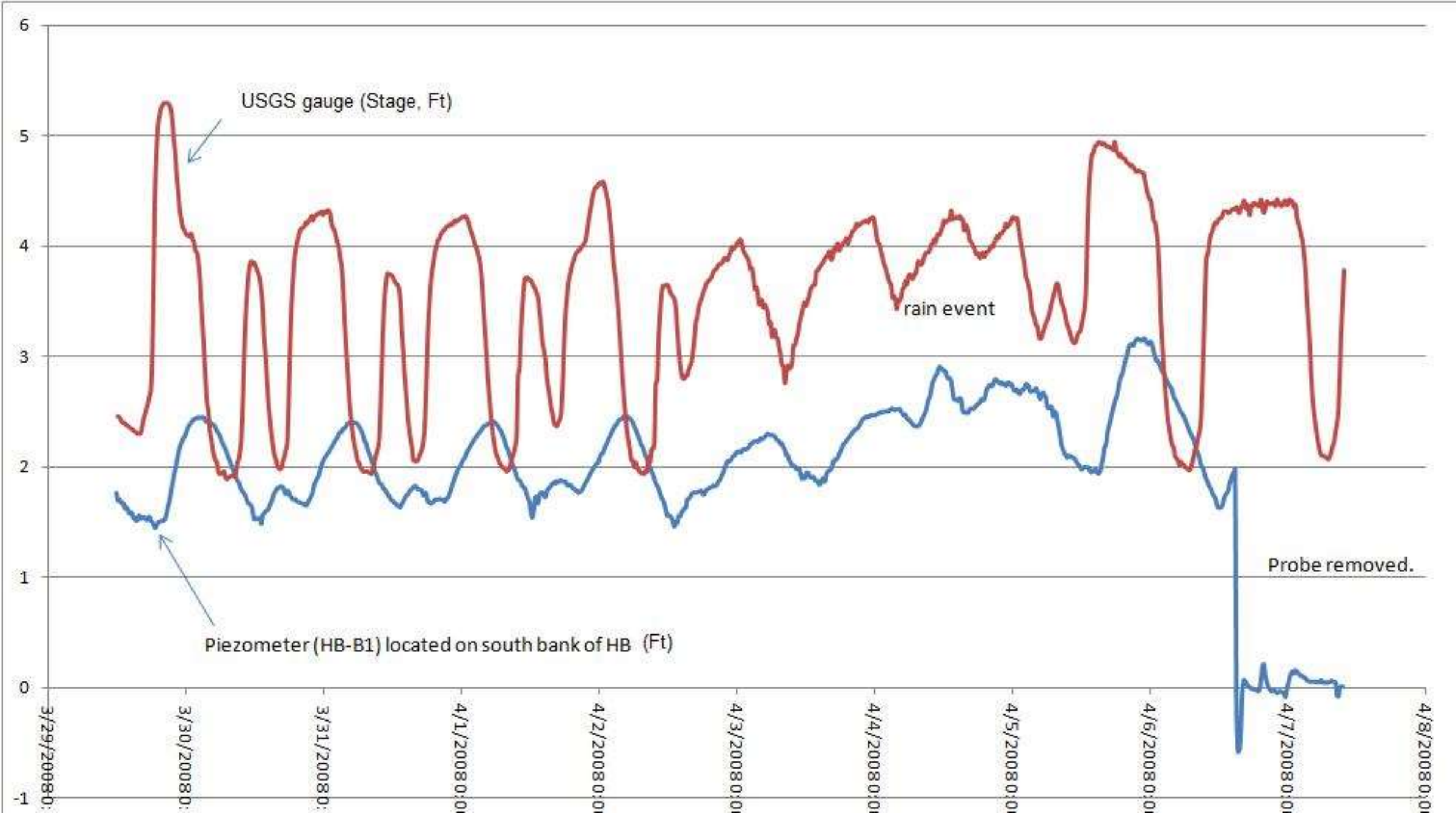


Figure 2. Map of Hornsby Bend piezometer transect. Bank piezometers are numbered in order of distance from the river, and the river stage recorder is denoted as (R). Dashed lines indicate the estimated extent of dam influence on the water table



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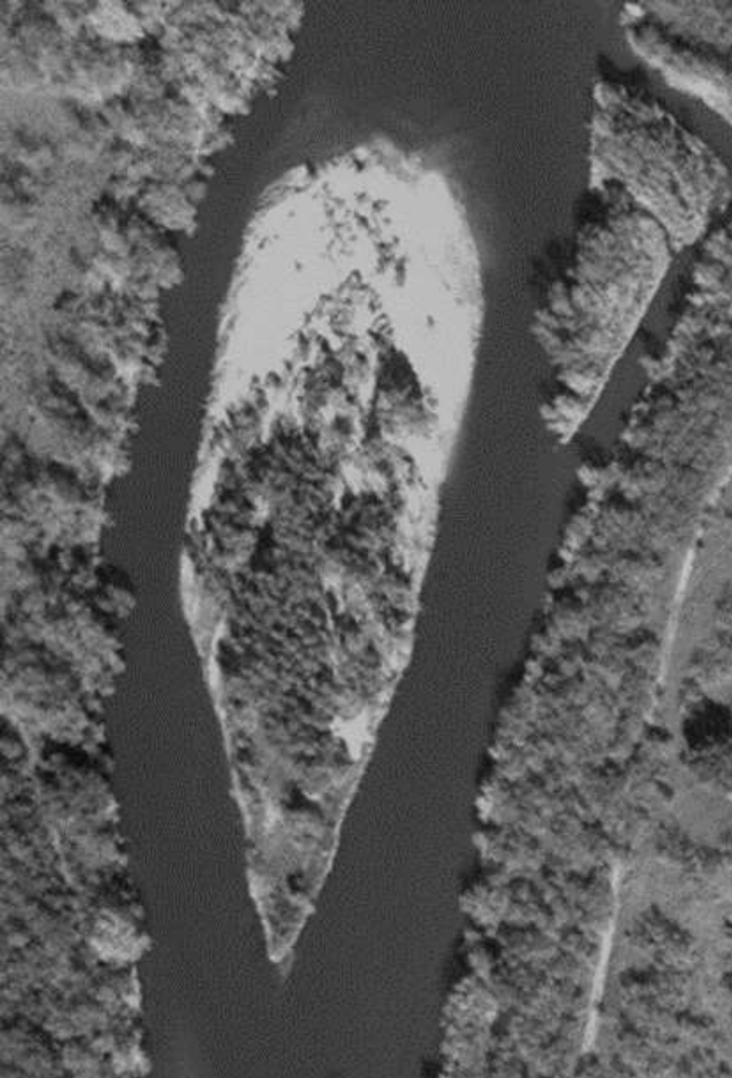

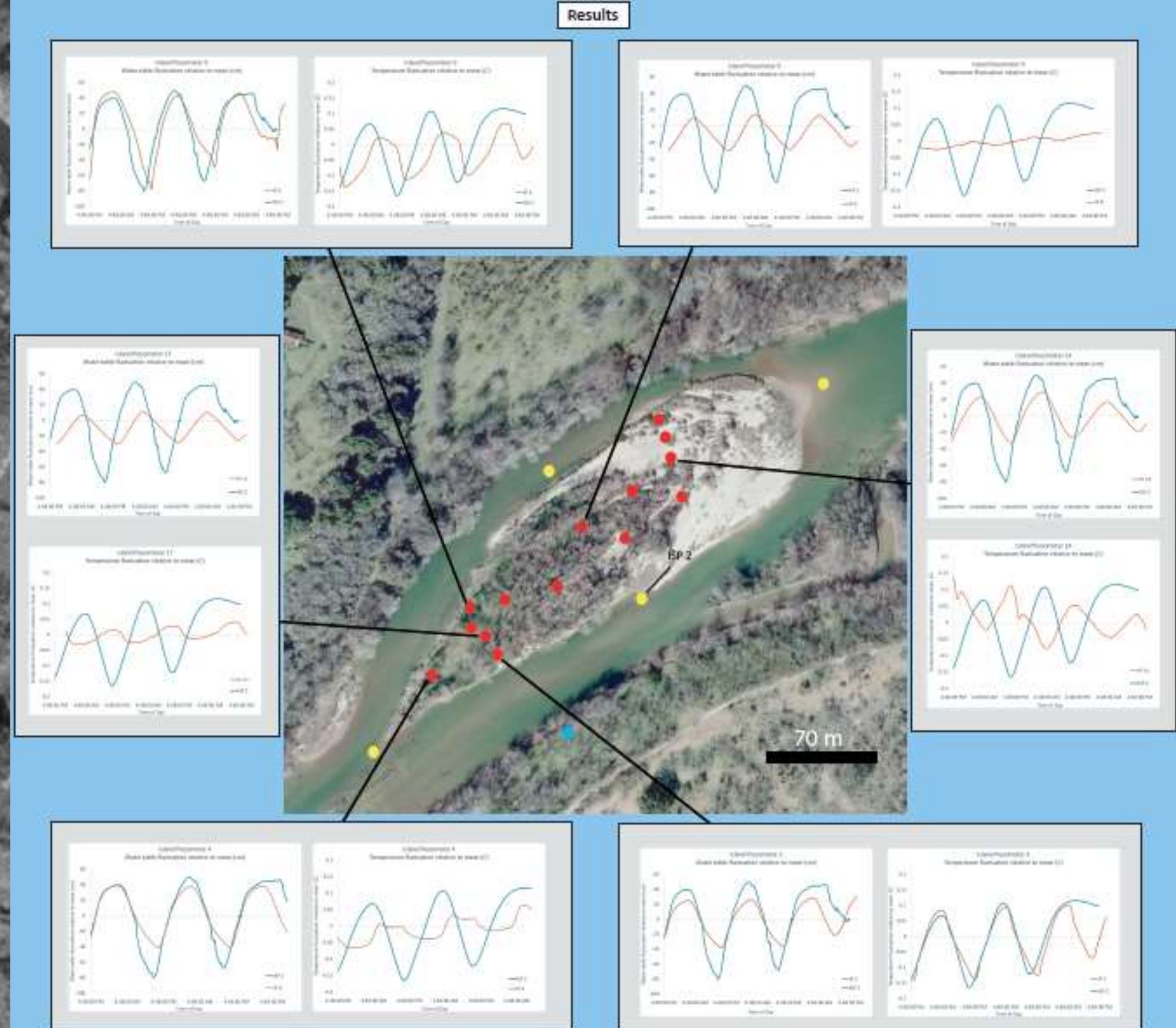

Figures 7-19. Map of Hornsby Bend Island showing the locations of island (red), instream (yellow), and bank (blue) piezometers, and time series data of water table and temperature fluctuations relative to a mean. Island piezometer (IP) data is coupled with instream piezometer (ISP) data.

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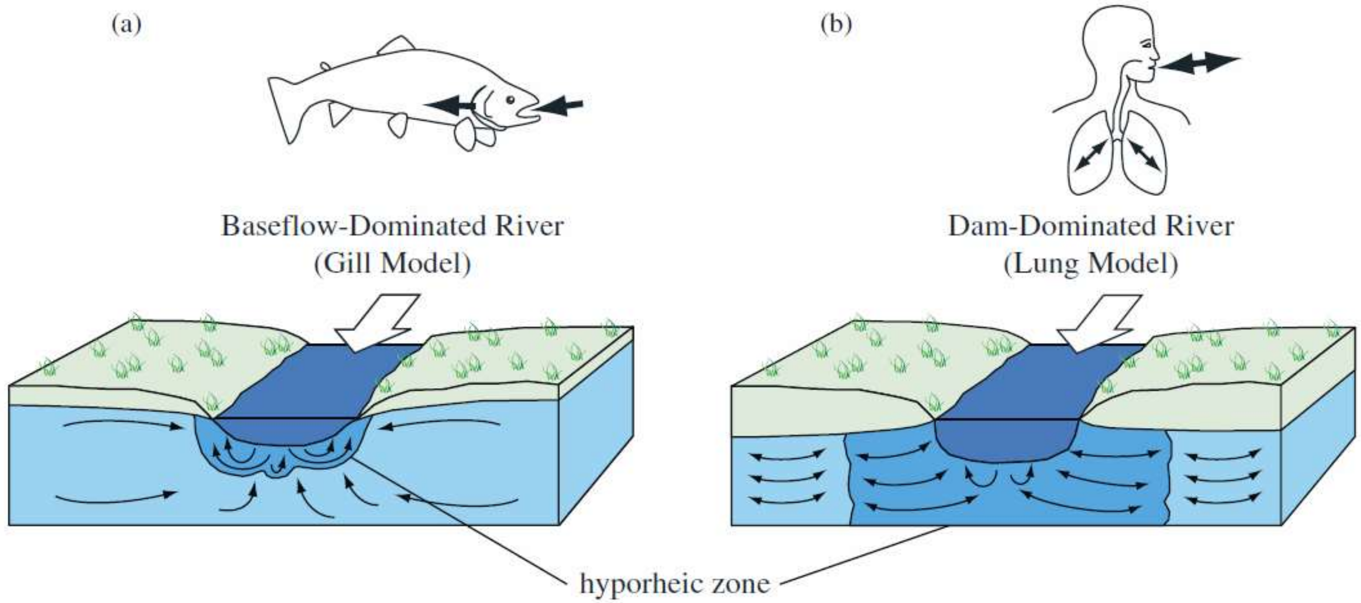


Figure 10. (a) Conceptual model of a natural river-groundwater system in a reach dominated by baseflow. During most of the year, groundwater flows steadily through the riparian aquifer in one direction like water through a gill. Groundwater discharge to the river limits the size of the hyporheic zone. (b) Conceptual model of a river-groundwater system downstream of a dam. Due to frequent stage fluctuations, river water flows in and out of the riparian aquifer like air flowing in and out of lungs. The hyporheic zone includes all flow paths that start and end in the channel

The Riparian Sponge

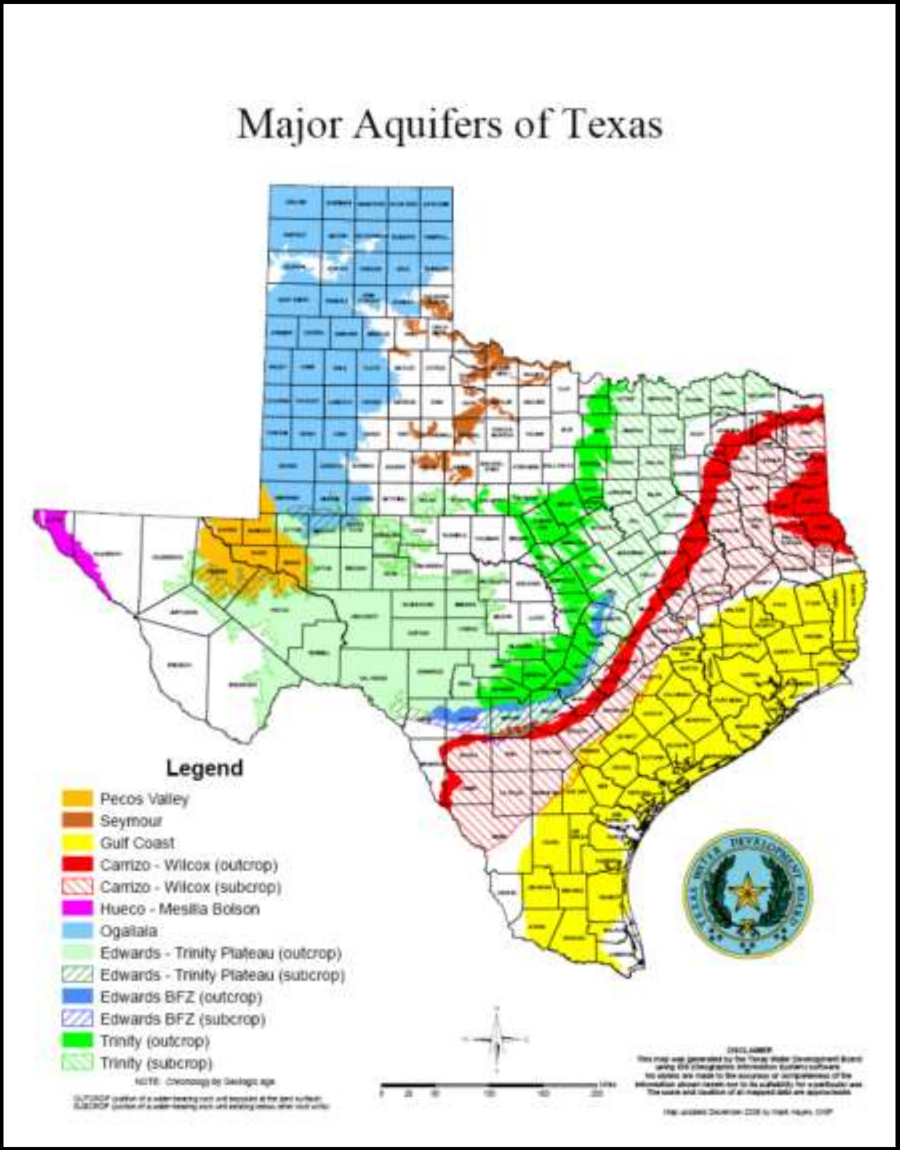
- One of the attributes of a properly functioning riparian area is the sponge effect and water storage capacity within the riparian area.
- This large absorbent sponge of riparian soil and roots will soak up, store, and then slowly release water over a prolonged period.
- This riparian sponge can be managed in a way to greatly increase and improve this storage or it can be managed in a way to decrease and degrade water storage.

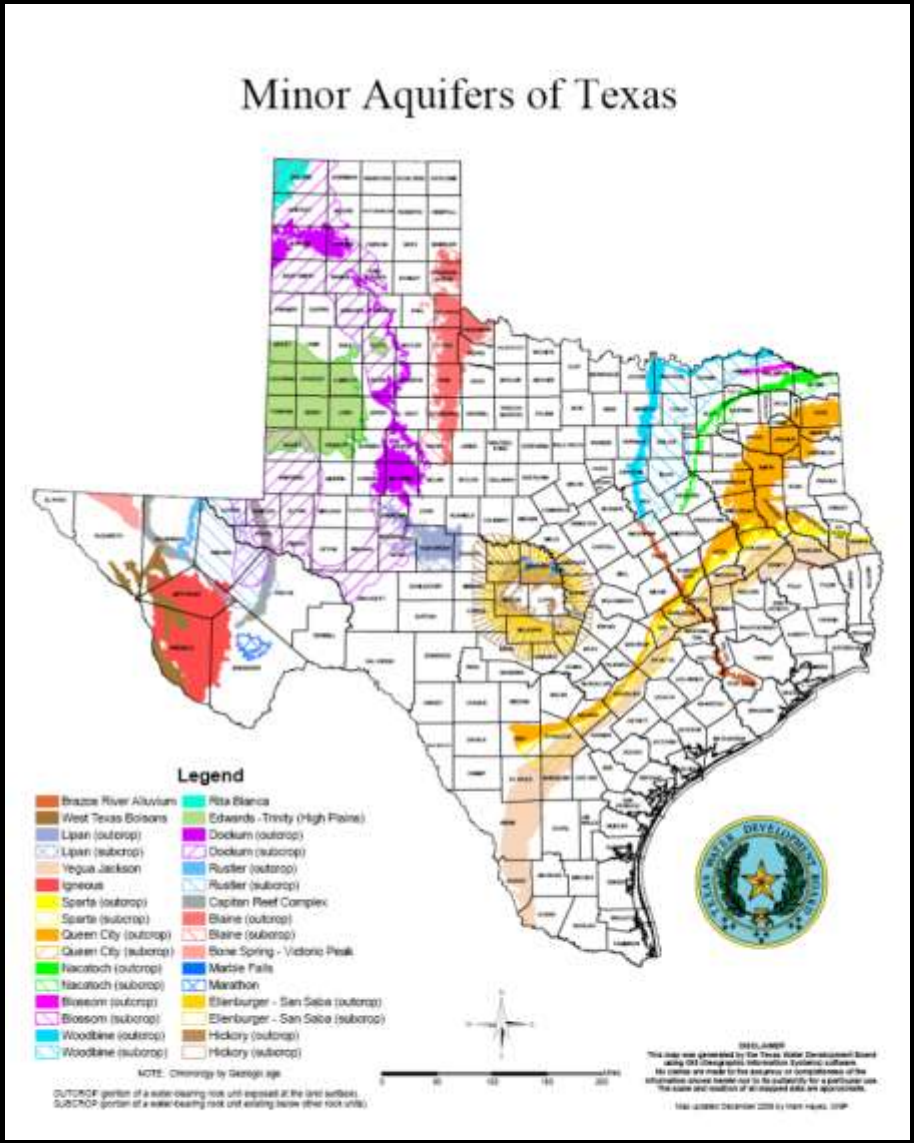
Alluvial Aquifers and the Riparian Sponge

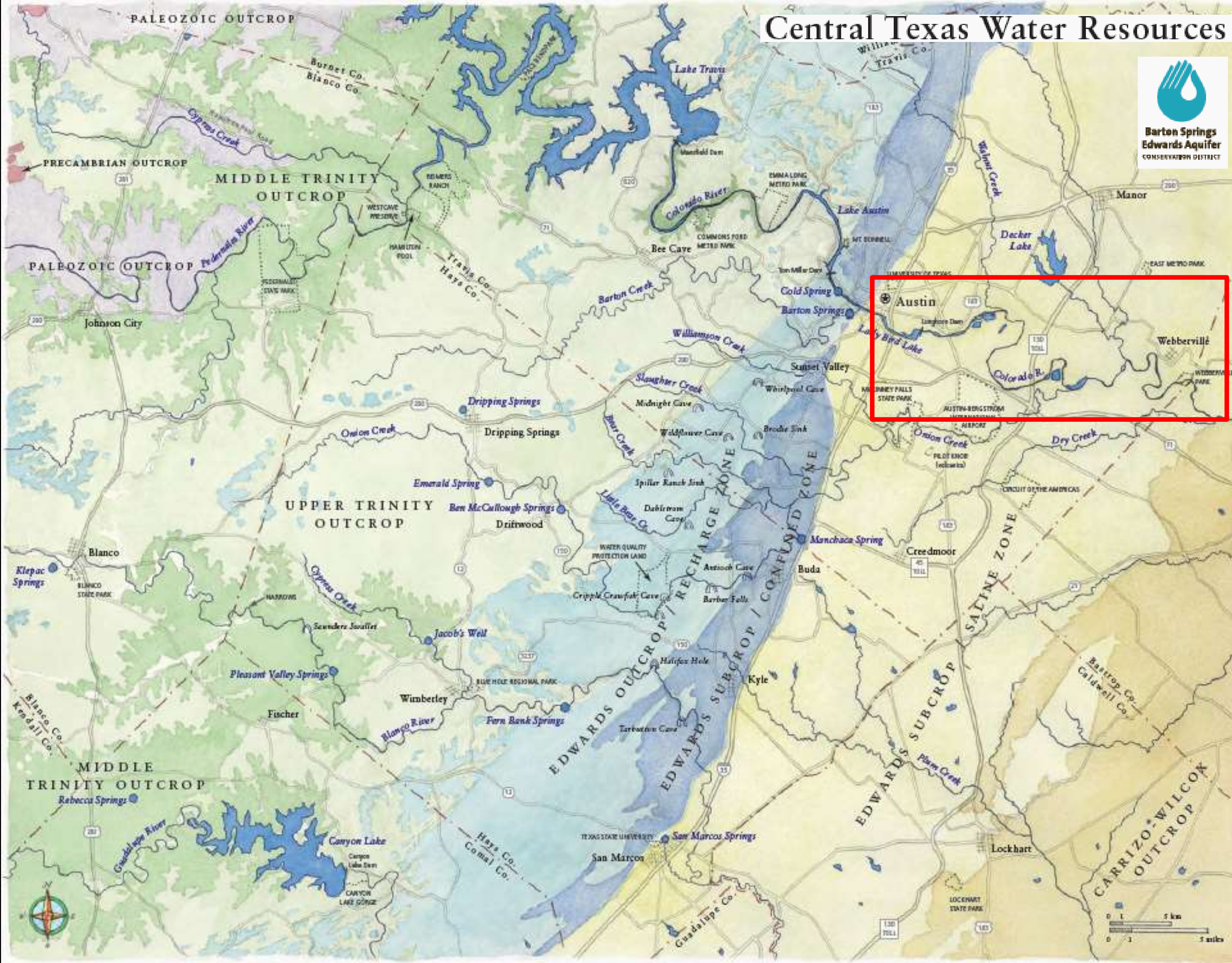
Storage capacity – Bear Creek, Central Oregon study

12 acres of riparian area per mile = 12 acre feet of water per mile

Riparian Water in Texas?
Alluvial Aquifers?



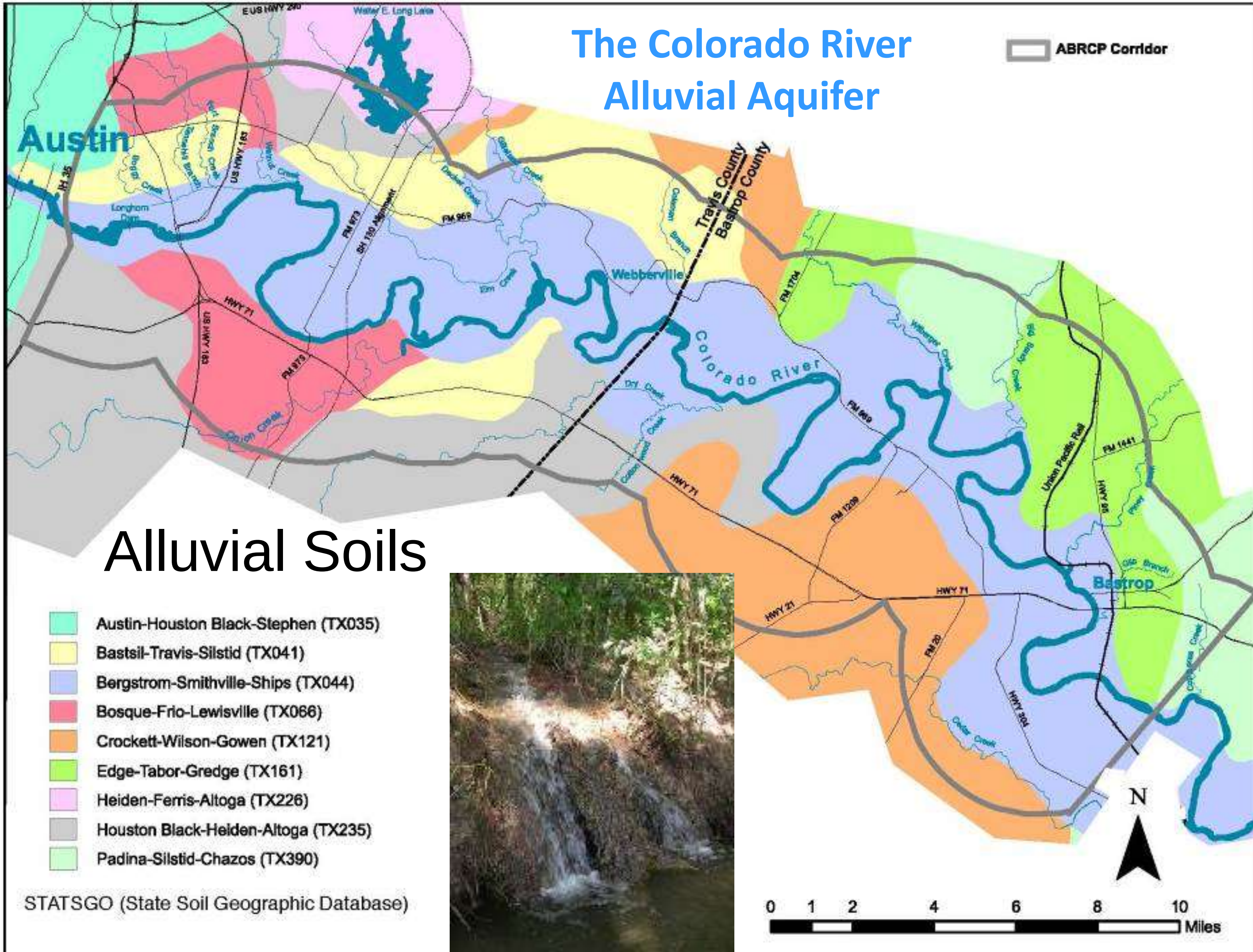




Central Texas Water Resources
Barton Springs Edwards Aquifer Conservation District
PALEOZOIC OUTCROP
PRECAMBRIAN OUTCROP
MIDDLE TRINITY OUTCROP
PALEOZOIC OUTCROP
UPPER TRINITY OUTCROP
MIDDLE TRINITY OUTCROP
EDWARDS OUTCROP / RECHARGE ZONE
EDWARDS SUBCROP / CONFINED ZONE
EDWARDS SUBCROP
SALINE ZONE
CARRIZO-WILCOX OUTCROP
Burnet Co.
Blanco Co.
Travis Co.
Hays Co.
Blanco Co.
Kendall Co.
Hays Co.
Comal Co.
Guadalupe Co.
Bastrop Co.
Caldwell Co.
Lake Travis
Mansfield Dam
Colorado River
Lake Austin
Cold Spring
Barton Springs
Lady Bird Lake
Longhorn Dam
Colorado R.
Decker Lake
Walnut Creek
Cypress Creek
Pedernales River
Barton Creek
Williamson Creek
Slaughter Creek
Bear Creek
Onion Creek
Little Bear Cr.
Dry Creek
Plum Creek
Cypress Creek
Blanco River
Guadalupe River
Canyon Lake
Canyon Lake Dam
Canyon Lake Gorge
Austin
Manor
Webberville
Webberville Park
East Metro Park
Bee Cave
Sunset Valley
Johnson City
Dripping Springs
Driftwood
Blanco
Buda
Creedmoor
Kyle
Wimberley
Fischer
San Marcos
Texas State University
Lockhart
Lockhart State Park
Westcave Preserve
Reimers Ranch
Hamilton Pool
Pedernales State Park
Emma Long Metro Park
Commons Ford Metro Park
Mt. Bonnell
Tom Miller Dam
University of Texas
McKinney Falls State Park
Austin-Bergstrom International Airport
Pilot Knob (volcanic)
Circuit of the Americas
Blanco State Park
Narrows
Blue Hole Regional Park
Water Quality Protection Land
Dripping Springs
Emerald Spring
Ben McCullough Springs
Klepac Springs
Jacob's Well
Pleasant Valley Springs
Fern Bank Springs
Rebecca Springs
Manchaca Spring
San Marcos Springs
Whirlpool Cave
Midnight Cave
Wildflower Cave
Brodie Sink
Spillar Ranch Sink
Dahlstrom Cave
Antioch Cave
Cripple Crawfish Cave
Barber Falls
Halifax Hole
Tarbottom Cave
Saunders Swallet
5 km
5 miles

The Colorado River Alluvial Aquifer

Alluvial Soils

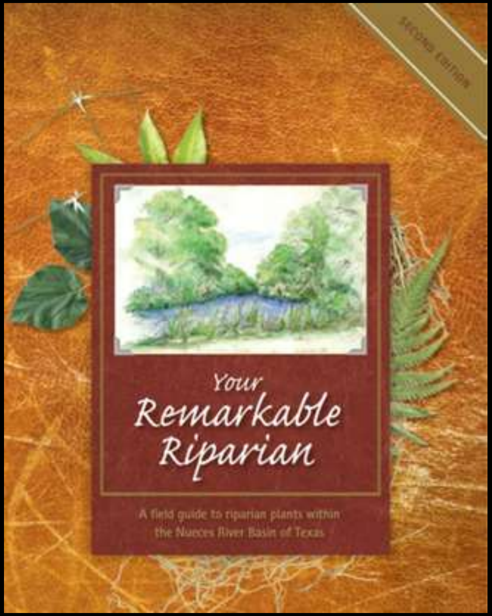


Texas Riparian Association - Founded 2001

Mission: Encouraging healthy riparian systems in Texas

Texas - 3,700 named streams and 15 major rivers

www.texasriparian.org



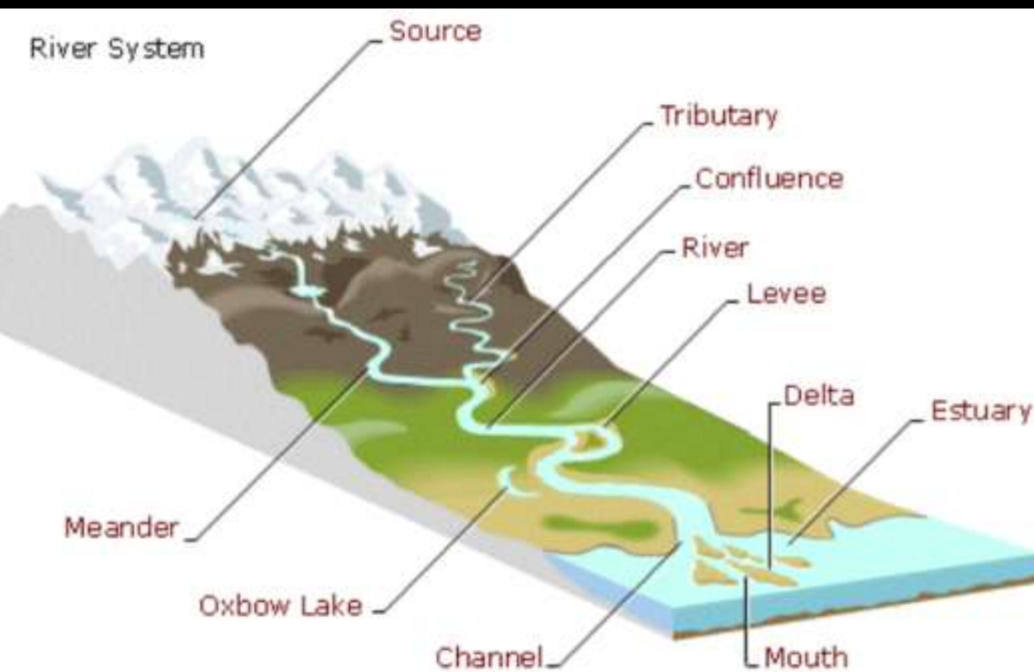
Riparian Zones and the River Course

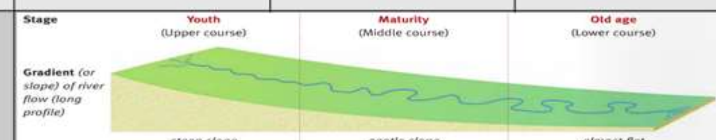
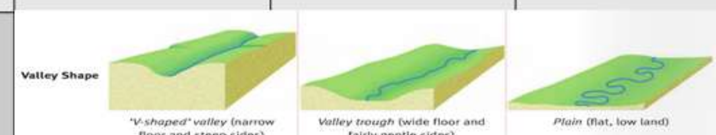
Fluvial Geomorphology and Riparian Ecology

The Upper Course: steep and rugged

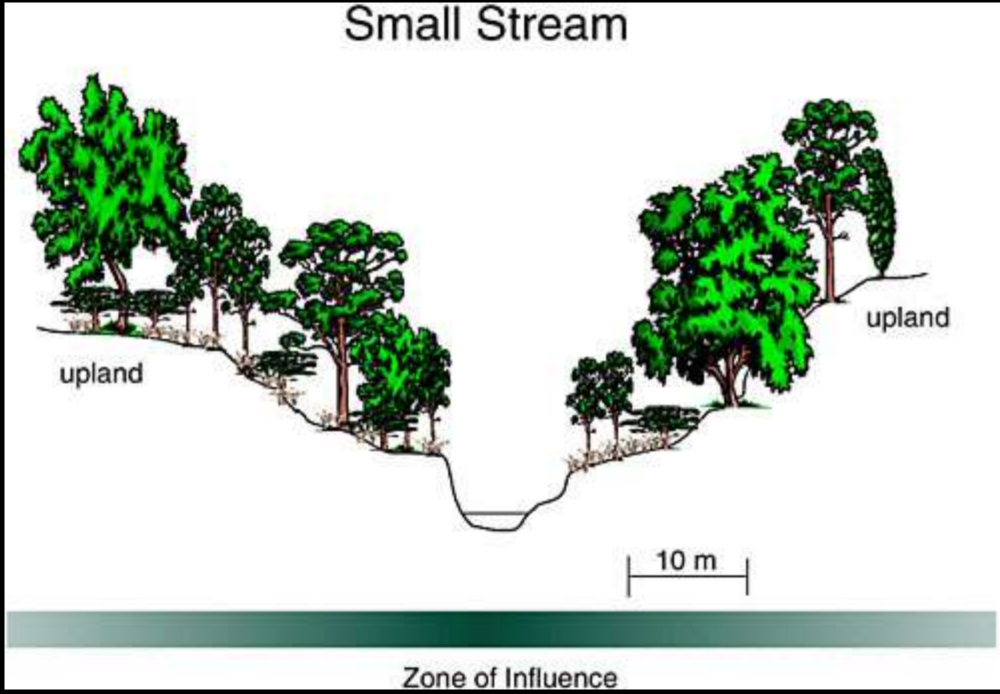
The Middle Course: winding sedately through wide valleys

The Lower Course: a somewhat aimless course toward final extinction



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)

The Upper Course - Youthful Headwaters

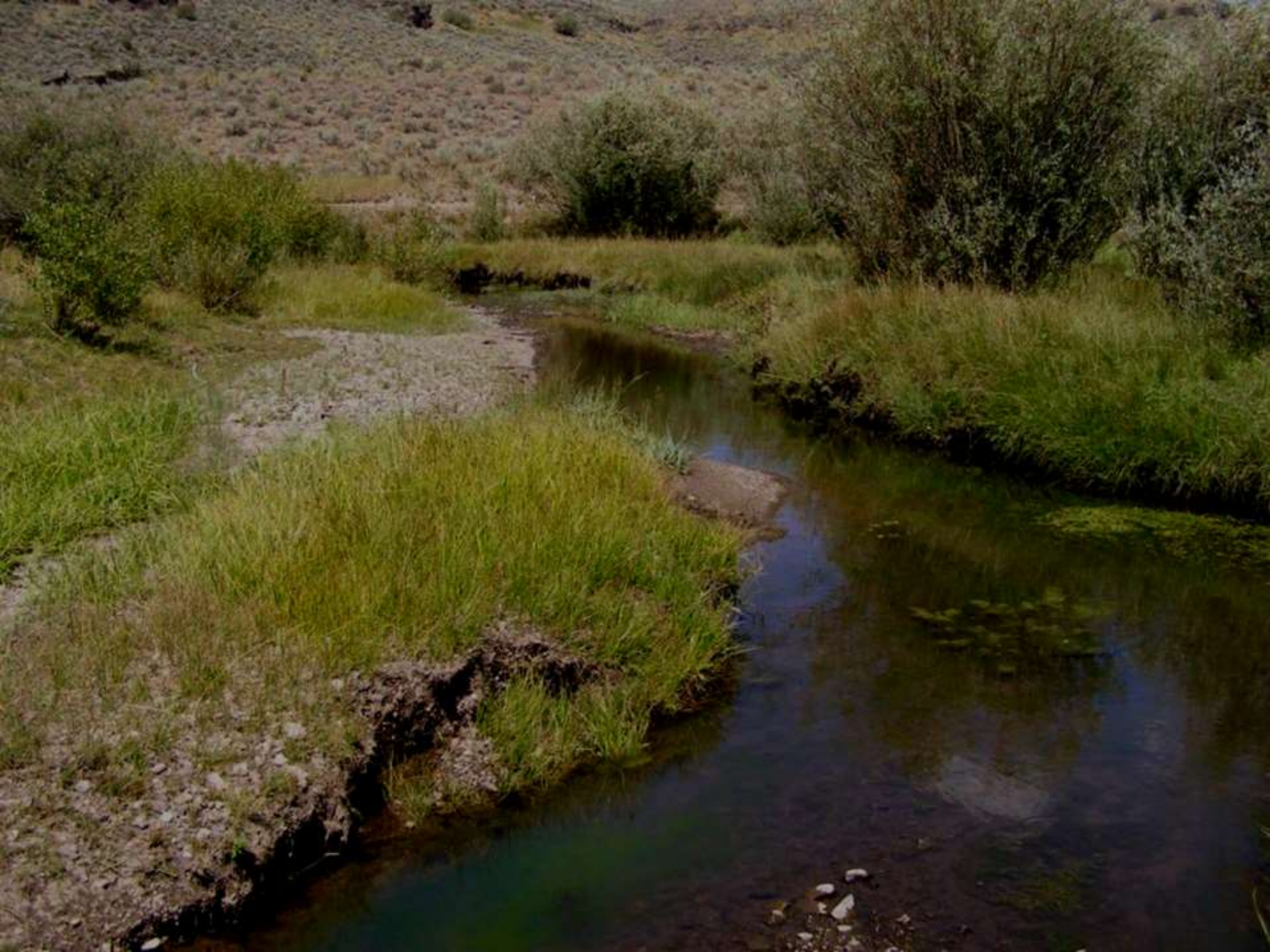


The Upper Course
Critical Riparian Zone

Shade and Plant Material

- Shade - In temperate environments, small streams tend to be shaded by an interlocking, overhead tree canopy.
- Such conditions result in cool, well-oxygenated streams that are abundantly supplied with a food base of plant material.
- Fine particles of organic matter are released as the plant material is broken down by biological communities in the streams
- The foundation of the aquatic food web

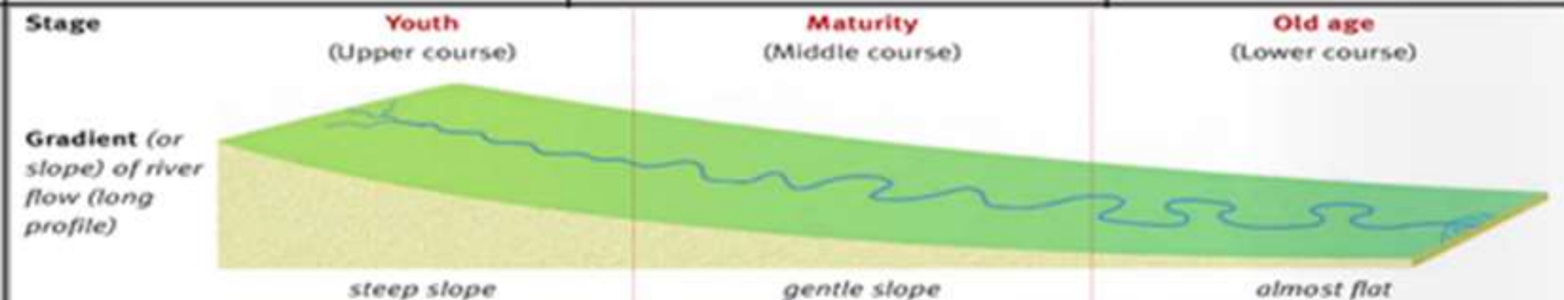

Upper Course – Arid Southwest
Critical Riparian Area

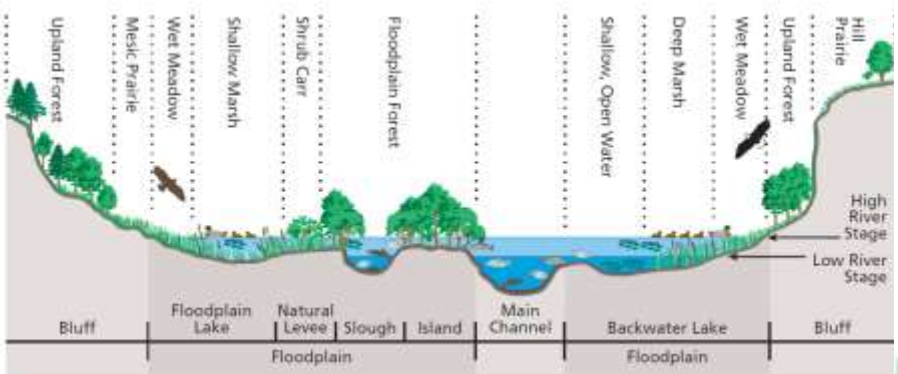


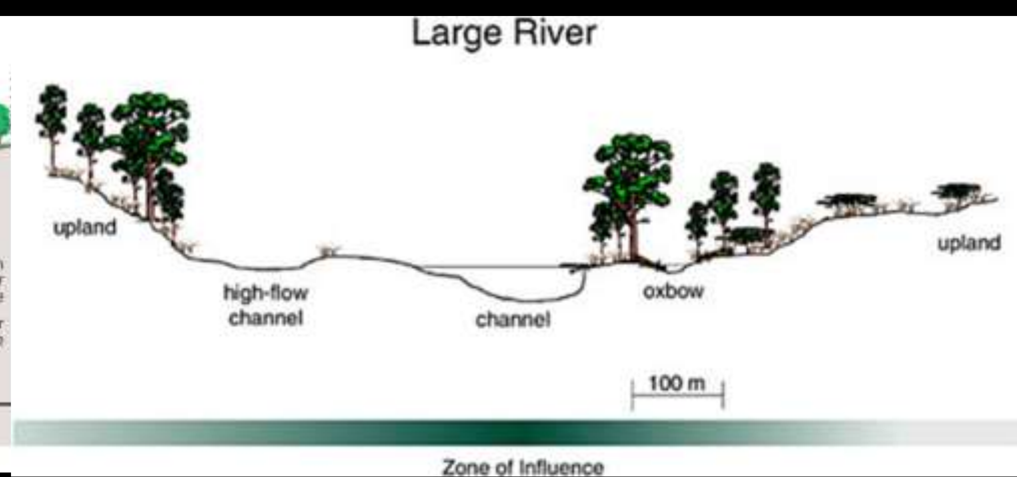
The Middle Course

Winding Sedately – Erosion and Deposition

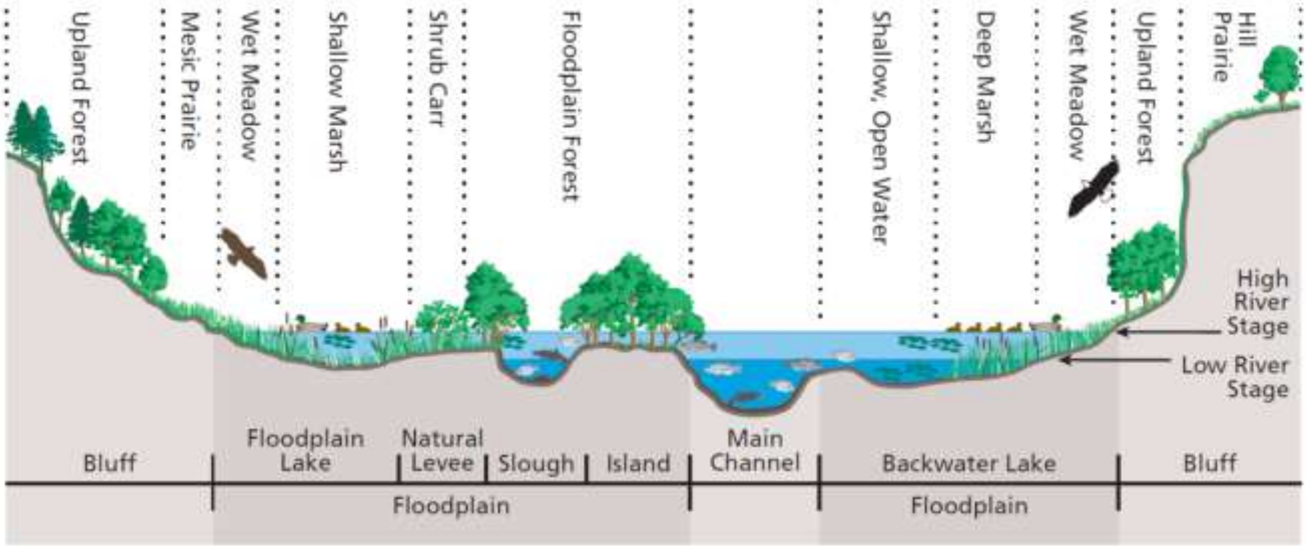
Sinuosity is inversely proportional to slope

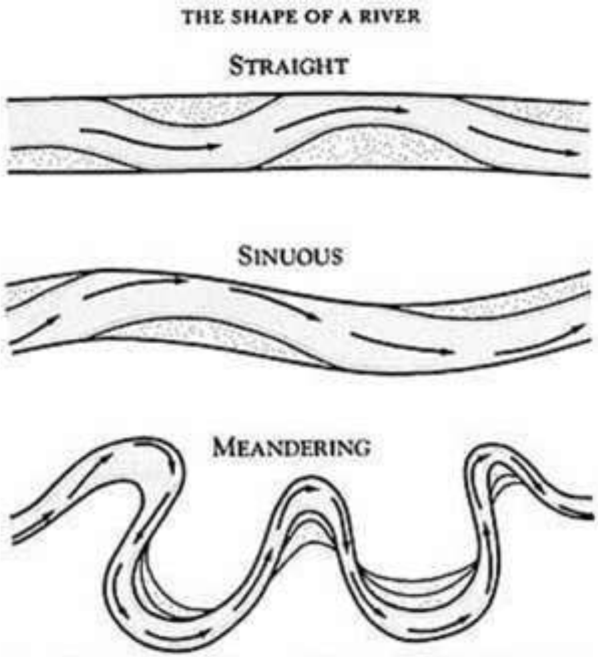
Course Stage	Upper Course Youth Stage	Middle Course Mature Stage	Lower Course Old Age Stage
Slope			

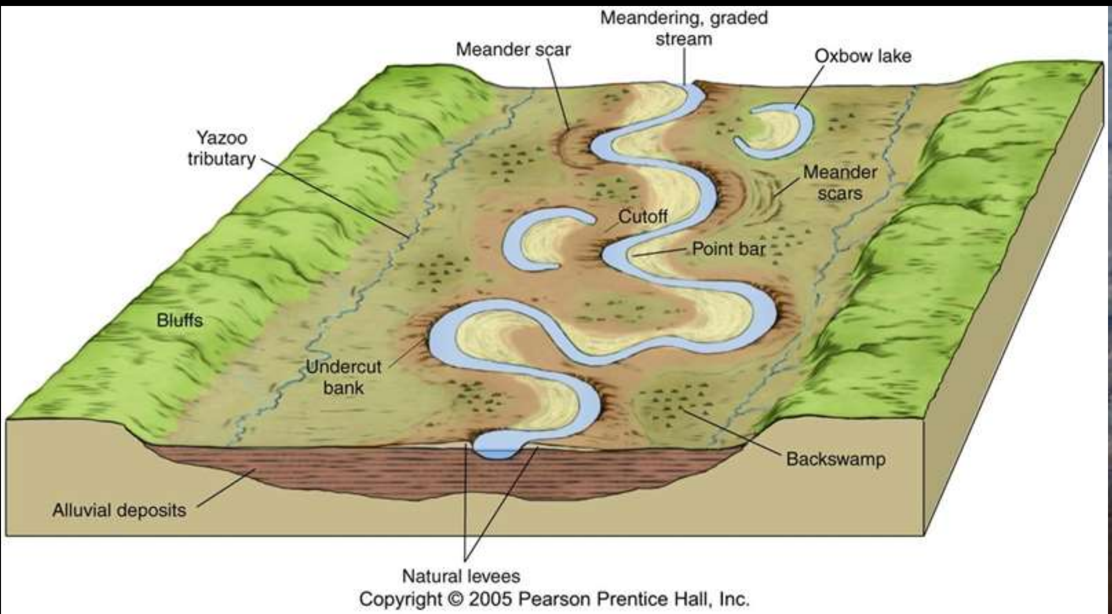




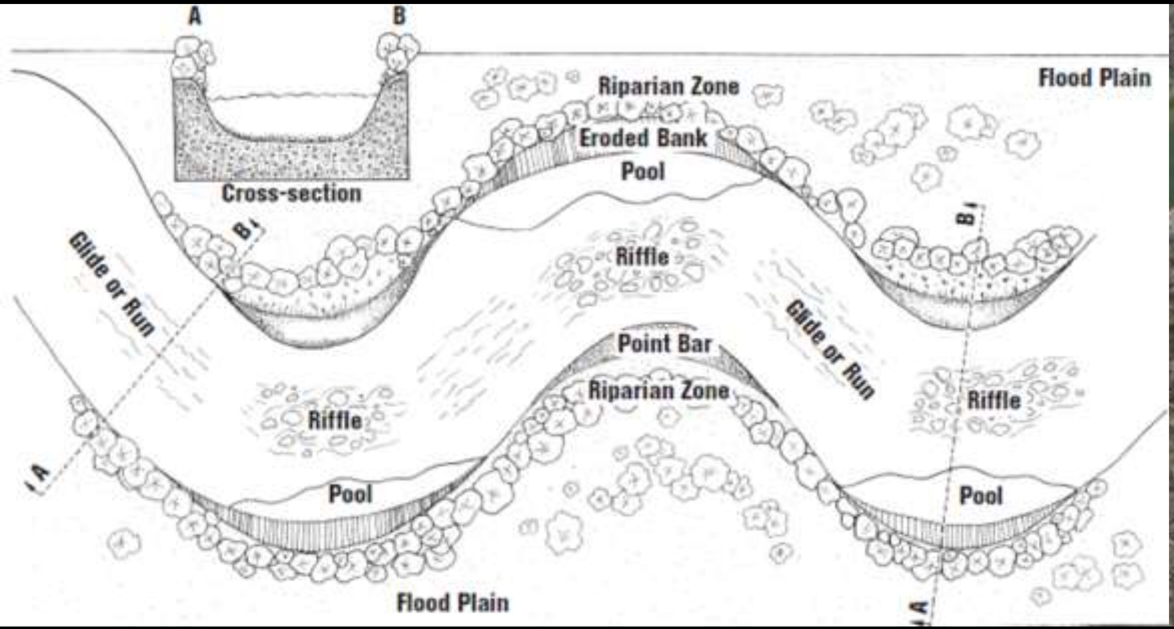
The Meander Belt – Diverse and Dynamic Riparian Habitat

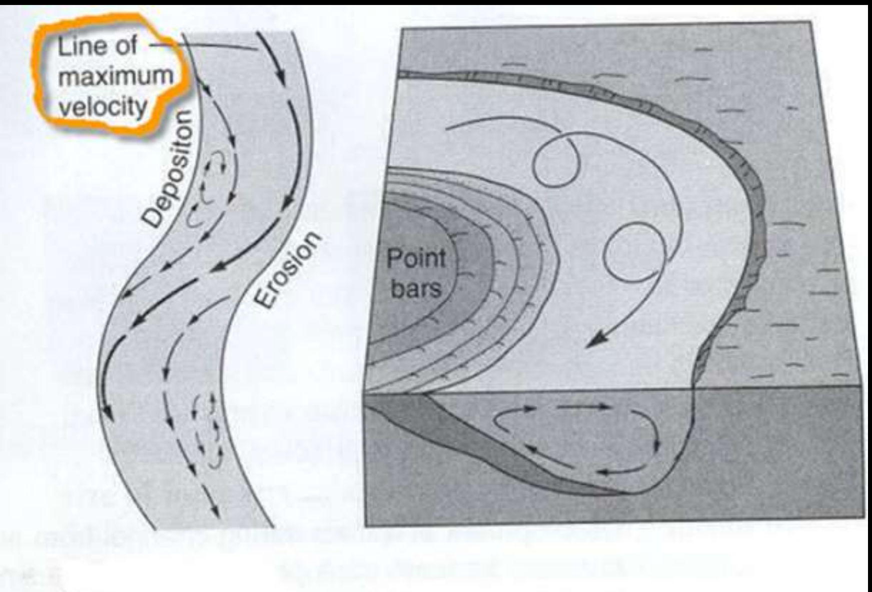






Erosional Zone and Depositional Zone





Helical flow in a meander.

The Middle Course

Wider Channel = More Solar Energy

- At some point along their path to the sea, rivers have typically gained enough water and width to preclude interlocking tree canopies.
- Streams at this point are warmer and less abundantly supplied with leaves than was the case upstream.
- Open canopy, and fairly shallow water, means that light can reach the river benthos, increasing in-stream primary productivity.

Colorado River, Texas

The Lower Course – Old Age

A somewhat aimless course toward final extinction

Wandering, Carrying, and Deposition

Colorado River, Texas

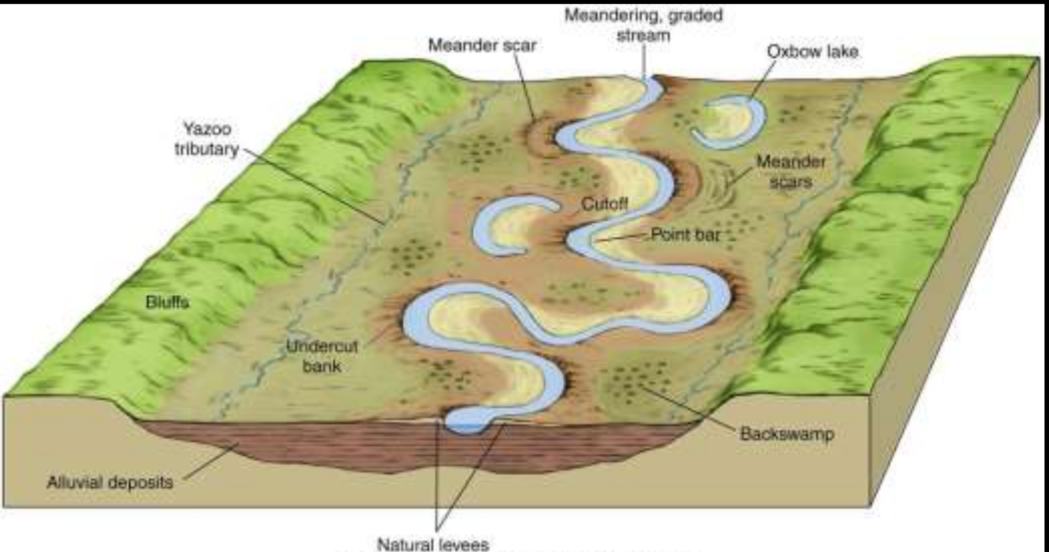
Floodplains, Bottomland Forests, and Riparian Levees (More Next Month!)

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

Bottomland Forest - When the floods subside, alluvium is deposited on the floodplain which can support a forest adapted to periodic flooding (hydric soils).

Natural levees - The larger materials, being heavier, are deposited at the river banks while the finer materials are carried and deposited further away from the river. The larger materials at the river banks build up into embankment called levees.

Riparian vegetation required for deposition to build banks/levees!!



Riparian Vegetation and Abiotic Functionality

The functionality of riparian zones is determined by a combination of factors –

- erosion
- deposition
- hydrology
- riparian vegetation

The most easily (and inexpensively) influenced factor is riparian vegetation

Bank Stability = Roots

A diverse plant community is critical to streambank stability.

Stable streambanks usually <u>need a mix of species that include those with both fine roots and those with larger, more substantial roots</u>. In most cases, this requires a mixture of sedges or rushes, grasses and woody species.

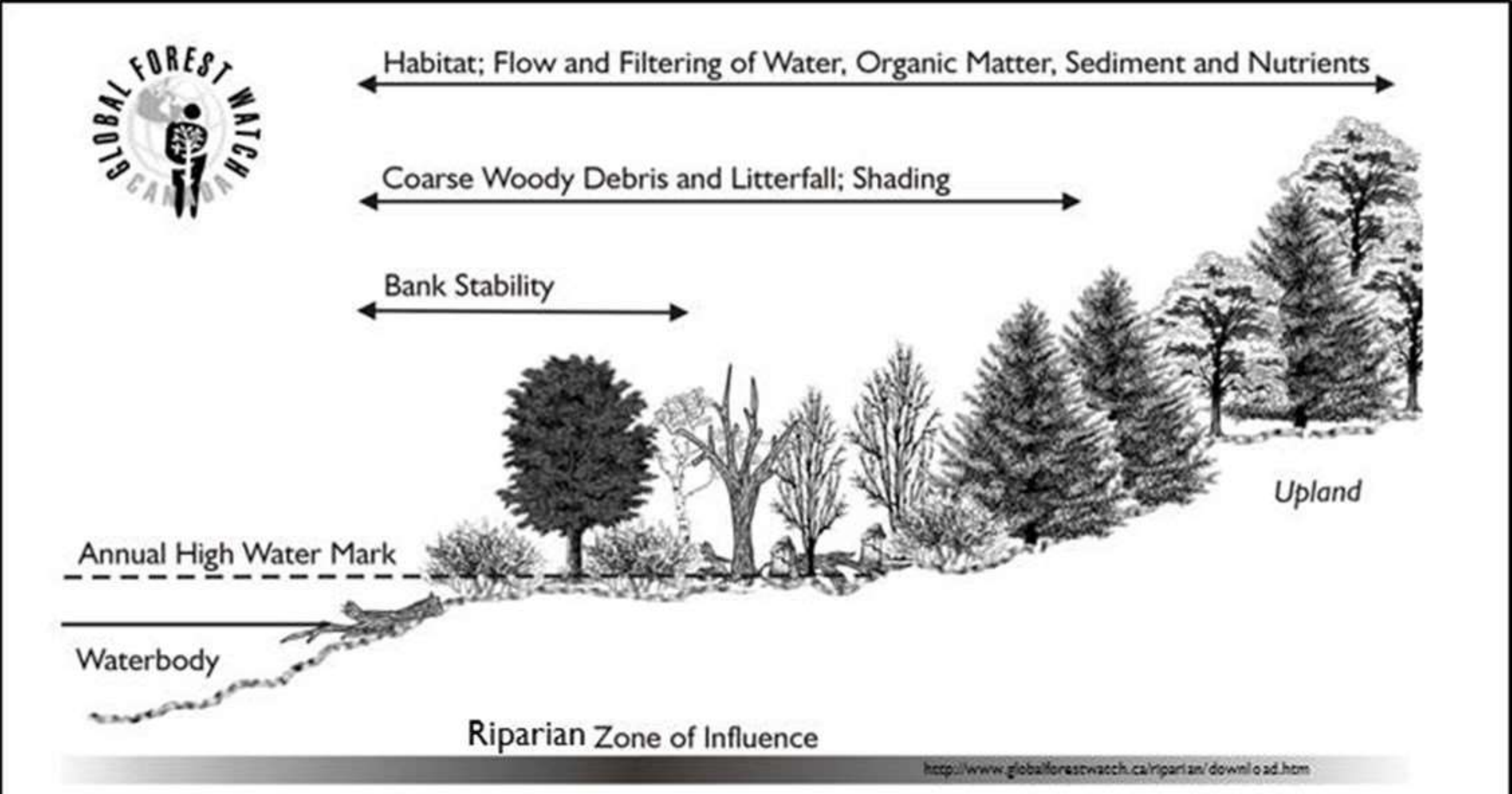
Proper Functioning Condition (PFC)

Riparian areas are functioning properly when adequate vegetation is present to:

- Dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality and quantity
- Filter sediment, capture bedload, and aid in floodplain development
- Improve flood-water retention and groundwater recharge
- Develop root masses that stabilize streambanks against cutting action and store water
- Develop diverse ponding and channel characteristics to provide habitat and the water depth and temperature necessary for fish, waterfowl, benthic macroinvertebrates, and other fauna
- Support greater biodiversity

Riparian Vegetation

- Plant community structured by hydrology
- Hydric Soils
- Different plant species support riparian zone ecosystem function.

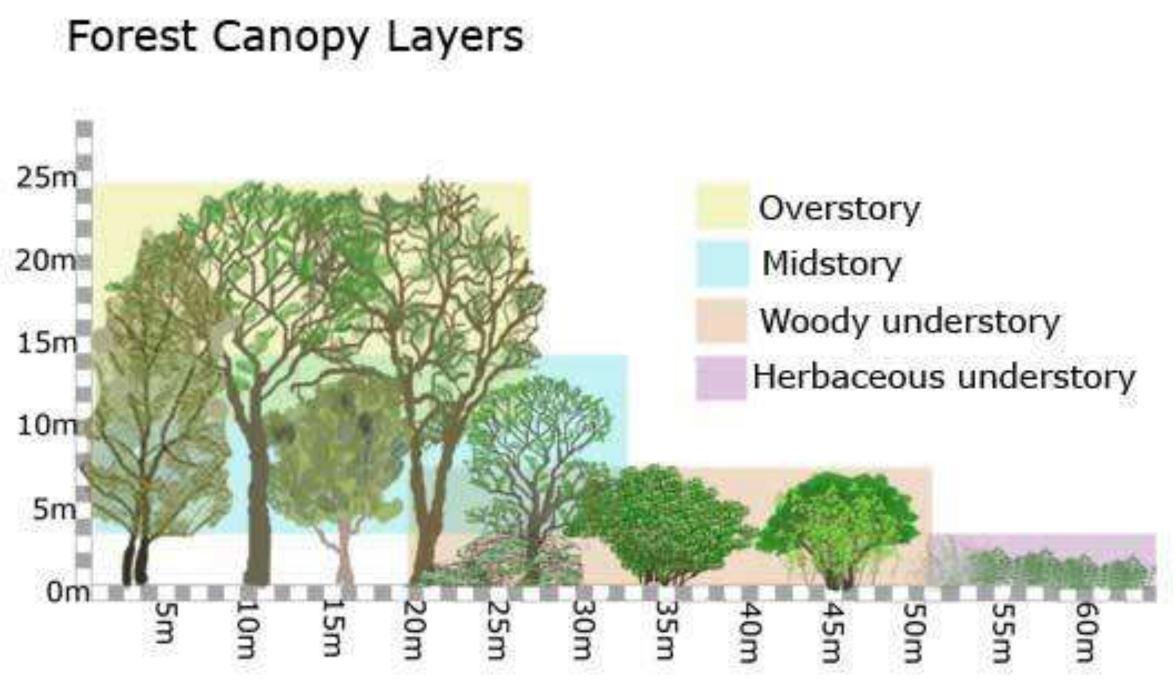


Riparian Vegetation

Riparian/Bottomland Forest and 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/Bottomland Forest - Vertical structure

At Permanent Waterline, not saturated year-long

Elderberry
Buttonbush
Dwarf willow
Sandbar willow
Black willow
Box elder
Sycamore
Cardinal Flower
Roughleaf dogwood
Bald cypress
Baccharis
River Hemp [Sesbania]

American Elm
Texas Sophora (Eve's Necklace)
Eastern Gamagrass
Switchgrass
Horsetail
Soft rush
Bulrushes
Sedges
Bushy bluestem
Smartweed
Cattails
Spikerushes

Permanently saturated (gravel bars)

Or in the water (wetland plants)

Bald Cypress

Southern wildrice (Zizaniopsis)

River Hemp [Sesbania]

Bulrushes

Horsetail

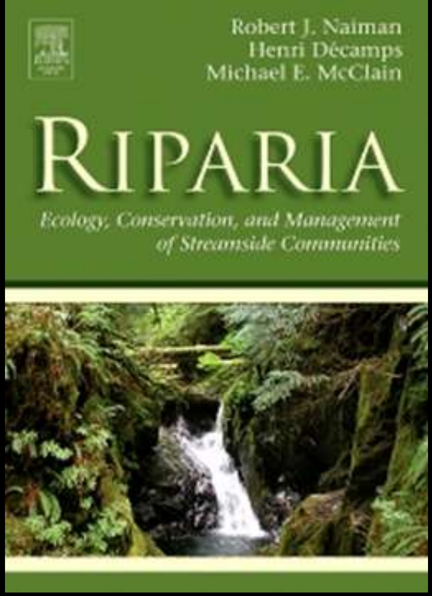
Rushes and Reeds

Sedges (have edges)

Cattails

Spikerushes

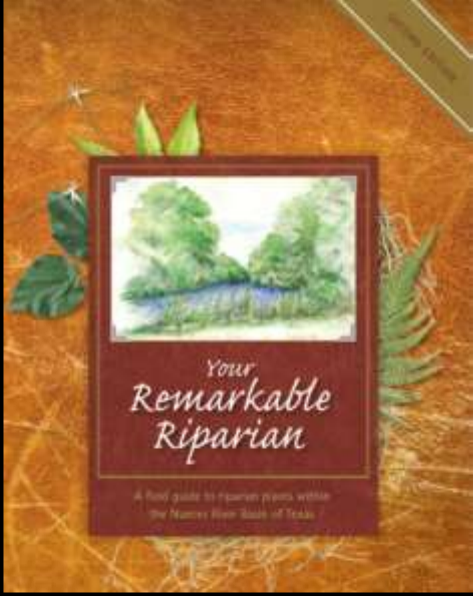
Ludwigia

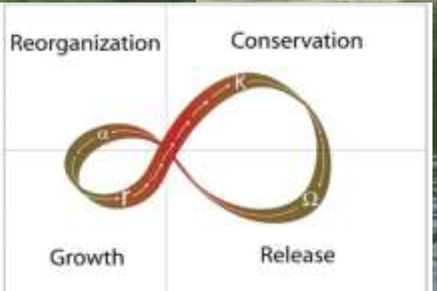


Riparian Process
Ecosystem Process

Types of Vegetation:
olonizers
Stabilizers
Woody

Nonequilibrium dynamics





Texas Riparian Ecosystems?

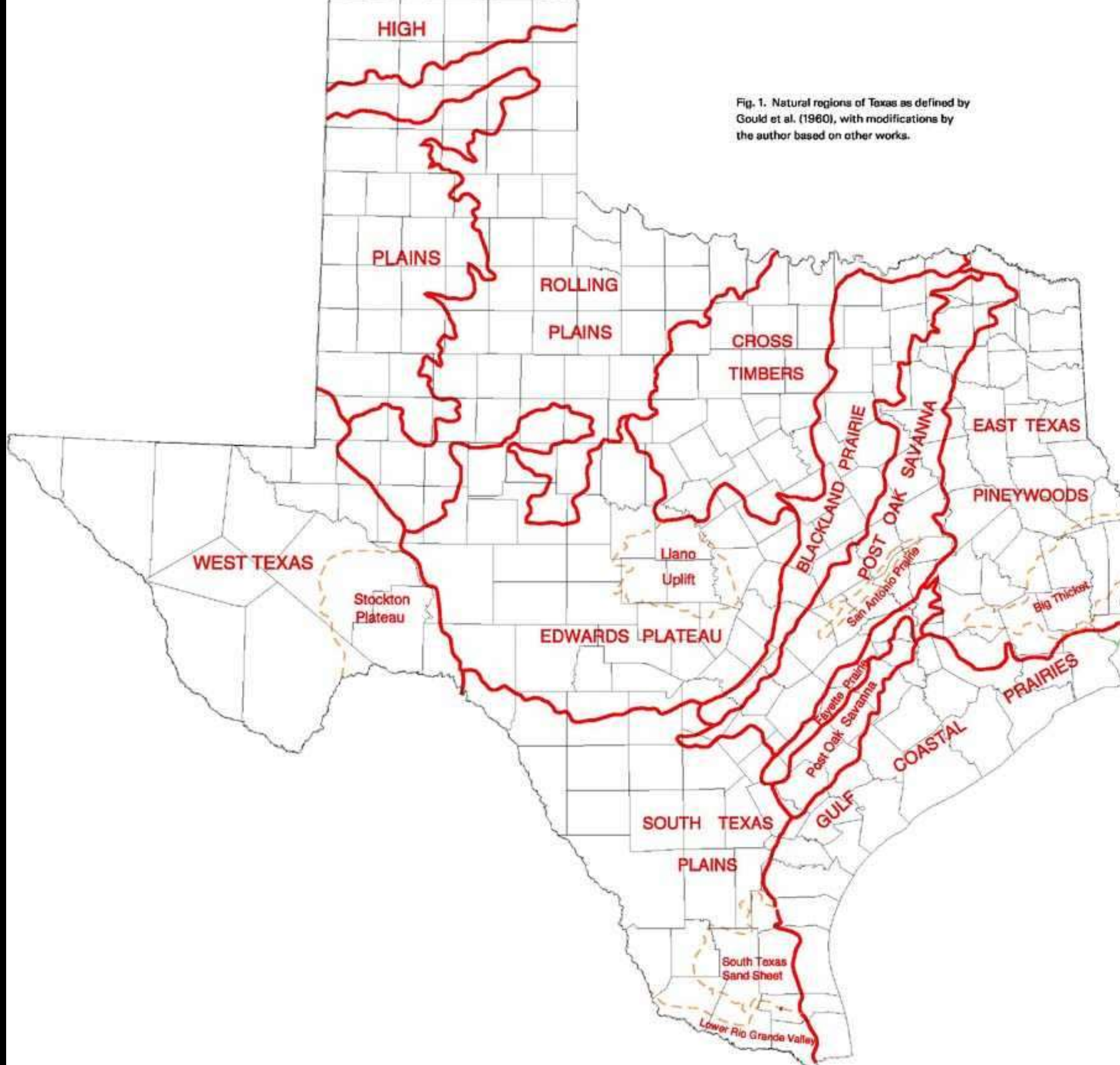
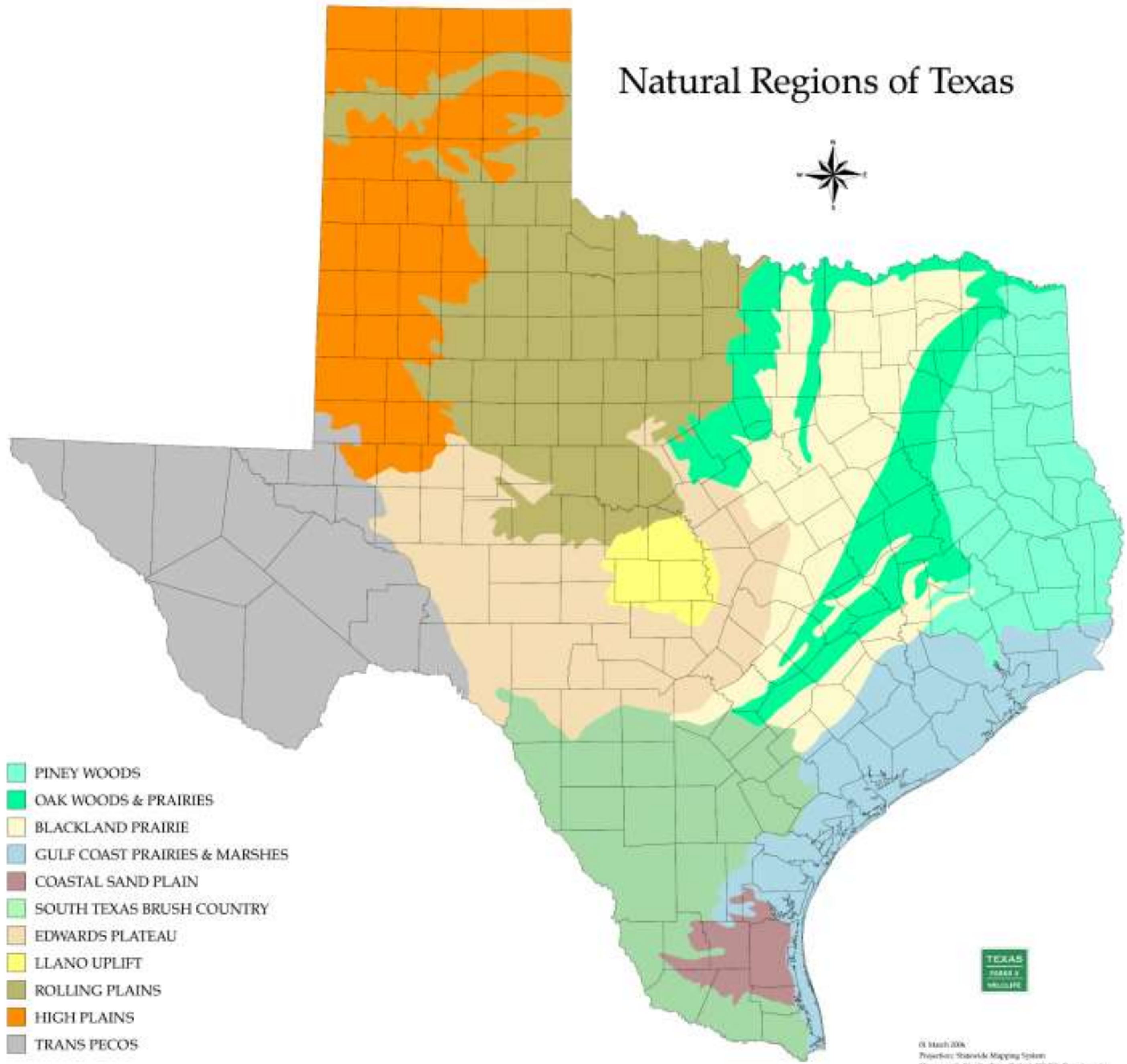


Fig. 1. Natural regions of Texas as defined by Gould et al. (1960), with modifications by the author based on other works.

Texas Riparian Ecosystems?



Source: *Preserving Texas' Natural Heritage.* LBJ School of Public Affairs Policy Research Project Report 31, 1978

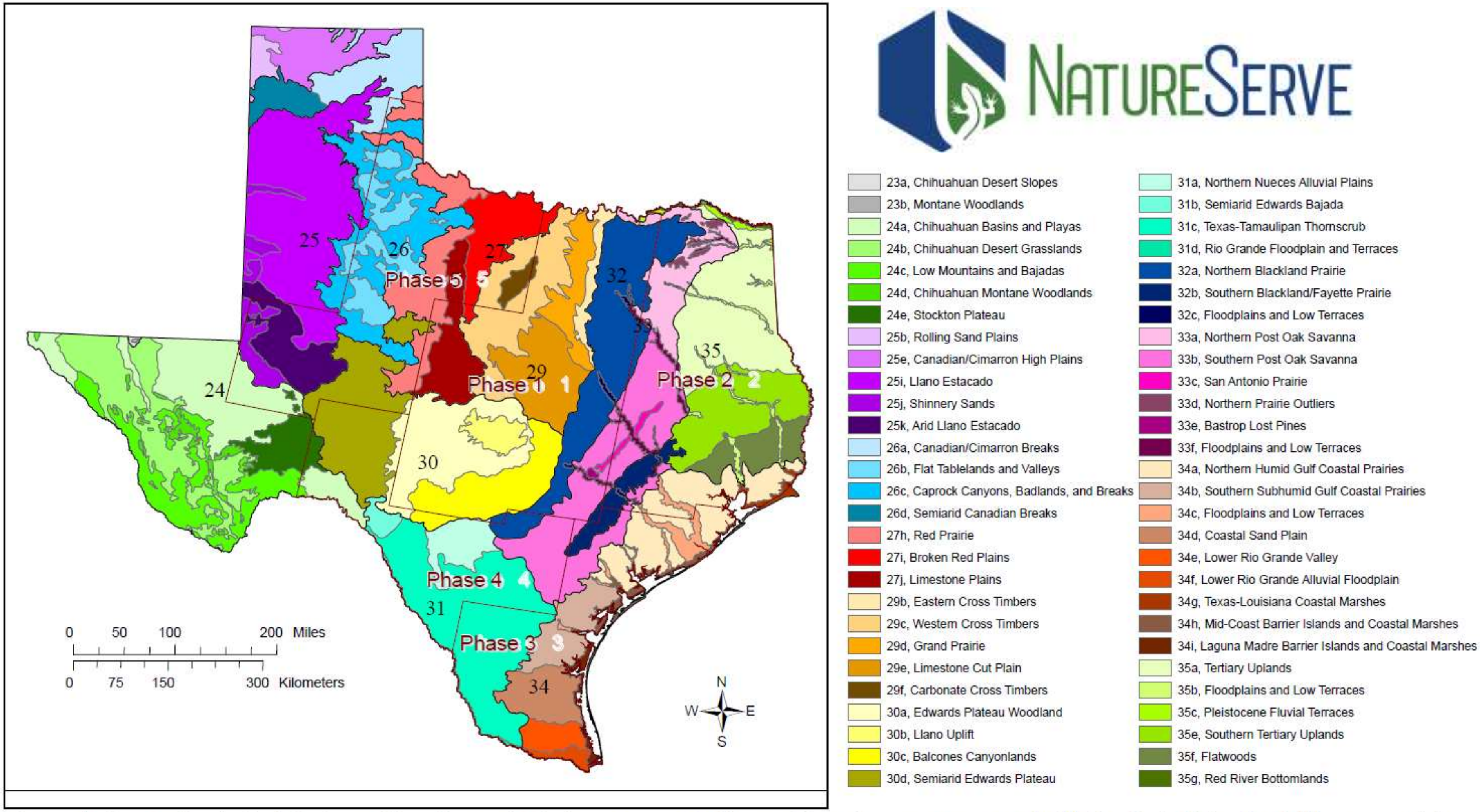


Figure 1. Texas Ecological Systems Mapping project phase map. Outlines of the phases correspond with the footprints of satellite scene data. The project will be completed in the early fall of 2012.

Contemporary Ecology of Texas - Texas Ecological Systems Project

Part of the NatureServe Terrestrial Ecological Systems of the United States

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

Texas Riparian Association

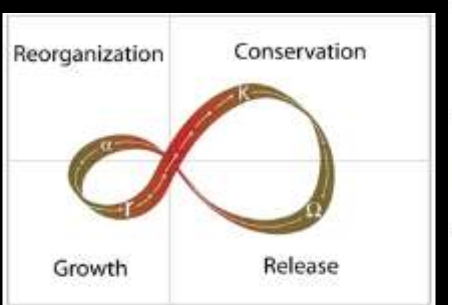
Southeastern Great Plains Floodplain Forest

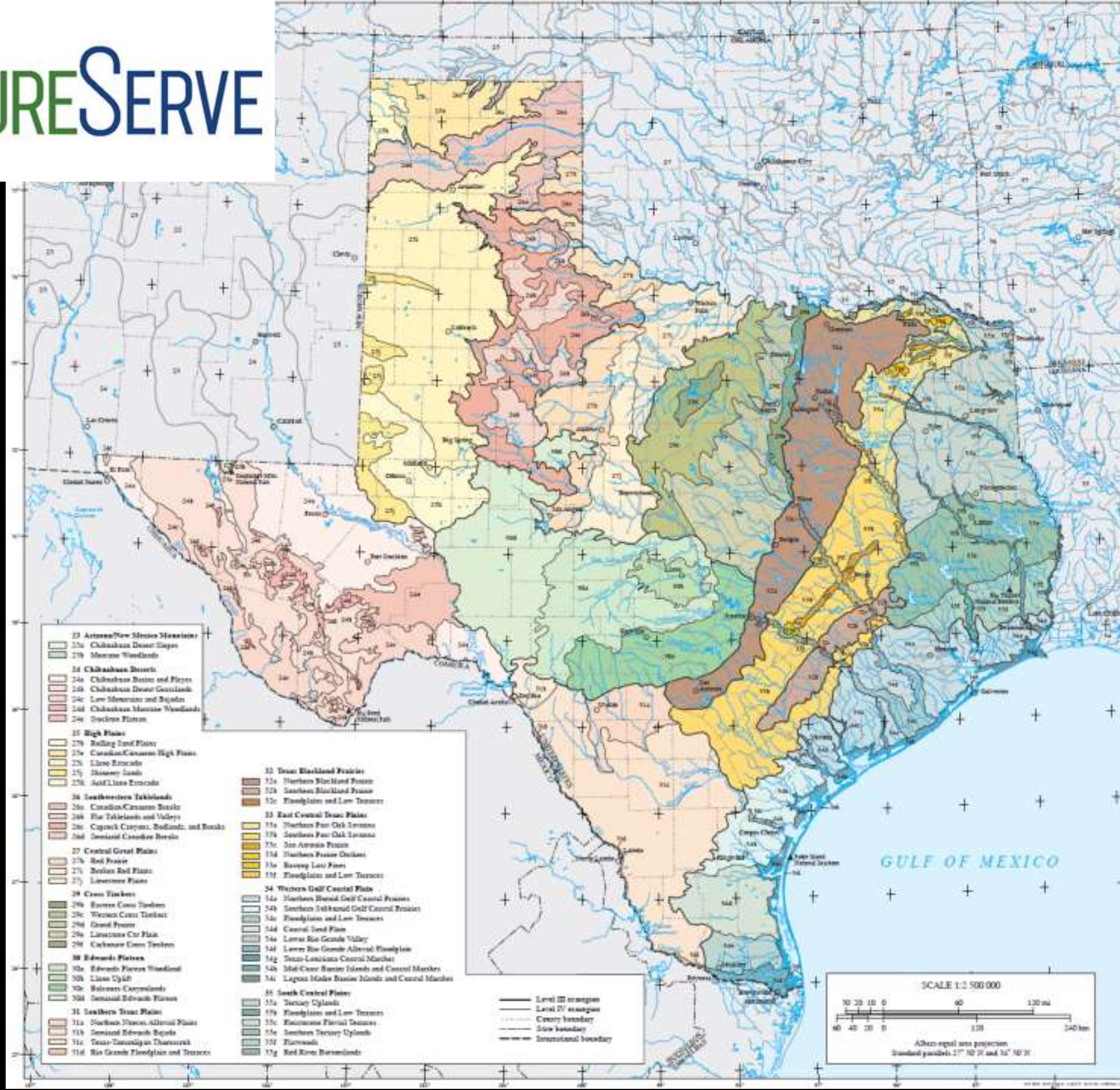
- Central Texas: Floodplain Juniper Forest
- Central Texas: Floodplain Live Oak Forest
- Central Texas: Floodplain Hardwood / Evergreen Forest
- Central Texas: Floodplain Hardwood Forest
- Central Texas: Floodplain Evergreen Shrubland
- Central Texas: Floodplain Deciduous Shrubland
- Central Texas: Floodplain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

NatureServe

Contemporary Texas Ecology

Prospective Ecology vs. Retrospective Ecology





Urban Riparian Restoration and Management

Texas Riparian Association

City of Austin
Founded 1839

Mowed | First Year Growth | 5 to 10 Years

City of Austin
WATERSHED PROTECTION


Riparian Faunal Biodiversity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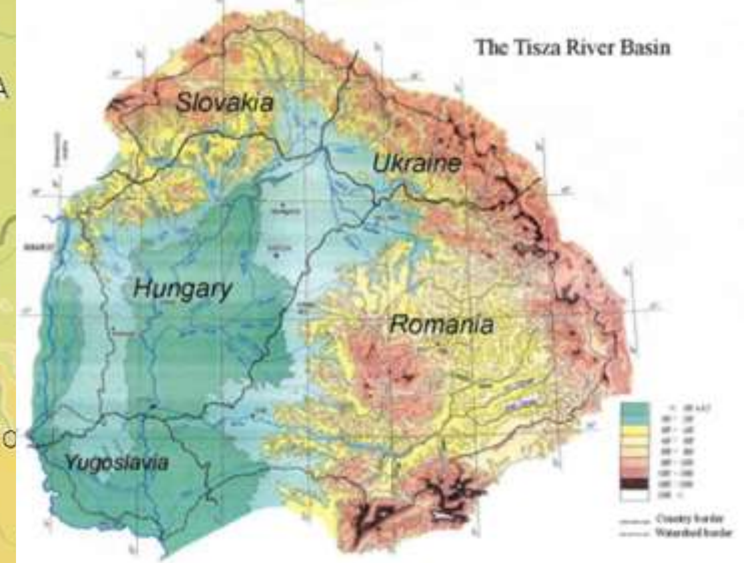
Hungary
The Tisza River

Riparia riparia
(Linnaeus, 1758)

Sand Martin
Bank Swallow

Upper Tisza Foundation
Felső-Tisza Alapítvány

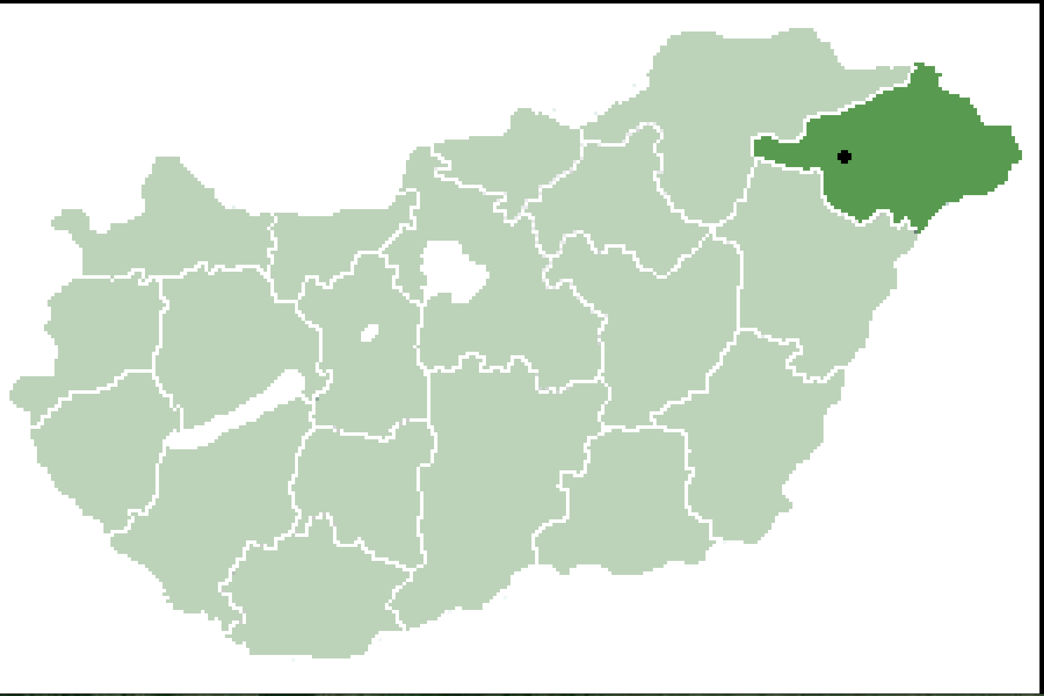

The Dismemberment of Hungary by the Treaty of Trianon - 4 June 1920
CZECHOSLOVAKIA
AUSTRIA
HUNGARY
BUDAPEST
ROMANIA
YUGOSLAVIA

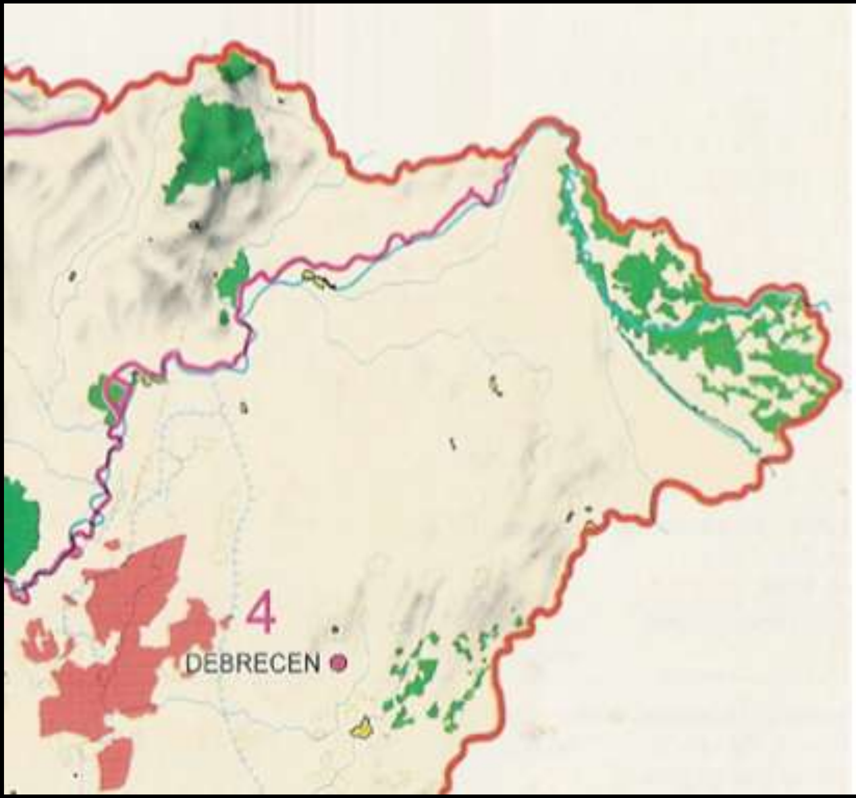

The Tisza River Basin
Slovakia
Ukraine
Hungary
Romania
Yugoslavia


SILESIAN PLATEAU
NORTHWESTERN
TATRAS
ORE
CARPATHIANS
FORESTED
EASTERN
MOLDAVIAN TABLELAND
BAVARIAN ALPS
ALPS
KARAWANKEN
JULIAN ALPS
DOLOMITES
HUNGARIAN PLAIN
TRANSYLVANIAN BASIN
APUSENI MTS.
TRANSYLVANIAN ALPS
COASTAL LOWLANDS
Danube River Delta
DOBRUJA TABLELAND
WALACHIAN PLAIN
SERBIAN MTS.
DINARIC RANGES
APPENINES
ADRIATIC SEA
BLACK SEA
BALKAN MTS.
RUMELIAN BASIN
RILA MTS.
Gulf of Venice
Gulf of Burgas
Lake Balaton
Danube
Tisza
Vistula
Iron Gates

Hungary and the Upper Tisza Region

The Upper Tisza Region - Szabolcs-Szatmár-Bereg County



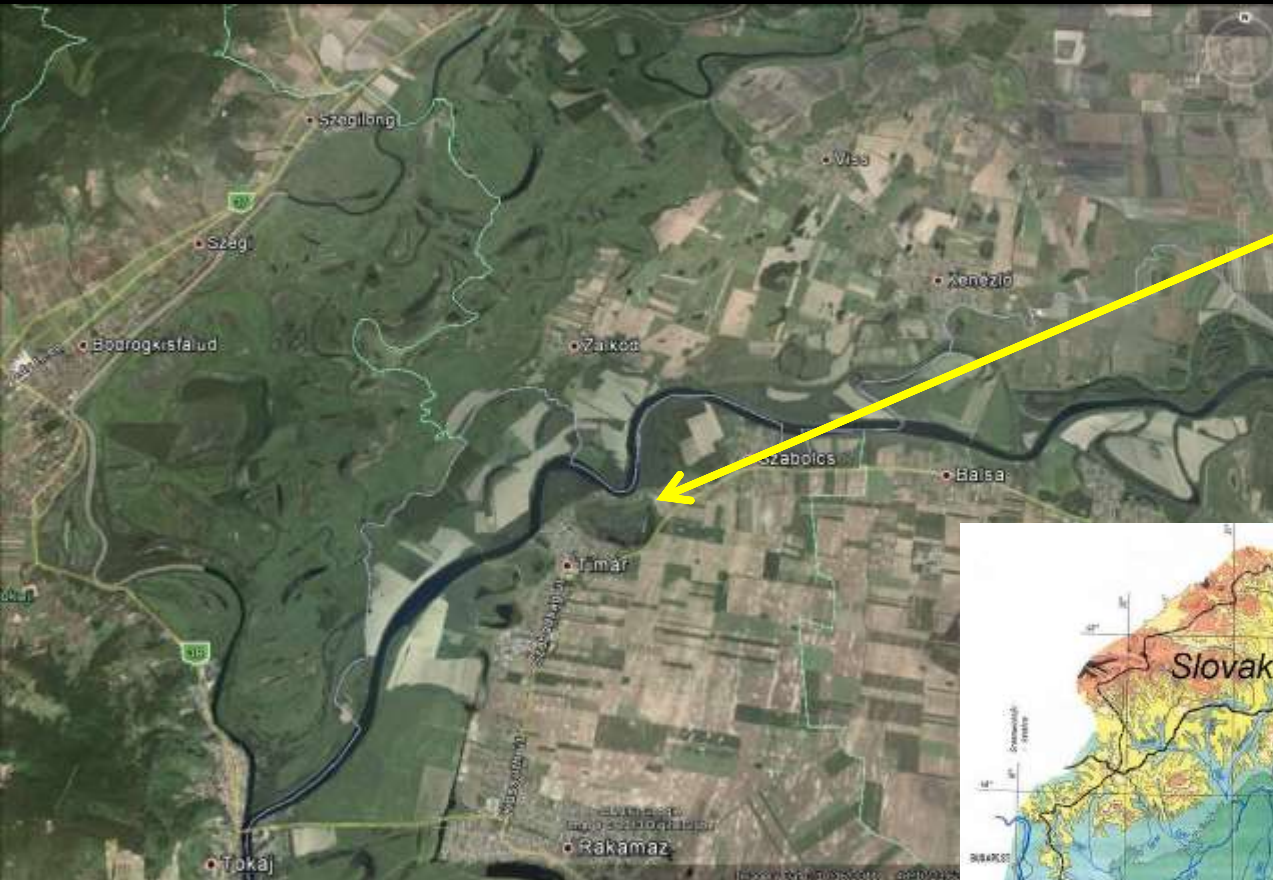


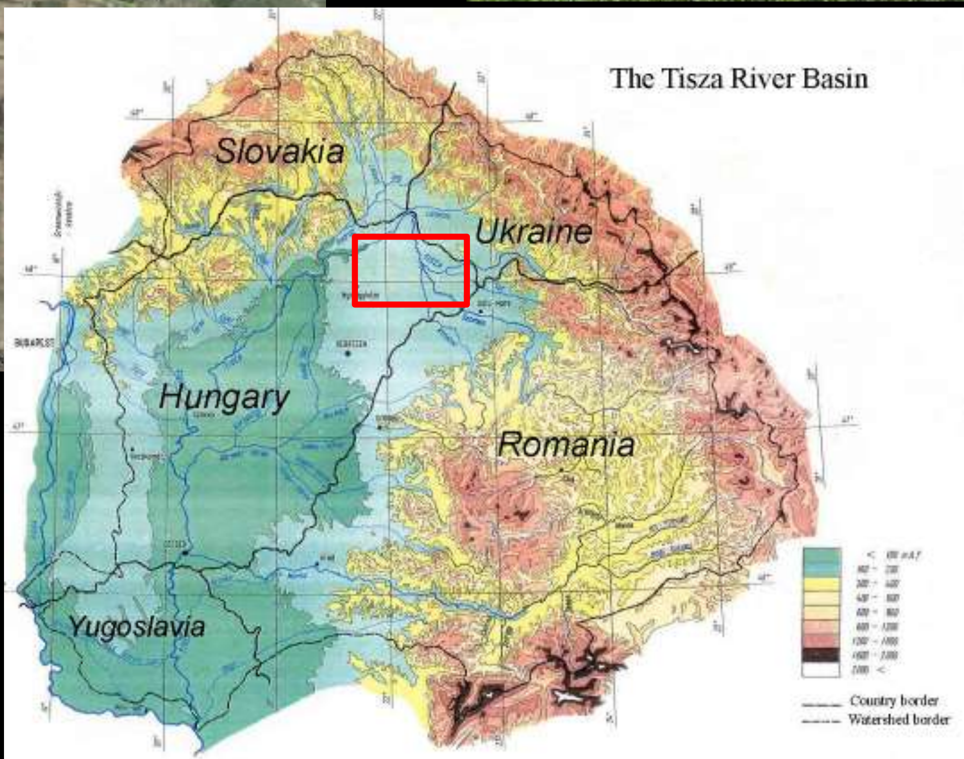
Green – Nature "Protected" Areas

Red – Hortobagy National Park

1990

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.

Upper Tisza River

Riparian Habitat

Forests and Wetlands

Biodiversity

PEACE CORPS

Hungary 1

1990-1992

Imre Vass

Dragonflies and Forests

Largest *Riparia riparia* Breeding Colonies in Europe - Dr. Tibor Szép

Magyar Madártani és
Természetvédelmi
Egyesület


Szép T.(c)



Nature “Protected” Areas

THINKING GLOBALLY

THE PEACE CORPS JOINS IN

Can teaching English help the upper Tisza?

by Judy Braus

When it first flows into Hungary from the Soviet Union, the Tisza River is relatively clean—especially when compared to its infamous neighbor, the Danube. But before long the water quality of the Tisza begins to plummet.

The Szamos and Kraszna rivers, flowing from Romania, dump heavy metals, phosphates, and other pollutants into the Tisza as it makes its way south. At Tokaj, near the lower end of the Upper Tisza, the Bodrog River, flowing from Czechoslovakia, dumps more tainted water. And along its 600-kilometer path through Hungary, the Tisza relentlessly receives in-country pollution, including waste and run-off from chemical factories, power plants, and agricultural fields.

Pollution of the Tisza River is just one example of many serious environmental problems facing Hungary. Like the rest of Central Europe, the country suffers from acid rain, smog, hazardous waste disposal, habitat destruction, and other environmental problems. But there is a bright spot in the doom and gloom of the pollution and degradation. Armed with enthusiasm and innovative ideas and backed by an agency-wide commitment to environmental education, U.S. Peace Corps volunteers have begun tackling environmental problems at the grass roots level, working in camps, schools, and communities across Hungary.

An environmental education workshop conducted in the dead of winter in a small town near the Czechoslovakian border gave many volunteers their first opportunity to get involved with Hungary's environmental problems. During the workshop, more than 60 volunteers working as English teachers and their Hungarian colleagues took part in sessions focusing on air and water pollution, solid waste, and natural resource issues—as well as on teaching strategies for incorporating environmental education into their English teaching lesson plans. They also studied strategies for motivating students to get involved in local environmental issues and for helping students develop lifelong problem-solving skills.

As a result of the workshop, many of the volunteers immediately began incorporating environmental topics into their daily lesson plans. During site visits, Kathryn Rulon, Associate Peace Corps Director for Education, found that volunteers were successfully using environmental content to teach English, encouraging student creativity, and empowering students to make a difference: "I couldn't believe how many of the volunteers were creatively adapting environmental content to match the interests and concerns of their students. I'd walk into classrooms and the students would be debating energy issues, writing environmental poetry, or performing pollution raps. Environmental education and English teaching are a natural fit!"

Several volunteers also took the activities and lesson plans developed during the workshop to camp. They

Paul S. Conklin photo. Copyright 1990. Peace Corps.

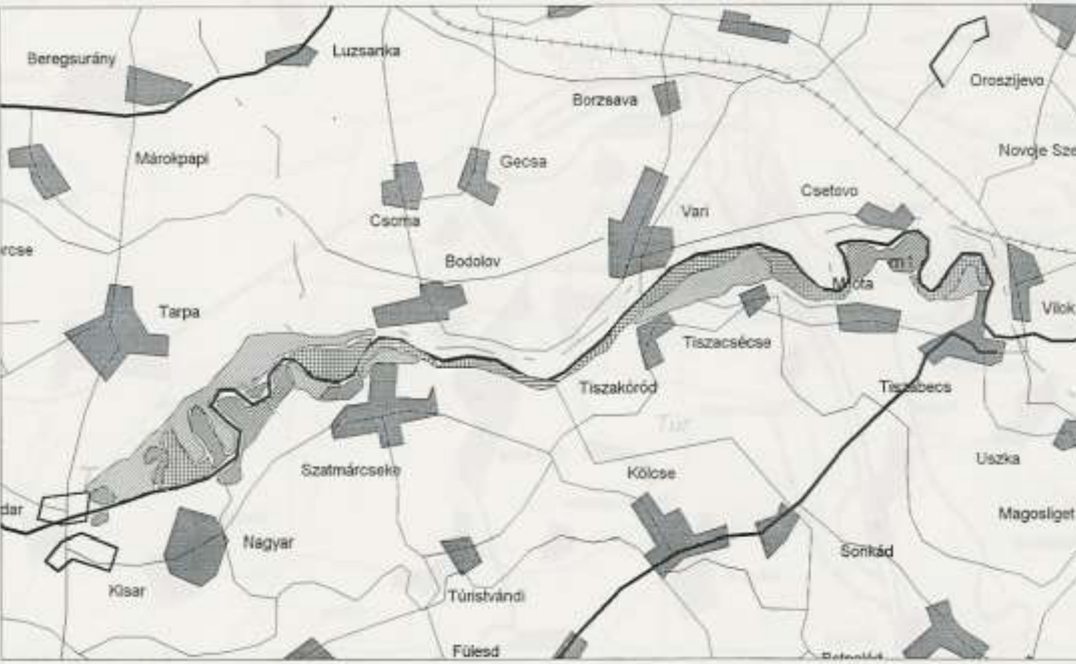
On assignment in Hungary, Peace Corps volunteers teach English and environmental literacy at the same time.

1991

As for the problems in the upper Tisza River, one Peace Corps volunteer, Kevin Anderson, channeled his concern into a concrete proposal for action. Before the workshop, Kevin had been working with the Nyireghyaza Chapter of the Hungarian Ornithological and Nature Protection Society to band sand martins and also to organize a summer environmental camp. Through his work, he discovered that the Upper Tisza not only supports the largest colony of sand martins in Europe, but it is also rich in forest and wetland habitats that provide homes to some of the most diverse wildlife in the country. He realized that a public awareness campaign would be important, given that many of his neighbors in the rural town of Nyireghyaza consider the area an undeveloped "wasteland" that would be more useful if it were developed.


REGIONAL
ENVIRONMENTAL
FOR


REGIONAL
ENVIRONMENTAL CENTER
FOR
CENTRAL & EASTERN
EUROPE



Riparian Habitat Mapping Project 1991

225km along the upper Tisza River

Felső-Tisza Alapítvány
Upper Tisza Foundation



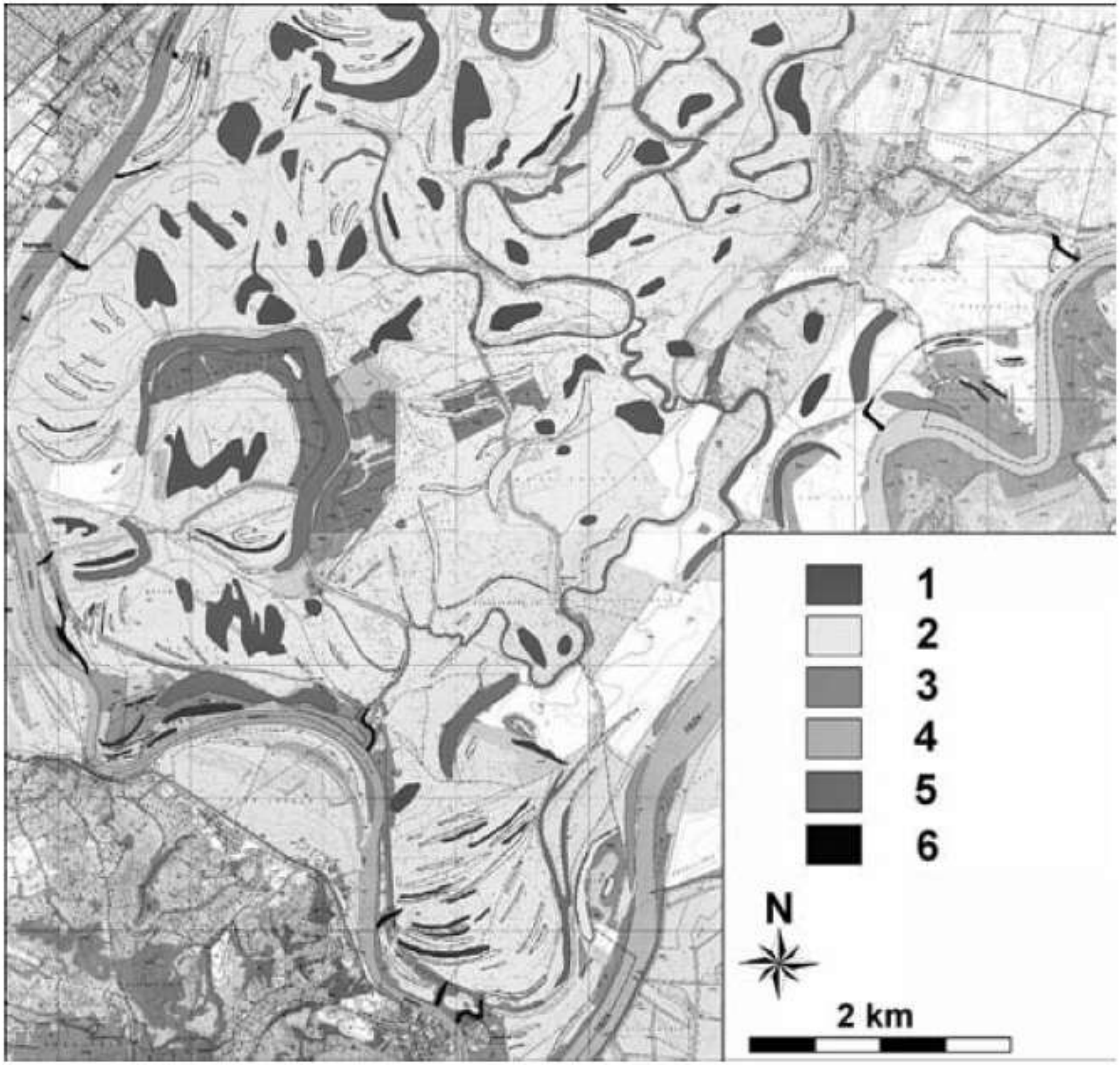
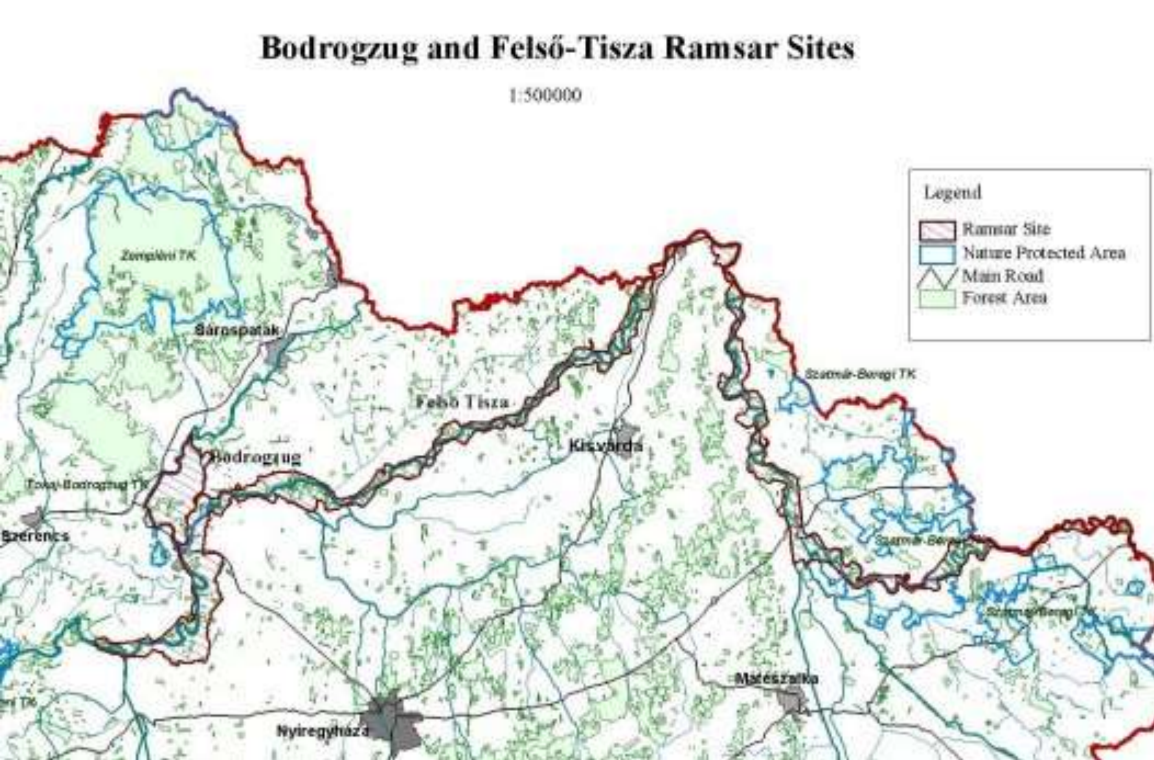
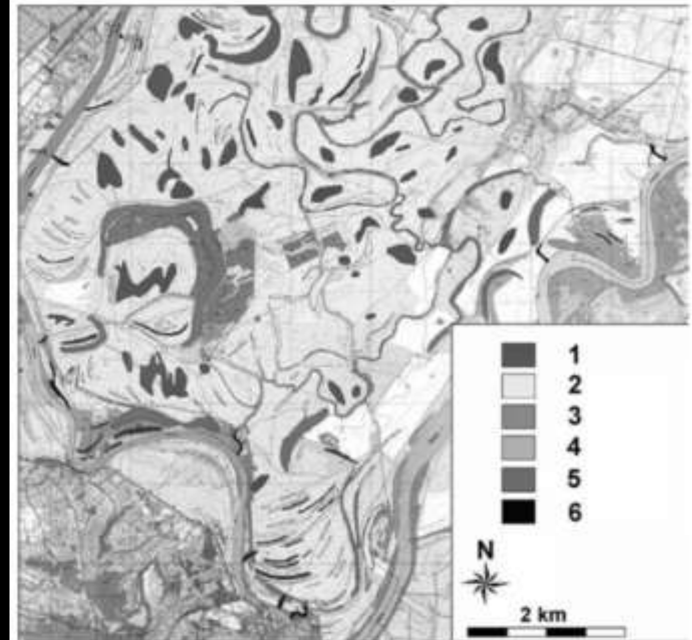



FIG. 2 - Landforms of the SW Bodrogköz (In: Szabó & *alii*, 2004). 1: fluvial ridge, 2: swale, 3: abandoned cut-offs, 4: present natural levee, 5: backswamps, 6: (remnants of) one-time flood-plain ditches.





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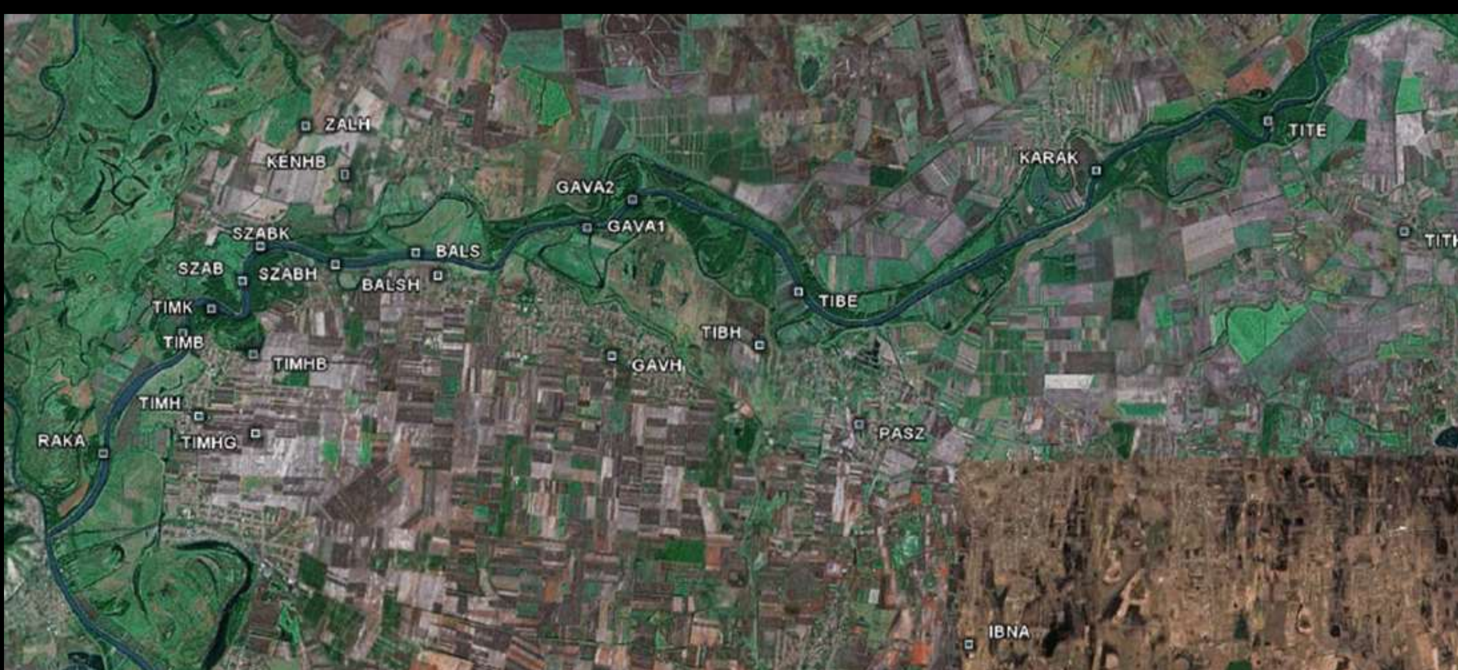


Upper Tisza River in northeastern Hungary.

Now a cross-border UN Ramsar Wetland of International Importance

Tisza River Ecological Research Center

Established 2002

Szabolcs, Hungary

Magyar Madártani és Természetvédelmi Egyesület

Felső-Tisza Alapítvány

Upper Tisza Foundation

Felső-Tisza Alapítvány
Upper Tisza Foundation

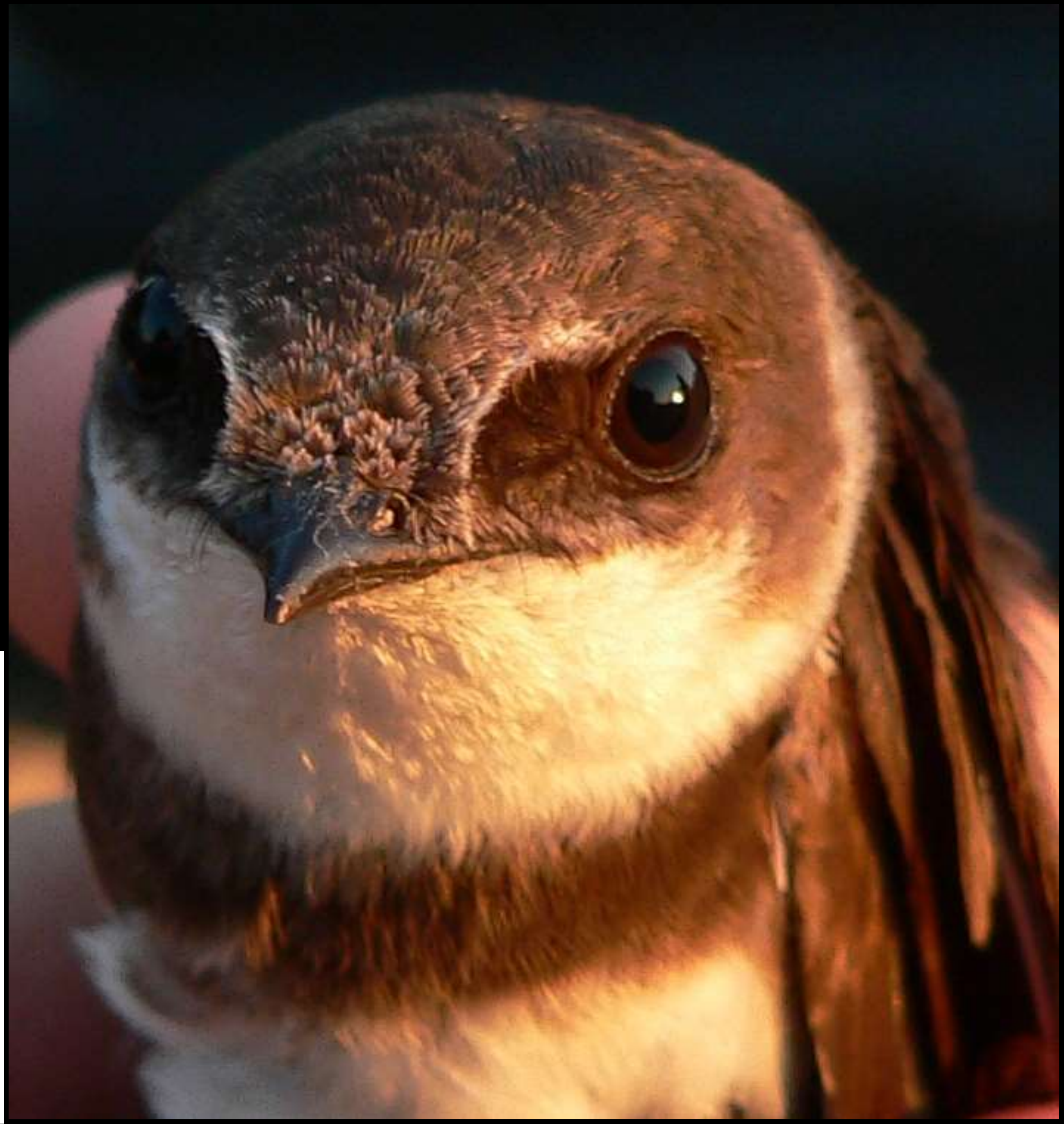

RIP

Life at the Edge

Riparia riparia
(Linnaeus, 1758)

Sand Martin
Bank Swallow

Upper Tisza Foundation
Felső-Tisza Alapítvány



Riparian Zone = Waterway Margins

Proper Functioning Condition

TEXAS RIPARIAN ASSOCIATION