QUAPAW WETLANDS TRAINING WORKSHOP

Day 1
Wetland Ecology & Restoration

Workshop Hosted By:

Quapaw Nation Environmental Office

Workshop Leader:

Steve Patterson

bioXdesign

Quapaw, OK

September 9-11, 2025

"Wetlands are the future at Tar Creek…"

--Craig Kreman

Welcome!

- Michelle Bowden, Dana Hummell, & Craig Kreman

Welcome!

- Introductions

Plan for the next three days

Day 1 - Wetland ecology & restoration

Day 2 - Wetland creation & ecological engineering

Day 3 – Mini Wetland ecological design charrette

Potential Wetland Ecosystem Services

- Carbon Sequestration and Storage
- Flood Retention
- Stormwater Retention
- Nutrient Retention
- Sediment Retention
- Plant Pollination
- Scenic Quality
- Education
- Habitat Provision
- Water Yield
- Cultural Values

Wetlands are places of transformation

Can we become Thoreauvian enough to see wetlands as desirable landscapes that protect the earth while refreshing our joy in existence?

--Annie Proulx, *Fen, Bog, & Swamp*

Wildfowl & Wetlands Trust, 2022

Part 1. Wetland ecology

- What is a wetland?
- Types of wetlands
- Why do we care?
- Wetland loss

What is a wetland?

Wetlands are :

"*areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas*."

EPA Regulations at 40 CFR 230.3(t)]

https://archive.epa.gov/water/archive/web/html/definitions.html

- *Shallow water*
- *Hydric soils*
- *Adapted plants*

- *Riparian*

- *Riparian*

  adjective

  Law
  1. relating to or situated on the banks of a river.
     “all the riparian states must sign an agreement"

- *Aquatic*
- *Rivers*
-
- *Lakes*
- *Ponds*

- *Native*
- *Non-native*
- *Introduced*
- *Invasive*
- *Extinct*
- *Extirpated*

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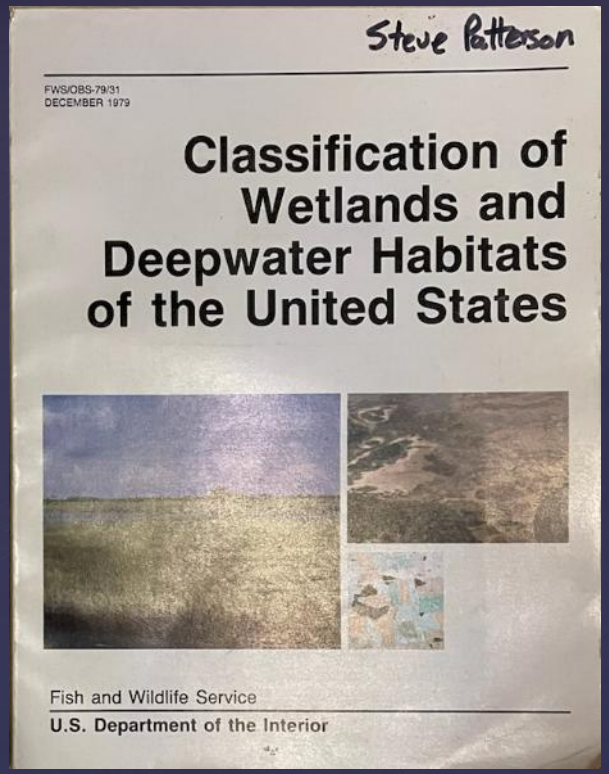
US Army Corps of Engineers
Section 404 Jurisdictional Wetland Delineations

US Army Corps of Engineers
Section 404 Jurisdictional Wetland Delineations

Three elements must be demonstrated:

- *Wetland hydrology*
- *Wetland soils*
- *Wetland plants*



Cowardin classification

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

System	L - Lacustrine													
Subsystem	1 - Limnetic						2 - Littoral							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed				RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	RS – Rocky Shore	US – Unconsolidated Shore		EM – Emergent	
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular				1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated		2 Nonpersistent	

System	P - Palustrine							
Class	RB – Rock Bottom	UB – Unconsolidated Bottom	AB – Aquatic Bed	US – Unconsolidated Shore	ML – Moss-Lichen	EM – Emergent	SS – Scrub-Shrub	FO – Forested
Subclass	1 Bedrock 2 Rubble	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic	1 Algal 2 Aquatic Moss 3 Rooted Vascular 4 Floating Vascular	1 Cobble-Gravel 2 Sand 3 Mud 4 Organic 5 Vegetated	1 Moss 2 Lichen	1 Persistent 2 Nonpersistent 5 *Phragmites australis*	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen	1 Broad-Leaved Deciduous 2 Needle-Leaved Deciduous 3 Broad-Leaved Evergreen 4 Needle-Leaved Evergreen 5 Dead 6 Deciduous 7 Evergreen

MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one each of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy.

Water Regime			Special Modifiers	Water Chemistry		Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Halinity/Salinity**	**pH Modifiers for Fresh Water**	
A Temporarily Flooded B Seasonally Saturated C Seasonally Flooded D Continuously Saturated E Seasonally Flooded / Saturated F Semipermanently Flooded G Intermittently Exposed H Permanently Flooded J Intermittently Flooded K Artificially Flooded	L Subtidal M Irregularly Exposed N Regularly Flooded P Irregularly Flooded	Q Regularly Flooded-Fresh Tidal R Seasonally Flooded-Fresh Tidal S Temporarily Flooded- Fresh Tidal T Semipermanently Flooded-Fresh Tidal V Permanently Flooded-Fresh Tidal	b Beaver d Partly Drained/Ditched f Farmed m Managed h Diked/Impounded r Artificial Substrate s Spoil x Excavated	1 Hyperhaline / Hypersaline 2 Euhaline / Eusaline 3 Mixohaline / M ixosaline (Brackish) 4 Polyhaline 5 Mesohaline 6 Oligohaline 0 Fresh	a Acid t Circumneutral i Alkaline	g Organic n Mineral

Federal Geographic Data Committee, 2013. Classification of Wetlands and Deepwater Habitats of the United States.

Oklahoma Hydrogeomorphic Wetland Classification

Dichotomous Key for HGM Wetland Classification in Oklahoma	
1. Wetland is within the 5 year floodplain of a river but not fringing an impounded water body.	*Riverine(5)*
1. Wetland is associated with a topographic depression, flat or slope.	2
2. Wetland is located on a topographic slope (slight to steep) and has groundwater as the primary water source. Wetland does not occur in a basin with closed contours.	*Slope* (15)
2. Wetland is located in a natural or artificial (dammed/excavated) topographic depression or flat.	3
3. Wetland is located on a flat without major influence from groundwater.	*Flat* (Hardwood Flat)
3. Wetland is located in a natural or artificial (dammed/excavated) topographic depression.	4
4. Topographic depression has permanent water greater than 2 meters deep and wetlands are restricted to the margin of the depression.	*Lacustrine Fringe (10)*
4. Topographic depression does not contain permanent water greater than 2 meters.	*Depression (11)*
Dichotomous Key for Riverine Wetland Subclassification in Oklahoma	
5. The wetland is a remnant river channel that is periodically hydrologically connected to a river or stream every 5 years or more frequently.	Connected Oxbow
5. The wetland is not an abandoned river channel.	6
6. The hydrology of the wetland is impacted by beaver activity.	Beaver Complex
6. The hydrology of the wetland is not impacted by beaver activity.	7
7. The wetland occurs within the bankfull channel (includes vegetated ephemeral channels, bars and islands).	In-channel
7. The wetland is directly adjacent to the river channel or occurs on a topographic floodplain (may include back-channels, swales or other topographic relief).	8
8. Stream is intermittent or ephemeral	Floodplain (Non-perennial)
8. Stream is perennial	9
9. Stream is a 1st or 2nd order	Floodplain (Upper Perennial)
9. Stream is a 3rd order or higher	Floodplain (Lower Perennial)
Dichotomous Key for Lacustrine Wetland Subclassification in Oklahoma	
10. Wetland is associated with a remnant river channel that is hydrologically disconnected from the stream or river of origin.	Disconnected Oxbow
10. Wetland is associated with a reservoir or pond created by impounded or excavation.	Man-made Lacustrine Fringe
Dichotomous Key for Depressional Wetland Subclassification in Oklahoma	
11. Wetland was created by human activity.	12
11. Wetland was not created by human activity.	13
12. Wetland does not have discernible water outlets.	Closed Impounded Depression
12. Wetland has discernible water outlet.	Open Impounded Depression
13. Wetland primary water source is groundwater.	Groundwater Depression
13. Wetland primary water source is surface water.	14
14. Wetland does not have any discernible water outlets.	Closed Surface Water Depression
14. Wetland has discernible water outlets.	Open Surface Water Depression
Dichotomous Key for Slope Wetland Subclassification in Oklahoma	
15. Wetland is hydrologically connected to a low order (Strahler <=4), high gradient, or ephemeral stream.	Headwater Slope
15. Wetland is hydrologically connected to a high order (Strahler >=5), low gradient river. Slope may be imperceptible or extremely gradual (includes wet meadows).	Low Gradient Slope

Fig XX. Keys to the HGM wetland classes and subclasses of Oklahoma

US Army Corps of Engineers
Section 404 Jurisdictional Wetland Delineations

Three elements must be demonstrated:

- *Wetland hydrology*
- *Wetland soils*
- *Wetland plants*

US Army Corps of Engineers
1987 Wetland Delineation Manual

https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/reg_supp/

https://www.bioxdesign.com/references-resources/

Regional Supplements to the Corps Delineation Manual

US Army Corps
of Engineers®
Engineer Research and
Development Center

Wetlands Regulatory Assistance Program

Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (Version 2.0)

U.S. Army Corps of Engineers

April 2012

US Army Corps
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Engineer Research and
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Wetlands Regulatory Assistance Program

Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region (Version 2.0)

U.S. Army Corps of Engineers

August 2010

https://wetland-plants.sec.usace.army.mil/

Asclepias incarnata L.

Plant Details

Scientific Name: *Asclepias incarnata* L.

Family Name: Asclepiadaceae Borkh. - Milkweed family

Common Name: swamp milkweed

Symbol: ASIN

Date Modified: June 21, 2023, 7:39 p.m.

Wetland Ratings

AGCP	AW	CB	EMP	GP	HI	MW	NCNE	WMVC	AK
OBL	OBL		OBL	FACW		OBL	OBL	OBL	

What Wetland Indicator Status Means

OBL: (Obligate Wetland): Almost always occurs in wetlands.

FACW: (Facultative Wetland): Usually occurs in wetlands but may occur in non-wetlands.

FAC: (Facultative): Occurs in both wetlands and non-wetlands.

FACU: (Facultative Upland): Usually occurs in non-wetlands but may occur in wetlands.

UPL: (Upland): Almost always occurs in non-wetlands

U.S. Army Corps of Engineers **WETLAND DETERMINATION DATA SHEET – Eastern Mountains and Piedmont Region** See ERDC/EL TR-12-9; the proponent agency is CECW-COR	*OMB Control #: 0710-0024, Exp: 09/30/2027* *Requirement Control Symbol EXEMPT:* *(Authority: AR 335-15, paragraph 5-2a)*

Project/Site: _____ City/County: _____ Sampling Date: _____

Applicant/Owner: _____ State: _____ Sampling Point: _____

Investigator(s): _____ Section, Township, Range: _____

Landform (hillside, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: _____ NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No ____ (If no, explain in Remarks.)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ____ No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No ____	**Is the Sampled Area**	
Hydric Soil Present?	Yes ____	No ____	**within a Wetland?**	**Yes** ____ **No** ____
Wetland Hydrology Present?	Yes ____	No ____		

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ True Aquatic Plants (B14)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

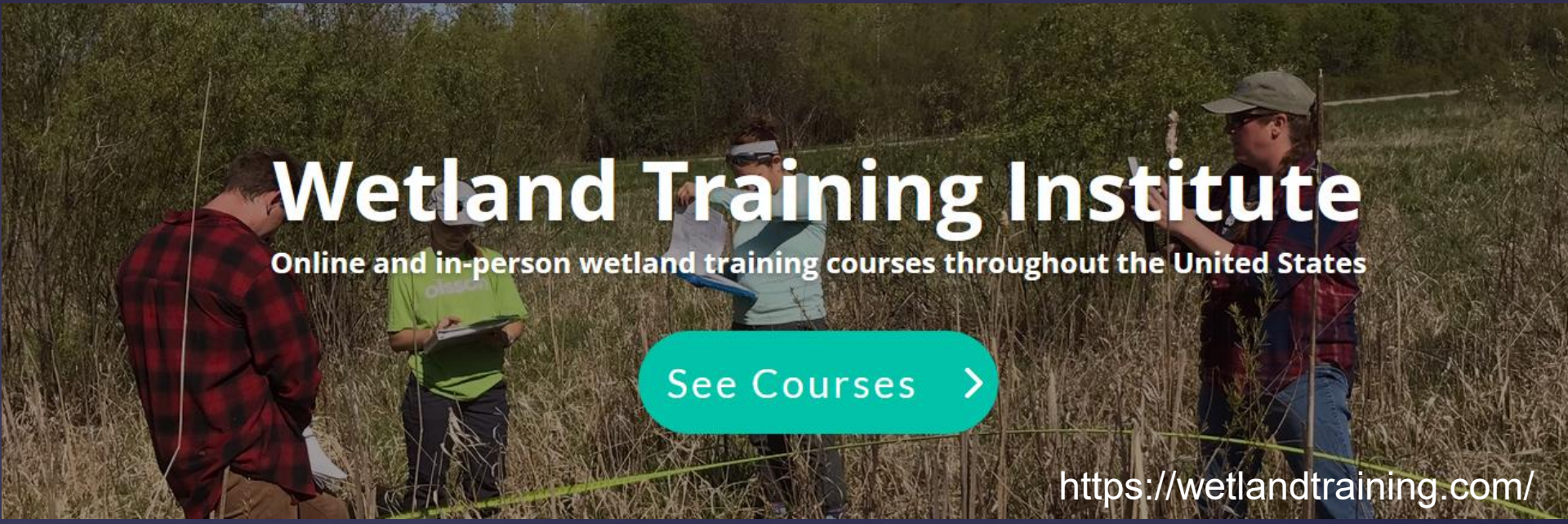
Field Observations:

Surface Water Present?	Yes ___	No ___	Depth (inches): ___
Water Table Present?	Yes ___	No ___	Depth (inches): ___
Saturation Present? (includes capillary fringe)	Yes ___	No ___	Depth (inches): ___

Wetland Hydrology Present? **Yes** ___ **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:



SOCIETY of WETLAND SCIENTISTS

NATIONAL ASSOCIATION OF WETLAND MANAGERS

National Association of Wetland Managers

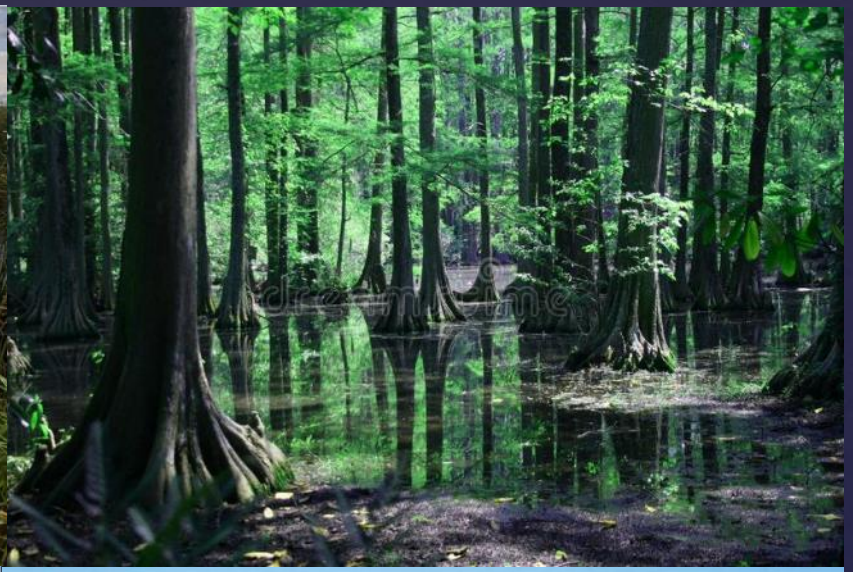
Protecting the Nation's Wetlands

Types of wetlands

6 basic types of wetlands

Marshes

Swamps (forested wetlands; bottomland hardwood)



Wet prairie (wet meadow)

Shallow water

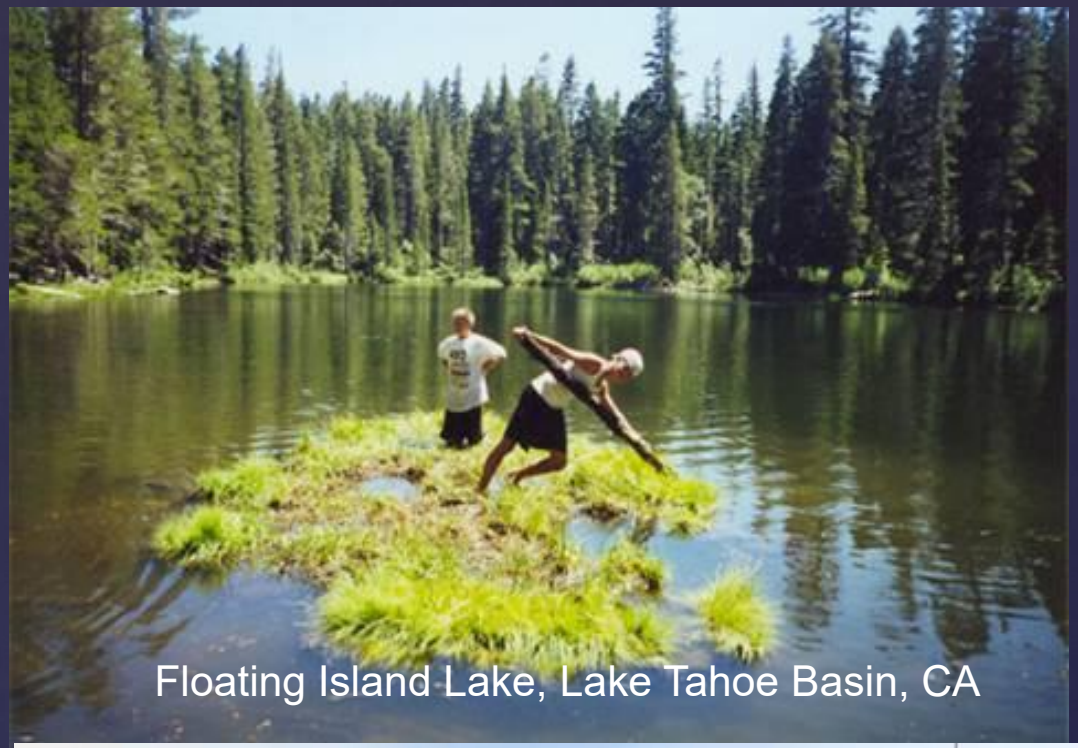
Types of wetlands, continued

Bogs

Fens

+ one:

Floating wetlands


Floating Island Lake, Lake Tahoe Basin, CA


Boehler Seeps, Atoka County, OK

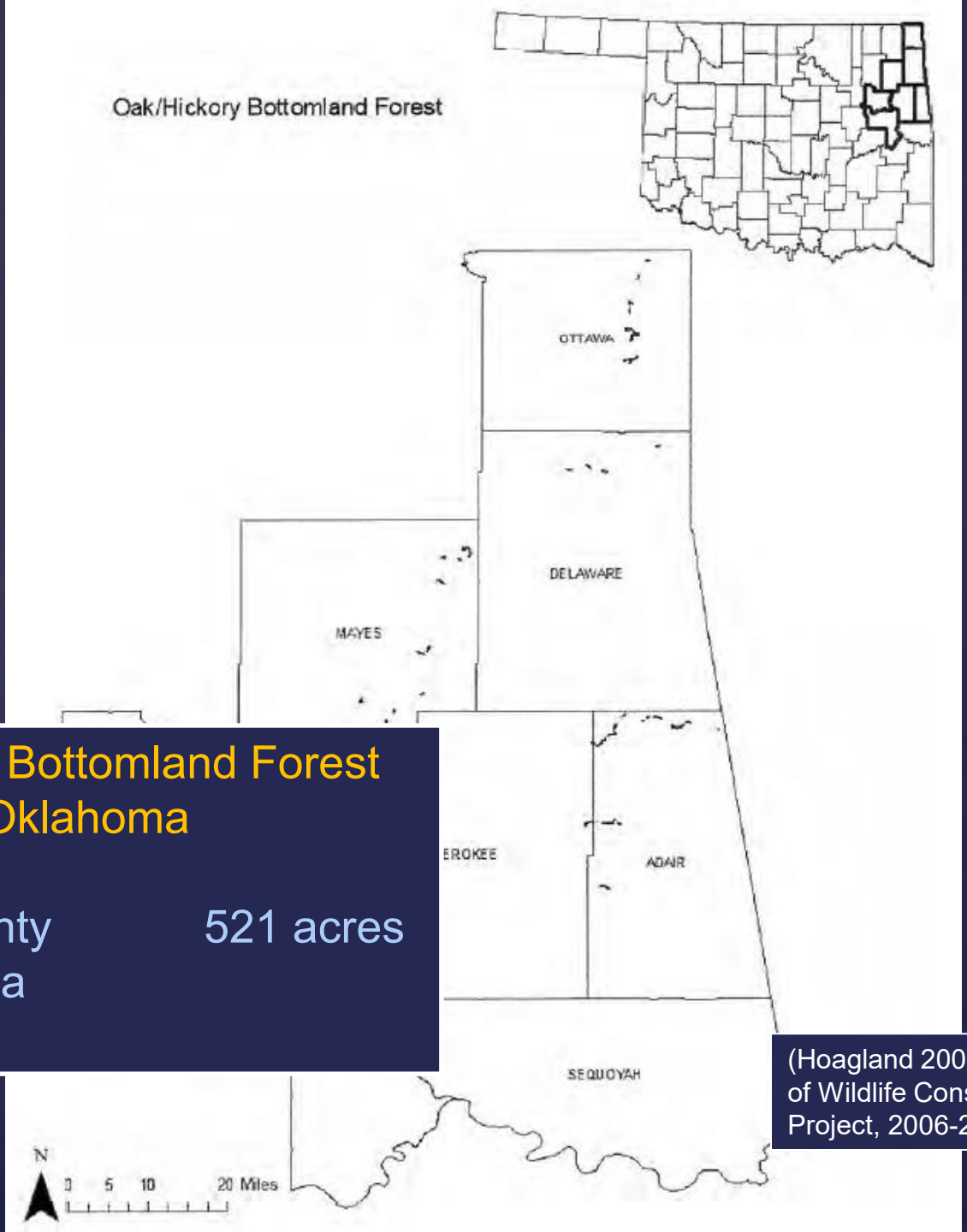
Marsh

Eufaula Wetland Park
Eufaula, OK

Eufaula Wetland Park is 0.2 mile from Lake Eufaula. A multifunction wetland—water quality, wildlife, recreation, education--Eufaula Wetland Park treats urban stormwater runoff from downtown Eufaula before it reaches the lake

Swamp
(aka forested wetlands, riparian wetlands; bottomland hardwood forests)

Saline Creek, Mayes County, OK



Oak-Hickory Bottomland Forest in Oklahoma

- Ottawa County 521 acres
- 8 county area
= 3,000 acres

(Hoagland 2009. Oklahoma Department of Wildlife Conservation Mapping Project, 2006-2009)

Wet Prairies

Wilson Springs Wet Prairie,
Fayetteville, AR
Northwest Arkansas Land Trust




Shallow water

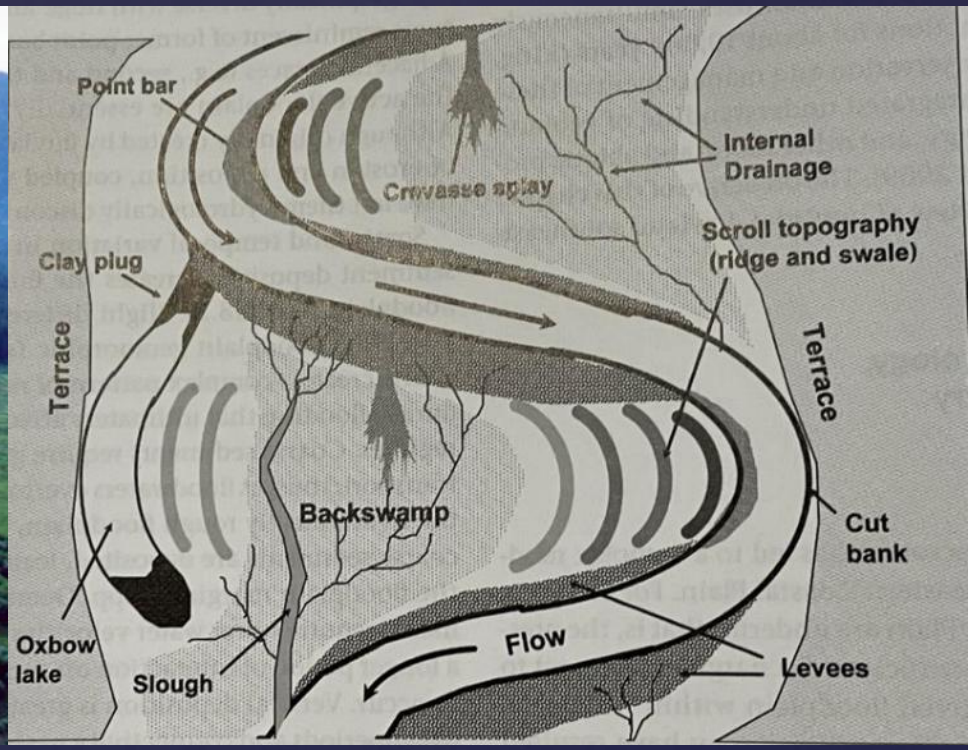
Ferndale Bog, SE OK

- Is really a fen

Other fens:

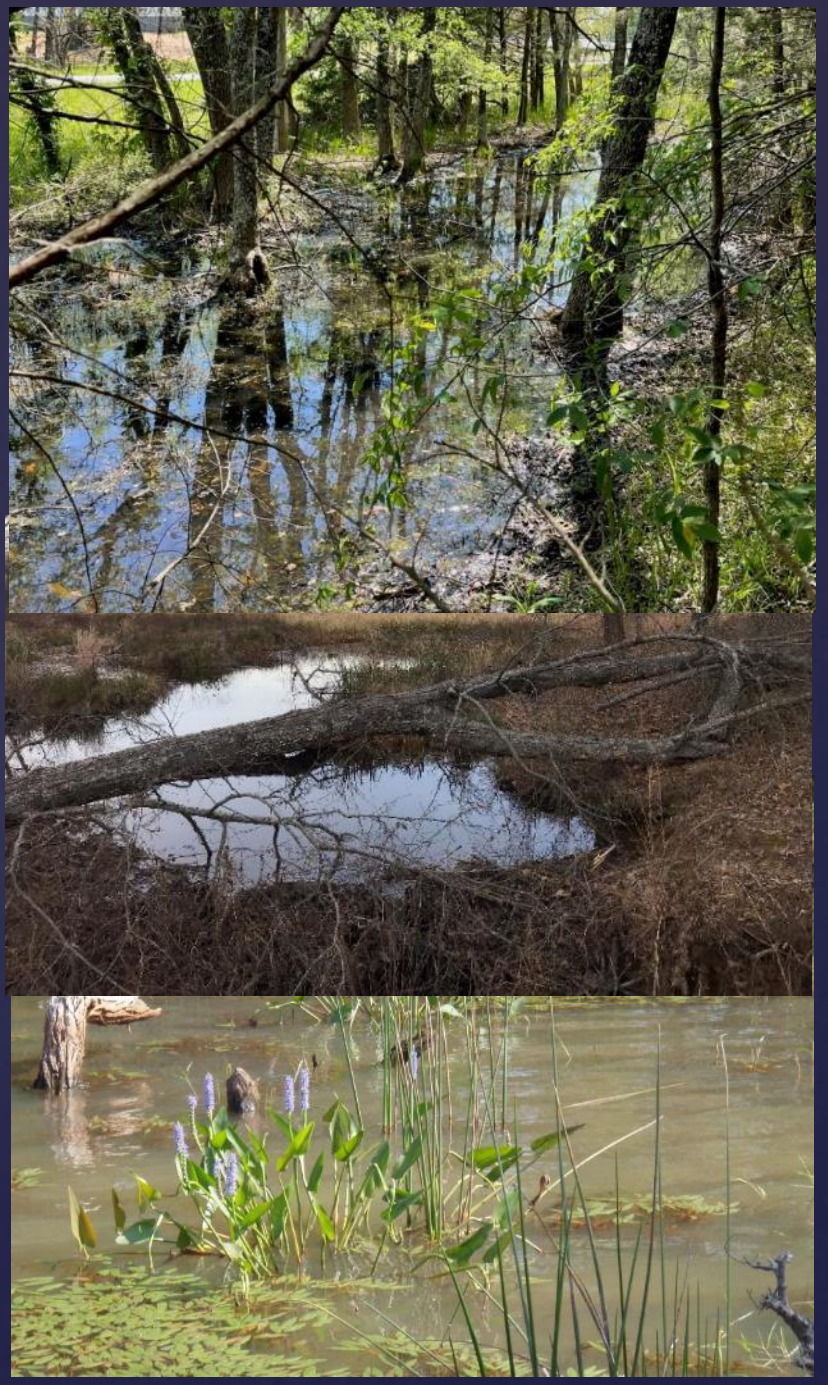
- Healing Springs Natural Area, NWA

Floodplain complexes



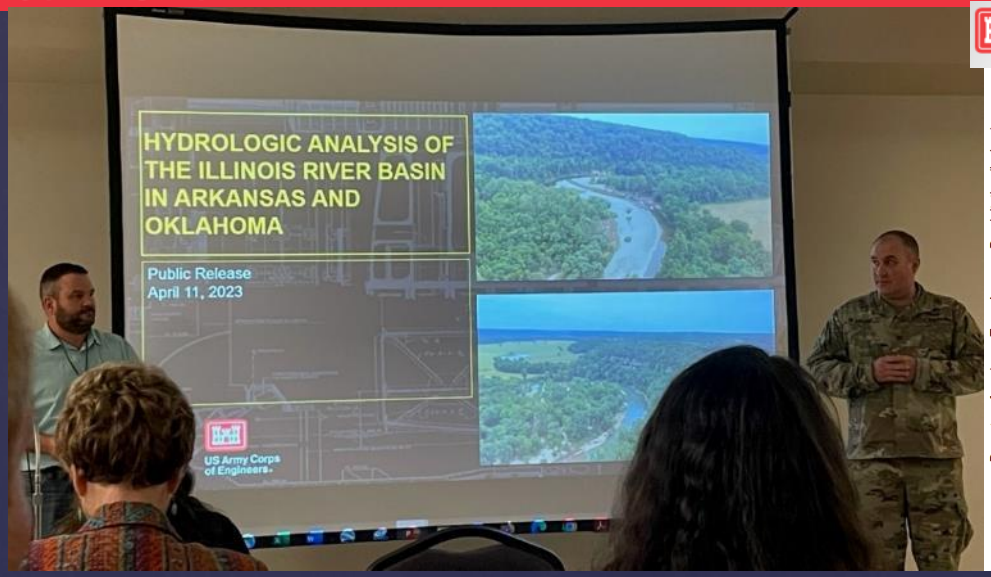
Why wetlands?

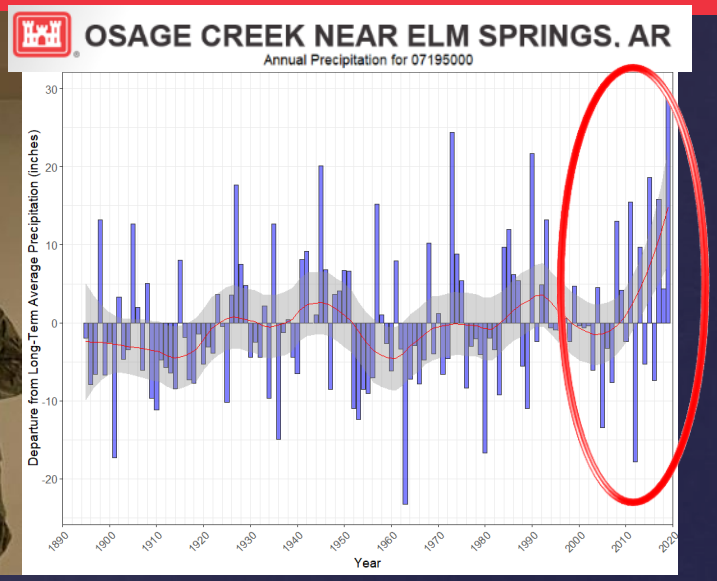
- Improve water quality
- Store water during droughts
- Minimize floods and mitigate flood peaks
- Create wildlife habitat
- Store carbon



US Army Corps of Engineers®
Little Rock District

Illinois River Flood Study





Projected:

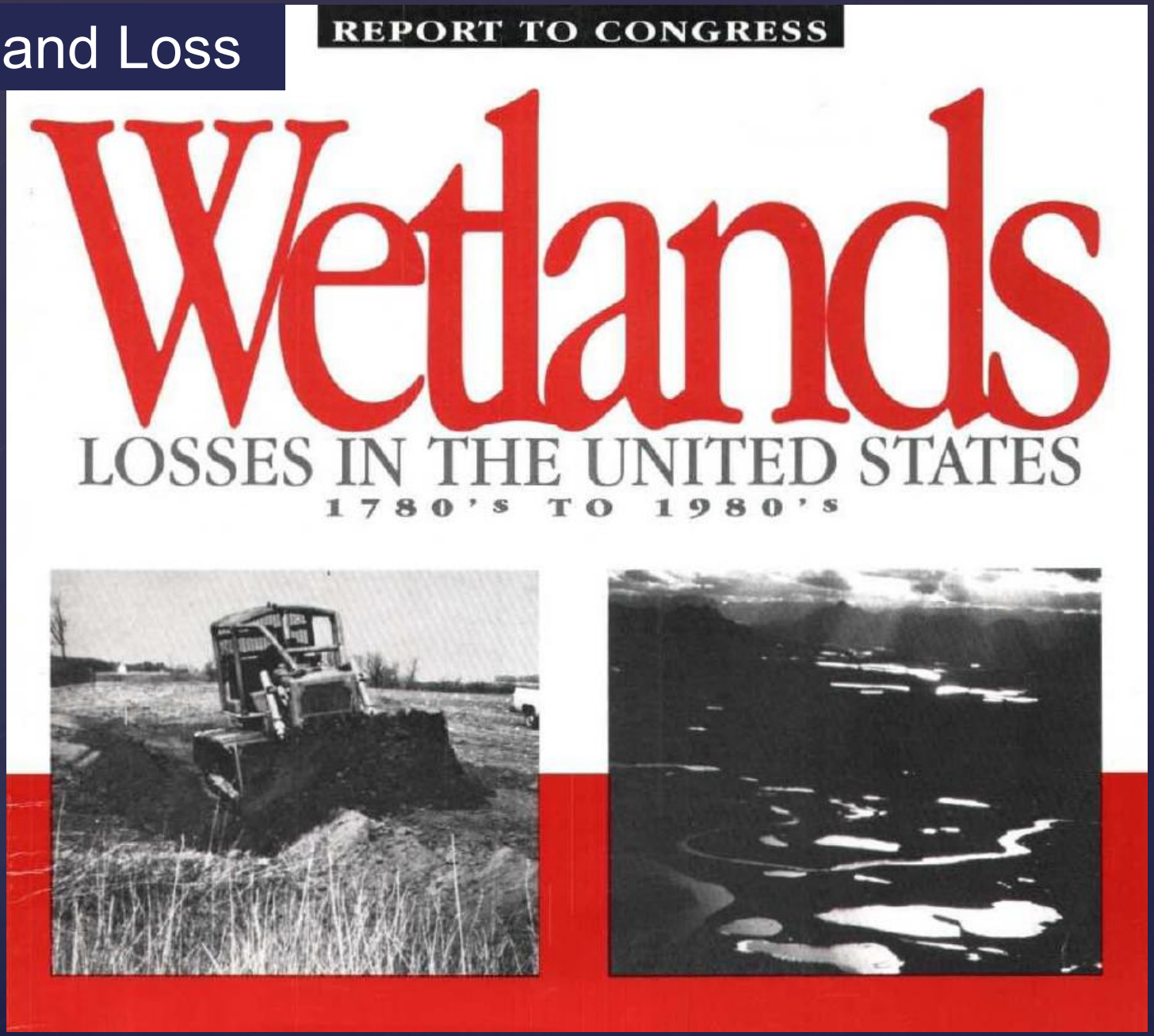
- Increase in rainfall quantity
- Increase in storm intensity
- Increase in NWA urbanization
- Land-use change along the river in OK
  - All contribute to increased flooding
  - The largest input is increase in precipitation

Scenarios:

- Detention/Storage ~1,000,000 ac-ft
  - ~ = 1.5 Lake Tenkillers by volume (677,000 ac-ft)
- Restore riparian buffers
  - 100’ on either side of the river

https://www.swl.usace.army.mil/Missions/Planning/Illinois-River-Flood-Study/

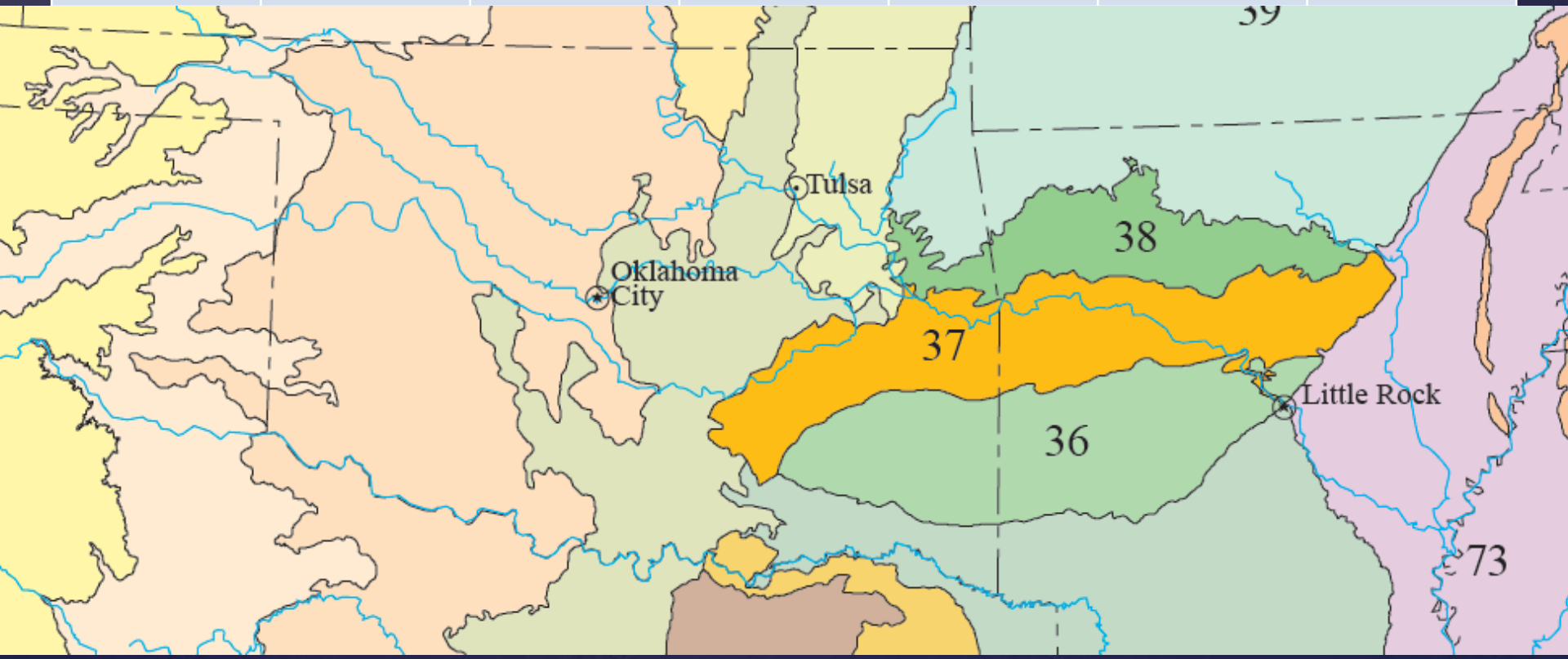
Wetland Loss



Dahl et al. 1990, US Fish & Wildlife Service

Wetland Loss in Oklahoma

Total Area (acres)	Wetland Area 1780s (acres)	Percent Wetland 1780s	Wetland Area 1980s (acres)	Percent Wetland 1980s	Acres Lost	% Loss
44,149,760	2,842,600	6.4%	949,700	2.1%	1,892,900	67%



Wetland Loss in Arkansas

Total Area (acres)	Wetland Area 1780s (acres)	Percent Wetland	Wetland Area 1980s (acres)	Percent Wetland	Acres Lost	% Loss
33,986,560	9,848,600	29%	2,763,600	8.1	7,085,000	72

Wetland Loss in Kansas

Total Area (acres)	Wetland Area 1780s (acres)	Percent Wetland 1780s	Wetland Area 1980s (acres)	Percent Wetland 1980s	Acres Lost	Percent Loss
52,648,960	841,000	1.6%	435,400	0.8%	405,600	48%

Wetland Loss in Missouri

Total Area (acres)	Wetland Area 1780s (acres)	Percent Wetland 1780s	Wetland Area 1980s (acres)	Percent Wetland 1980s	Acres Lost	Percent Loss
44,599,040	4,844,000	10.9%	643,000	1.4%	4,201,000	87%

Loss of Beaver Ponds & Wetlands

- Beaver mostly extirpated in US by 1840's (except Pacific Northwest)
- By 1952 only **~ 485** beaver remained in Oklahoma (in west-central OK)
- By the end of the 1800's, beaver were eliminated from most of Arkansas.
- Today, nationally, beaver numbers estimated still only ~ 10% of historic population

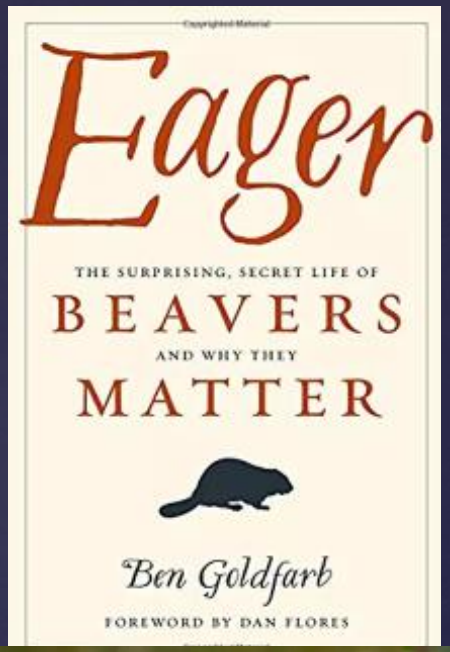


Photo Emily Fairfax

Plant species research

National Wetland Plant List:

https://nwpl.sec.usace.army.mil/

Questions?