Shoreline Stabilization

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Reservoir Habitat Restoration Workshop

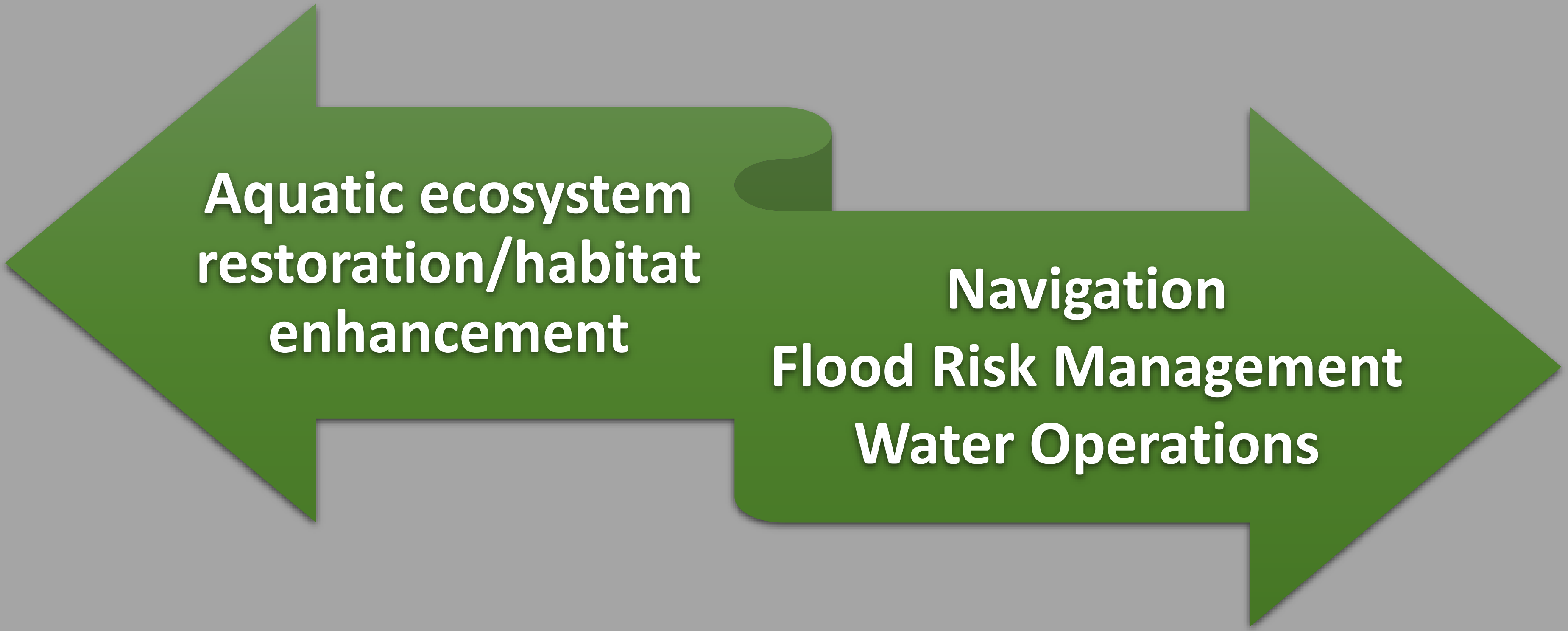
Reservoir Fisheries Habitat Partnership

2019 Annual Meeting

Kansas City, KS, USA

October 5th, 2019 11:50-12:20

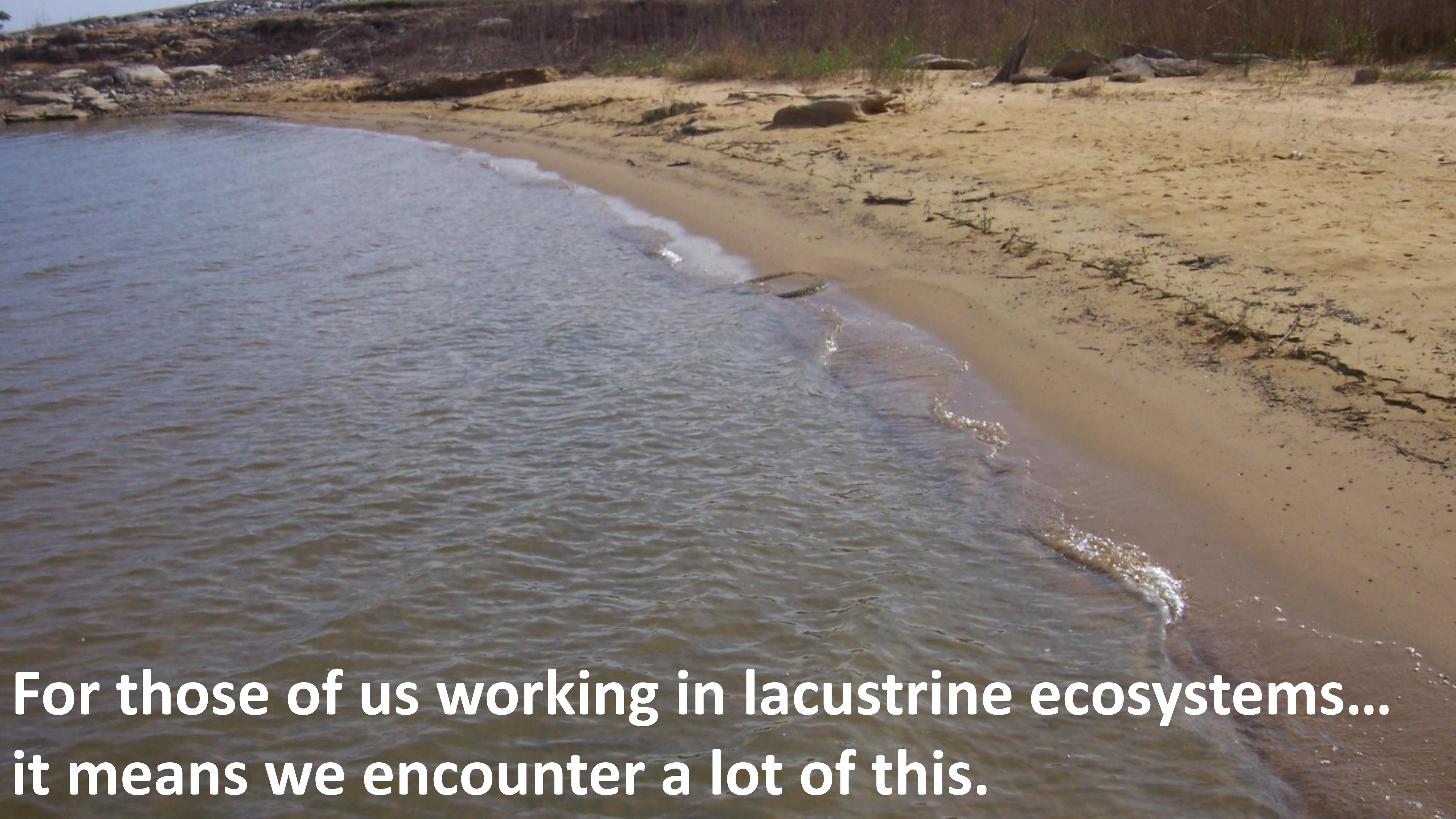
Hydrology – makes life a little challenging….

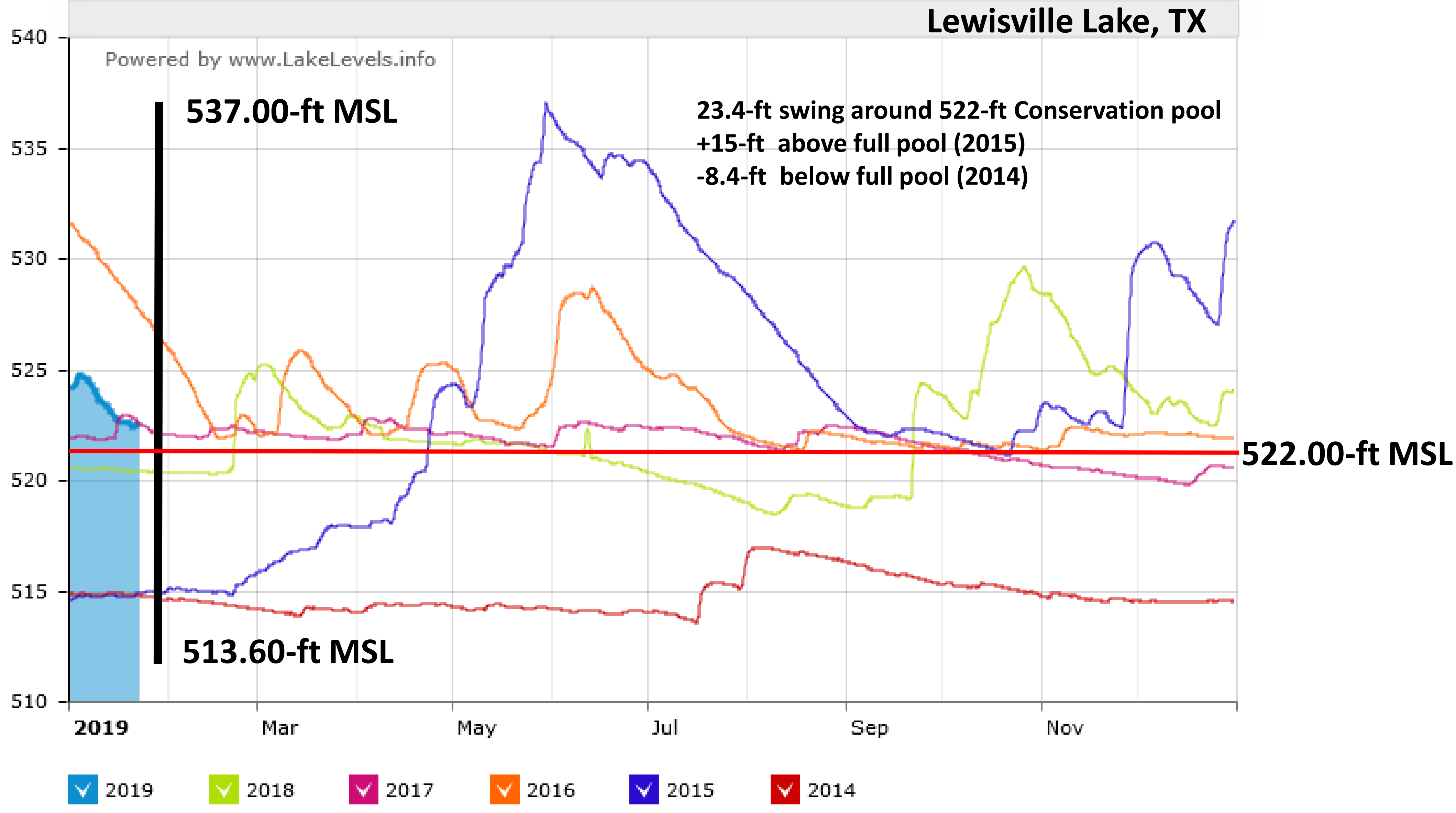


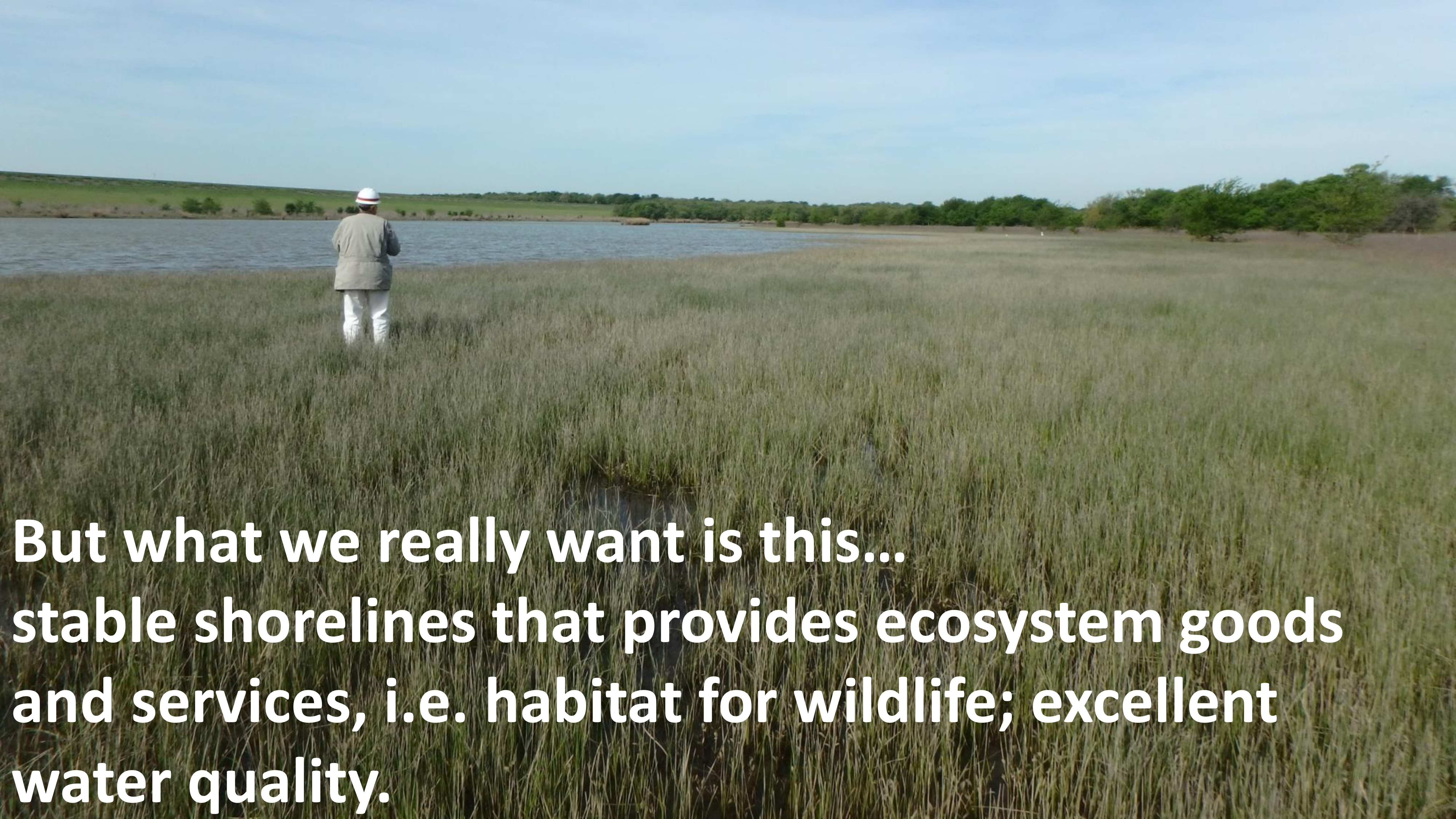
What is it about hydrology that is so troublesome for water resource managers?

- Water - you either have it or you don’t
  - Regional variability (east coast to west coast)
  - Seasonality (spring, summer, fall, winter)
  - Flow regime
  - Water rights (surface water/ground water)

- When you do get it - not sure what you’re gonna get along with those H_2O molecules – i.e. excess nutrients, toxic contaminants, debris (not the good kind that helps to stabilize shorelines, but mostly trash)


For those of us working in lacustrine ecosystems…
it means we encounter a lot of this.

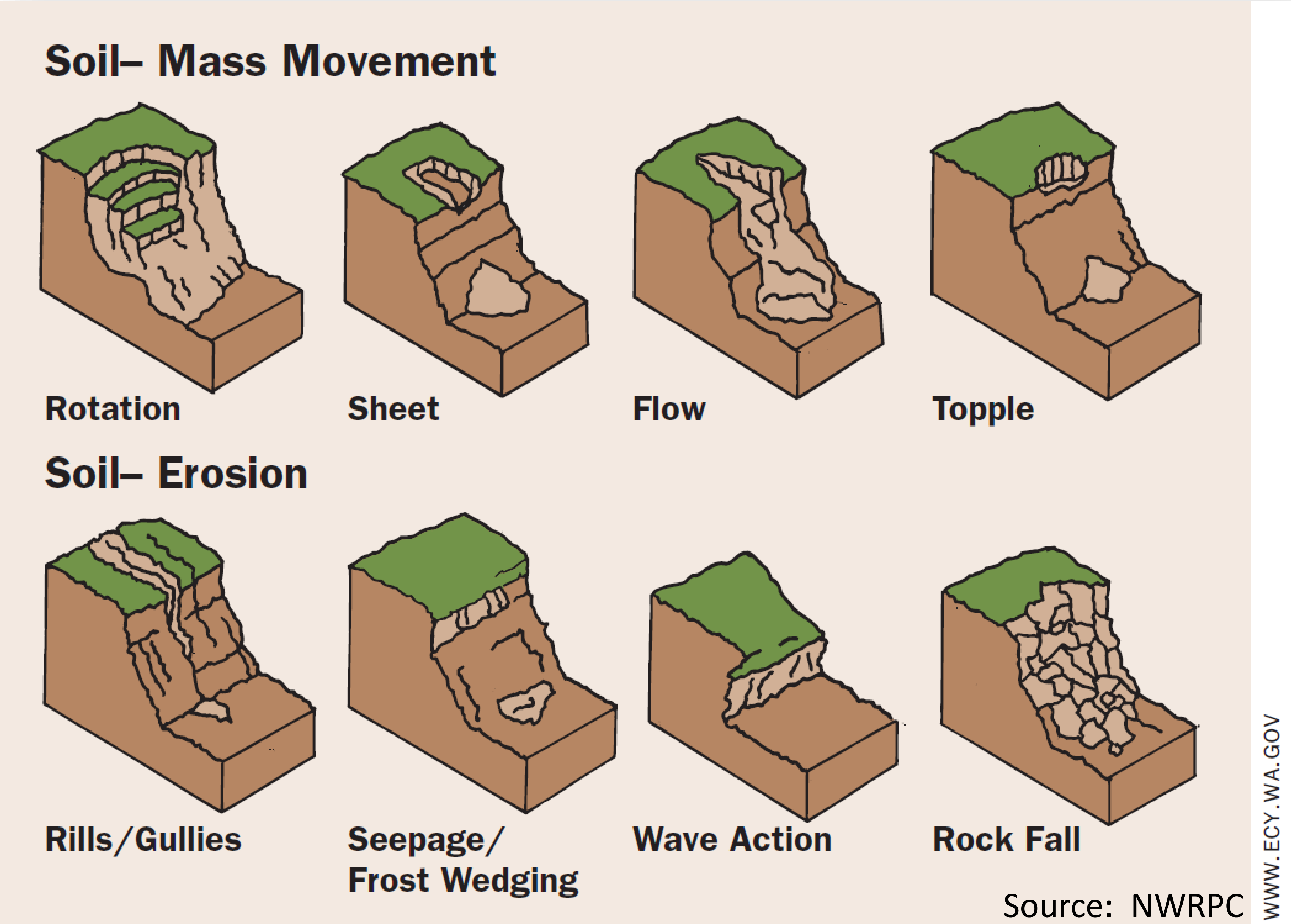

Lewisville Lake, TX
Powered by www.LakeLevels.info
537.00-ft MSL
23.4-ft swing around 522-ft Conservation pool
+15-ft above full pool (2015)
-8.4-ft below full pool (2014)
522.00-ft MSL
513.60-ft MSL
540
535
530
525
520
515
510
2019
Mar
May
Jul
Sep
Nov
2019
2018
2017
2016
2015
2014


But what we really want is this…
stable shorelines that provides ecosystem goods and services, i.e. habitat for wildlife; excellent water quality.


Switchgrass along the shoreline of Lake Aquilla, TX

What are common issues that cause shoreline erosion (an otherwise natural process) or more importantly, shoreline instability?

- Sediment transport (erosion vs. accretion)
  - Geology generally drives this – unconsolidated material (sand, gravel, clay, silt); consolidated material like bedrock
    - Storms
      - Surface water runoff; long term inundation causing die-off of riparian/terrestrial vegetation; ice/wind; gully formation
    - Wave energy
      - Splash, overwash, sediment drift; can be intensified with hard structures i.e. bulkheads.



Source: NWRPC

- Anthropogenic influences
  - Development that increases impervious surfaces
  - Control structures/bulkheads/revetments (↑wave energy)
  - Removal of riparian/aquatic vegetation along shoreline
    - Includes native or invasive vegetation
  - Water operations
    - Navigation
    - Flood risk management (WATER LEVEL FLUCUATIONS)
    - Recreation (↑ wave activity)

Lady Bird Lake, Austin, TX


???
Lake Austin, Austin, TX

Lake Austin, Austin, TX

Lake Austin, Austin, TX

Lake Austin, Austin, TX

What is a LIVING SHORELINE?

"A shoreline management practice that provides erosion control benefits; protects, restores, or enhances natural shoreline habitat; and maintains ~~coastal~~ processes through the strategic placement of plants, stone, sand fill, and other structural organic materials (e.g. biologs, oyster reefs, etc)." (NOAA)


Living shoreline


Navarro Mills Lake, Purdon, TX

What are some techniques to stabilize sediments to achieve a LIVING SHORELINE?

Other than minimizing disturbance and avoiding only hard armoring…

- Soft armoring in low energy areas – degradable materials (coir), vegetation
- Mix of both hard infrastructure and vegetation in moderate to high energy areas - i.e. riprap planted with high stability rated vegetation; high density outplantings of suitable woody/emergent/submersed vegetation

The Lower Black River Fish Habitat Restoration Project - Phase I

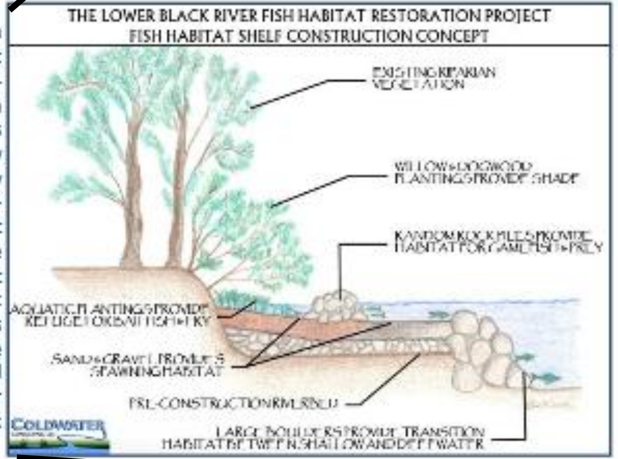
City of Lorain, Ohio

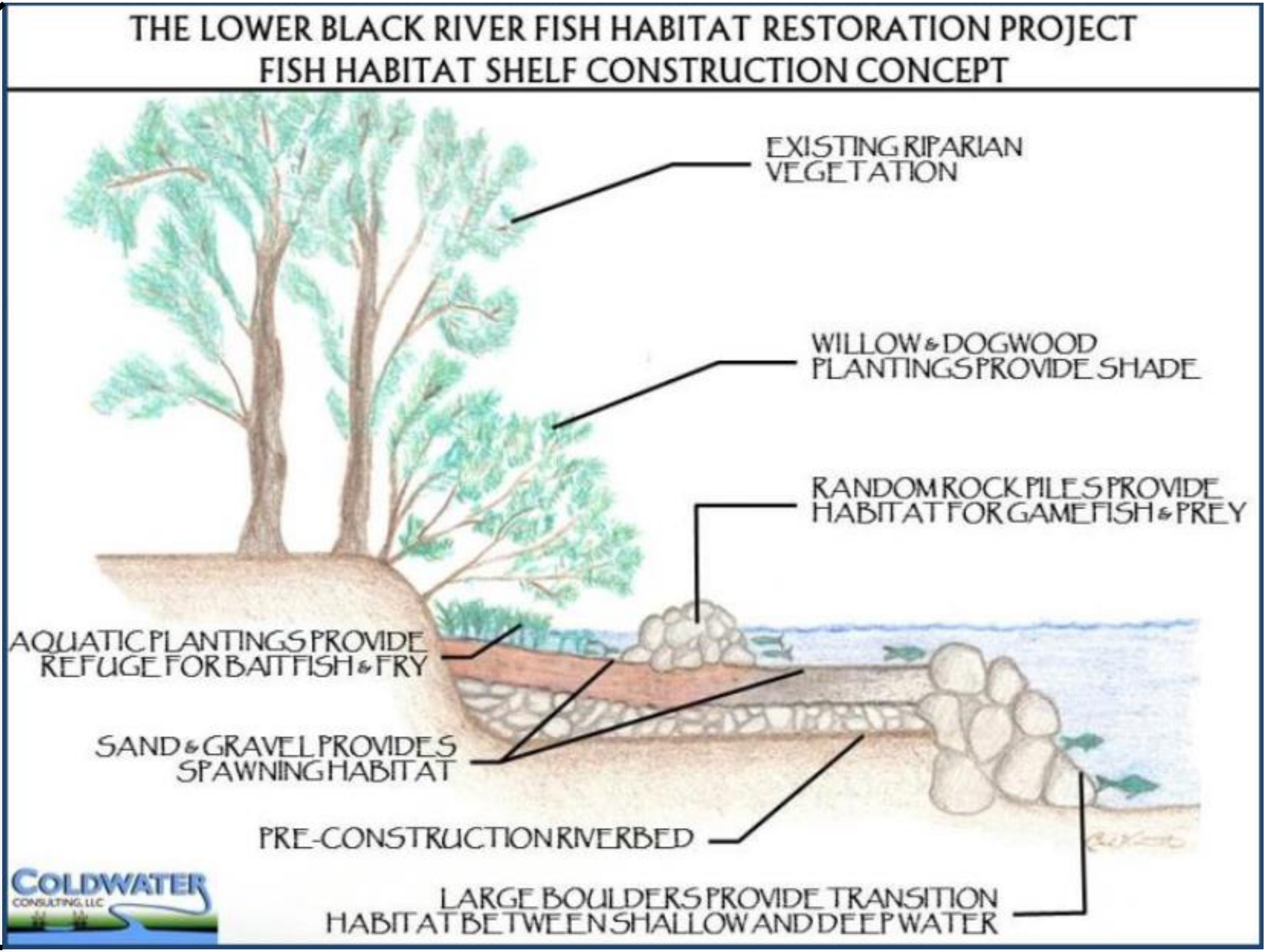
Funding provided by NOAA under the Great Lakes Restoration Initiative (GLRI)

A $1.7 million grant from NOAA funded Phase I of The Lower Black River Fish Habitat Restoration Project. The project design was completed by ARCADIS U.S., Inc. and Coldwater Consulting, LLC, was constructed by Mark Haynes Construction, Inc., and was completed in December of 2011. This project restored habitat for fish and wildlife in the lower Black River, an area that is highly deficient of aquatic structure. The project included construction of over 3,000 linear feet of fish habitat shelves, restoration of eroding river banks utilizing natural bank stabilization and bio-engineering techniques, and installation of other fish habitat features including rootwad revetments and boulder clusters. An invasive plant species (*Phragmites australis*) was also removed within the project area and over 4,800 native plants were installed.

River bank restoration utilizing bio-engineering techniques

Public outreach and education efforts introduced the first annual Black River Kayak-A-Thon, the first of it's kind on the Black. This event was coupled with Port Fest on July 3, 2011 and was attended by over 70 paddlers. The Kayak-A-Thon and other public outreach activities are designed to get the public involved and educated about ecological restoration efforts that are underway to improve fish habitat, recreational opportunities, and water quality in the lower Black River.






Lady Bird Lake, Austin, TX - 2014
Outfall - 2012

Common Plants of Riparian Areas - Central – Southwest Texas

With Wetland Indicator (WI) and Proposed Stability Rating (SR)

Sedges / Grasses	WI	SR	Forbs	WI	SR	Woody	WI	SR
Spikerushes (most)	OBL	6	Water willow	OBL	7	Buttonbush	OBL	8
Emory sedge	OBL	9	Ludwigia	OBL	3	Bald Cypress	OBL	9
Sawgrass	OBL	9	Watercress *	OBL	3	Indigobush amorpha	OBL	7
Rice cutgrass	OBL	6	Scouring rush	OBL	6	Seepwillow baccharis		
Water bentgrass	OBL	5	Marsh aster	OBL	3	(B. salicifolia)	FACW	6
Cattail	OBL	9	Marsh fleabane	OBL	5	Black willow	FACW	7
Bulrushes (most)	OBL	9	Smooth bidens	OBL	5	Arroyo willow	FACW	7
Porcupine sedge	OBL	5	Water hyssop	OBL	3	Sandbar willow	FACW	7
Black sedge	OBL	6	Burhead	OBL	3	Spiny aster	FACW	8
Teal lovegrass	OBL	4	Pennywort	OBL	3	Box elder maple	FACW	6
Knotgrass	FACW	6	Monkeyflower	OBL	3	Retama	FACW	6
Hairyseed paspalum	FACW	6	Swamp rosemallow	OBL	5	Possum haw	FACW	6
Bushy bluestem	FACW	5/6	California loostrife	OBL	5	Sycamore	FAC	6
Flatsedges (most)	FACW	5/6	Cardinalflower	FACW	5	Eastern cottonwood	FAC	7
Common reed	FACW	9	Tall aster	FACW	5	Pecan	FAC	6
Gulf cordgrass	FACW	9	Spiny aster	FACW	8	Little walnut	FAC	7
White top sedge	FACW	5/6	Large buttercup	FACW	6	Roosevelt baccharis		
Rushes (most) OBL or	FACW	6	Smartweed (most)	FACW	3	(B. neglecta)	FAC	6
Aparejograss	FACW	6	Bog nettle	FACW	5	American elder	FAC	6
Spike bentgrass	FACW	5	Dock (most)	FACW	3/4	Roughleaf dogwood	FAC	6
Barnyardgrass	FACW	4	Mint *	FACW	3	Sugar hackberry	FAC	5
Junglerice *	FACW	4	Smallhead sneezeweed	FACW	3	American elm	FAC	6
Rabbitsfoot grass *	FACW	3	Sesbania	FACW	3	Cedar elm	FAC	6
Carolina canarygrass *	FACW	3	Frogfruit	FAC	4	Mexican ash	FAC	6
Wetland sprangletops	FACW	4	Late boneset	FAC	5	Bur oak	FAC	6
Switchgrass	FAC	9	Ironweed	FAC	5	Chinquapin oak	FAC	6
Eastern gammagrass	FAC	9	Shield fern	FAC	6	Lindheimer indigo	FAC	5
Big sacaton	FAC	9	Giant ragweed	FAC	3	Wafer ash (Ptelea)	FAC	6
Alkali sacaton	FAC	7	Annual sumpweed	FAC	5	Dewberry	FAC	4
Lindheimer muhly	FAC	7	Brazilian verbena *	FAC	4	Greenbriar	FAC	5
Wildrye	FAC	5/6	Cocklebur	FAC	3	Poison ivy	FAC	5
White tridens	FAC	5	Tall goldenrod	FACU	6	Grape vine (most)	FAC	5
Vine-mesquite	FAC	6	Common ragweed	FACU	2	Japanese honeysuckle *	FAC	6
Seep muhly	FAC	6	Frostweed	FACU	6	Live oak	FACU	6
Nimble-will	FAC	5	Maximilian sunflower	FACU	6	Netleaf hackberry	FACU	5
Broadleaf Uniola	FAC	5	Heath aster	FACU	5	Red mulberry	FACU	6
Dallisgrass *	FAC	7	Illinois bundleflower	FACU	4	Mesquite	FACU	5
Vaseygrass *	FAC	5/6	Clammyweed	FACU	3	Huisache	FACU	5
Rustyseed paspalum	FAC	5	Castor bean *	FACU	3	Western soapberry	FACU	6
Giant reed (Arundo)*	FAC	7	Western ragweed	UPL	5	Bumelia	FACU	6
St Augustine grass *	FAC	6	Field ragweed	UPL	5	Black walnut	FACU	6
Buffalograss	FACU	3	Mexican sagewort	UPL	5	Desert willow	FACU	6
Indiangrass	FACU	7	Turk's cap	UPL	5	Carolina snailseed	FACU	4
Johnsongrass *	FACU	6	Toothed goldeneye	UPL	5	Chinese tallow *	FACU	6
Bermudagrass *	FACU	6				Gravelbar bricklebush	UPL	5
Big sandbur	FACU	7				Slender bricklebush	UPL	5
Dichanthelium (most)	FACU	4				Burrobush	UPL	6
Southwestern bristle	UPL	5				Whitebrush	UPL	6
King Ranch bluestem *	UPL	5				Juniper	UPL	5
Creeping muly	UPL	6				Mexican persimmon	UPL	5
						Spiny hackberry	UPL	5
						Bois d'arc	UPL	6
						Vitex *	UPL	6
						Ligustrum *	UPL	6
						Chinaberry *	UPL	6

*Indicates Introduced Species

SR - Stability Ratings (Draft) on a scale of 1 – 10. Based on USFS GTR-47, by Al Winward. Bare ground has a SR of 1. Anchored rock or logs have a SR of 10. A SR of 7 (or 6) is considered the minimum for acceptable bank stability. Woody plants, when associated with stabilizing grasses and sedges provide a higher stability rating that shown

WI - Wetland Indicator Categories
(Region 6 USFWS)

OBL *Obligate Wetland* Almost always occur in wet areas.
FACW *Facultative Wetland* Occur in wet areas 67-99% probability.
FAC *Facultative* About equally likely to occur in wet and non wet areas.
FACU *Facultative Upland* Occur in wet areas 1-33% probability; otherwise, in uplands
UPL *Obligate Upland* Almost always occur in non wet areas

Revised May, 2009

For comments, additions or corrections contact: steve.nelle@tx.usda.gov

Spikerushes – SR 9

Waterwillow – SR 7

Buttonbush – SR 8

Bulrushes – SR 9

Black willow – SR 7

Switchgrass – SR 9

Eastern gamma – SR 9

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Winward, Alma H. 2000. **Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRSGTR-**47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p. https://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf

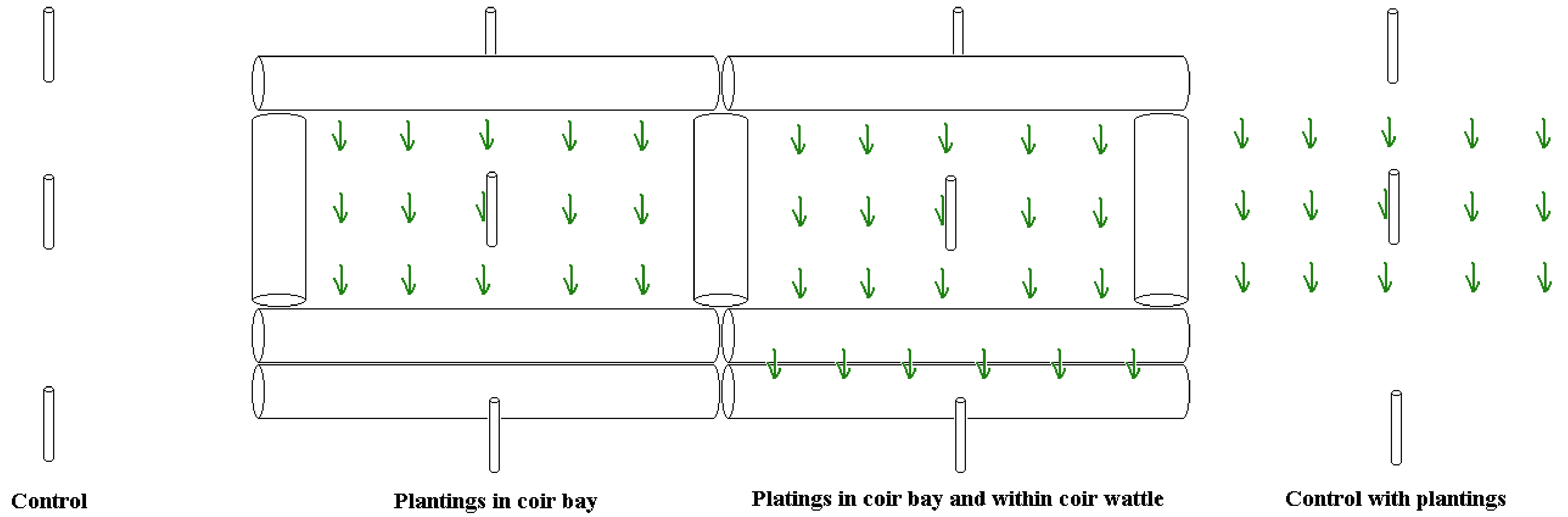

2012


2013


2014

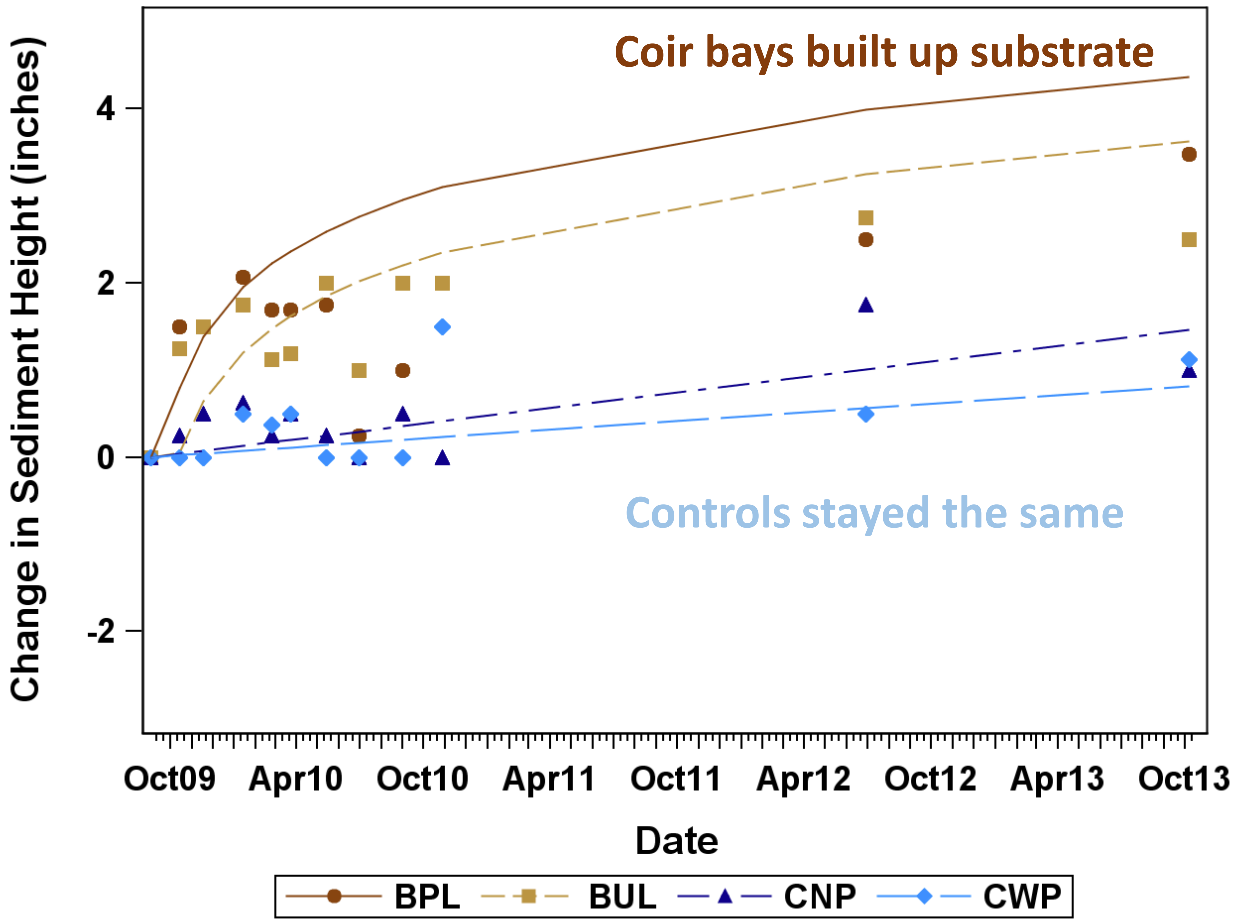
Bioengineering Pilot Project with City of Austin and LAERF - 2009

Objective: Test living shoreline approach to stabilize shoreline and restore habitat function – biodegradable material (coir logs) and wetland vegetation (Clamann – COA)



Control
Plantings in coir bay
Platings in coir bay and within coir wattle
Control with plantings

Bioengineering Pilot Project with City of Austin and LAERF - 2009



Results of plantings in control and in coir bays:

Pickerelweed - none remaining after 4 years

American bulrush - none remaining after 4 years

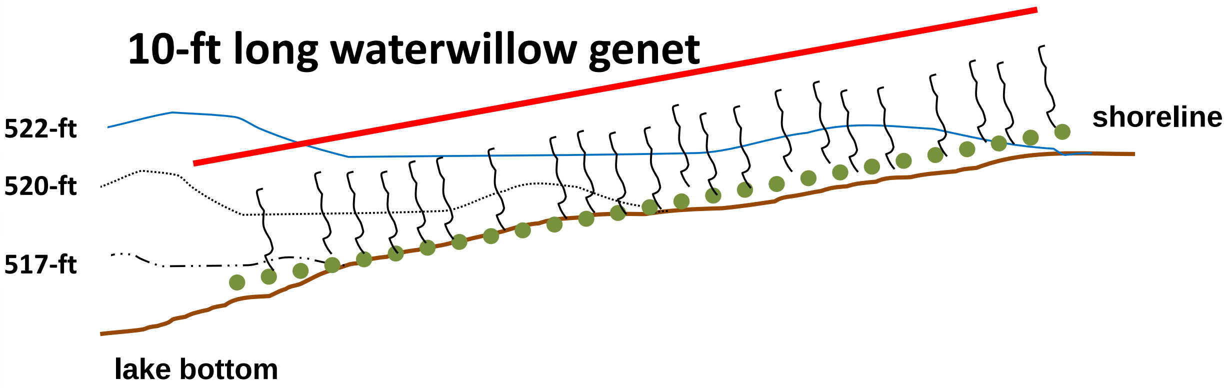
American water-willow -
in control = avg 50 stems/bay
in coir bays = avg 247 stems/bay

Bioengineering Pilot Project with City of Austin and LAERF - 2009

Large Scale Implementation with City of Austin and LAERF - 2014

Investigate experimental strategies for outplanting in reservoirs with fluctuating water levels…

Acropetal – growth or development upward from base or point of attachment – outward toward shoot and root apex…



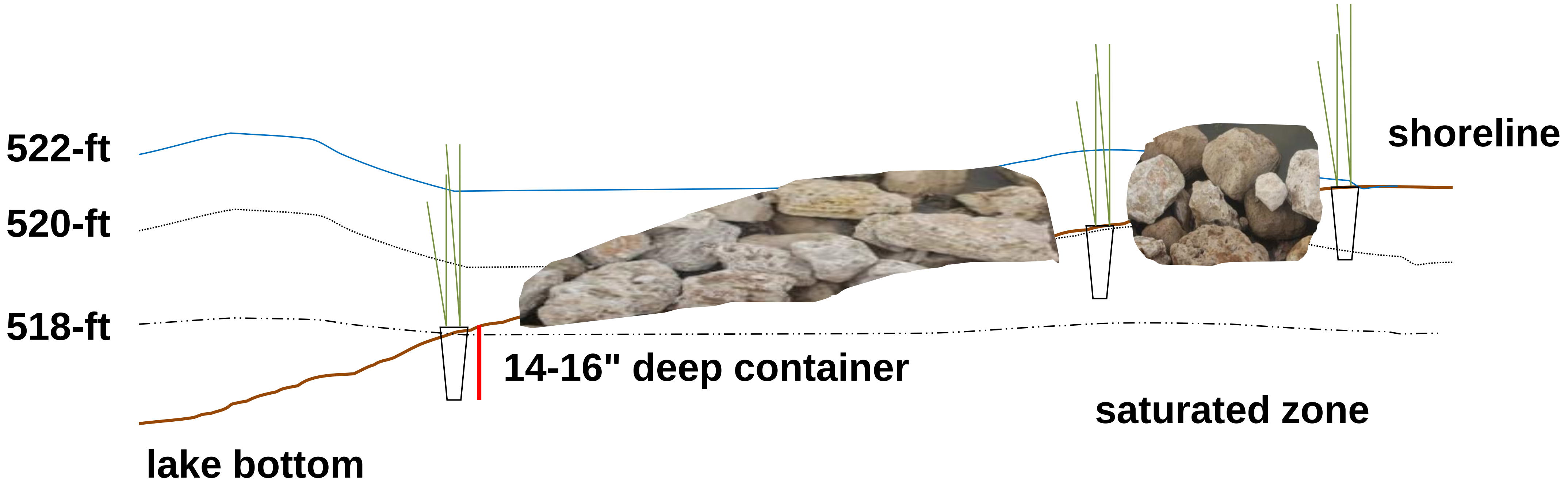
bulrush

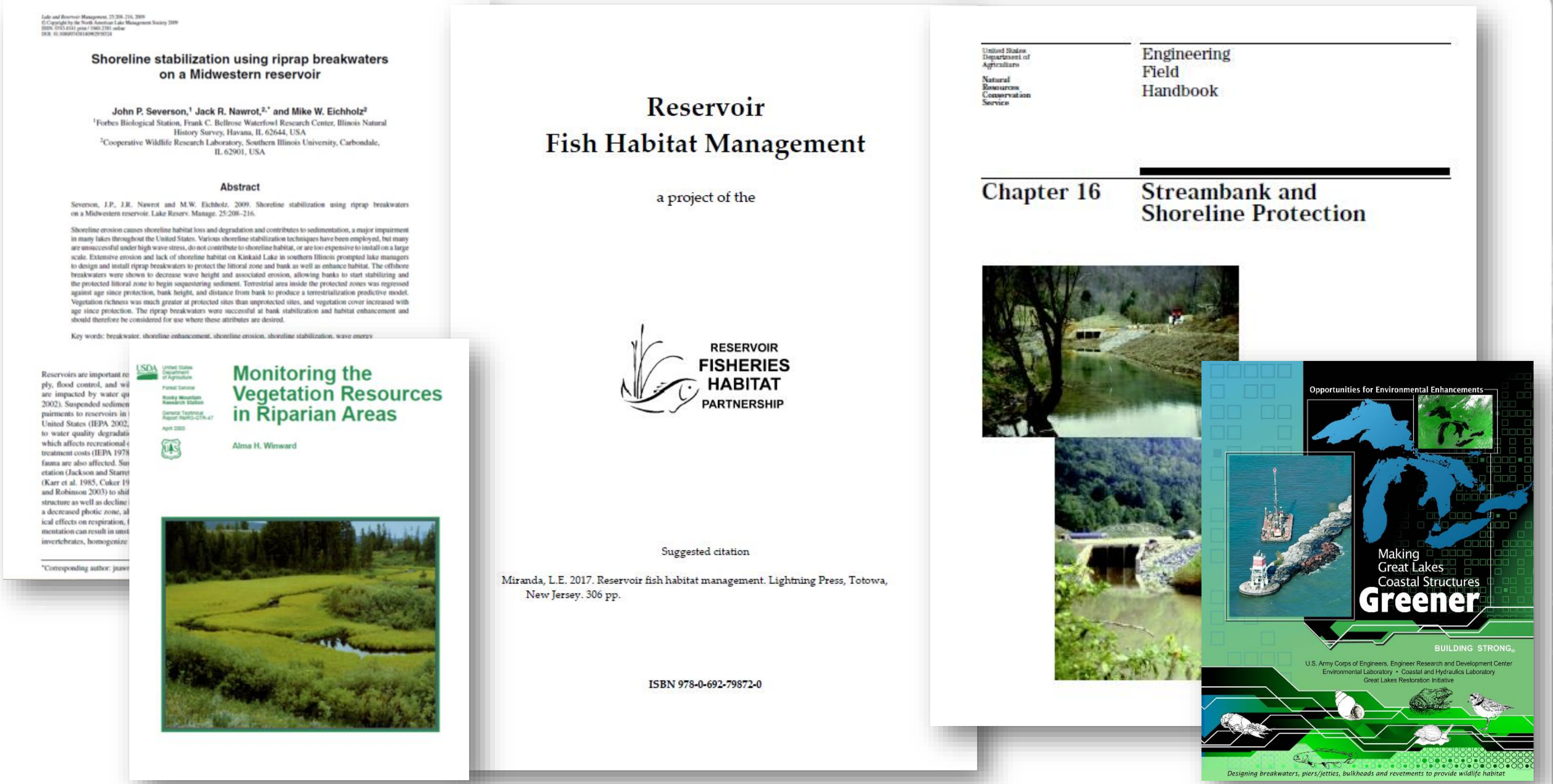
waterwillow

Touchette, B. W., J. W. G. Moody, C. M. Byrne, and S. E. Marcus. 2013. Water integration in the clonal emergent hydrophyte, Justicia americana: benefits of acropetal water transfer from mother to daughter ramets. Hydrobiologia 702:83-94.

Experimental strategies for outplanting in reservoirs with fluctuating water levels…

Chasing water levels with deeper containerized rhizomatic plants in concert with hard armoring…




Shoreline stabilization using riprap breakwaters on a Midwestern reservoir
John P. Severson,[1] Jack R. Nawrot,[2,*] and Mike W. Eichholz[2]
[1]Forbes Biological Station, Frank C. Bellrose Waterfowl Research Center, Illinois Natural History Survey, Havana, IL 62644, USA
[2]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901, USA
Abstract
Severson, J.P., J.R. Nawrot and M.W. Eichholz. 2009. Shoreline stabilization using riprap breakwaters on a Midwestern reservoir. Lake Reserv. Manage. 25:208–216.
Monitoring the Vegetation Resources in Riparian Areas
Alma H. Winward
Reservoir Fish Habitat Management
a project of the
RESERVOIR FISHERIES HABITAT PARTNERSHIP
Suggested citation
Miranda, L.E. 2017. Reservoir fish habitat management. Lightning Press, Totowa, New Jersey. 306 pp.
ISBN 978-0-692-79872-0
Engineering Field Handbook
Chapter 16 Streambank and Shoreline Protection
Opportunities for Environmental Enhancements
Making Great Lakes Coastal Structures Greener
BUILDING STRONG
U.S. Army Corps of Engineers, Engineer Research and Development Center
Environmental Laboratory • Coastal and Hydraulics Laboratory
Great Lakes Restoration Initiative
Designing breakwaters, piers/jetties, bulkheads and revetments to provide wildlife habitat

References/helpful links:

Bailey, P. 2014. A Sustainable Design Manual: Engineering With Nature using Native Plant Communities. U.S. Army Corps of Engineers for EWN Program, Engineer Research and Development Center. https://ewn.el.erdc.dren.mil/

Clamann, A. City of Austin Watershed Protection Department "Application of Coir Logs and Emergent Vegetation for Urban Lake Shoreline Stabilization" http://texasriparian.org/wp-content/uploads/2014/10/clamann_coir_URS.pdf

Dick, G. O., Smart, R. M. and Dodd, L. L. 2013. Propagation and establishment of native plants for vegetative restoration of aquatic ecosystems, ERDC/EL TR-13-9, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Great Lakes Restoration Initiative. Lower Black River Fish Habitat Restoration Project – Phase I, City of Lorain, Ohio Fact Sheet. https://www.cityoflorain.org/DocumentCenter/View/594/Lower-Black-River-Fish-Habitat-Restoration-Phase-I-Informational-Sheet-PDF?bidId=

Miranda, L. E. 2017. Reservoir fish habitat management. Lightening Press, Totowa, New Jersey. 306 pp.

National Oceanic and Atmospheric Administration. Understanding Living Shorelines. https://www.fisheries.noaa.gov/insight/understanding-living-shorelines

Severson, J. P., J. R. Nawrot, and M. W. Eichholz. 2009. Shoreline stabilization using riprap breakwaters on a Midwestern reservoir. Lake and Reservoir Management 25:208-216.

"The Shoreline Stabilization Handbook" Northwest Regional Planning Commission (NWRPC). St. Albans, Vermont. Accessed 3October 2018. https://www.uvm.edu/seagrant/sites/default/files/uploads/publication/shorelinestabiliationhandbook.pdf

Touchette, B. W., J. W. G. Moody, C. M. Byrne, and S. E. Marcus. 2013. Water integration in the clonal emergent hydrophyte, Justicia americana: benefits of acropetal water transfer from mother to daughter ramets. Hydrobiologia 702:83-94.

USACE. 2002. Making Great Lakes Coastal Structures Greener. Engineer Research and Development Center Booklet. https://ewn.el.erdc.dren.mil/pub/GLGB-Booklet.pdf

USDA NRCS Engineering Field Handbook, Part 650, Chapter 16, Streambank and Shoreline Protection. December 1996. https://efotg.sc.egov.usda.gov/references/public/IA/Chapter-16_Streambank_and_Shoreline_Protection.pdf

Webb, M. A., r. A. Ott, Jr., C. C. Bonds, R. M. Smart, G. O. Dick, and L. L. Dodd. 2012. Propagation and establishment of native aquatic plants in reservoirs. Texas Parks and Wildlife Management Data Series No. 273. 61 pgs.

Winward, Alma H. 2000. **Monitoring the vegetation resources in riparian areas. Gen. Tech. Rep. RMRSGTR-**47. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 49 p. https://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf

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Up next…

Shoreline Stabilization: Hard Armoring

Jeremy Shiflet, Kentucky Department Fish and Wildlife