An Automated LLWW Model to Predict Wetland Function

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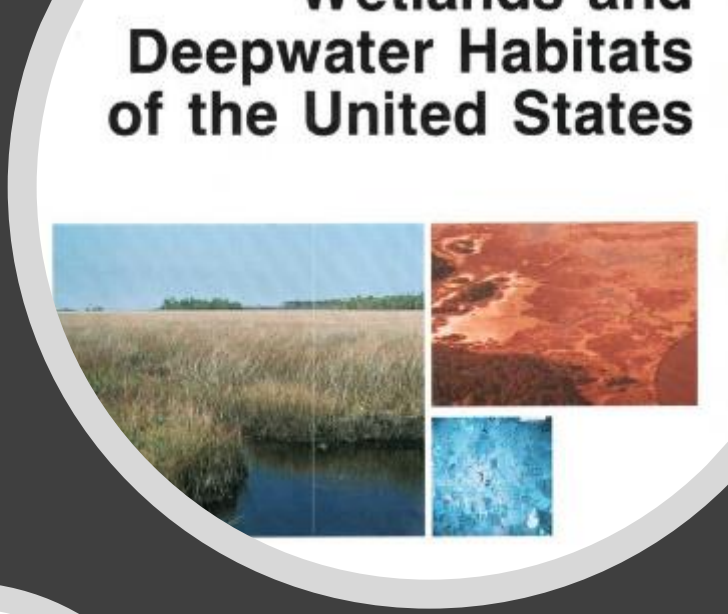
Overview

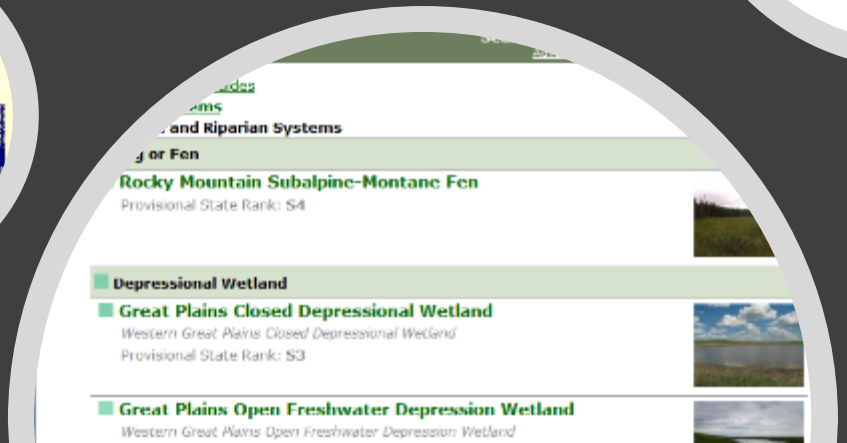
1. What is LLWW? Why use it?
2. How is LLWW derived from NWI & ancillary data?
3. Automated model – results in Colorado
4. Example of how to use model outputs

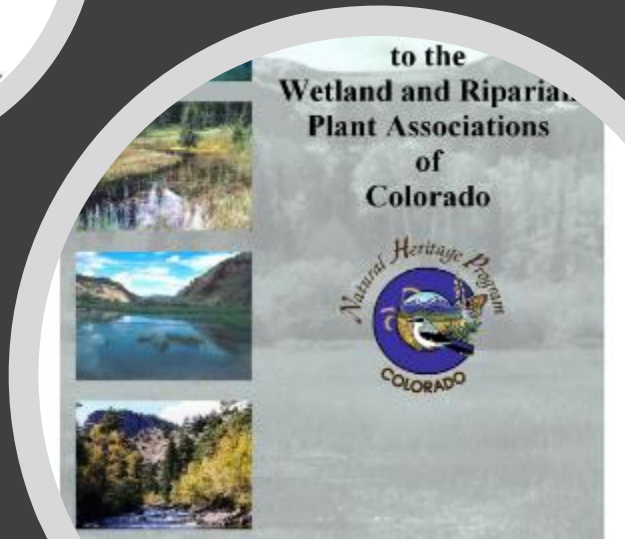
Wetland Classification Systems

based on

- Aquatic ecosystem
- Substrate
- Vegetation
- Water regime
- Landscape
- Plant communities
- Ecological system
- Function







What is LLWW*?

Landscape position:

Lentic (LE) *Lotic (LO)*

Terrene (TE)

Landform:

Basin (BA) *Fringe (FR)*

Slope (SL) *Flat (FL)*

Floodplain (FP)

Waterbody type:

River (RV) *Lake (LK)*

Stream (ST) *Pond (PD)*

Waterflow path:

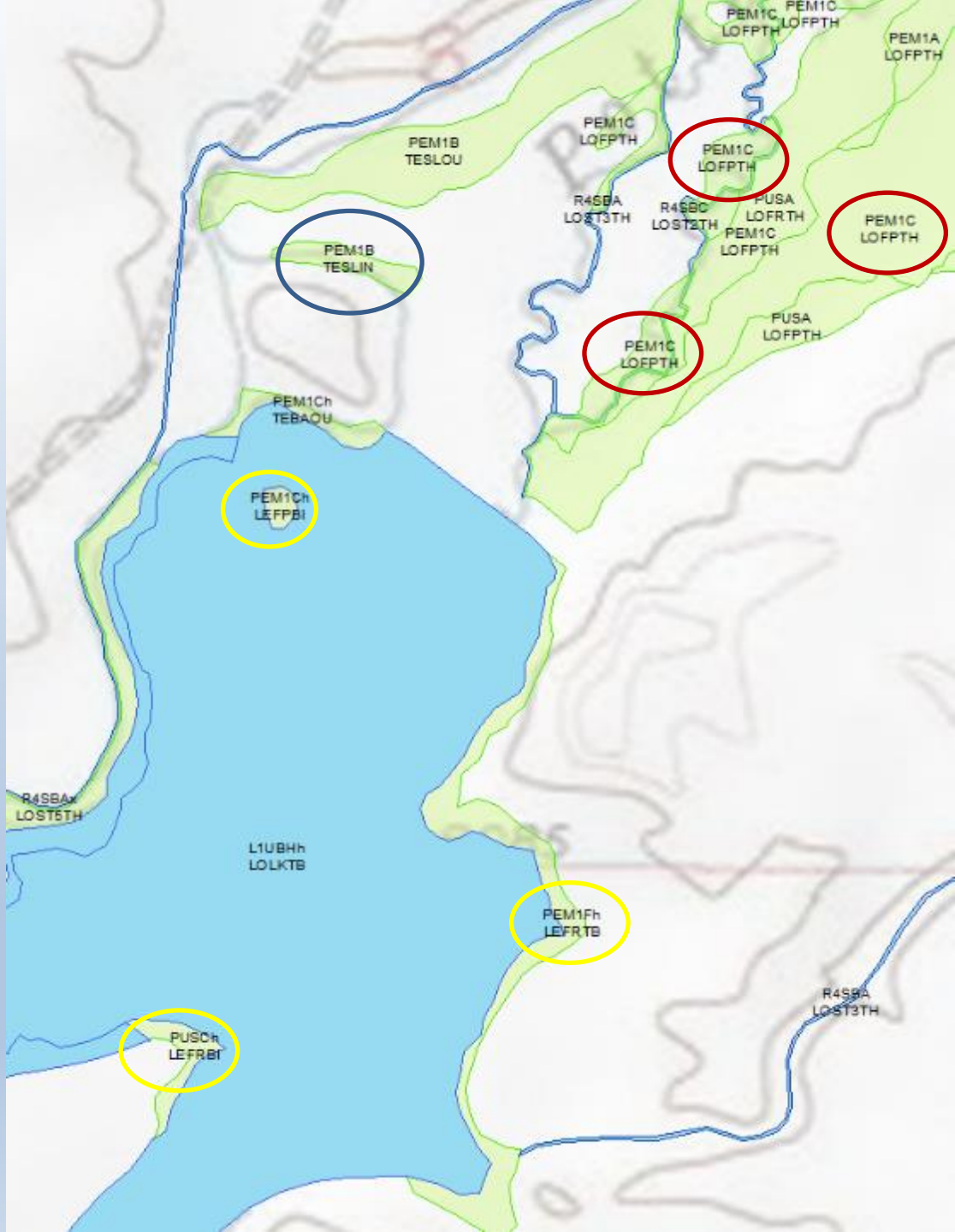
Inflow (IN) *Outflow (OU)*

Vertical flow (VR) *Throughflow (TH)*

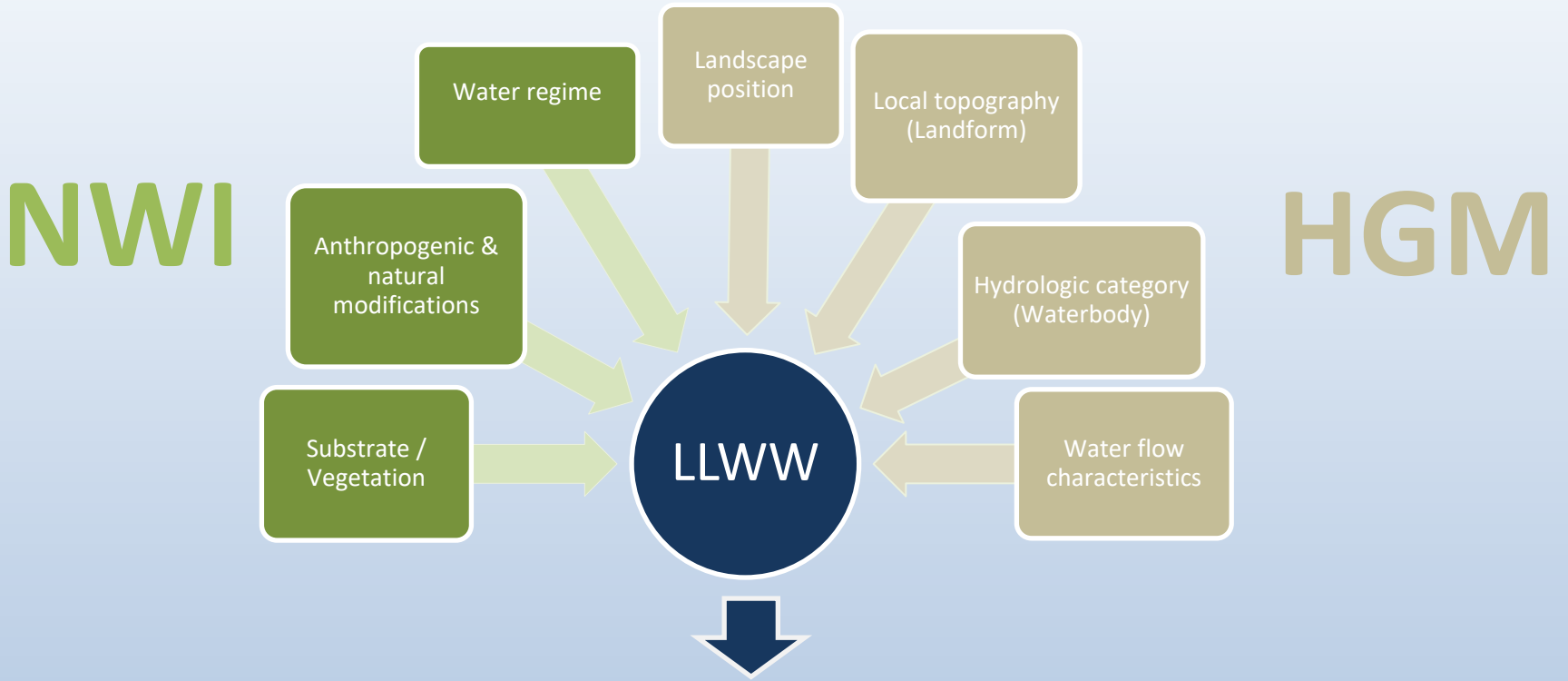
Throughflow-Bidirectional (TB)

Bidirectional (BI)

**Keys to LLWW for Inland Wetlands of the Western United States*



Why use LLWW?

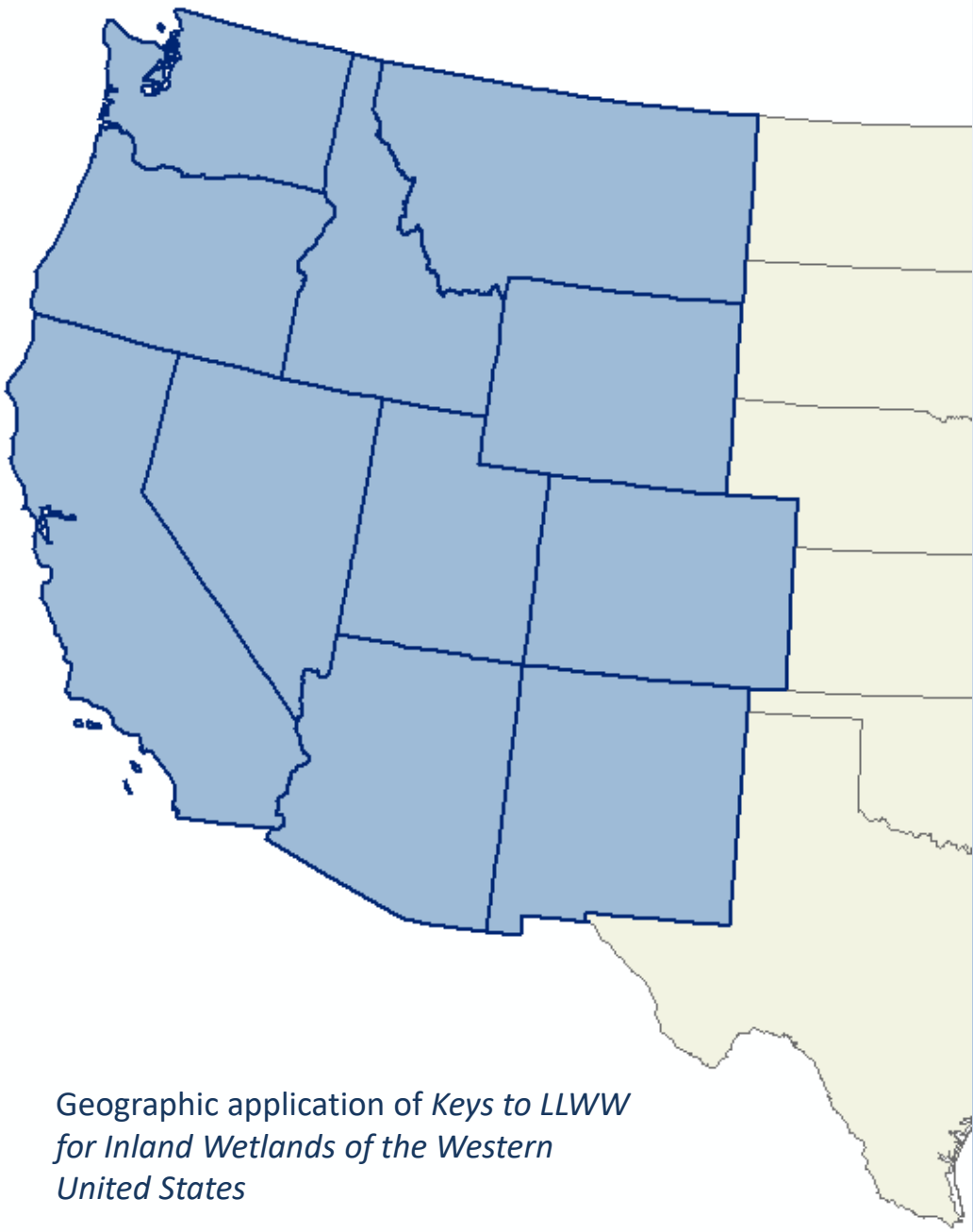


LLWW: Potential wetland functions

Streamflow maintenance	Generation & export of organic carbon	Waterfowl & waterbird habitat
Surface water retention	Sediment/particulate retention	Other wildlife habitat
Groundwater recharge/storage/flow	Bank & shoreline stabilization	Diverse wetland plant communities
Nutrient cycling & transformation	Fish & aquatic invertebrate habitat	Characteristic plant community resilience & maintenance
Carbon sequestration	Energy dissipation	Maintain wetland connectivity & interspersion
Maintain characteristic detrital biomass	Maintain spatial structure of habitat	

Automated LLWW model for Western U.S.

- 2017 EPA WPDG: U of M developed model for Montana's statewide wetland mapping layer
- *Keys to LLWW for Inland Wetlands of the Western United States:* 2018
  - updated model in 2019-2020
- Working with Saint Mary's University to combine models into one
  - Consistent LLWW attribution & product



Geographic application of *Keys to LLWW for Inland Wetlands of the Western United States*

How do you derive LLWW from NWI?

Model inputs:

Data production:

1. NWI
2. LLWW modifiers—manual assignment

Data downloads:

3. National Hydrography Dataset (NHD)

Derivatives:

4. Lake basins polygons
5. 100-year floodplain map (EPA & SSURGO soils query)
6. Slope raster
7. Topographic Position Index (TPI)
8. Headwaters binary raster

ArcGIS Model Builder

Application of LLWW modifiers

Manual	Notes	Semi-Automate	Notes	Automate	Notes	Possible Automation	Notes
aq: aquaculture		ag: agricultural		ar: artificial flow		al: alpine	
ay: arroyo		ch: channelized		bv: beaver		au: augmented flow	
ds: discharge to stream★				dr: partially drained		ba: burn area	
fm: floating mat	ǂ			ex: excavated		bg: bog	A
go: golf course				fn: fen		bk: beetle killed forest	
gr: gravel				fs: flashy		gl: glacial	
gz: grazed				gf: geomorphic floodplain		id: interdunal	
hf: hayfield				gw: groundwater-driven		ir: irrigation-influenced★	◊
hs: hot spring				hw: headwater		kt: kettle	
hy: hydropower				il: island		lg: logged	
ld: lock & dammed				im: impounded		ml: mineral	
mn: mining				it: temporary-intermittent flow		pf: permafrost	A
mr: mire				pd: pond fringe		pl: playa	
ox: oxbow★				rn: rainfall		sa: saline	
pp: prairie pothole						sf: spring fed★	
re: restoration site						sv: stream valley	
rf: regulated flow						ts: toe-of-slope	
rr: run of river dammed							
sl: seepage lake							
sn: snowmelt							
sr: snow + rain							
sw: stormwater							
wm: wildlife management							
ww: wastewater							

★ **These modifiers heavily influence the model**

Notes:

ǂ: Not to be applied via photo interpretation

A : Limited to Alaska; automation will require ancillary GIS layers

◊: Explore options for selecting 'ag' / 'hf' adjacent to R4%x

Likely to be the most commonly encountered modifiers that need manual attribution


Irrigation-influenced


Discharge to stream


Spring fed


Oxbow

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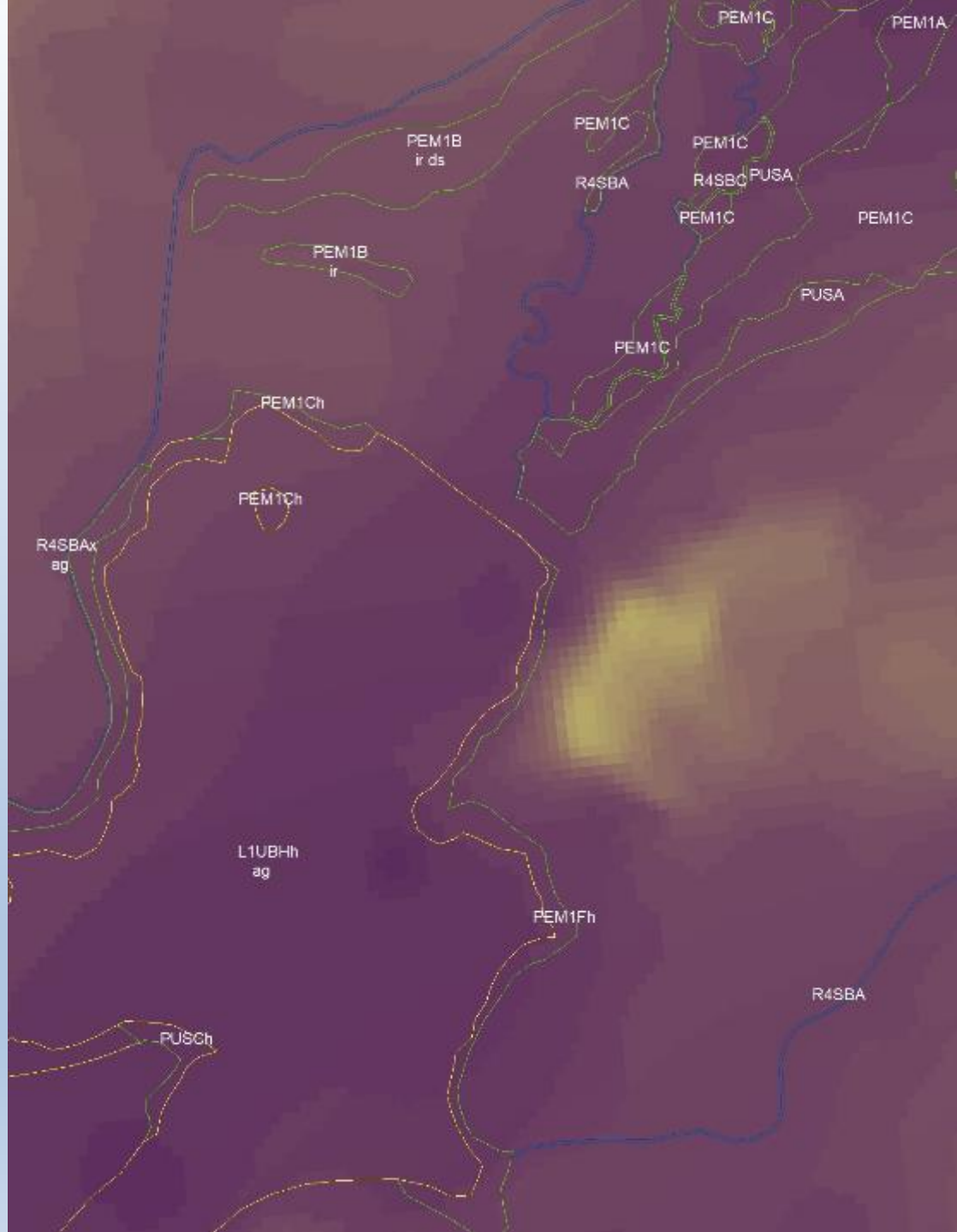


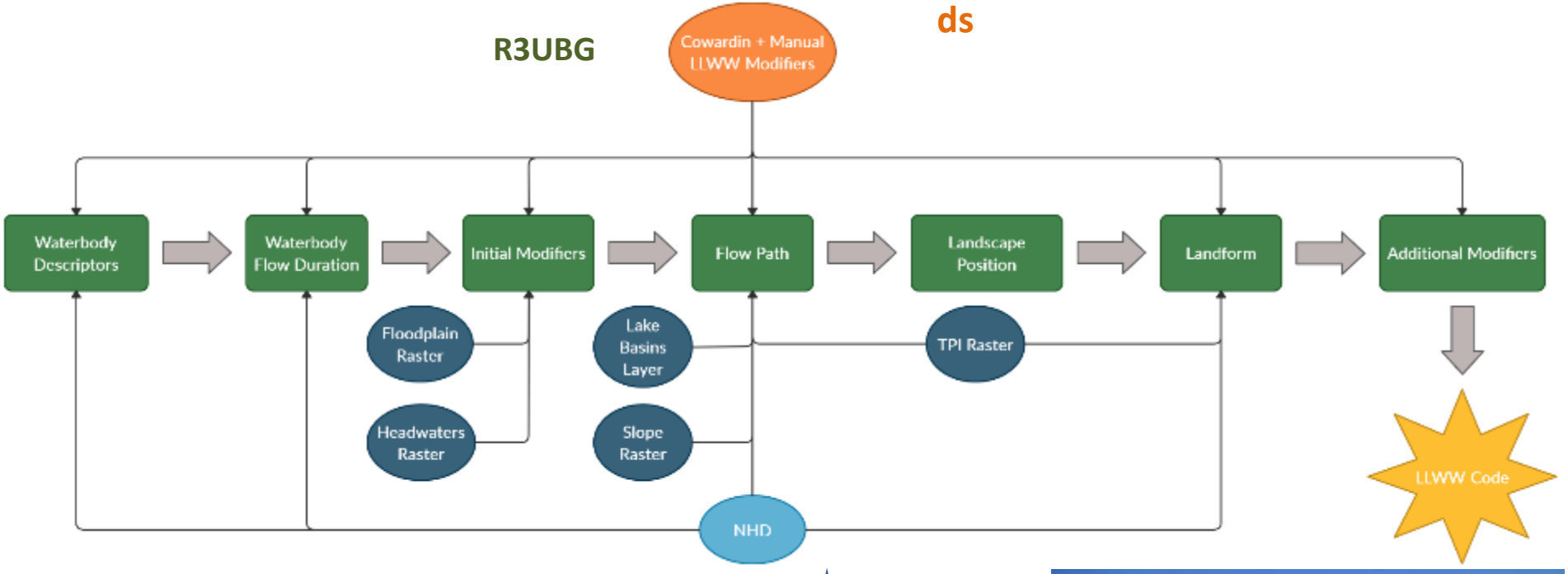
Automated LLWW model for Western U.S.

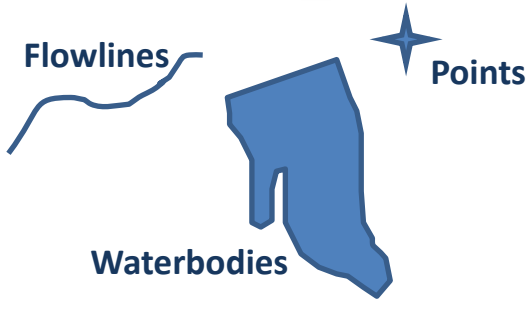
PEM1C PSS1A

ox ir

ds

R3UBG



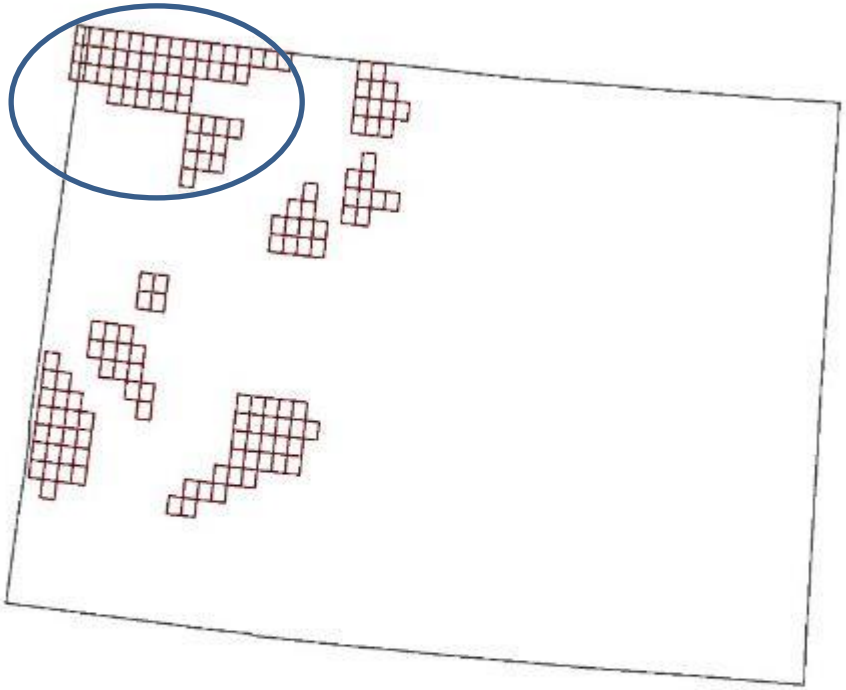


LLWW model results in Colorado

156 1:24,000 USGS quads

100,041 total polygons:

- 17,932 Rp
- 59,709 LO
- 22,104 TE
- 296 LE



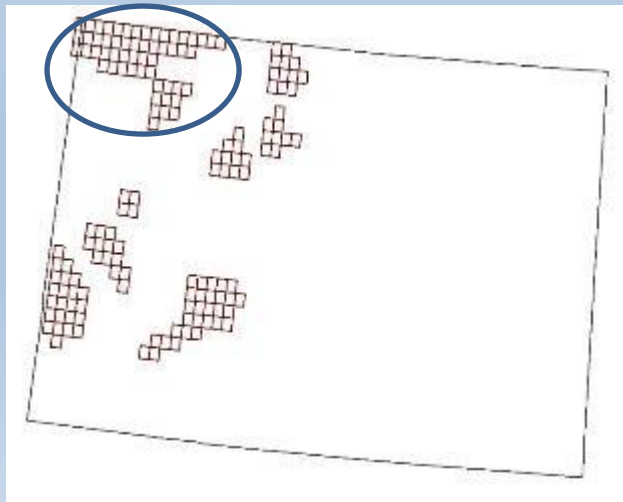
PA 1: 55 1:24,000 USGS quads

34,178 total polygons:

- 7,686 Rp
- 20,288 LO
- 6,185 TE
- 19 LE

Frequency of LLWW codes in Colorado BLM PA 1

CODE	FREQUENCY	CODE	FREQUENCY	CODE	FREQUENCY
LOFPTH	7058	TESLOU	1585	LEFRTB	5
LOST4TH	4429	TEPDVR	1331	LEFPBI	4
LOFRTH	2694	TEBAVR	1325	LEPDTH	3
LOBATH	1828	TESLVR	993	LEFRBI	3
LOPDTH	1643	TEPDOU	437	LEFPTB	3
LOST3TH	1066	TESLTH	226	LEBAVR	1
LOST5TH	520	TEBAOU	173		
LOST2TH	399	TESLIN	42		
LOBAVR	323	TEFRVR	34		
LOPDVR	125	TEPDIN	23		
LOST1TH	93	TEBATH	7		
LORV1TH	71	TEVR	2		
LOLKTB	5	TELKIN	2		
LOST1BATH	4	TEPDTH	1		
LORV5TH	3				
LOST2BATH	2				
LOFRVR	2				
LOLKIN	1				
LO2TH	1				



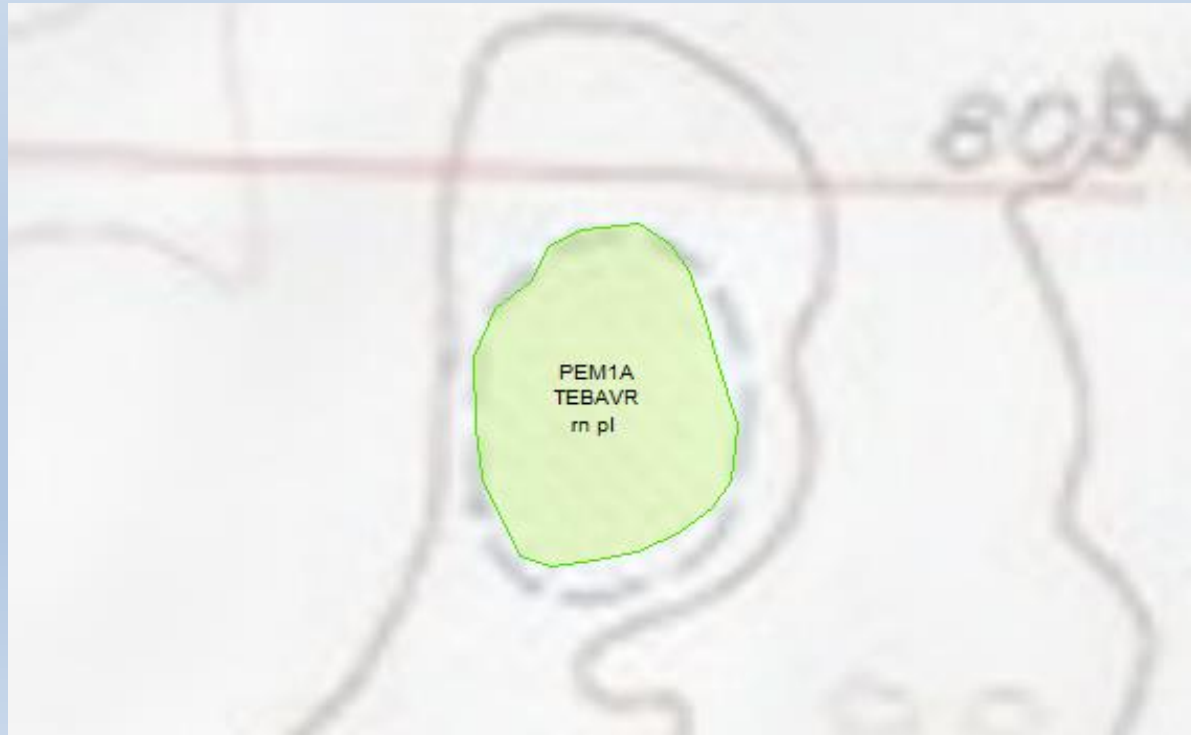
LLWW model Quality Control

LLWW Category	LLWW Codes	Flagged Features*/ Reviewed Features	Total Features	Percent Accuracy	Percent of Features Reviewed
Landscape Position - Pond	LEPD / LOPD / TEPD	50/264	3563	81.1%	7.4%
Landscape Positon - Lake	LELK / LOLK / TELK	1/8	8	87.5%	100.0%
Flow Path - Pond	PDIN / PDOU / PDTH / PDVR / PDBI / PDTB	42/351	3563	88.0%	9.9%
Flow Path - Lake	LKIN / LKOU / LKTH / LKVR / LKBI / LKTB	3/8	8	62.5%	100.0%
Landform - Lotic (Non-Riverine)	LOBA / LOSL / LOFR / LOFP / LOFL	11/214	11832	94.9%	1.8%
Landform - Lentic	LEBA / LESL / LEFR / LEFP / LEFL	0/15	18	100.0%	88.3% (Note: 3 Lentic Ponds not reviewed)
Landform - Terrene	TEBA / TESL / TEFR / TEFP / TEFL	27/454	6324	94.1%	7.2%
Flow Path - Lotic (Non-Riverine)	LOIN / LOOU / LOTH / LOVR / LOBI / LOTB	23/141	11832	83.7%	1.2%
Flow Path - Lentic	LEIN / LEOU / LETH / LEVR / LEBI / LETB	1/18	18	94.4%	100.0%
Flow Path - Terrene	TEIN / TEOU / TETH / TEVR / TEBI / TETB	35/540	6324	93.5%	8.5%

* Flagged Features = flagged during QC: needed further review for accuracy

What works?

- Landscape position
- Waterbodies
- Lotic floodplain
- Lotic fringe
- Isolated terrene basin features



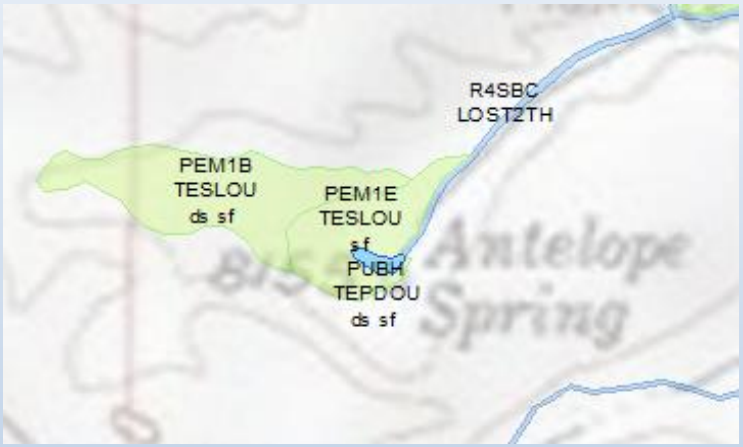
What needs more work?

- If manual attribution of modifiers is inaccurate / conflicting
- Lotic and lentic basins are challenging
  - Limited LiDAR coverage in Western U.S. (5-10m DEM)
- Can’t split NWI polygons with same attribute (ex. stream networks, regulated flow)

How does LLWW get to function?

Streamflow maintenance

TE (moderate) + SL (moderate) + OU (high) = Potential Function (moderate)



Surface Water Retention

TE (high) + SL (moderate) + OU (moderate) = Potential Function (moderate)

Other wildlife habitat

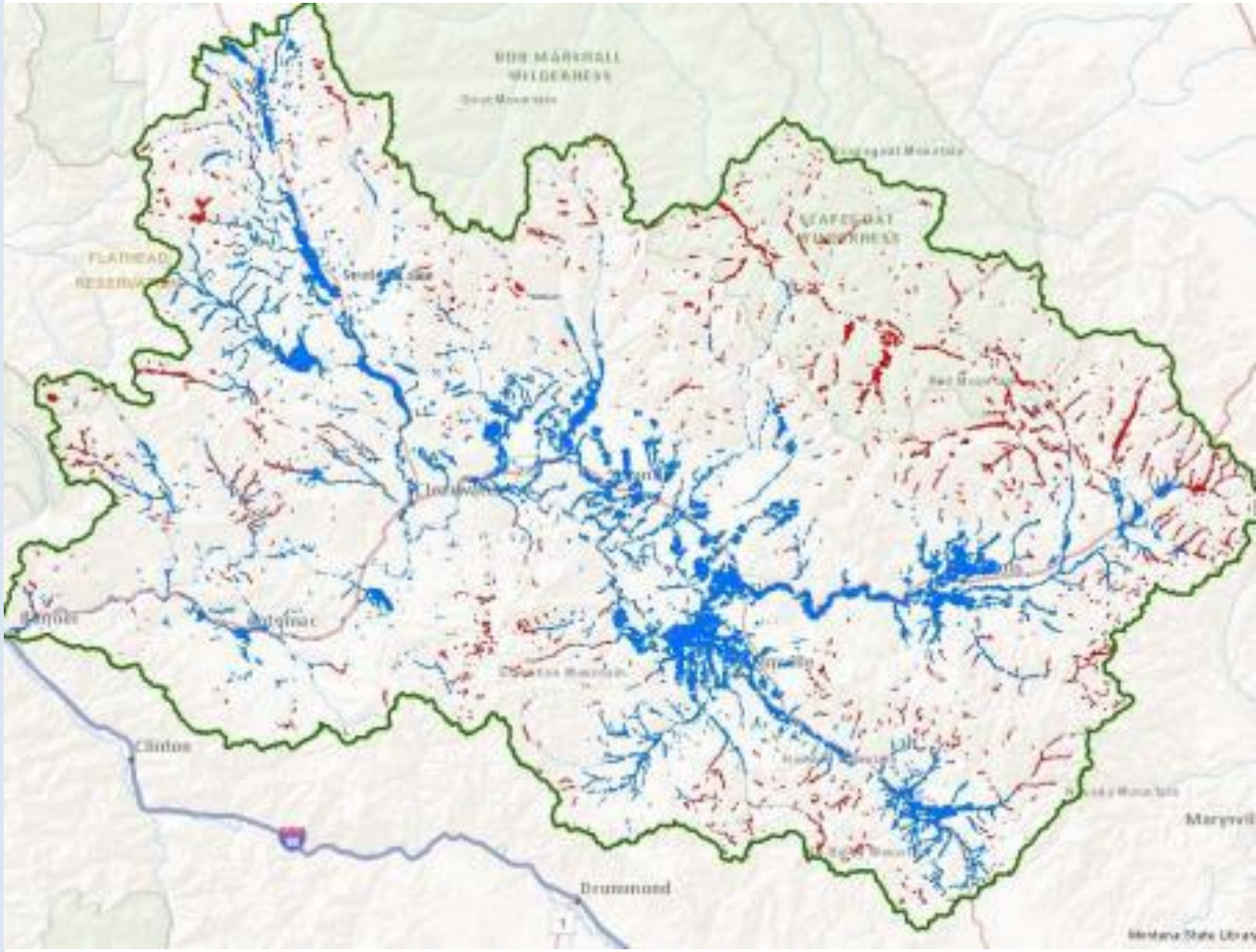
TE (high) + SL (moderate) + OU (high) = Potential Function (high)

What can LLWW do?

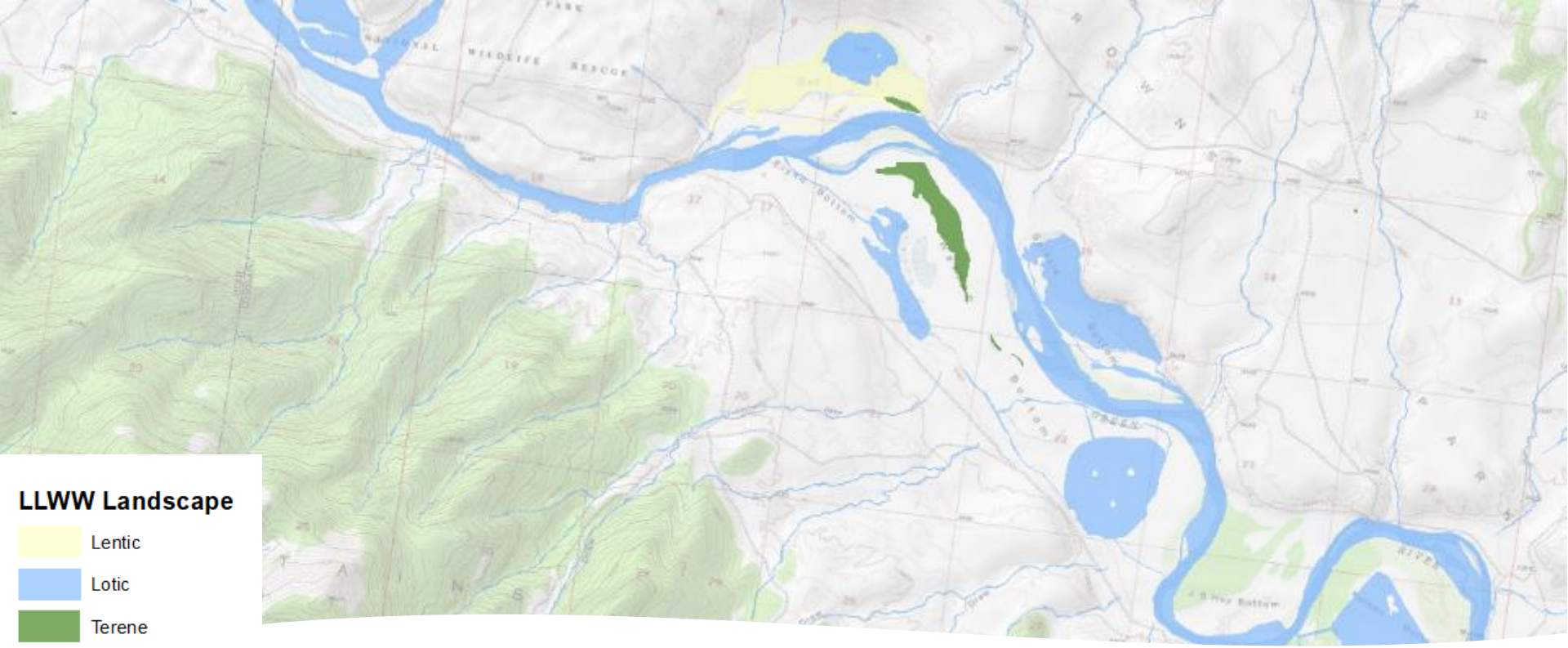
Question: will minimum streamflows be met for fish in this watershed?

Potential streamflow maintenance

*headwater wetlands
* beaver complexes
* oxbows
* ponds
* fens



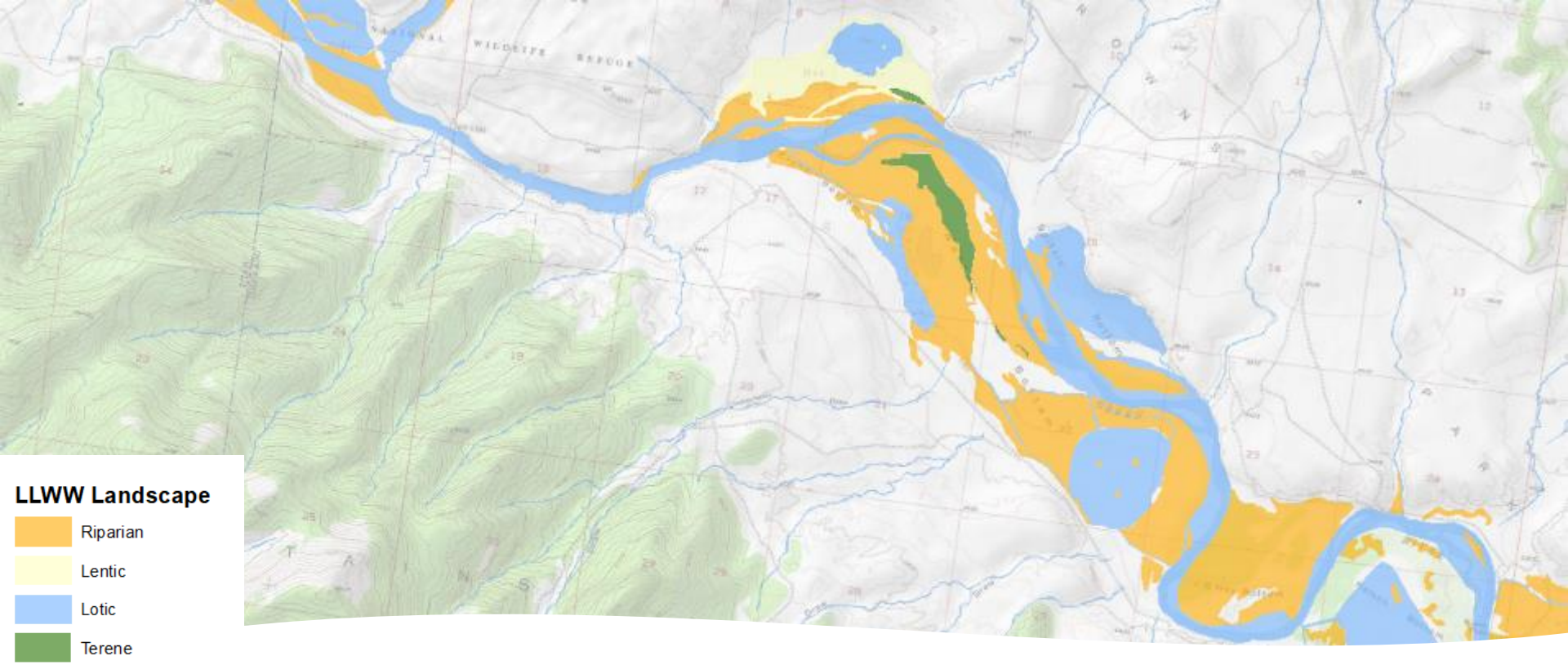
Map potential function at the landscape level



Limitations of LLWW

Wetland connectivity and interspersion

- Wetland areas along large rivers appear somewhat disconnected



Limitations of LLWW

Wetland connectivity and interspersion

- Riparian mapping shows greater connectivity between wetlands and informs potential function

Summary

General

- LLWW predicts *potential* wetland functions
  - Actual function ascertained via conditional assessments

Automation

- Model works well for most LLWW attribution
- Needs work: Lentic systems, some flow paths
  - Finer elevation detail: LiDAR
- Manual assignment of modifiers plays key role

Application

- Can give managers better idea of where certain wetland functions take place

Thank You

- EPA Region 8
- Saint Mary's University
- Joe Fortier
- Jen Chutz
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- Colorado Natural Heritage Program
- Utah Geological Survey
- EMMA workgroup at UM
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