Characterizing Floodplains


Kuskokwim River


Mississippi River

Rio Paraguay


CA Central Valley (Daniel Nylen)

Characterizing Floodplains

Floodplains can be delineated by their geomorphic, hydrologic, hydraulic, soil, and ecological properties

Characterizing Floodplains

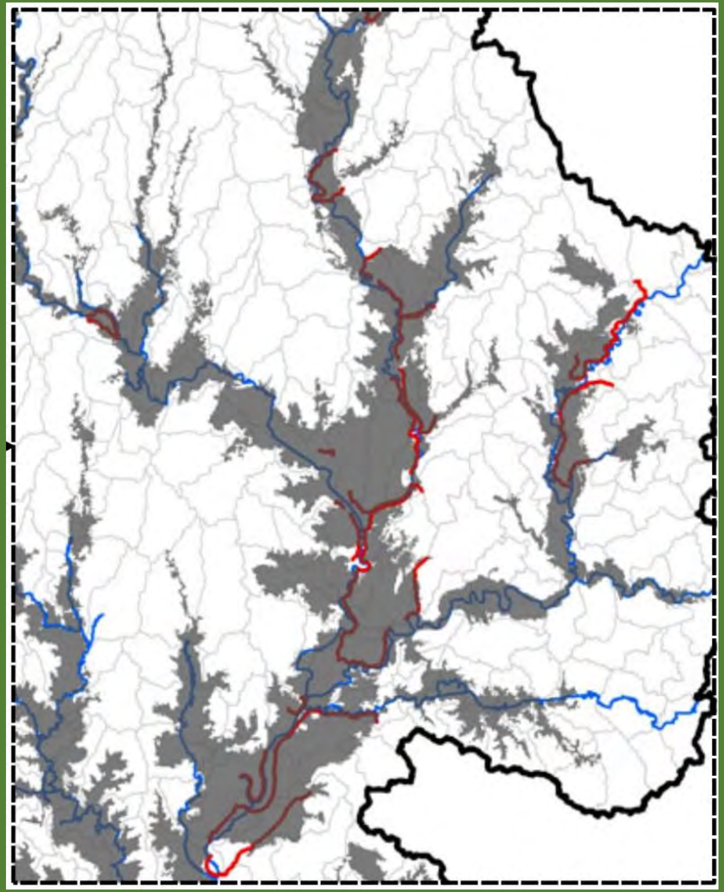
*Floodplains can be delineated by their **geomorphic**, **hydrologic**, hydraulic, soil, and ecological properties*

e.g., river valleys, valley bottoms, fluvial corridors

Where are the Floodplains?

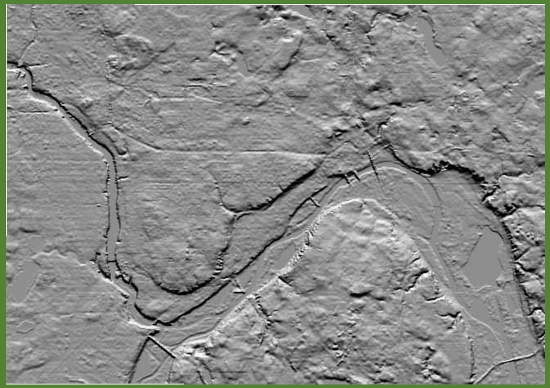
Where are the Floodplains?

Delineate floodplains at network-scale



Inferring Floodplains from Valley Morphology

Basin topography contains hydrogeomorphic signature of erosional and depositional processes that shape river valleys



AND

Water levels at flood flows scale predictably across a river basin

$h \propto A^b$

(Adaptation of Leopold scaling law)

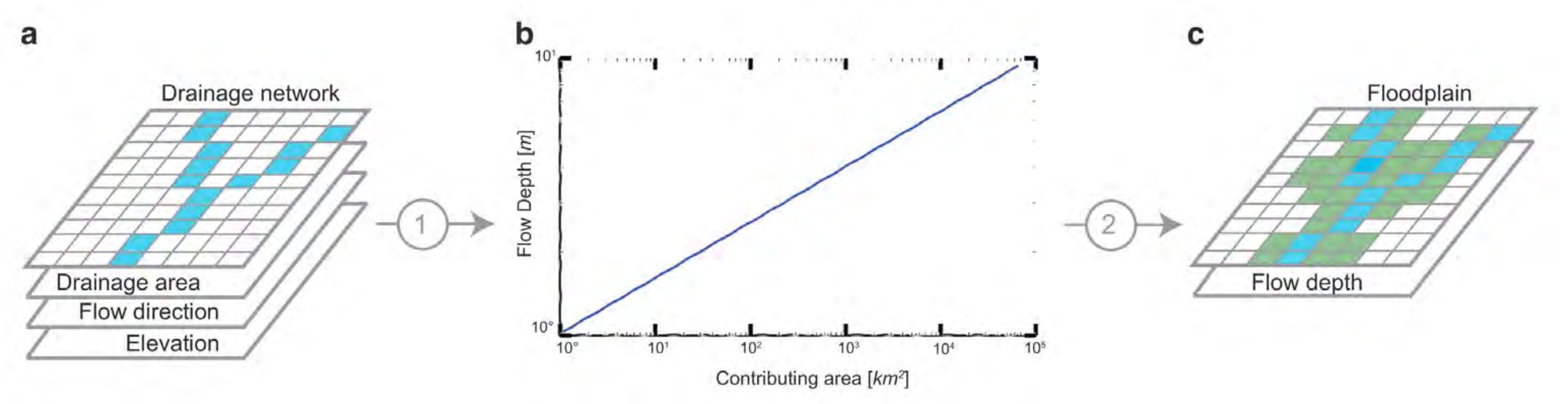
GFPLAIN

Data Descriptor: GFPLAIN250m, a global high-resolution dataset of Earth's floodplains

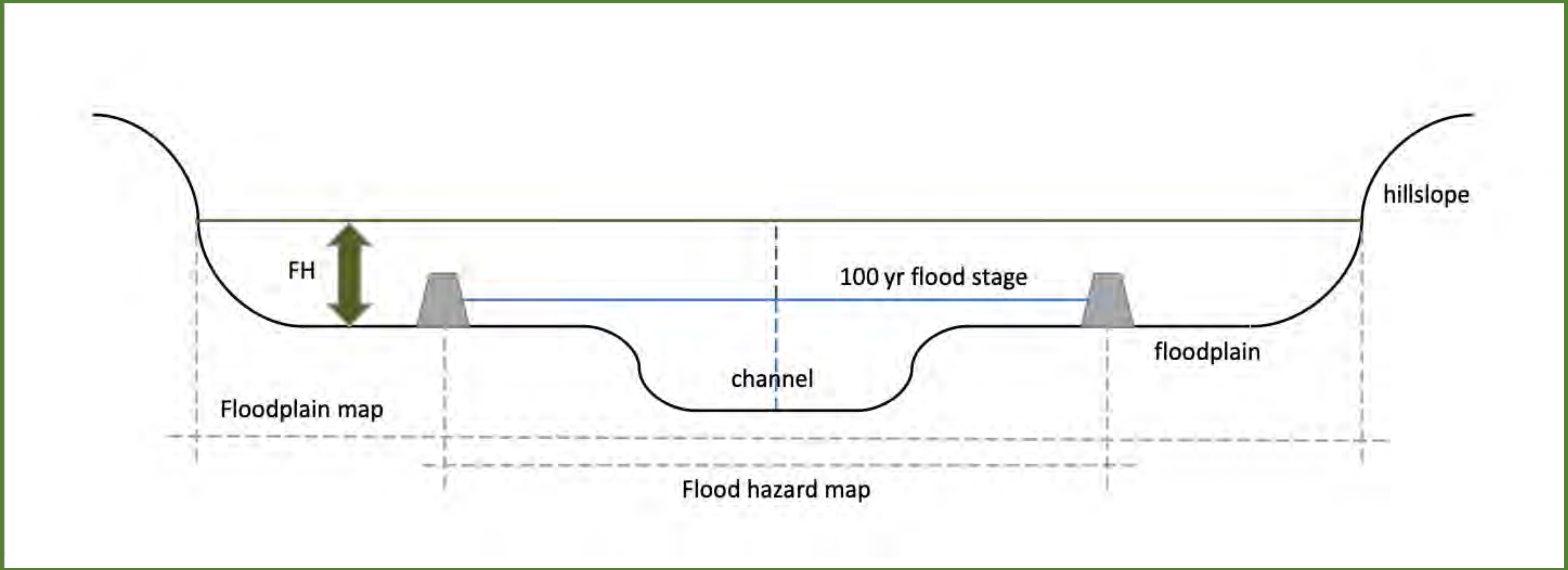
Nardi, F., Annis, A., Di Baldassarre, G., Vivoni, E. R., & Grimaldi, S. (2019). GFPLAIN250m, a global high-resolution dataset of Earth's floodplains. Scientific Data, 6(1), 180309. https://doi.org/10.1038/sdata.2018.309

Basin-scale Delineations

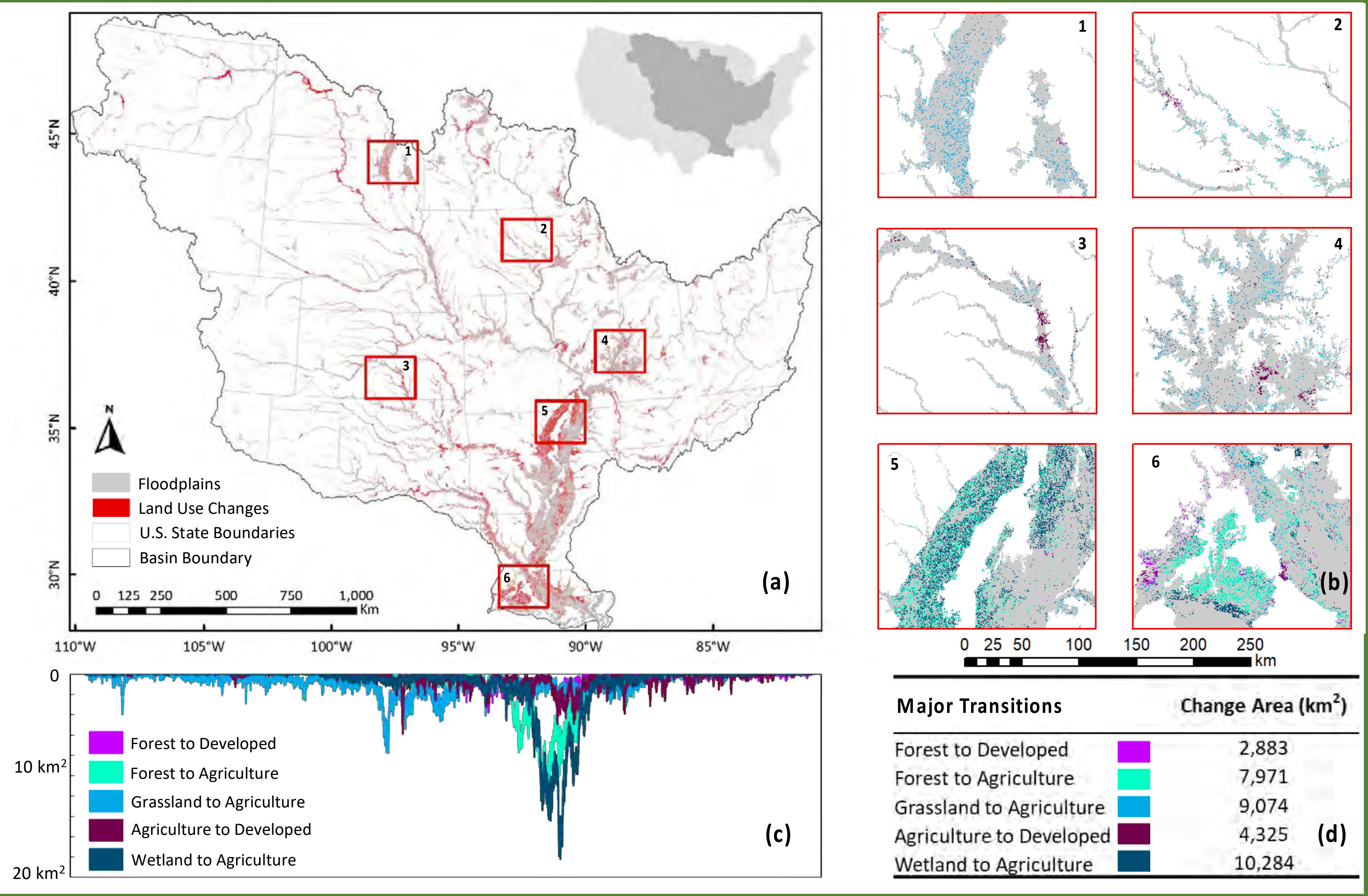
GIS-based tool that relies only on topography and flow-stage observations to delineate floodplains at basin scale…



Floodplain vs Flood Hazard Maps



Floodplain Land Cover Characteristics



Major Transitions	Change Area (km^2)
Forest to Developed	2,883
Forest to Agriculture	7,971
Grassland to Agriculture	9,074
Agriculture to Developed	4,325
Wetland to Agriculture	10,284

Adnan et al. (2021). The Changing Face of Floodplains in the Mississippi River Basin Detected by a 60-year Land Use Change Dataset. Nature Scientific Data, In Press.

Thanks!

Ryan Morrison

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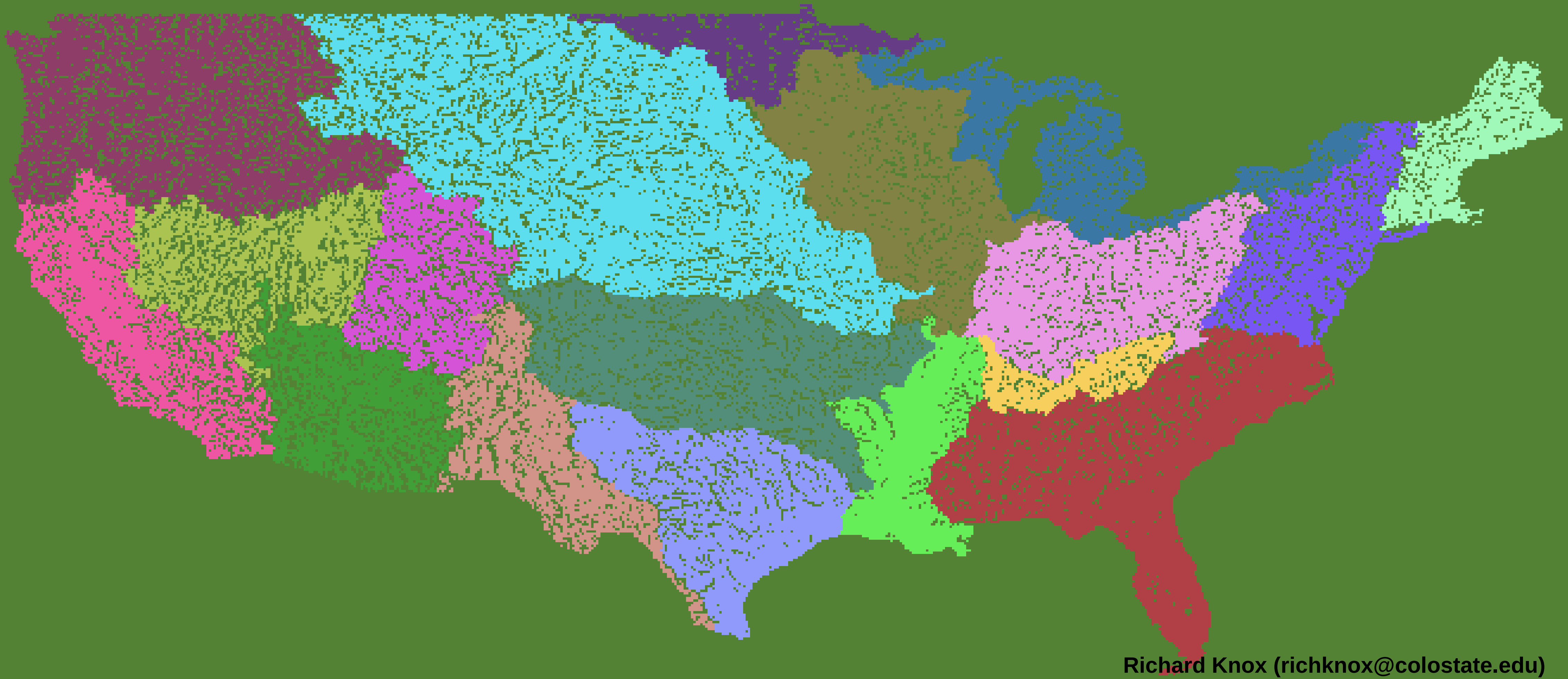
The Geography of Artificial Levees in the U.S.



Richard Knox (richknox@colostate.edu)

Advisors: Professors Ellen Wohl and Ryan Morrison

Where are the dammed levees?

National+ impacts from dams?
Graf, 1999; Lehner et al., 2011; Jones et al., 2019

National impacts from roads/rail roads?
Blanton and Marcus, 2009

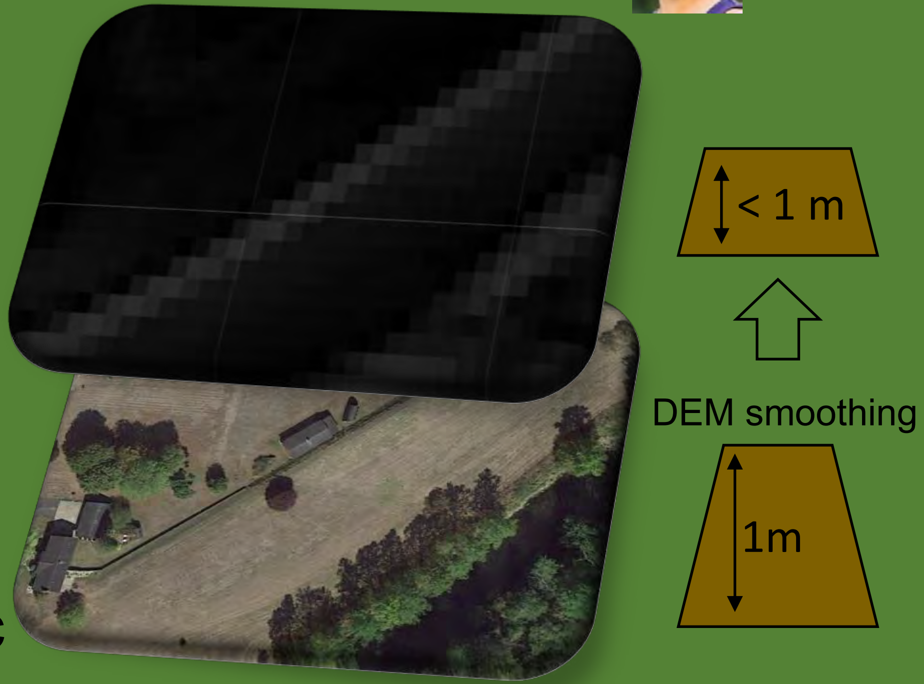
National impacts from artificial levees?
?

Finding artificial levees is hard

Where's the dam levee?

KATHERINE

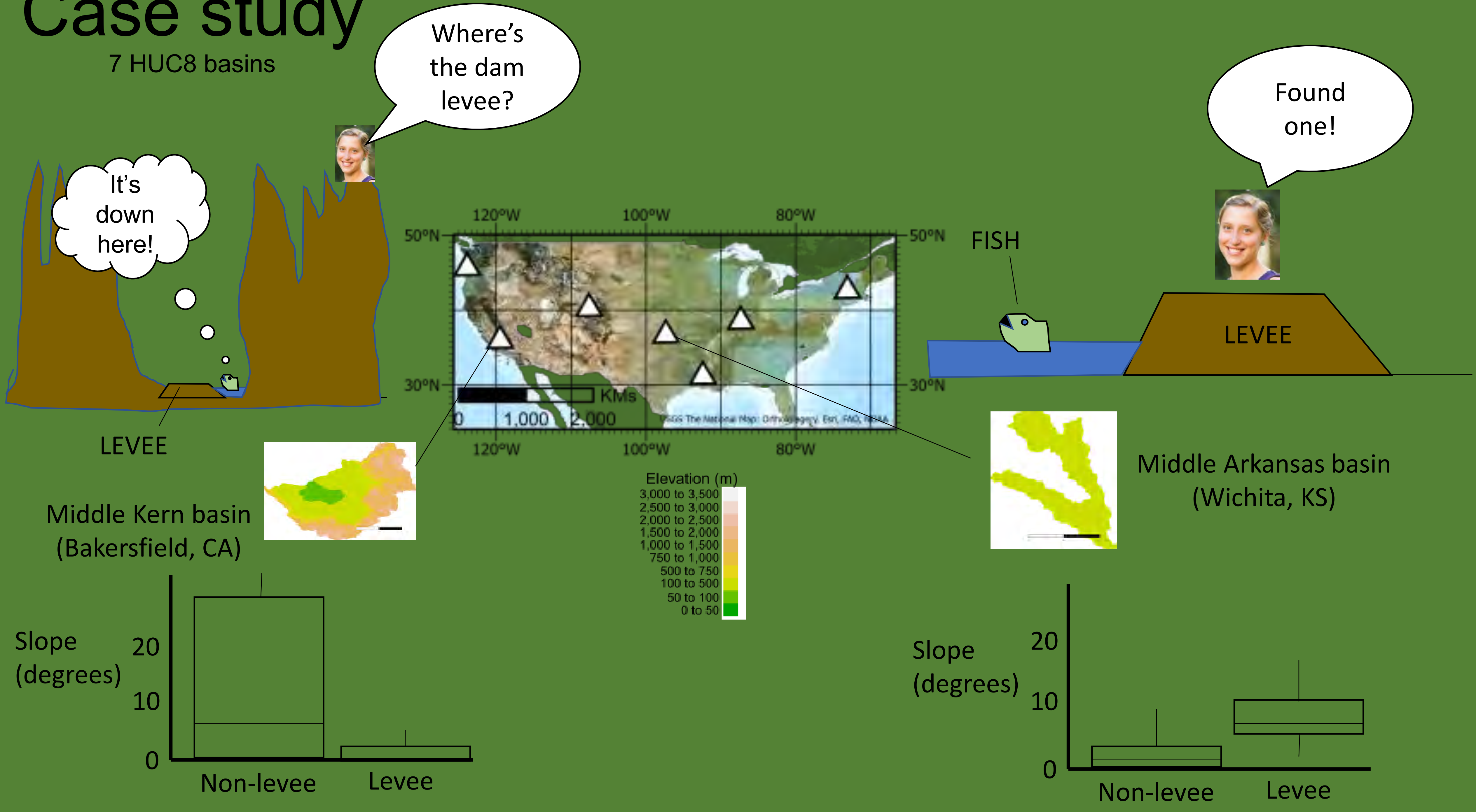
c



Two artificial levees in the National levee database.

Case study

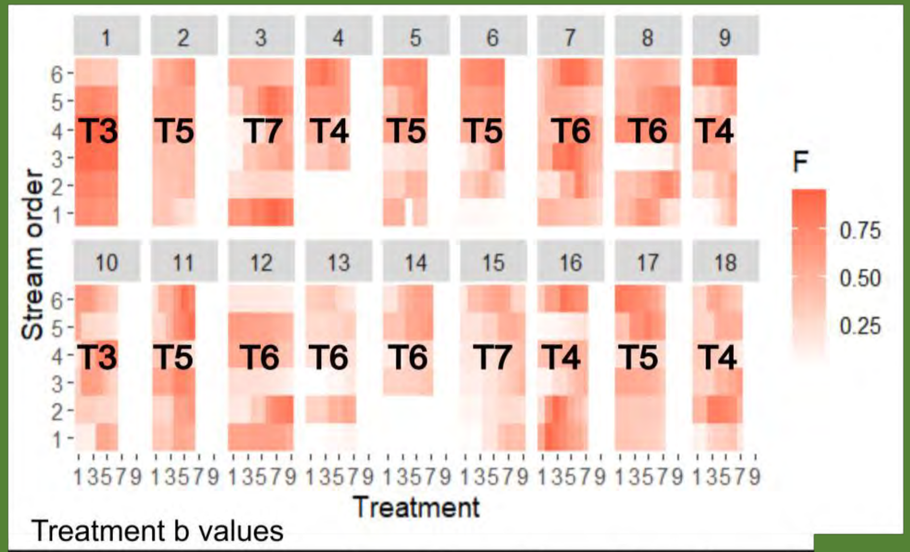
7 HUC8 basins



CONUS hydrogeomorphic floodplain calibration

a

b

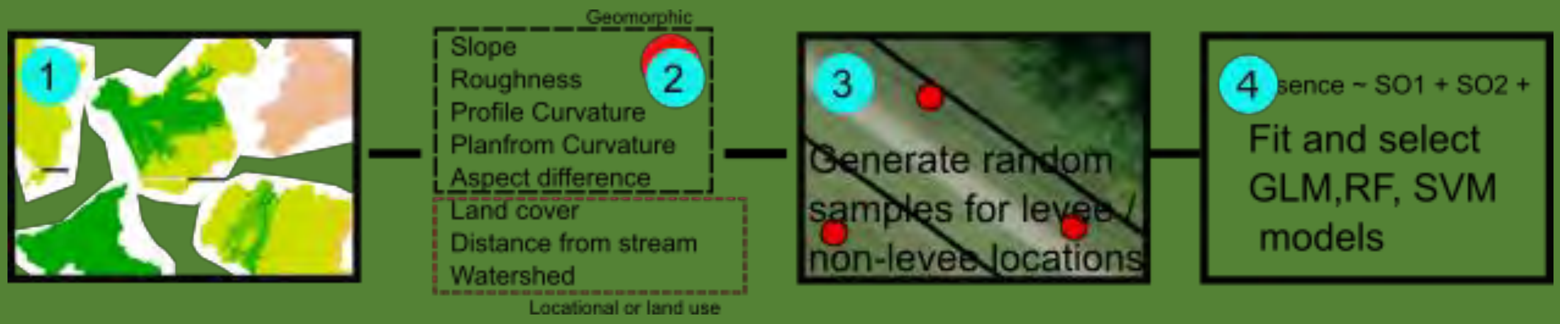


Treatment b values

T1	T2	T3	T4	T5	T6	T7	T8	T9
0.26	0.28	0.3	0.32	0.34	0.36	0.38	0.4	0.42

Range of b values based on previous studies (Nardi et al., 2006; Nardi et al., 2018, Annis et al., 2019, Scheel et al., 2019)

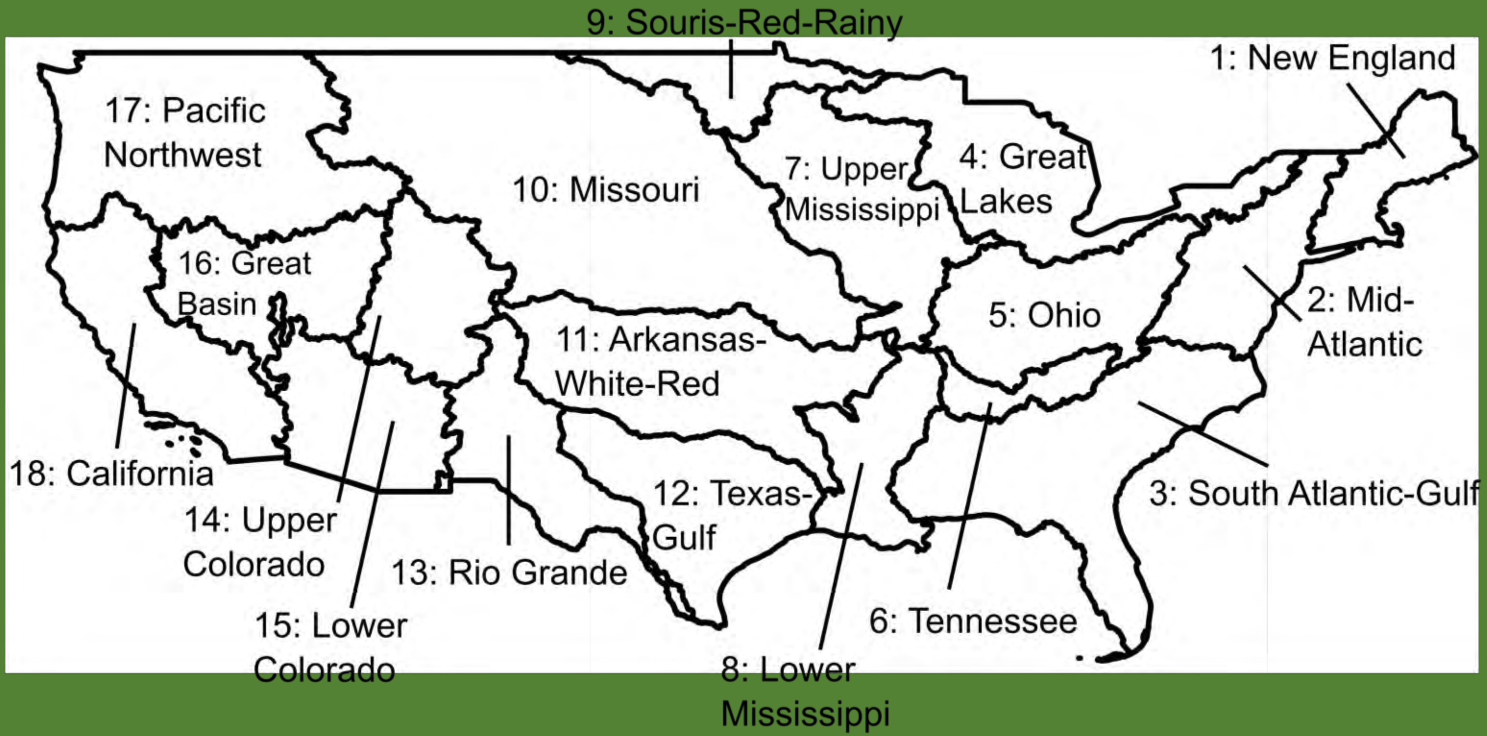
Testing in the case study

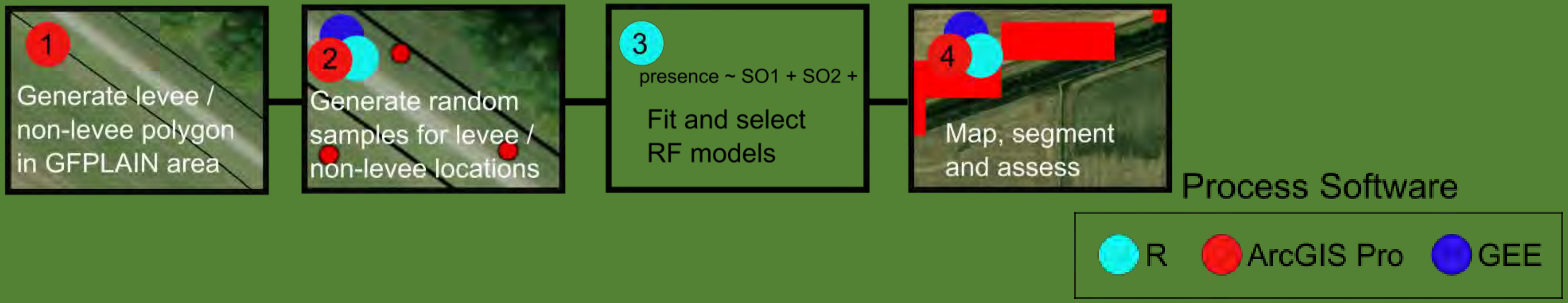


Process Software

R ArcGIS Pro GEE

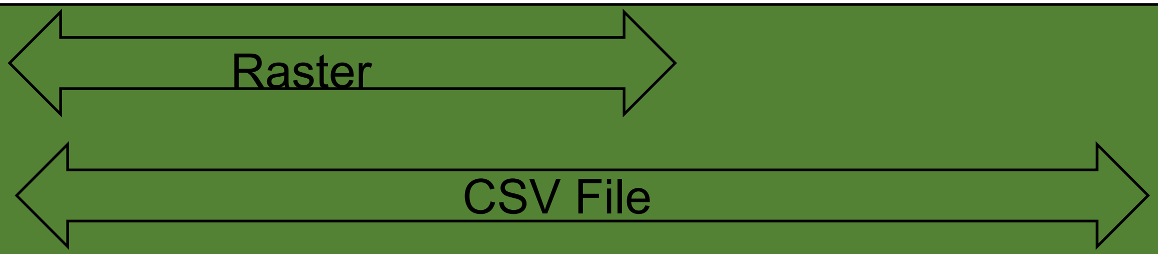
CONUS study


9: Souris-Red-Rainy
1: New England
17: Pacific Northwest
10: Missouri
7: Upper Mississippi
4: Great Lakes
16: Great Basin
11: Arkansas-White-Red
5: Ohio
2: Mid-Atlantic
18: California
12: Texas-Gulf
3: South Atlantic-Gulf
14: Upper Colorado
13: Rio Grande
6: Tennessee
15: Lower Colorado
8: Lower Mississippi


1
Generate levee / non-levee polygon in GFPLAIN area
2
Generate random samples for levee / non-levee locations
3
presence ~ SO1 + SO2 +
Fit and select RF models
4
Map, segment and assess
Process Software
R
ArcGIS Pro
GEE

Why did we use ArcGIS Pro, R, and Google Earth Engine (GEE)?

	ArcGIS Pro	**R**	**GEE**
Used for.....	**Fast sampling** (e.g. 3.5 hours to extract 7 variables from 112,000,000 locations)	**Reproducibility** (generating and modelling 100s of digital samples)	**Digital Earth Observation data trove** (e.g. 24 hours to extract 5 topographic variables from NED at 3,000,000 locations)
	Segmentation (great tools for analyzing prediction surface of 1s and 0s)	**Combining data** (neat tools to....)	
	Reproducibility (Model builder for data generation, analysis of 18 HUC2s)		



Some challenges....and solutions

C1: Levees can be topographically stealthy/invisible and look like a lot of other things (e.g. road embankments)

S1: Don't use topography! Our best performing model was a large random forest model (RF) with land use, HUC2 basin, and six distance from stream order (1-6) variables

C2: This model's high performance is due to spatial autocorrelation only

S2: We increased the validation rigor with a leave-one-out cross-validation with 1,100 artificial levees in the LMR..... 61% of the levees were detected but these represented 94% of the total levee length.

C3: The CONUS is really big, where are we going to get the computing power from?

S3: The above model didn't include topographic variables which are computationally expensive. We also used the GFPLAIN floodplain which reduced the study area to ~ 10% of CONUS. So, the study time was measured in months, not years.

Thank you!

Richard Knox (richknox@colostate.edu)

Advisors: Professors Ellen Wohl and Ryan Morrison

Annis, A., Nardi, F., Morrison, R. R., & Castelli, F. (2019). Investigating hydrogeomorphic floodplain mapping performance with varying DTM resolution and stream order. *Hydrological Sciences Journal*, *64*(5), 525-538.

Blanton, P. and W.A. Marcus (2009). Railroads, roads and lateral disconnection in the river landscapes of the continental United States, Geomorphology, 112, 212-227.

Gesch, D. B., Oimoen, M. J., & Evans, G. A. (2014). Accuracy assessment of the US Geological Survey National Elevation Dataset, and comparison with other large-area elevation datasets: SRTM and ASTER (Vol. 1008). US Department of the Interior, US Geological Survey.

Graf, W.L. (1999). Dam nation: A geographic census of American dams and their large-scale hydrologic impacts, Water Resources Research, 35(4), 1305-1311, doi: 10.1029/1999WR900016.

Jones, J., L. Borger, J. Tummers, P. Jones, M. Lucas, J. Kerr, P. Kemp, S. Bizzi, S. Consuergra, L. Marcello, A. Vowles, B. Belletti, E. Verspoor, W. Van de Bund, C.G. Leaniz (2019). A comprehensive assessment of stream fragmentation in Great Britain, Science of the Total Environment, 673, 756-762, doi: 10.1016/j.scitoteinv.2019.04.125.

Lehner, B., Liermann, C.R., Revenga, C., Vorosmarty, C., Fekete, B., Crouzet, P., et al. (2011). High-resolution mapping of the world's reservoirs and dams for sustainable river-flow management. Frontiers in Ecology and the Environment, 9, 494-502.

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Nardi, F., Annis, A., Di Baldassarre, G., Vivoni, E. R., & Grimaldi, S. (2019). GFPLAIN250m, a global high-resolution dataset of Earth's floodplains. Scientific data, 6(1), 1-6.

Scheel, K., Morrison, R. R., Annis, A., & Nardi, F. (2019). Understanding the Large-Scale Influence of Levees on Floodplain Connectivity Using a Hydrogeomorphic Approach. *JAWRA Journal of the American Water Resources Association*, *55*(2), 413-429.

Characterization the Configuration of River Beads (Wide River Corridors) in Mountain River Networks

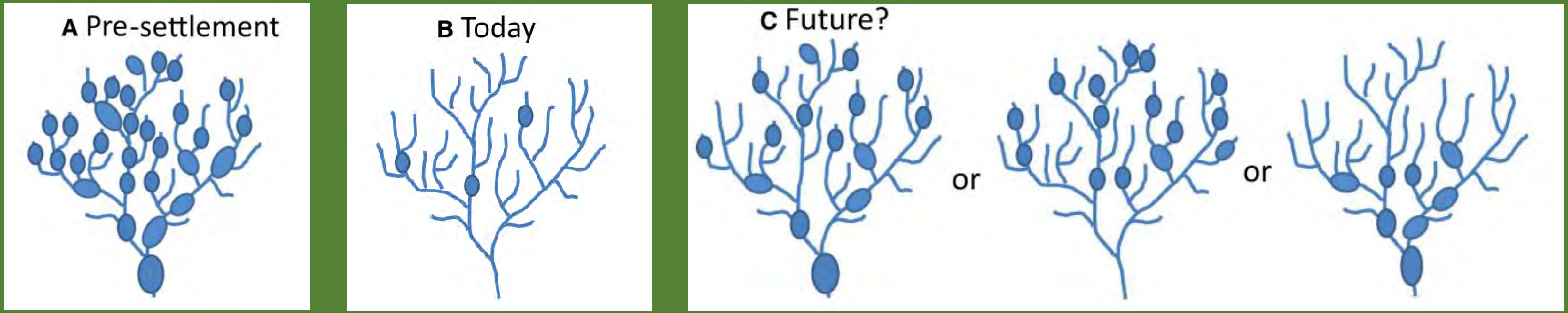
Collaborators:

Alex Brooks, Tim Covino, Matt Ross,

Ryan Morrison, Ellen Wohl, Xiao Yang

Background

- Growing interest in promoting river bead functions and resilience and in restoring river segments for services that operate at the network scale
  - e.g. sediment retention, flood attenuation, water quality, habitat.
- Many restoration effort target individual reaches or segments but critical river processes are an accumulation across networks
- Remains the question of where and how to focus restoration efforts



Adapted from (Wohl et al, 2017)

What We Want To Know

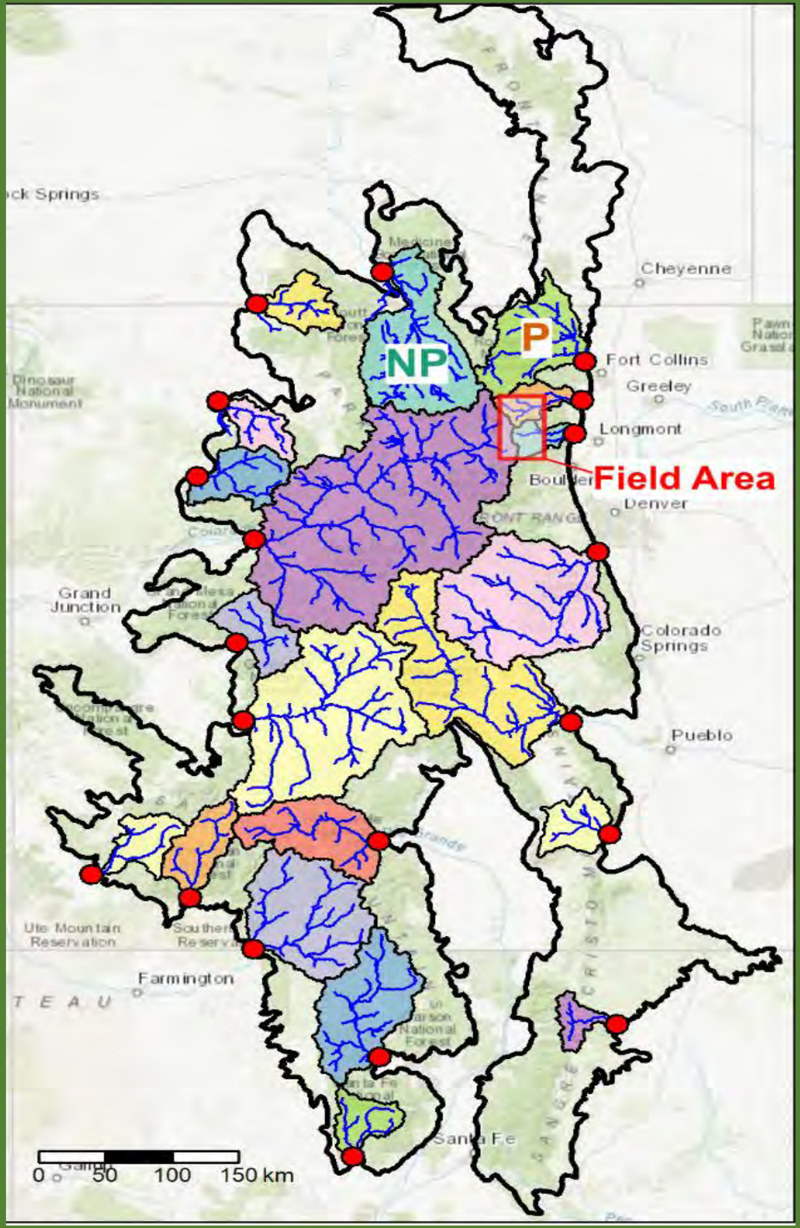
How does condition in river beads (and/or restoration) impacts hydrology and water quality at river network scales?

But First

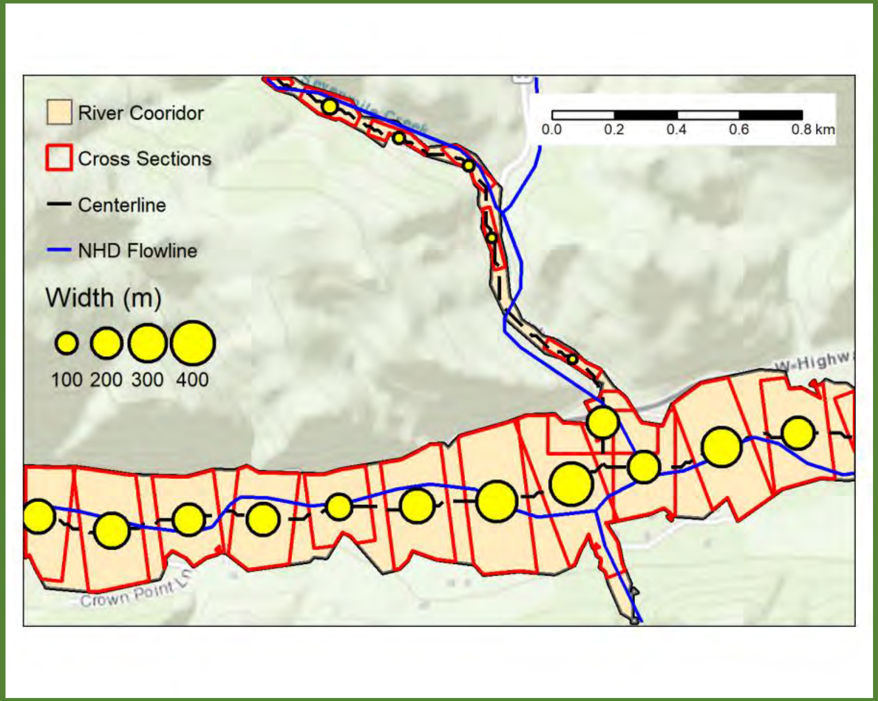
Where are river beads in mountain river networks and how are they configured at network scales?

Where are the beads?

Went looking in 20 river basins in Southern Rockies Ecoregion



Quick Methods



1. Delineated River Corridor

2. Measured River Corridor Widths

3. Identified River Beads Along Network

4. Analyzed Spatial Distribution of Beads

5. Assess River Bead Condition

DEM 10m

NHD PLUS

GFPLAIN Algorithm (Nardi et al., 2019)

RivWidth Cloud (Yang et al., 2019)

nhdplusTools

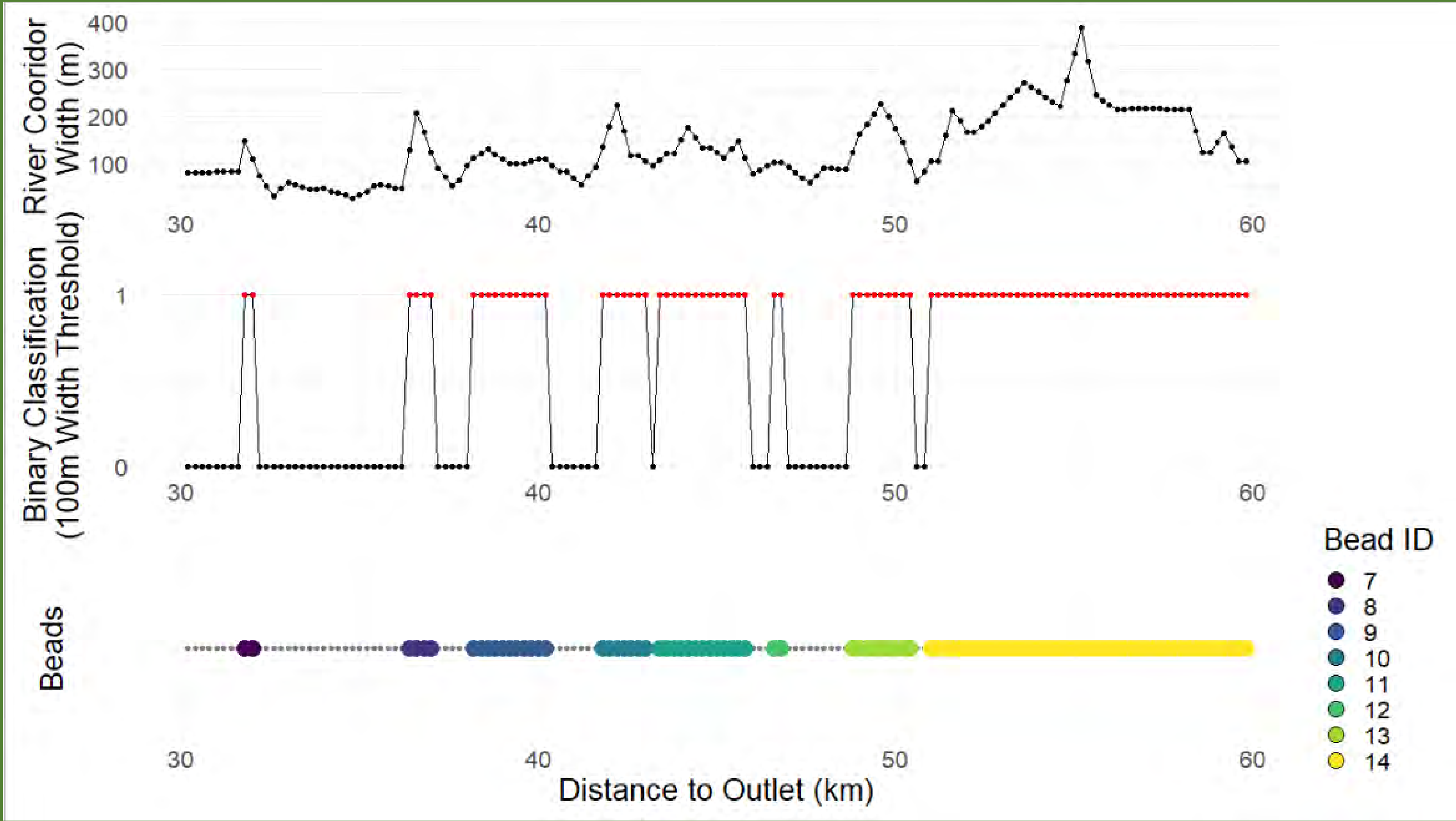
NLCD (2016)

How do we define a river bead?

Methods

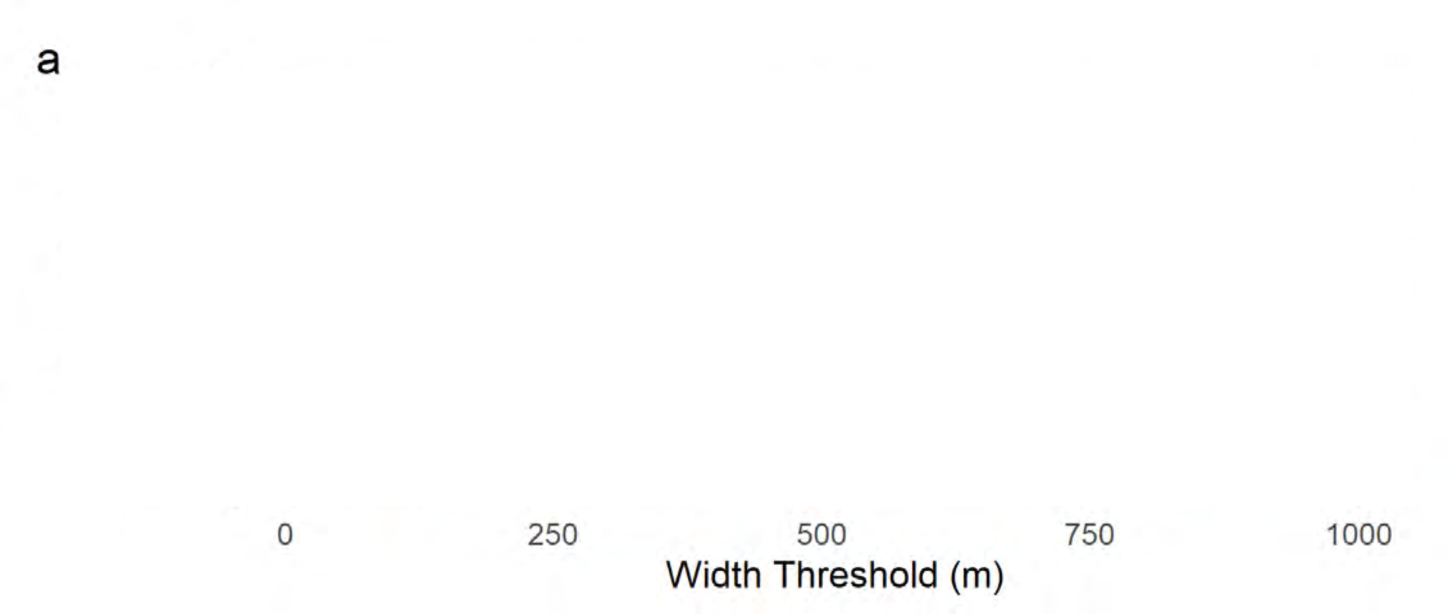
*Contiguous longitudinal segments of river corridors with widths above a **specified width threshold***

Example From Poudre River with 100m Width Threshold



Methods

But what is the correct river corridor length to use as a width threshold?

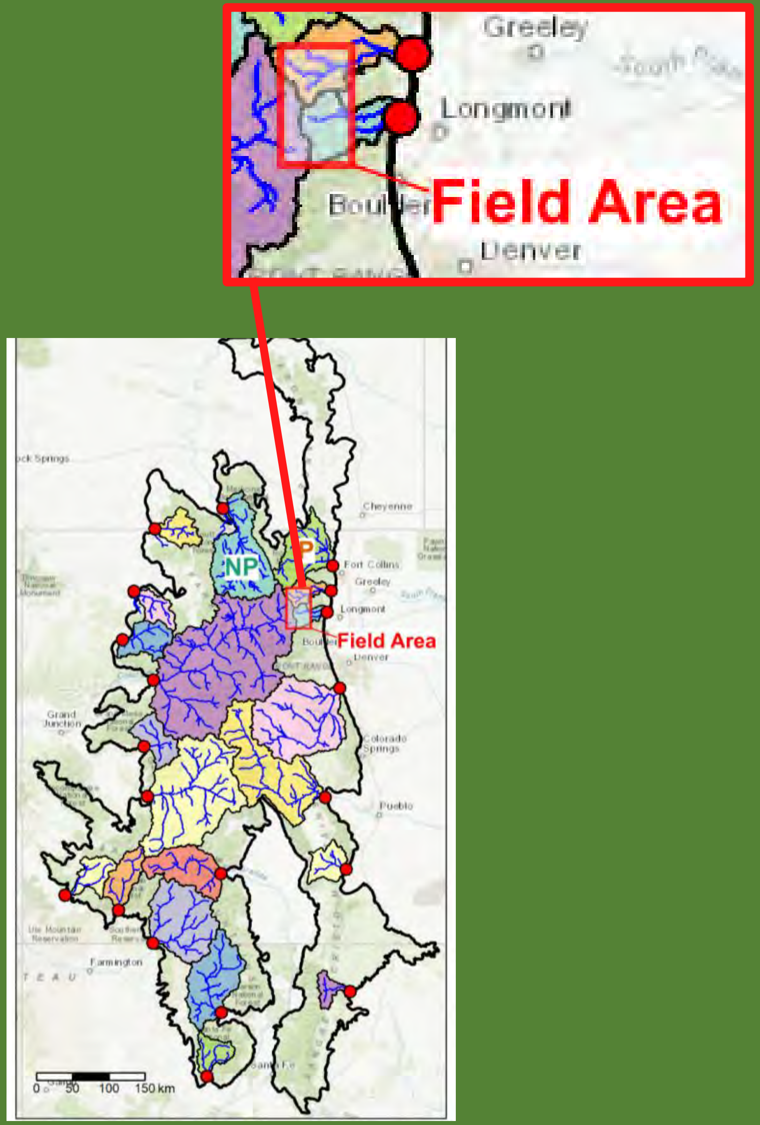


Contiguous longitudinal segments of river corridors with widths above a ***specified width threshold***

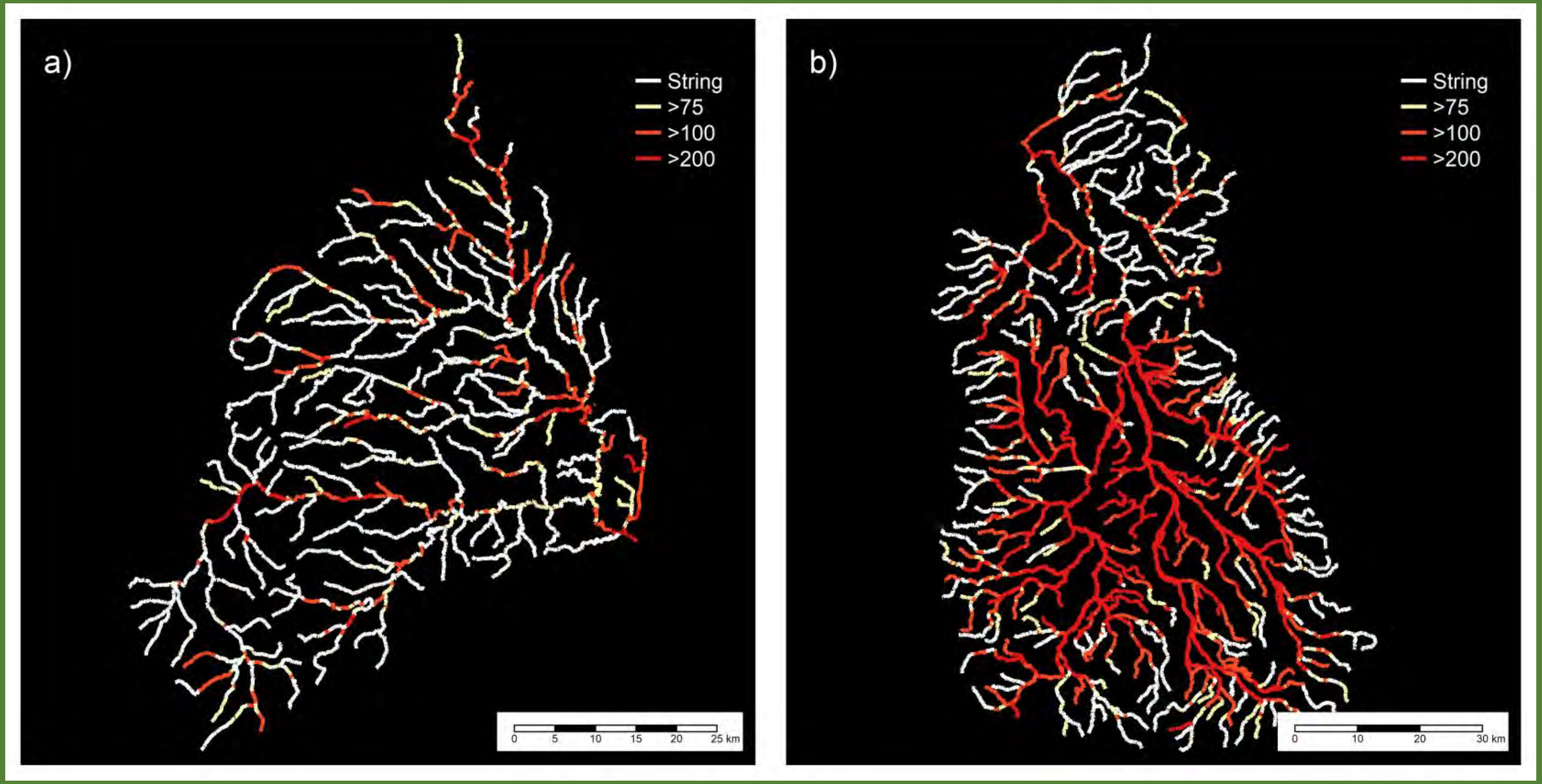
We tested thresholds between 25 to 1000m

Comparison to Field Data Of River Beads in Rocky Mountain National Park

- Datasets matched best at longer river beads (>0.5km) and at higher order streams (>3rd order streams)
- River corridor width measurements in narrow (<50m wide reaches) may be somewhat inflated
- Overall, field mapped dataset matched best with width thresholds between 75-200m.



Mapping Across River Networks



Cache La Poudre

North Platte

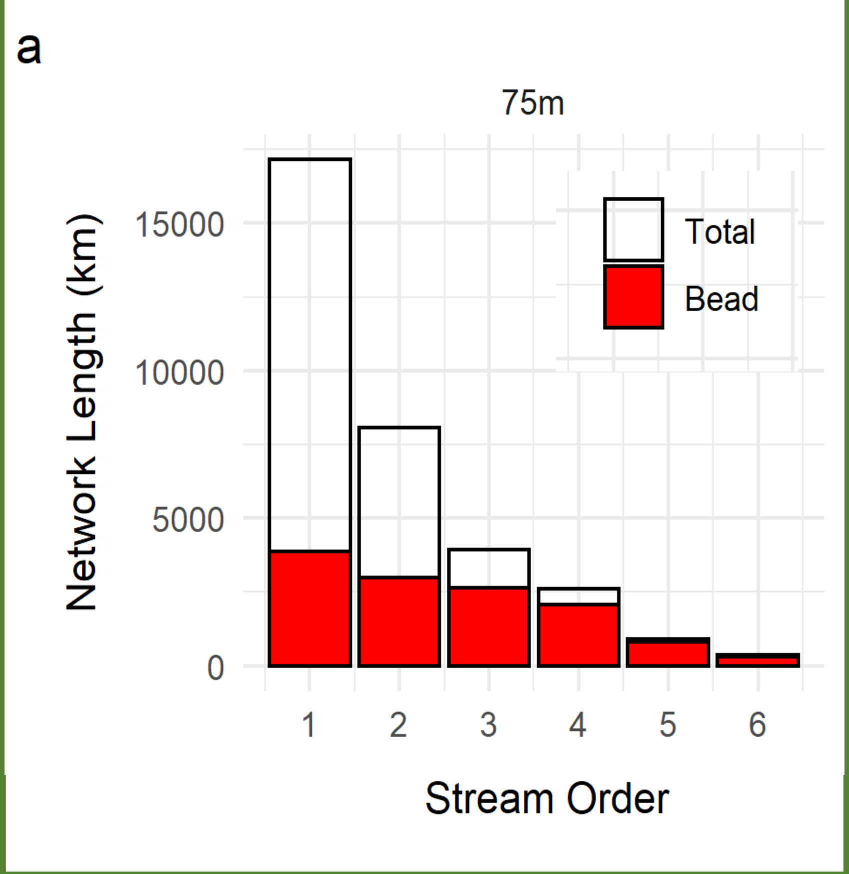
Some river basins have alternating pattern of narrow and wide river corridors, but in others, patterns are more longitudinal with wider corridors in higher stream order

Results

Where are river beads in the network?

River beads are relative rare in headwater streams

Overall length in headwater reaches is equal or higher than at high order portions of the network

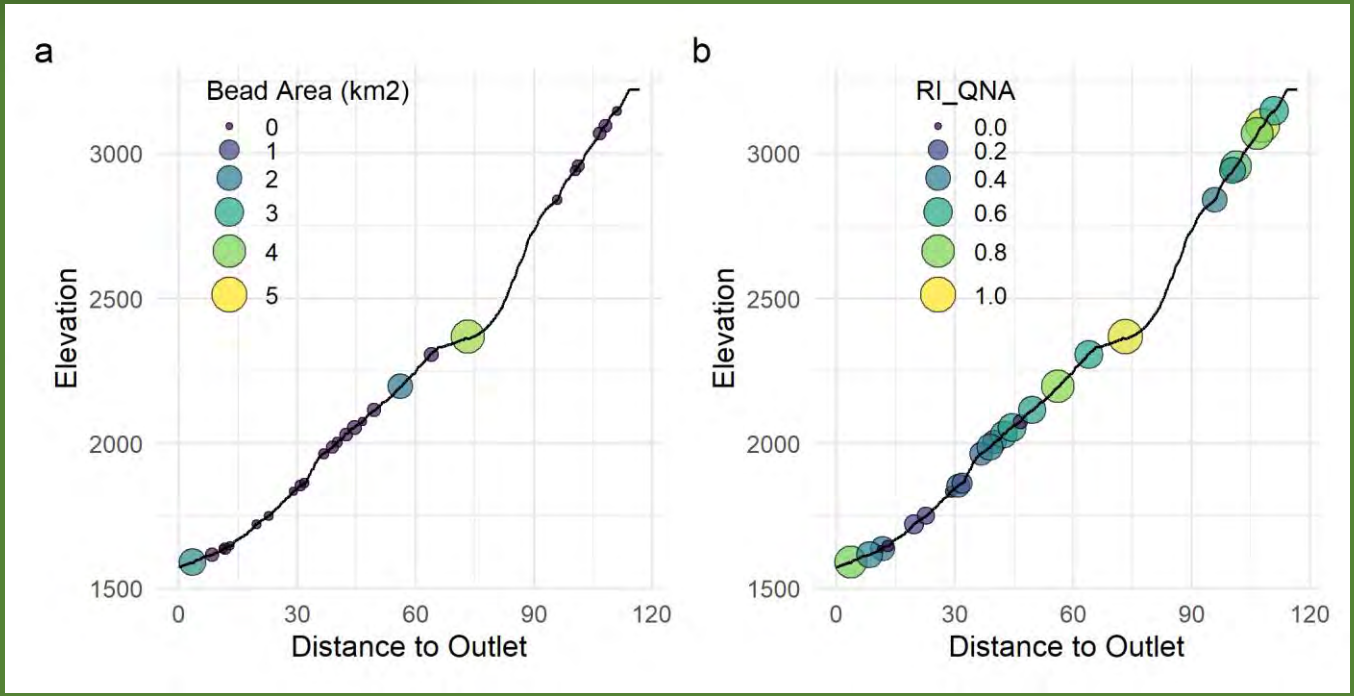


Network context of individual river beads

Example Metrics:

- River bead length
- River bead area
- Ratio of bead area to the annual volumetric flow (RI_QNA)
- Ratio of bead area to total upstream bead area

Cache La Poudre Mainstem



Questions?

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