CHaMP

GEOMORPHIC UNIT DERIVATION

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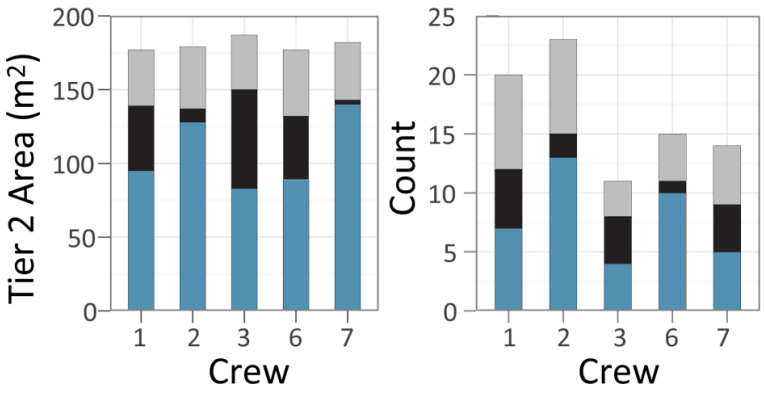
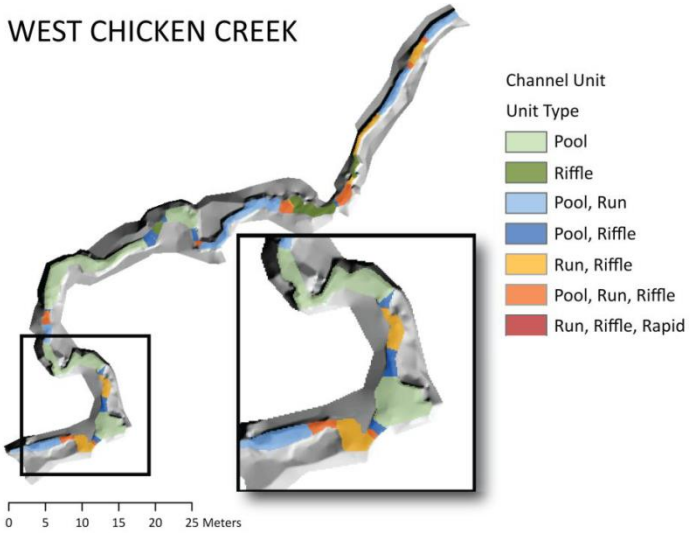
UtahStateUniversity
ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY

BACKGROUND: CHANNEL UNITS & CREW VARIABILITY

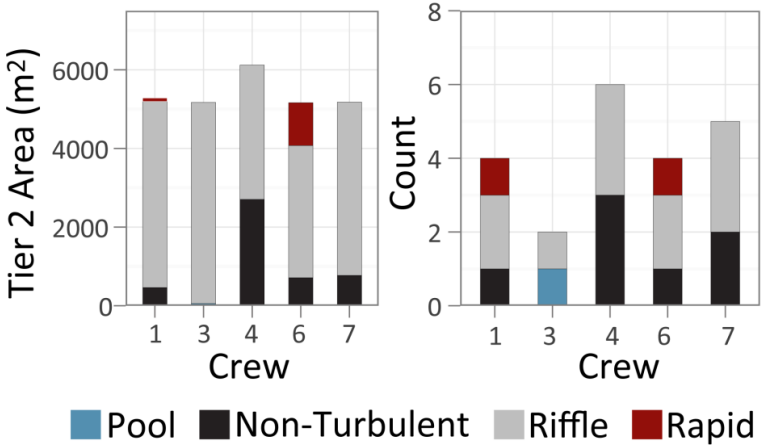
Comparing Simple v Complex Sites

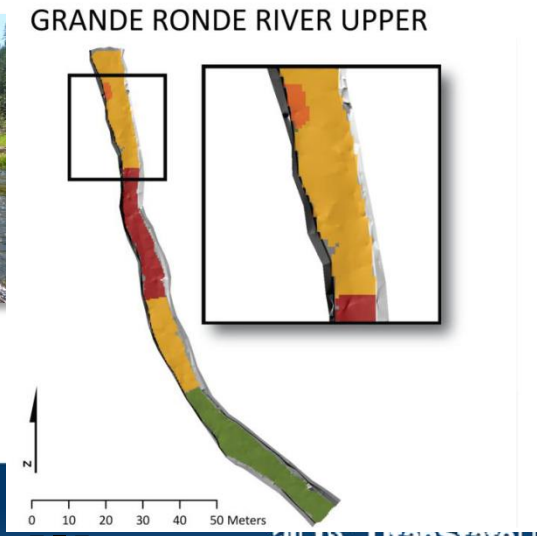
WEST CHICKEN CREEK





GRANDE RONDE RIVER - UPPER

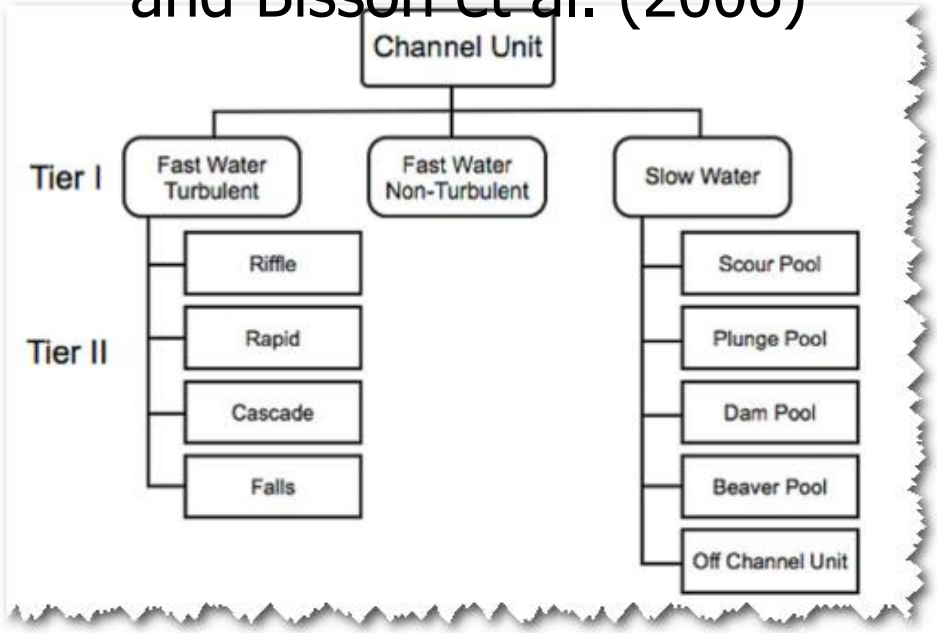


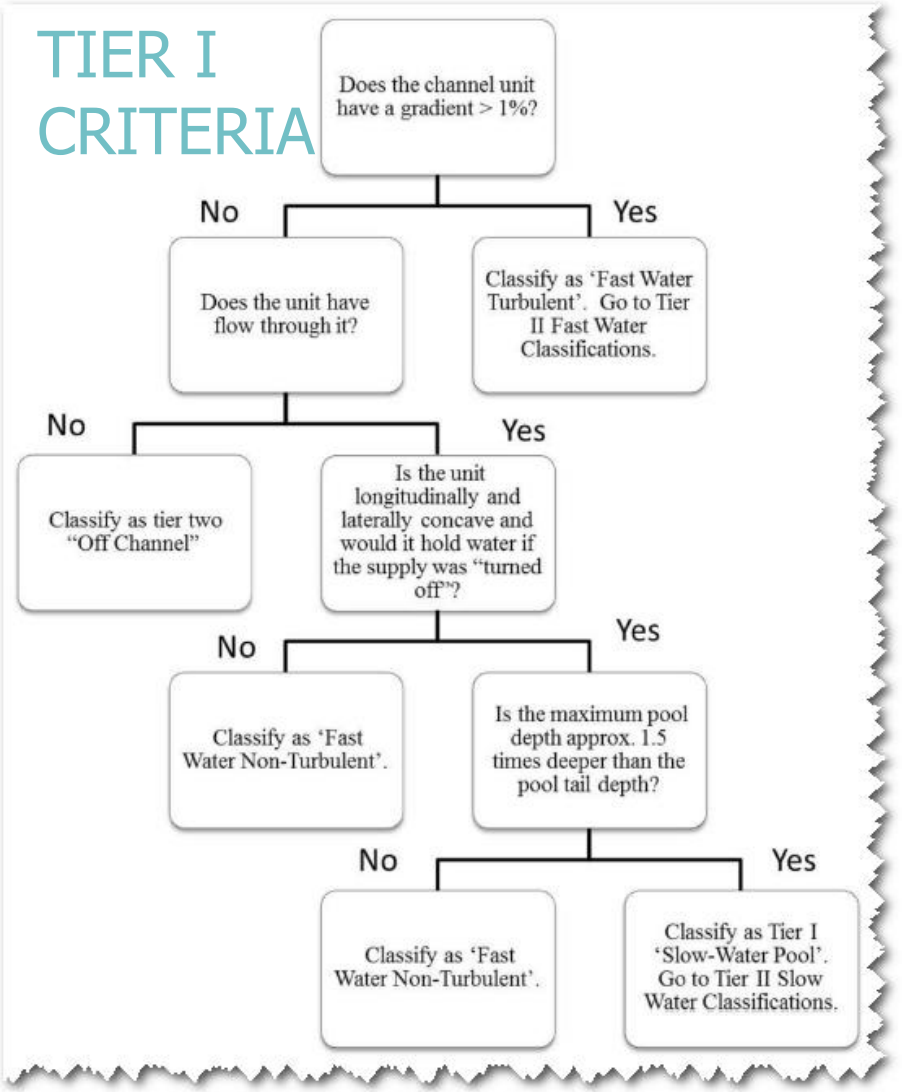


Take home: A lot of crew variability

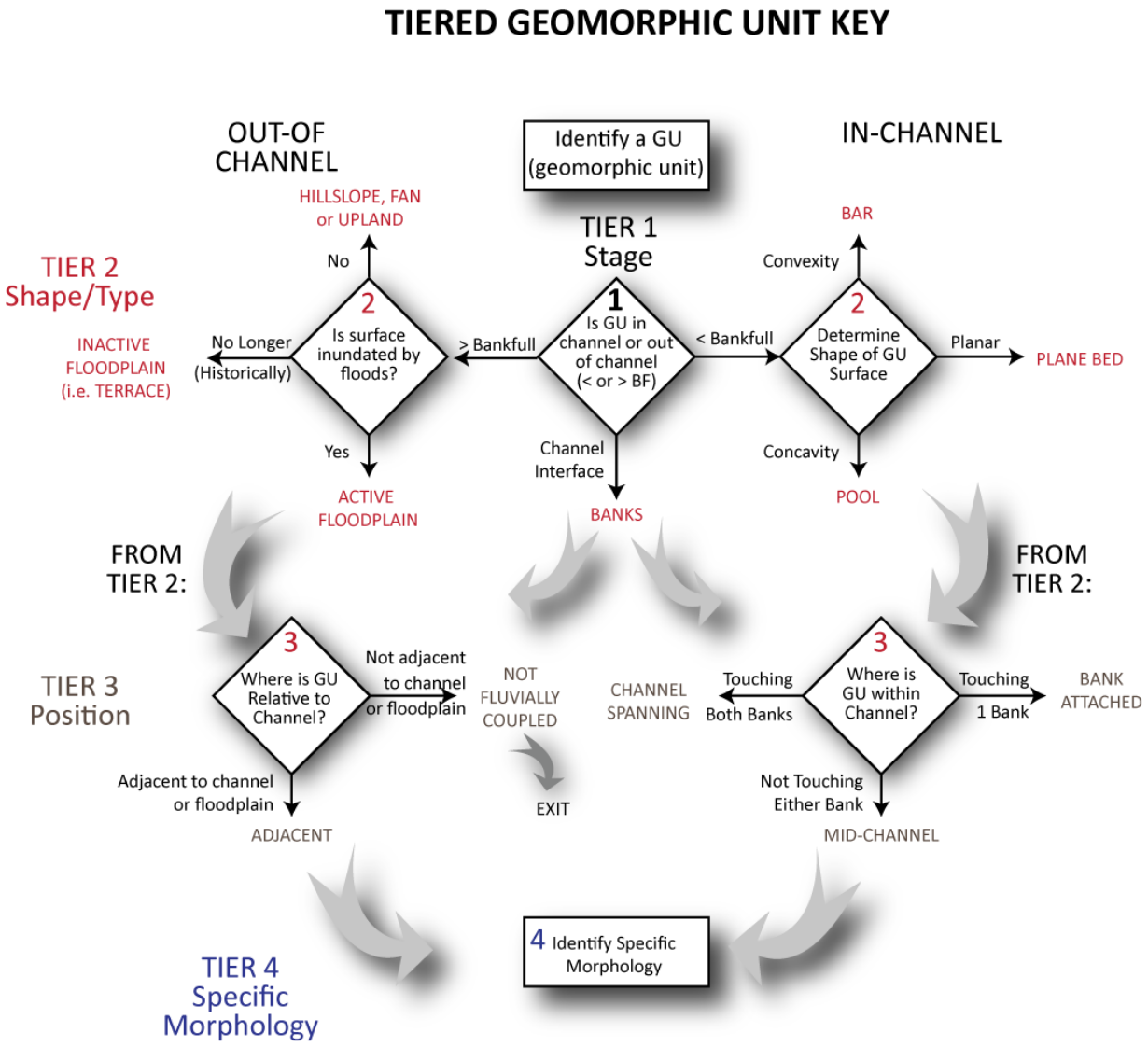
BACKGROUND: CHAMP CHANNEL UNIT CLASSIFICATION

- Two-tier hierarchical channel unit classification
- Based on Hawkins et al. (1993)
  and Bisson et al. (2006)





PROPOSED CLASSIFICATION



- Four tier process-based classification based off Brierley and Fryirs (2005)

GEOMORPHIC UNIT DEFINITION

- A geomorphic unit is a landform that is a byproduct of erosion and deposition of sediment
- Fluvial geomorphic units are the result of fluvial (by water) erosion and deposition

For mapping purposes

- GU's are spatially continuous areas that can be topographically defined
- GU's can be represented on a cell-by-cell basis by probabilistic or fuzzy membership in a class (e.g. probability of being a bar)
- GU's are often represented as polygons

DIFFERENTIATING GU'S

KEY DISTINCTIONS

1. Stage – (> or < bankfull)
    1. Out-of-Channel
    2. In-Channel
    3. Interface
2. Shape/Type
    1. Convexity
    2. Concavity
    3. Planar
    4. Bank

IMPORTANT ATTRIBUTES

- Position
  - Bank Attached
  - Channel Spanning
  - Mid-Channel
- Orientation
  - Transverse
  - Diagonal
  - Streamwise
- GU Associations
- SE Associations
- Vegetation?
- Sediment type

STRUCTURAL ELEMENT DEFINITION

In a fluvial/riverscape context,

- Structural elements are discrete entities or objects that have the potential to directly influence hydraulics and subsequently the presence/absence, maintenance and destruction of geomorphic units.

  - From a mapping perspective, structural elements:
    - SE's are vector objects, which can be represented as individual points (e.g. location of LWD), polylines (e.g. levee, road or beaver dam), or polygons (e.g. bedrock outcrop, concrete bridge abutment, rip-rapped area)

DIFFERENTIATING STRUCTURAL ELEMENTS

KEY DISTINCTIONS

1. Type
    1. Anthropogenic
    2. Natural - Inorganic
    3. Natural - Organic
2. Position
    - Bank Attached, Channel Spanning, or Mid-Channel, overbank

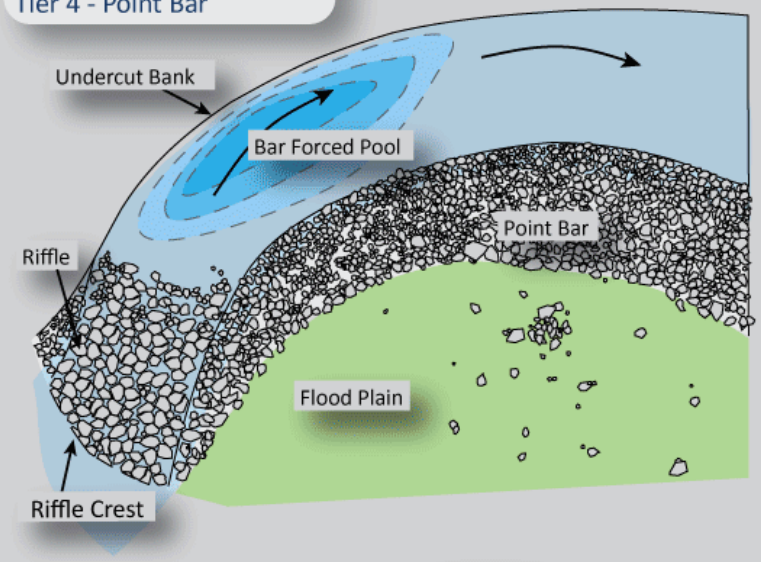
IMPORTANT ATTRIBUTES

- Orientation
    - Transverse, Diagonal or Streamwise
- Hydraulic Influence
    - Lateral constriction
    - Vertical constriction
    - Damming/Jamming
    - Roughening
    - Sieving
- GU Forcing Potential
- GU Associations
- Other SE Associations

PLAYING CARDS -> POINT BAR

POINT BAR

Tier 1 - (< or > bankful)
Tier 2- Convexities
Tier 3 - Bank Attached
Tier 4 - Point Bar



South Fork Long Creek, Middle Fork John Day Watershed, OR

TIERED GEOMORPHIC UNIT BUILDING BLOCK REFERENCE CARDS

GEOMORPHIC FORM

Point Bars are convex, bank attached bars that form on the inside banks of meander bends. Grain size tends to fine with downstream and lateral distance from the bank. Bar surface inclines toward the channel.

Green River, UT

PROCESS INTERPRETATION

Point bars result from the process of lateral channel migration, i.e., the change in lateral channel position caused by deposition of sediment on the convex bank and erosion along the outside, concave bank. Sand and gravel are moved by traction toward the inside bank by helical flow.

ASSOCIATED GEOMORPHIC UNITS AND STRUCTURAL ELEMENTS

Point Bars are closely associated with *riffles, runs, Bar-Forced Pools,* and various types of *banks;* notably, *Undercut Banks.*

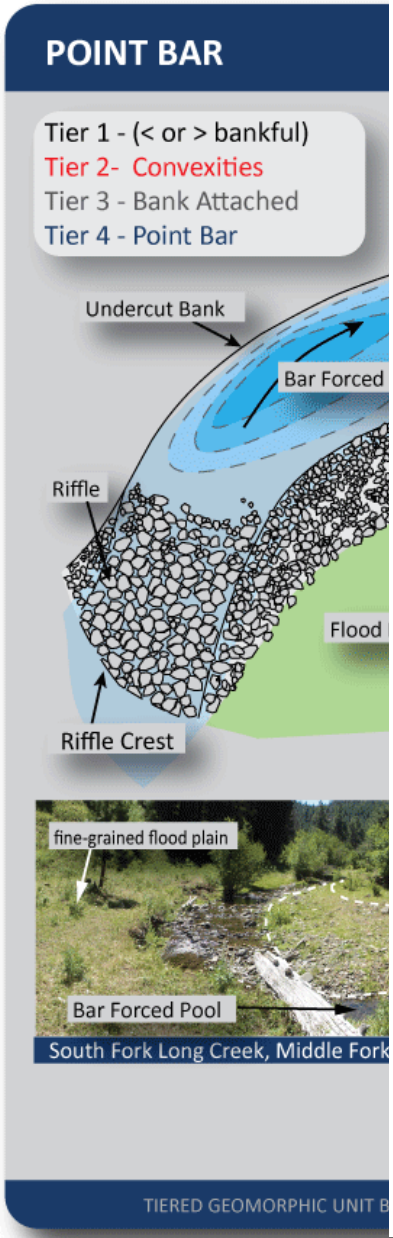
TYPICAL SALMONID FISH HABITAT ASSOCIATIONS

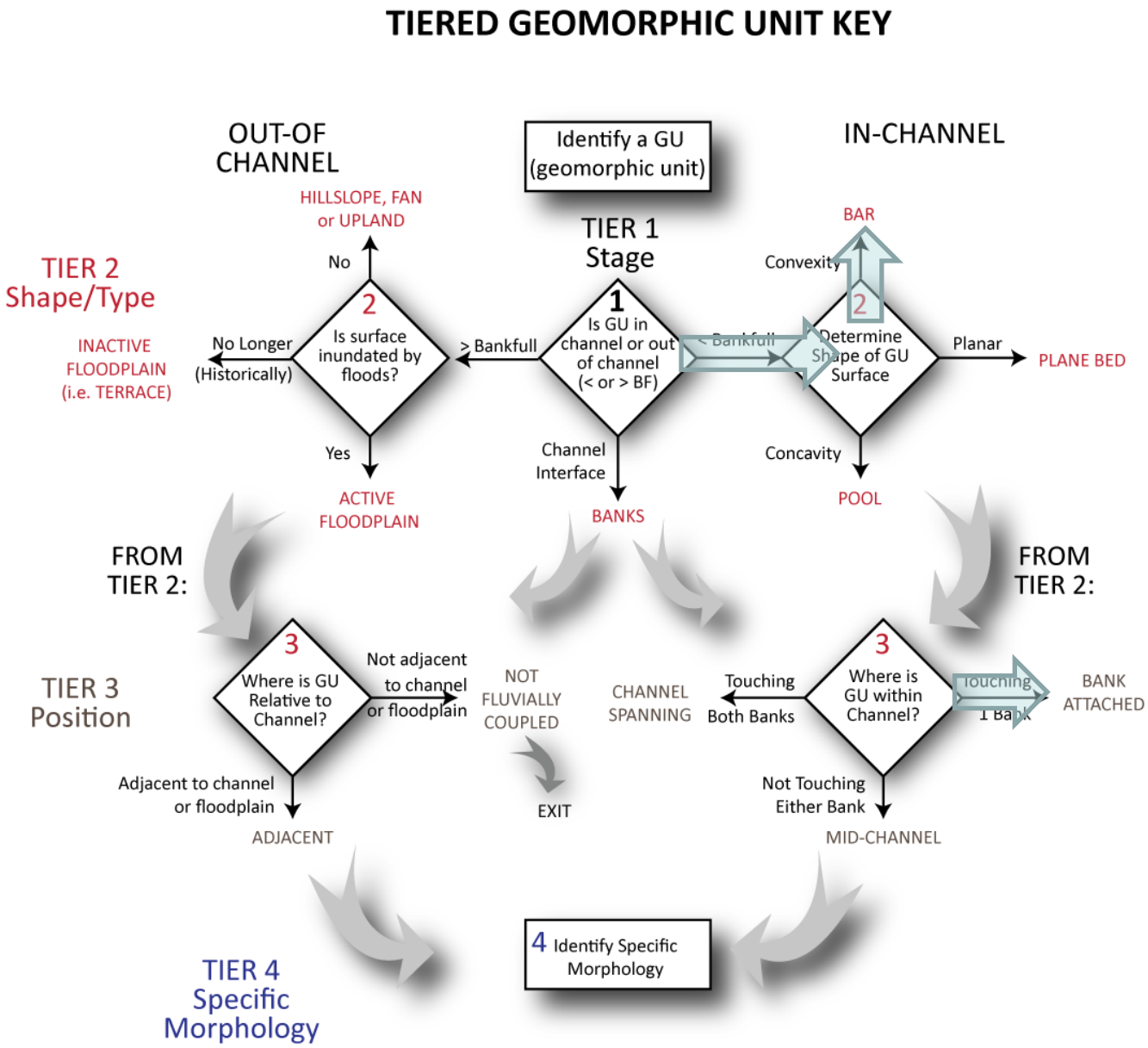
Typical fish habitat is focused at pool tails at the tops of riffles (potentially a Point Bar Forced Pool) where holding occurs, and pool heads at the base of Bar Forced Pools, (i.e., Point Bars), where fish can forage on food items being washed down from the steepened ramp above.

Anadromous life stages	Fry	Parr (Juvinile)	Smolt	Adult
Foraging				
Energy Refugia	O	O	O	O
Predation Refugia	✓	✓	✓	✓
Thermal Refugia	X	X	X	X

na- Not Applicable ; X - Not Typically Important ; O - Occasionally Provided ; ✓Critical

I LAND ON A POINT BAR

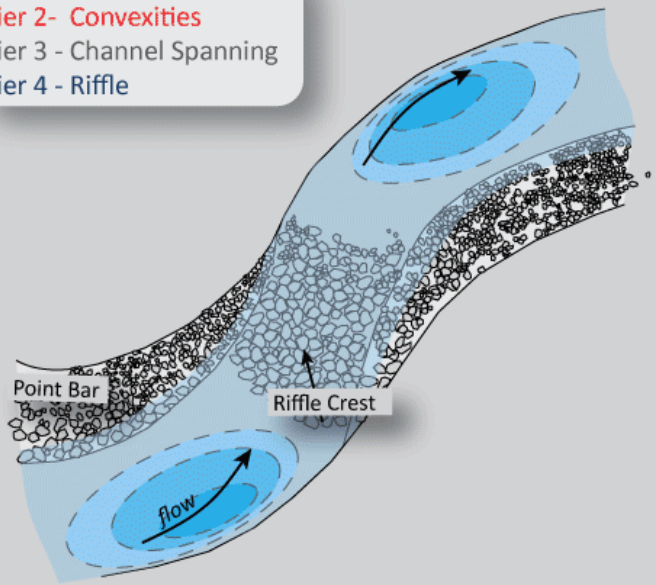




PLAYING CARDS -> RIFFLE

RIFFLE

Tier 1 - (< or > bankful)
Tier 2- Convexities
Tier 3 - Channel Spanning
Tier 4 - Riffle



Jungle Creek, Middle Fork John Day Watershed, OR

TIERED GEOMORPHIC UNIT BUILDING BLOCK REFERENCE CARDS

GEOMORPHIC FORM

Riffles form as topographic highs along an uneven longitudinal profile, between bends in sinuous alluvial channels. Alluvial riffles are shallow, step-like, channel-spanning features.

Middle Fork John Day River, OR

PROCESS INTERPRETATION

Riffles are zones of sediment accumulation that increase channel roughness during high flow stages, and are maintained or built at various flow stages by the consequent increased turbulence and reduced velocity over the steepened surface. Riffles are often dissected at low flow stages, and reworked or removed altogether at stages higher than bankful.

TYPICAL *ADJACENT* GEOMORPHIC UNITS

Riffles are commonly associated geomoprhic units that help to force it as a channel spanning bar: the *riffle crest* and steepened planar surface separates the upstream and downstream *Bar-Forced Pools, Bank-attached bars (i.e., Point Bars),* and undercut banks.

TYPICAL SALMONID FISH HABITAT ASSOCIATIONS

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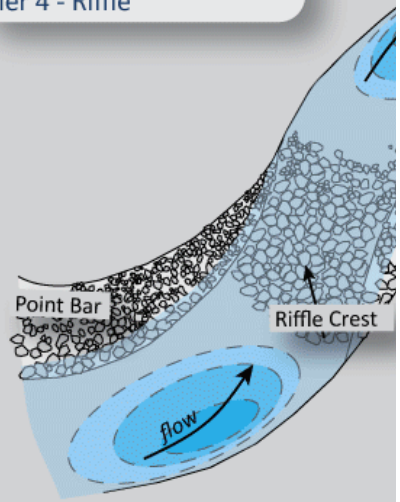
I LAND ON A RIFFLE

RIFFLE

Tier 1 - (< or > bankful)
Tier 2- Convexities
Tier 3 - Channel Spanning
Tier 4 - Riffle



TIERED GEOMORPHIC UNIT BUILDING

TIERED GEOMORPHIC UNIT KEY

Identify a GU (geomorphic unit)

OUT-OF CHANNEL

IN-CHANNEL

TIER 1 Stage

1 Is GU in channel or out of channel (< or > BF)

< Bankfull

> Bankfull

Channel Interface

BANKS

TIER 2 Shape/Type

2 Is surface inundated by floods?

No

HILLSLOPE, FAN or UPLAND

No Longer (Historically)

INACTIVE FLOODPLAIN (i.e. TERRACE)

Yes

ACTIVE FLOODPLAIN

2 Determine Shape of GU Surface

Convexity

BAR

Planar

PLANE BED

Concavity

POOL

FROM TIER 2:

FROM TIER 2:

TIER 3 Position

3 Where is GU Relative to Channel?

Not adjacent to channel or floodplain

NOT FLUVIALLY COUPLED

Adjacent to channel or floodplain

ADJACENT

EXIT

CHANNEL SPANNING

Touching Both Banks

3 Where is GU within Channel?

Touching 1 Bank

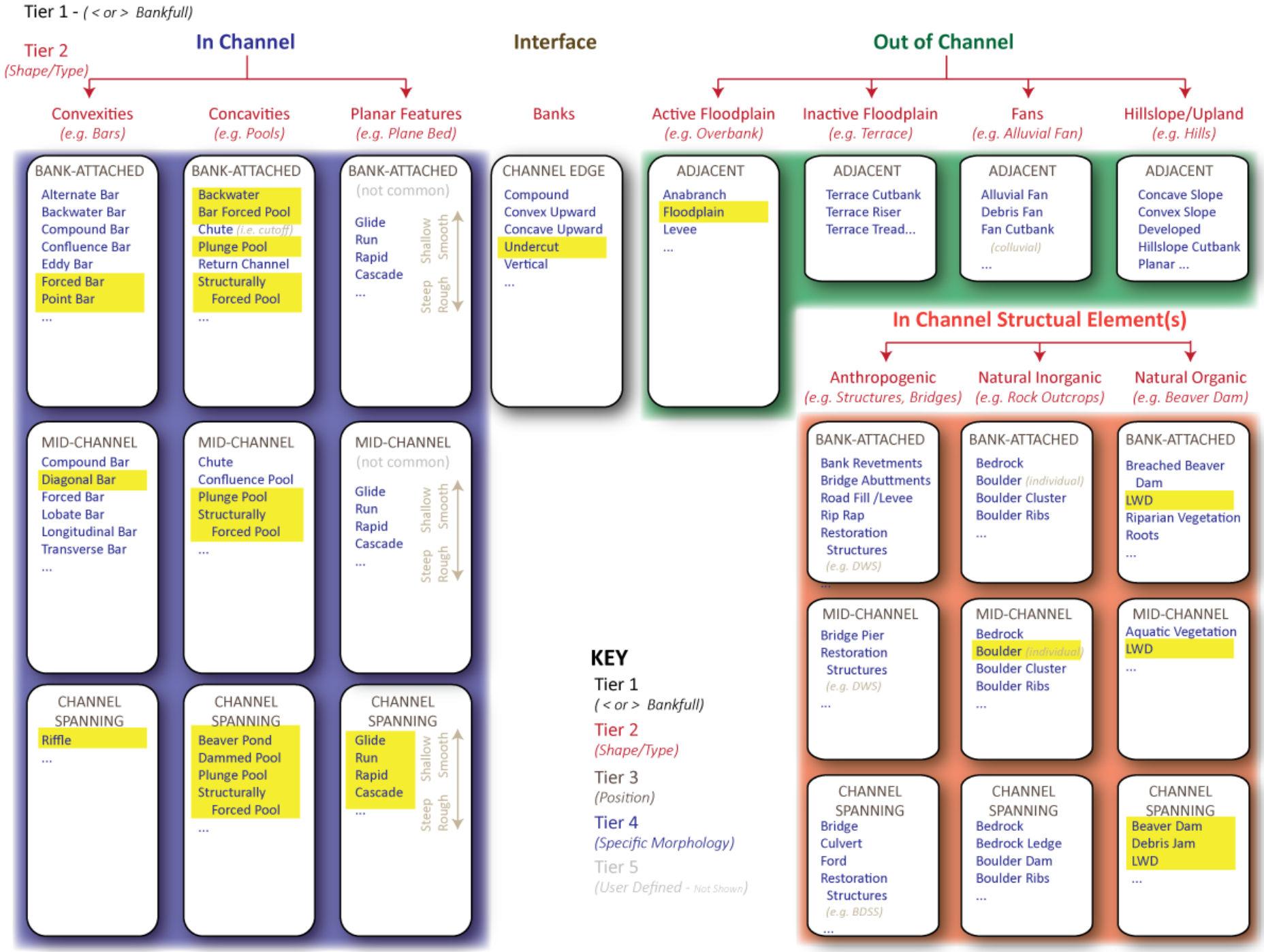
BANK ATTACHED

Not Touching Either Bank

MID-CHANNEL

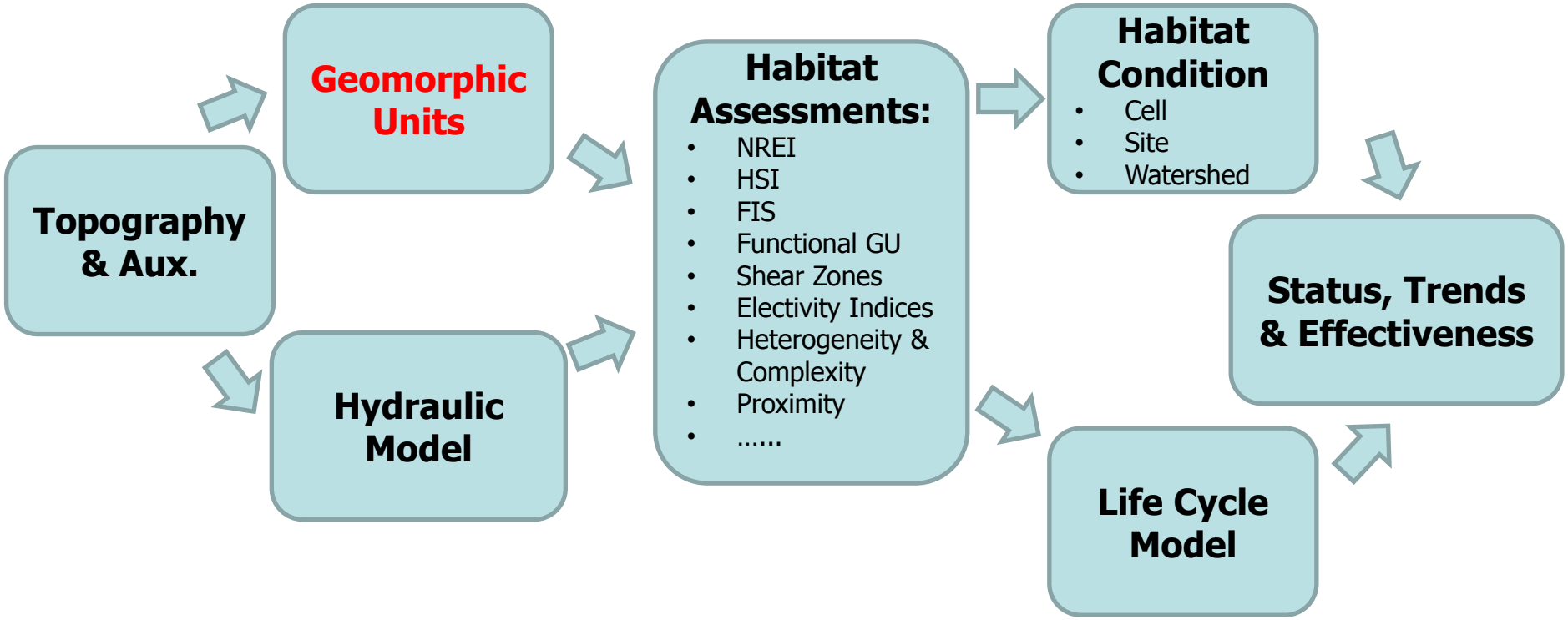
TIER 4 Specific Morphology

4 Identify Specific Morphology

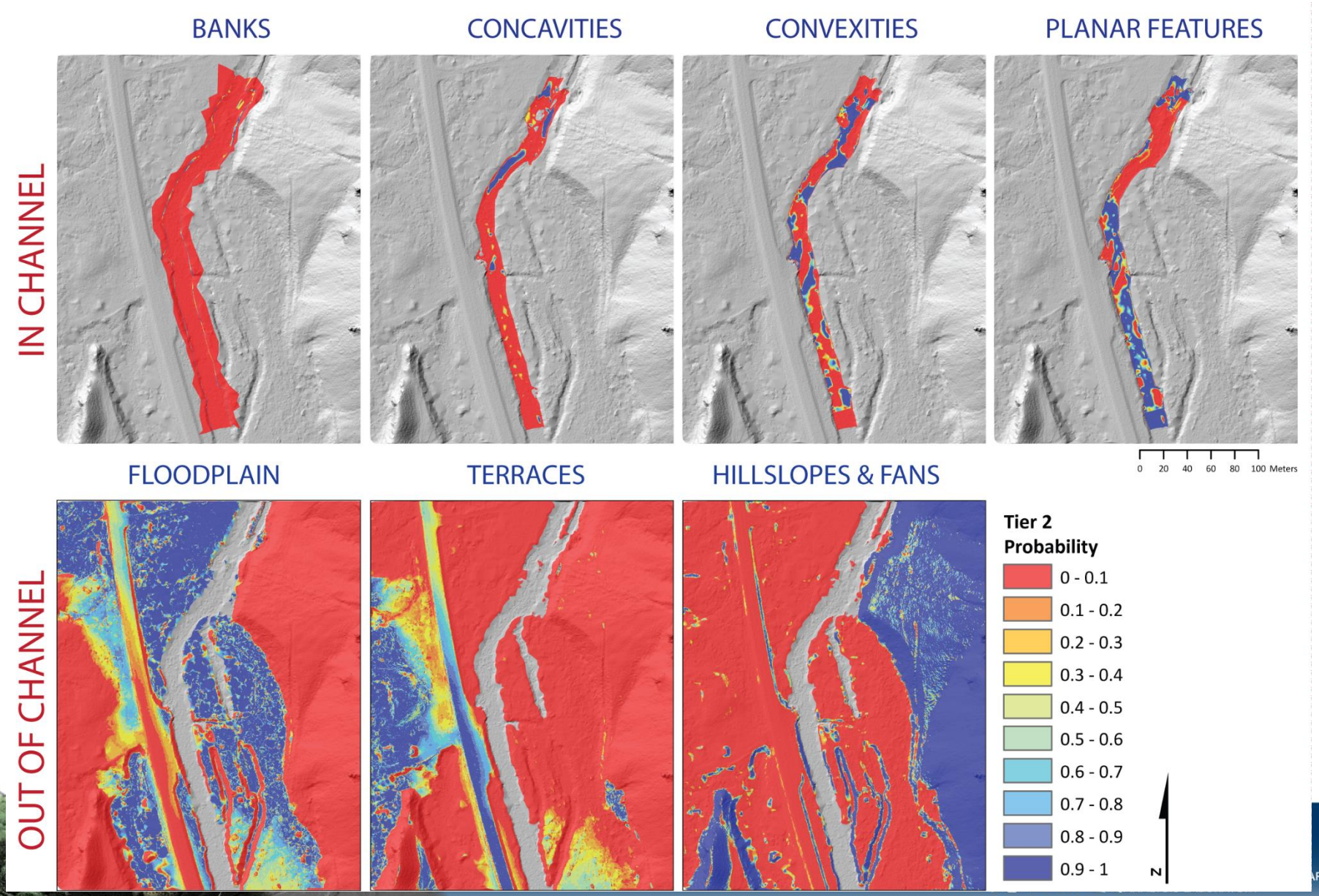

Tier 1 - (< or > Bankfull)
Tier 2
(Shape/Type)
In Channel
Interface
Out of Channel
Convexities
(e.g. Bars)
Concavities
(e.g. Pools)
Planar Features
(e.g. Plane Bed)
Banks
Active Floodplain
(e.g. Overbank)
Inactive Floodplain
(e.g. Terrace)
Fans
(e.g. Alluvial Fan)
Hillslope/Upland
(e.g. Hills)
BANK-ATTACHED
Alternate Bar
Backwater Bar
Compound Bar
Confluence Bar
Eddy Bar
Forced Bar
Point Bar
...
BANK-ATTACHED
Backwater
Bar Forced Pool
Chute (i.e. cutoff)
Plunge Pool
Return Channel
Structurally
Forced Pool
...
BANK-ATTACHED
(not common)
Glide
Run
Rapid
Cascade
...
Shallow
Smooth
Steep
Rough
CHANNEL EDGE
Compound
Convex Upward
Concave Upward
Undercut
Vertical
...
ADJACENT
Anabranch
Floodplain
Levee
...
ADJACENT
Terrace Cutbank
Terrace Riser
Terrace Tread...
ADJACENT
Alluvial Fan
Debris Fan
Fan Cutbank
(colluvial)
...
ADJACENT
Concave Slope
Convex Slope
Developed
Hillslope Cutbank
Planar ...
In Channel Structual Element(s)
Anthropogenic
(e.g. Structures, Bridges)
Natural Inorganic
(e.g. Rock Outcrops)
Natural Organic
(e.g. Beaver Dam)
MID-CHANNEL
Compound Bar
Diagonal Bar
Forced Bar
Lobate Bar
Longitudinal Bar
Transverse Bar
...
MID-CHANNEL
Chute
Confluence Pool
Plunge Pool
Structurally
Forced Pool
...
MID-CHANNEL
(not common)
Glide
Run
Rapid
Cascade
...
Shallow
Smooth
Steep
Rough
BANK-ATTACHED
Bank Revetments
Bridge Abuttments
Road Fill /Levee
Rip Rap
Restoration
Structures
(e.g. DWS)
...
BANK-ATTACHED
Bedrock
Boulder (individual)
Boulder Cluster
Boulder Ribs
...
BANK-ATTACHED
Breached Beaver
Dam
LWD
Riparian Vegetation
Roots
...
CHANNEL
SPANNING
Riffle
...
CHANNEL
SPANNING
Beaver Pond
Dammed Pool
Plunge Pool
Structurally
Forced Pool
...
CHANNEL
SPANNING
Glide
Run
Rapid
Cascade
...
Shallow
Smooth
Steep
Rough
MID-CHANNEL
Bridge Pier
Restoration
Structures
(e.g. DWS)
...
MID-CHANNEL
Bedrock
Boulder (individual)
Boulder Cluster
Boulder Ribs
...
MID-CHANNEL
Aquatic Vegetation
LWD
...
CHANNEL
SPANNING
Bridge
Culvert
Ford
Restoration
Structures
(e.g. BDSS)
...
CHANNEL
SPANNING
Bedrock
Bedrock Ledge
Boulder Dam
Boulder Ribs
...
CHANNEL
SPANNING
Beaver Dam
Debris Jam
LWD
...
KEY
Tier 1
(< or > Bankfull)
Tier 2
(Shape/Type)
Tier 3
(Position)
Tier 4
(Specific Morphology)
Tier 5
(User Defined - Not Shown)

DEM-DRIVEN FISH HABITAT

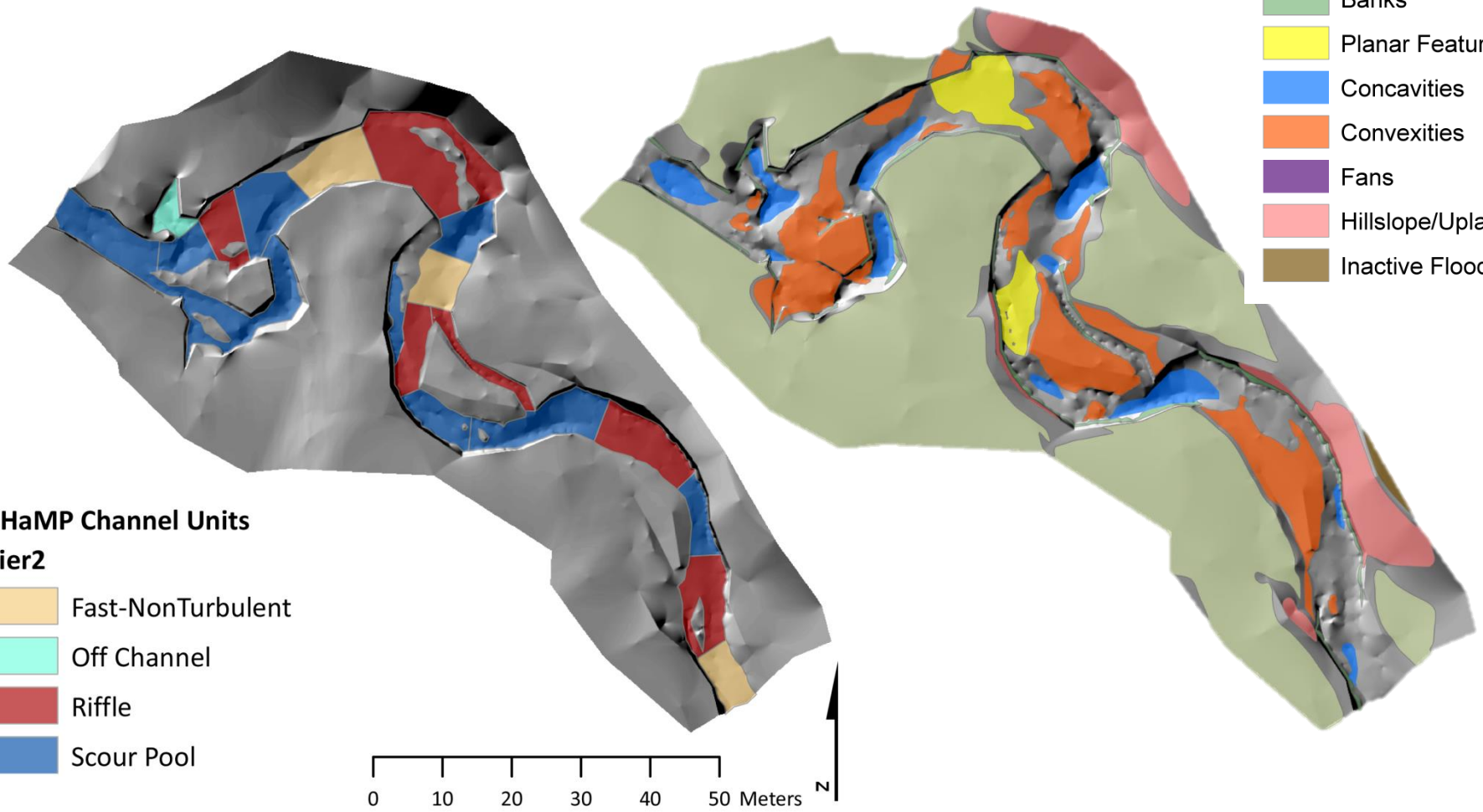
- Multiple lines of *topographic* evidence



FROM DEM…. PROBABILITY OF GU TYPE

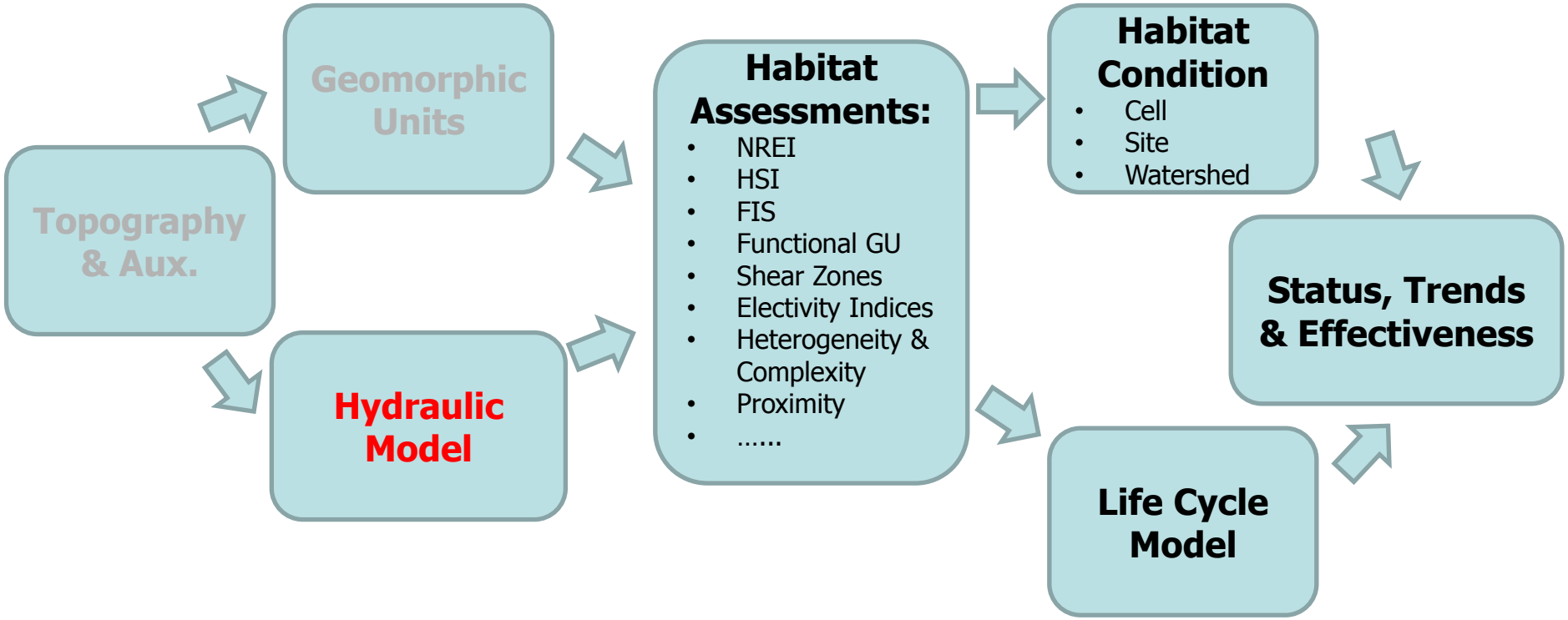


FROM CUs TO GUs

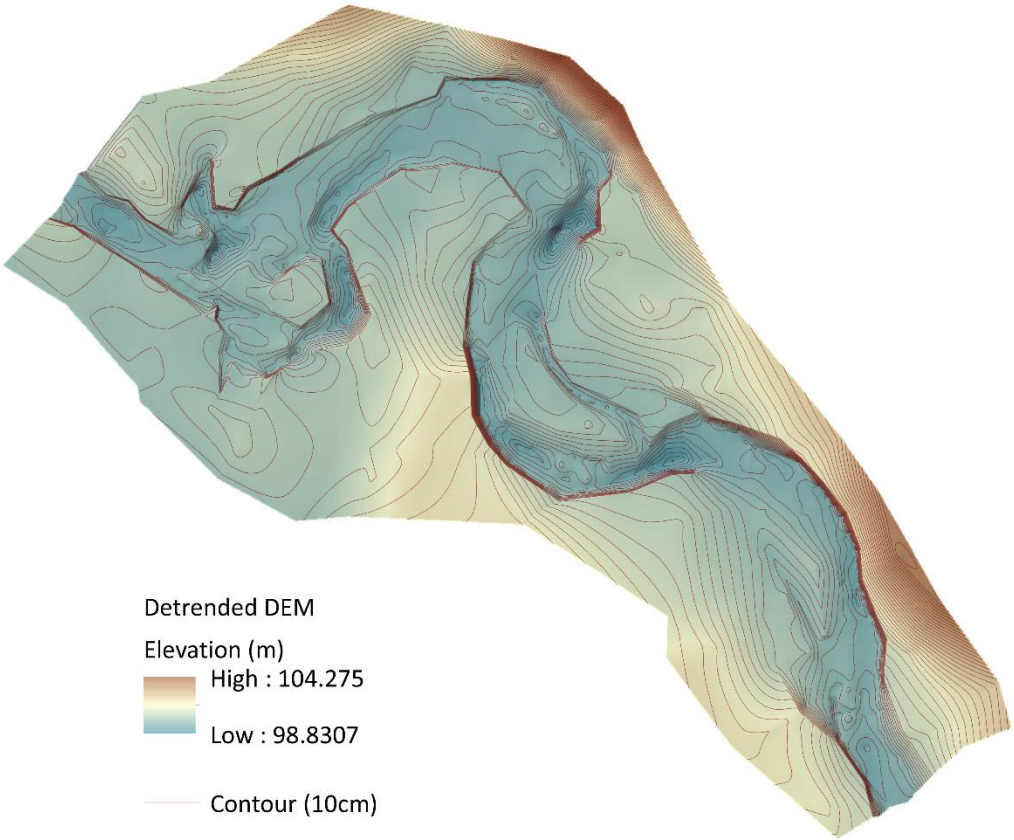


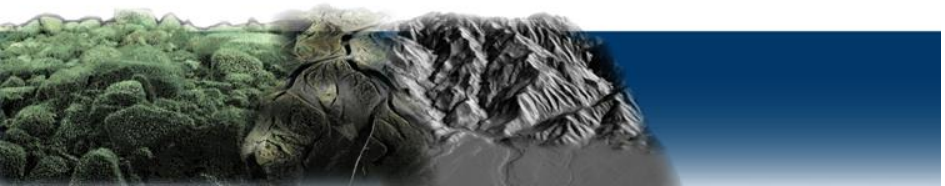
DEM-DRIVEN FISH HABITAT

- Multiple lines of *topographic* evidence



MANUAL APPLICATION – BEAR VALLEY





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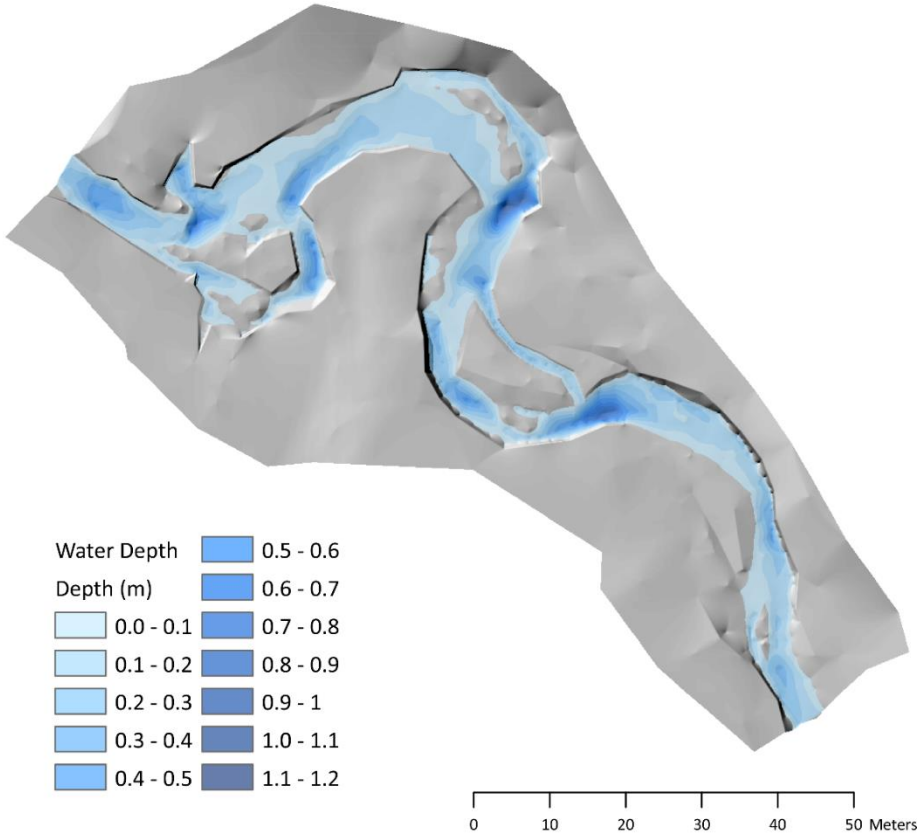

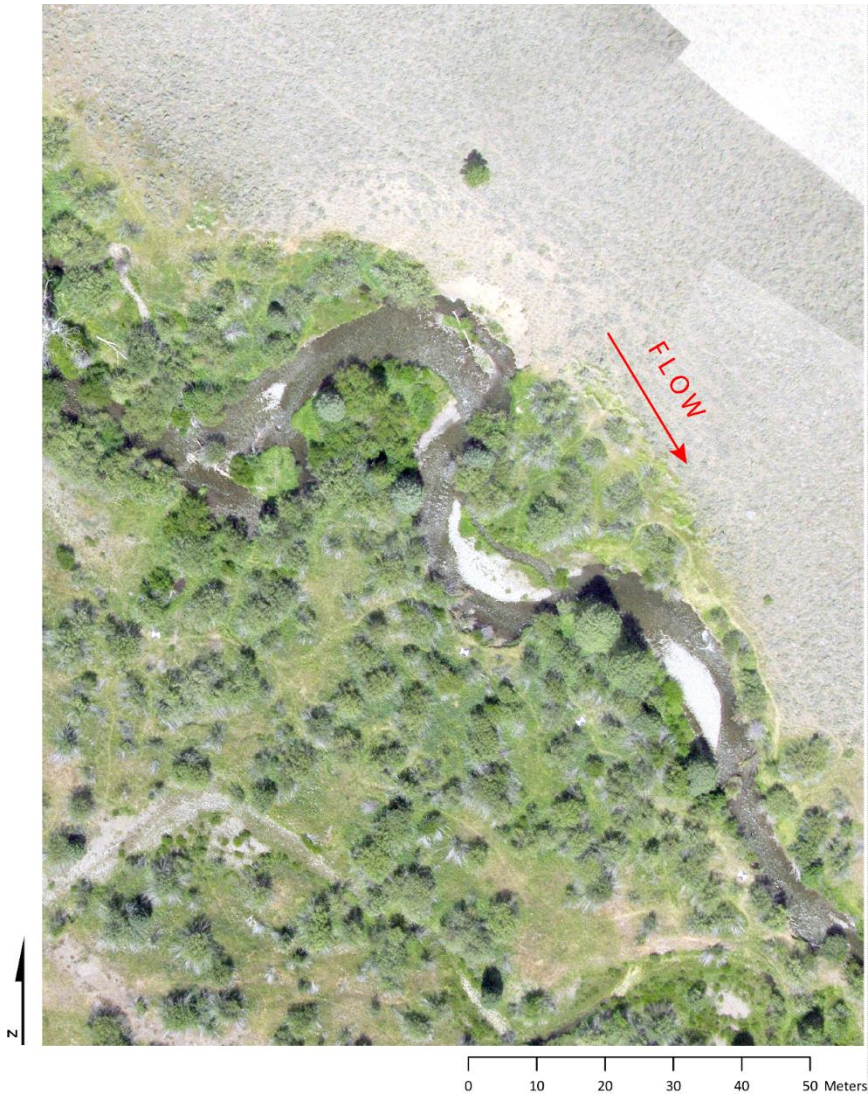

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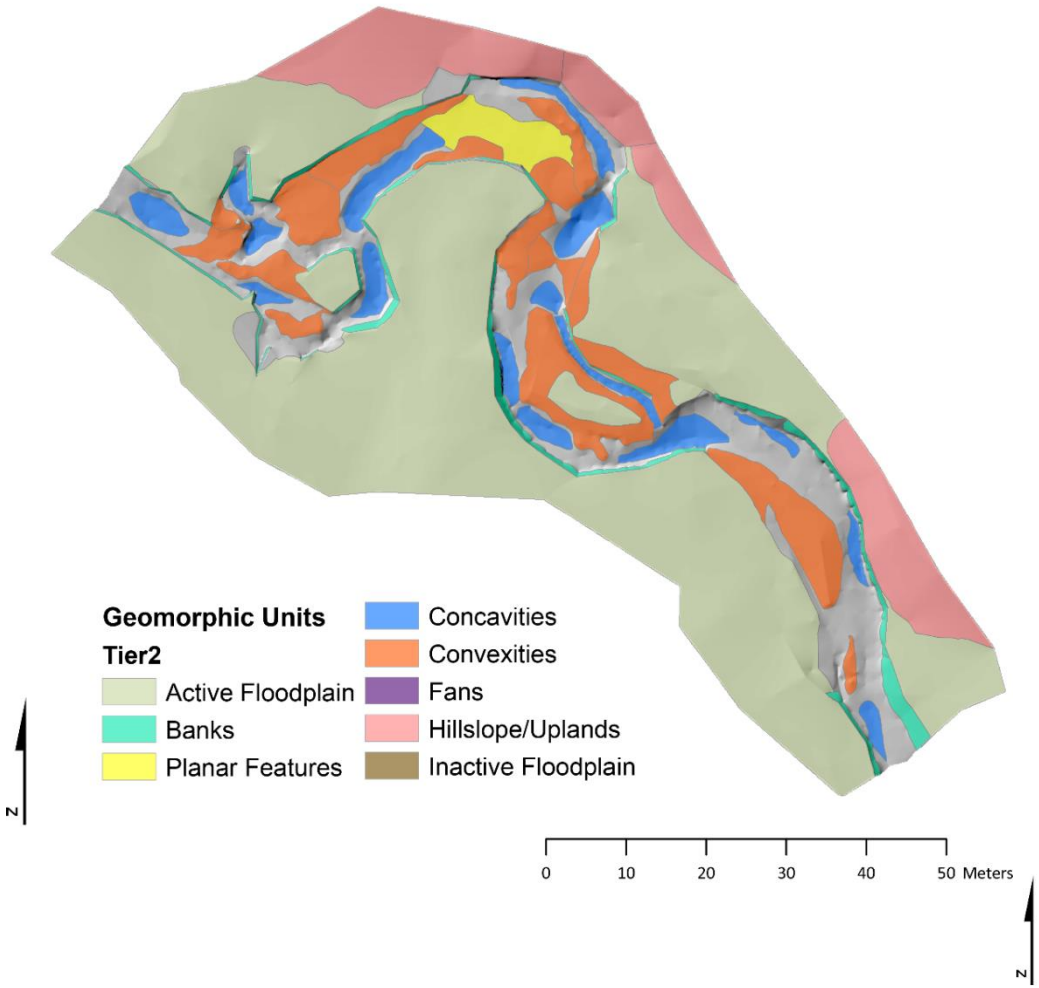

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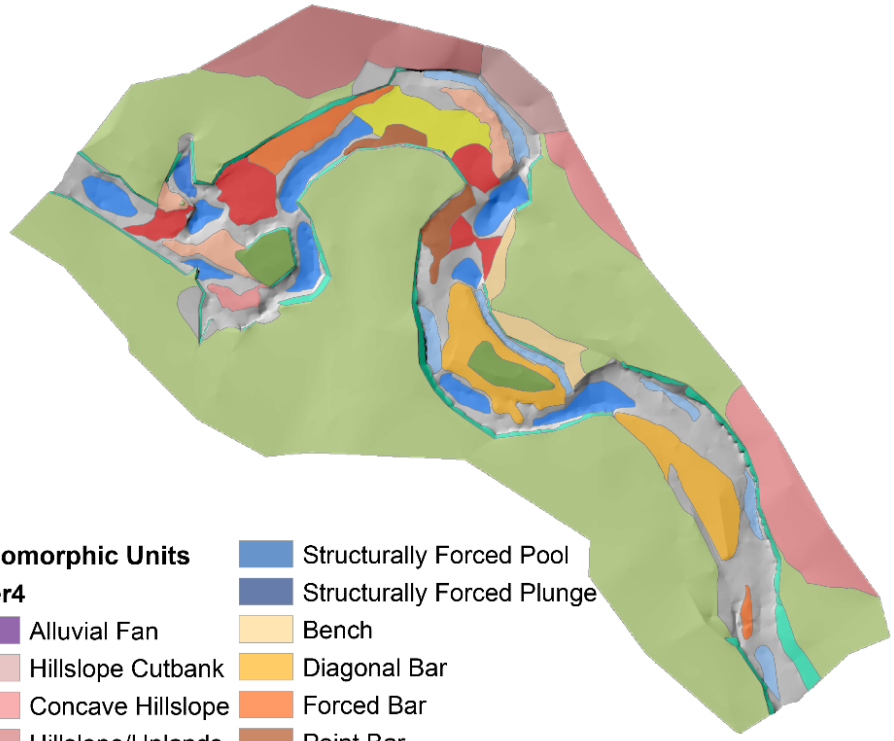


Geomorphic Units

Tier4

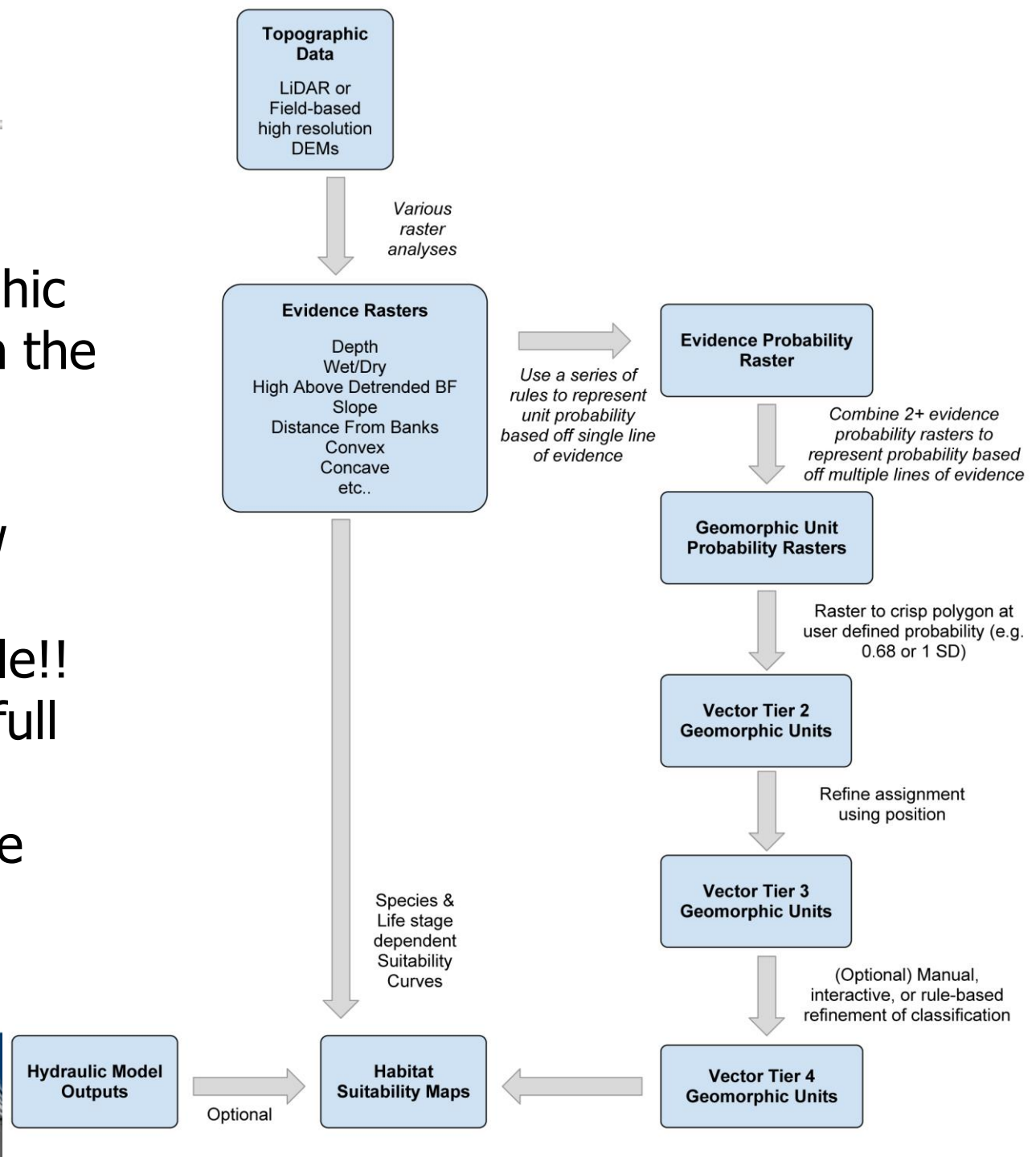
- Alluvial Fan
- Hillslope Cutbank
- Concave Hillslope
- Hillslope/Uplands
- Banks
- Floodplain
- Island
- Chute
- Bar Forced Pool
- Backwater Pool
- Structurally Forced Pool
- Structurally Forced Plunge
- Bench
- Diagonal Bar
- Forced Bar
- Point Bar
- Transverse Bar
- Compound Bar
- Riffle
- Forced Riffle
- Rapid
- Run

N

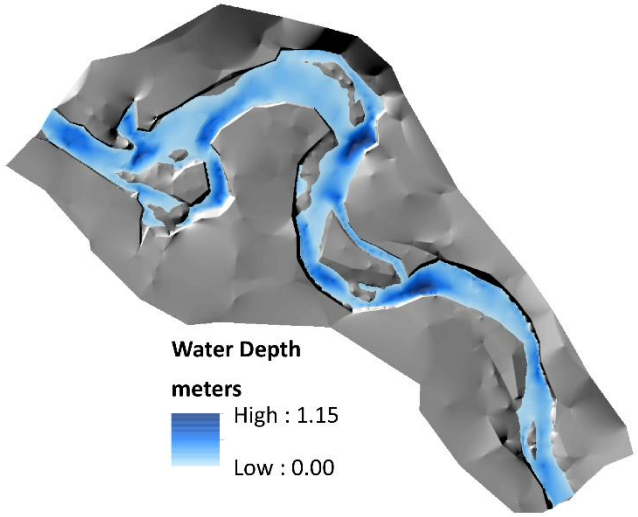
0 10 20 30 40 50 Meters

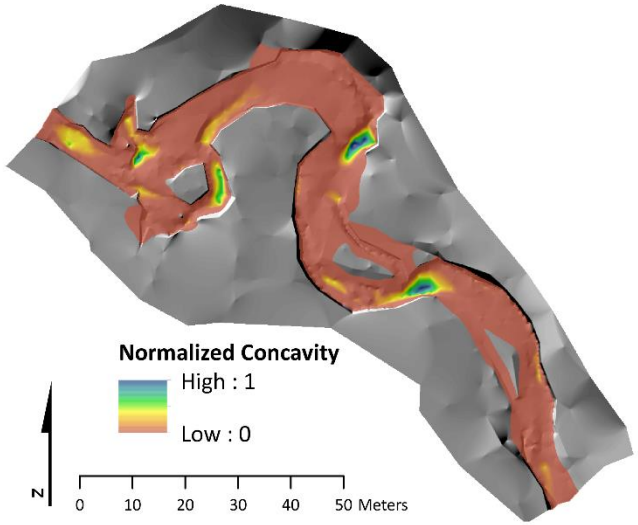
METHODS

- All CHaMP topographic surveys run through the RBT
- Developing/testing using sites we know well
- Make rules scale-able!! (e.g. 10% av bankfull width NOT 2 m)
- Unit classifier will be part of RBT tool

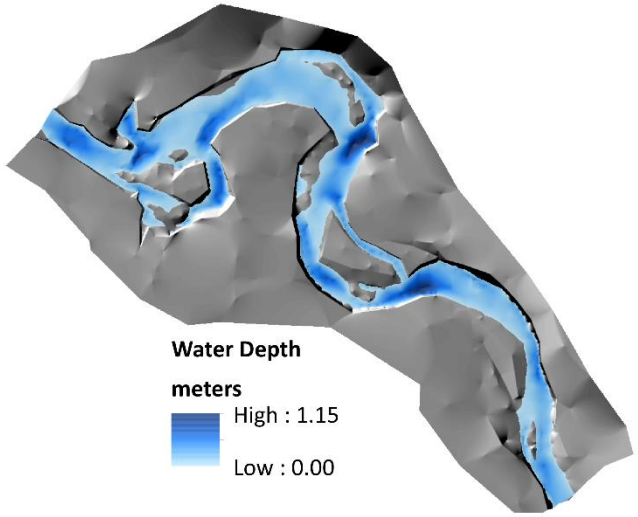


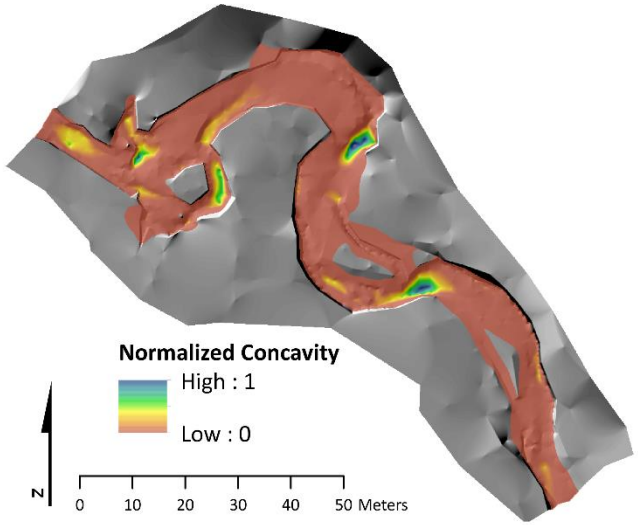
TOPOGRAPHIC LINES OF EVIDENCE

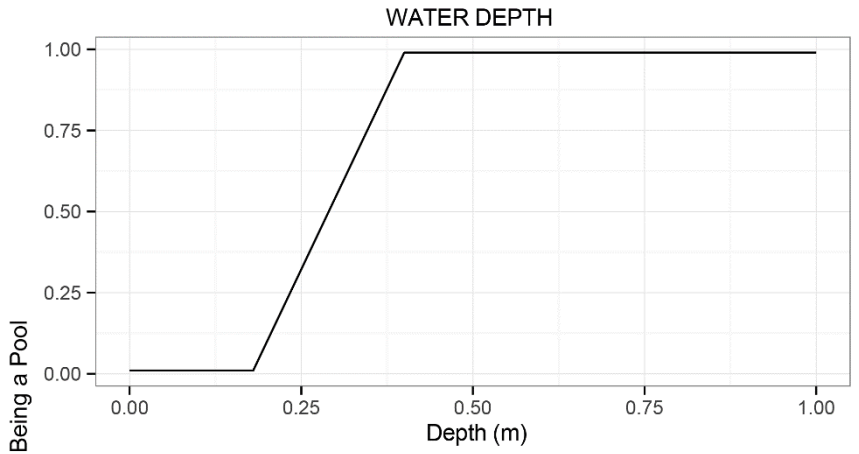


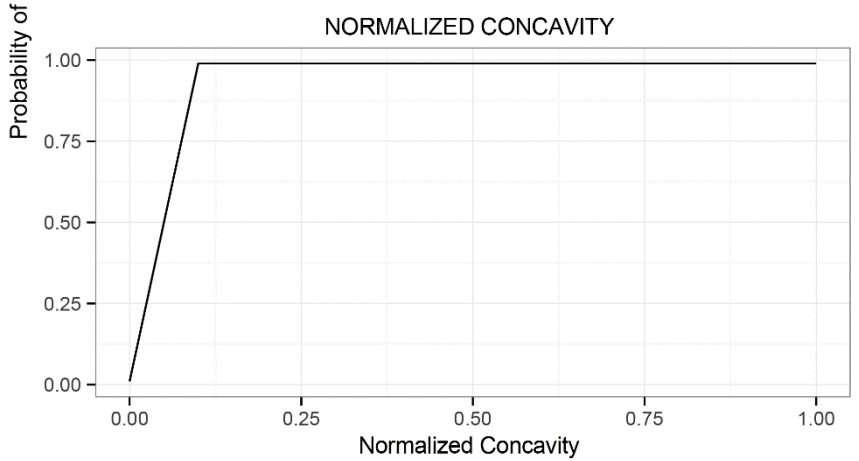


TRANSFORM FUNCTIONS…

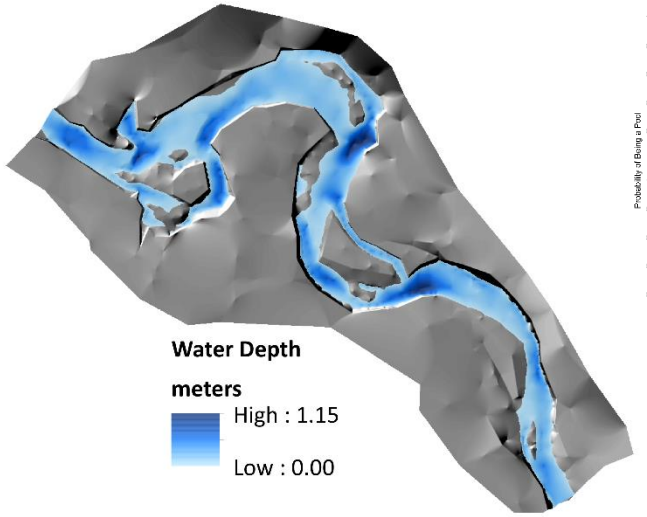


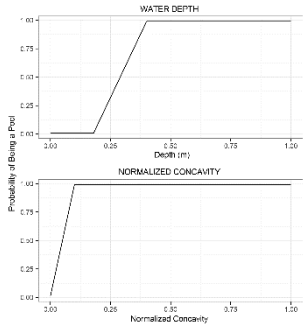


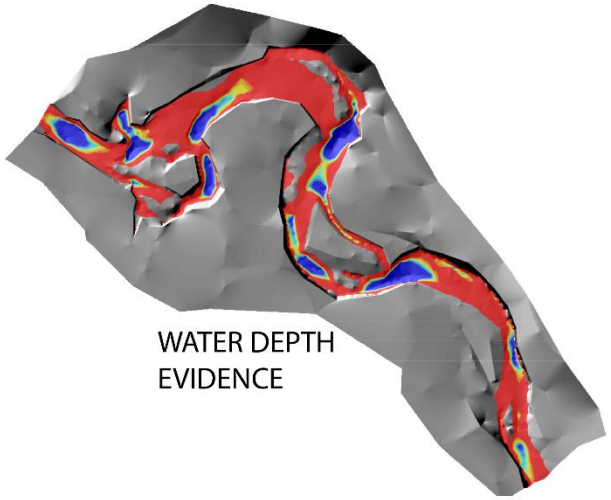


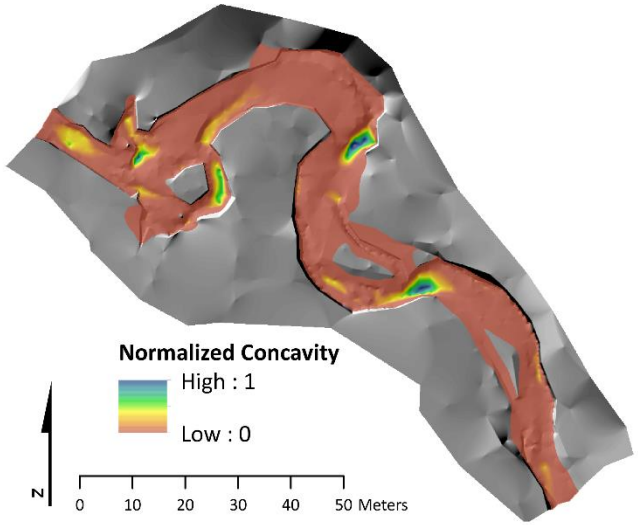


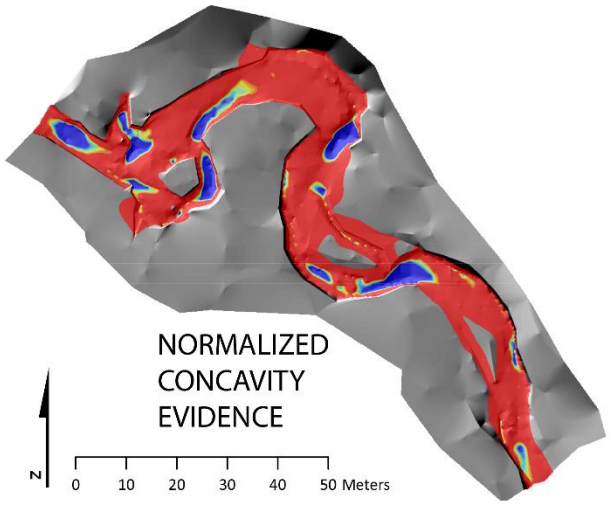
TFs TRANSFORM IT TO A PROBABILITY





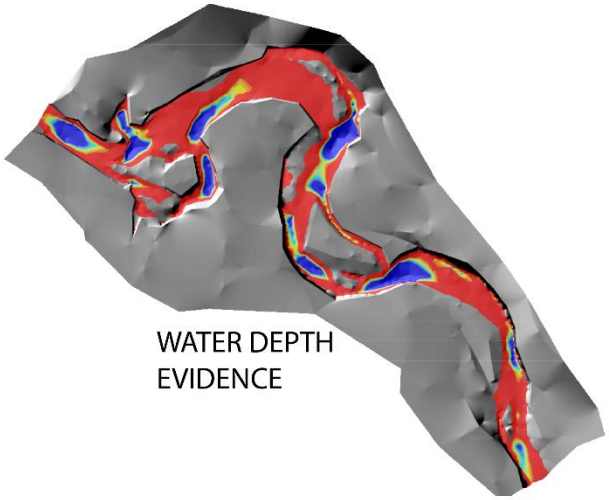




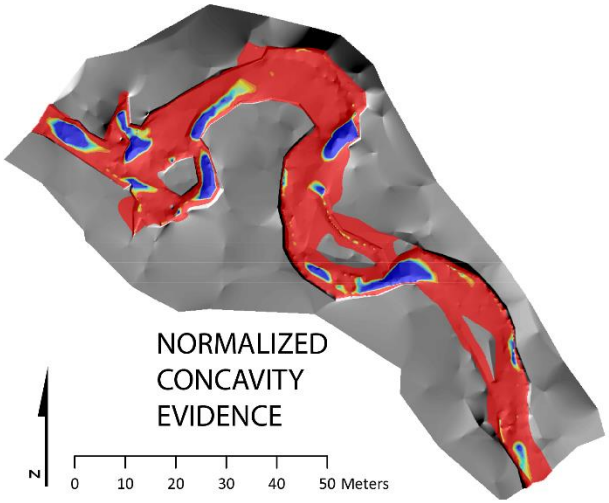


Probability of Being a Pool
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1

COMBINE PROBABILITIES



WATER DEPTH EVIDENCE



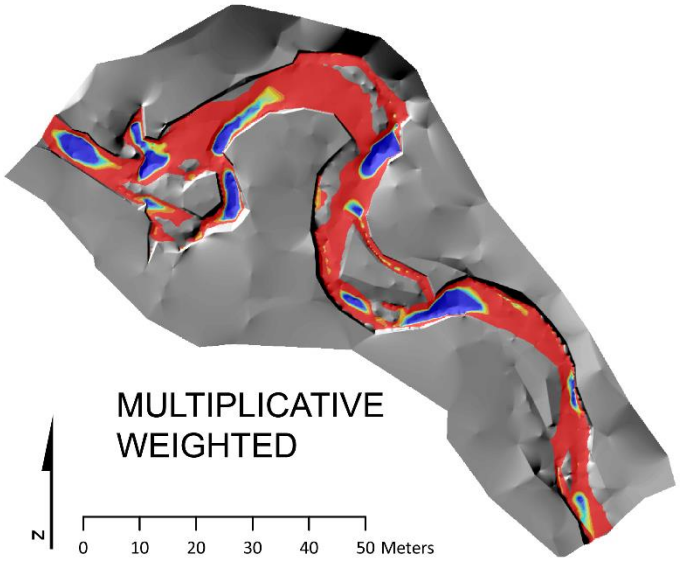
NORMALIZED CONCAVITY EVIDENCE

N

0 10 20 30 40 50 Meters

Probability of Being a Pool

- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1



MULTIPLICATIVE WEIGHTED

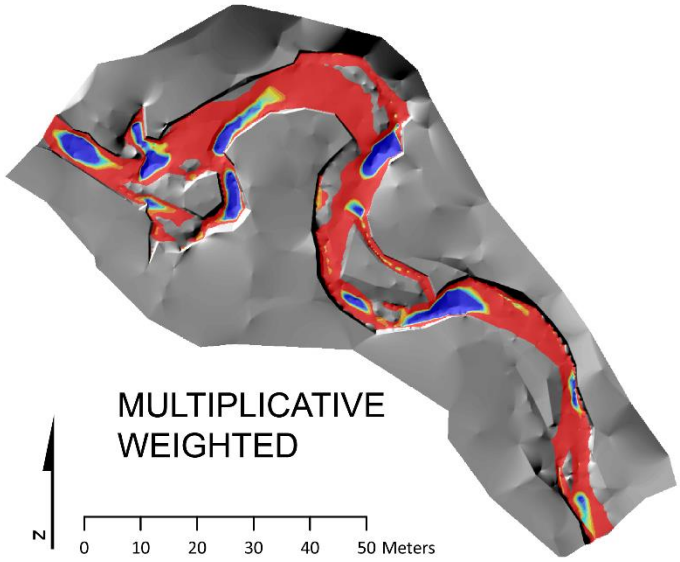
N

0 10 20 30 40 50 Meters

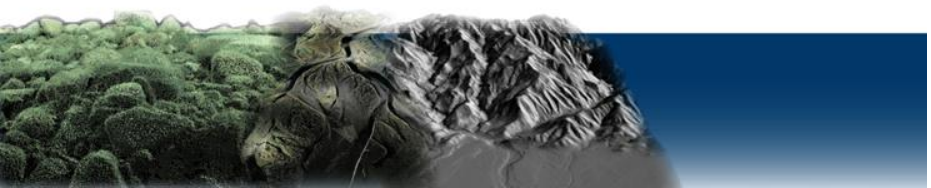
Probability of Being a Pool

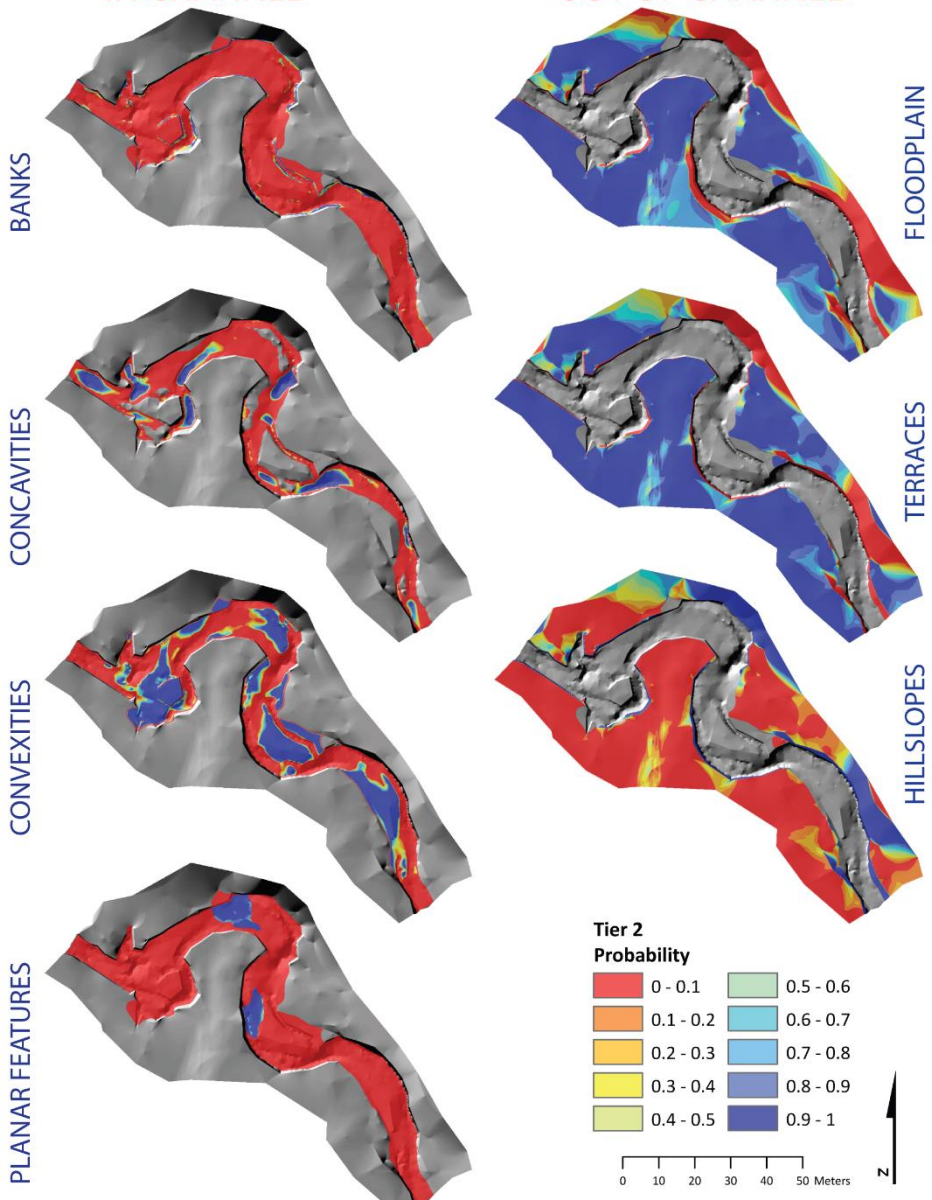
- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1

REPEAT FOR ALL CATEGORIES

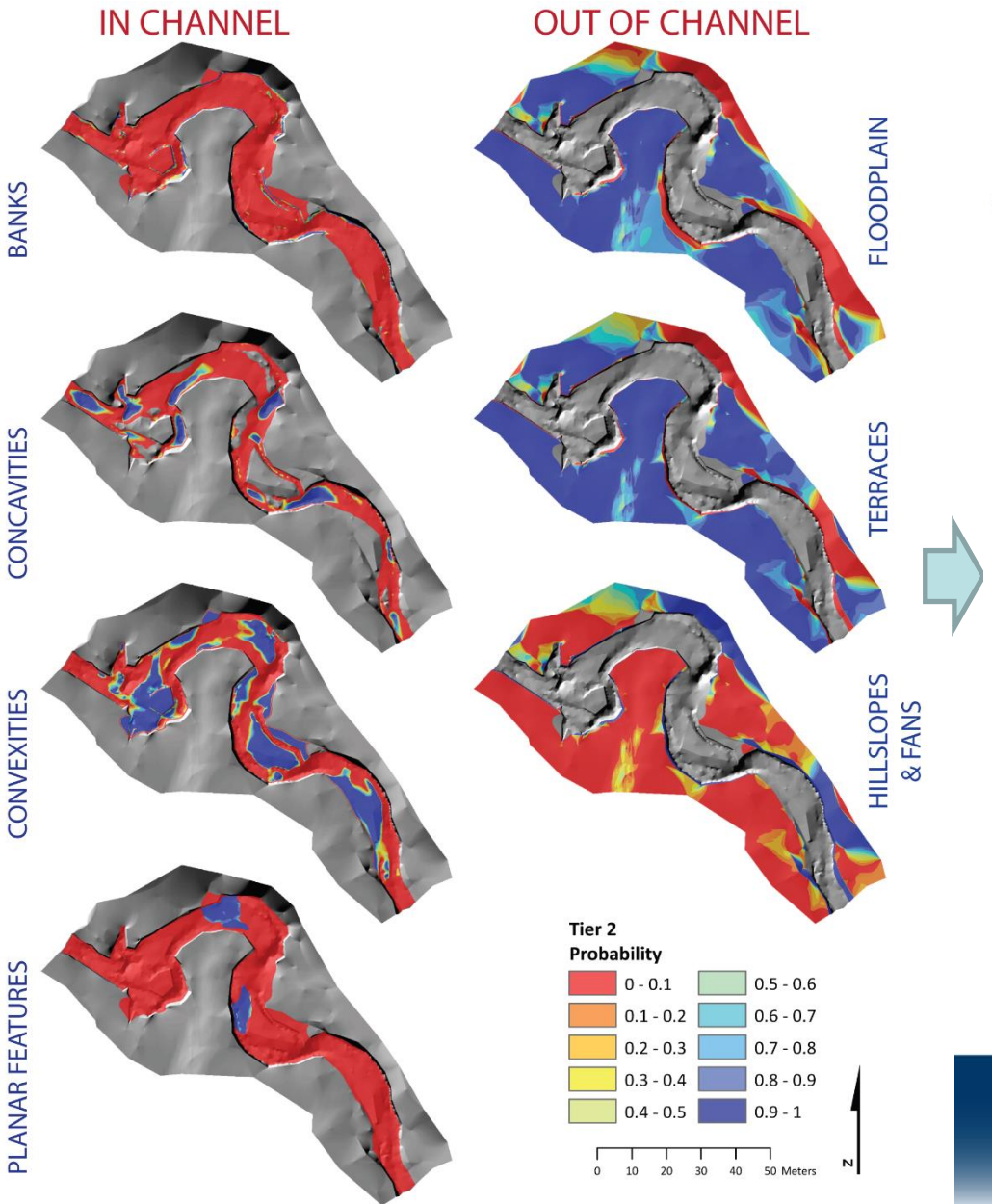


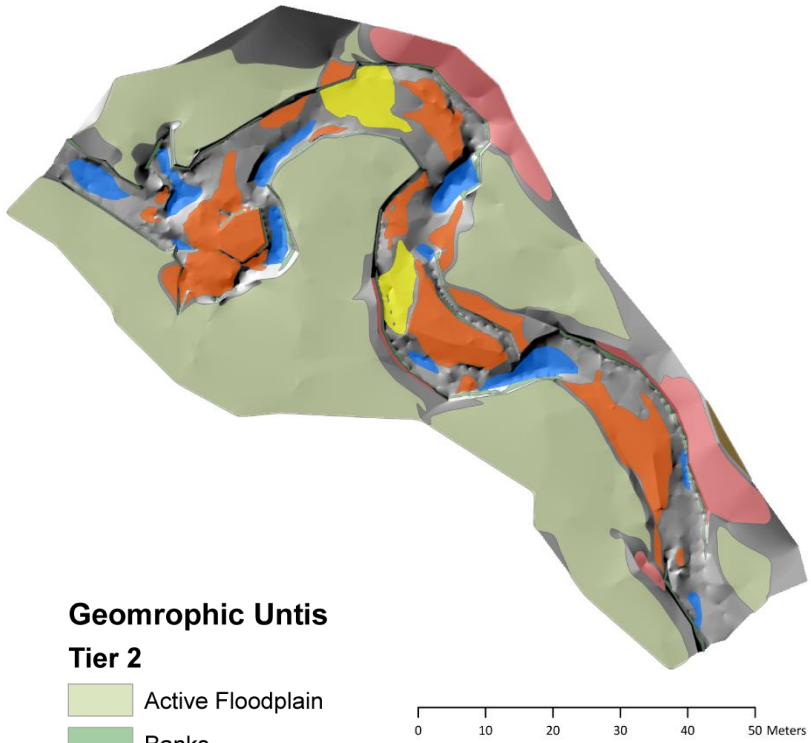
Probability of Being a Pool
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.8
0.8 - 0.9
0.9 - 1





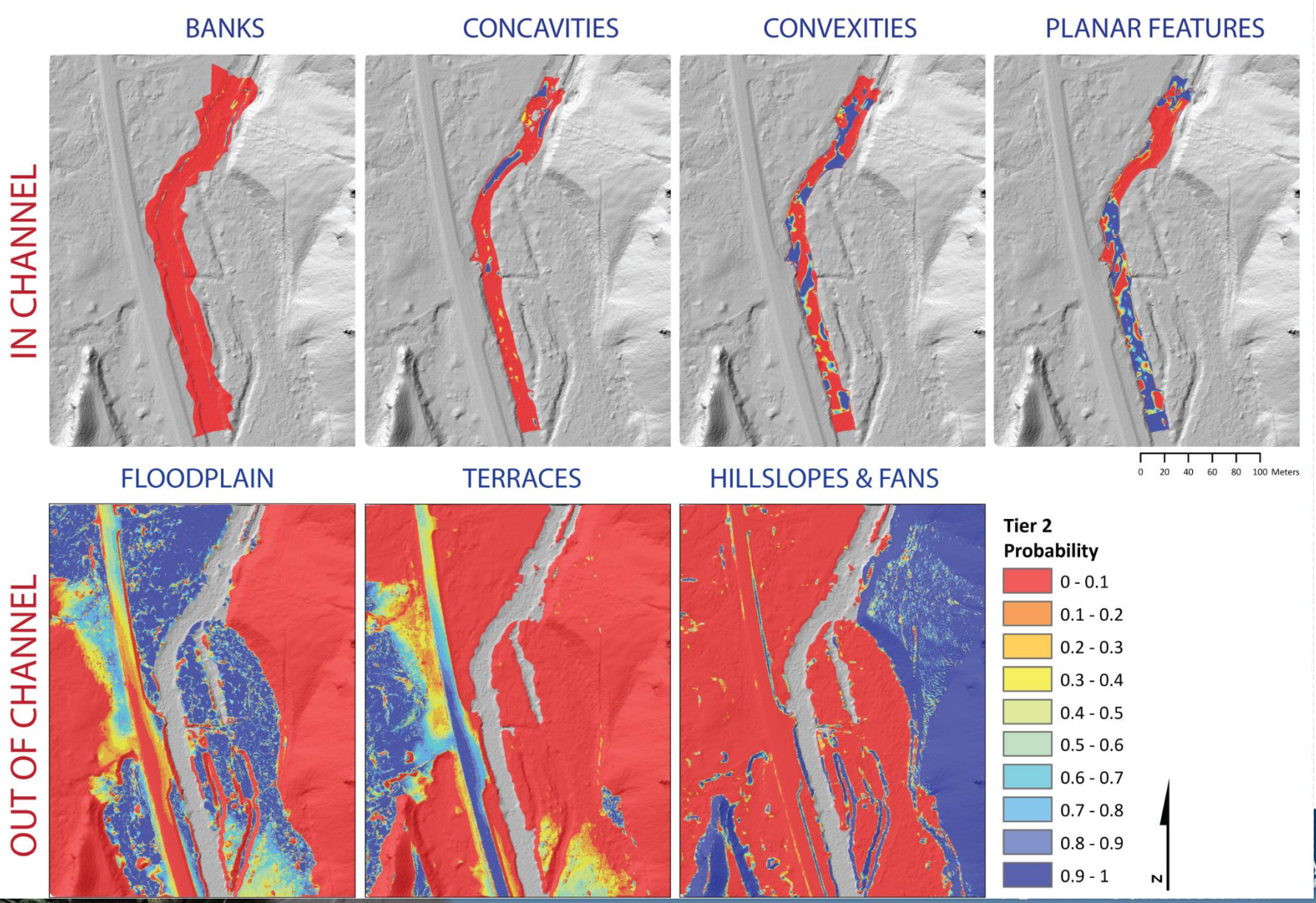
THRESHOLD PROBABILITIES





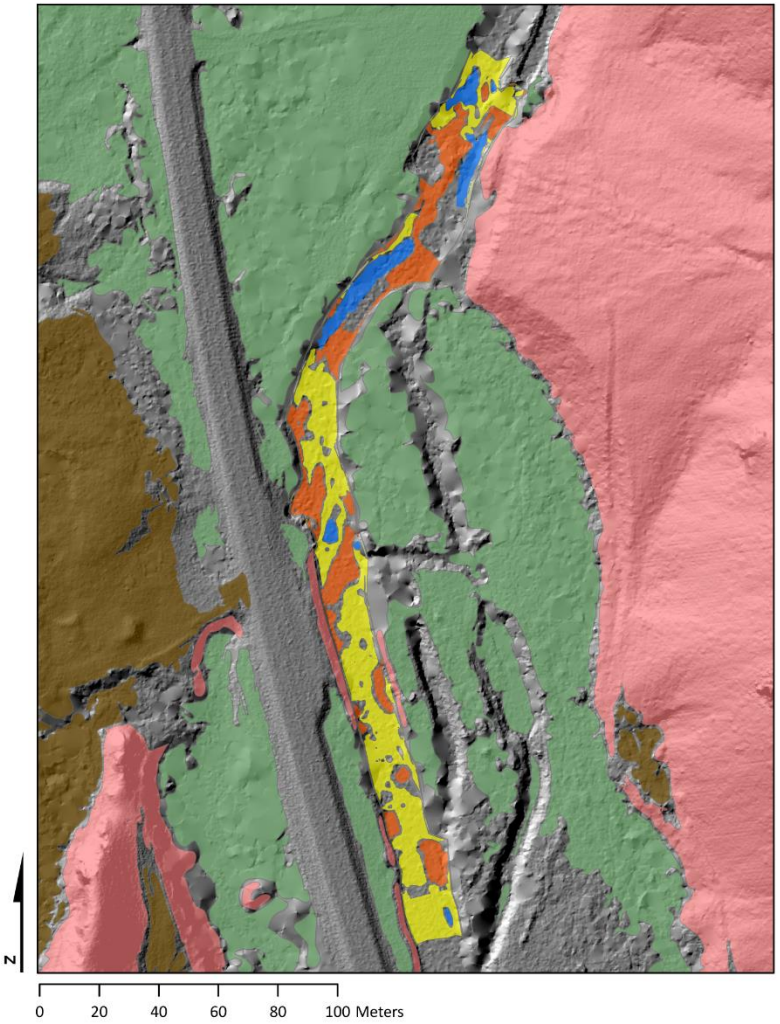
UtahStateUniversity
ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY

A DIFFERENT EXAMPLE



LEMHI SITE

N
0 20 40 60 80 100 Meters


N
0 20 40 60 80 100 Meters
Geomorphic Units
Tier 2 Units
Active Floodplain
Banks
Planar Features
Concavities
Convexities
Fans
Hillslope/Uplands
Inactive Floodplain

WHERE WE ARE… WHERE TO GO

- Topographic lines of evidence and transform functions done for all but planar units
- Workflow dialed and tested at six sites
- RBT architecture to facilitate designed and partially built
- We need to build out automation of derivation of topographic lines of evidence
- Finish RBT console & GUI
- Test at more sites
- Validate against crew variability sites