Geomorphic & Network Context

2015 CHaMP Camp Advanced Workshop

Cove, Oregon – June 1st, 2015

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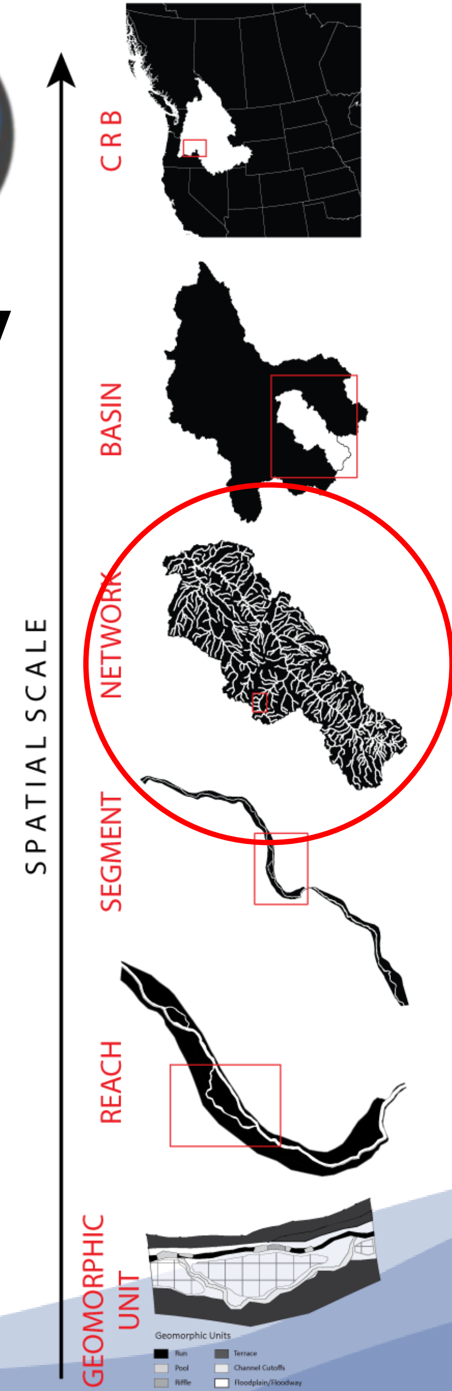
PURPOSE OF MODULE

How do we get to these summary products at a network scale?



BONNEVILLE POWER ADMINISTRATION

ISEMP

CHaMP

CHaMP | Columbia Habitat Monitoring Program

OUTLINE

GEOMORPHIC & NETWORK CONTEXT

I. **Background**

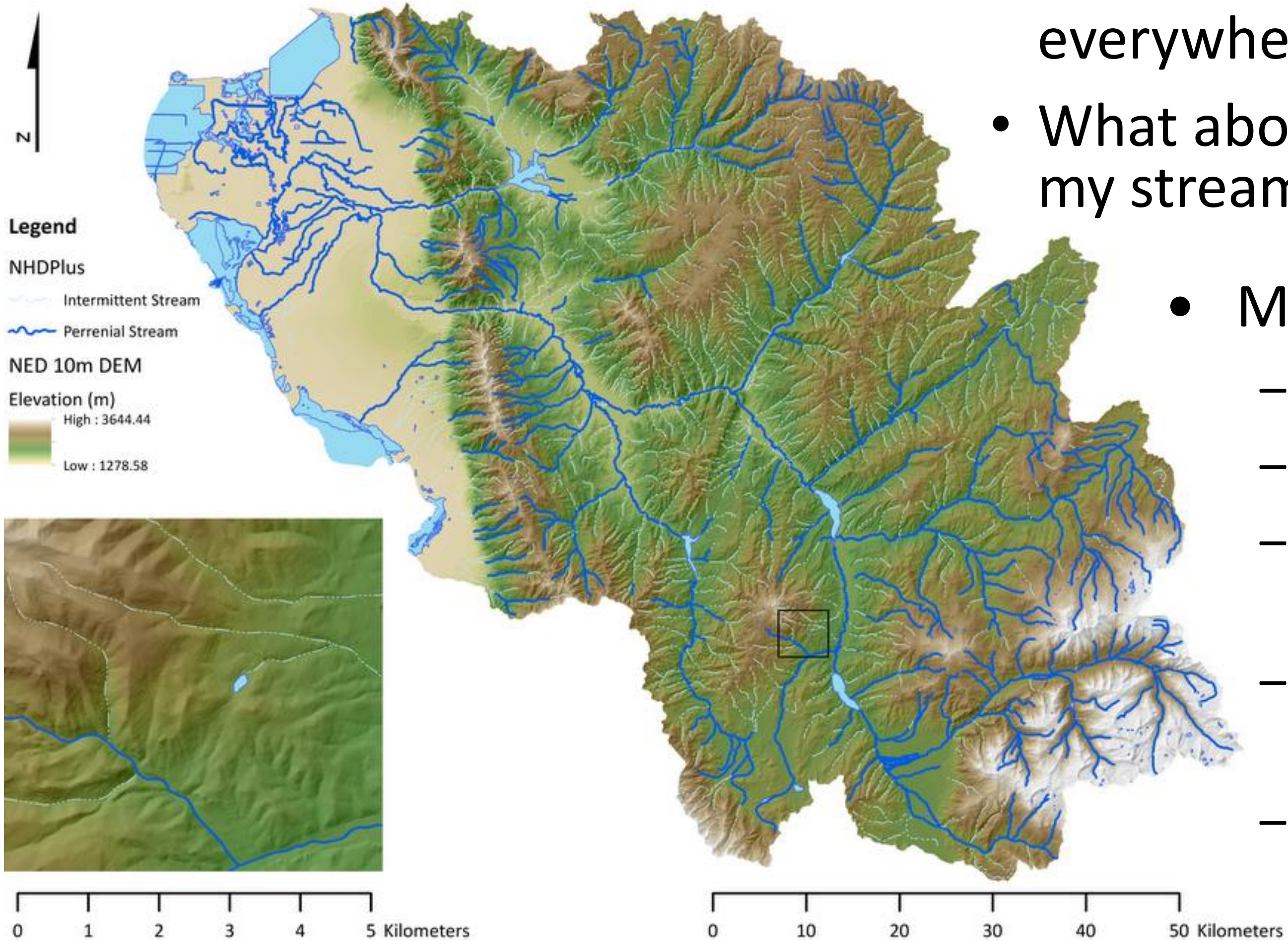
II. Reach Types - GNAT
   - I. Reach Type (River Style) Tree
   - II. Valley Setting
     - I. Valley Bottom
     - II. Confinement
     - III. Sinuosity
   - III. Reach Typing of CHaMP Basins & CRB

III. Condition
   - I. Geomorphic Condition
   - II. Riparian Condition
   - III. Habitat & Population Condition

IV. Recovery Potential
   - I. Geomorphic Recovery Potential
   - II. Riparian Recovery Potential
   - III. BRAT & WRAT

V. Future Work

WHY THE NETWORK SCALE?



- CHaMP Sample Sites don't cover everywhere we care about
- What about in my watershed, on my stream?

- Maps that are:
  - Data driven
  - Model informed
  - Use best available science
  - Take into account the constraints
  - Resolved at a scale that matters to on the ground implementation

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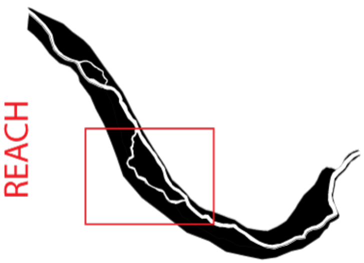
MAPS @ DIFFERENT SCALES TO ADDRESS DIFFERENT NEEDS

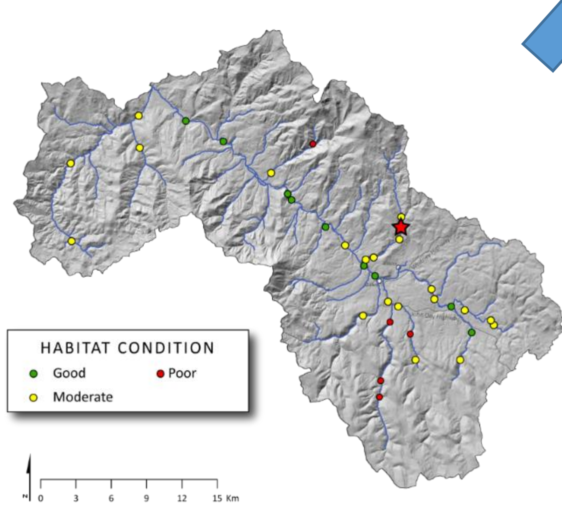
REACH



1 SITE LEVEL

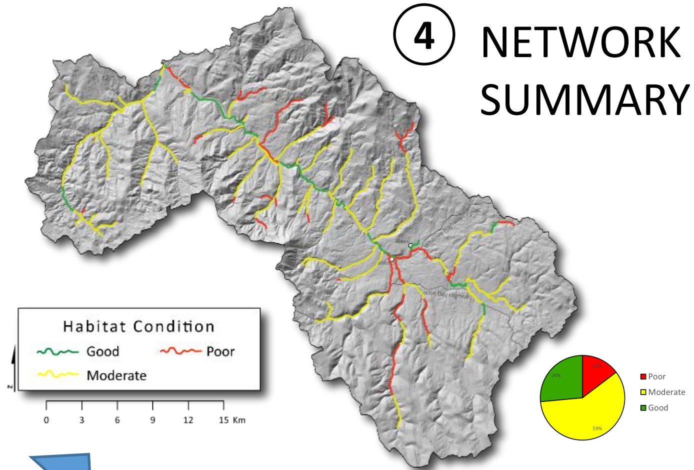
2 SITE SUMMARY:

3 SITES ON NETWORK



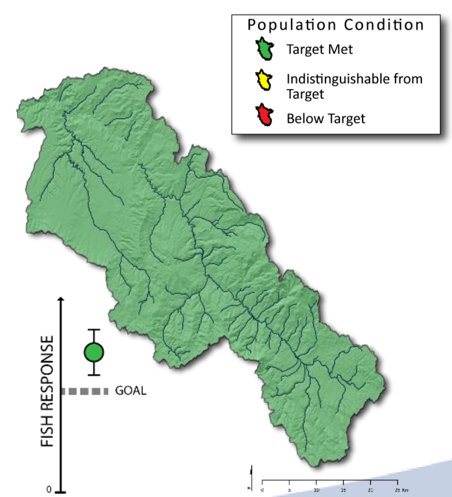
NETWORK

4 NETWORK SUMMARY



BASIN

5 WATERSHED / POPULATION



6 BASIN

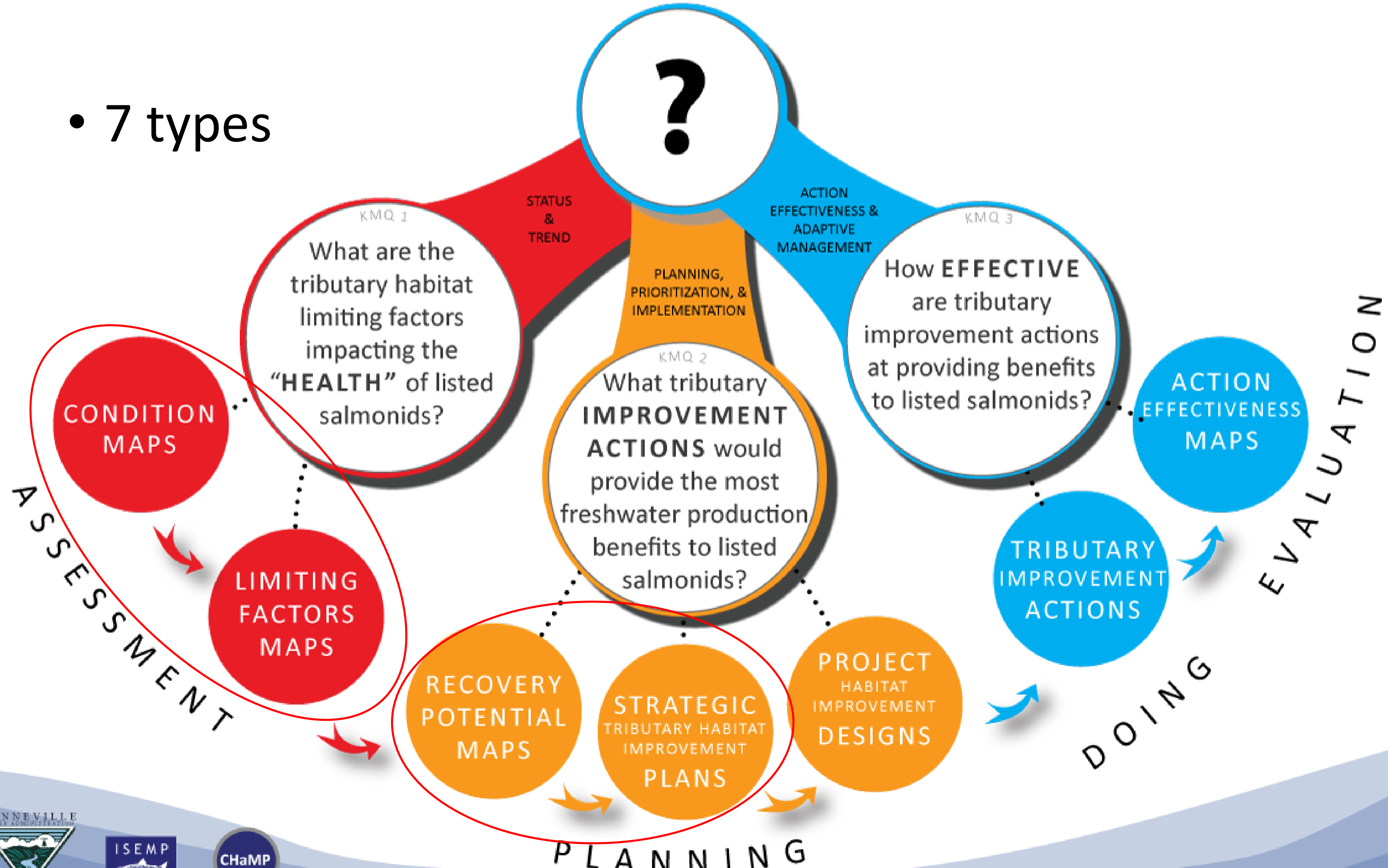
HOW DO YOU PRIORITIZE IMPROVEMENT ACTIONS?

- For specific threats, you need assessments of :
  - Condition
  - Limiting Factors
  - Recovery Potential

- To inform:
  - Strategic Plan
  - Detailed Designs & Implementations
- Stakeholder Informed…
- BUT avoid just opportunistic…

SUMMARY PRODUCTS

- 7 types



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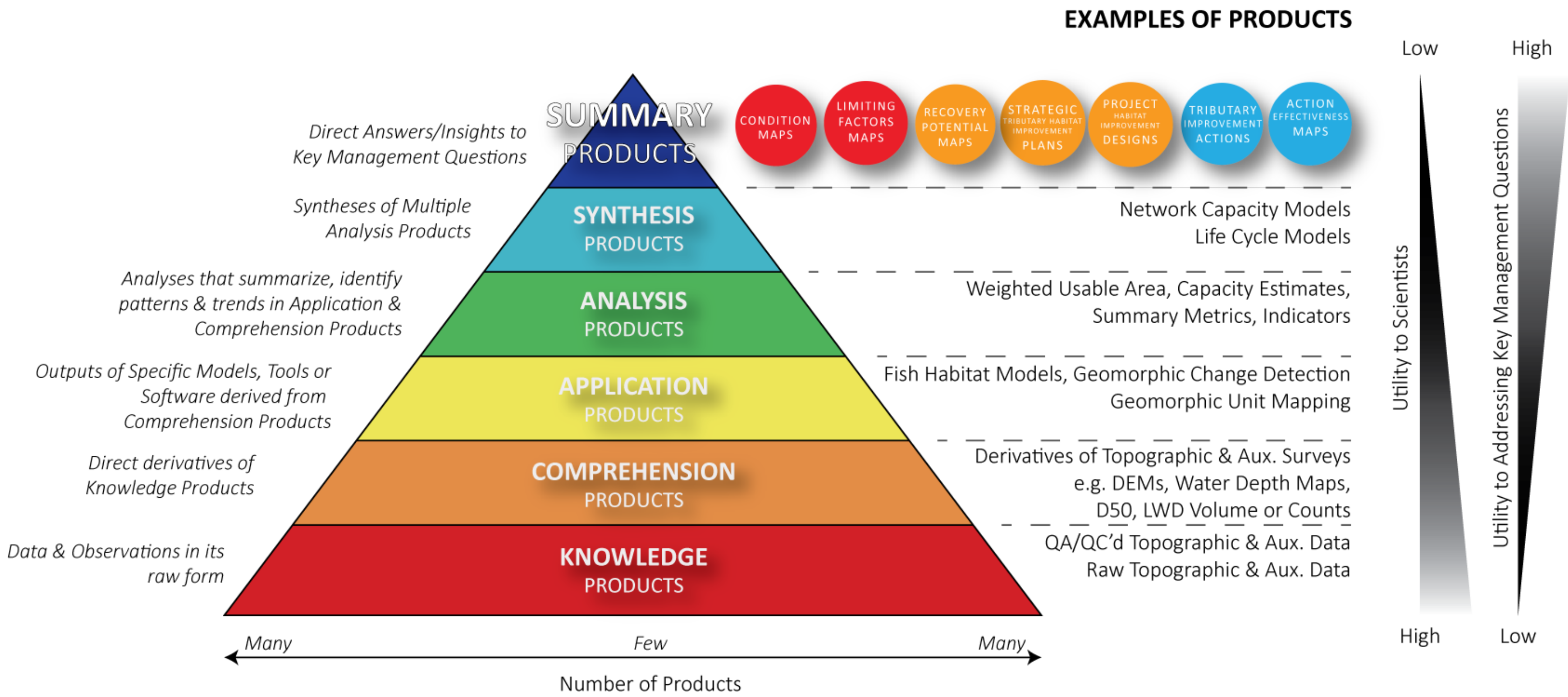
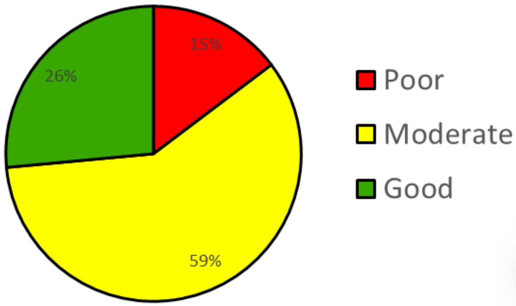
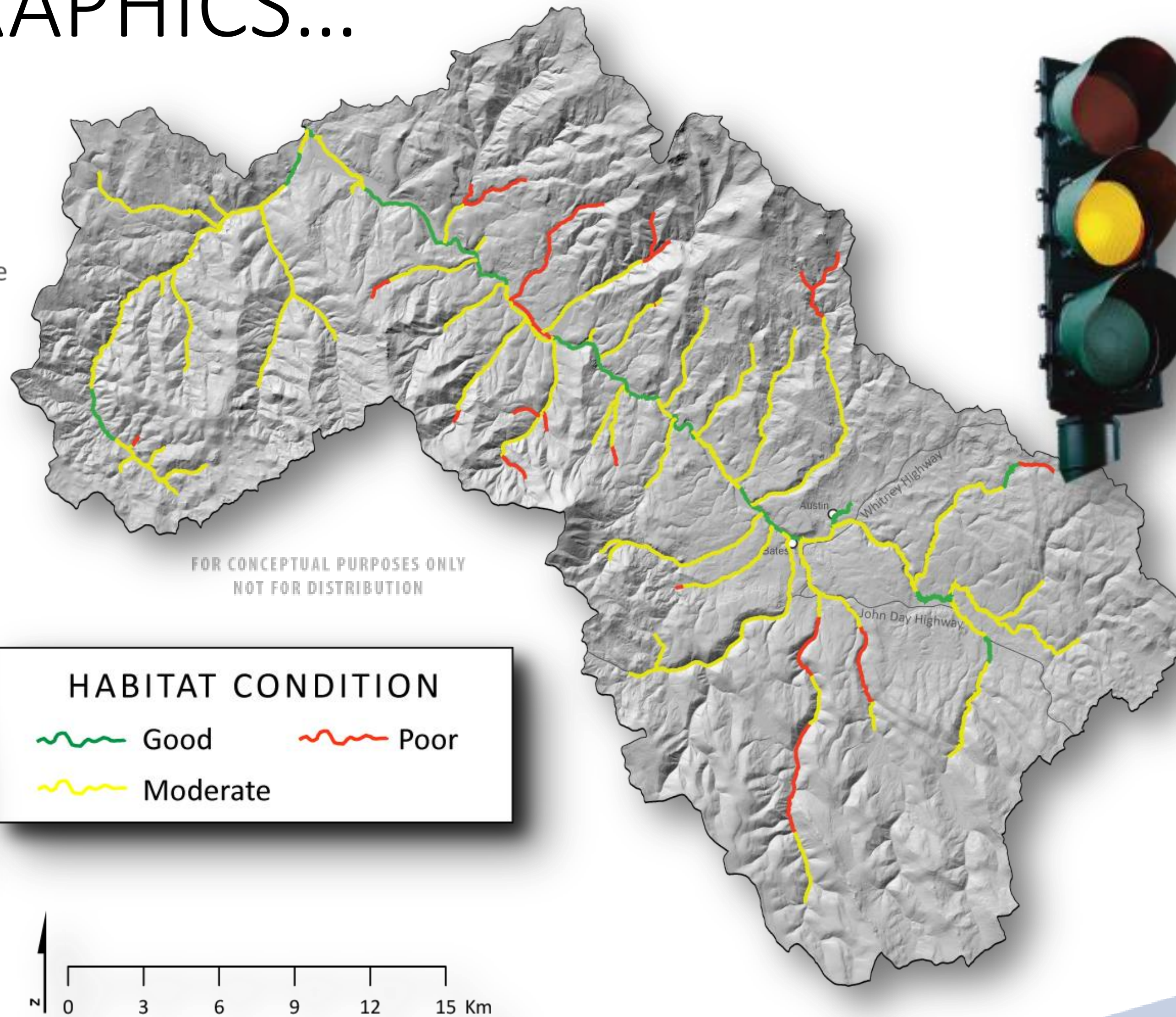
WHAT MAKES A SUMMARY PRODUCT?



Direct answers to key management questions!
Includes interpretation & value judgement.

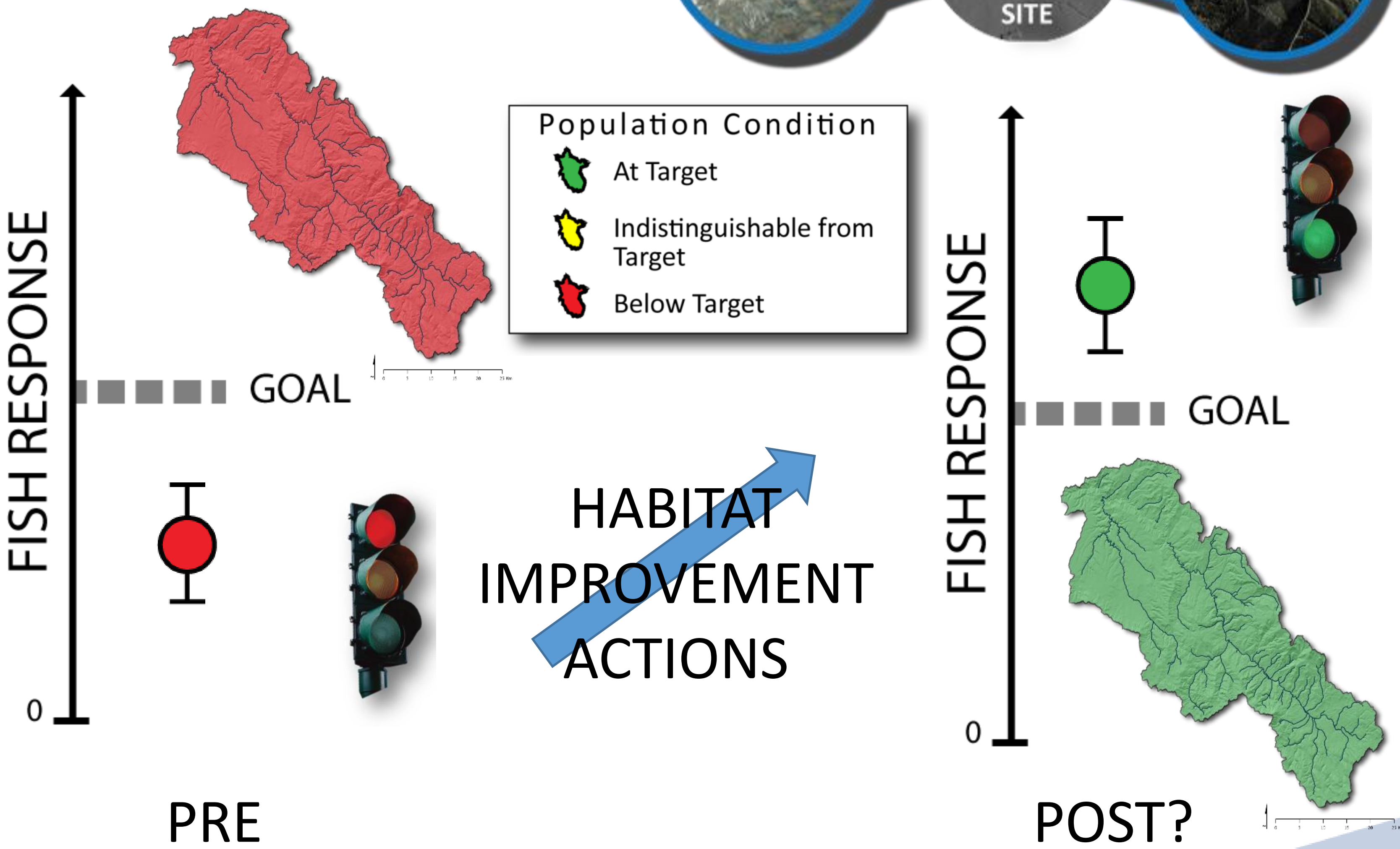
CONVEYED AS EASY-TO-INTERPRET MAPS & GRAPHICS…





CONDITION MAPS

WILL ACTION ACHIEVE GOAL?



ASSUMPTIONS & PREMISE

- You can't meaningfully upscale fish habitat relationships without geomorphic context
  - Inclusive of reach types & *condition*
- You can't develop realistic and appropriate *tributary habitat improvement actions* (e.g. restoration *designs*) without geomorphic context
  - Inclusive of reach types & *recovery potential*
- To inform whether *improvement actions* could even plausibly achieve salmonid population goals you need life cycle models with more explicit fish habitat relationships
  - Capacity estimates rely on reach type & condition, temperature & primary production

CONDITION MAPS

RECOVERY POTENTIAL MAPS

PROJECT HABITAT IMPROVEMENT DESIGNS

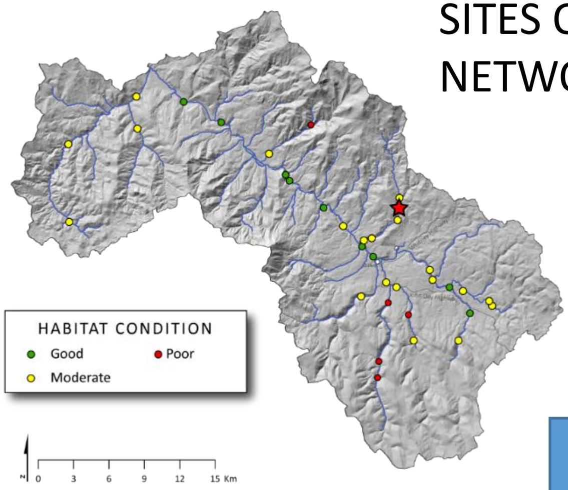
STRATEGIC TRIBUTARY HABITAT IMPROVEMENT PLANS

TRIBUTARY IMPROVEMENT ACTIONS

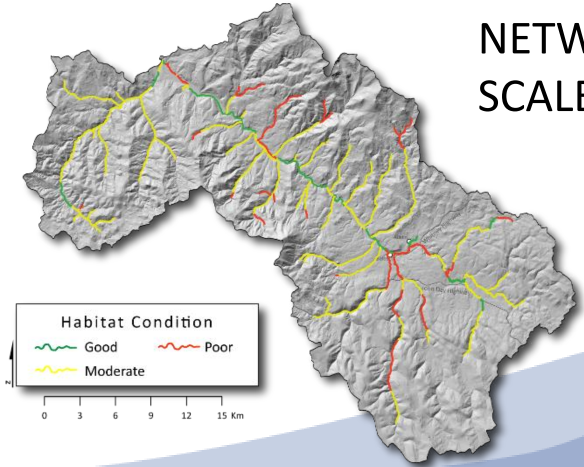
Two Primary Motivations for getting Geomorphic & Network Context

1. **Extrapolation**: From sites on map to network scale
2. Network Scale **Prediction** in Absence of Site-Level Data

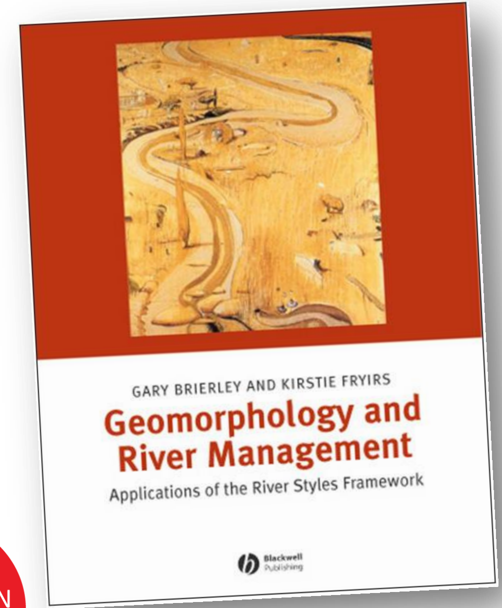
SITES ON NETWORK



NETWORK SCALE



METHODS



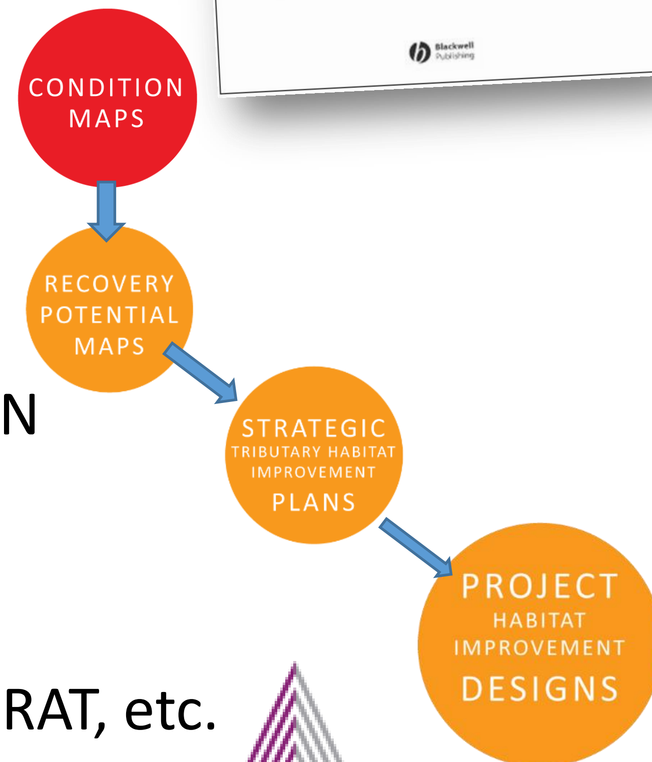
Conceptual Basis: Adaptations of Brierley & Fryirs (2005):

STAGE ONE – RIVER CHARACTER AND BEHAVIOR

STAGE TWO – GEOMORPHIC CONDITION

STAGE THREE – RECOVERY POTENTIAL

STAGE FOUR – STRATEGIC MANAGEMENT PLAN



Conversion from manual method to semi-automated geoprocessing methods:

In house tool development: GNAT, VBET, BRAT, etc.

SOUTH FORK RESEARCH, INC.

UtahStateUniversity ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY

NORTH ARROW RESEARCH

CHaMP Columbia Habitat Monitoring Program

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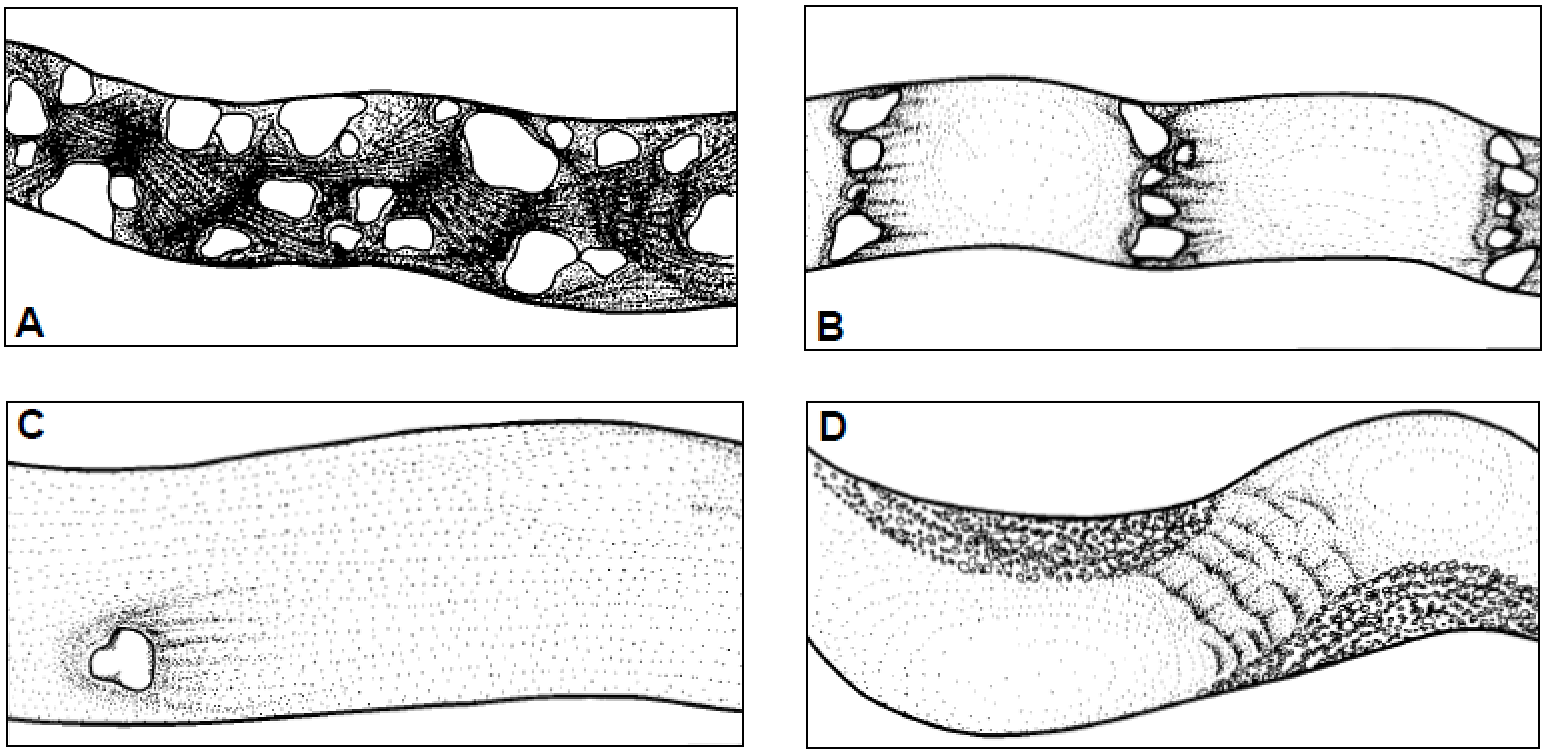
WHAT ARE GEOMORPHIC REACH TYPES?

MONTGOMERY AND BUFFINGTON



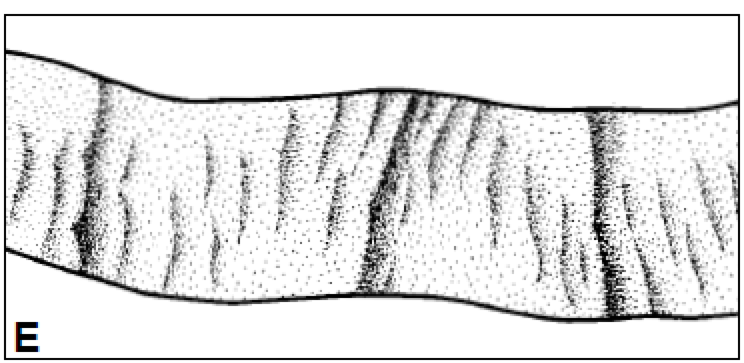


Figure 2. Schematic planform illustration of alluvial channel morphologies at low flow: (A) cascade channel showing nearly continuous, highly turbulent flow around large grains; (B) step-pool channel showing sequential highly turbulent flow over steps and more tranquil flow through intervening pools; (C) plane-bed channel showing single boulder protruding through otherwise uniform flow; (D) pool-riffle channel showing exposed bars, highly turbulent flow through riffles, and more tranquil flow through pools; and (E) dune-ripple channel showing dune and ripple forms as viewed through the flow.

WHAT IS DISTINCTIVE?

DESCRIBE VALLEY SETTING

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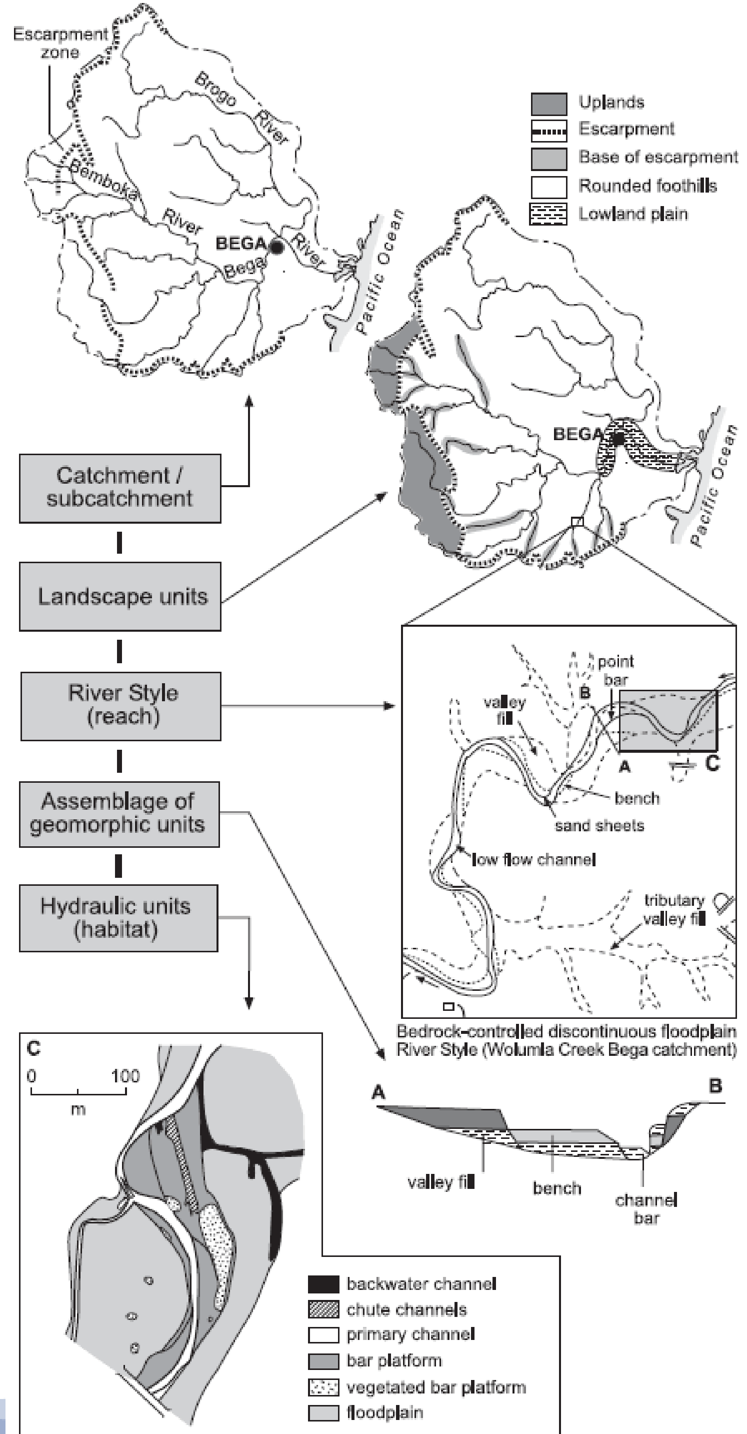
MANY REACH TYPING SCHEMES TO CHOOSE FROM

- Montgomery & Buffington (1997)
- 'Beechie' – WRR (2014) – 'Natural Channel Classification'
- Rosgen Channel Classification
- Brierley & Fryirs (2005) – 'River Styles Framework'



COMPONENTS OF A PROCEDURAL TREE

264 *Chapter 9*

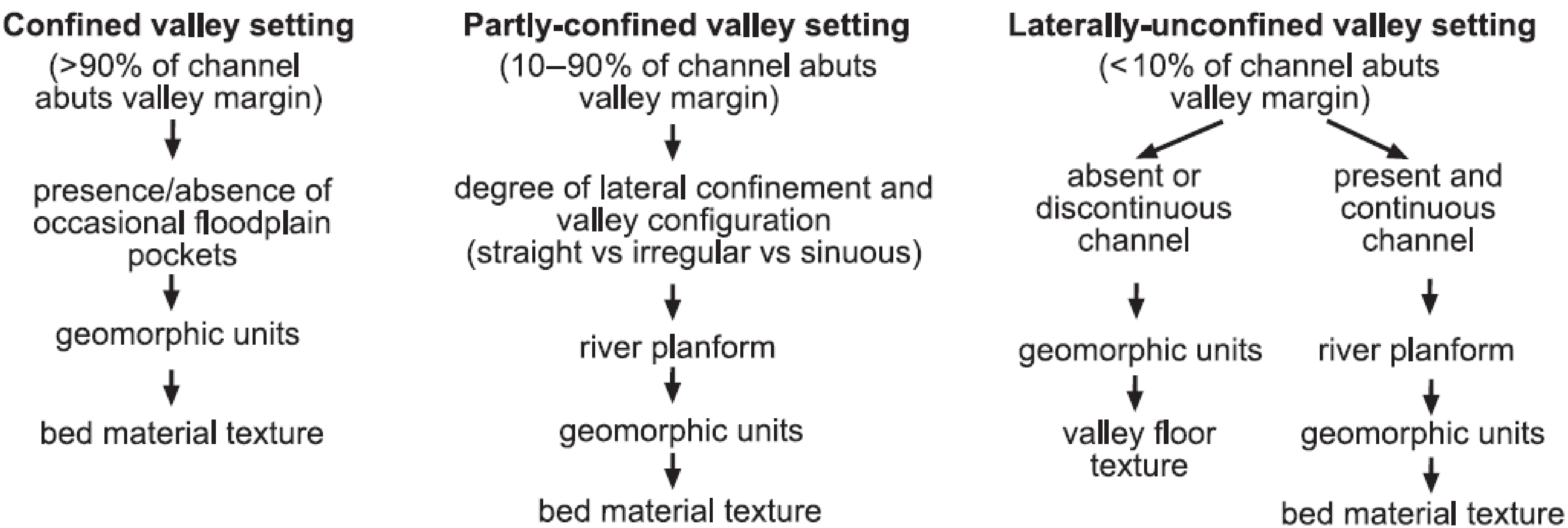


Figure 9.6 The River Styles procedural tree
Each River Style is identified on the basis of its planform, assemblage of geomorphic units, and bed material texture. Depending on the valley setting, different sequences of procedures are applied to identify the River Style. Modified from Brierley et al. (2002). Reproduced with permission from Elsevier, 2003.

SPECIFIC RIVER STYLES TREE

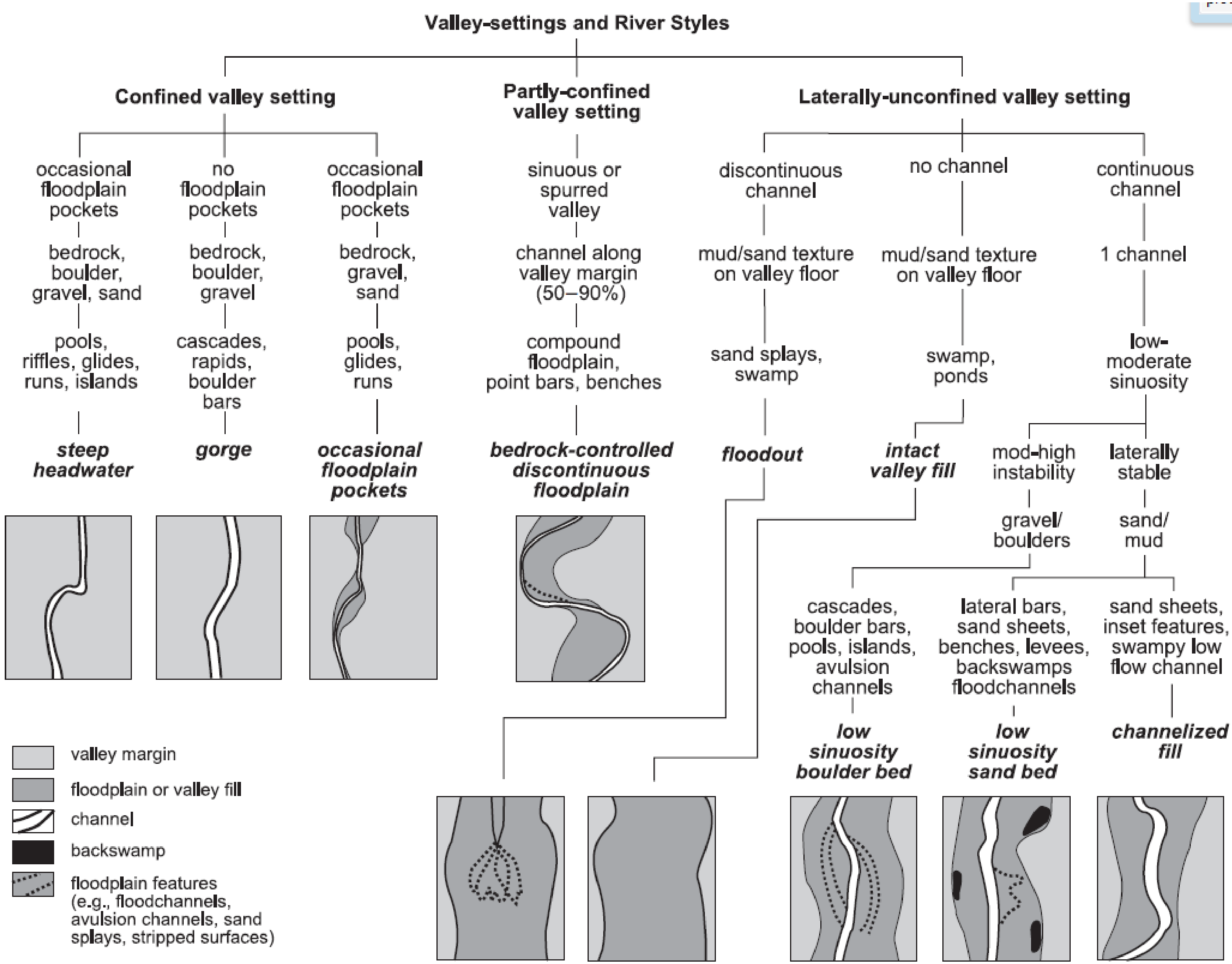


Figure 9.10 The Bega catchment River Styles tree (from Fryirs, 2001)

OTHER EXAMPLE…

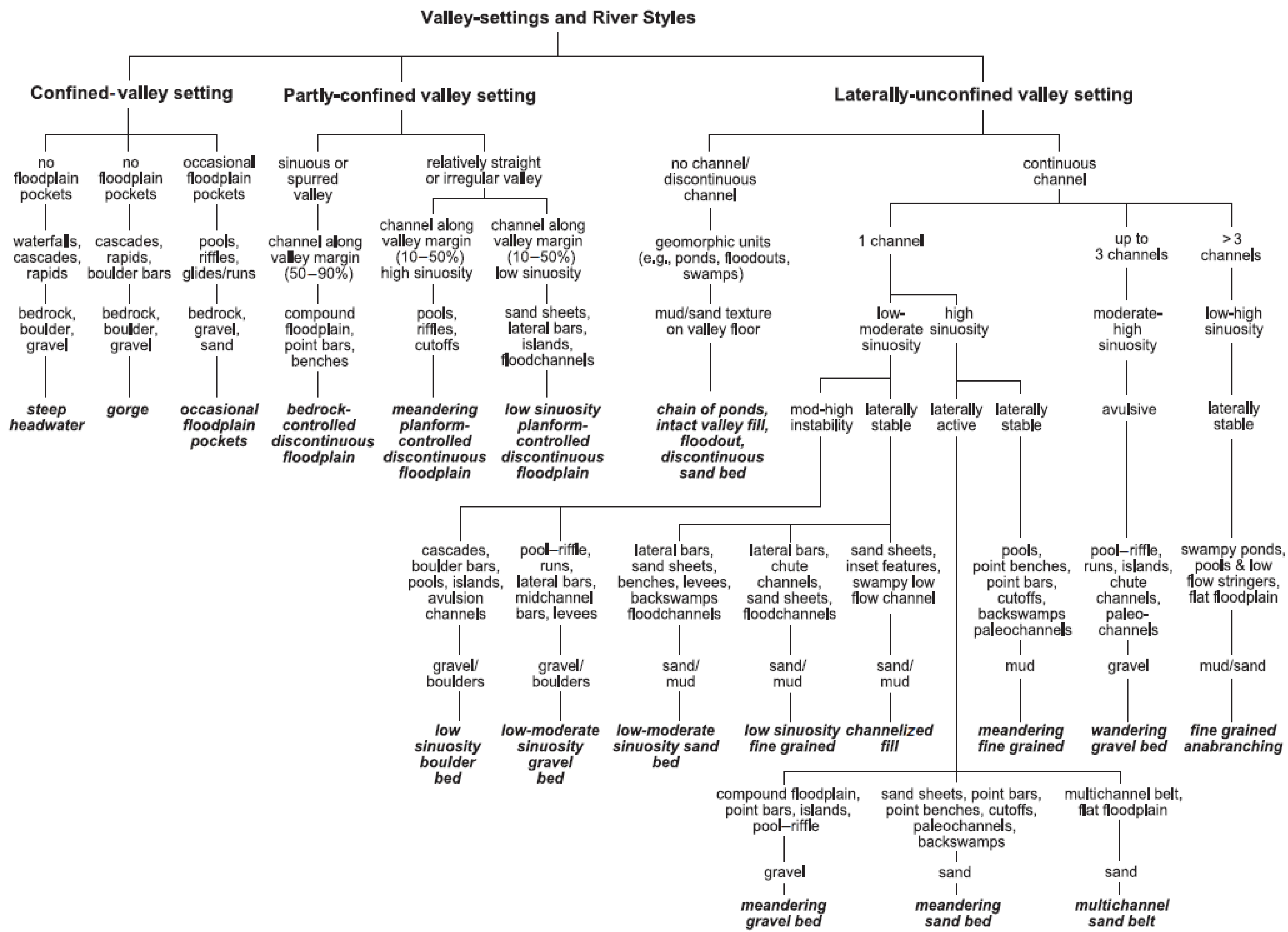


Figure 9.7 River Styles tree for a range of River Styles found in coastal NSW. Modified from Brierley et al. (2002). Reproduced with permission from Elsevier, 2003

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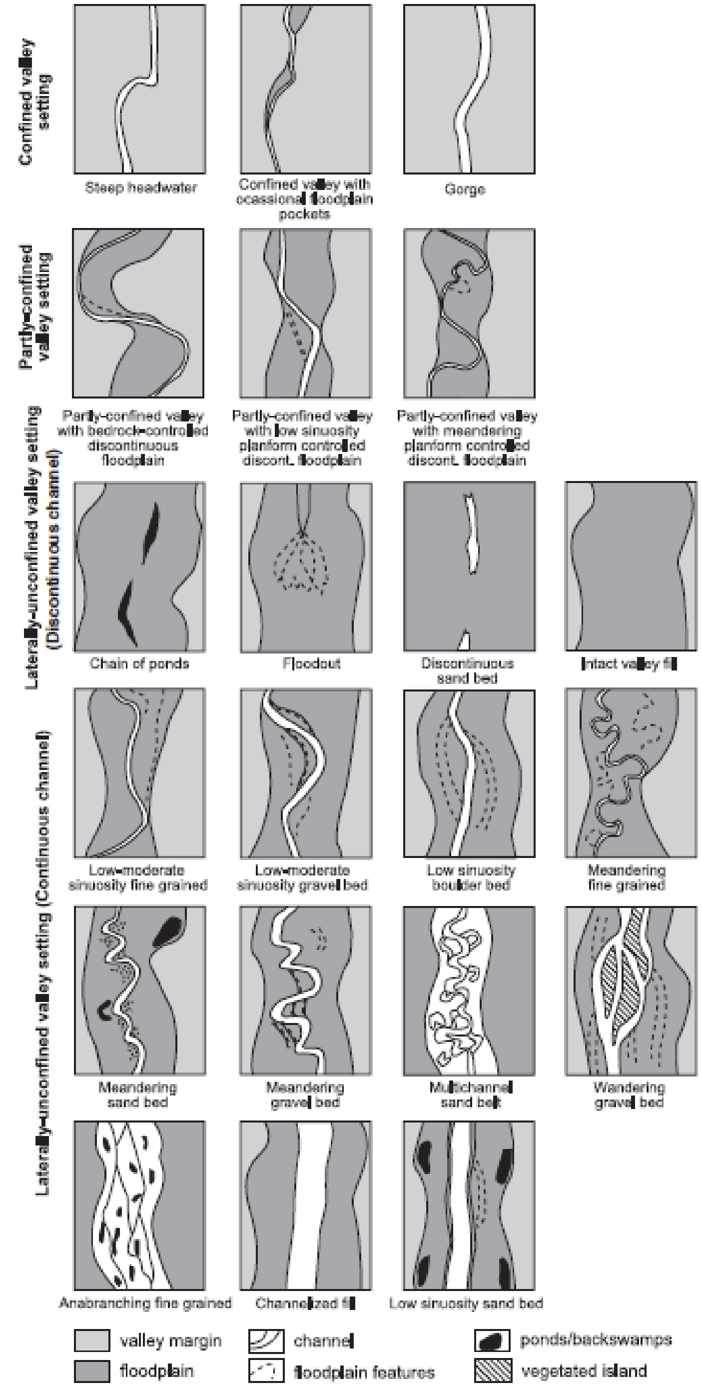
EXAMPLE CARTOONS OF THOSE RIVER STYLES



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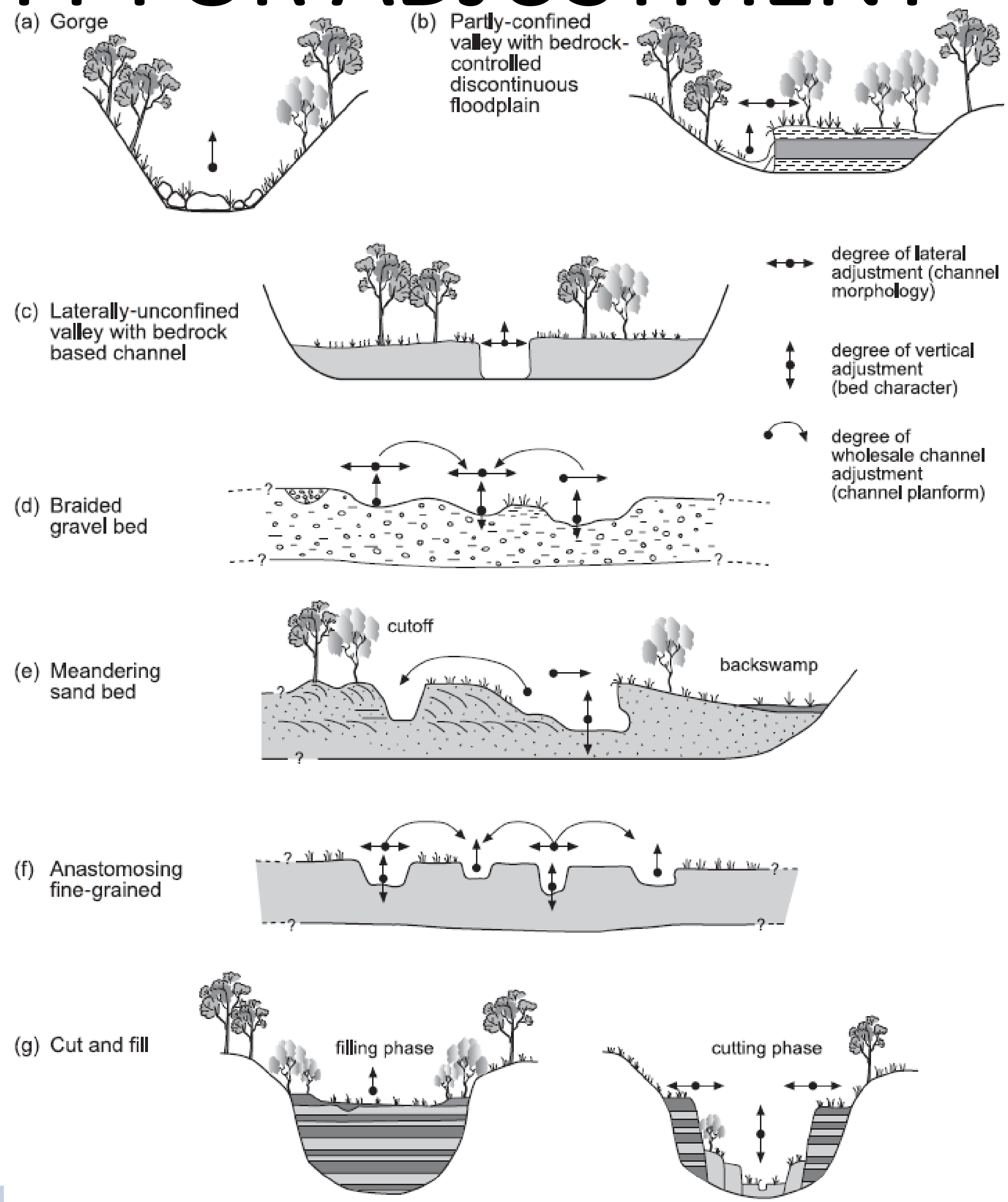
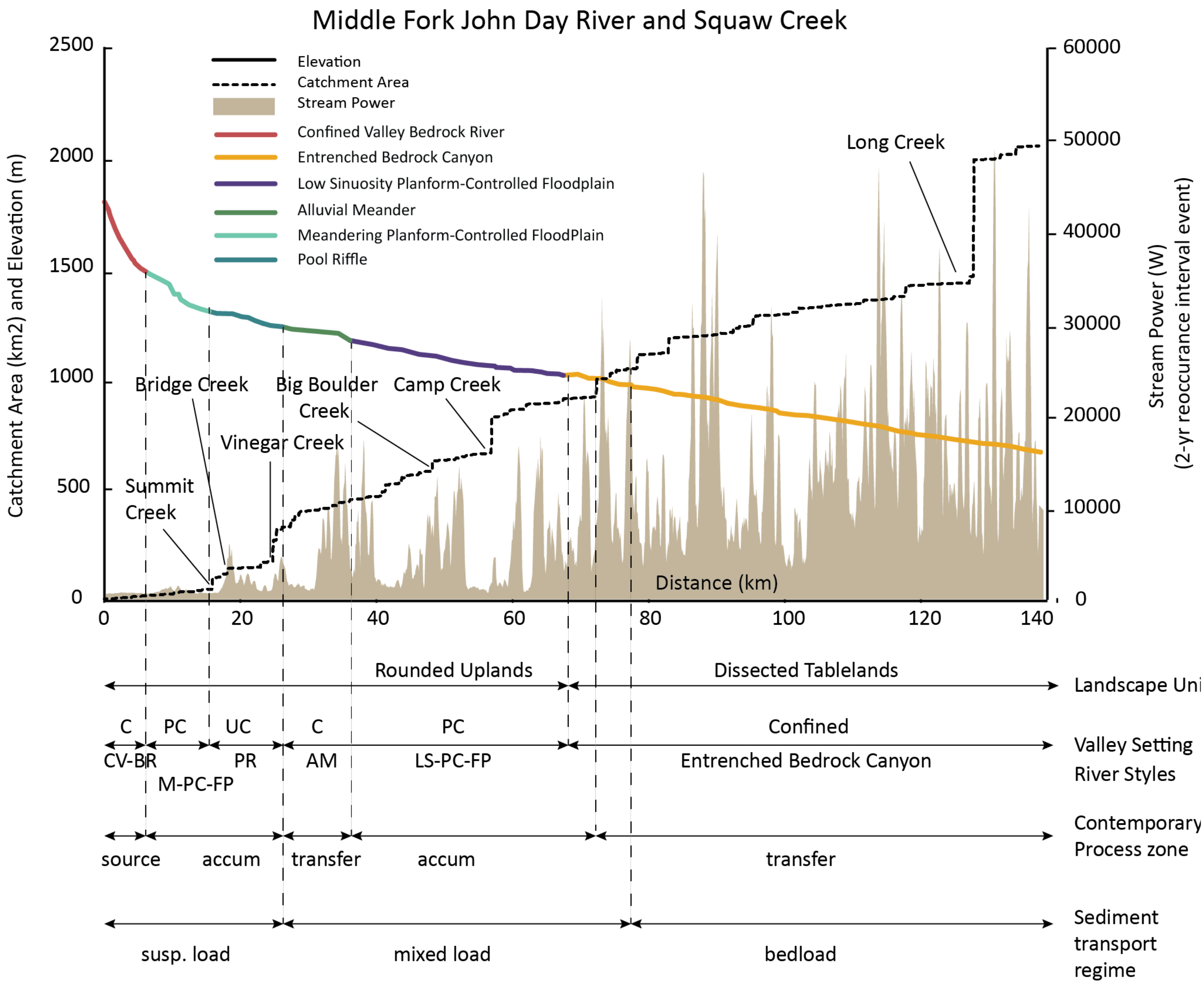
NATURAL CAPACITY FOR ADJUSTMENT

- Plausible limits on what adjustments are possible
- Geomorphic context matters
  - Confinement
  - Sediment Supply
  - Flow Regime
  - Vegetation
  - Land use
  - History



From Brierley & Fryirs (2005)

CONTROLS ON RIVER CHARACTER & BEHAVIOR



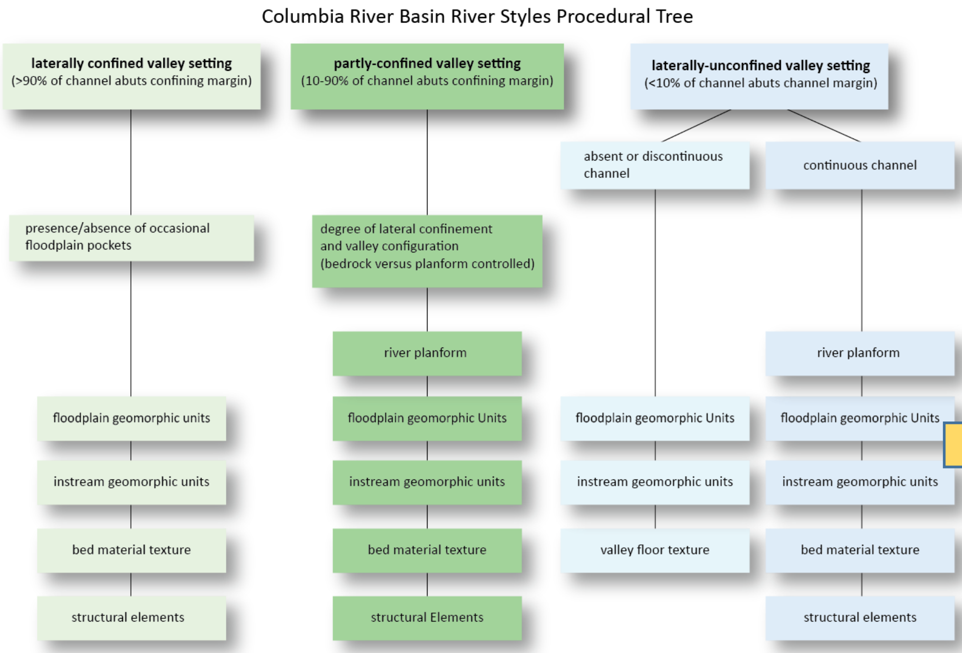
Driving

- ELEVATION
- STREAM POWER
- DISCHARGE
- UPSTREAM DRAINAGE AREA

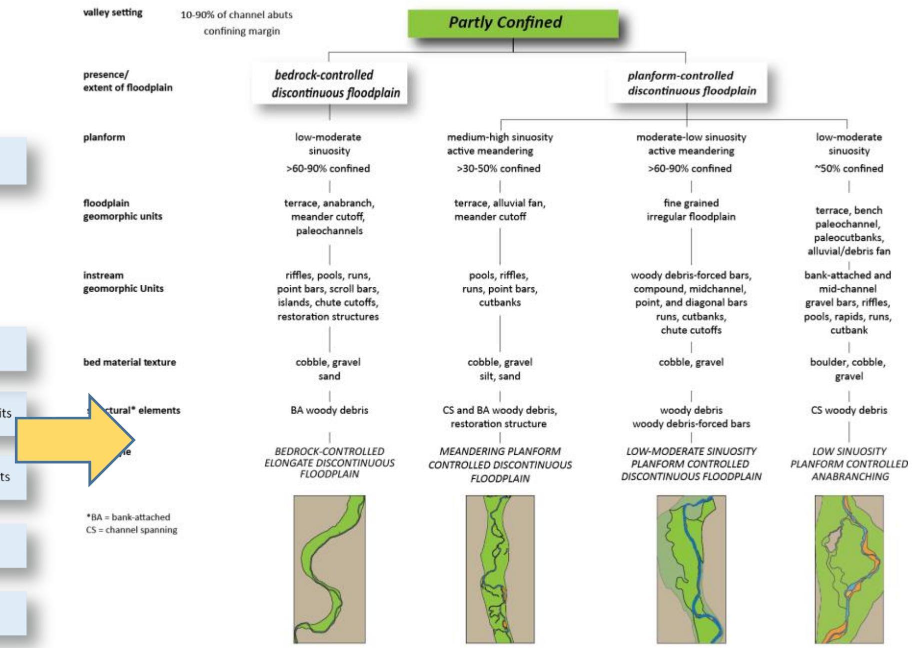
Resisting

- GEOLOGY - BEDROCK
- LAND COVER
- SEDIMENT TRANSFER

PROCEDURAL TREE vs. SPECIFIC TREE

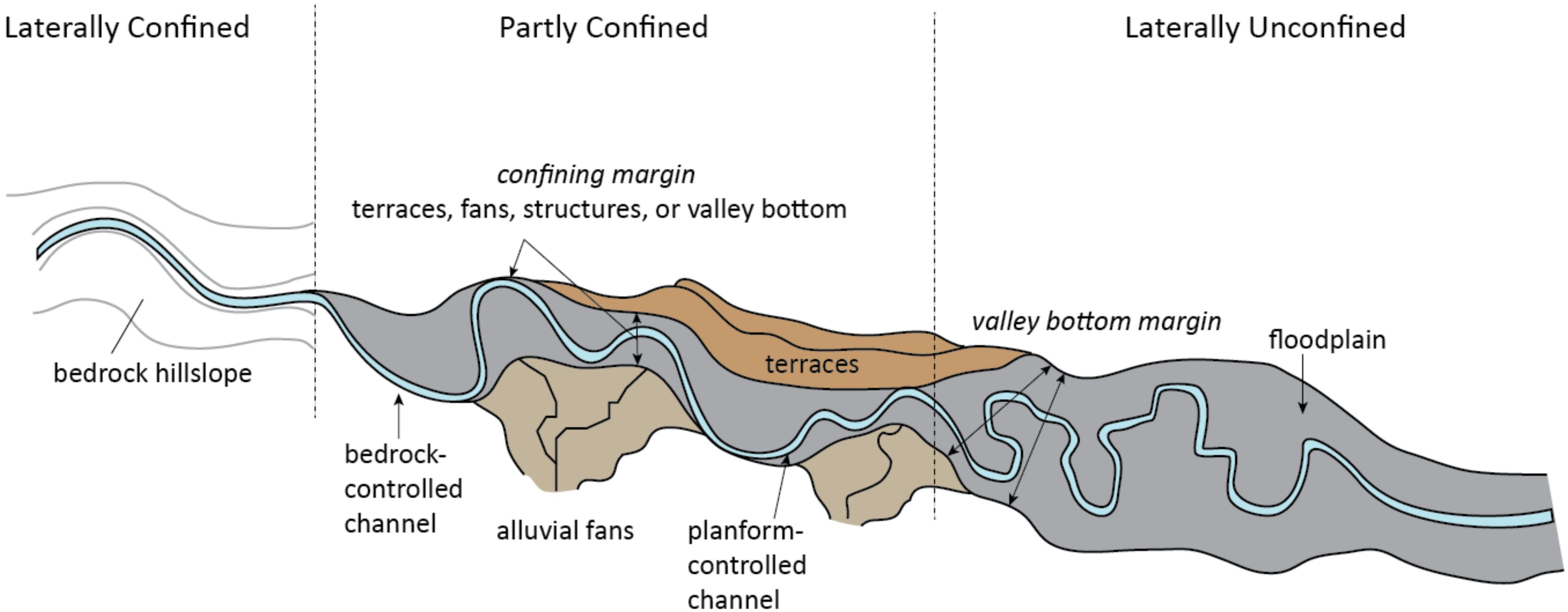


RIVER STYLES PROCEDURATL TREE



RIVER STYLES TREE

VALLEY SETTING ENTRY POINT FORM MOST



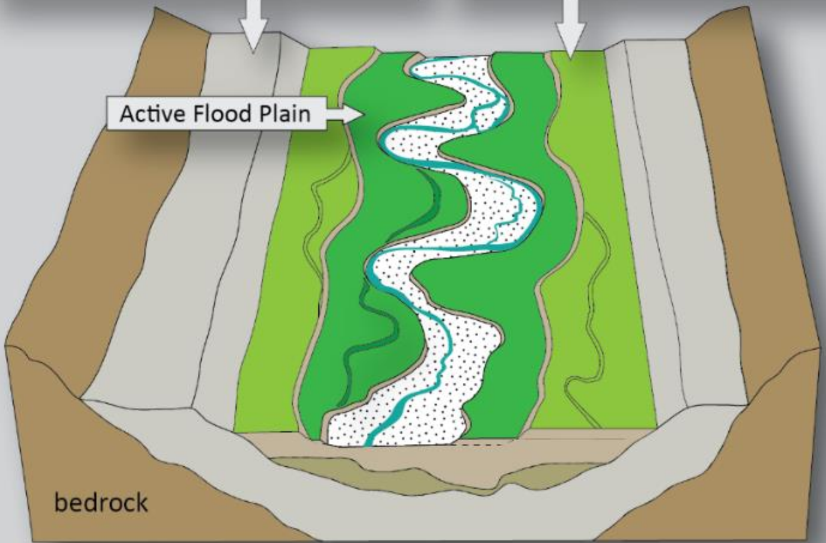
In **confined valley settings** the channel abuts a confining margin >90% of its length.

In **partly confined valley settings** the channel abuts a confining margin 10-90% of its length.
-- ***bedrock-controlled rivers*** have channels that abut a confining margin 50-90% of its length.
-- ***planform-controlled rivers*** have channels that abut a confining margin 10-50% of its length.

In **laterally unconfined valley settings** the channel abuts a confining margin <10% of its length.

ABANDONED FLOOD PLAIN (TERRACE)

Tier 1 - (< or > bankful)
Tier 2- Active Flood plain
Tier 3 - Bank Attached
Tier 4 - Floodplain

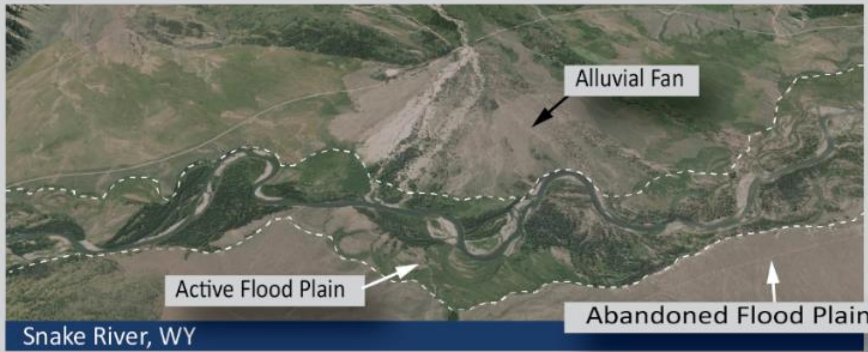


GEOMORPHIC FORM

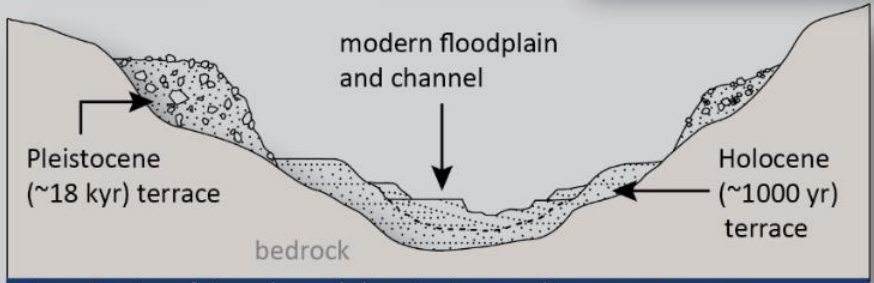
An abandoned Flood Plain (Terrace) is a valley bottom, planar accumulation of stream-deposited alluvium that is no longer directly associated with the active channel. Terraces comprise a ***tread***, the planar upper surface representing the relict floodplain surface; and a ***riser***, the erosional slope or flank of the terrace landform. Terrace sequences can be inset within other terrace deposits forming "flights" of step-like features surrounding the active channel (see above and right).

PROCESS INTERPRETATION

Terraces form as valley-fill floodplain sediments are later eroded (incised) and remnant surfaces are left abandoned along the channel margins. Terraces can form as ***cut*** features, by subsequent incision of valley fill alluvium; as ***fill*** features that are subsequently eroded into terrace forms; or as purely erosional ***strath*** surfaces, etched into resistant deposits, or even bedrock of the confining canyon walls.



Snake River, WY



Cross Section of river channel showing inset and remnant terraces

ASSOCIATED GEOMORPHIC UNITS AND STRUCTURAL ELEMENTS

Abandoned floodplains-terraces-are closely associated with both floodplain and hillslope geomorphic units. Older, coarse terrace remnants directly overlie bedrock (above); younger, fine-grained and inset terraces underlie the contemporary floodplain and include paleochannels, channel cutoffs and banks (at left). Terraces are generally not in contact with instream geomorphic units, except where the abandoned floodplain acts as the confining boundary--in this case, the terrace riser would exhibit cutbank forms, and would supply sediment to the active channel.

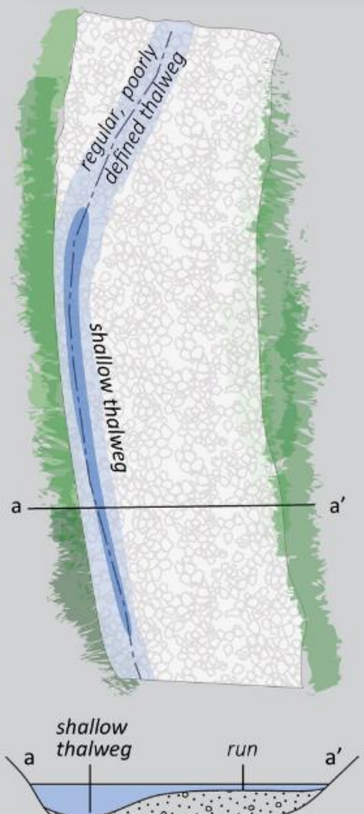
SHALLOW THALWEG

DEFINITION KEY

Tier 1 - In-channel

└ Tier 2 - Concavity (In-channel cross section)

Key Attributes to Differentiate Specific Morphologies				
GU Forcing	**Low Flow Relative Roughness**	**GU Orientation**	**GU Position**	**Low Flow Water Surface Slope**
Forced by planar GU or occasionally bars	Varies	Streamwise	Bank-Attached	Varies, but typically moderate

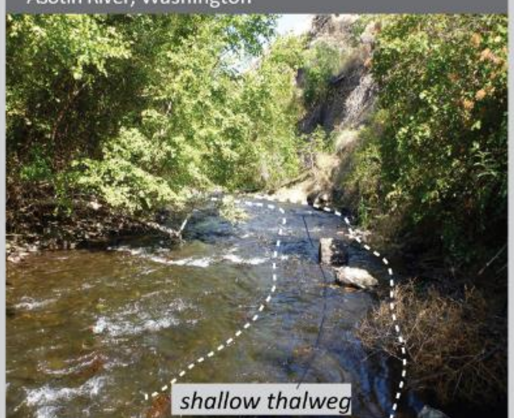


channel cross-section

GEOMORPHIC FORM

A *shallow thalweg* is an in-channel concavity found on the outside bend of a channel that is distinctive because although it shows a modest concave cross section, longitudinally it lacks a concave profile or residual pool. A thalweg is defined as the line that traces the deepest part of the channel (not a unit). *Shallow thalwegs* are concavities that surround the thalweg, are found along an outside channel margin (i.e. bank-attached), oriented streamwise and are subtly forced by planar geomorphic units and occasionally low amplitude *bars*.

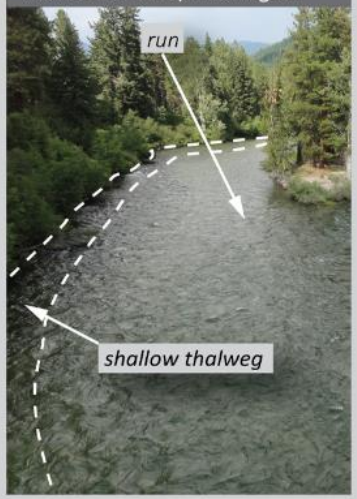
Asotin River, Washington



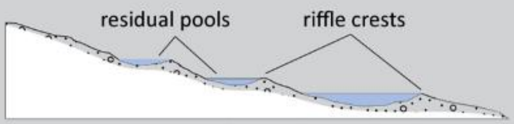
TYPICAL CONFIGURATIONS

Shallow thalwegs are typically found along the banks of the outside bends of relatively straight channels with low sinuosity, where the main channel is dominated by *planar* geomorphic units (e.g. *runs, glides, rapids*), or occasionally poorly defined, low-amplitude *bars*. They occupy positions where a *pool* may be expected, but this concavity lacks a residual pool of qualifying size.

Wenatchee River, Washington



The long profile of a channel associated with a *shallow thalweg*, lacking pools or residual pool features.



A long profile with riffles and pools highlighting residual pools left behind if river were drained.

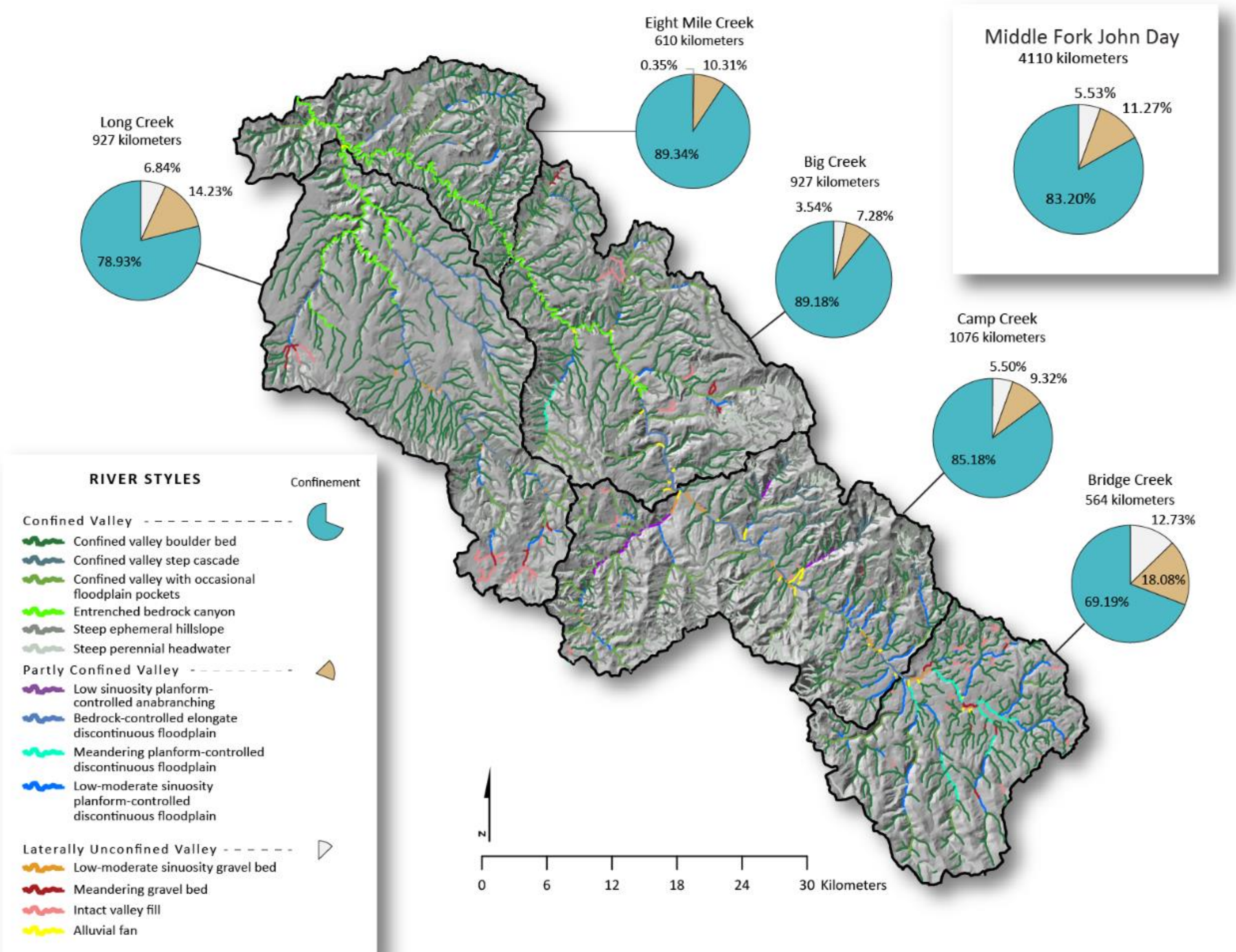
PROCESS INTERPRETATION

Shallow thalwegs are typically relatively stable units formed by modest erosion in an outside bend (typically of low curvature), but not enough erosion to excavate or maintain a *pool*. They form adjacent to *planar* geomorphic units or broad *bars* that are steering the flow towards the edge of the channel and so they winnow out a thalweg where those flows are concentrated. *Shallow thalwegs* can form and are maintained most often in relatively stable channels that are transport limited (e.g. *plane-bed*). They can also form in non-transport limited situations where active *bars* or *planar* units are forcing lateral migration and bank erosion. Therein the rate of retreat is overwhelmed by deposition from the *bar*, which prevents a *pool* from fully forming (for *pools* to form in this situation would require a more resistant bank to concentrate the flow energy).

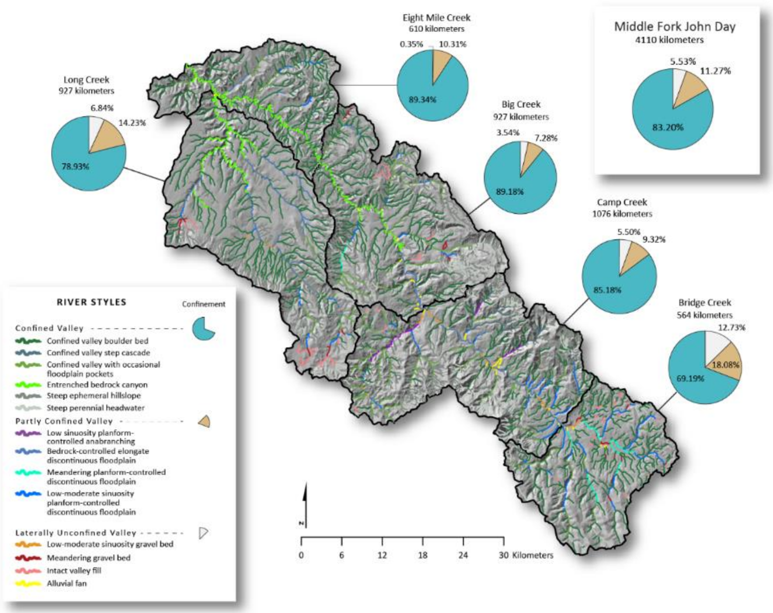
SIMILAR TO OR MISTAKEN WITH

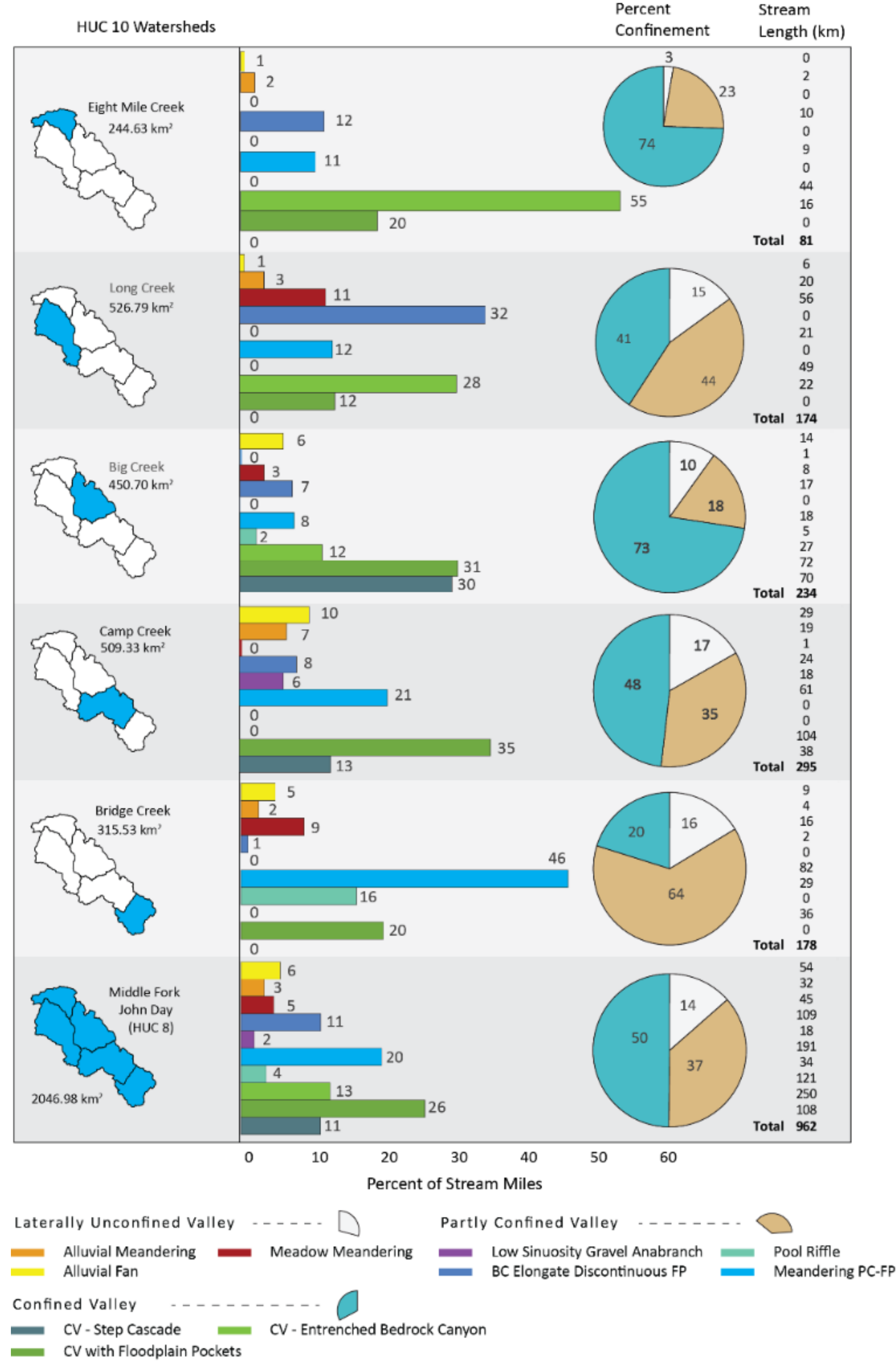
Shallow thalwegs are similar to elongated *bar-forced pools* on outside bends and could be confused if the *pool* is weakly formed. Use a minimum mapping unit and/or minimum residual pool depth (puddle left over if river were drained) to help differentiate from a qualifying residual pool. *Shallow thalwegs* can also be confused with a *chute*, which tends to short-circuit flows either across *bar* or *floodplain* surface or along an inside bend.

REACH TYPE MAP – MF JOHN DAY



MANY WAYS TO SUMMARIZE

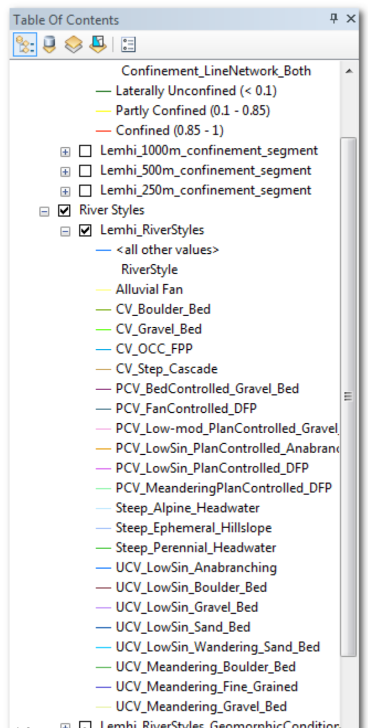


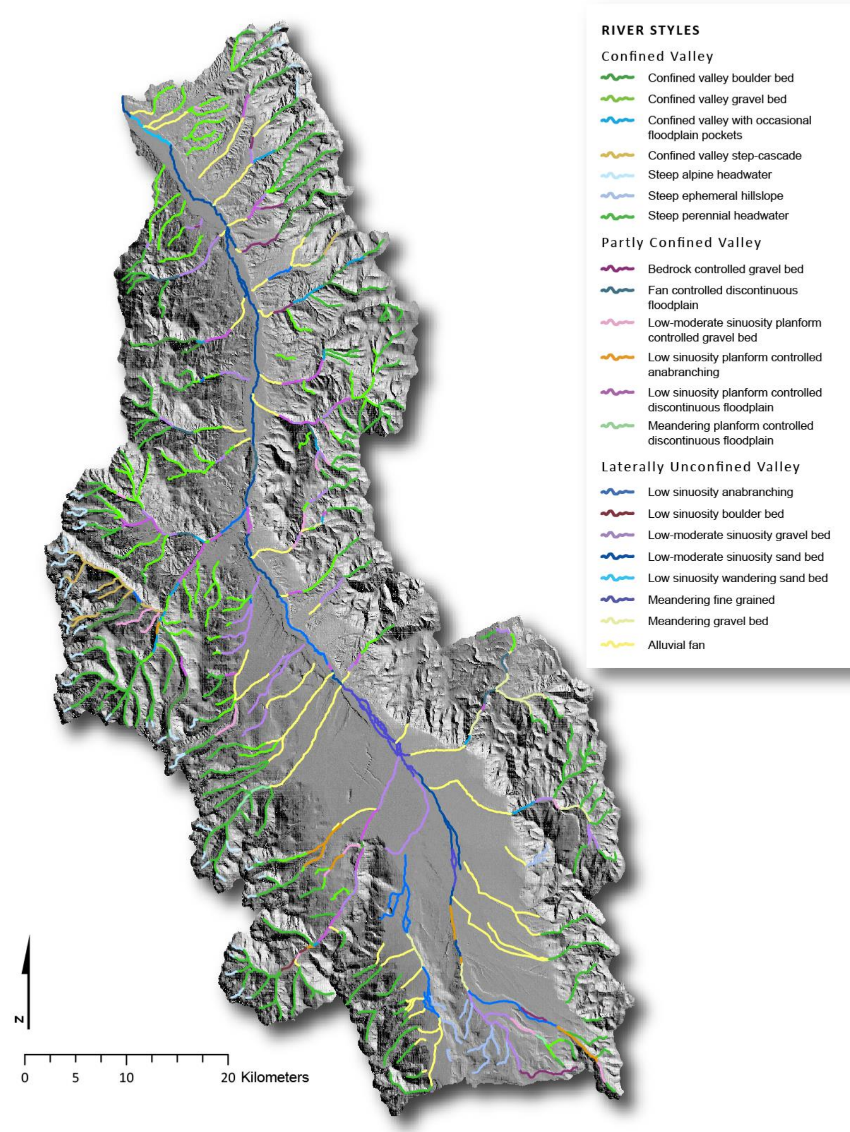


EXERCISE: EXPLORE REACH TYPES

C:\0_GNAT\CHaMPWorkshopLemhiGNAT.mxd

1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on Lemhi River Styles



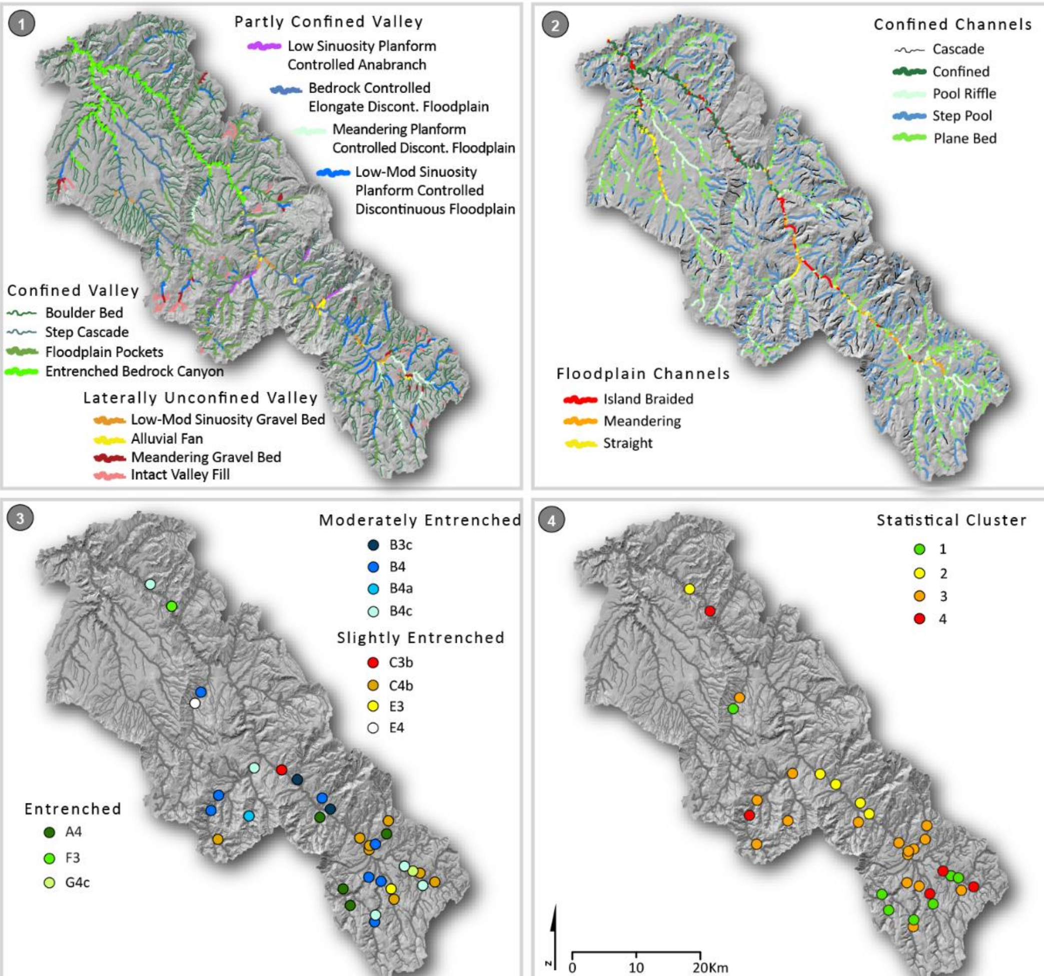


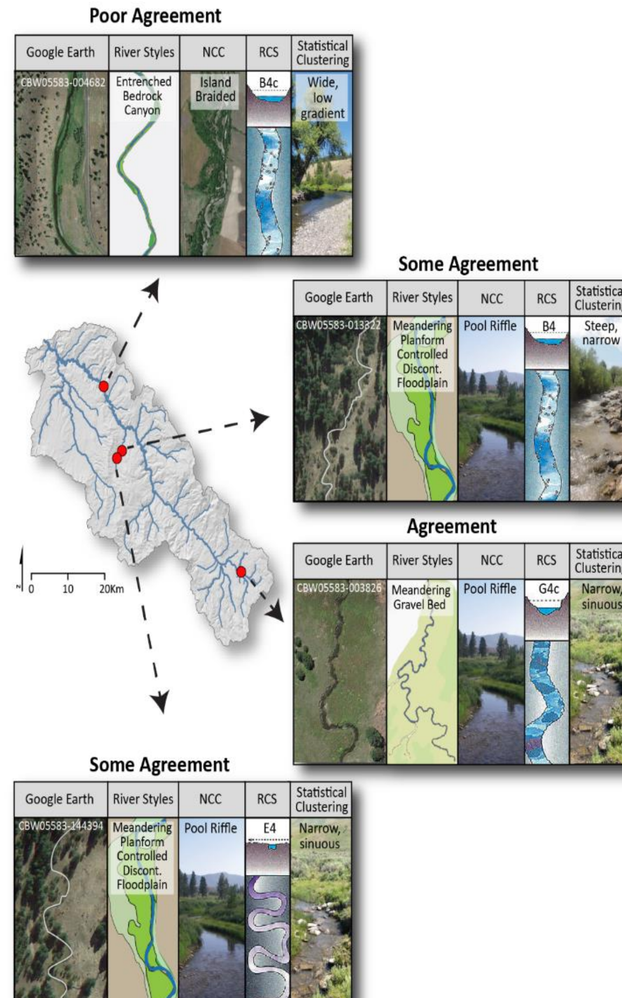
HOW WE'VE DONE THIS IN PAST…

- Desktop Analysis
- Overflights
- Fieldwork – Proforma Sites & Network Spot Checks
- More Desktop Analysis

- i.e. MANUAL

DIFFERENCES BETWEEN SCHEMES





- In Revision. Kasprak AK*, Hough-Snee N*, Beechie T, Bouwes N, Brierley G, Camp R*, Fryirs K, Imaki H, Jensen M*, O'Brien G, Rosgen D, and **Wheaton JM**. Choosing the Right Tool for the Job: Comparing Stream Channel Classification Frameworks. For Submission to PLOSOne. Preprint available at: DOI: 10.7287/peerj.preprints.885v1.

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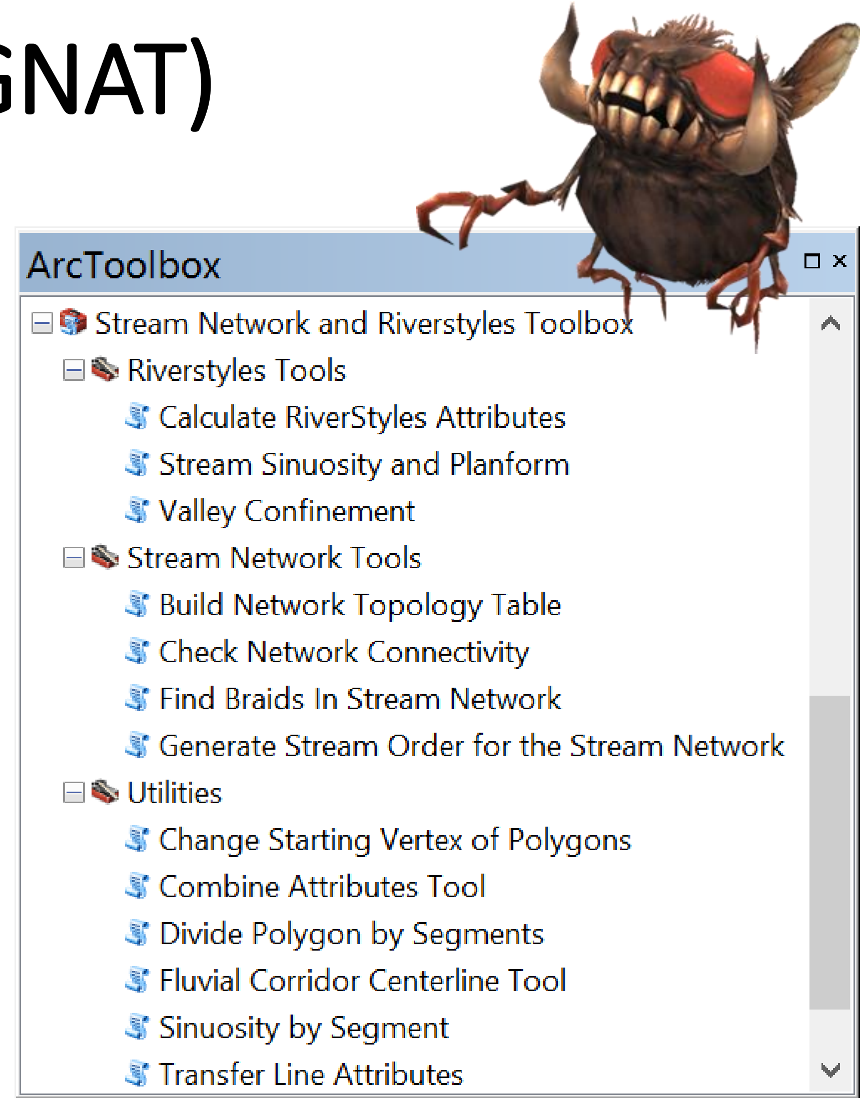
   III. Habitat & Population Condition
IV. Recovery Potential
   I. Geomorphic Recovery Potential
   II. Riparian Recovery Potential
   III. BRAT & WRAT
V. Future Work

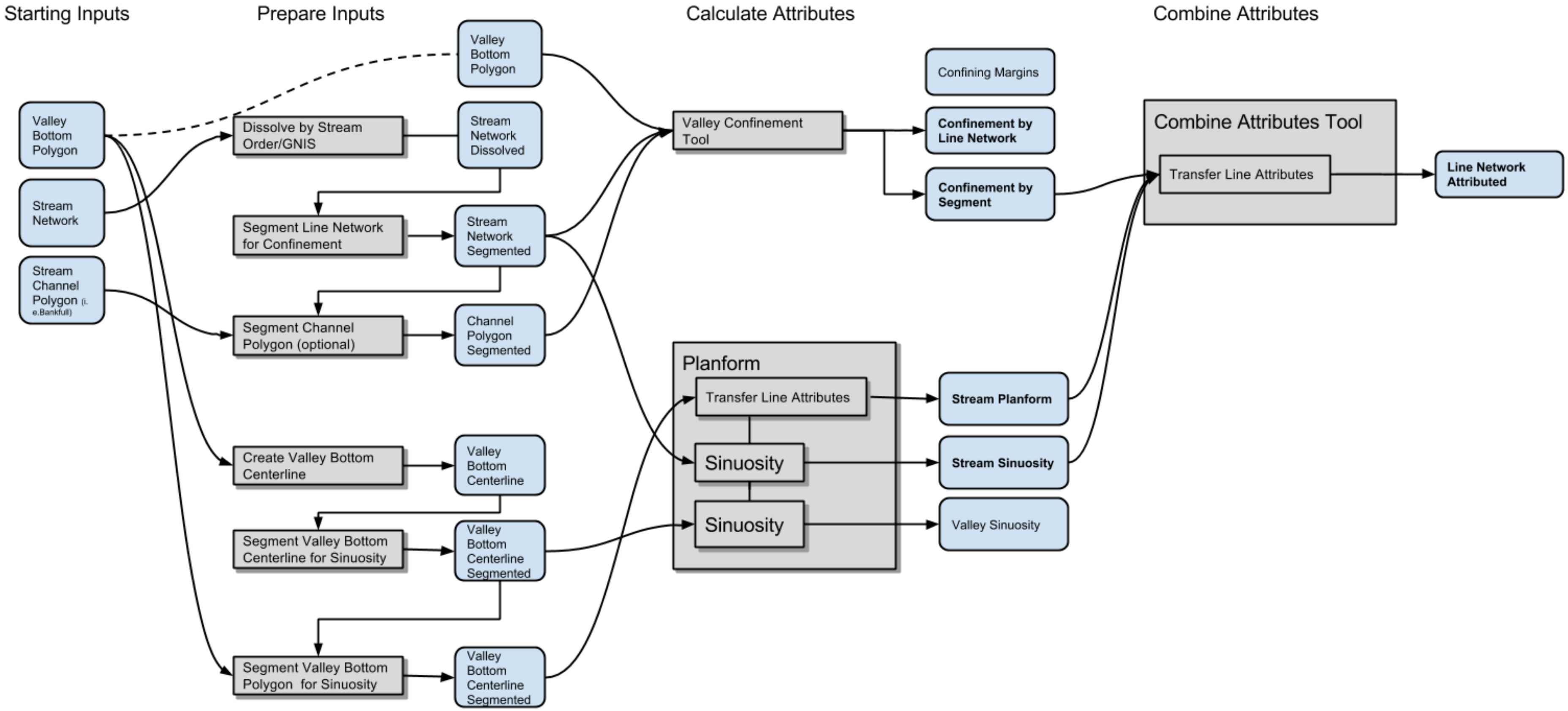
GEOMORPHIC & NETWORK ASSESSMENT TOOLS (GNAT)

- ArcGIS 10.1 Toolbox
- Geomorphic metric calculations
- Network management
- Flexible utilities



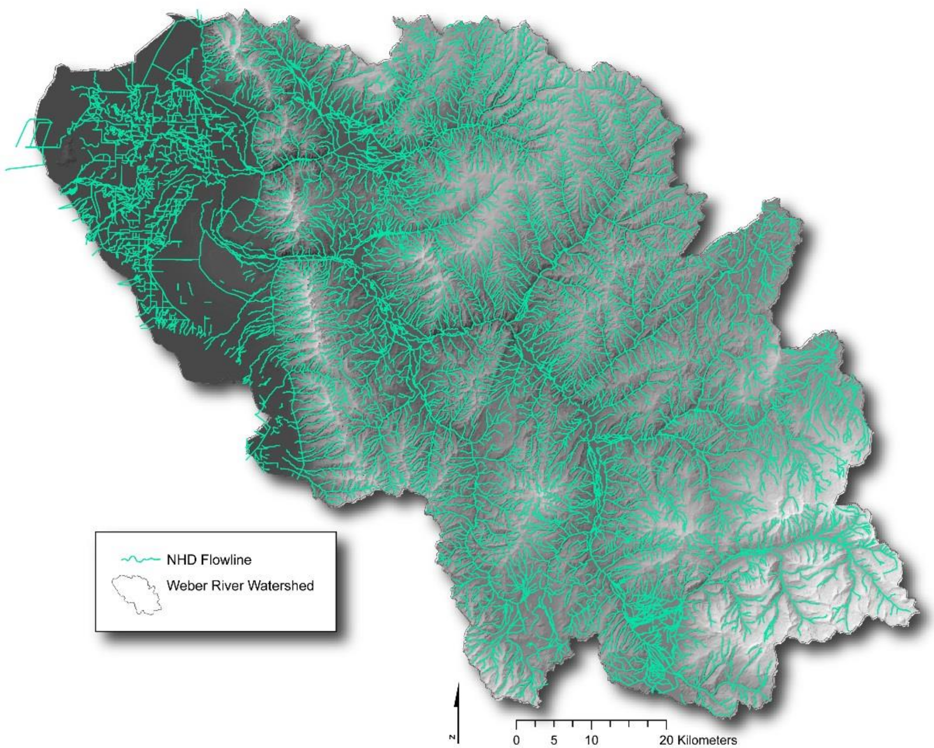
BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

GNAT WORKFLOW



CREATING A USEFUL STREAM NETWORK

- National Hydrography Dataset 24k Flowlines
- Subset by “F Codes”



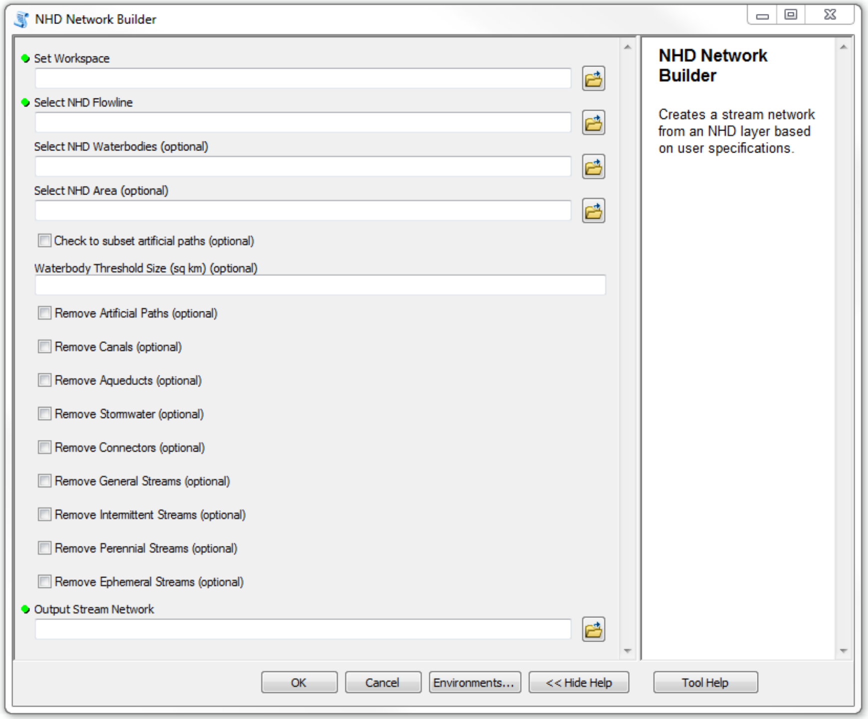
NHDFlowline

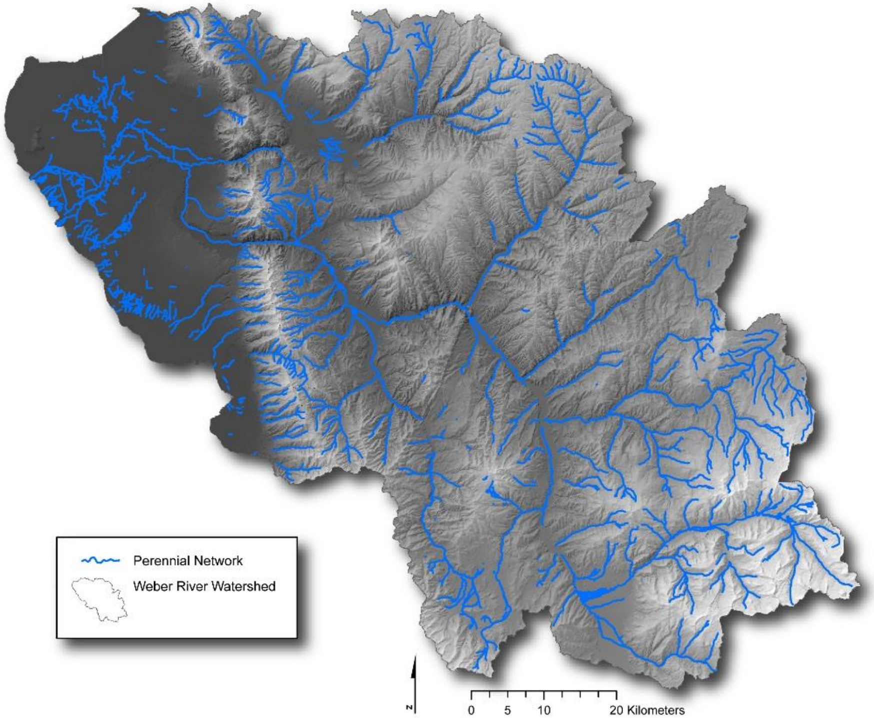
Feature Type	FCode	Description
ARTIFICIAL PATH	55800	feature type only: no attributes
CANAL/DITCH	33600	feature type only: no attributes
CANAL/DITCH	33601	Canal/Ditch Type|aqueduct
CANAL/DITCH	33603	Canal/Ditch Type|stormwater
COASTLINE	56600	feature type only: no attributes
CONNECTOR	33400	feature type only: no attributes
PIPELINE	42800	feature type only: no attributes
PIPELINE	42801	Product|water; Pipeline Type|aqueduct; Relationship to Surface|at or near
PIPELINE	42802	Product|water; Pipeline Type|aqueduct; Relationship to Surface|elevated
PIPELINE	42803	Product|water; Pipeline Type|aqueduct; Relationship to Surface|underground
PIPELINE	42804	Product|water; Pipeline Type|aqueduct; Relationship to Surface|underwater
PIPELINE	42805	Product|water; Pipeline Type|general case; Relationship to Surface|at or near
PIPELINE	42806	Product|water; Pipeline Type|general case; Relationship to Surface|elevated
PIPELINE	42807	Product|water; Pipeline Type|general case; Relationship to Surface|underground
PIPELINE	42808	Product|water; Pipeline Type|general case; Relationship to Surface|underwater
PIPELINE	42809	Product|water; Pipeline Type|penstock; Relationship to Surface|at or near
PIPELINE	42810	Product|water; Pipeline Type|penstock; Relationship to Surface|elevated
PIPELINE	42811	Product|water; Pipeline Type|penstock; Relationship to Surface|underground
PIPELINE	42812	Product|water; Pipeline Type|penstock; Relationship to Surface|underwater
PIPELINE	42813	Product|water; Pipeline Type|siphon; Relationship to Surface|unspecified
PIPELINE	42814	Product|water; Pipeline Type|general case
PIPELINE	42815	Product|water; Pipeline Type|penstock
PIPELINE	42816	Product|water; Pipeline Type|aqueduct
STREAM/RIVER	46000	feature type only: no attributes
STREAM/RIVER	46003	Hydrographic Category|intermittent
STREAM/RIVER	46006	Hydrographic Category|perennial
STREAM/RIVER	46007	Hydrographic Category|ephemeral
UNDERGROUND CONDUIT	42000	feature type only: no attributes
UNDERGROUND CONDUIT	42001	Positional Accuracy|definite
UNDERGROUND CONDUIT	42002	Positional Accuracy|indefinite
UNDERGROUND CONDUIT	42003	Positional Accuracy|appoximate

ISEMP CHaMP

NHD NETWORK BUILDER TOOL

- Tool developed to automatically create a network
- Script keeps appropriate "connector" segements
- User specifies how they would like "artificial paths" to be dealt with





STREAM NETWORK SEGMENTATION

Main Stem vs Tributaries

Length is important

- Generate for each attribute independently
- Compile all attributes later

Method

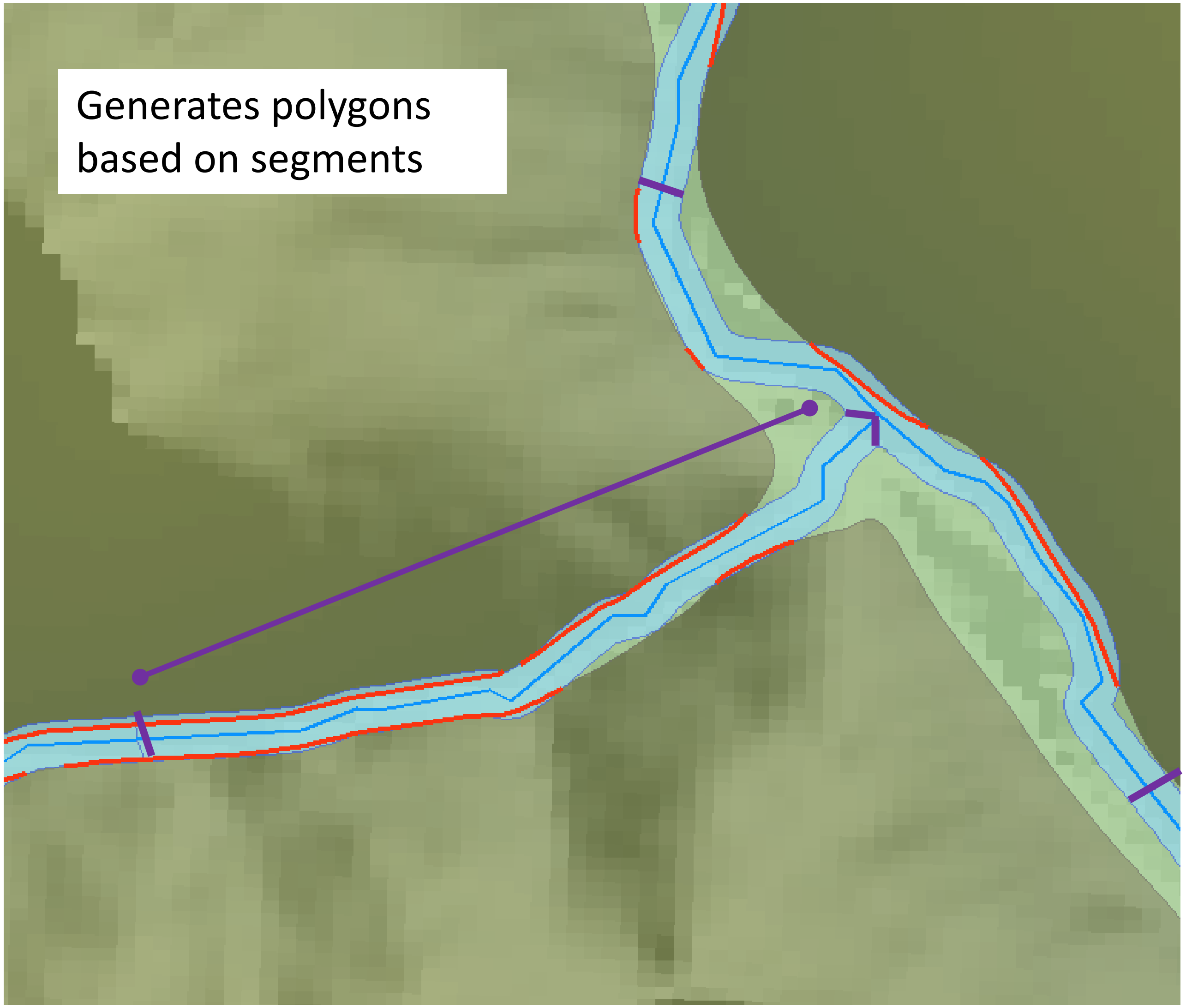
1. Dissolve Network by Junctions
2. Run Stream Order tool
3. Dissolve by GNIS (Stream Name) and then Stream order for upper reaches.
4. Run Segmentation tool along long sections (Fluvial Corridor Tools)

Limitations

- No "Braids"
- Stream network must be continuous

Segmenting Polygons

SEGMENTING POLYGONS



CHaMP Columbia Habitat Monitoring Program

OUTLINE

GEOMORPHIC & NETWORK CONTEXT

I. Background

II. Reach Types - GNAT

- I. Reach Type (River Style) Tree
- **II. Valley Setting**
  - **I. Valley Bottom**
  - II. Confinement
  - III. Sinuosity
- III. Reach Typing of CHaMP Basins & CRB

III. Condition

- I. Geomorphic Condition
- II. Riparian Condition
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- II. Riparian Recovery Potential
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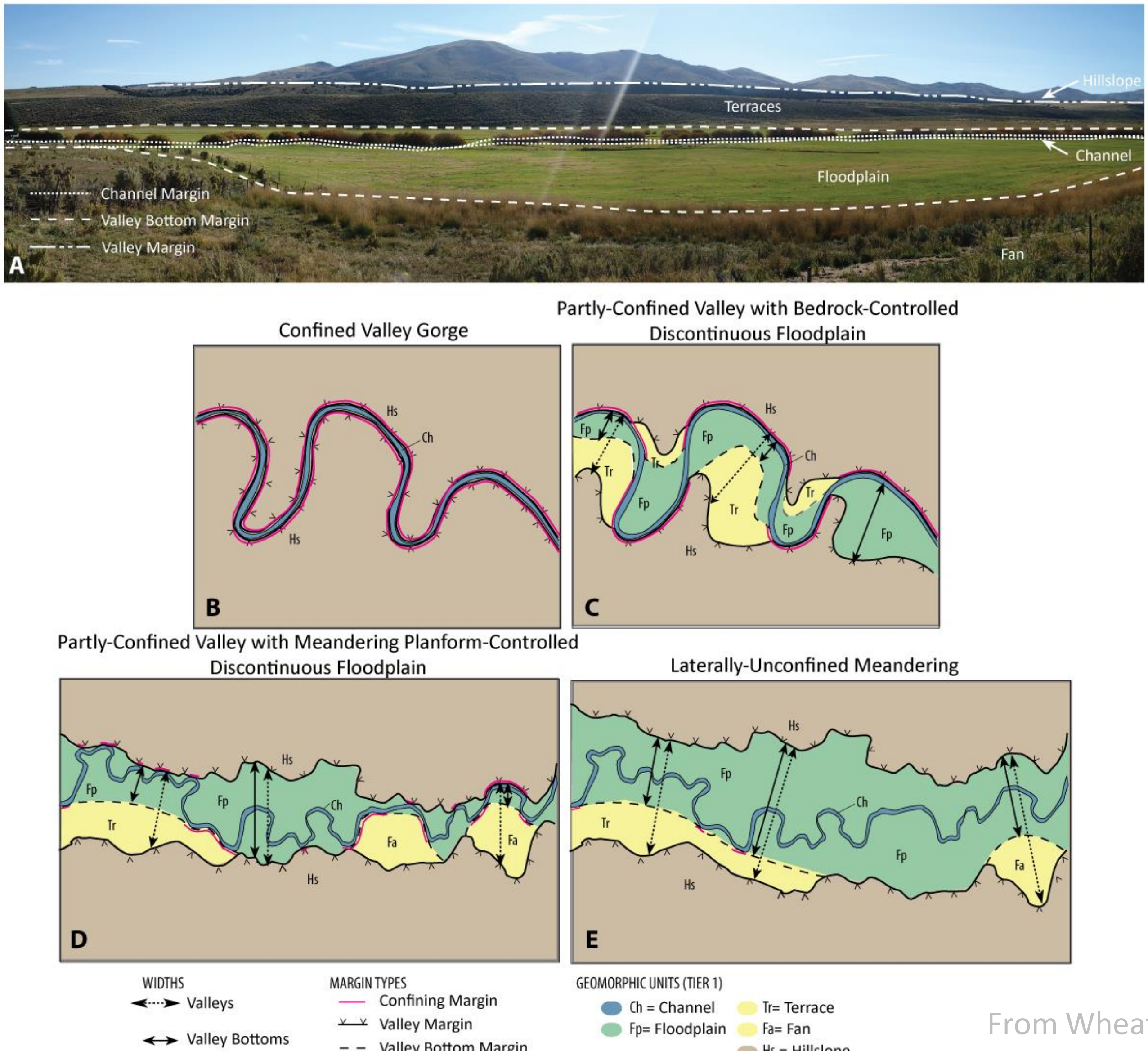
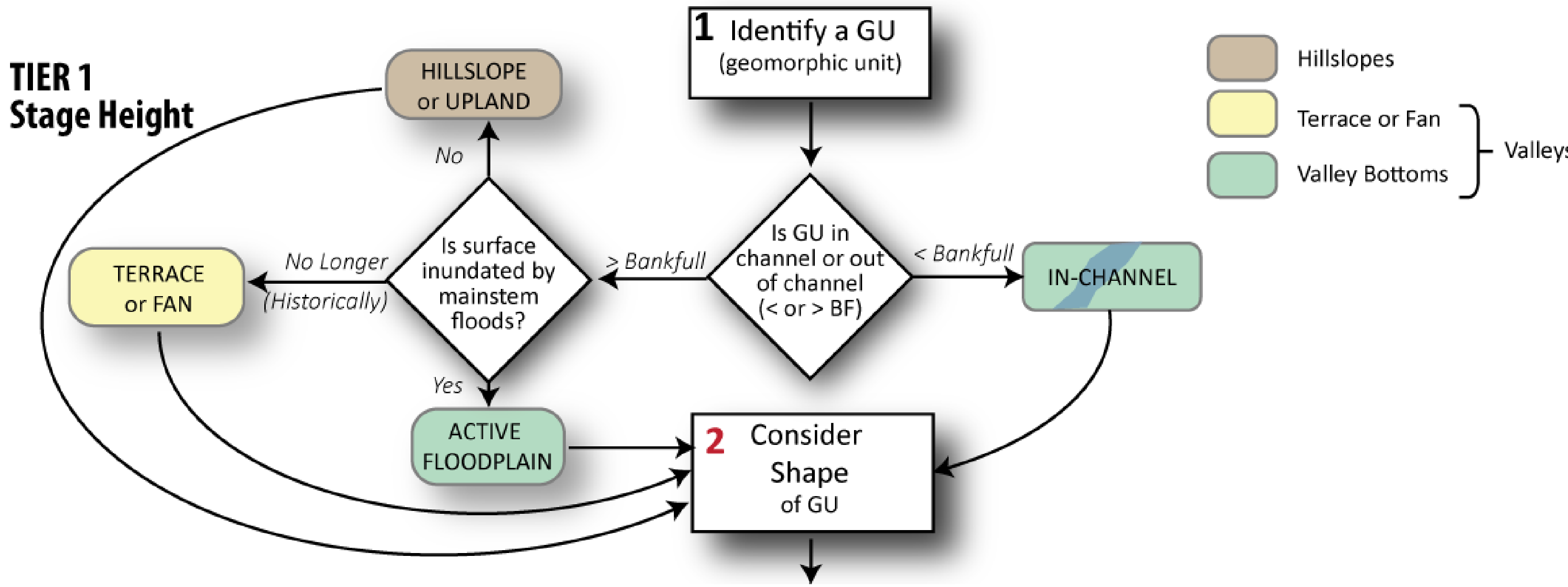
WHAT IS A VALLEY?

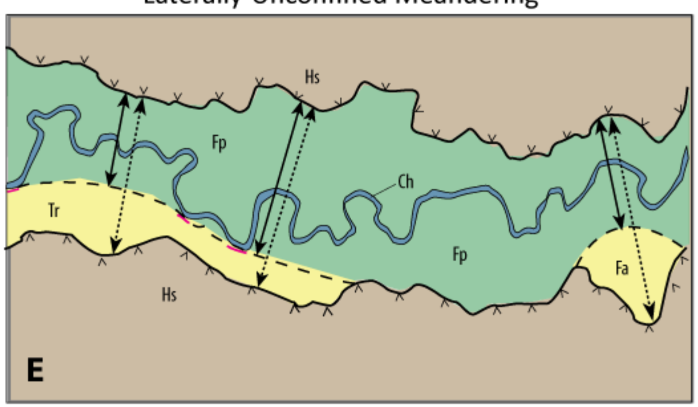


From Wheaton et al. (In Review) - Geomorphology

VALLEY BOTTOM vs. VALLEY?



Laterally-Unconfined Meandering



GEOMORPHIC UNITS (TIER 1)
Ch = Channel
Fp= Floodplain
Tr= Terrace
Fa= Fan
Hs = Hillslope

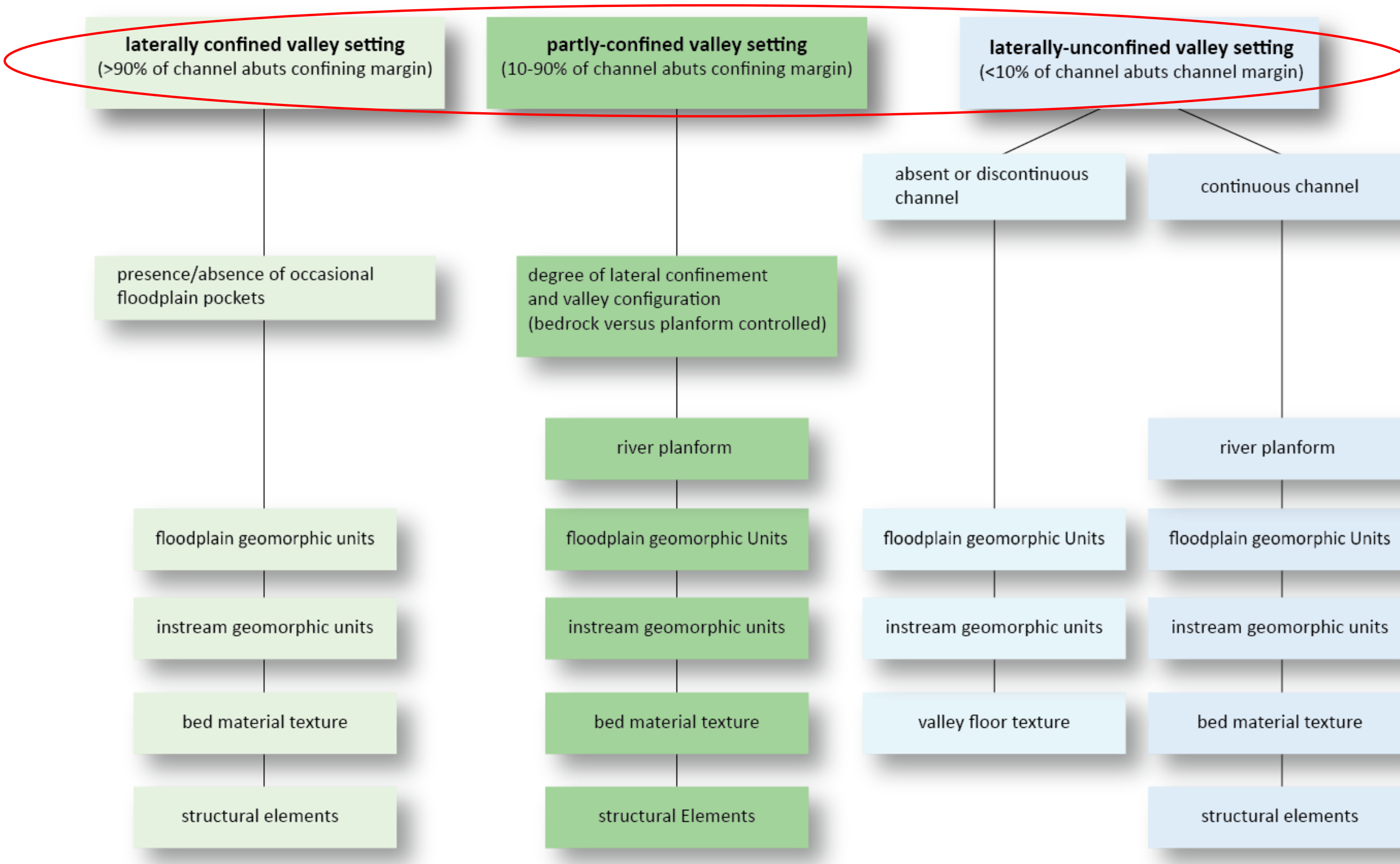
- The building blocks of a Valley?

vs.

- The building blocks of a Valley Bottom?

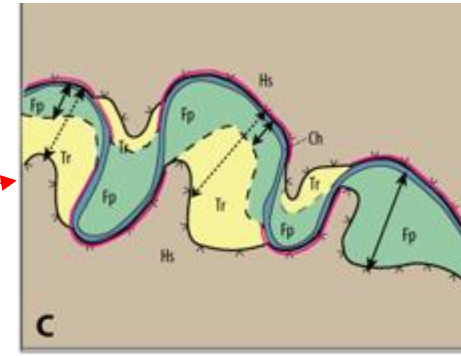
WHY VALLEY BOTTOM MATTERS?

Columbia River Basin River Styles Procedural Tree



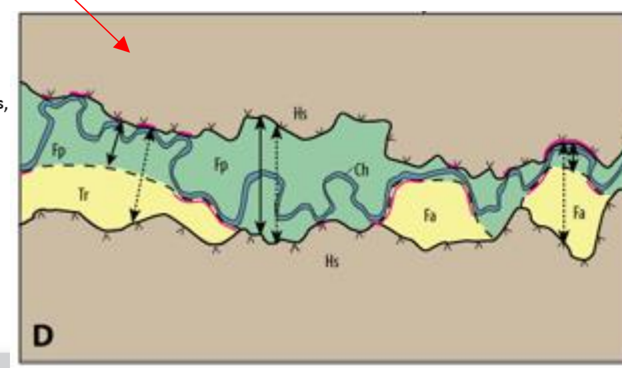
- CONFINED VS. PARTLY-CONFINED VS. LATERALLY UNCONFINED

PLANFORM CONTROLLED VS. BEDROCK CONTROLLED



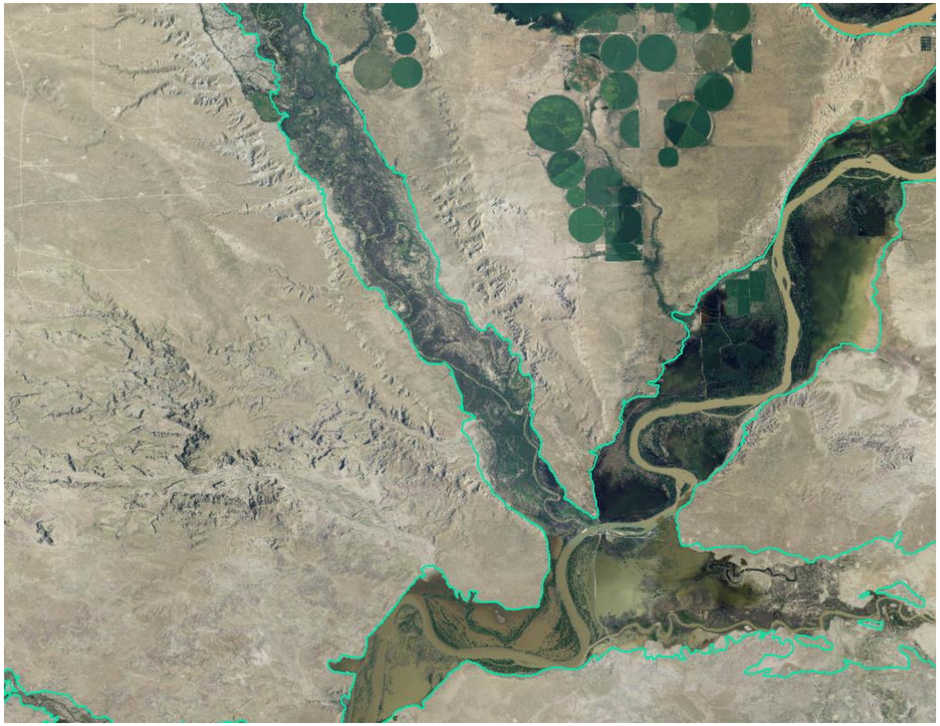
Valley Setting	River Styles of **Partly Confined** valley settings - Idaho Batholith (10-90% of channel abuts confining margin)					
Presence/ extent of floodplain	***bedrock-controlled discontinuous floodplain***		***planform-controlled discontinuous floodplain***			
planform	low-moderate sinuosity >60-90% confined		low-moderate sinuosity ~50% confined	low-moderate sinuosity ~50% confined	moderate-low sinuosity active meandering >60-90% confined	medium-high sinuosity active meandering >30-50% confined
Floodplain geomorphic units	terrace, anabranch, meander cutoff, paleochannels	Alluvial Fans, pleistocene terraces	terrace, bench paleochannel, paleocutbanks, alluvial/debris fan	terrace, bench paleochannel, paleocutbanks, alluvial/debris fan	fine grained irregular floodplain	terrace, alluvial fan, meander cutoff
Instream Geomorphic Units	riffles, pools, runs, point bars, scroll bars, islands, chute cutoffs,		bank-attached and mid-channel gravel bars, riffles, pools, rapids, runs, cutbank	bank-attached and mid-channel gravel bars, riffles, pools, rapids, runs, cutbank	LWD-forced bars, compound, midchannel, point, and diagonal bars runs, cutbanks, chute cutoffs	pools, riffles, runs, point bars, cutbanks
Bed Material Texture	cobble, gravel sand		boulder, cobble, gravel	boulder, cobble, gravel	cobble, gravel	cobble, gravel silt, sand
Structural* Elements						
River Style	*BC ELONGATE DISCONTINUOUS FLOODPLAIN* Salmon, Big Lost	*FAN/TERRACE CONTROLLED DISCONTINUOUS FLOODPLAIN* Salmon, Big Lost	*LOW SINUOSITY PC ANABRANCHING* Salmon, Payette	*LOW-MODERATE SINUOSITY WANDERING GRAVEL BED* Salmon, Big Lost	*LOW-MODERATE SINUOSITY PC DISCONTINUOUS FLOODPLAIN* Higher elevation valleys in Salmon, Payette, Boise, Big Lost	*MEANDERING PC DISCONTINUOUS FLOODPLAIN* glacial drift-filled valleys, alpine glacial valleys, impounded sections; Salmon, Payette, Big Lost Rivers

*BA = bank-attached
CS = channel spanning

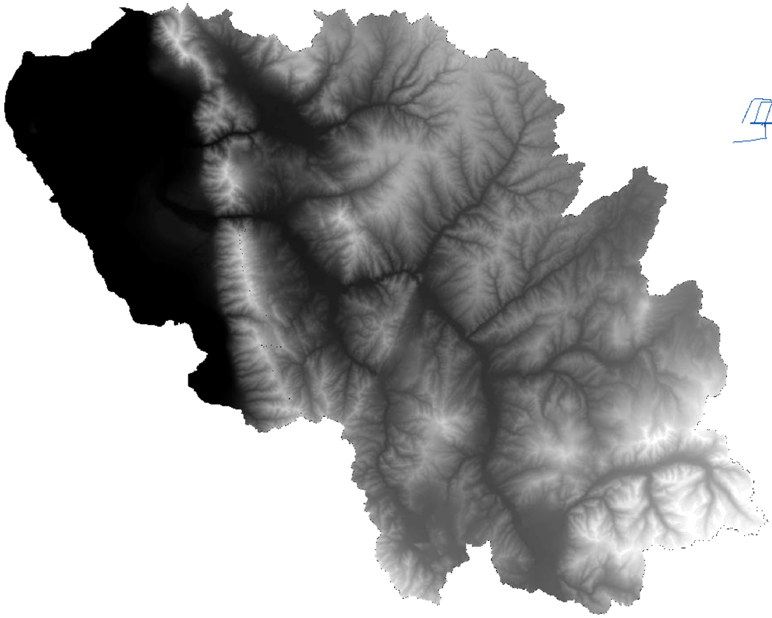


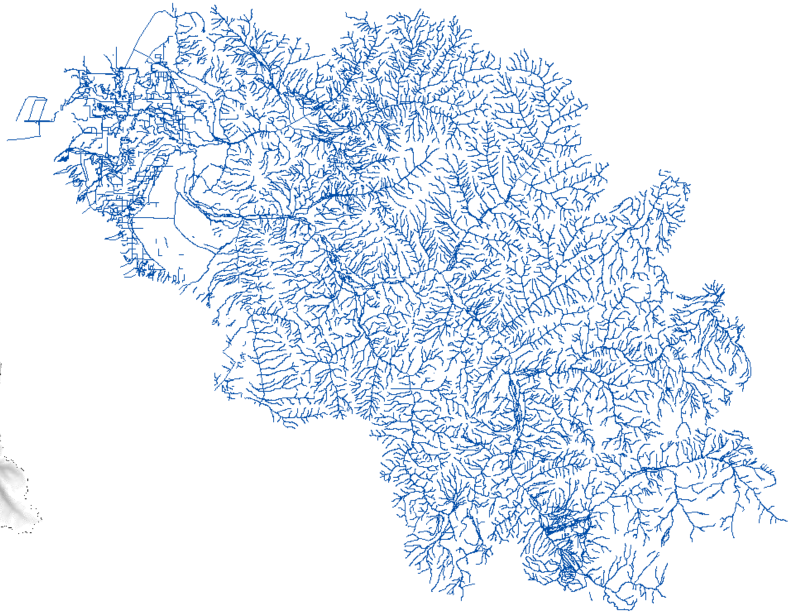
DERIVING A VALLEY BOTTOM

VBET – Valley Bottom Extraction Tool



VALLEY BOTTOM… TWO INPUTS

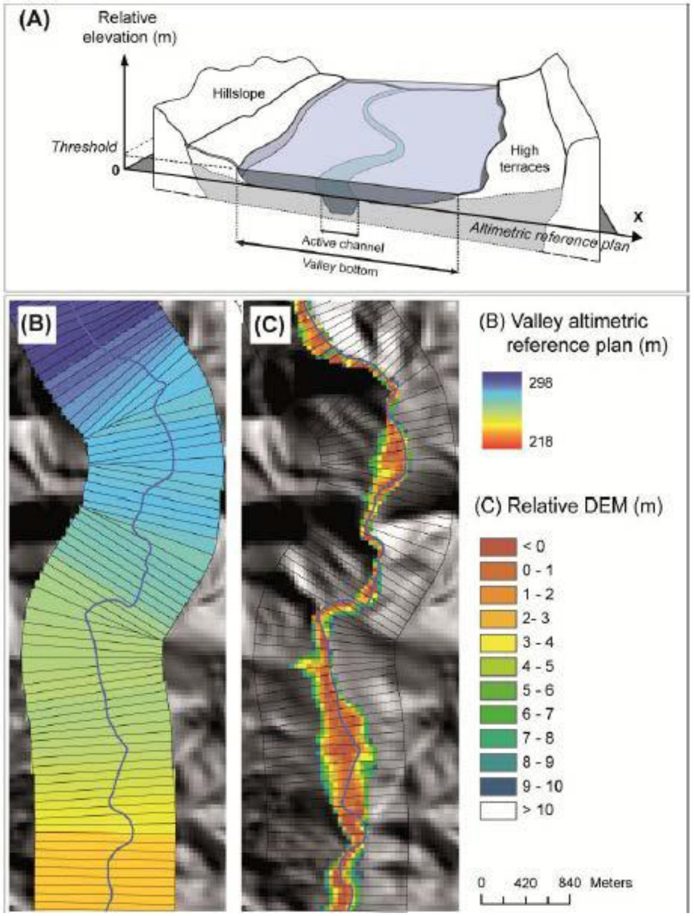




- Digital Elevation Model (DEM)
- Stream Network

DERIVING THE VALLEY BOTTOM (ORIGINAL METHOD)

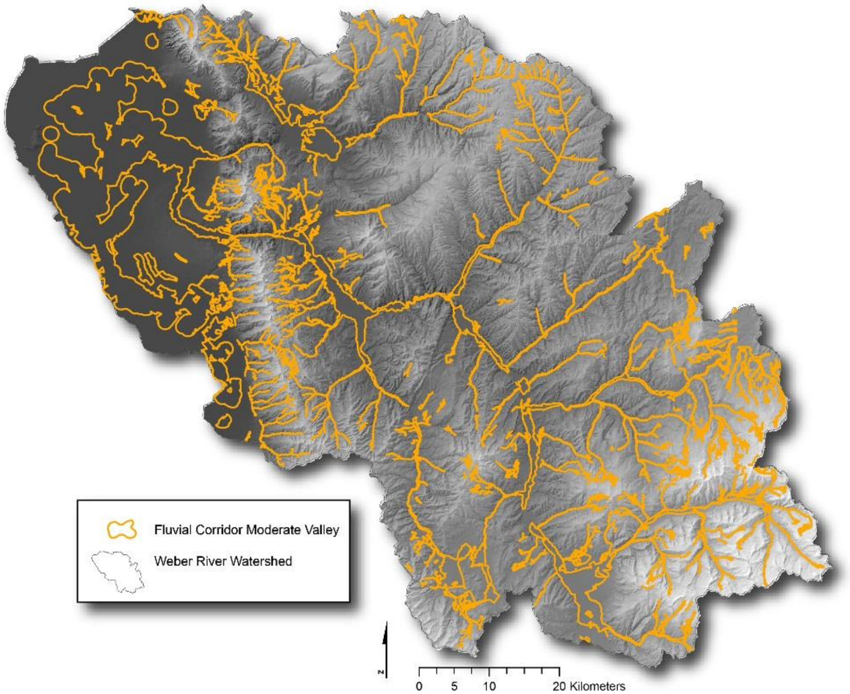
- Used "Fluvial Corridor" toolkit (Roux et al)
- Simplifies the stream network and creates a relative (detrended DEM)
- Fills the DEM to user specified depth

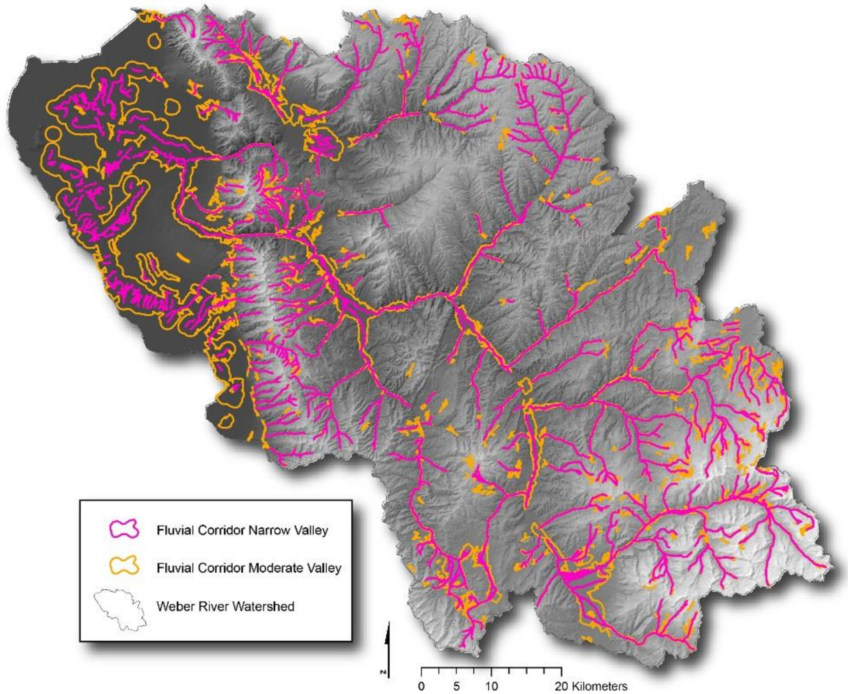


Drawbacks:

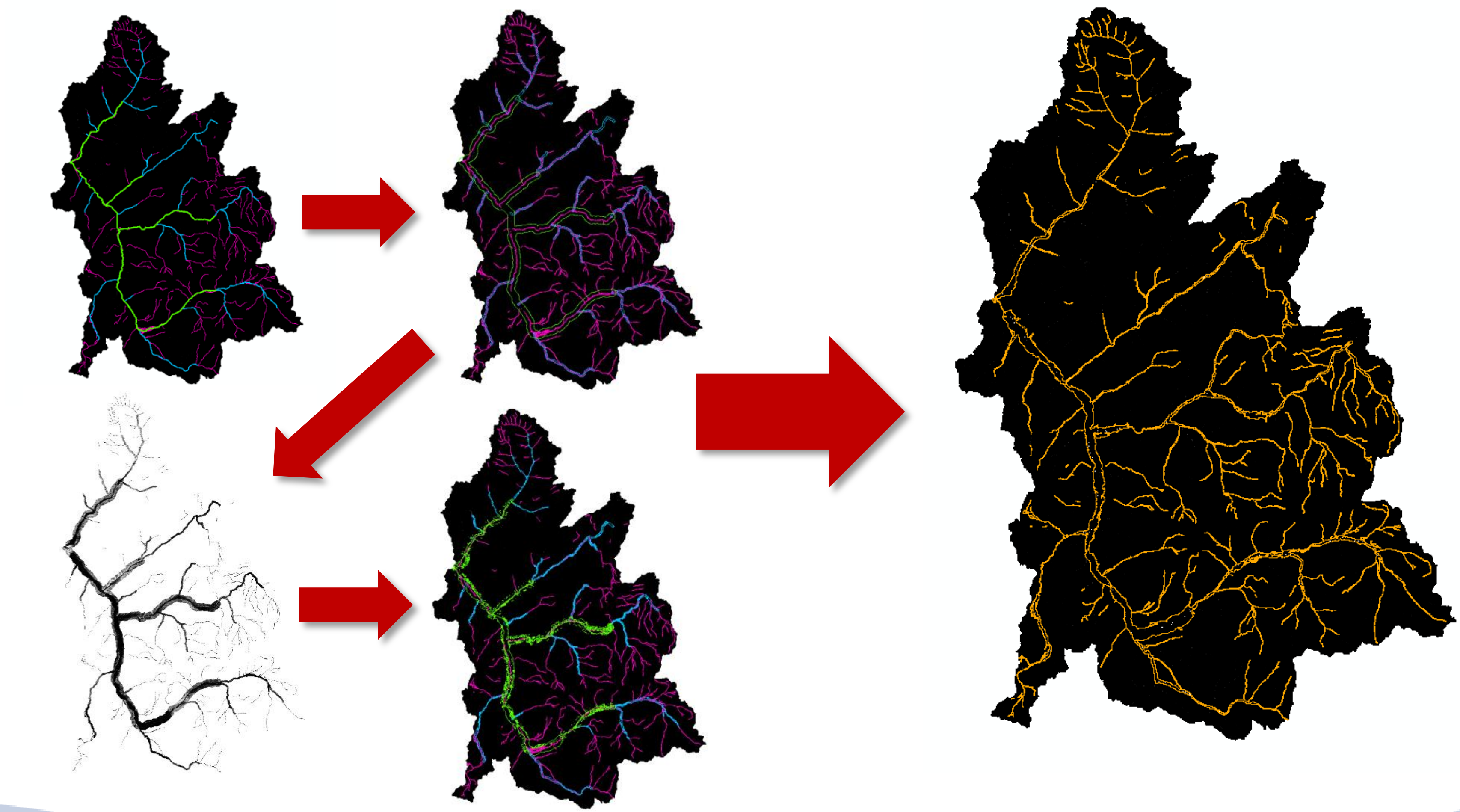
- The uniform fill depth causes the valley to be more exaggerated toward the headwaters
- Because of this, two runs of the tool are necessary to create a wider and narrower valley
- These two valleys must then be merged together manually where a transition is appropriate
- Merging the two valleys creates a need for extensive manual editing
- Unrealistically large fill depths must be specified to accurately delineate valley bottoms lower in the watershed

FLUVIAL CORRIDOR OUTPUTS



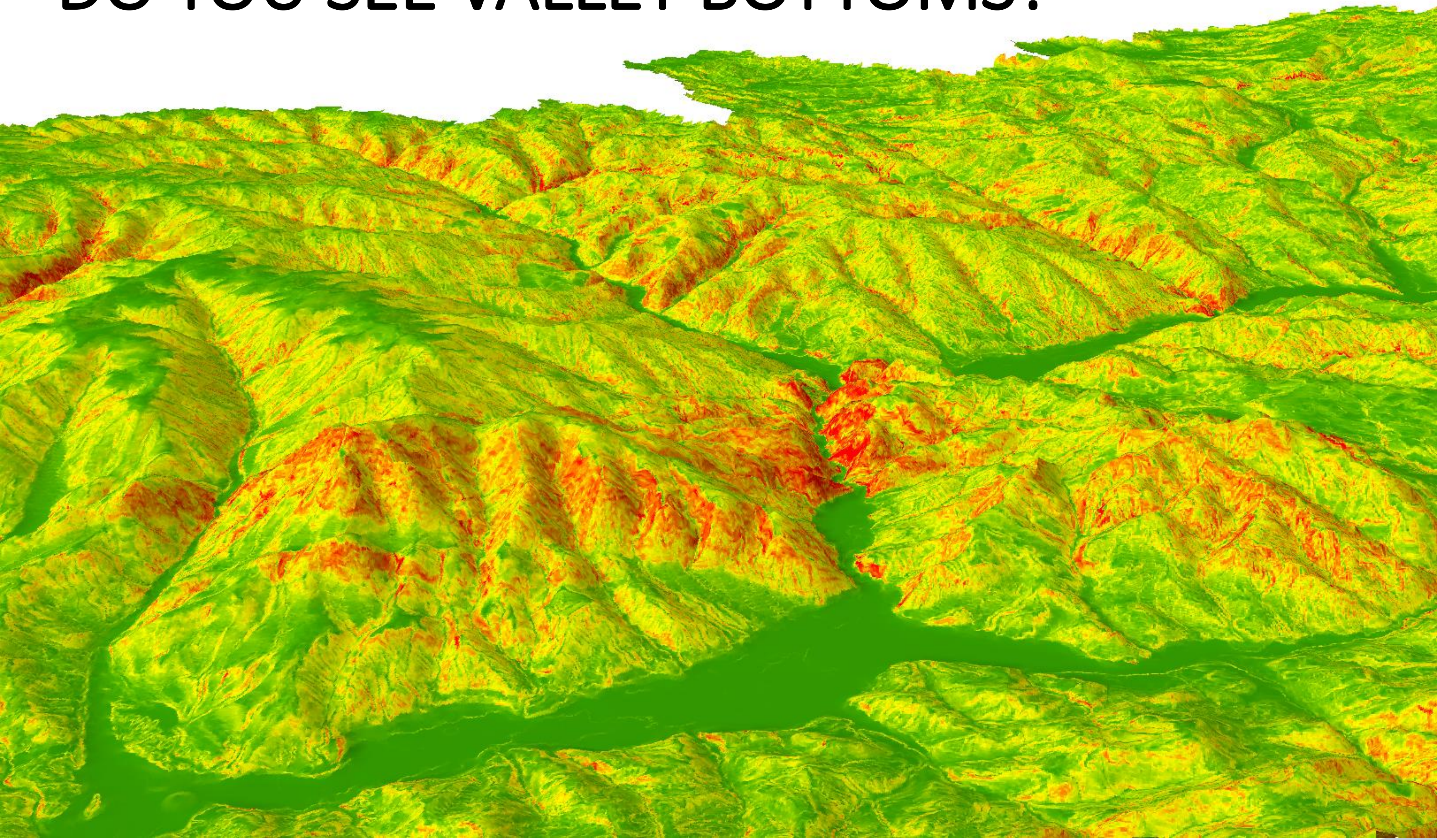


DERIVING THE VALLEY BOTTOM (V-BET)



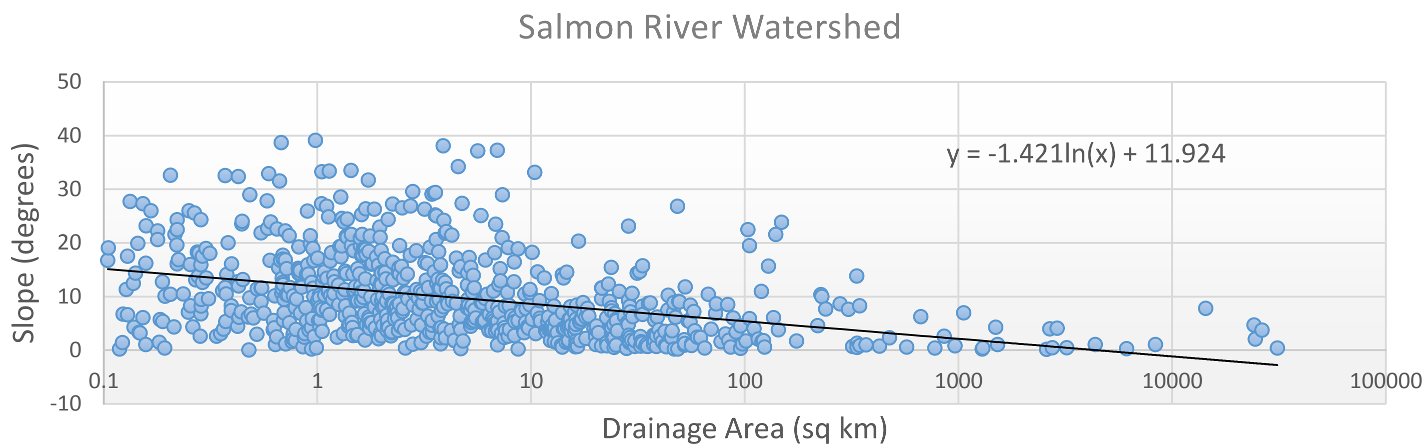
- New tool, Valley Bottom Extraction Tool (V-BET) extracts valley bottom based on slope, upstream drainage area, and longitudinal location within watershed

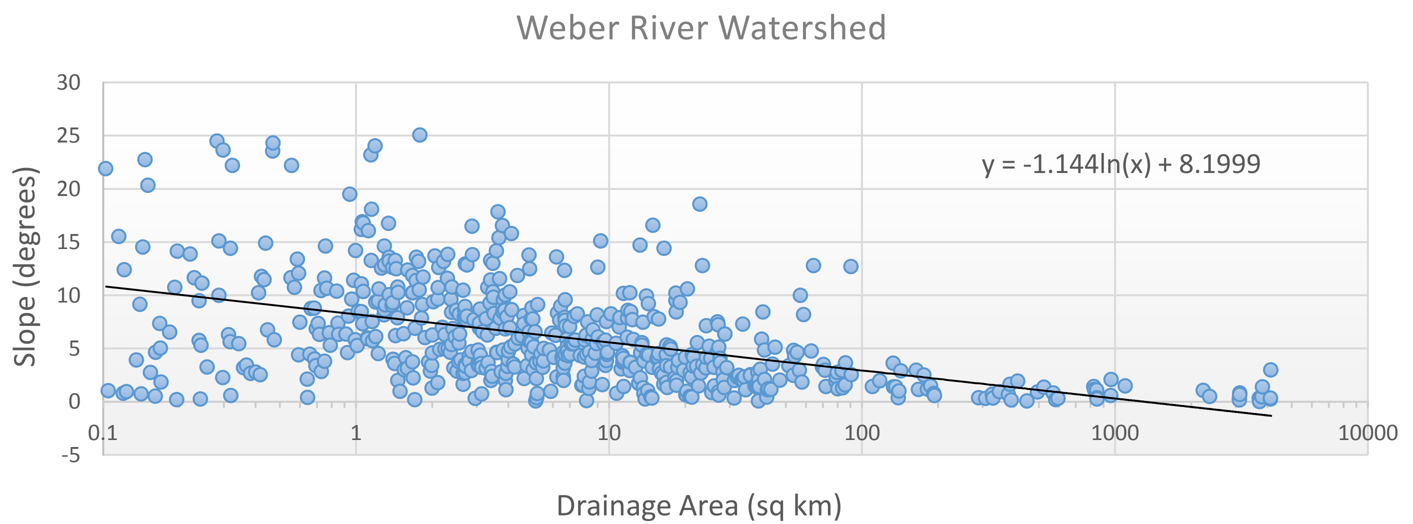
DO YOU SEE VALLEY BOTTOMS?



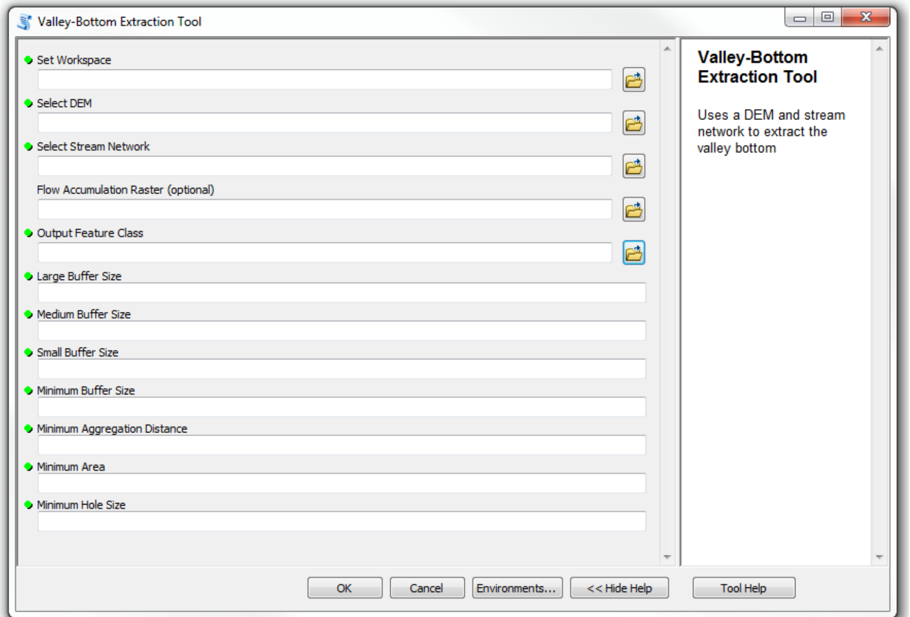
BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

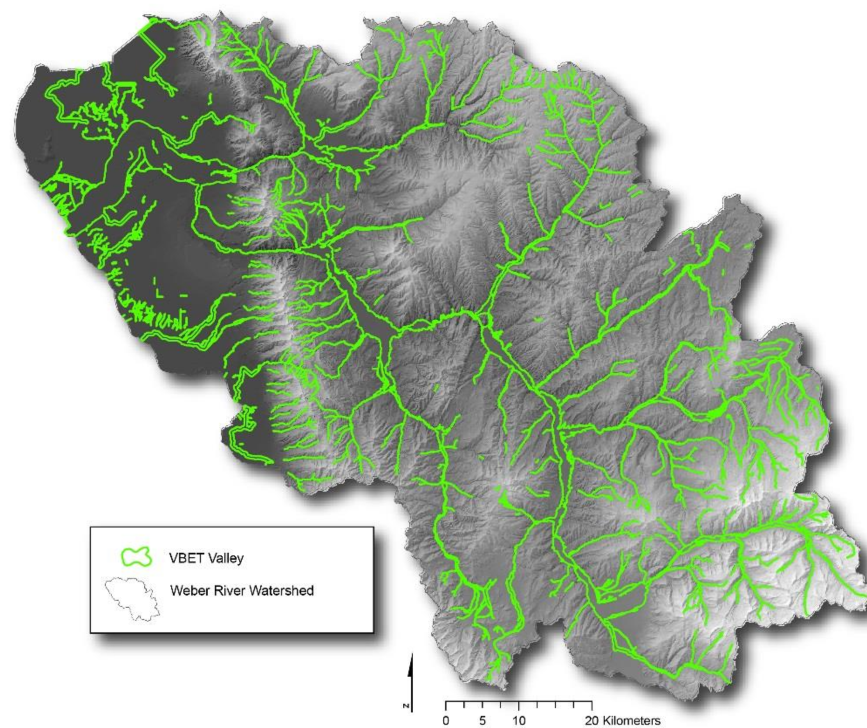
DRAINAGE AREA – SLOPE REGRESSION



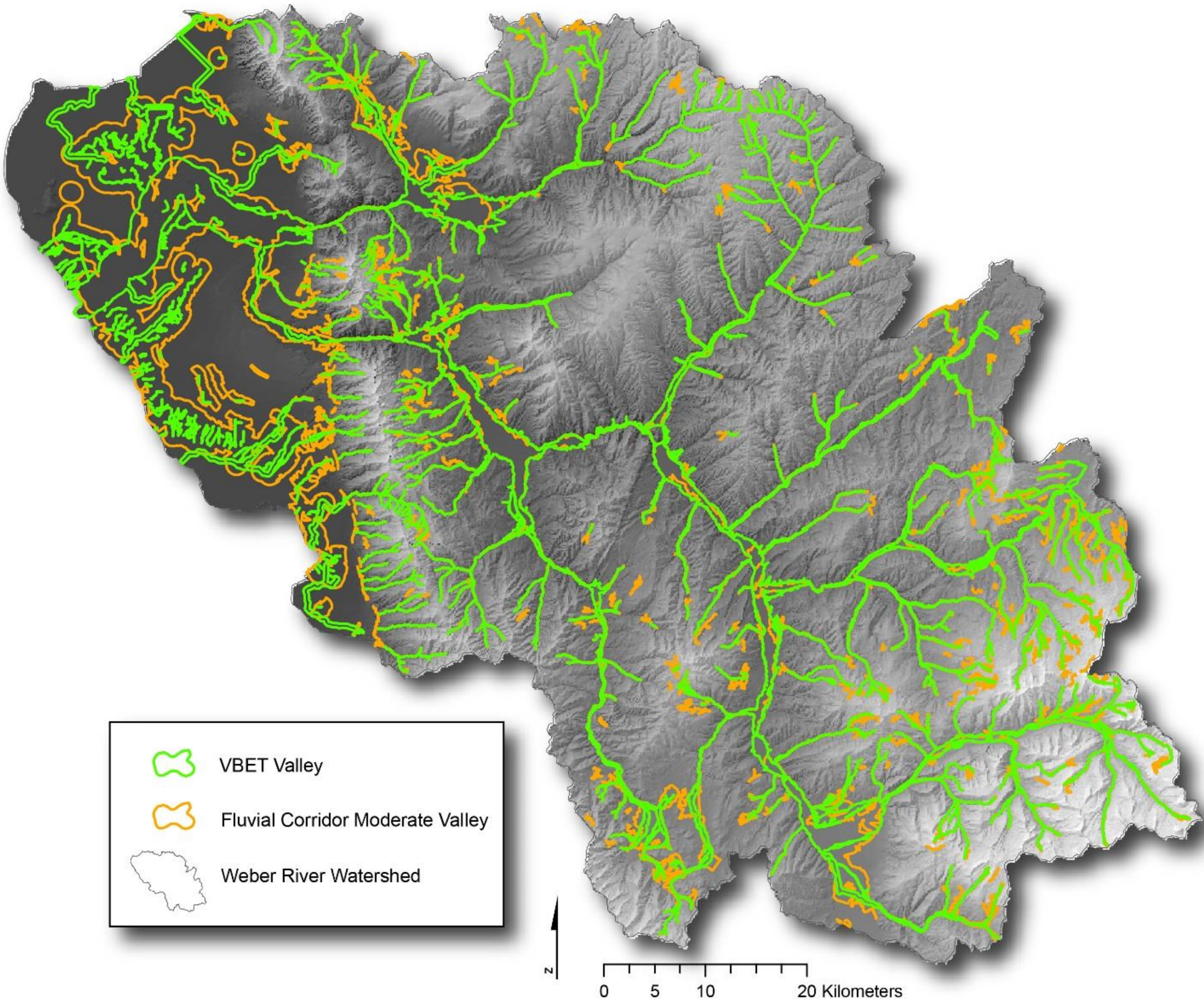


V-BET TOOL & OUTPUT

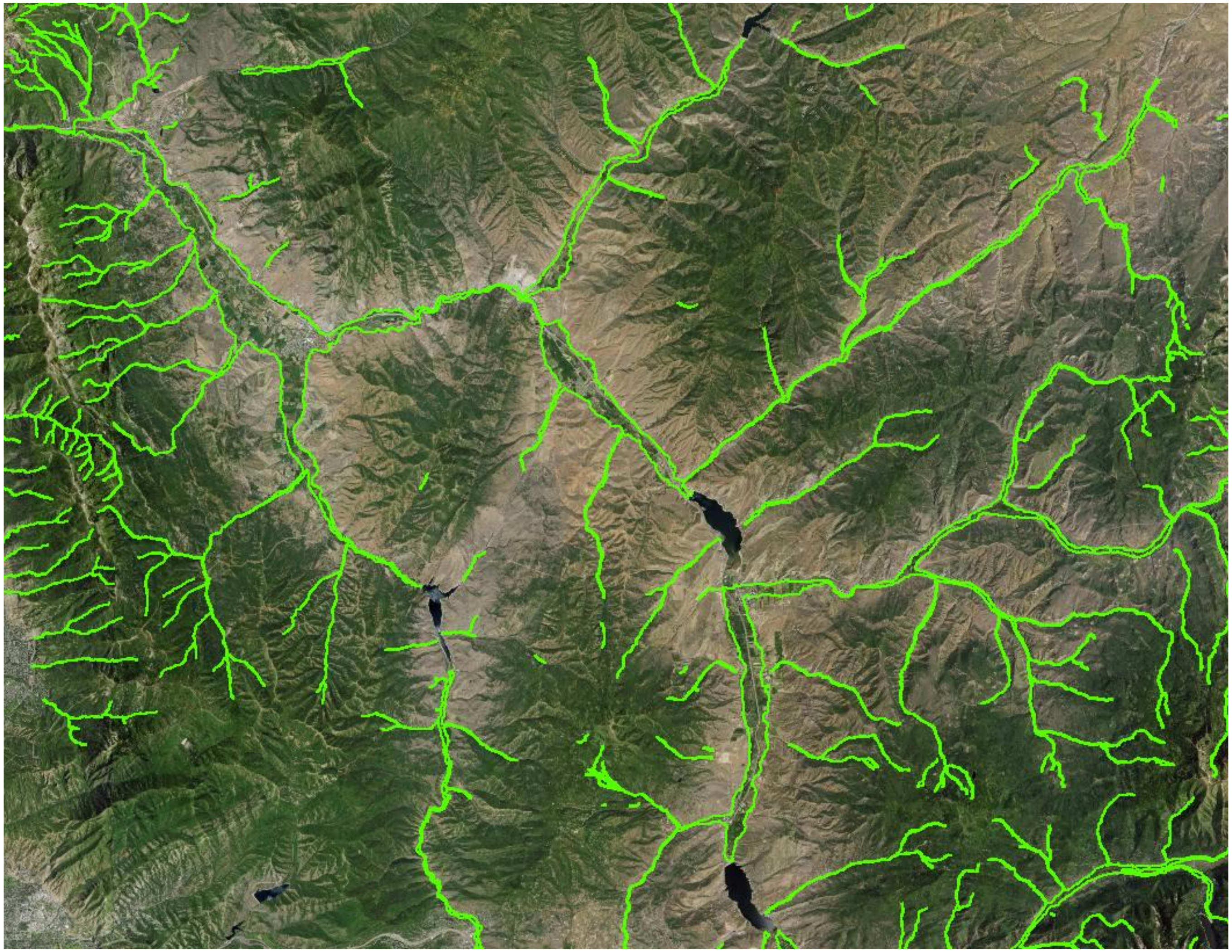




FLUVIAL CORRIDOR VS V-BET



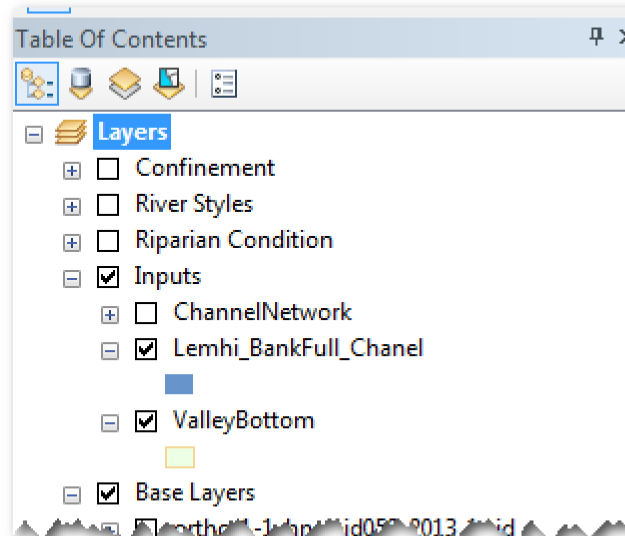
EDITED V-BET OUTPUT

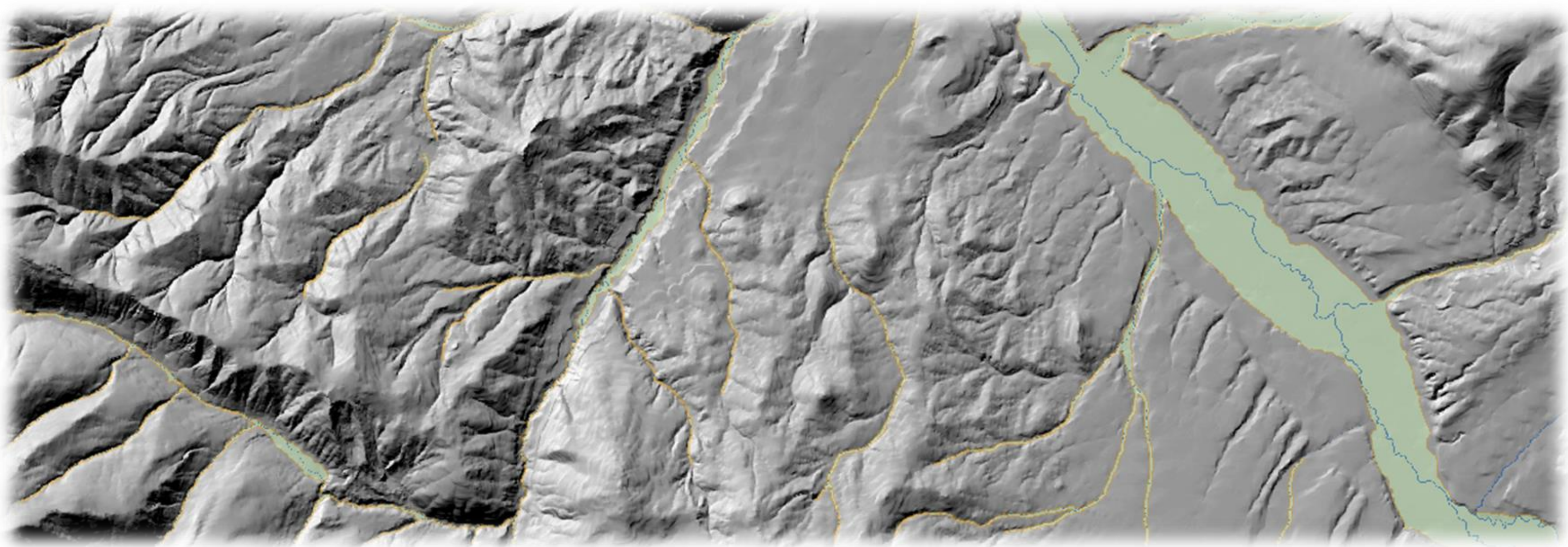


EXERCISE: VBET

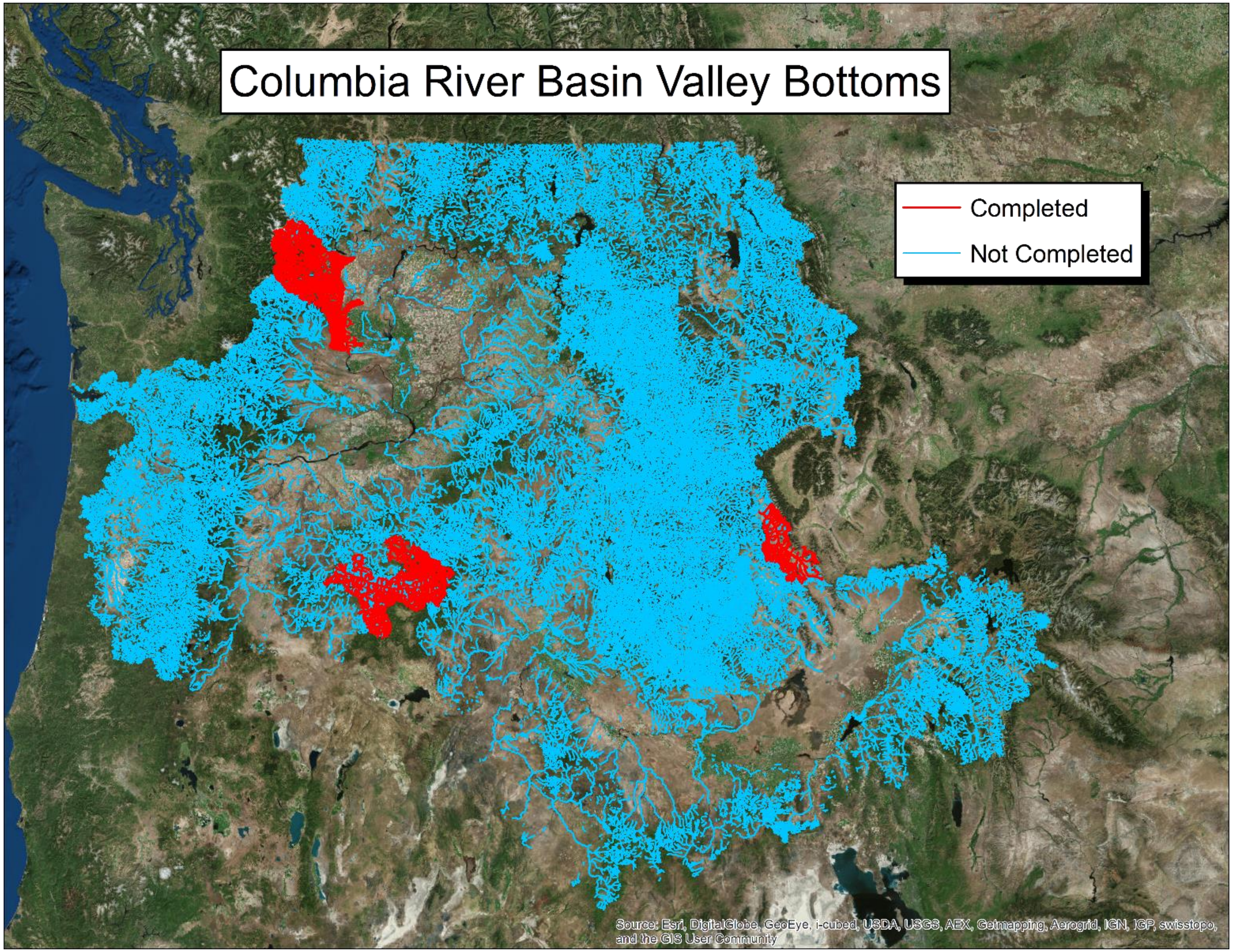
C:\0_GNAT\CHaMPWorkshopLemhiGNAT.mxd

1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on the Valley Bottom Layer





WHERE VBET HAS BEEN RUN



- Middle Fork John Day
- South Fork John Day
- Lemhi
- Wenatchee
- Entiat

OUTLINE

GEOMORPHIC & NETWORK CONTEXT

I. Background

II. Reach Types - GNAT

  I. Reach Type (River Style) Tree

  II. Valley Setting

    I. Valley Bottom

    II. Confinement

    III. Sinuosity

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  I. Geomorphic Condition

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  I. Geomorphic Recovery Potential

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V. Future Work

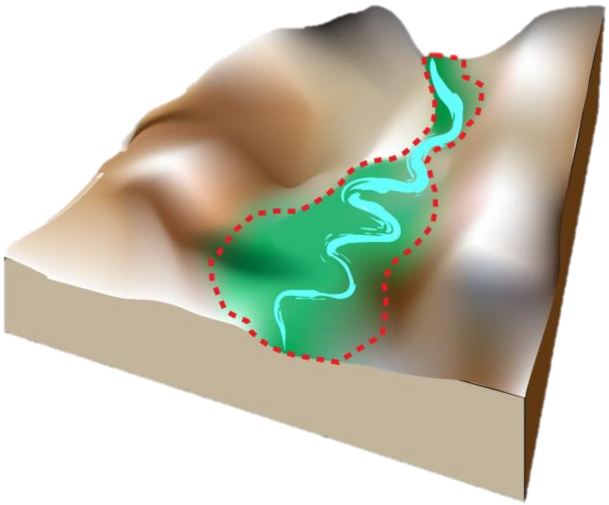
CONFINEMENT TOOL

- Uses ***Confining Margin*** *to* generate ***Confinement***

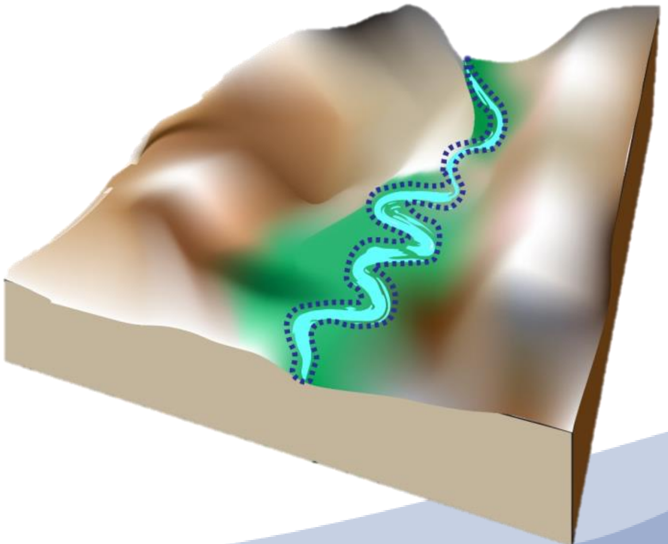
Input Data

- Valley Polygon
- Stream Channel Polygon
  - Bankfull, with buffer
  - Stream Network, segmented, approximately the centerline

Valley bottom polygon



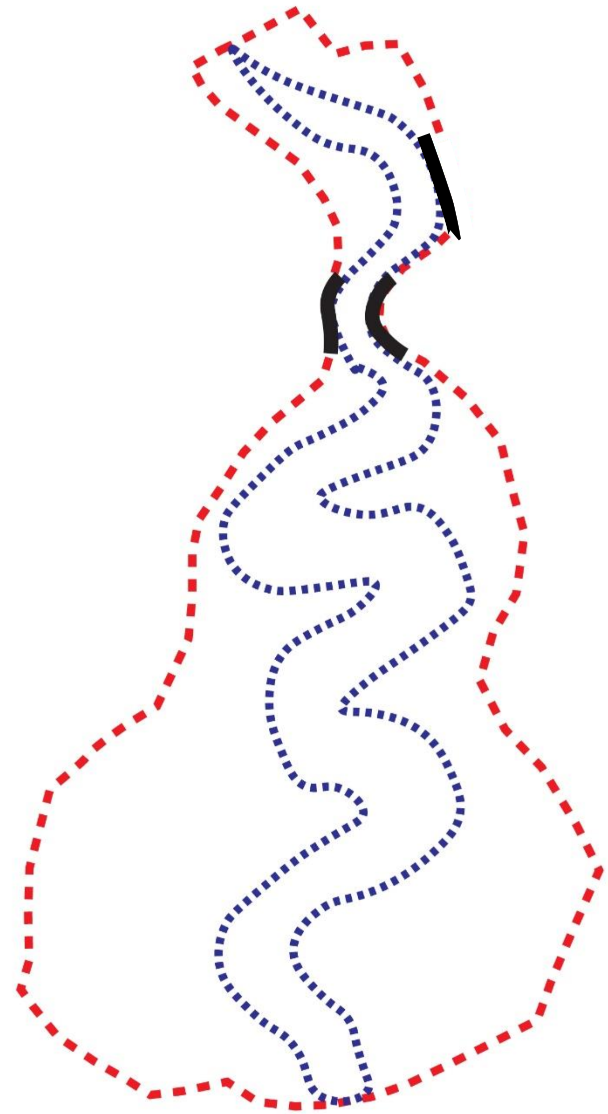
Stream Channel polygon



CONFINEMENT TOOL

Intersects Valley and Channel Polygons

to find *Confining Margins*



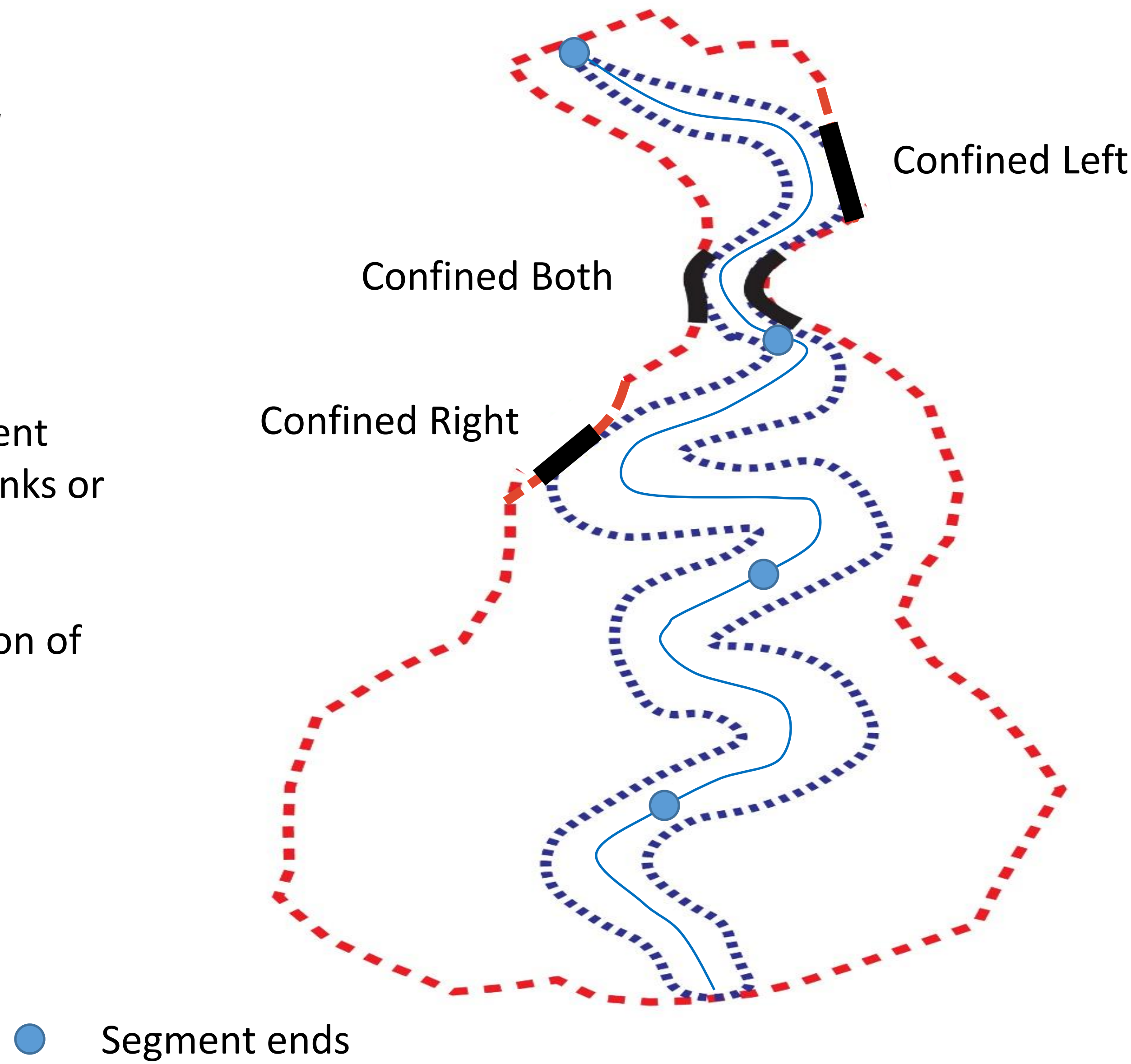
CONFINING MARGINS

Transpose *Confining Margins* to Stream Network

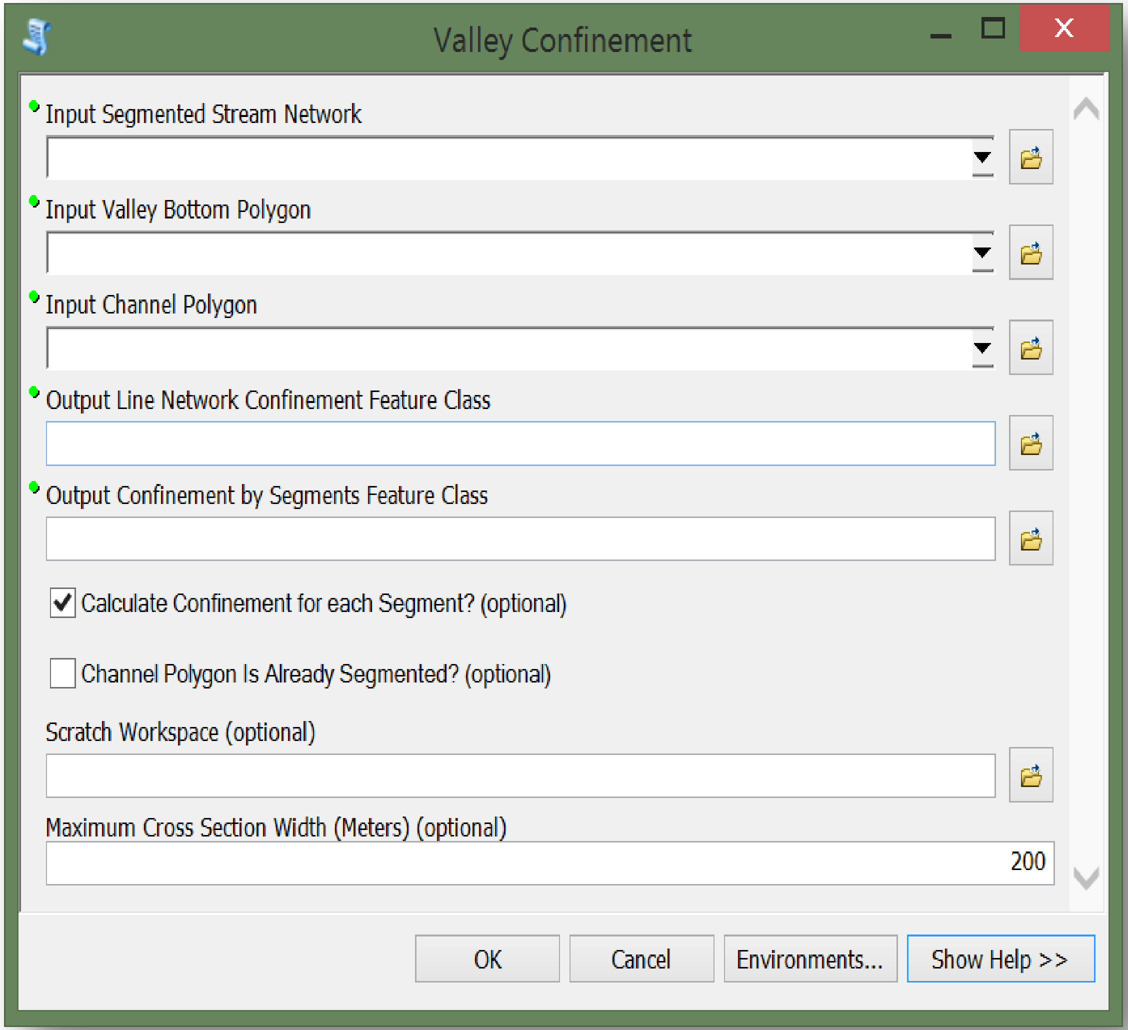
Split By Segments

Calculate Confinement (Left, Right, Both banks or none)

Retain spatial location of confinement



HERE'S THE ACTUAL TOOL…



CONFINEMENT OUTPUTS

Outputs:

- Confining Margins (new)
- Confinement Along Network
- Confinement Along Segments

EXERCISE: CONFINEMENT

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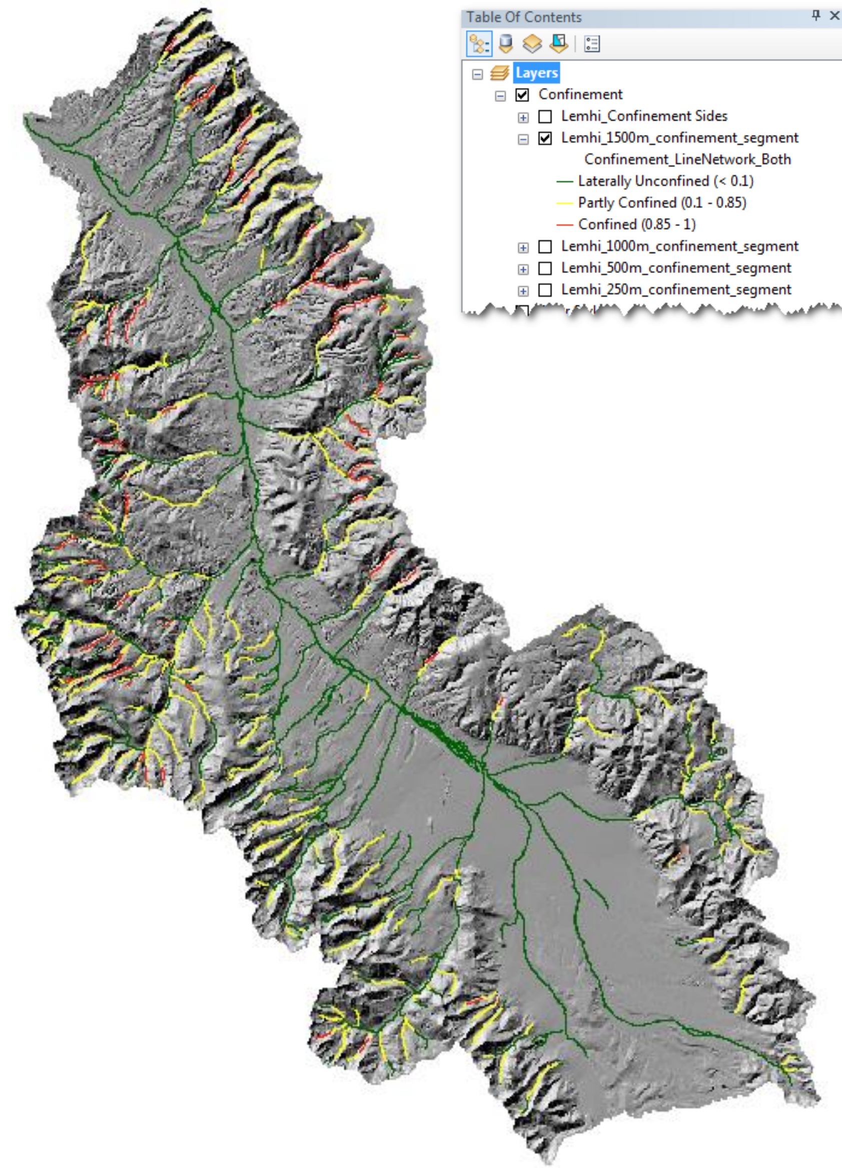
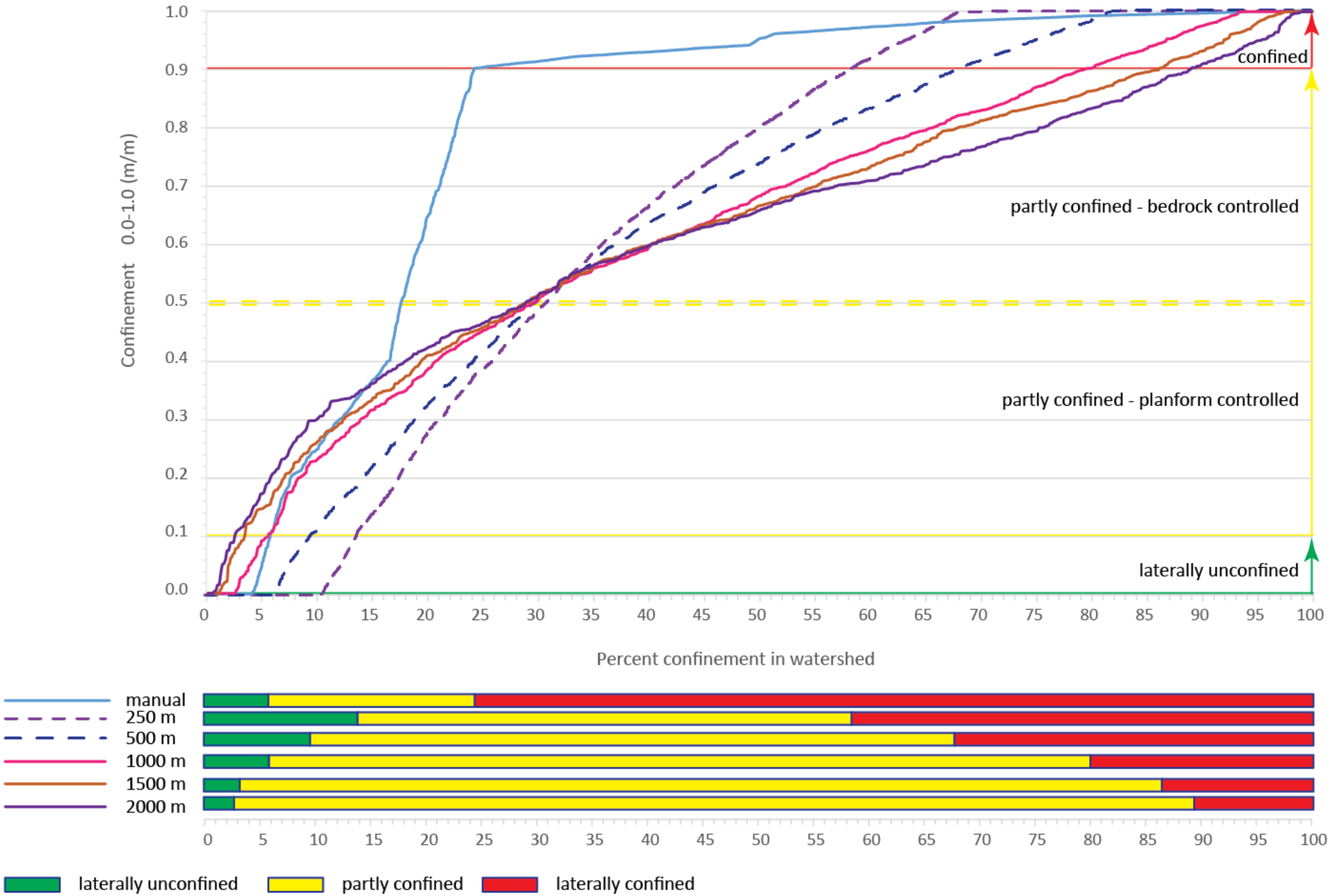
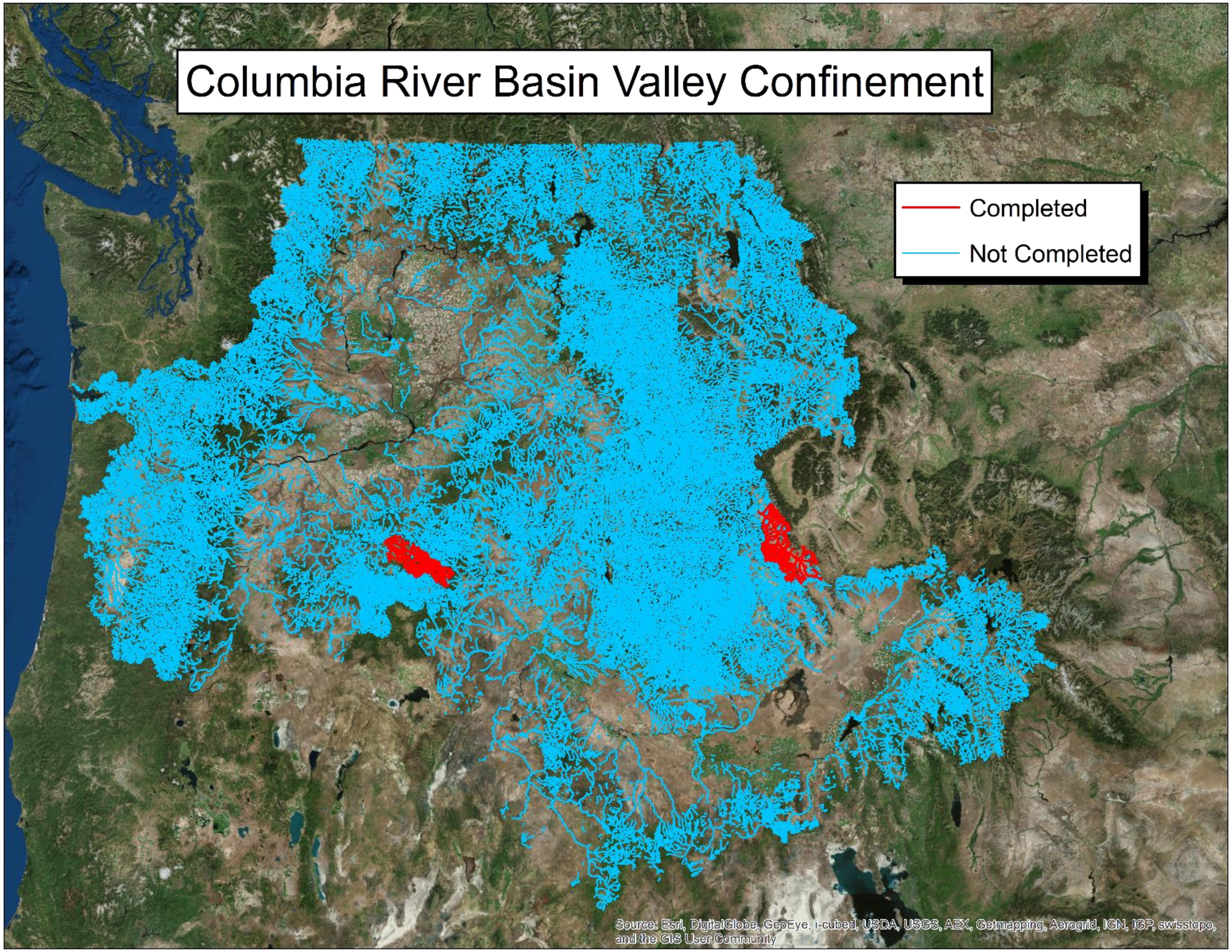
1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on one of the Confinement Layers



CONFINEMENT SENSITIVITY TO LENGTH



WHERE CONFINEMENT HAS BEEN RUN



- Middle Fork John Day
- Lemhi

OUTLINE

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I. Background

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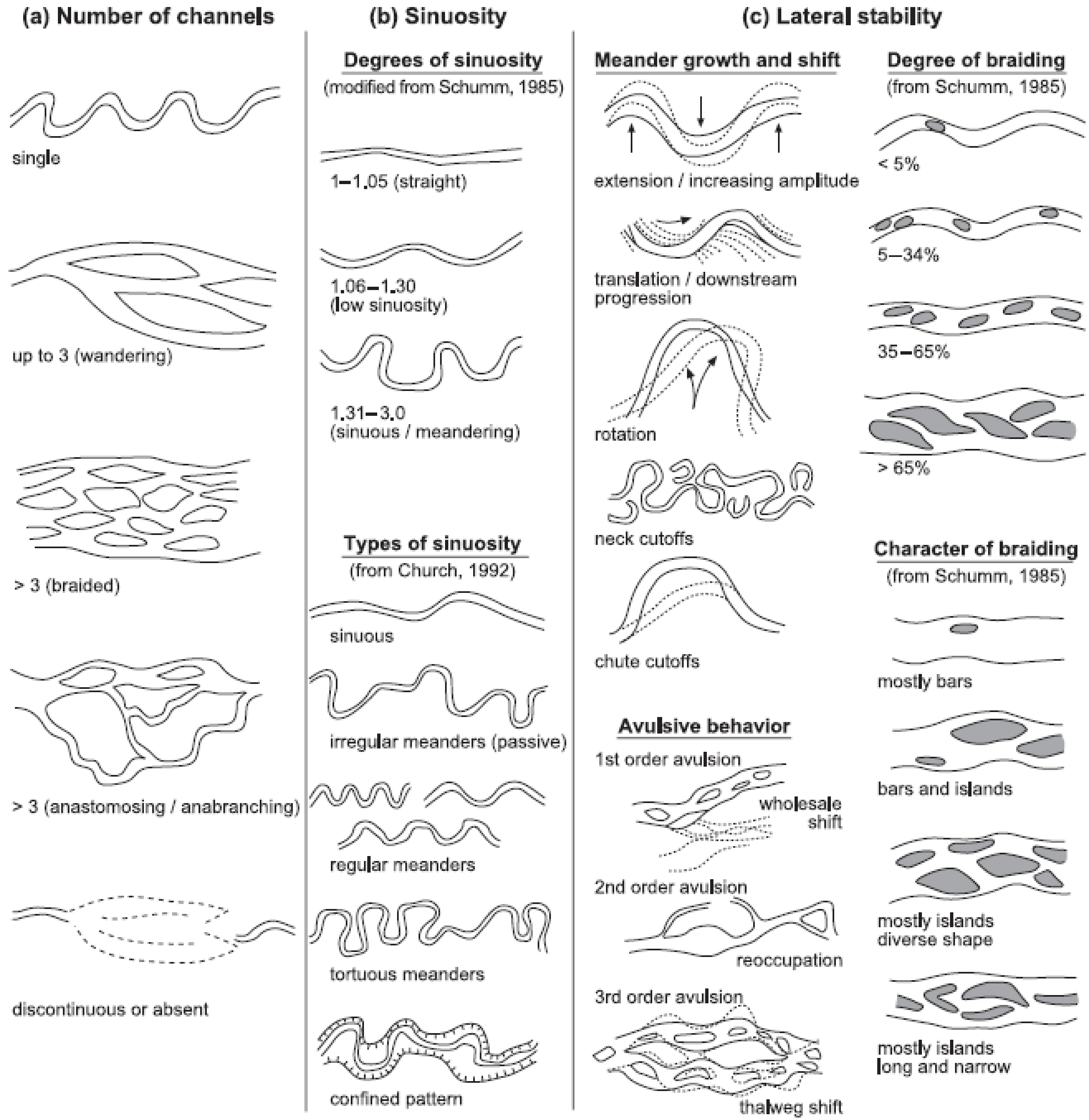
SINUOSITY

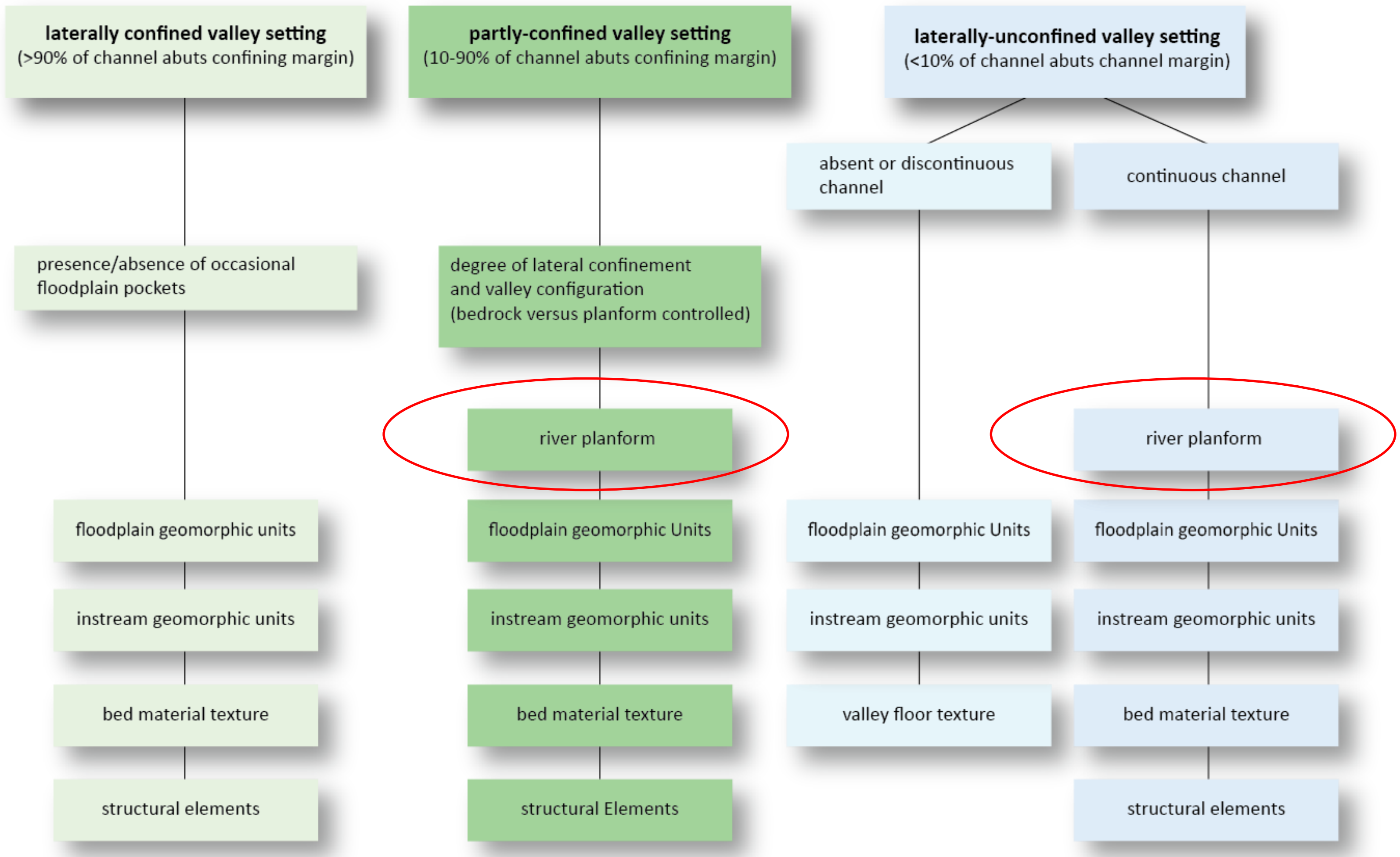
- Straight: 1 – 1.05
- Low Sinuosity: 1.06 - 1.3
- Sinuous / Meandering: 1.3 -3.0



BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

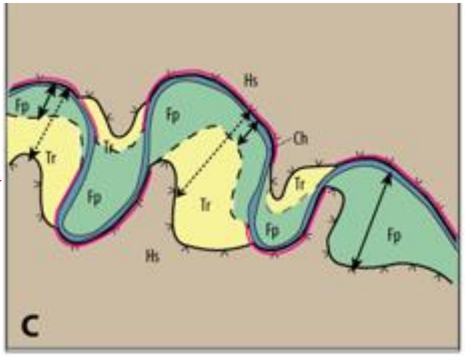
WHY SINUOSITY MATTERS

Columbia River Basin River Styles Procedural Tree



- Valley vs. Channel Sinuosity

PLANFORM CONTROLLED VS. BEDROCK CONTROLLED

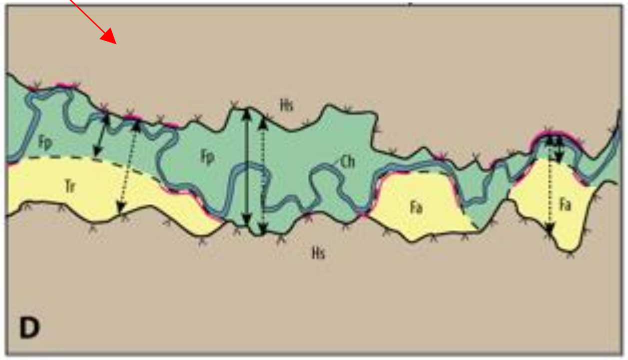


Valley Setting: River Styles of **Partly Confined** valley settings - Idaho Batholith

10-90% of channel abuts confining margin

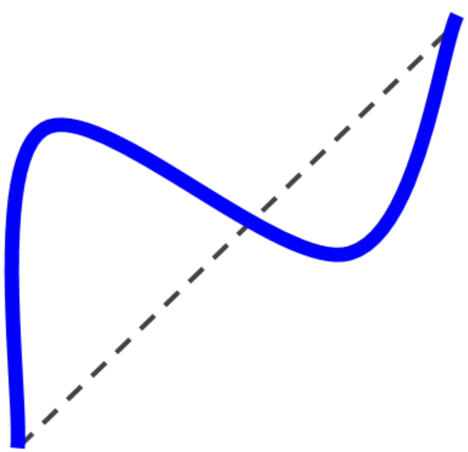
Presence/ extent of floodplain	***bedrock-controlled discontinuous floodplain***		***planform-controlled discontinuous floodplain***			
planform	low-moderate sinuosity >60-90% confined		low-moderate sinuosity ~50% confined	low-moderate sinuosity ~50% confined	moderate-low sinuosity active meandering >60-90% confined	medium-high sinuosity active meandering >30-50% confined
Floodplain geomorphic units	terrace, anabranch, meander cutoff, paleochannels	Alluvial Fans, pleistocene terraces	terrace, bench paleochannel, paleocutbanks, alluvial/debris fan	terrace, bench paleochannel, paleocutbanks, alluvial/debris fan	fine grained irregular floodplain	terrace, alluvial fan, meander cutoff
Instream Geomorphic Units	riffles, pools, runs, point bars, scroll bars, islands, chute cutoffs,		bank-attached and mid-channel gravel bars, riffles, pools, rapids, runs, cutbank	bank-attached and mid-channel gravel bars, riffles, pools, rapids, runs, cutbank	LWD-forced bars, compound, midchannel, point, and diagonal bars runs, cutbanks, chute cutoffs	pools, riffles, runs, point bars, cutbanks
Bed Material Texture	cobble, gravel sand		boulder, cobble, gravel	boulder, cobble, gravel	cobble, gravel	cobble, gravel silt, sand
Structural* Elements						
River Style	*BC ELONGATE DISCONTINUOUS FLOODPLAIN* Salmon, Big Lost	*FAN/TERRACE CONTROLLED DISCONTINUOUS FLOODPLAIN* Salmon, Big Lost	*LOW SINUOSITY PC ANABRANCHING* Salmon, Payette	*LOW-MODERATE SINUOSITY WANDERING GRAVEL BED* Salmon, Big Lost	*LOW-MODERATE SINUOSITY PC DISCONTINUOUS FLOODPLAIN* Higher elevation valleys in Salmon, Payette, Boise, Big Lost	*MEANDERING PC DISCONTINUOUS FLOODPLAIN* glacial drift-filled valleys, alpine glacial valleys, impounded sections; Salmon, Payette, Big Lost Rivers

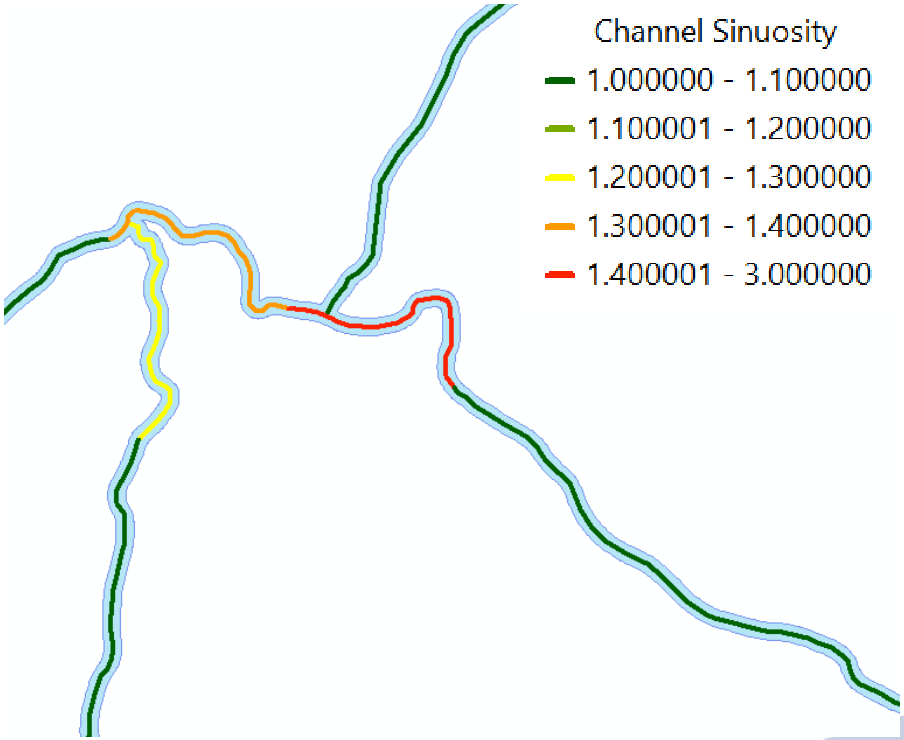
*BA = bank-attached
CS = channel spanning



SINUOSITY

Basic sinuosity calculation on pre-segmented stream network.





LEVERAGING DATA FROM MULTIPLE NETWORKS

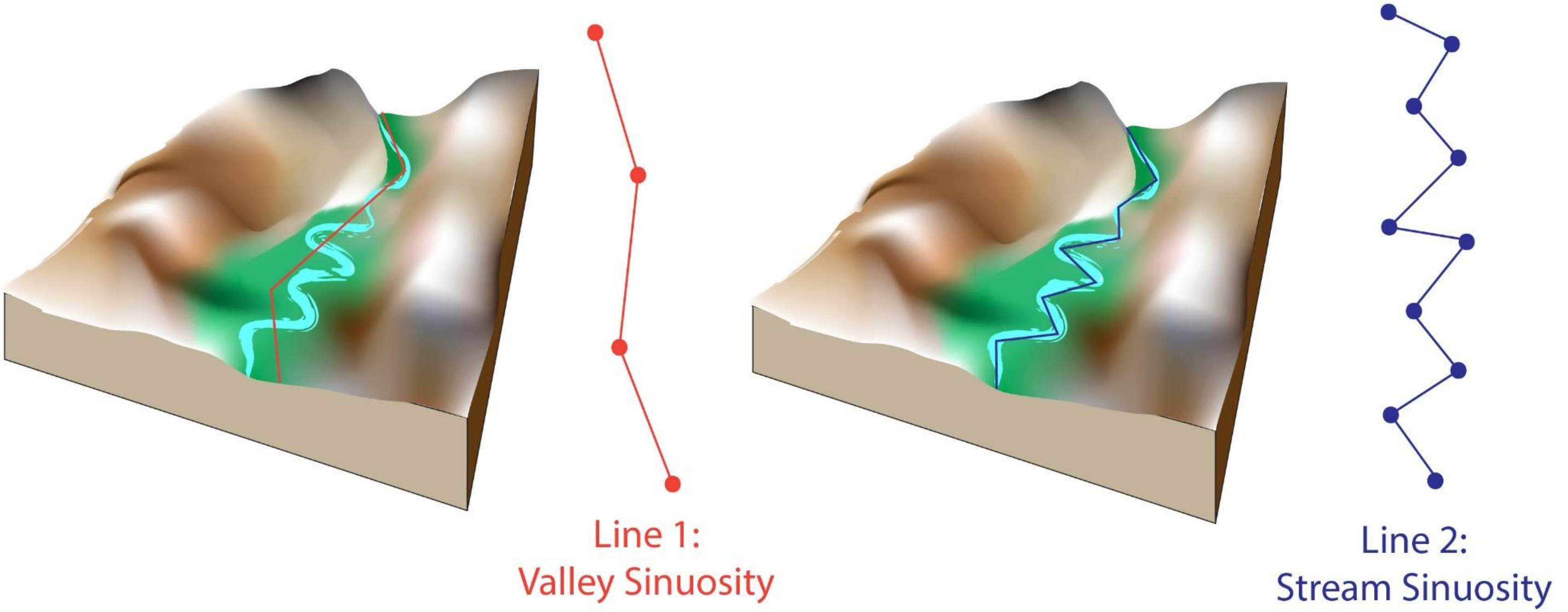
- Logistics of using all this great information involves getting information into the same network space
- BUT It's not appropriate nor practical for everyone to use the same network:

Question of interest
Scale of data available
Resolution of available data
Feasibility—processing time and bang for buck
Parallel development logistics

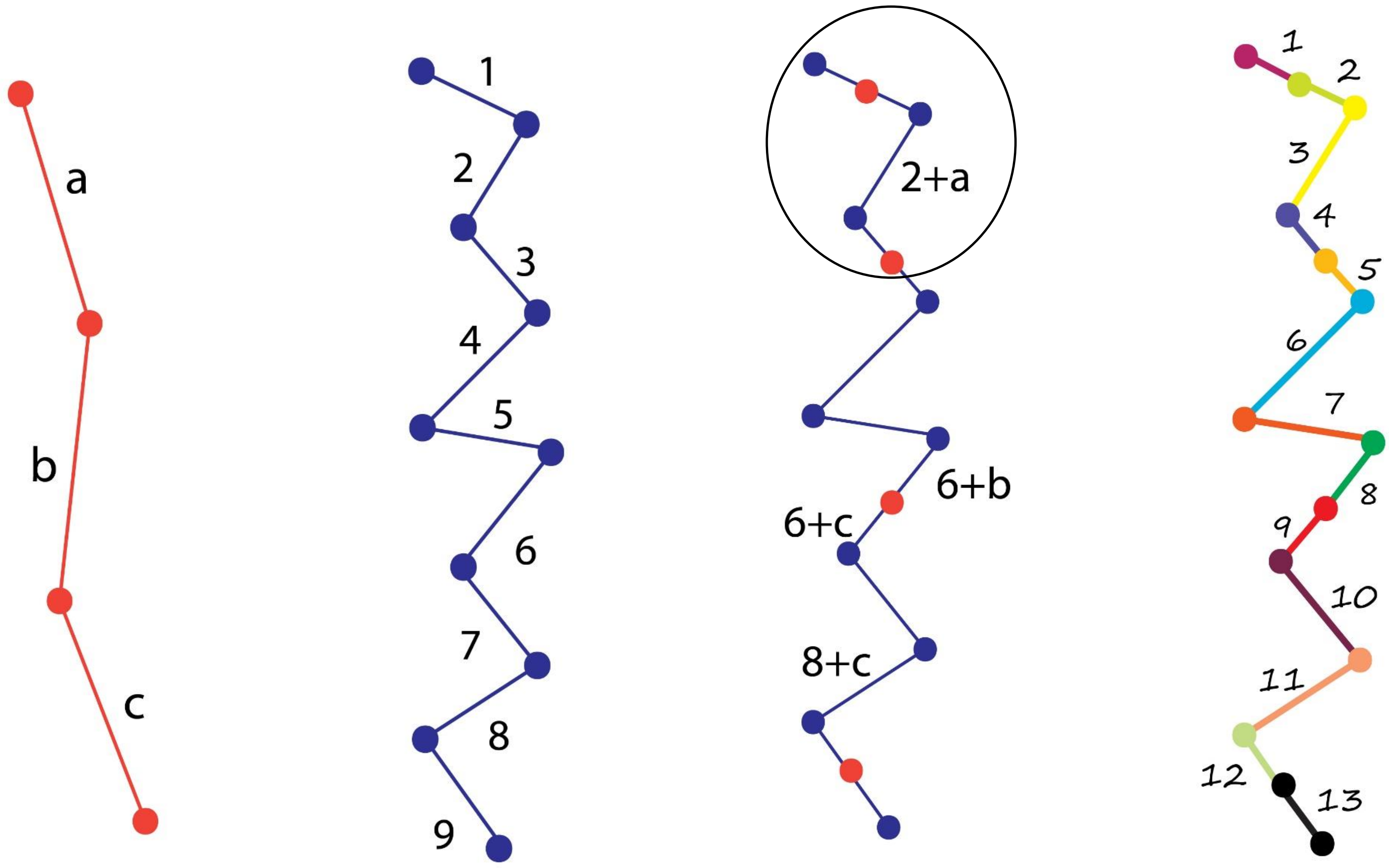
Develop the building blocks of information and then move information to the same network space

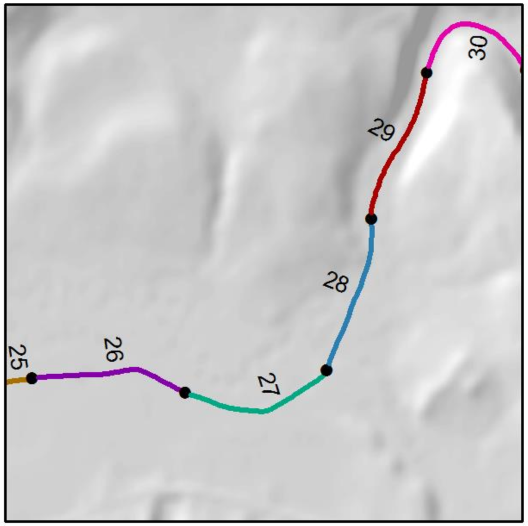
EXAMPLE: VALLEY AND STREAM SINUOSITY

Two lines with different geometries

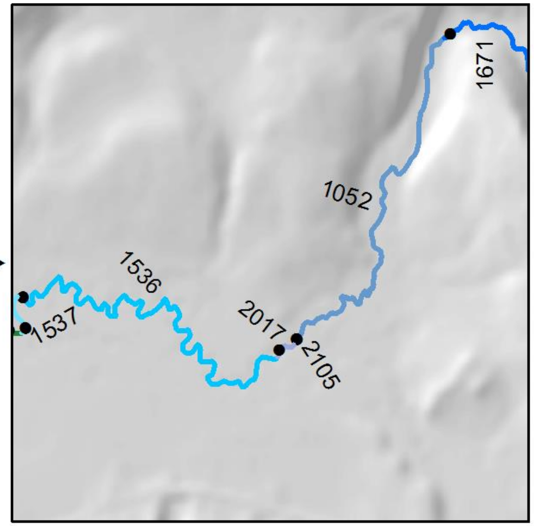


EXAMPLE: VALLEY AND STREAM SINUOSITY

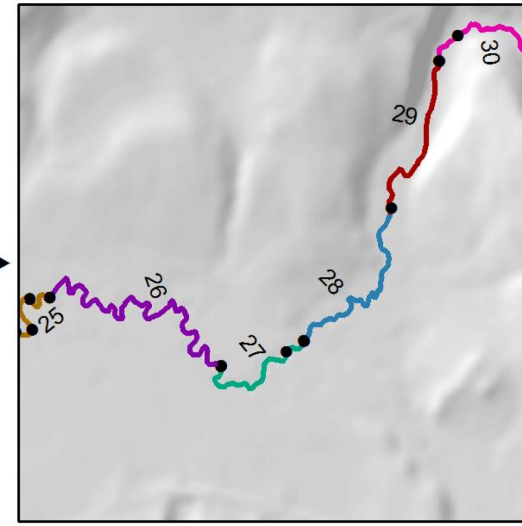




Valley Centerline, 300m segments



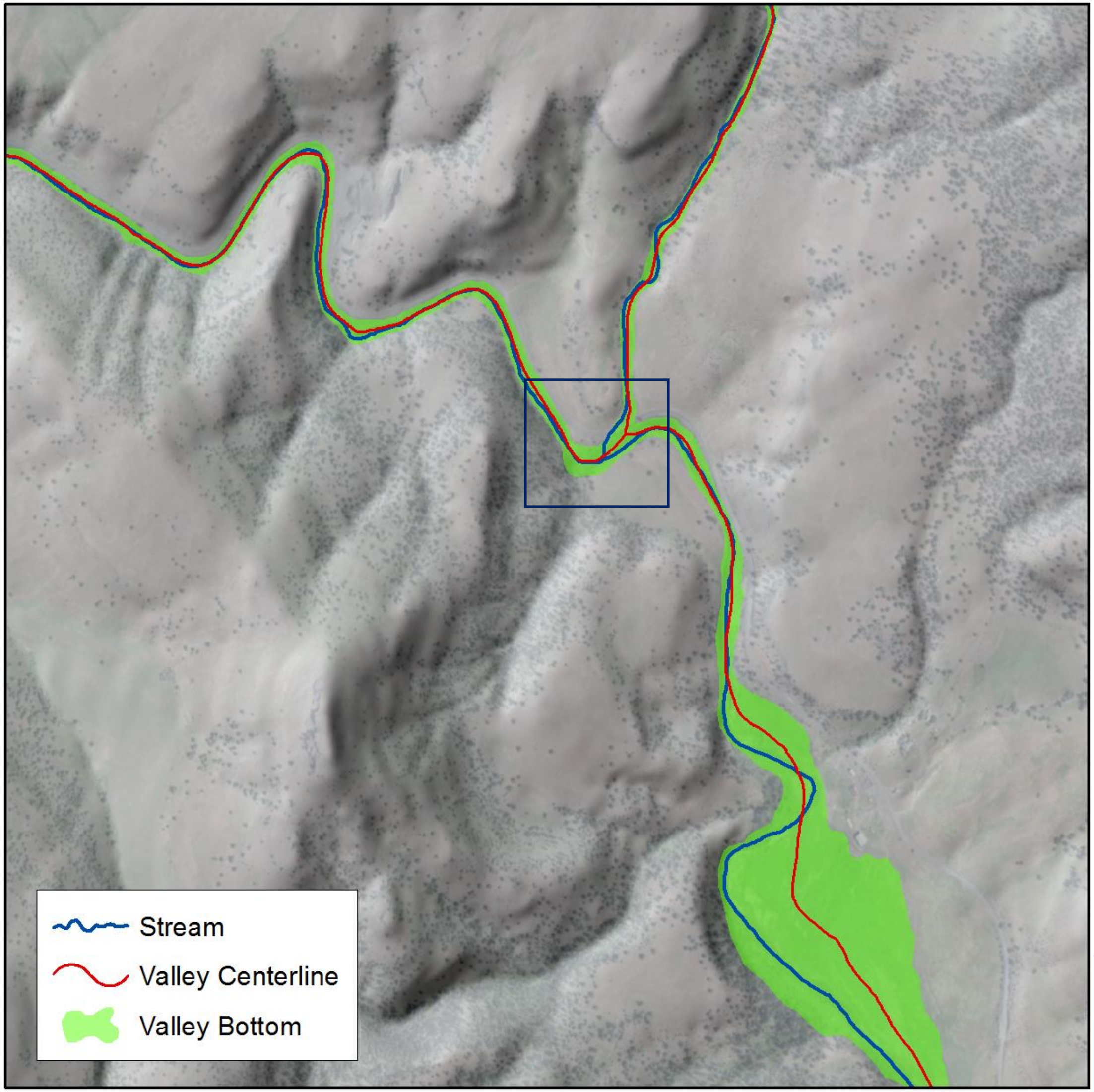
Streams, 1000m segments



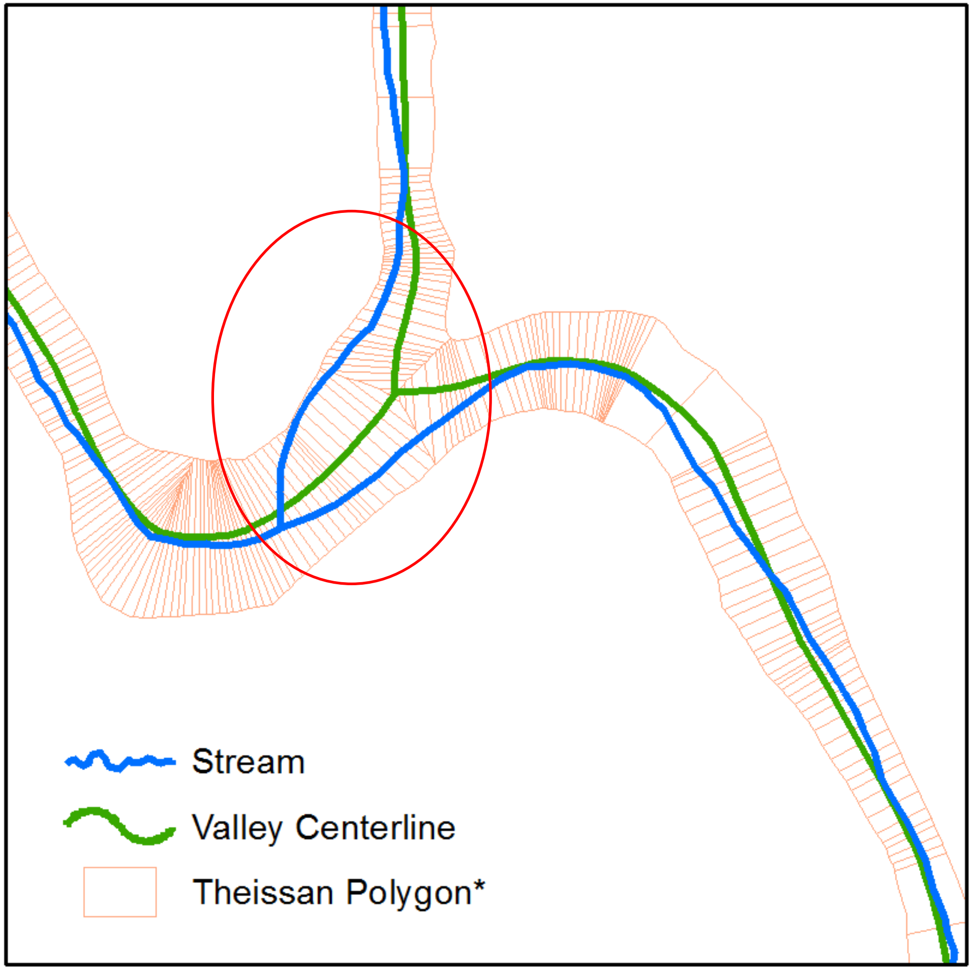
Valley centerlines transferred to streams

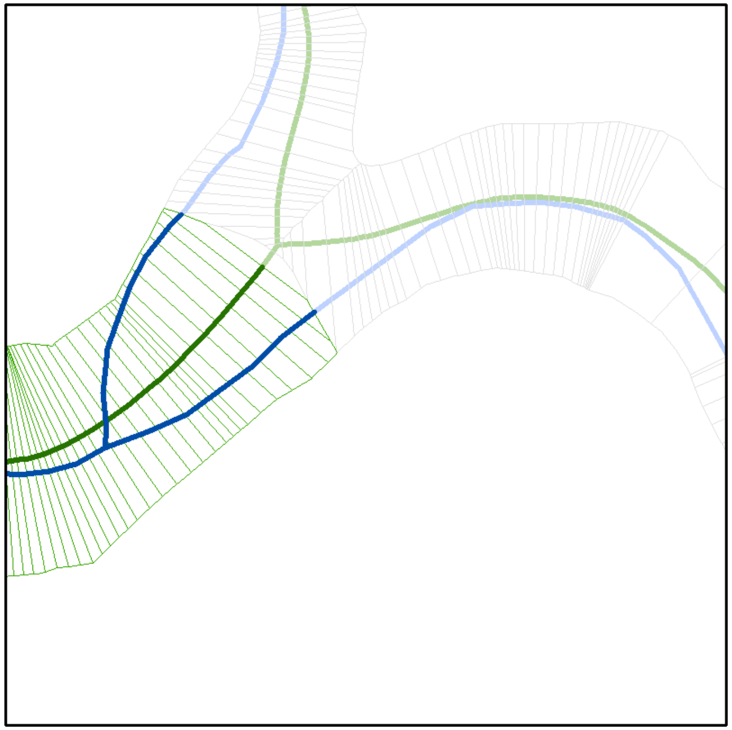
BUT SOME LINES HAVE GEOMETRY THAT MAKE TRANSFERS DIFFICULT

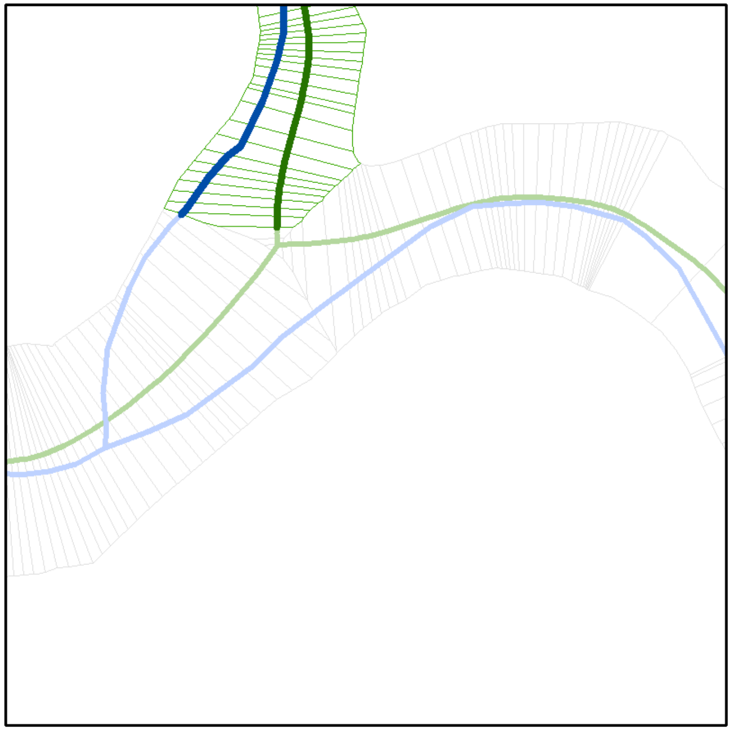
Valley centerline attributes transferred to stream network



CONFLUENCES & THEISSAN POLYGONS



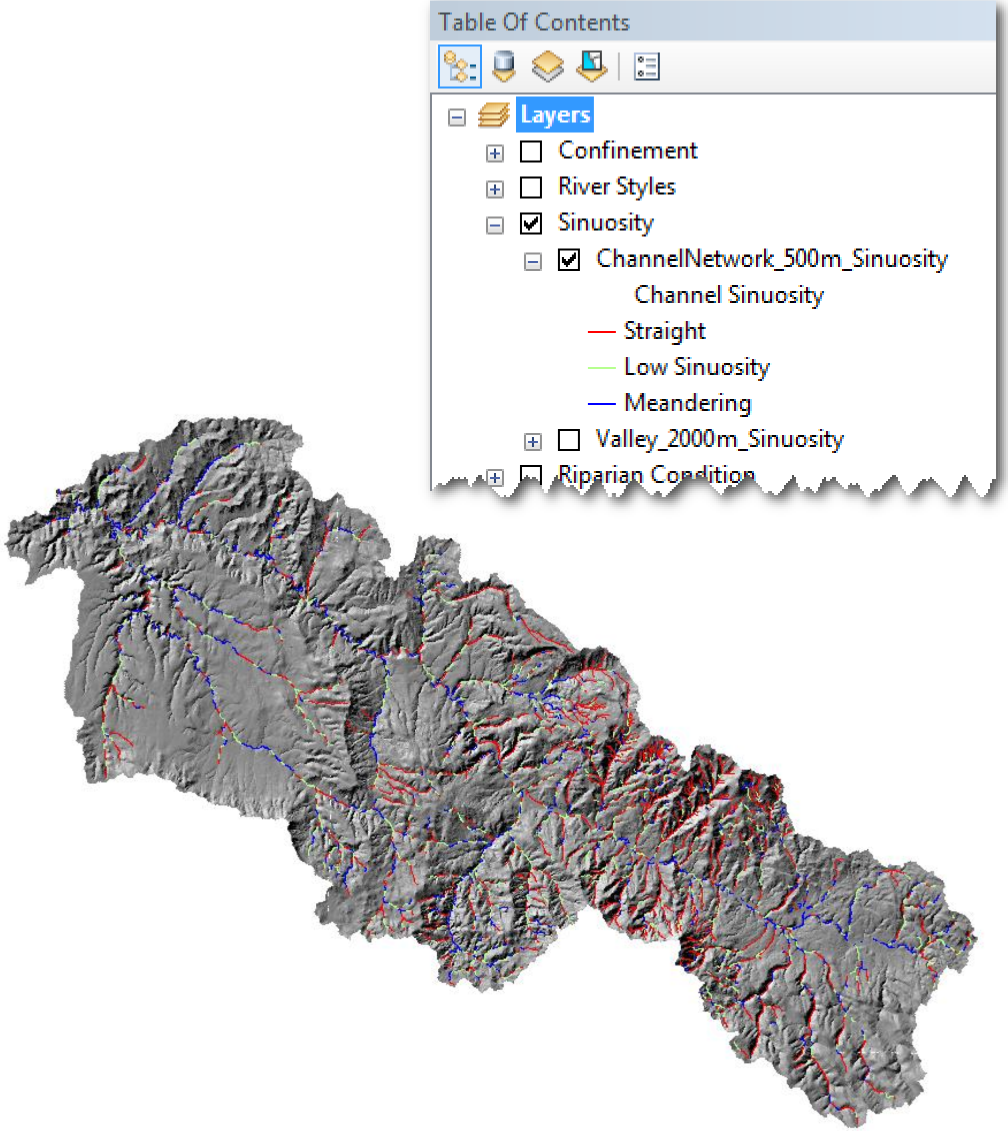




EXERCISE: SINUOSITY

C:\0_GNAT\CHaMPWorkshopMFJDGNAT.mxd

1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on Channel Sinuosity
4. Turn off Channel Sinuosity
5. Turn on Valley Sinuosity



OUTLINE

CHaMP Columbia Habitat Monitoring Program

GEOMORPHIC & NETWORK CONTEXT

I. Background

II. Reach Types - GNAT

  I. Reach Type (River Style) Tree

  II. Valley Setting

    I. Valley Bottom

    II. Confinement

    III. Sinuosity

  III. Reach Typing of CHaMP Basins & CRB

III. Condition

  I. Geomorphic Condition

  II. Riparian Condition

  III. Habitat & Population Condition

IV. Recovery Potential

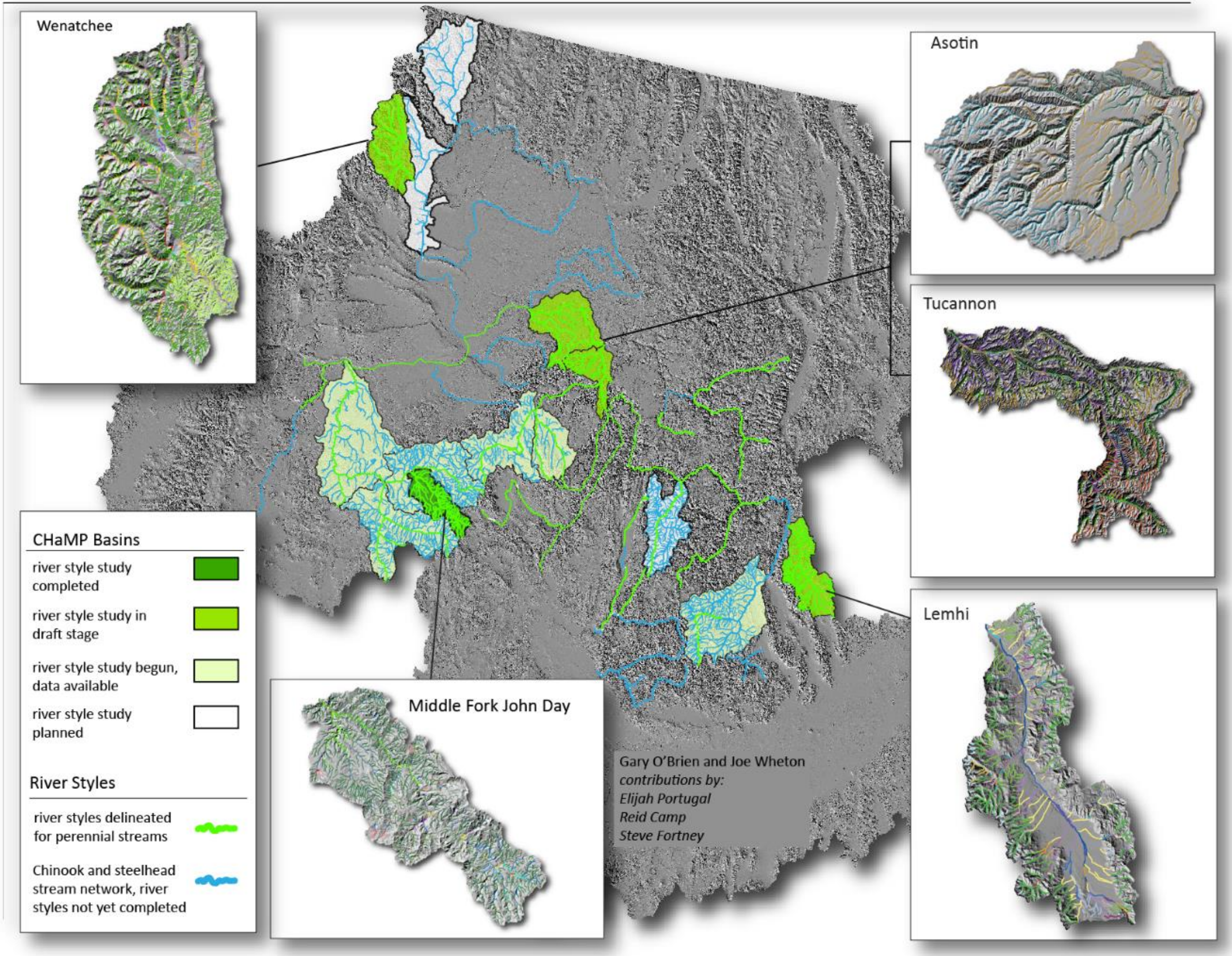
  I. Geomorphic Recovery Potential

  II. Riparian Recovery Potential

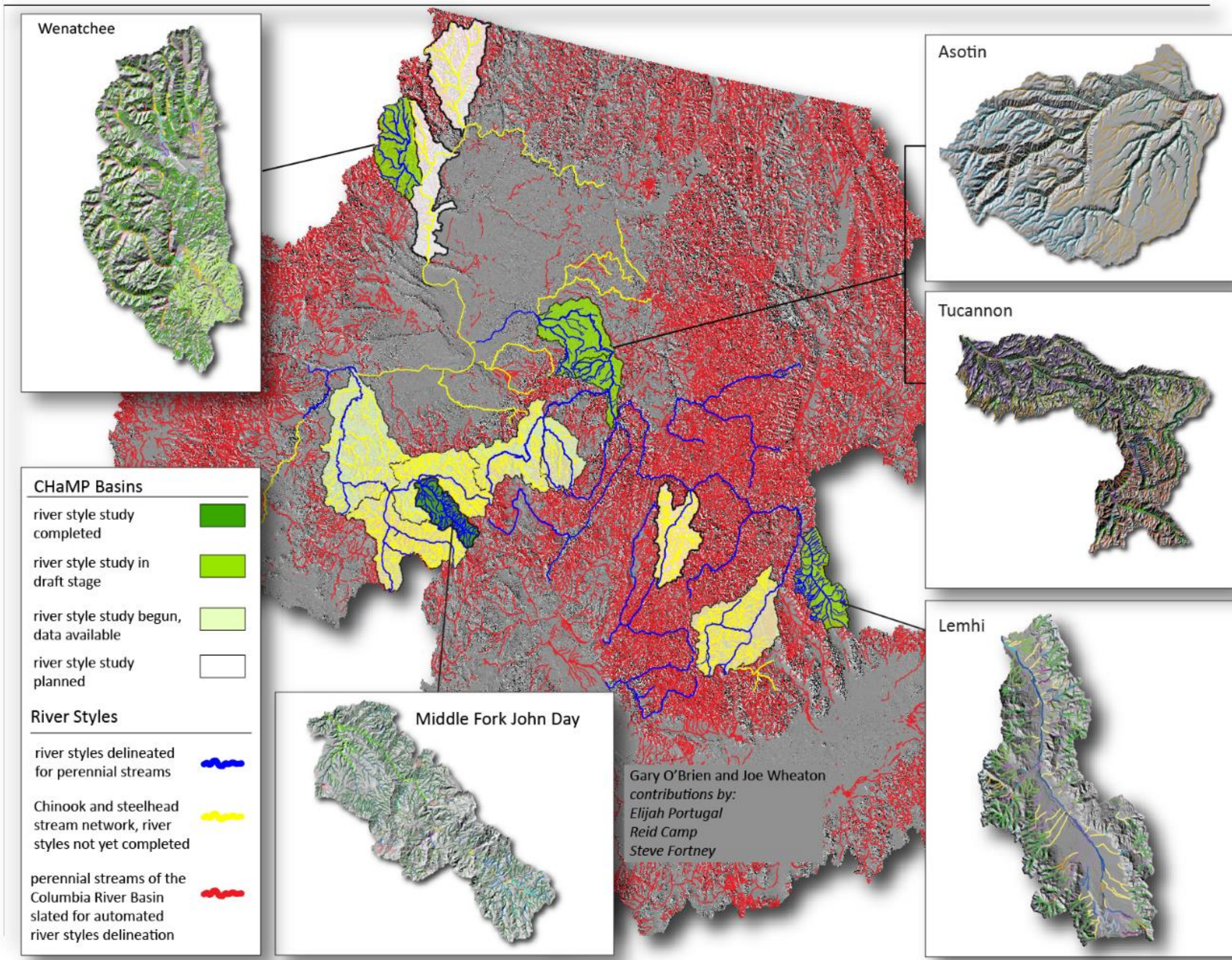
  III. BRAT & WRAT

V. Future Work

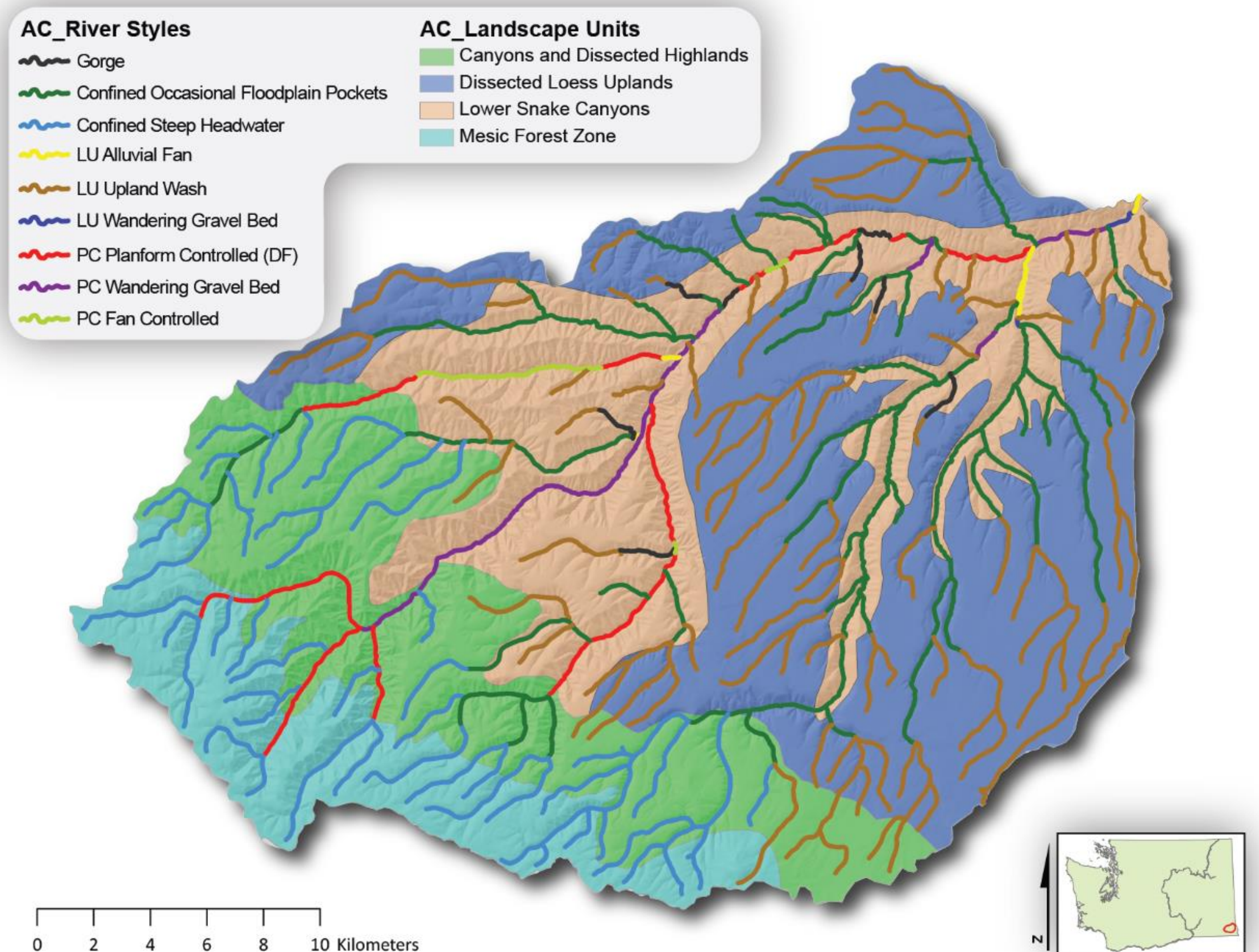
BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP


Wenatchee
Asotin
Tucannon
Lemhi
Middle Fork John Day
CHaMP Basins
river style study completed
river style study in draft stage
river style study begun, data available
river style study planned
River Styles
river styles delineated for perennial streams
Chinook and steelhead stream network, river styles not yet completed
Gary O'Brien and Joe Wheton
contributions by:
Elijah Portugal
Reid Camp
Steve Fortney

REACH TYPING ANALYSES PLANNED FOR ENTIRE CRB



ASOTIN WATERSHED



Manually delineated by Reid Camp (Camp 2015)

COMING SOON TO A GNAT NEAR YOU

- Segmentation Moving Window Analysis
  - Moving windows: run tool at multiple segment lengths to identify areas that are not sensitive to segment length
  - Smart Segments (mainstem vs. tributary)
  - Reach Breaks Identification (e.g. changes in slope)
  - Smart attribute transfer (using common attributes to restrict transfer)
- Network Management
  - Topology: Organizes up/downstream, trib junctions
    - Support Braided Segments
    - Support Discontinuities
- Probabilistic Reach Typing Tool…

CHaMP Columbia Habitat Monitoring Program

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   - I. Geomorphic Recovery Potential
   - II. Riparian Recovery Potential
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GEOMORPHIC CONDITION

Using Brieley & Fryirs (2005) methods, evaluate:

- ADJUSTMENT CAPACITY
- EVOLUTION OF STREAM TYPES
- GEOMORPHIC CHANGE IRREVERSIBLE?
- RECOGNIZING CONDITION VARIANTS AND A REFERENCE REACH

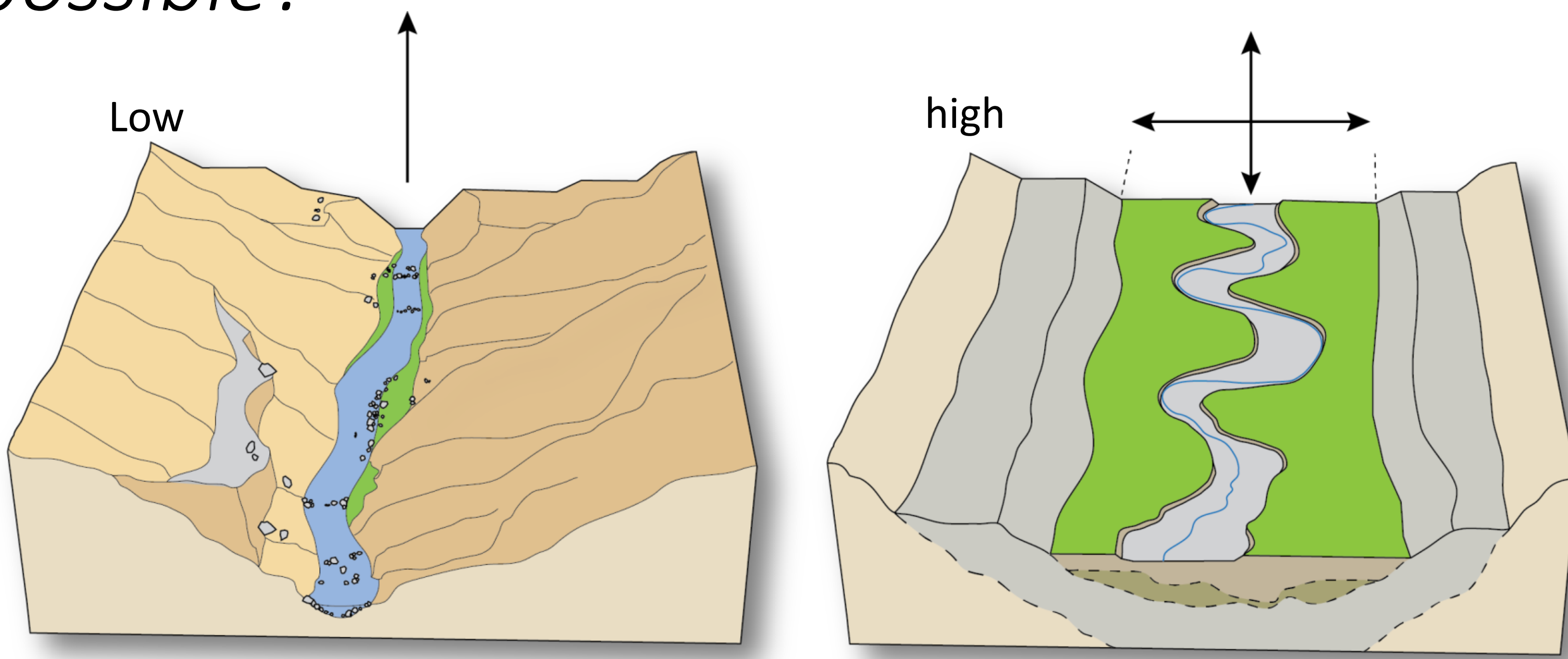
“STOPLIGHT” WATERSHED MAPS

- **INTACT REACHES**
- **GOOD**
- **MODERATE**
- **POOR**

BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

CAPACITY FOR ADJUSTMENT OF EACH RIVER STYLE:

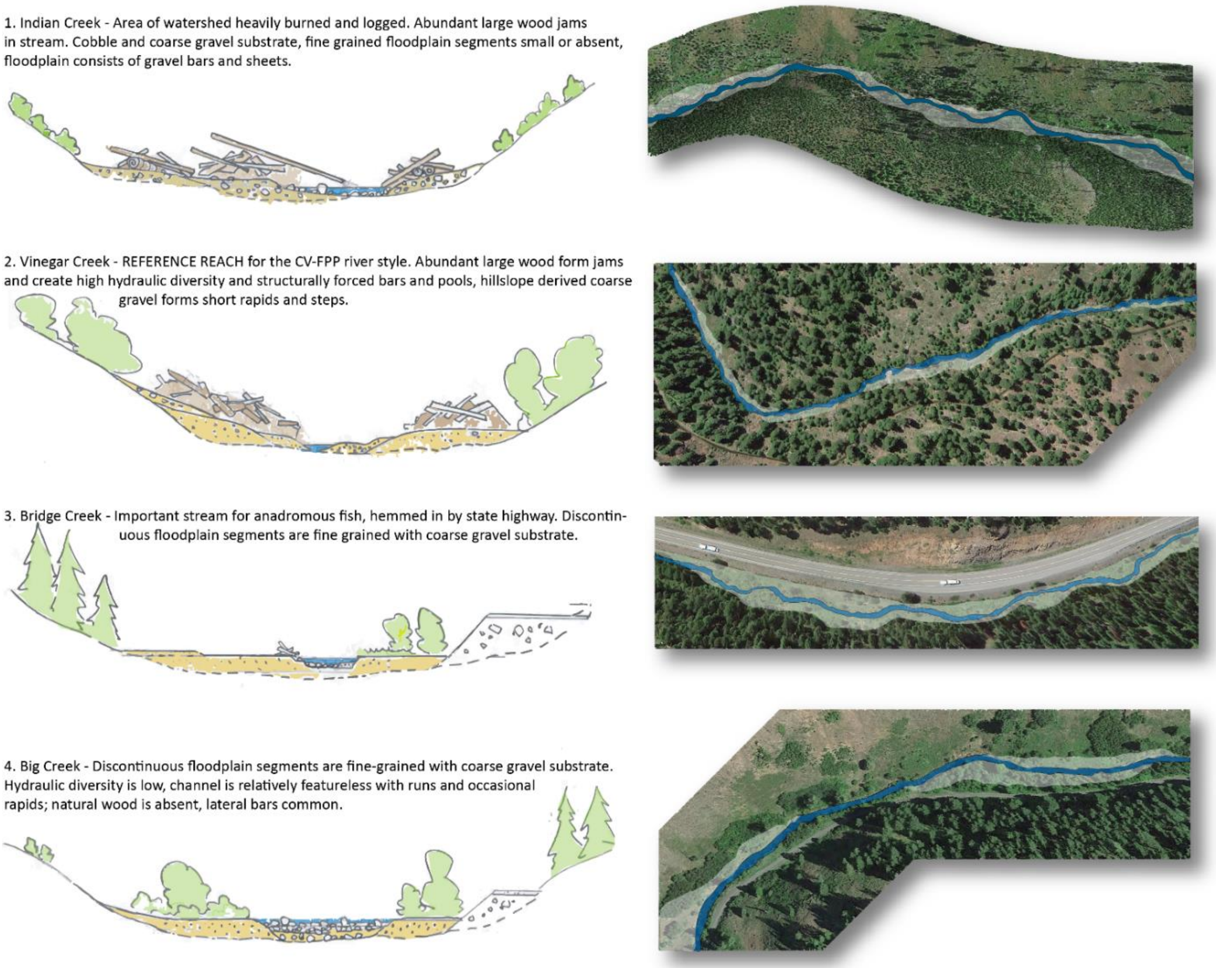
what range of geomorphic variability is possible?



Confined valley setting

Laterally unconfined valley setting

RECOGNIZING CONDITION VARIANTS AND THEIR GU ASSEMBLAGES…



Reference Reach—

- Diverse instream/floodplain GU's (bars, pools, channels)
- Structurally forced heterogeneity (abundant wood)
- Free of human development
- Healthy riparian cover

GEOINDICATORS → CONDITION

- *Geoindicators* set stage for assessment of geomorphic condition….
- Reach type specific geoindicators

Degrees of Freedom and their relevant Geoindicators	Questions to be answered to assess geomorphic condition of each reach of the Alluvial Meandering River Style.	Clear Creek	MF John Day (near Bates)	MF John Day (Oxbow area)	MF John Day (near Bates)
Channel Attributes (2 out of 3)	**3 out of 4 questions must be answered YES For stream to be assessed in GOOD condition**				
Size	Is channel size appropriate given the catchment area, the prevailing sediment regime, and the vegetation character?	✓	X	X	X
Bank	Is the bank morphology consistent with caliber of sediment? Are banks eroding in the correct places?	✓	X	X	X
Woody Debris Loading	Is there woody debris in the channel or potential for recruitment of woody debris?	✓	X	✓	X
		✓	X	X	X
Channel Planform (3 out of 5)	**3 out of 4 questions must be answered YES**				
Number of Channels	Is the channel single thread as appropriate for this river style? Are there signs of change such as avulsions or overbank channels forming on the floodplain?	✓	✓	✓	X
Geomorphic Unit Assemblage	Are the number, type and pattern of instream geomorphic units appropriate for the sediment regime, slope, bed material and valley setting? Are key units of *this* River Style present (riffles, pools, plane bed runs & glides, cutbanks, point bars)?	✓	X	X	X
Riparian Vegetation	Are the appropriate types and density of riparian vegetation present on the banks?	✓	X	✓	X
		✓	X	✓	X
Bed Character (3 out of 4)	**3 out of 4 questions must be answered YES**				
Grain Size and Sorting	Is the range of sediment throughout the channel and floodplain organized and distributed appropriately?	✓	✓	✓	X
Bed Stability	Is the bed vertically stable such that it is not incising or aggrading inappropriately for the channel slope, sediment caliber, and sinuosity?	✓	✓	✓	X
Sediment Regime	Is the sediment storage and transport function of the reach appropriate for the catchment? position (i.e., is it a sediment transfer or accumulation zone?)?	✓	X	✓	X
Hydraulic diversity	Are roughness characteristics and the pattern of hydraulic diversity appropriate for the catchment position?	✓	✓	✓	X
		✓	✓	✓	X
		✓	X	X	X
Geomorphic Condition	Total ticks and crosses are added for each stream reach	**Good**	**Moderate**	**Moderate**	**Poor**

BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

EXPLANATION OF GEOMORPHIC CONDITION

Degree of Freedom	Good Condition	Moderate Condition	Poor Condition
Channel Attributes	Steep-sided asymmetrical cross section within a fine-grained sand to mud floodplain. Bank erosion is minimal. Channel bed is free of vegetation except for occasional tussock grasses. ☑	Steep-sided asymetric cross section within a fine-grained sand to mud floodplain. Bank erosion rate is correct for fine-grained floodplain and steep banks, but restoration projects have inserted large wood that is focused only at bends, to "prevent erosion" (will retard natural tendency to adjust). Channel shape and size are consistent, yet bank erosion is irregular as indicated by a greater abundance of channel margin tussock stands ☑	Original channel has been dredged in extensively, so width-depth ratio is uneven and shape inconsistent. Channel size is OK for catchment, but there are multiple channels and diversions. Banks have been armored with coarse bed material, creating uneven erosion rates and characteristics. ☒
Channel Planform	Irregular, moderate to high sinuosity planform, well-connected to floodplain, occasional overbank crevasse-splays and channel cutoffs developed. Riparian vegetation consists of scattered woody stands with rich grass cover on floodplain, partly influencing meander development. Abundant recruitment of woody debris plays role in channel shape and sinuosity as well as forcing bars and pools ☑	irregular, moderate to high sinuosity planform, adjustment is gradual on scale of decades, not years; well-connected to floodplain, channel cutoffs developed. Riparian vegetation is very scattered with few woody stands, but rich grass cover on floodplain. Emplaced wood is abundant through the restoration reach, but is distributed only at bends and not likely to play a role in channel shape and sinuosity as well as forcing bars and pools. Bed is stable. Geomorphic units are not well-developed, as restoration was recent. ☑	Planform has been truncated and straightened to accommodate placer mining activites. New channels were dug, making the number and shape of channels inappropriate for the catchment size. Sinuosity is correct where the natural channel trace is preserved, but flow characteristics are affected by multiple channels and ponds. Geomorphic units are appropriate in original channel, but are restricted to featureless plane bed where dredging has occurred. Channel-floodplain connectivity is impossible owing to levee of coarse, dredged bed material now placed on banks. Artificial backwaters and ponds produced by disruption of tributary access to mainstem Middle Fork John Day River. ☒
Bed Material	Segregated, bi-modal sediment mix, with channel bed composed of coarse gravel and cobble; coarse sediment projects beneath Floodplain composed of fine sand, silt and mud. ☑	Segregated, bi-modal sediment mix, with channel bed composed of coarse gravel and cobble; coarse sediment forms planar geomorphic units, with little diversity (pool-riffle sequences and cutbanks) ☒	Bed and bank material has been overturned and mixed except in places where original channel was not directly dredged. Integrated coarse gravel and cobble substrate. ☒

Camp Creek, Middle Fork John Day Watershed

Middle Fork John Day River

Middle Fork John Day River Near Galena, OR.

Important 'cause it sets the stage for informed restoration/rehabilitation efforts, AND *Helps avoid misdirected manipulation of geomorphic attributes*

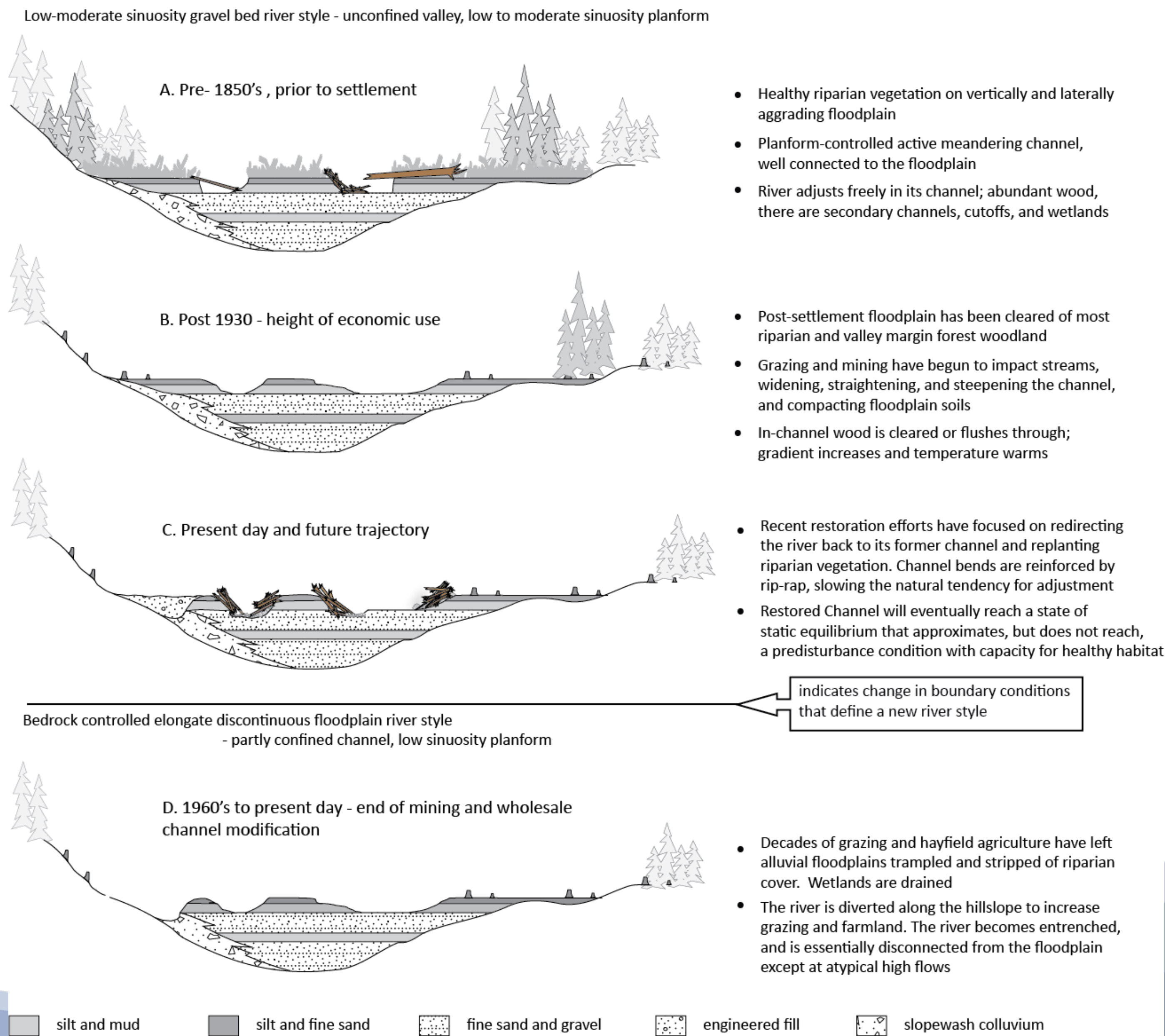
ISEMP

CHaMP

HISTORIC RECONSTRUCTION

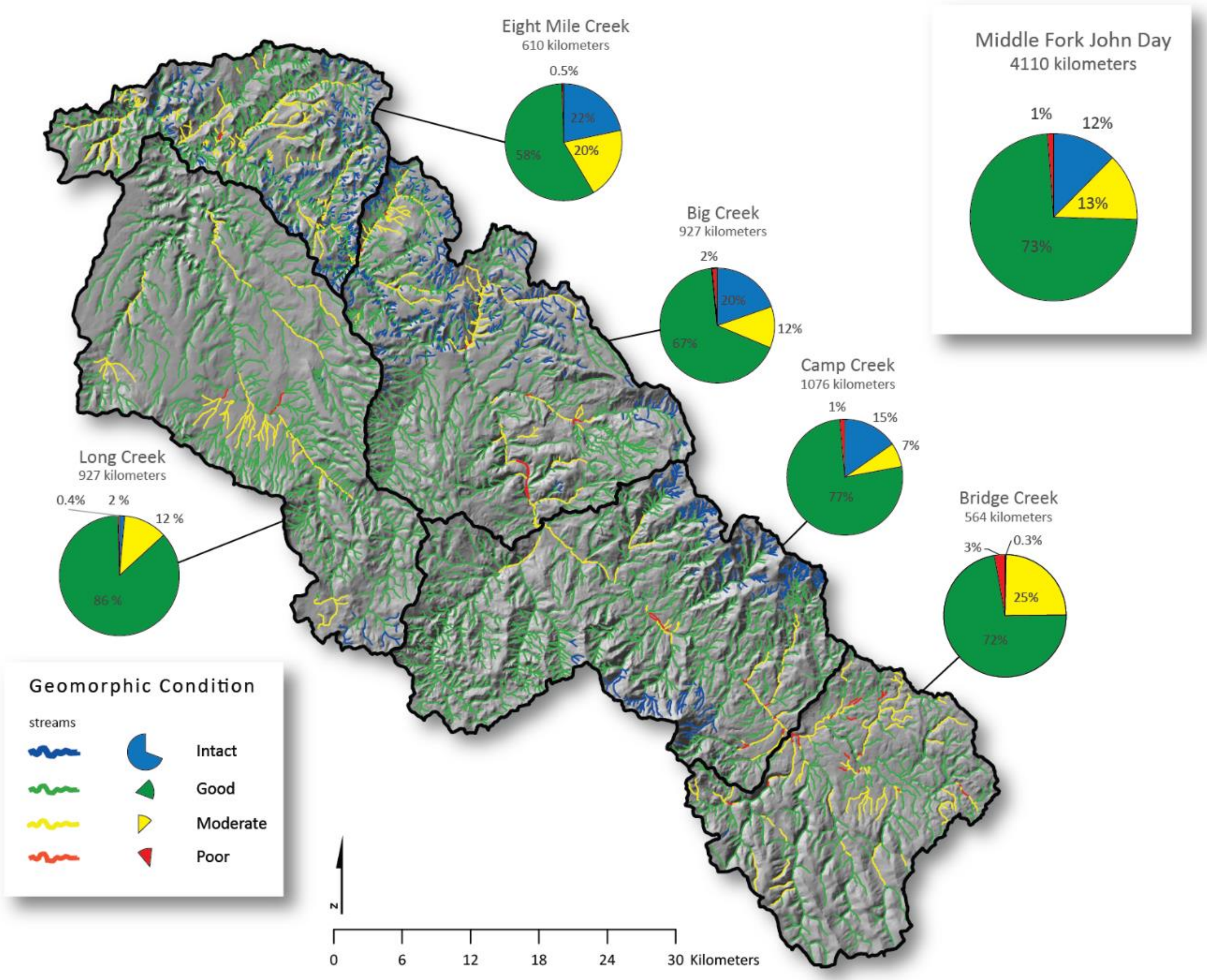
Variants of each river style show departure from the *intact, pristine condition.*

Evolution diagrams trace effects of impacts or pathways of geomorphic change.

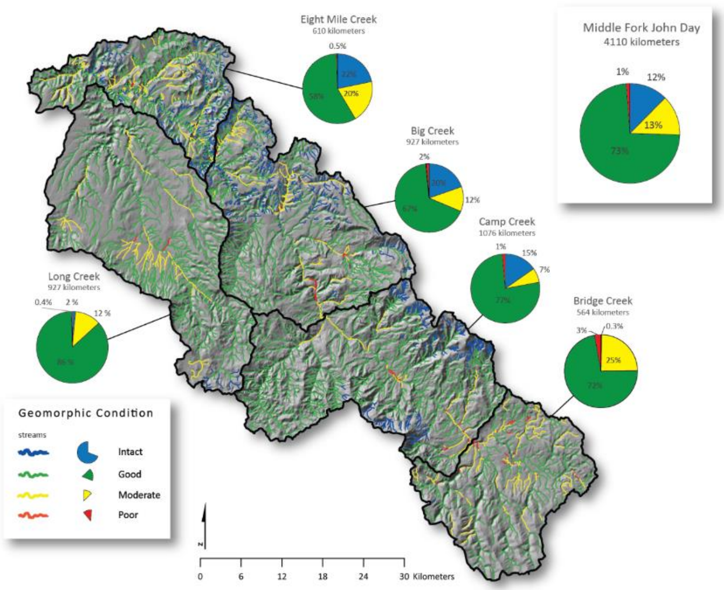


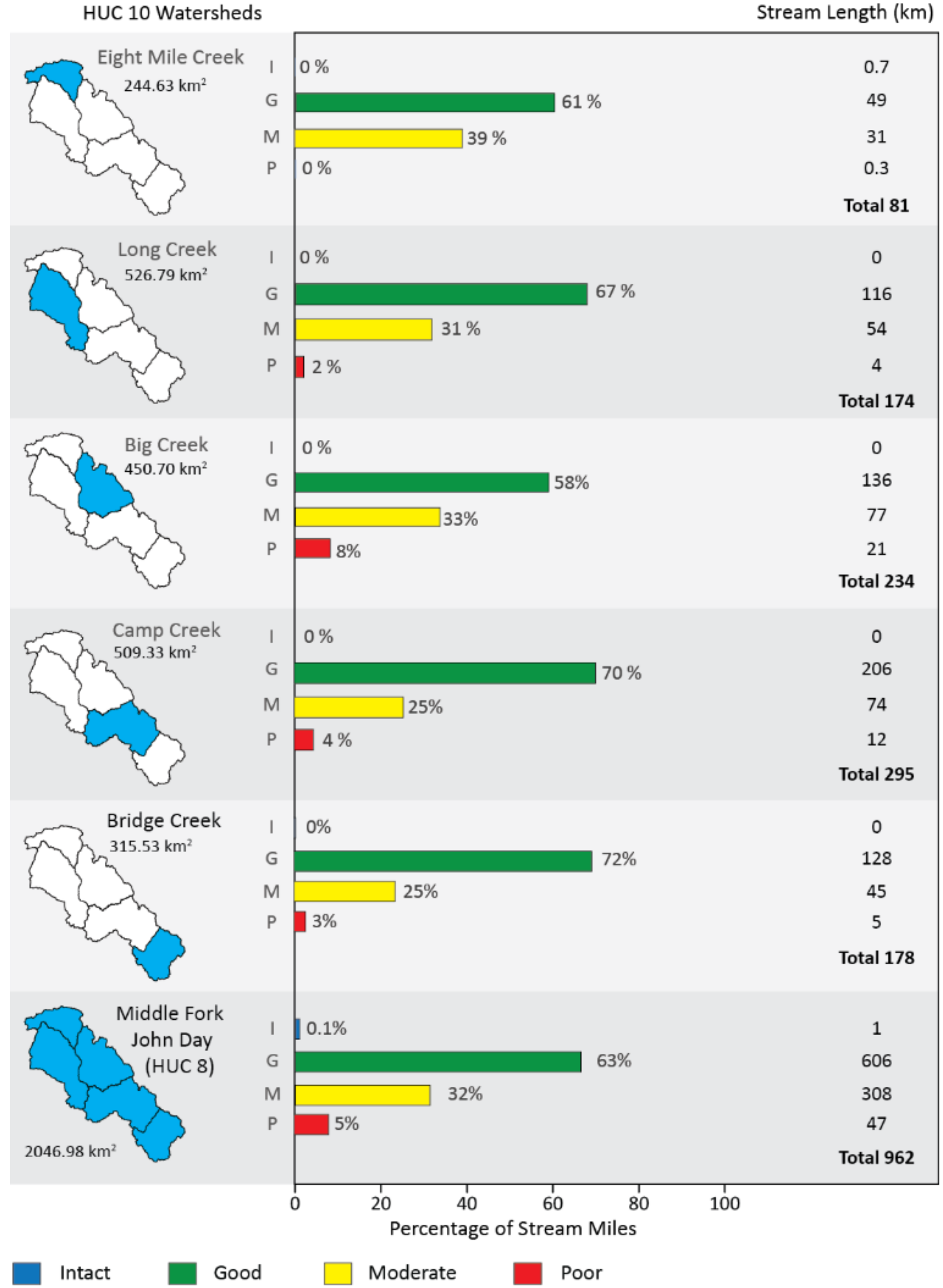
GEOMORPHIC CONDITION MAP

CONDITION MAPS



GEOMORPHIC CONDITION SUMMARY





EXERCISE: EXPLORING GEOMORPHIC CONDITION

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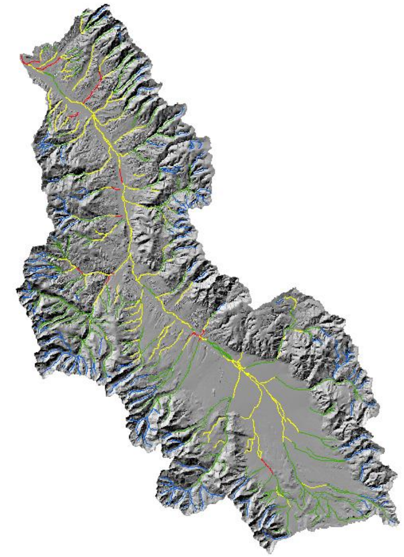
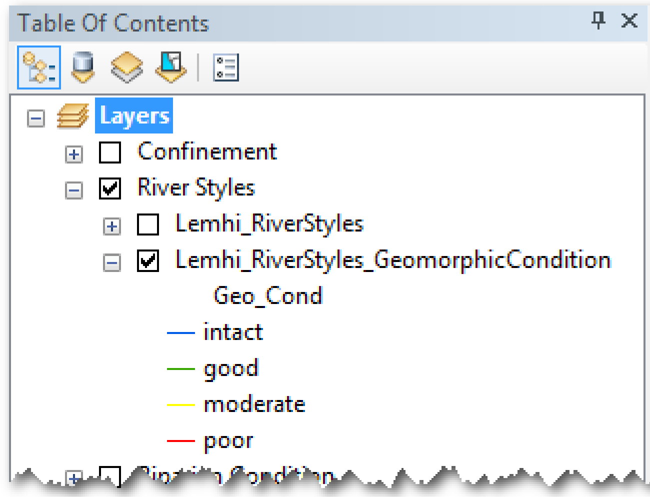
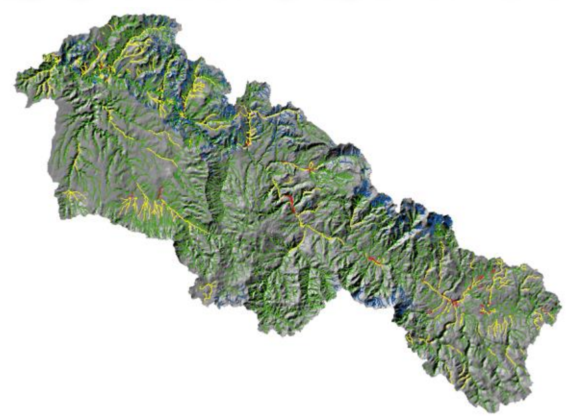
C:\0_GNAT\CHaMPWorkshopLemhiGNAT.mxd



1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on *_RiverStyles_Geomorhpic Condition





CHaMP Columbia Habitat Monitoring Program

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RIPARIAN VEGETATION CONDITION ASSESSMENT (PROCESS)

- Inputs:
  1. LANDFIRE Existing Vegetation Type (EVT) representing current (2012) vegetation
  2. LANDFIRE Biophysical Settings (BpS) estimated pre-settlement condition

  Coding:
  1. Native riparian vegetation classes coded as a 1
  2. All other land cover classes coded as a 0

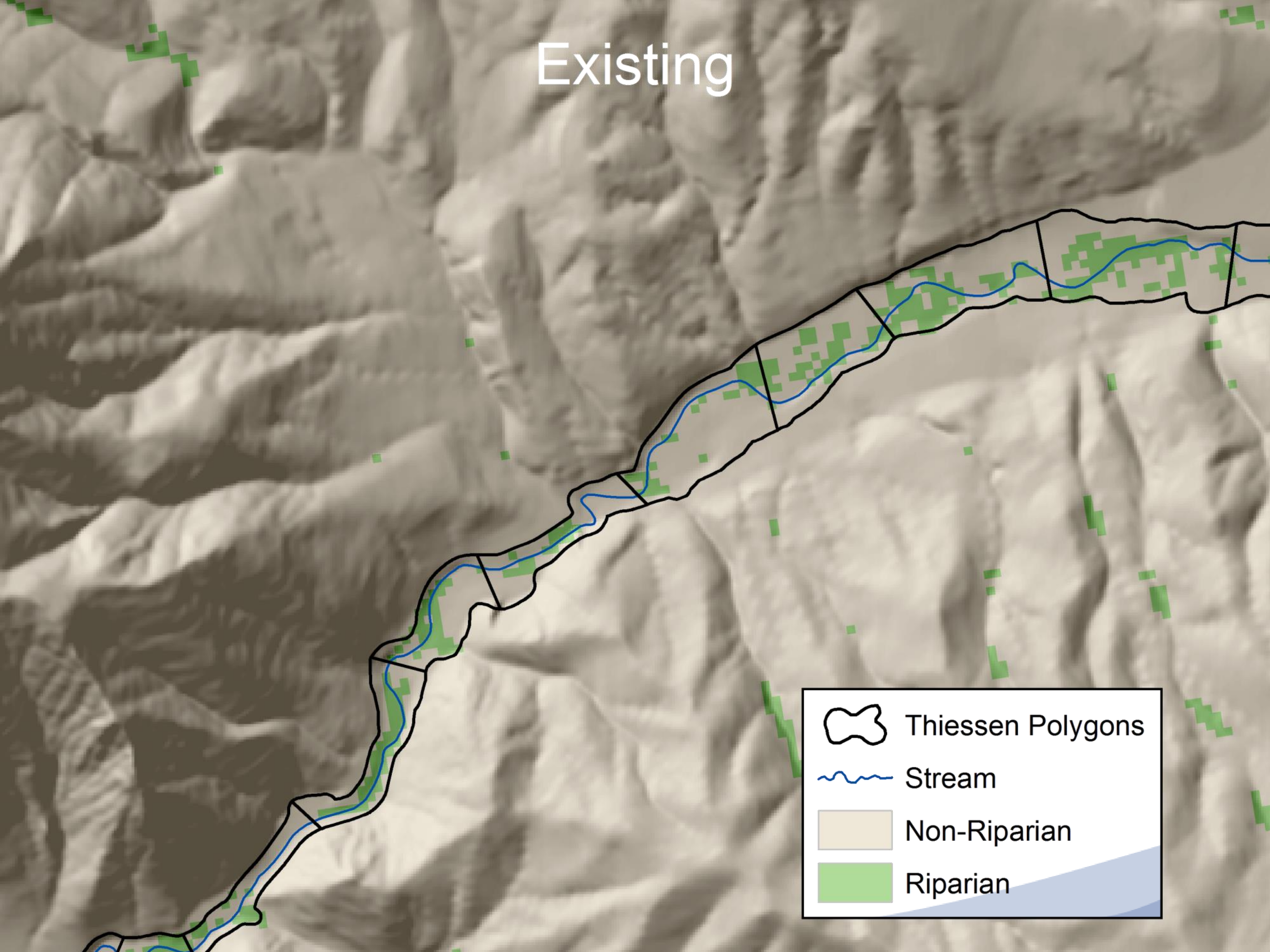
RIPARIAN VEGETATION CONDITION ASSESSMENT (PROCESS)

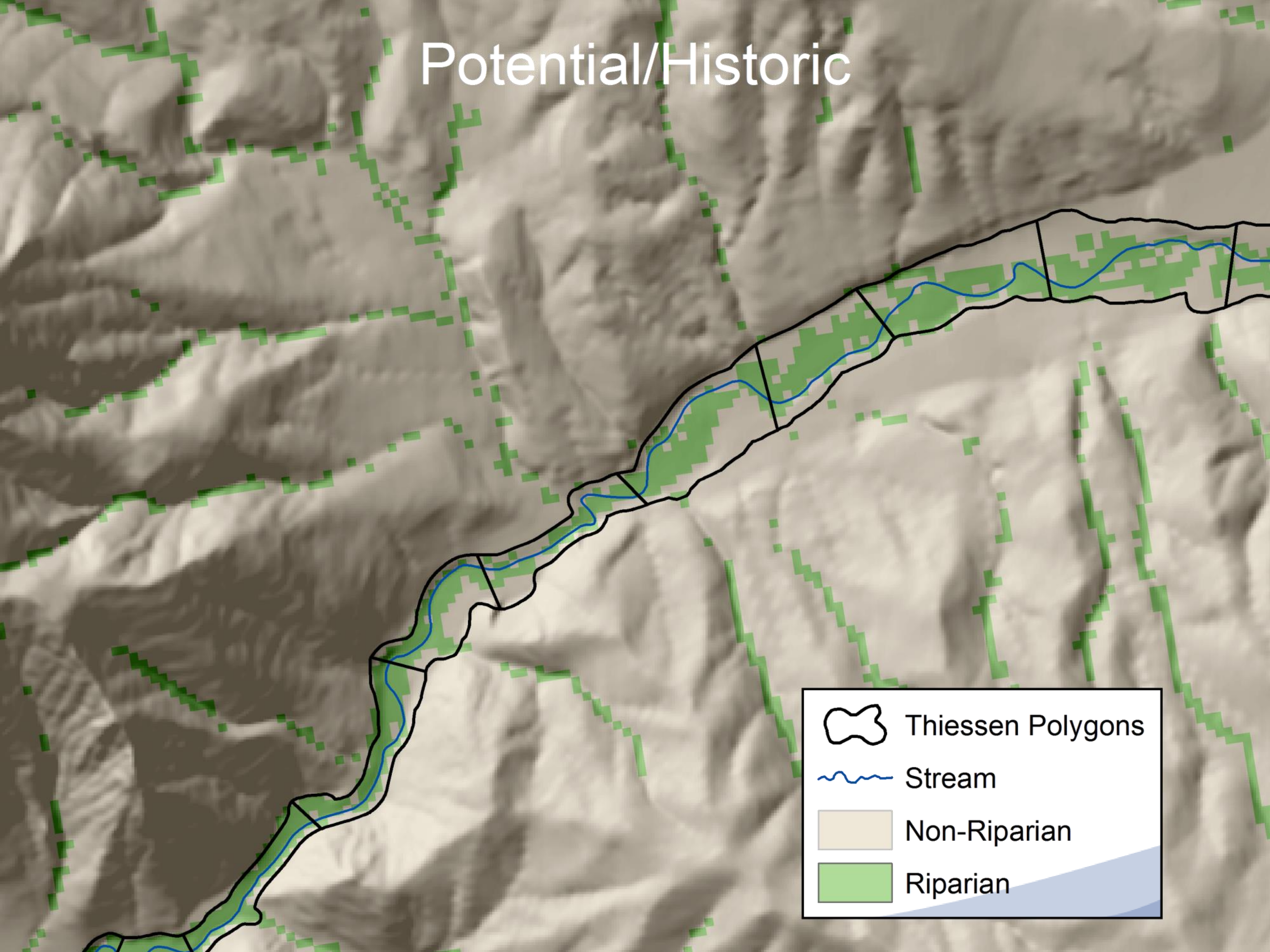
Condition is based on the **deviation from the pre-settlement condition.**

- A dimensionless **ratio** was calculated: *(mean EVT vegetation value)/(mean BpS vegetation value).*
  - Values **closer to 0** represent **degraded** condition
  - Values **near 1** represent **good** condition
  - Values of **1 or above** represent **intact** condition

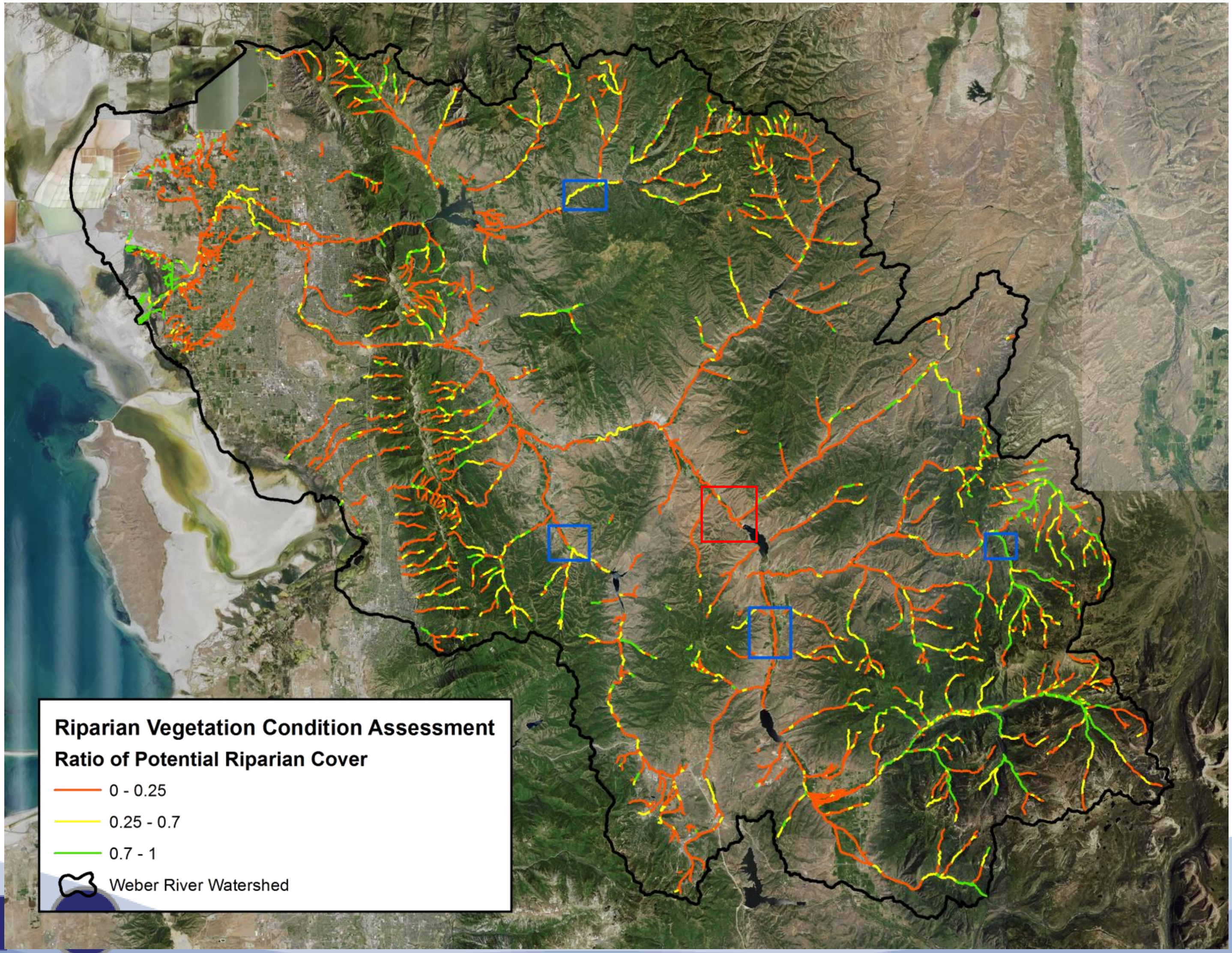
Output: Basin-wide reach level (1 km) condition assessment map.

Existing



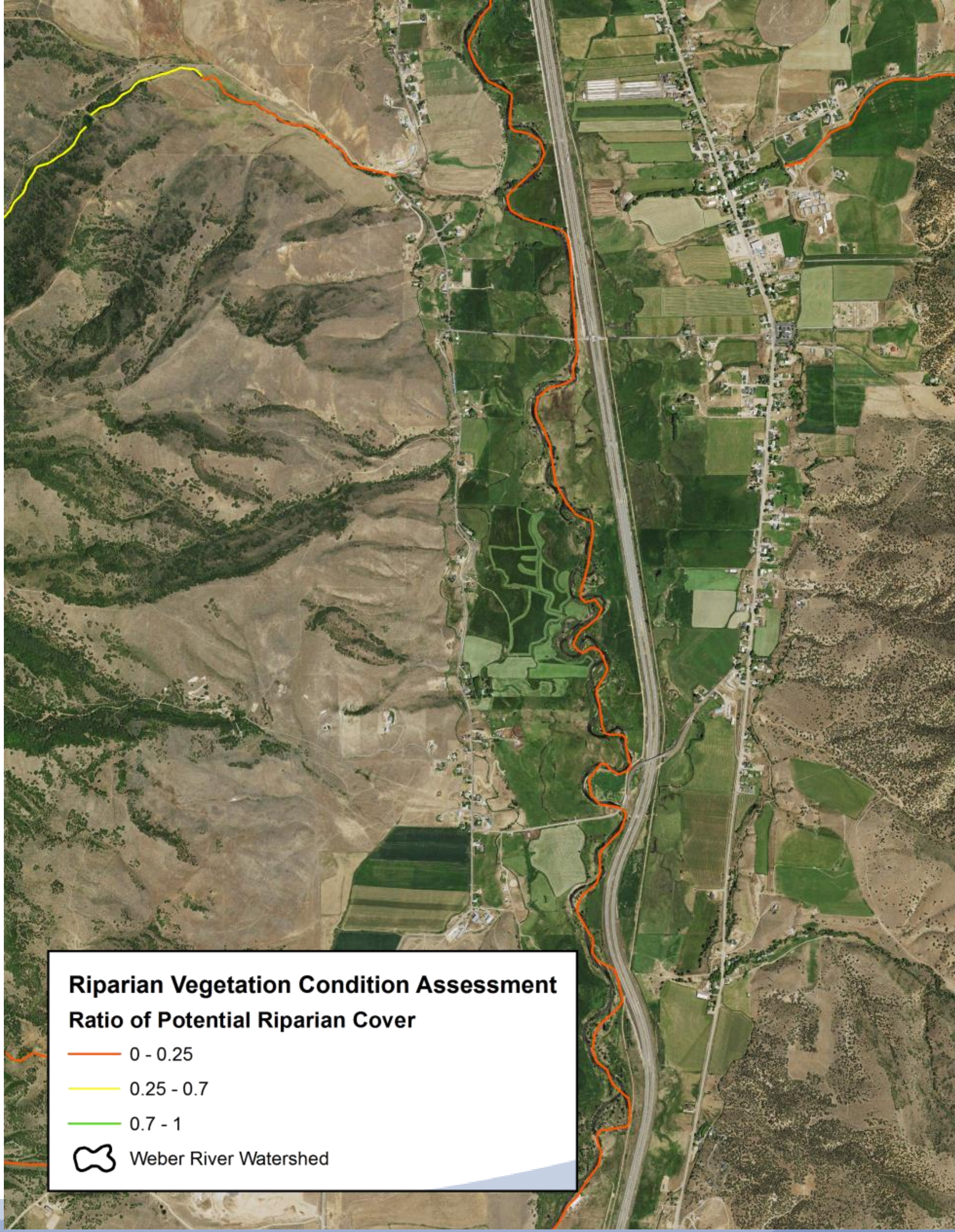

Potential/Historic
Thiessen Polygons
Stream
Non-Riparian
Riparian

RIPARIAN VEGETATION CONDITION ASSESSMENT (DRAFT RESULTS)

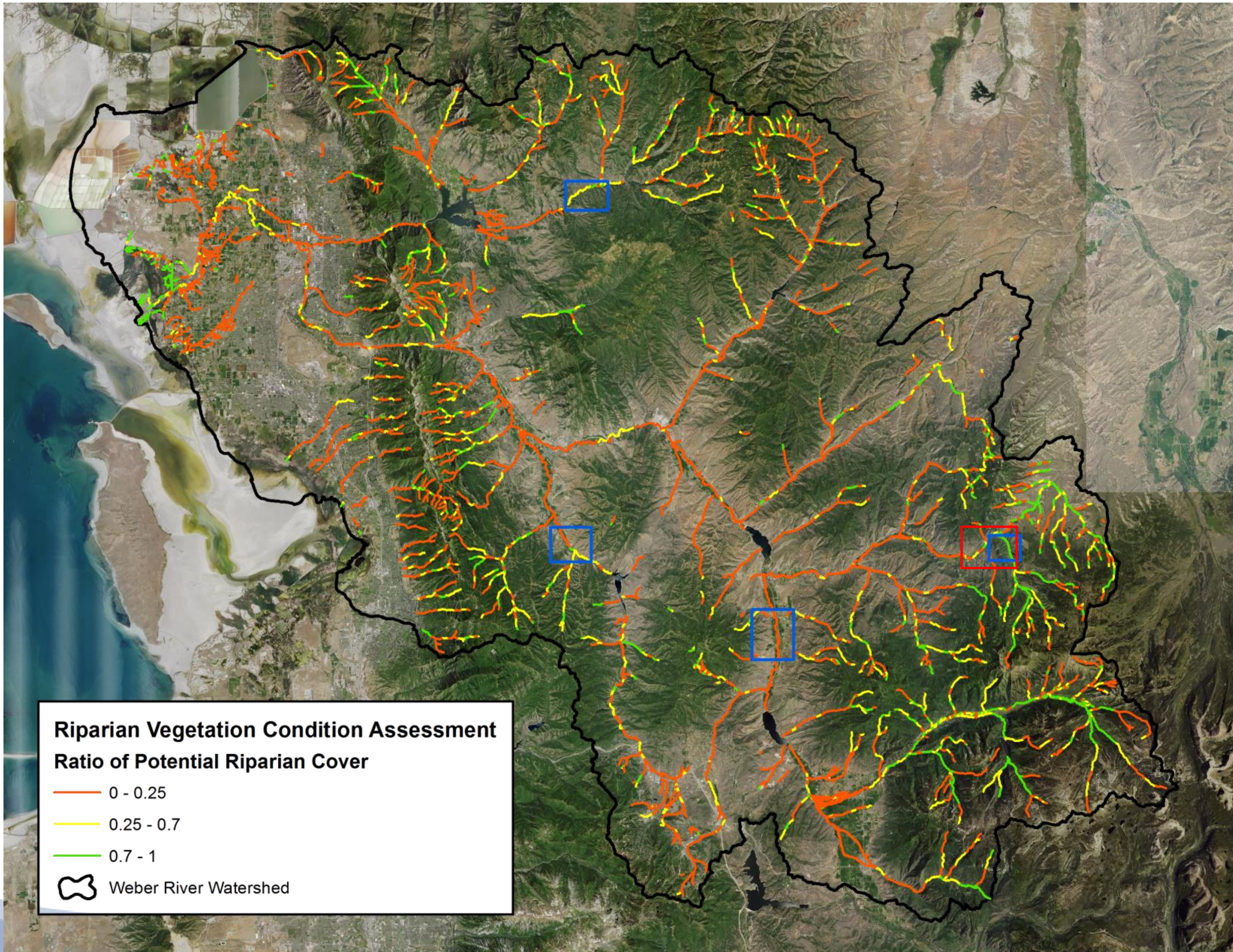


RIPARIAN VEGETATION CONDITION ASSESSMENT

(POOR COND.)

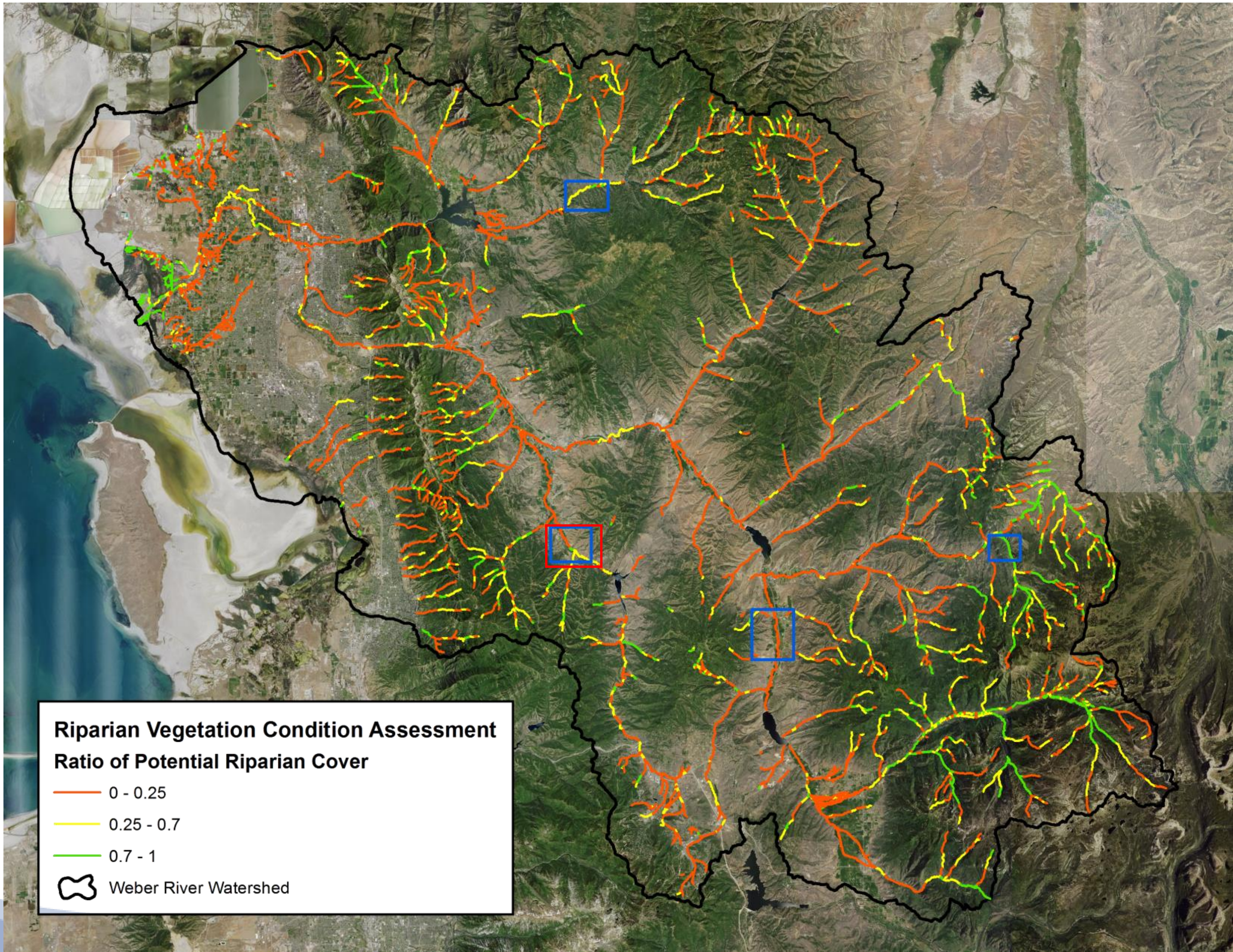


RIPARIAN VEGETATION CONDITION ASSESSMENT (DRAFT RESULTS)

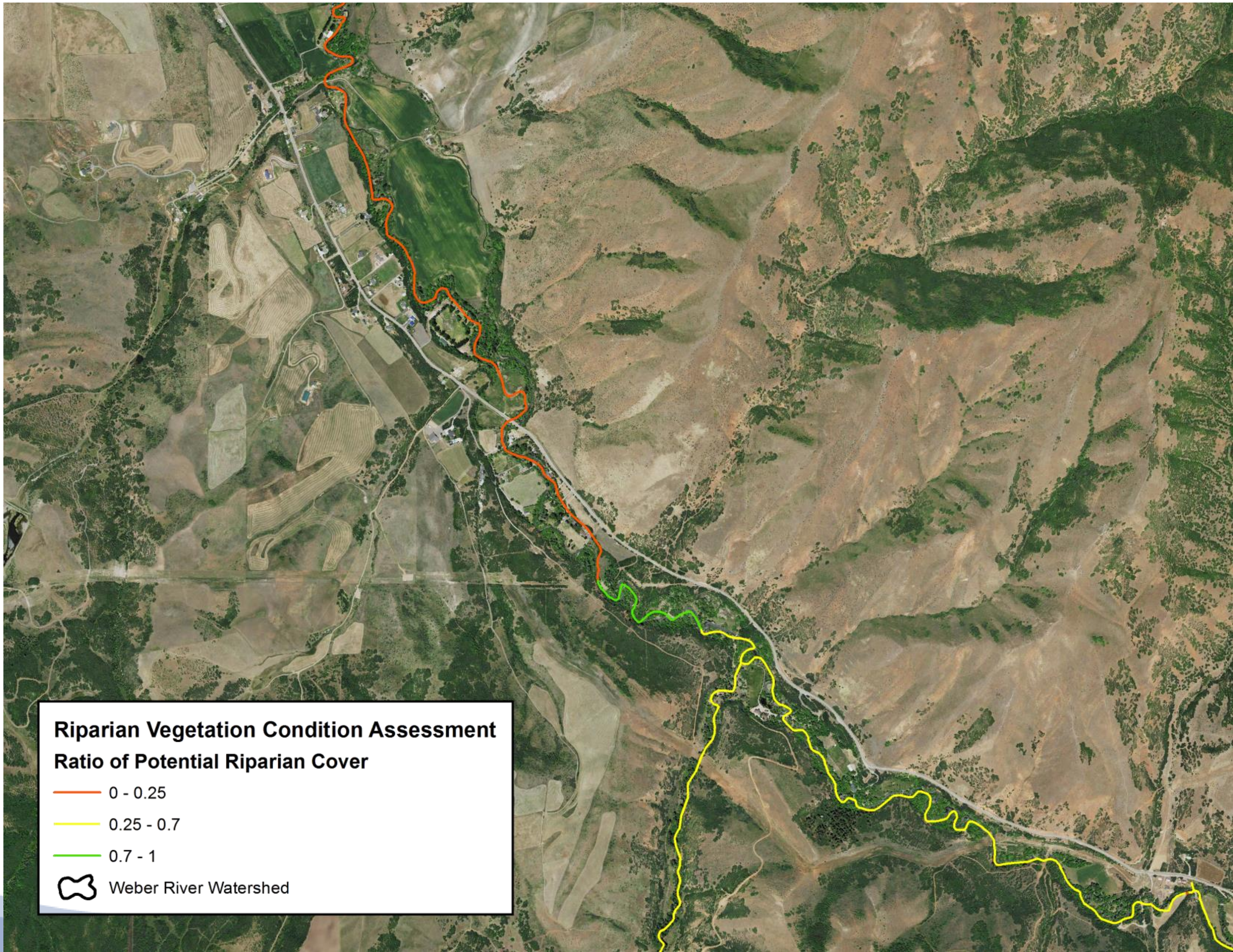


RIPARIAN VEGETATION CONDITION ASSESSMENT (GOOD COND.)

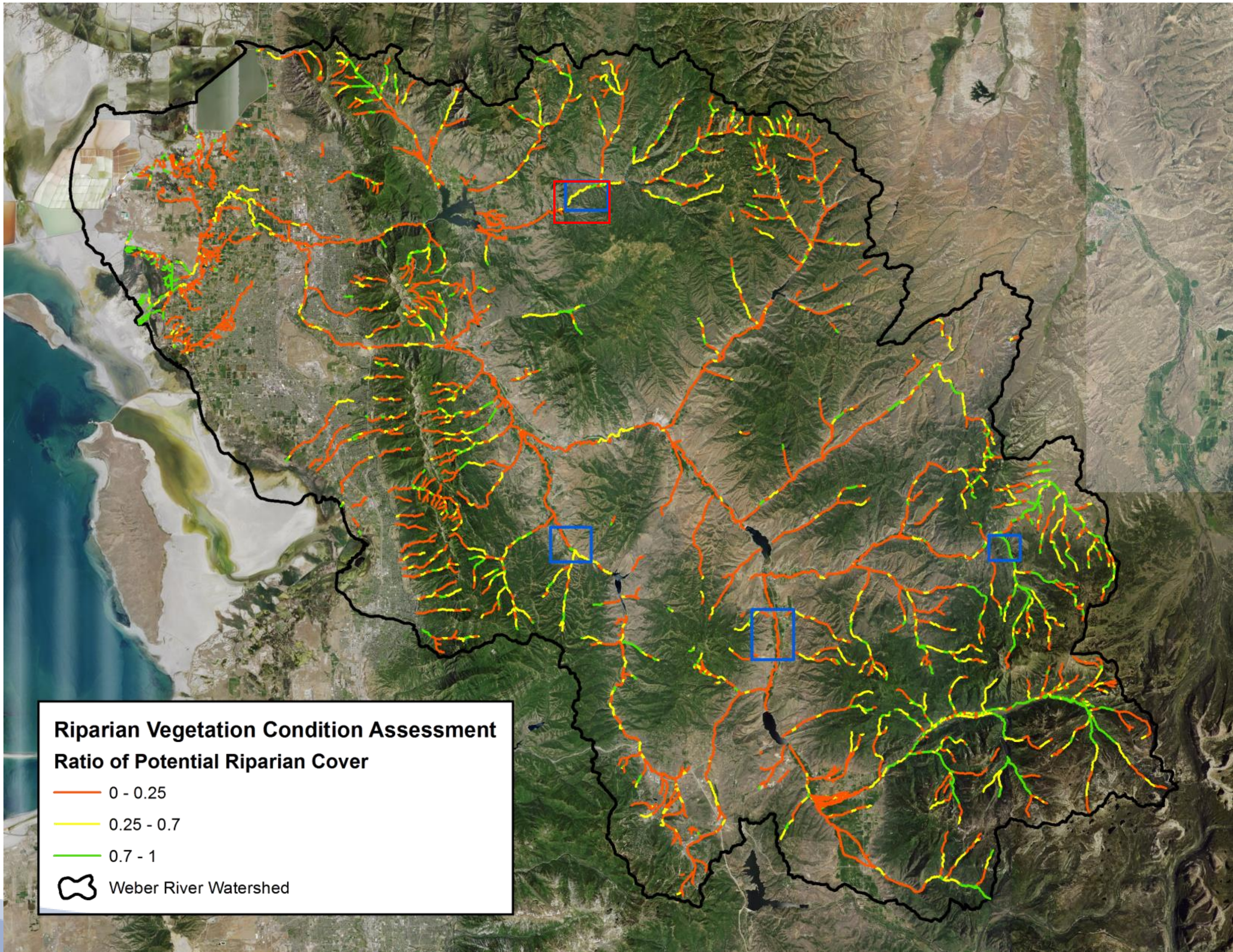
RIPARIAN VEGETATION CONDITION ASSESSMENT (DRAFT RESULTS)



RIPARIAN VEGETATION CONDITION ASSESSMENT (MIXED)



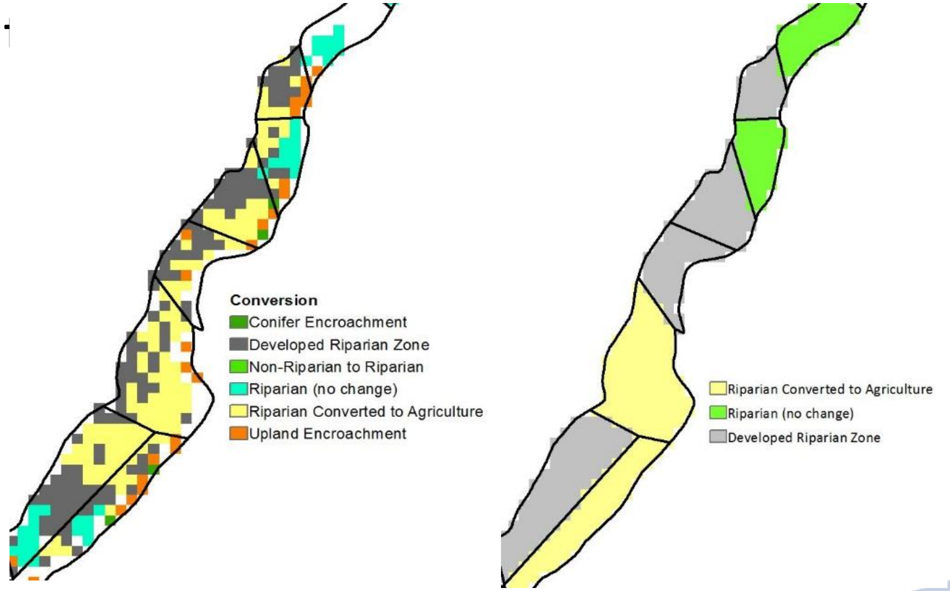
RIPARIAN VEGETATION CONDITION ASSESSMENT (DRAFT RESULTS)

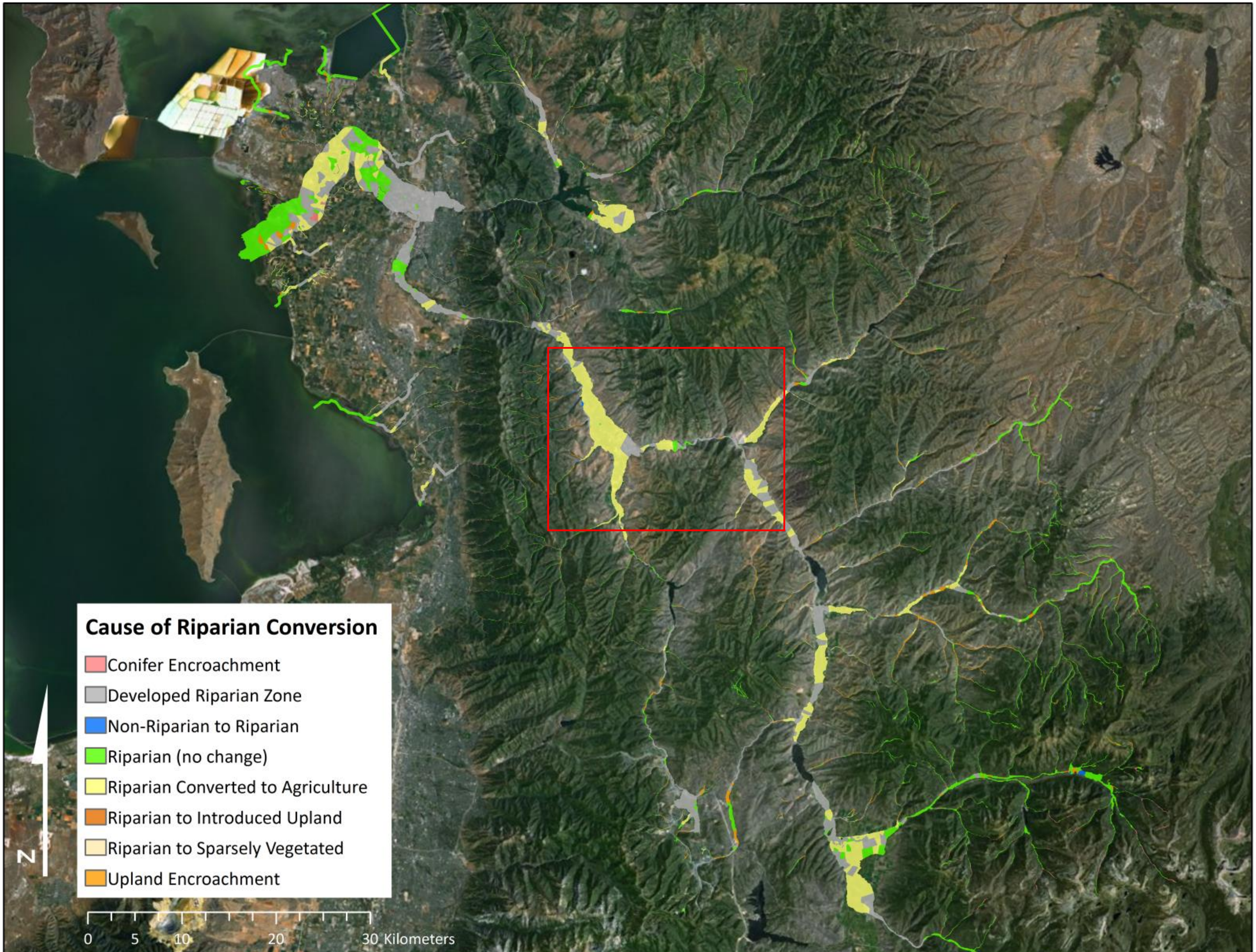


RIPARIAN VEGETATION CONDITION ASSESSMENT (MIXED)

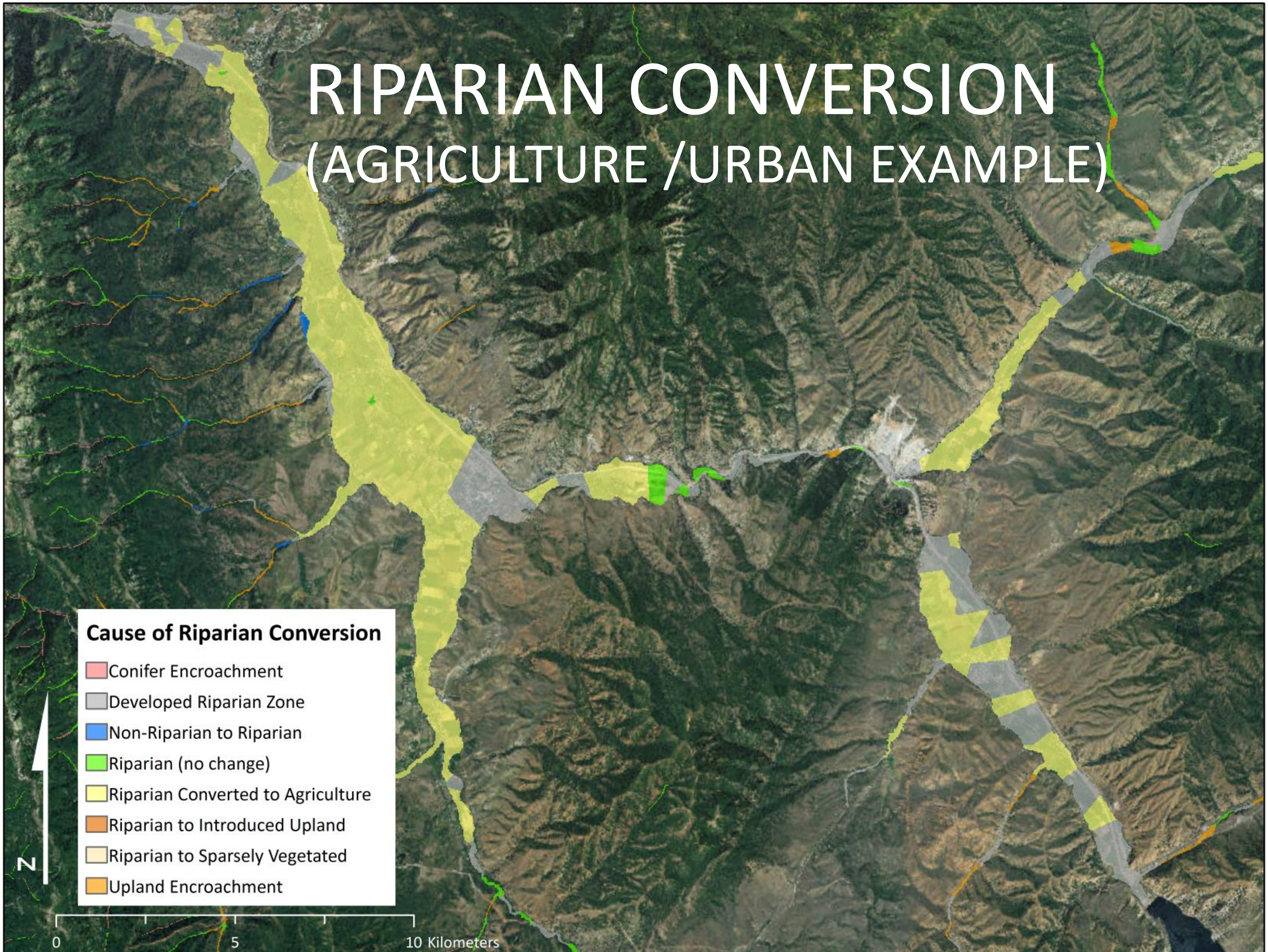
RIPARIAN CONVERSION ASSESSMENT
(PROCESS)

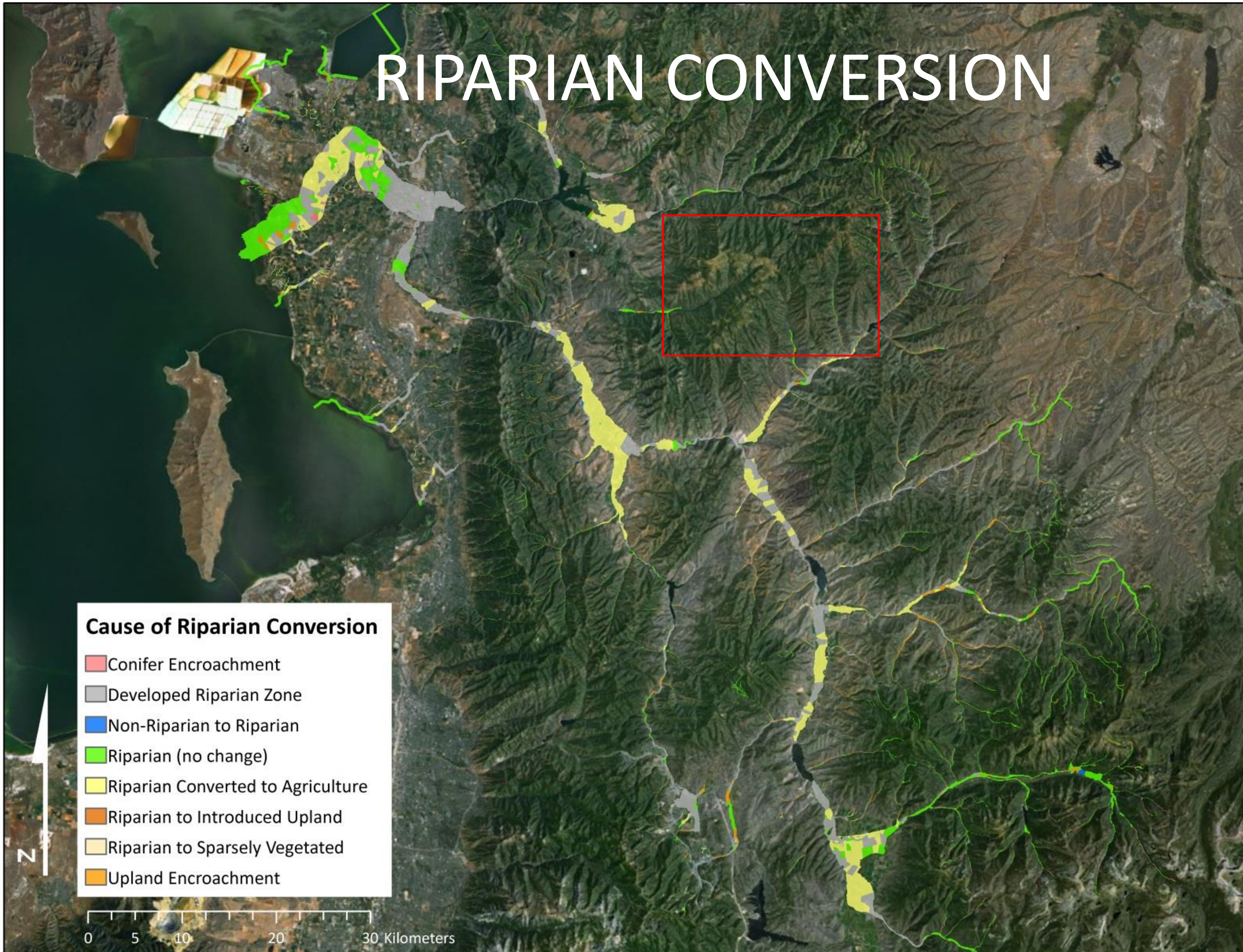
- The Bps and EVT lookup rasters are added together.
  - The pixel values in the new raster represent the type of conversion (i.e. conifer encroachment, conversion to agriculture)
- The number of each type of conversion pixels is counted
- Each polygon is represented by the conversion type with the **majority** of pixels within i



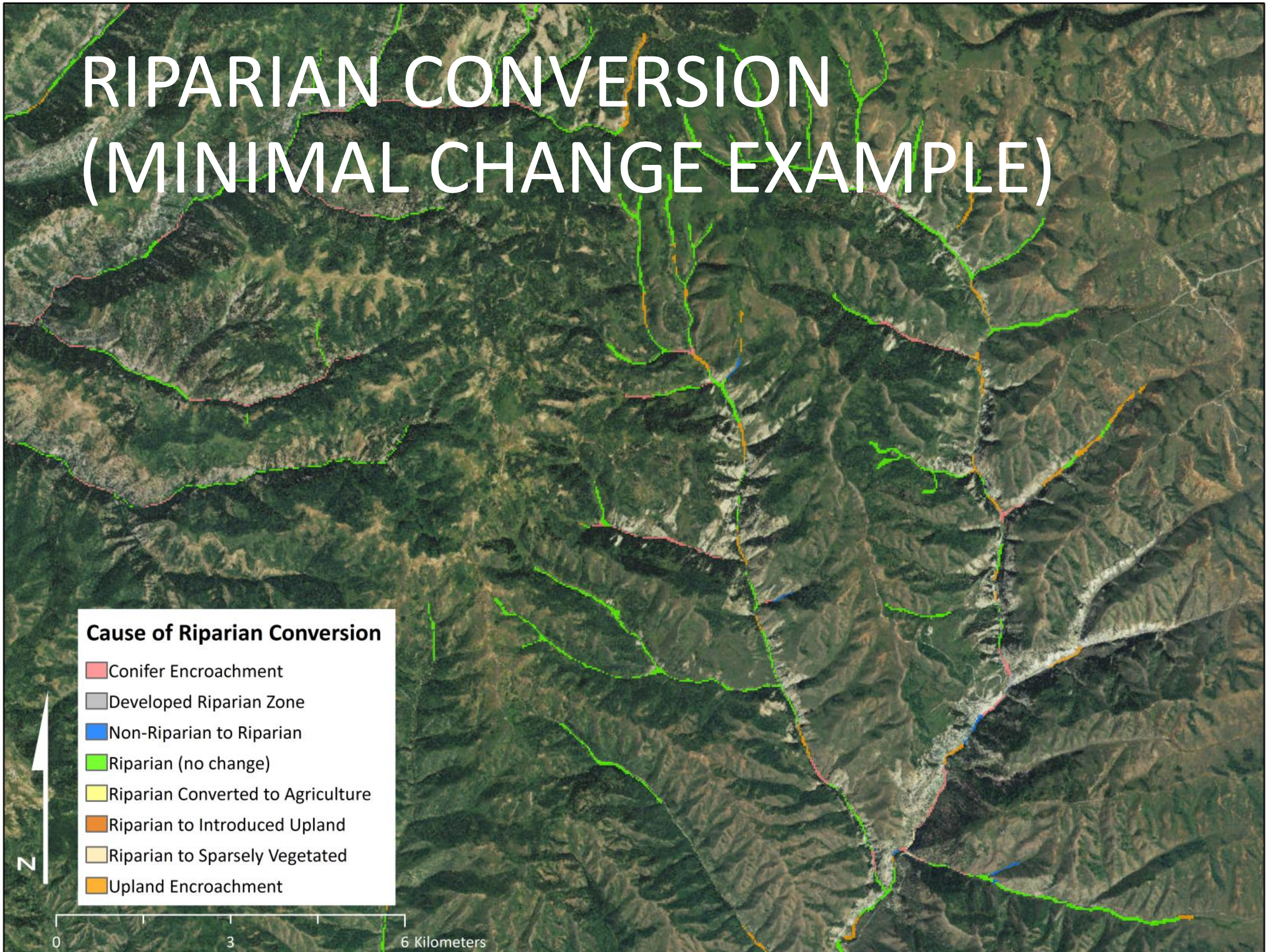


Cause of Riparian Conversion
Conifer Encroachment
Developed Riparian Zone
Non-Riparian to Riparian
Riparian (no change)
Riparian Converted to Agriculture
Riparian to Introduced Upland
Riparian to Sparsely Vegetated
Upland Encroachment
N
0
5
10
20
30 Kilometers

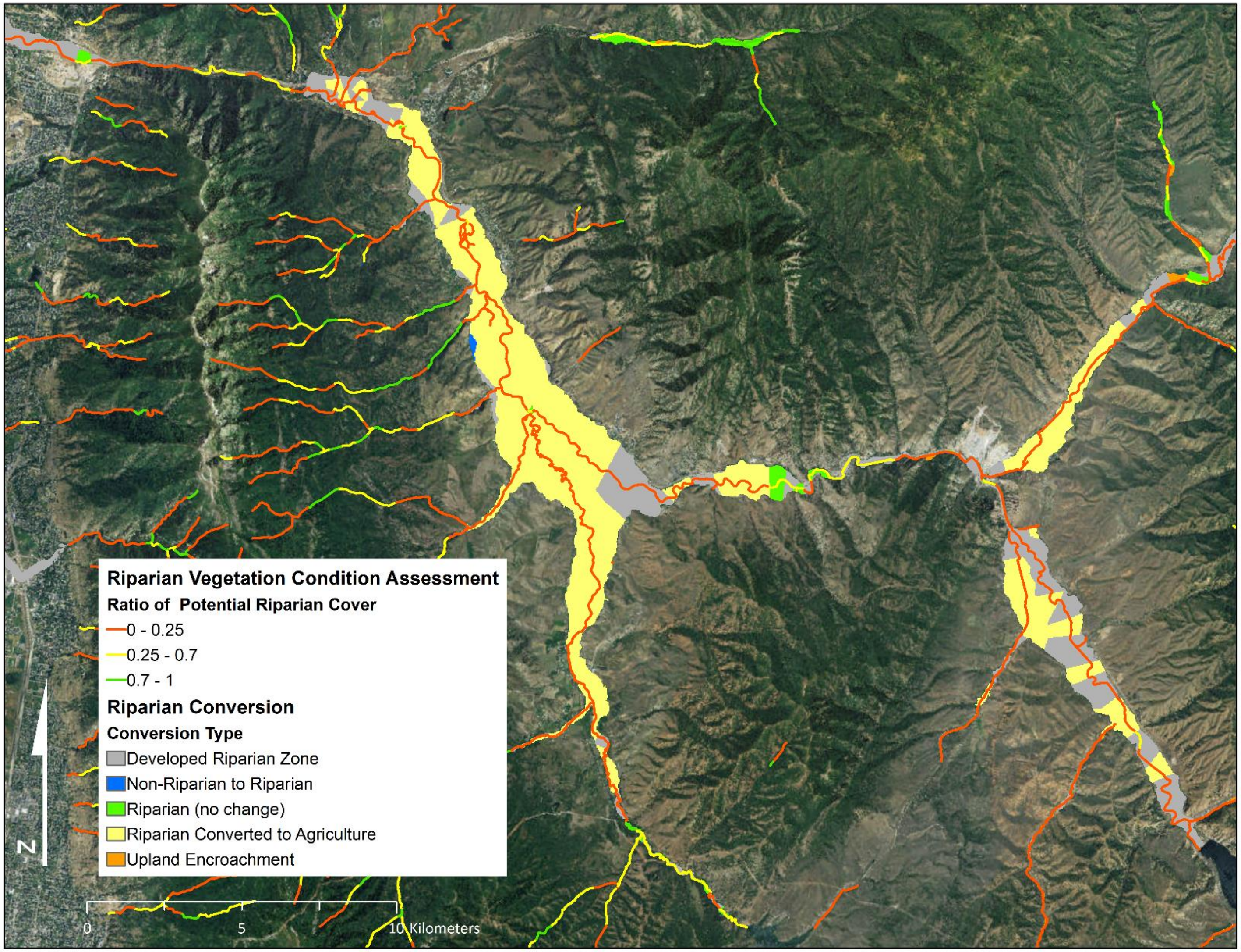

RIPARIAN CONVERSION
(AGRICULTURE /URBAN EXAMPLE)
Cause of Riparian Conversion
Conifer Encroachment
Developed Riparian Zone
Non-Riparian to Riparian
Riparian (no change)
Riparian Converted to Agriculture
Riparian to Introduced Upland
Riparian to Sparsely Vegetated
Upland Encroachment
N
0
5
10 Kilometers


RIPARIAN CONVERSION
Cause of Riparian Conversion
Conifer Encroachment
Developed Riparian Zone
Non-Riparian to Riparian
Riparian (no change)
Riparian Converted to Agriculture
Riparian to Introduced Upland
Riparian to Sparsely Vegetated
Upland Encroachment
N
0 5 10 20 30 Kilometers

RIPARIAN CONVERSION (MINIMAL CHANGE EXAMPLE)



Rip

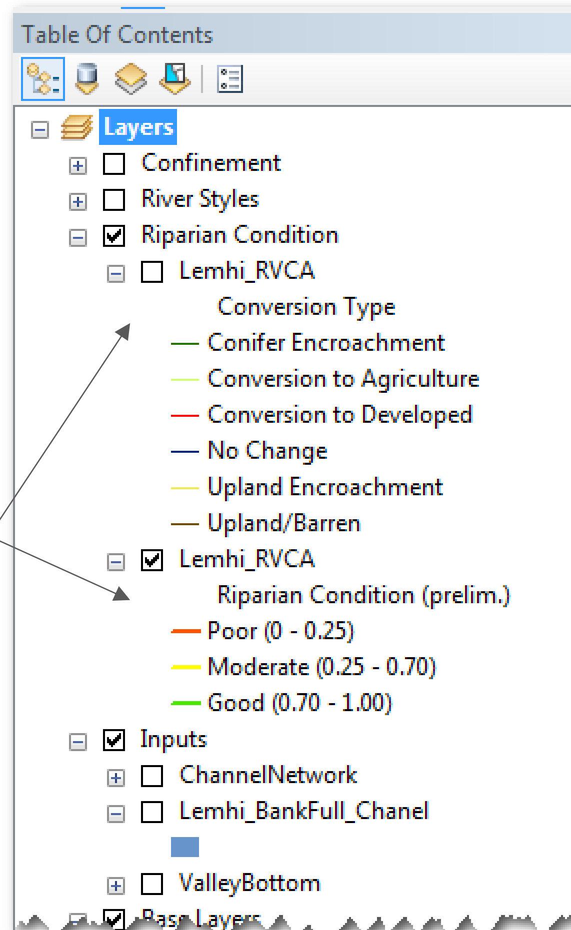


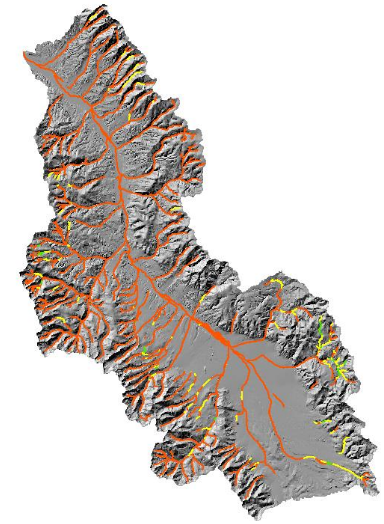
Riparian Vegetation Condition Assessment
Ratio of Potential Riparian Cover
0 - 0.25
0.25 - 0.7
0.7 - 1
Riparian Conversion
Conversion Type
Developed Riparian Zone
Non-Riparian to Riparian
Riparian (no change)
Riparian Converted to Agriculture
Upland Encroachment
N
0
5
10 Kilometers

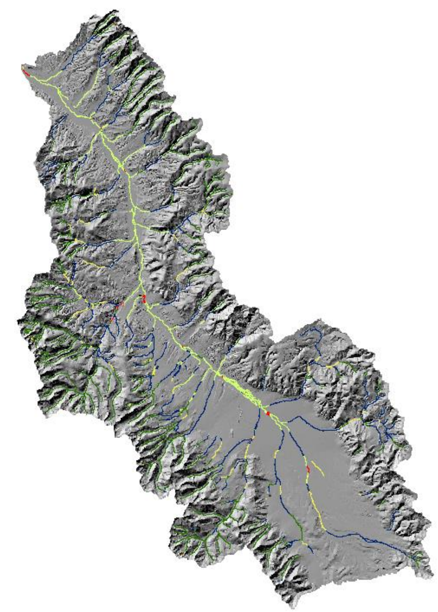
EXERCISE: EXPLORING PRELIMINARY RIPARIAN CONDITION

```
C:\0_GNAT\CHaMPWorkshopLemhiGNAT.mxd
```

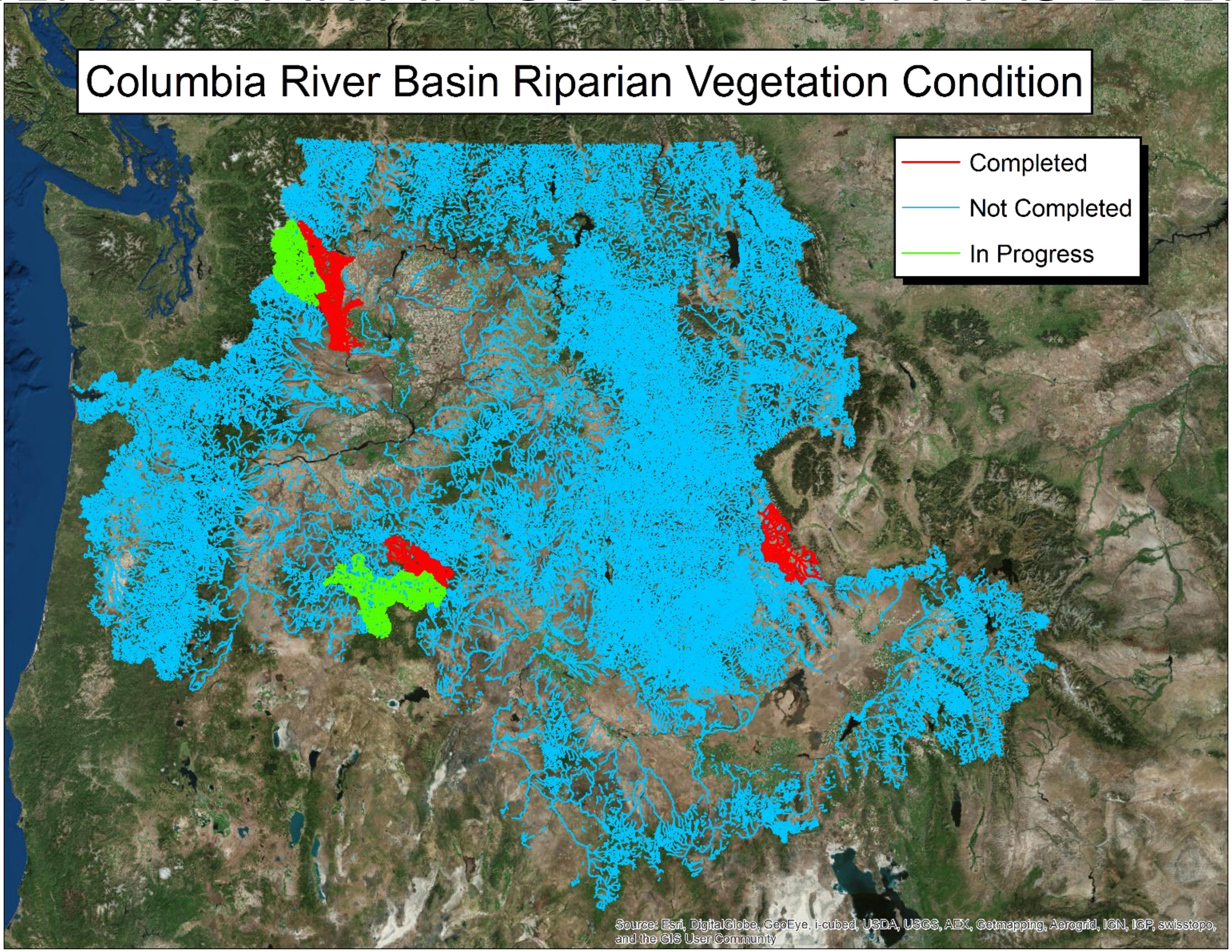
1. Make sure you have some context turned on (e.g. hillshade or NAIP)
2. Turn off other network layers
3. Turn on only Riparian Condition First
4. Next Explore Conversion Type







WHERE RIPARIAN CONDITION HAS BEEN RUN



- Middle Fork John Day
- South Fork John Day
- Lemhi
- Wenatchee
- Entiat

CHaMP Columbia Habitat Monitoring Program

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   - I. Geomorphic Condition
   - II. Riparian Condition
   - **III. Habitat & Population Condition**

IV. Recovery Potential
   - I. Geomorphic Recovery Potential
   - II. Riparian Recovery Potential
   - III. BRAT & WRAT

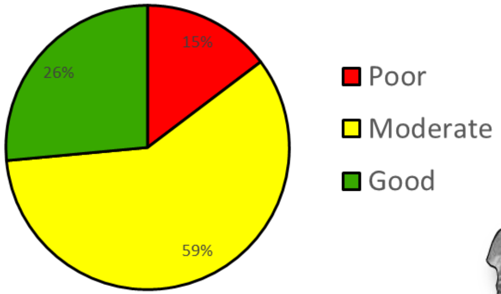
V. Future Work

TO-DO

- How good a proxy is riparian condition for geomorphic condition?
- Test using manual assessments of condition in:
  - Asotin Watershed, Washington
  - Middle Fork John Day Watershed, Oregon
  - Tucannon Watershed, Washington
  - Lemhi Watershed, Idaho
  - Wenatchee Watershed, Washington
- If not good, we can manually assess in priority basins
- How does geomorphic or riparian condition contribute to habitat condition?

GEOMORPHIC CONDITION VS. HABITAT CONDITION

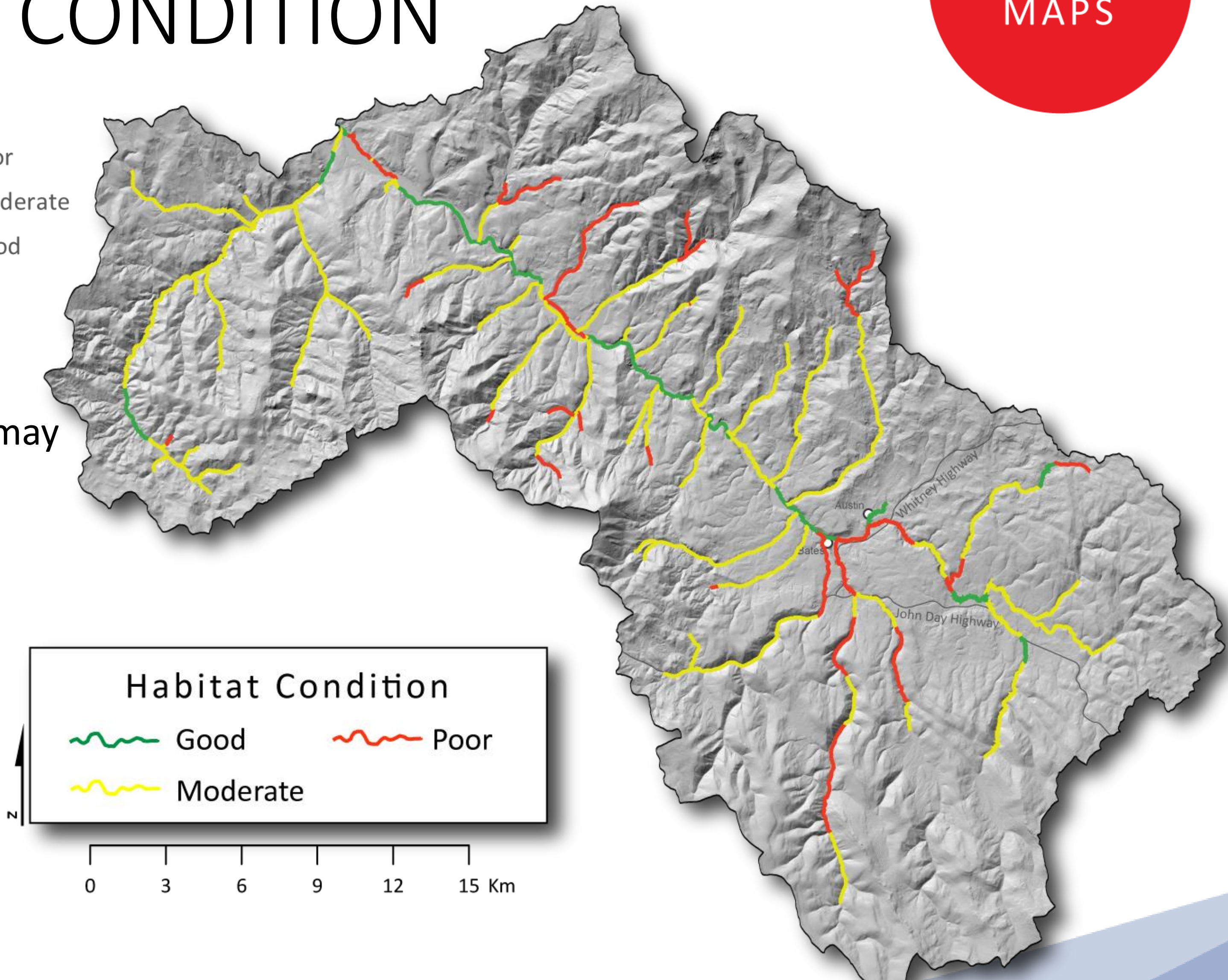
CONDITION MAPS



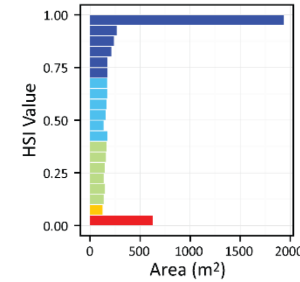
Habitat is species & lifestage specific & may include:

- Geomorphic Condition
- Temperature
- Food Availability

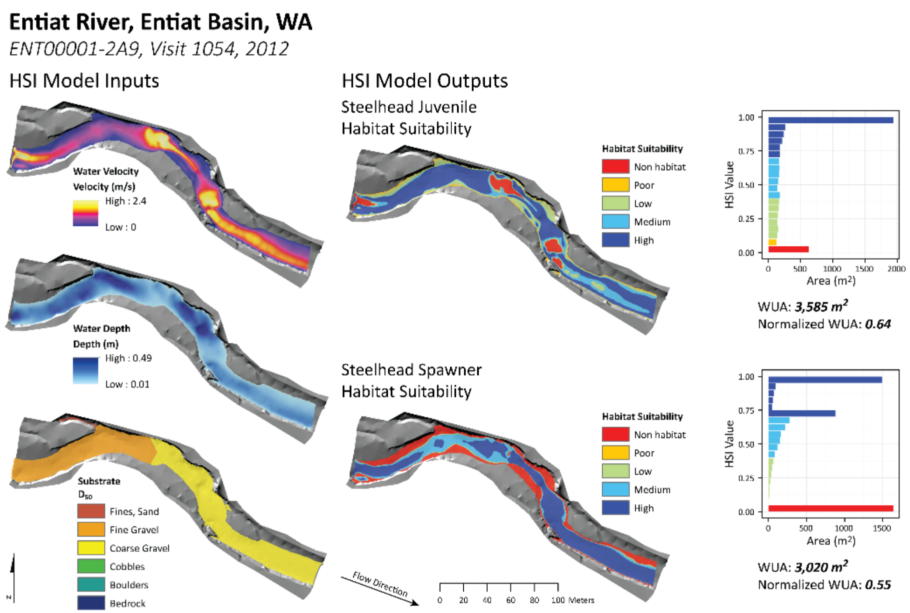
Stage 2 of Brierley & Fryirs (2005)

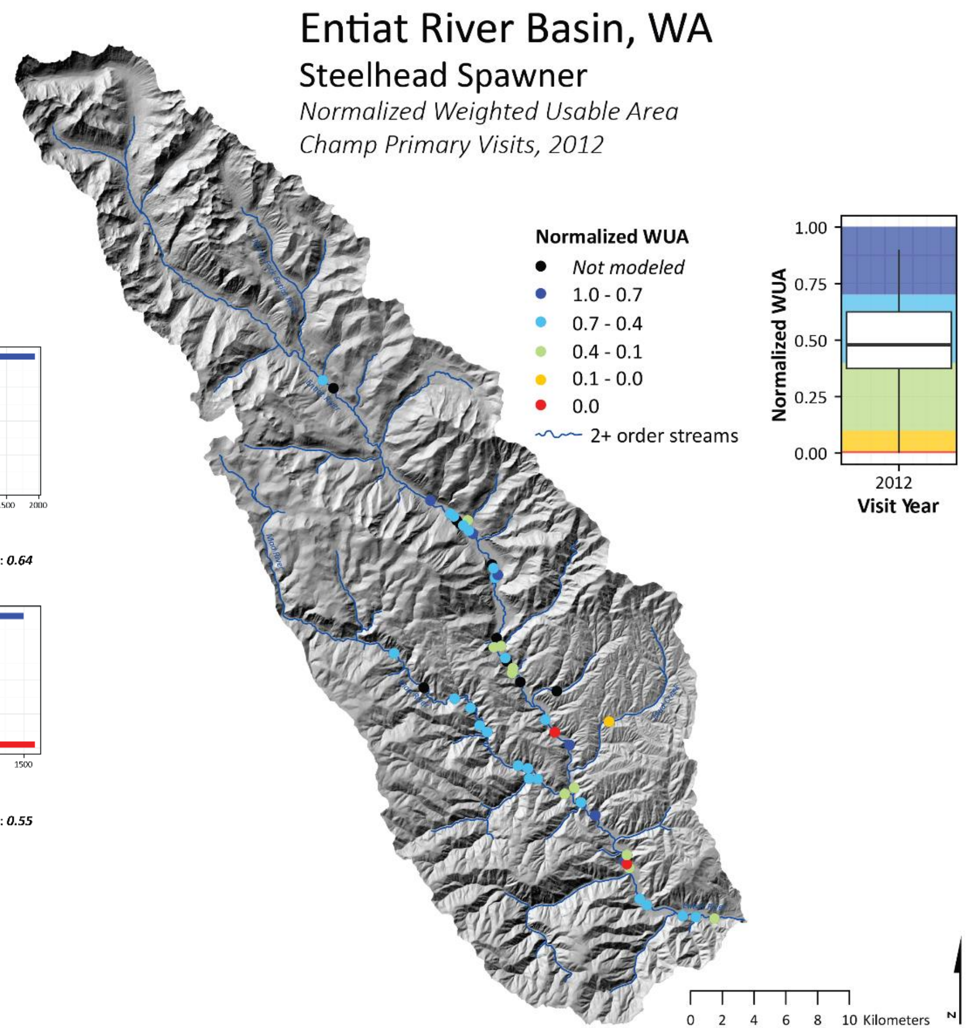


ALTERNATIVELY, WE MIGHT UPSCALE FISH HABITAT MODEL RESULTS



WUA: ***3,585 m²***
Normalized WUA: ***0.64***





BONNEVILLE POWER ADMINISTRATION
ISEMP
CHaMP

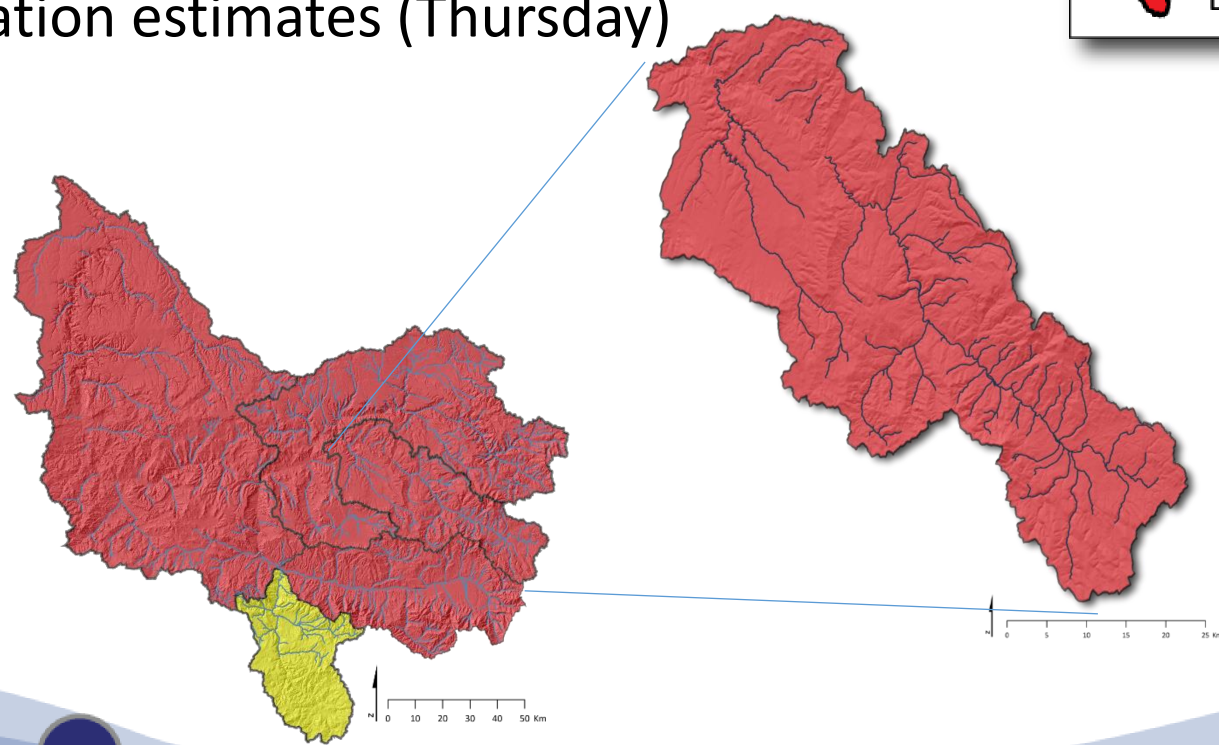
POPULATION CONDITION

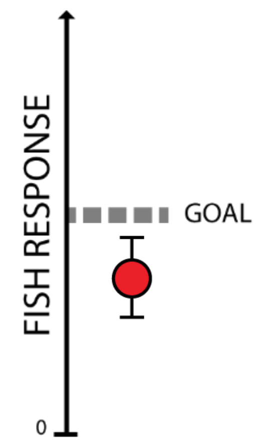
- A fish population exists across a fundamentally different scale than habitat actions typically take place…
- Life cycle modelling can translate capacity estimates (from habitat modelling) and survival estimates (from fish monitoring) to population estimates (Thursday)

CONDITION MAPS

Population Condition

- Target Met
- Indistinguishable from Target
- Below Target





ISEMP

CHaMP

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CHaMP Columbia Habitat Monitoring Program

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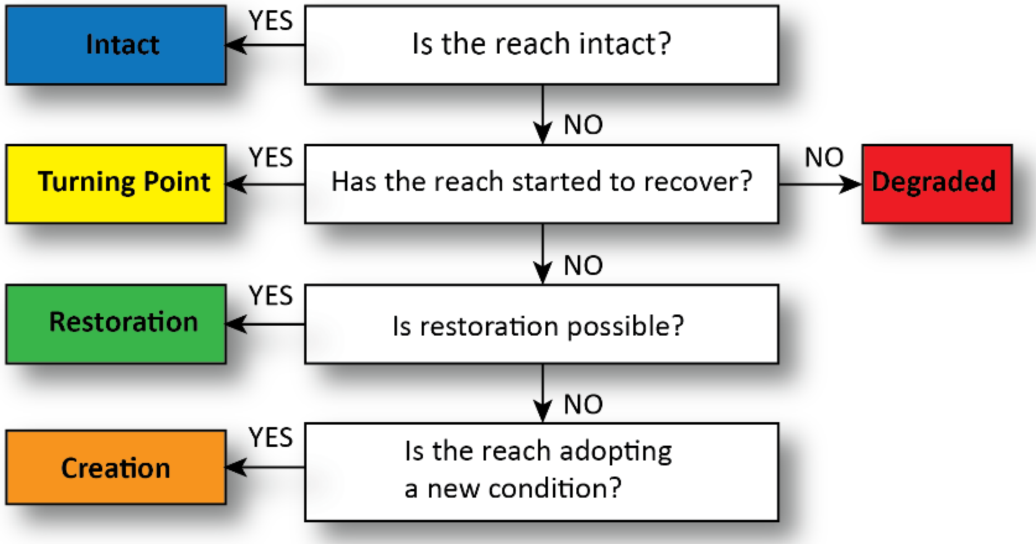
RS STAGE THREE:
RIVER RECOVERY POTENTIAL

GEOMORPHIC CONDITION

- TRAJECTORY OF CHANGE
- POSITION IN THE CATCHMENT AND LIMITING FACTORS AND PRESSURES
- DETERMINE RECOVERY POTENTIAL

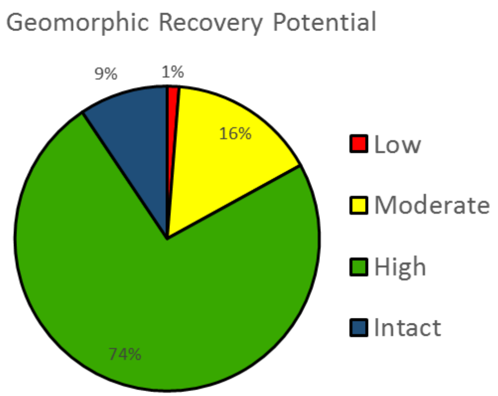
STOP LIGHT WATERSHED MAPS

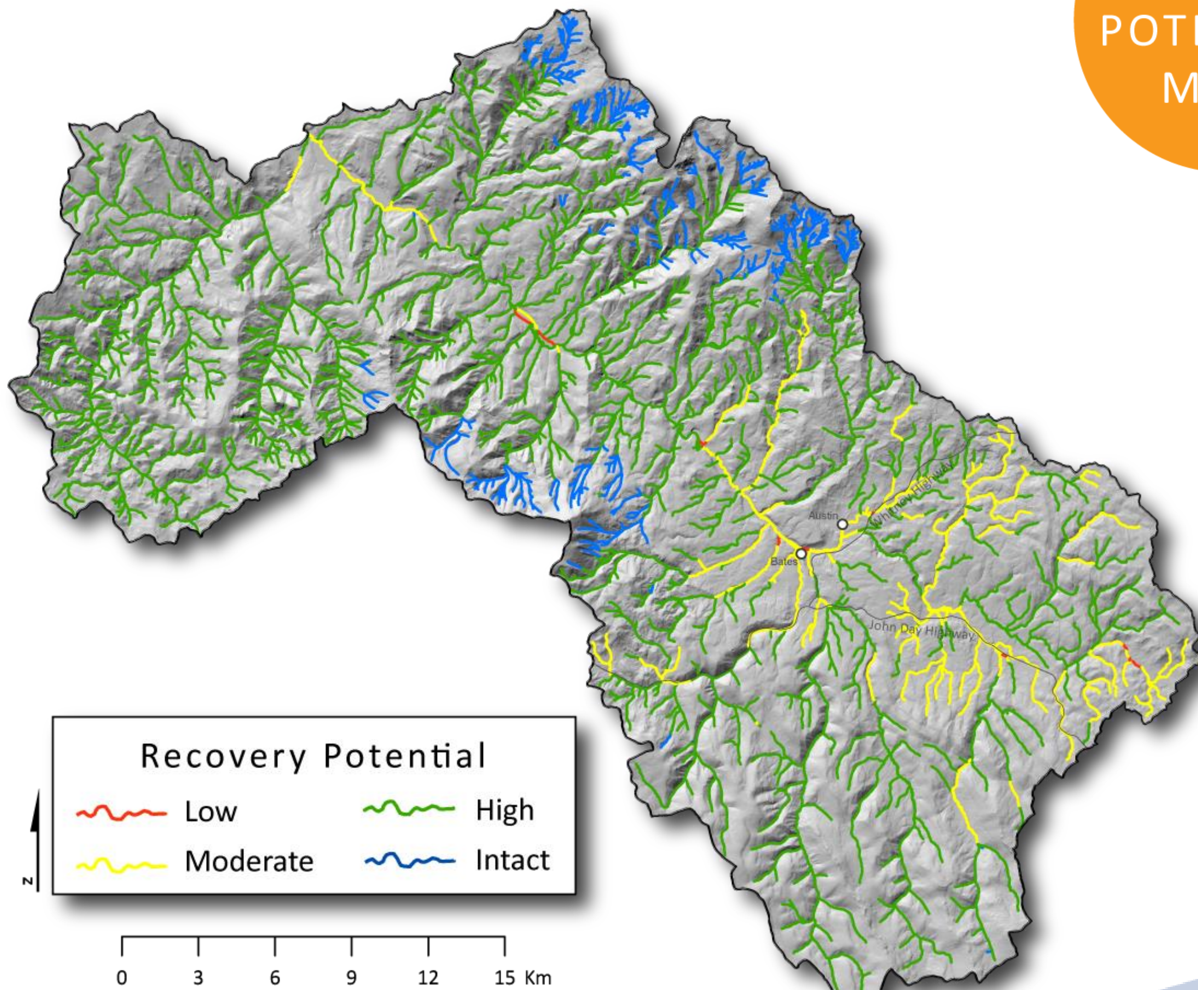
INTACT REACHES
HIGH
MODERATE
LOW



GEOMORPHIC RECOVERY POTENTIAL

RECOVERY POTENTIAL MAPS

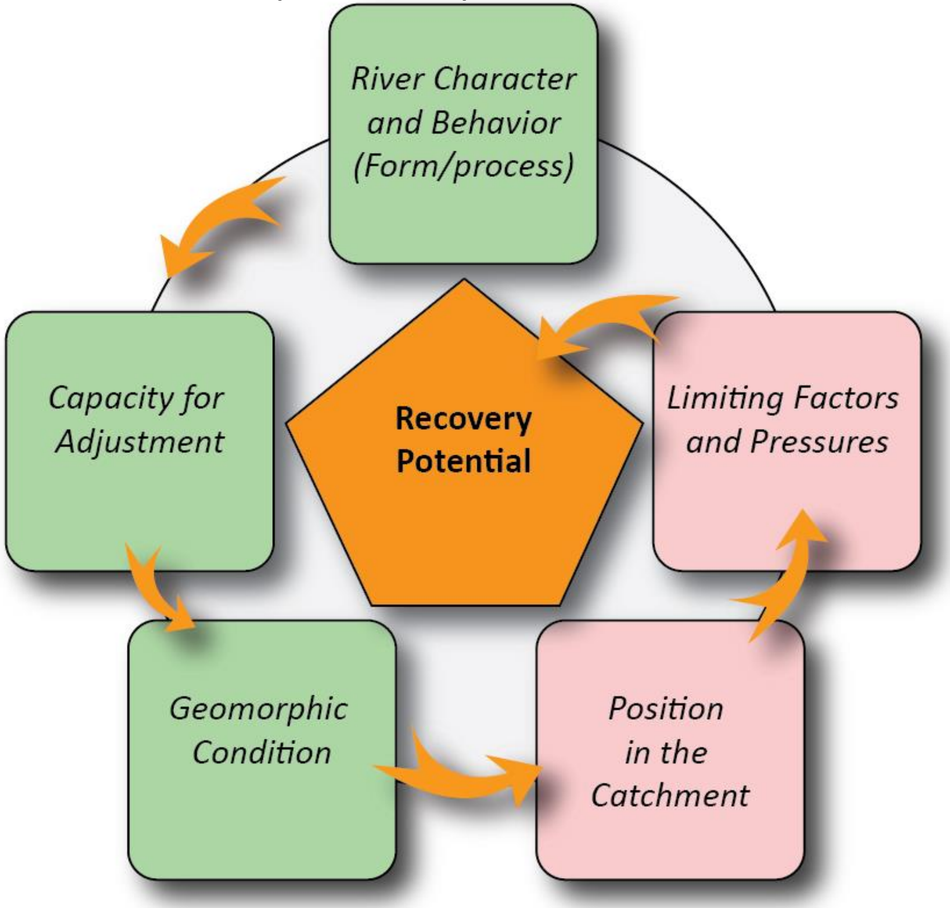


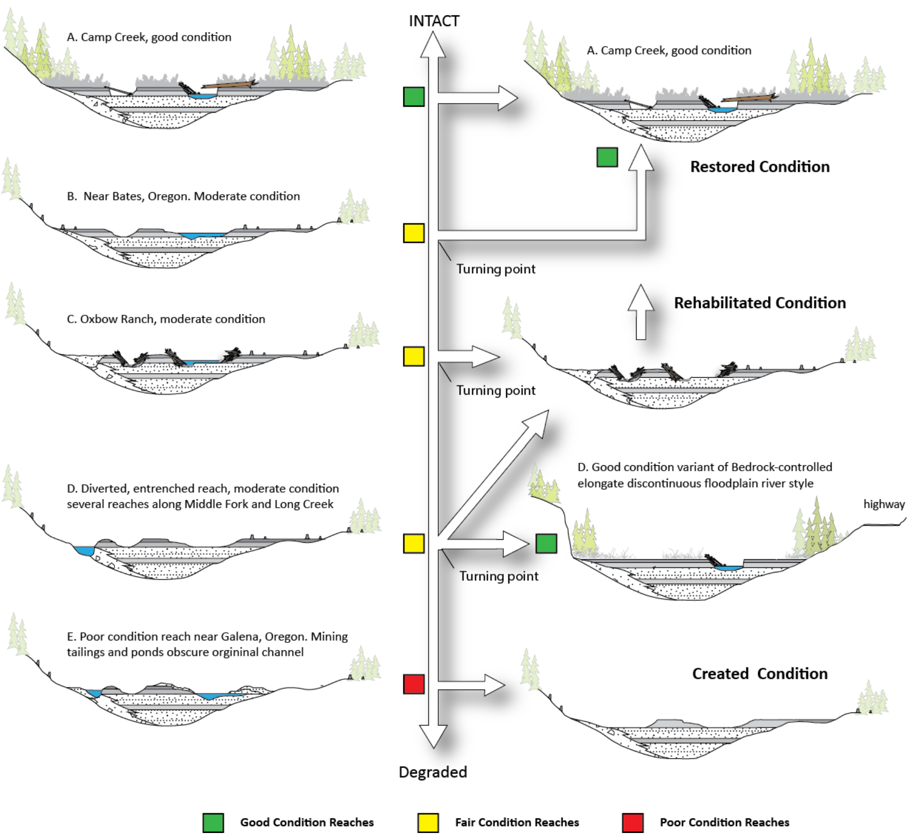


Stage 3 of

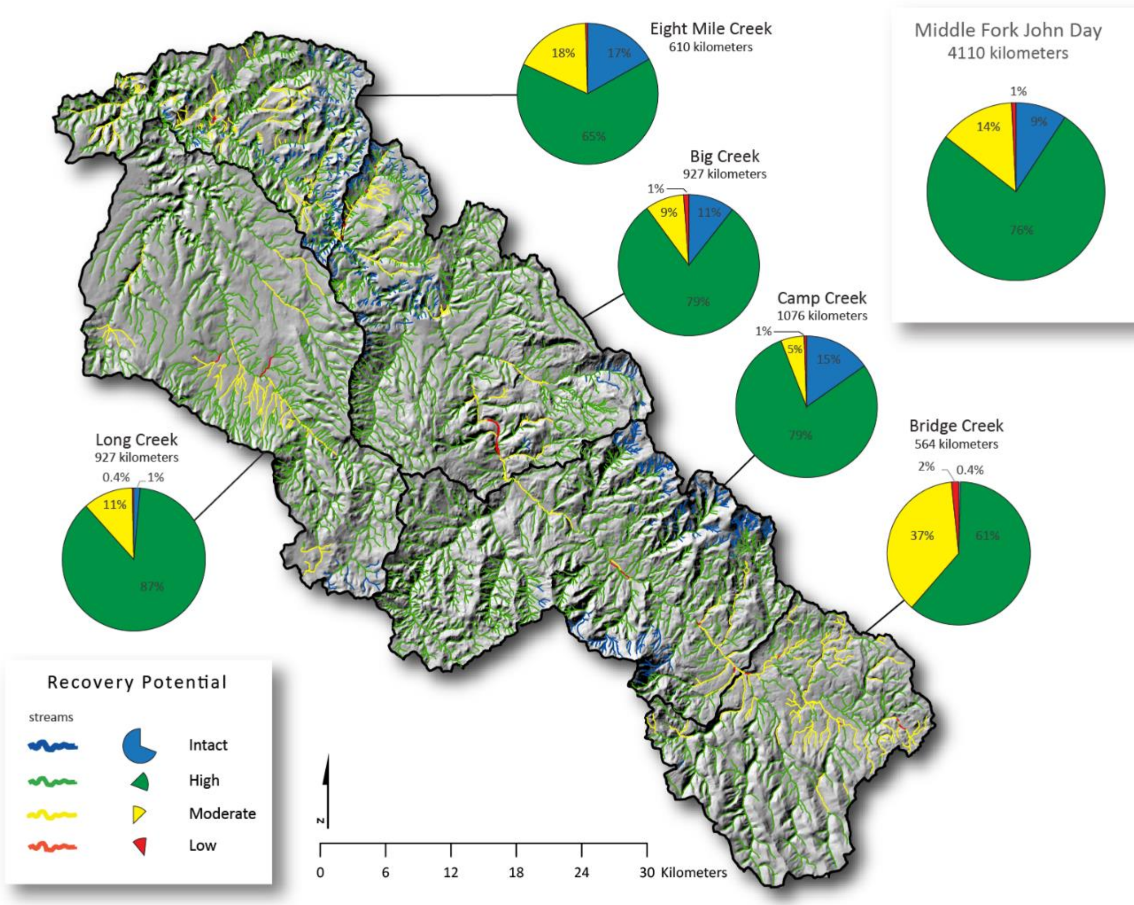
RECOVERY POTENTIAL DRIVERS

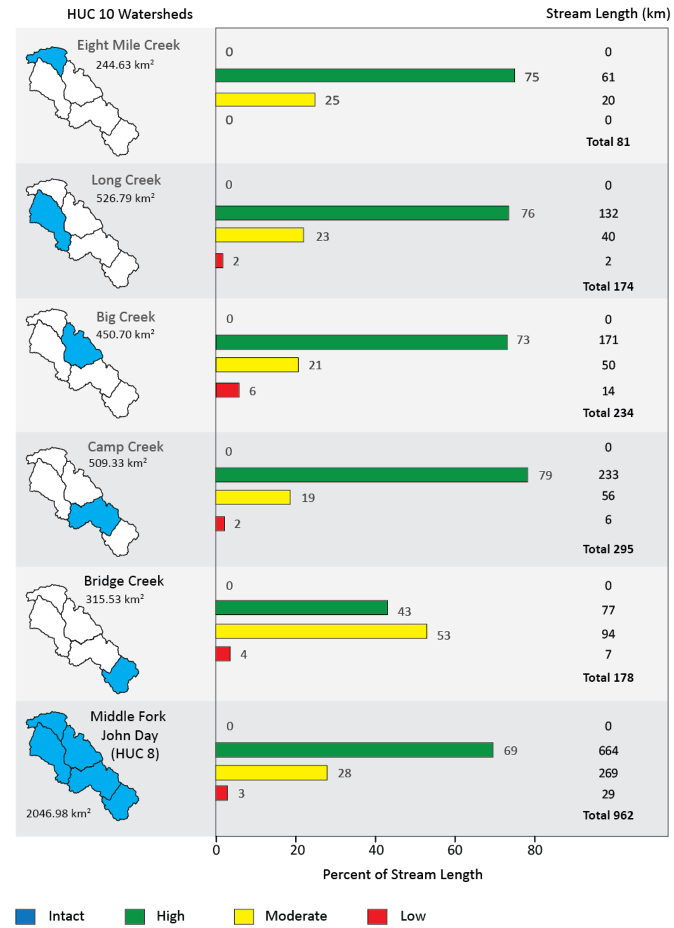
Recovery potential driven by condition, watershed position, and development pressures



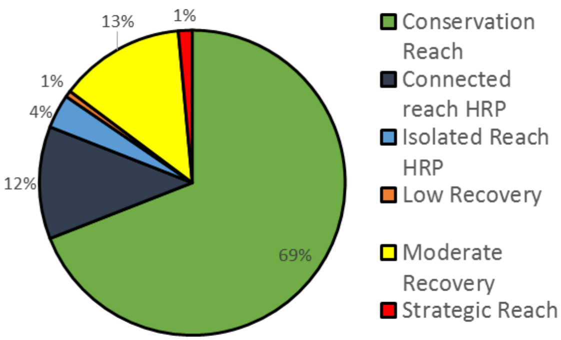


RECOVERY POTENTIAL MAP

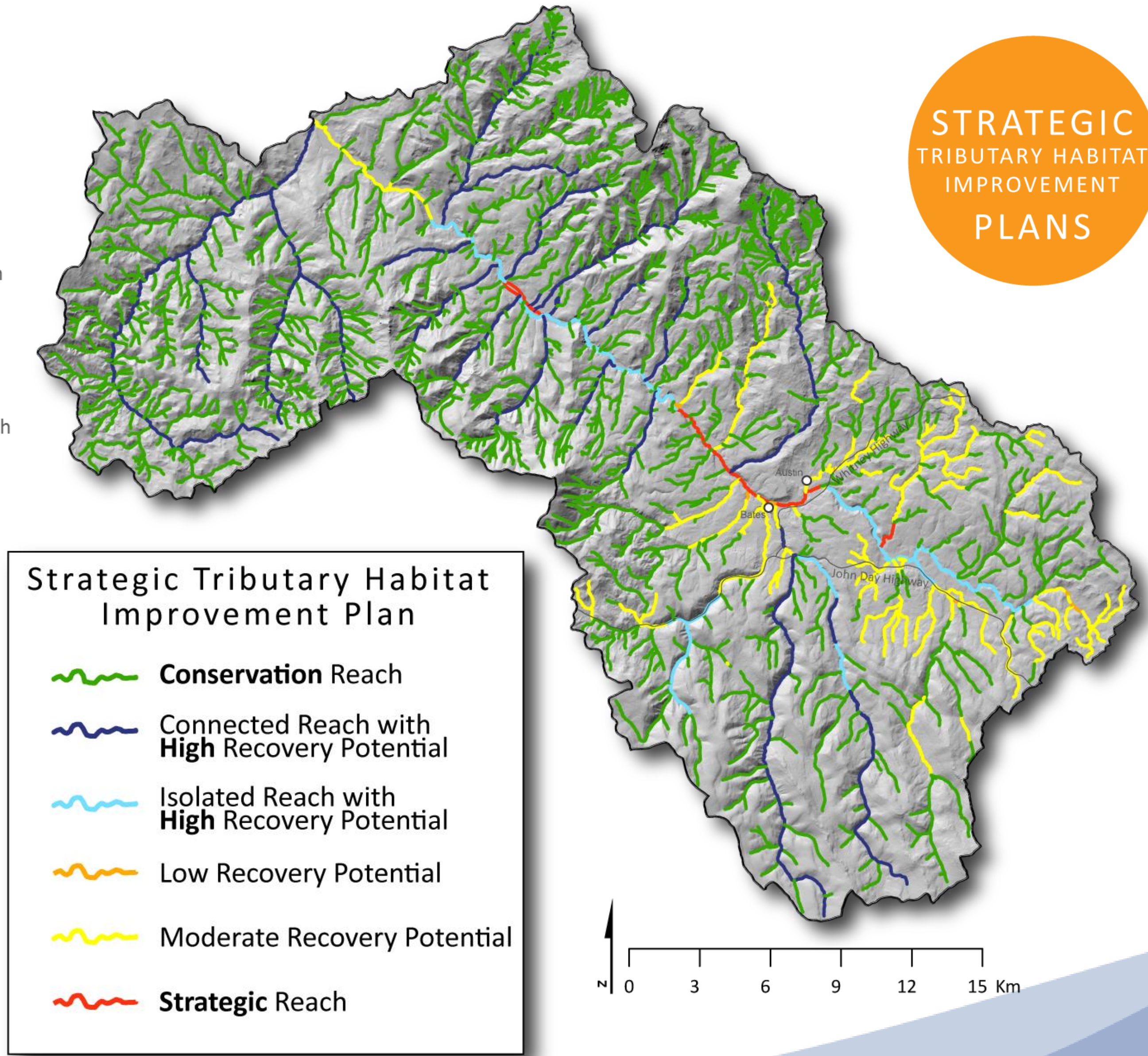




A ~~OPPORTUNISTIC~~ STRATEGIC PLAN…



STRATEGIC TRIBUTARY HABITAT IMPROVEMENT PLANS



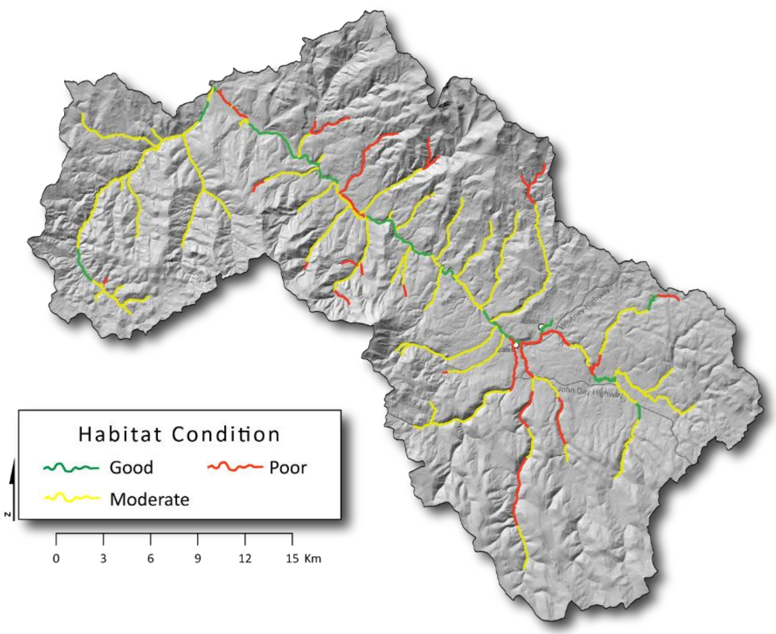
Stage 4 of

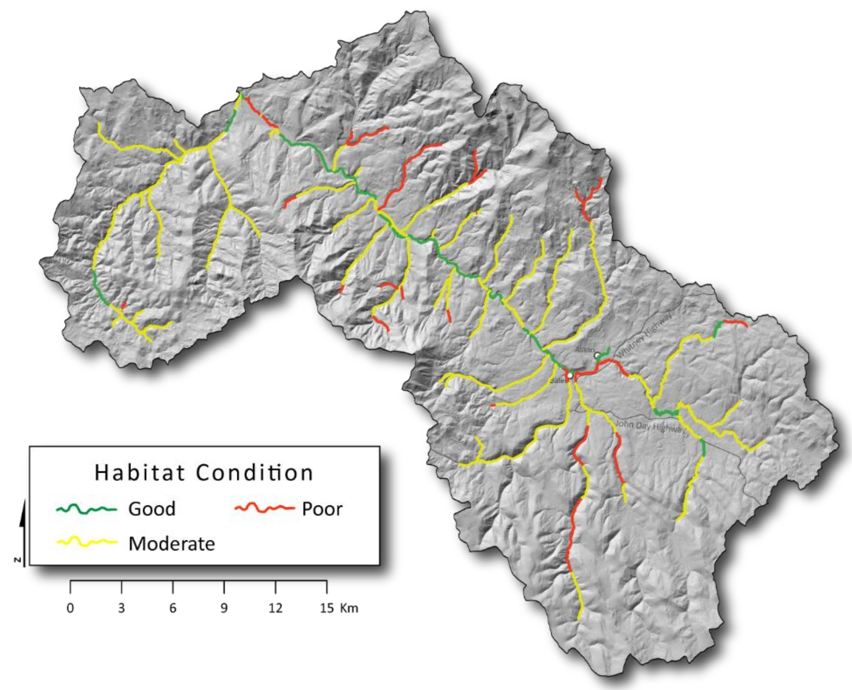
EXPECTATION MANAGEMENT

CONDITION MAPS

Pre Habitat Condition

+5 Years Habitat Condition





Physical responses may be detected relatively fast…

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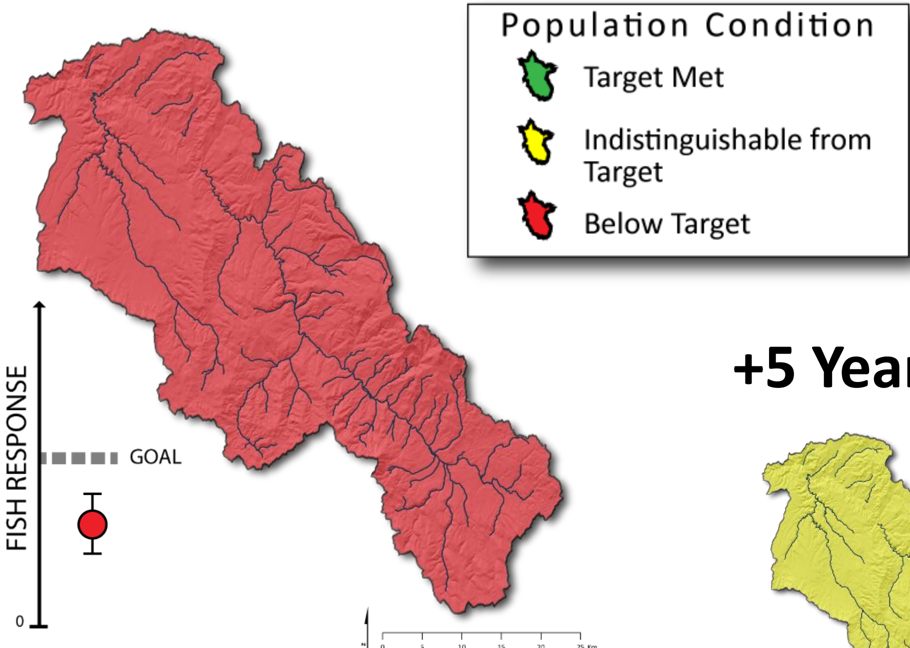
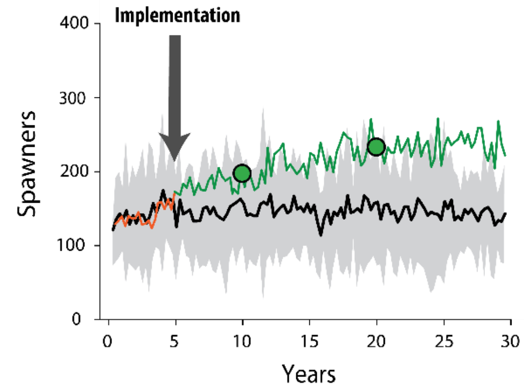
COMPARING PRE AND POST CONDITION

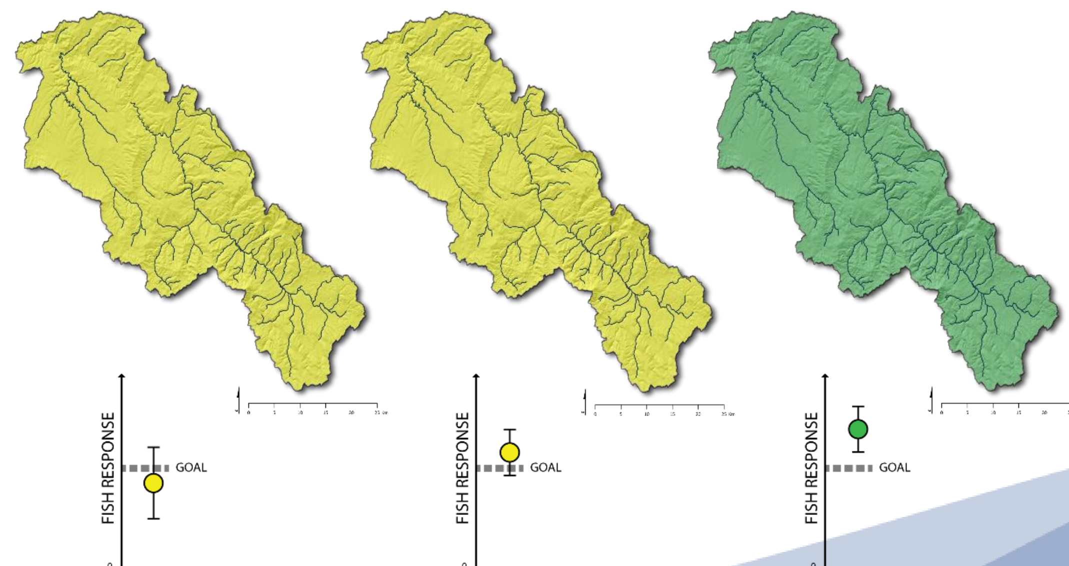
CONDITION MAPS

Pre Population Condition



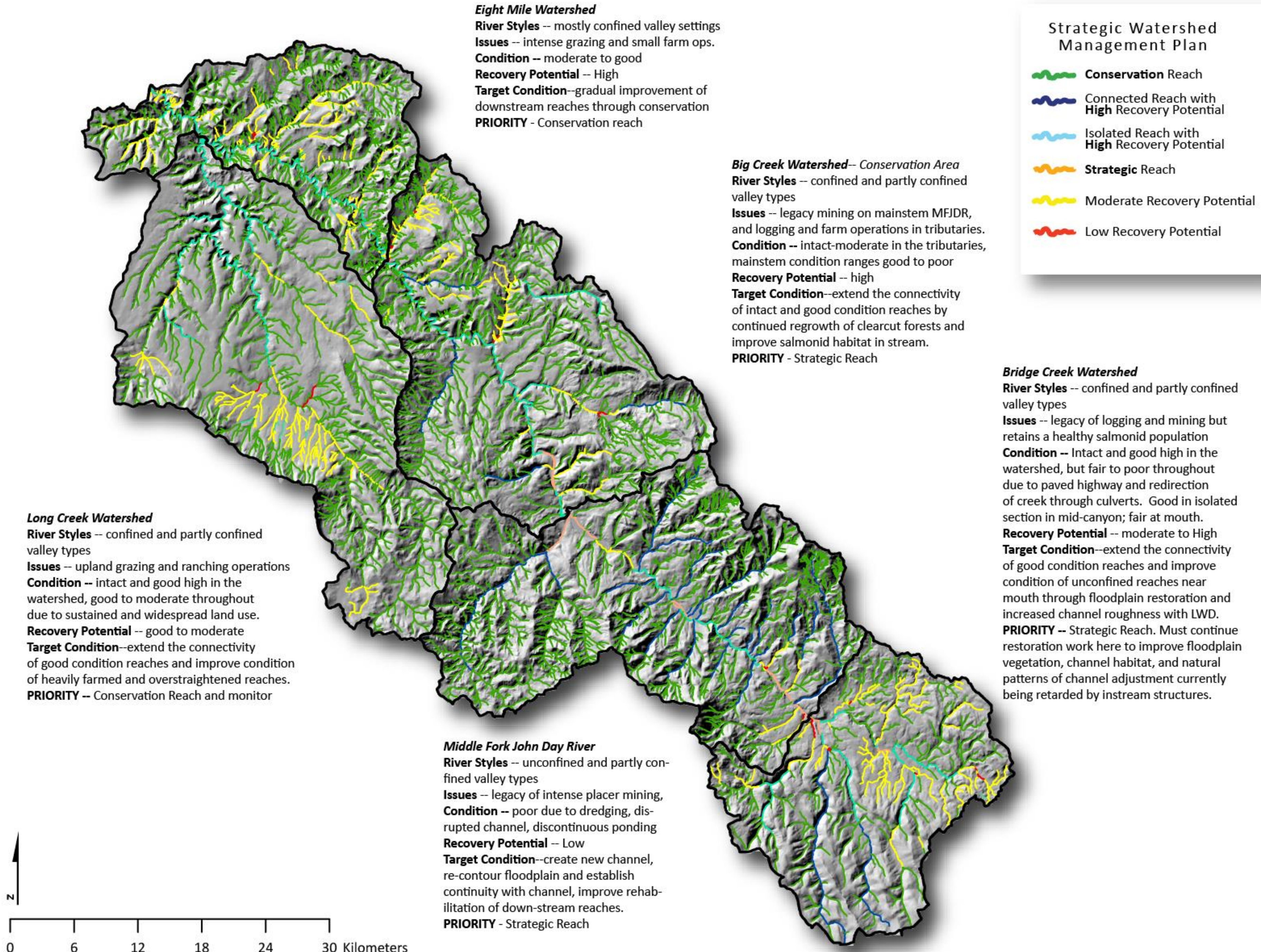


+5 Years   +10 Years   +20 Years



Fish population responses may take longer to detect

BONNEVILLE POWER ADMINISTRATION   ISEMP   CHaMP


Strategic Watershed Management Plan
Conservation Reach
Connected Reach with **High** Recovery Potential
Isolated Reach with **High** Recovery Potential
Strategic Reach
Moderate Recovery Potential
Low Recovery Potential
Eight Mile Watershed
River Styles -- mostly confined valley settings
Issues -- intense grazing and small farm ops.
Condition -- moderate to good
Recovery Potential -- High
Target Condition--gradual improvement of downstream reaches through conservation
PRIORITY - Conservation reach
Big Creek Watershed-- Conservation Area
River Styles -- confined and partly confined valley types
Issues -- legacy mining on mainstem MFJDR, and logging and farm operations in tributaries.
Condition -- intact-moderate in the tributaries, mainstem condition ranges good to poor
Recovery Potential -- high
Target Condition--extend the connectivity of intact and good condition reaches by continued regrowth of clearcut forests and improve salmonid habitat in stream.
PRIORITY - Strategic Reach
Bridge Creek Watershed
River Styles -- confined and partly confined valley types
Issues -- legacy of logging and mining but retains a healthy salmonid population
Condition -- Intact and good high in the watershed, but fair to poor throughout due to paved highway and redirection of creek through culverts. Good in isolated section in mid-canyon; fair at mouth.
Recovery Potential -- moderate to High
Target Condition--extend the connectivity of good condition reaches and improve condition of unconfined reaches near mouth through floodplain restoration and increased channel roughness with LWD.
PRIORITY -- Strategic Reach. Must continue restoration work here to improve floodplain vegetation, channel habitat, and natural patterns of channel adjustment currently being retarded by instream structures.
Long Creek Watershed
River Styles -- confined and partly confined valley types
Issues -- upland grazing and ranching operations
Condition -- intact and good high in the watershed, good to moderate throughout due to sustained and widespread land use.
Recovery Potential -- good to moderate
Target Condition--extend the connectivity of good condition reaches and improve condition of heavily farmed and overstraightened reaches.
PRIORITY -- Conservation Reach and monitor
Middle Fork John Day River
River Styles -- unconfined and partly confined valley types
Issues -- legacy of intense placer mining,
Condition -- poor due to dredging, disrupted channel, discontinuous ponding
Recovery Potential -- Low
Target Condition--create new channel, re-contour floodplain and establish continuity with channel, improve rehabilitation of down-stream reaches.
PRIORITY - Strategic Reach
N
0 6 12 18 24 30 Kilometers

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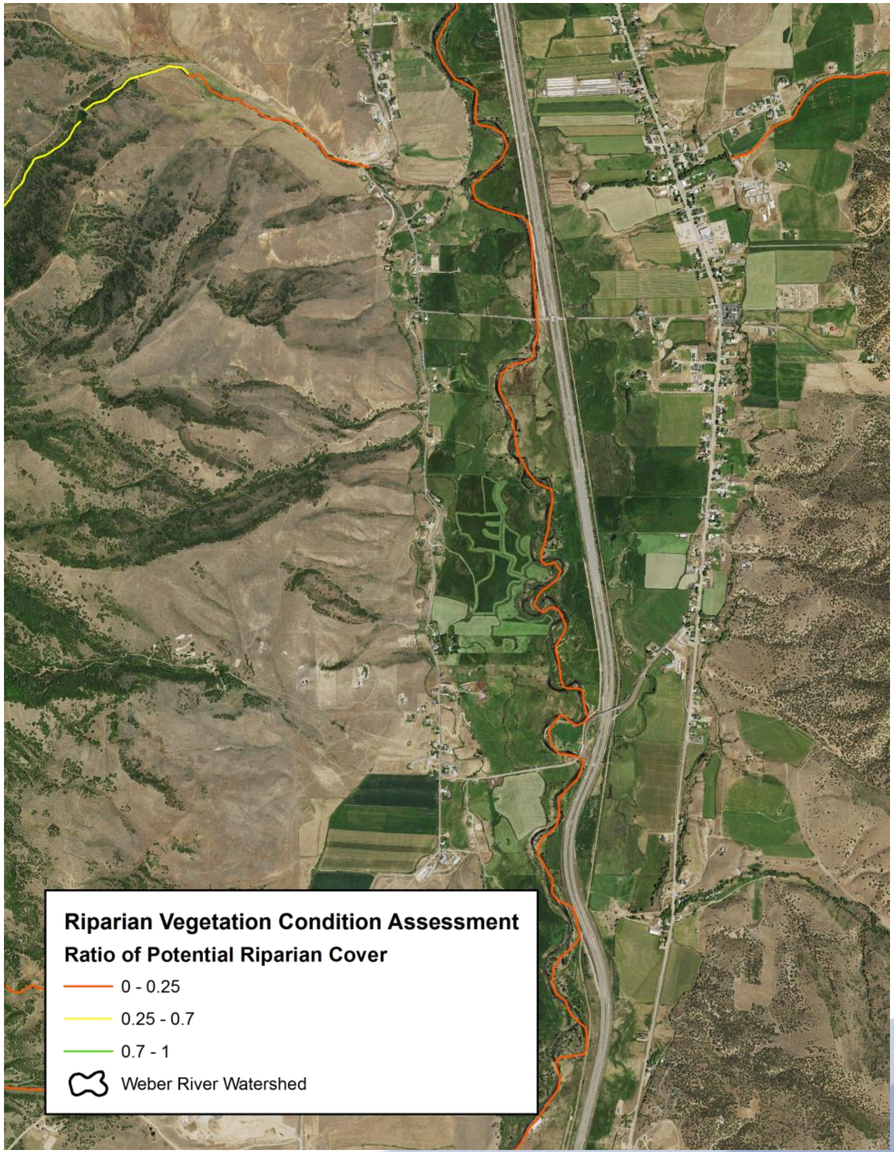
RIPARIAN RECOVERY POTENTIAL

- In the works…
- How do anthropogenic realities constrain restoration & recovery potential?
- Order of difficulty:
    - Urban Development
    - Mining
    - Interstates/ Railroads
    - Invasive Species
    - Arabale Agriculture
    - Grazing



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LETS TALK ABOUT…

- Cheap & Cheerful Restoration
  - Because you don't have endless budgets and the spatial scope of your problems are extensive
- One example involving a rodent…

HDLWD

Airborne Beavers Fight Floods

OUT in Idaho, the Department of Fish and Game is teaching eager beavers to yell "Geronimo!" These busy little creatures are being dropped by parachute to terrain where they can do their bit in the conservation battle.

Idaho state caretakers trap unwanted beavers which may be a nuisance in certain areas, round them up at central points and pack them in pairs in specially constructed wooden crates. After they are dropped, the boxes remain closed as long as there's some tension on the parachute shrouds but pull open as soon as the chute collapses on the ground. Then, out crawl Mama and Papa beaver, ready to start work.

After they're settled, the 40-pound, web-footed rodents multiply and become outpost agents of flood control and soil conservation. Fur supervisor John Smith reports that in carefully observed early operations, the beavers headed straight for water and started building a new dam within a couple of days.

However, one problem still remains to be solved—a question of ethics more than conservation. *Are these eager beavers bona fide members of the Caterpillar Club?* •

1. Boxed for travel, this beaver is placed in a crate designed by Scotty Heter, left.
2. Rubber bands pull the box apart when the chute hits the ground, freeing the animals.
3. Heading for water, the airborne beavers start working like beavers on their new dam.

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PERCEIVED + IMPACTS OF DAM BUILDING

- Slow snowmelt runoff
- Create ponds, wetlands & critical habitat for fish, amphibians, small mammals, vegetation
- Increased groundwater recharge/ elevated water tables
- Dam complexes increase system roughness & resilience
- Increased LWD
- Change timing, delivery and storage or water, sediment and nutrients

http://www.wildearthguardians.org/site/DocServer/Beaver_and_Climate_Change_Final.pdf?docID=3482

POPULARITY GROWING RAPIDLY RECENTLY


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What If the 'Ri[…] Way' Is Wrong[…]

A-HED

With Trouble on the Range, Ranchers Wish They Could Leave It to Beavers

Critters, Once Reviled, Gain Popularity With 'Believers'; a Good Rodent Is Hard to Find

Email Print Save 44 Comments

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[…]CESS: LOG IN OR SUBSCRIBE NOW - $1 A WEEK FOR 12 WEEKS

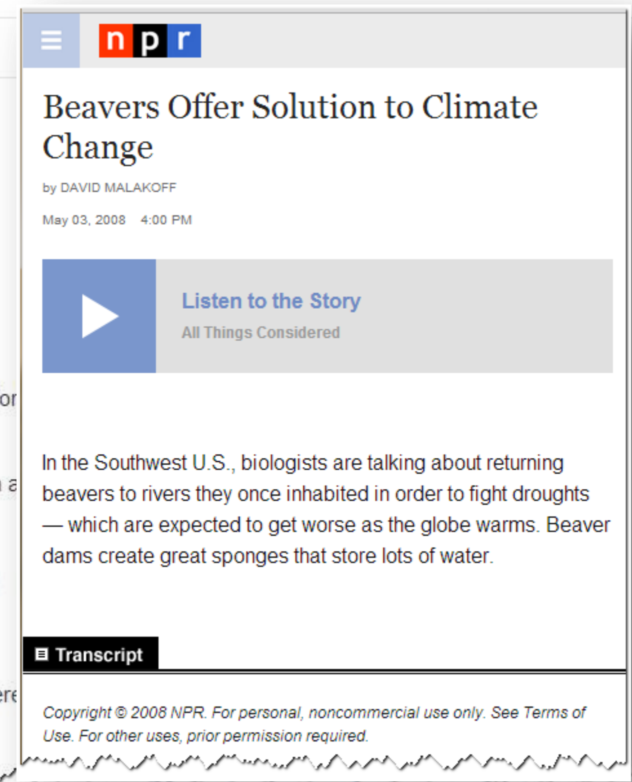
[…]nts his beavers back.

[…]h on Beaver Creek outside Kinnear, Wyo., has been beaver-free for […]uld sure use their help now. A small beaver colony, he says, would […]t raise the water table under his pastures, opening up drinking holes for

So the 64-year-old rancher put himself on a […] waiting list this year hoping state officials would bring him a beaver or two. Wyoming's Game and Fish Commission periodically plucks the rodents from drainage culverts.

It's a bit of a turnabout in these parts, where beavers have long been considered something of a nuisance—blamed for

The Beaver Solution Team live traps beavers on properties where they are causing damage and relocates them to […]


npr

Beavers Offer Solution to Climate Change

by DAVID MALAKOFF

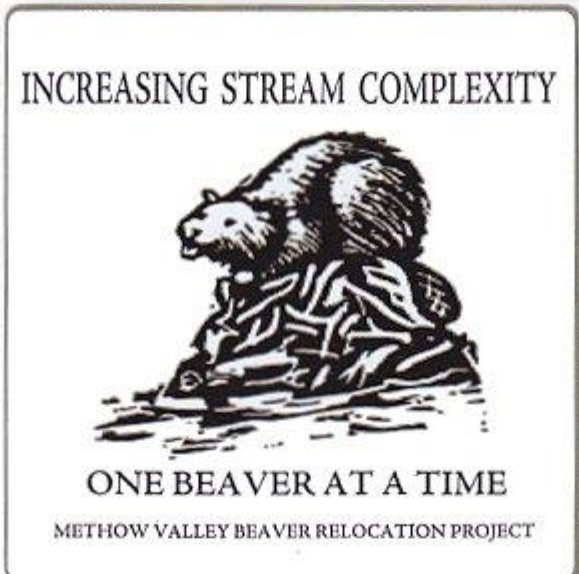
May 03, 2008 4:00 PM

Listen to the Story

All Things Considered

In the Southwest U.S., biologists are talking about returning beavers to rivers they once inhabited in order to fight droughts — which are expected to get worse as the globe warms. Beaver dams create great sponges that store lots of water.

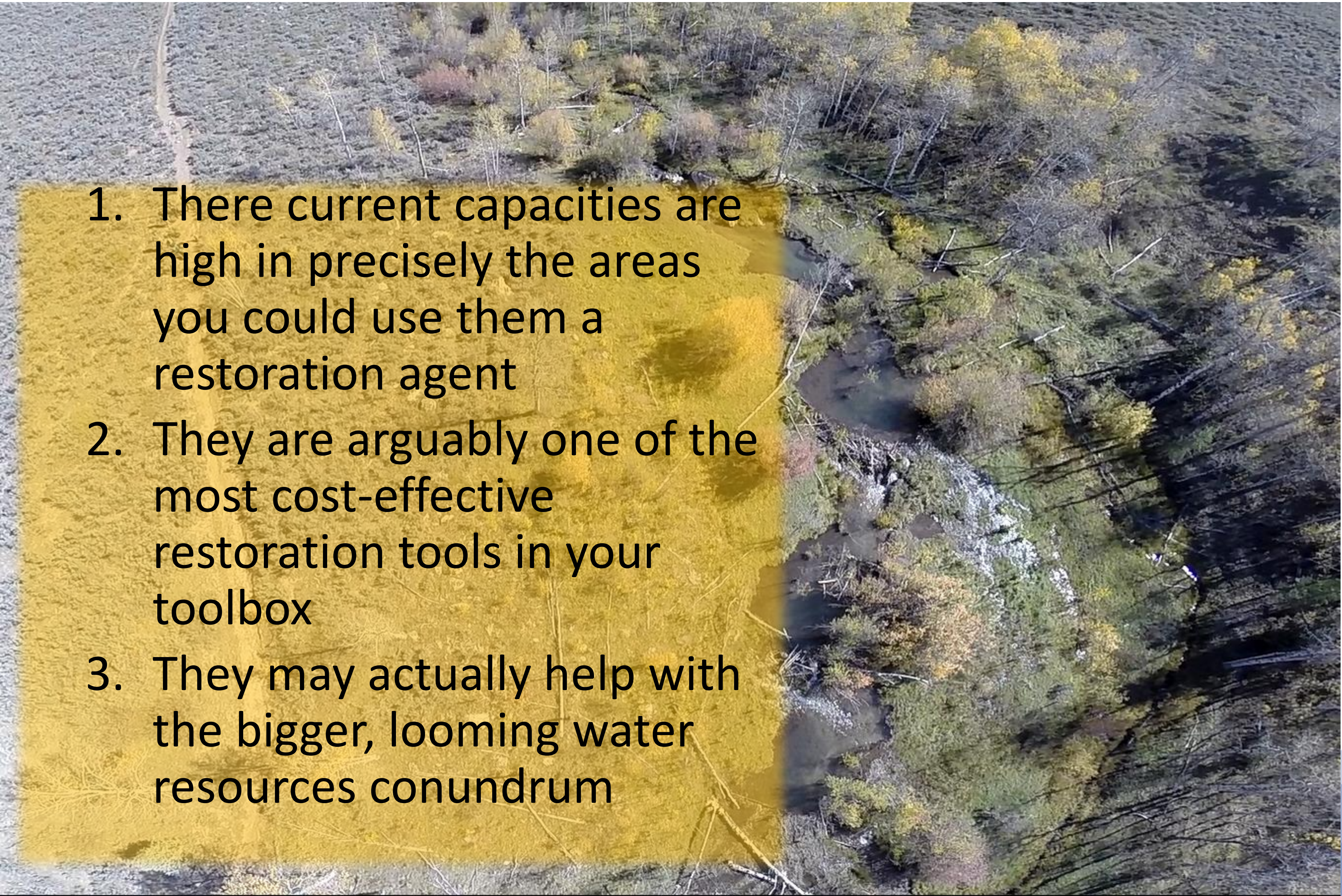
Transcript



SOME THINGS TO THINK ABOUT…

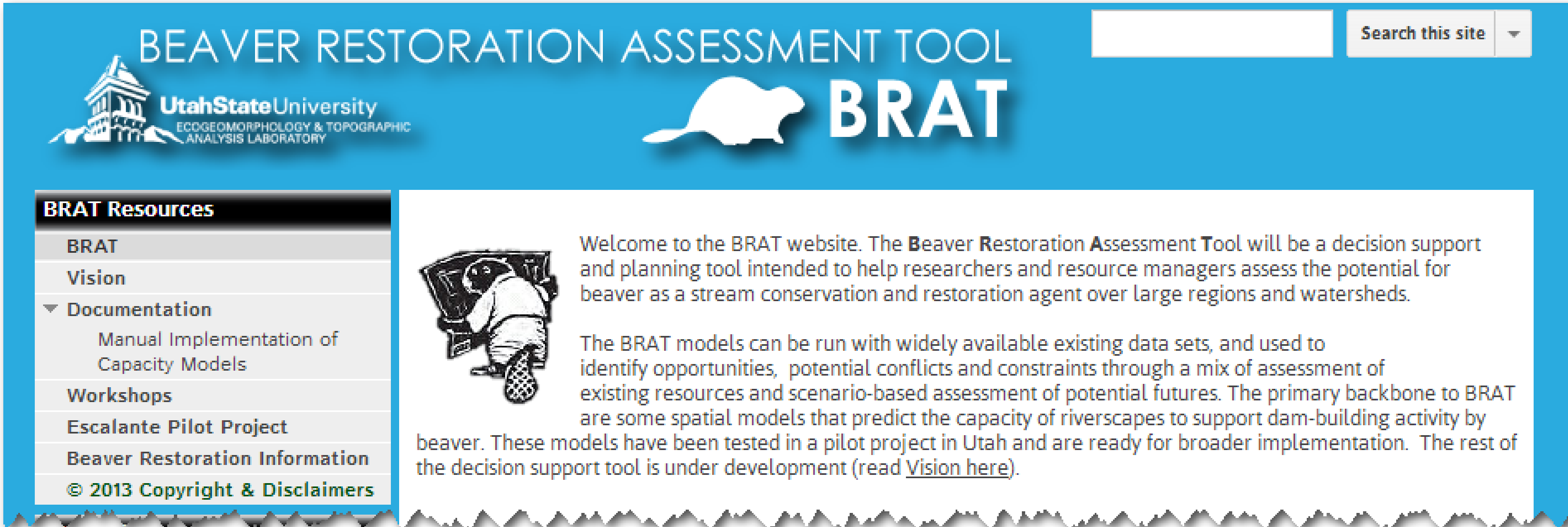
- The ecosystem engineer is very experienced
- Most the species we care about have co-evolved with this engineer
- The science is conceptually solid… but fairly qualitative
- Precautionary Principle?
- The cost is one of the most compelling arguments from a restoration perspective

WHY SHOULD YOU CARE ABOUT BEAVER?



1. There current capacities are high in precisely the areas you could use them a restoration agent
2. They are arguably one of the most cost-effective restoration tools in your toolbox
3. They may actually help with the bigger, looming water resources conundrum

BRAT – BEAVER RESTORATION ASSESSMENT TOOL



Grand Canyon Trust — DEDICATED TO THE CONSERVATION OF THE COLORADO PLATEAU

UTAH DNR WILDLIFE RESOURCES

The WALTON FAMILY FOUNDATION

ECOFLIGHT

- Wally MacFarlane
- Martha Jensen
- Jordan Gilbert
- Jordan Burningham

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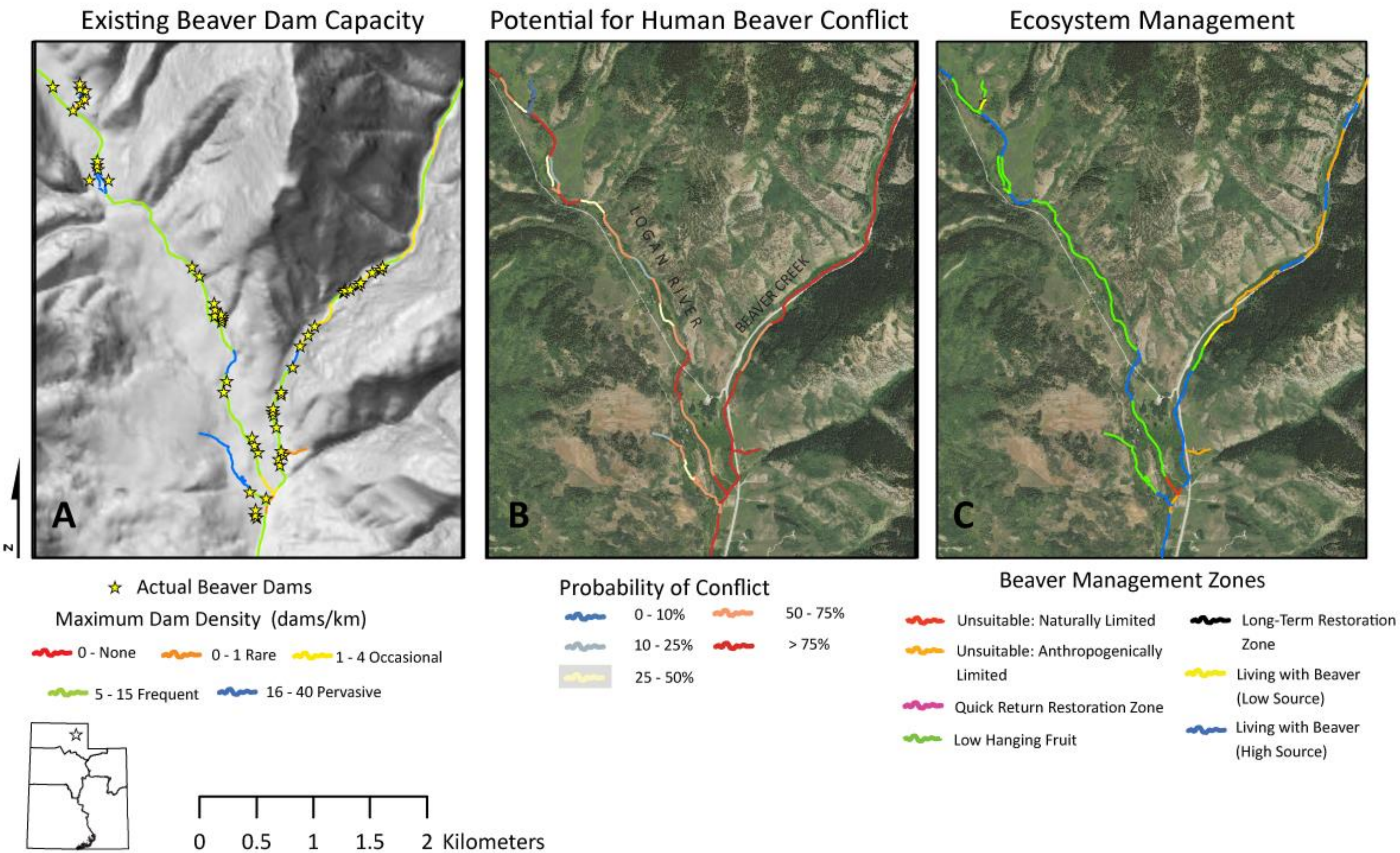
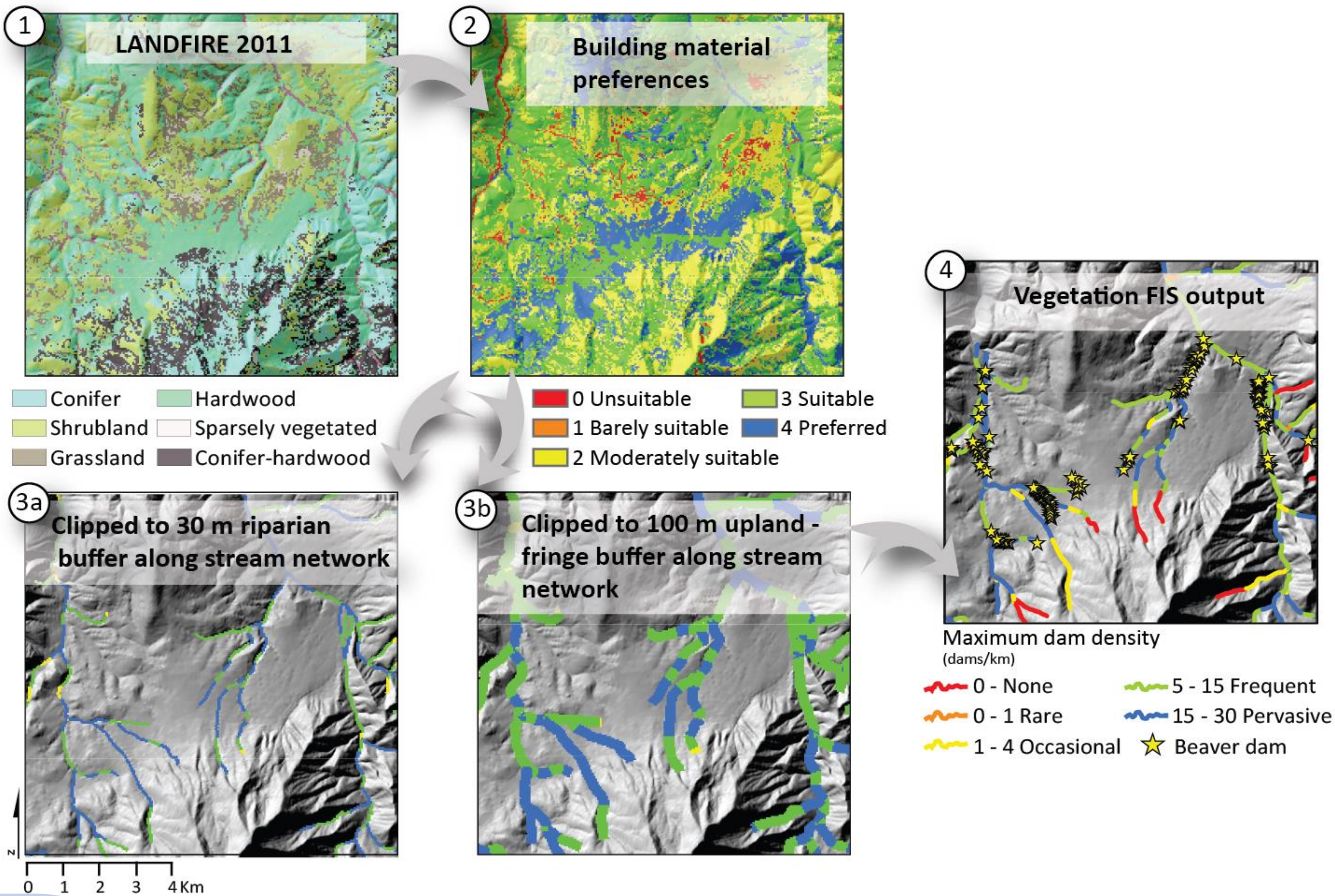
http://brat.joewheaton.org

BRAT OUTPUTS IN A NUTSHELL

- Existing & Historic Capacities → Potential Conflict → Management

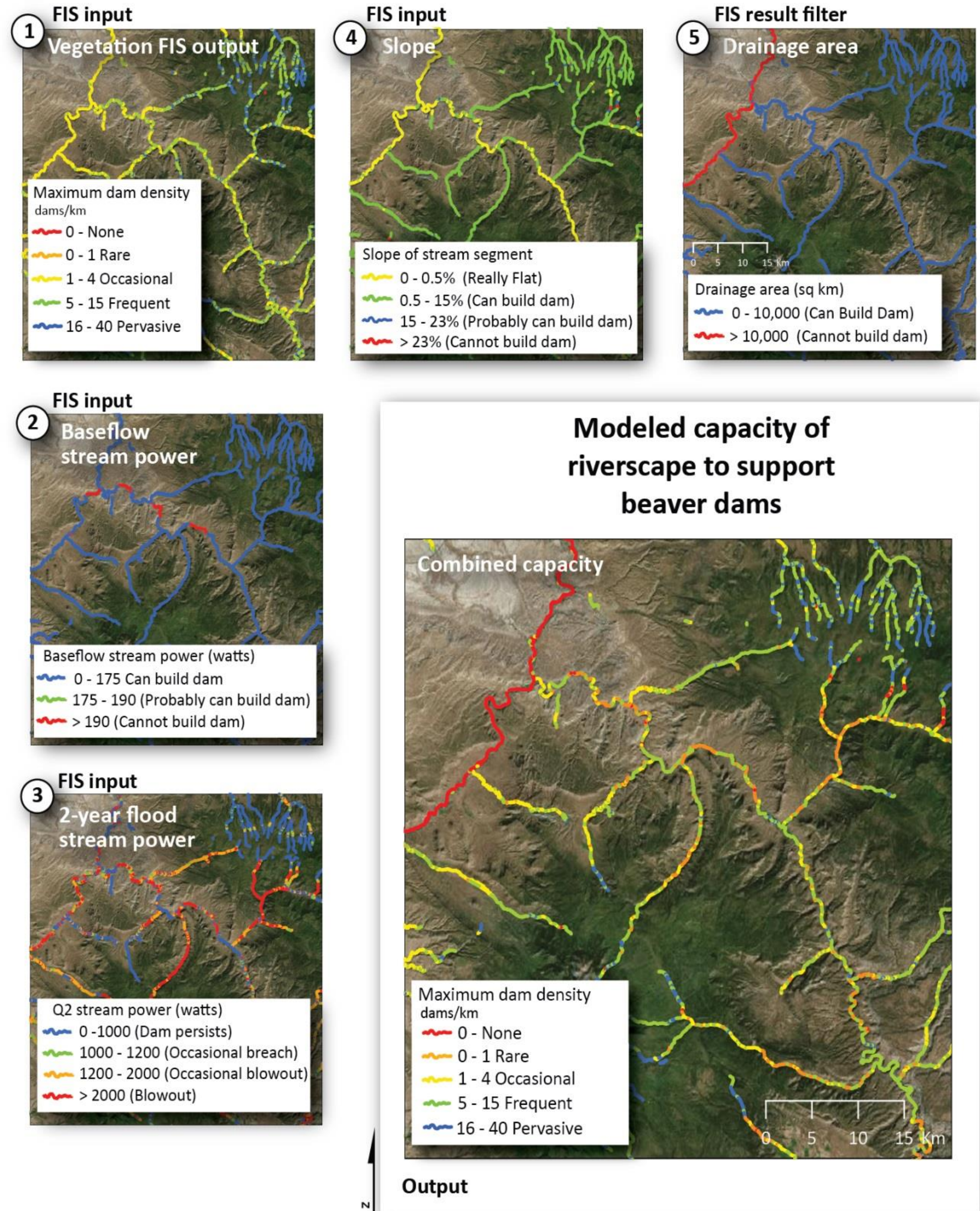


FLOW DIAGRAM: VEGETATION CLASSIFICATION



ISEMP CHaMP

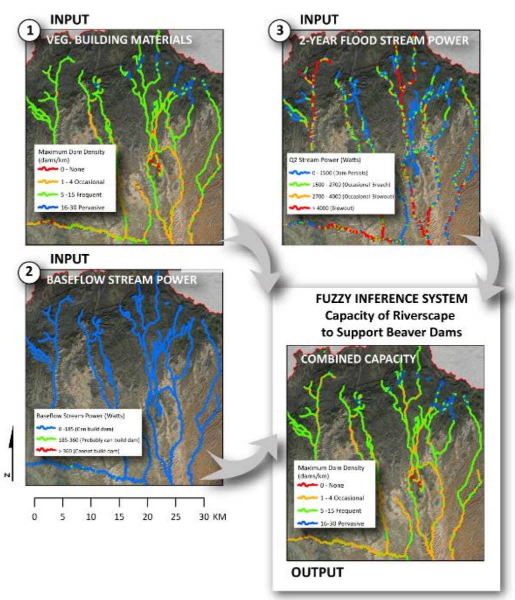
FLOW DIAGRAM: BEAVER DAM CAPACITY MODEL



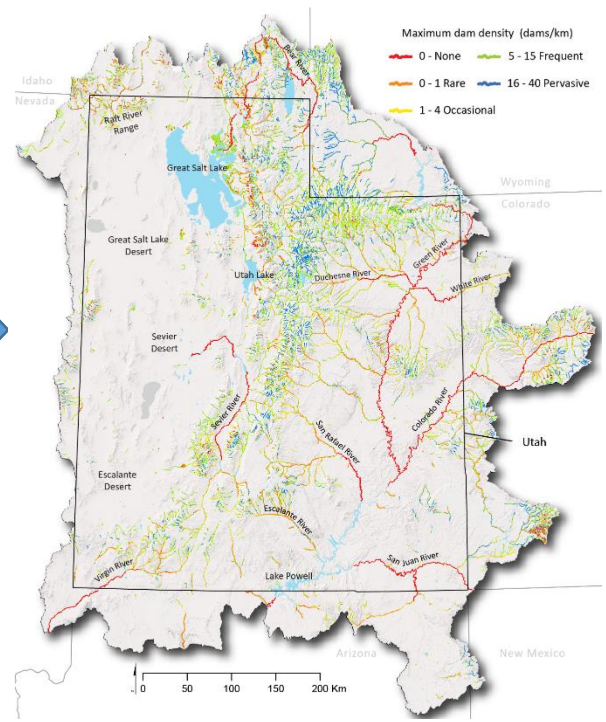
BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

WHAT WE DID WITH BRAT…

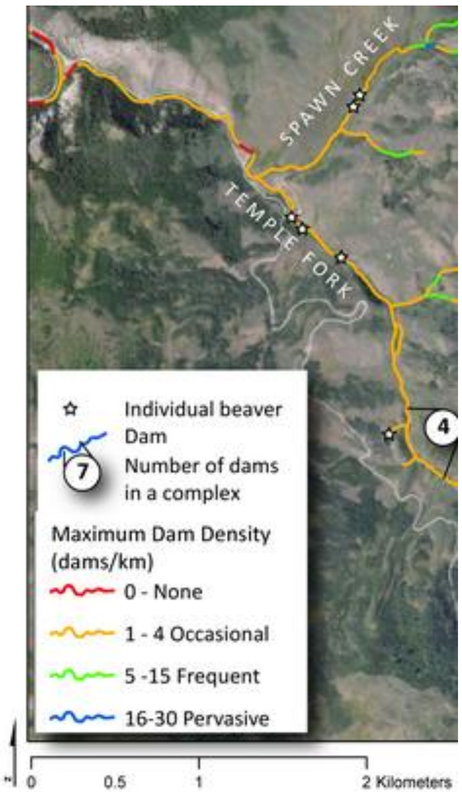
- Ran BRAT for whole state
- Created a decision support elements of BRAT in bespoke manner for UDWR



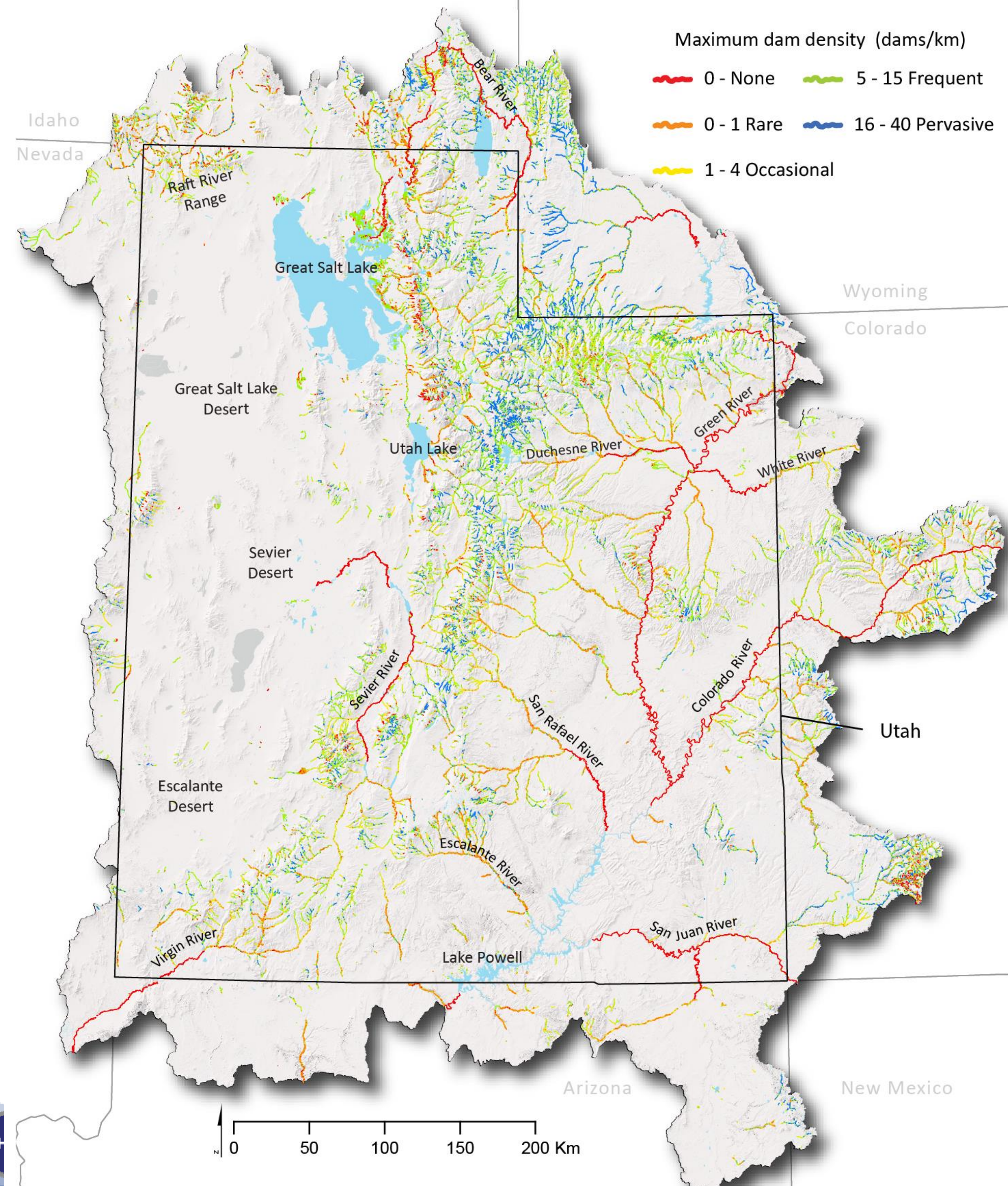
Run Model with Nationally Available Datasets



STATE OF UTAH (> 225,000 km^2)



Resolved at every 250 m long reach within State (27,000 km)

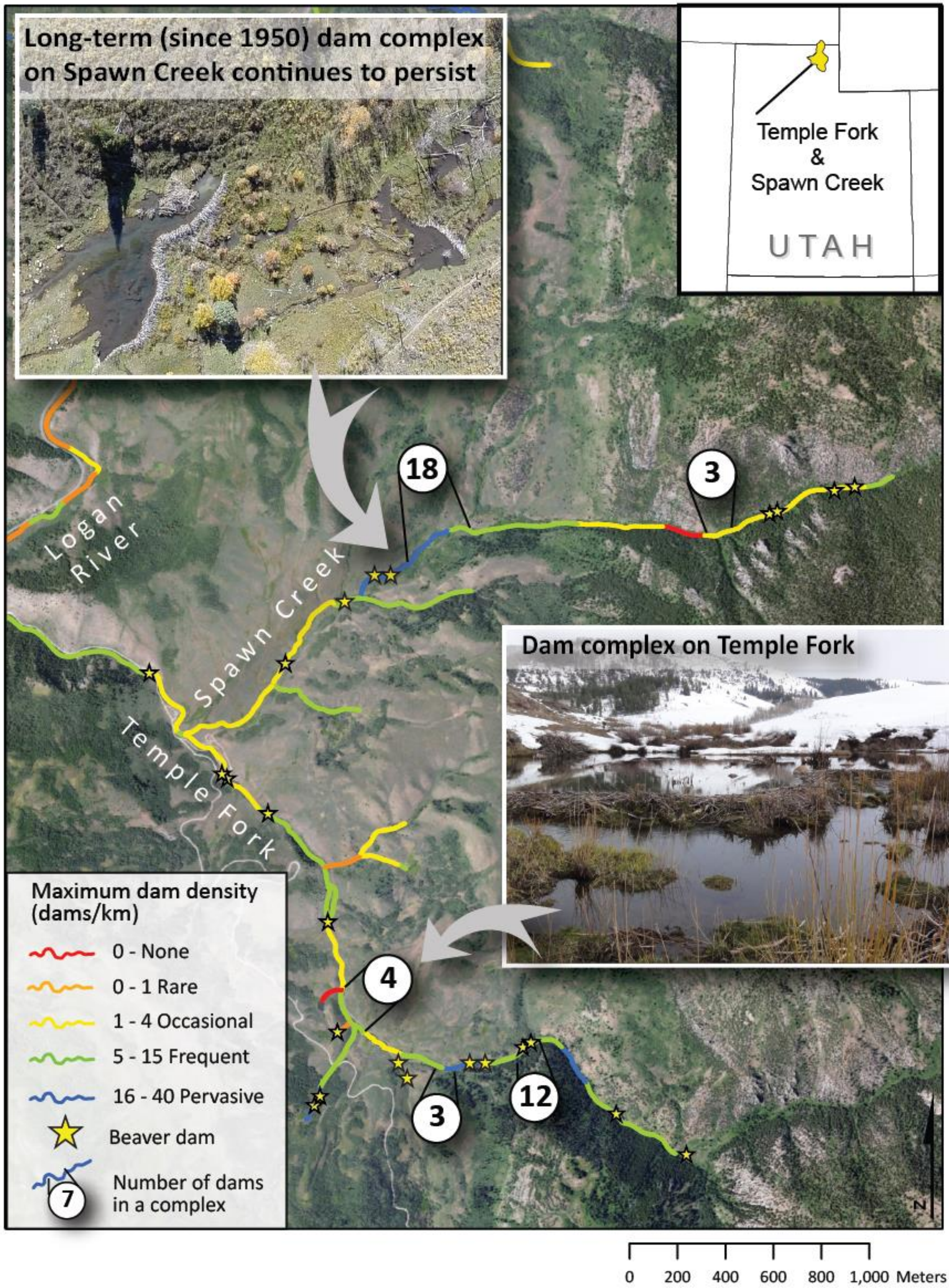


Maximum dam density (dams/km)
0 - None
0 - 1 Rare
1 - 4 Occasional
5 - 15 Frequent
16 - 40 Pervasive
Idaho
Nevada
Wyoming
Colorado
Arizona
New Mexico
Utah
Raft River Range
Bear River
Great Salt Lake
Great Salt Lake Desert
Utah Lake
Duchesne River
Green River
White River
Sevier Desert
Sevier River
San Rafael River
Colorado River
Escalante Desert
Escalante River
Virgin River
San Juan River
Lake Powell
0 50 100 150 200 Km

HOW IT DOES

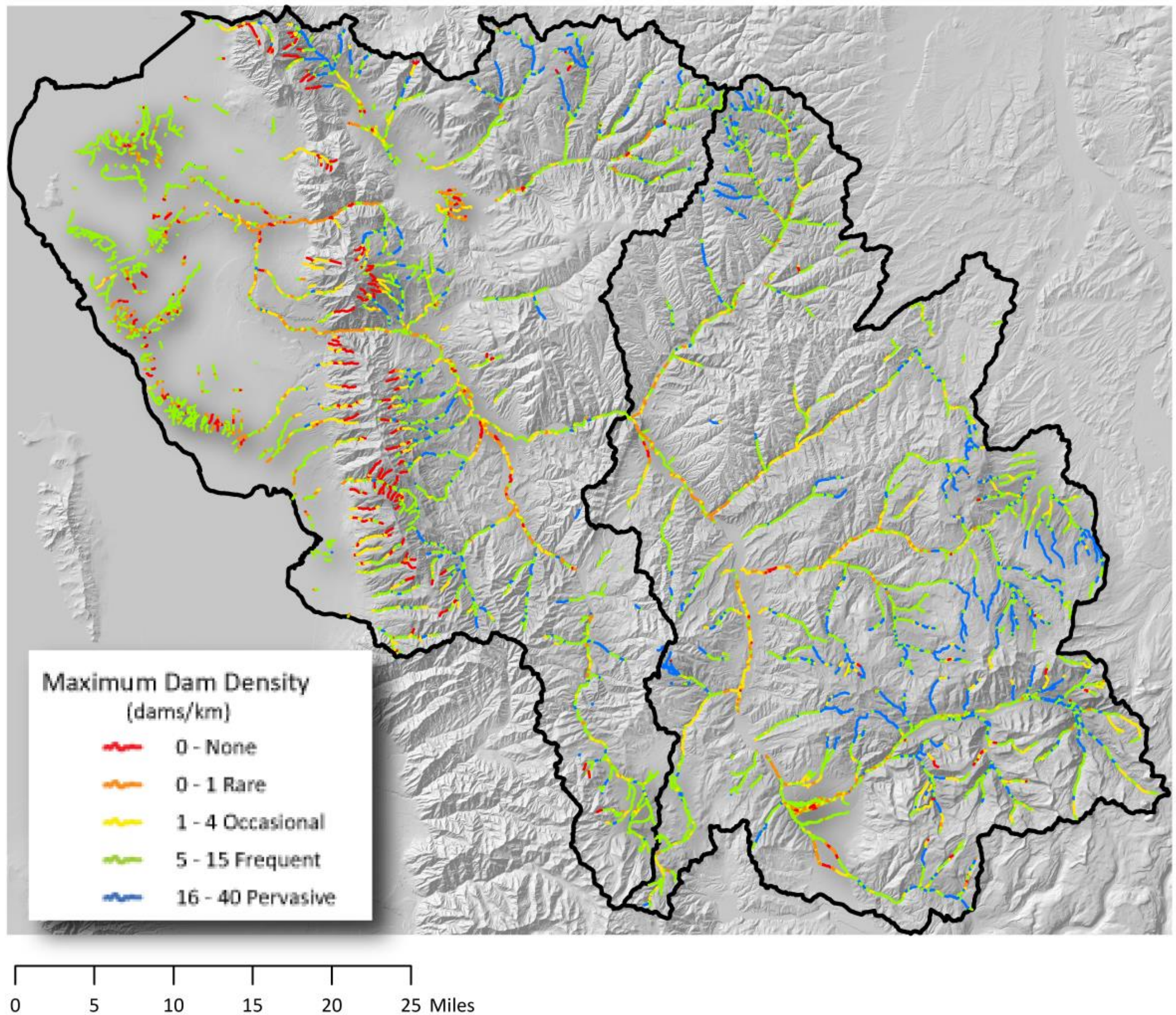
What you look for…

- No beaver dams where None predicted
- Low densities in ‘occasional’ zones
- Stable long-term dam complexes in ‘frequent’ or ‘pervasive’
- High quality (‘frequent’/’pervasive’) areas as likely locations of new colonies



EXISTING BEAVER DAM CAPACITY

- Weber Basin BRAT Model:
  - Max Capacity: ~ 23,477 dams
  - Over 2358 km of streams
  - Avg. Max Density: 10 dams/km



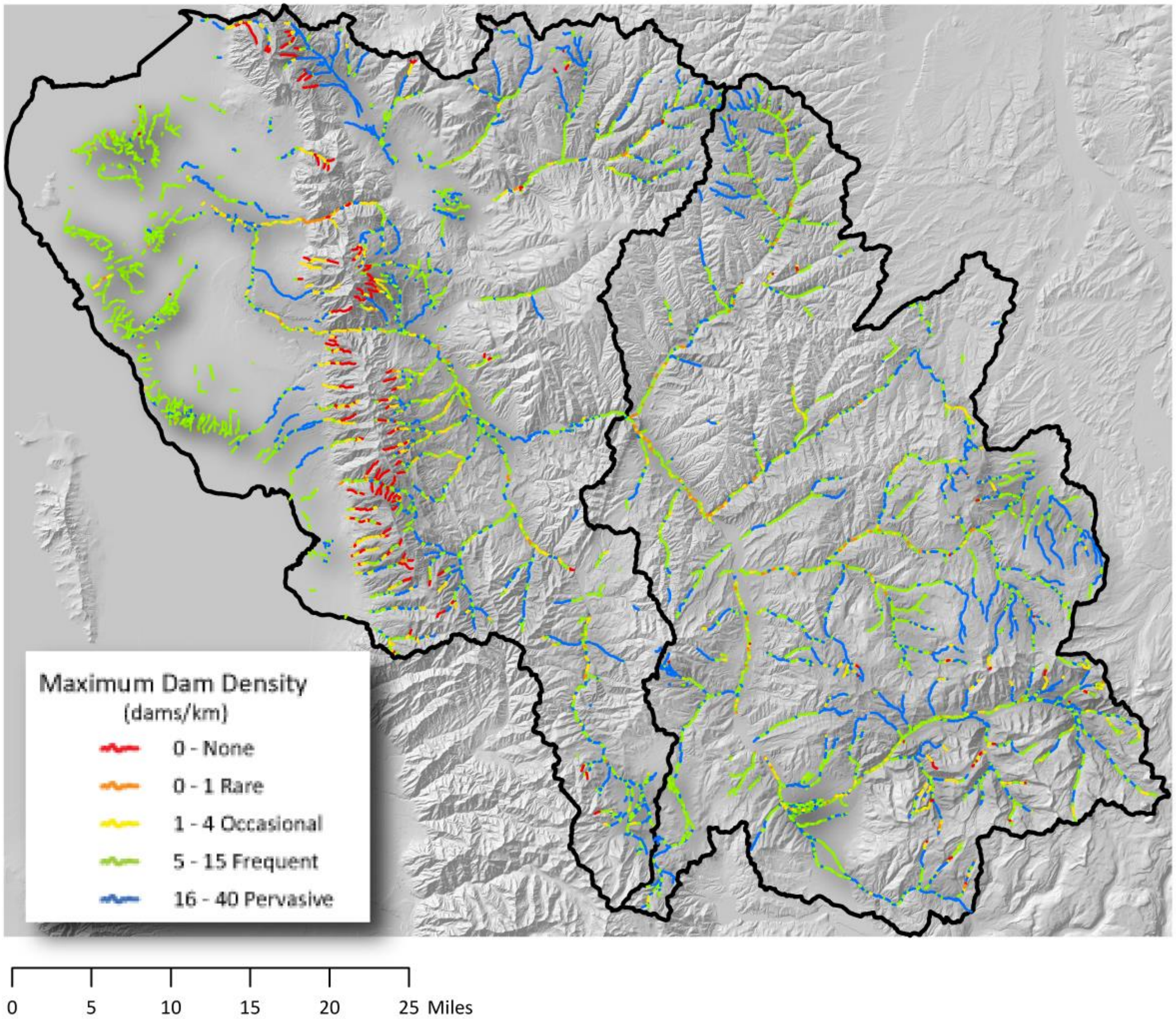
HISTORIC BEAVER DAM CAPACITY

- Weber Basin BRAT Model:

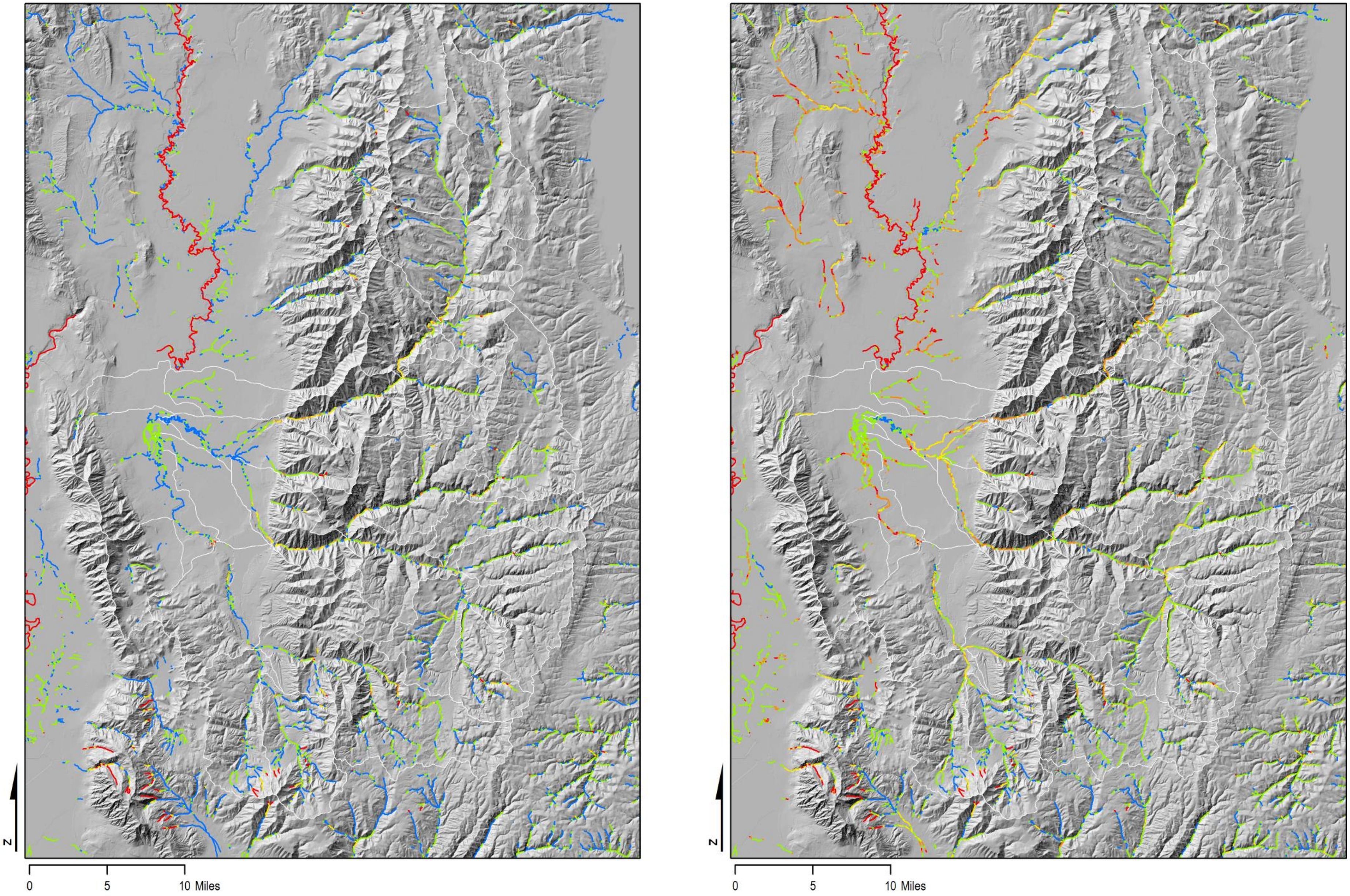
  Max Capacity: ~ 32,409 dams

  Over 2358 km of streams

  Avg. Max Density: 14 dams/km



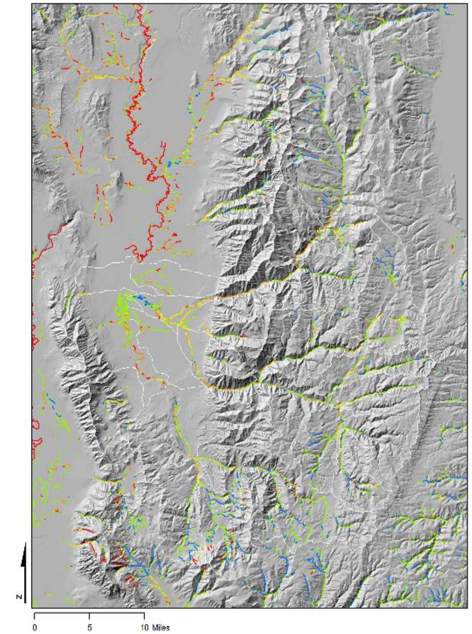
CACHE VALLEY – HISTORIC VS. EXISTING



- 11,038 historic capacity vs. 7,402 existing capacity

LOOKING CLOSER AT OUTPUT

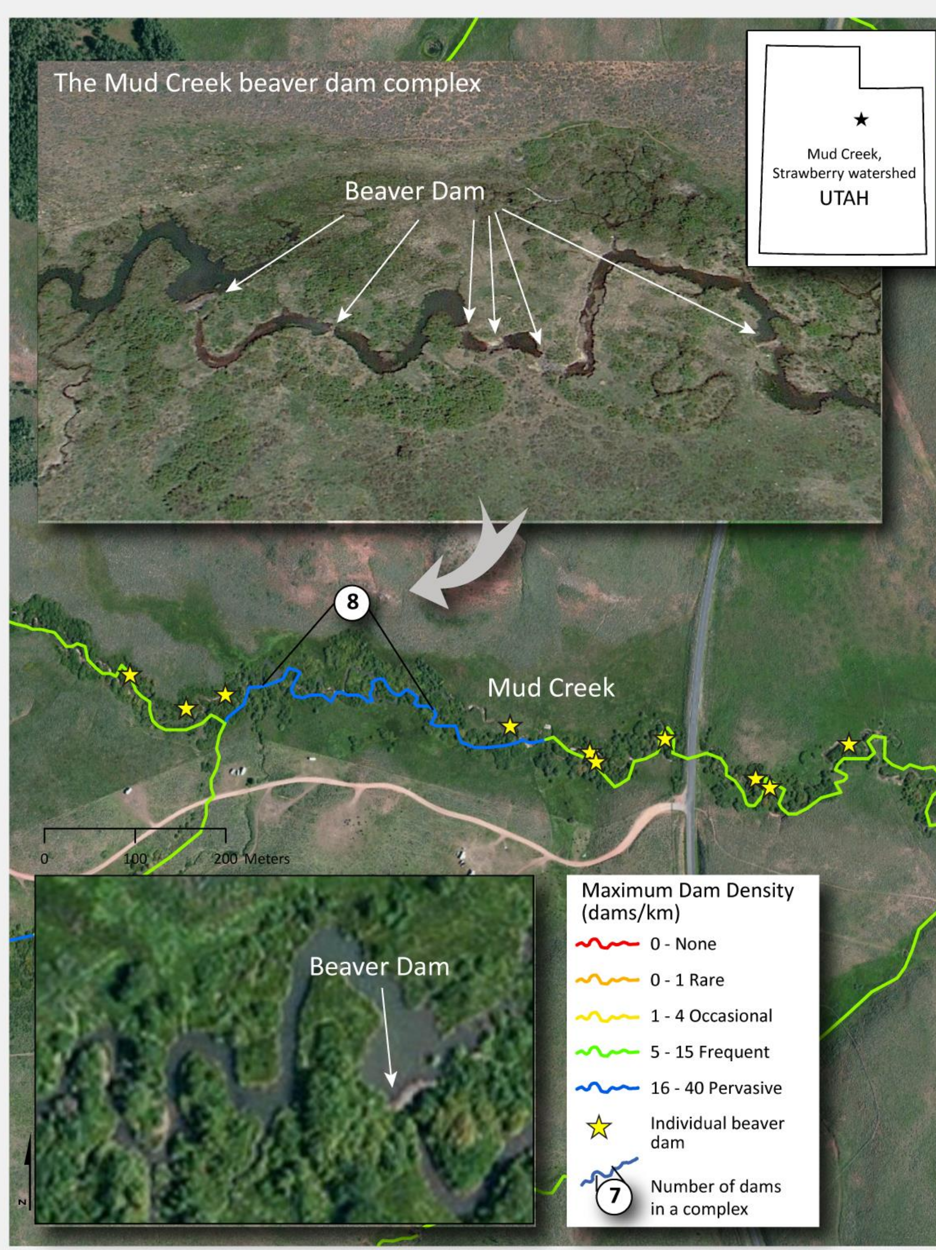
- Logan River
  - Max Capacity: 7402 dams
  - Currently 1313 dams
  - Current average of 1.8 dams/km
  - Current capacity of 10.1 dams/km



	Length of Stream	Existing Capacity (Density)	Historic Capacity (density)	Existing Capacity	Historic Capacity	Existing Count	Existing Dam Density	% of Existing Capacity	% of Historic Capacity
	iGeoLength	*oCC_EX*	*oCC_PT*	*mCC_EX_Ct*	*m_CC_PT_CT*	*e_DamCT*			
	km	Average Dam Density (Dams/Km)		Total Dams	Total Dams	Total Dams	Actual Dam Density	%	%
Logan River HUC8	731	10.1	15.1	7,402	11,038	1,313	1.8	18%	12%
∟Logan River HUC10	211	10.2	15.4	2,146	3,255	449	2.1	21%	14%
∟ Temple Fork HUC12	14	7.7	11.3	108	158	42	3.0	39%	27%
∟ Beaver Creek HUC12	25	11.2	16.2	281	405	142	5.7	51%	35%
∟ Right Hand Fork HUC12	14	7.7	11.3	108	158	42	3.0	39%	27%
∟ Franklin Basin HUC12	32.7	15.5	17.7	506	578	138	4.2	27%	24%
∟ Red Banks Logan HUC12	43.2	11.3	13.8	488	596	58	1.3	12%	10%
∟ Blacksmith Fork HUC 10	205	9.6	13.8	1,968	2,827	437	2.1	22%	15%
∟Curtis Creek HUC12	13.5	8.2	13.8	111	186	16	1.2	14%	9%
∟ Rock Creek HUC12	26.4	10.3	14.7	272	388	58	2.2	21%	15%
City Logan	59	9.0	20.2	533	1,192	4	0.1	1%	0%

RESOLUTION OF BRAT

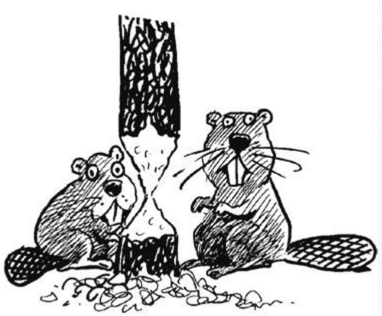
- At a scale that is still meaningful on the ground (250 m reaches)
- Just because BRAT predicts high capacity, does not mean it will be realized… but it does define a plausible upper limit
- In many places, at some point in time this upper limit is reached… just never all at once



BONNEVILLE POWER ADMINISTRATION ISEMP CHaMP

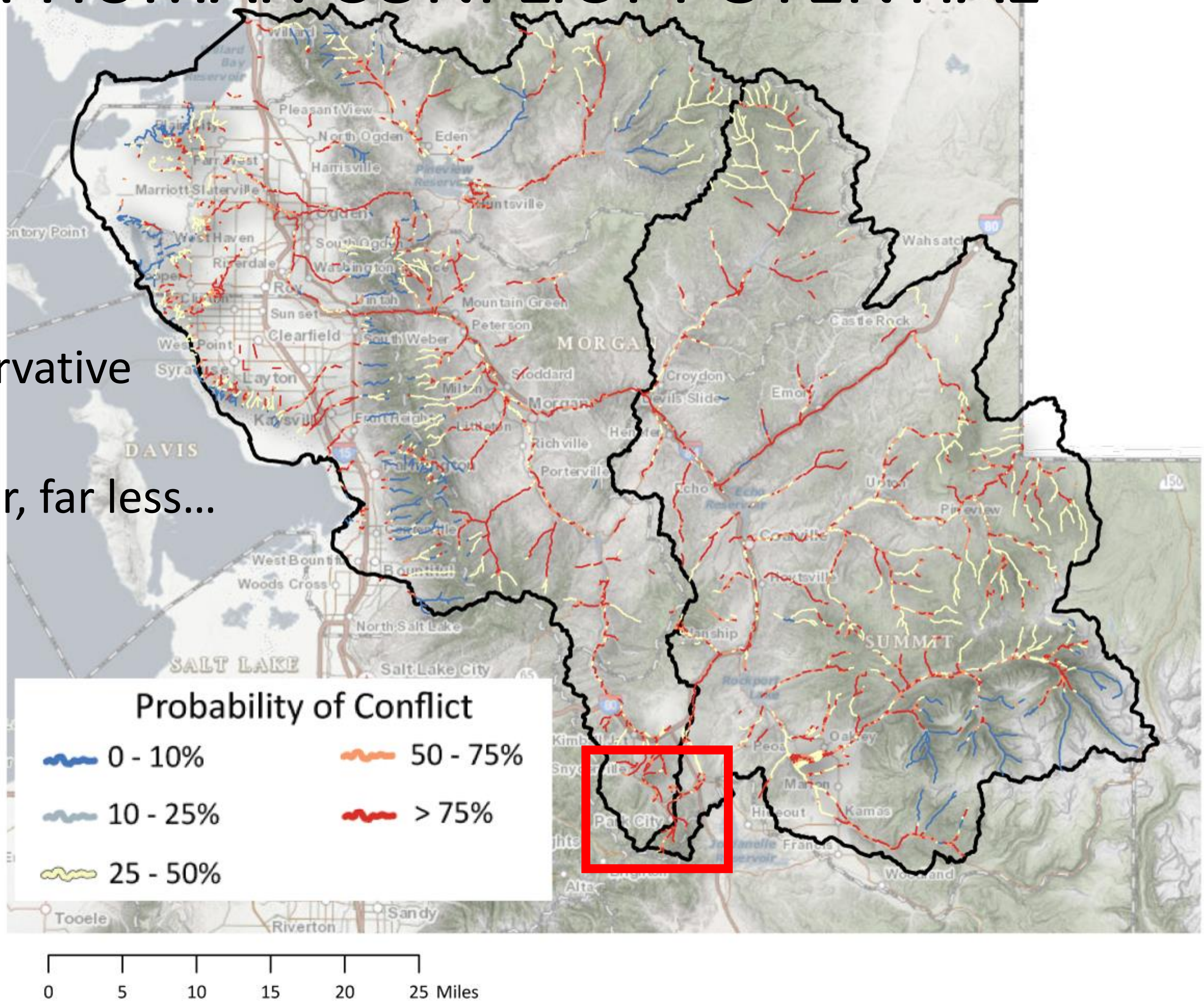
IN SOME PLACES… THEY ARE A NUISANCE

- In residential areas they can cause flooding…
- They often block culverts, which can flood roads
- They can chop down our ornamental landscape trees
- They can make a mess of irrigation diversions



BEAVER-HUMAN CONFLICT POTENTIAL

- Very conservative estimate
- Probably far, far less…

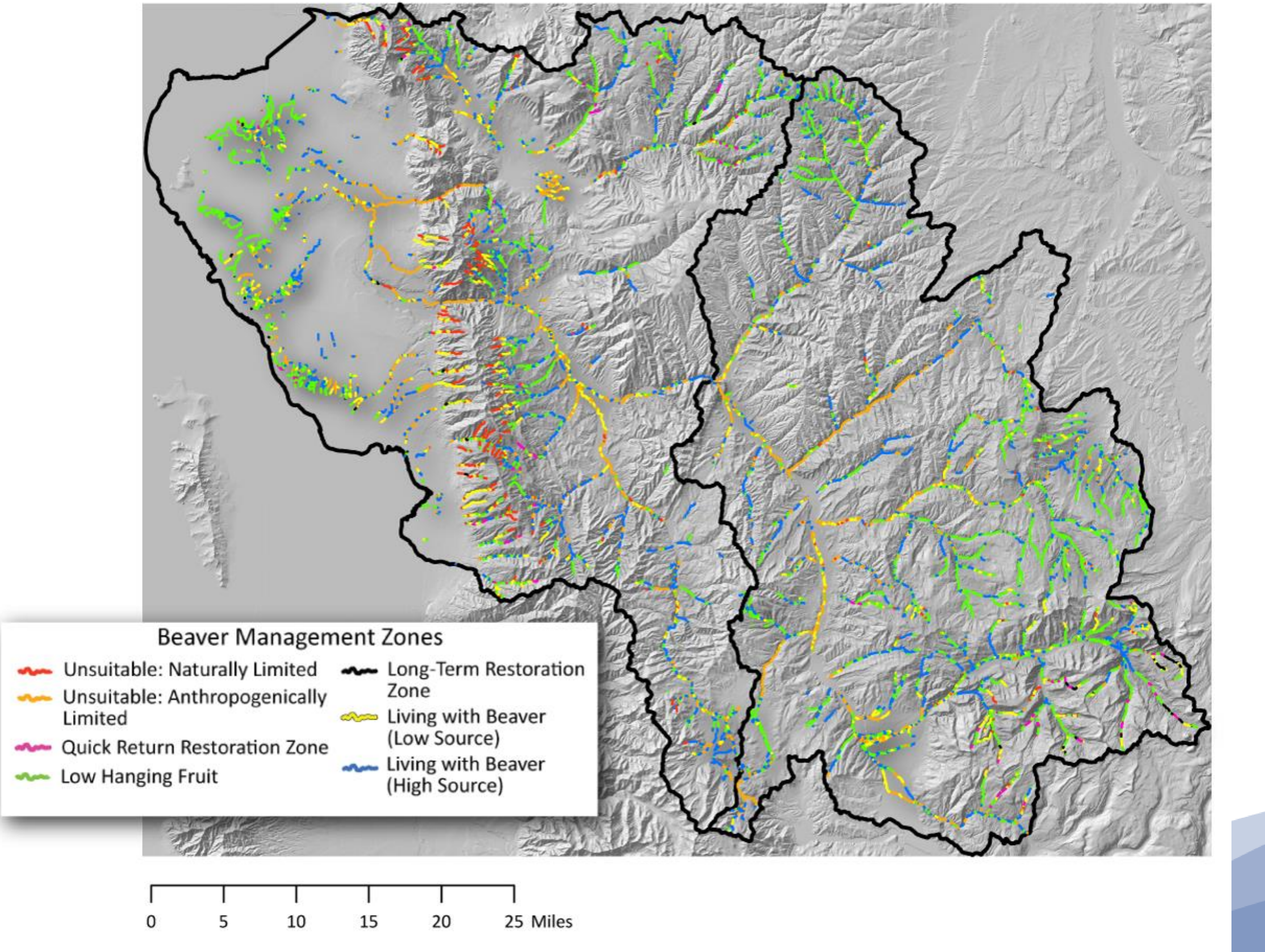


TRANSLOCATION

- In Utah, translocation is already allowed under UDWR's Beaver Management Plan

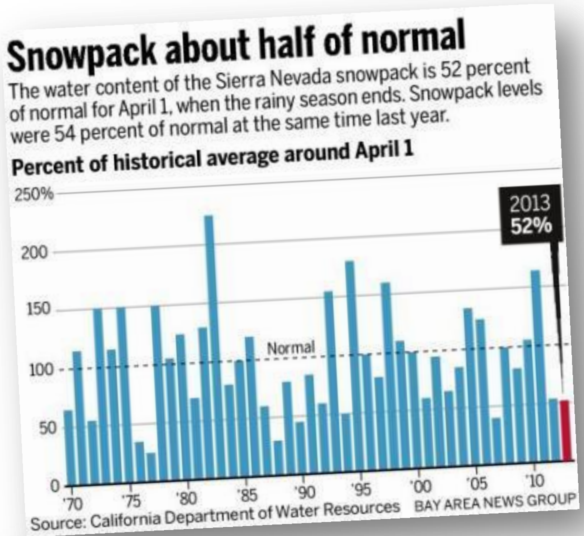
UTAH DNR
WILDLIFE RESOURCES

Nuisance beavers being translocated from Henry's Fork to High Unitah's (Courtesy of Sorenson).


Beaver Management Zones
Unsuitable: Naturally Limited
Unsuitable: Anthropogenically Limited
Quick Return Restoration Zone
Low Hanging Fruit
Long-Term Restoration Zone
Living with Beaver (Low Source)
Living with Beaver (High Source)
0
5
10
15
20
25 Miles

WHAT ABOUT DECLINING SNOWPACK?

- Could we get enough beaver dams back on landscape to mitigate this?



- We desperately need research to better quantify hydrologic impacts of beaver dams and how they scale up

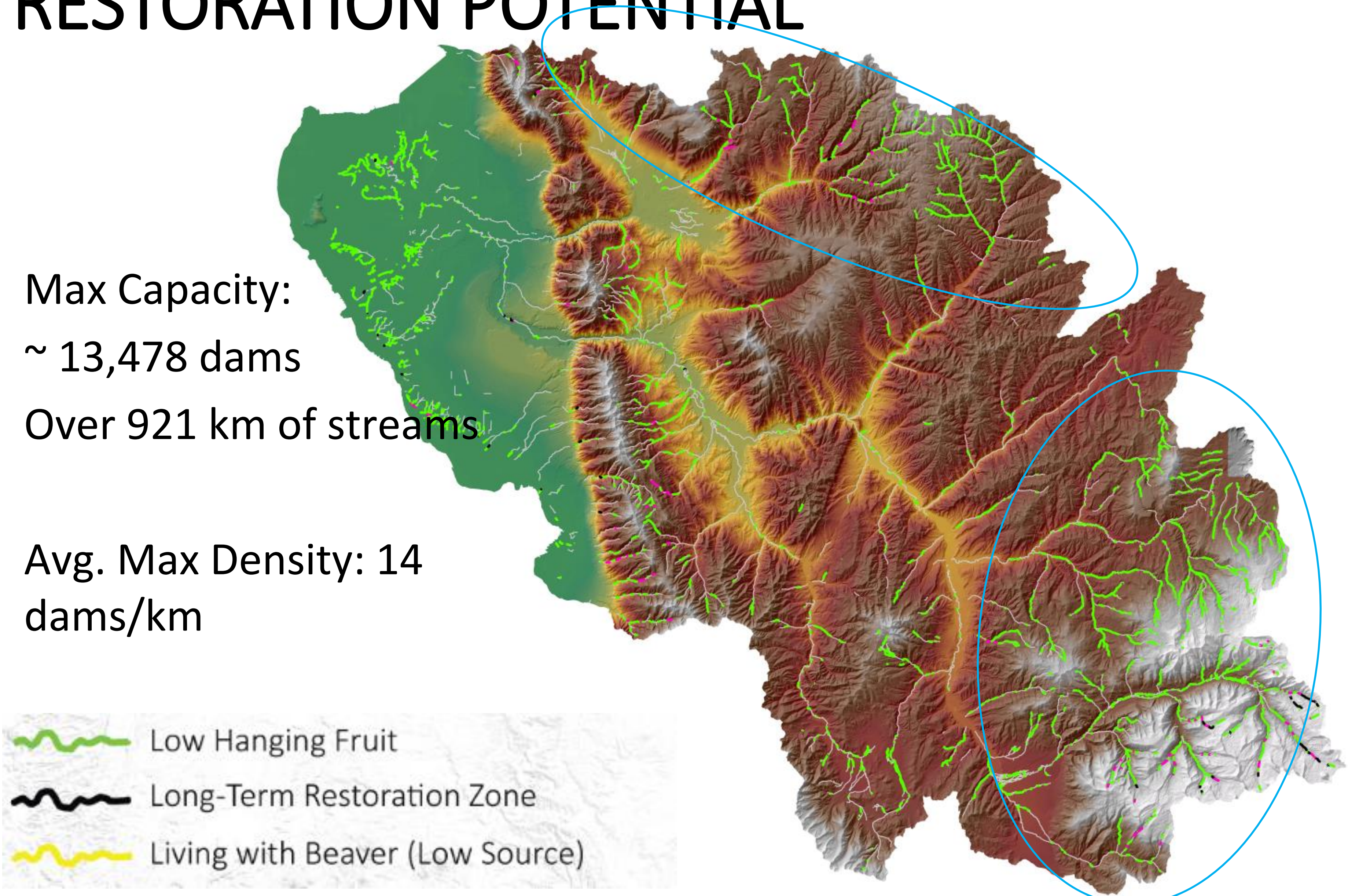
CLIP DOWN TO JUST AREAS WITH BEAVER RESTORATION POTENTIAL

Max Capacity:

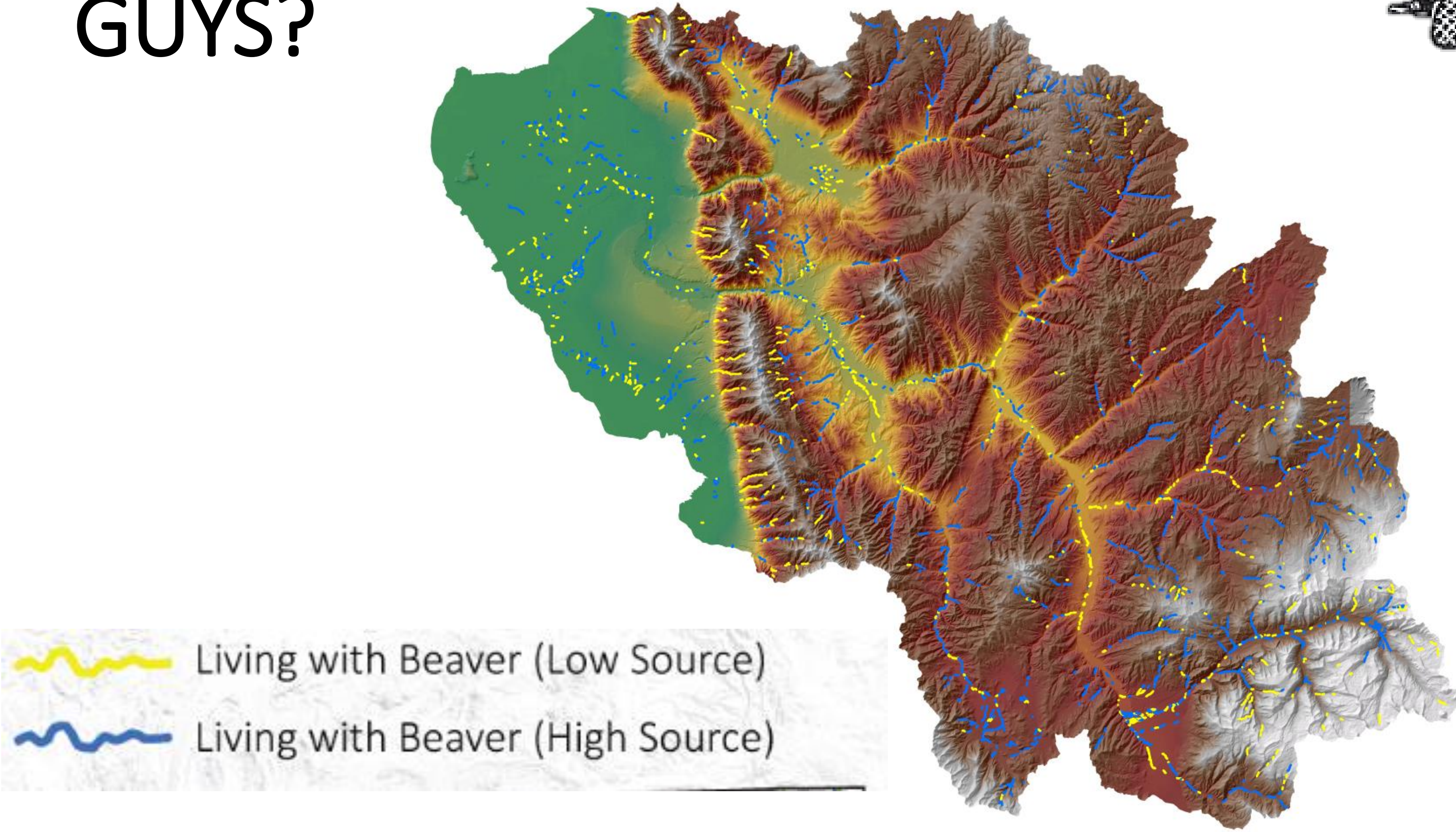
~ 13,478 dams

Over 921 km of streams

Avg. Max Density: 14 dams/km



WHERE COULD WE GET THOSE GUYS?

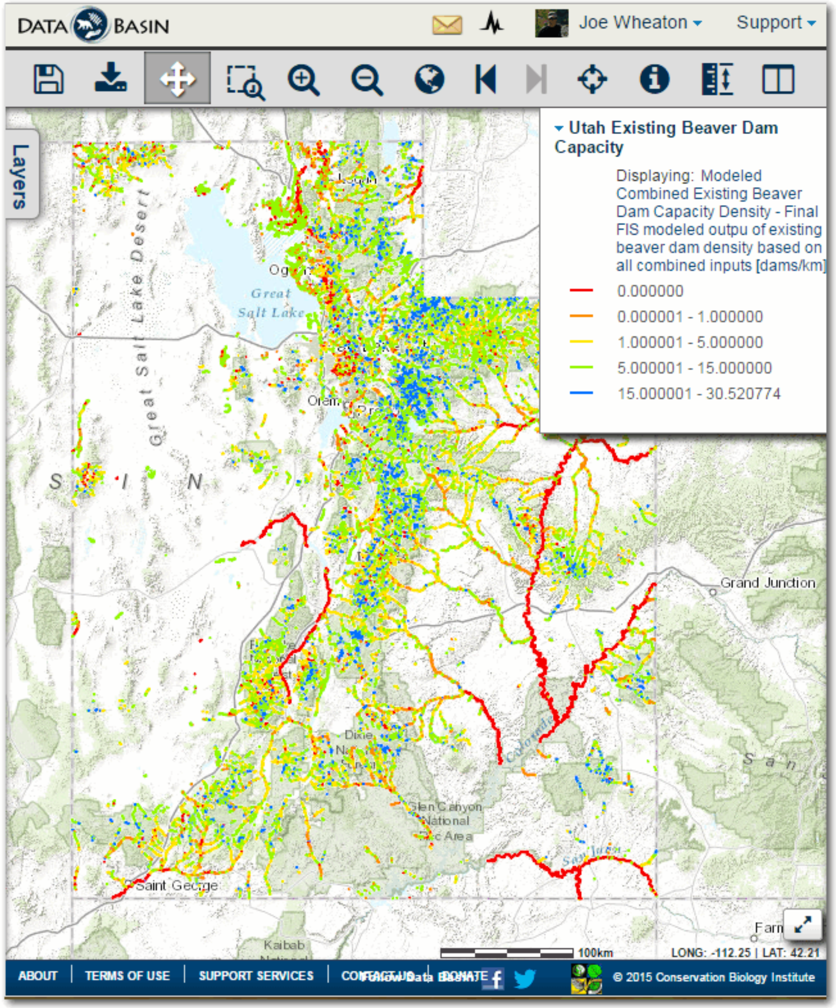


FUTURE & DOWNLOADS…

- We're running for as many regions as we can…
- So far, some in Idaho, Wyoming, Colorado, Utah, Nevada, Oregon, New York, New Mexico
- Discussions/proposals for Washington, Oregon, Montana, New England

BEAVER RESTORATION ASSESSMENT TOOL
UtahStateUniversity
ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY
BRAT

For more information on BRAT, visit: http://brat.joewheaton.org



CHaMP Columbia Habitat Monitoring Program

OUTLINE

GEOMORPHIC & NETWORK CONTEXT

- I. Background
- II. Reach Types - GNAT
  - I. Reach Type (River Style) Tree
  - II. Valley Setting
    - I. Valley Bottom
    - II. Confinement
    - III. Sinuosity
  - III. Reach Typing of CHaMP Basins & CRB
- III. Condition
  - I. Geomorphic Condition
  - II. Riparian Condition
  - III. Habitat & Population Condition
- IV. Recovery Potential
  - I. Geomorphic Recovery Potential
  - II. Riparian Recovery Potential
  - III. BRAT & WRAT
- **V. Future Work**