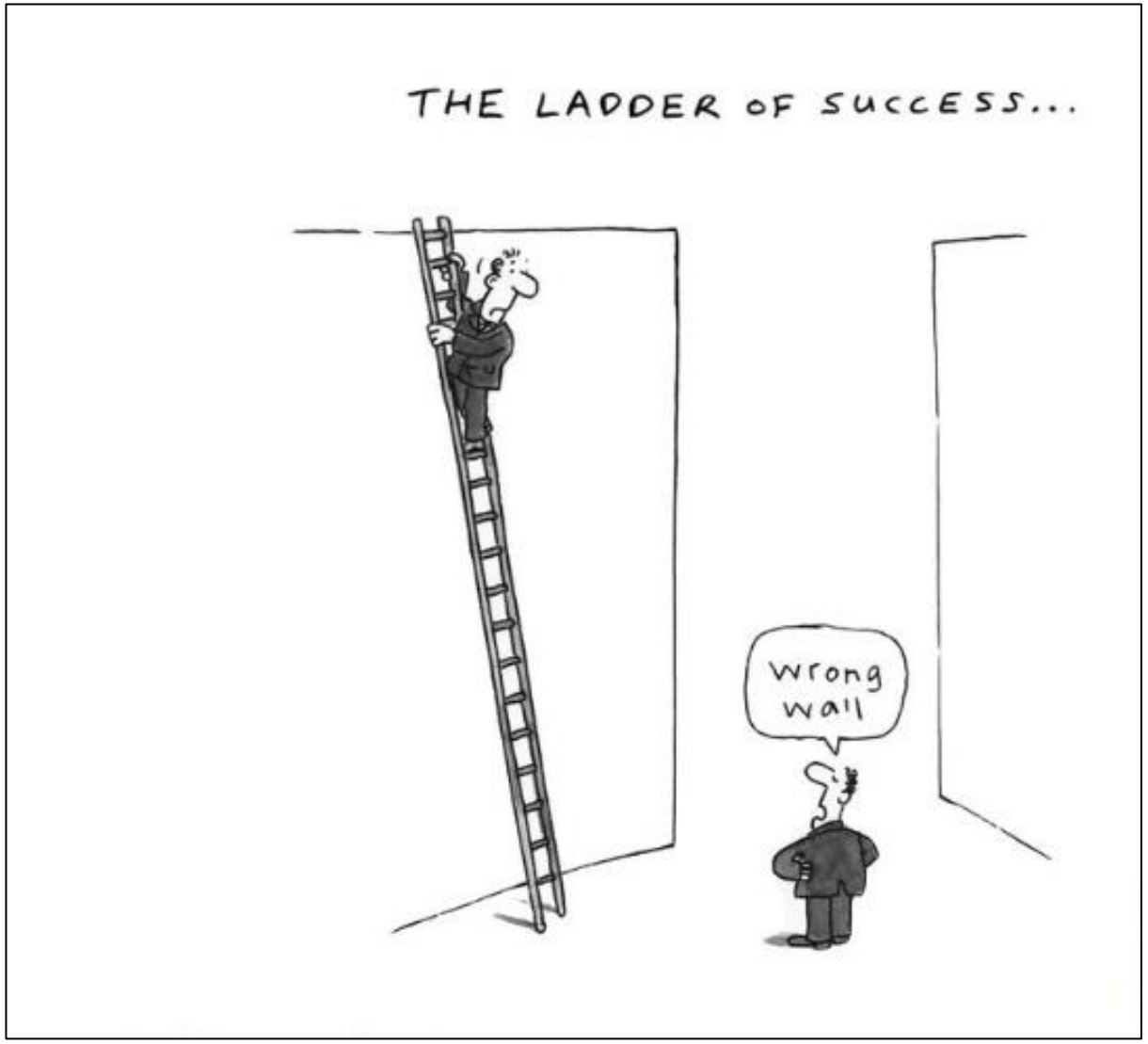


What we are discussing today:
Data and tools that can help you construct the “right ladder” on the “right wall”

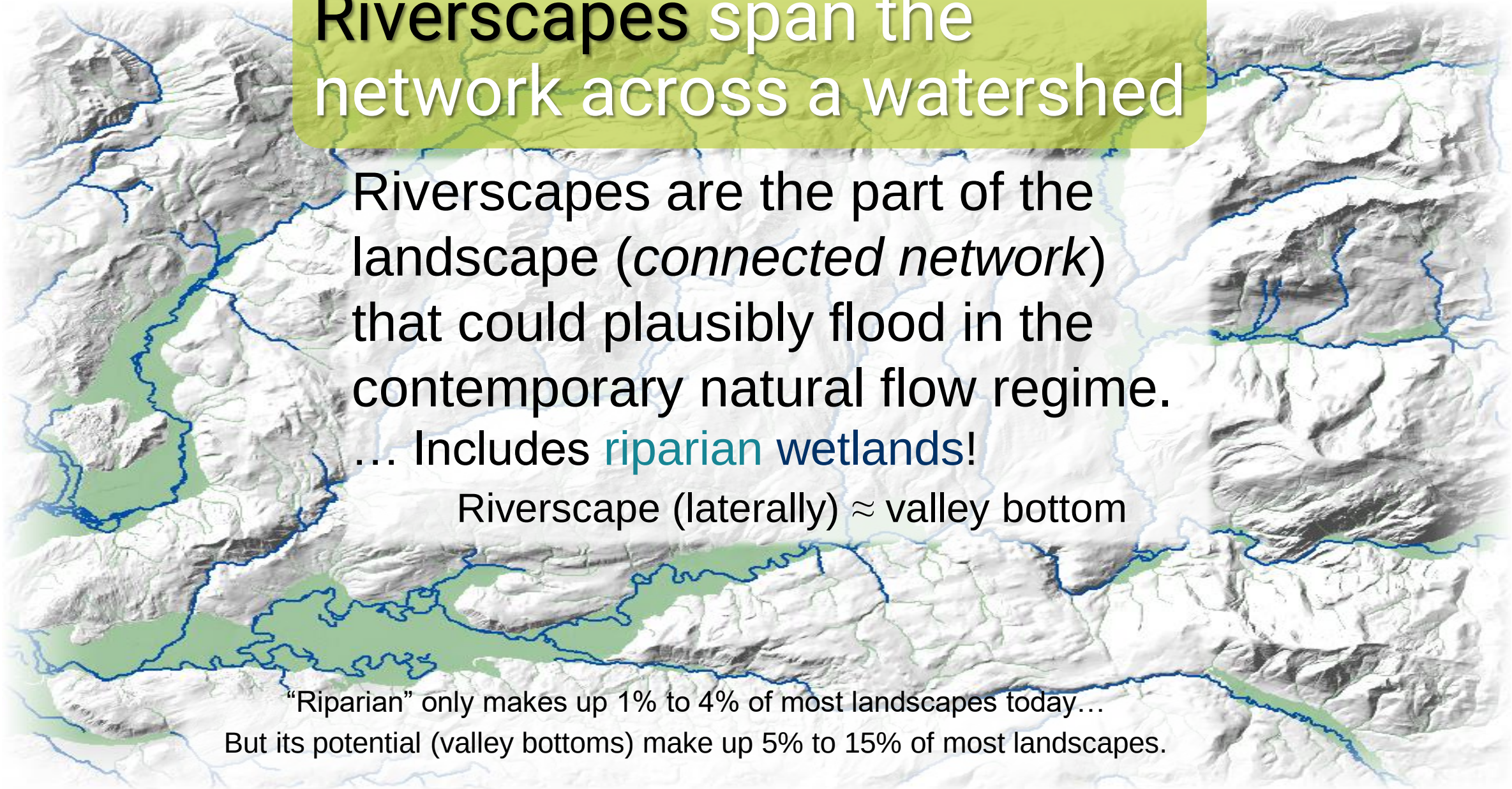
Your task:
Put crews on the right streams, with the right tools and designs to:

- restore as many miles/acres of riverscape as possible
- …..So, they provide more of the resource values that we all care about

Part 1: Overview of riverscape concepts, data, and tools for BLM

Part 2: Application of concepts, data, and tools at the various spatial scales of planning

Riverscapes span the network across a watershed



Riverscapes are the part of the landscape (*connected network*) that could plausibly flood in the contemporary natural flow regime.

… Includes riparian wetlands!

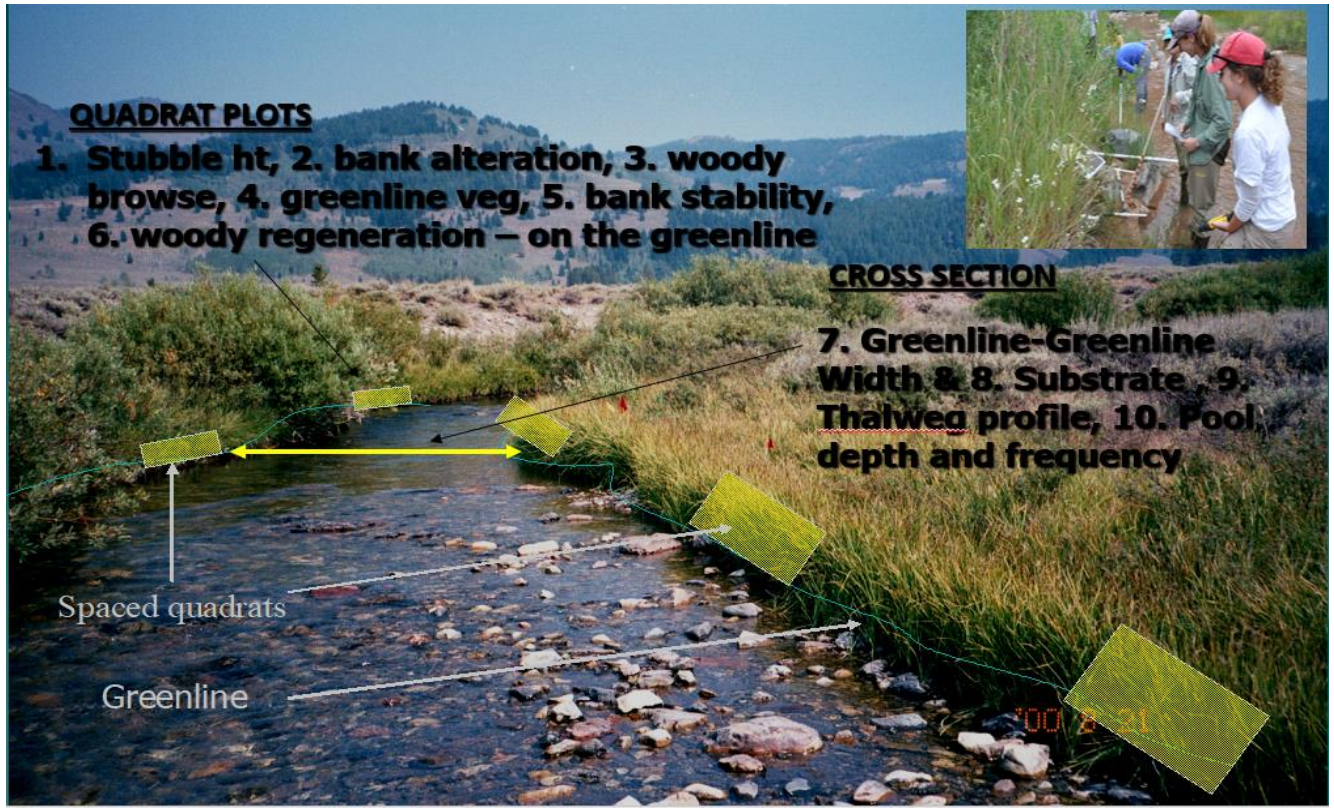
Riverscape (laterally) ≈ valley bottom

"Riparian" only makes up 1% to 4% of most landscapes today…

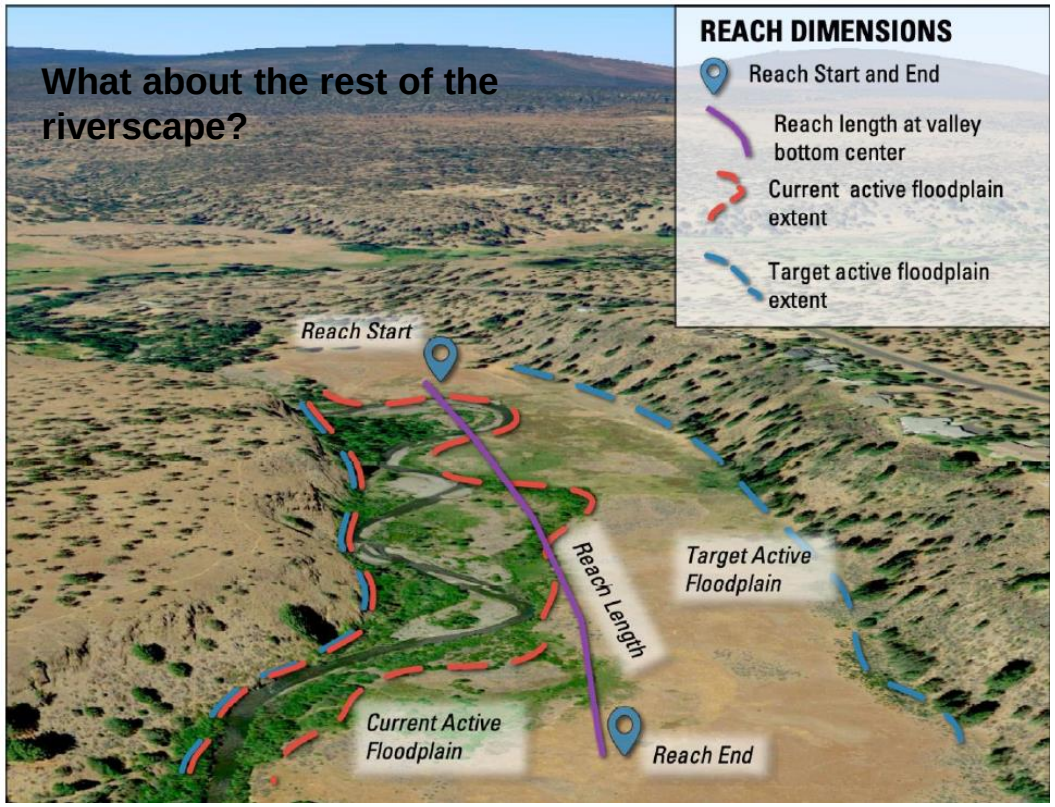
But its potential (valley bottoms) make up 5% to 15% of most landscapes.

Implications of a Riverscape Perspective on Monitoring Extent

Traditional Monitoring: Reaches of CHANNEL



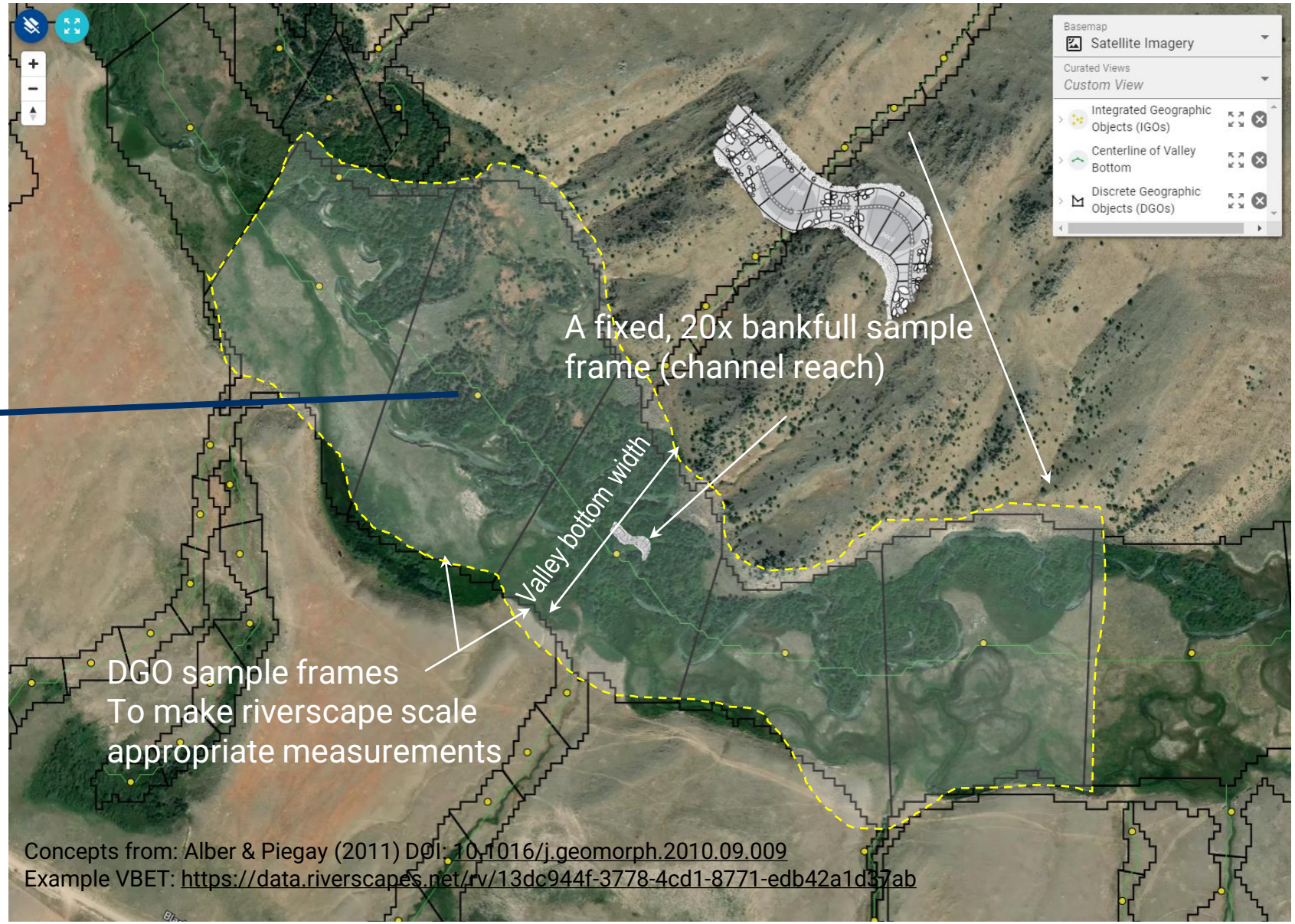
What we Need: Reaches of Riverscape



Riverscape-Sized Sample Frame

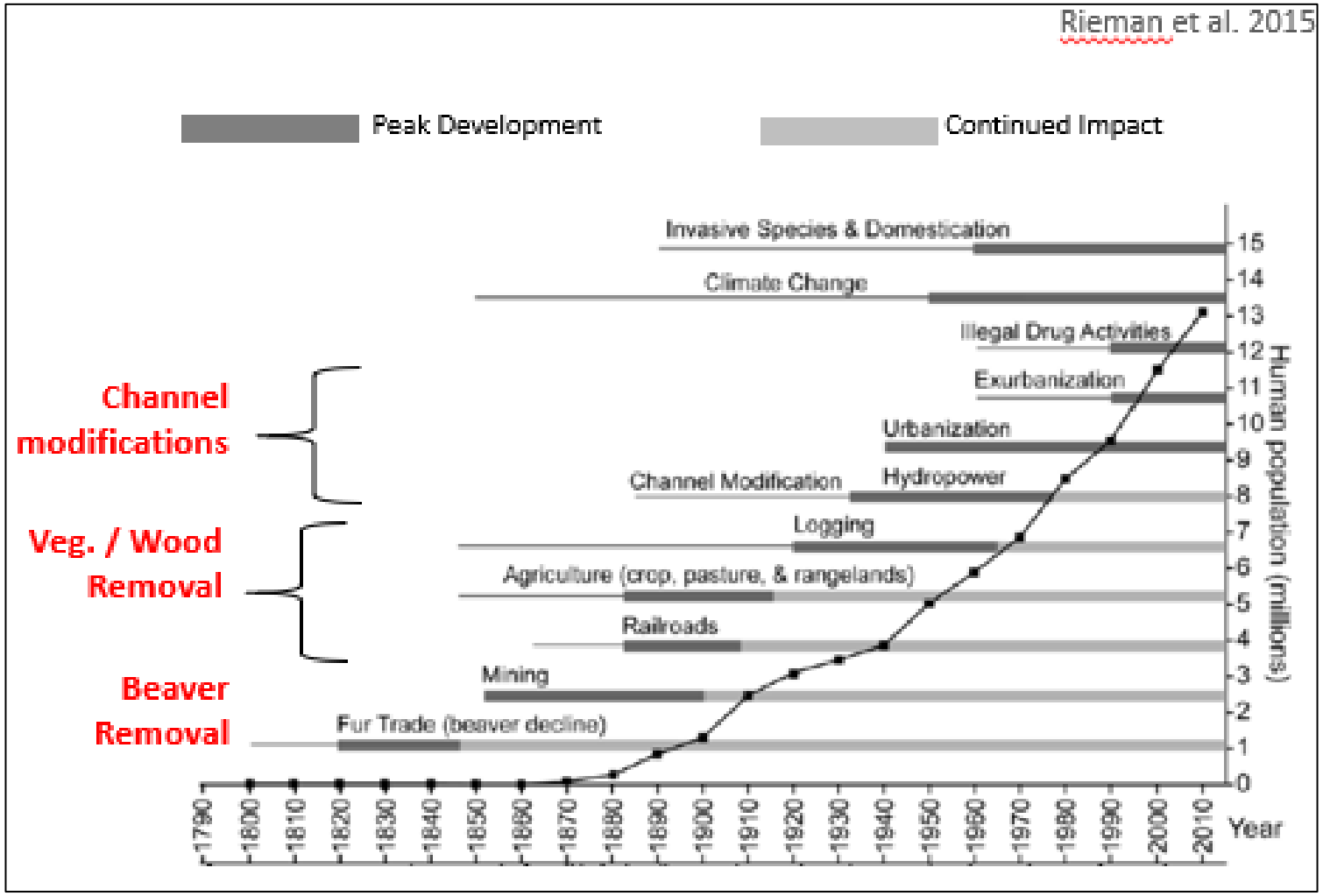
Discrete Geographic Object (DGO) Metrics

Valley bottom extent (acres)
Active channel, active floodplain, inactive floodplain (acres)
Riparian extent (acres)
Primary Channel (mi)
Secondary Channel (mi)
Confluence (count)
Difluence (count)
Channel head (count)
Natural Dams & jams (count)
Artificial Dams & Jams



Concepts from: Alber & Piegay (2011) DOI: 10.1016/j.geomorph.2010.09.009
Example VBET: https://data.riverscapes.net/rv/13dc944f-3778-4cd1-8771-edb42a1d37ab

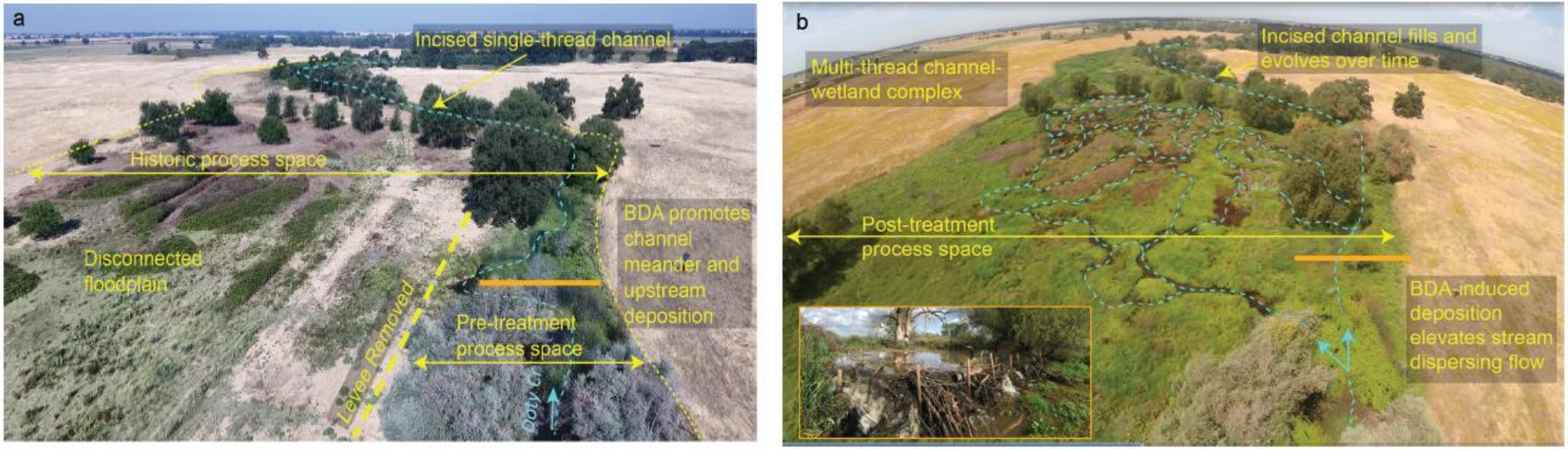
Historic Context is Critical for Riverscape Management



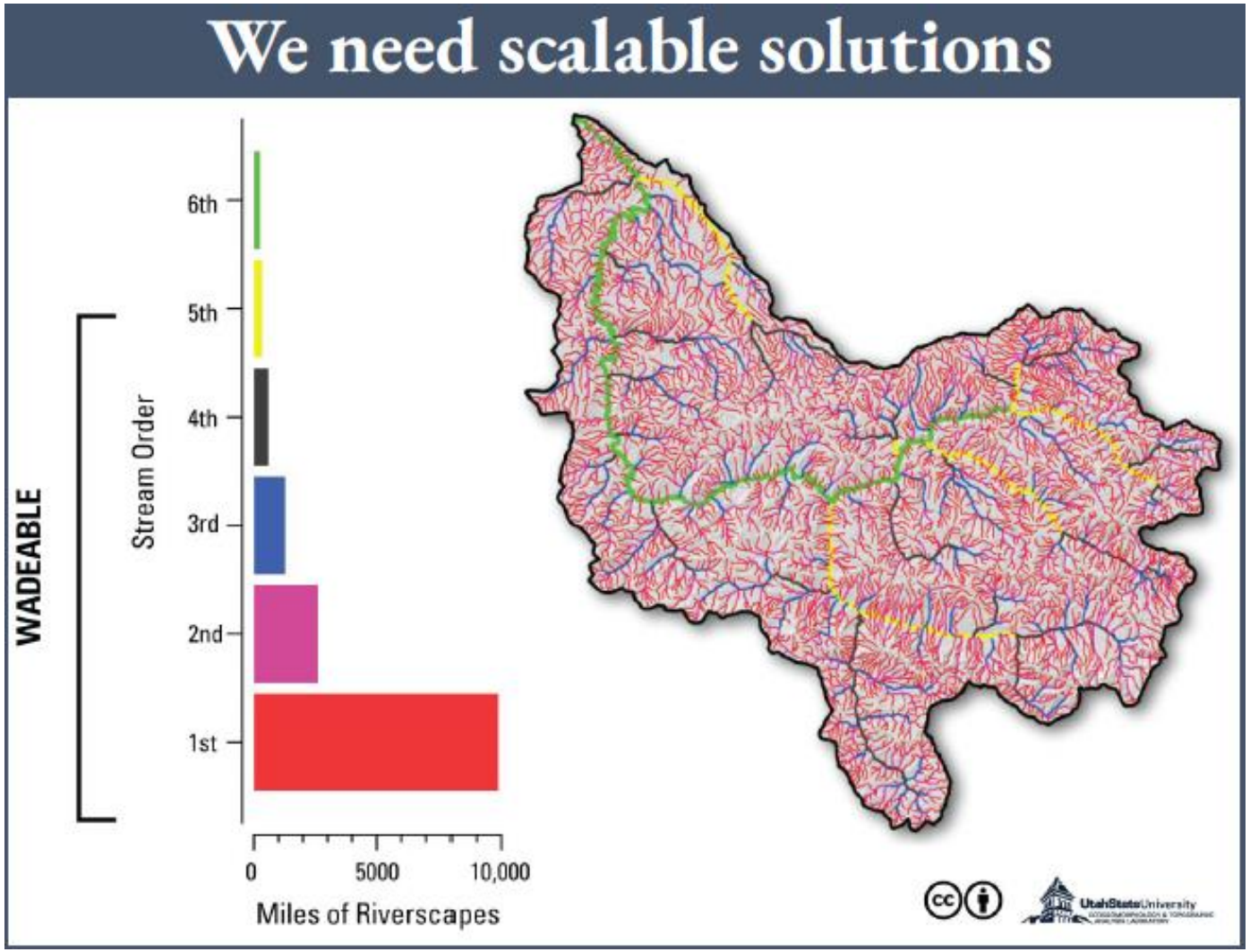
*Many systems were degraded before BLM existed

What Do These Impacts Have in Common?

- ***Removed process-space (direct & indirect)***
- ***Structural starvation***
- ***Increased hydrologic efficiency***
- ***Altered supply of water, sediment and vegetation***



Doty Ravine Creek, California project area (a) in August 2017 before the floodplain was reconnected (b) in August 2019 after the floodplain was reconnected. Restoration design elements are highlighted on images along with gains in process space and stream recovery in response to restoration actions. Photographs: (a) Drone image by Placer Land Trust, (b) drone image by Matt Hamman.



Status Quo "Restoration" isn't Working

- U.S. ecological restoration economy (BenDor et. al, 2015)
  - 126,000 people
  - Worth $9.5 billion/year
  - Overall economic impact = $24.8 billion/year
- Median Cost of Stream Restoration = $265,000/mile
- Median Project Length = 0.5 miles (Bair, 2004, Bernhardt et al., 2007).
- ROI is worrying (Hiers et al., 2016b)

Scalable Alternative: Help Water Do the Work

- Restore freedom space to facilitate stream-floodplain connections & lateral adjustments (Riverscape Health Principle 1)
- Restore the diet of water, sediment, and vegetation (Riverscape Health Principle 4)
- Restore the supply of structural elements (Riverscape Health Principles 2, 3, and 4)
- Defer decision-making to the system

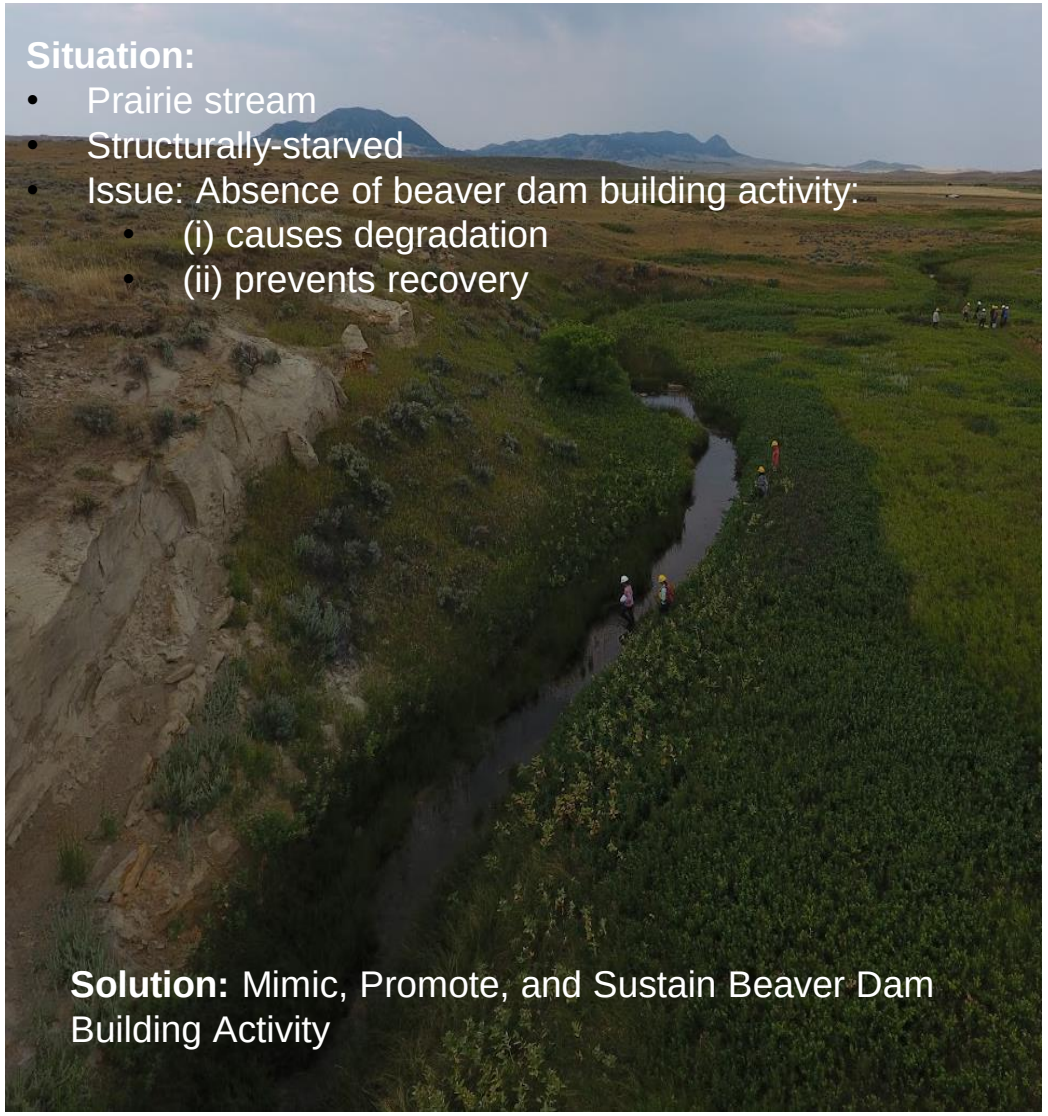
Streams need a healthy diet and exercise

Levee removal, Green River, WA

Post assisted BDA, Central Montana

Post assisted log structure, Eastern Oregon

Example: Lewistown, MT



LTPBR of Riverscapes Introductory Workshop

- 40 Students
- 2 days of lecture
- 1 day in field

Mimic → Promote

Promote (September 2019)

beaver packing BDA with clay

November 2020: Mimic + Promote = Success!
New Objective = Sustain

Network-scale tools take free data (available nationally) and estimate what you will find in a local riverscape (good for prioritization, inventory, planning)

Reach-scale tools take the user to their “my riverscape” and lets them author their own:

- Assessments
- Designs
- As-Builts
- Monitoring

Spatial Scale of Planning

Broad-scale management goals and objectives

Project scale

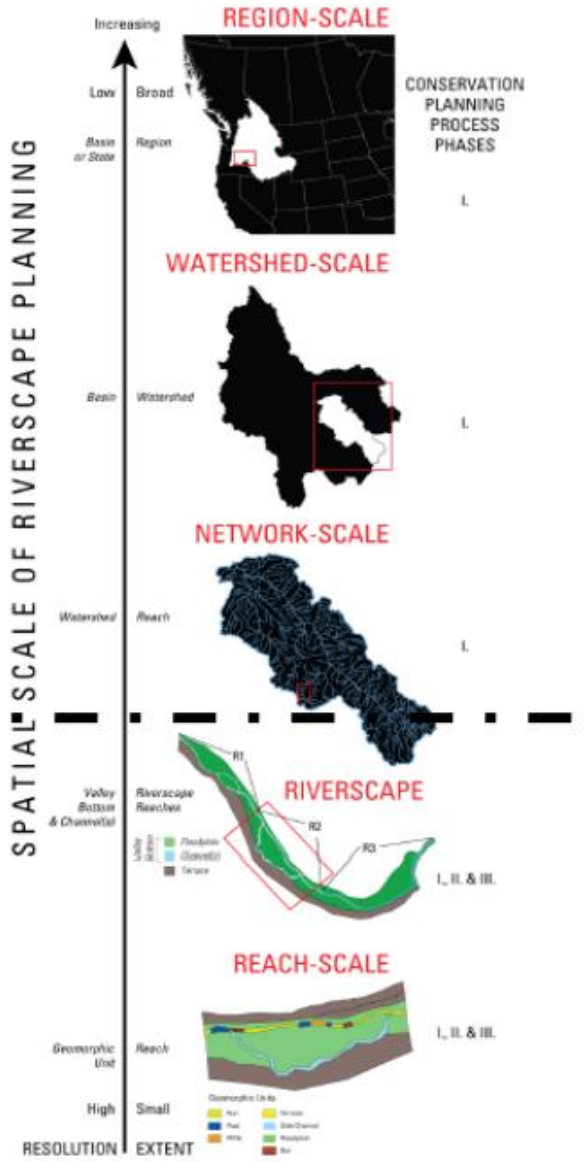


Figure 3.2 (pg. 90) from Bennett et al. (2019) – Chapter 3 LTPBR Manual

DOI: 10.13140/RG.2.2.15815.75680

Network-Scale Tools – Broadscale Management Questions

- Remote sensing & nationally-available data
- Geoprocessing & modelled logic
- Getting the most we can from existing data

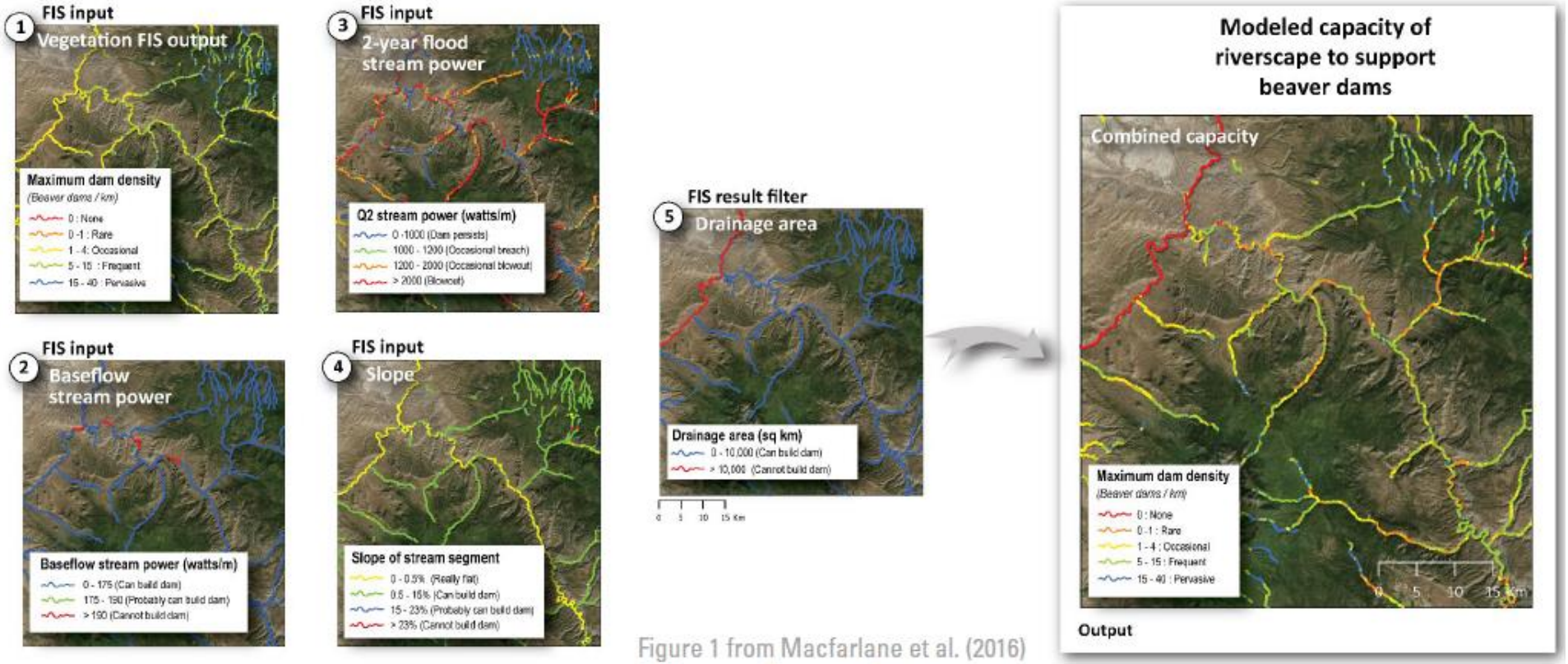
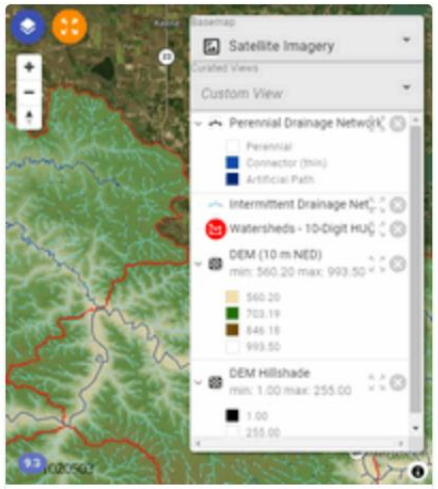
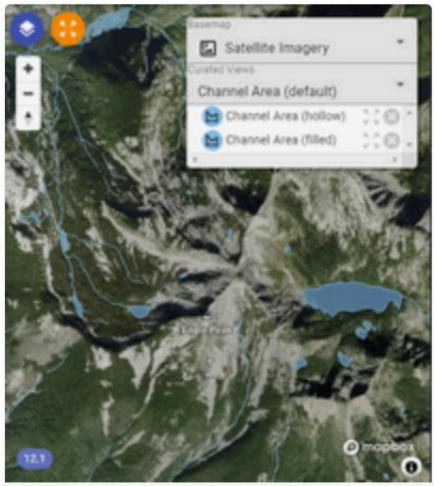


Figure 1 from Macfarlane et al. (2016)
DOI: 10.1016/j.geomorph.2015.11.019

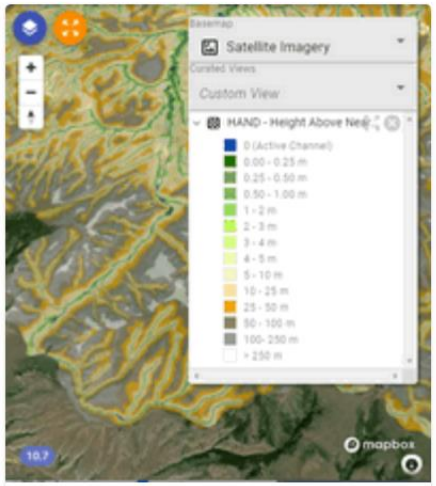
Production-Grade Tools for BLM's Restoration Landscapes



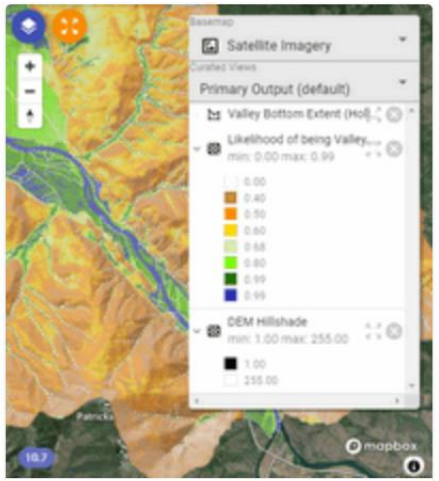
Riverscapes Context



Channel Area

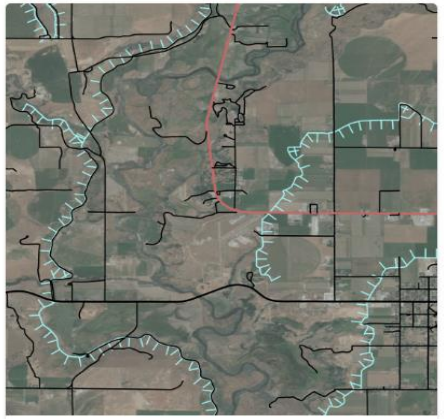


TauDEM

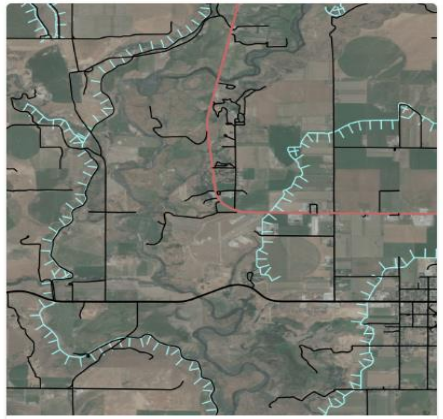


VBET

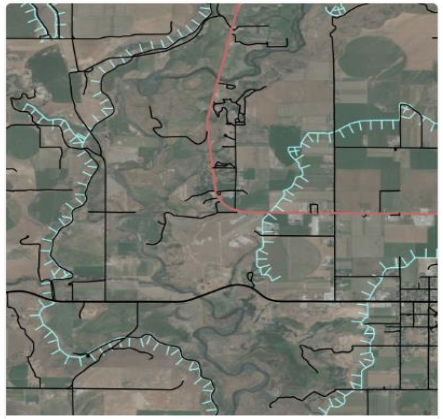
BRAT



Anthropogenic Context

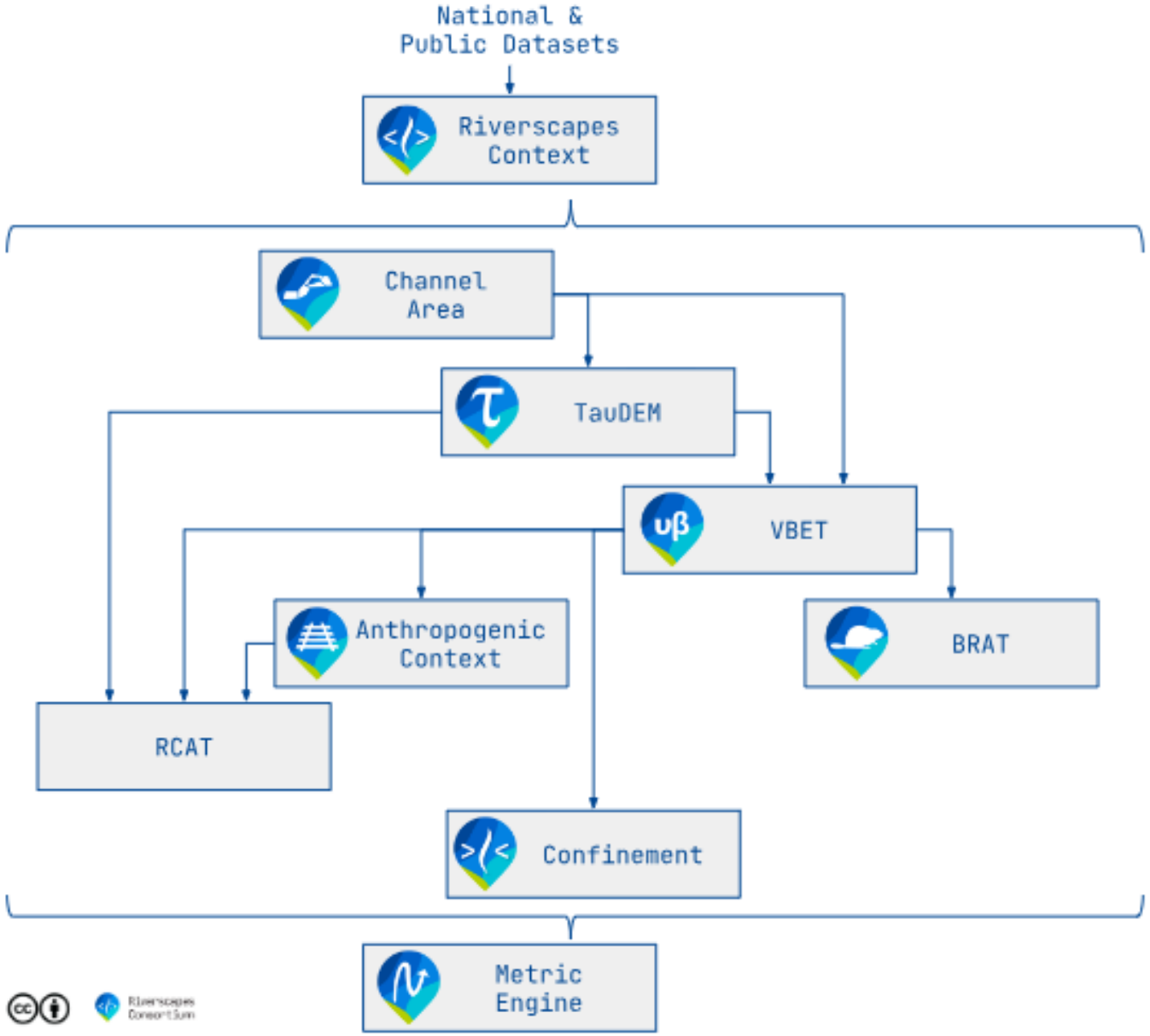


RCAT



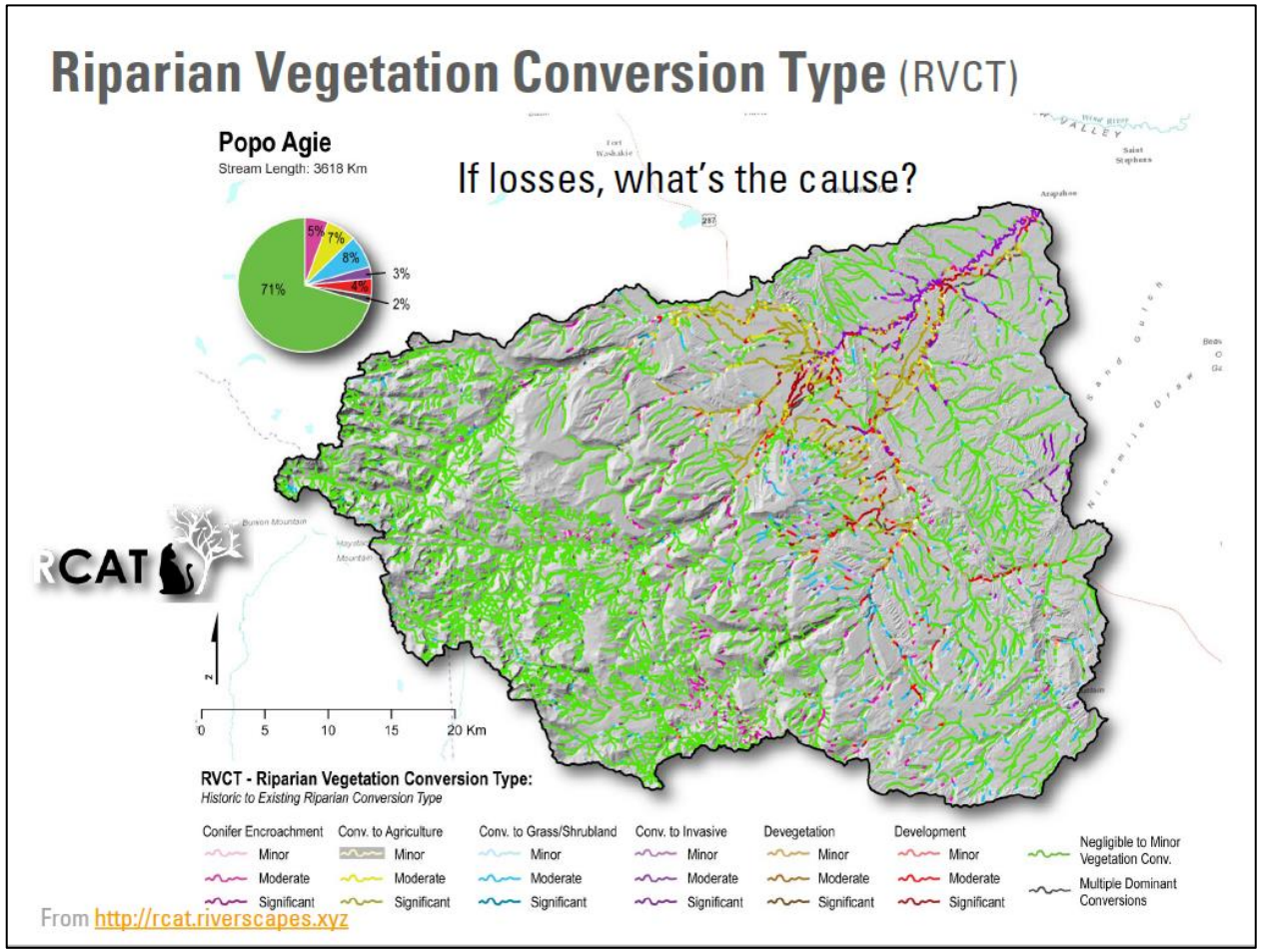
RME

Riverscapes Model Waterfall

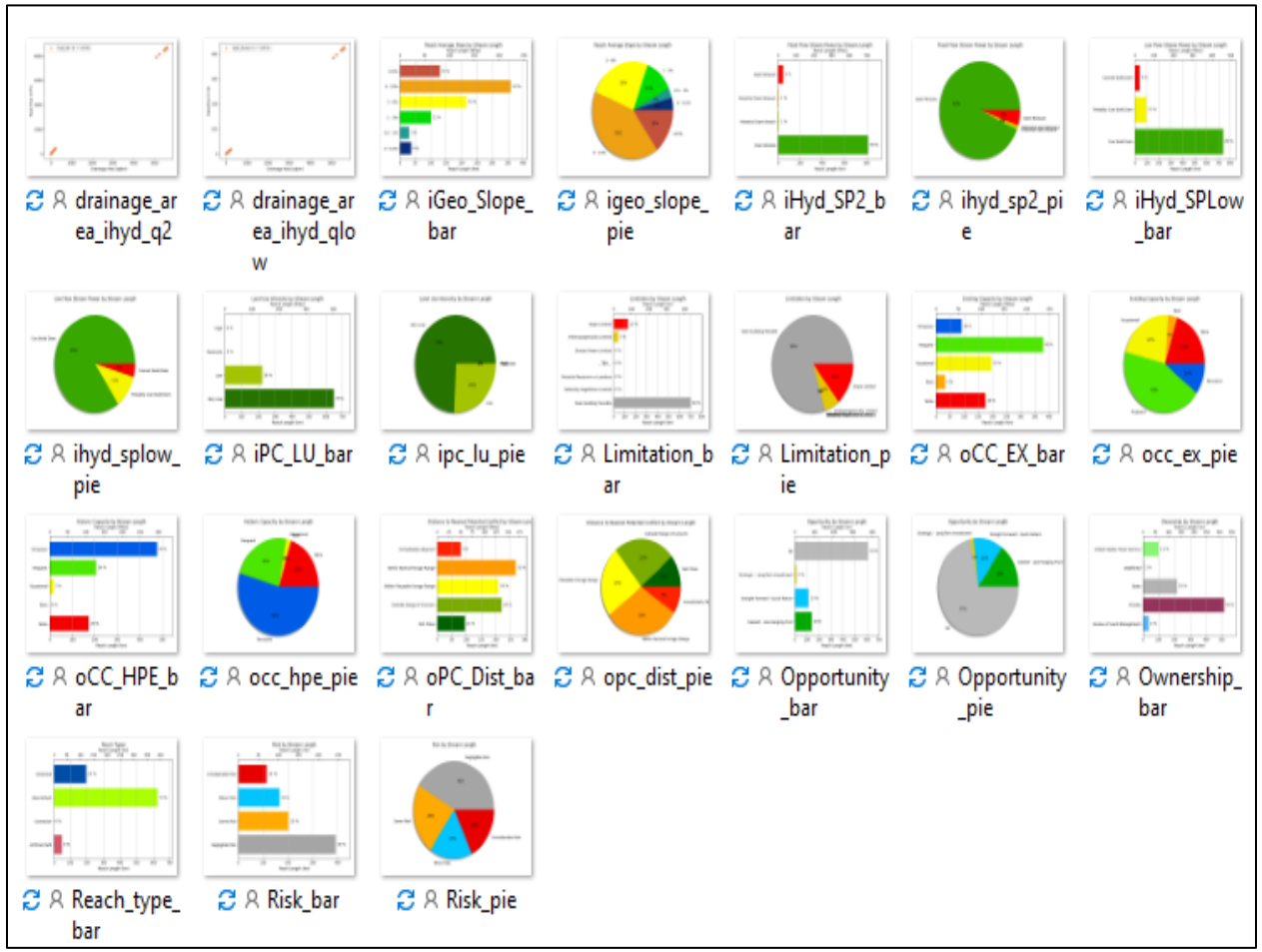


Types of Output to Inform Planning

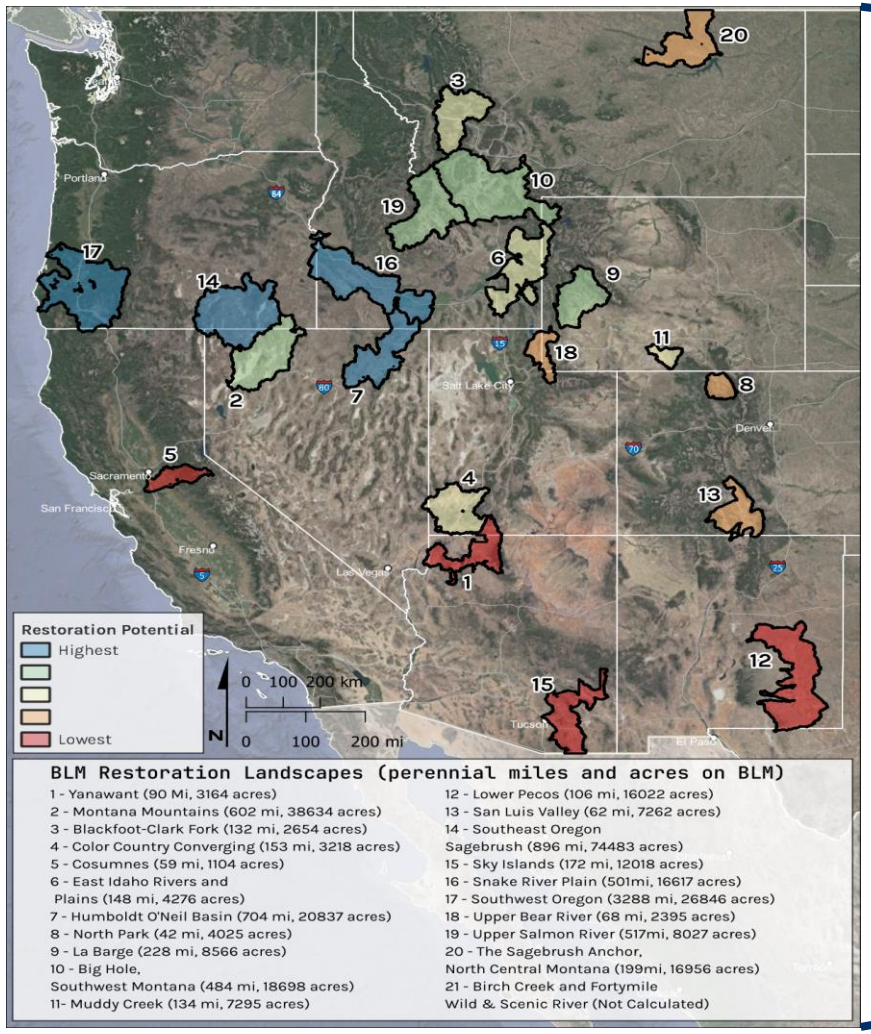
Map Products

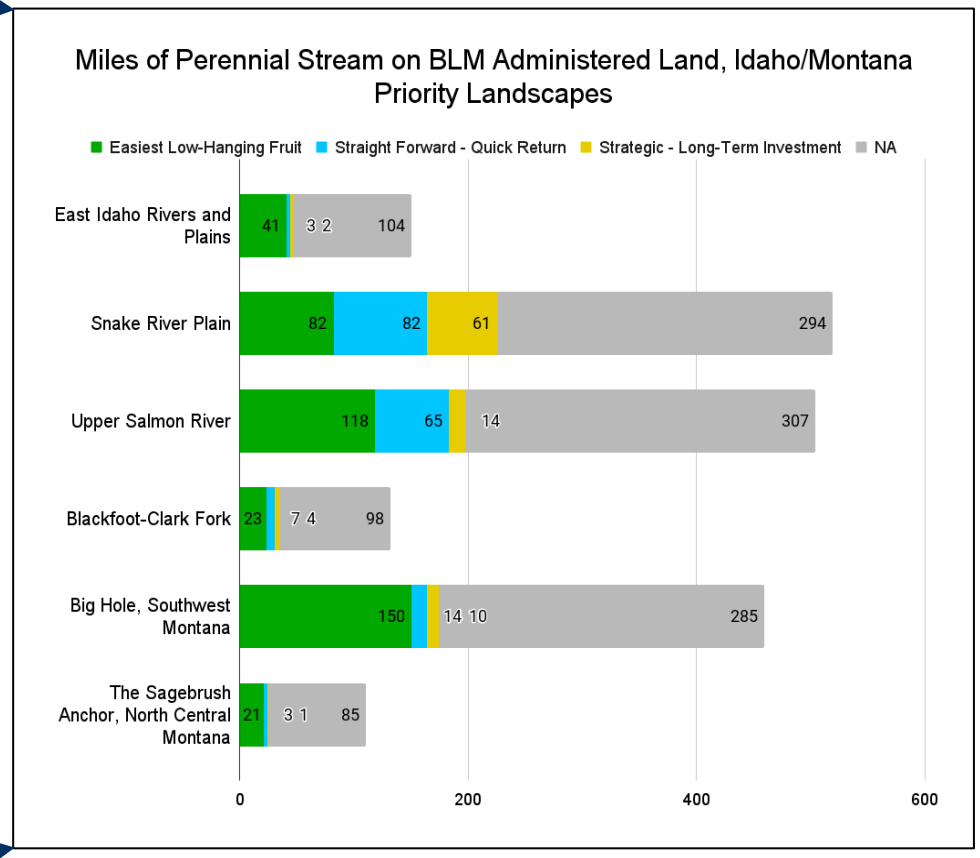


Statistics – Riverscape Health & Restoration Opportunities



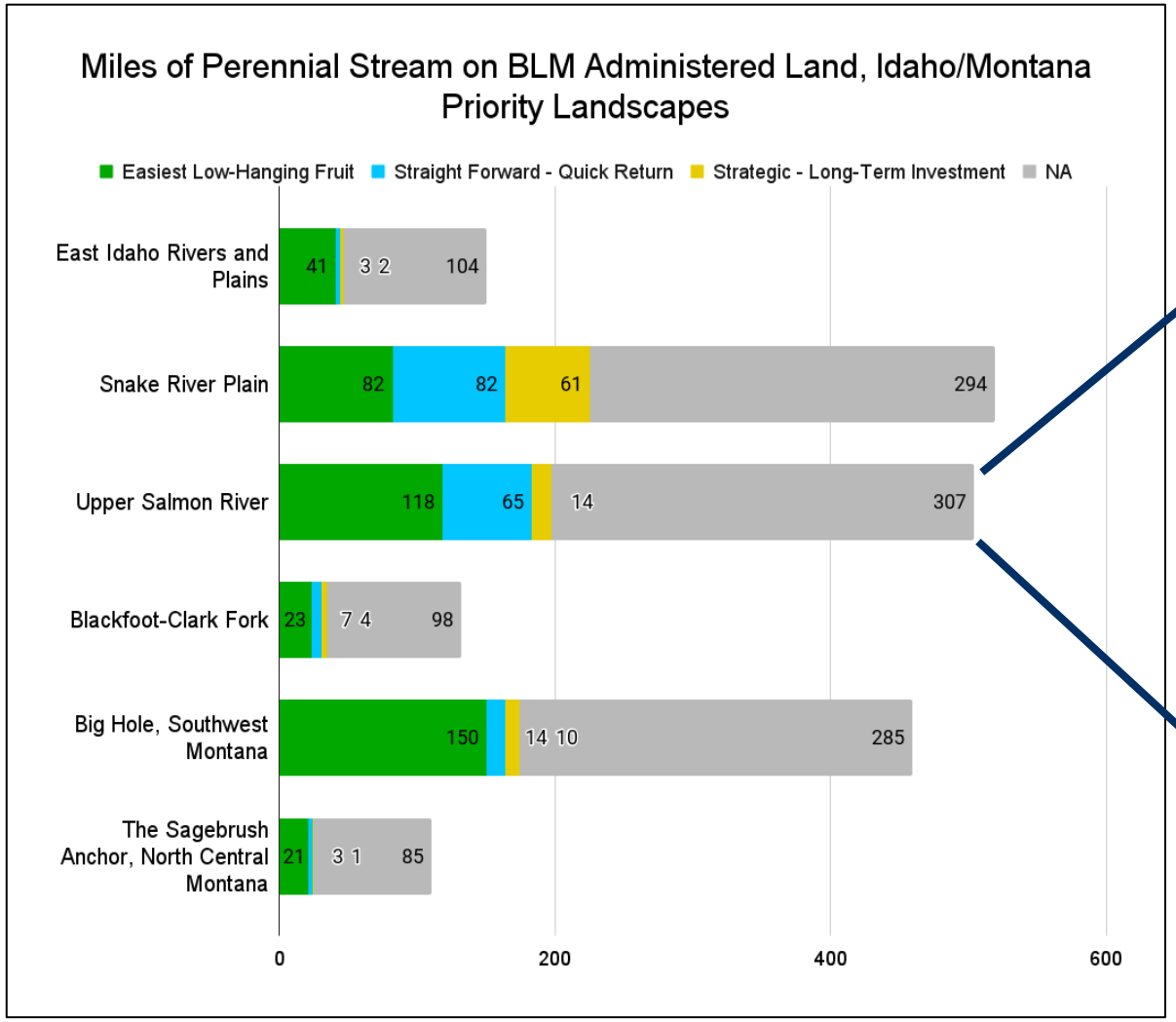
Example Application: Opportunities Among Restoration Landscapes?

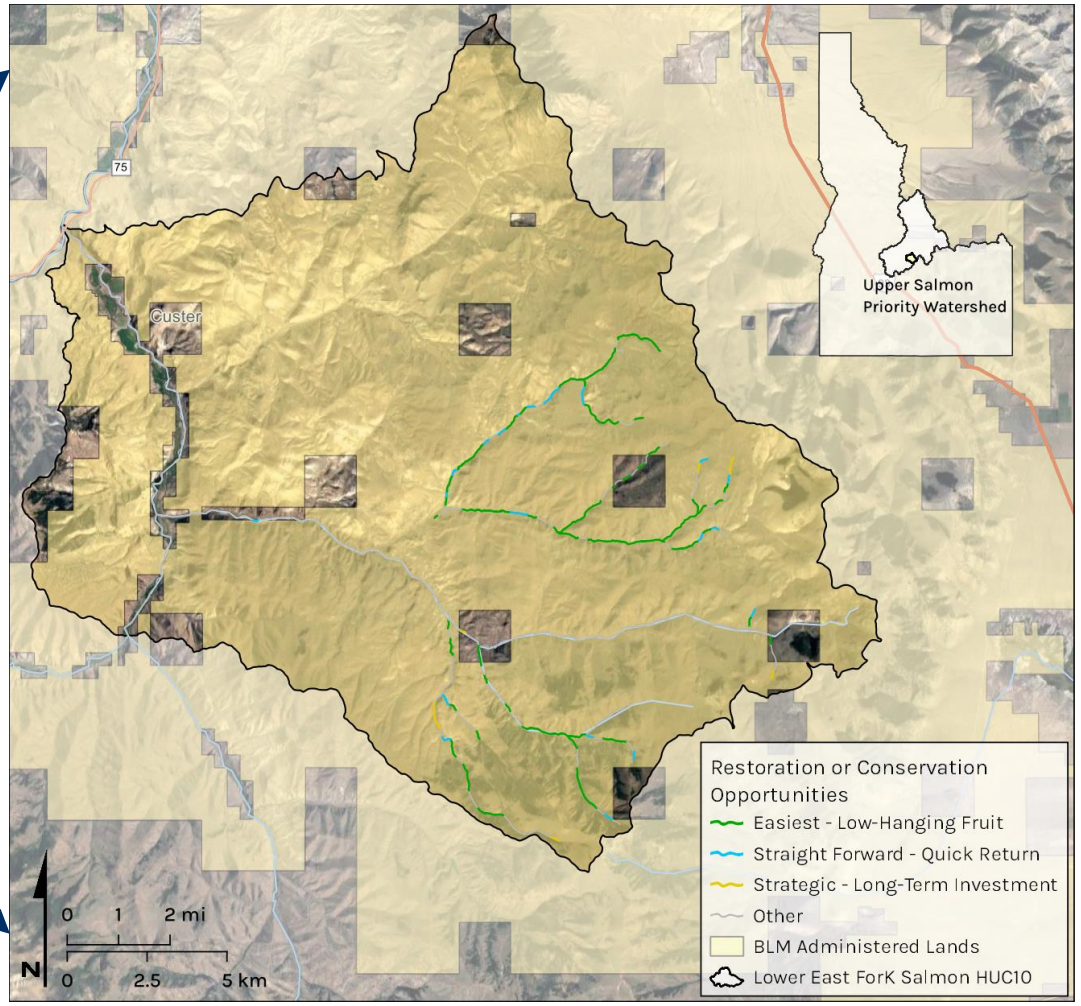




*excludes streams where conflict is moderate/high or dam building not possible

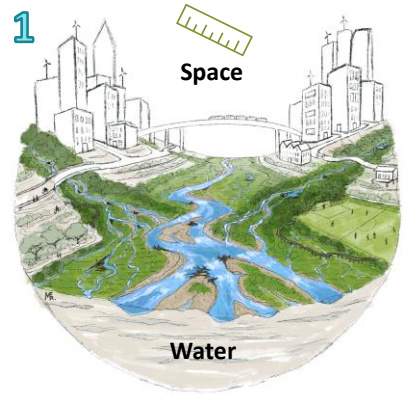
Riverscape Restoration: Where within a Watershed?

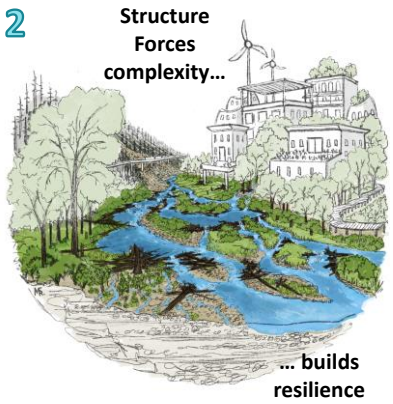


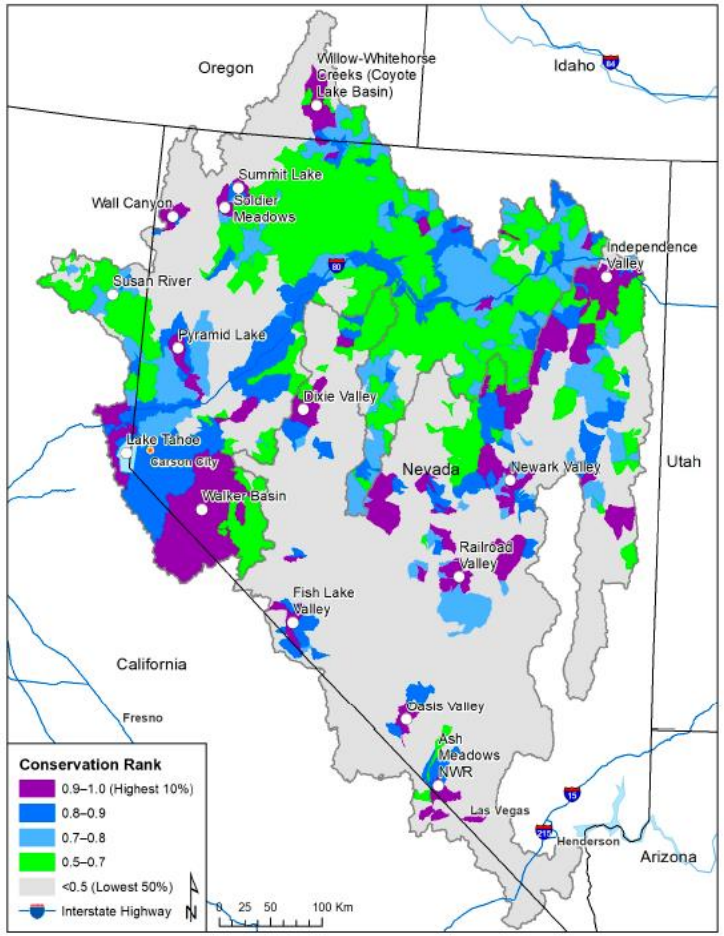


Further Filtering by Restoration Objectives: Cold-water Fishes

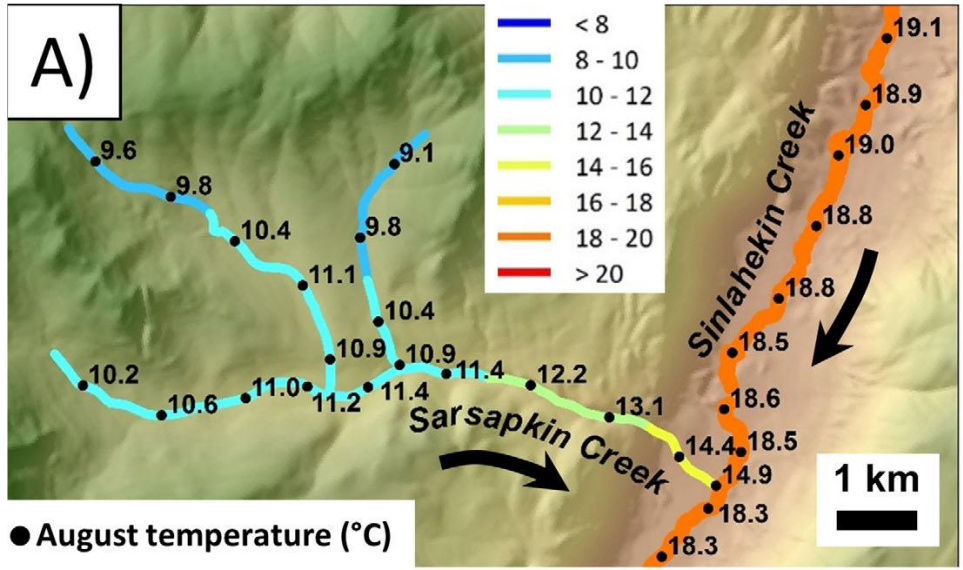
Riverscape Principles + Native Fish Distribution + Stream Temperature





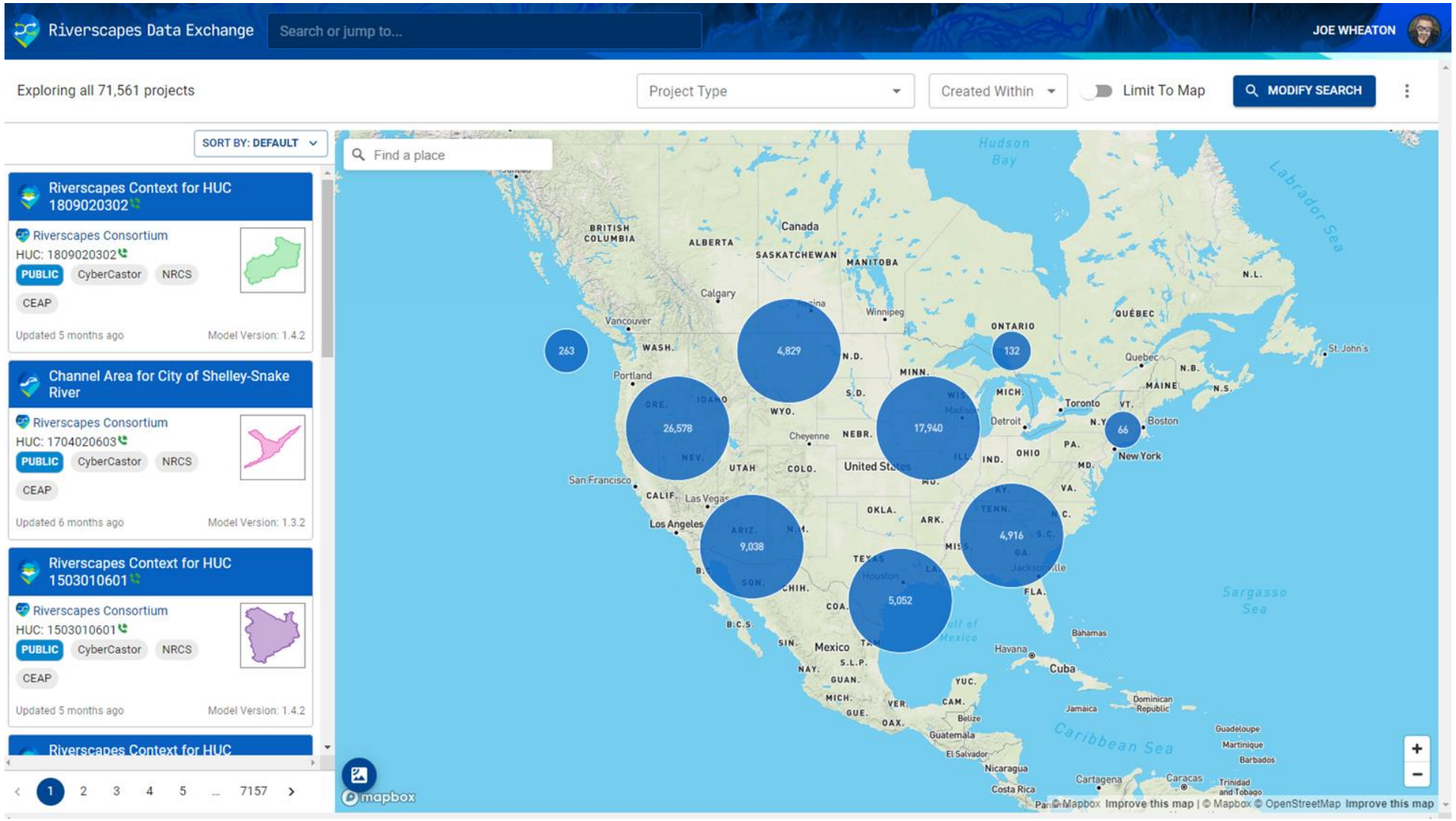


Dauwalter et al 2017



Isaak et al. 2017

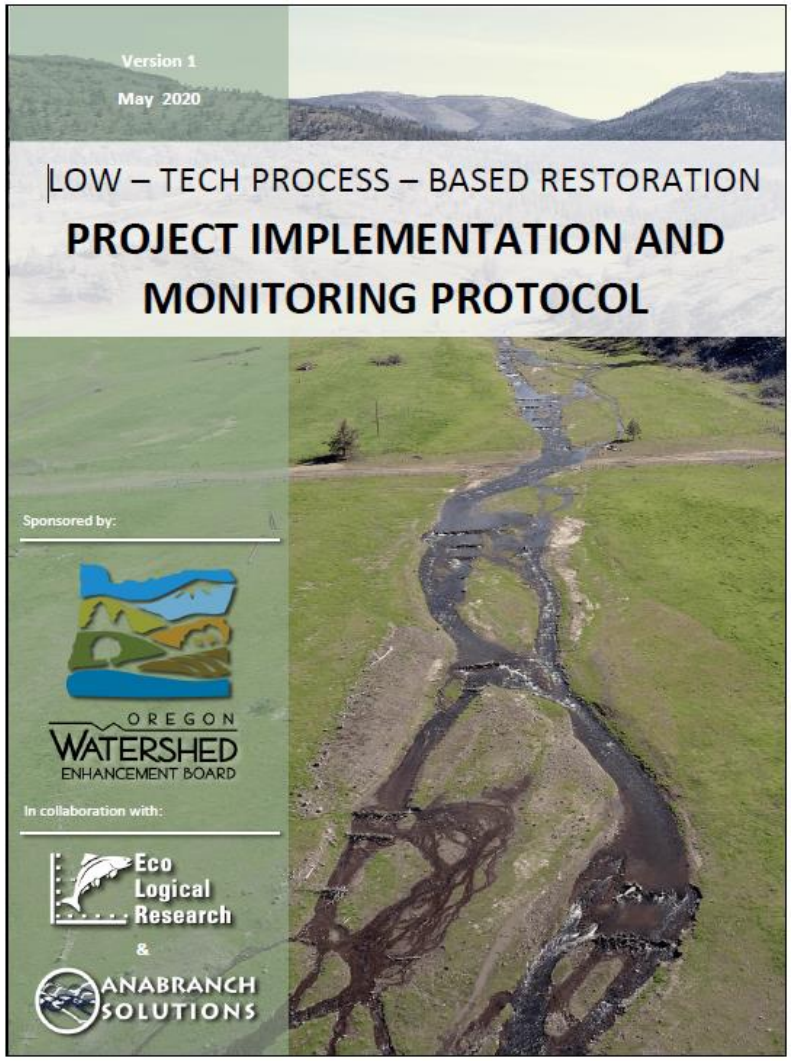
Riverscapes Data Exchange



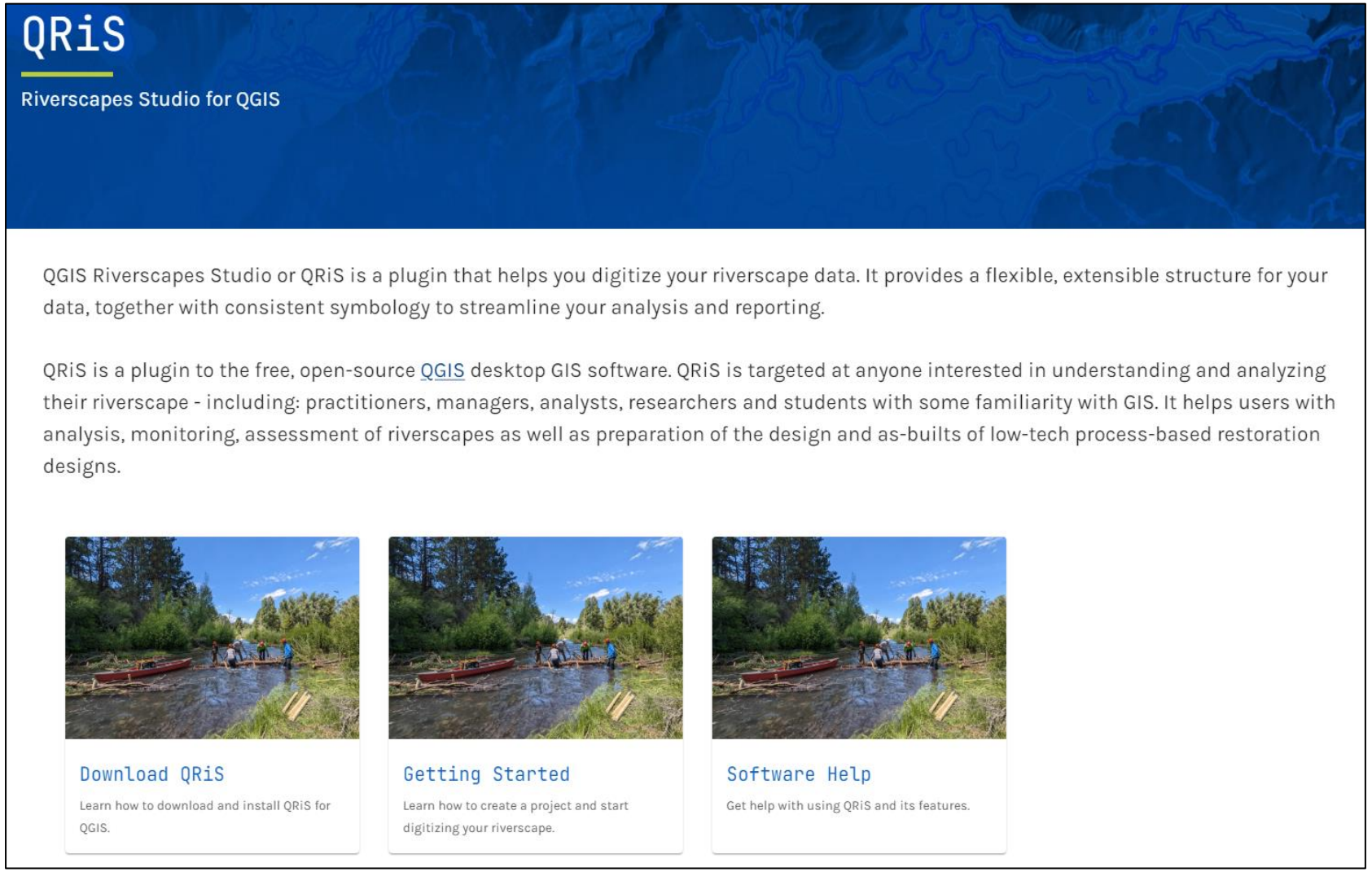
- Find, view, and download data
- Network models stored as “projects” with curated & custom views
- Can create groups to share data
- “Collection” tags for AOIs or project types
- Upload complimentary data
- Standardized metadata (e.g. riverscapes compliant) to ensure interoperability with all Riverscape Consortium tools (track geoprocessing and edits and automate metadata updates, enable viewers, etc.).

Project Design & Monitoring: Tools & Framework

Protocol – V2.0 by Summer



Tools: Riverscape Studio (QRiS)



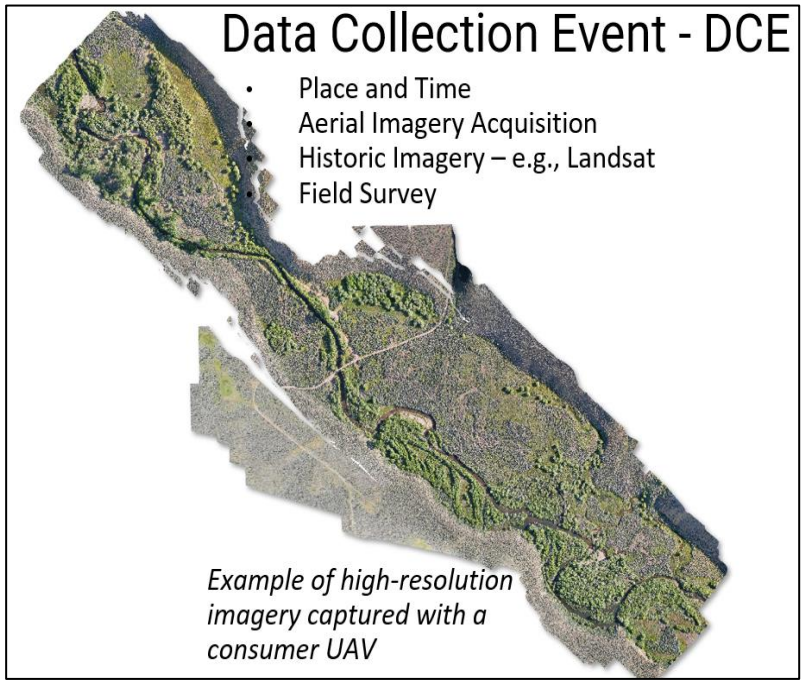
Riverscape Health Metrics: Similar Process

		Planning								
	What?	Status & Context						What's Possible		
	When → Indicators ↓	Existing Conditions			Historic Estimate			Recovery Potential		
	Principle 1 - Streams need space.									
	Proportion of Active Valley Bottom	0%	±	0%	0%	±	0%	0%	±	0%
	Principle 2 - Structure forces complexity and builds resilience									
Complexity Indicators Structure Indicators	Jam Desnity (LWD jams / km)	0	±	0	0	±	0	0	±	0
	Jam Capacity (LWD jams / km)	0	±	0	0	±	0	0	±	0
	Beaver Dam Density (beaver dams / km)	0	±	0	0	±	0	0	±	0
	Beaver Dam Capacity (beaver dams / km)	0	±	0	0	±	0	0	±	0
Complexity Indicators	Number of Active Channels	0	±	0	0	±	0	0	±	0
	Number of Active Channels	0	±	0	0	±	0	0	±	0
	Diffluence Density (# / km)	0	±	0	0	±	0	0	±	0
	Confluence Density (# / km)	0	±	0	0	±	0	0	±	0
	Floodplain Channel Head Density (# / km)	0	±	0	0	±	0	0	±	0
	Pool Desnity (# / km)	0	±	0	0	±	0	0	±	0
	Mid Channel Bar Density (# / km)	0	±	0	0	±	0	0	±	0
	Riffle Density (# / km)	0	±	0	0	±	0	0	±	0
Resilience Indicators	VB Mesic Resources (% of years mesic)	0%	±	0%	0%	±	0%	0%	±	0%
	VB Mesic Resource Resilience (0 to 1)	0.00	±	0.00	0.00	±	0.00	0.00	±	0.00
	Complexity Resilience (0 to 1)	0	±	0	0	±	0	0	±	0

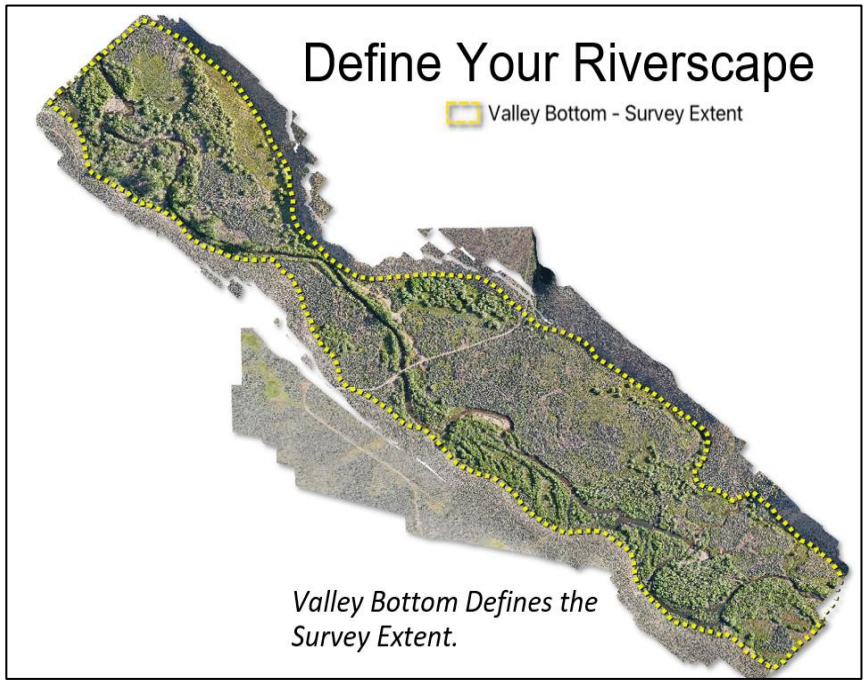
	Principle 4 - Inefficient conveyance of water is healthy									
	% Inundated @ Baseflow	0%	±	0%	0%	±	0%	0%	±	0%
	% Inundated @ Typical Flood	0%	±	0%	0%	±	0%	0%	±	0%
Inundation Type (% of Inundated Area @ Baseflow)	Free-Flowing	0%	±	0%	0%	±	0%	0%	±	0%
	Backwater / Ponded	0%	±	0%	0%	±	0%	0%	±	0%
	Overflow	0%	±	0%	0%	±	0%	0%	±	0%
	Check ∑ to 100%	0%		NA	0%		NA	0%		NA
	Geomorphic Condition									
Percent RS Length in Cluer & Throne Stages	Stage 0 - Anastamsoing	0%	±	0%	75%	±	25%		±	0%
	Stage 1 - Single Thread	10%	±	5%	0%	±	0%		±	0%
	Stage 2 to 3 - Incised	90%	±	5%	0%	±	0%		±	0%
	Stage 4 - Degradation & Widening	0%	±	0%	0%	±	0%		±	0%
	Stage 5 - Aggradation & Widening	0%	±	0%	0%	±	0%		±	0%
	Stage 6 - Quasi-Eqilibirum	0%	±	0%	0%	±	0%		±	0%
	Stage 7 - Laterally Active	0%	±	0%	5%	±	5%		±	0%
	Stage 8 - Anastamosing	0%	±	0%	20%	±	15%		±	0%
	Check ∑ to 100%	100%		NA	100%		NA	0%		NA
	Management & Project Specific Indicators									
	Day of Year Flows Dry Up	200	±	5	200	±	5		±	
	Fish Density (fish / 100 m)	5	±	5	75	±	25		±	

Riverscape Health and Project Effectiveness Monitoring

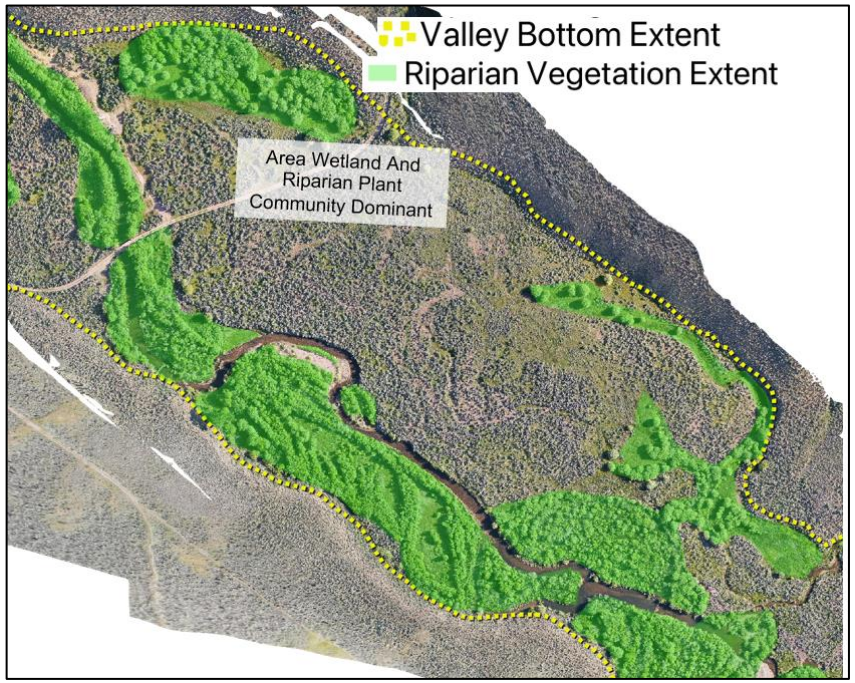
Step 1



Step 2

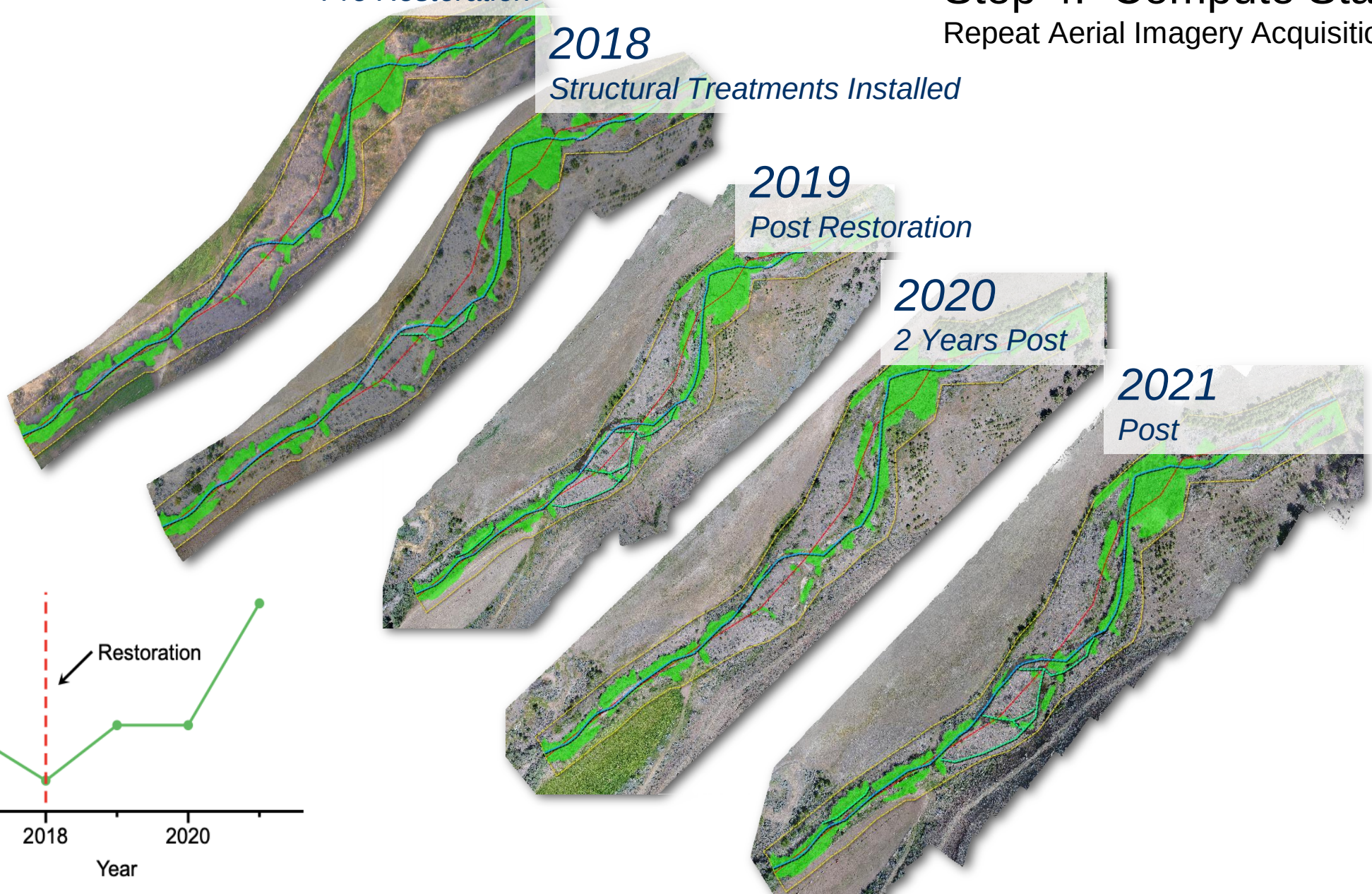


Step 3

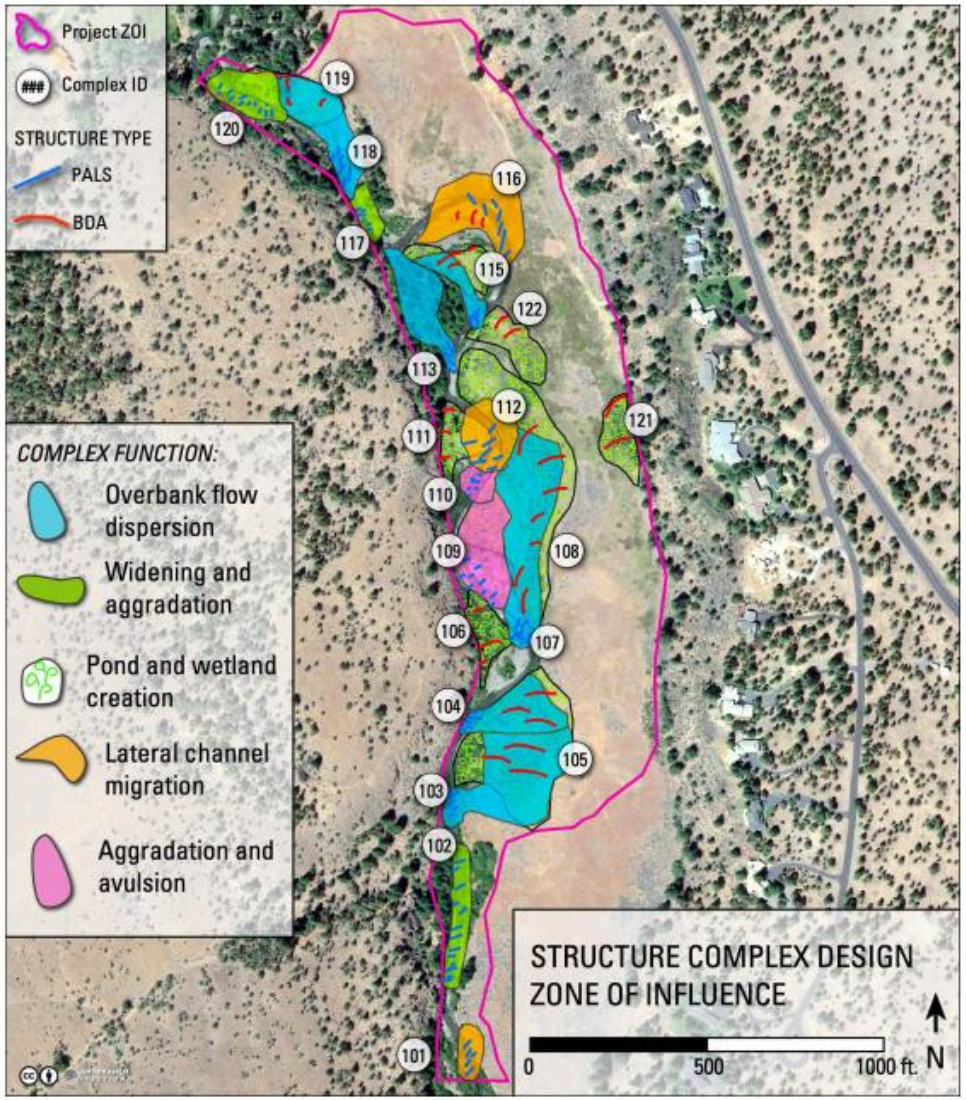


Step 4: Compute Stats & Repeat

Repeat Aerial Imagery Acquisition & Surveys



Project Designs & Tracking



SMART INDICATOR TABLES

INDICATOR	GOAL	TIME HORIZON: HISTORIC	EXISTING (Current)	AS-BUILT (0 Years)	MEDIUM (3 – 5 Years)	LONG (5 – 10 Years)
VALLEY BOTTOM ACTIVE (% of Valley Bottom Area)	GOAL 1: ACTIVE FLOODPLAIN	90% ± 10	20%	25 ± 5%	40 ± 10 %	90% ± 10
CEM STAGE (% of Valley Bottom Length)	GOAL 1: CEM STAGE COMPOSITION	S0: 80% ± 20 S8: 15% ± 10 S7: 5% ± 5 S5: 0% S2: 0%	S0: 0% S8: 25% S7:35% S5: 10% S2: 20%	S0: 0% S8: 25% S7: 35% S5: 10% S2: 20%	S0: 0% S8: 75% ± 10 S7: 15% ± 10 S5:<5% S2: <5%	S0: 80% ± 20 S8: 15% ± 10 S7: 5% ± 5 S5: 0% S2: 0%
LWD ACCUMULATIONS (Jams / mile)	GOAL 2: LTPBR PRINCIPLES	300 ± 50 (Natural)	2 / mi.	100 (PALS)	200 ± 25 (PALS + Natural)	250 ± 50 (Natural > PALS)
BEAVER DAM DENSITY (Dams / mile)	GOAL 2: LTPBR PRINCIPLE	75 ± 20 (Natural)	0 / mi.	50 (BDAs)	60 ± 10 (BDAs + Natural)	75 ± 20 (Natural > BDAs)
WETTED CHANNEL LENGTH (miles)	GOAL 3: FISH HABITAT QUANTITY AND QUALITY	4.0 ± 0.5	1.8	2 ± 0.2	3 ± 0.5	3.5 ± 0.5
SPAWNING HABITAT QUANTITY (Riffles / mi.)	GOAL 3: FISH HABITAT QUANTITY AND QUALITY	30 ± 10	10	10	20 ± 5	25 ± 10

To answer key questions:
What are we doing, where, why, and when?
How much of a response do we expect, where, and when?

Part 1: Overview of riverscape concepts, data and tools for BLM

Part 2: Application of concepts, data, and tools at the various spatial scales of planning

Planning: What Actions to Implement & Where?

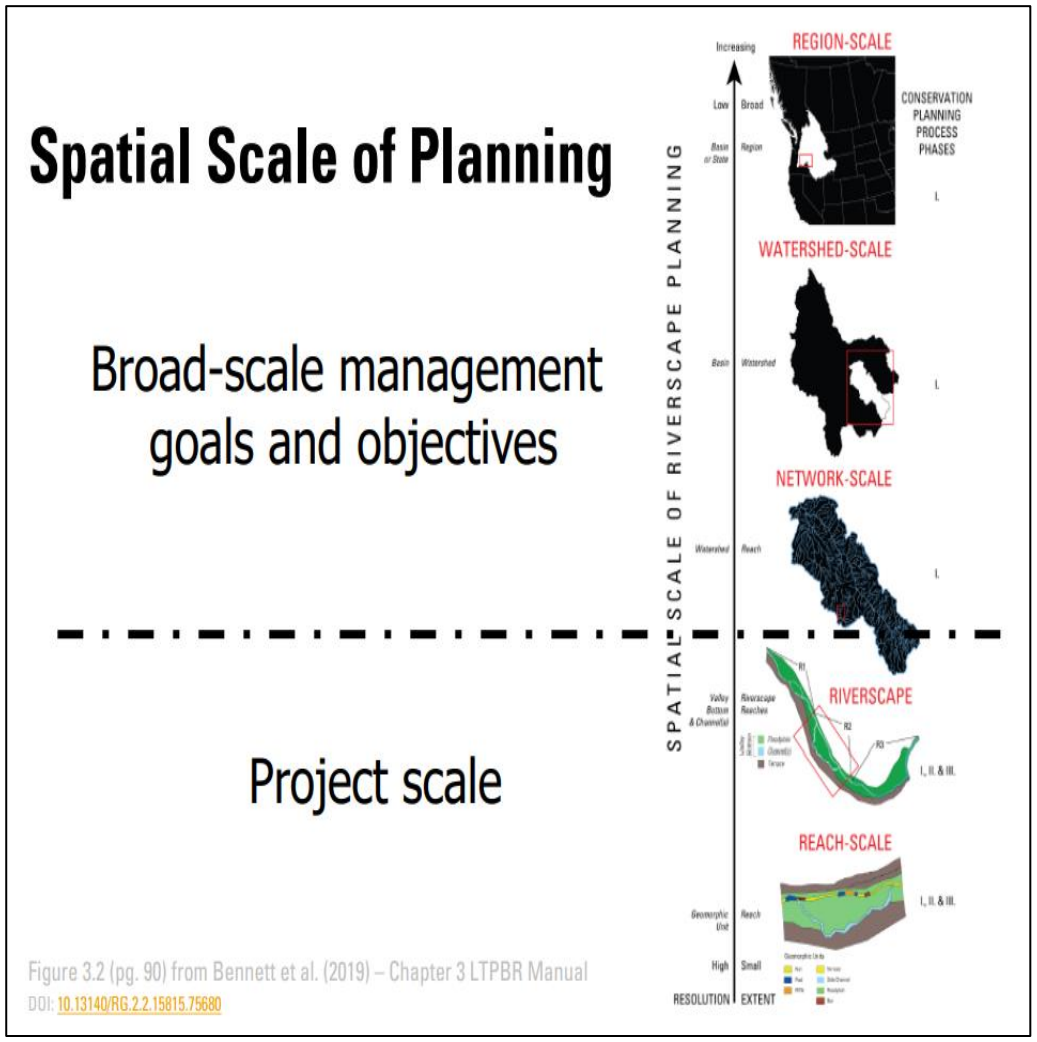


Figure 3.2 (pg. 90) from Bennett et al. (2019) – Chapter 3 LTPBR Manual
DOI: 10.13140/RG.2.2.15815.75680

Broadscale Goal

- Maximize the rate and extent at which key processes are active

Project Screening:

- Stream type/style: (laterally unconfined, require structural elements & veg…)
- Extent: acres & miles of restorable VB
- Recovery rate: geomorphic condition + Ingredients
- High values (T&E….)
- High stakeholder engagement
- Low risk
- Practical considerations (access, NEPA, permitting, proximity to complimentary projects)

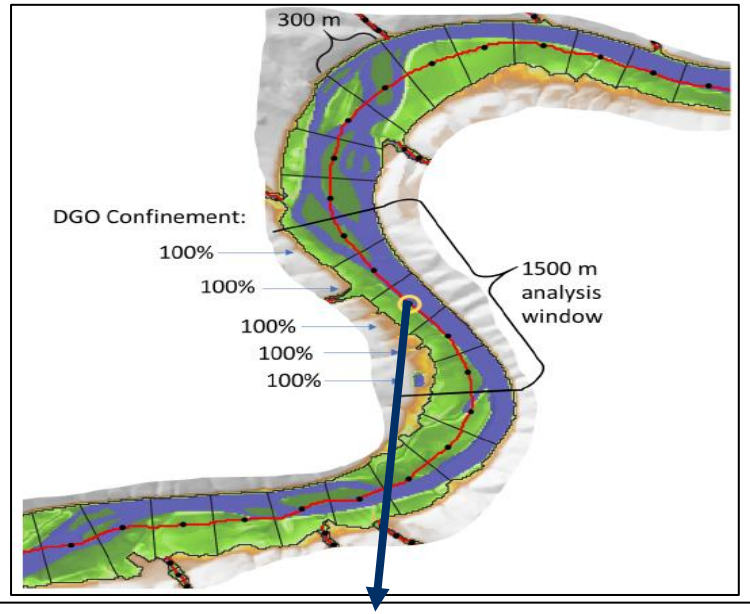
Project, Reach & Complex-Scale Objectives

Spatially Continuous Broadscale Data

Project-Scale Data

Where are those riverscapes? Attribute filters

Network-scale Data



Discrete Geographic Object (DGO) Metrics

- Acres of valley bottom
- % riparian
- Riparian departure and type
- VB confinement
- Hydroperiod (perennial, intermittent, ephemeral)
- Risk (e.g., development in VB)
- Beaver dam building capacity

Riverscape Attribute Filter

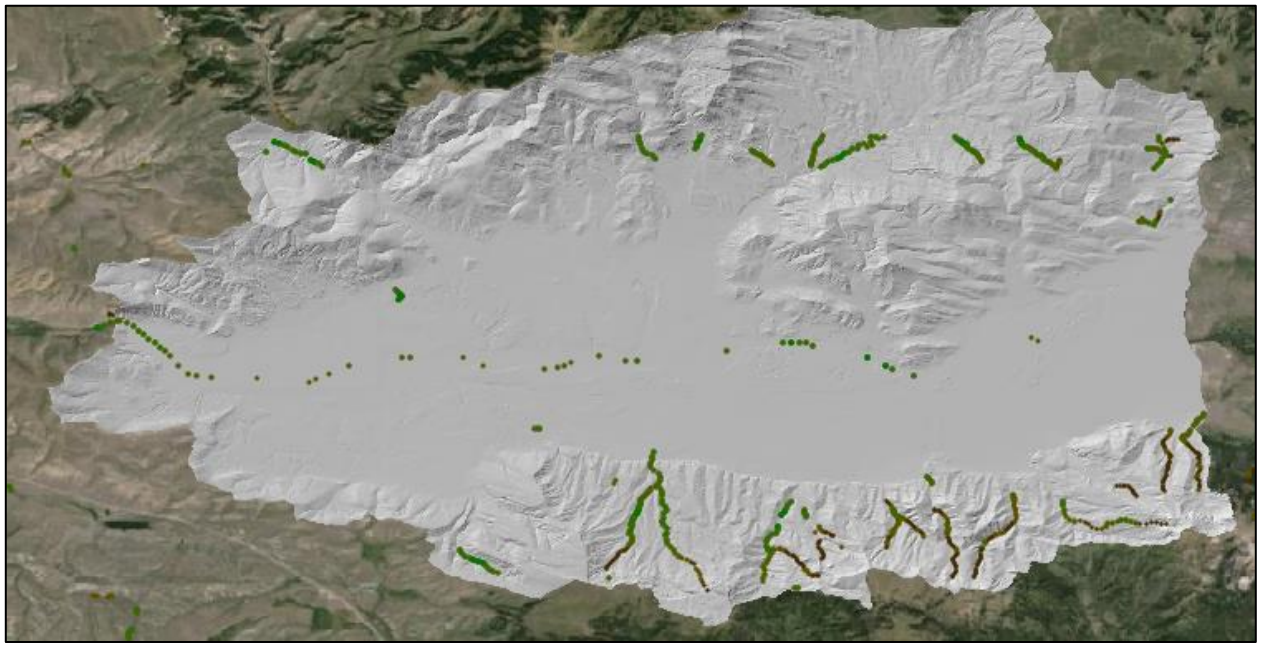
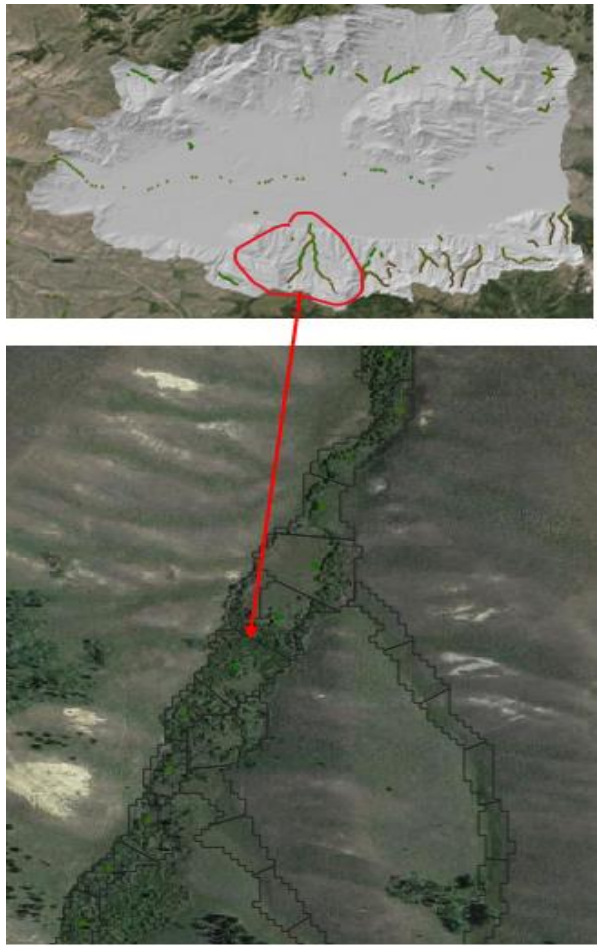


***Figure: Lima Reservoir Watershed, MT**: Perennial streams, on BLM lands, with low/absent risk, moderate riparian vegetation departure, moderate/high historic beaver dam building capacity, and existing capacity > 2 dams/km*

Evaluate Filter Results

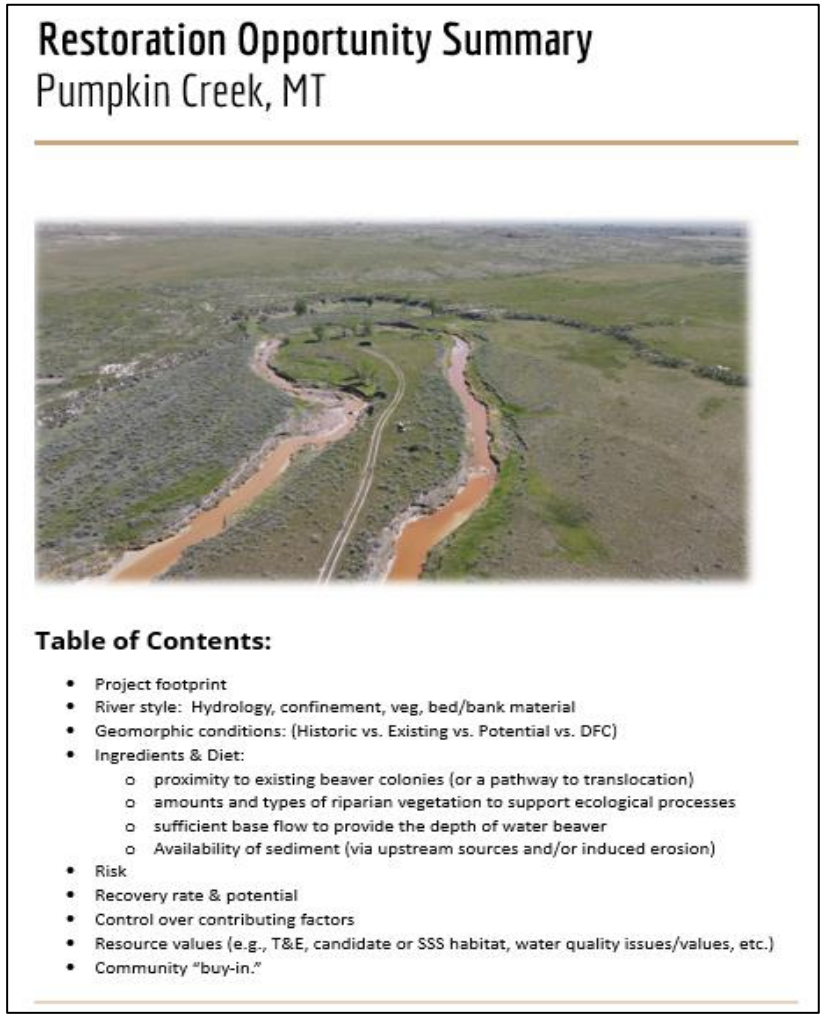


- ~7 miles of contiguous riverscape
- 30% to 90% of VB Riparian
- ~100% free flow
- Stages 1-3 CEM (promote incision recovery)
- Materials – conifer encroachment
- Access – dirt road to ~60% of project

- Single beaver dam, likely inactive
- Existing dam capacity – 5-15/km
- Historic dam capacity – 15 to 40
- ~ 4 miles of perennial tributary misclassified as ephemeral (validate)
- Cattle/wildlife trailing absent – likely compatible with restoration objectives

- Diversion to flood irrigation: impediment to natural dispersal
- 2 Stream crossings – no culvert?

Summarize the “Best” Opportunities – Desktop Review



Restoration Opportunity Summary
Pumpkin Creek, MT

Table of Contents:

- Project footprint
- River style: Hydrology, confinement, veg, bed/bank material
- Geomorphic conditions: (Historic vs. Existing vs. Potential vs. DFC)
- Ingredients & Diet:
  - proximity to existing beaver colonies (or a pathway to translocation)
  - amounts and types of riparian vegetation to support ecological processes
  - sufficient base flow to provide the depth of water beaver
  - Availability of sediment (via upstream sources and/or induced erosion)
- Risk
- Recovery rate & potential
- Control over contributing factors
- Resource values (e.g., T&E, candidate or SSS habitat, water quality issues/values, etc.)
- Community “buy-in.”

High-level review:

- Describe the project, relative to the screening criteria:
- Identify unknowns that warrant more review

The “best”: size of this subset is influenced by:

- Budgets vs scope of opportunities’
- Clear “breaks” between top and lower-tier opportunities

Consideration:

- Err on side of “reasonable” commission error. For example, if you have funding for 10 miles of restoration and 20 are clearly superior opportunities, focus on those 20 miles.
- Avoid analysis paralysis, but answer key questions

Deeper-Dive

Field Tours
- validate observations from imagery & GIS data
- investigate questions that couldn't be answered with coarse data

Records & Issue-Specific Data
- historic photos
- land health assessments
- fish/wildlife inventories and habitat designations

Human-Dimension & Practical Considerations
- engage stakeholders
- explore partnership opportunities

Compare & Select Project(s) for Planning & Design

Restoration Opportunity Summary
Pumpkin Creek, MT

Table of Contents:

- Project footprint
- River style: Hydrology, confinement, veg, bed/bank material
- Geomorphic conditions: (Historic vs. Existing vs. Potential vs. DFC)
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  - Availability of sediment (via upstream sources and/or induced erosion)
- Risk
- Recovery rate & potential
- Control over contributing factors
- Resource values (e.g., T&E, candidate or SSS habitat, water quality issues/values, etc.)
- Community "buy-in."

Restoration Opportunity Summary
Rose Creek, MT

Table of Contents:

- Project footprint
- River style: Hydrology, confinement, veg, bed/bank material
- Geomorphic conditions: (Historic vs. Existing vs. Potential vs. DFC)
- Ingredients & Diet:
  - proximity to existing beaver colonies (or a pathway to translocation)
  - amounts and types of riparian vegetation to support ecological processes
  - sufficient base flow to provide the depth of water beaver
  - Availability of sediment (via upstream sources and/or induced erosion)
- Risk
- Recovery rate & potential
- Control over contributing factors
- Resource values (e.g., T&E, candidate or SSS habitat, water quality issues/values, etc.)
- Community "buy-in."

Restoration Opportunity Summary
Lower Dog Creek, MT

Table of Contents:

- Project footprint
- River style: Hydrology, confinement, veg, bed/bank material
- Geomorphic conditions: (Historic vs. Existing vs. Potential vs. DFC)
- Ingredients & Diet:
  - proximity to existing beaver colonies (or a pathway to translocation)
  - amounts and types of riparian vegetation to support ecological processes
  - sufficient base flow to provide the depth of water beaver
  - Availability of sediment (via upstream sources and/or induced erosion)
- Risk
- Recovery rate & potential
- Control over contributing factors
- Resource values (e.g., T&E, candidate or SSS habitat, water quality issues/values, etc.)
- Community "buy-in."

Art & Science: priorities are the intersection of values, physical/ecological opportunities and practical considerations

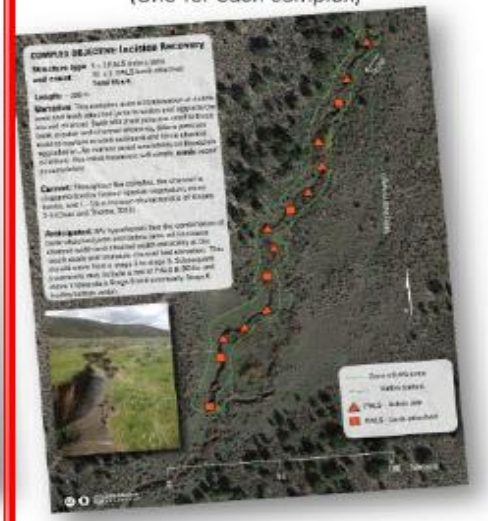
Project Planning & Design – Riverscape Studio

LOW-TECH PROCESS-BASED RESTORATION
RECOMMENDED DESIGN PACKAGE

Project-Scale Map(s) ✓
(Drainage Network)

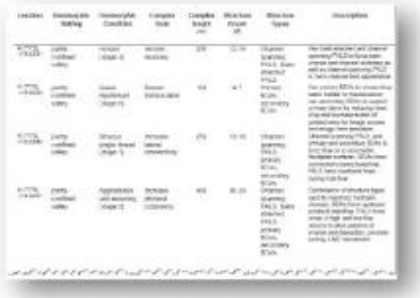
Shows complex locations on drainage network.

Complex-Scale Map(s) ✓
(One for each complex)



Shows structure locations within each complex, complexes zone of influence, structure types, & valley bottom extents.

Complex Design Tables ✓
(Clear Complex Objectives & Hypotheses)



Note, structure design tables are possible but not always necessary as during construction not all structures are built exactly as designed, and flexibility is key (e.g. 12-15 structures specified).

Typical Structure Schematics ✓

Schematics of planforms, cross-sections, & profiles are helpful to convey what typical structures will look like, but need not be followed rigidly.

From page 20 of Pocket Guide; Wheaton et al. (2019)
DOI: 10.13140/RG.2.2.28222.13123/1

Questions

Links

Riverscape Data Exchange: This is where you will access, view, share, and download riverscape data. Create an account, then send me an email. I'll add you to the BLM Riverscapes group.

Riverscape Studio for QGIS - QGIS Riverscapes Studio or QRiS is a plugin that helps you digitize your riverscape data. It provides a flexible, extensible structure for your data, together with consistent symbology to streamline your analysis and reporting.

QRiS is a plugin to the free, open-source QGIS desktop GIS software. QRiS is targeted at anyone interested in understanding and analyzing their riverscape - including: practitioners, managers, analysts, researchers and students with some familiarity with GIS. It helps users with analysis, monitoring, assessment of riverscapes as well as preparation of the design and as-builts of low-tech process-based restoration designs.

Riverscapes Consortium Knowledge Base: Access the tools, links to tool documentation, FAQs, recently recorded BLM trainings, and more. Users can also submit a "Help Desk Ticket" for assistance from our partners at the Riverscapes Consortium or simply to notify them of an issue that the team may want to fix.

Riverscape Consortium and Vision for Data & Tool Standards: Watch the 3 videos to acquaint yourself with the team and its vision for the data, tools, and databases we're producing to help practitioners create the information they need to conserve/restore riverscapes more efficiently and effectively.

Tool Standards: Like climate scientists did 20+ years ago, the RC has developed standards for the tools (largely based on NASA readiness levels), data, and database. This enables us to produce a cohesive suite of data management and analysis products that meet FAIR standards. They also help staff "squeeze the juice" from the data, auto-populate metadata during geoprocessing, and enable use via the various toolbars we've developed to help practitioners interact with these data. You'll likely want to view the series of short videos in which the PI on our partnership describes these concepts and standards. This year, I'd like to add the requisite metadata to several BLM funded layers (e.g. NWI++, LLWW attributes, etc.), so we can include them within the RC tools & database.

Production-grade riverscape tools overview: These are riverscapes-compliant tools, which have been refactored to be capable of running in the cloud over regional, state-wide and/or nation-wide extents, while still resolving predictions of what is happening in individual reaches (i.e. 100 m to 500 m length scales) of riverscape. You'll want to be familiar with the model inputs, intermediaries, outputs, and common uses. You can review the full array of riverscape tools here.

Catalog of Process-based restoration resources: Here, you can access manuals, self-paced training modules, protocols, and more. Since we complete our project designs in QGIS via the QRiS tool, you may want to watch the Design Modules. They are a few years old and don't cover the tools. However, they do cover the concepts, which is important, so that you can understand the objectives of technical staff who may come to you for assistance.