

# Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration

## Beaver Restoration Webinar Series



September 24, 2020

DOI: [10.13140/RG.2.2.31135.59045](https://doi.org/10.13140/RG.2.2.31135.59045)



# Logistics – Getting the most out of your webinar

- Look in **GoTo Chat window** for link to PDF of **Slides** on ResearchGate
- Look in **GoTo Handouts** for a BRAT cIS form (for **exercise**)... print have
- We will take **questions** at three different points (queue them up in **GoTo Questions window**)
- Slides are littered with **hyperlinks** (clickable in PDF) to cited works, datastes, examples and other talks, resources, & training materials

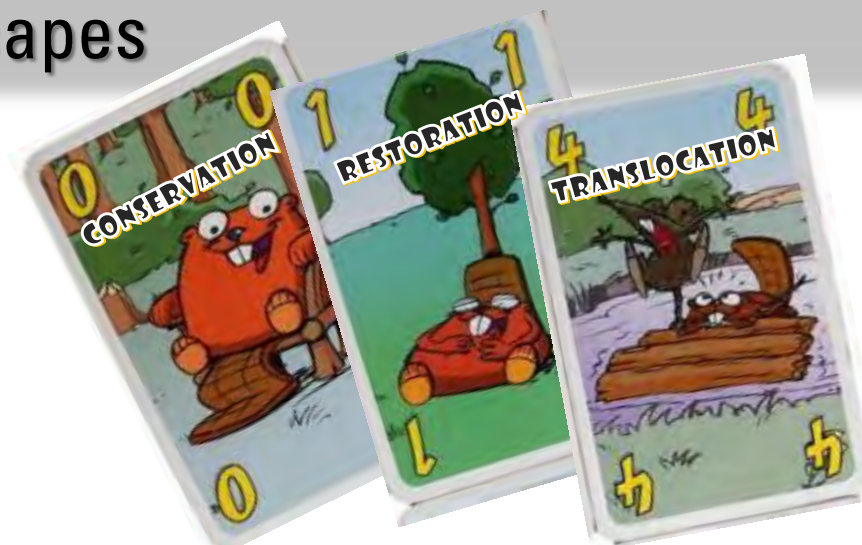
DOI: [10.13140/RG.2.2.31135.59045](https://doi.org/10.13140/RG.2.2.31135.59045)





# Purpose of Webinar

**Expectation management** around beaver as a restoration/conservation partner, vs. mitigating their impacts in riverscapes



**Mimic** → **Promote** → **Sustain**

When, where and how to play the beaver cards?



From [Beaver Gang Card Game](#)



From Goldfarb (2018) Science:  
<http://science.sciencemag.org/content/360/6393/1058>



# OUTLINE

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration



- I. Background & Other Resources
- II. Dam Building Focus – Expectations
- III. Contextualizing Risk
- IV. Prioritizing Opportunities
- V. Partnering with Beaver... A people business





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A topographic map showing a complex network of rivers and streams. The terrain is rendered in shades of gray and white, with blue lines indicating the waterways. The rivers flow through valleys and converge into larger channels.

# What's a **Riverscape** ?

We know that our rivers and streams are critically important to our fresh-water ecosystems



# Riverscapes span the network across a watershed

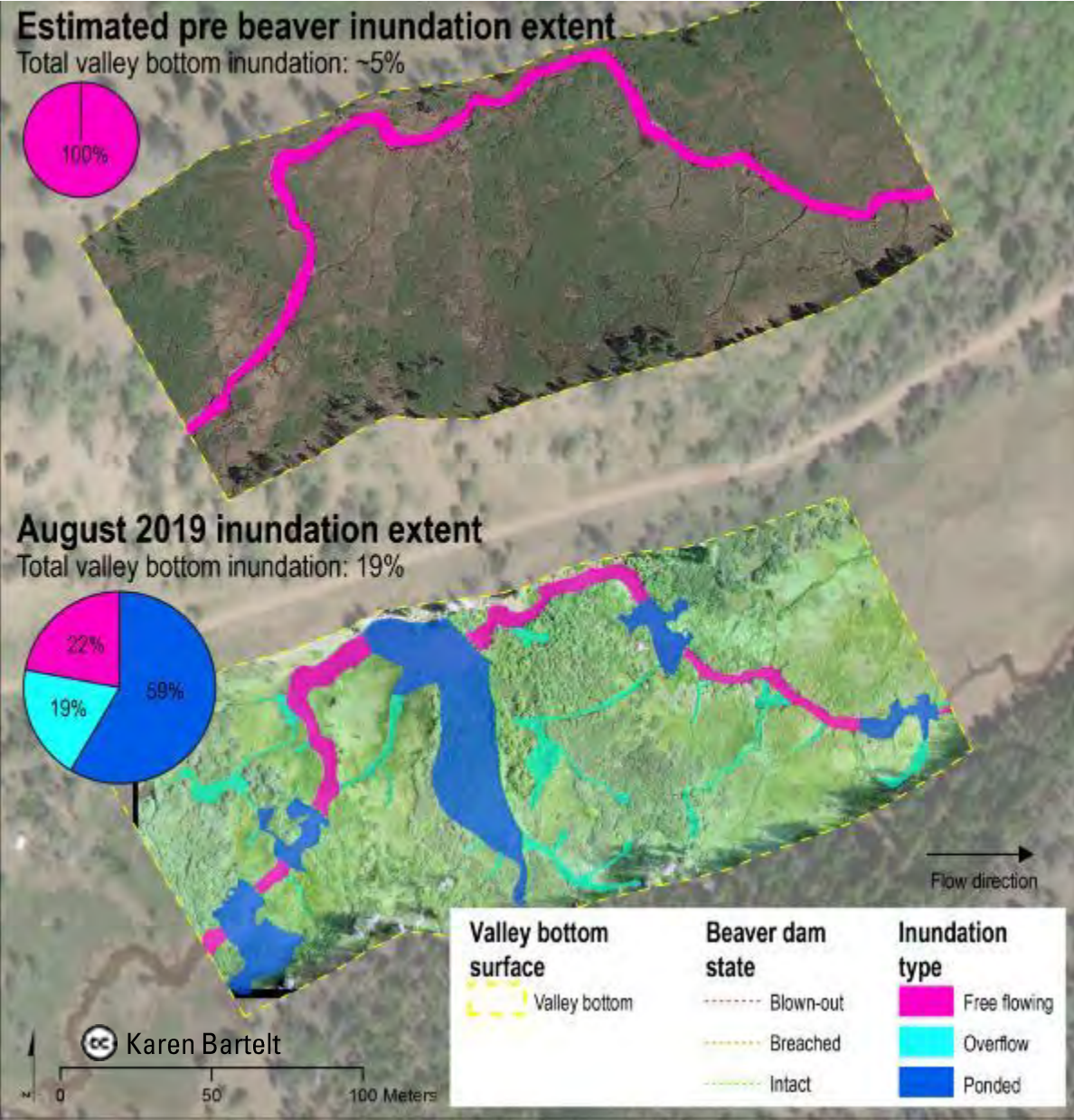
Riverscapes are the part of the landscape that could **plausibly** flood by their rivers & streams in the natural flow regime.

Hmm.. I could increase that plausibility of flooding





# The Water Magic Trick – Beaver Induced Flooding



- Inundation types great proxy for residence time...



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# Global threat to river biodiversity

## Global threats to human water security and river biodiversity

C. I. Vörösmarty<sup>1\*</sup>, P. E. McIntyre<sup>2,3\*</sup>, M. G. Otson<sup>1</sup>, D. Dodge<sup>4</sup>, A. Probst<sup>5</sup>, P. Green<sup>6</sup>, S. Glendon<sup>7</sup>, S. E. Huan<sup>8</sup>, C. J. Sullivan<sup>1</sup>, S. Kelly (Jermann)<sup>9</sup> & P. M. Hayes<sup>1</sup>

Protecting the world's freshwater resources requires diagnosing threats over a broad range of scales, from global to local. Here we present the first worldwide synthesis to jointly consider human and biodiversity perspectives on water security using a spatial framework that quantifies multiple stressors and accounts for downstream impacts. We find that nearly 80% of the world's population is exposed to high levels of threat to water security. Massive investment in water technology enables rich nations to offset high stressor levels without remedying their underlying causes, whereas low wealthy nations remain vulnerable. A similar lack of precautionary investment jeopardizes biodiversity, with habitats associated with 65% of continental discharge classified as moderately to highly threatened. The cumulative threat framework offers a tool for prioritizing policy and management responses to this crisis, and underscores the necessity of limiting threats at their source instead of through costly remediation of symptoms in order to assure global water security for both humans and freshwater biodiversity.

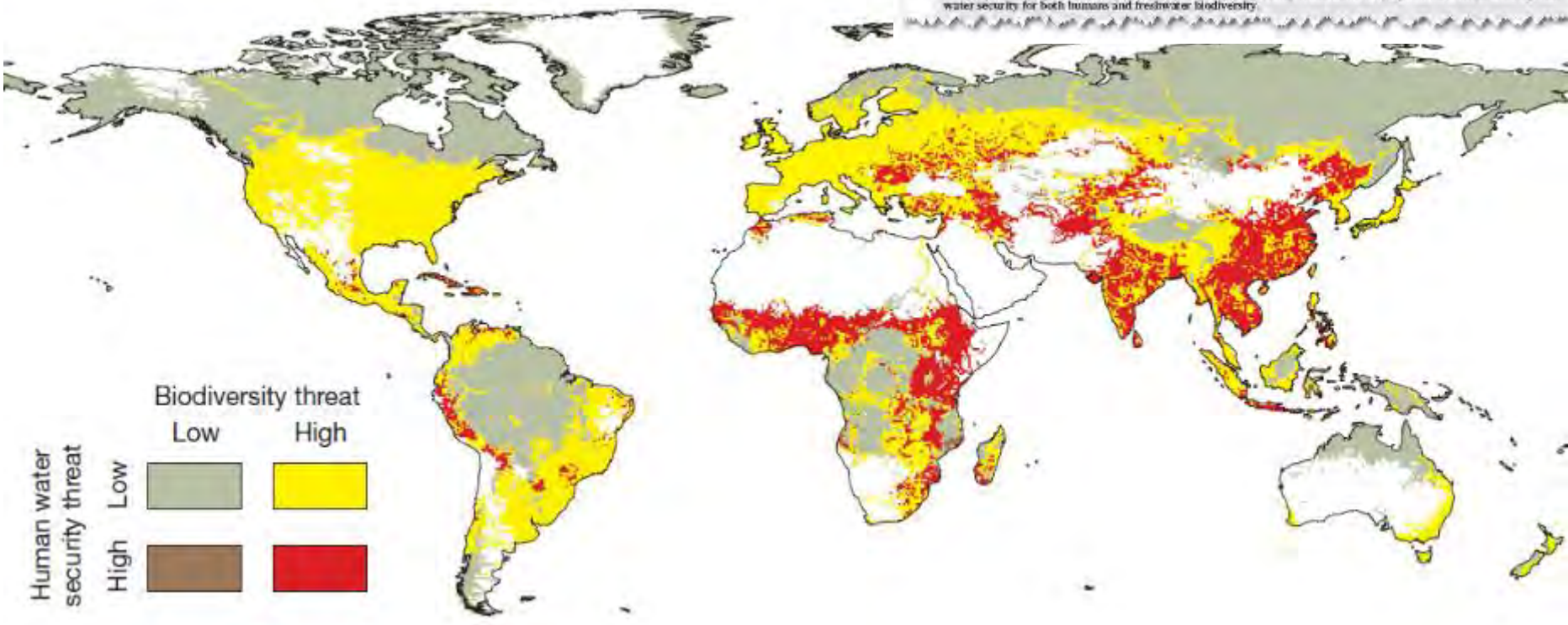


Figure 6 from Vörösmarty et al. (2010)

DOI: [10.1038/nature09440](https://doi.org/10.1038/nature09440)



# Problem is Simple to State...

## Scope of riverscape degradation is massive

- ~ Multi-Billions spent annually, but **barely scratching surface**
- We spend disproportionate \$\$\$\$ on **too few kilometers** of streams and rivers
- Leaving tens of millions of miles **neglected...**

[Agricultural Stream Ecosystem \(PDF\)](#)



[Urban Stream Ecosystem \(PDF\)](#)





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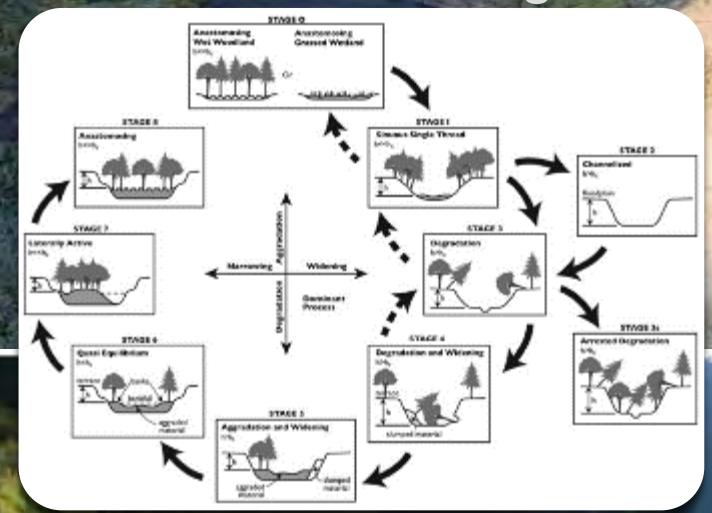




A

# We forgot what valley bottoms could be & that **STAGE 0** was **NOT** an anomaly!

## Stage 0 or 8 Anastomosing



From: Cluer & Throne (2013)  
DOI: [10.1002/rra.2631](https://doi.org/10.1002/rra.2631)

CC Joe Wheaton

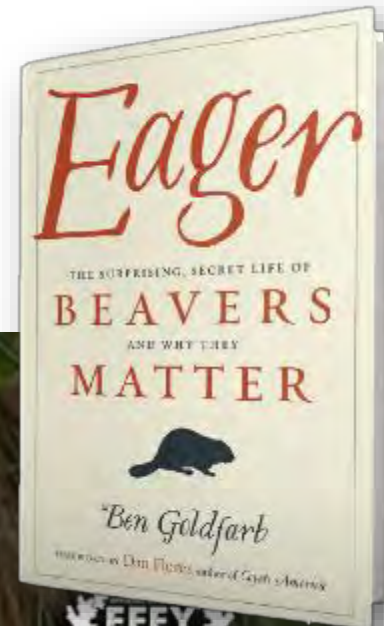
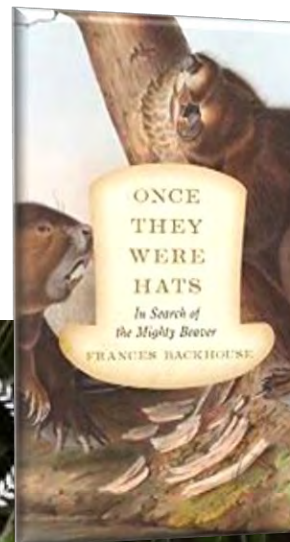
E

Adapted from Figure 1.7 (p 36) of Shahverdian et al. (2019) – Chapter 1 LTPBR Manual DOI: [10.13140/RG.2.2.14138.03529](https://doi.org/10.13140/RG.2.2.14138.03529)

CC Joe Wheaton



So many places to go...  
For why beaver...



**the BEAVER believers**

Five scientists and a hairdresser taking a bite out of climate change one stick at a time.

2018 OFFICIAL SELECTION  
**BANFF**  
MOUNTAIN FILM FESTIVAL  
04:14

OFFICIAL SELECTION  
**VAIL**  
Film Festival  
2019

2019 MFF  
FILM AWARDS  
Nominated Film  
Película nominada

OFFICIAL SELECTION  
**MINT**  
FILM FESTIVAL  
2018

OFFICIAL SELECTION  
**SANTA CRUZ**  
FILM FESTIVAL  
2018

GREEN SPRING LAUREL  
American Conservation Film Festival  
2019

JEFFERSON STATE  
**FLIXX FEST**  
2019

IRLAND MOUNTAIN  
**FILM FESTIVAL**  
OFFICIAL SELECTION  
2019

Riding Mountain National Park Film Festival  
2019

EFFY  
2019  
ENVIRONMENTAL FILM FESTIVAL  
AT YALE

VIMFF  
MOUNTAIN INTERNATIONAL MOUNTAIN FILM FESTIVAL  
FINALIST 2019

OFFICIAL SELECTION  
**WASATCH**  
MOUNTAIN FILM  
2019

OFFICIAL SELECTION  
**BANFF**  
MOUNTAIN FILM FESTIVAL  
WORLD TOUR







# Two days Ago... As the American West burns...

NATIONAL GEOGRAPHIC



BY BEN GOLDFARB

3 MINUTE READ



PUBLISHED SEPTEMBER 23, 2020

The American West is ablaze with fires fueled by climate change and a century of misguided fire suppression. In [California](#), wildfire has blackened more than [three million acres](#); in [Oregon](#), a once-in-a-generation crisis has forced [half a million people to flee their homes](#). All the while, one of our most valuable firefighting allies has remained overlooked: [The beaver](#).

A new study concludes that, by building dams, forming ponds, and digging canals, beavers irrigate vast stream corridors and create fireproof refuges in which plants and animals can shelter. In some cases, the rodents' engineering can even stop fire in its tracks.

"It doesn't matter if there's a wildfire right next door," says study leader [Emily Fairfax](#), an ecohydrologist at California State University Channel Islands.

"Beaver-dammed areas are green and happy and healthy-looking."

| ANIMALS |

## How beavers became North America's best firefighter

The rodent creates fireproof refuges for many species, suggesting wildlife managers should protect beaver habitat as the U.S. West burns.



# Beaver increase riverscape resiliency to fire!



This beaver-dammed wetland in Baugh Creek, Idaho, is a so-called "emerald refuge" that can serve as a firebreak and refuge for other species during wildfires.

PHOTOGRAPH BY JOSEPH WHEATON

A screenshot of a YouTube video player. The video title is "Smokey the Beaver: Can Beaver Dams Help Protect Riparian Vegetation During Wildfire?". The video is by Emily Fairfax and Andrew Whittle. The video player shows a close-up of a beaver's head as it gnaws on a tree trunk. The video player interface includes a play button, a progress bar at 0:00 / 11:02:10, and a share button. Below the video player, the video title is repeated: "Smokey the Beaver: A Webinar for the U.S. Forest Service by Dr. Emily Fairfax." The video has 160 views and was posted on Feb 2, 2020. The channel name is "Emily Fairfax" with 13 subscribers. There is a "SUBSCRIBED" button and a notification bell icon.

Fairfax & Whittle (2020) - Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western USA. DOI: [10.1002/eap.2225](https://doi.org/10.1002/eap.2225)



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# Beaver Management / Restoration Strategies

1. **Conservation** / Promotion (leave them alone or protect)
2. **Living with beaver**
3. **Translocation** to areas with suitable capacity → BDAs for release
4. Restore riparian → Followed by Translocation
5. Help beaver out – **Beaver Dam Analogues** → *Facilitated dispersal of opportunistic species*
6. Mimic Beaver Dam Activity – *construction & maintenance (low-tech... NOT PBR)*





# Conservation - Passive Beaver Strategies

Beaver protection- work with wildlife departments to get temporary or permanent closures for trapping in targeted areas





# Translocation – *or “Forced Dispersal”*

- Find a source population of nuisance beaver OR area with ample population...
- Relocate to areas with no or limited population & high capacity to support dam building activity

Kent Sorenson  
(UDWR)



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

See [Kent & Amy's Webinar](#) in this ASWM Series



# Beaver Restoration Guidelines

USDA  
United States Department of Agriculture  
Northwest Climate Hub

## Using Beaver Dam Analogues for Fish and Wildlife Recovery on Public and Private Rangelands in Eastern Oregon

Rachael Davee, Hannah Gosnell, and Susan Chamley



Forest  
Service

Pacific Northwest  
Research Station

Research Paper  
PNW-RP-612

July  
2019

## The Beaver Restoration Guidebook

*Working with Beaver to Restore Streams, Wetlands, and Floodplains*

Version 2.0, June 30, 2017



Photo credit: World A Dam Foundation ([www.a-dam.org](http://www.a-dam.org))

Prepared by

US Fish and Wildlife Service  
National Oceanic and Atmospheric Administration  
University of Saskatchewan  
US Forest Service

Janine Castro  
Michael Pollock and Chris Jordan  
Gregory Lewallen  
Kent Woodruff

Funded by

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Published with the support of the U.S. Forest Service, Pacific Northwest Research Station, PNW-RP-612, July 2019

Davee et al. (2019).

Pollock et al. (2017).



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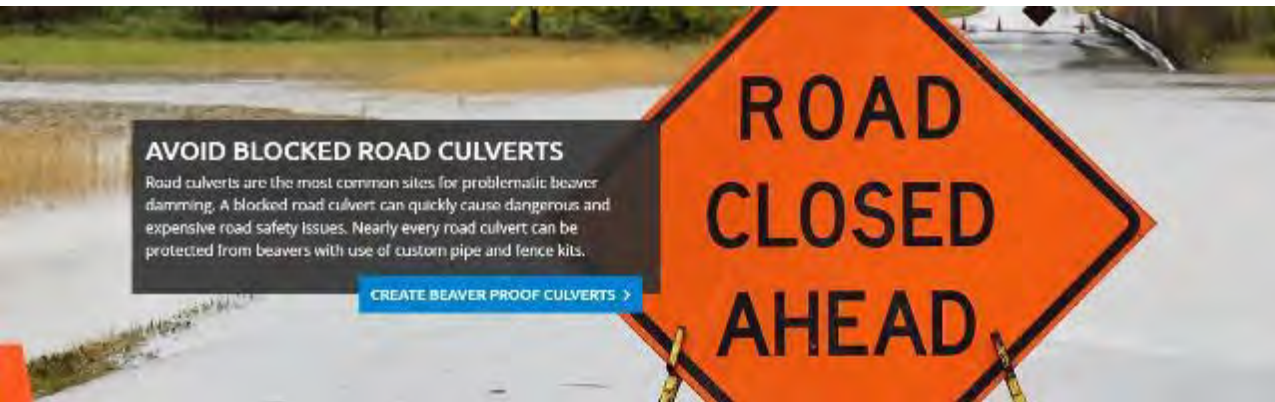




# Recognizing beaver can cause damage, builds your credibility – empathize with the impacted

No denying, beaver can:

- cause flooding
- block culverts, which wash out roads
- chop down ornamental landscape trees
- impact irrigation diversions





# Living With Beaver Strategies...

- Is problem real or perceived?
- If real:
  - 'Beaver Deceivers'
  - 'Pond Levelers'
  - 'Caging' or painting trees
  - All require maintenance
- If those don't work, live trap and relocation

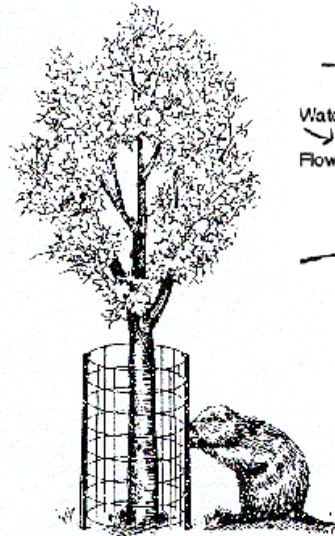


Figure A - Side View

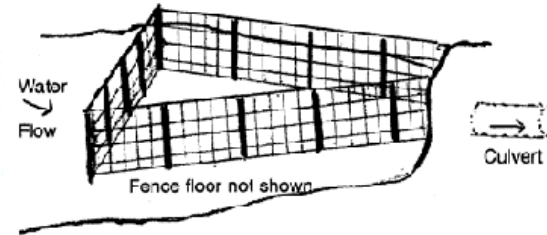
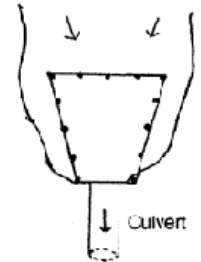


Figure B - Top View



**BEAVER**  
SOLUTIONS

**Working With Nature**  
Resolve Your Flooding Problems

» Buy Now

**The Best Beaver  
Management Practices**

*Long Term Solutions to  
Beaver Dam Flooding*



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## Low-tech process-based restoration

noun

1. A practice of using simple, low unit-cost, structural additions (e.g., wood and beaver dams) to [riverscapes](#) to mimic functions and promote specific processes. Hallmarks of this approach include an explicit focus on the promoting geomorphic and [fluvial](#) processes, a conscious effort to use cost-effective, low-tech treatments (e.g., hand-built, natural materials, non-engineered, short-term design life-spans) because of the need to efficiently scale-up application, and 'Letting the [system](#) do the work', which defers critical decision making to riverscapes and beaver.





# Key Processes to **DESIGN & SOLVE** for!!!



**WOOD ACCUMULATION** on a  
Post-Assisted Log Structure **(PALS)**



**BEAVER DAM ACTIVITY** on a  
beaver dam analogue **(BDA)**

From Shahveridan et al. (2019)  
Chap 4 LTPBR Manual  
DOI: [10.13140/RG.2.2.22526.64324](https://doi.org/10.13140/RG.2.2.22526.64324)



# PALS and BDAs



## PALS

### POST-ASSISTED LOG STRUCTURES

- PALS are handbuilt structures that mimic and promote the processes of **wood accumulation**.
- Woody material of various sizes pinned together with untreated wooden posts driven into the substrate.



## BDAs

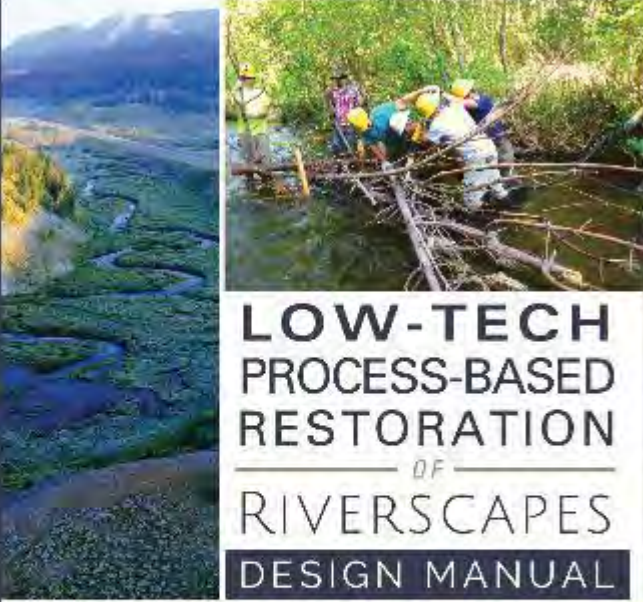
### BEAVER DAM ANALOGUES

- BDAs are handbuilt structures that mimic and promote the processes of **beaver dam activity**.
- BDAs are a permeable, channel-spanning structure with a constant crest elevation, constructed with a mixture of woody debris and fill material to promote temporary ponding of water.

From Page 23 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)





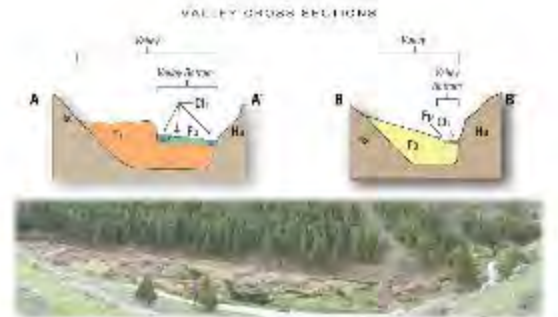
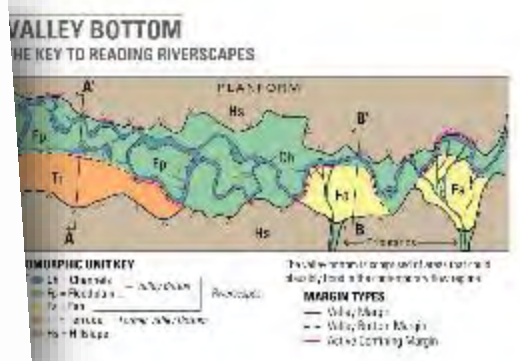
# LOW-TECH PROCESS-BASED RESTORATION *OF* RIVERSCAPES DESIGN MANUAL



Edited by: Joseph M. Wheaton, Stephen N. Bennett, Nicolaas Bouwae, Jeremy D. Maestas & Scott M. Shahverdian



- Manual defines LTPBR Standard of Practice
- Print version now available for \$60 on Amazon



Free Digitally @: <http://lowtechpbr.restoration.usu.edu>



**THERE IS STRENGTH IN NUMBERS**  
RESTORATION PRINCIPLE 6.

# Build the workforce!



© Jeremy Maestas

We've taught over 20 LTPBR workshops

See Wheaton et al. (2019, p. 283)  
Chapter 7 of LTPBR Manual  
DOI: [10.13140/RG.2.2.18332.33922](https://doi.org/10.13140/RG.2.2.18332.33922).



# Free Self-Paced Workshop Modules

LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES DESIGN MANUAL, RESOURCES, WORKSHOPS

2020 NRCS WLFW LOW-TECH RIVERSCAPE RESTORATION WORKSHOP

2020 Virtual Workshop  
August 11-14, 2020 - Anywhere with Internet

**Go right to Module Materials**

UPDATE - As of July 30, 2020, we have had over 1,000 registrations from all of you that have registered. The interest is wonderful. Unfortunately, we can only accommodate 1,000 participants, so registration is now closed.

Couldn't register? Don't despair! All of the presentations and discussions will be recorded, organized and made available from this page after the workshop. Thus, you can still participate at your own pace, asynchronously.

Overview

USDA

Modules on:

1. Intro to LTPBR
2. Science
3. Planning
4. Design
5. Implementation



<http://lowtechpbr.restoration.usu.edu>



MODULE 3

Below you can find PDFs and video recordings of the slides we cover in the intro to low-tech process-based restoration virtual workshop. Each is licensed with a Creative Commons license, so you are free to re-use subject the terms of the license.

**Module 3: Planning Low-Tech PBR**  
Wednesday Aug 12 1:00 PM - 4:30 PM (Mountain Time)

**Slides & Videos**

**A. Logistics, Learning Objectives & Introductions**

Watch Video of Lecture or Download Slides

Video

Module 3, Instruction Team  
03-6 Introduction to ...

Slides

LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES  
VIRTUAL WORKSHOP  
Module 3 - Planning  
August 12, 2020

**SITE CONTENTS**

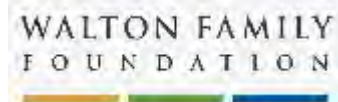
- Home
- Design Manual
- PBR Resources
- Low-Tech PBR Workshop

Subscribe to the Low-Tech PBR mailing list



# A Lot of Amazing People are behind LTPBR:

An incomplete acknowledgement...





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# Really... Remember the Principles



Take some time to pause and focus on health, healing & hope

**RIVERSCAPES PRINCIPLES:**

- 1 Streams need space. Healthy streams are dynamic, regularly shifting position within their valley bottom, re-working and interacting with their floodplain. Allowing streams to expand within their valley bottom is essential for maintaining functioning riverscapes.
- 2 Structure forces complexity and builds resilience. Structural elements, such as beaver dams and large woody debris, force changes in flow patterns that produce physically diverse habitats. Physically diverse habitats are more resilient to disturbances than simplified, homogeneous habitats.
- 3 The importance of structure varies. The relative importance and abundance of structural elements varies across different settings, flow regimes and watershed contexts. It is important to consider the form and function of structures in the context of the system.
- 4 Efficiency matters. Structures should be designed to be efficient, minimizing the amount of material and effort required to build and maintain them.



Recognizing what **Healthy** looks like

**RESTORATION PRINCIPLES:**

- 5 It's okay to be messy. When structure is added back to streams, it is meant to mimic and promote the processes of wood accumulation and beaver dam activity. Structures are not intended to be perfect and should resemble natural structures (log jams, beaver dams, fallen trees) in naturally "messy" systems. Structures do not have to be perfectly built to yield desirable outcomes. Focus less on the form and more on the processes the structures will promote.
- 6 There is strength in numbers. A large number of smaller structures working in concert with each other can achieve much more than a few isolated, over-built, highly-secured structures. Using a lot of smaller structures provides redundancy and reduces the importance of any one structure. It generally takes many structures, designed in a complex to promote the processes of wood accumulation and beaver dam activity that lead to the desired outcomes.
- 7 Use natural building materials. Natural materials should be used because structures are simply intended to initiate process recovery and go away over time. Locally sourced materials are preferred because they are more readily available and keep costs down.
- 8 Let the system do the work. Giving the riverscape another chance to do the work reduces the need for artificial structures. Natural processes to heal itself with stream power and ecosystem engineering, as opposed to diesel power, promotes efficiency that allows restoration to scale to the scope of degradation.
- 9 Deferring decision making to the system. Whenever possible, let the system make critical design decisions by simply providing the tools and space it needs to adjust. Deferring decision making in the system downplays the significance of uncertainty due to limited knowledge. For example, choosing a floodplain elevation to grade to based on limited hydrology information can be a complex and uncertain endeavor, but deferring to the hydrology of that system to build its own floodplain grade reduces the importance of uncertainty due to limited knowledge.
- 10 Self-sustaining systems are the solution. Low-tech restoration actions in and of themselves are not the solution. Rather they are just intended to initiate processes and nudge the system toward the ultimate goal of building a resilient, self-sustaining riverscape.



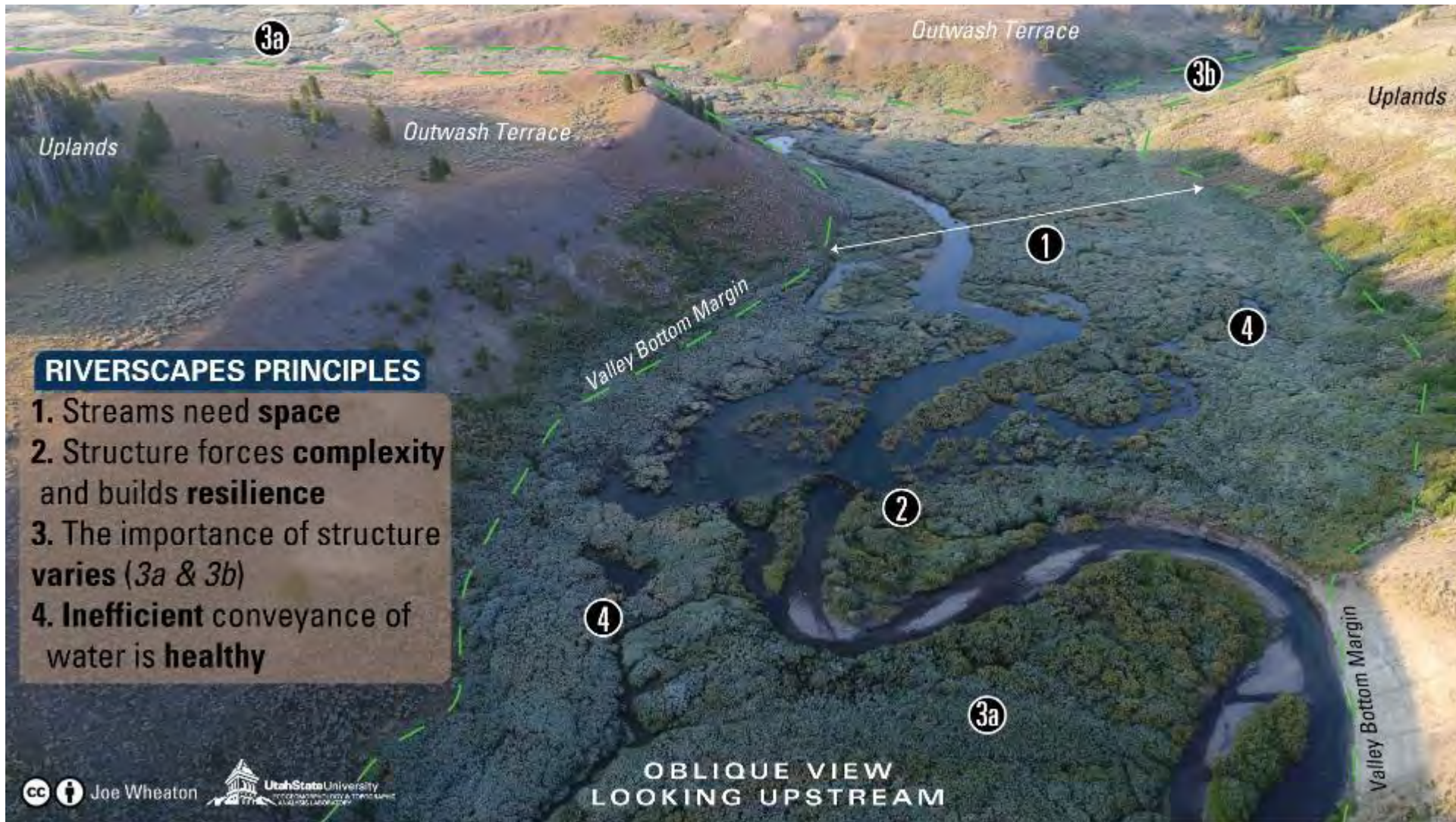
What we can do to **let it get to healthy**

A whole day to say what we cover in 4 pages and a top 10 list...

Free Digitally @: <http://lowtechpbr.restoration.usu.edu>



# What constitutes a healthy riverscape?



## RIVERSCAPES PRINCIPLES

1. Streams need **space**
2. Structure forces **complexity** and builds **resilience**
3. The importance of structure **varies** (3a & 3b)
4. **Inefficient** conveyance of water is **healthy**

From pages 3-4 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See Wheaton et al. (2019, p 60): Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)

## Riverscapes Principles



## RESTORATION PRINCIPLES

5. It's okay to be **messy**
6. There is strength in **numbers**
7. Use **natural** building materials
8. Let the system **do the work**
9. **Defer decision making** to the system
10. **Self-sustaining** systems are the solution

# Low-Tech Restoration Principles



From pages 3-4 of Pocket Guide; Wheaton et al. (2019)

DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See Wheaton et al. (2019, p 72)

Chapter 2 LTPBR Manual for Principles

DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)



# Beaver Like to Make Messes... **So can you**



- And it is precisely that messiness, that is so critical to ecosystem health
- So why not take a cue from the rodent?



# 9. Defer Decision Making to System



Transfer decision making  
& liability to the  
ecosystem engineer



 Joe Wheaton

Pocket Guide; Wheaton et al. (2019, p. 3-4)  
DOI: [10.13140/RG.2.2.28222.13123/1](https://doi.org/10.13140/RG.2.2.28222.13123/1)

See Wheaton et al. (2019, p 77)  
Chapter 2 LTPBR Manual for Principles  
DOI: [10.13140/RG.2.2.34270.69447](https://doi.org/10.13140/RG.2.2.34270.69447)



# 10. Self-Sustaining Systems are the Solution

From Goldfarb (2018) Science:

<http://science.sciencemag.org/content/360/6393/1058>



## Adding dams

Beaver trapping and overgrazing have caused countless creeks to cut deep trenches and water tables to drop, drying floodplains. Installing BDAs can help.

## Widening the trench

BDAs divert flows, causing streams to cut into banks, widening the incised channel, and creating a supply of sediment that helps raise the stream bed.

## Beavers return

As BDAs trap sediment, the stream bed rebuilds and forces water onto the floodplain, recharging groundwater. Slower flows allow beavers to recolonize.

## A complex haven

Re-established beavers raise water tables, irrigate new stands of willow and alder, and create a maze of pools and side channels for fish and wildlife.



# What's your exit strategy?

**Mimic** → **Promote** → **Sustain**



# So back to the title and purpose?

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration

**Expectation management** around beaver as a restoration/conservation partner, vs. mitigating their impacts in riverscapes



When, where and how to play the beaver cards?





# Meet the BRAT

## Beaver Restoration Assessment Tool

Build your understanding of BRAT for:

- conservation/restoration planning & prioritization
- risk/opportunity assessment
- expectation management

### Beaver Management / Restoration Strategies

1. **Conservation** / Promotion (leave them alone or protect)
2. **Living with beaver**
3. **Translocation** to areas with suitable capacity → BDAs for release
4. Restore riparian → Followed by Translocation
5. Help beaver out – **Beaver Dam Analogues** → *Facilitated dispersal of opportunistic species*
6. ~~Mimic Beaver Dam Activity – construction & maintenance (low-tech... NOT PBR)~~



# BRAT



**Just a tool... we'll use it to organize our thoughts,  
but don't get obsessed with having the tool run**

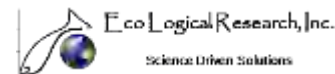




## Acknowledging 'WE' from USU & NAR Development Team...

- Wally Macfarlane (USU)
- Philip Bailey (NAR)
- Matt Reimer (NAR)
- Sara Bangen (USU)
- Jordan Gilbert (USU)
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- Chalese Hafen (USU)
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- Matt Meier (USU)
- Nick Weber (ELR/Anabranh)
- Scott Shahveridan (USU/Anabranh)
- And many others... we are neglecting

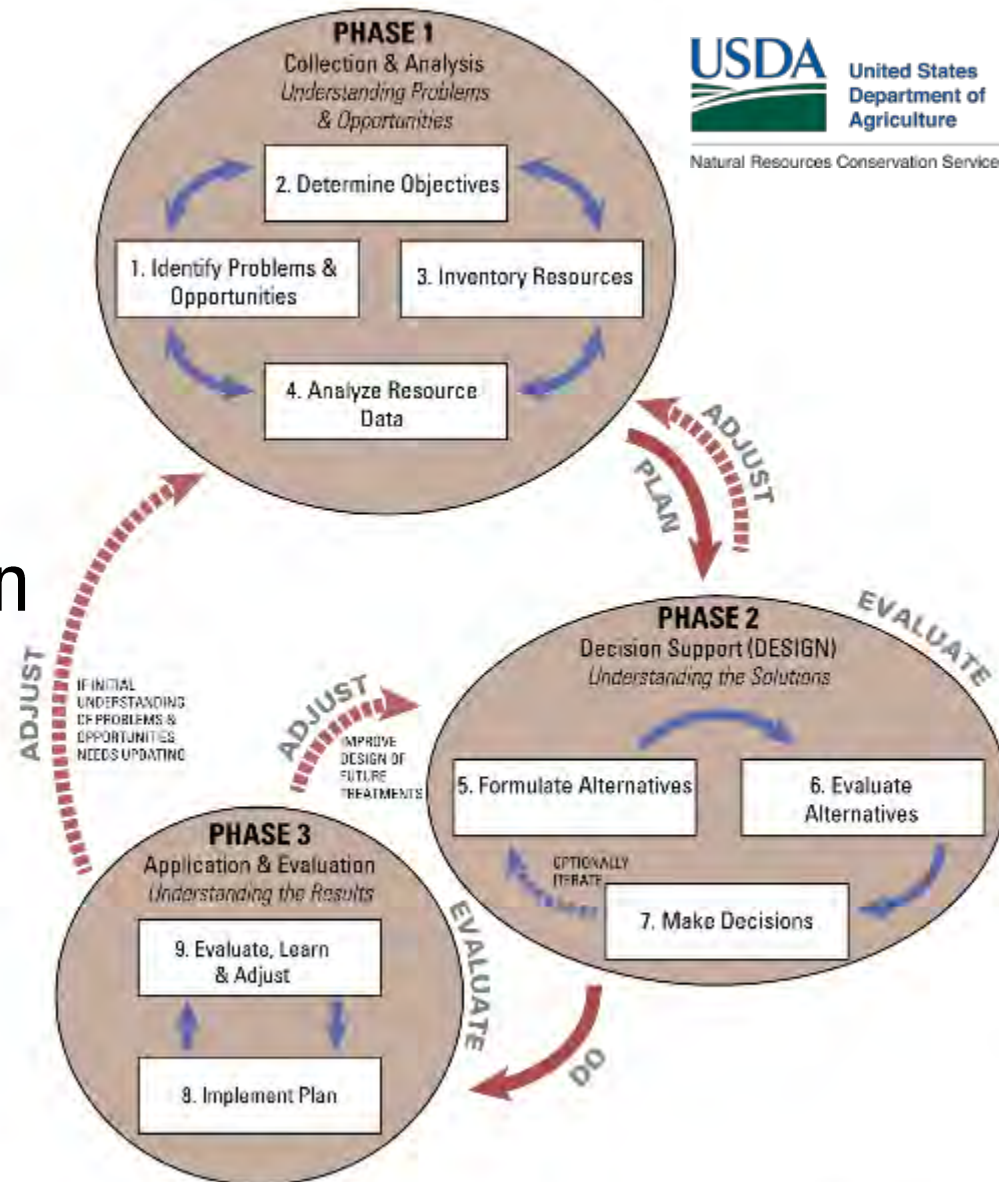
BRAT 





# Conservation Planning Process

- Phase 1 – Planning
- Phase 2 – Design
- Phase 3 – Implementation



Covered in Detail in [Module 3](#)

Figure 3.1 (p. 89) from Bennett et al. (2019)

Chapter 3 LTPBR Manual

DOI: [10.13140/RG.2.2.15815.75680](https://doi.org/10.13140/RG.2.2.15815.75680)



# FOCUS on Key Questions related to Low-Tech Process-Based Restoration

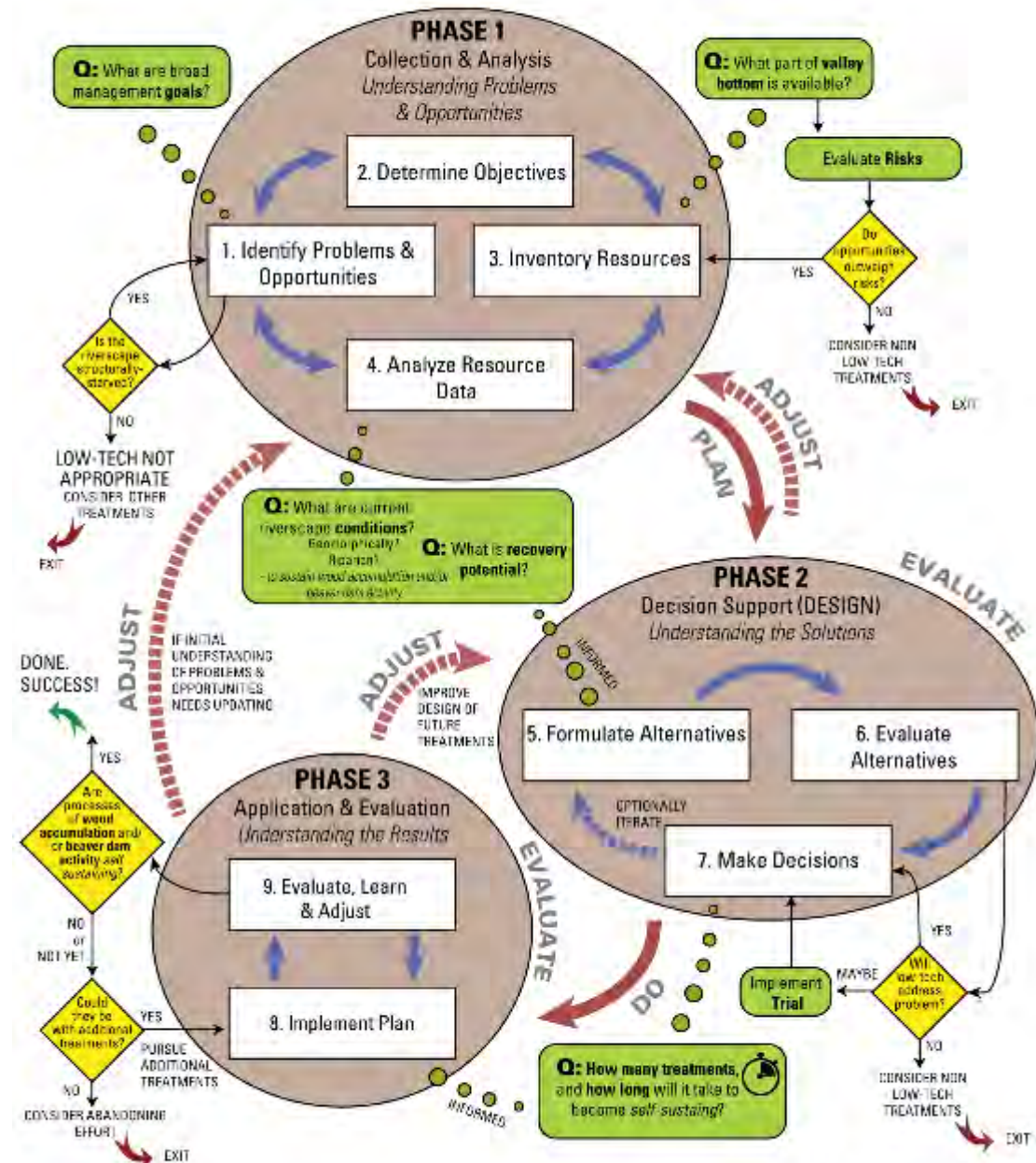


Figure 3.20 from Bennett et al. (2019, p 115)  
Chapter 3 LTPBR Manual  
DOI: [10.13140/RG.2.2.15815.75680](https://doi.org/10.13140/RG.2.2.15815.75680)



# PHASE 1 with Low-Tech

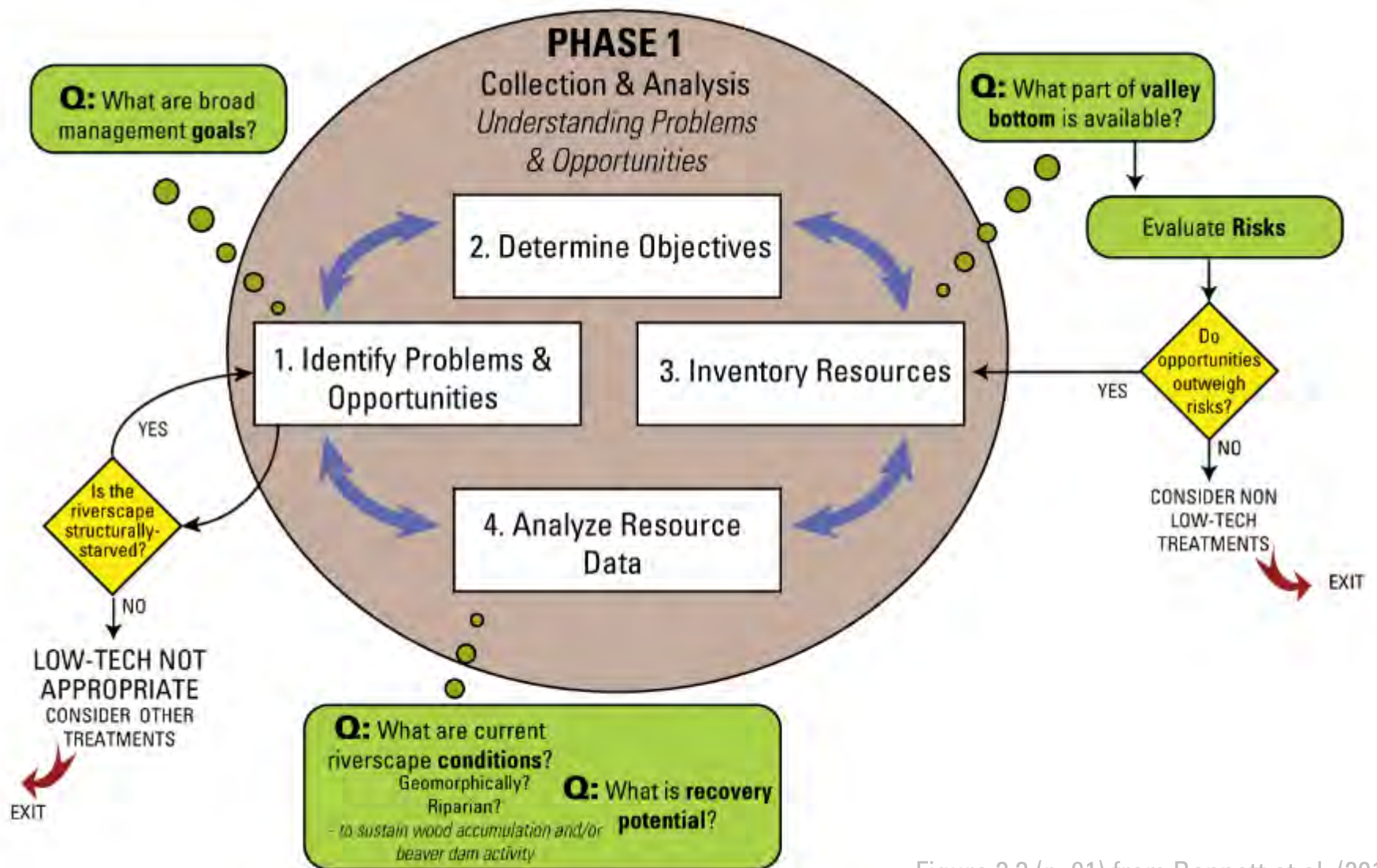


Figure 3.3 (p. 91) from Bennett et al. (2019)



# Take a Moment to Consider...

**Q:** What are current  
riverscape **conditions?**

Geomorphically?  
Riparian?

- to sustain wood accumulation and/or  
beaver dam activity

**Q:** What is **recovery  
potential?**

**Mimic** → **Promote** → **Sustain**



1. Are the woody or vegetative resources present to support process of **wood accumulation**?
2. Could **beaver dam activity** be supported?



# Could **beaver dam activity** be supported?

6/2014

See Appendix 3F (p 127) in Bennett et al. (2019)

Chapter 3 LTPBR Manual

DOI: [10.13140/RG.2.2.15815.75680](https://doi.org/10.13140/RG.2.2.15815.75680)

**BRAT** 

See: <http://brat.riverscapes.xyz>

- If beaver dams are present... apparently
- If so, to what degree?
- How much beaver dam activity?
- How much more?

**Q:** What are current riverscape **conditions**?  
Geomorphically?  
Riparian?

- to sustain wood accumulation and/or  
beaver dam activity

**Q:** What is **recovery potential**?

Google Earth

1994

Imagery Date: 6/30/2014 43°19'40.13" N 110°47'48.18" W elev 6271 ft eye alt 7603 ft



# OUTLINE

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration



- I. Background & Other Resources
- II. Dam Building Focus – Expectations**
- III. Contextualizing Risk
- IV. Prioritizing Opportunities
- V. Partnering with Beaver... A people business



# Dam-Building Capacity Modeling

- **Beaver dams**, not beaver themselves, provide the desired impacts to habitat
- While beaver can survive in wide range of conditions, **where they build dams is more limited**
- Dam building activity varies dramatically according to availability of **dam building materials & flow regime**





# Capacity Model In A Nutshell



Dam building beaver need water and wood...

- Type and extent of wood/vegetation matters most
- Flow regime act to potentially limit capacity





# The Primary Questions We Ask

1. Is their *enough* **water** present to maintain a pond?
2. Are *enough* and the *right* type of **woody** resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to withstand *typical floods*?

Some nationally-available lines of evidence to address questions:

- NHD – perennial streams (1:24K)
- LANDFIRE - vegetation type (EVT)
- USGS Regional Curves for
  - *Baseflow statistics*
  - $Q_2$
- USGS NED 10 m DEM – derive reach slope and estimate stream power

Macfarlane et al. (2016) DOI:

[10.1016/j.geomorph.2015.11.019](https://doi.org/10.1016/j.geomorph.2015.11.019)



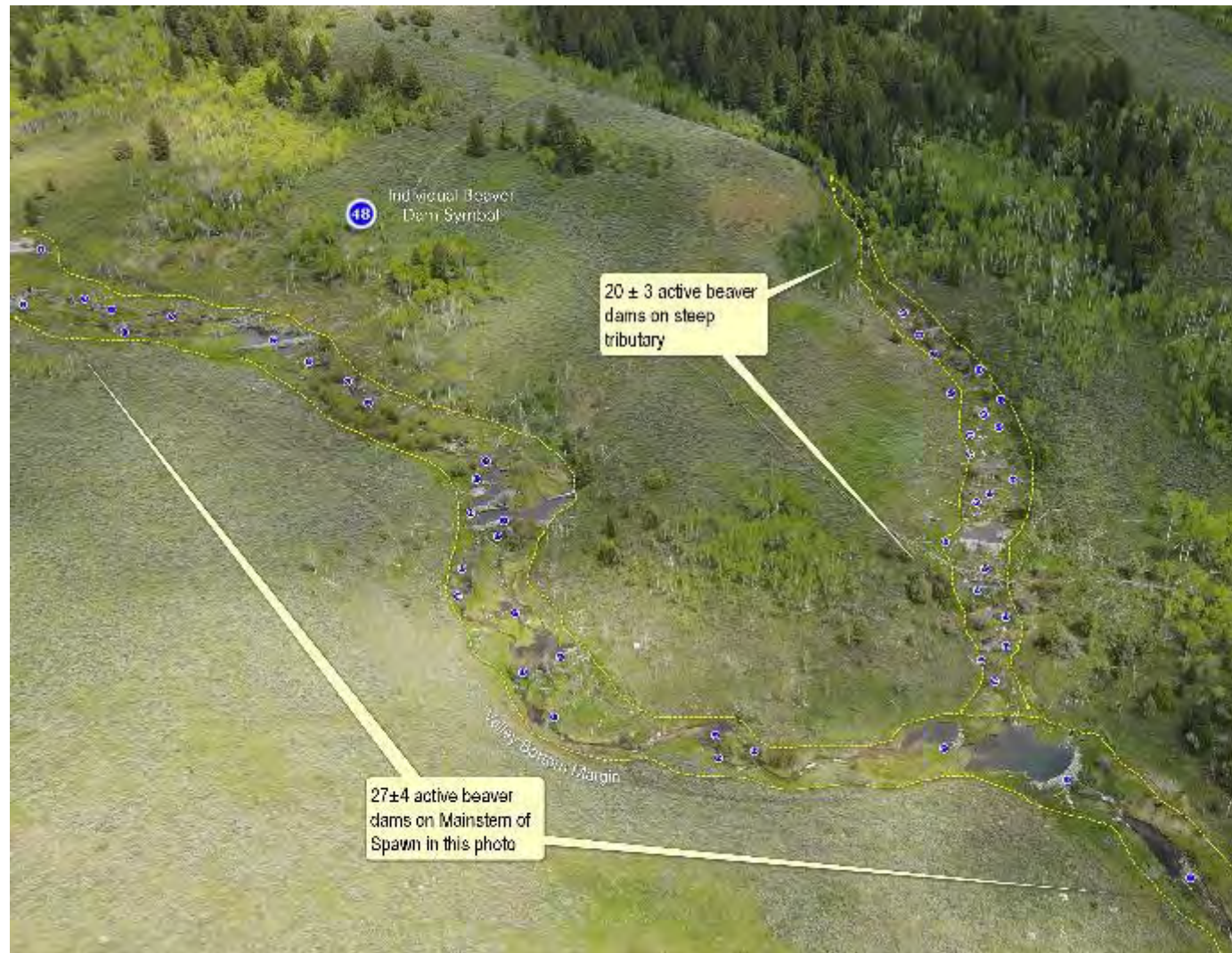
# BRAT Dam Capacity Model

- Resolves **where** and at **what level** (within a drainage network) **beaver dams** can be built and sustained.





# How many Dams? Capacity is upper limit?



Joe Wheaton @flu... · May 31

How many beaver dams do you think you see in Spawn Creek and that tributary (you're looking at 0.5 mile of trib up center of photo and about ~ 1 mile flowing from left to right)?

There aren't any dams!	4.2%
5-10 beaver dams	16.7%
<b>10-50 beaver dams</b>	<b>62.5%</b>
> 50	16.7%

24 votes · Final results



Joe Wheaton  
@fluvialwheaton

Thanks to those of you that weighed in. Either 10-50 or > 50 are good answers. All the blue dots are what I counted... ~ 47. There are a lot more both upstream and downstream (left and right) out of view.

11:12 AM · Jun 3, 2020 · Twitter Web App



# How Many & Where?



- Existing capacity: 356,294 dams
- 8.3 dams/km

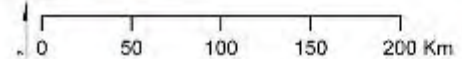
**Table 4**  
Summary of existing beaver dam gross modeled capacity estimates by capacity categories.

Category	Stream length (km)	% of stream network	Estimated dam capacity
Pervasive	6219	15%	147,644
Frequent	18,162	45%	186,184
Occasional	8234	20%	21,544
Rare	3307	8%	922
None	4639	12%	
Total	40,561		356,294

- Note: Utah is second driest state in US



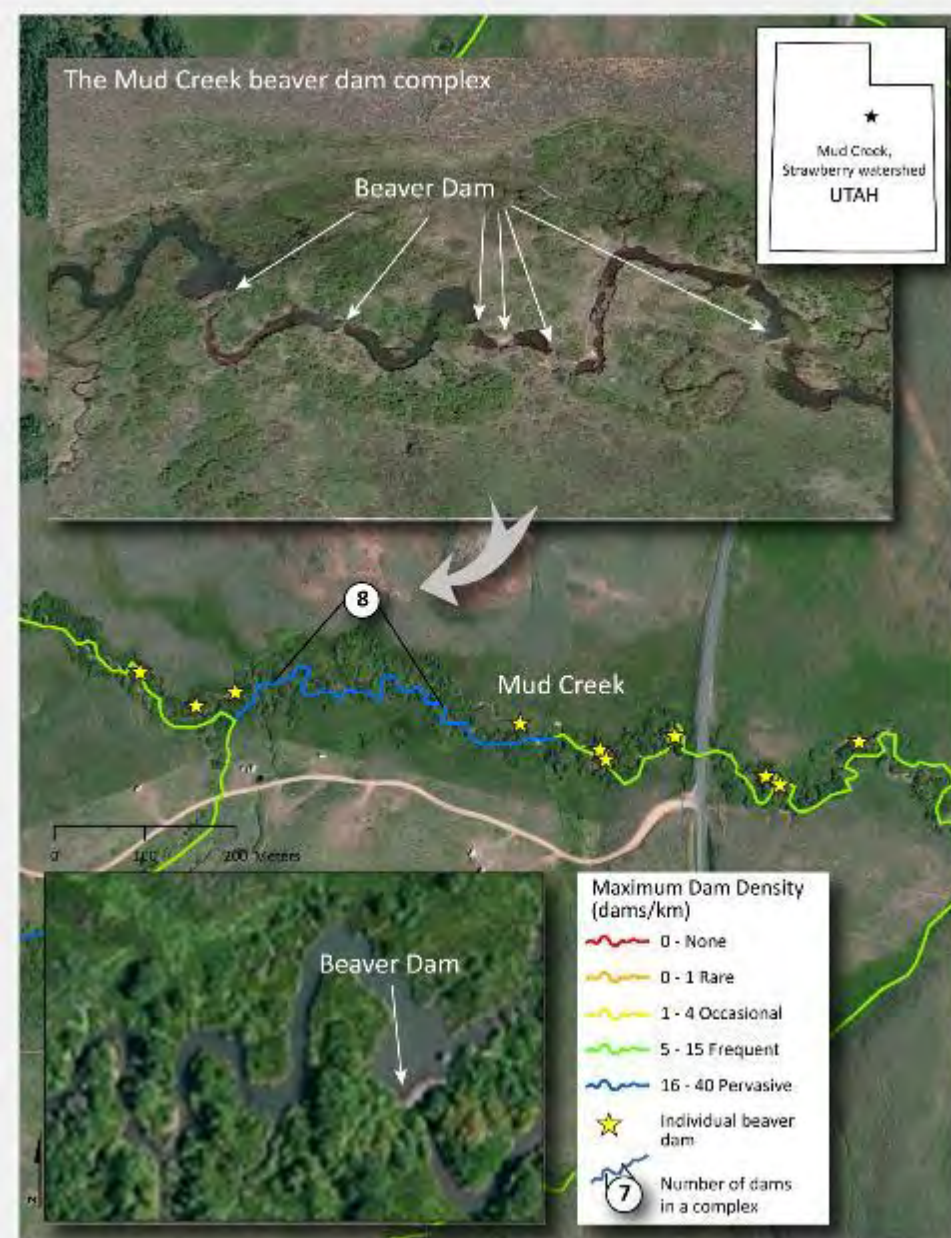
## Maximum Dam Density (Beaver Dams / km)





# Resolution of BRAT

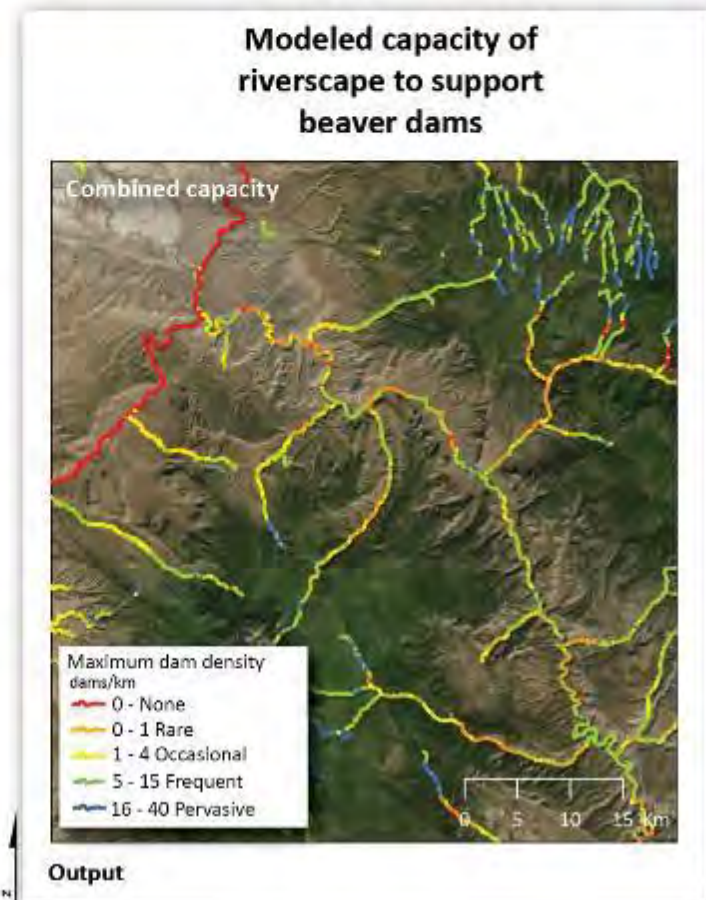
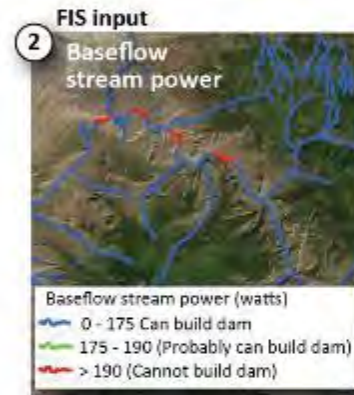
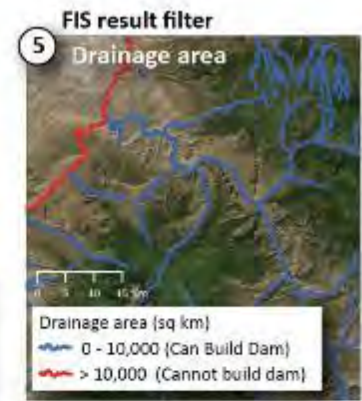
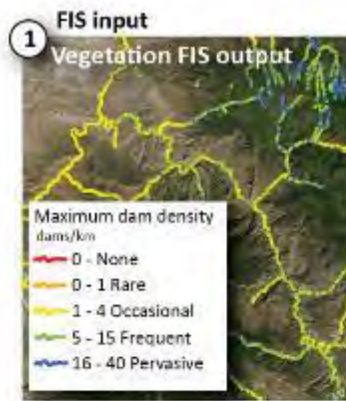
- At a scale that is still meaningful on the ground (250 m reaches)
- Just because BRAT predicts high capacity, does not mean it will be realized... but it does define a plausible upper limit
- In many places, at some point in time this upper limit is reached... just never all at once





# The Questions

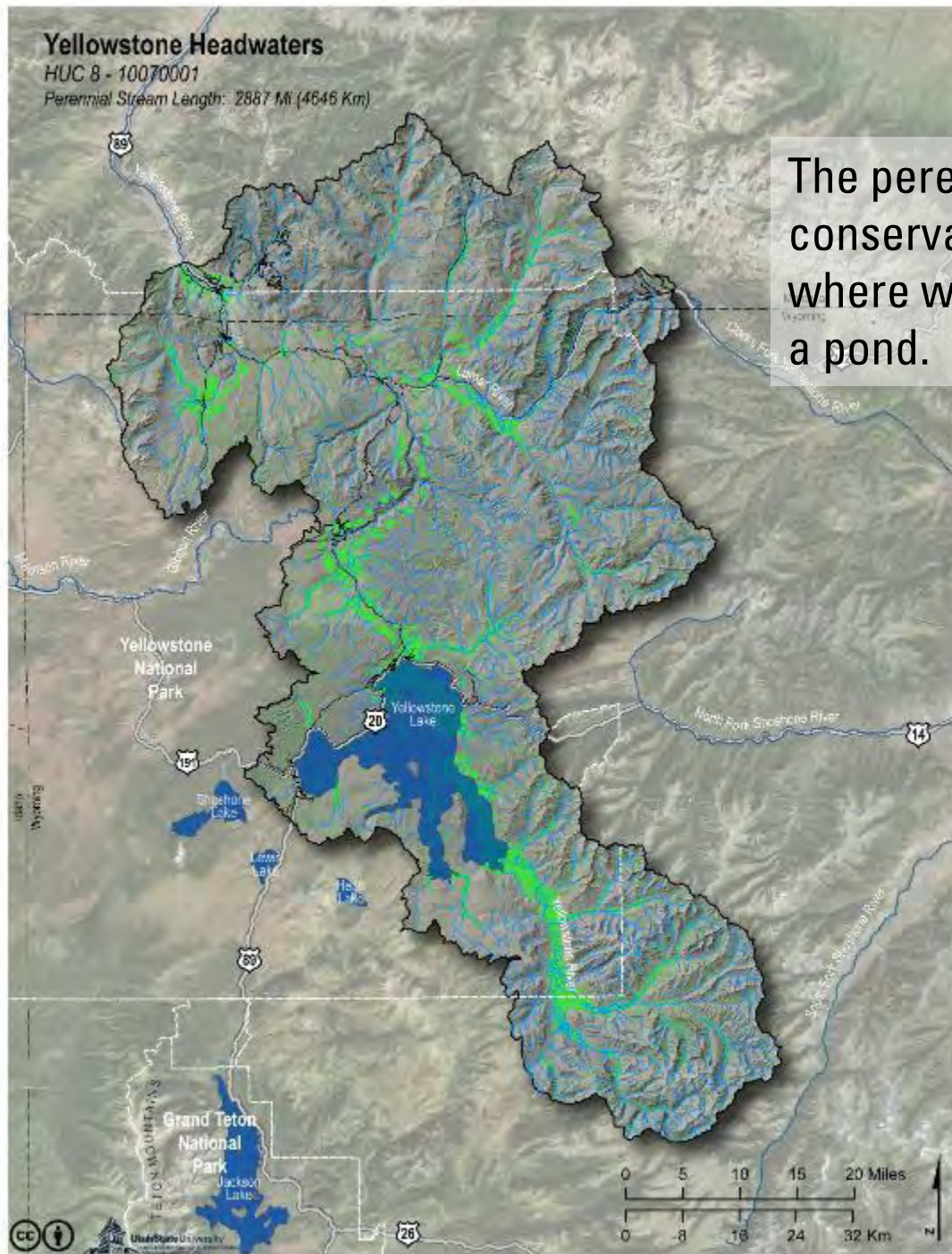
1. Is there *enough* water present to maintain a pond?
2. Are *enough* and the *right* type of woody resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to withstand *typical floods*?





**Yellowstone Headwaters**  
HUC 8 - 10070001  
Perennial Stream Length: 2887 Mi (4646 Km)

The perennial network is a conservative estimate of where water exists to make a pond.



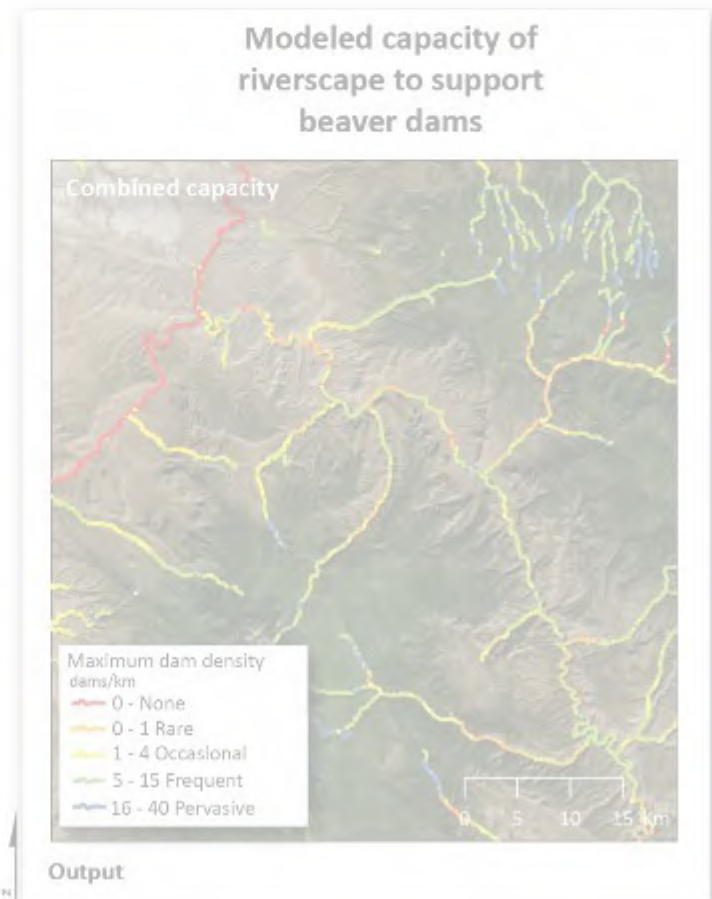
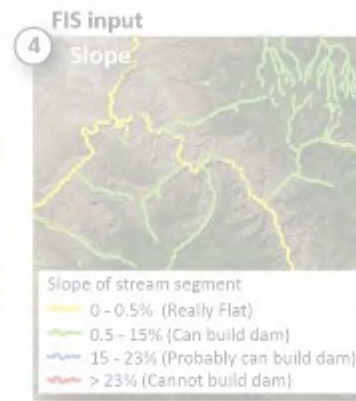
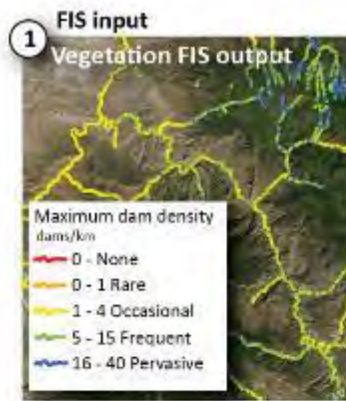
### Context Layers

- Canals
- Valley Bottom
- Roads
- Railroad
- Perennial Network**



# THE QUESTIONS

1. Is there *enough* water present to maintain a pond?
2. Are enough and the right type of woody resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to withstand *typical floods*?





# After perennial... proceed with veg

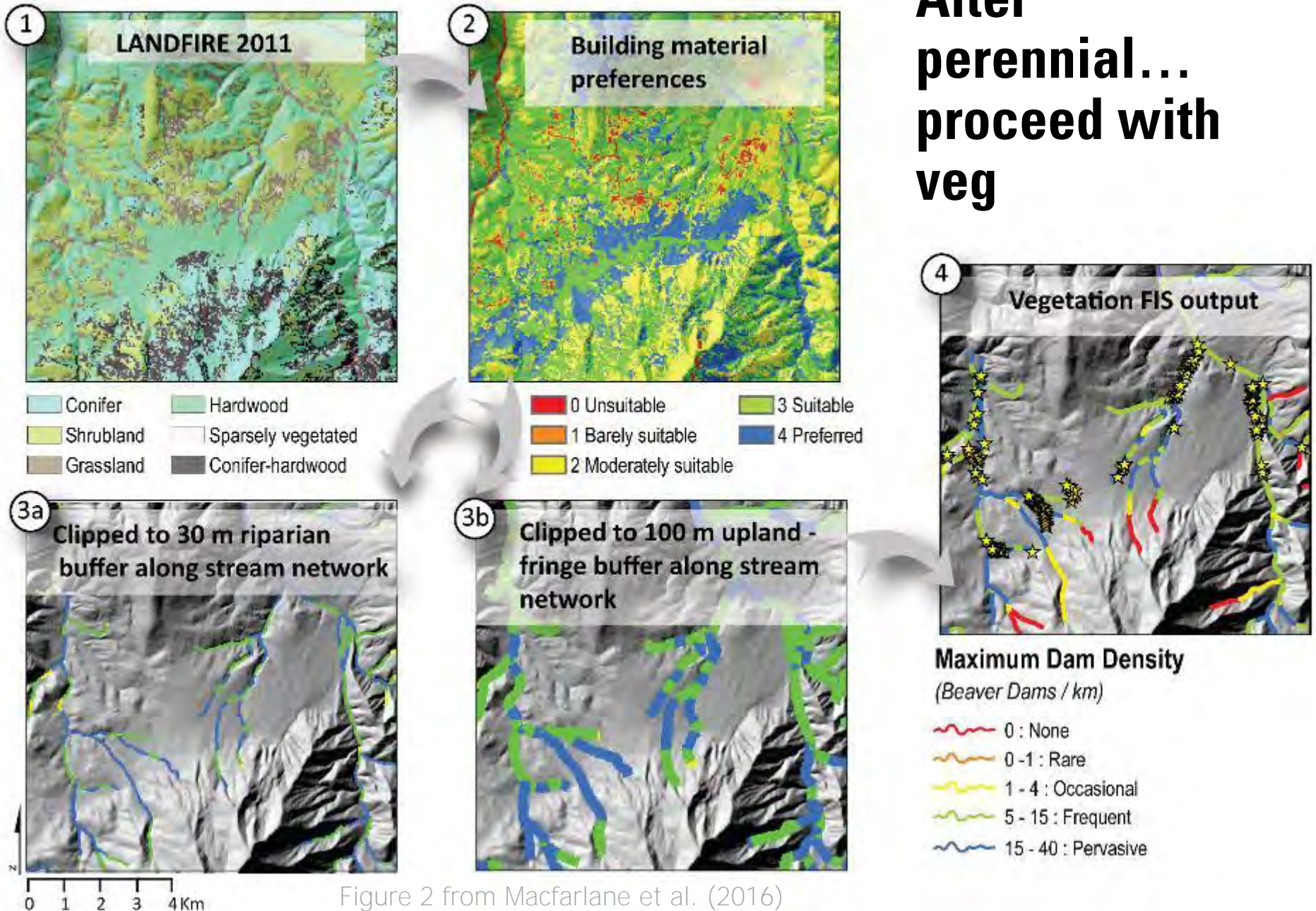


Figure 2 from Macfarlane et al. (2016)  
DOI: [10.1016/j.geomorph.2015.11.019](https://doi.org/10.1016/j.geomorph.2015.11.019)



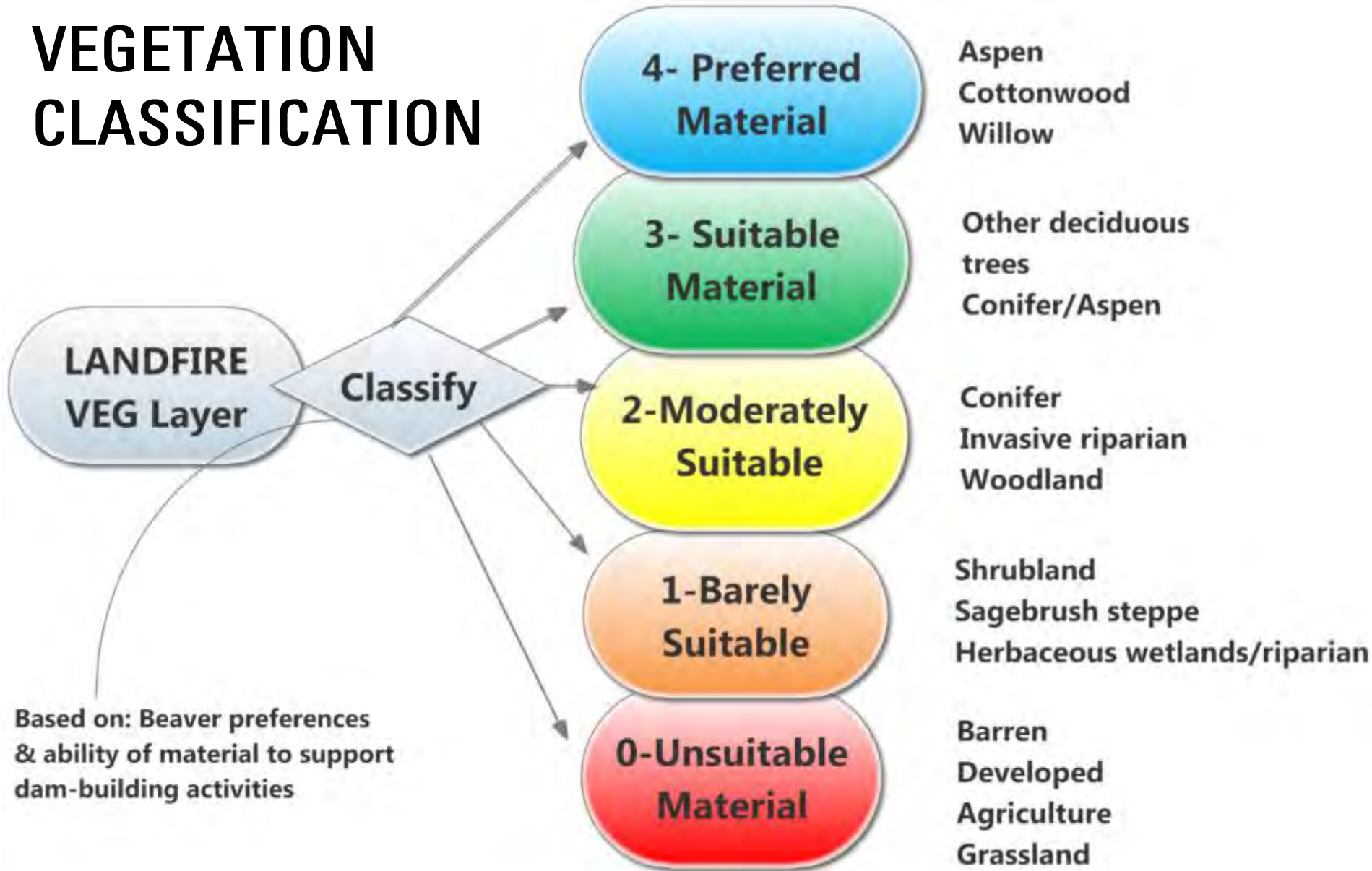


100 m

30 m



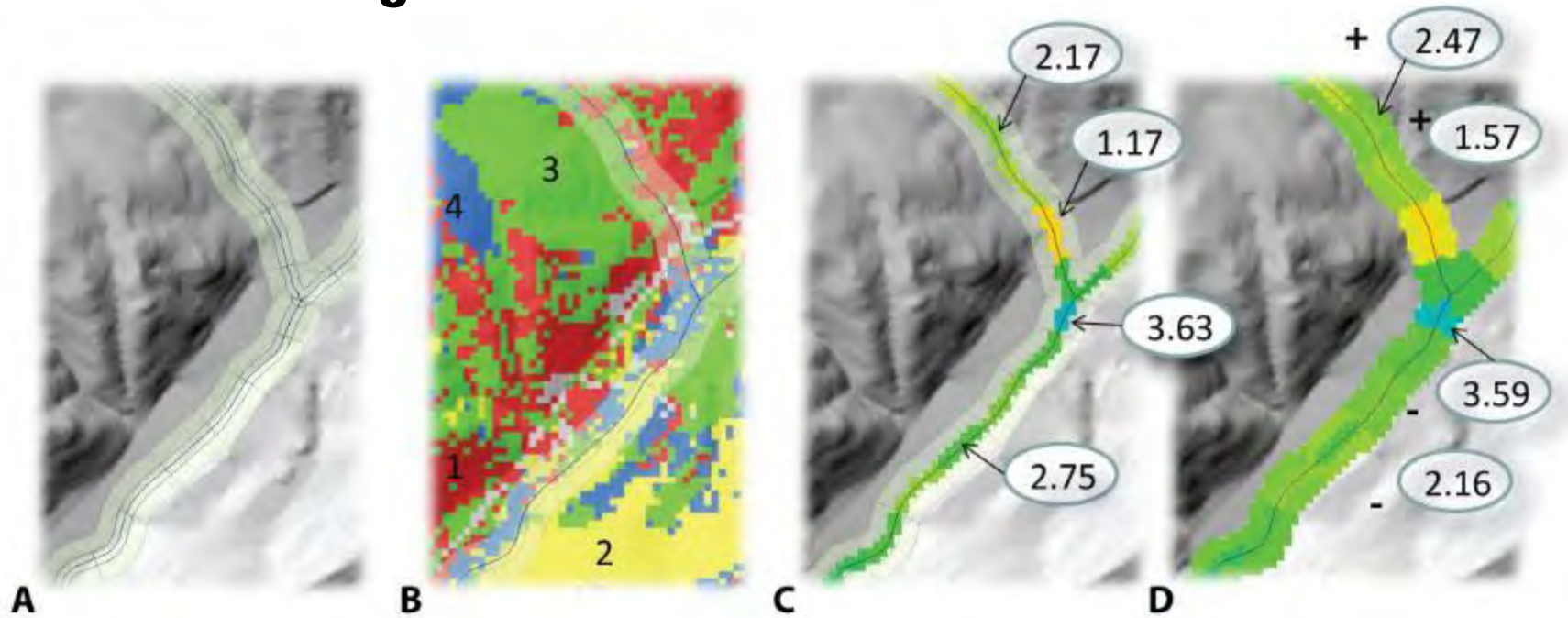
# VEGETATION CLASSIFICATION





# Appropriate Spatial Sampling

## Converts Categorical Pixels To Continuous Measure



- A. 30 vs. 100 m stream network buffer (300 m reaches)
- B. Classified LANDFIRE raster-- shows dam building suitability from 0 (unsuitable) to 4 (optimal)
- C. Averaged values for the 30 m buffer (300 m reaches)
- D. Averaged values for the 100 m buffer (300 m reaches)

Figure 3 from Macfarlane et al. (2016)

DOI: [10.1016/j.geomorph.2015.11.019](https://doi.org/10.1016/j.geomorph.2015.11.019)



# Inference System – (Simple Rules)

		INPUTS			OUTPUT	
IF	Suitability of Streamside Vegetation		Suitability of Riparian/Upland Vegetation		Dam Density Capacity	
<b>RULES</b>	12	Barely Suitable	&	Moderately Suitable	, then	Occasional
	13	Moderately Suitable	&	Moderately Suitable	, then	Frequent
	14	Suitable	&	Moderately Suitable	, then	Frequent
	15	Preferred	&	Moderately Suitable	, then	Frequent
	16	Unsuitable	&	Suitable	, then	Occasional
	17	Barely Suitable	&	Suitable	, then	Occasional
	18	Moderately Suitable	&	Suitable	, then	Frequent
	19	Suitable	&	Suitable	, then	Frequent
	20	Preferred	&	Suitable	, then	Frequent
	21	Unsuitable	&	Preferred	, then	Occasional
	22	Barely Suitable	&	Preferred	, then	Frequent
	23	Moderately Suitable	&	Preferred	, then	Frequent
	24	Suitable	&	Preferred	, then	Pervasive
25	Preferred	&	Preferred	, then	Pervasive	



# MADE FIS – BY FUZZY MEMBERSHIP FUNCTIONS

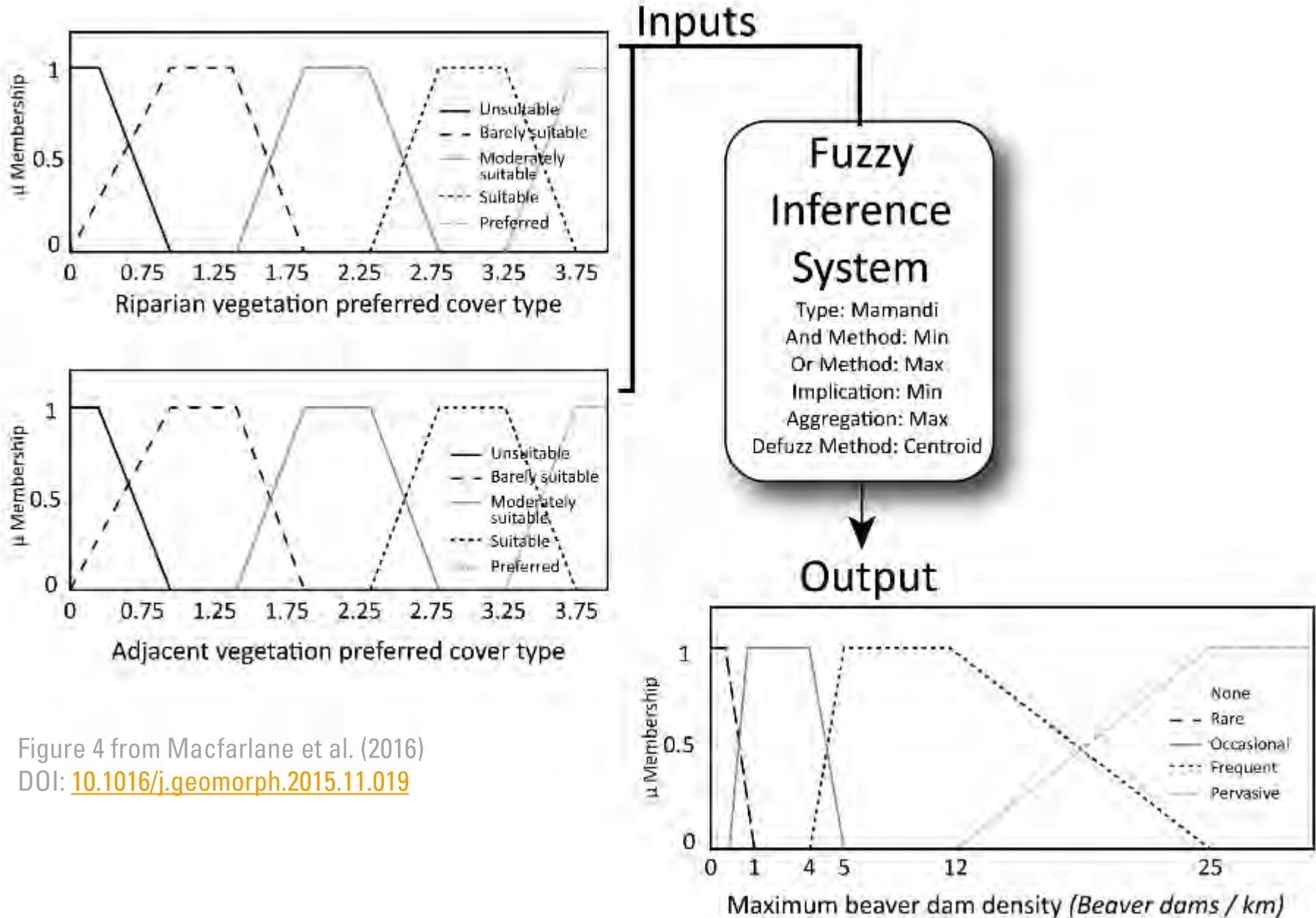


Figure 4 from Macfarlane et al. (2016)

DOI: [10.1016/j.geomorph.2015.11.019](https://doi.org/10.1016/j.geomorph.2015.11.019)



# Dam Density Output Categories:

- **None** – 0 dams: *segments deemed not capable of supporting dam building activity*
- **Rare** – 1 dam/km: *segments barely capable of supporting dam building activity; likely used by dispersing beaver*
- **Occasional** – 2-4 dams/km: *segments that are not ideal, but can support an occasional dam or even a small colony*
- **Frequent** – 5-15 dams/km: *segments that can support multiple colonies and dam complexes, but may be slightly resource limited*
- **Pervasive** – 16-40 dams/km: *segments that can support extensive dam complexes and many colonies*



# If you don't believe me on dam density

> 100 dams/km ... but closer to 40 dams/km/thread (i.e. 1 dam every 25 m)

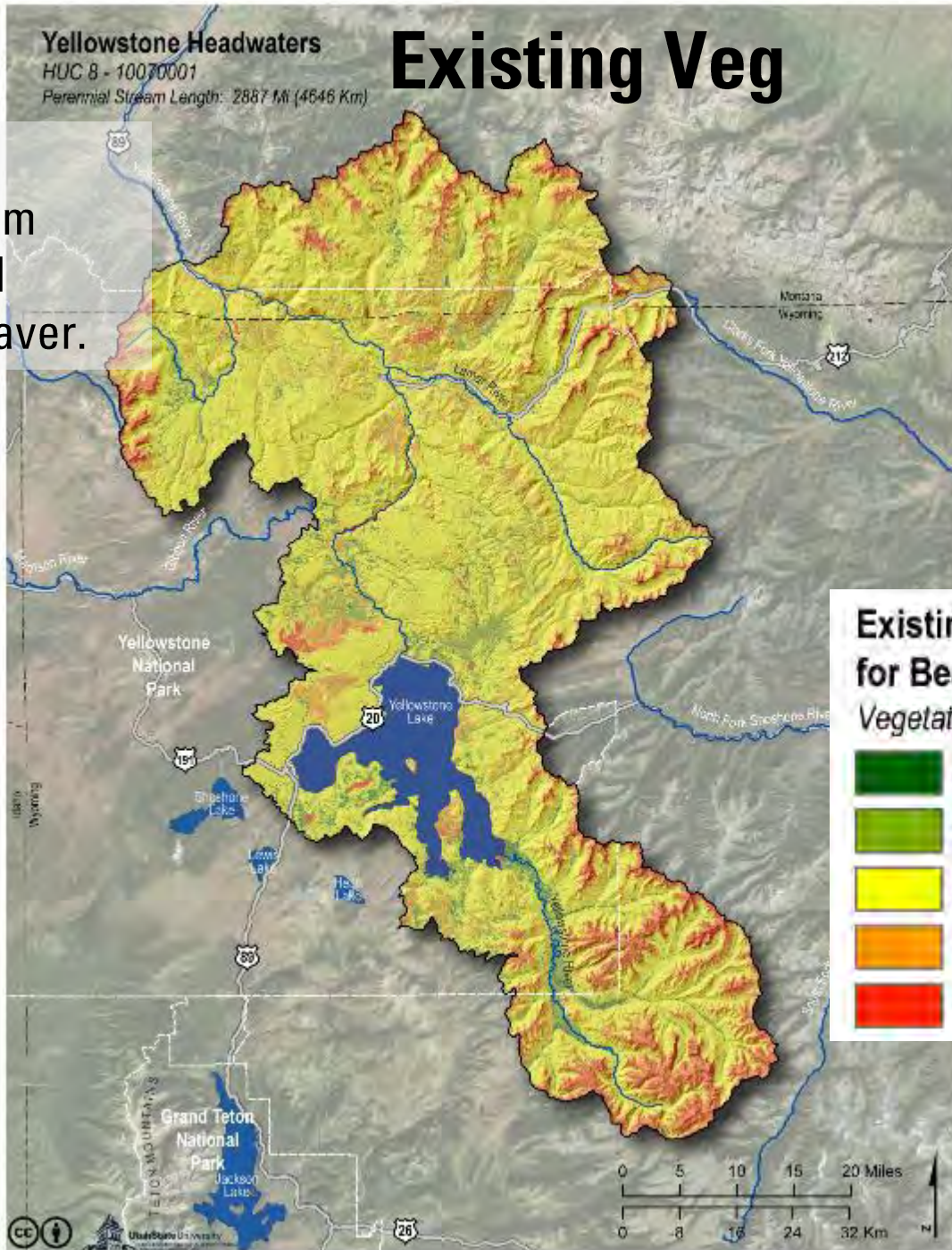




Yellowstone Headwaters  
HUC 8 - 10070001  
Perennial Stream Length: 2887 Mi (4646 Km)

# Existing Veg

Classify existing vegetation as dam building material suitability for beaver.





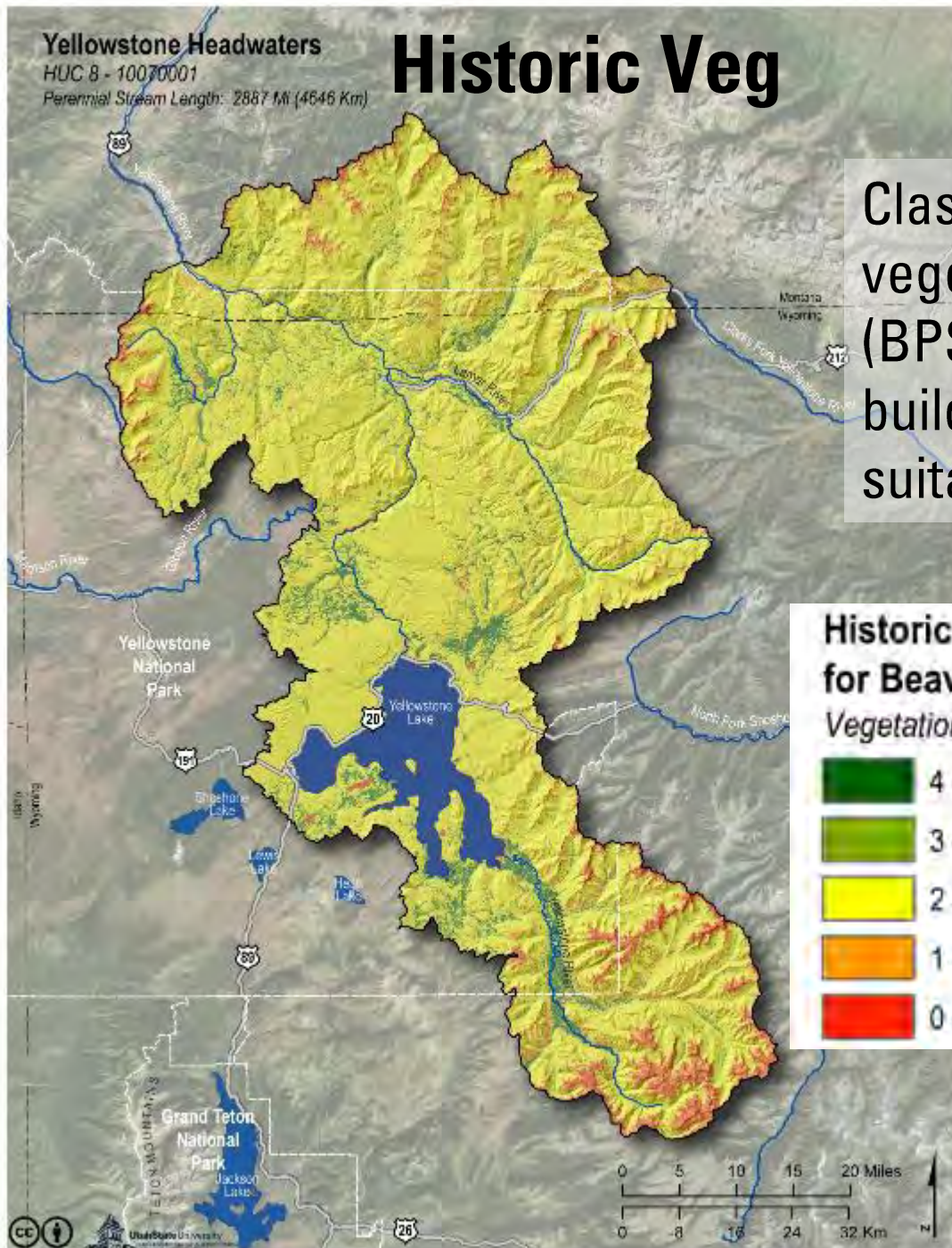
## Yellowstone Headwaters

HUC 8 - 10070001

Perennial Stream Length: 2887 Mi (4646 Km)

# Historic Veg

Classify historic vegetation estimate (BPS) as dam building material suitability for beaver.





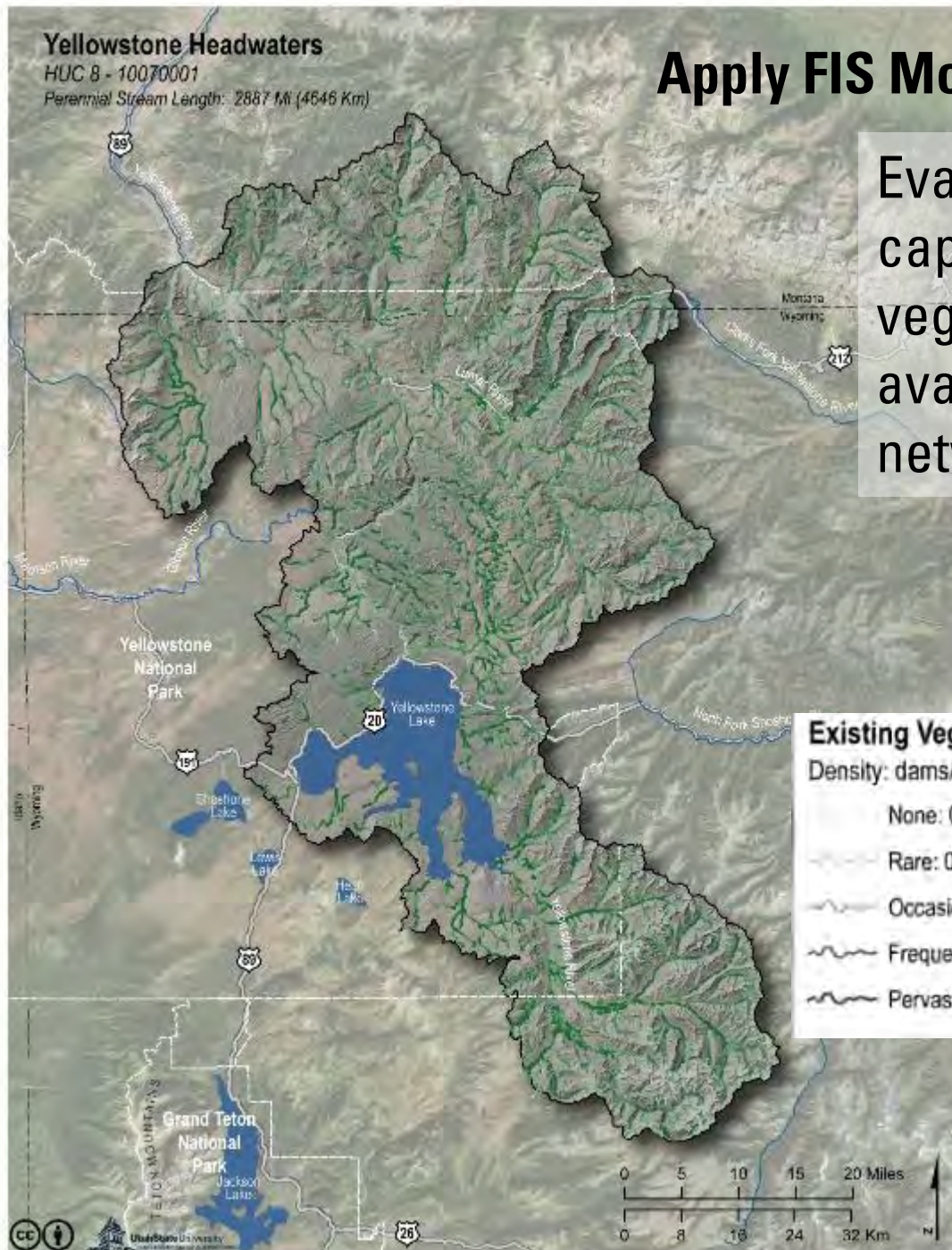
## Yellowstone Headwaters

HUC 8 - 10070001

Perennial Stream Length: 2887 Mi (4646 Km)

## Apply FIS Model → Network

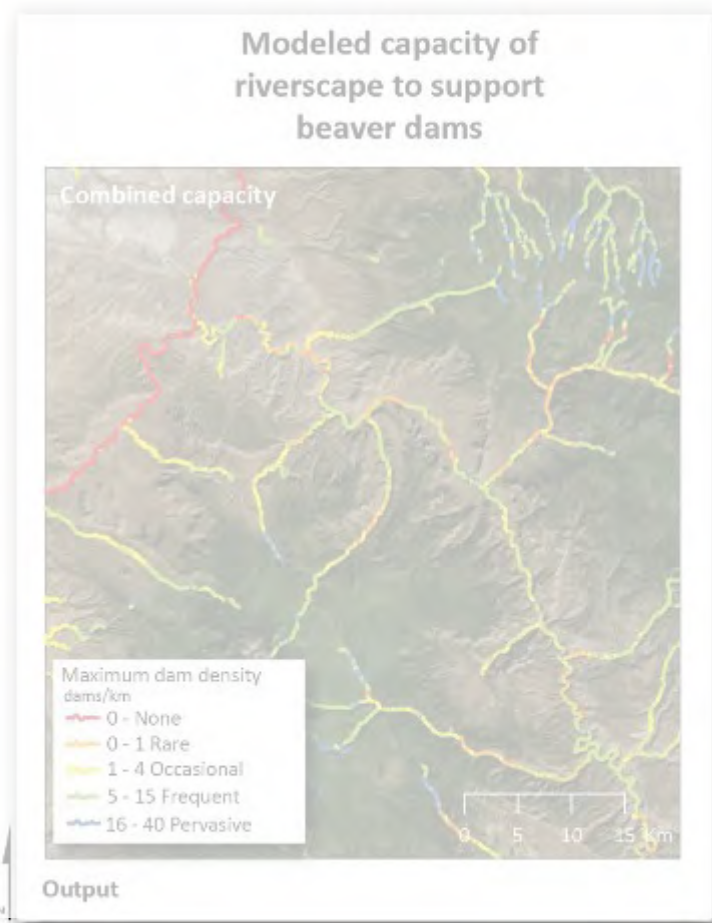
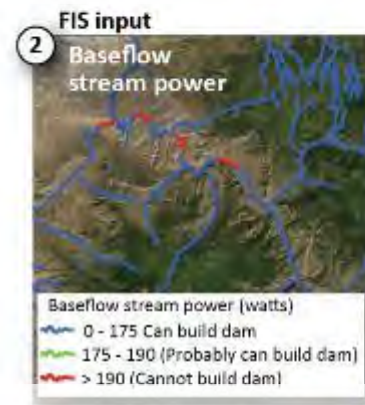
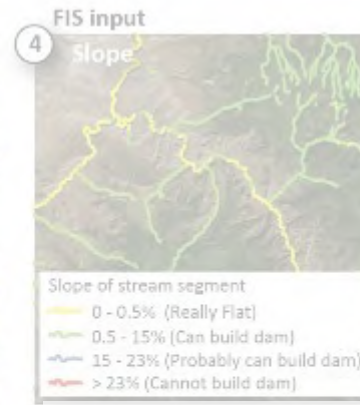
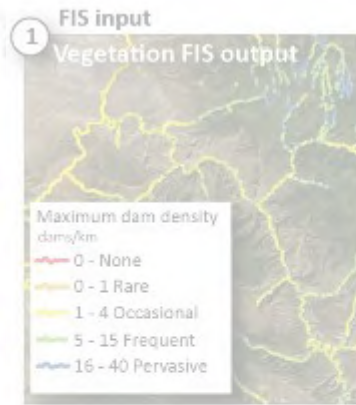
Evaluate **existing** capacity strictly on vegetation availability along network.





# THE QUESTIONS

1. Is their *enough* water present to maintain a pond?
2. Are enough and the right type of woody resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to withstand *typical floods*?

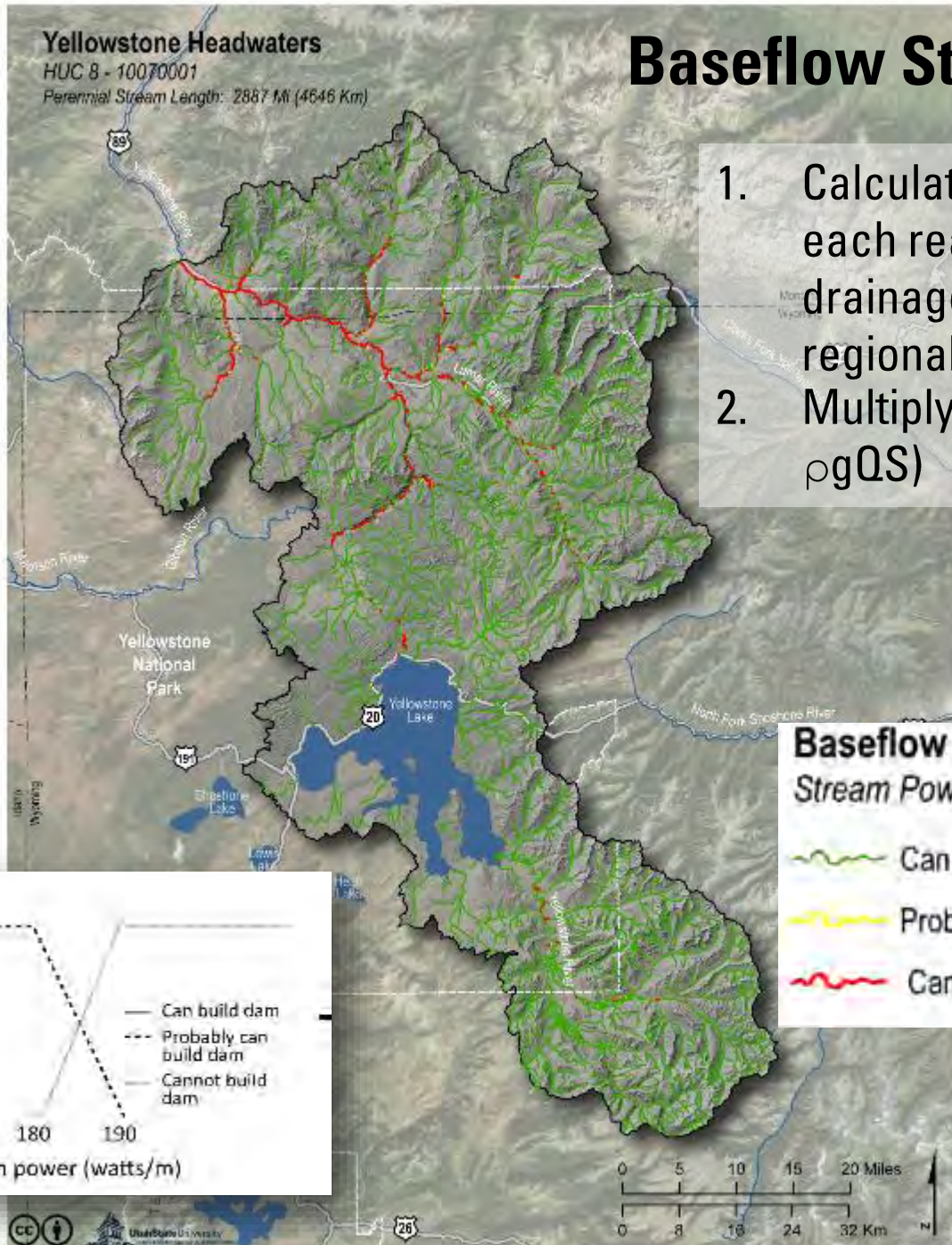




Yellowstone Headwaters  
HUC 8 - 10070001  
Perennial Stream Length: 2887 Mi (4646 Km)

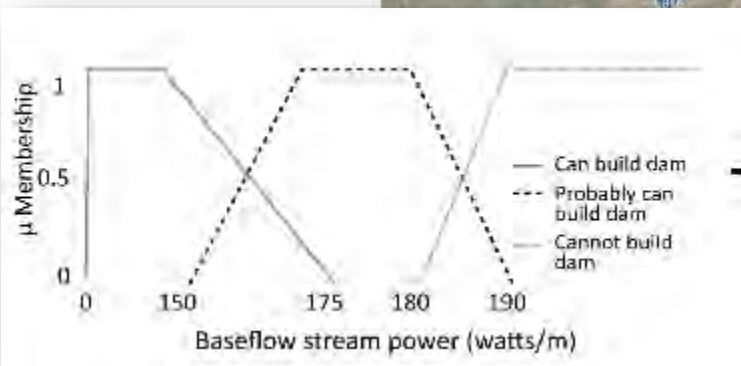
# Baseflow Stream Power

1. Calculate  $Q$  @ baseflow for each reach based on drainage area and USGS regional curves
2. Multiply  $Q$  by slope ( $S$ ) ( $\Omega = \rho g QS$ )



## Baseflow Stream Power Stream Power (watts)

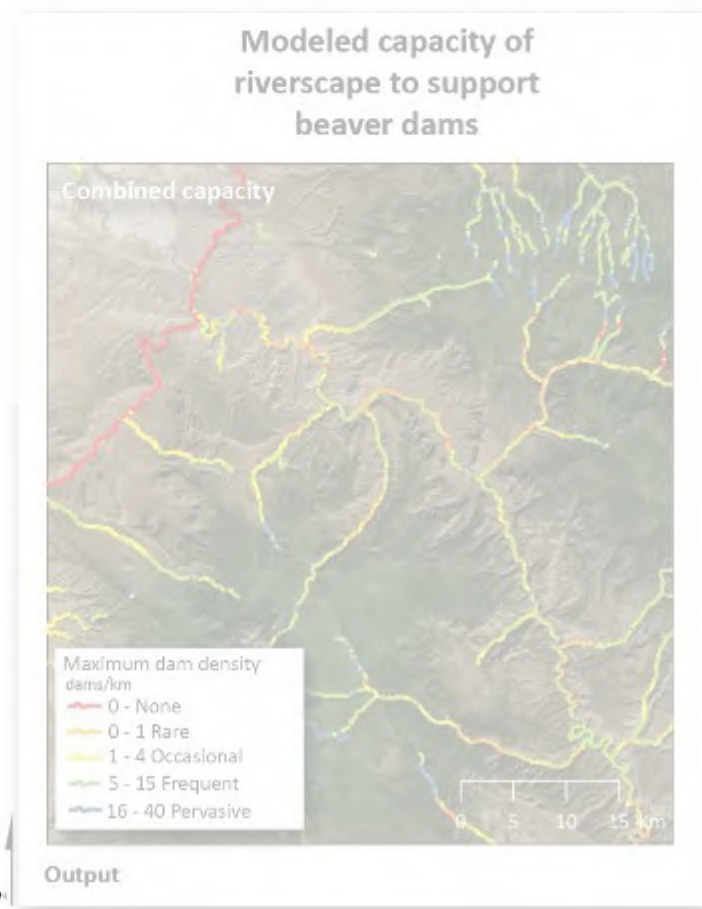
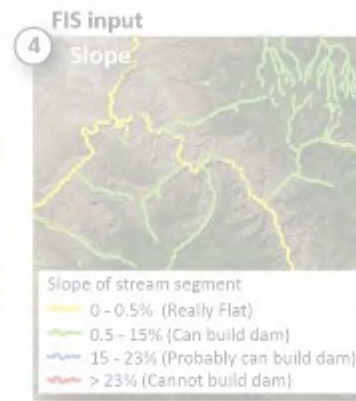
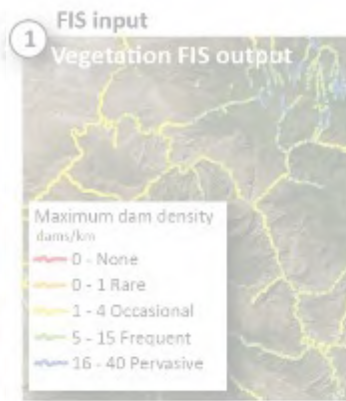
- Can Build Dam: 0 - 160
- Probably Can Build Dam: 160 - 185
- Cannot Build Dam: > 185





# THE QUESTIONS

1. Is there *enough* water present to maintain a pond?
2. Are enough and the right type of woody resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to withstand *typical floods*?

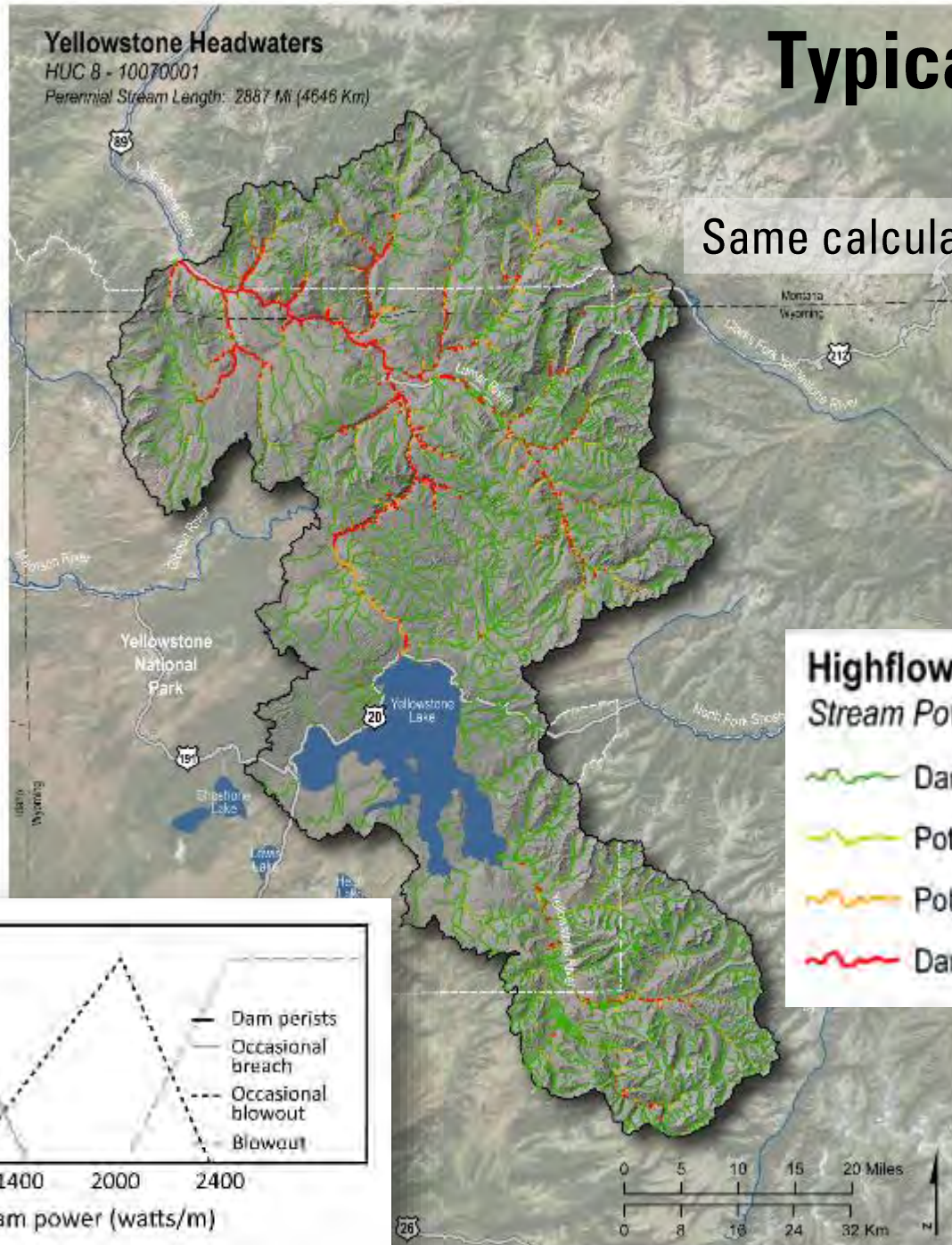








# Typical Floods?

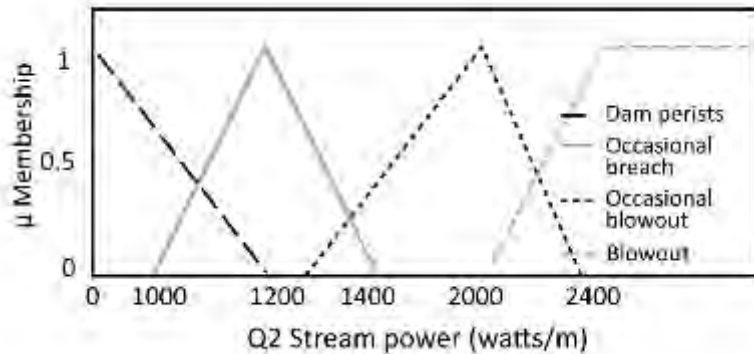
Yellowstone Headwaters  
HUC 8 - 10070001  
Perennial Stream Length: 2887 Mi (4646 Km)

Same calculation, but for  $Q_2$



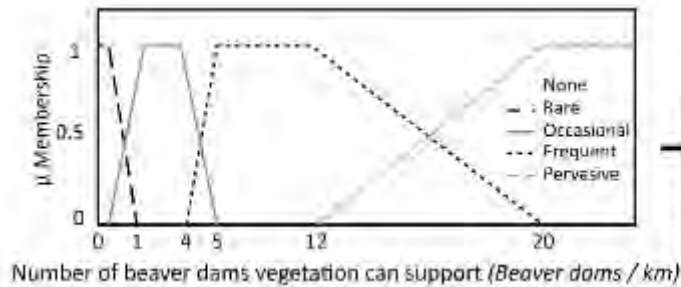
## Highflow Stream Power Stream Power (watts)

-  Dam Persists: 0 - 1100
-  Potential Dam Breach: 1100 - 1400
-  Potential Dam Blowout: 1400 - 2200
-  Dam Blowout: > 2200

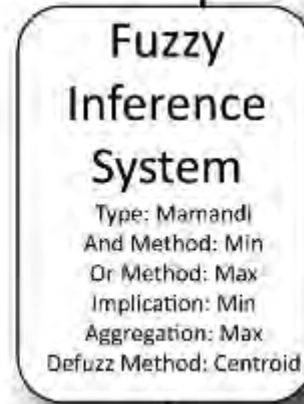




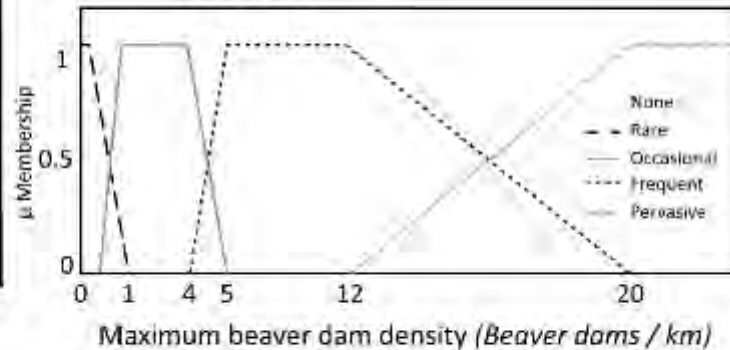
# Put the other inputs together



Inputs



Output



1. Is their *enough* water present to maintain a pond?
2. Are *enough* and the *right* type of **woody** resources present to support dam building?
3. Can they build a dam at *base flows*?
4. Are dams likely to **withstand** *typical floods*?

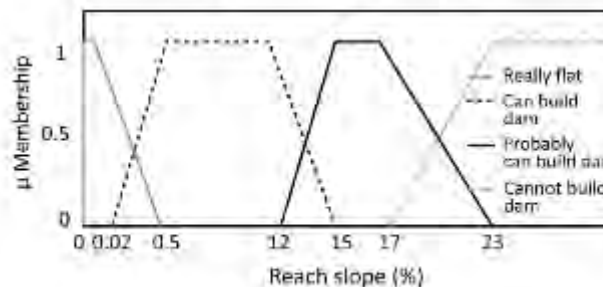
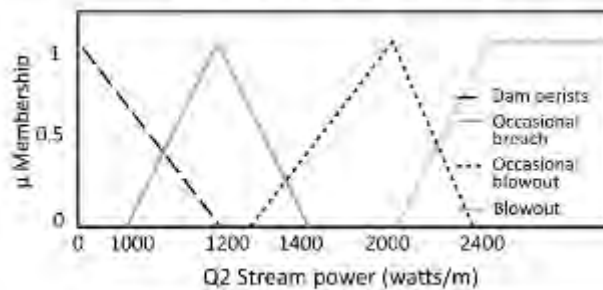
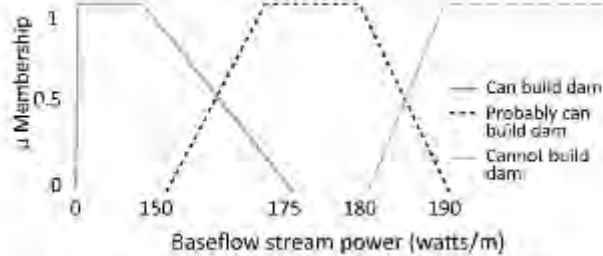


Figure 6 from Macfarlane et al. (2016)

DOI: [10.1016/j.geomorph.2015.11.019](https://doi.org/10.1016/j.geomorph.2015.11.019)



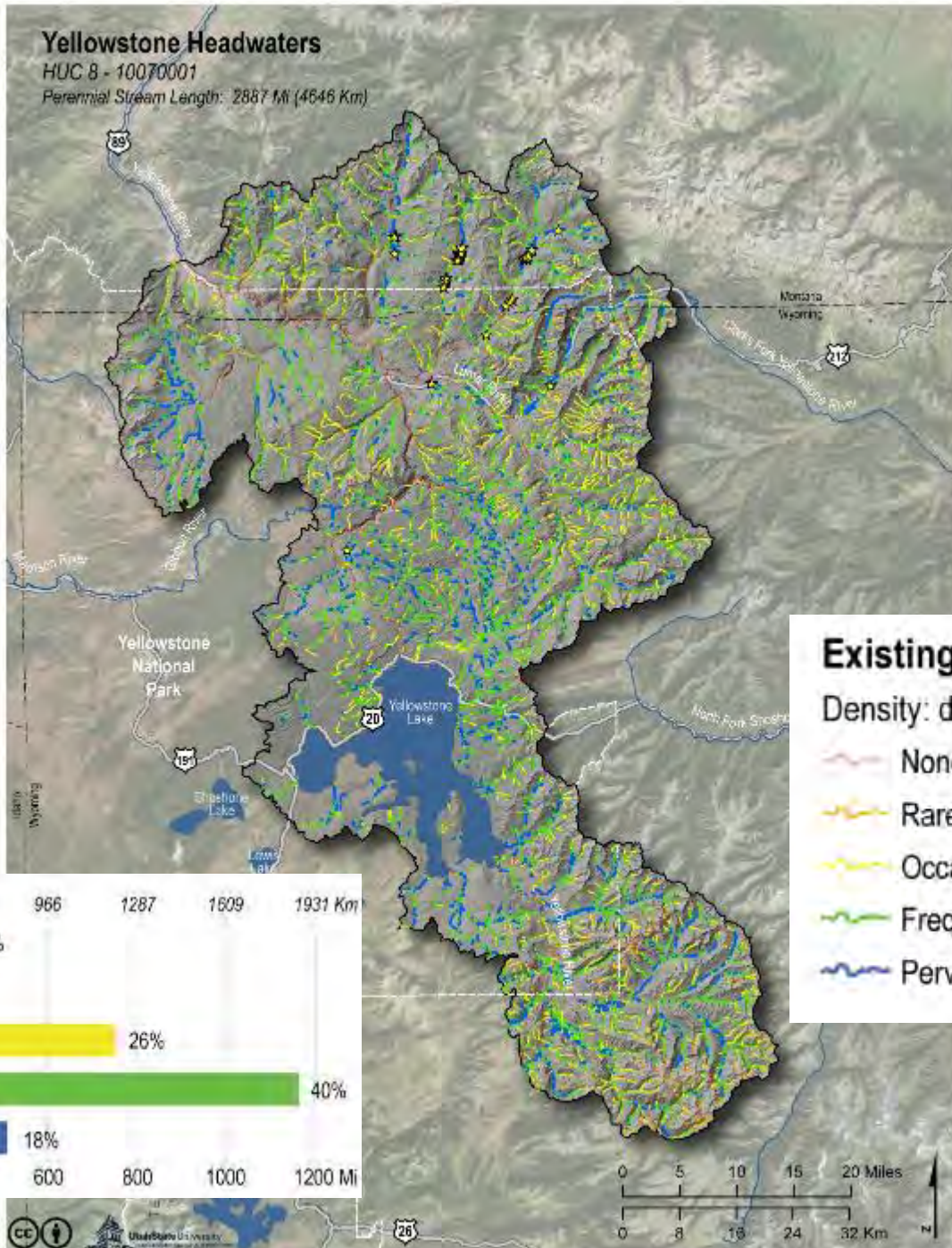
# Yellowstone Headwaters

HUC 8 - 10070001

Perennial Stream Length: 2887 Mi (4646 Km)

# Existing Capacity

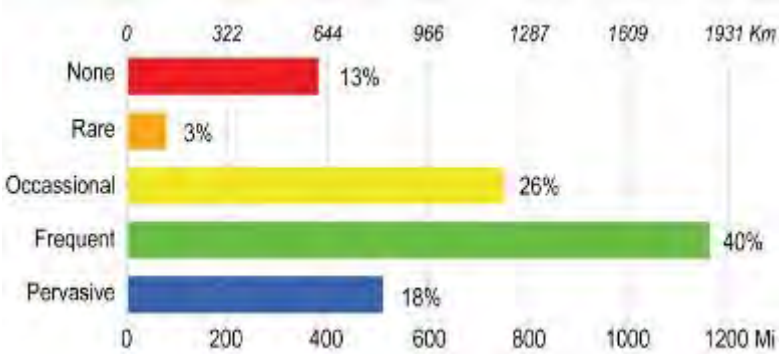
Where can beaver build dams now & what extent?



## Existing Dam Building Capacity

Density: dams/mile (dams/km)

- None: 0 dams
- Rare: 0 - 2 (0 - 1)
- Occasional: 2 - 8 (1 - 5)
- Frequent: 8 - 24 (5 - 15)
- Pervasive: 24 - 64 (15 - 40)

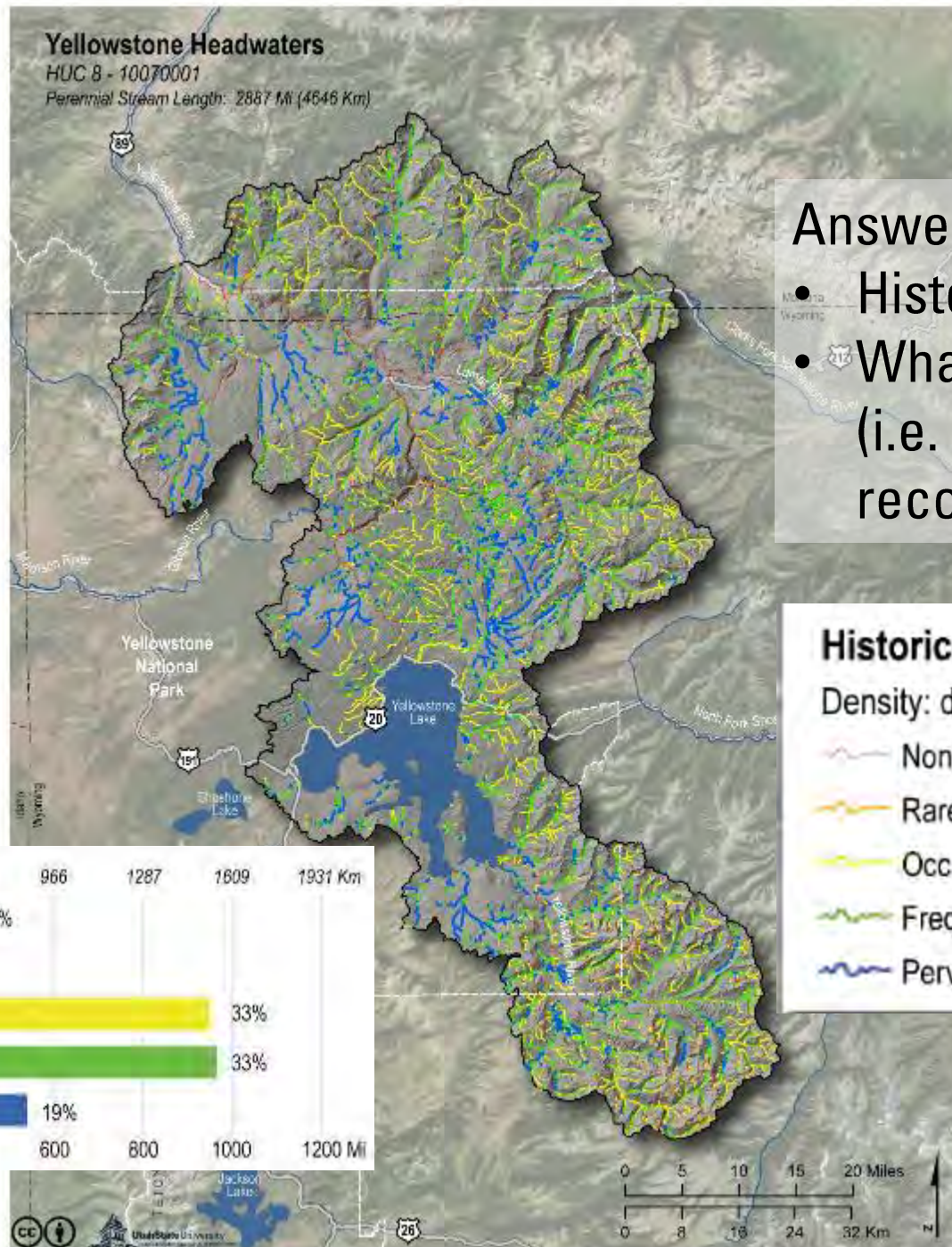




# Historic Capacity

Answer questions for:

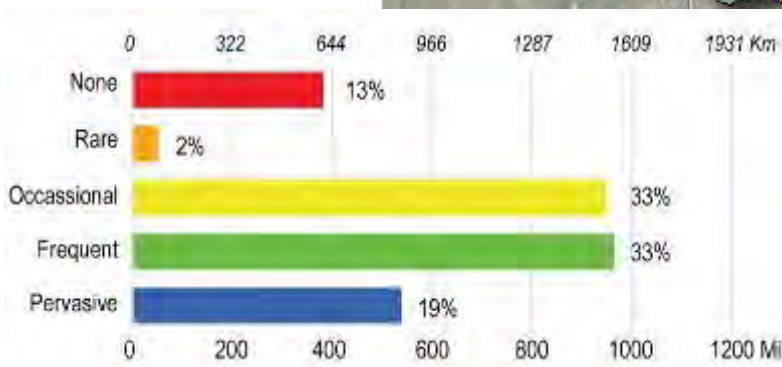
- Historic conditions
- What is possible (i.e. upper limit of recovery potential)



## Historic Dam Building Capacity

Density: dams/mile (dams/km)

- None: 0 dams
- Rare: 0 - 2 (0 - 1)
- Occasional: 2 - 8 (1 - 5)
- Frequent: 8 - 24 (5 - 15)
- Pervasive: 24 - 64 (15 - 40)



Utah State University





# Capacity... Max Number Of Dams

- You can do this..
- You will answer those basic questions... and the inference system
- With the actual model, we approximate quantitative answers to those with GIS data

<https://tinyurl.com/y4osd5wu>

BRAT-cIS – BEAVER DAM CAPACITY ASSESSMENT FORM - BASIC

**OBSERVATION INFO**

Observer Name: \_\_\_\_\_ Observation Date: \_\_\_\_\_  
Reach ID: \_\_\_\_\_ Stream Name: \_\_\_\_\_

**LOCATION OF ASSESSMENT REACH** \_\_\_\_\_  
GPS UTM Easting: \_\_\_\_\_ **LENGTH OF REACH** \_\_\_\_\_  
GPS UTM Northing: \_\_\_\_\_ Length \_\_\_\_\_ meters OR \_\_\_\_\_ x bankfull widths

**VEGETATION CAPACITY TO SUPPORT DAM BUILDING ACTIVITY**

<p><b>SUITABILITY OF STREAMSIDE VEGETATION</b></p> <p><input type="radio"/> Unsuitable <input type="radio"/> Barely Suitable <input type="radio"/> Moderately Suitable <input type="radio"/> Suitable <input type="radio"/> Preferred</p> <p><i>Vegetation within 30 m of water's edge</i></p> <p>What vegetation types are abundant? <input type="checkbox"/> Desirable woody (e.g. Aspen, Willow, Cottonwood) <input type="checkbox"/> Other woody (e.g. conifers, sagebrush) <input type="checkbox"/> Grasses <input type="checkbox"/> Crops <input type="checkbox"/> Ornaments <input type="checkbox"/> Developed</p>	<p><b>SUITABILITY OF RIPARIAN/UPLAND VEGETATION</b></p> <p><input type="radio"/> Unsuitable <input type="radio"/> Barely Suitable <input type="radio"/> Moderately Suitable <input type="radio"/> Suitable <input type="radio"/> Preferred</p> <p><i>Vegetation within 100 m of water's edge</i></p> <p>What vegetation types are abundant? <input type="checkbox"/> Desirable woody (e.g. Aspen, Willow, Cottonwood) <input type="checkbox"/> Other woody (e.g. conifers, sagebrush) <input type="checkbox"/> Grasses <input type="checkbox"/> Crops <input type="checkbox"/> Ornaments <input type="checkbox"/> Developed</p>
---	---

**DAM DENSITY CAPACITY ASSESSMENT BASED ON SUITABILITY OF VEGETATION ONLY (USE TABLE 1)**

None (no dams)  
 Rare (0-1 dams/km)  
 Occasional (1-4 dams/km)  
 Frequent (5-15 dams/km)  
 Pervasive (15-40 dams/km)

**COMBINED CAPACITY TO SUPPORT DAM BUILDING ACTIVITY**

**CAN BEAVER BUILD A DAM AT BASEFLOWS?**

Probably can build dam  
 Can build dam  
 Can build dam (saw evidence of recent dams)  
 Could build dam at one time (saw evidence of relic dams)  
 Cannot build dam (streampower really high)

**IF BEAVERS BUILD A DAM, CONSIDER WHAT HAPPENS TO THE DAM(S) IN A TYPICAL FLOOD (E.G. MEAN ANNUAL FLOOD)?**

Blowout  Occasional Blowout  
 Occasional Breach  Dam Persists


**HOW DOES THE REACH SLOPE IMPACT THEIR ABILITY OR NEED TO BUILD DAMS?**

So steep they cannot build a dam (e.g. > 20% slope)  
 Probably can build dam  
 Can build dam (inferred)  
 Can build dam (evidence or current or past dams)  
 Really flat (can build dam, but might not need as many as one dam might back up water > 0.5 km)

**COMBINED DAM DENSITY CAPACITY ASSESSMENT BASED ON ALL (USE TABLE 2)**

None (no dams)  
 Rare (0-1 dams/km)  
 Occasional (1-4 dams/km)  
 Frequent (5-15 dams/km)  
 Pervasive (15-40 dams/km)

Maximum Dam Density (dams/km)





# Desktop – BRAT cIS Evaluation

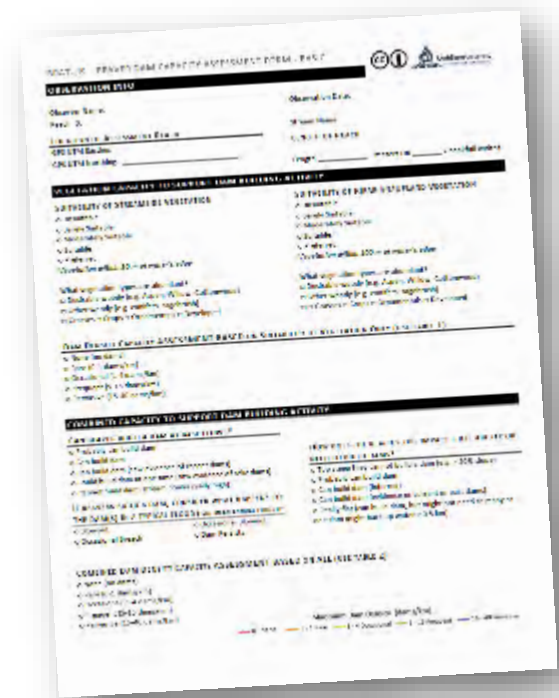


- You will evaluate how many beaver dams (max) could this reach support



# BRAT - cIS

Who?  
Where?  
When?



## BRAT-cIS – BEAVER DAM CAPACITY ASSESSMENT FORM - BASIC



### OBSERVATION INFO

Observer Name: \_\_\_\_\_

Observation Date: \_\_\_\_\_

Reach ID: \_\_\_\_\_

### LOCATION OF ASSESSMENT REACH

Stream Name: \_\_\_\_\_

GPS UTM Easting: \_\_\_\_\_

### LENGTH OF REACH

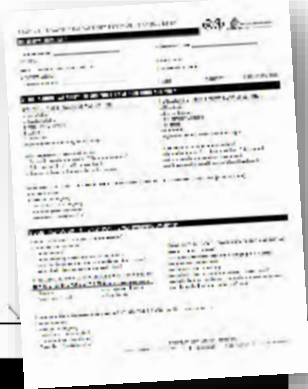
GPS UTM Northing: \_\_\_\_\_

Length \_\_\_\_\_ meters OR \_\_\_\_\_ x bankfull widths



# BRAT - cIS

## The veg questions... - dam building materials



### VEGETATION CAPACITY TO SUPPORT DAM BUILDING ACTIVITY

#### SUITABILITY OF STREAMSIDE VEGETATION

- Unsuitable
- Barely Suitable
- Moderately Suitable
- Suitable
- Preferred

*Vegetation within 30 m of water's edge*

What vegetation types are abundant?

- Desirable woody (e.g. Aspen, Willow, Cottonwood)
- Other woody (e.g. conifers, sagebrush)
- Grasses
- Crops
- Ornamentals
- Developed

#### SUITABILITY OF RIPARIAN/UPLAND VEGETATION

- Unsuitable
- Barely Suitable
- Moderately Suitable
- Suitable
- Preferred

*Vegetation within 100 m of water's edge*

What vegetation types are abundant?

- Desirable woody (e.g. Aspen, Willow, Cottonwood)
- Other woody (e.g. conifers, sagebrush)
- Grasses
- Crops
- Ornamentals
- Developed

### DAM DENSITY CAPACITY ASSESSMENT BASED ON SUITABILITY OF VEGETATION ONLY (USE TABLE 1)

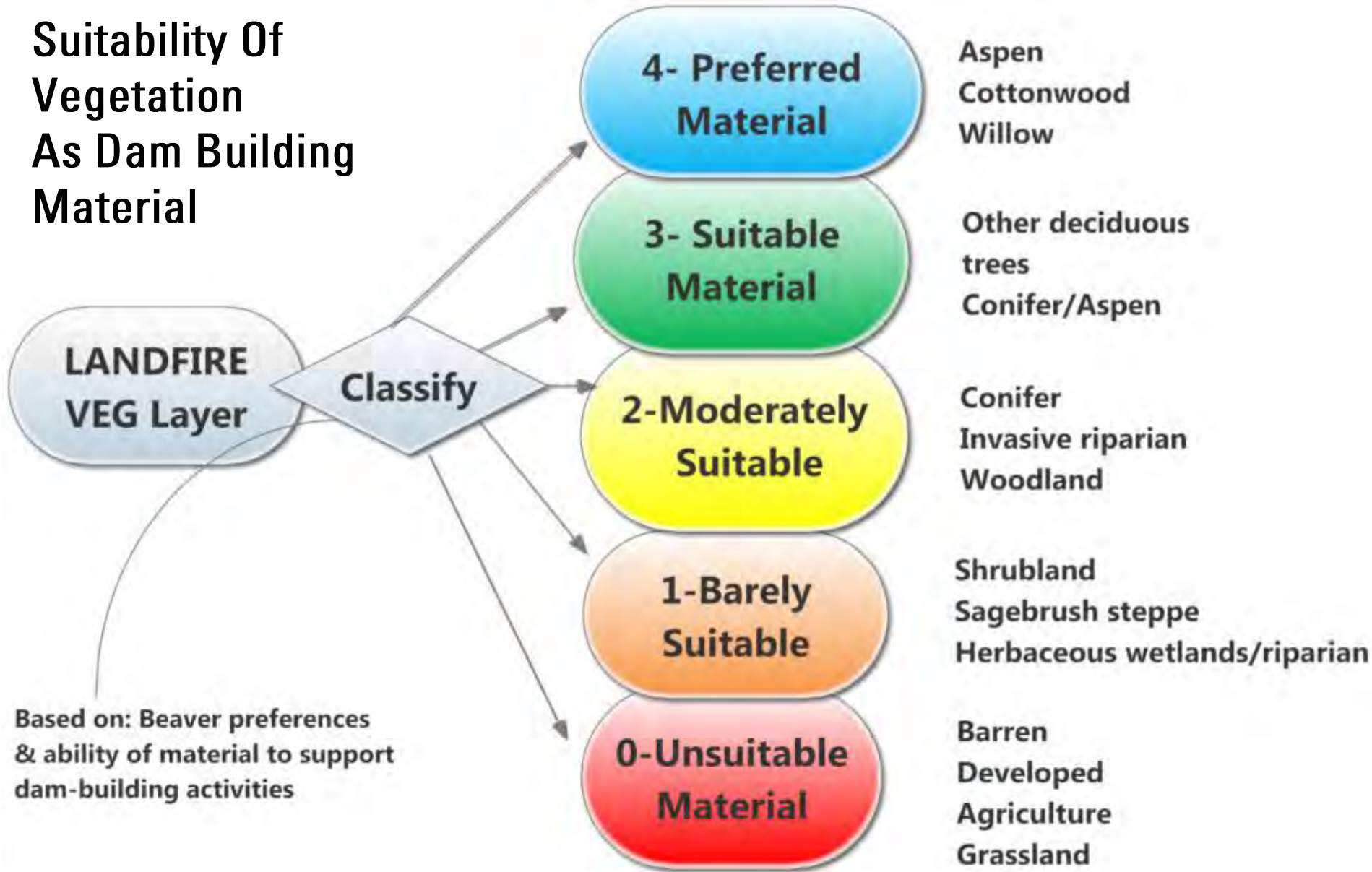
- None (no dams)
- Rare (0-1 dams/km)
- Occasional (1-4 dams/km)
- Frequent (5-15 dams/km)
- Pervasive (15-40 dams/km)

### COMBINED CAPACITY TO SUPPORT DAM BUILDING ACTIVITY

CAN BEAVER BUILD A DAM AT BASE FLOWS?



# Suitability Of Vegetation As Dam Building Material





# Desktop – BRAT cIS Evaluation



- For vegetation question, answer separately within 30 m vs. 100 m buffer:
  - Proportion of building material
    - **Unsuitable (0)**
    - **Barely Suitable (1)**
    - **Moderately Suitable (2)**
    - **Suitable (3)**
    - **Preferred (4)**
  - And estimate an area weighted average (between 0 & 4), then choose closest category

# BRAT - cIS

The inference system... look up table!



## VEGETATION CAPACITY TO SUPPORT DAM BUILDING ACTIVITY

### SUITABILITY OF STREAMSIDE VEGETATION

- Unsuitable
- Barely Suitable
- Moderately Suitable
- Suitable
- Preferred

*Vegetation within 30 m of water's edge*

- What vegetation types are abundant?
- Desirable woody (e.g. Aspen, Willow, Cottonwood)
  - Other woody (e.g. conifers, sagebrush)
  - Grasses
  - Crops
  - Ornamentals
  - Developed

### SUITABILITY OF RIPARIAN/UPLAND VEGETATION

- Unsuitable

**INFERENCE SYSTEM OF CAPACITY BASED ON VEGETATION ONLY:**

Table 1. Rule table for two input inference system that models the capacity of the reach to support dam building activity (in dam density) using the suitability of streamside vegetation and suitability of riparian/upland vegetation as inputs.

Rules	Inputs	Output
	Suitability of streamside vegetation & Suitability of riparian/upland vegetation	Dam density capacity
1	if Unsuitable & Unsuitable	then None
2	if Unsuitable & Barely suitable	then Rare
3	if Unsuitable & Moderately suitable	then Rare
4	if Unsuitable & Suitable	then Occasional
5	if Unsuitable & Preferred	then Occasional
6	if Barely suitable & Unsuitable	then Rare
7	if Barely suitable & Barely suitable	then Rare
8	if Barely suitable & Moderately suitable	then Occasional
9	if Barely suitable & Suitable	then Occasional
10	if Barely suitable & Preferred	then Occasional
11	if Moderately suitable & Unsuitable	then Occasional
12	if Moderately suitable & Barely suitable	then Occasional
13	if Moderately suitable & Moderately suitable	then Frequent
14	if Moderately suitable & Suitable	then Frequent
15	if Moderately suitable & Preferred	then Occasional
16	if Suitable & Unsuitable	then Occasional
17	if Suitable & Barely suitable	then Frequent
18	if Suitable & Moderately suitable	then Frequent
19	if Suitable & Suitable	then Pervasive
20	if Suitable & Preferred	then Occasional
21	if Preferred & Unsuitable	then Frequent
22	if Preferred & Barely suitable	then Pervasive
23	if Preferred & Moderately suitable	then Pervasive
24	if Preferred & Suitable	then Pervasive
25	if Preferred & Preferred	then Pervasive

### DAM DENSITY CAPACITY ASSESSMENT BASE

- None (no dams)
- Rare (0-1 dams/km)
- Occasional (1-4 dams/km)
- Frequent (5-15 dams/km)
- Pervasive (15-40 dams/km)

### COMBINED CAPACITY TO SUPPORT DAM

CAN BEAVER BUILD A DAM AT BASE FLOWS?





# BRAT - cIS

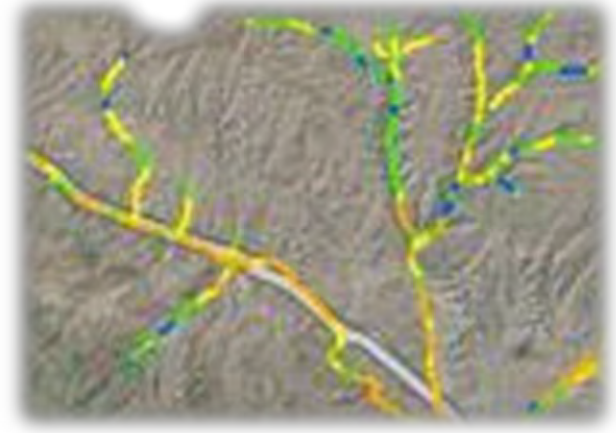
## COMBINED INFERENCE SYSTEM:

Table 2. 2x table for four variables (reach slope, dam density, flood stream power, baseflow stream power) build a decision tree to predict vegetation dam density capacity (Table 1) based on the analysis of flood stream power, baseflow stream power and reach slope.

Reach	Vegetation dam density capacity	2-year flood stream power	Baseflow stream power	Reach slope	Dam density capacity
1.0 - 1.5	None	< 1000	< 1000	> 0.05	None
1.5 - 2.0	None	< 1000	< 1000	> 0.05	None
2.0 - 2.5	Rare	< 1000	< 1000	> 0.05	Rare
2.5 - 3.0	Rare	< 1000	< 1000	> 0.05	Rare
3.0 - 3.5	Occasional	< 1000	< 1000	> 0.05	Occasional
3.5 - 4.0	Occasional	< 1000	< 1000	> 0.05	Occasional
4.0 - 4.5	Occasional	< 1000	< 1000	> 0.05	Occasional
4.5 - 5.0	Occasional	< 1000	< 1000	> 0.05	Occasional
5.0 - 5.5	Occasional	< 1000	< 1000	> 0.05	Occasional
5.5 - 6.0	Occasional	< 1000	< 1000	> 0.05	Occasional
6.0 - 6.5	Occasional	< 1000	< 1000	> 0.05	Occasional
6.5 - 7.0	Occasional	< 1000	< 1000	> 0.05	Occasional
7.0 - 7.5	Occasional	< 1000	< 1000	> 0.05	Occasional
7.5 - 8.0	Occasional	< 1000	< 1000	> 0.05	Occasional
8.0 - 8.5	Occasional	< 1000	< 1000	> 0.05	Occasional
8.5 - 9.0	Occasional	< 1000	< 1000	> 0.05	Occasional
9.0 - 9.5	Occasional	< 1000	< 1000	> 0.05	Occasional
9.5 - 10.0	Occasional	< 1000	< 1000	> 0.05	Occasional
10.0 - 10.5	Occasional	< 1000	< 1000	> 0.05	Occasional
10.5 - 11.0	Occasional	< 1000	< 1000	> 0.05	Occasional
11.0 - 11.5	Occasional	< 1000	< 1000	> 0.05	Occasional
11.5 - 12.0	Occasional	< 1000	< 1000	> 0.05	Occasional
12.0 - 12.5	Occasional	< 1000	< 1000	> 0.05	Occasional
12.5 - 13.0	Occasional	< 1000	< 1000	> 0.05	Occasional
13.0 - 13.5	Occasional	< 1000	< 1000	> 0.05	Occasional
13.5 - 14.0	Occasional	< 1000	< 1000	> 0.05	Occasional
14.0 - 14.5	Occasional	< 1000	< 1000	> 0.05	Occasional
14.5 - 15.0	Occasional	< 1000	< 1000	> 0.05	Occasional
15.0 - 15.5	Occasional	< 1000	< 1000	> 0.05	Occasional
15.5 - 16.0	Occasional	< 1000	< 1000	> 0.05	Occasional
16.0 - 16.5	Occasional	< 1000	< 1000	> 0.05	Occasional
16.5 - 17.0	Occasional	< 1000	< 1000	> 0.05	Occasional
17.0 - 17.5	Occasional	< 1000	< 1000	> 0.05	Occasional
17.5 - 18.0	Occasional	< 1000	< 1000	> 0.05	Occasional
18.0 - 18.5	Occasional	< 1000	< 1000	> 0.05	Occasional
18.5 - 19.0	Occasional	< 1000	< 1000	> 0.05	Occasional
19.0 - 19.5	Occasional	< 1000	< 1000	> 0.05	Occasional
19.5 - 20.0	Occasional	< 1000	< 1000	> 0.05	Occasional
20.0 - 20.5	Occasional	< 1000	< 1000	> 0.05	Occasional
20.5 - 21.0	Occasional	< 1000	< 1000	> 0.05	Occasional
21.0 - 21.5	Occasional	< 1000	< 1000	> 0.05	Occasional
21.5 - 22.0	Occasional	< 1000	< 1000	> 0.05	Occasional
22.0 - 22.5	Occasional	< 1000	< 1000	> 0.05	Occasional
22.5 - 23.0	Occasional	< 1000	< 1000	> 0.05	Occasional
23.0 - 23.5	Occasional	< 1000	< 1000	> 0.05	Occasional
23.5 - 24.0	Occasional	< 1000	< 1000	> 0.05	Occasional
24.0 - 24.5	Occasional	< 1000	< 1000	> 0.05	Occasional
24.5 - 25.0	Occasional	< 1000	< 1000	> 0.05	Occasional
25.0 - 25.5	Occasional	< 1000	< 1000	> 0.05	Occasional
25.5 - 26.0	Occasional	< 1000	< 1000	> 0.05	Occasional
26.0 - 26.5	Occasional	< 1000	< 1000	> 0.05	Occasional
26.5 - 27.0	Occasional	< 1000	< 1000	> 0.05	Occasional
27.0 - 27.5	Occasional	< 1000	< 1000	> 0.05	Occasional
27.5 - 28.0	Occasional	< 1000	< 1000	> 0.05	Occasional
28.0 - 28.5	Occasional	< 1000	< 1000	> 0.05	Occasional
28.5 - 29.0	Occasional	< 1000	< 1000	> 0.05	Occasional
29.0 - 29.5	Occasional	< 1000	< 1000	> 0.05	Occasional
29.5 - 30.0	Occasional	< 1000	< 1000	> 0.05	Occasional
30.0 - 30.5	Occasional	< 1000	< 1000	> 0.05	Occasional
30.5 - 31.0	Occasional	< 1000	< 1000	> 0.05	Occasional
31.0 - 31.5	Occasional	< 1000	< 1000	> 0.05	Occasional
31.5 - 32.0	Occasional	< 1000	< 1000	> 0.05	Occasional
32.0 - 32.5	Occasional	< 1000	< 1000	> 0.05	Occasional
32.5 - 33.0	Occasional	< 1000	< 1000	> 0.05	Occasional
33.0 - 33.5	Occasional	< 1000	< 1000	> 0.05	Occasional
33.5 - 34.0	Occasional	< 1000	< 1000	> 0.05	Occasional
34.0 - 34.5	Occasional	< 1000	< 1000	> 0.05	Occasional
34.5 - 35.0	Occasional	< 1000	< 1000	> 0.05	Occasional
35.0 - 35.5	Occasional	< 1000	< 1000	> 0.05	Occasional
35.5 - 36.0	Occasional	< 1000	< 1000	> 0.05	Occasional
36.0 - 36.5	Occasional	< 1000	< 1000	> 0.05	Occasional
36.5 - 37.0	Occasional	< 1000	< 1000	> 0.05	Occasional
37.0 - 37.5	Occasional	< 1000	< 1000	> 0.05	Occasional
37.5 - 38.0	Occasional	< 1000	< 1000	> 0.05	Occasional
38.0 - 38.5	Occasional	< 1000	< 1000	> 0.05	Occasional
38.5 - 39.0	Occasional	< 1000	< 1000	> 0.05	Occasional
39.0 - 39.5	Occasional	< 1000	< 1000	> 0.05	Occasional
39.5 - 40.0	Occasional	< 1000	< 1000	> 0.05	Occasional

Uglier table... but simple to apply

Rules	Vegetation dam density capacity	& 2-year flood stream power	& Baseflow stream power	& Reach slope	Output
1	if None	& -	& -	& -	, then None
2	if -	& -	& Cannot build dam	& -	, then None
3	if -	& -	& -	& Cannot build dam	, then None
4	if Rare	& Dam persists	& Can build dam	& NOT Cannot build dam	, then Rare
5	if Rare	& Dam persists	& Probably can build dam	& NOT Cannot build dam	, then Rare



Maximum Dam Density (dams/km)





# BRAT - cIS

Answer is?

Still **occasional**

But if blowout drops to **rare**



## COMBINED CAPACITY TO SUPPORT DAM BUILDING ACTIVITY

### CAN BEAVER BUILD A DAM AT BASE FLOWS?

- Probably can build dam
- Can build dam
- Can build dam (saw evidence of recent dams)
- Could build dam at one time (saw evidence of relic dams)
- Cannot build dam (stream power really high)

### IF BEAVERS BUILD A DAM, CONSIDER WHAT HAPPENS TO THE DAM(S) IN A TYPICAL FLOOD (E.G. MEAN ANNUAL FLOOD)?

- Blowout
- Occasional Blowout
- Occasional Breach
- Dam Persists

### HOW DOES THE REACH SLOPE IMPACT THEIR ABILITY OR NEED TO BUILD DAMS?

- Too steep they cannot build a dam (e.g. > 20% slope)
- Probably can build dam
- Can build dam (inferred)
- Can build dam (evidence or current or past dams)
- Really flat (can build dam, but might not need as many as one dam might back up water > 0.5 km)

## COMBINED DAM DENSITY CAPACITY ASSESSMENT BASED ON ALL (USE TABLE 2)

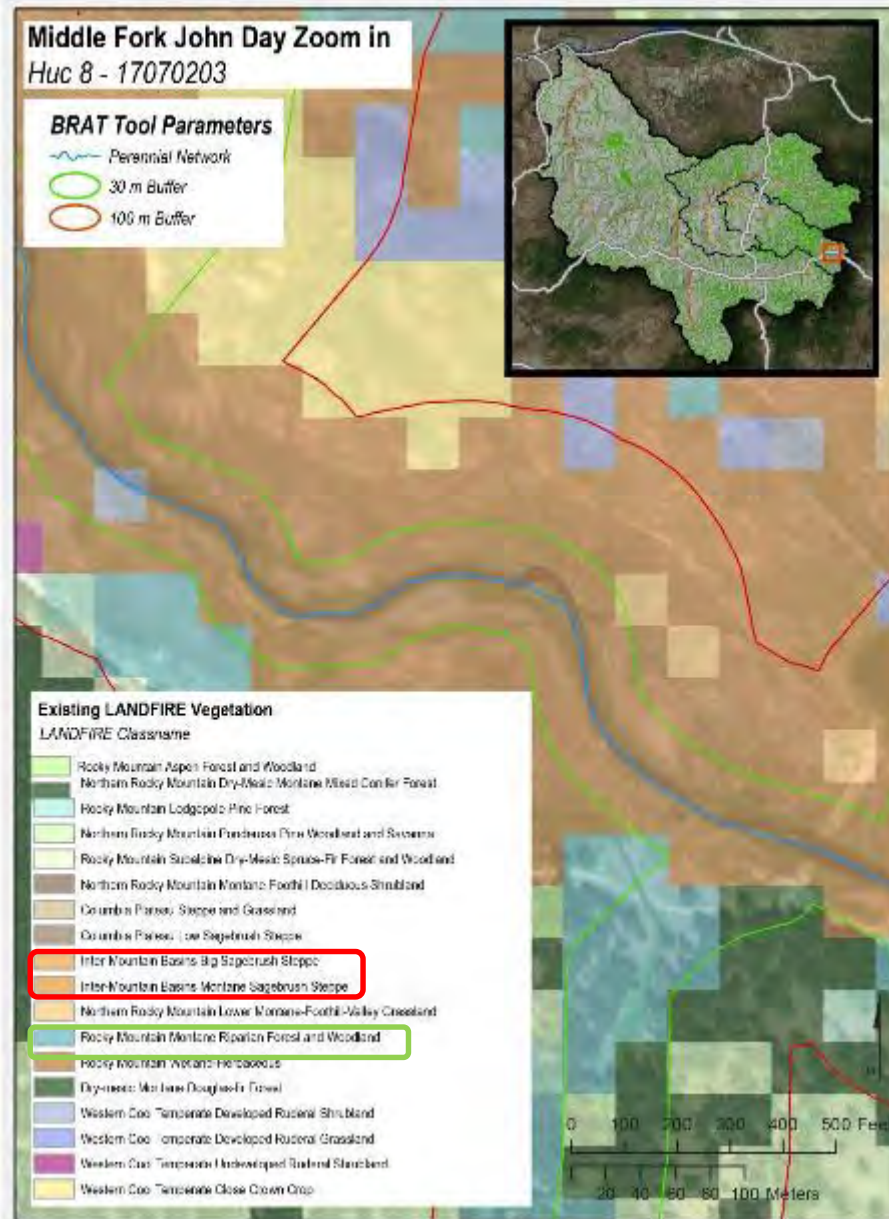
- None (no dams)
- Rare (0-1 dams/km)
- Occasional (1-4 dams/km)
- Frequent (5-15 dams/km)
- Pervasive (15-40 dams/km)

Maximum Dam Density (dams/km)

0 - None   0 - 1 Rare   1 - 4 Occasional   5 - 15 Frequent   16 - 40 Pervasive

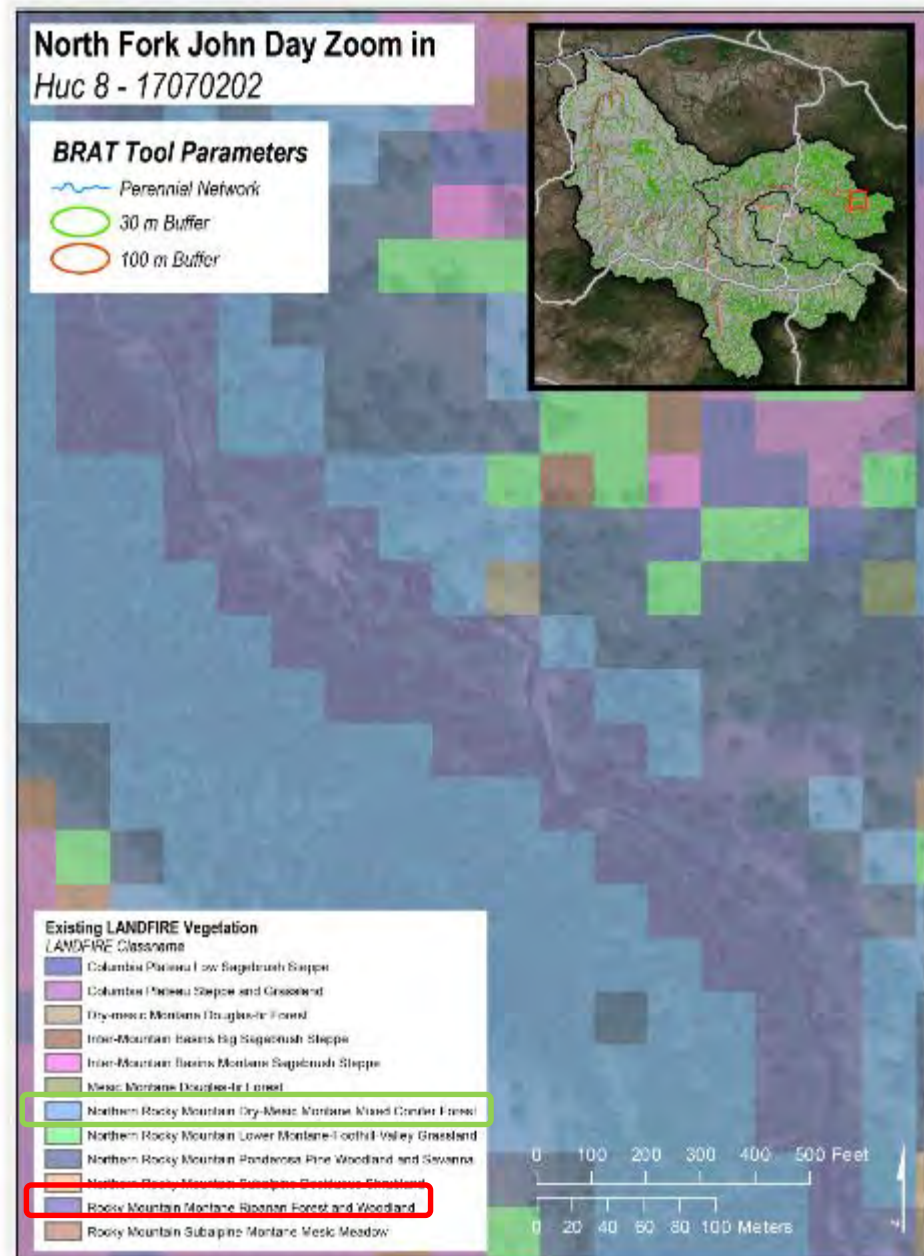
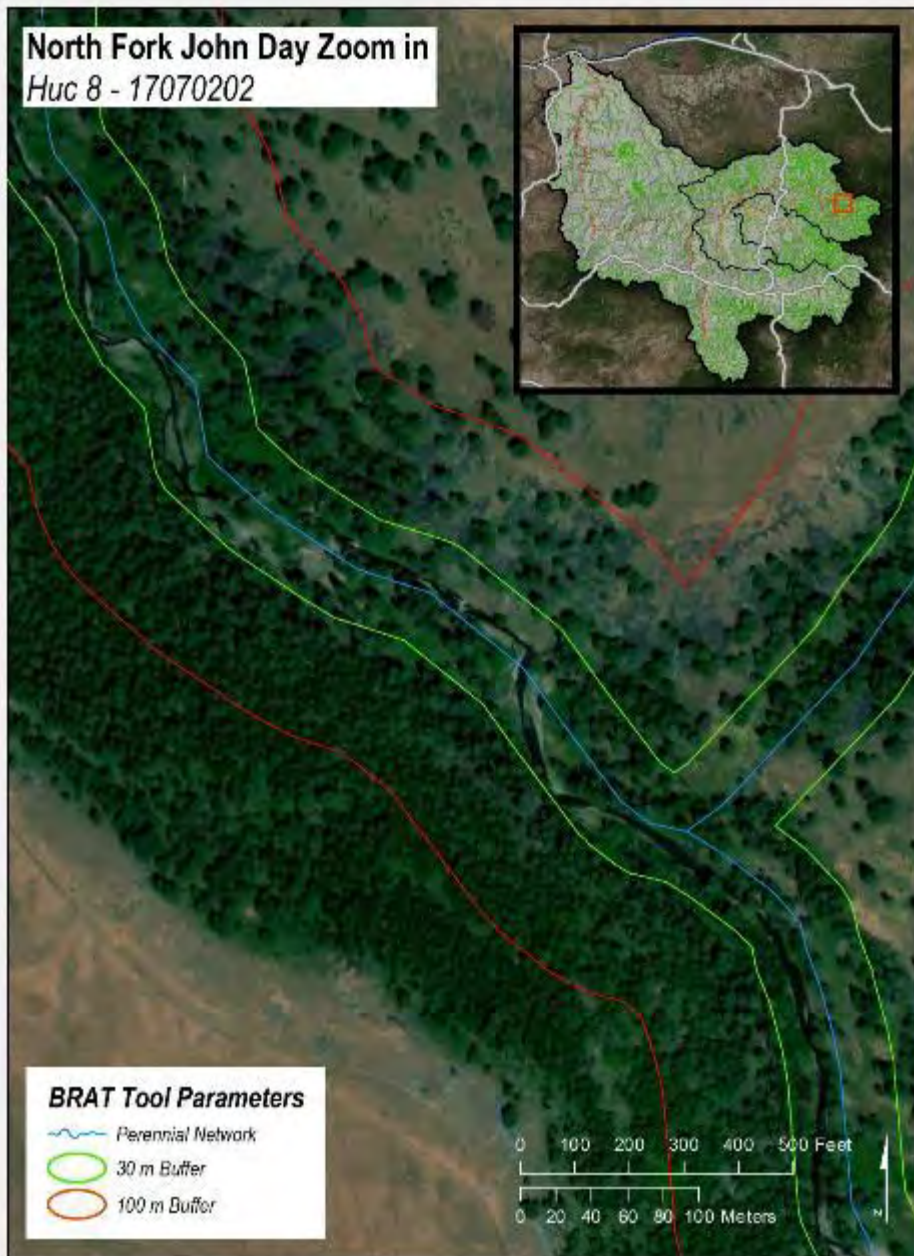


# AP Evidence Vs. LANDFIRE Evidence



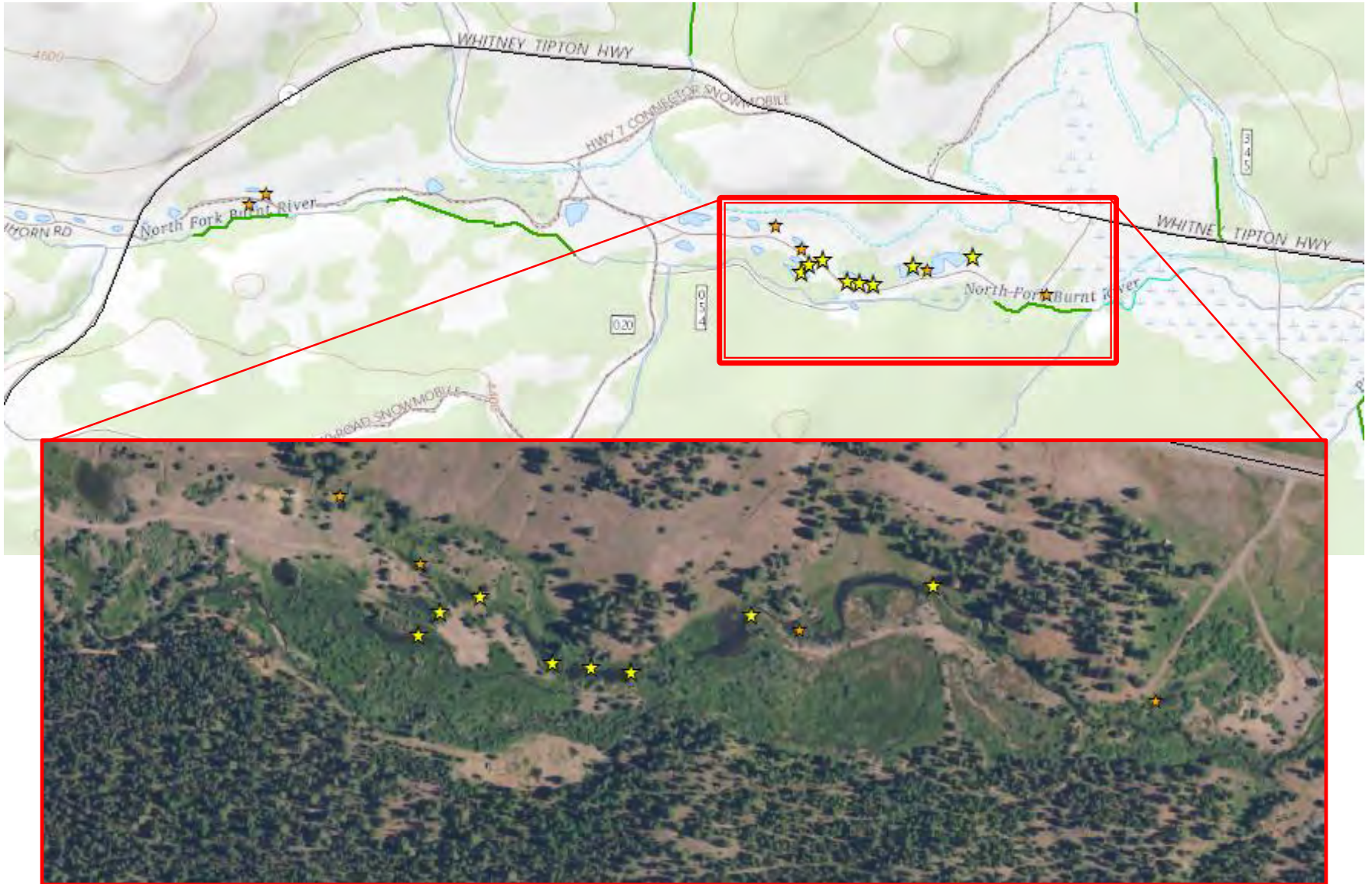


# ANOTHER...





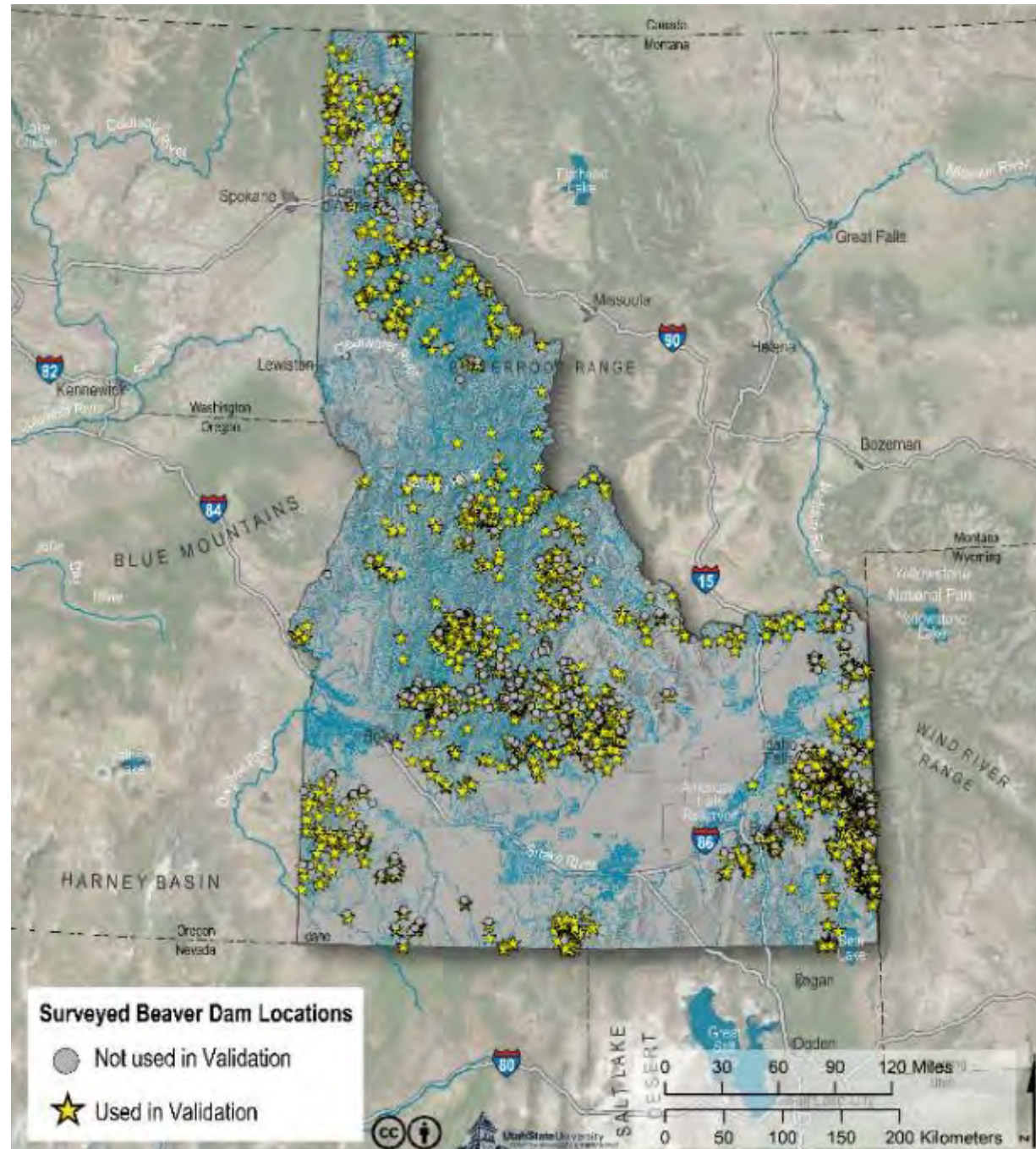
# Surveying Dams... Gives you data in same currency of density (dams/km)





# Can be done at broader scales...

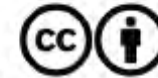
- 9048 dams from desktop census
- Statewide current capacity is 994,299 (i.e.  $< 1\%$ ) or 8 dams/km
- Historic was 1.7 million



# Dam Surveys in Field

- Simple...

## BEAVER DAM MONITORING FORM - BASIC



### OBSERVATION INFO

Observer Name: \_\_\_\_\_

Site ID: \_\_\_\_\_

Observation Date: \_\_\_\_\_

### BEAVER BUILT DAM?

- Beaver Dam
- Beaver Dam Analogue (manmade)

### DAM TYPE:

- Primary (has lodge... typically larger)
- Secondary (typically smaller – part of complex)

### POSITIONAL ATTRIBUTES

GPS UTM Easting: \_\_\_\_\_

GPS UTM Northing: \_\_\_\_\_

Stream Name: \_\_\_\_\_

### NOTES &/OR SKETCH

### STATUS

- Active
- Abandon
- Historic/Relic

### CONFIDENCE IN STATUS

- Certain - Documented Evidence
- Probable - Strong Evidence
- Possible - Anecdotal or Inconclusive Evidence
- Unsure - Just a guess



# Monitoring Complexes in Field Is Quicker

## BEAVER DAM COMPLEX MONITORING FORM - BASIC



### OBSERVATION INFO

Observer Name: \_\_\_\_\_

Site ID: \_\_\_\_\_

Observation Date: \_\_\_\_\_

#### BEAVER BUILT DAMS?

- Beaver-only Built Dams
- Beaver Dam Analogue (manmade)
- Mix of beaver-built and manmade

#### COMPLEX TYPE:

- Single Dam only
- Primary + One or More Secondary
- Multiple Possible Primaries + One or More Secondary

#### STATUS

- Active
- Abandon
- Historic/Relic

#### CONFIDENCE IN STATUS

- Certain - Documented Evidence
- Probable - Strong Evidence
- Possible - Anecdotal or Inconclusive Evidence
- Unsure - Just a guess

### POSITIONAL ATTRIBUTES

#### LOCATION OF PRIMARY DAM

GPS UTM Easting: \_\_\_\_\_

GPS UTM Northing: \_\_\_\_\_

#### COMPLEX SIZE

Number of Primary Dams: \_\_\_\_\_

Number of Secondary Dams: \_\_\_\_\_

#### POSITION OF DAMS

Primary Dam Location:  Top  Bottom  In-between

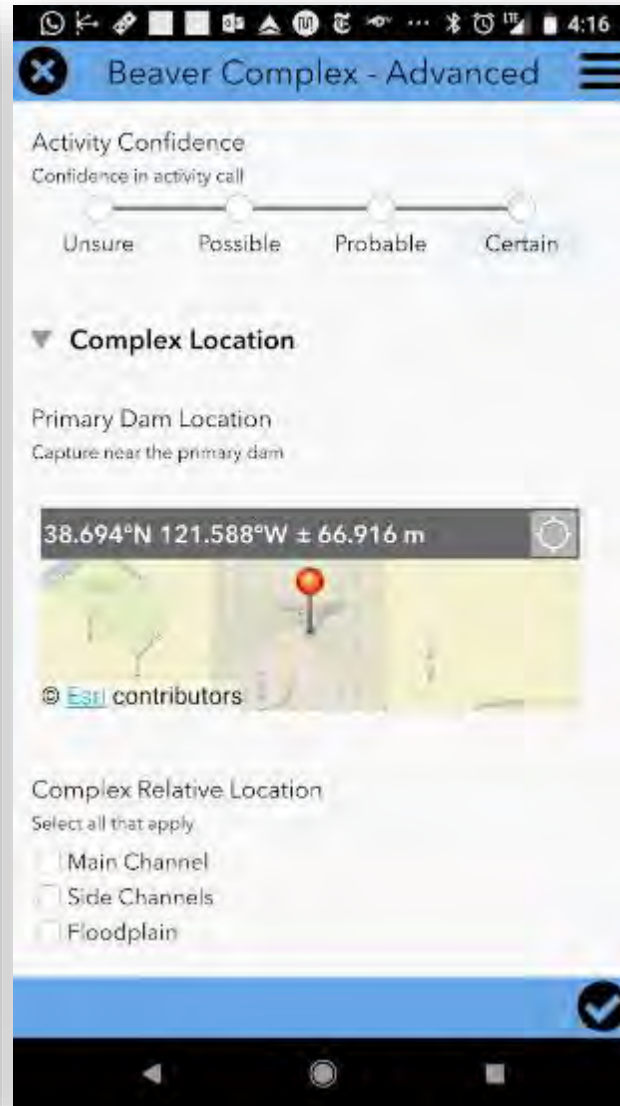
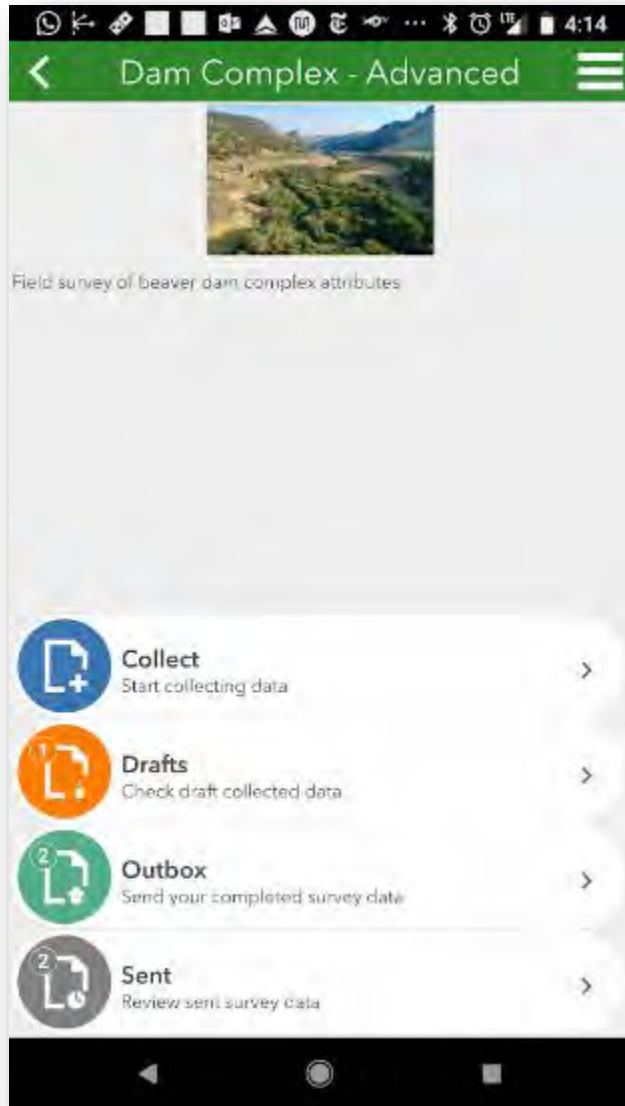
Number of Secondary Dams Upstream of Primary: \_\_\_\_\_

Number of Secondary Dams Downstream of Primary: \_\_\_\_\_

### NOTES & / OR SKETCH



# Same Thing but as Survey 123 App



No substitute for thinking...



# What's Limiting?

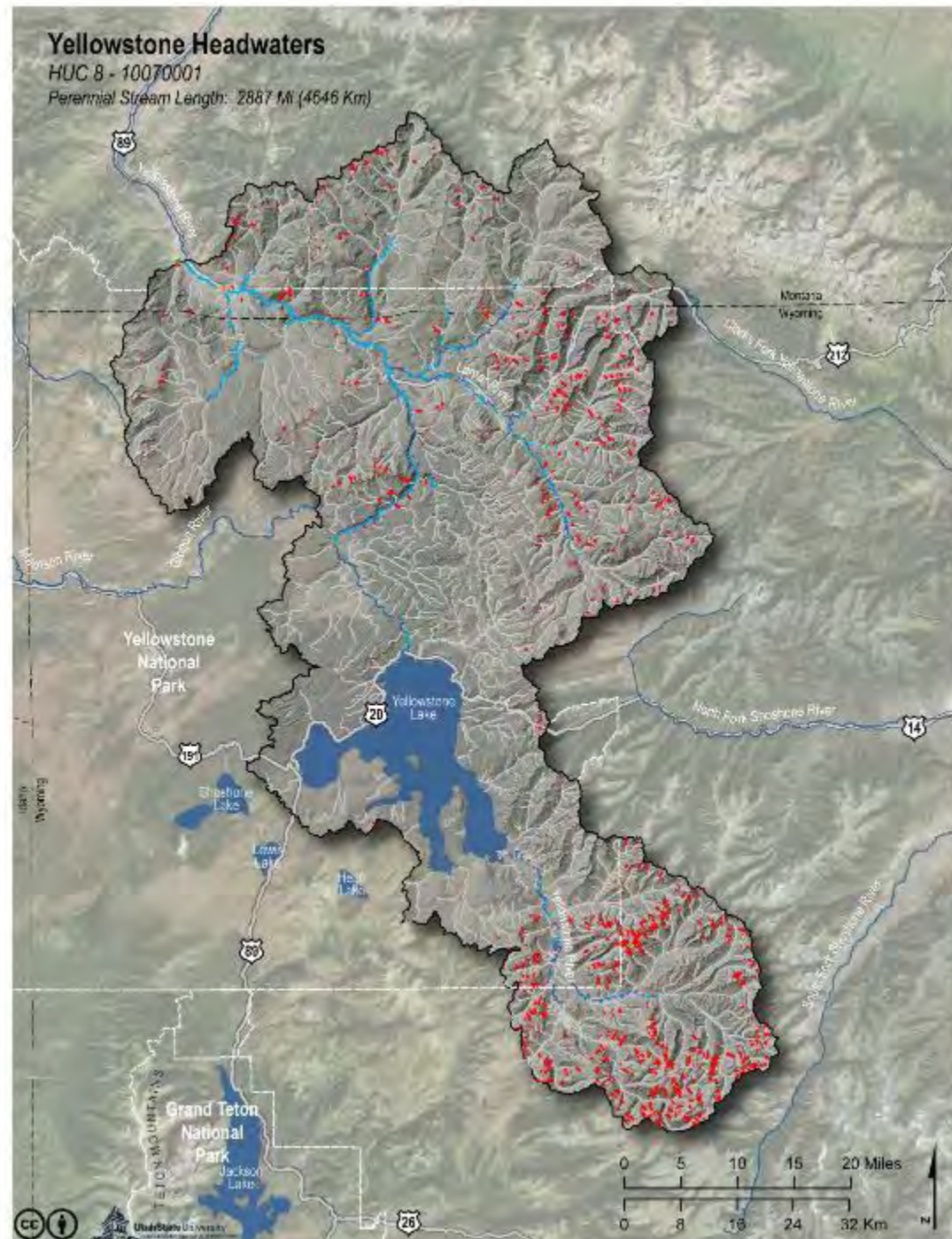
Where beaver cannot build dams and why?

## Unsuitable/Limited Dam Building Opportunities

-  Anthropogenically Limited
-  Stream Power Limited
-  Slope Limited
-  Naturally Vegetation Limited
-  Stream Size Limited
-  Dam Building Possible



\*'Dam Building Possible' values excluded from chart. Percent perennial stream length for this category is 87%





# OUTLINE

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration



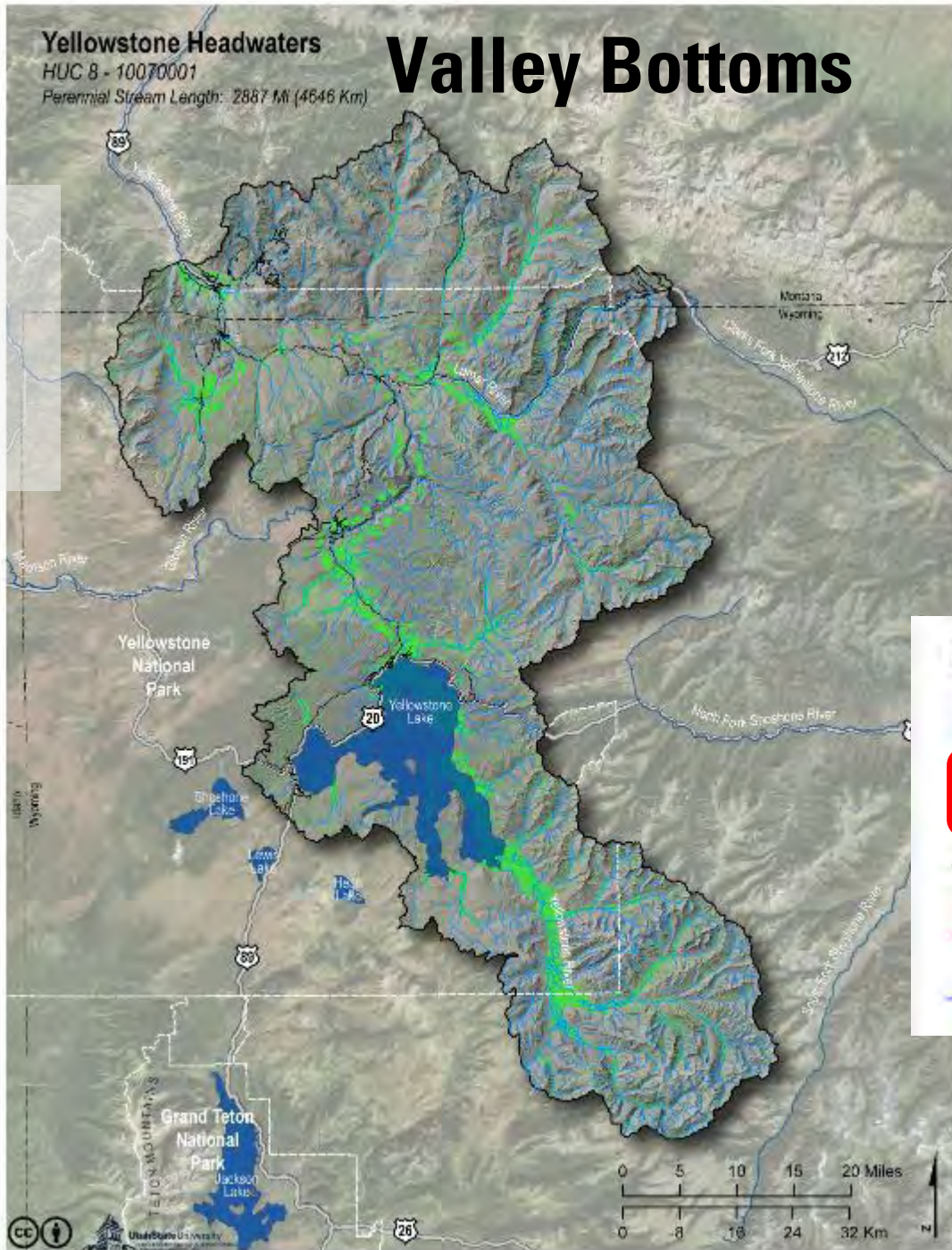
- I. Background & Other Resources
- II. Dam Building Focus – Expectations
- III. Contextualizing Risk**
- IV. Prioritizing Opportunities
- V. Partnering with Beaver... A people business



Yellowstone Headwaters  
HUC 8 - 10070001  
Perennial Stream Length: 2887 Mi (4646 Km)

# Valley Bottoms

Let's start with the areas beavers could impact: **Valley bottoms**

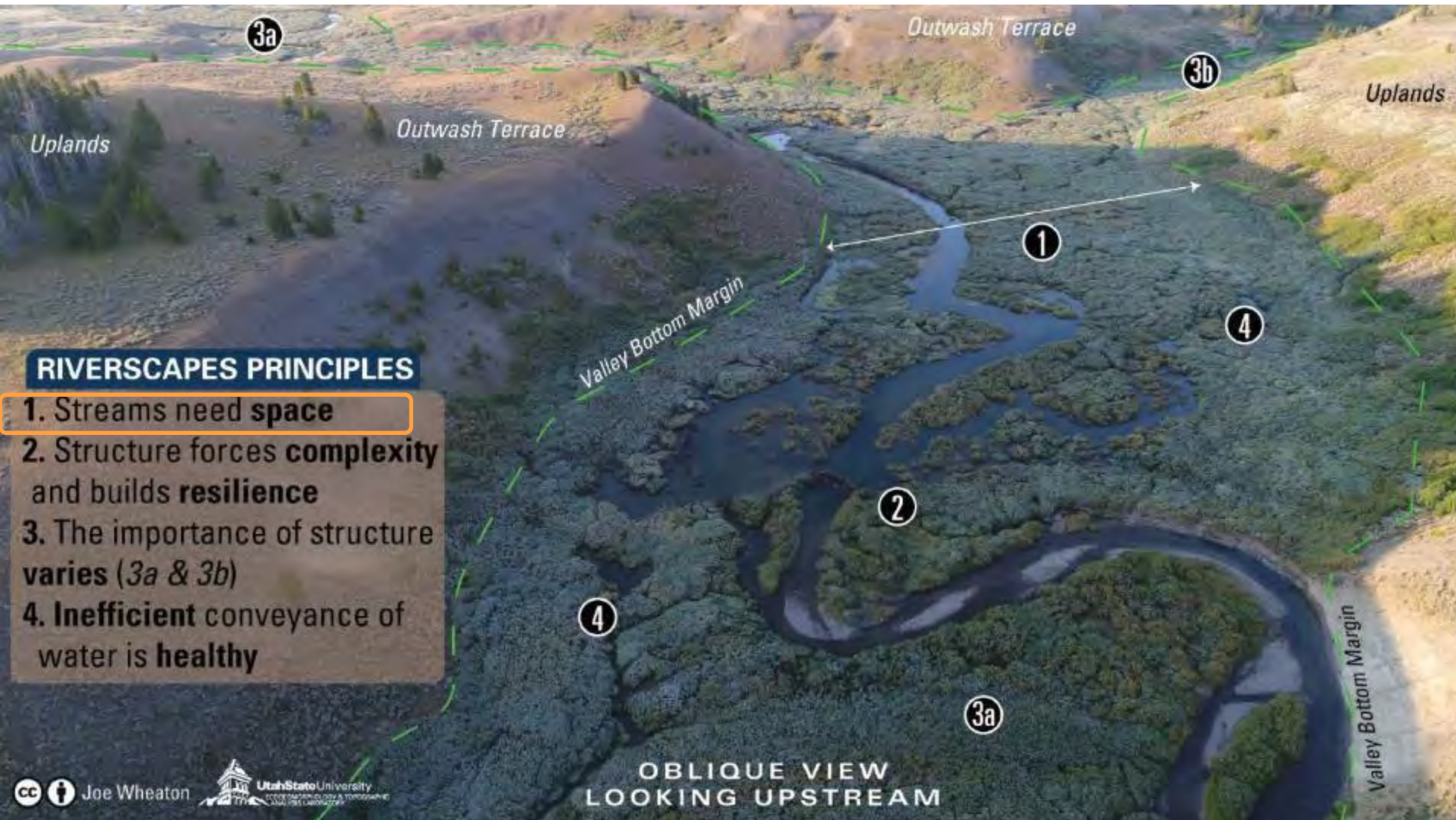


## Context Layers

- Canals
- Valley Bottom**
- Roads
- Railroad
- Perennial Network



# RECALL, Streams need space (i.e. their valley bottoms)



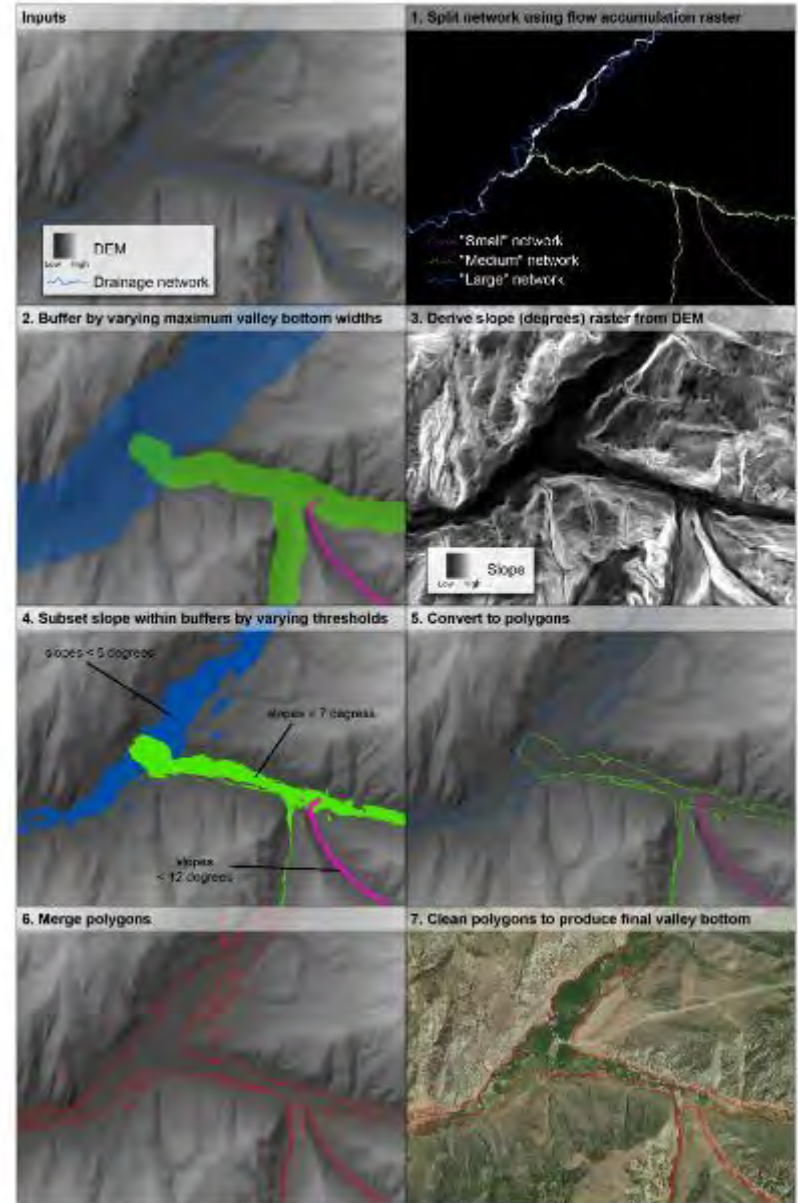
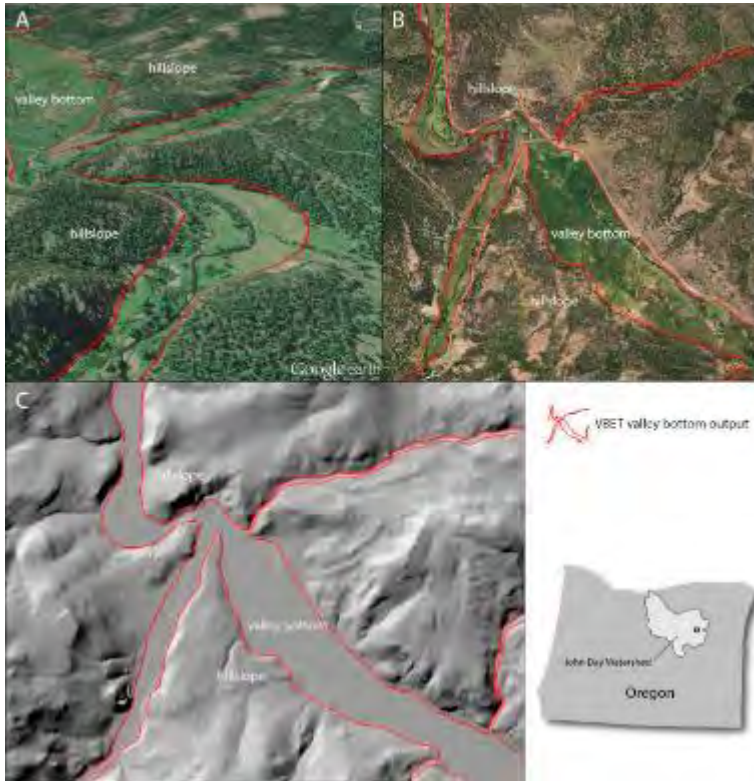
From Wheaton et al. (2019) – LTPBR Manual

DOI: [10.13140/RG.2.2.19590.63049/1](https://doi.org/10.13140/RG.2.2.19590.63049/1)



# V-BET: VALLEY BOTTOM EXTRACTION TOOL

- From topography (e.g. USGS 10 m NED or LiDAR) & V-BET



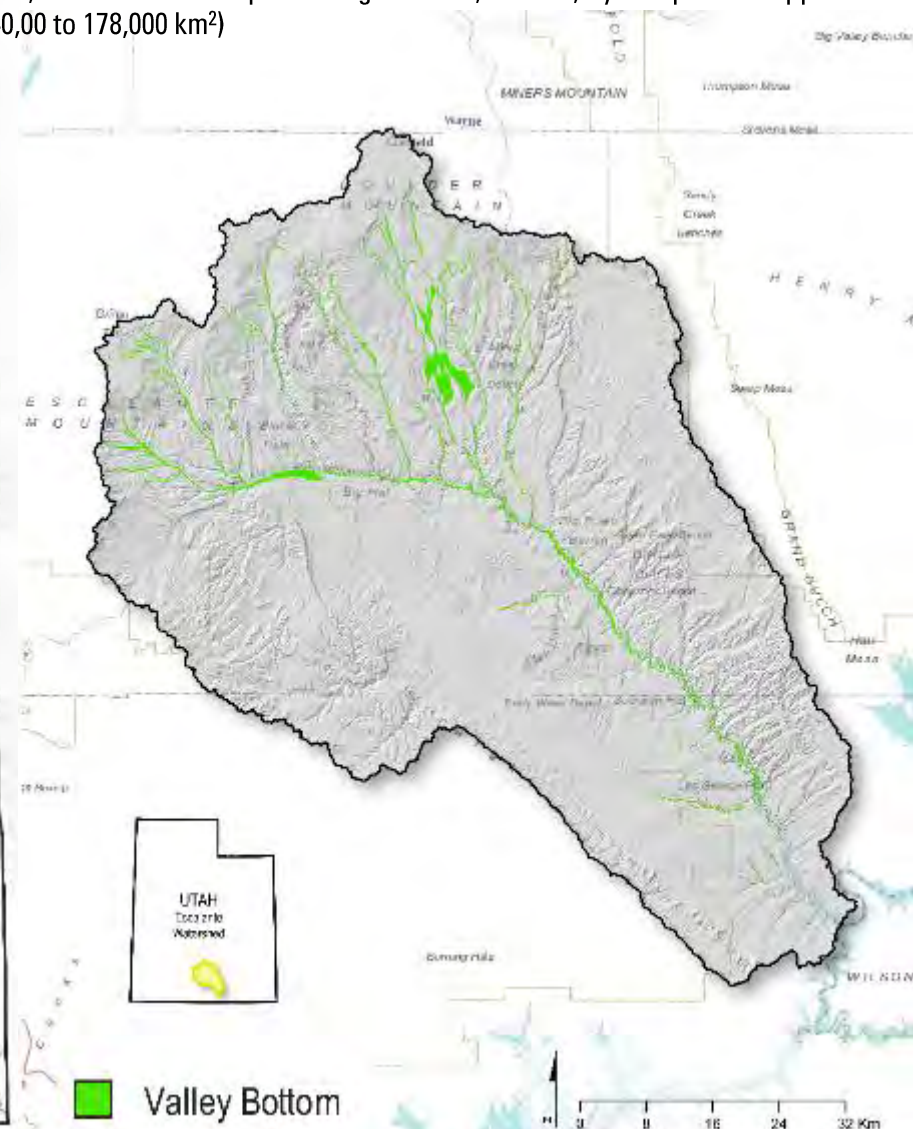
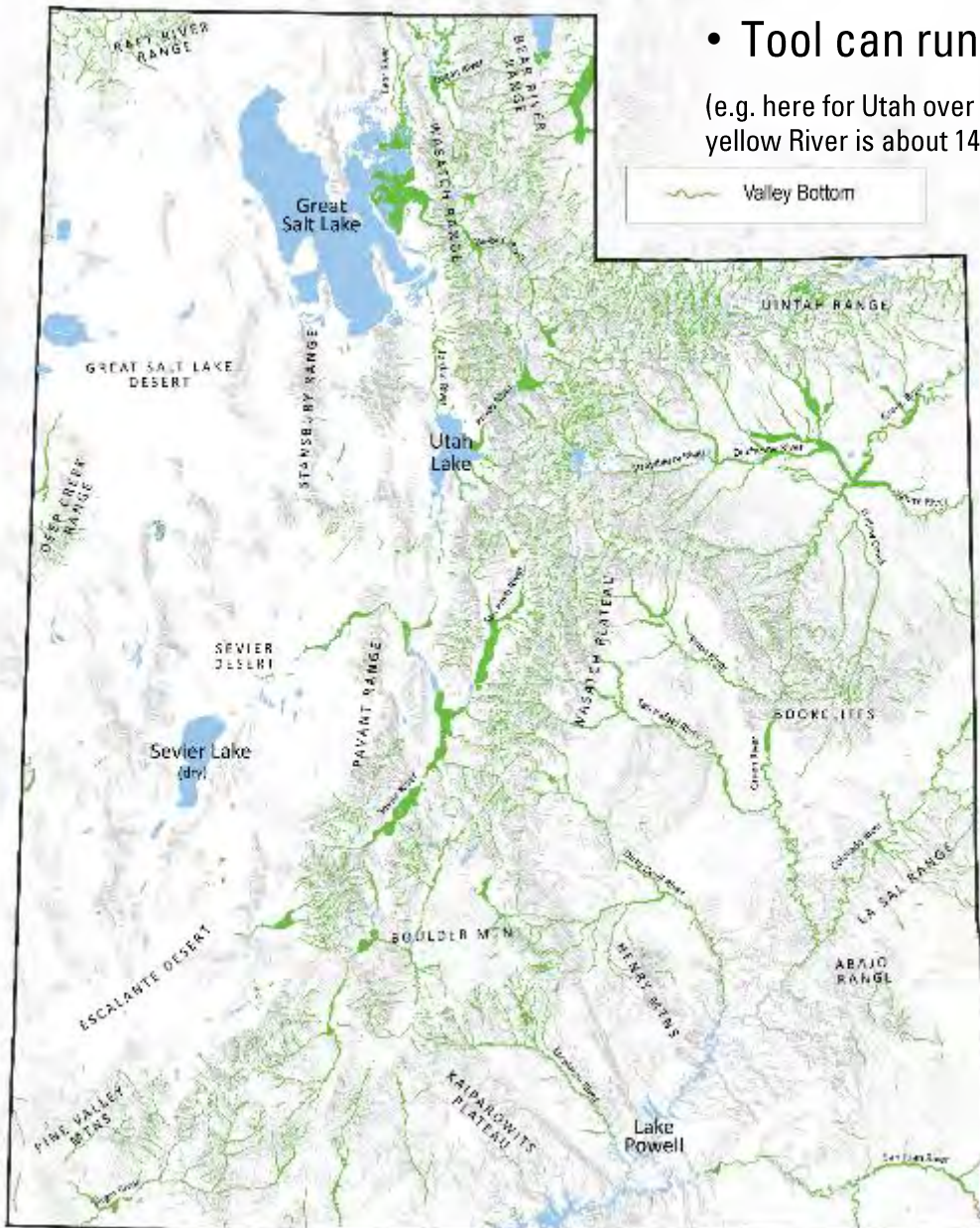
From: Gilbert et al. (2016) – Computers & Geosciences ;  
 DOI: [10.1016/j.cageo.2016.07.014](https://doi.org/10.1016/j.cageo.2016.07.014)  
<http://rcat.riverscapes.xyz>



# State-Wide or Watershed Wide: VALLEY BOTTOMS

- Tool can run @ broad spatial scales from DEM

(e.g. here for Utah over 25,000 km of riverscape in a region ~ 220,000 km<sup>2</sup>; by comparison Upper yellow River is about 140,00 to 178,000 km<sup>2</sup>)



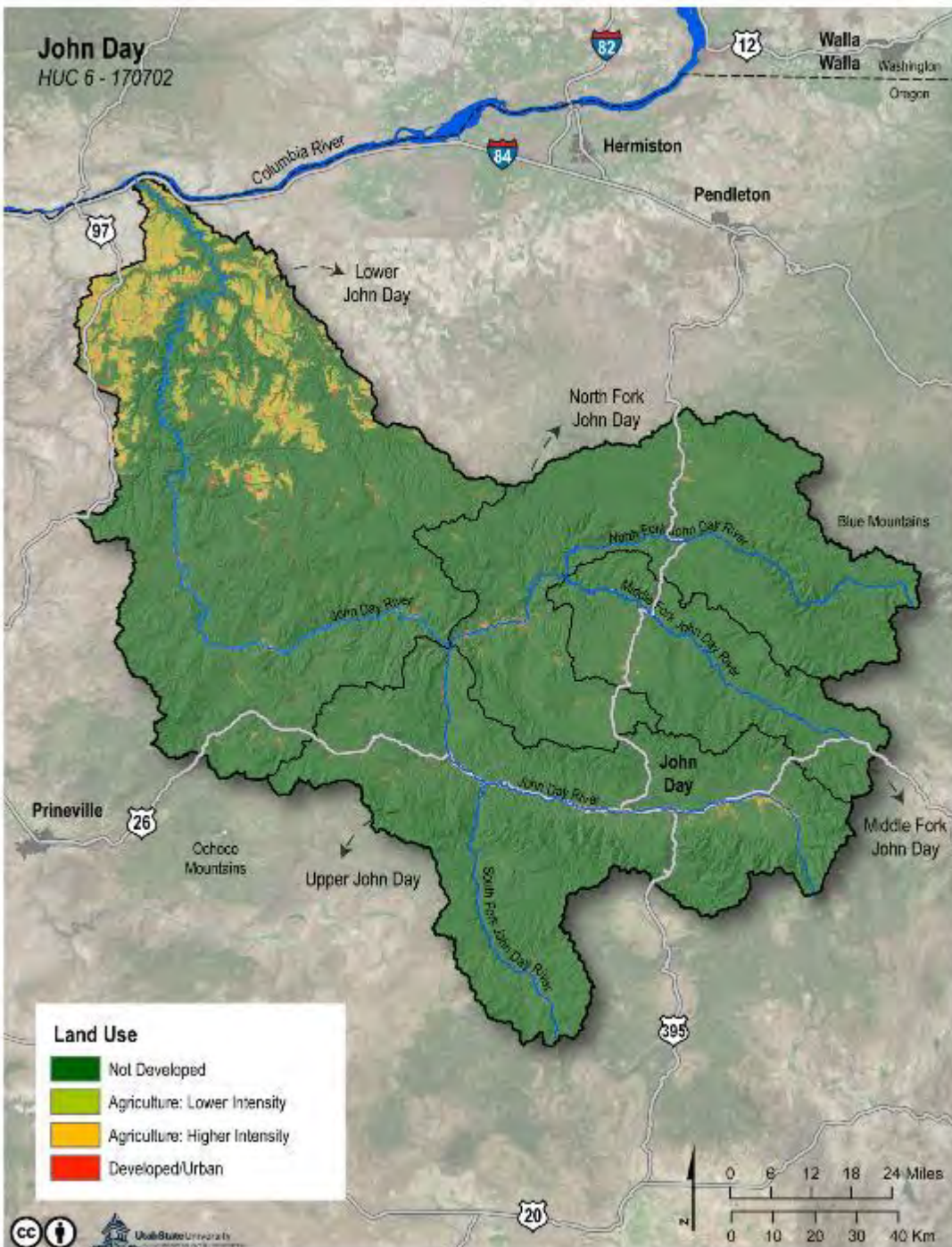


# Making Investment





John Day  
HUC 6 - 170702

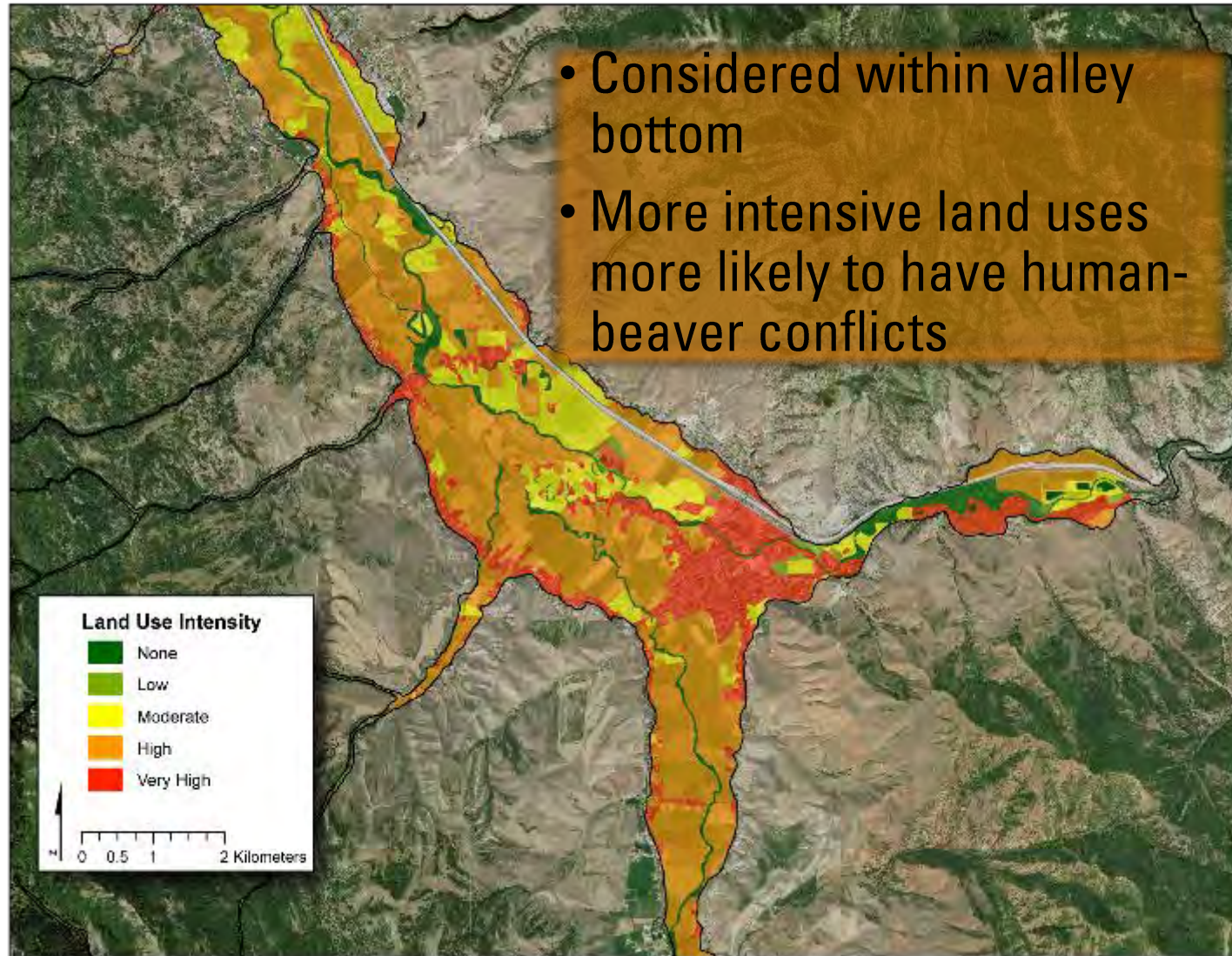


# Land Use Intensity

- Land use intensity is easily derived from LANDFIRE



# Within Valley Bottom: Land Use Intensity





# Land use intensity on network

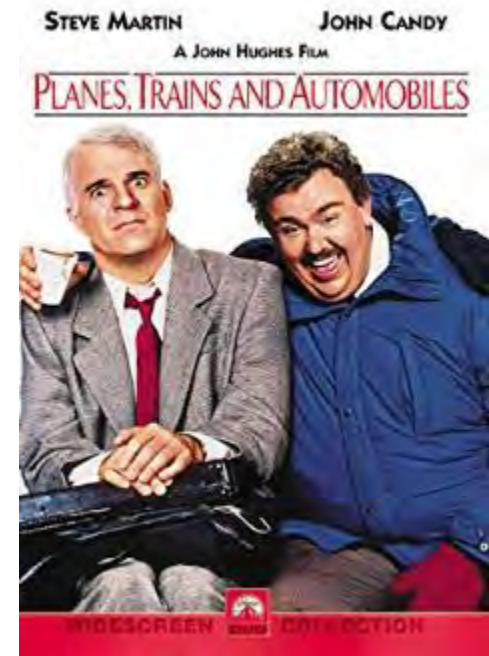


An average land use intensity within the valley bottom of each reach can be easily calculated

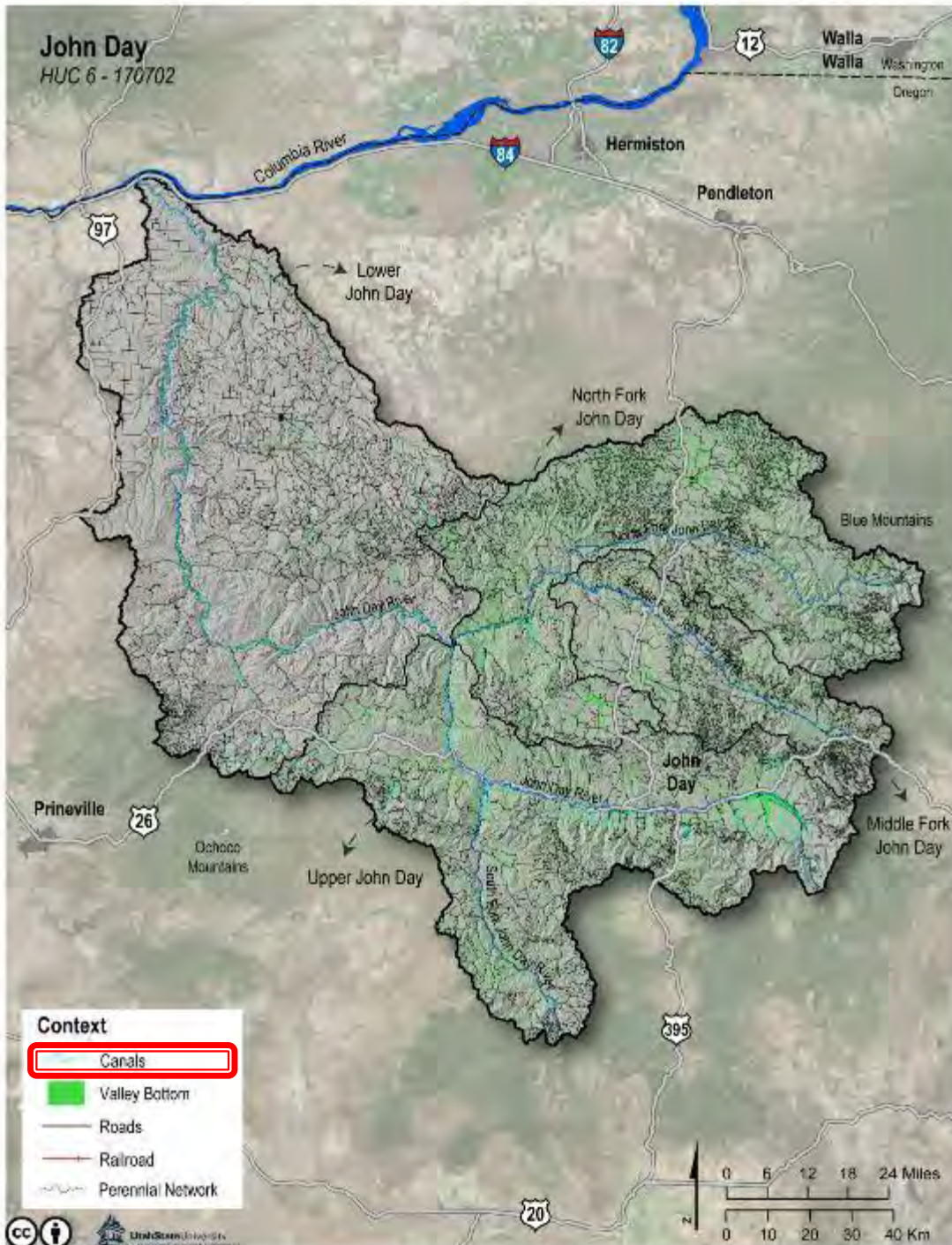




# Infrastructure

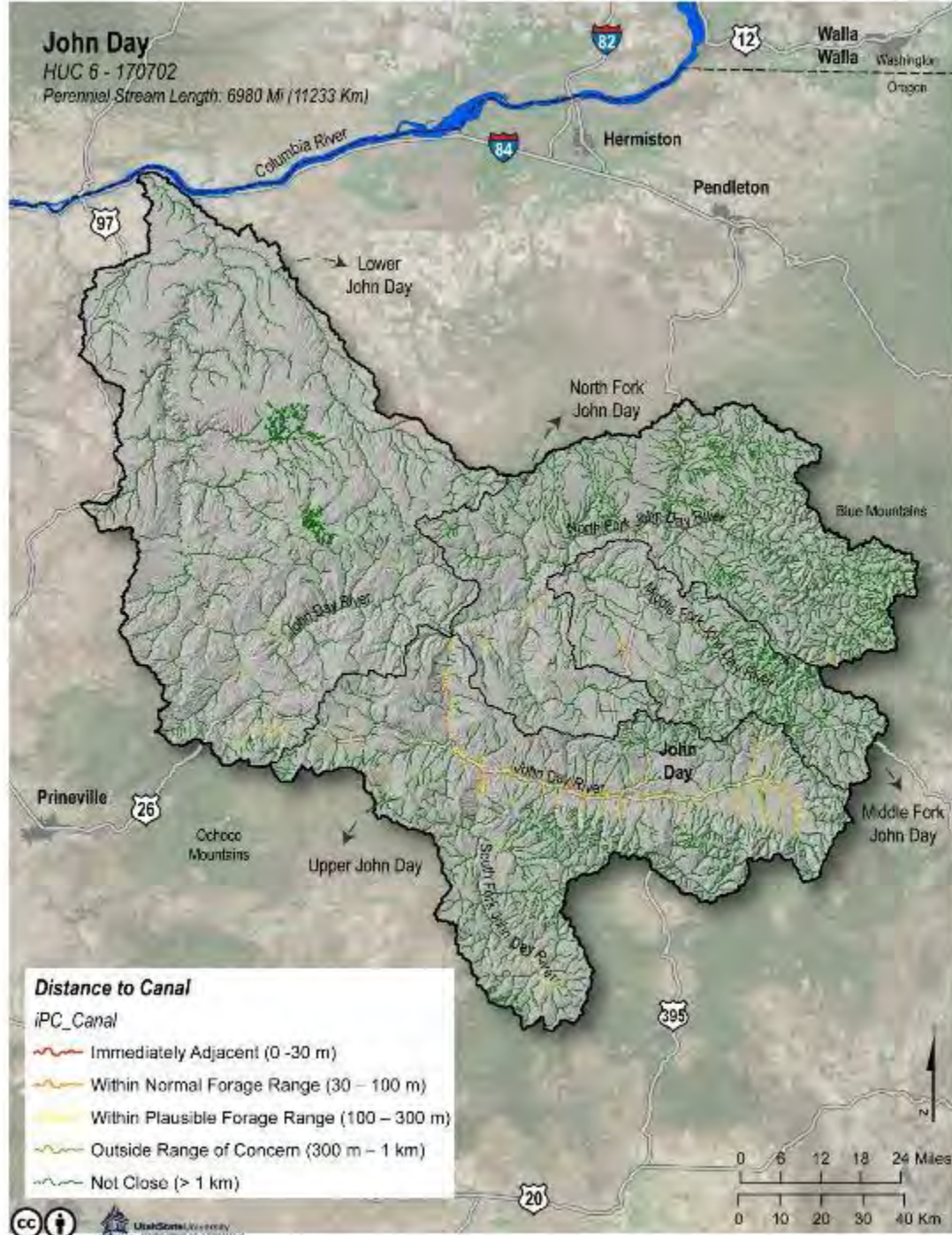


Next, we can look at how close we are to infrastructure beaver could flood or damage: roads, railroads, canals





# Canals

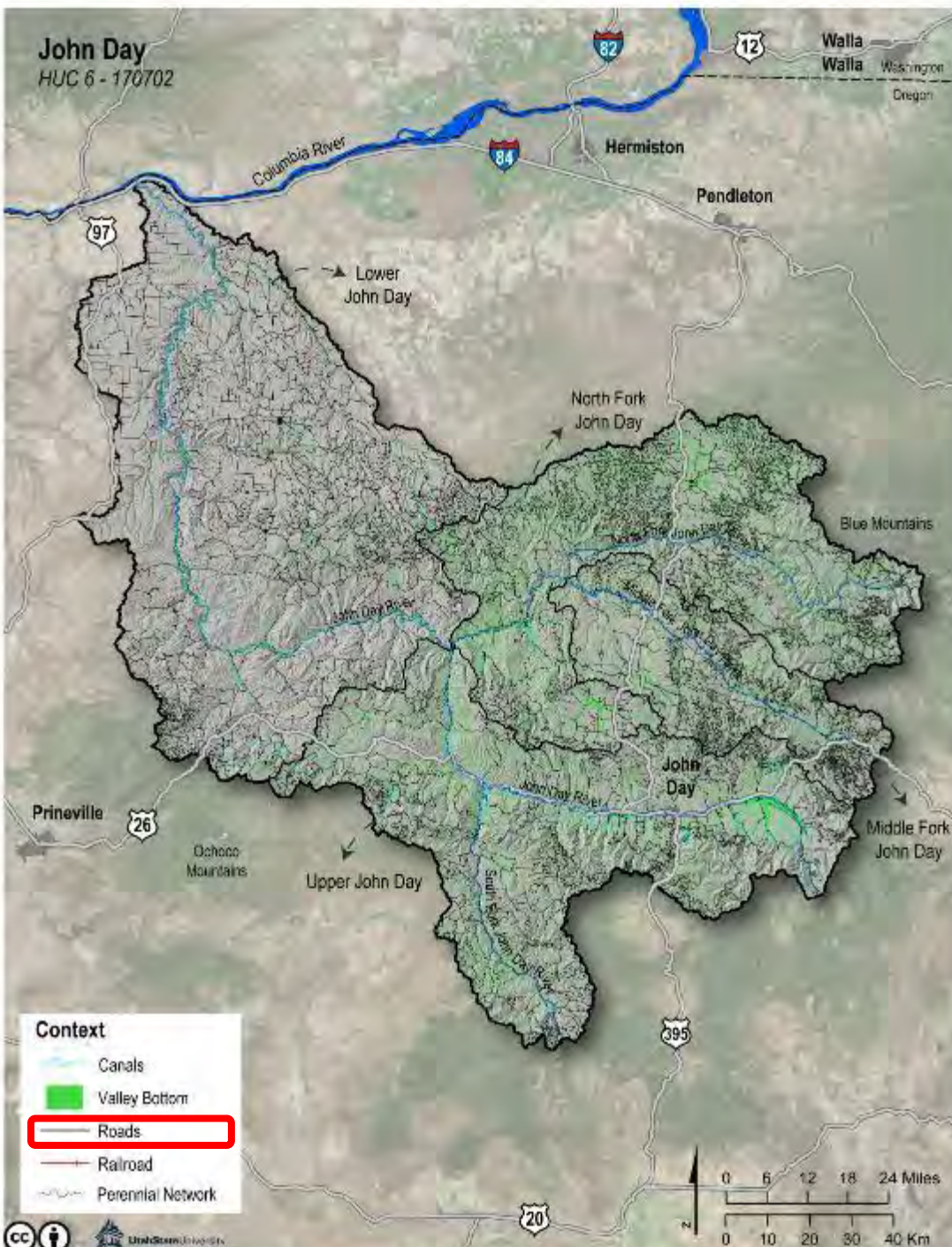


Generally, beaver are not welcome or useful additions to irrigation canals

There are a lot of irrigation ditches... evaluating distance from canals can be cast in terms of 'beaver distances'



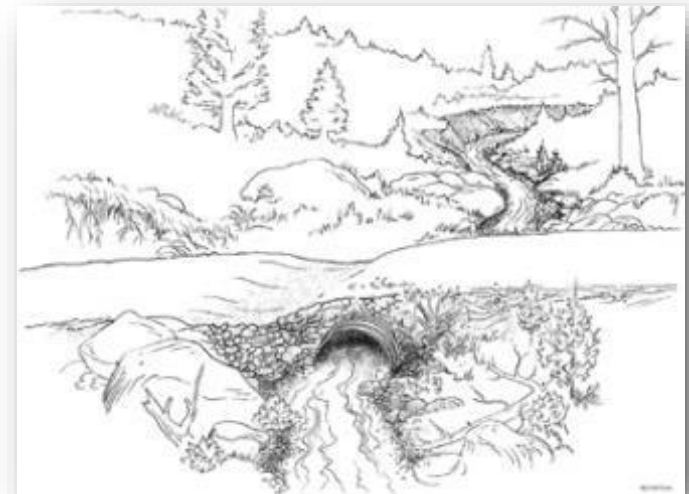
John Day  
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# Roads?



The black lines are roads  
(note the extremely high  
density in headwaters)





# A RISK WITH ROADS... CROSSINGS



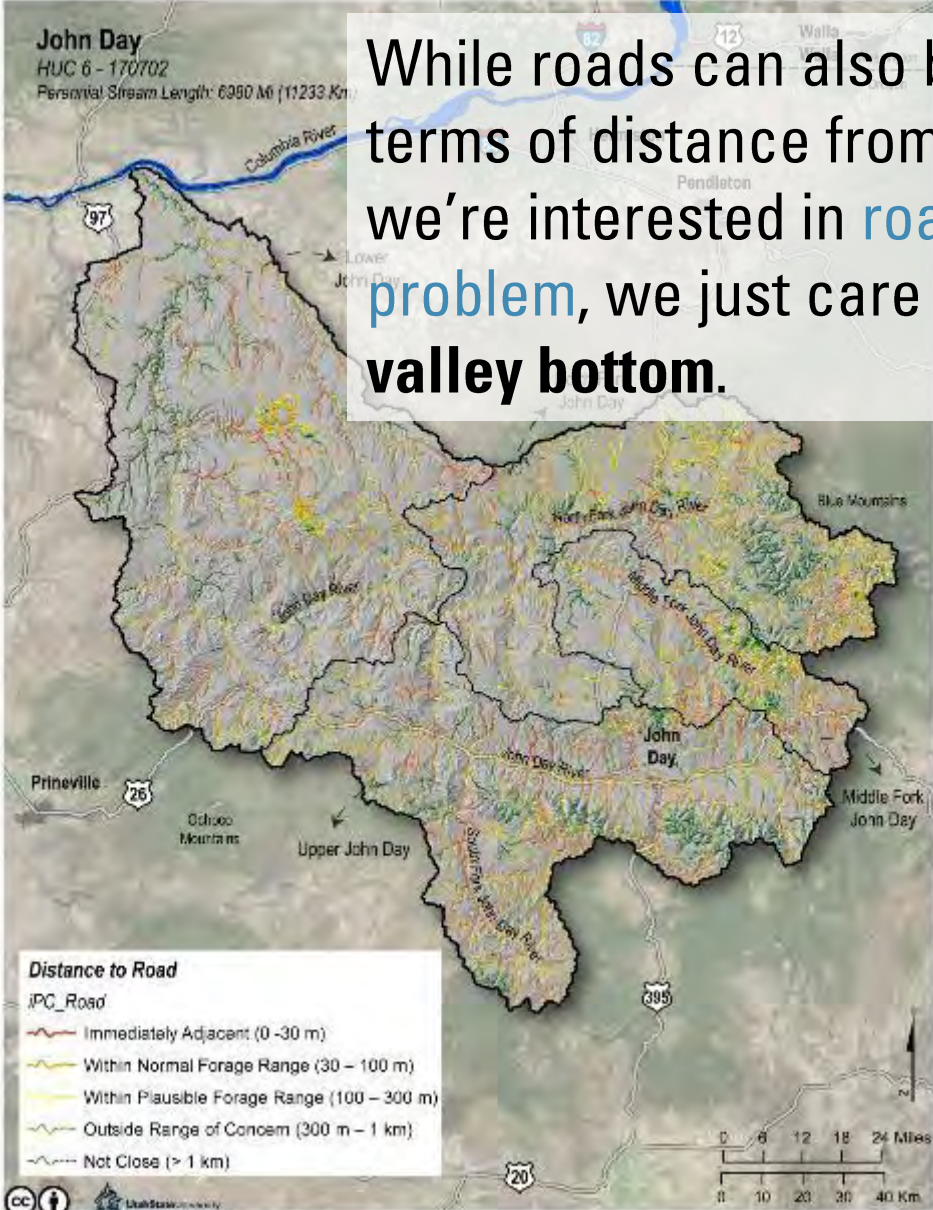
- Simply looking at road crossings and distance from that can help evaluate potential 'clogging' locations
- A large bridge with plenty of clearance is not necessarily a problem...
- A small culvert might be





# Distance to road vs. Road in valley bottom

While roads can also be looked at in terms of distance from the channel, if we're interested in **road flooding problem**, we just care about **roads in the valley bottom**.



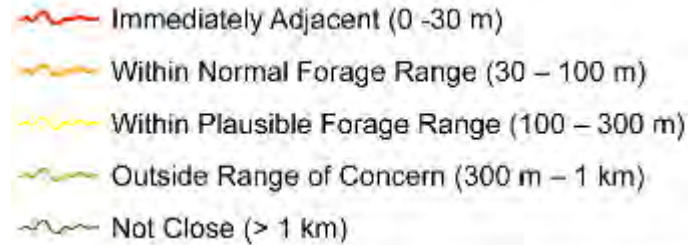


# Bringing All These Together

- Proximity to 'floodable' or 'clogable' infrastructure:

- Roads
- Road Crossings
- Canals
- Railroads

- How far to closest threat?





# Nearest

# Infrastructure

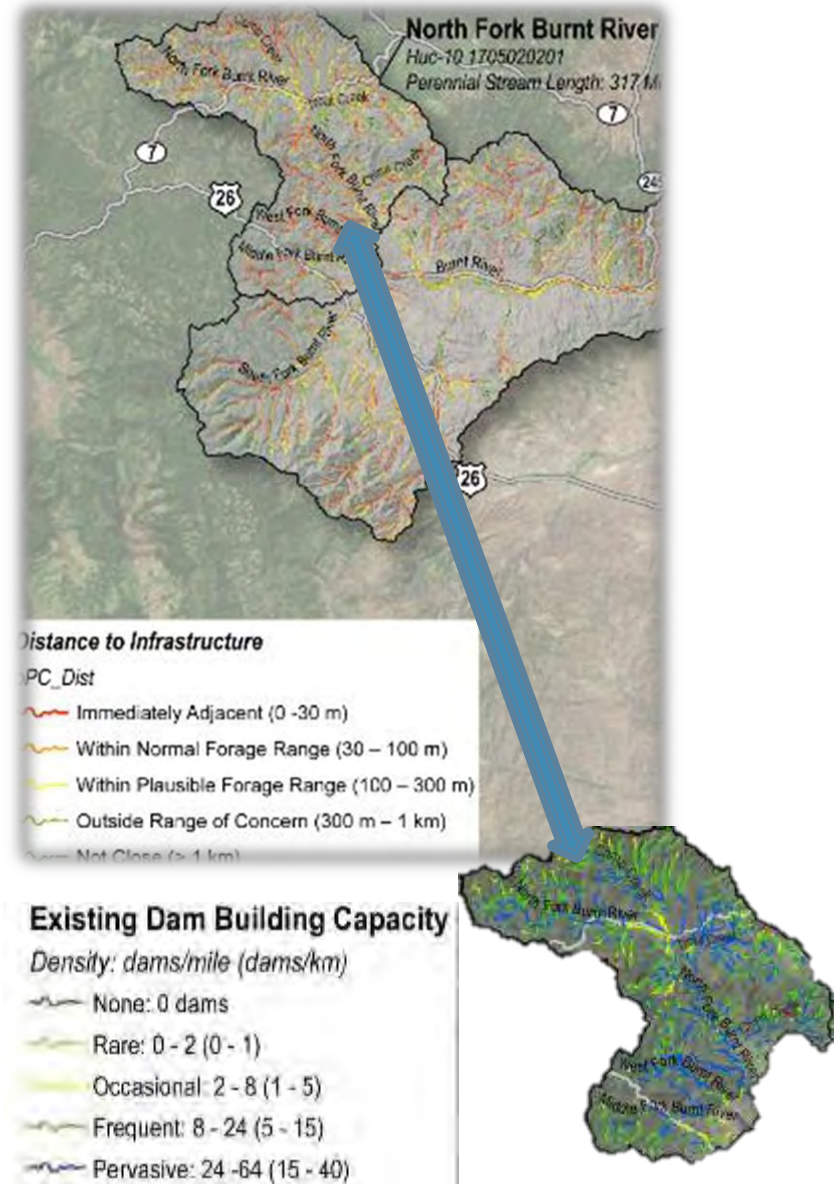
We can synthesize all these by calculating the distance to **closest infrastructure** (i.e. road in valley bottom, road crossing, railroad, or canal)





# But, this is unrealistically pessimistic

- This is just how close is the stream to these things!
- NOT how close will beaver be
- Setting aside undesirable harvest of vegetation/trees, main impact of beavers is damming
- So just look at where proximity is higher, and where beaver are likely to build dams

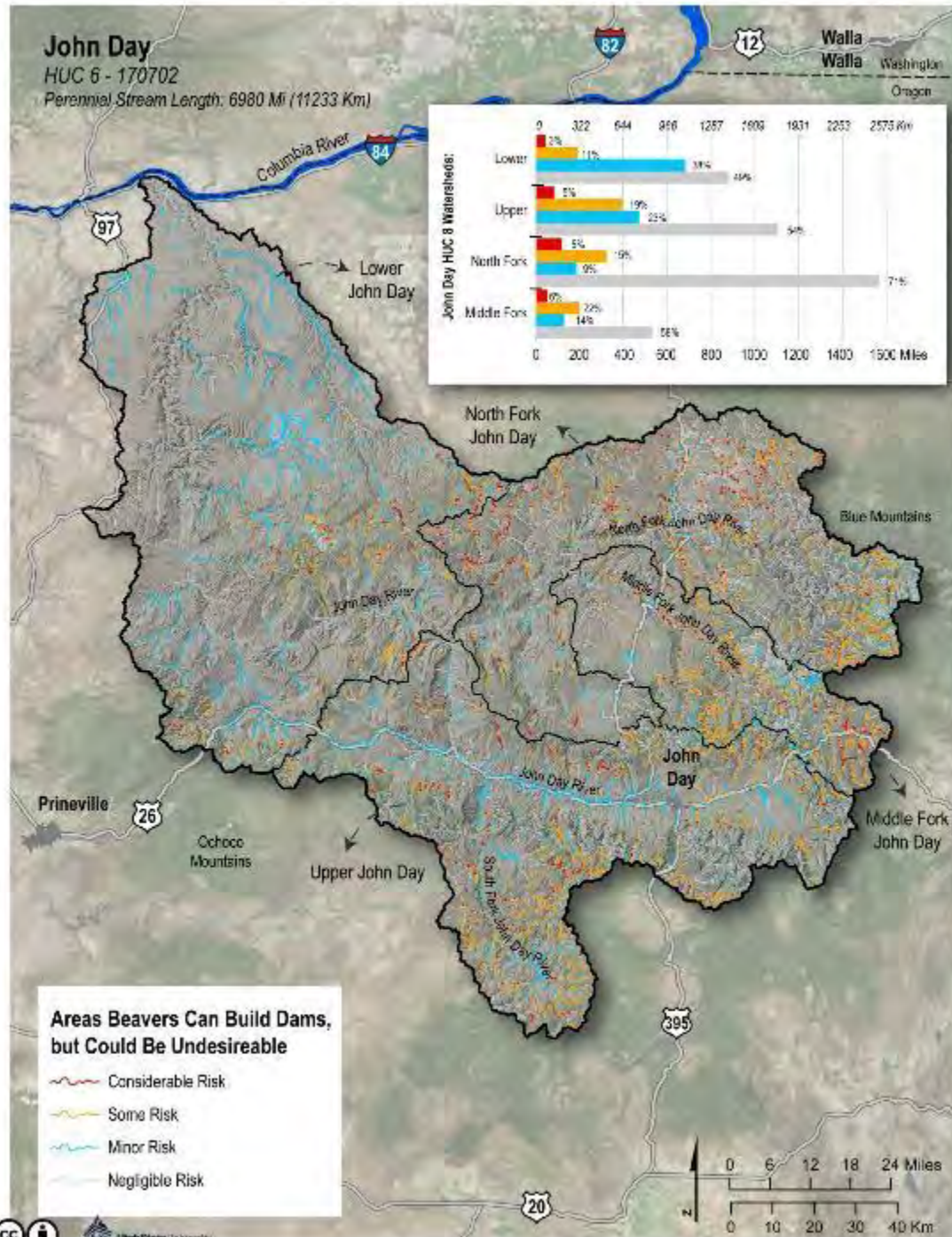




# More Focused Look @ "Risk"

Where could there be some risks of human-beaver conflict?

- Assuming that beaver are present in that reach & they decide to build dam & it actually causes impact... ( i.e. very conservative over-prediction)





# OUTLINE

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration

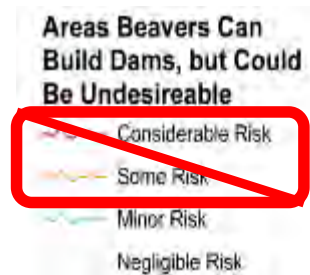


- I. Background & Other Resources
- II. Dam Building Focus – Expectations
- III. Contextualizing Risk
- IV. Prioritizing Opportunities**
- V. Partnering with Beaver... A people business

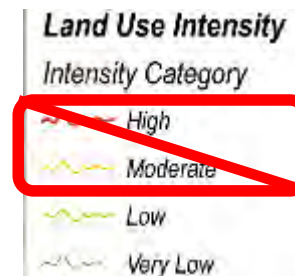


# With risks considered, where are the restoration & conservation opportunities?

- Be conservative:
  - Only look in areas of:
    - Minor risk
    - Negligible risk



- Avoid high intensity land use:
  - Low
  - Very low





# Restoration & Conservation Opportunities

- Areas with limited 'risk' of human-beaver conflict & some ex. capacity.
  - **Low Hanging Fruit** has capacity, just needs some beaver!

## Possible Beaver Dam Conservation/Restoration Opportunities

- Easiest - Low-Hanging Fruit
- Straight Forward - Quick Return
- Strategic - Long-Term Investment
- Other

## Existing Dam Building Capacity

Density: dams/mile (dams/km)

- None: 0 dams
- Rare: 0 - 2 (0 - 1)
- Occasional: 2 - 8 (1 - 5)
- Frequent: 8 - 24 (5 - 15)
- Pervasive: 24 - 64 (15 - 40)

- **Quick Return** is currently *UCCASIONAL* but historically higher





- **Strategic** is currently hammered but historically was high

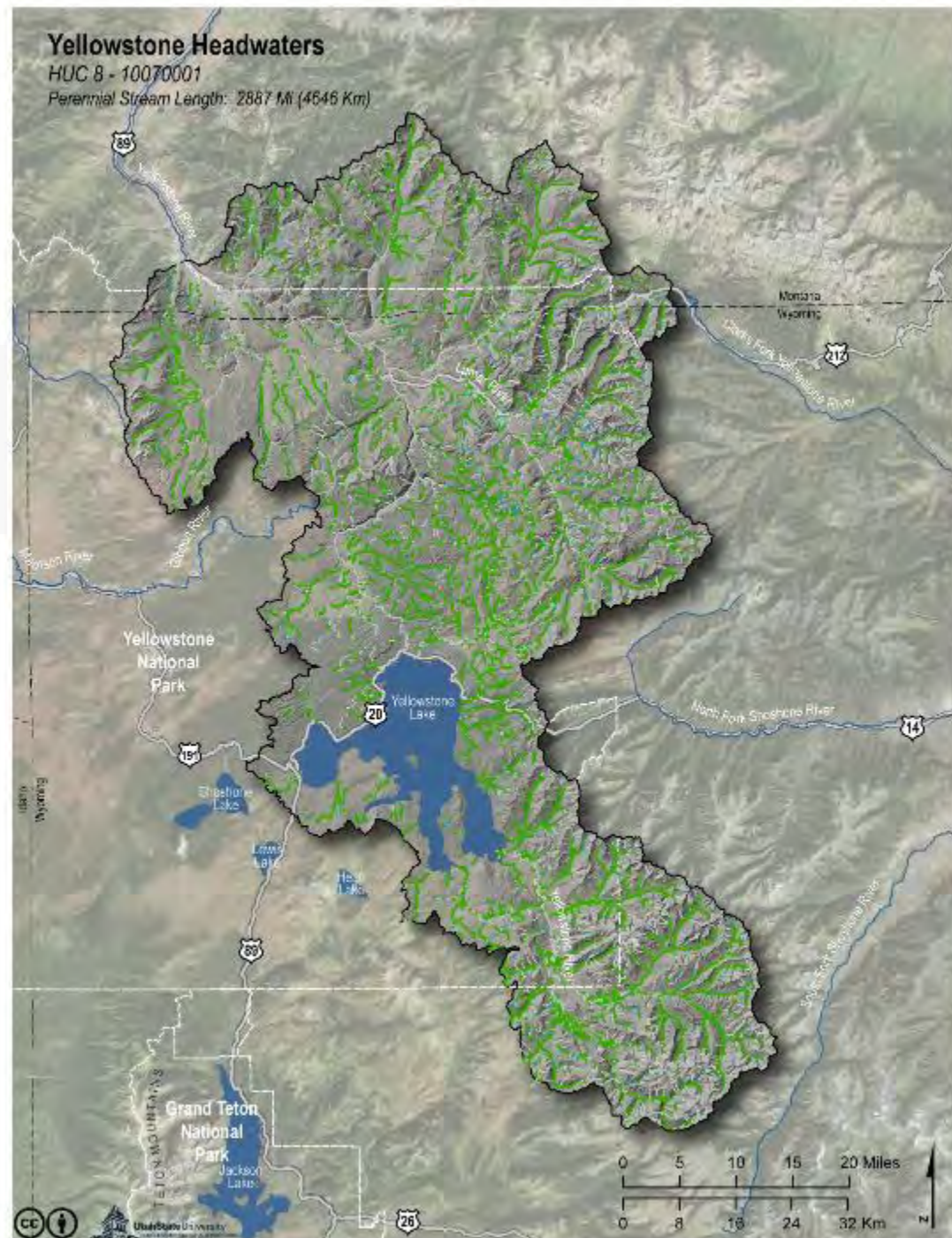
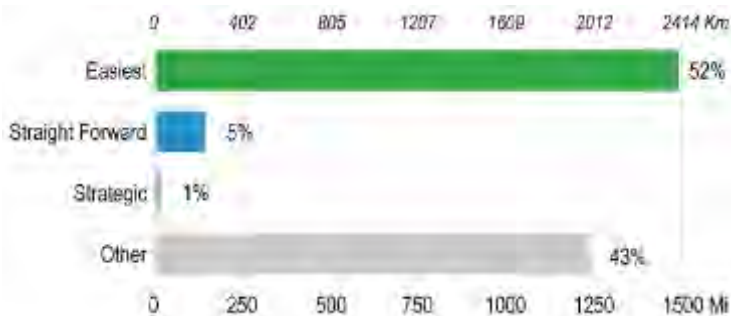
These areas typically need long-term riparian recovery first (e.g. grazing management)

# Restoration & Conservation Opportunities

Where are low-risk beaver restoration & conservation opportunities located?

## Possible Beaver Dam Conservation/Restoration Opportunities

-  Easiest - Low-Hanging Fruit
-  Straight Forward - Quick Return
-  Strategic - Long-Term Investment
-  Other

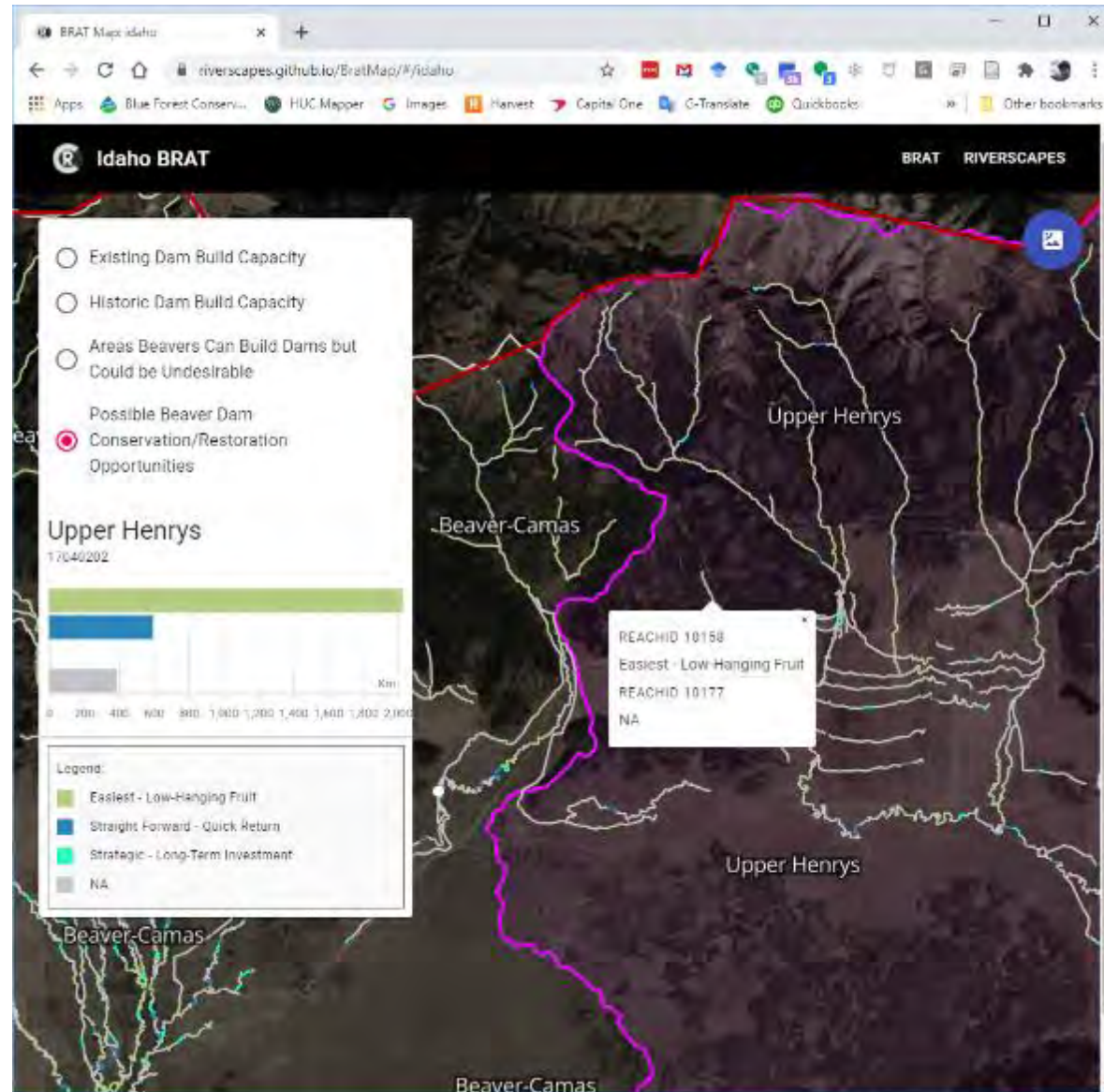






# So where should you work?

- What are you trying to do?
- What impairments are you trying to address?
- What species are you trying to benefit?
- What uplift or improvement (e.g. in quantity of mesic habitat) are you trying to get?
- What risks should you be aware of, mitigate and/or avoid?





# Difference between conservation & restoration

- Compare realized dam counts to existing capacity
- In reaches @ or near capacity & in 'low hanging fruit'
  - Flag as conservation (e.g. trapping closure)
- In reaches with no realized-capacity or under-utilized-capacity:
  - Target for restoration and/or translocation
  - Maybe use BDAs to promote beaver to stick
- In quick-return areas, use low-tech PBR & better land management to improve conditions and try to get beaver to help
- If 'long-term' areas are important, strategically invest to improve riparian conditions





# OUTLINE

## Identifying Where to Place Beavers and When to Use Beaver Mimicry for Low Tech Restoration



- I. Background & Other Resources
- II. Dam Building Focus – Expectations
- III. Contextualizing Risk
- IV. Prioritizing Opportunities
- V. **Partnering with Beaver... A people business**



# Examples of how to do AM...

Lays out an adaptive management response to beaver problems...

## SPRING CREEK WETLAND AREA ADAPTIVE BEAVER MANAGEMENT PLAN

FOR WALMART STORES INC. AND THE CITY OF LOGAN



Prepared by:

Elijah Portugal<sup>1</sup>, Joseph Wheaton<sup>1</sup>, and Nick Bouwes<sup>2</sup>

<sup>1</sup> Watershed Sciences Department,  
Utah State University, 5210 Old Main Hill, NR 210  
Logan, Utah 84322

<sup>2</sup> Eco Logical Research Inc.,  
Po Box 706, Providence, Utah 84332

Prepared for:

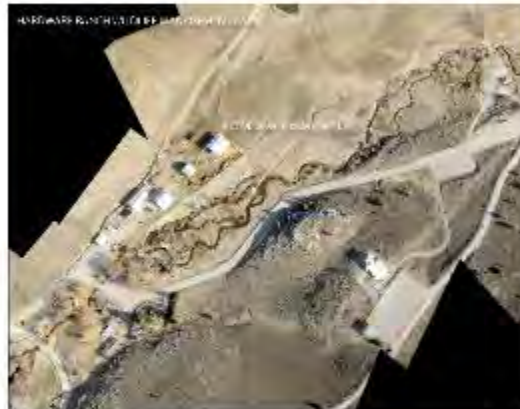
Walmart Supercenter  
1150 South 100 West  
Logan, UT

February 2015

Recommended Citation:  
Portugal E., Wheaton, J., Bouwes, N. 2015. Recommendations for an Adaptive Beaver Management Plan. Prepared by  
and the City of Logan, Logan, Utah. 24 Pages

## DRAFT VERSION: HARDWARE RANCH ADAPTIVE BEAVER MANAGEMENT PLAN

FOR UTAH DIVISION OF WILDLIFE RESOURCES



Prepared by:

Elijah Portugal<sup>1</sup>, Joseph Wheaton<sup>1</sup>, Nick Sorenson<sup>1</sup>

<sup>1</sup> Watershed Sciences Department,  
Utah State University, 5210 Old Main Hill, NR 210  
Logan, Utah 84322

Utah Division of Wildlife Resources,  
Northern Region  
515 East 1300 South  
Ogden, UT 84405

Prepared for:

Utah Division of Wildlife Resources  
Northern Region  
515 East 1300 South  
Ogden, UT 84405

March 2015

## RECOMMENDATIONS FOR AN ADAPTIVE BEAVER MANAGEMENT PLAN

FOR PARK CITY MUNICIPAL CORPORATION



LATON, Assistant Professor

Corporation

ID-1480

# Park City Story

- Good old days of traditional, undocumented beaver management
- Change of mgmt...
- Beaver come back
- Beaver cause flooding problems
- City removes (traditional mgmt.)
- But people liked the beaver... and complained
- CONFLICT!



Wheaton ( 2013)

DOI: [10.6084/m9.figshare.903648](https://doi.org/10.6084/m9.figshare.903648).

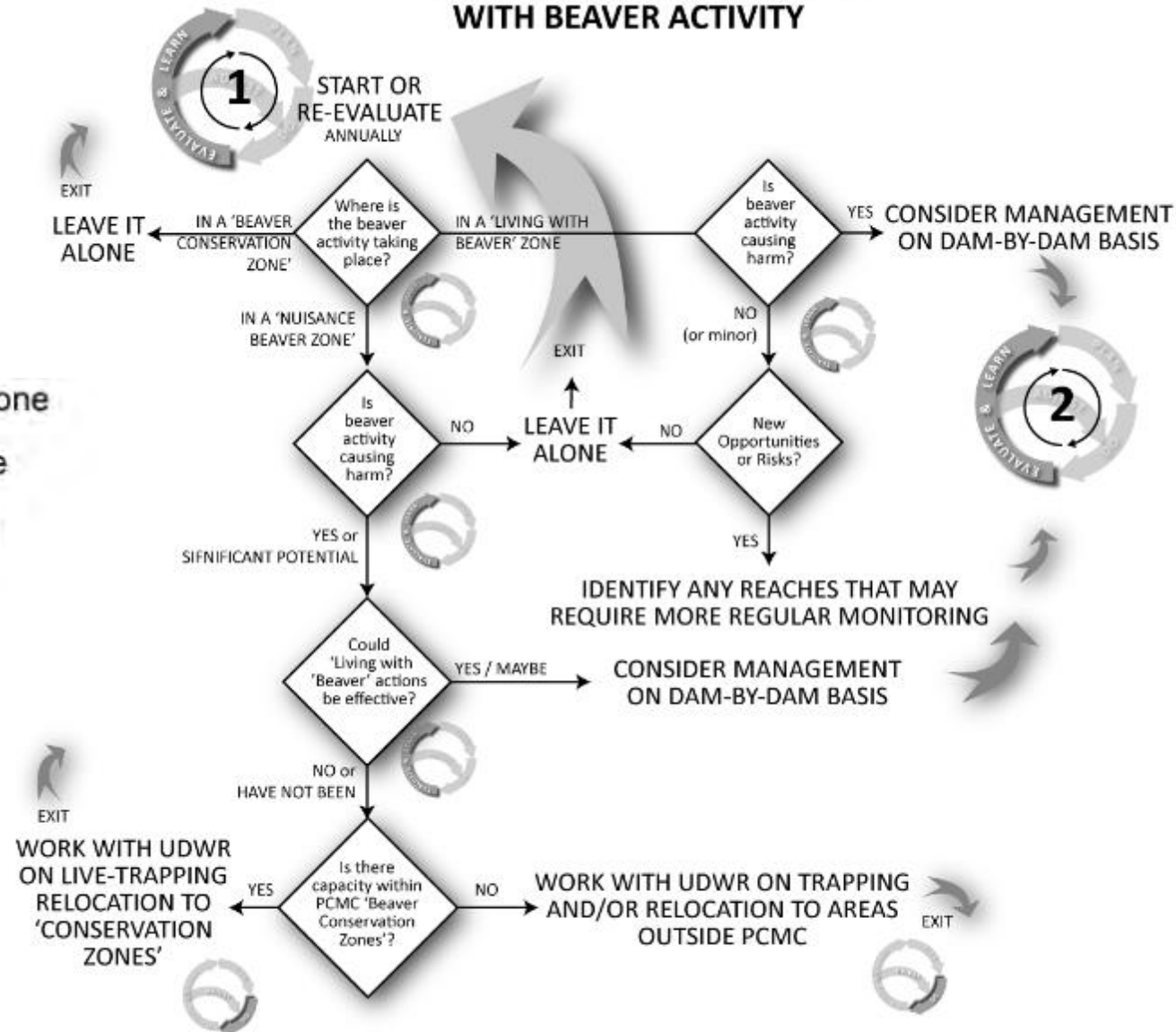


# Simple Decision Points – By Water Course

- Cheaper and more effective than just lethal treatment everywhere...

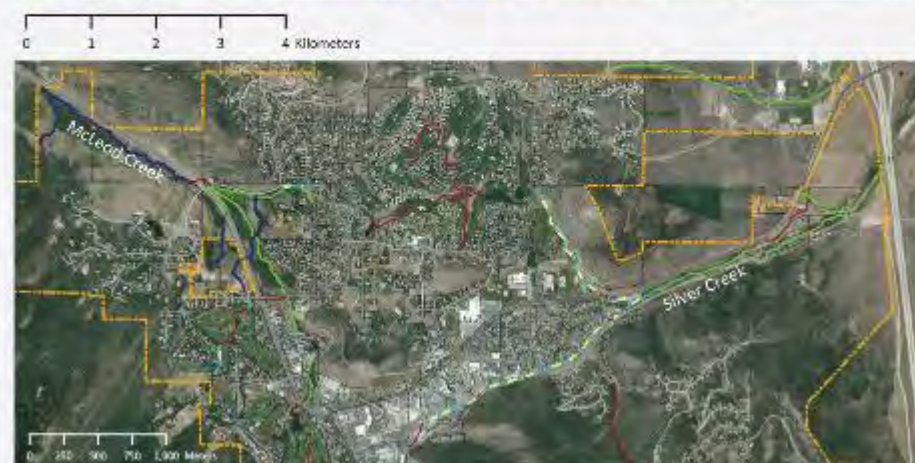


## EVALUATION OF WATER COURSES WITH BEAVER ACTIVITY



# Adaptive Beaver Management Plan

-  Beaver Conservation Zone
-  Living with Beaver Zone
-  Nuisance Beaver Zone
-  Non-Beaver Bearing
-  Culvert or Bridge



## PCMC BEAVER ADAPTIVE MANAGEMENT PLAN

**IDENTIFY PROBLEM**  
 The Council of 2013-14  
 Proposed to Re-evaluate the  
 Management Plan of 2013-14

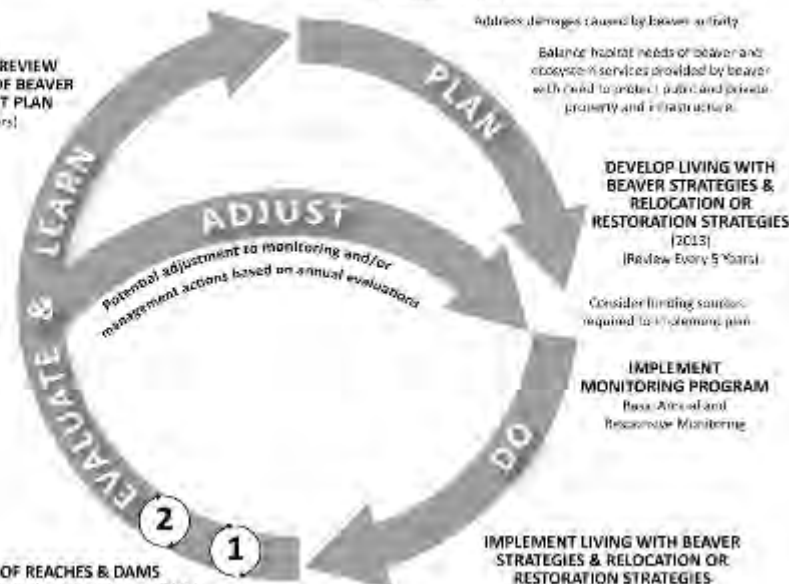
**PCMC GOALS & OBJECTIVES**  
 (Established in 2013)

- Address damages caused by beaver activity
- Balance habitat needs of beaver and ecosystem services provided by beaver with need to protect public and private property and infrastructure.

**PERIODICALLY REVIEW EFFECTIVENESS OF BEAVER MANAGEMENT PLAN**  
 (Every 5 Years)

**DOCUMENT MONITORING & ACTIONS**

**EVALUATION OF REACHES & DAMS**  
 Annually at reaches in spring (prior to spring runoff) & in Fall (after period of dam building and cutting)  
 OR  
 At individual dams as triggered by nuisance complaints



**DEVELOP LIVING WITH BEAVER STRATEGIES & RELOCATION OR RESTORATION STRATEGIES**  
 (2013)  
 (Review Every 5 Years)

Consider funding sources required to implement plan

**IMPLEMENT MONITORING PROGRAM**  
 Pass Annual and Reservoir Monitoring

**IMPLEMENT LIVING WITH BEAVER STRATEGIES & RELOCATION OR RESTORATION STRATEGIES**  
 Primarily Responsive to Problems



# Genuine Partnerships



## BEEF

Animal Health

Market Reports

Management

BEEF Vet

Cow-Calf

Our Ev



MIDDAY Midwest Digest, March 3, 2020



MAR 03, 2020

Farm Progress America, March 3, 2020



MAR 03, 2020

SPONSORED CONTENT

Autogenous vaccines: A targeted option for bovine enteric diseases



## Beaver power provides year-long water to Idaho ranch

Beavers? You read that right. Here's how four-legged engineers helped restore an Idaho ranch.

By Brianna Randall | Feb 20, 2020

Beavers are some of nature's best engineers. They were key to improving the water supply to one Idaho rancher's pastures.

Jay Wilde's story of restoring perennial flow to his creek using beaver...



# LOW-TECH PROCESS-BASED RESTORATION OF RIVERSCAPES

## DESIGN MANUAL, RESOURCES, WORKSHOPS



### LOW-TECH PBR VIRTUAL FIELD TRIP

#### PAGE CONTENTS

[Low-Tech PBR Virtual Field trip](#)

[Virtual Field Trip to Birch Creek](#)

[\(Topic Covered in WATS Classes\)](#)

[Birch Creek Field Tour](#)

[Guided Virtual Tour](#)

[Where is this?](#)

[Subscribe to the Low-Tech PBR mailing list](#)

#### SITE CONTENTS

## Virtual Field Trip to Birch Creek

Normally, in our in-person workshops, we like to take participants in the field to see an actual low-tech process-based restoration (LTPBR) project on the ground. This helps you see first-hand a real riverscape subjected to "structural starvation", and for which a LTPBR project was successfully completed.

There is no substitute for meeting Jay Wilde in person and seeing what the beaver have done to Birch Creek, Idaho because of his efforts. Tromping around in the water and mud and experiencing this for yourself, really helps the concepts and the scope of what is possible sink in. This page attempts to reproduce as much of that experience as we can virtually for you in Birch Creek.



[Buy-into PBR-grade Studies](#)

[LTPBR \(contracts\)](#)

[LTPBR Rates](#)

[LTPBR in SWs](#)

[Free Learning Modules](#)

[Q1 Overview](#)

[Q3 Planning](#)

[Beating the system](#)

[Low-Tech PBR Virtual Field trip](#)

[Q5 Implementation](#)

[LTPBR Recipes](#)

[Low-Tech PBR Workshops](#)

#### Subscribe to the Low-Tech PBR mailing list

Email Address

First Name

#### Virtual Field Tour

In this 90 minute video, you are invited to a series of stops up and down Birch Creek. The conversation between Jay Wilde and Joe Wheaton is similar to the conversation we have when we take a whole class out. Unlike the real field trip, where when you've had enough you can just hang back and wander around on your own, with this one you can fast forward if you get bored.





# So where has pyBRAT 3.0 been run?

Is the tool the GIS tool or the outputs? Or the thought process?



<http://brat.riverscapes.xyz/BRATData/>

# Everything Is Open-source... But

## WHY YOU'RE REALLY HERE... THE TOOLS

### OUR TOOLS - YOUR RIVERSCAPES...

Our consortium has been practical in developing the science and theoretical underpinnings essential to understanding and explaining how riverscapes work and are organized across a range of nested hierarchical spatial scales. We have also committed to building [open source algorithms](#), models and GIS tools to make it easier for researchers, professionals, practitioners and students to apply those concepts to their own riverscapes.

All of our [tools](#) are based on peer-reviewed methods. When we have developed the methods ourselves, we aim to have them vetted, published and disseminate in the [open-source literature](#). We then also make sure to have a well documented website (you'll find them from RC-

### SOME OF OUR NETWORK-SCALE MODELS:

BRAT



RCAT



GNAT



### SOME OF OUR REACH-SCALE MODELS:



GUT



MoRPHEd



<http://riverscapes.xyz>

<https://github.com/Riverscapes>



The nested hierarchical spatial scales of riverscapes...





# pyBRAT is just Operational Grade Tool



OPERATIONAL  
GRADE



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[Learn More About Beavers](#)

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- [BRAT Documentation](#)
- [BRAT Help](#)
- [BRAT Workshops](#)
- [Data Capture Forms & Apps](#)
- [BRAT Data](#)

## About

Welcome to the pyBRAT website. The **Beaver Restoration Assessment Tool (BRAT)** is planning tool intended to help researchers, restoration practitioners and resource managers assess the potential for beaver as a stream conservation and restoration agent over large regions and watersheds. At the heart of BRAT is a capacity model, which estimates the upper limit of dam density (dams per kilometer) for individual stream reaches throughout a drainage network. We focus on predicting where beavers could build dams and to what extent (as opposed to the more general case of where beaver could make a living), because it is the dam building activity they do as ecosystem engineers, which we are typically most interested in.



# BRAT



The BRAT model can be run with freely available national data sets, or with higher resolution data, and is used to identify opportunities, potential risks and constraints through a mix of assessment of existing resources and proximity to infrastructure). The backbone to BRAT are **spatial models that predict the capacity of riverscapes to support dam-building activity by beaver**. By combining capacity and potential risk, researchers and resource managers have the information necessary to determine where and at what level reintroduction of beaver and/or conservation is appropriate.

[BRAT Outputs](#)

[Download BRAT Model](#)

[Start the Step-by-Step Tutorials](#)

[BRAT Publications](#)

## A Riverscapes Network Model



OPERATIONAL  
GRADE



UtahStateUniversity  
ECOSYSTEM MORPHOLOGY & TOPOGRAPHIC  
ANALYSIS LABORATORY

BRAT 1x through 3x were developed by the Wharton/EL AL lab at Utah State University. The Riverscapes Consortium has given pyBRAT 3.1.0 a **operational grade** ranking (see [grading table](#))

BRAT is one of a suite of network models that are part of the **Riverscapes Consortium's** suite of open-source tools for better understanding, studying and managing our riverscapes.



<http://brat.riverscapes.xyz>

# RIVERSCAPES REPORT CARD

## PAGE CONTENTS

Riverscapes Report Card

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Tool Output Utility

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Data Capture Forms & Apps

BRAT Data

BRAT is one of several tools developed by the [Riverscapes Consortium](#). This report card communicates BRAT's compliance with the Riverscape Consortium's published [tool standards](#).

## Report Card Summary

Tool BRAT - Beaver Restoration Assessment Tool


Version 3.1.00

Date 2020-03-18

Assessment Team Bailey & Wheaton

Current Assessment  Operational Grade

Target Status  Commercial Grade

Riverscapes Compliance  Pending

BRAT has been applied extensively throughout the Western US and in the UK. It has been used extensively to inform policy and planning and state-wide, regional and watershed extents, but also to inform restoration planning and design at the reach-scale. Others have applied the model, but for the most part it has been implemented by the USU ETAL team. It is well deserving of an Operational Grade.





# View in RAVE – Riverscapes Analysis Viewer Explorer

## Glorified Housekeeping?

Yes, but who has time for it? Going to the effort of making your tool riverscapes-compliant turns the process of file management and metadata production and curation automatic for every analysis and write operation in your tools.

The screenshot displays the RAVE Project Explorer interface. On the left is a hierarchical file tree for a project named 'BRAT for HUC 14050001'. The tree includes folders for 'Outputs', 'Inputs', and 'Basemaps', with numerous sub-items like 'Existing Dam Capacity', 'Slope', 'DEM', and 'Topography'. The central map shows a 3D topographic view of a river basin with various colored overlays representing different data layers. On the right, a 'Table of Contents' panel lists the layers, including 'BRAT for HUC 14050001' and 'Existing Dam Capacity'. Below the map, a metadata panel titled 'BRAT for 14050001 - Upper Yampa' provides detailed information about the project, including a table of reach statistics.

BRAT for 14050001 - Upper Yampa		
Introduction		
Number of reaches	04,904	
Total reach length (km)	10,000	
Total reach length (miles)	6,200	
Watershed ID	14050001	
Watershed Name	Upper Yampa	
Elevation	8,000 to 14,000	
Area (square miles)	6774.00	
State	CO	
BRAT Build Date/Time	2021-08-25 10:01:28 5/23/20	
Max Length	900.0	
Min Length	20.0	
Streamside Buffer	20.0	
Riparian Buffer	100.0	
Reach Count		
Max Watershed	0.00	
Elevation Buffer	100.0	
BRAT Run Date/Time	2021-08-25 10:01:28 5/23/20	

<http://rave.riverscapes.xyz>



# Map Example – Network Going to sqlBRAT 4.0 – Don't need to be a GIS user



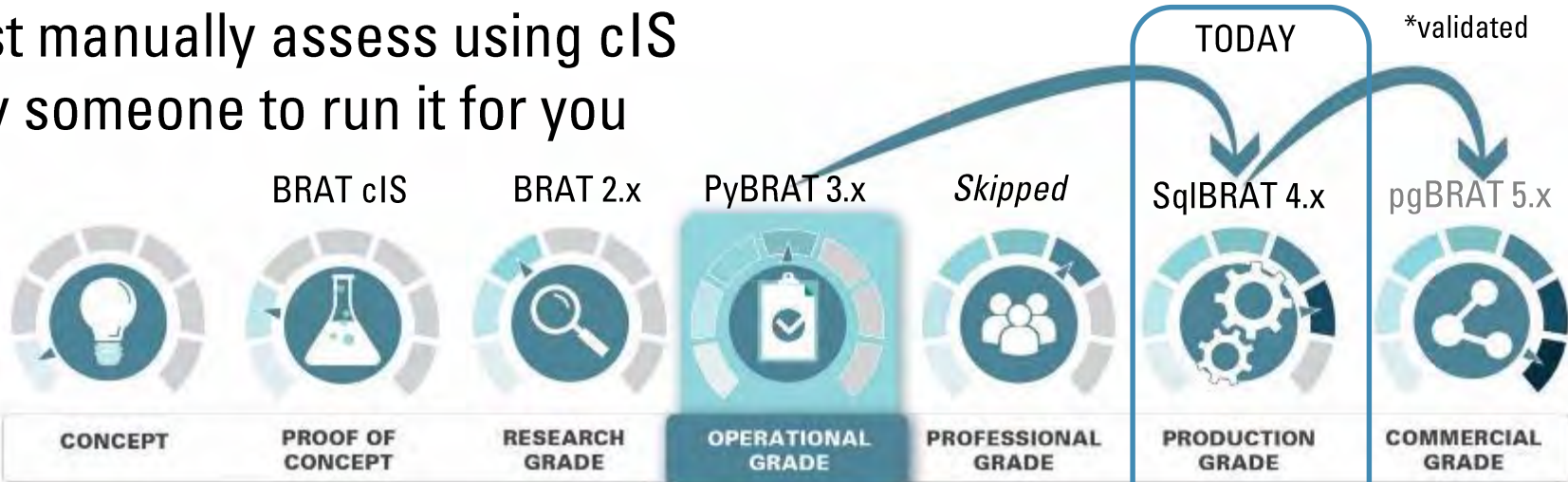
The screenshot displays the 'Idaho BRAT' web application. The main map shows a complex network of rivers and streams, with different colors indicating dam density: red for 'None (0 dams)', orange for 'Rare (0-1 dams/km)', yellow for 'Occasional (1-5 dams/km)', green for 'Frequent (5-15 dams/km)', and blue for 'Pervasive (15-40 dams/km)'. A legend on the left side of the map provides the key for these colors. The interface includes a search bar at the top, a 'BRAT RIVERSCAPES' header, and a 'Current Beaver Dam Capacity' section with a search filter. A text box at the bottom of the map area explains that the BRAT tool is used for network modeling and is hosted in a Riverscapes Warehouse. The map also shows labels for 'Clearwater' and 'Fork Clearwater' rivers.

Will be available *next year (thank you BLM)* at: <https://maps.riverscapes.xyz>



# If there isn't a run in my area...

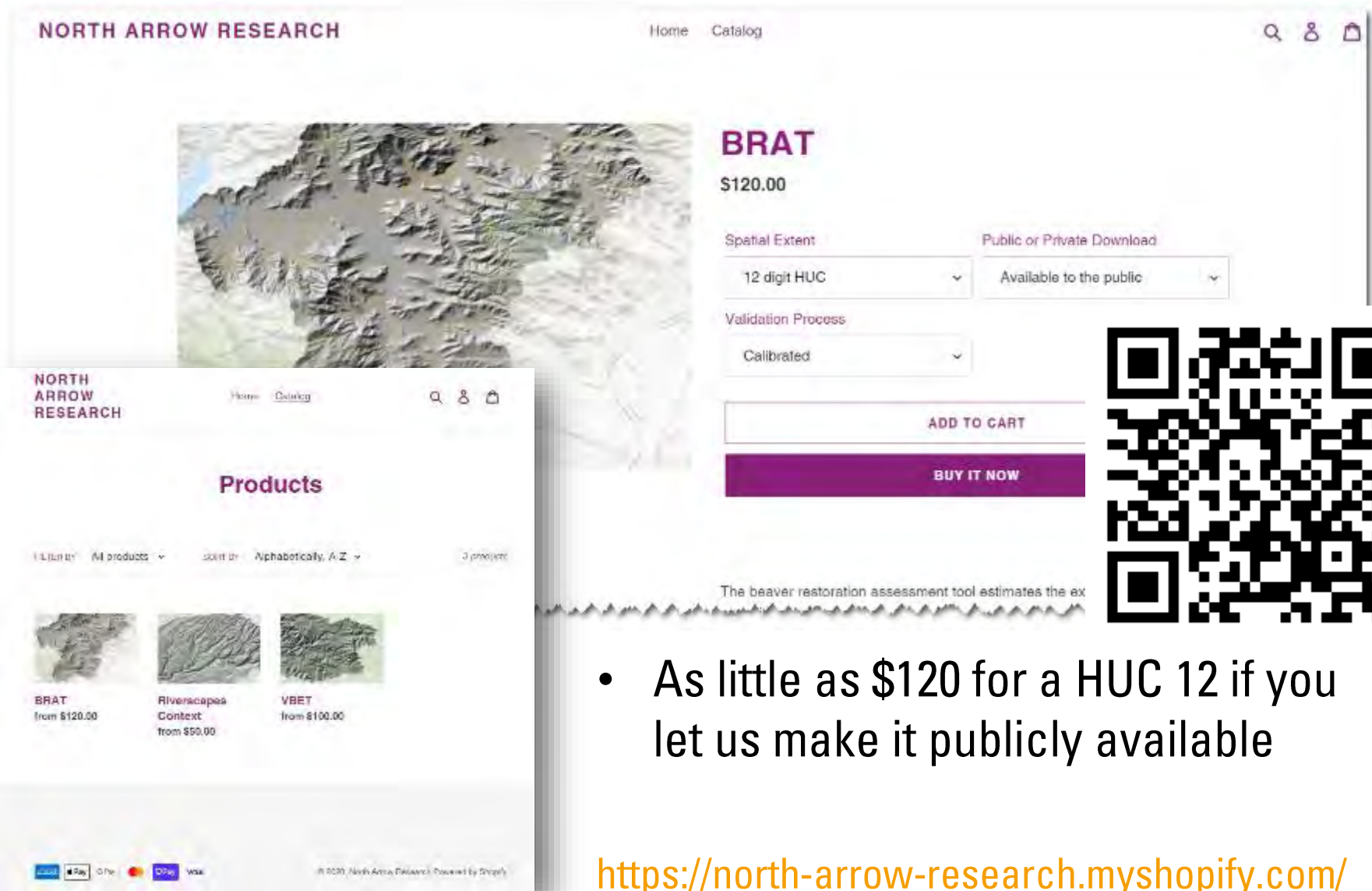
1. Struggle through teaching yourself ArcPy and running GIS yourself
2. Just manually assess using cIS
3. Pay someone to run it for you



## Cost for

	CONCEPT	PROOF OF CONCEPT	RESEARCH GRADE	OPERATIONAL GRADE	PROFESSIONAL GRADE	PRODUCTION GRADE	COMMERCIAL GRADE
Site Visit Reach		\$ 250 to \$1000	NA	NA	NA	NA	NA
Dekstop Visit Reach (you)		<i>Free</i>	NA	NA	NA	NA	<i>Free</i>
HUC 12		\$30K	NA	~\$8K	NA	\$120 to \$350*	<i>Free</i>
HUC 10		NA	NA	~\$10K	NA	\$250 to \$550*	<i>Free</i>
HUC 8		NA	\$30K	~\$15K	NA	\$600 to \$1300*	<i>Free</i>
State		NA	\$75K to \$150K	\$50K to \$100K	NA	Contact Us \$25K to \$40K	<i>Free</i>
Investment R&D		\$30K	\$150K	\$110K	NA	\$150K	\$350K to \$500K

# While we wait for Commercial Grade, YOU can help crowd source this & GET BRAT for your AREA



The image shows two overlapping screenshots of the North Arrow Research website. The top screenshot displays the product page for BRAT, priced at \$120.00. It includes dropdown menus for 'Spatial Extent' (set to '12 digit HUC'), 'Public or Private Download' (set to 'Available to the public'), and 'Validation Process' (set to 'Calibrated'). There are 'ADD TO CART' and 'BUY IT NOW' buttons. A QR code is positioned to the right of the product page. The bottom screenshot shows a 'Products' catalog with three items: BRAT (from \$120.00), Riverscapes Context (from \$50.00), and VBET (from \$100.00). The website header includes 'NORTH ARROW RESEARCH', navigation links for 'Home' and 'Catalog', and search, user, and cart icons. The footer contains payment logos and copyright information: '© 2020, North Arrow Research. Powered by Shopify.'

- As little as \$120 for a HUC 12 if you let us make it publicly available

<https://north-arrow-research.myshopify.com/>



# Conclusions

## Beaver Restoration Assessment Tool

Build your understanding of BRAT for:

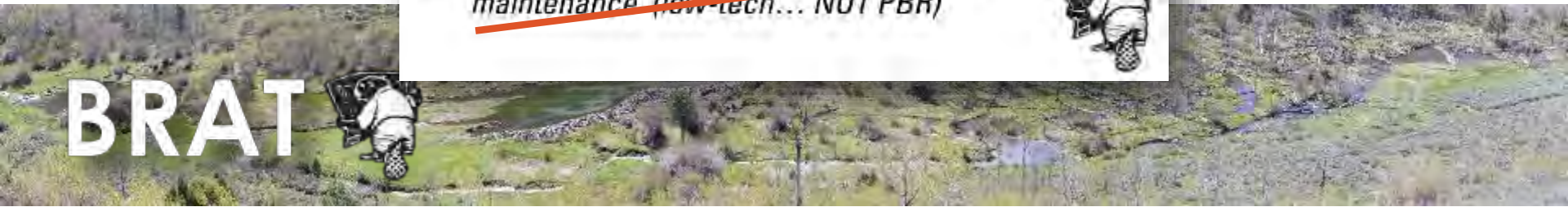
- conservation/restoration planning & prioritization
- risk/opportunity assessment
- expectation management

### Beaver Management / Restoration Strategies

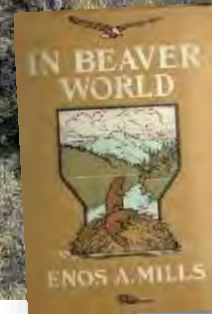
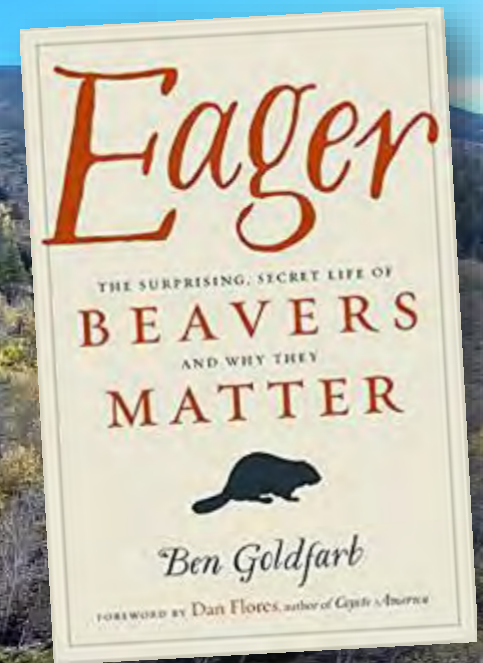
1. **Conservation** / Promotion (leave them alone or protect)
2. **Living with beaver**
3. **Translocation** to areas with suitable capacity → BDAs for release
4. Restore riparian → Followed by Translocation
5. Help beaver out – **Beaver Dam Analogues** → *Facilitated dispersal of opportunistic species*
6. ~~Mimic Beaver Dam Activity – construction & maintenance (low-tech... NOT PBR)~~



# BRAT



# Questions?



- BRAT: <http://brat.riverscapes.xyz/>
- Crowd Source it: <https://north-arrow-research.myshopify.com/>
- Low-Tech Process-Based Restoration: <http://lowtechpbr.restoration.usu.edu>

1913 vs. 2018