PARTNERING WITH BEAVER TO BENEFIT SAGE GROUSE AND WORKING LANDS:

Restoring Emerald Islands in the Sagebrush Sea

ASWM's Hot Topics Webinar Series

July 26, 2017

Photo by: iStock

YOUR PRESENTERS

Joe Wheaton

UtahState University
DEPARTMENT OF WATERSHED SCIENCES

ANABRANCH SOLUTIONS
ALTERNATIVE WAYS TO RESTORE RIVERS

Jeremy Maestas

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

WORKING LANDS FOR WILDLIFE

SAGE GROUSE INITIATIVE

Today's slides available on http://www.researchgate.net

WHEN we SAY WE…

Wally Macfarlane

ANABRANCH SOLUTIONS

Nick Bouwes

EcoLogical Research, Inc. Science Driven Solutions

Northwest Fisheries Science Center

USDA NRCS United States Department of Agriculture Natural Resources Conservation Service

Steve Bennett

- Brady Alred (UM)
- Sara Bangen (USU)
- Reid Camp (ELR/ Anabranch)
- Patrick Donnelly (UM)
- Dennis Duehren (USFS)
- Jordan Gilbert (USU)
- Josh Gilbert (USU)
- Konrad Hafen (USU)
- Brad Higginson (USFS)
- Thad Heater (SGI)

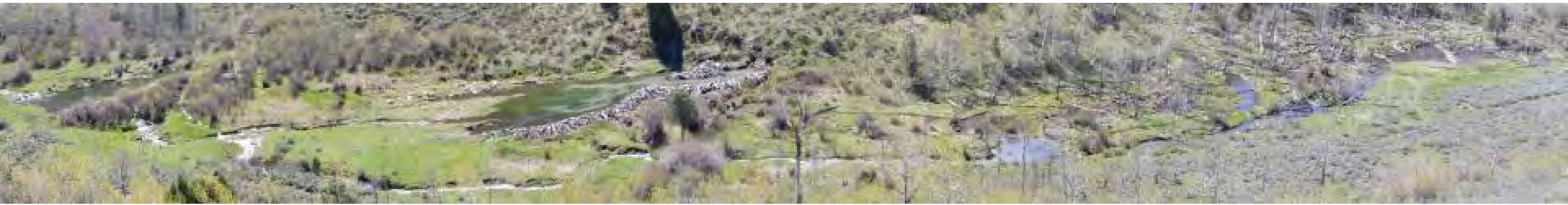
Scott Shahverdian

- Frank Howe (UDWR/USU)
- Chris Jordan (NOAA)
- Justin Jimenz (BLM)
- Timmie Mandish (NRCS)
- Marcus Miller (NRCS)
- Elijah Portugal (NRS)
- Michael Pollock (NOAA)
- Brett Roper (USFS)
- Kent Sorenson (UDWR)

- Jay & Diane Tanner
- Eric Thacker (USU)
- Carol Volk (SFR)
- Nick Weber (ELR/ Anabranch)
- Jay Wilde
- Nick Silverman (UM)
- And many others… we're neglecting

PURPOSE OF TALK

- Explain the connection between mesic riparian areas and sage grouse in the arid West
- Talk about role beaver can play in creating and maintaining mesic habitats
- Show how beaver dam analogues can act as meals to kick start and accelerate process of wetting & greening up



OUTLINE

I. **Background on sage grouse & mesic habitats**

II. Scope of mesic/riparian degradation

III. Partnering with beaver as cheap and cheerful restoration of mesic habitats

IV. Beaver Dam Analog Case Studies

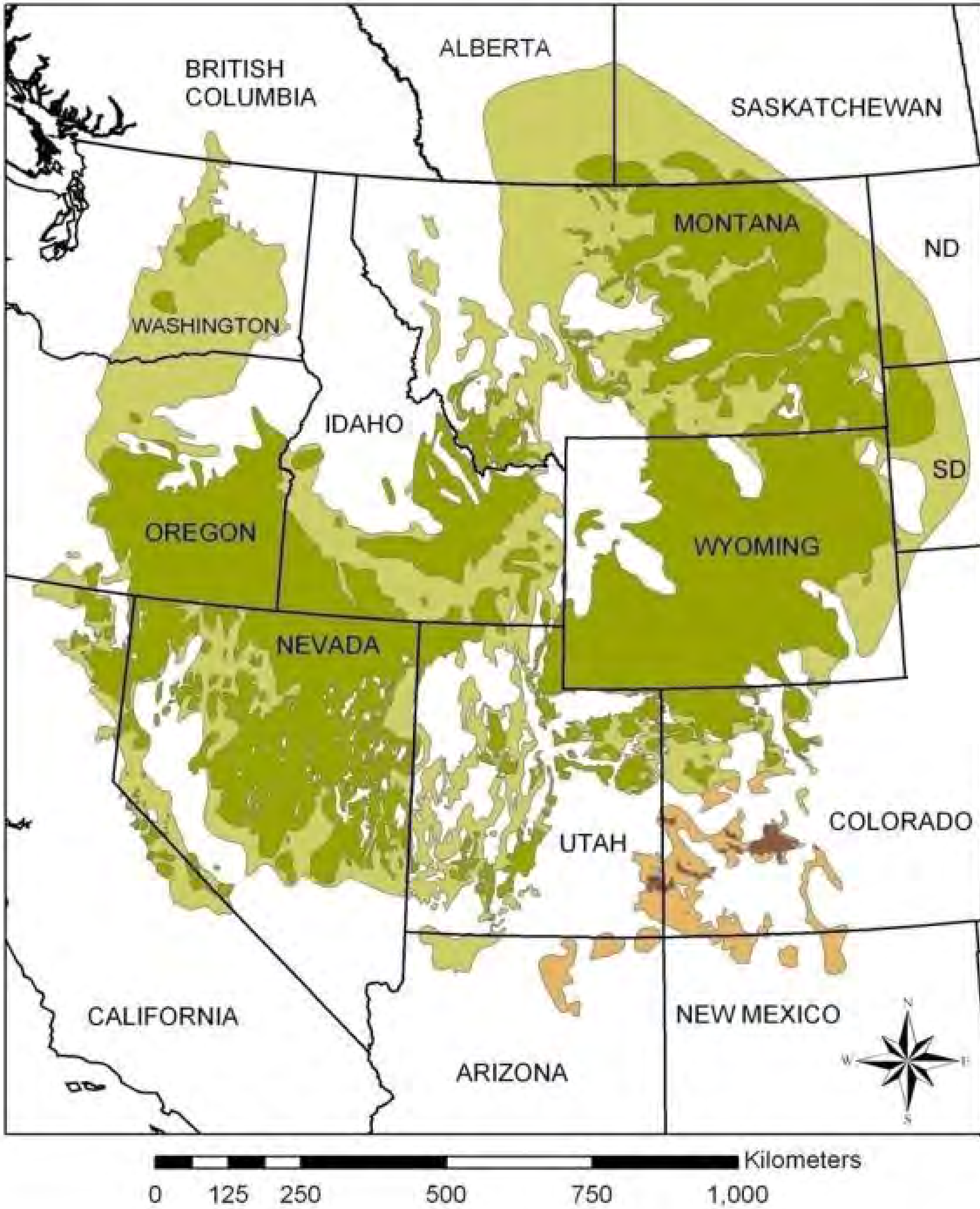
  I. Bridge Creek, OR (fish)

  II. Birch Creek, ID (hydrology)

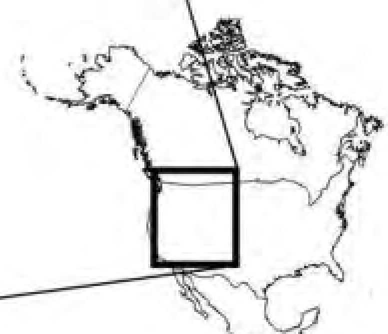
  III. Grouse Creek, UT (grouse & hydrology)

V. General BDA Planning & Design Principles

VI. Summary/Resources



Bellwether for health of sagebrush ecosystem



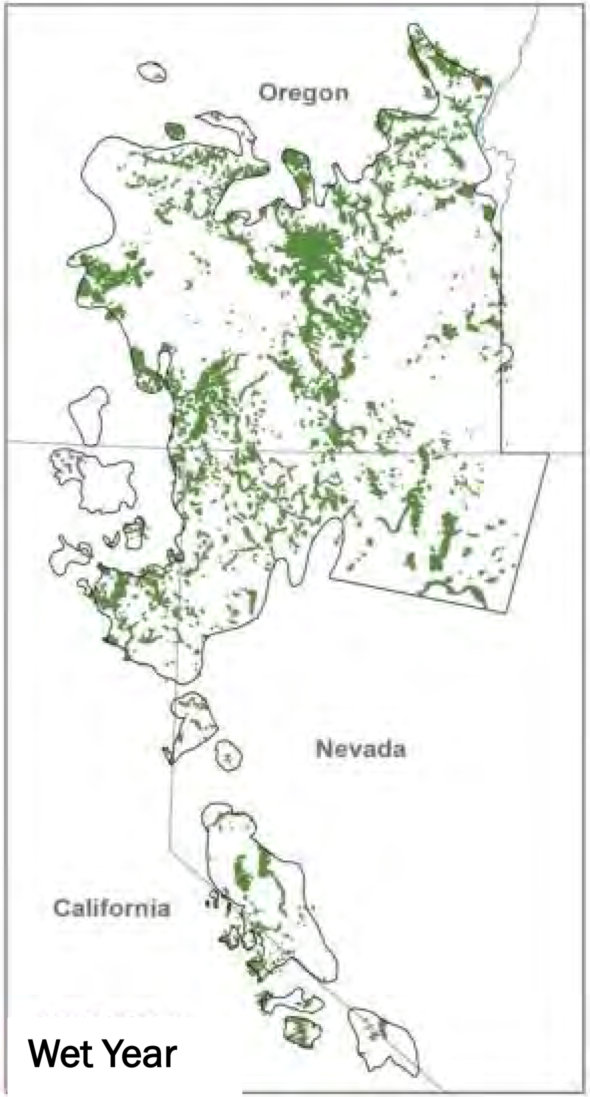
Produced by C.L. Aldridge, after Schroeder et al. 2004, Condor 106:363-376

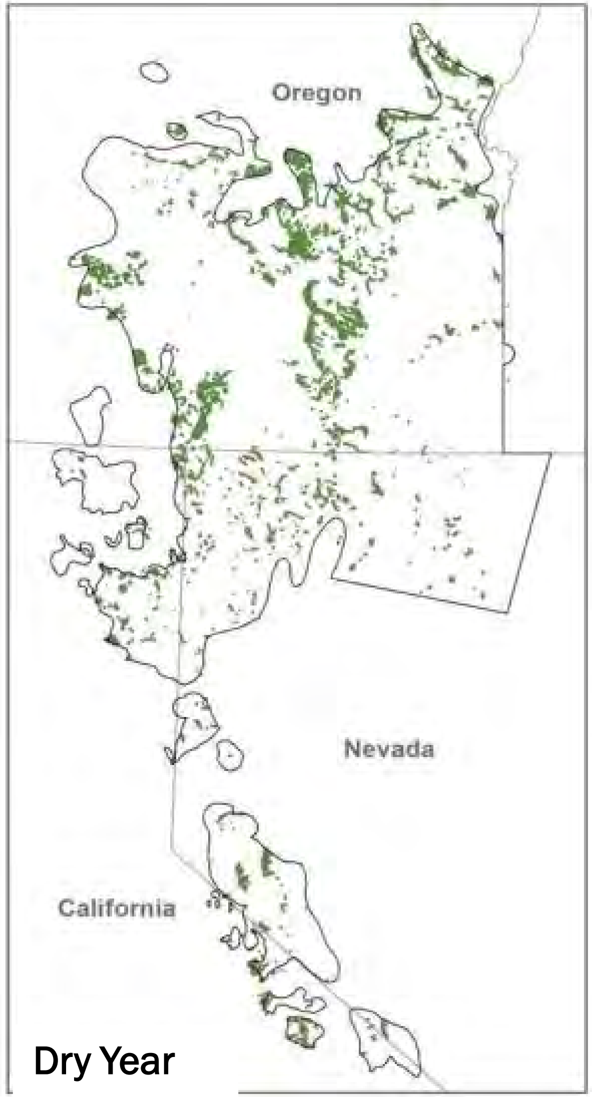
“Largest land conservation effort in U.S. history”

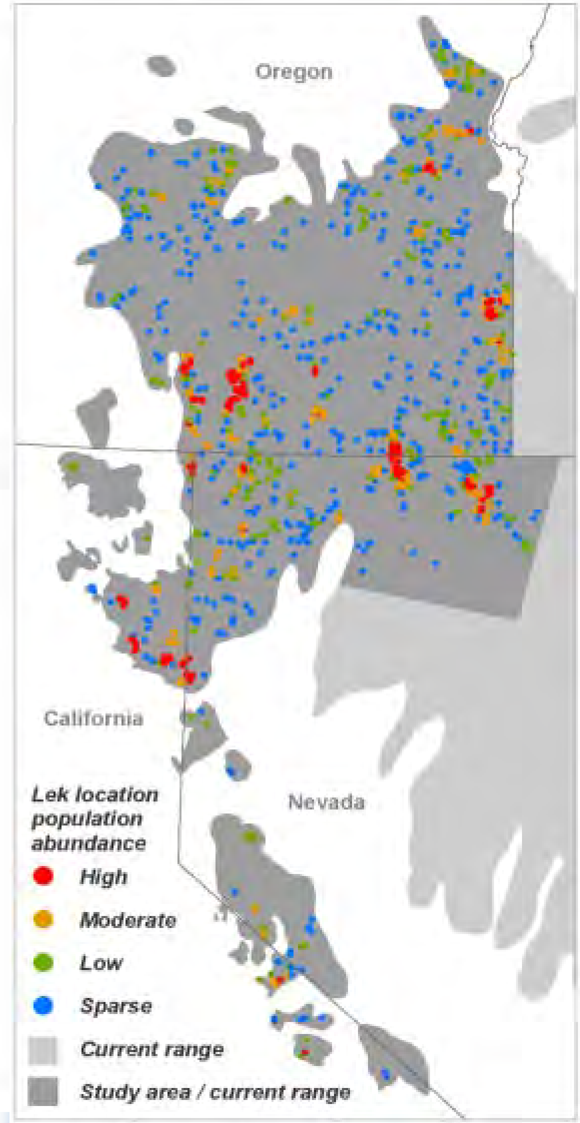
Former Secretary of Interior Sally Jewell

Nesting/ Early Brood-Rearing
Late Brood-Rearing
Fall/ Winter
Lekking/ Breeding

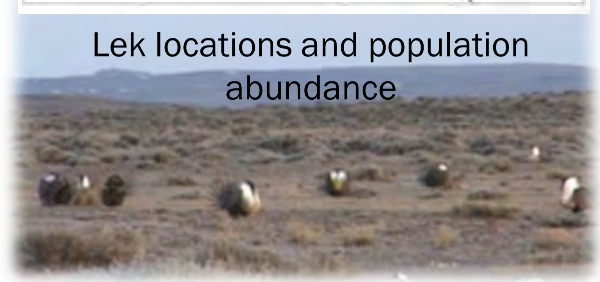
When we say "emerald islands"…..
this is what we're referring to





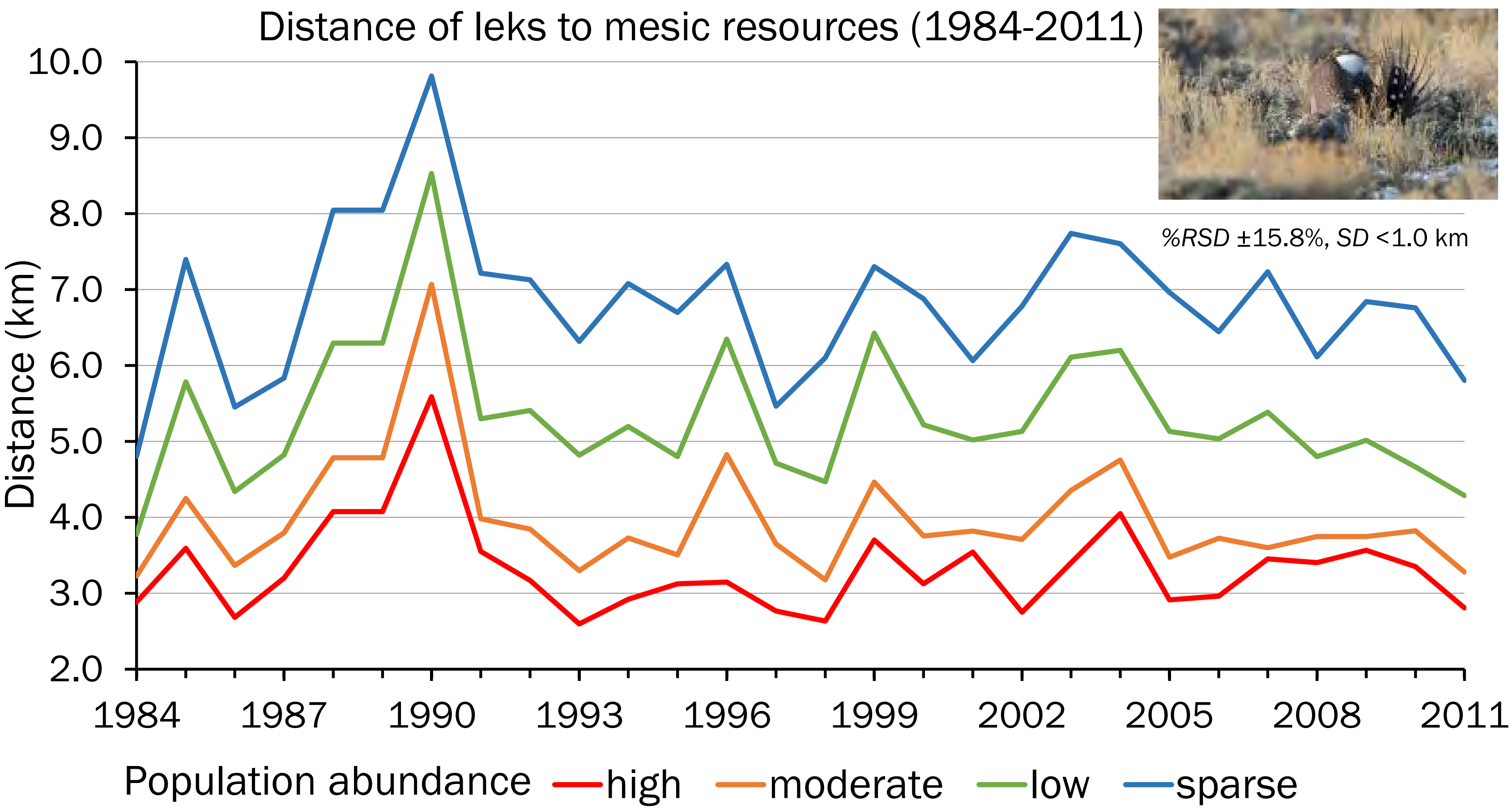


Spatiotemporal availability of mesic resources (1984-2011)



Lek locations and population abundance

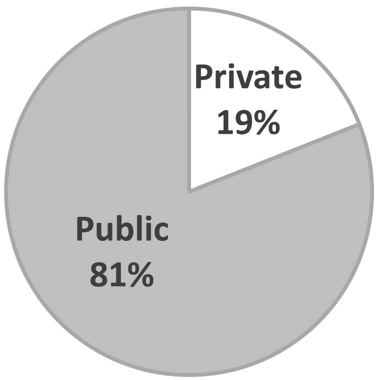
Donnelly et al. 2016 Ecosphere. DOI: [10.1002/ecs2.1208](10.1002/ecs2.1208)



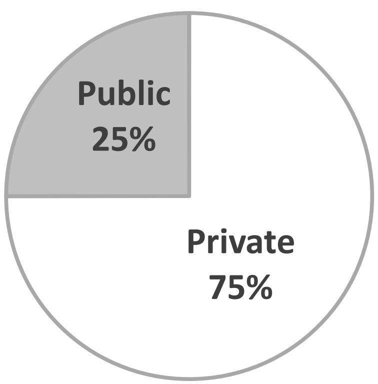
Donnelly et al. 2016 Ecosphere.
DOI: 10.1002/ecs2.1208

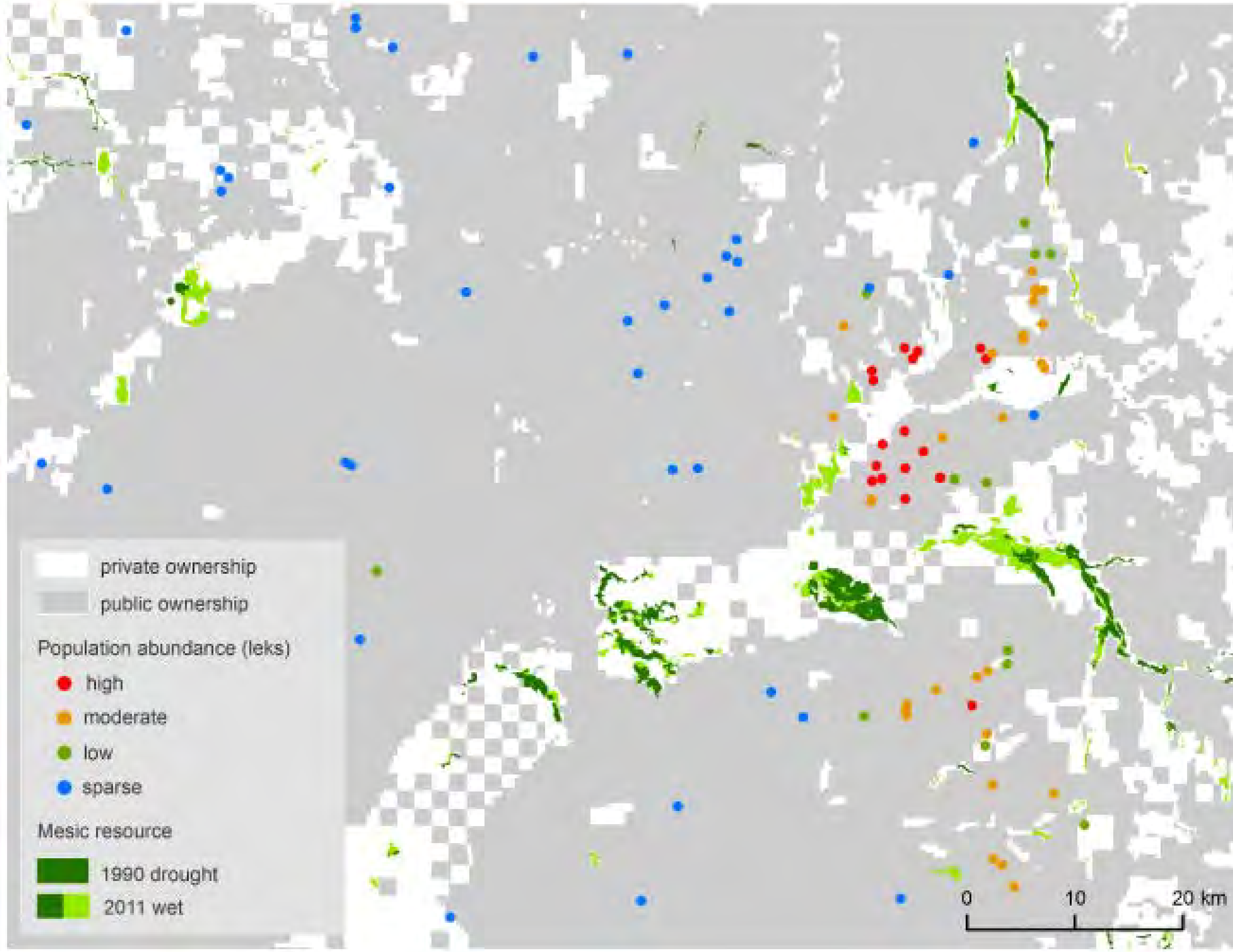
PUBLIC LANDS AND PRIVATE WATERS

Overall Ownership



Mesic Resources





Mesic areas represent <2% of the landscape

Donnelly et al. 2016 Ecosphere.
DOI: 10.1002/ecs2.1208


WA
MT
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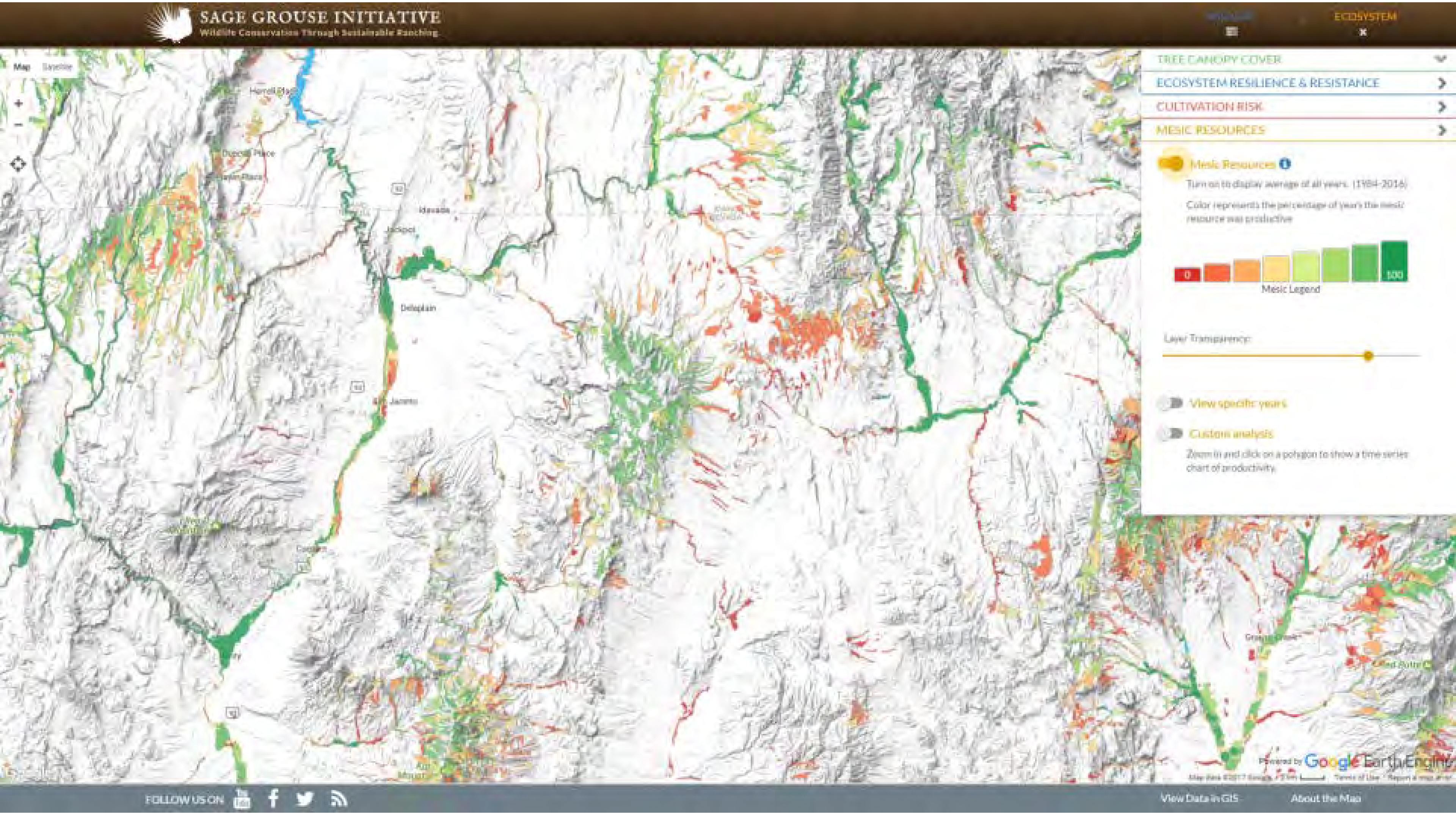
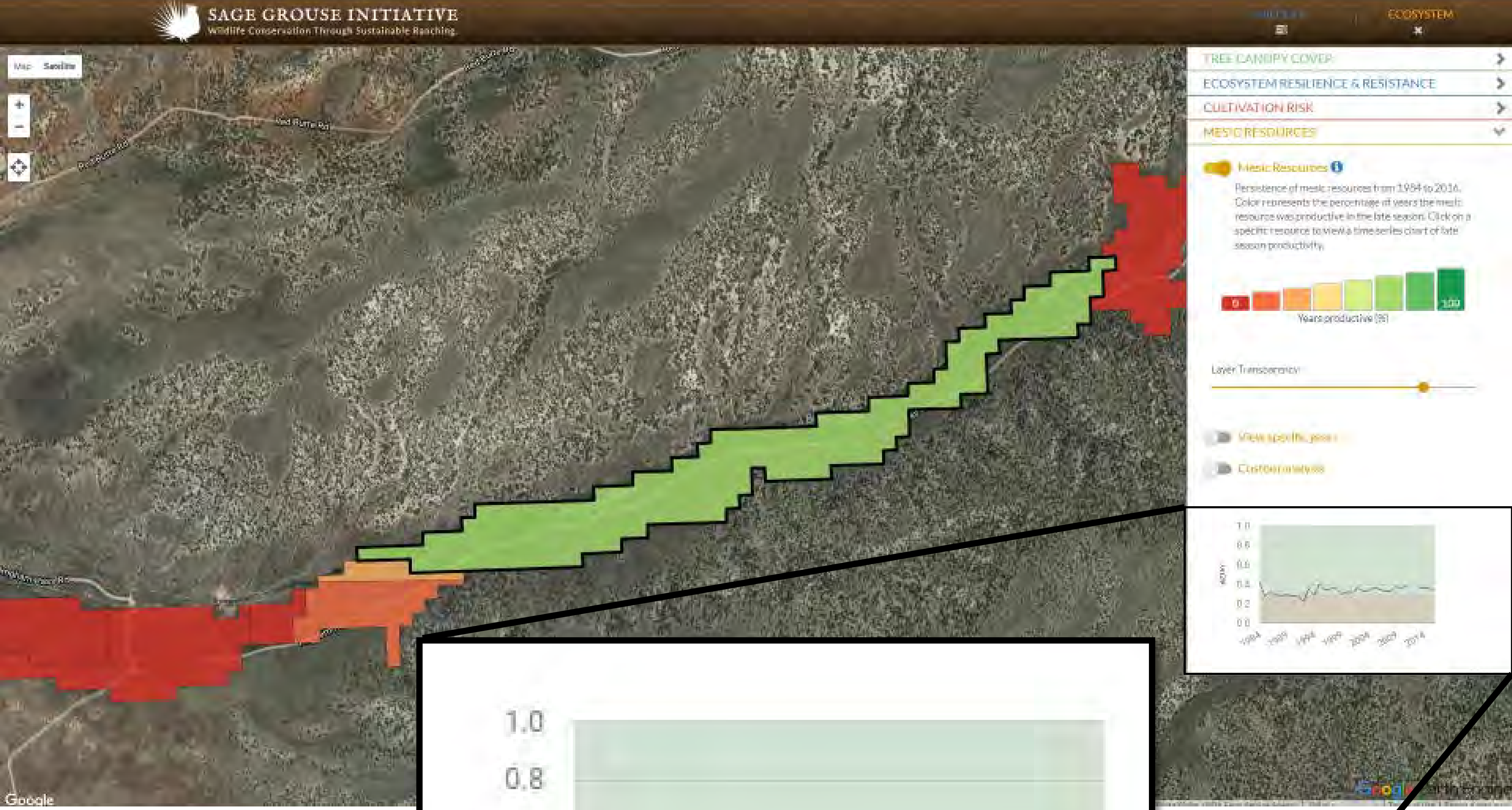
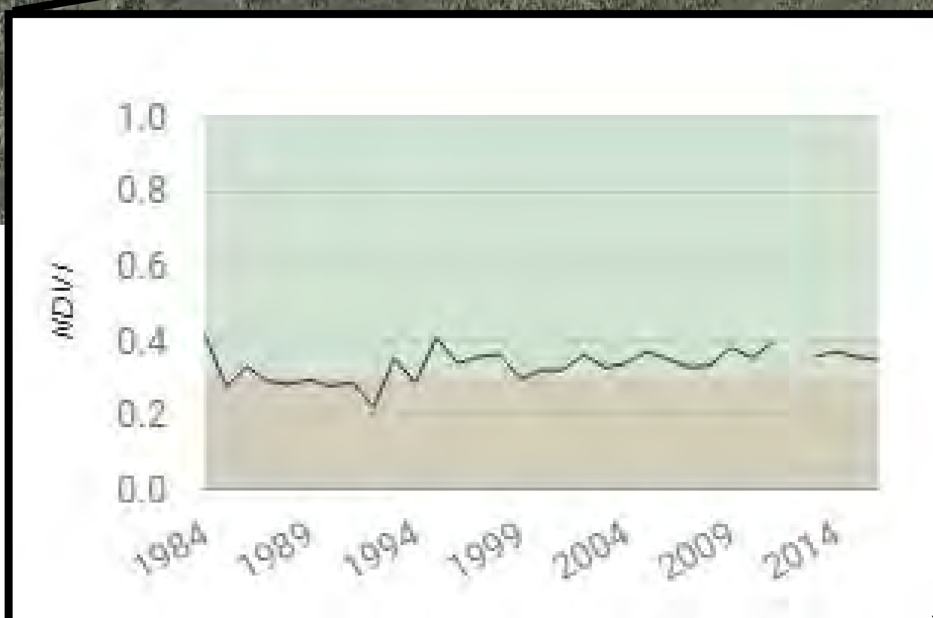


map.sagegrouseinitiative.com





Google Earth Engine

map.sagegrouseinitiative.com

Natural Storage
Soil Moisture
Productivity
Resiliency

ON THE RANGE, WATER IS LIFE

Photo by: MT Stockgrowers Assoc.

SGI EXPANDS TO ENCOMPASS MESIC AREAS

Conifer Expansion

Wildfire & Invasives

Residential Development

SAGE GROUSE INITIATIVE

Grazing Land Cultivation

Infrastructure

Mesic Area Loss and Degradation

1,500 ranchers enrolled, 5.6 million acres conserved in 7 years
Equivalent to 2.5 Yellowstone National Parks

sagegrouseinitiative.com

CONSERVING MESIC AREAS THROUGH THE LENS OF SAGE GROUSE

"Strategically protect, restore, or enhance mesic areas ('green spots') so sage-grouse hens and chicks can more readily and reliably access forb- and insect-rich summer habitats"

Photo by: Tom Koerner

HOW SGI IS PARTNERING WITH RANCHERS

Higher Cost, Limited Extent

- Conservation easements
- Mechanical restoration

Lower Cost, Broader Extent

- Grazing management
- Spring protection and enhancement
- Conifer removal
- Low-tech restoration ("sticks and stones")

Photo by: Utah NRCS

www.sagegrouseinitiative.com/water-is-life/

OUTLINE

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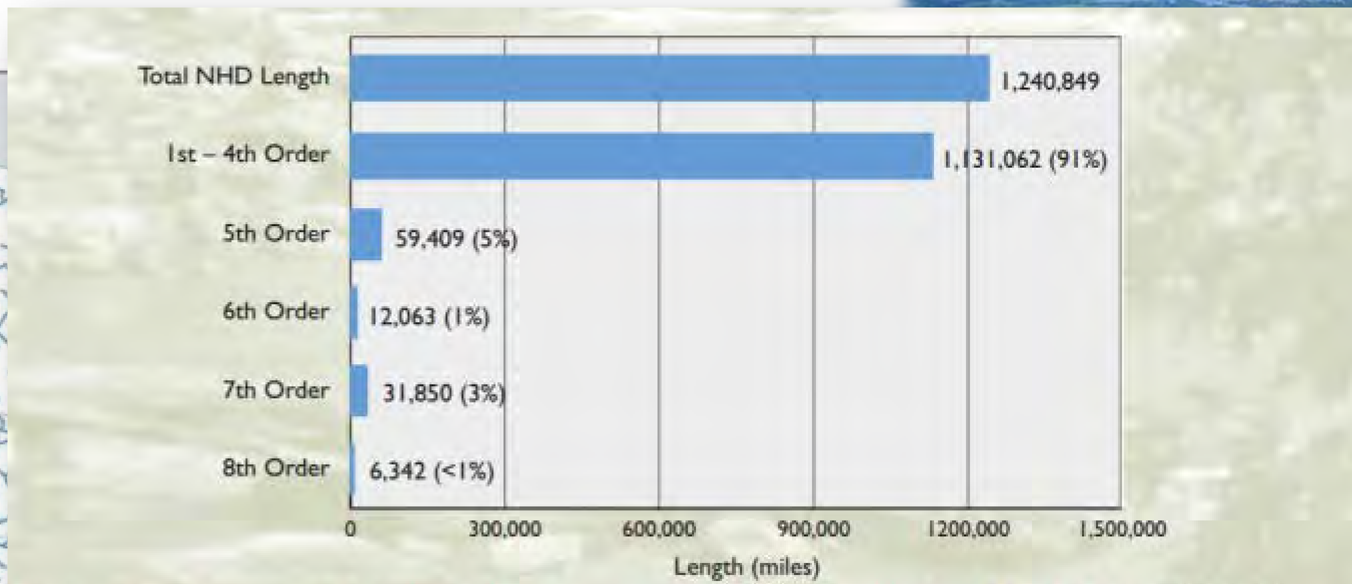
BIG RIVERS ARE IMPORTANT, BUT...

- They constitute < 3% of the 3.5 million miles of streams in US...



Estimate of perennial length of streams and rivers from the NHD (U.S. EPA/WSA). The 1st- through 4th-order streams comprise 91% of total estimated stream length in the NHD. The 1st- through 5th-order streams form the basis for the sampling design frame for the WSA.

US EPA (2007)

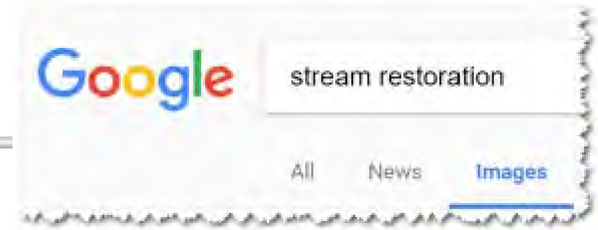
Figure 3. Major rivers and streams of the conterminous United States (NationalAtlas.gov, 2006). Major rivers comprise only 10% of the length of U.S. flowing waters, whereas the nation's wadeable streams and rivers comprise 90% of the length of U.S. flowing waters.

PROBLEM IS SIMPLE TO STATE...

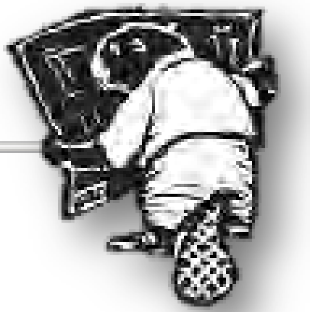
- Scope of stream and mesic riparian degradation is massive
- Even with >> $10 Billion spent annually, barely scratching surface
- We spend disproportionate amount of money on too few miles of streams and rivers
- Leaving millions of miles neglected...

USGS

WHY ALWAYS TONKA TOYS?



THE RIVER HEALTH ANALOGY…



- What is a healthy diet for a river?
- Different rivers have different metabolisms.
- What is role of exercise in a healthy life-style?
- What is it beaver do? What could BDAs do?
- Premise:
  - Most existing restoration practices akin to medical procedures & treatments
  - Using beaver as a restoration agent is more like helping prepare meals for a system
  - Ultimate goal is 'system' can self-prepare its own meals (i.e. self-sustaining) and exercise on its own

2017. Wheaton JM. What is a river's health? What role do restoration treatments play in improving or sustaining good health? Upper Midwest Stream Restoration Symposium. La Crosse, WI. DOI: 10.13140/RG.2.2.15857.48486 ·

A BDA recipe just helps you prepare one dish in a meal

TYPICAL RESTORATION PROCEDURE

- Surgery (channel realignment/grading)

1. *Shaving* and clearing the surface (remove vegetation)
2. *Opening* the system up with (i.e. cutting an access route in)
3. Rearranging what's inside or *operating* (i.e. the grading*)*
4. *Stitching* the cut back up (e.g. re-seeing, erosion control, planting)
5. Over fortify channel with preservatives (rip rap) over fear it might *exercise*

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DON'T MISUNDERSTAND US…

- We're not saying that surgery is always bad or not necessary in some cases

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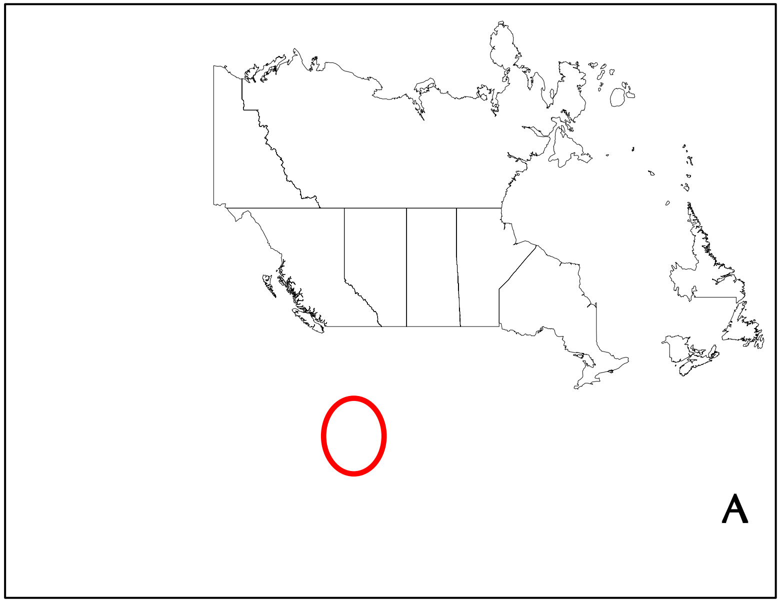
BEAVER HISTORY...

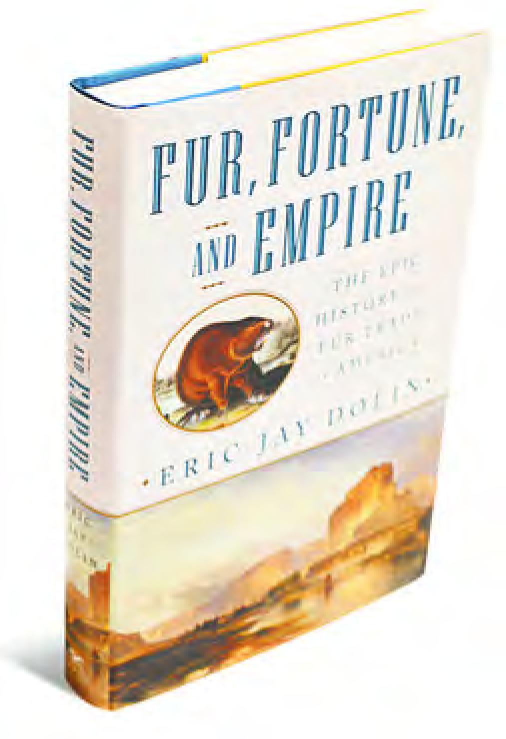
- Historically, est. 60–400 million pre-European settlement
- Extirpated to near extinction by late 1800s
- Currently, est. 6-12 million
- Spatial distribution approaches its historical range



Slide from John Stella
Pollock et al. (2013)

BEAVER WERE THE MAIN REASON EUROPEANS CAME HERE!

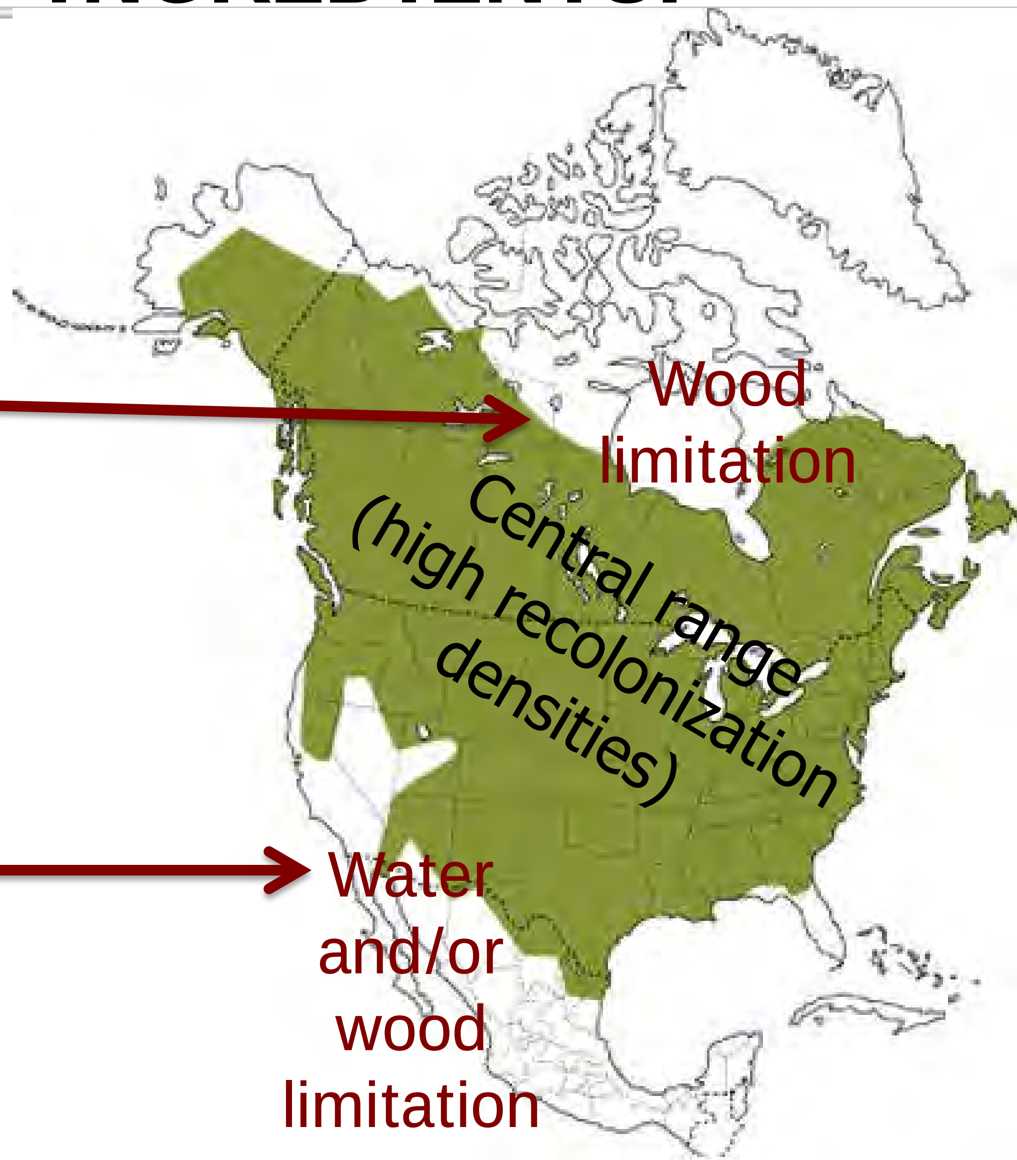
- From 1600s to 1800s beaver essentially extirpated...
- Their pelts were ‘worth more than gold’
- Beaver Wars
- Today, a pelt goes for $8 - $20... even in 1700s they went for $30!



Fascinating read
Dolin (2011)

COMMON HABITAT INGREDIENTS: WATER + TREES

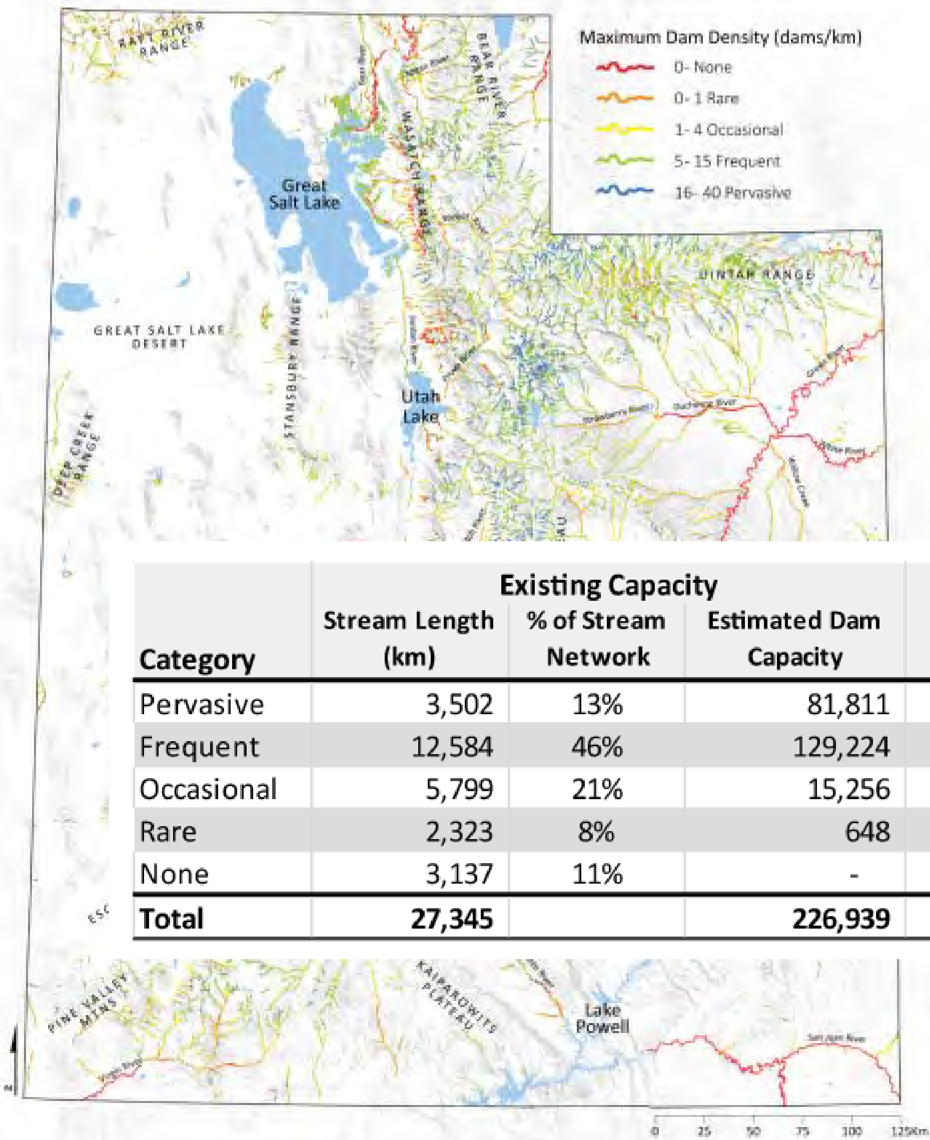
- Northern tundra and treeline range boundary: wood limitation
- Southern desert range boundary: perennial streamflow and/or wood limitation



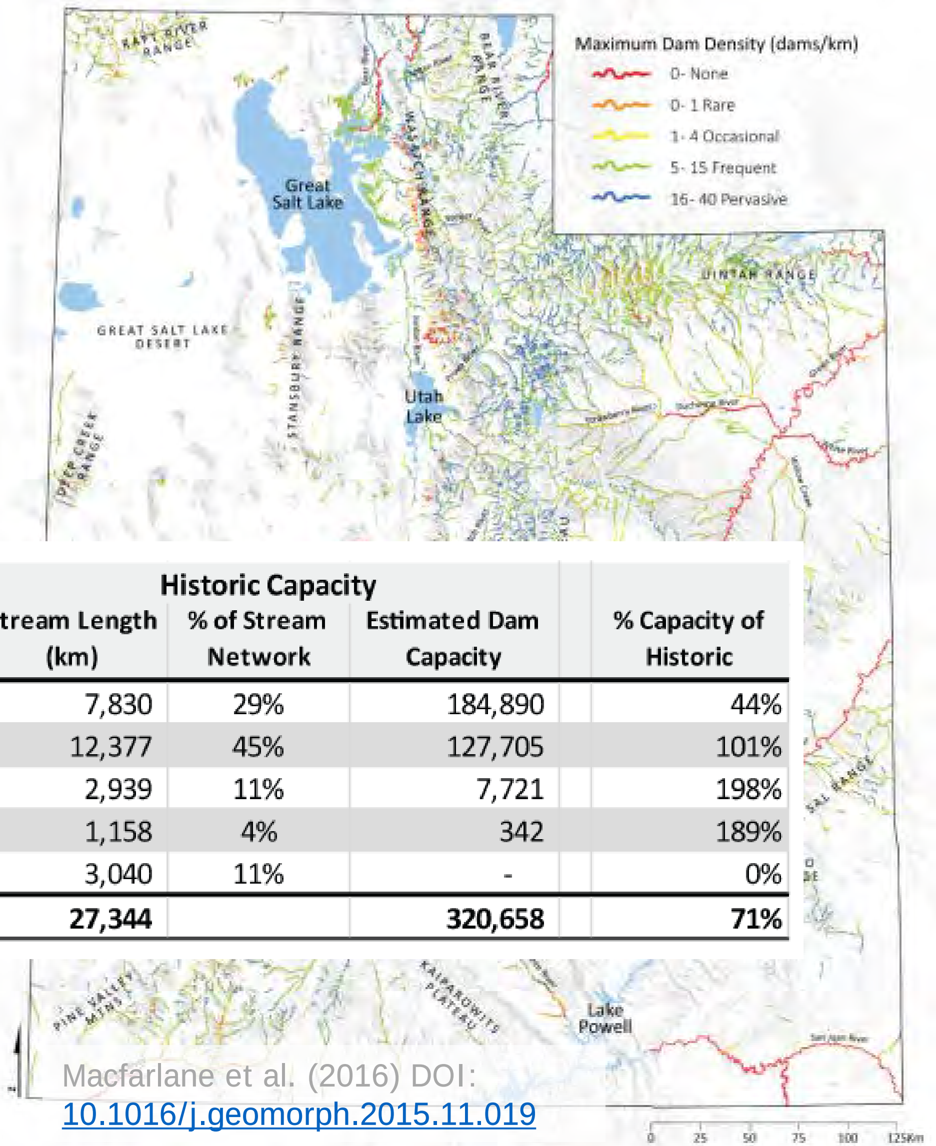
Slide from John Stella

EXISTING VS. HISTORIC CAPACITY - UTAH

WHAT IT IS...



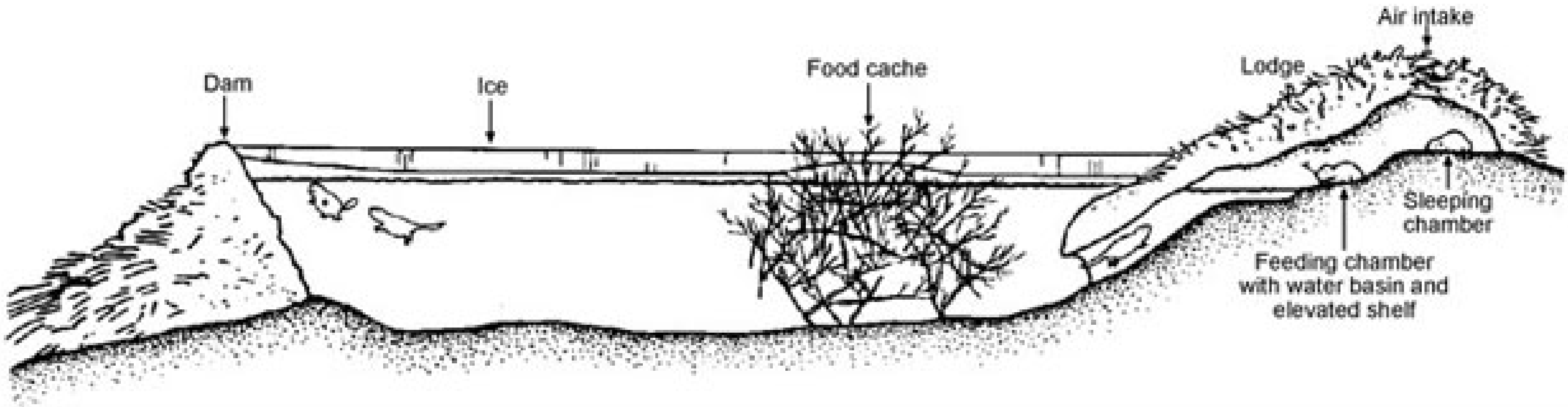
WHAT IT WAS...



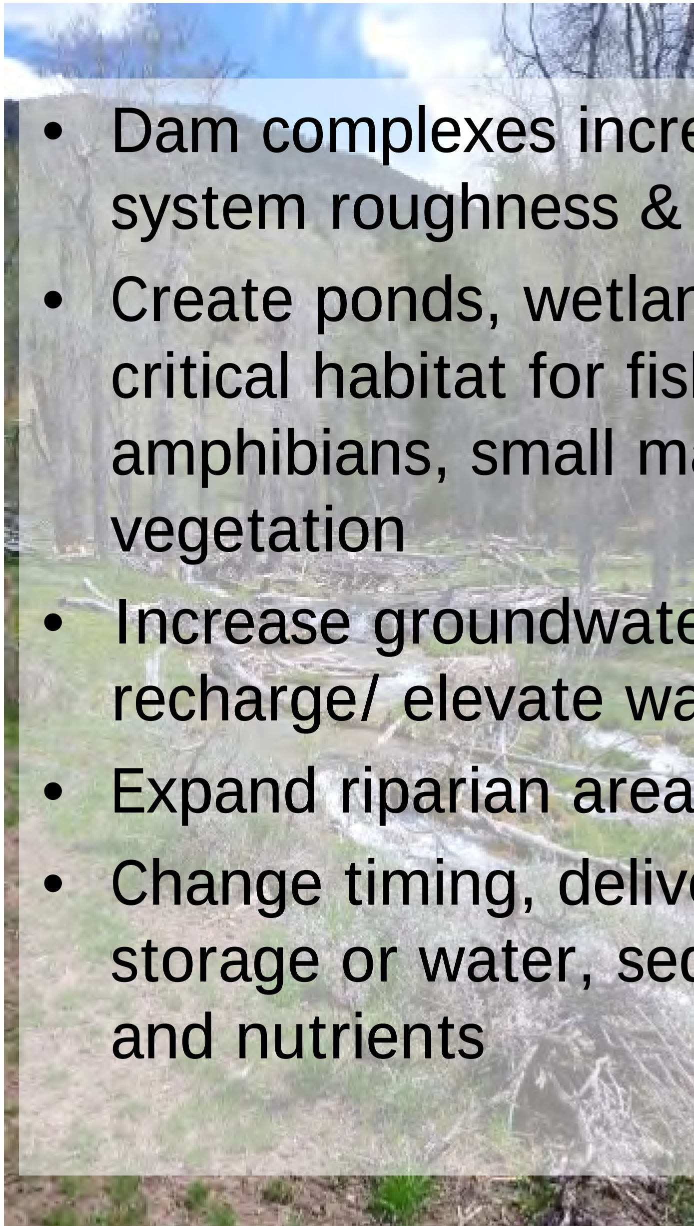
	Existing Capacity			Historic Capacity			
Category	**Stream Length (km)**	**% of Stream Network**	**Estimated Dam Capacity**	**Stream Length (km)**	**% of Stream Network**	**Estimated Dam Capacity**	**% Capacity of Historic**
Pervasive	3,502	13%	81,811	7,830	29%	184,890	44%
Frequent	12,584	46%	129,224	12,377	45%	127,705	101%
Occasional	5,799	21%	15,256	2,939	11%	7,721	198%
Rare	2,323	8%	648	1,158	4%	342	189%
None	3,137	11%	-	3,040	11%	-	0%
Total	**27,345**		**226,939**	**27,344**		**320,658**	**71%**

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

SO WHY DO THEY BUILD DAMS?



BEAVER LIKE TO MAKE MESSES



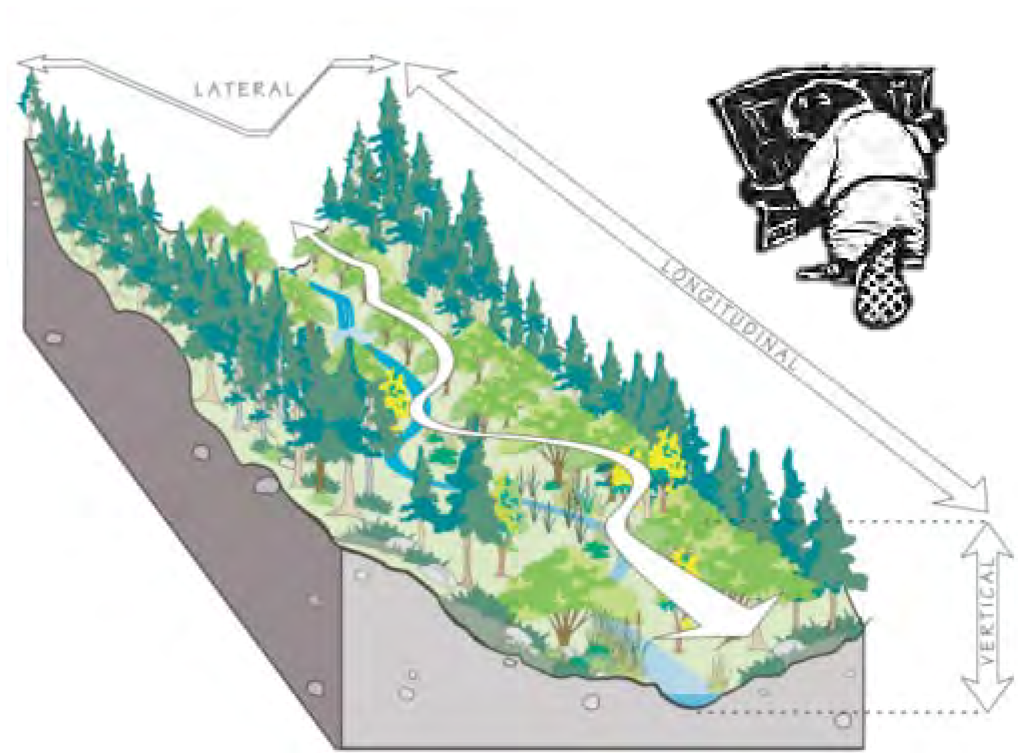
- Dam complexes increase system roughness & resilience
- Create ponds, wetlands & critical habitat for fish, amphibians, small mammals, vegetation
- Increase groundwater recharge/ elevate water tables
- Expand riparian areas
- Change timing, delivery and storage or water, sediment and nutrients

But it is precisely that messiness, that is so critical to ecosystem health

Bird et al. (2011)

CONNECTIVITY & BEAVER DAMS?

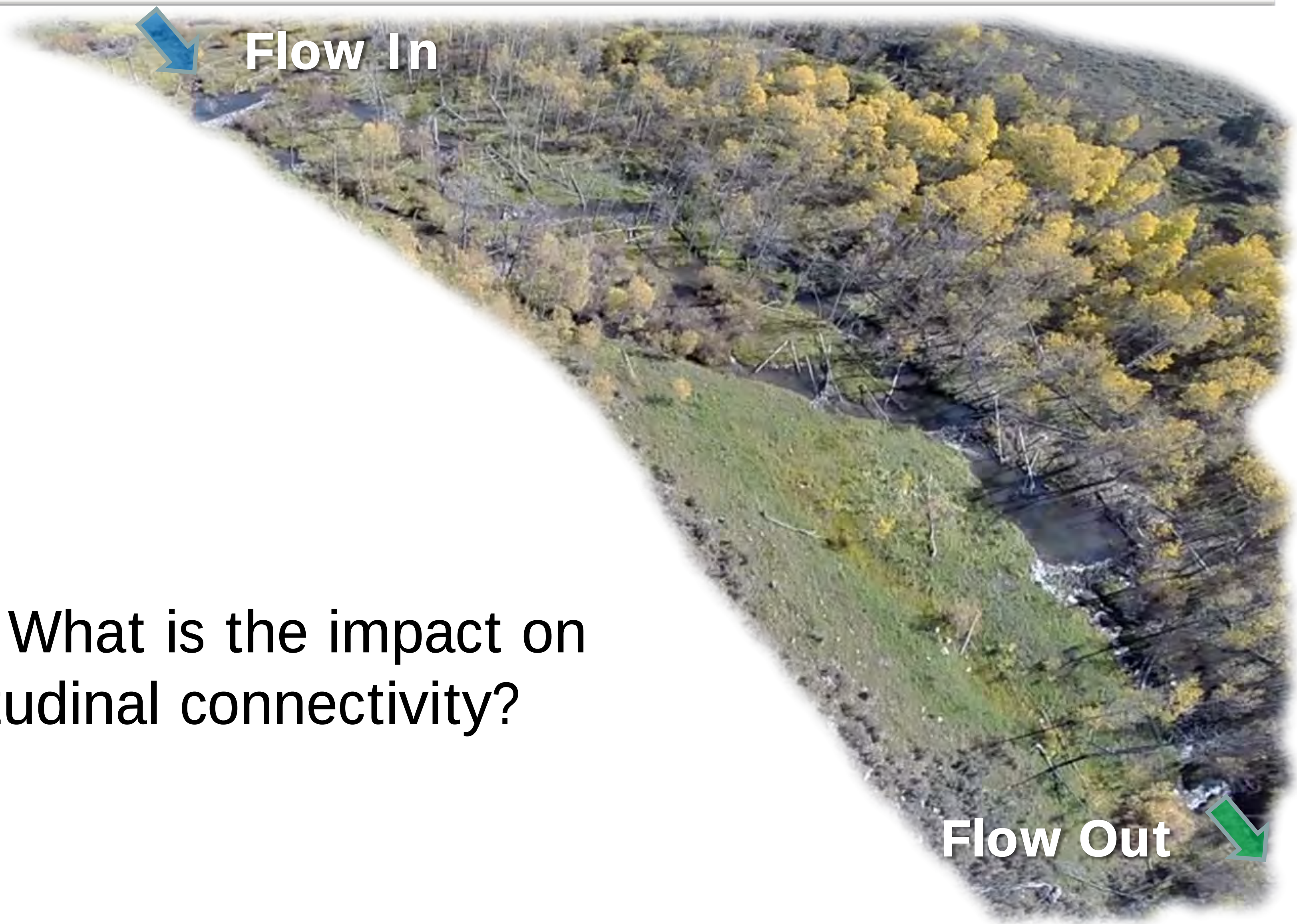
- **Vertical connectivity** increased by increasing:
  - stage, hydraulic head
  - hyporheic exchanges and groundwater exchanges
- That drives increases in **lateral connectivity** and increases channel-floodplain interactions



- **Longitudinal connectivity** is decreased by:
  - Slowing, diverting and obstructing flow
  - Changing the timing, delivery and **diversifying residence time** of water, sediment, nutrients, carbon, wood, etc.

Figure From: USFS (2004) Riparian Restoration (SDTDC 04231 1201)

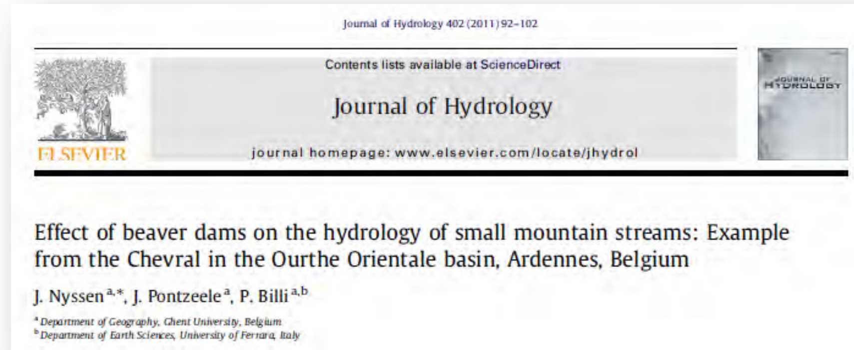
HOW DOES FLOW CHANGE WITH DAMS?



- i.e. – What is the impact on longitudinal connectivity?

TYPICAL IMPACT ON FLOWS

- Lower peaks @ flood
- Elevated baseflow following


Journal of Hydrology 402 (2011) 92–102

Contents lists available at ScienceDirect

Journal of Hydrology

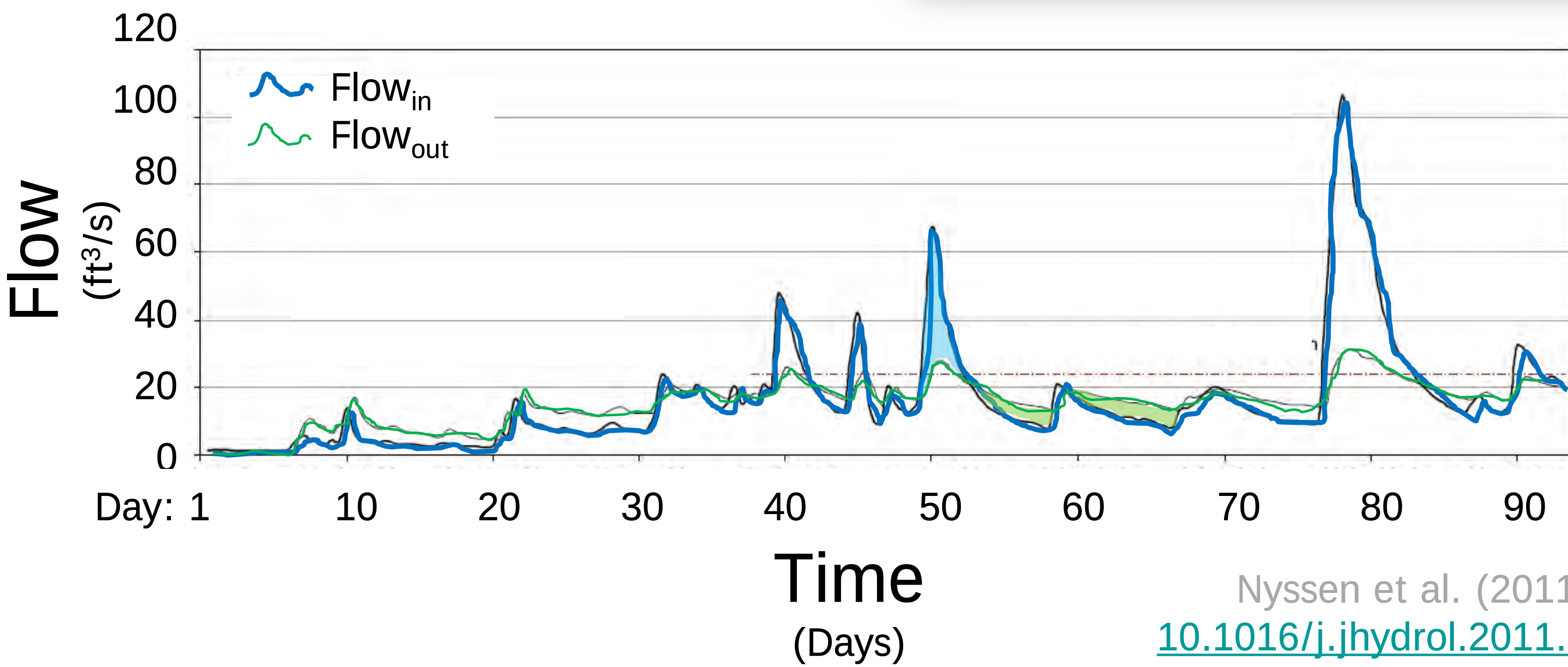
journal homepage: www.elsevier.com/locate/jhydrol

ELSEVIER

Effect of beaver dams on the hydrology of small mountain streams: Example from the Chevral in the Ourthe Orientale basin, Ardennes, Belgium

J. Nyssen[a,*], J. Pontzeele[a], P. Billi[a,b]

[a] Department of Geography, Ghent University, Belgium
[b] Department of Earth Sciences, University of Ferrara, Italy



Nyssen et al. (2011) DOI: 10.1016/j.jhydrol.2011.03.008

WE SEE THESE *LOCAL* TIMING IMPACTS IN MANY SMALL STREAMS…

Science of the Total Environment 576 (2017) 430–443

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Eurasian beaver activity increases water storage, attenuates flow and mitigates diffuse pollution from intensively-managed grasslands

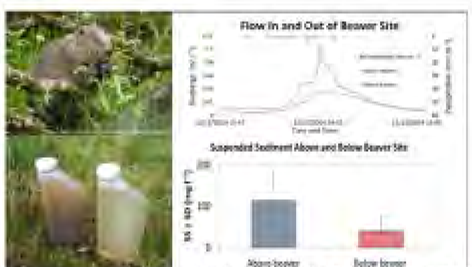
Alan Puttock [a,*], Hugh A. Graham [a], Andrew M. Cunliffe [a], Mark Elliott [b], Richard E. Brazier [a]

[a] Geography, University of Exeter, Exeter, United Kingdom
[b] Devon Wildlife Trust, Cricklepit Mill, Exeter, United Kingdom

HIGHLIGHTS

- Beavers in wooded site, on first order tributary draining from agricultural land.
- Beaver activity has resulted in major changes to ecosystem structure at the site.
- Beaver activity increased water storage within site and attenuated flow.
- Reduced sediment, N and P, but more DOC in water leaving site.
- Important implications for nature based solutions to catchment management issues.

GRAPHICAL ABSTRACT



Hydrol. Earth Syst. Sci., 19, 3541–3556, 2015
www.hydrol-earth-syst-sci.net/19/3541/2015/
doi:10.5194/hess-19-3541-2015

Hydrology and Earth System Sciences

Impacts of beaver dams on hydrologic and temperature regimes in a mountain stream

M. Majerova[1], B. T. Neilson[1], N. M. Schmadel[1], J. M. Wheaton[2], and C. J. Snow[3]

[1]Utah Water Research Laboratory, Department of Civil and Environmental Engineering, Utah State University, 8200 Old Main Hill, Logan, Utah, 84322-8200, USA
[2]Department of Watershed Sciences, Utah State University, 8200 Old Main Hill, Logan, Utah 84322-8200, USA

Correspondence to: M. Majerova (milada.majerova@gmail.com) and B. T. Neilson (bethany.neilson@usu.edu)

Received: 3 December 2014 – Published in Hydrol. Earth Syst. Sci. Discuss.: 22 January 2015
Revised: 30 June 2015 – Accepted: 2 July 2015 – Published: 11 August 2015

Abstract. Beaver dams affect hydrologic processes, channel complexity, and stream temperature in part by inundating riparian areas, influencing groundwater–surface water interactions, and changing fluvial processes within stream systems. … understand the impacts of beaver dams on stream ecosystems and their potential role in stream restoration.

- Has lead to the extrapolation of impacts on hydrologic connectivity
- But, we DO NOT know how these local impacts scale-up and culminate…

IN THEIR ECOSYSTEM ENGINEERING, THEY CREATE STARK CONTRASTS

(ESPECIALLY FOR SAGEBRUSH ECOSYSTEMS)

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TYPES OF RESTORATION WITH BEAVER

1. **Promote & protect** beaver where they are (encourage accidental restoration)
2. **Transplant** nuisance beaver
3. Use **beaver dam analogues** (BDAs) to give them head-start (or w/o beaver)

WHY THE FOCUS ON BDAs TODAY?

- Proper pacing
  - Land managers hungry for cheaper alternatives but may not be ready to hand over the system to beaver
- Restoration needed at meaningful scales
  - BDAs allow more people to engage in riparian restoration at large scales
- BDAs aren't just for beaver
  - Can be used to mimic beaver activity in many types of incised channels to kickstart desirable processes
  - Slow water + trap sediment + raise water tables + inundate floodplains = more green groceries (with stronger roots)

THIS IS GOOD SAGE GROUSE HABITAT…

USDA NRCS

UTAH's WATERSHED RESTORATION INITIATIVE

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UtahState University
DEPARTMENT OF WATERSHED SCIENCES


BDAs CAN BE USED TO PROMOTE HYDROLOGIC FUNCTION AND RIPARIAN RECOVERY (with or without beaver)

NOTHING SELLS CONSERVATION LIKE MORE WATER AND GREEN GROCERIES

Susie Creek, NV

"By 2014, even in the midst of severe drought, Susie Creek had water all summer. A lot of my peers were having to haul water to stock."
~ Jon Griggs,
Maggie Creek Ranch

USDA NRCS

Photos by: BLM Elko District

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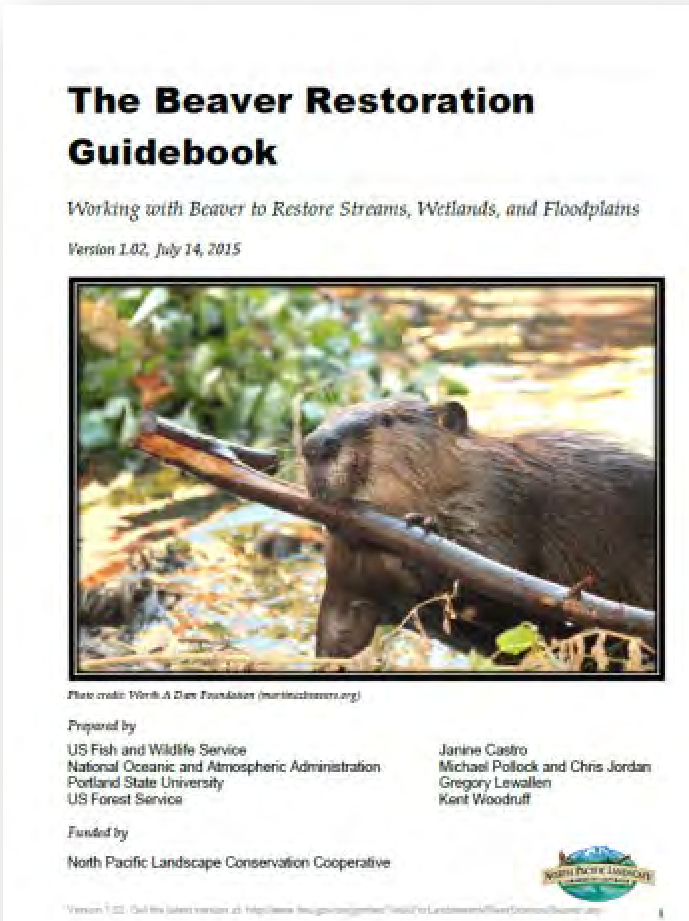
DEPARTMENT OF WATERSHED SCIENCES

BDA – BEAVER DAM ANALOGUES

- A term we made up in Pollock et al. (2012) from Bridge Creek project
- Channel-spanning structures, mimicking beaver dams



The Beaver Restoration Guidebook

Working with Beaver to Restore Streams, Wetlands, and Floodplains

Version 1.02, July 14, 2015

Photo credit: Worth A Dam Foundation (martinezbeavers.org)

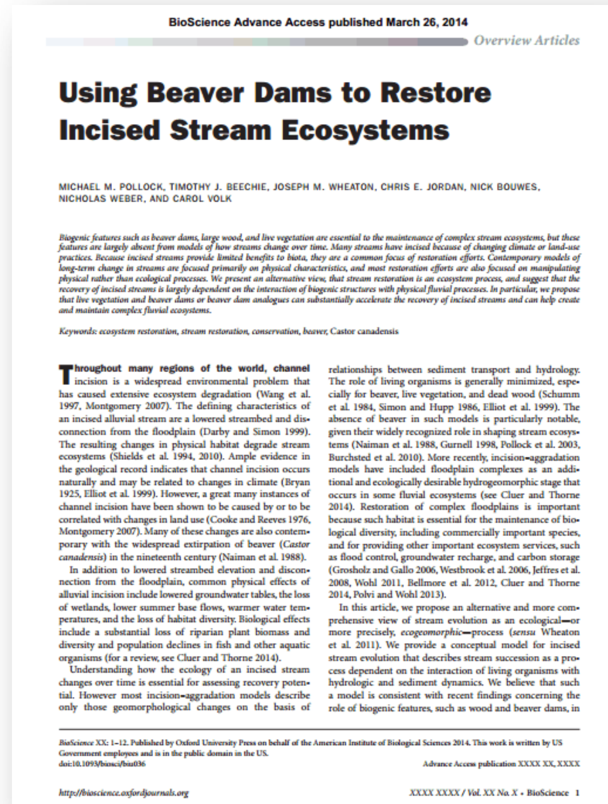
Prepared by

US Fish and Wildlife Service
National Oceanic and Atmospheric Administration
Portland State University
US Forest Service

Janine Castro
Michael Pollock and Chris Jordan
Gregory Lewallen
Kent Woodruff

Funded by

North Pacific Landscape Conservation Cooperative



BioScience Advance Access published March 26, 2014

Overview Articles

Using Beaver Dams to Restore Incised Stream Ecosystems

MICHAEL M. POLLOCK, TIMOTHY J. BEECHIE, JOSEPH M. WHEATON, CHRIS E. JORDAN, NICK BOUWES, NICHOLAS WEBER, AND CAROL VOLK

Biogenic features such as beaver dams, large wood, and live vegetation are essential to the maintenance of complex stream ecosystems, but these features are largely absent from models of how streams change over time. Many streams have incised because of changing climate or land-use practices. Because incised streams provide limited benefits to biota, they are a common focus of restoration efforts. Contemporary models of long-term change in streams are focused primarily on physical characteristics, and most restoration efforts are also focused on manipulating physical rather than ecological processes. We present an alternative view, that stream restoration is an ecosystem process, and suggest that the recovery of incised streams is largely dependent on the interaction of biogenic structures with physical fluvial processes. In particular, we propose that live vegetation and beaver dams or beaver dam analogues can substantially accelerate the recovery of incised streams and can help create and maintain complex fluvial ecosystems.

Keywords: ecosystem restoration, stream restoration, conservation, beaver, Castor canadensis

Throughout many regions of the world, channel incision is a widespread environmental problem that has caused extensive ecosystem degradation (Wang et al. 1997, Montgomery 2007). The defining characteristics of an incised alluvial stream are a lowered streambed and disconnection from the floodplain (Darby and Simon 1999). The resulting changes in physical habitat degrade stream ecosystems (Shields et al. 1994, 2010). Ample evidence in the geological record indicates that channel incision occurs naturally and may be related to changes in climate (Bryan 1925, Elliot et al. 1999). However, a great many instances of channel incision have been shown to be caused by or to be correlated with changes in land use (Cooke and Reeves 1976, Montgomery 2007). Many of these changes are also contemporary with the widespread extirpation of beaver (*Castor canadensis*) in the nineteenth century (Naiman et al. 1988).

In addition to lowered streambed elevation and disconnection from the floodplain, common physical effects of alluvial incision include lowered groundwater tables, the loss of wetlands, lower summer base flows, warmer water temperatures, and the loss of habitat diversity. Biological effects include a substantial loss of riparian plant biomass and diversity and population declines in fish and other aquatic organisms (for a review, see Cluer and Thorne 2014).

Understanding how the ecology of an incised stream changes over time is essential for assessing recovery potential. However most incision–aggradation models describe only those geomorphological changes on the basis of relationships between sediment transport and hydrology. The role of living organisms is generally minimized, especially for beaver, live vegetation, and dead wood (Schumm et al. 1984, Simon and Hupp 1986, Elliot et al. 1999). The absence of beaver in such models is particularly notable, given their widely recognized role in shaping stream ecosystems (Naiman et al. 1988, Gurnell 1998, Pollock et al. 2003, Burchsted et al. 2010). More recently, incision–aggradation models have included floodplain complexes as an additional and ecologically desirable hydrogeomorphic stage that occurs in some fluvial ecosystems (see Cluer and Thorne 2014). Restoration of complex floodplains is important because such habitat is essential for the maintenance of biological diversity, including commercially important species, and for providing other important ecosystem services, such as flood control, groundwater recharge, and carbon storage (Grosholz and Gallo 2006, Westbrook et al. 2006, Jeffres et al. 2008, Wohl 2011, Bellmore et al. 2012, Cluer and Thorne 2014, Polvi and Wohl 2013).

In this article, we propose an alternative and more comprehensive view of stream evolution as an ecological—or more precisely, *ecogeomorphic*—process (*sensu* Wheaton et al. 2011). We provide a conceptual model for incised stream evolution that describes stream succession as a process dependent on the interaction of living organisms with hydrologic and sediment dynamics. We believe that such a model is consistent with recent findings concerning the role of biogenic features, such as wood and beaver dams, in

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Advance Access publication XXXX XX, XXXX

Pollock et al. (2014) Bioscience
DOI: 10.1016/j.geomorph.2015.11.019

ORIGINAL BDA STRUCTURE TYPES

Figure 10. A typical starter dam (SF-17 at Sunflower) with willow branches woven between vertical posts and the back side sealed with rock and clay. Note the dam height is sufficient to divert flow onto the RL terrace, mimicking a stable beaver dam.

Figure 11. A post line with wicker weave is similar to a starter dam, but acts more like a weir in that water is allowed to flow through the willow branches such that low flows are not over topping the structure and the woven branches may not extend to the top of the posts. These may naturally seal up by trapping sediment and organic material moving downstream or they may be utilized by beaver. Note that beaver have started to colonize this PLWW, as evidenced by the chewed stems on the right of the photograph, aligned parallel to the flow.

Figure 12. The purpose of a post line is to provide a site where beaver can build a stable dam. They generally create little or no geomorphic changes unless utilized by beaver.

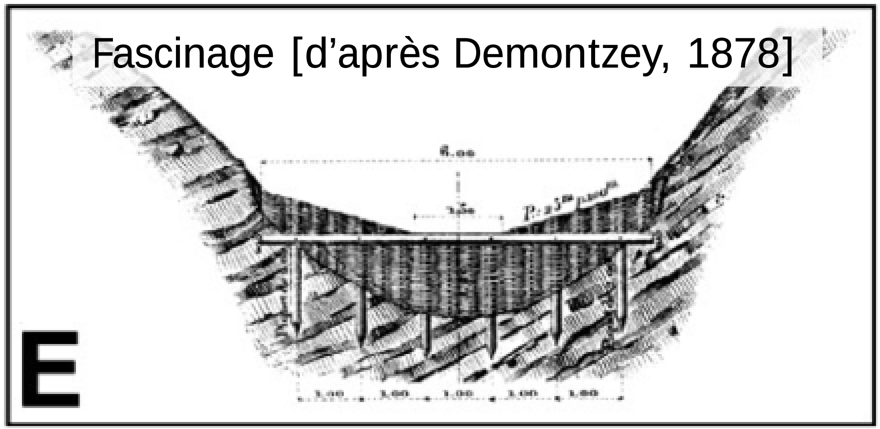
Figure 13. Any active dams within the treatment areas were strengthened with posts to lengthen their functional life, since most dams along the incised Bridge Creek have been shown to last less than a year (Demmer and Beschta, 2008). This structure was one of four dams built in sequence in Lower Owens to form a new colony. Within one year, all four dams had backfilled with sediment, which improved floodplain connectivity and habitat complexity, but made the site unsuitable for beaver. However, because we had installed additional post lines just downstream the beaver were able to use them to build new dams which allowed the colony to persist.

Design Life: < 1 year; Actual lifespan (1- 10+ years)

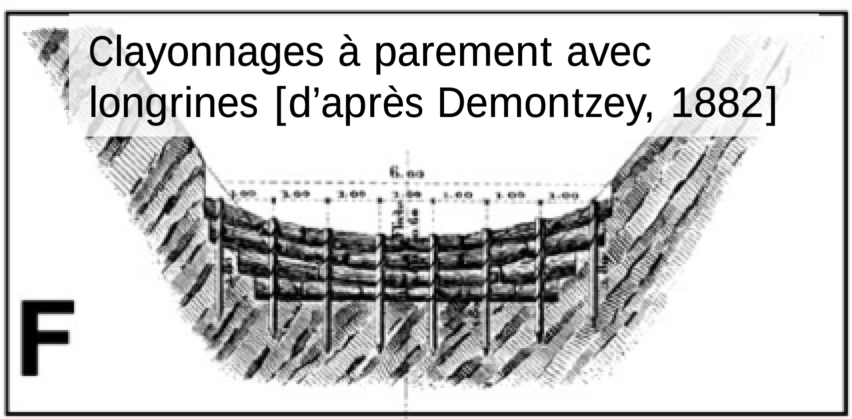
From Pollock et al. (2012)

STRUCTURAL ADDITIONS NOT A NEW IDEA...

‘Exemples de correction hydraulique torrentielle’ – Figure 66 from Frédéric Liébault (2003); used extensively in afforestation in France in 1870s-1890s

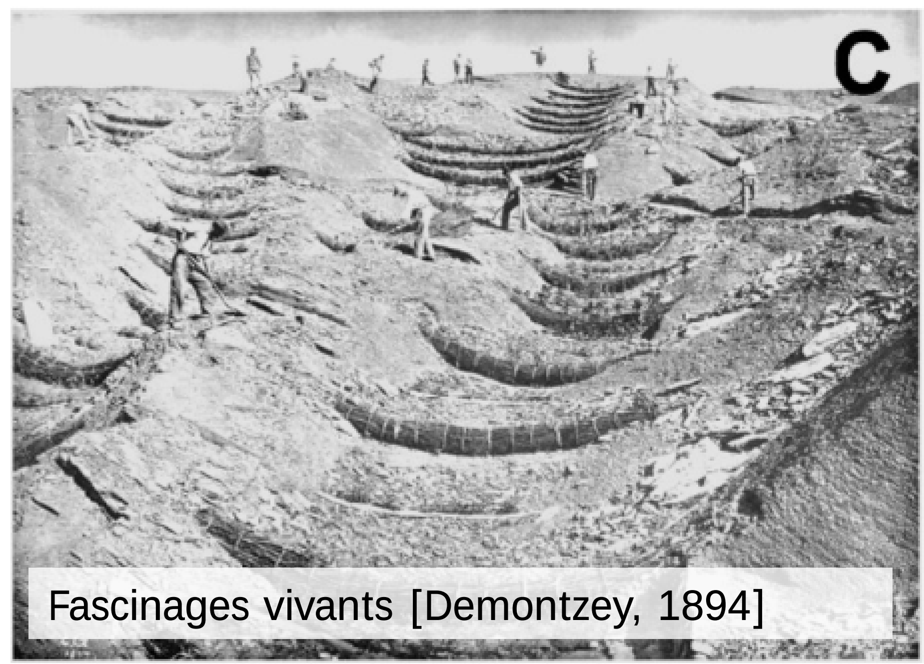


Fascinage [d’après Demontzey, 1878]



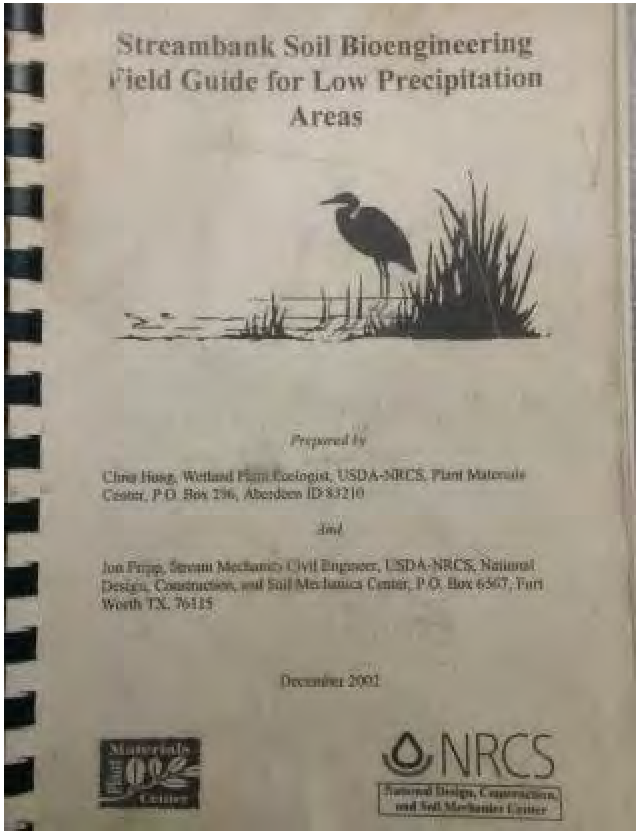
Clayonnages à parement avec longrines [d’après Demontzey, 1882]

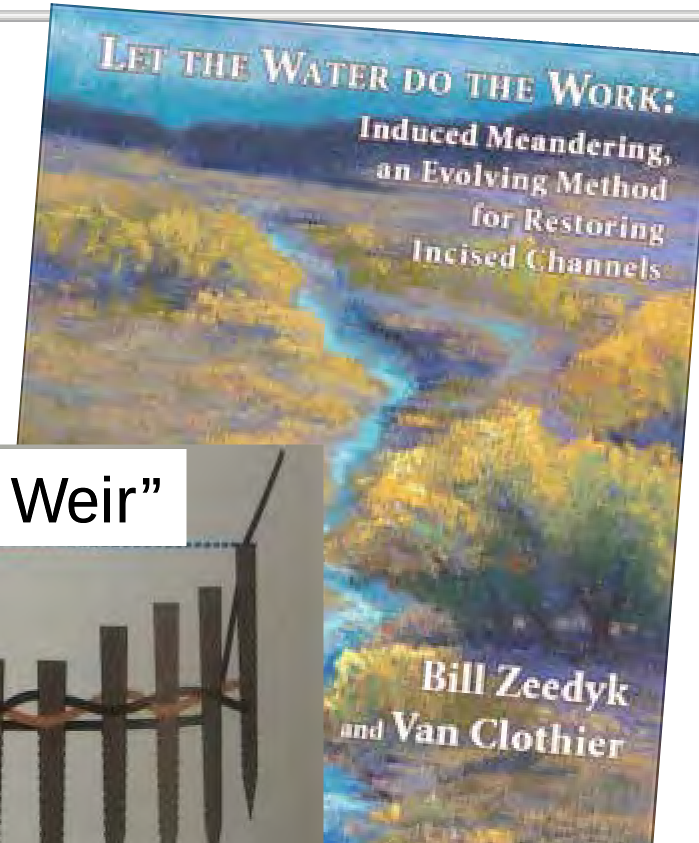
Série de barrages rustiques en pierres sèches [Demontzey, 1894]



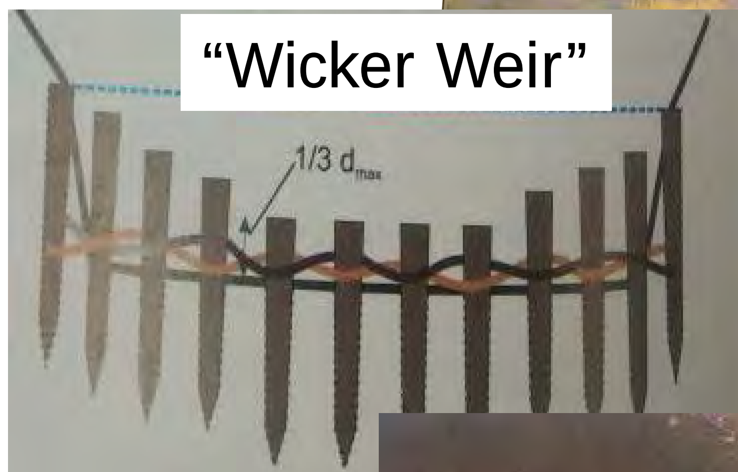
Fascinages vivants [Demontzey, 1894]

AND IN MORE RECENT TIMES…

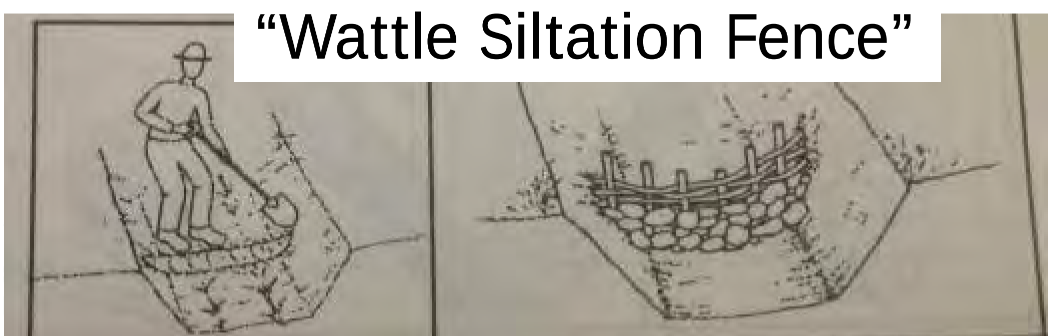




“Wicker Weir”



“Wattle Siltation Fence”



MANY VARIATIONS OF THE BDA RECIPE

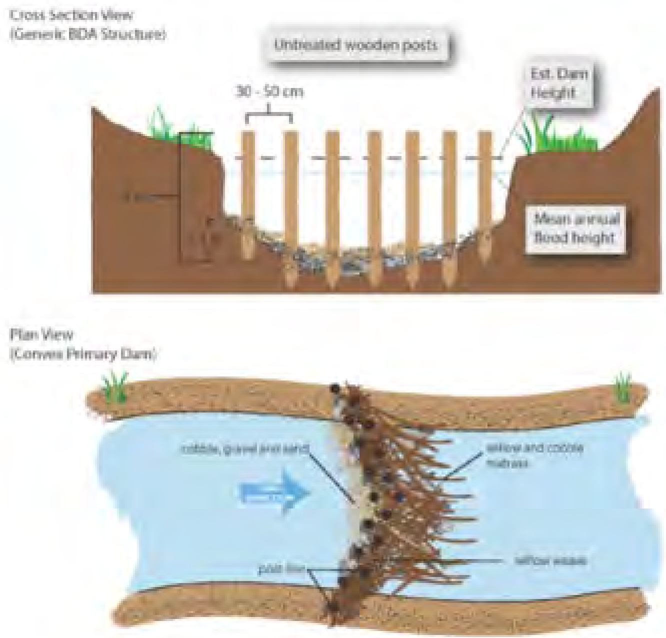


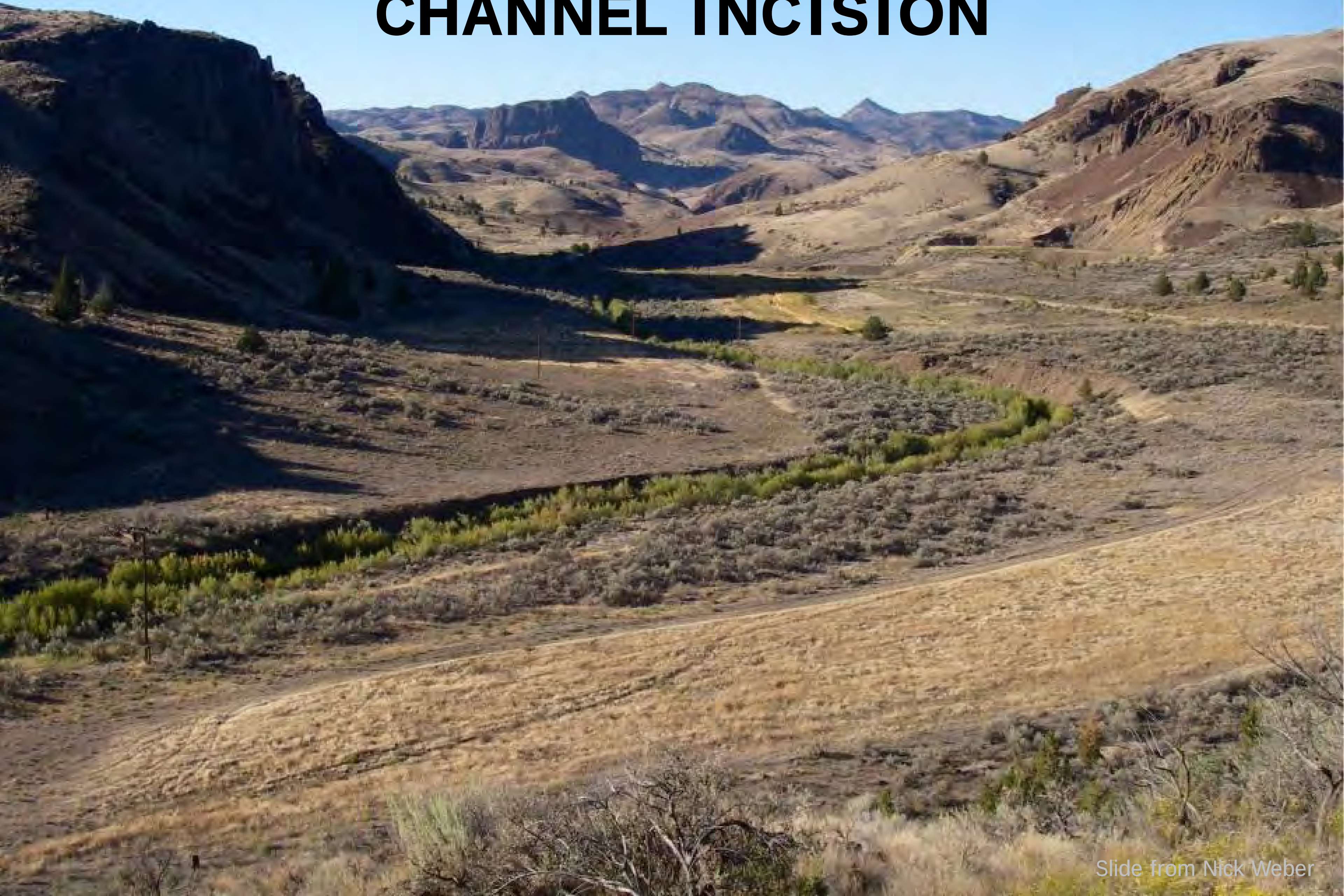
Figure 3 -Cross section and planview of generic BDA structure. Actual structure details depend on site-specific channel attributes e.g. channel width and bank height.

Figure by Portugal

- Our early recipes
  - overlooked importance of mattress
  - Overemphasized willow weave as ingredients

Figure 18. A typical starter dam (ST-17 at Sunflower) with willow branches woven between vertical posts and the back side sealed with rock and clay. Note the dam height is sufficient to divert flow onto the fill terrace, mimicking a stable beaver dam.

BDAs GREW OUT OF NEED TO ADDRESS CHANNEL INCISION



Slide from Nick Weber

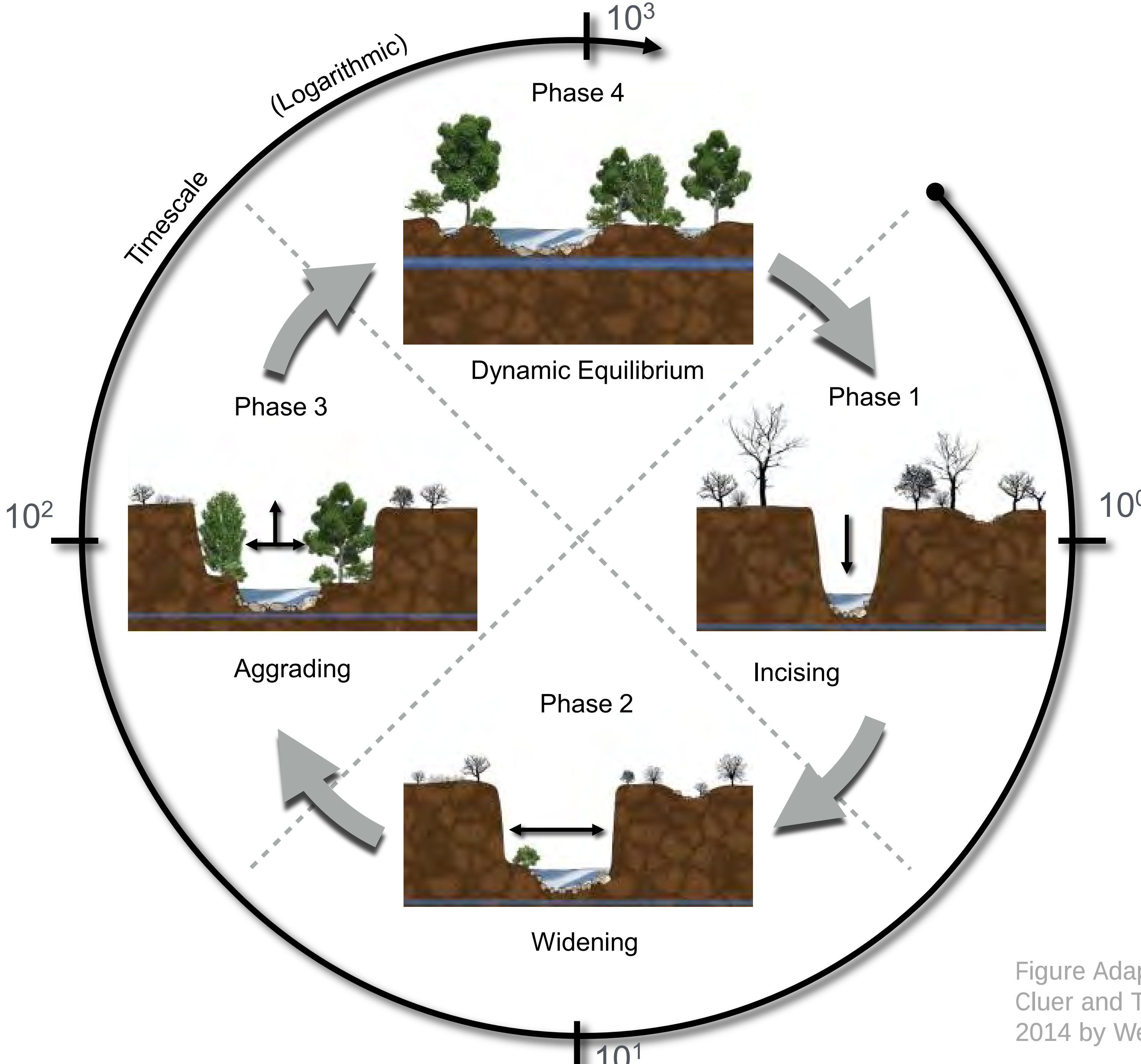
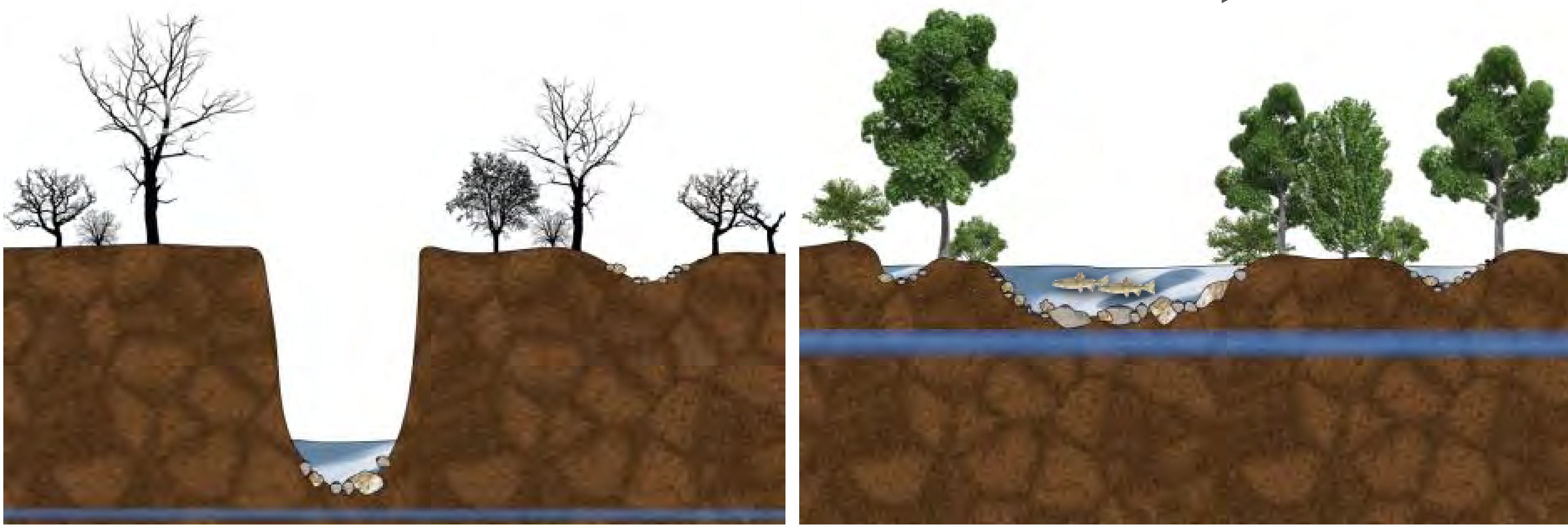


Figure Adapted from Cluer and Thorne, 2014 by Weber

CHANNEL INCISION RECOVERY

Incised Channel — 10^3 years → Channel in Equilibrium



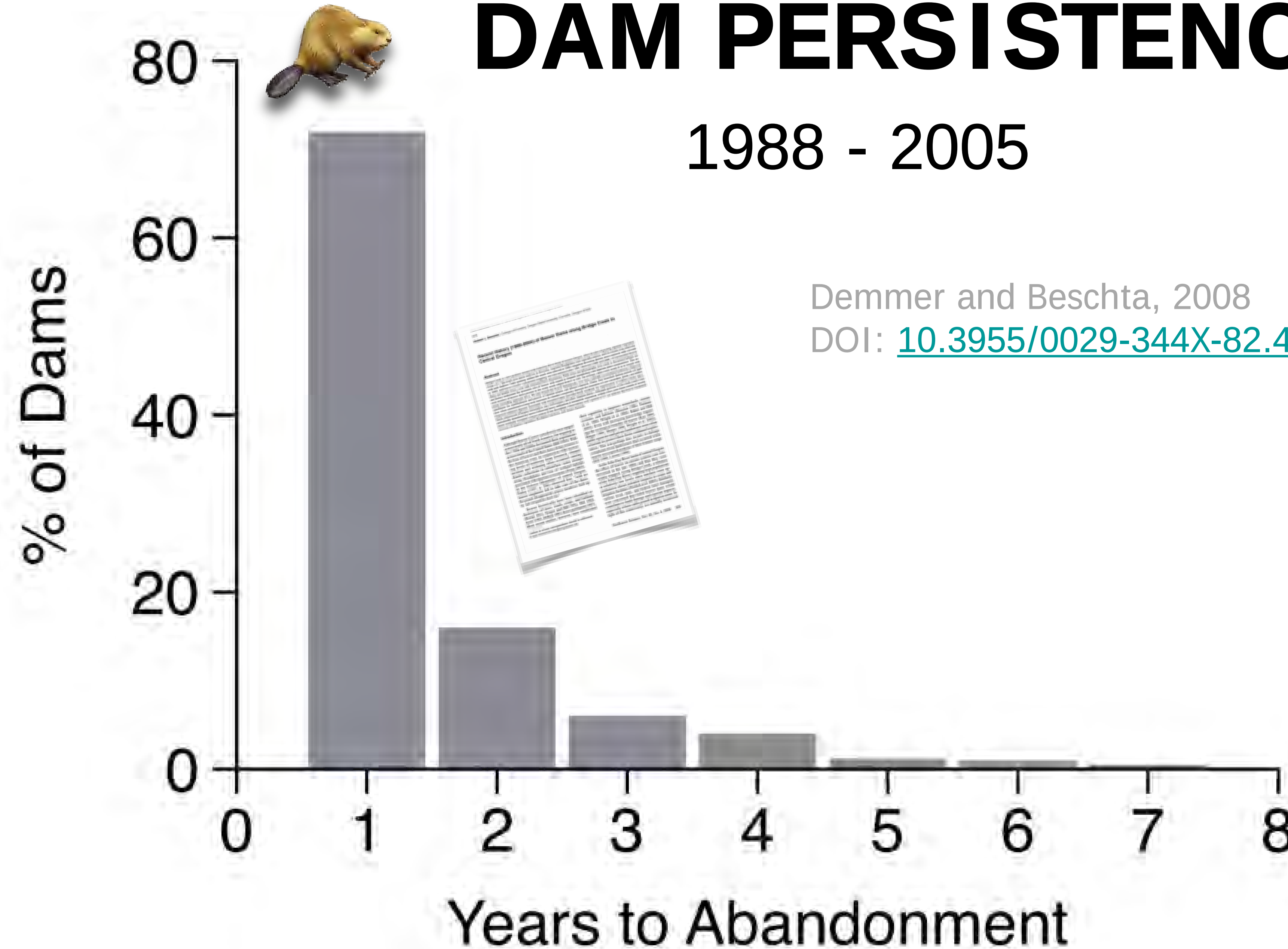
- Simplified and static channel
- Low habitat quality

- Sediment output = inputs
- Complex and dynamic channel
- Floodplain and groundwater connectivity
- High habitat quality


Slide from Nick Weber

DAM PERSISTENCE

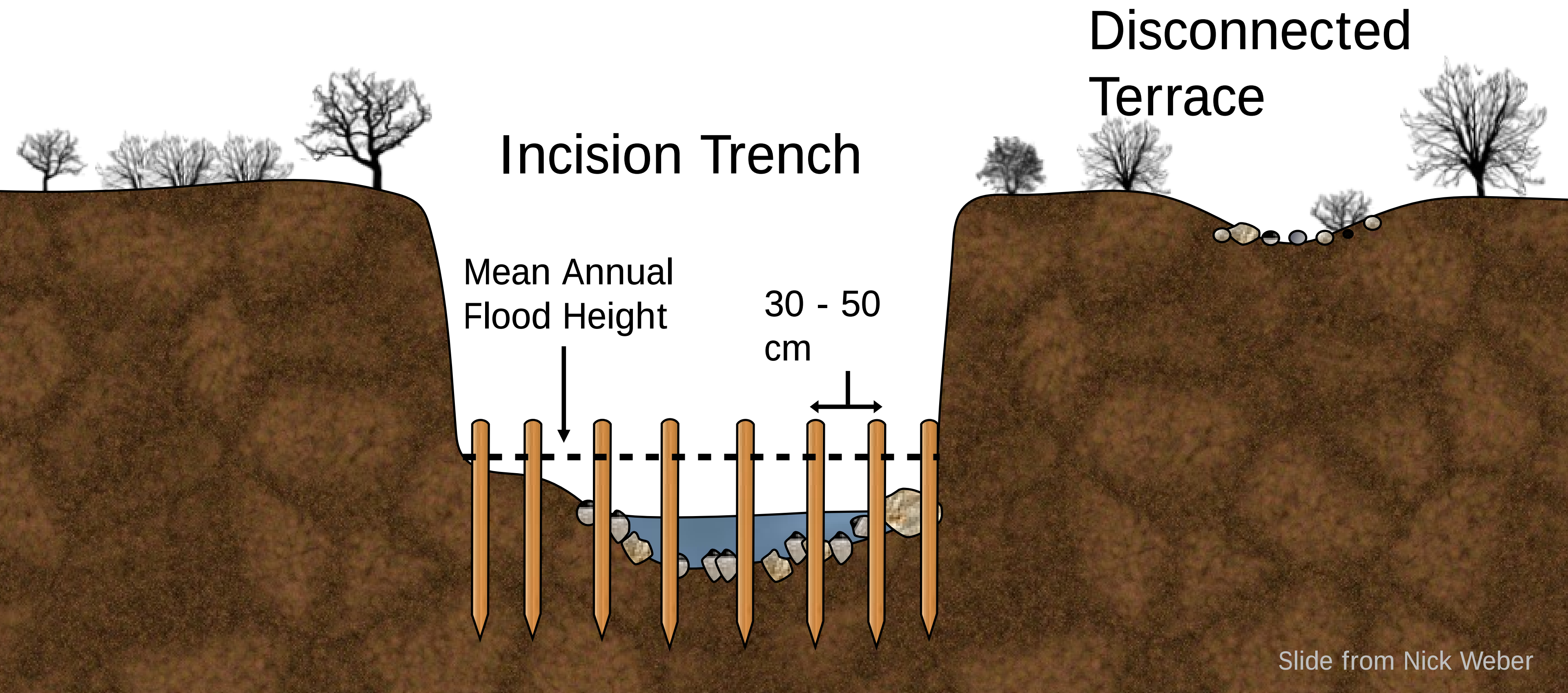
1988 - 2005



Demmer and Beschta, 2008
DOI: 10.3955/0029-344X-82.4.309

BDAs

Beaver Dam Analogs



USING BEAVER TO RESTORE INCISED STREAMS

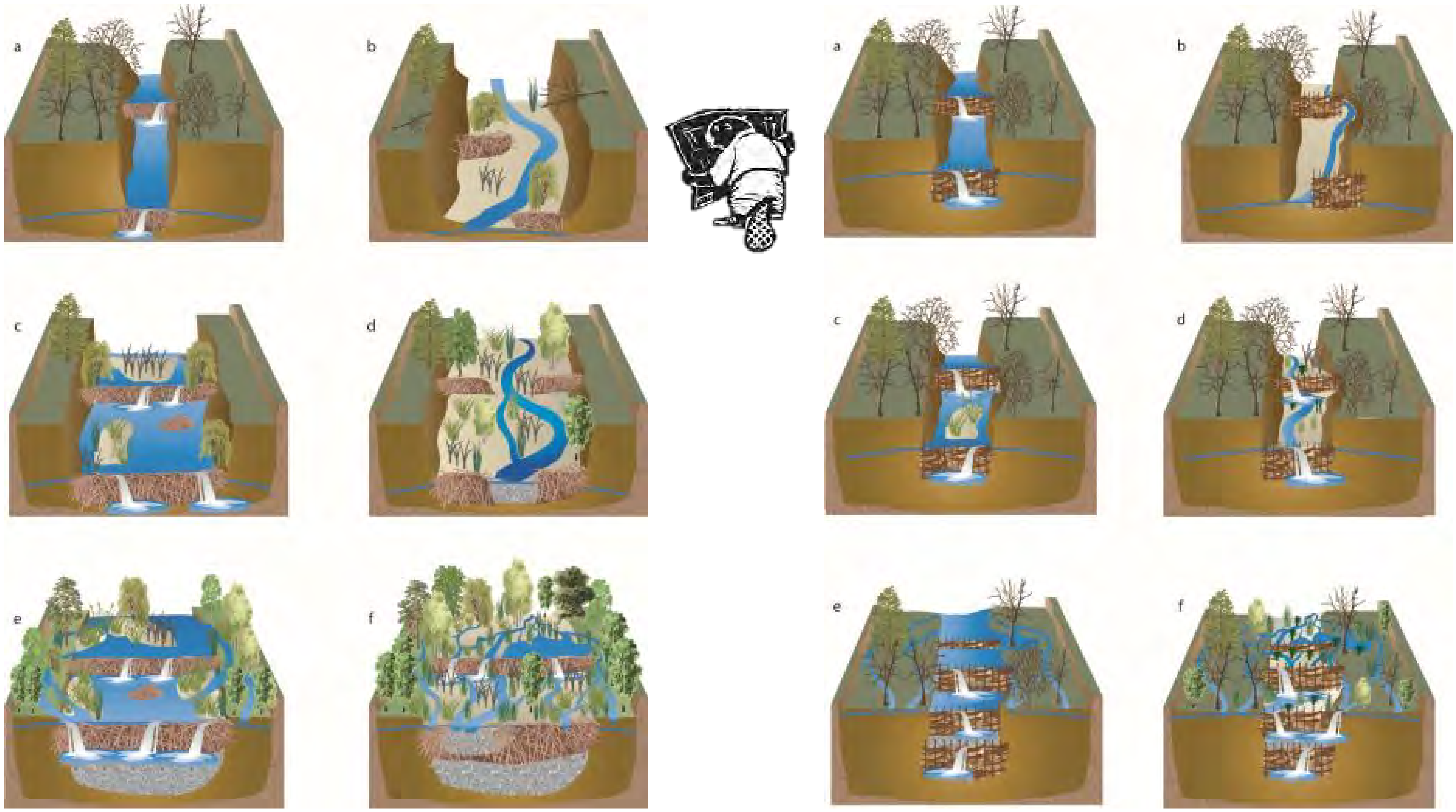
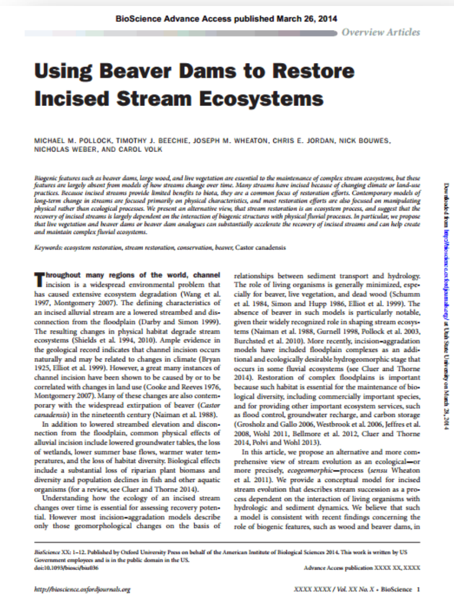


Figure from Pollock et al. (2014) Bioscience
DOI: 10.1093/biosci/biu036

THE INCISION-AGGRADATION CYCLE WITH BEAVER DAMS & BEAVER DAM ANALOGUES



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Overview Articles

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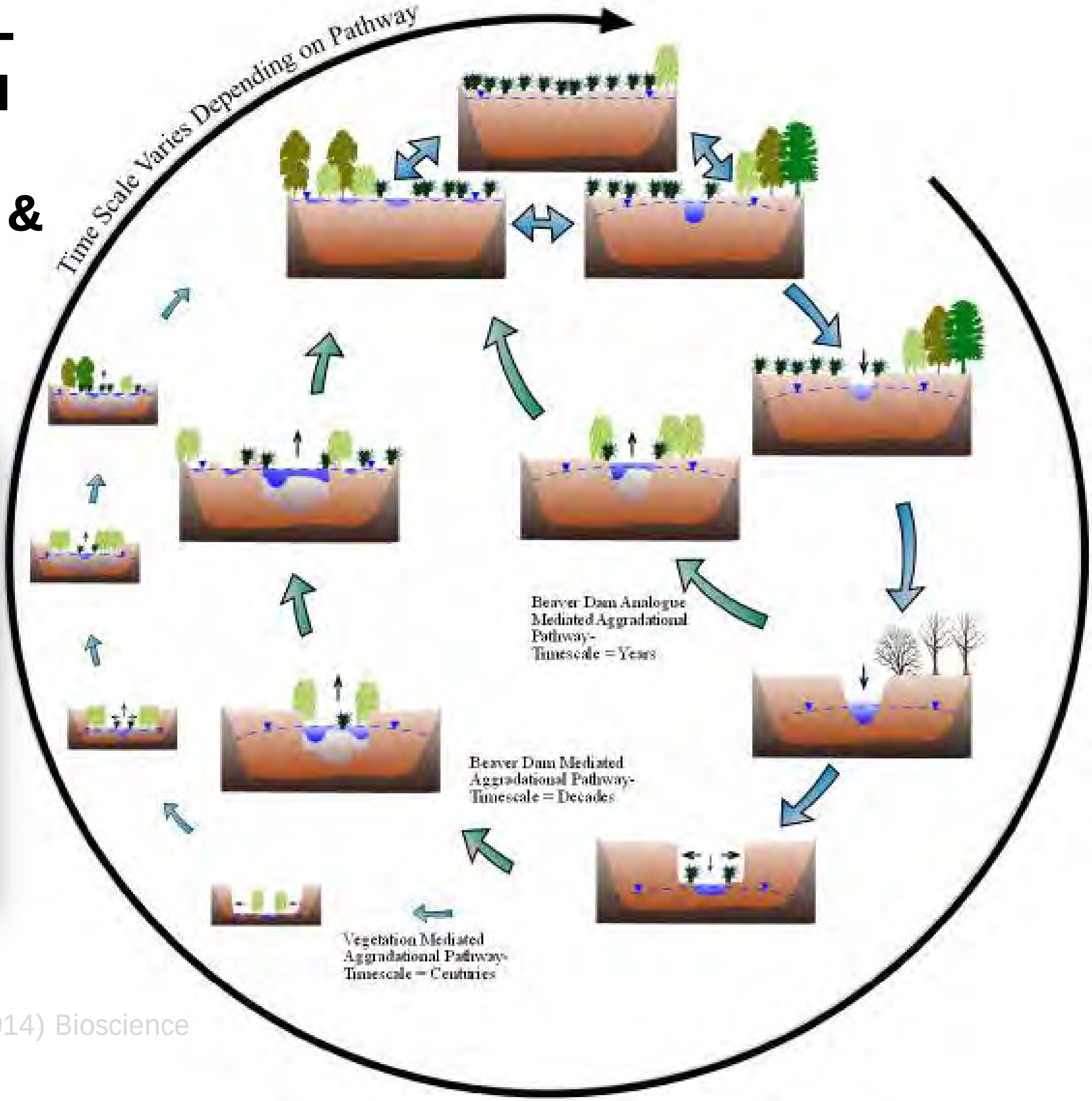

Figure from Pollock et al. (2014) Bioscience
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OUTLINE

I. Background on sage grouse & mesic habitats
II. Scope of mesic/riparian degradation
III. Partnering with beaver as cheap and cheerful restoration of mesic habitats
IV. **Beaver Dam Analog Case Studies**
    I. **Bridge Creek, OR (fish)**
    II. Birch Creek, ID (hydrology)
    III. Grouse Creek, UT (grouse & hydrology)
V. General BDA Planning & Design Principles
VI. Summary/Resources

USDA NRCS

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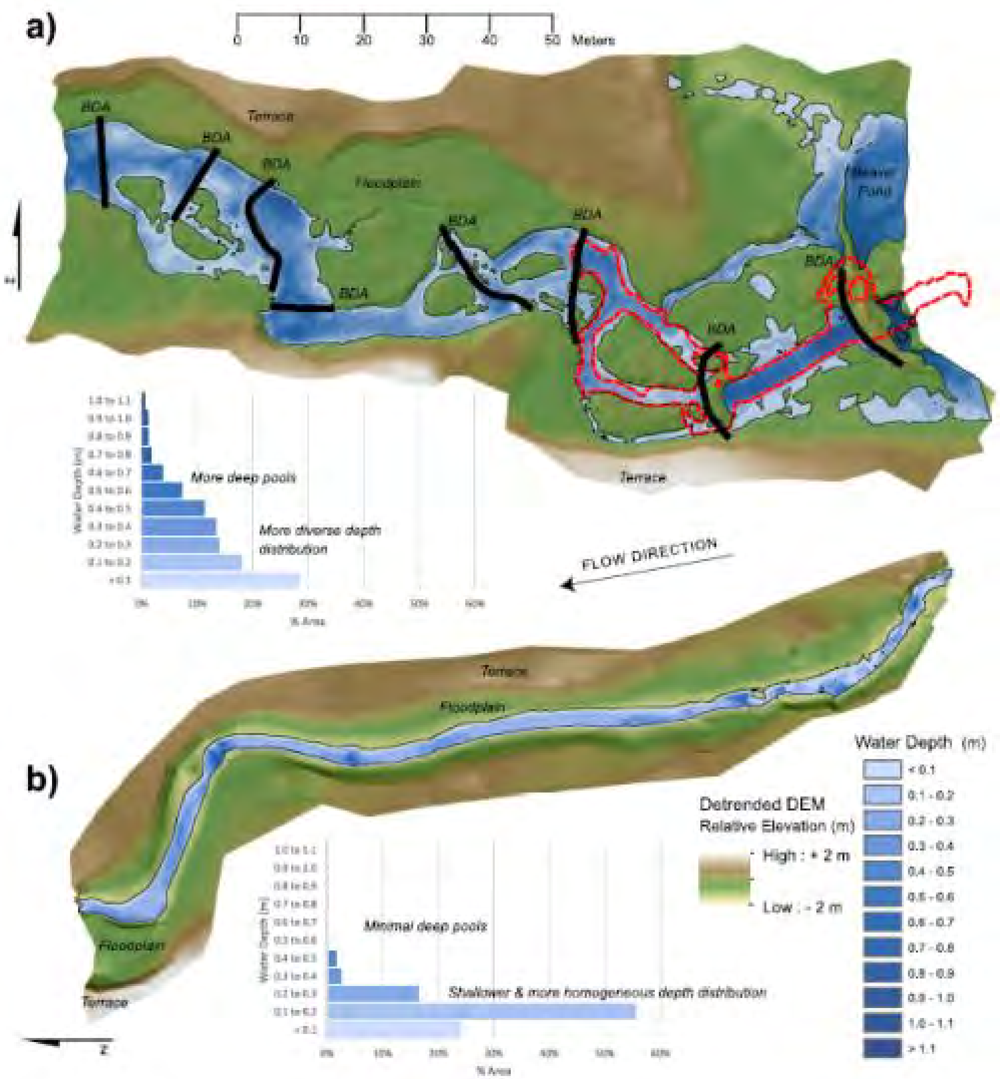
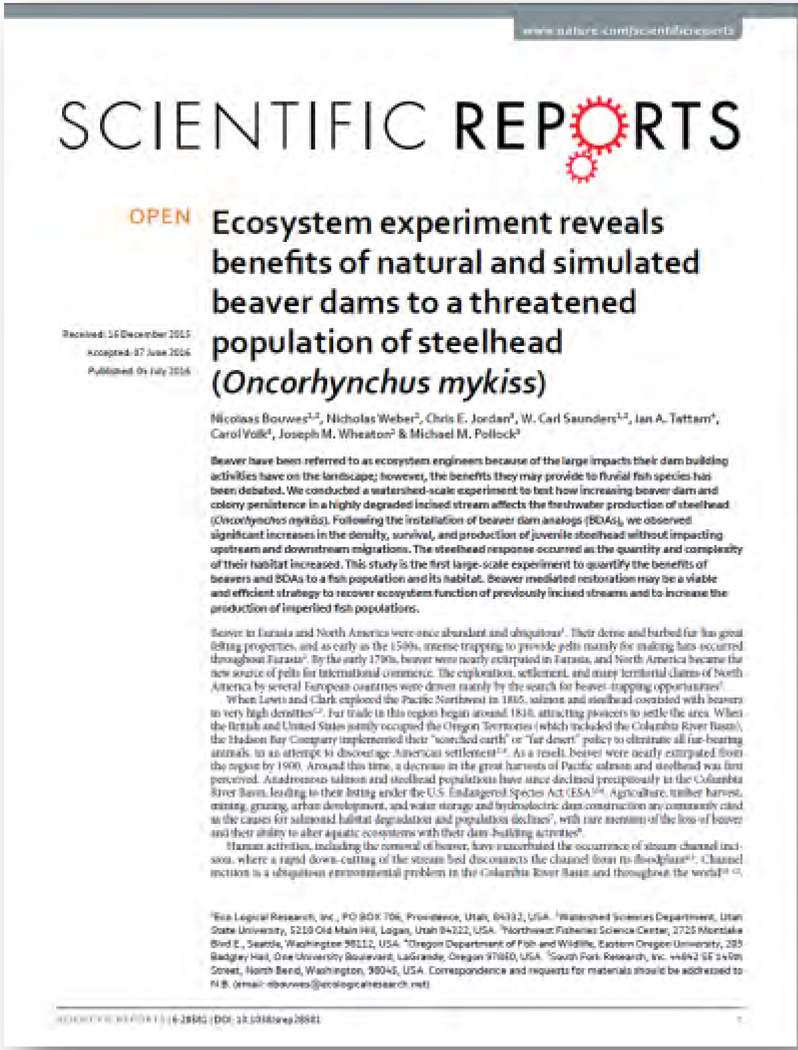
UtahState University DEPARTMENT OF WATERSHED SCIENCES

THE EXAMPLE THAT GAVE BDAs CREDIBILITY





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Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (*Oncorhynchus mykiss*)

Nicolaas Bouwes[1,2], Nicholas Weber[2], Chris E. Jordan[3], W. Carl Saunders[1,2], Ian A. Tattam[4], Carol Volk[5], Joseph M. Wheaton[2] & Michael M. Pollock[3]

Beaver have been referred to as ecosystem engineers because of the large impacts their dam building activities have on the landscape; however, the benefits they may provide to fluvial fish species has been debated. We conducted a watershed-scale experiment to test how increasing beaver dam and colony persistence in a highly degraded incised stream affects the freshwater production of steelhead (*Oncorhynchus mykiss*). Following the installation of beaver dam analogs (BDAs), we observed significant increases in the density, survival, and production of juvenile steelhead without impacting upstream and downstream migrations. The steelhead response occurred as the quantity and complexity of their habitat increased. This study is the first large-scale experiment to quantify the benefits of beavers and BDAs to a fish population and its habitat. Beaver mediated restoration may be a viable and efficient strategy to recover ecosystem function of previously incised streams and to increase the production of imperiled fish populations.

Beaver in Eurasia and North America were once abundant and ubiquitous[1]. Their dense and barbed fur has great felting properties, and as early as the 1500s, intense trapping to provide pelts mainly for making hats occurred throughout Eurasia[2]. By the early 1700s, beaver were nearly extirpated in Eurasia, and North America became the new source of pelts for international commerce. The exploration, settlement, and many territorial claims of North America by several European countries were driven mainly by the search for beaver-trapping opportunities[3].

When Lewis and Clark explored the Pacific Northwest in 1805, salmon and steelhead coexisted with beavers in very high densities[1,2]. Fur trade in this region began around 1810, attracting pioneers to settle the area. When the British and United States jointly occupied the Oregon Territories (which included the Columbia River Basin), the Hudson Bay Company implemented their "scorched earth" or "fur desert" policy to eliminate all fur-bearing animals, in an attempt to discourage American settlement[1,4]. As a result, beaver were nearly extirpated from the region by 1900. Around this time, a decrease in the great harvests of Pacific salmon and steelhead was first perceived. Anadromous salmon and steelhead populations have since declined precipitously in the Columbia River Basin, leading to their listing under the U.S. Endangered Species Act (ESA)[5,6]. Agriculture, timber harvest, mining, grazing, urban development, and water storage and hydroelectric dam construction are commonly cited as the causes for salmonid habitat degradation and population declines[7], with rare mention of the loss of beaver and their ability to alter aquatic ecosystems with their dam-building activities[8].

Human activities, including the removal of beaver, have exacerbated the occurrence of stream channel incision, where a rapid down-cutting of the stream bed disconnects the channel from its floodplain[9,11]. Channel incision is a ubiquitous environmental problem in the Columbia River Basin and throughout the world[10,12].

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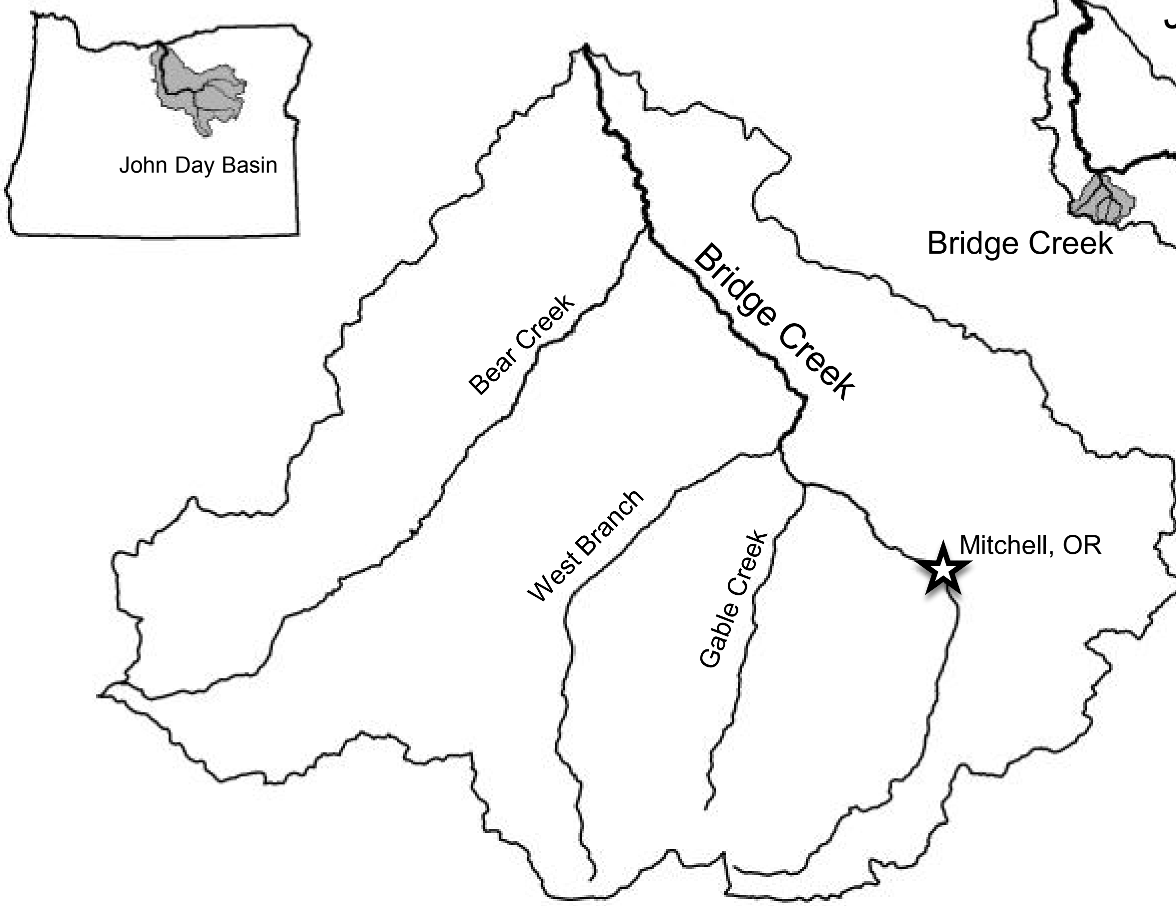
Figure 5 from Bouwes et al. (2016)
DOI: 10.1038/srep28581

BRIDGE CREEK

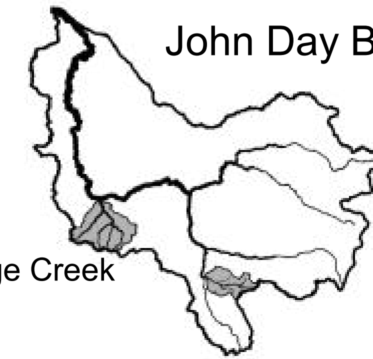
INTENSIVELY MONITORED WATERSHED

Bridge Creek Watershed
- 710 km^2

Oregon, USA



John Day Basin

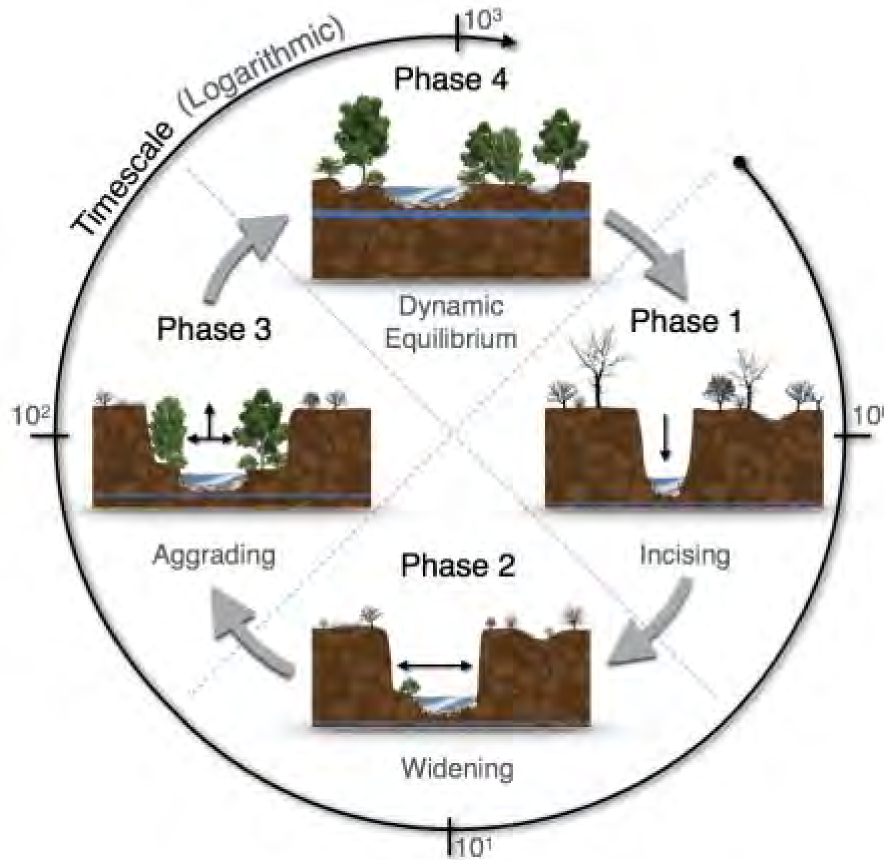


Mid-Columbia Steelhead

Slide from Nick Weber

BRIDGE CREEK IMW

- Testing BDA Assisted Incision Recovery
- Benefits to Fish Populations and Habitat



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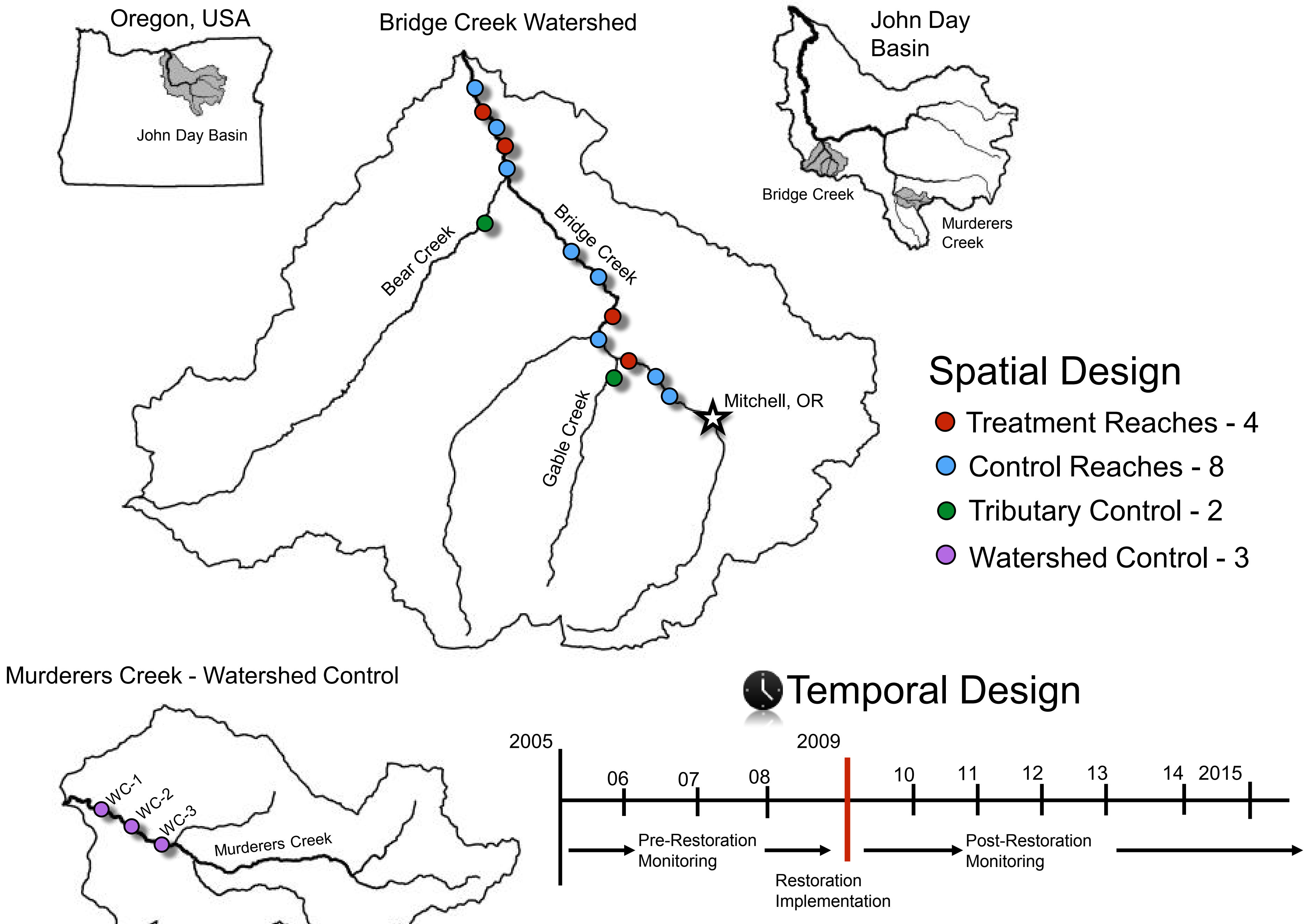

Adapted from Figure 2 of Bouwes et al. (2016)
DOI: 10.1038/srep28581


Structure ID:
MC-08.2

Restoration Implementation

- 4 Treatment Reaches ~ 1 km each
- 114 Total BDA Structures

0 25 50 100 m

BDA Structure

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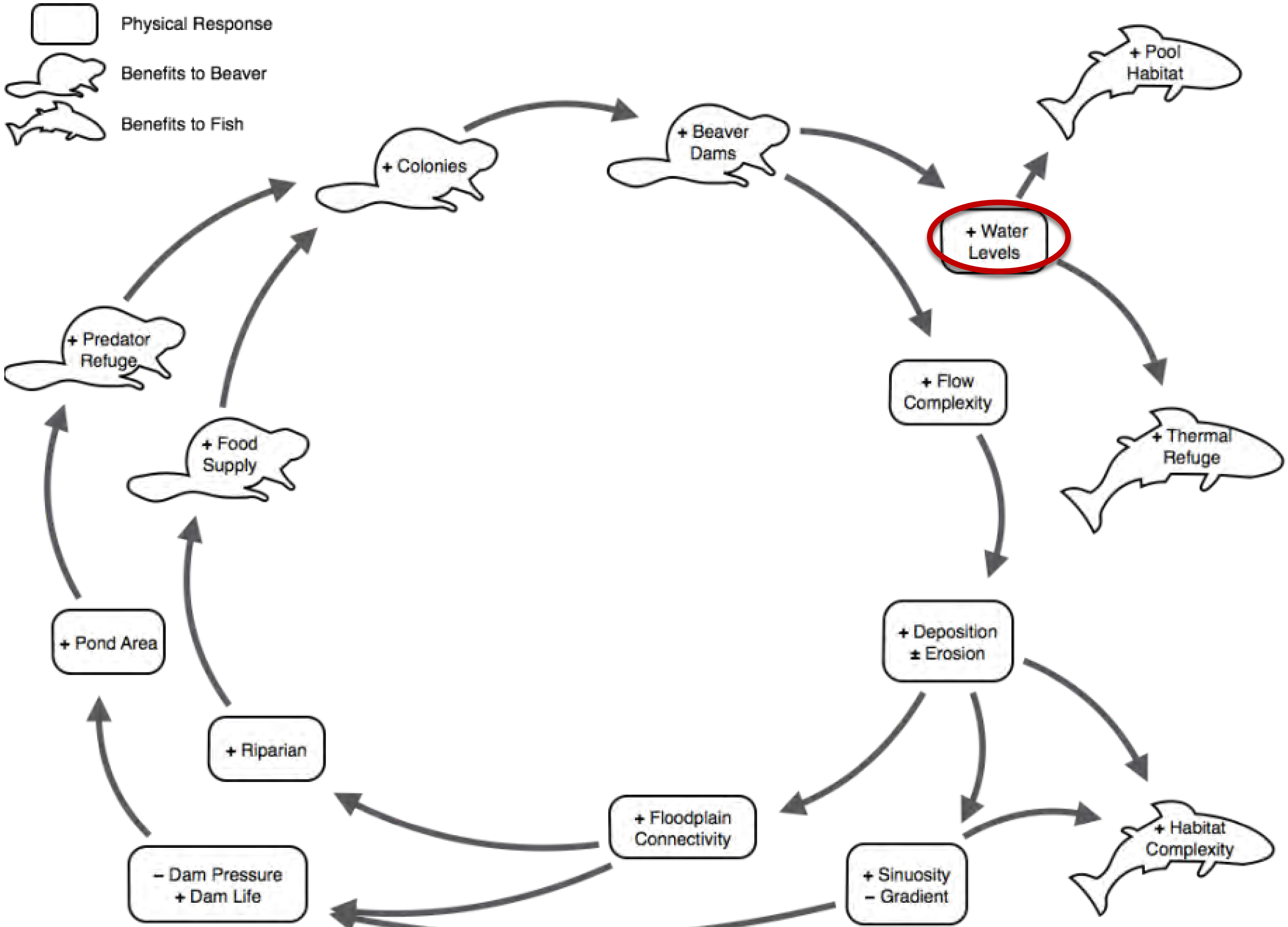

Figure 1 of Bouwes et al. (2016)
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WATER TABLE ELEVATION CHANGE

1’-3’ increase in the height of the water table

WATER TABLE ELEVATION

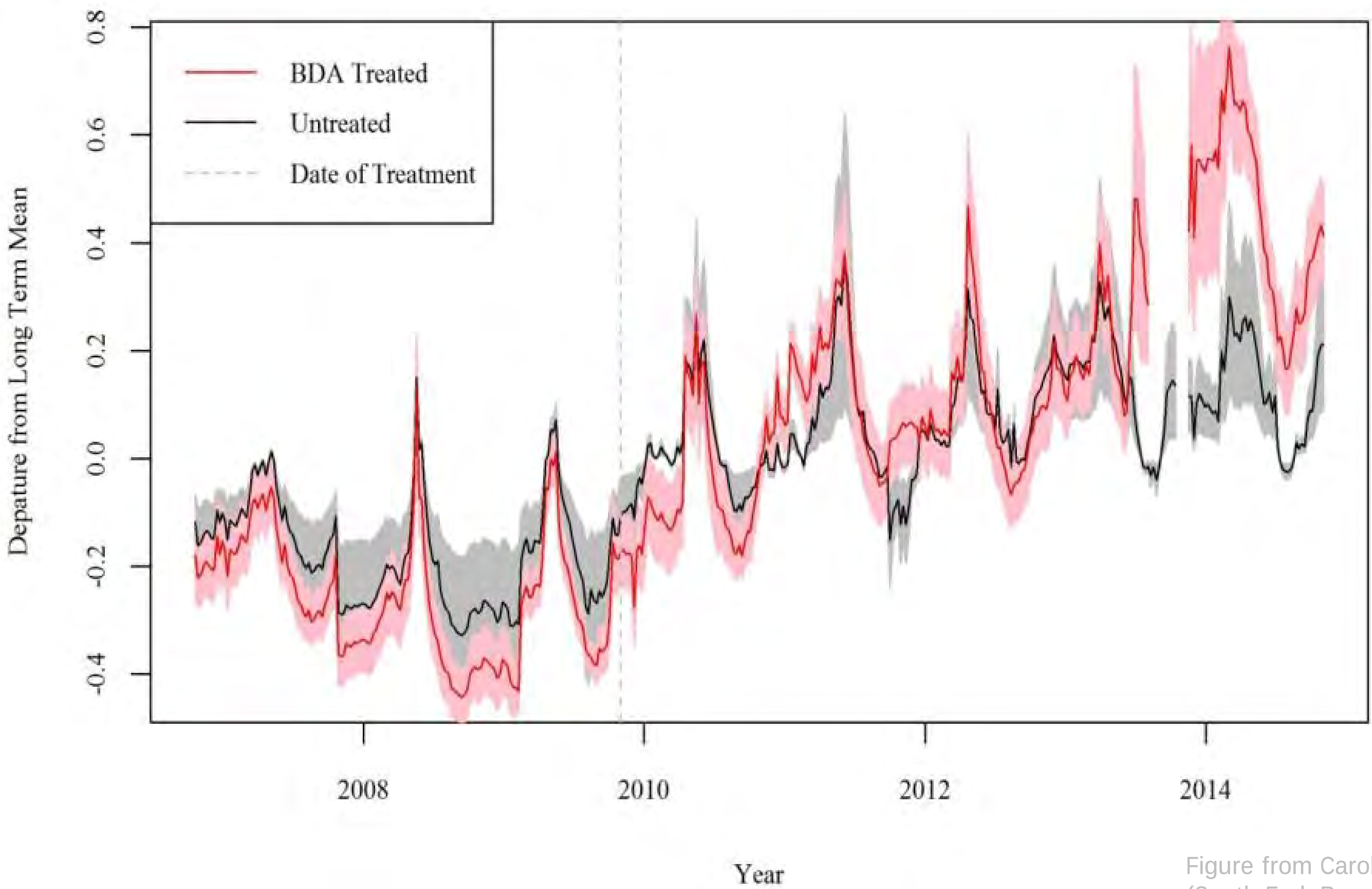
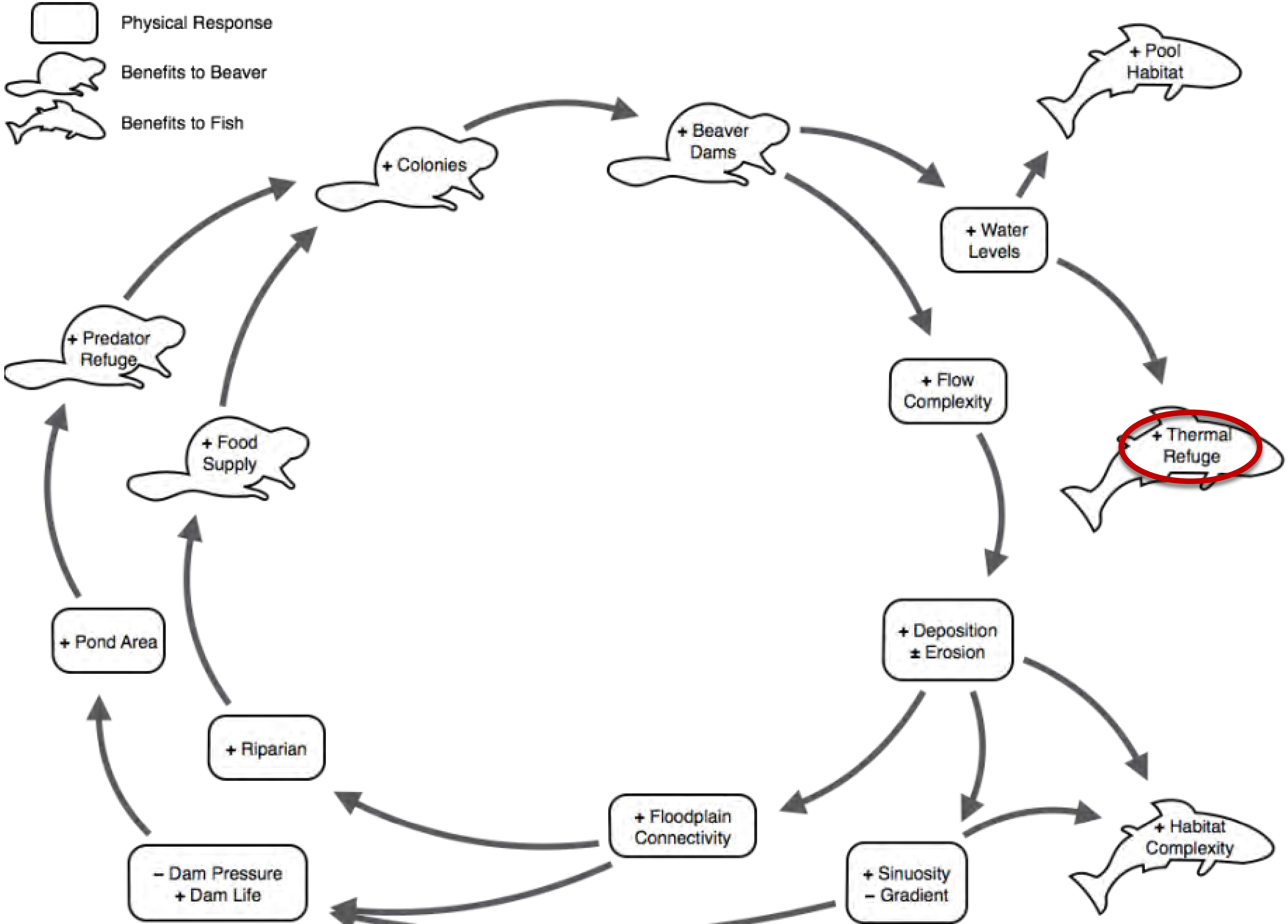


Figure from Carol Volk
(South Fork Research)



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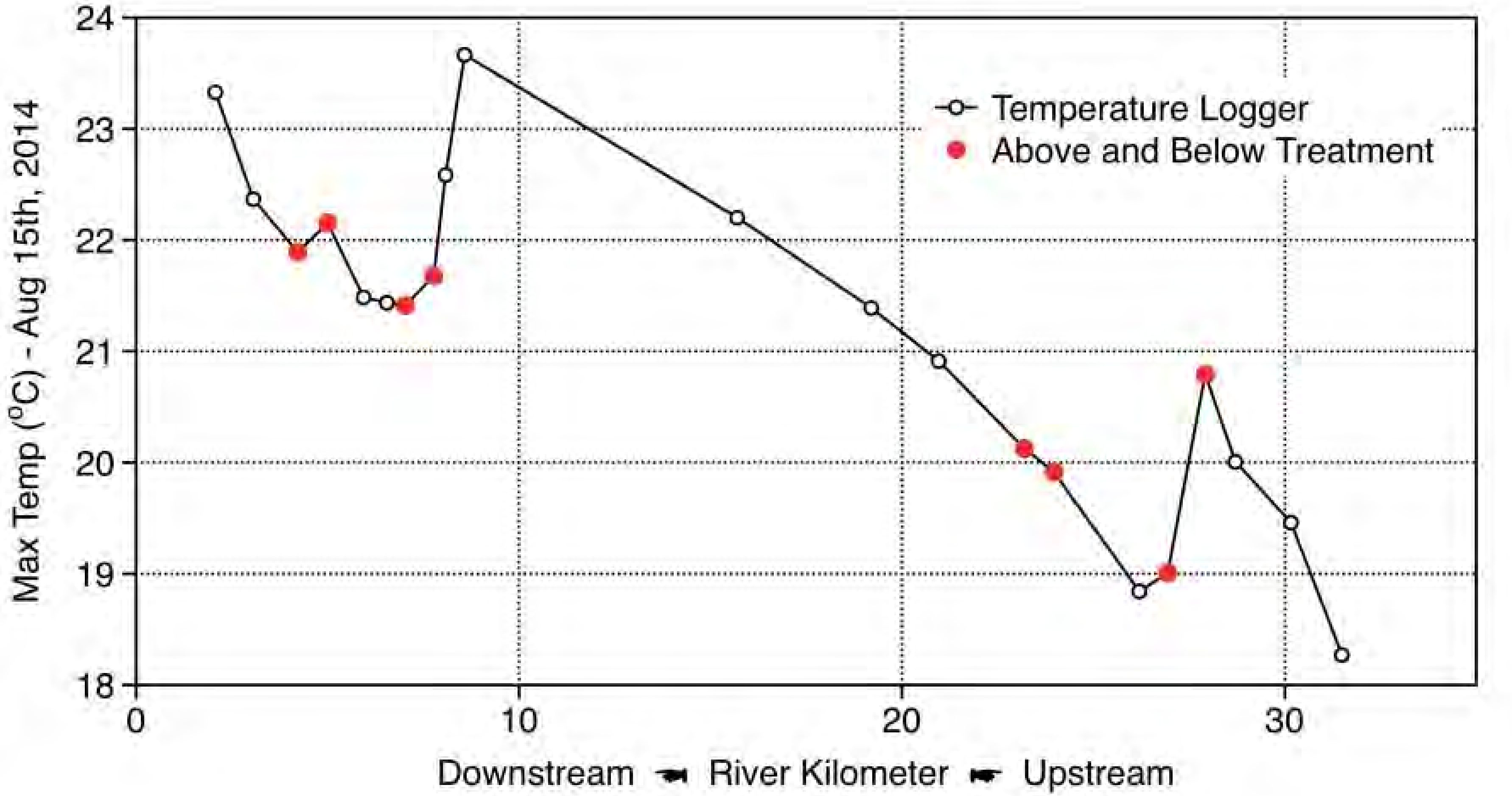
LONG TEMPERATURE PROFILE

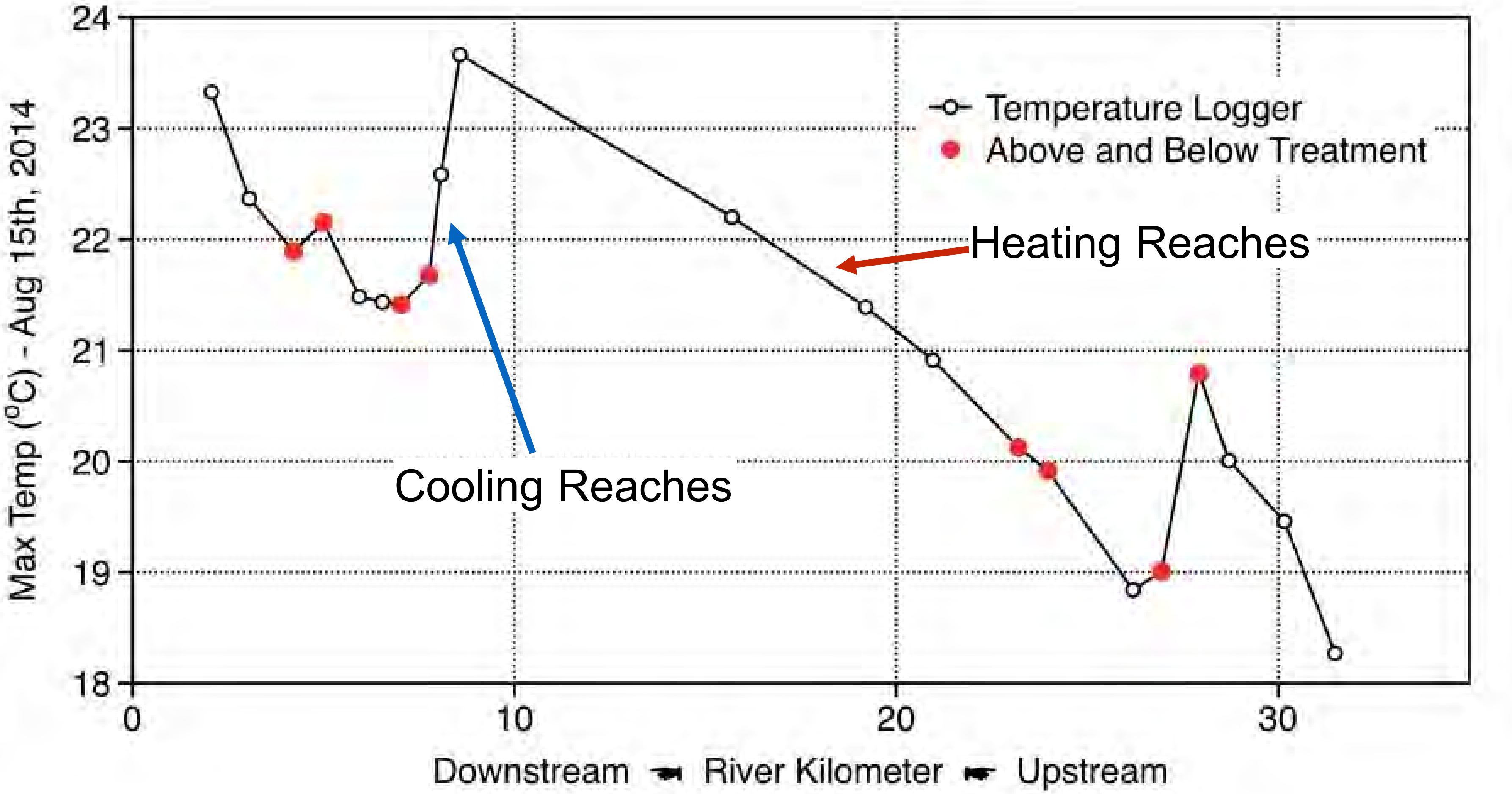
August 2014



Weber et al. (2017) DOI: 10.1371/journal.pone.0176313

LONG TEMPERATURE PROFILE

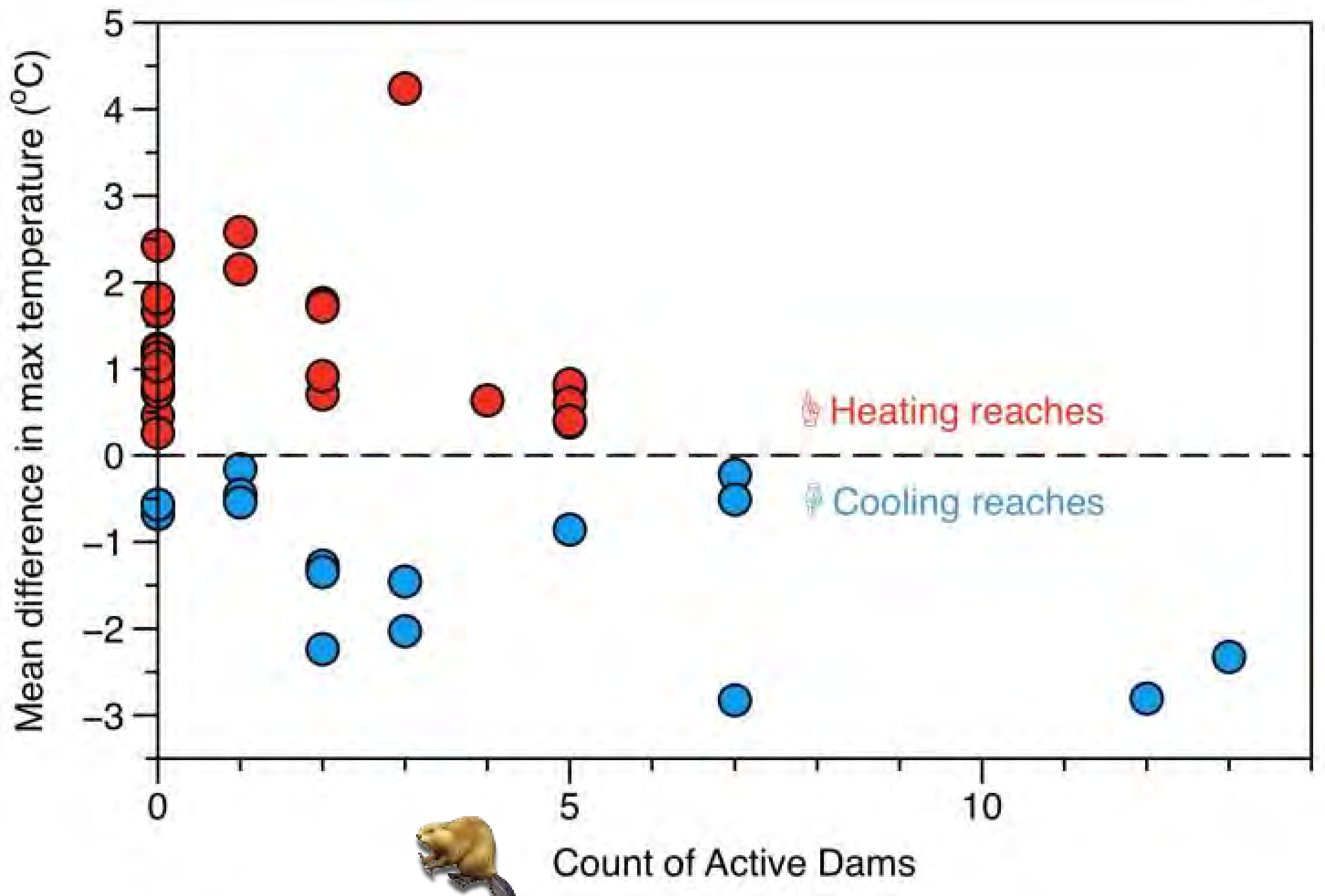
August 2014



Weber et al. (2017) DOI: [10.1371/journal.pone.0176313](https://doi.org/10.1371/journal.pone.0176313)

LONGITUDINAL TEMPERATURE CHANGE

Maximum Daily Temperature - August
2007 - 2014



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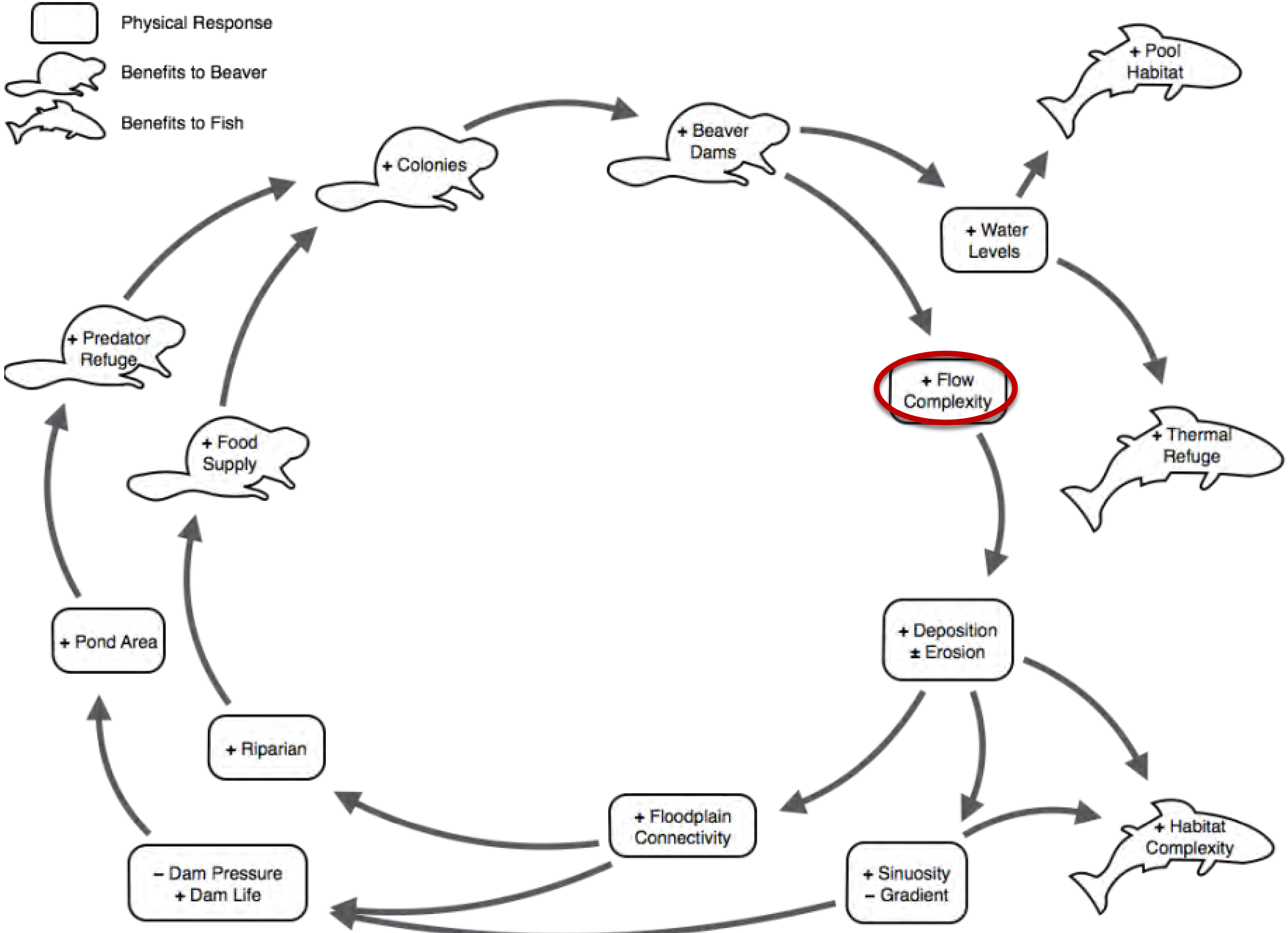

Figure 1 of Bouwes et al. (2016)
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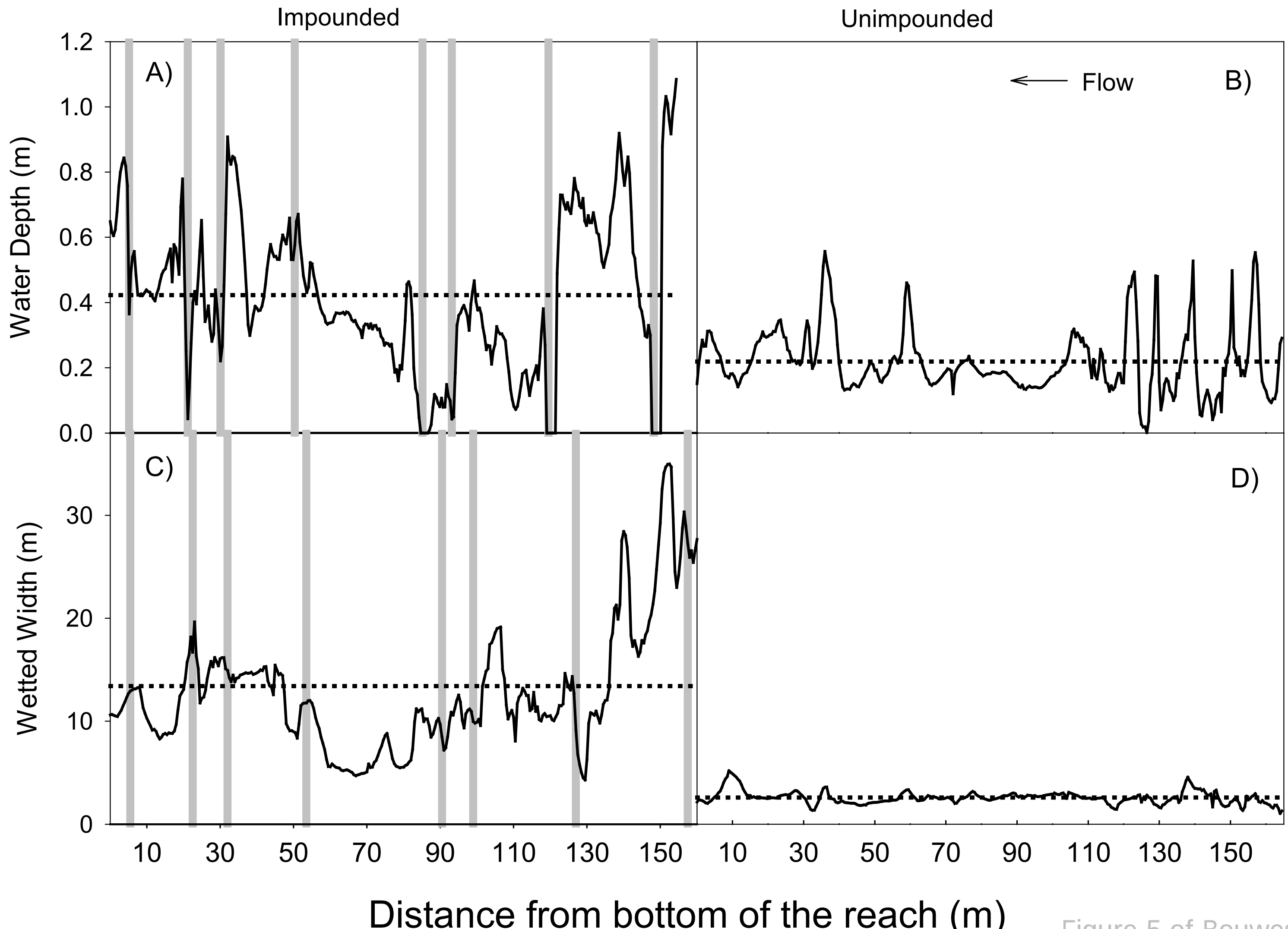
DEPTH & WIDTH DIVERSITY – THE ILUSION OF MORE WATER (A TIMING TRICK)



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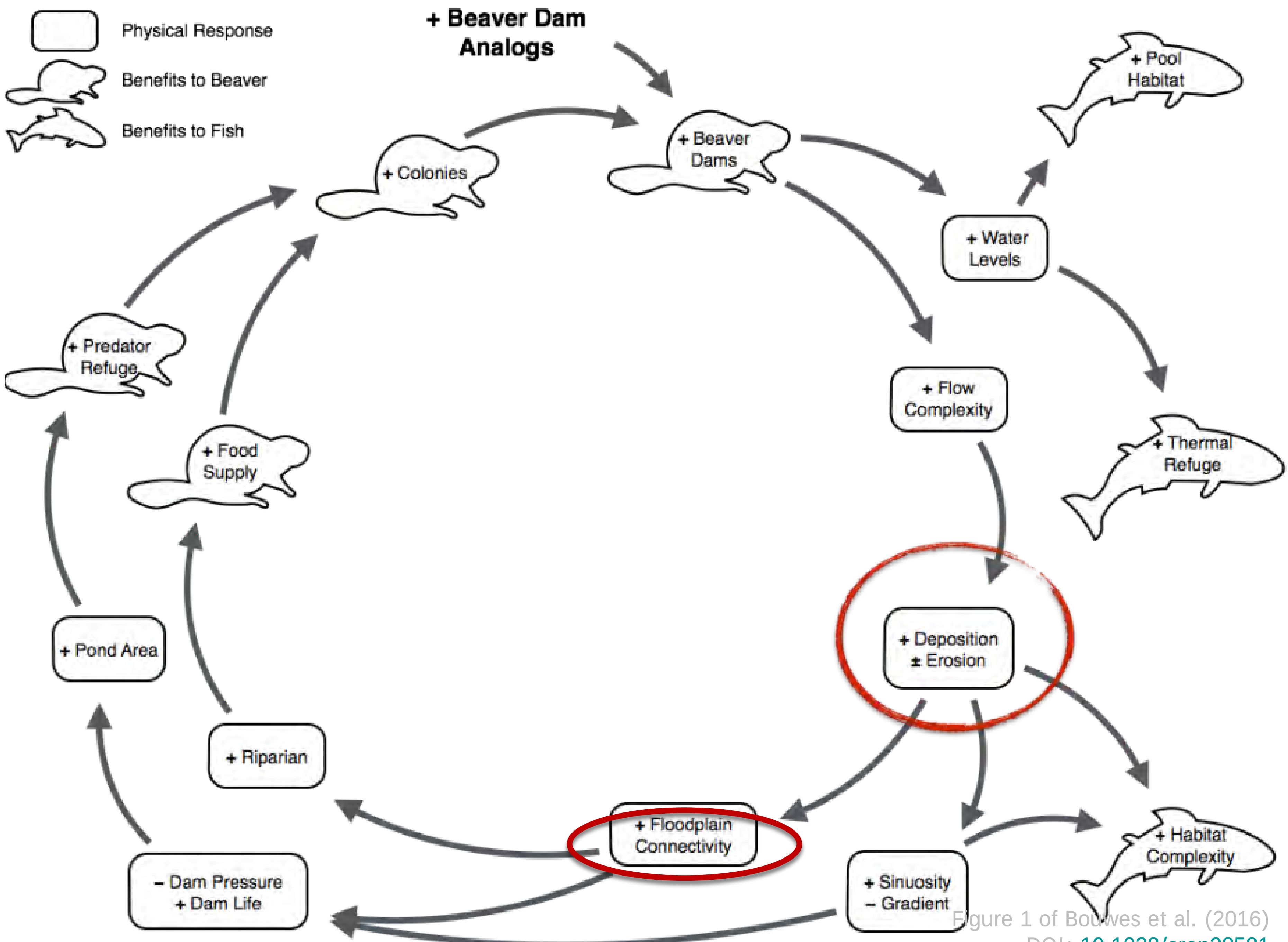

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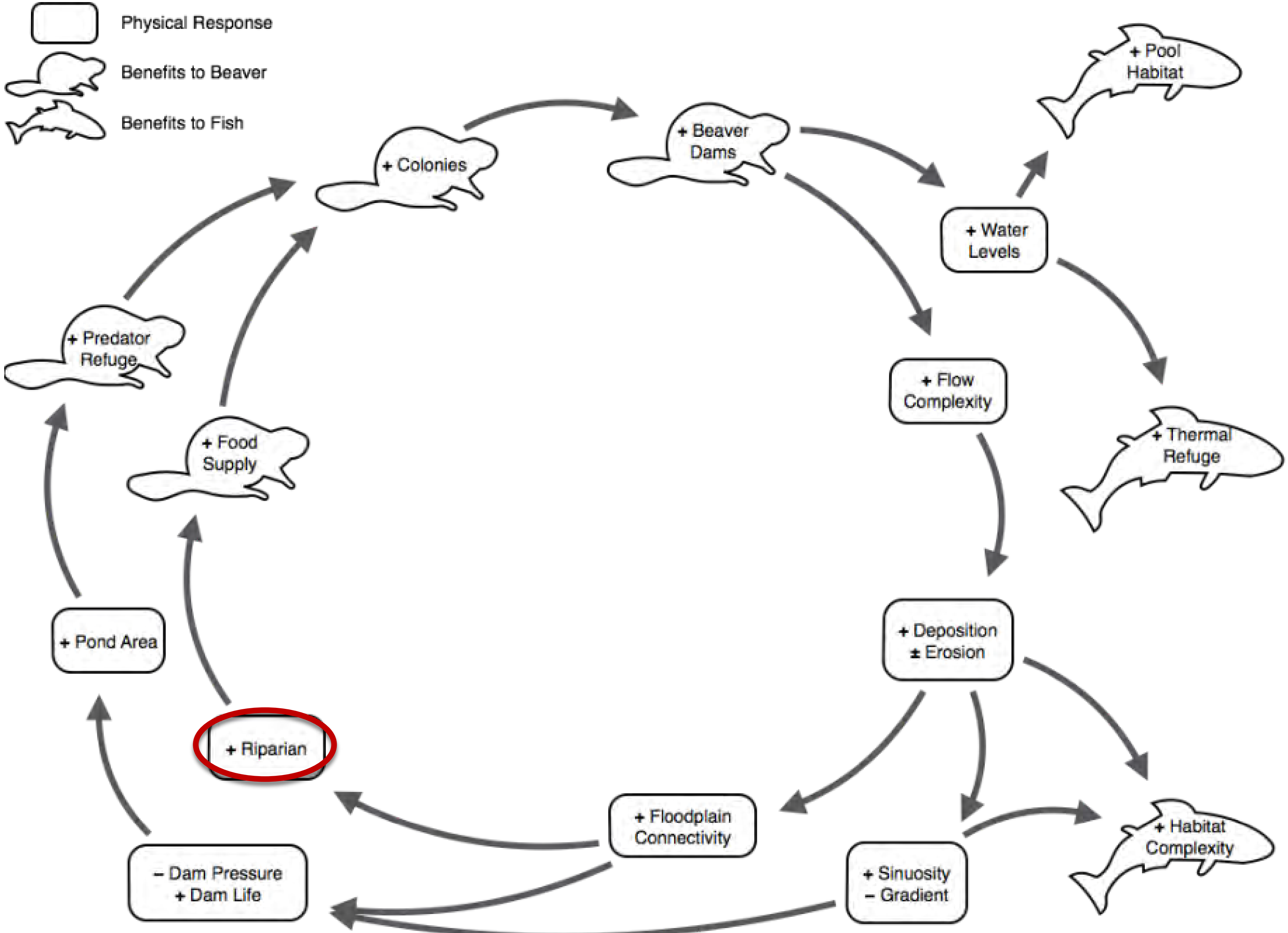
FLOODPLAIN FREQUENTLY INUNDATED

Weber et al. (2017) DOI: 10.1371/journal.pone.0176313



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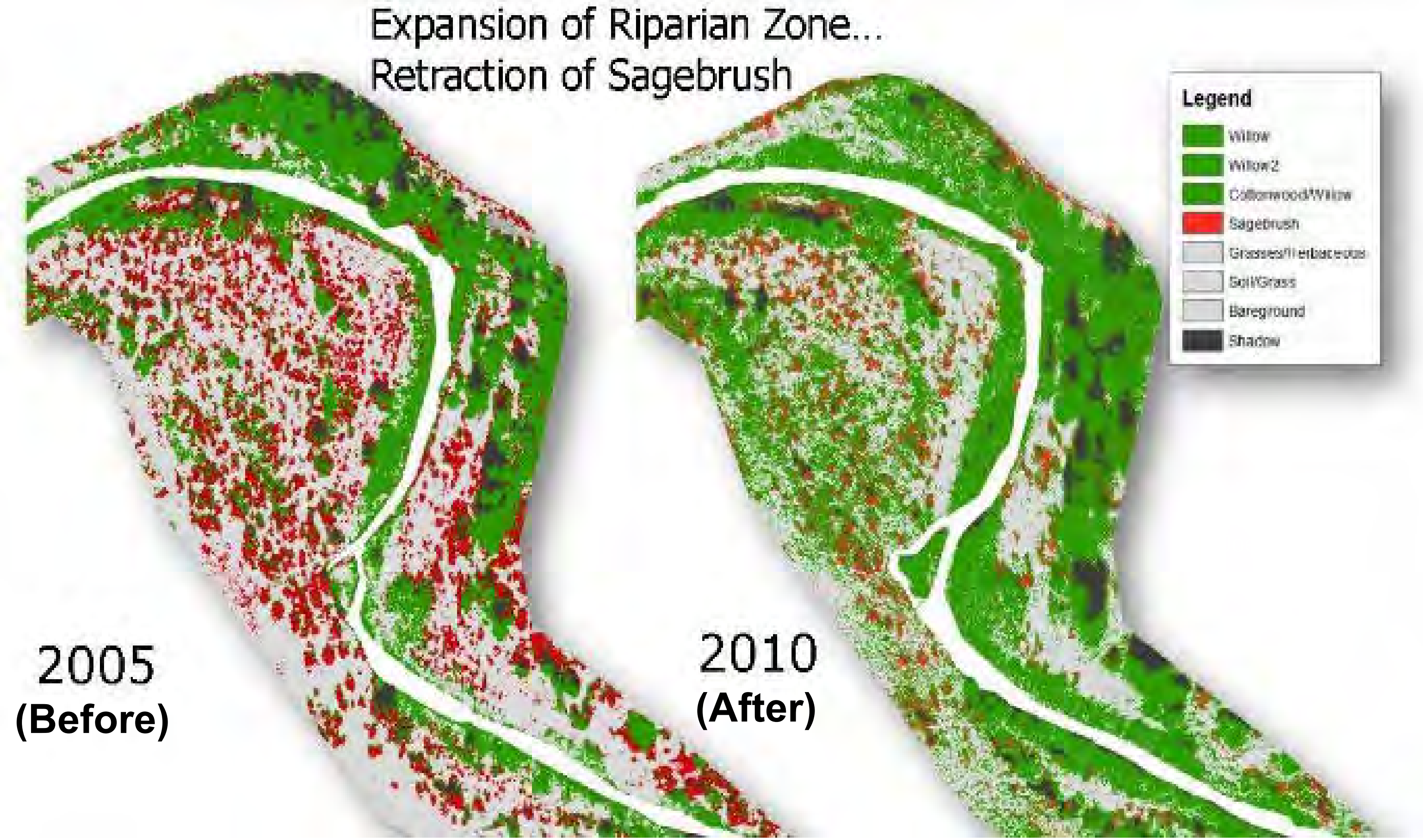
DOI: 10.1038/srep28581

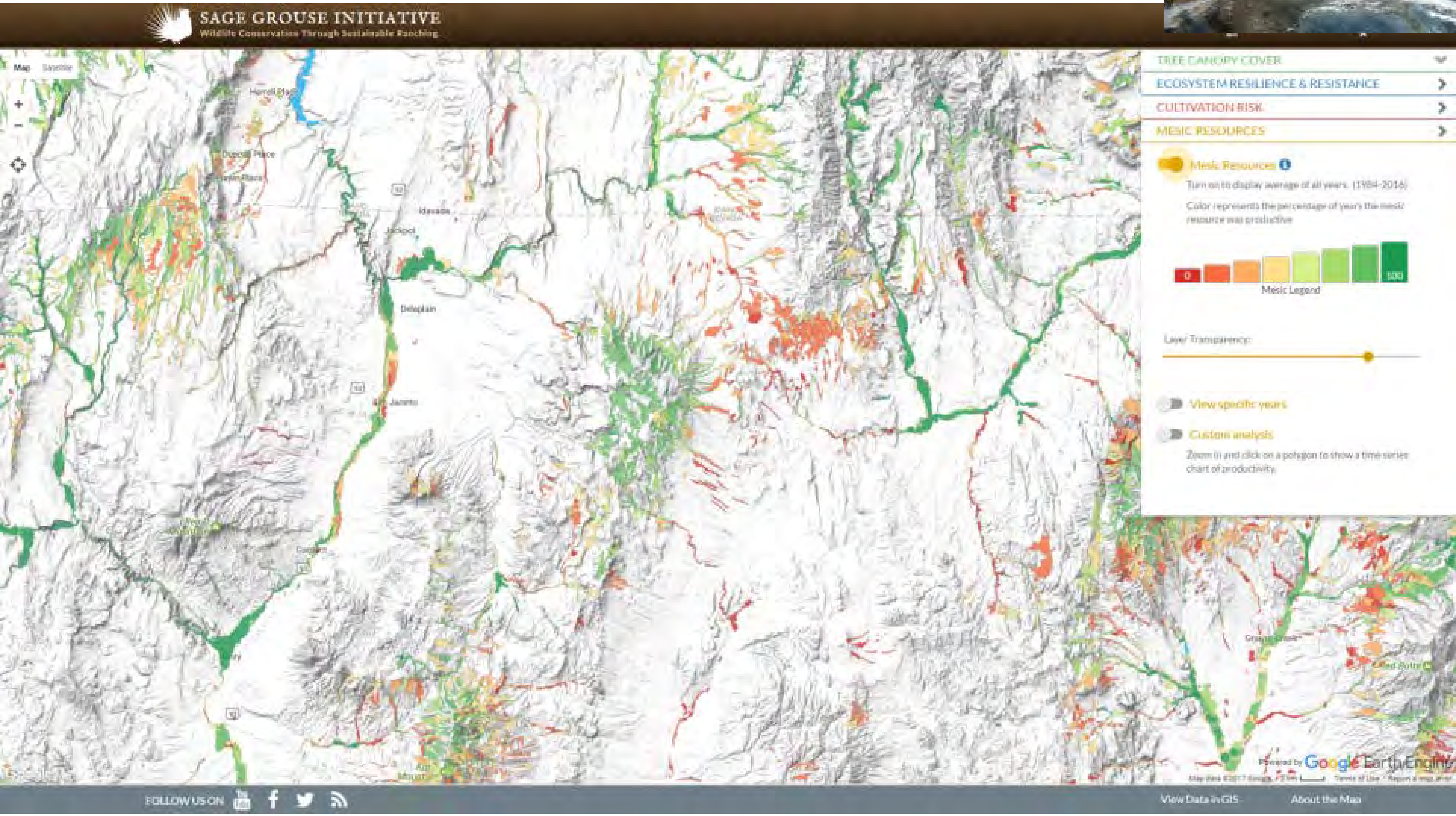
REALLY? KILLING SAGE BRUSH?



- Repeat high resolution (10 cm) imagery before & after 2009 treatment

Figure from Carol Volk (South Fork Research)

IF SIGNAL IS MEANINGFUL...

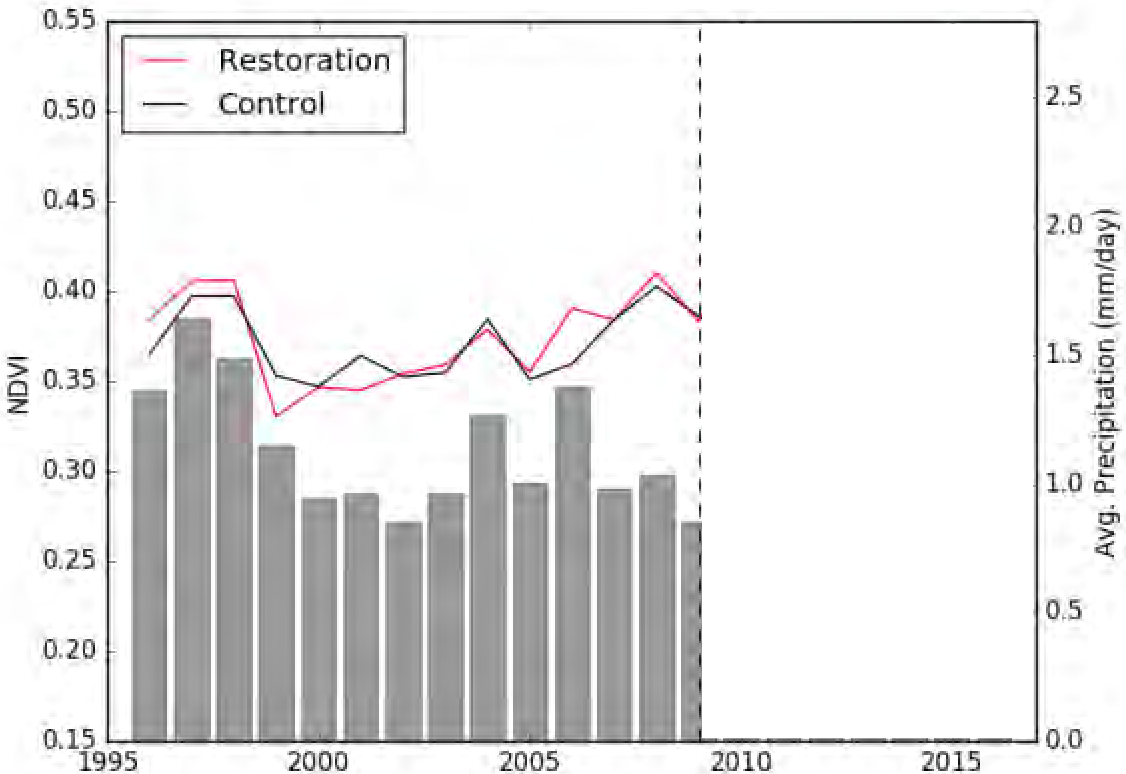


WE OUGHT TO BE ABLE TO DETECT IT FROM SPACE

map.sagegrouseinitiative.com

BRIDGE CREEK NDVI ANALYSIS

Silverman et al. In Prep



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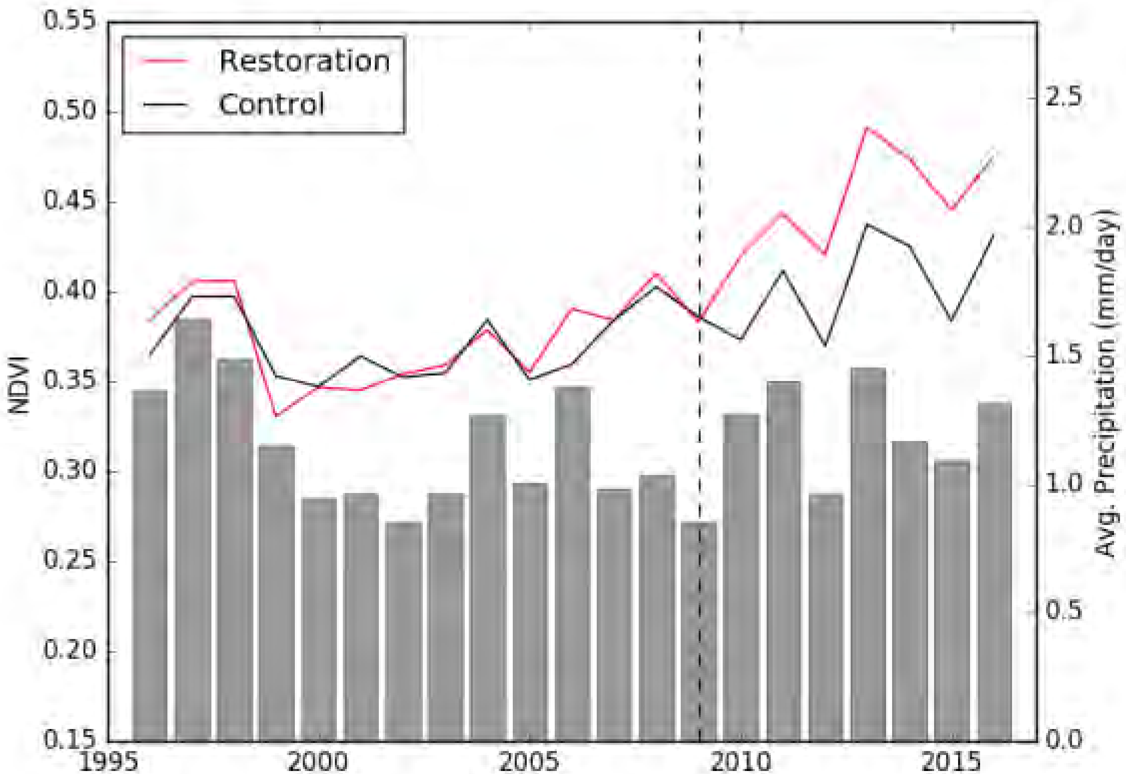
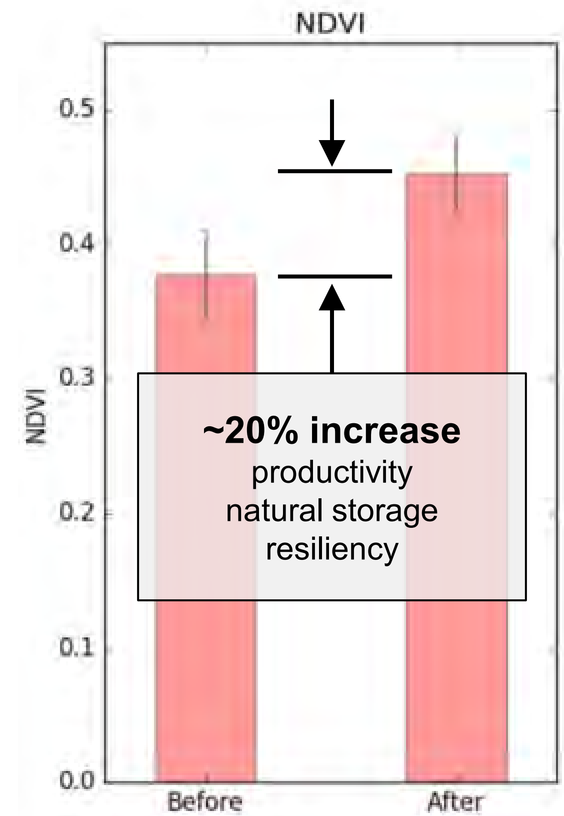
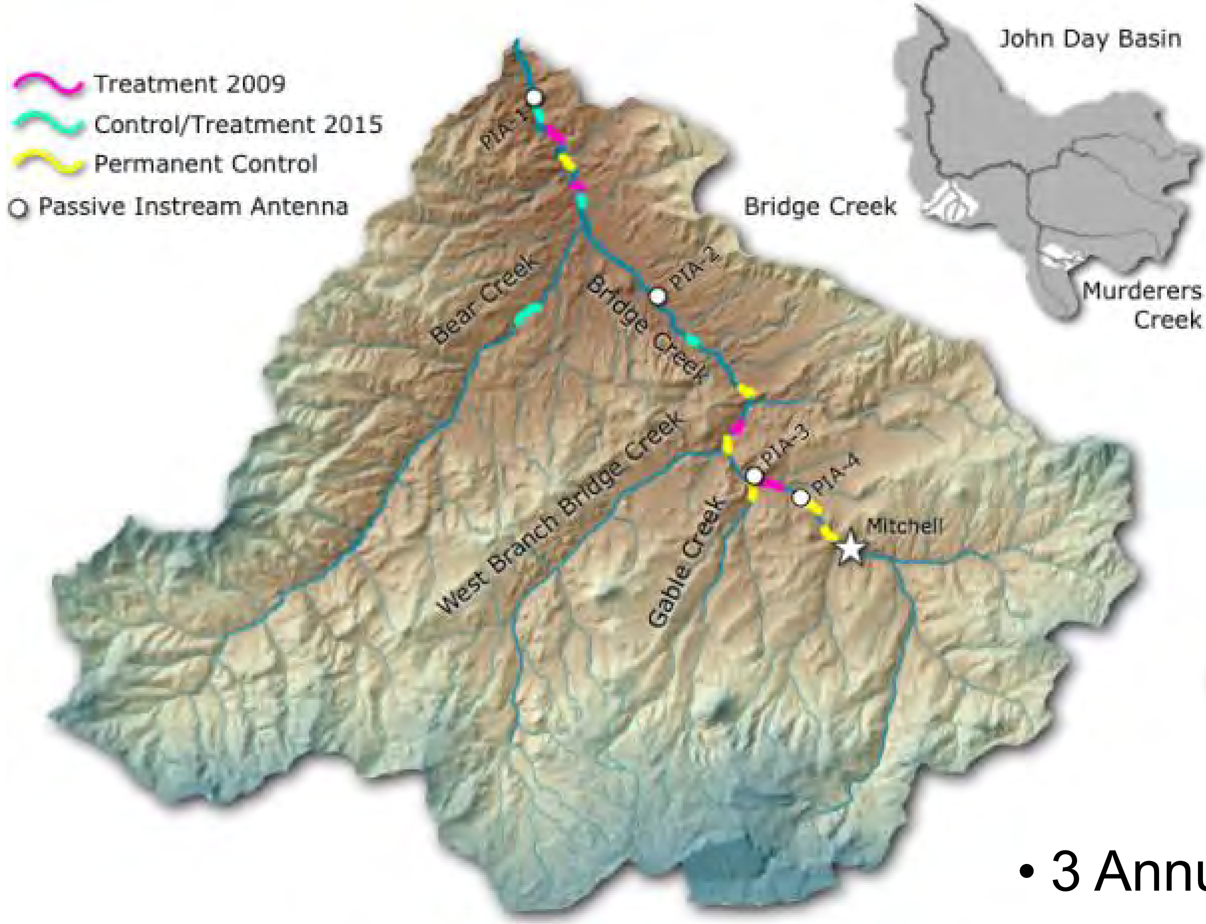
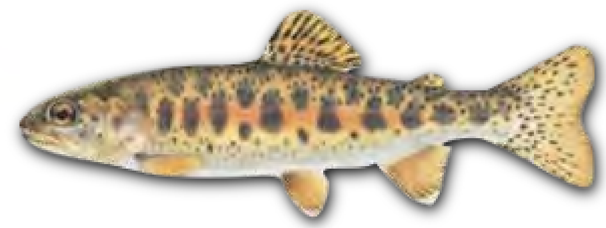




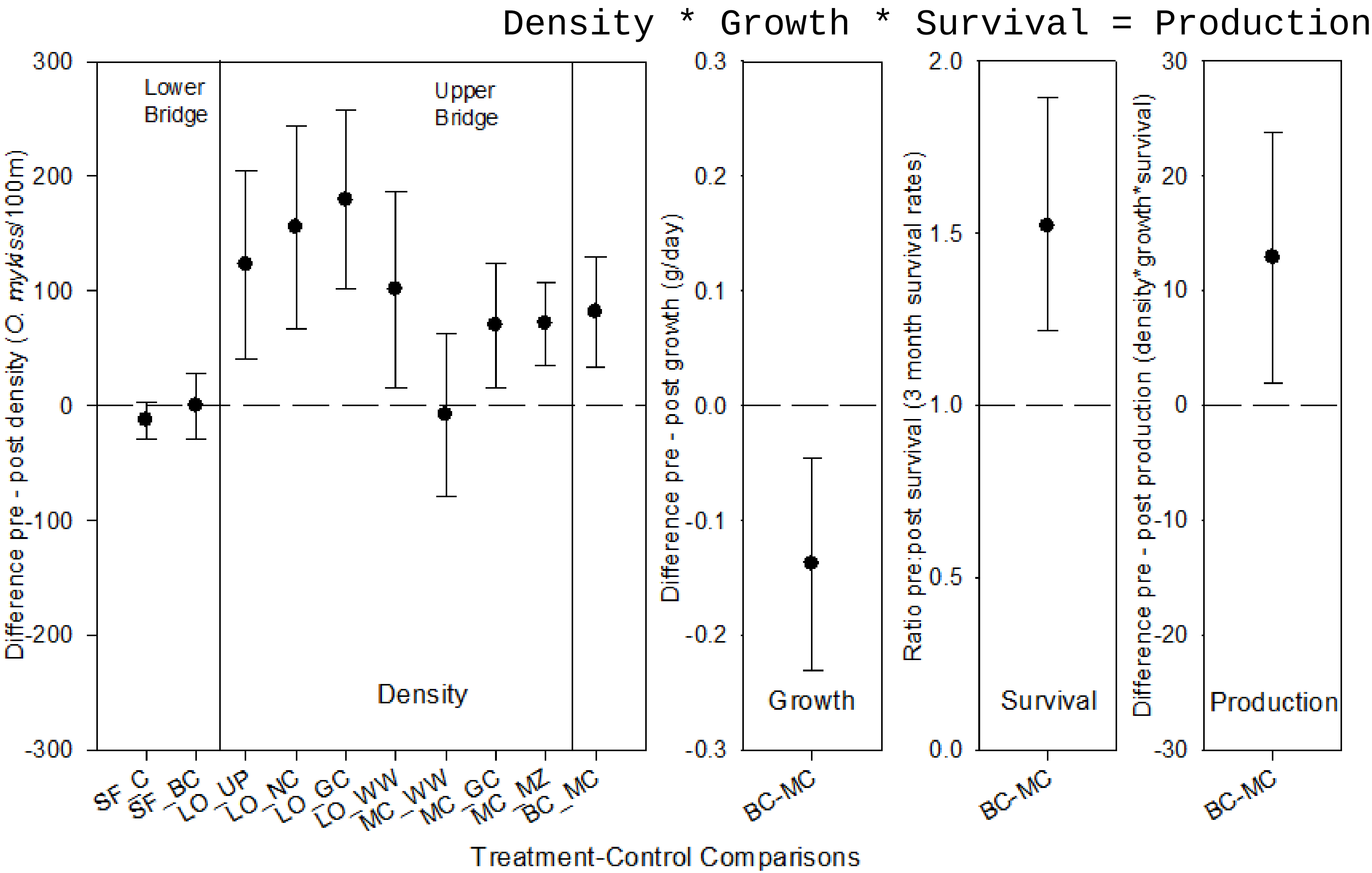
BRIDGE CREEK FISH POPULATION MONITORING





- 3 Annual M-R Surveys - 9 yrs
- ~ 50,000 Juveniles Pit-tagged
- 4 Passive Instream Antennas
- Adult Steelhead Trap

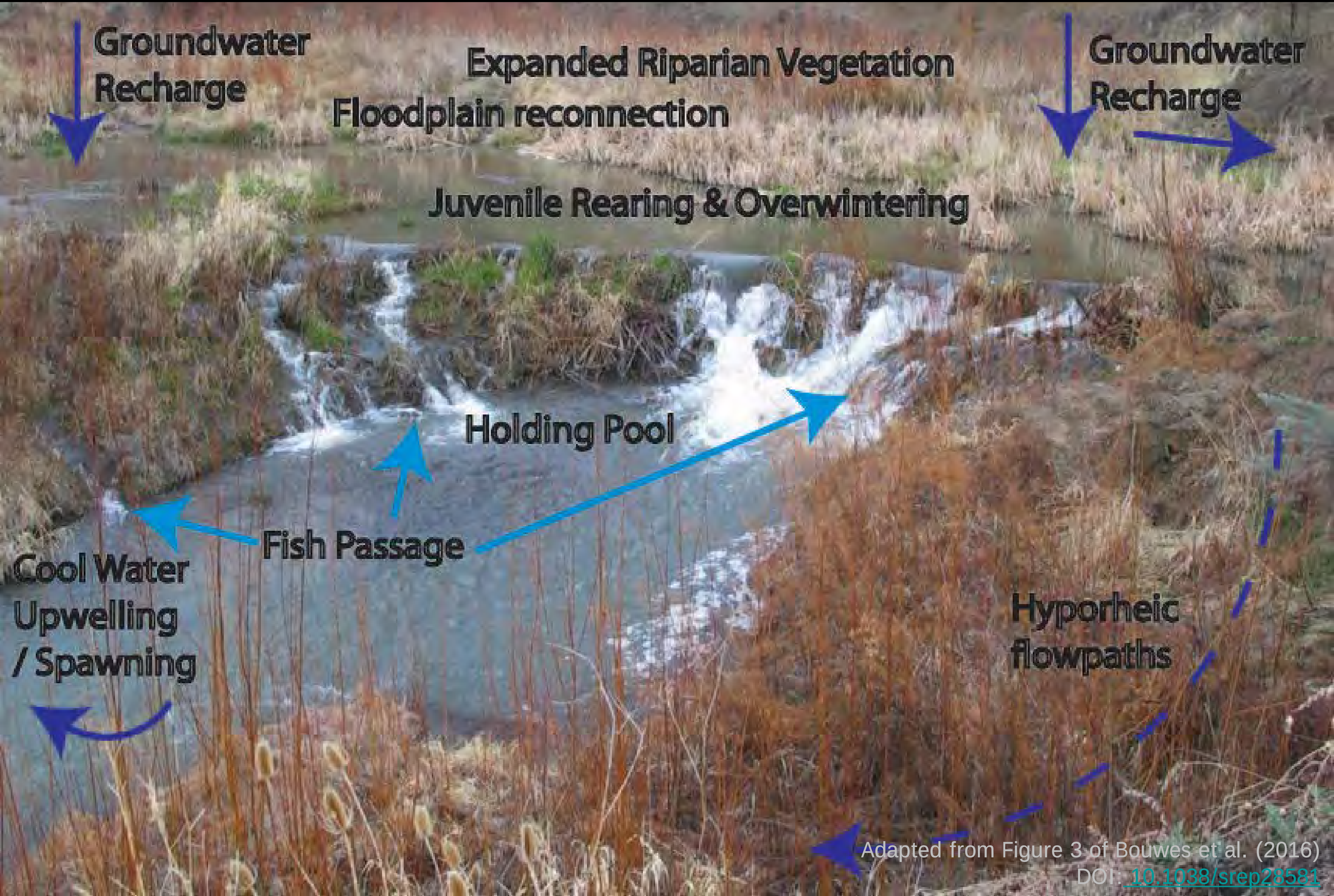
POPULATION LEVEL RESULTS!



Juvenile *O. mykiss*

Figure 7 of Bouwes et al. (2016)
DOI: 10.1038/srep28581

Beaver dams provide many benefits



Adapted from Figure 3 of Bouwes et al. (2016)
DOI: 10.1038/srep28581

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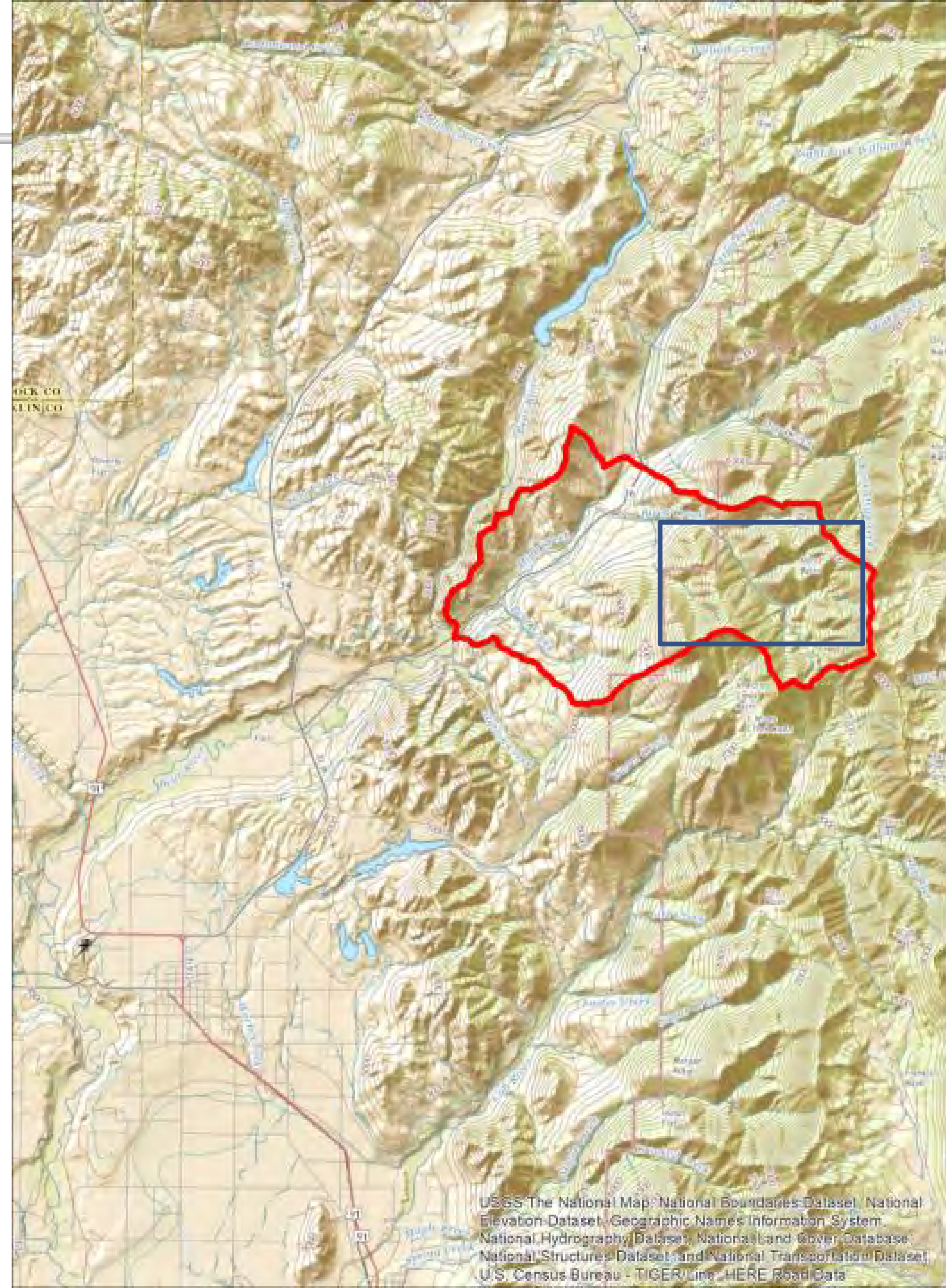
SOMETIMES JUST BEAVER ALONE ARE NOT ENOUGH…

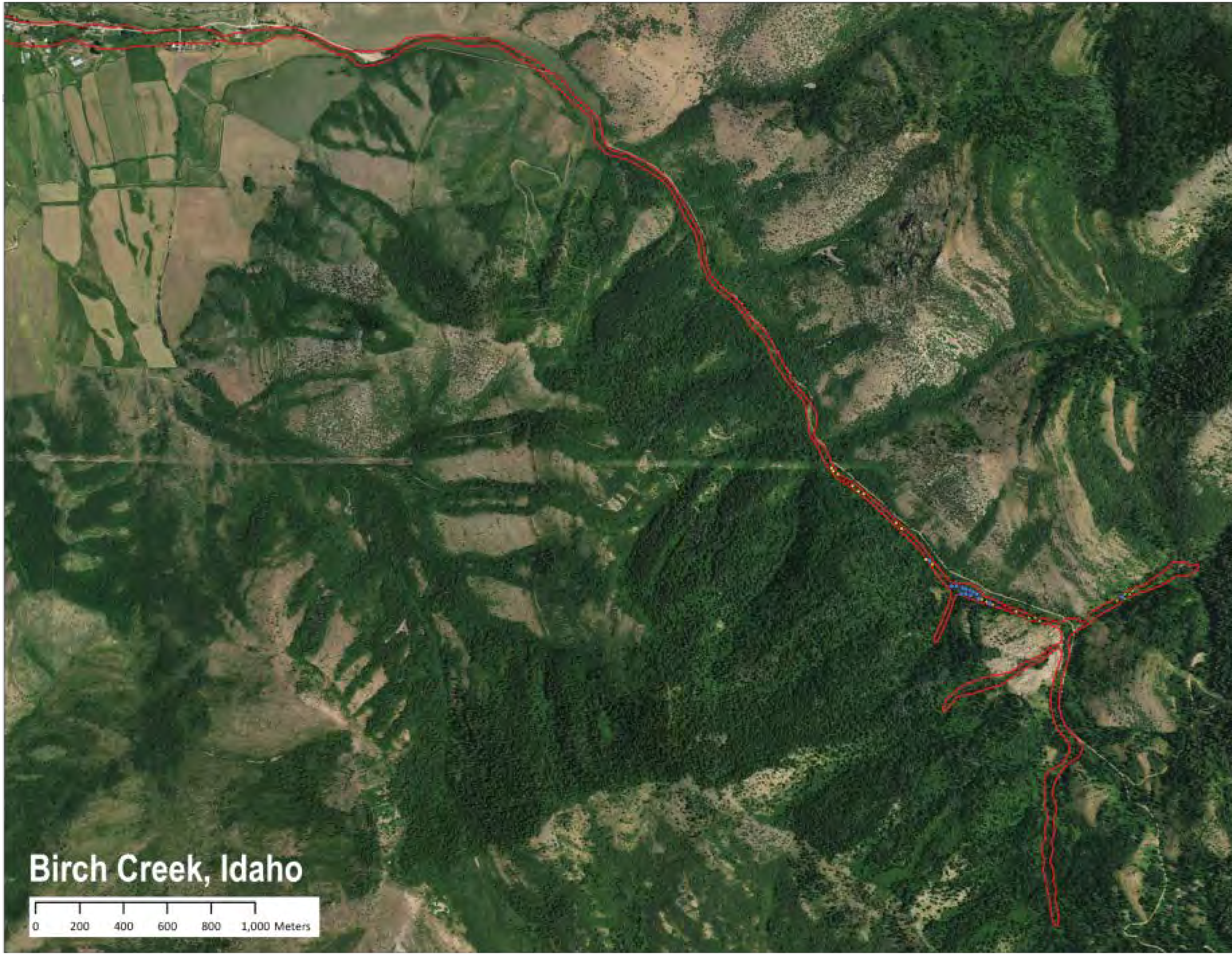
- Jay Wilde & the Birch Creek, ID story
- Using BDAs to provide immediate cover and homes

BIRCH CREEK, ID



ROUGH TIME LINE... BIRCH CREEK

- 1970s – Beaver Dams Present... last beaver extirpated from system
- 1990s – Jay move's back to family ranch, discovers creek now drying up (& no beaver)
- Late 2000s – 2 Reintroduction attempts (11 nuisance beaver), none stayed or survived
- Nov, 2014 – Jay shows interest in BDAs, we build pilot (4 BDAs – 2 complexes)
- Sep, 2015 – We build 15 more BDAs (6 complexes total)
- Oct, 2015- Reintroduce 5 beaver (4 adults; 1 kit)
- Sep, 2016 – NRCS Course & USFS maintain 3 BDAs, & build 3 new BDAs on mainstem, & 4 postless BDAs on 1st order tributary
- Oct, 2016 – 6 more beaver introduced


Birch Creek, Idaho
0 200 400 600 800 1,000 Meters

BDA TREATMENTS & BEAVER DAMS

- ★ 2014 November Pilot BDAs (4 in 2 complexes)
- ★ 2015 September BDAs (15 more in 4 complexes)
- ★ 2016 September BDAs (7 more in 2 complexes)
- ● 2016 Natural Dams

MEAL PREPARERS:

Ranchers, volunteer groups, kids and then hand off to beaver...

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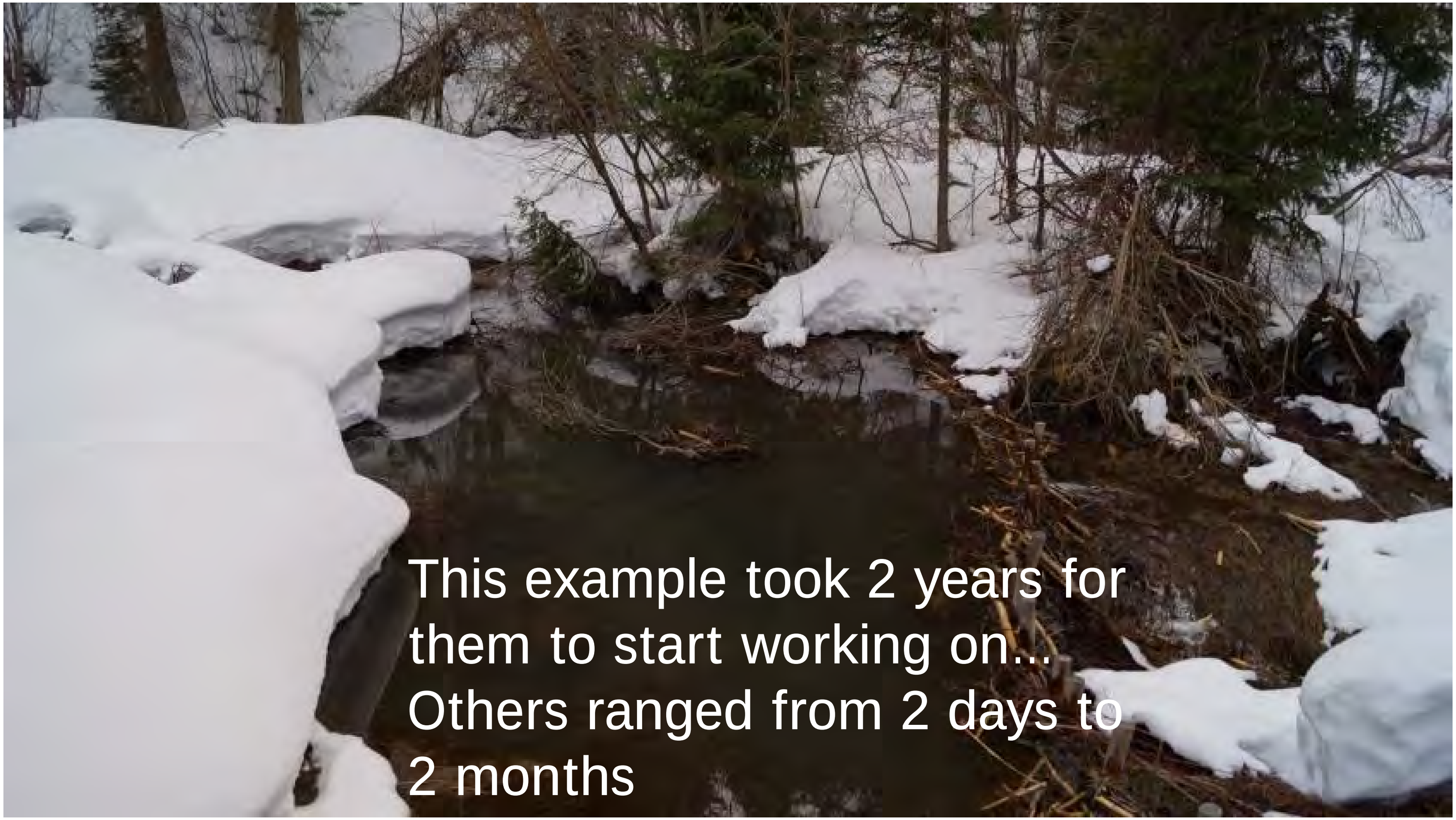
BEAVER TAKE OVER MAINTENANCE OF BDAs… IDEALLY



NOT ALL BDAs NEED POSTS

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AN NRCS CLASS, SOME POSTLESS BDAs

+ 4 BEAVER & 1.5 MONTHS =

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A POSTLESS EXAMPLE…

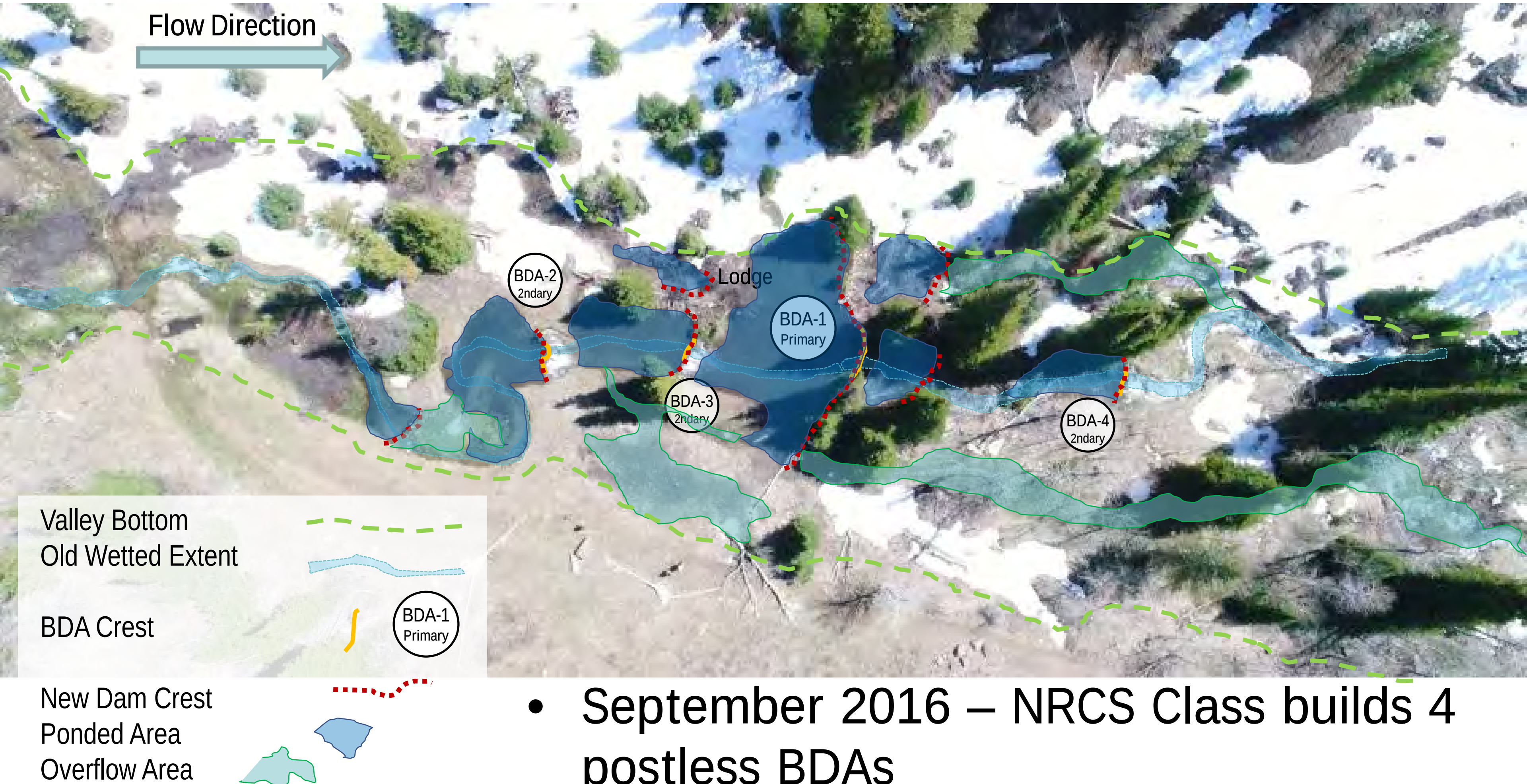
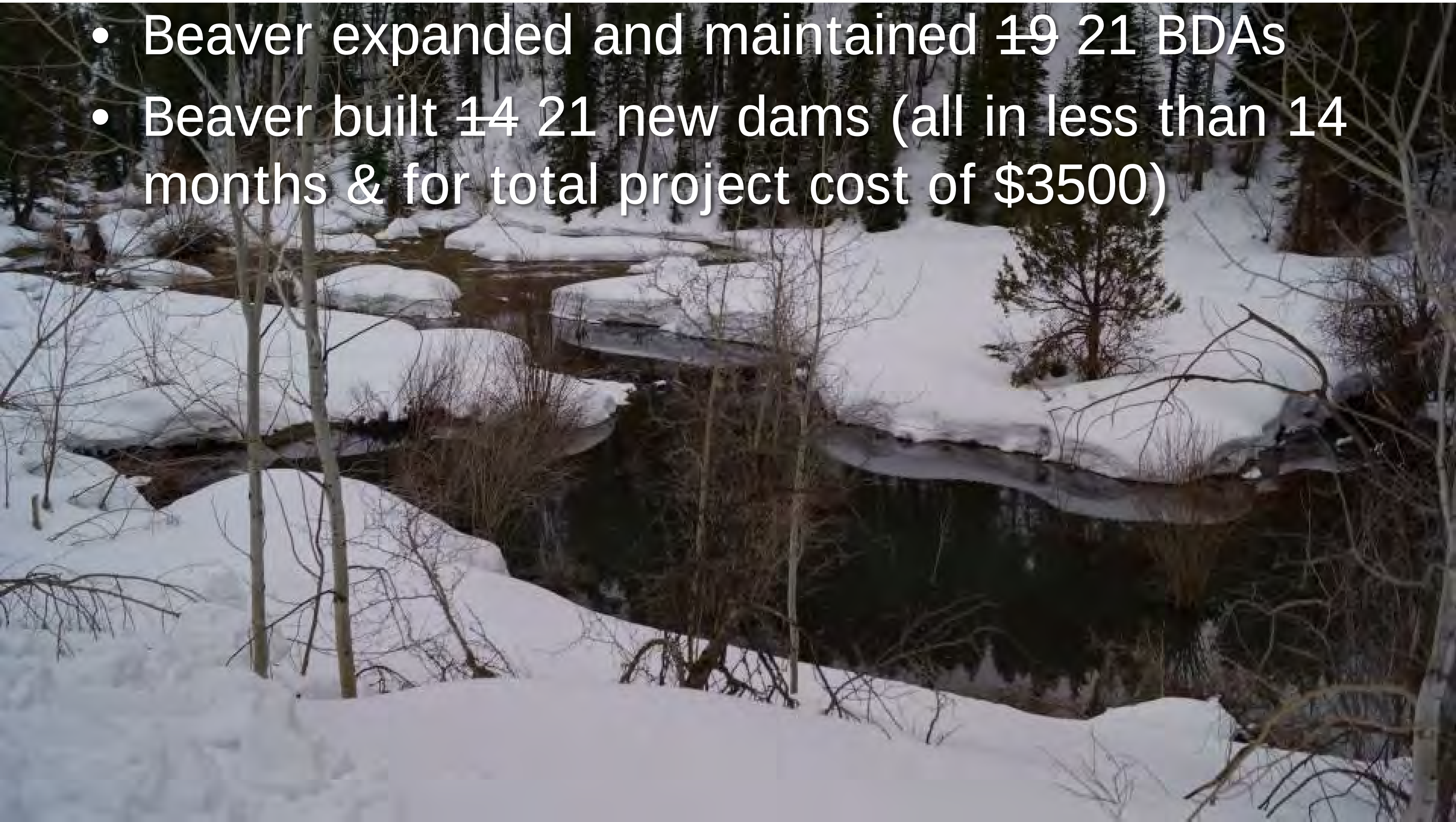


Photo from April 2017
(8 months later)

- September 2016 – NRCS Class builds 4 postless BDAs
- October 2016 – 6 more beaver introduced
- By November, they remodeled…

AND THEY EXPANDED…

- 11 Beaver occupied & used ~~22~~ 24 of 26 BDAs
- Beaver expanded and maintained ~~19~~ 21 BDAs
- Beaver built ~~14~~ 21 new dams (all in less than 14 months & for total project cost of $3500)



LOTS OF WAYS TO BUILD BDAs…

BUT, BY HAND IS BEST (just like beaver)

SGI/NRCS 2016 Workshop Participants working building a BDA:
http://beaver.joewheaton.org/syllabus/workshop-schedules/2016---sage-grouse-initative-pheasants-forever-and-nrcs


USFS + IDFG + USU + 3 GENERATONS OF RANCHERS + NRCS CLASS
No big budget science or monitoring... but a lot of collective learning with good will and volunteer efforts

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WA
MT
ND
OR
ID
SD
WY
NV
CA
UT
CO
WELCOME TO
GROUSE CREEK
"A PLACE LIKE NO OTHER"
EST. 1875

CHALLENGES

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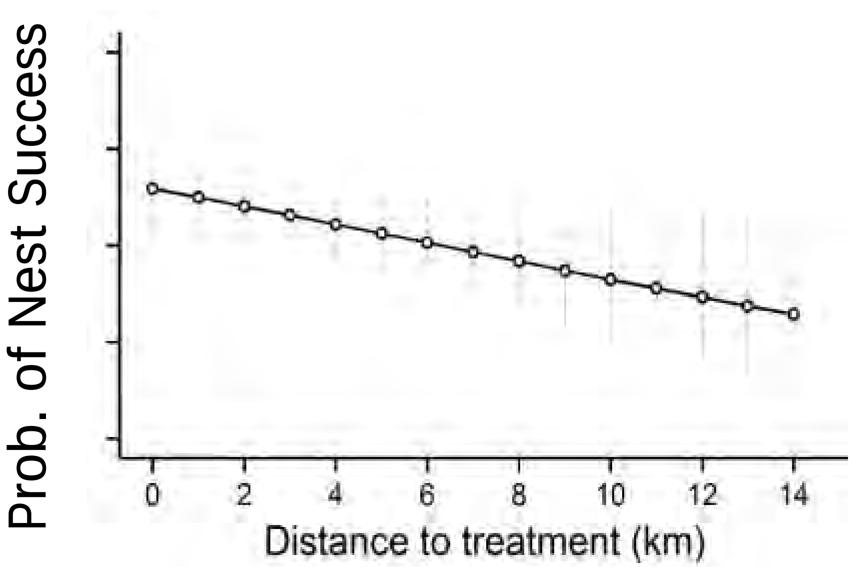
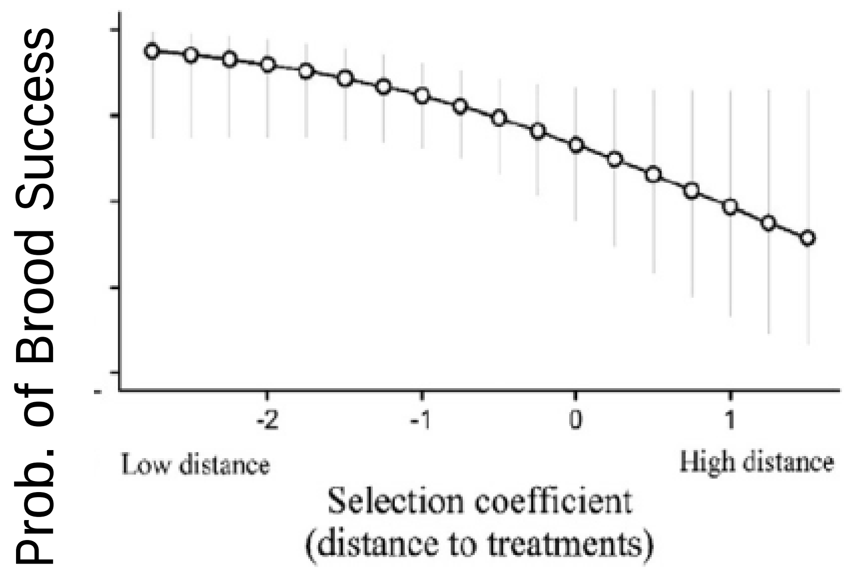
SAGE GROUSE HATE TREES

Sandford et al. 2017

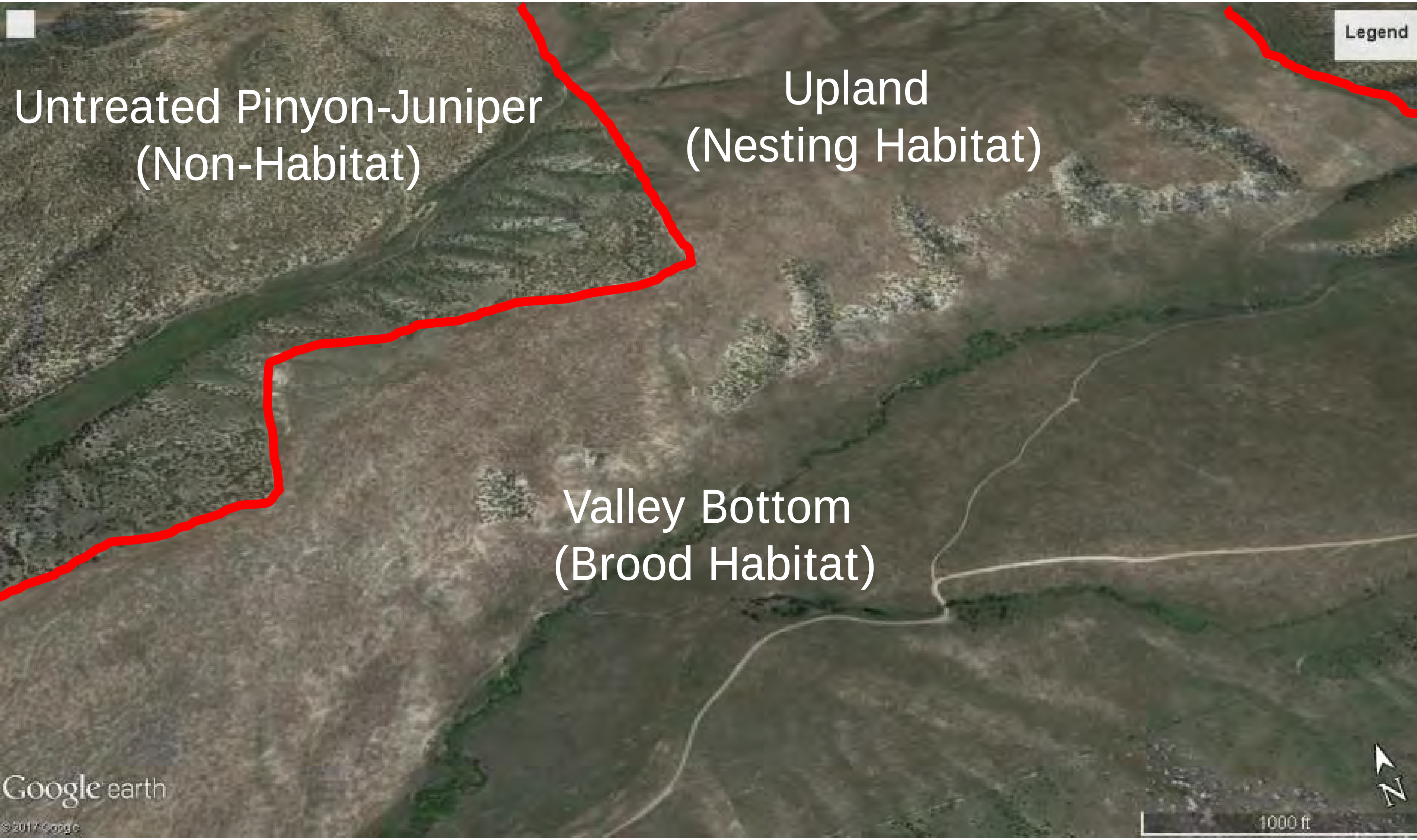
DOI: 10.1016/j.rama.2016.09.002

- 86% of hens avoided conifer-invaded habitats
- Nest and brood success higher near cuts





WIN-WIN FOR SAGE GROUSE



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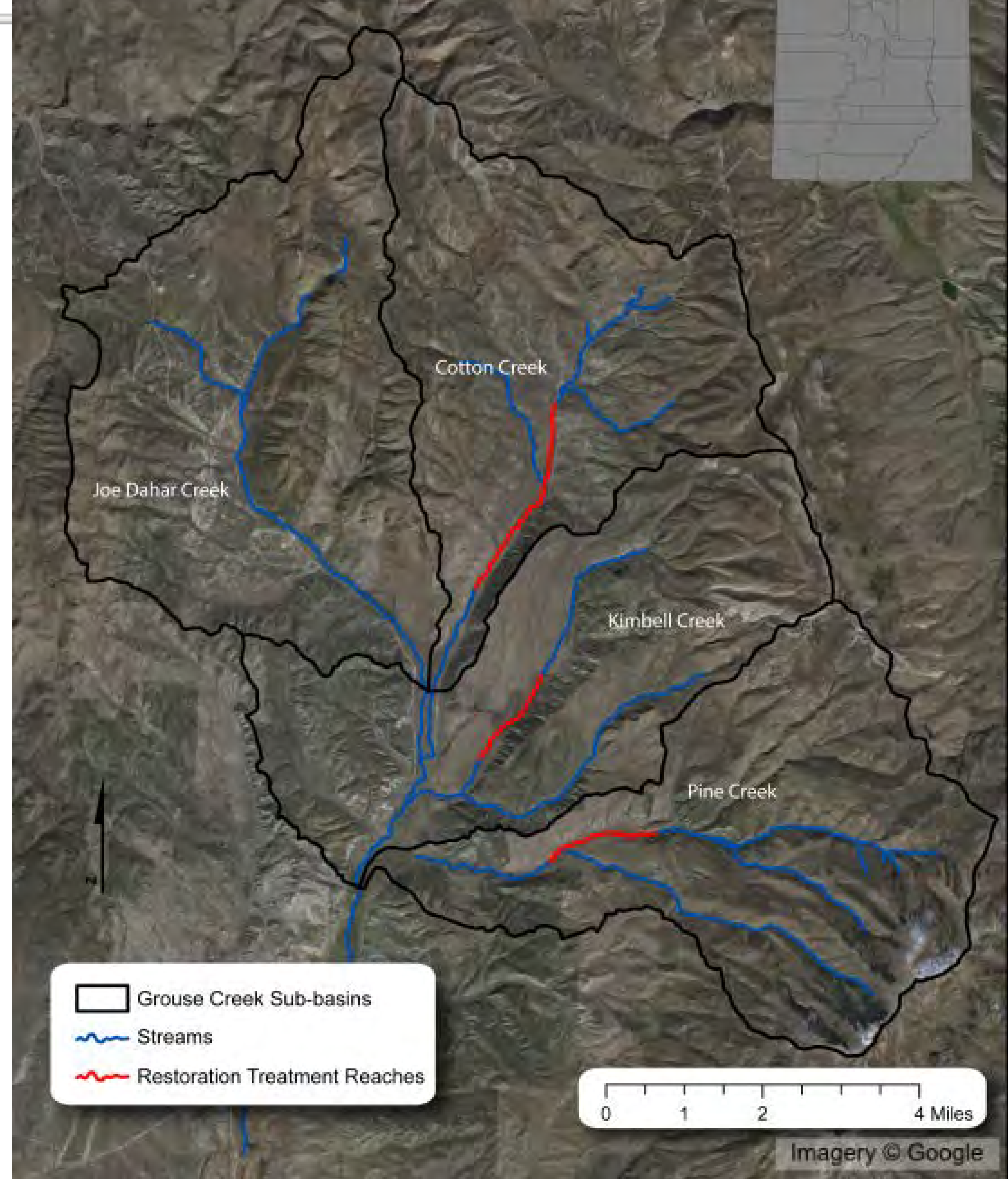
Partnership:

- WRI/SGI Funding
- Tanner Family
- Kent Sorenson (UDWR)
- USU
  - Eric Thacker, Randy Dahlgren, Terry Mesmer, Joe Wheaton
- Anabranch Solutions

Utah State University Magazine – Fall 2016

UTAH's WATERSHED RESTORATION INITIATIVE

GROUSE CREEK - BDA RESTORATION



Figures from Scott Shahverdian (Anabranch Solutions, 2017)

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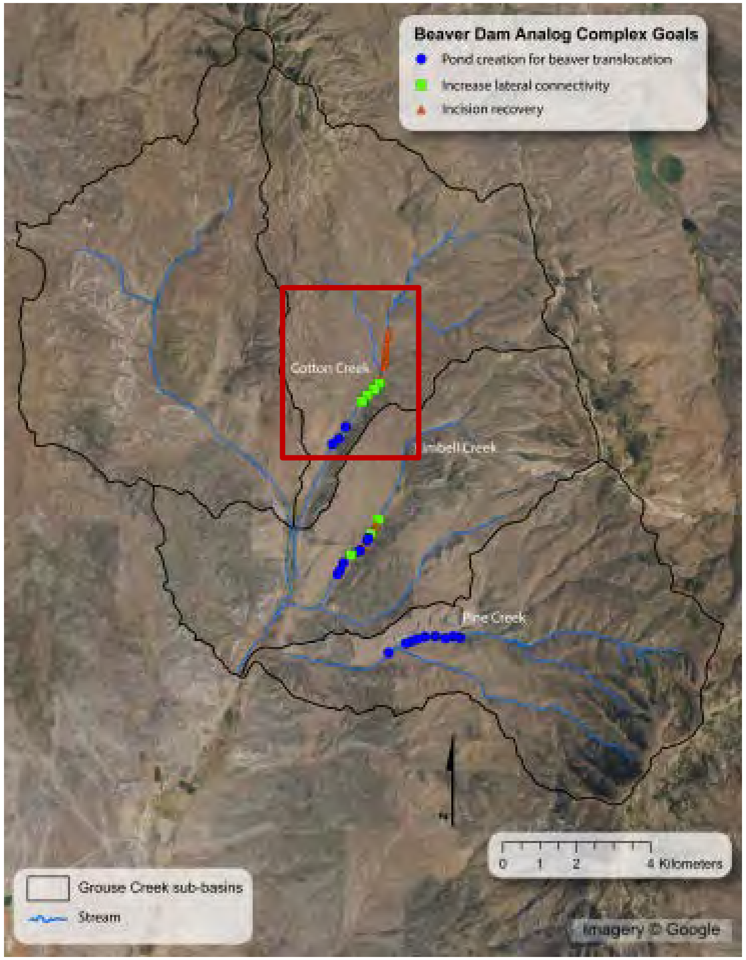
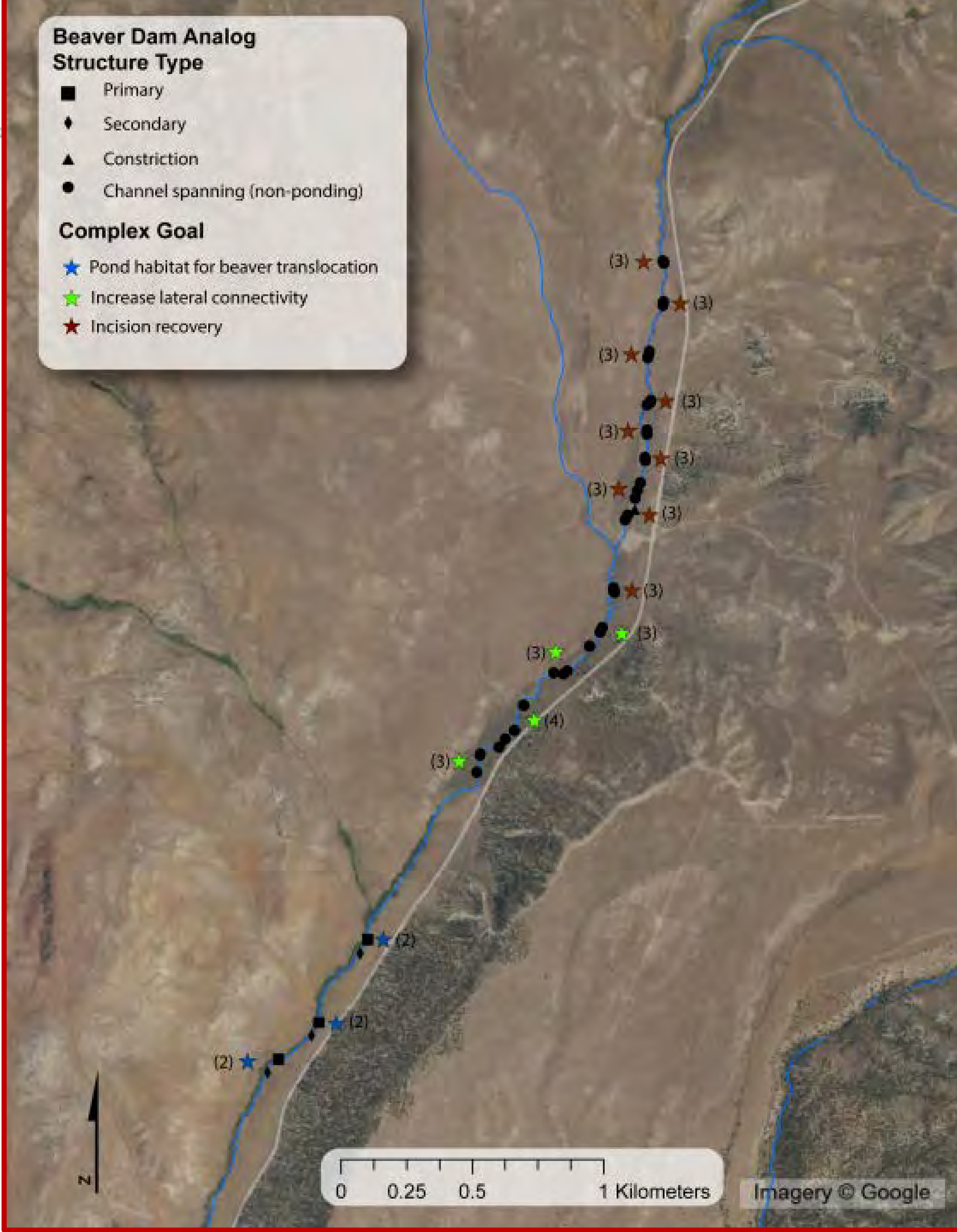
BDA TREATMENTS





Figures from Scott Shahverdian (Anabranch Solutions, 2017)

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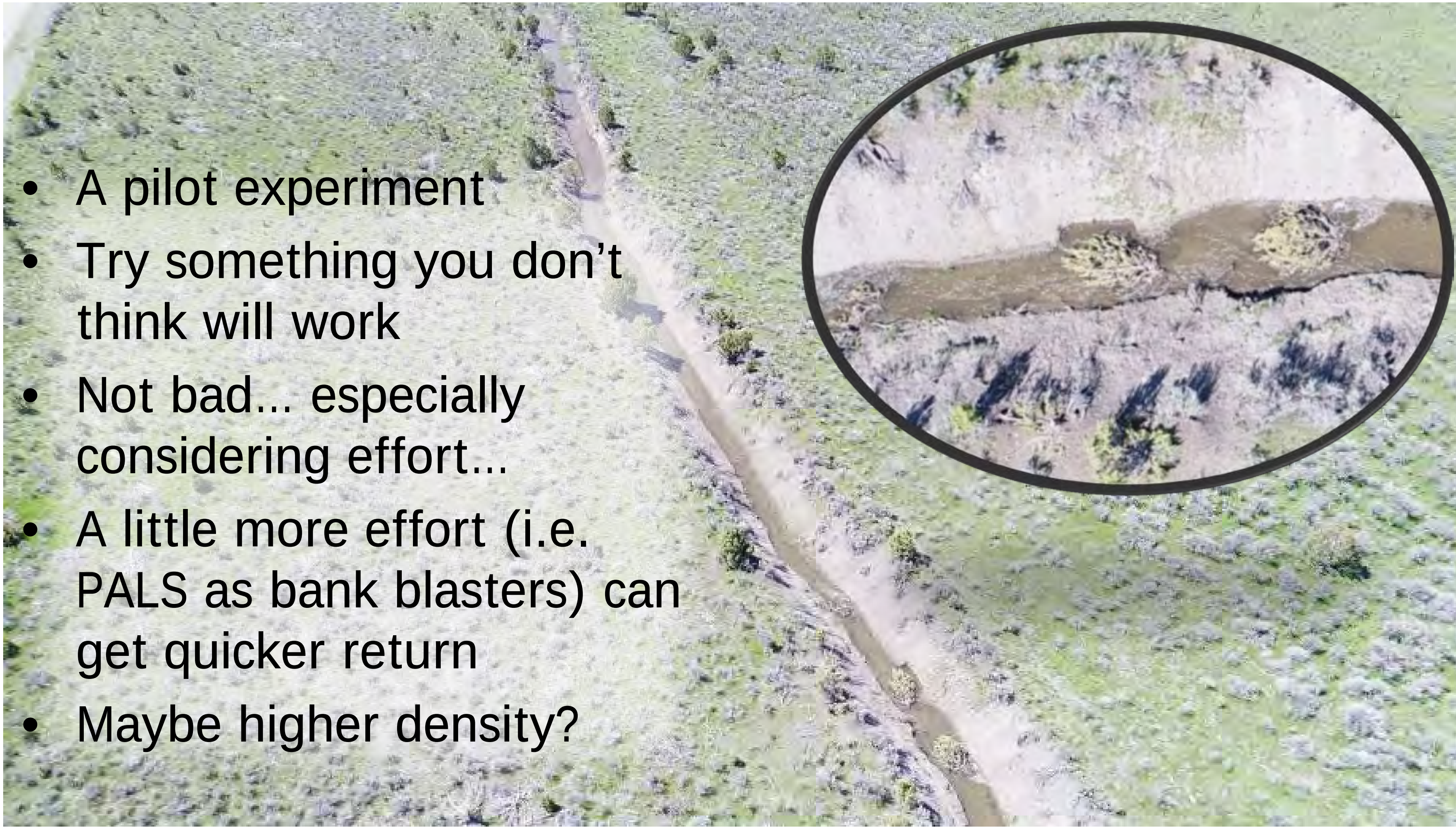
A PILOT STRUCTURE IN HIGH FLOW

No scientific results yet... just built pilots last fall (16 structures in 3 creeks) & implemented 114 structures this June

A PRETTY MODEST BDA STRUCTURE…

REALLY? THAT WAS DESIGNED?

TOSSING PJ IN THE BOWLING ALLEY



- A pilot experiment
- Try something you don't think will work
- Not bad... especially considering effort...
- A little more effort (i.e. PALS as bank blasters) can get quicker return
- Maybe higher density?

FAILURE? GOOD!

WIDEN THAT TRENCH → BUILD INSET FLOODPLAINS → RAISE WATER TABLES → EXPAND MESIC HABITATS

FLOODPLAIN CONNECTIVITY! WITH PJ?

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PILOT STRUCTURES INVOKING FLOODING & TRENCH WIDENING

READING THE LANDSCAPE…

EXPANDING THE EMERARLD RIBBON

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USE POSTS WHERE YOU NEED THEM…

POST-FLOOD MATTRESS MAINENANCE

DOWN IN AN INSET VALLEY BOTTOM

- Here, BDAs not used to do the restoration
- Just to provide encouraging release sites for beaver reintroduction this Fall

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SOME PLACES WE'LL LEAVE IT TO BEAVER

Stay tuned for results (USU monitoring hydrologic response, vegetative response, forage resources, sage grouse response)

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PUTTING IN BDAs STRAIGHT-FORWARD…

These critical tasks take more thought:

- Properly **planning** where BDAs makes sense (e.g. BRAT)
- Organizing and **orchestrating implementation** to feed many miles of streams with 100’s to 1000’s of BDAs
- **Feeding** (hitting) system well enough that it will respond (through its metabolism & exercise) in a way that achieves desired response
- Building **realistic expectations** and adaptive management plans – who does maintenance?
- Allowing **exercise**!

Photo from Steve Bennett (Anabranch Solutions, 2017)

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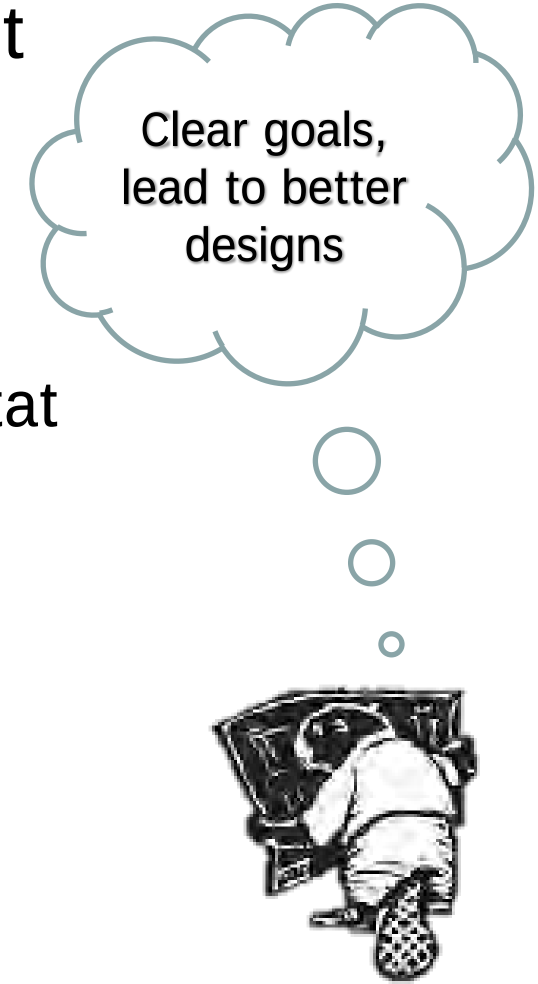
WHY ARE YOU USING BEAVER OR BDAs?

- More specifically, what impairment are you trying to address:
  - Hydrologic (restoring flows)
  - Wet meadow/ mesic restoration?
  - Diversifying Habitat (improving habitat for aquatic or upland species)
  - Water Quality (sediment / nutrients / temperature)
  - Improve/expand riparian vegetation
  - System resilience (dynamic stability?)
  - Building/reconnecting floodplains
  - Restoring incised channels
  - Improving forage production for livestock



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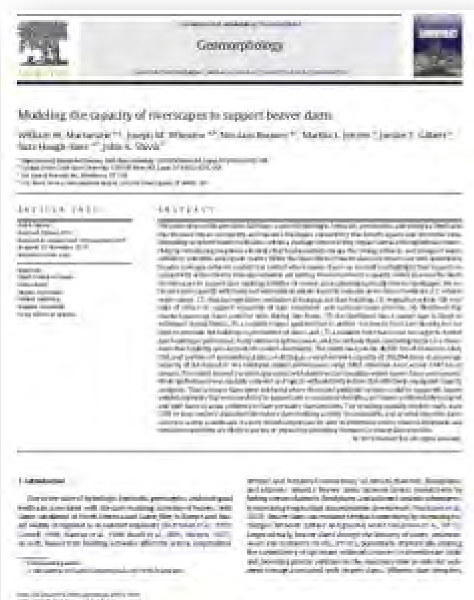
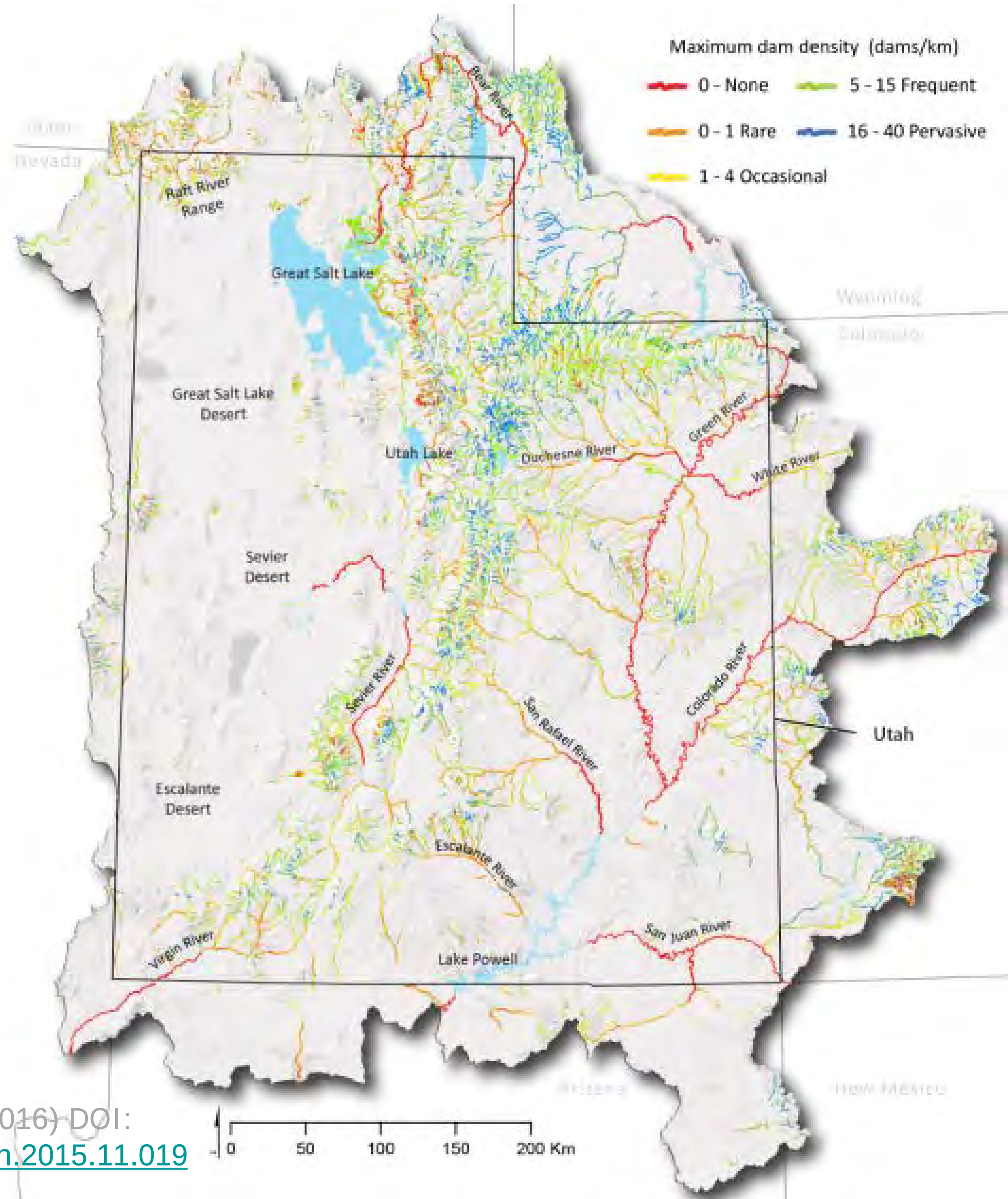
AN ATTEMPT TO PLAN REALISTICALLY

- Where makes sense, where does not?
- Model capacity to support beaver dams as well as conflict potential
- BRAT: http://brat.joewheaton.org

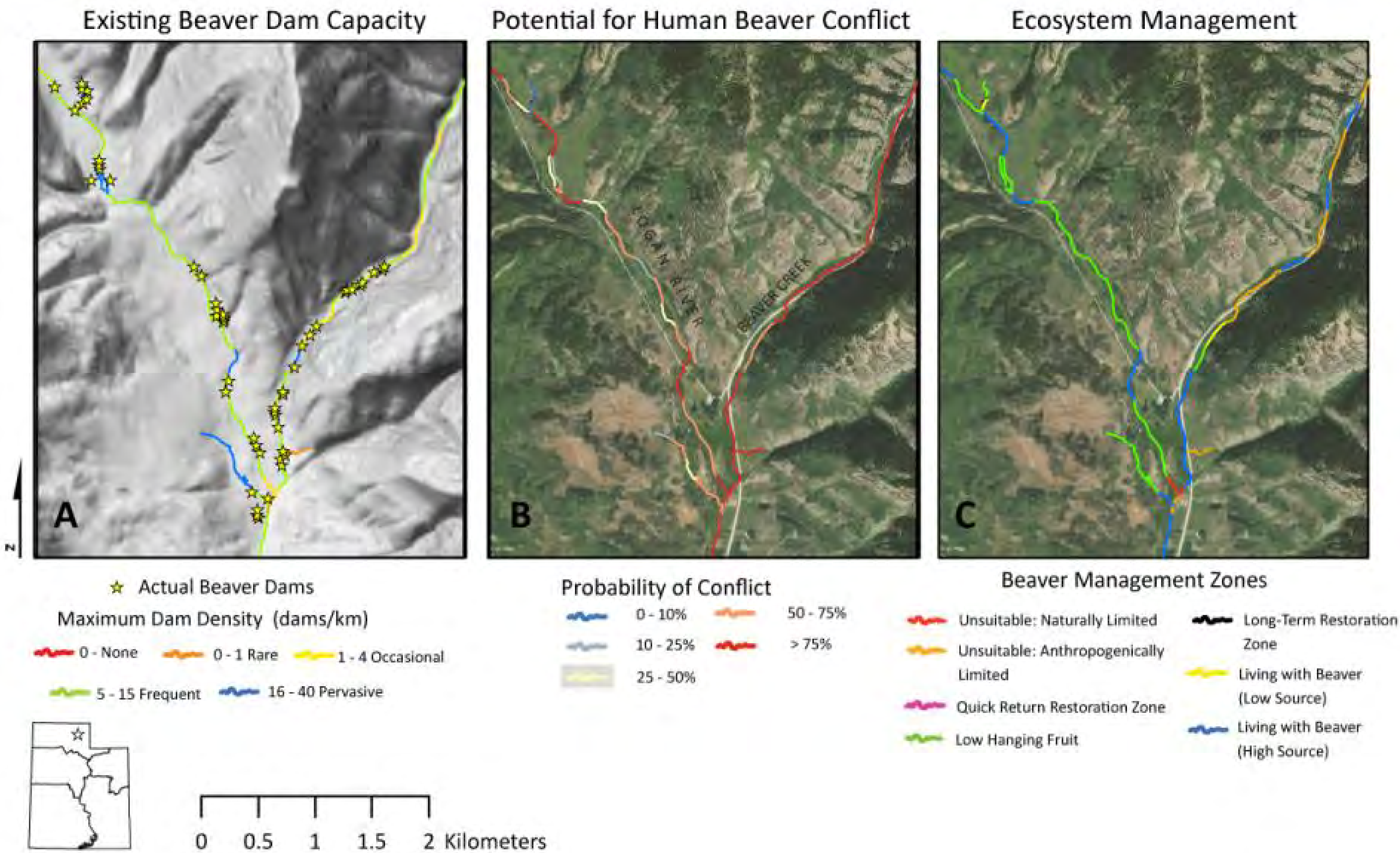




Macfarlane et al. (2016) DOI: 10.1016/j.geomorph.2015.11.019

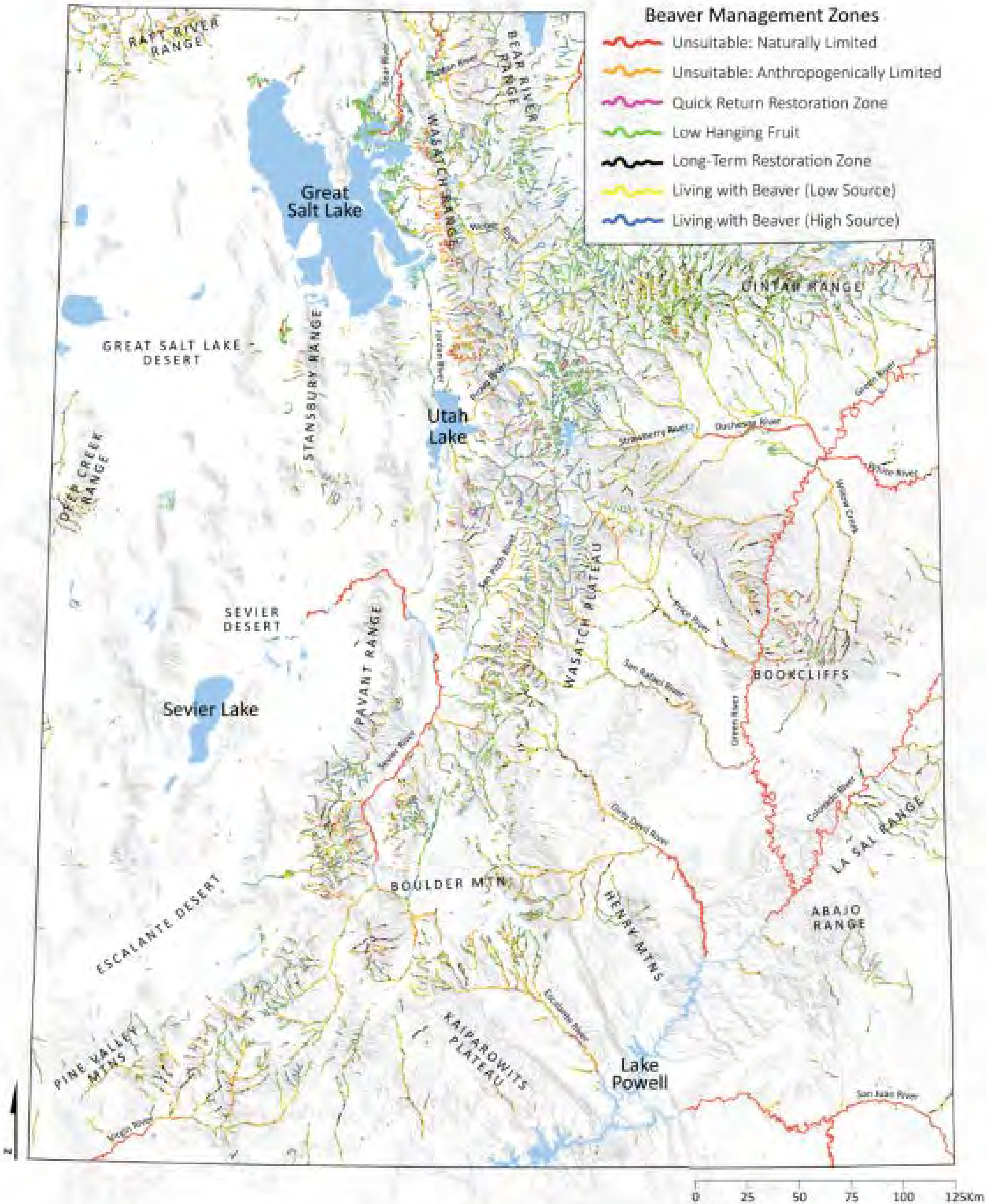
BRAT OUTPUTS IN A NUTSHELL

- **Existing & Historic Capacities** → Potential Conflict → Management



A FIRST CUT

- Focus on areas deemed ‘suitable’ for restoration
- How much effort?



http://brat.joewheaton.org

ASSESSING RISKS: NRCS EXAMPLE

Adjacent Land Use	
Is the project in a remote rangeland setting?	green
Is the project in an agricultural setting with limited infrastructure?	yellow
Is the project in a rural, suburban, or cropland setting, where structure movement or flooding could affect nearby property, but unlikely to cause damage?	orange
Is the project in an urban or other setting where structure movement or flooding could damage nearby property?	red
Infrastructure	
Is the project area removed from nearby infrastructure?	green
Are there downstream bridges? Are they large enough that woody material or sediment from project would be unlikely to affect their structural integrity?	yellow
Are there nearby or downstream culverts? Are they likely to become plugged with woody debris or sediment?	orange
Are there inlet or outlet structures that could be negatively impacted by woody debris or sediment, or are likely locations for beaver to utilize for dam building purposes?	orange
Monitoring and Adaptive Management	
Landowner or partner committed to monitoring structures and adaptively managing if negative impacts occur or project objectives are not being met	green
Monitoring will occur but ability to correct problems is limited	yellow
No monitoring or maintenance will occur	red
Stream Power- Higher power increases the likelihood of structure movement prior to ecological benefits being realized	
Stream is wadable at low flow.	green
Stream is **not** wadable at low flow.	red
Stream Order- Larger systems decrease structure viability and increase the likelihood of structure movement prior to ecological benefits being realized	
1st or 2nd order stream	green
3rd order stream	yellow
Mainstem or greater than 3rd order	red
Incision- Systems actively downcutting often require more structural/active restoration techniques	
Out of bank flow occurs on a regular basis	green
Out of bank flow rarely occurs. Incised channel lacks inset floodplain.	orange

Slide from Timmie Mandish (NRCS)

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START WITH PILOTS!

- Don’t boldly and arrogantly proceed with full blown implementation
- Put in a trial and wait a year or season or so...
- Design some structures to ‘fail’!
- Test a handful of treatments in the diversity of situations you will encounter at full implementation
- You’ll learn about:
  - Feasibility, timing and cost of installation
  - Subtle nuances that can save you a ton of time and money

Photo from Holy Strand (USU)

STRATEGIC SITING OF COMPLEXES

- Where (what reach segment) do I position the complex?
- Where is the primary dam placed to maximize:
  - Ability to spread flows out onto floodplain surface
  - Maintain deeper water depth for food caching and under water entrance to lodge
  - Provide good lodge options
  - Easy access to best building materials

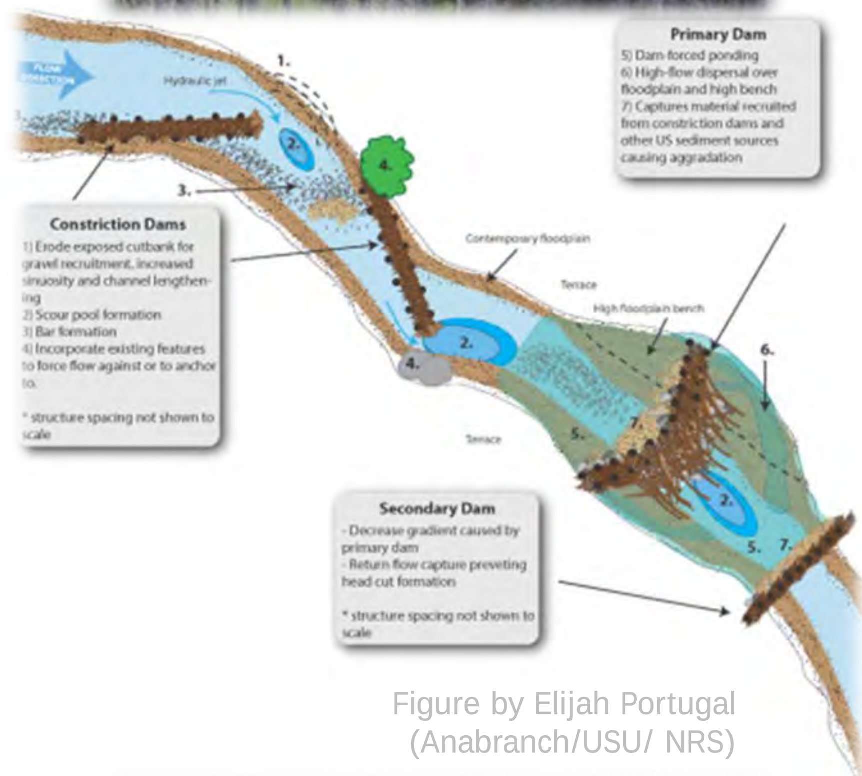

Figure by Elijah Portugal (Anabranch/USU/ NRS)

PRIMARY vs. SECONDARY DAMS?

- How can secondary dams be
  - Placed downstream of primary dam to extend forage/harvest range and alleviate excessive head drop from primary dam
  - Placed upstream to extend forage range or act as sinks
- How do structures work in concert with each other to achieve goals:
  - Hydrologic (flood attenuation, increased baseflow)
  - Hydraulic (deep pond and flooding)
  - Geomorphic (diversifying topography & residence time of sediment)

Figure by Nick Weber (Anabranch/ELR)

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STRUCTURE DESIGN

- Most critical design element is crest elevation
  - Primary dams spread low flows out onto floodplains
  - Secondary dams typically within bankfull channel
- Building materials
  - Source all locally if possible, but if using beaver don’t harvest best beaver food (e.g. aspen) if avoidable
  - Do you need posts?
- Articulate formal design hypotheses
  - What specifically are you hoping to achieve
    - Short term hydraulic responses
    - Medium & long term geomorphic and habitat responses
    - Hydrologic impacts
    - Ecological response/use by target biota/species

PUTTING JUNIPER TO WORK

- Conifer removal a primary restoration practice for benefiting sage grouse
- ~1 million acres of trees already on the ground
- **Why not use the juniper slash for BDAs?**

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WE'RE DEALING WITH A LOT OF LOADED TERMS

When you say…

- Structure
- Dam
- Beaver

Some hear…

- Engineering
- Water rights
- $@!*% nuisance

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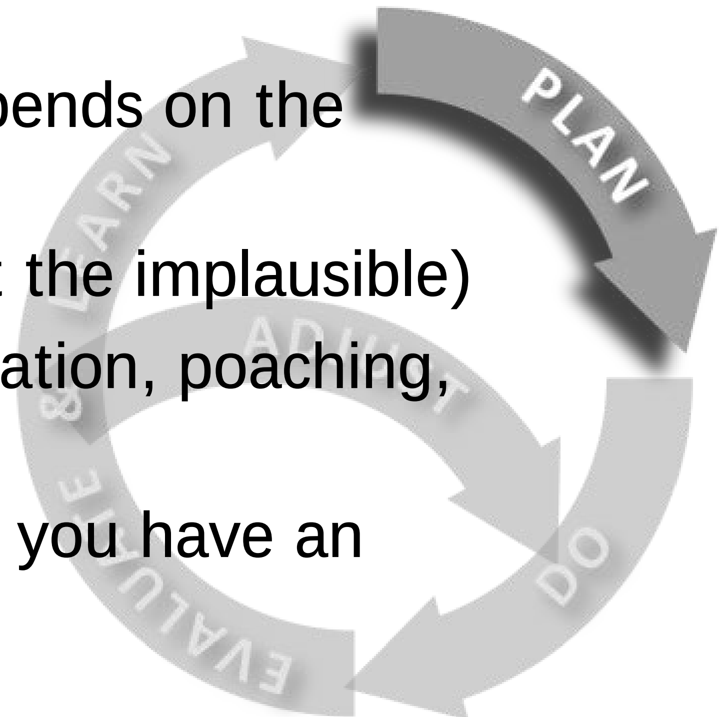
TALKING BDAs

- What are you fundamentally trying to accomplish?
  - Erosion control/stabilization vs. habitat/process restoration
- Shift emphasis away from an individual ‘structure’ - use a complex of structures to achieve habitat effects within a reach
- Emphasize key features of BDAs: natural materials, hand-built, low-profile, short structure lifespan designed to kickstart processes
- Everything makes more sense in the field - take them to walk the creek

REALISTIC EXPECTATIONS ARE CRITICAL

- Remember… You're relying on a rodent (or at least design ideas stolen from one)
- Don't take too narrow of a focus on individual dams or one dam complex... take a broader view
- Beaver come and go... as do their dams... and with that we get dynamism
- How 'instant' the gratification depends on the physiographic setting...
- Expect the unexpected... (but not the implausible)
- How vulnerable is project to predation, poaching, etc.?
- IF you have an invasive problem, you have an invasive problem



HDLWD & ADAPTIVE MANAGEMENT

- Example of how AM can be done for cheaper...

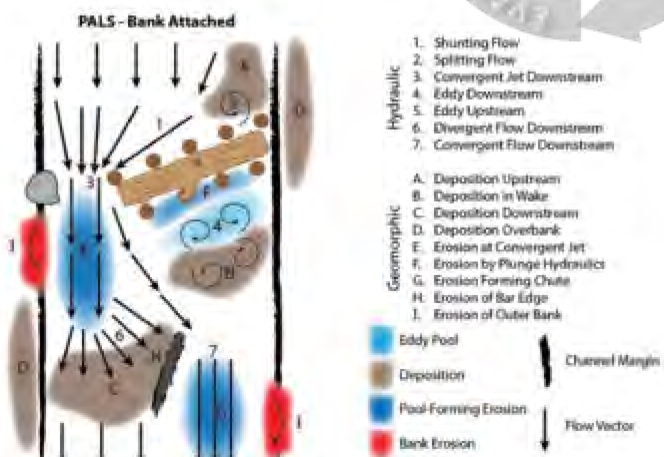


Figure 3. An example of detailed design hypotheses for a postassisted log structure (PALS) used to increase large woody debris (LWD) in the Asotin Creek intensively monitored watershed treatment sections. Each number refers to either a hypothesized hydraulic or geomorphic response. Blue = scour, brown = deposition, red = undercut bank creation. Adapted from Camp (2015).

ESSAY

ADAPTING ADAPTIVE MANAGEMENT FOR TESTING THE EFFECTIVENESS OF STREAM RESTORATION: AN INTENSIVELY MONITORED WATERSHED EXAMPLE

84 Fisheries | Vol. 41 • No. 2 • February 2016

From: 2016. Bouwes N, Bennett S and Wheaton JM. Adapting Adaptive Management for Testing the Effectiveness of Stream Restoration: An Intensively Monitored Watershed Example Fisheries. 41: 2: pp. 84-91 DOI: 10.1080/03632415.2015.1127806

MUCH EASIER TO GO PASSIVE IF YOU CAN

Transfer decision making & liability to the ecosystem engineer

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SUMMARY

- Mesic areas are rare but vital islands in sagebrush sea
- Grouse and beavers meet at the riparian fringe
- Huge opportunity exists to scale-up riparian restoration on the wings of sage grouse
- Traditional restoration approaches alone won't get us there
- BDAs represent a low-cost approach to kickstart recovery
- Ultimate goal is resilient, self-sustaining systems

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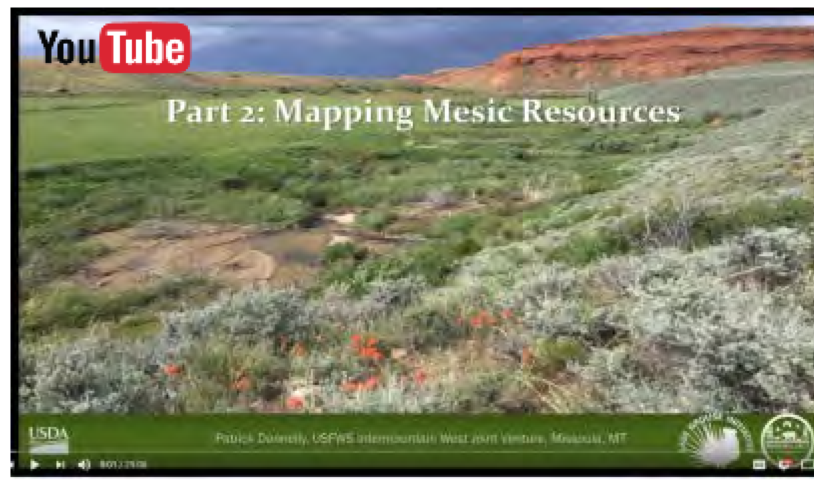
SGI RESOURCES

- Mesic Planning Guide
- Mesic Brochure
- ESRI Storyboard
- SGI Events & Webinars page
- SGI Mesic Resources Layer and Interactive Web App



www.sagegrouseinitiative.com/water-is-life/

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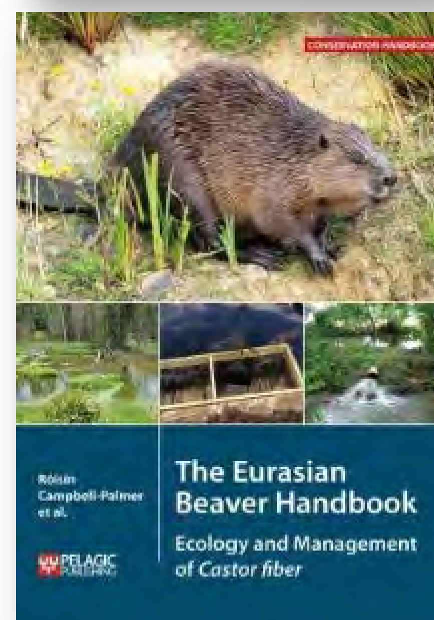
PARTNERING WITH BEAVER RESOURCES



THANK YOU! QUESTIONS?

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Mahogany Creek, UT

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