BEAVER – NUISANCE OR RESTORATION PARTNER?

Utah State University

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Swaner Preserve and EcoCenter
Utah State University

May 29th, 2013

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MAIN PARTNERS… OTHER THAN RODENTS

Nick Bouwes

Michael Pollock

Chris Jordan

Wally Macfarlane

PURPOSE OF TALK

All to easy to get people excited about beaver as a restoration tool… so we're interested in **expectation management**:

1. Where could beaver work?
2. Where are they a problem?
3. What do we do where beaver alone are not enough?

Airborne Beavers Fight Floods

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

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

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

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

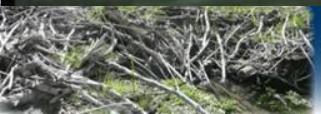
1. Boxed for travel, this beaver is placed in a crate designed by Scotty Heter, left. 2. Rubber bands pull the box apart when the chute hits the ground, freeing the animals. 3. Heading for water, the airborne beavers start working like beavers on their new dam.

TALK PLAN

I. **A bit of Background on Beaver**
II. Where are beaver a nuisance?
III. Exploiting the Undiscriminating Rodent
IV. Where might this work? - BRAT
V. Beaver in Incised Streams?
    I. Bridge Creek IMW Experiment
VI. Take-Homes

A HABITAT GENERALIST, AND HIGHLY ADAPTABLE

- Lakes
- Rivers and streams
- Abandoned channels on floodplains
- Wetlands



Slide from John Stella

FROM BOREAL FORESTS….

Fred Hirschmann—Science Faction/Getty Images

http://www.for.gov.bc.ca/dfn

Slide from John Stella

UtahState University
DEPARTMENT OF WATERSHED SCIENCES

…TO DESERTS

http://www.rv-boondocking-the-good-life.com/

Beaver Dam Creek,
Long Island, NY

EVEN SOME UNLIKELY PLACES…

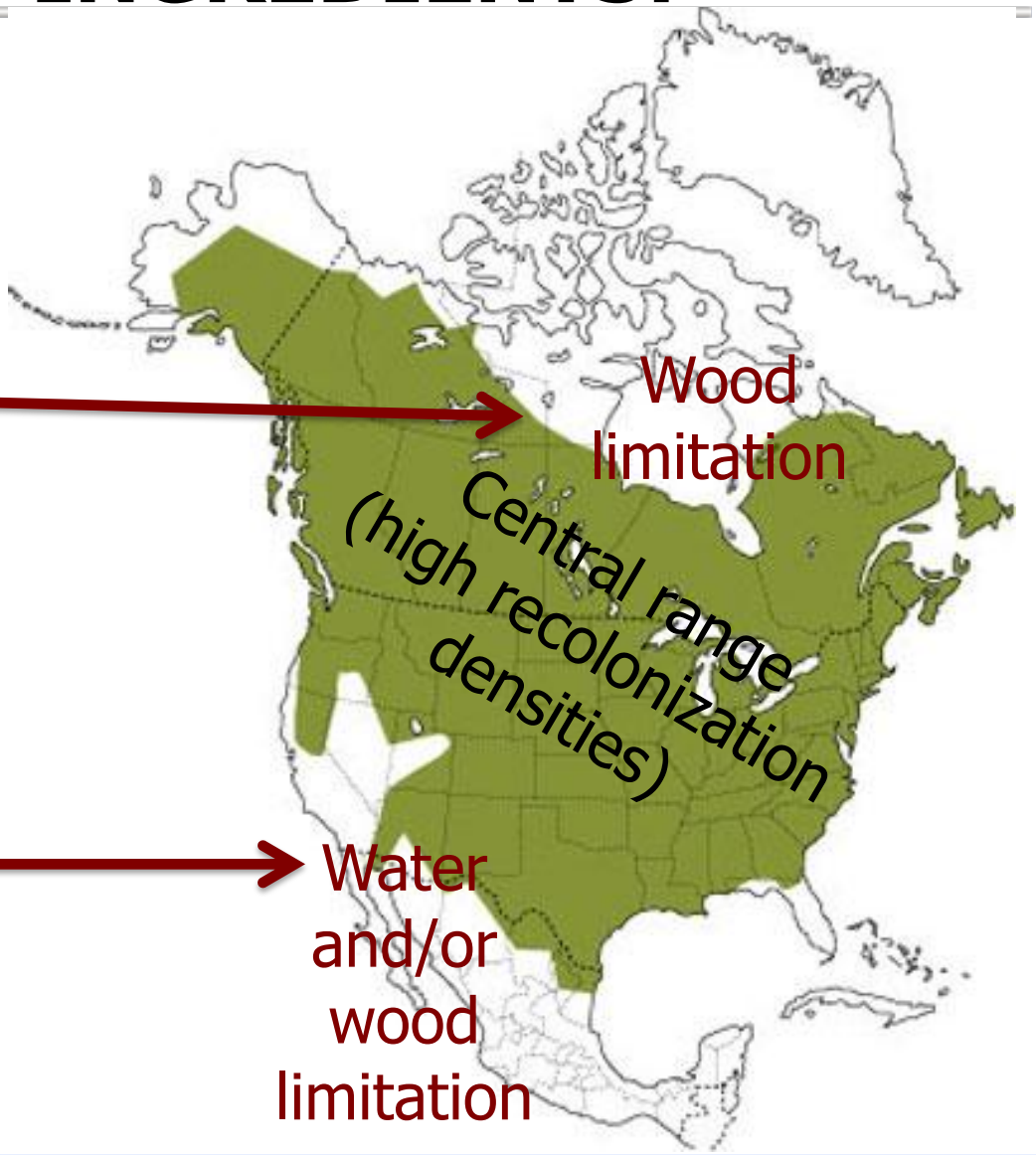
- Estuaries
- Glacier outwash streams

Mendenhall Glacier, AK (*Photo Bob Armstrong*)

Slide from John Stella

COMMON HABITAT INGREDIENTS: WATER + TREES

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



AQUATIC HABITAT IS CRITICAL TO THEIR SUCCESS

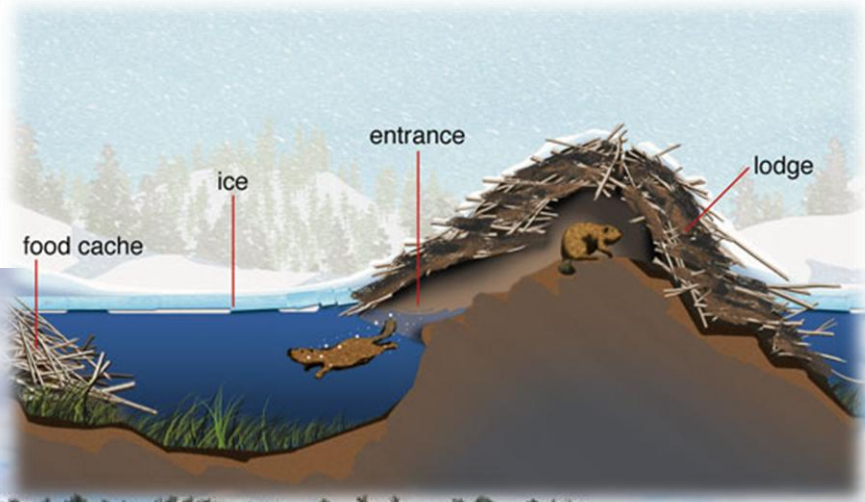
- Beaver more agile in water than on land; maximize time in the water
- Ponds provide cover from predators and foraging pathways
- Lodge includes underwater entrance, nest area above water

LODGES

- Bank lodge vs. Central Above Grouund

Bank den *(Colorado Natural Heritage Program)*

Mid-stream lodge in Hinsdale County, CO *(Colorado Natural Heritage Program)*



Mid-lake lodge

Slide from John Stella

AN EXPOSED LODGE

- They dig lots of tunnels

THE COLONY

- Colony unit = 6–8 related individuals
- Avg. litters = 2–5 kits
- Young stay with parents at least 2 years
- Adults (>2 yrs) disperse to establish new lodge
- Territories marked with scent mounds
- Home ranges tend to follow shorelines

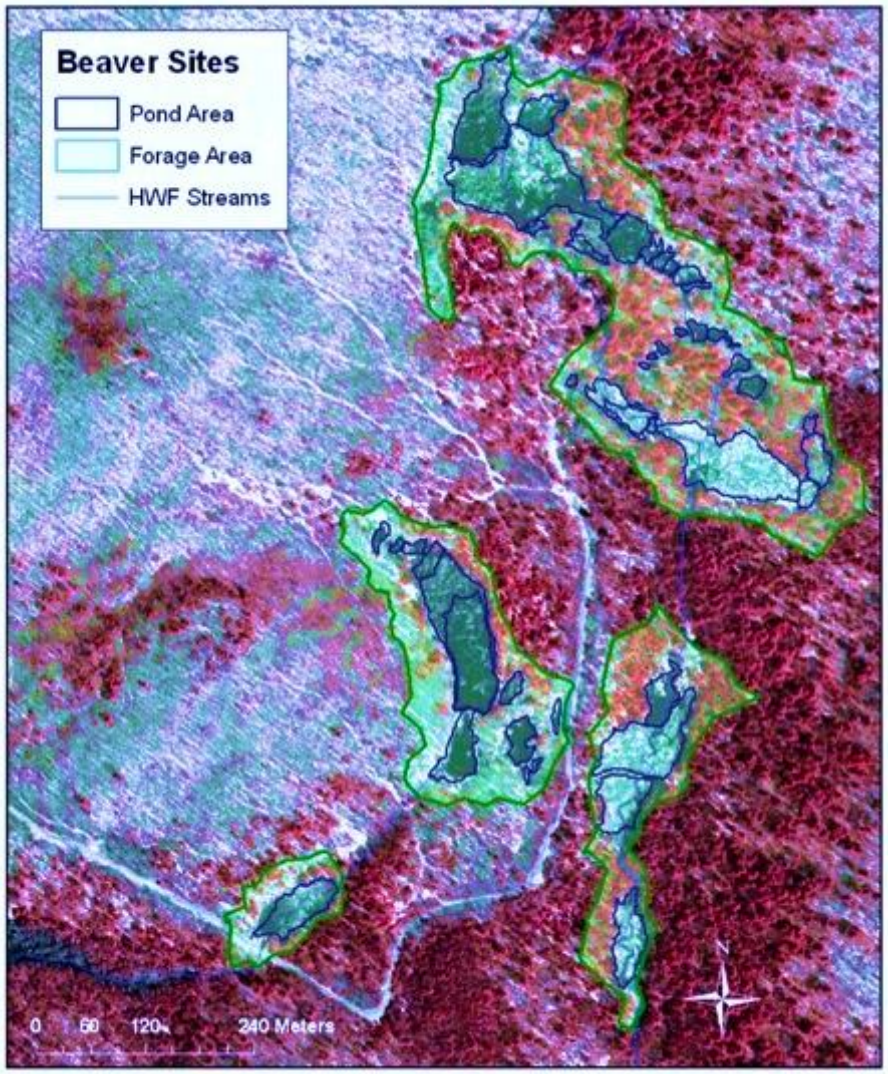


Photo: C. Demers, SUNY-ESF

WHAT DO BEAVER EAT?

- Spring/Summer: herbaceous plants, incl. aquatic and riparian forbs, grasses, grains and row crops
- Fall/Winter: tubers, bark and cambium of cached woody plants
- Woody plants comprise 86% of winter diet; 16% of summer diet

WOODY FOOD CONSIDERATIONS

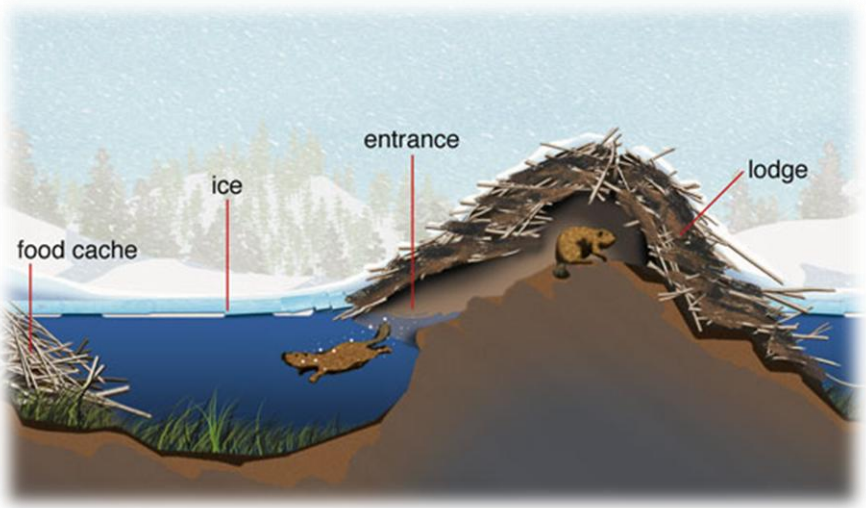
- Maximizes energy intake with low costs
- Easy digestibility; short gut retention time
- Avoid bad-tasting secondary compounds
- Willows, aspen most commonly preferred; conifers avoided

Photo by Michael S. Quinton, National Geographic Societ

Photo by Anna M. Harriso

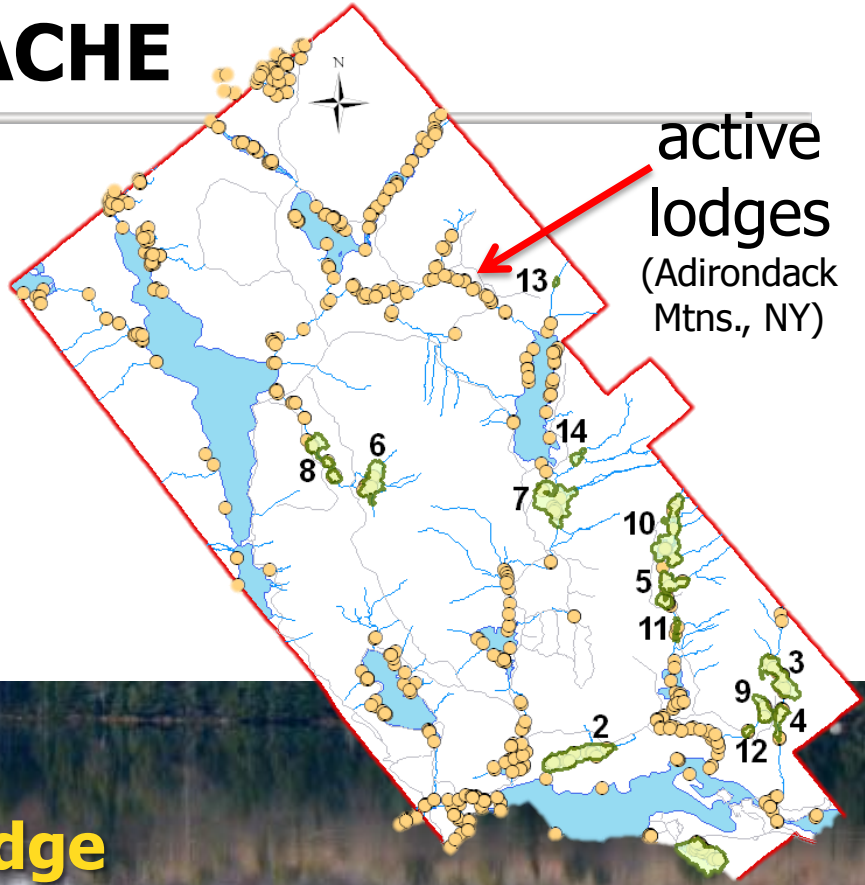
Slide from John Stella

A BEAVER FOOD CACHE…

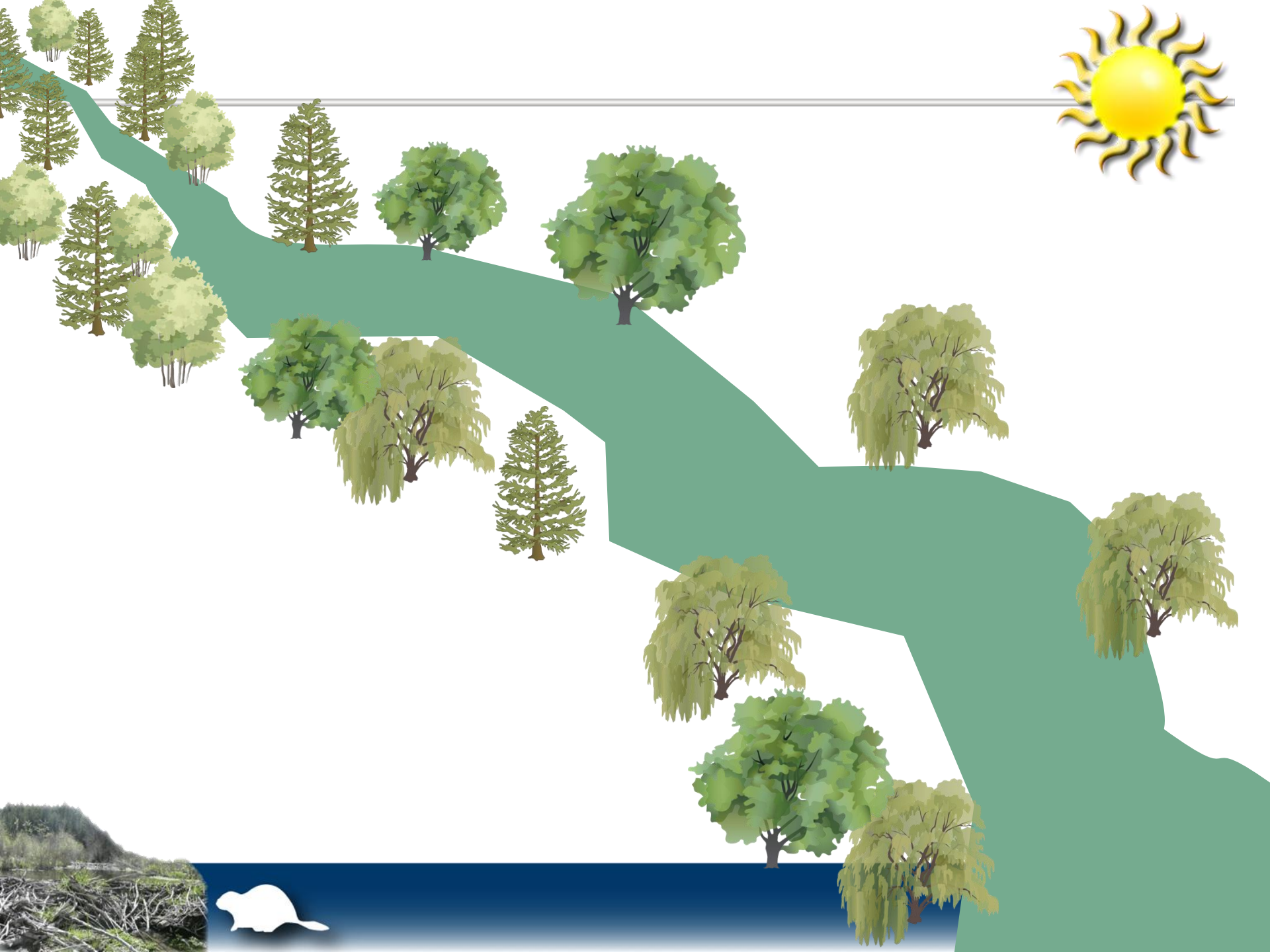


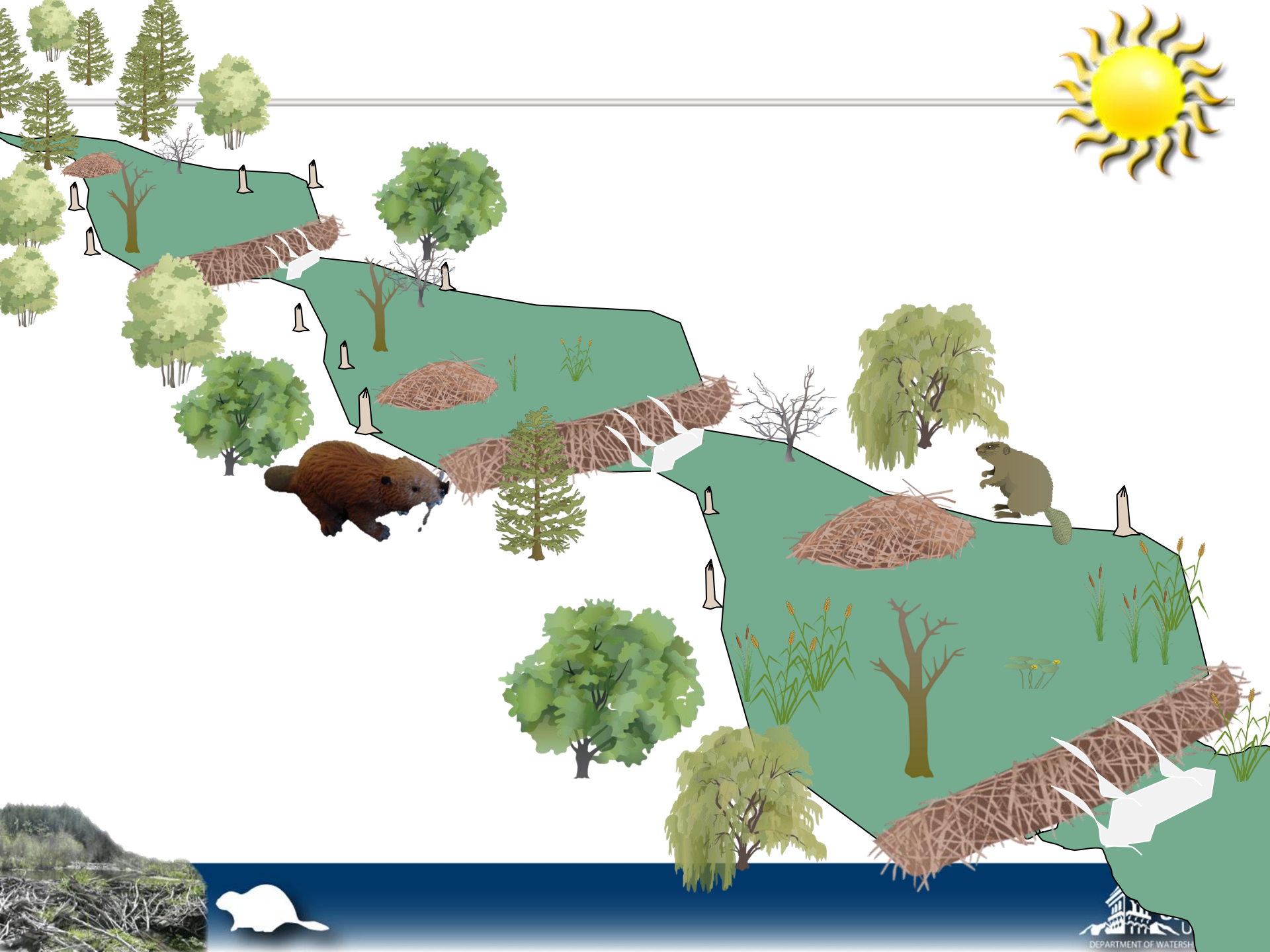
THE LODGE AND FOOD CACHE

- Active lodges indicated by fresh food cache in fall
- Active lodges spaced at least 0.5–1 km apart
- Colony saturation densities vary with landscape and region
- Max. density ranges 0.5–5 colonies/km^2 (Hill 1976, Novak 1987, Baker and Hill 2003)

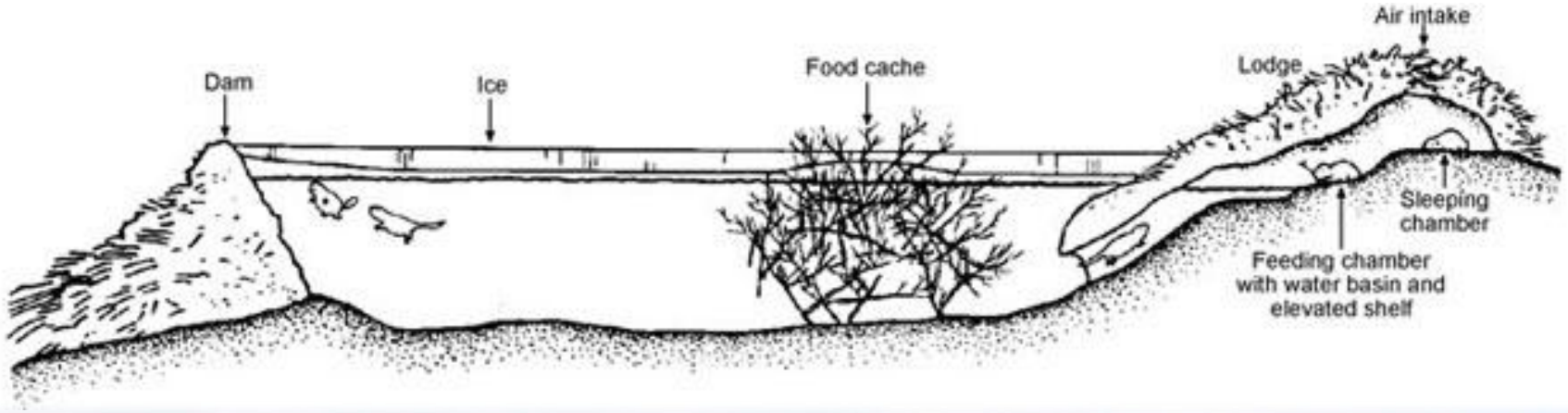


WHAT IS AN ECOSYSTEM ENGINEER?




DEPARTMENT OF WATERSH

SO WHY DO THEY BUILD DAMS?

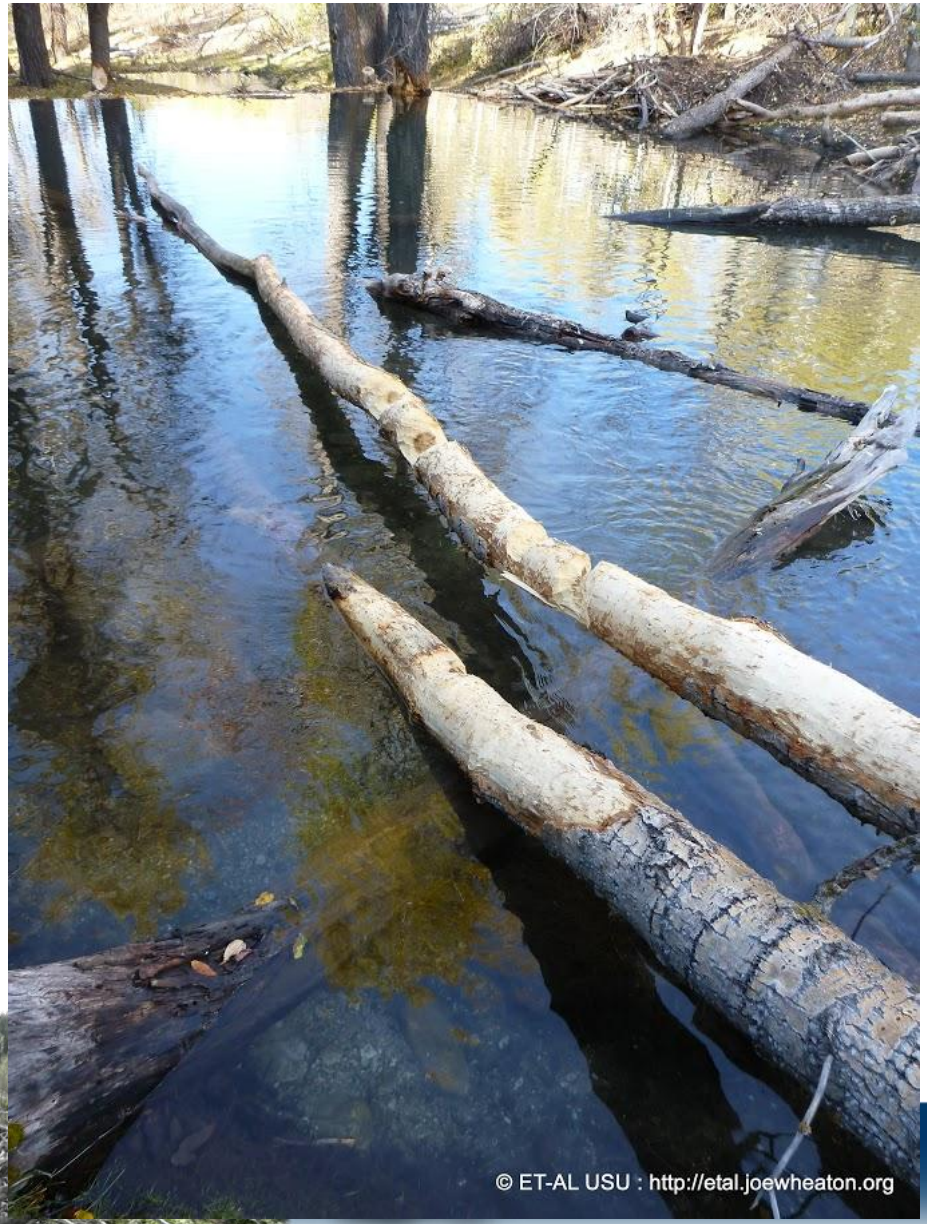


DAMS & BUILDING MATERIALS

- Created to impound water around lodge
- Dam location cued by running water

- Dams constructed of wood and available debris (e.g., plastic, metal)

CAN THEY MOVE A WHOLE TREE?



DAM/POND COMPLEXES

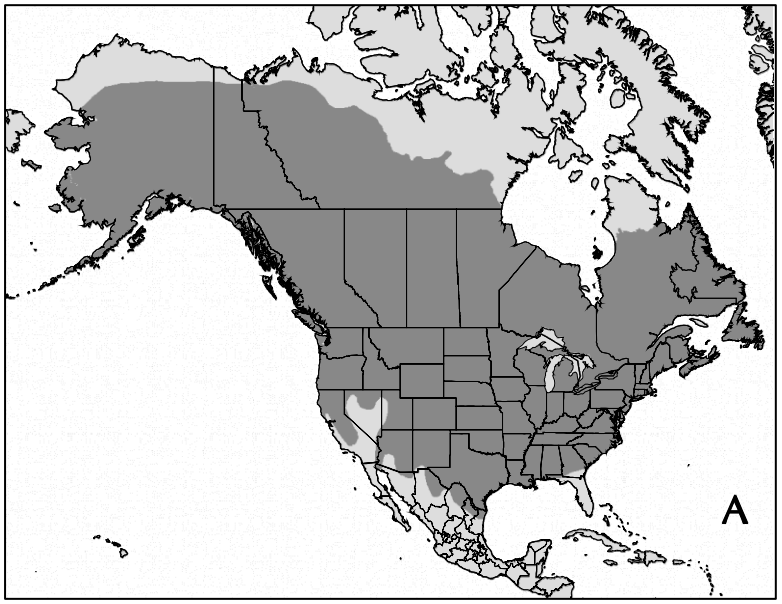
- Multiple dams create safe transportation corridors to connect large ponds
- Dams complexes grow over time, allowing beaver more access to food sources
- Canals constructed to float materials in…

Photo: G.S. Haulton

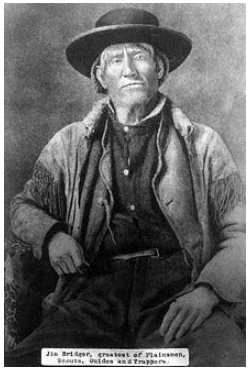
Photo by Anna M. Harrison

BEAVER HISTORY…

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

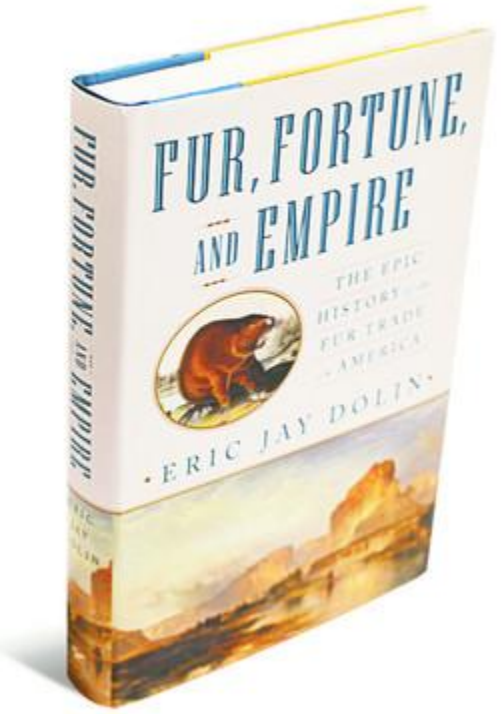


- *Why so few?*



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 $30-$40… even in 1700s they went for $30!



Fascinating read
Dolin (2011)

THE HABITAT THEY MAKE IS GOOD FOR OTHERS TOO!

Before & After Wolves

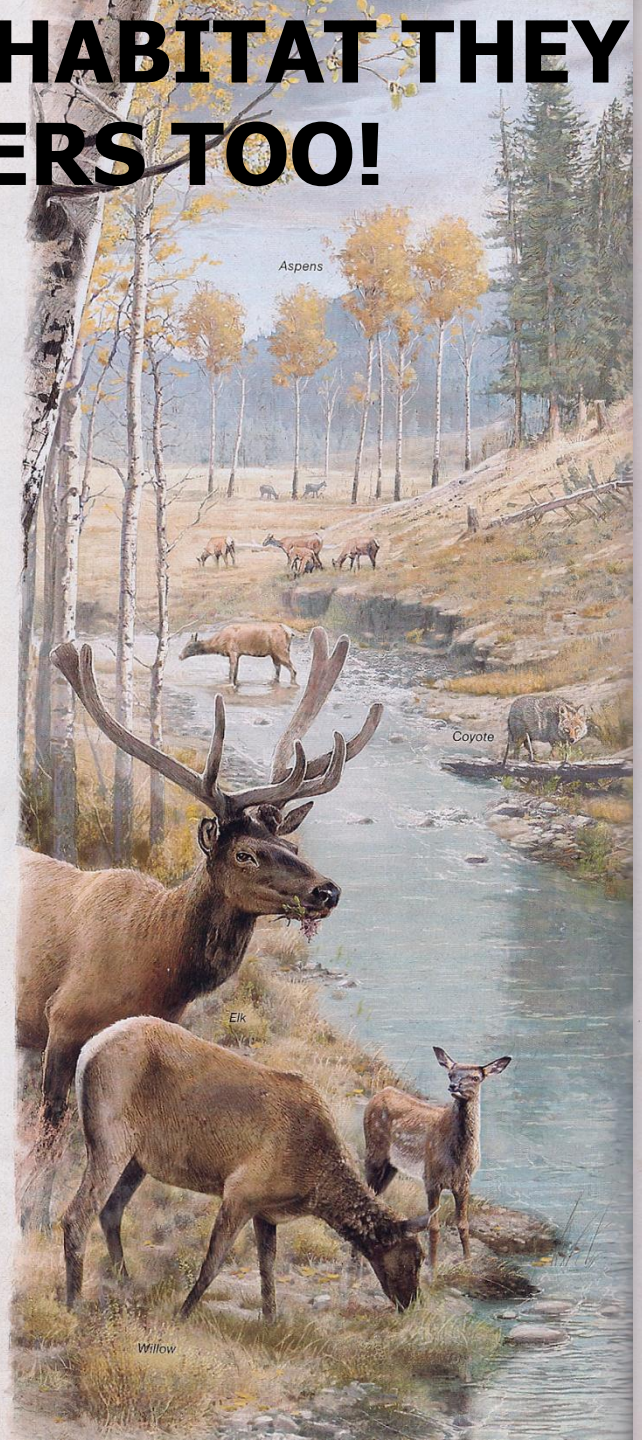
Restoring wolves to Yellowstone after a 70-year absence as a top predator—especially of elk—set off a cascade of changes that is restoring the park's habitat as well.

YELLOWSTONE WITHOUT WOLVES 1926-1995

ELK overbrowsed the streamside willows, cottonwoods, and shrubs that prevent erosion. Birds lost nesting space. Habitat for fish and other aquatic species declined as waters became broader and shallower and, without shade from streamside vegetation, warmer.

ASPEN trees in Yellowstone's northern valleys, where elk winter, were seldom able to reach full height. Elk ate nearly all the new sprouts.

COYOTE numbers climbed. Though they often kill elk calves, they prey mainly on small mammals like ground squirrels and voles, reducing the food available for foxes, badgers, and raptors.



ART BY FERNANDO G. BAPTISTA, NG STAFF; AMANDA HOBBS, NG STAFF
SOURCES: ROBERT L. BESCHTA AND WILLIAM J. RIPPLE, OREGON STATE UNIVERSITY; DOUGLAS W. SMITH, YELLOWSTONE NATIONAL PARK

YELLOWSTONE WITH WOLVES 1995-PRESENT

ELK population has been halved. Severe winters early in the reintroduction and drought contributed to the decline. A healthy fear of wolves also keeps elk from lingering at streamsides, where it can be harder to escape attack.

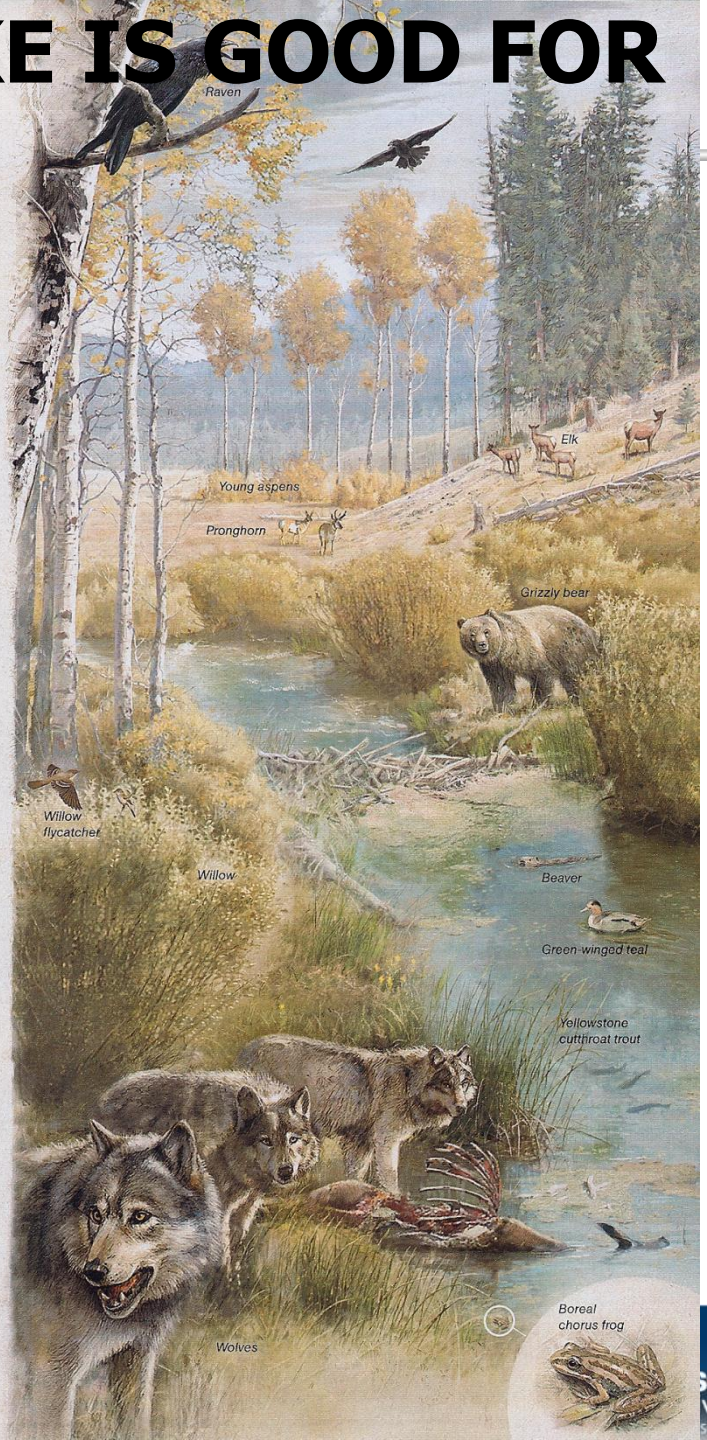
ASPENS The number of new sprouts eaten by elk has dropped dramatically. New groves in some areas now reach 10 to 15 feet tall.

COYOTES Wolf predation has reduced their numbers. Fewer coyote attacks may be a factor in the resurgence of the park's pronghorn.

WILLOWS, cottonwoods, and other riparian vegetation have begun to stabilize stream banks, helping restore natural water flow. Overhanging branches again shade the water and welcome birds.

BEAVER colonies in north Yellowstone have risen from one to 12, now that some stream banks are lush with vegetation, especially willows (a key beaver food). Beaver dams create ponds and marshes, supporting fish, amphibians, birds, small mammals, and a rich insect population to feed them.

CARRION Wolves don't cover their kill, so they've boosted the food supply for scavengers, notably bald and golden eagles, coyotes, ravens, magpies, and bears.



HOW BEAVERS DRIVE RIPARIAN VEGETATION

Herbivory

↓

(Dam building)

↓

Raised water tables

↓

Moderated flows

↓

Changes in Riparian Habitat

Slide from Nate Hough-Snee

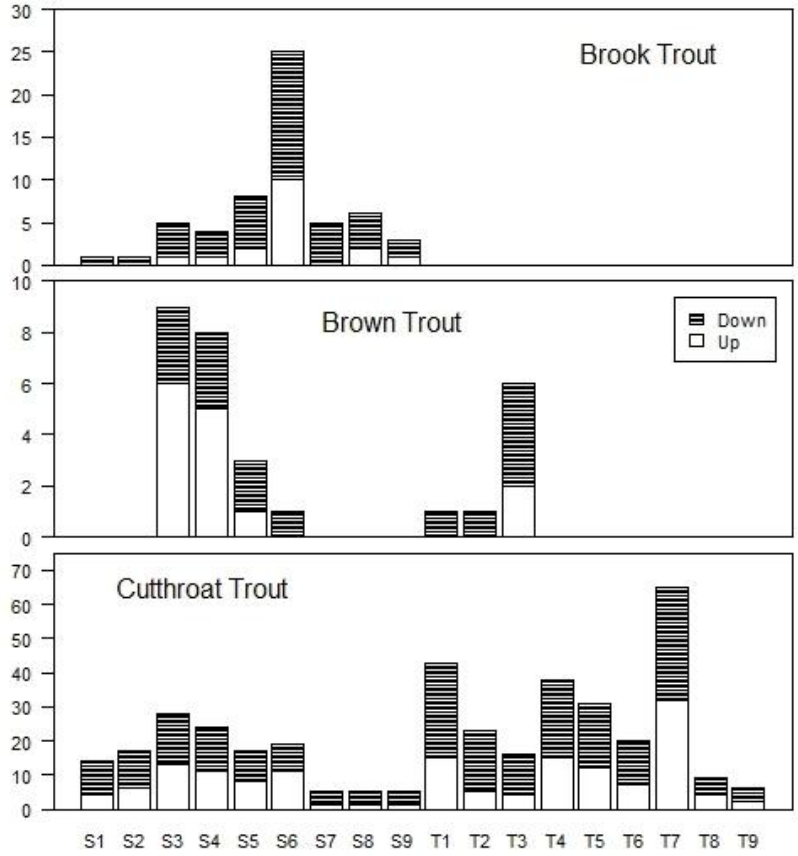
BEAVER IMPACTS ON FISH?

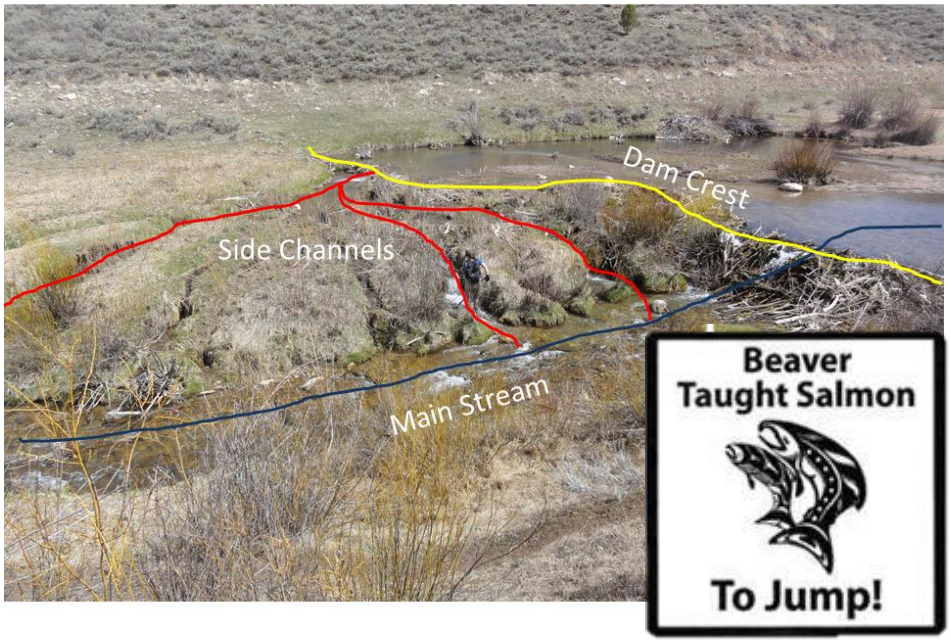
Table 3 Citation of negative impacts of beaver activity on fish populations and the percentage of citations based on quantitative analysis or speculation. Different impacts are expressed as the number of times they are cited in 108 literature sources and as a percentage of the total number of citations.

Negative impacts	Number	% of total citations	Data driven (%)	Speculative (%)
Barriers to fish movement	51	42.9	21.6	78.4
Reduced spawning habitat	20	16.8	40.0	60.0
Altered temperature regime	11	9.2	9.1	90.9
Reduced oxygen levels	12	10.1	50.0	50.0
Reduced habitat quality	2	1.7	0	100
Altered flow regimes	4	3.4	75.0	25.0
Loss of cover	5	4.2	0	100
Reduced productivity	9	7.6	33.3	66.7
Retarded growth	2	1.7	50.0	50.0
Abandonment of beaver settlements	1	0.8	100	0
Reduced water quality	2	1.7	50.0	50.0
Total	119	100	28.6	71.4

Kemp et al. 2012

DO BEAVER DAMS PREVENT FISH FROM GETTING UPSTREAM?





- Native cutthroats can pass easier then invasive Browns!

Lokteff RL*, Roper B and **Wheaton JM**. In Press. Do beaver dams impede the movement of trout? Transactions of American Fisheries Society.

MITIGATE IMPACTS OF CLIMATE CHANGE?

Climate Change

- Less snowfall, earlier snowmelt
- Earlier Spring runoff, late; reduced or absent late-season flows or
- Higher temperatures and increased evaporation
- Longer, more intense droughts
- Reduced wetlands

Dam-building Beaver

- Slow snowmelt and other runoff
- Extend the seasonal flow
- Store and cool water underground
- Slow release water during drought
- Create wetlands

TALK PLAN

I. A bit of Background on Beaver

II. Where are beaver a nuisance?

III. Exploiting the Undiscriminating Rodent

IV. Where might this work? - BRAT

V. Beaver in Incised Streams?

   I. Bridge Creek IMW Experiment

VI. Take-Homes

IN SOME PLACES… THEY ARE A PAIN!

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

STUTTLER & STUTTLER

BEAVER BUSTERS

DYNAMITE DOESN'T WORK

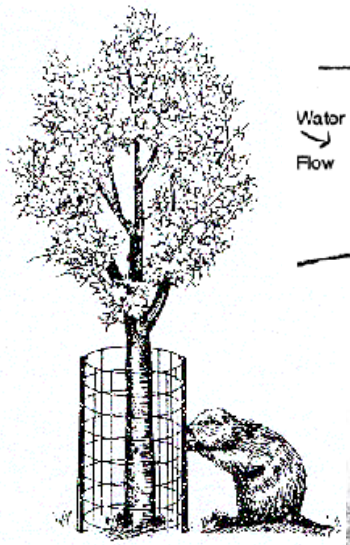
- A common response to nuisance beaver dam building is to blow the dam up
- The dynamite is effective at breaching dam….
- But, the beaver are persistent, they can rebuild a dam in a night or two

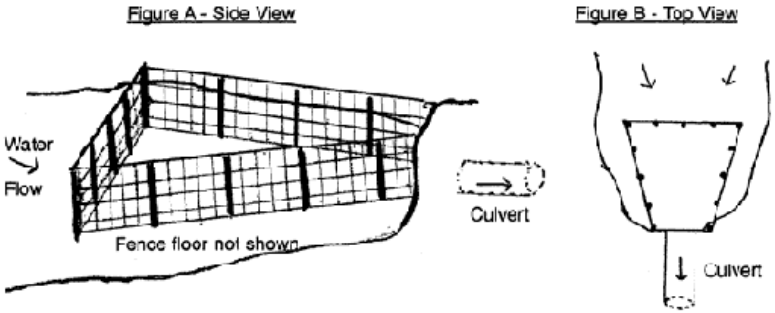
LETHAL TRAPPING

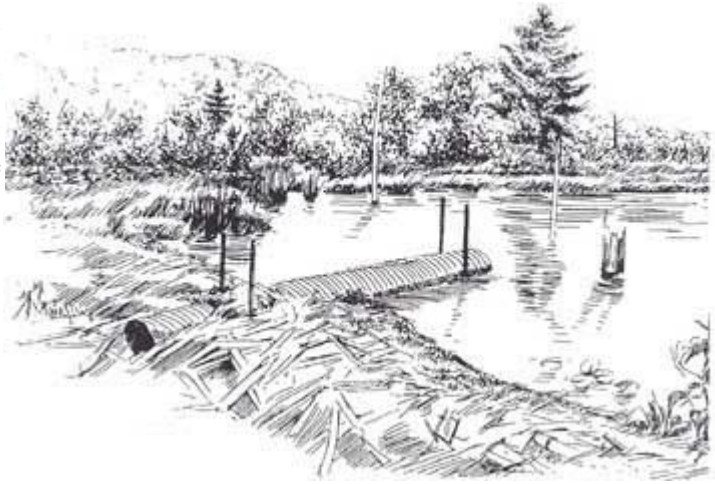
- Lethal trapping is very common (and legal)
- Sometimes effective at temporarily alleviating problems IF all beaver are trapped out
- However, very hard to actually trap ALL beaver

LIVING WITH BEAVER STRATEGIES…

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







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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SOME COMPELLING REASONS TO PARTNER WITH A RODENT

- Just a rodent… but far more experienced at engineering riparian systems then we are
- Carry their own liability insurance & non-union
- Capable of creating dynamic stream habitat with benefits for multiple species
- Widespread throughout North America

OUR HOPE IS…

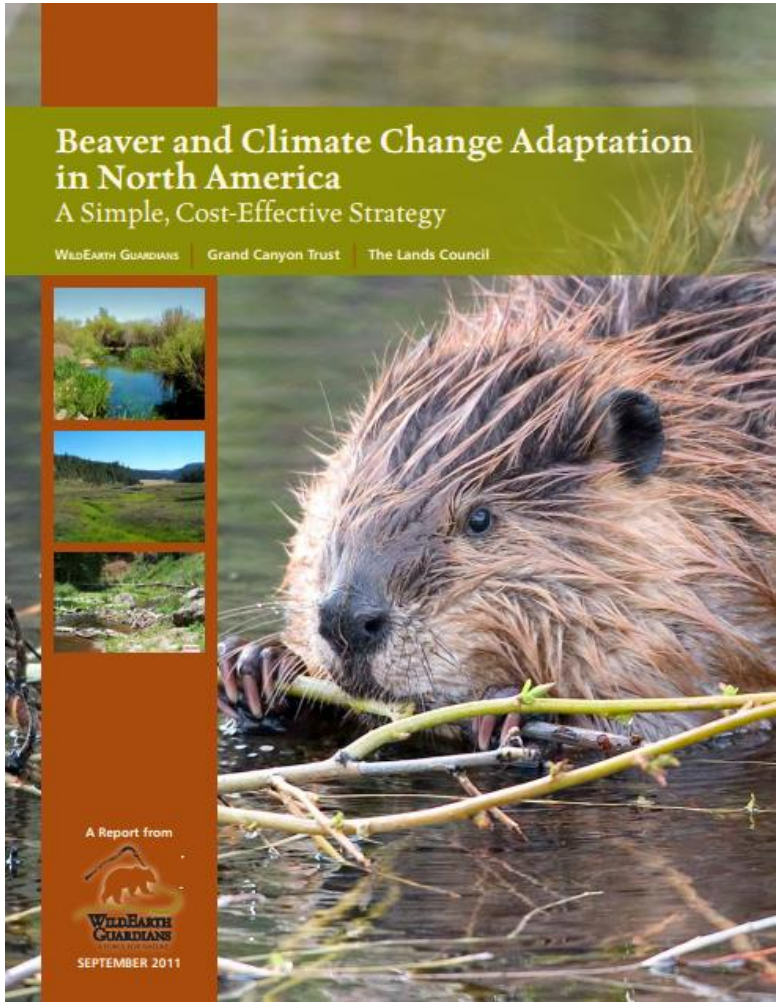
Sticker available from:
http://www.redbubble.com/shop/beaver+stickers

- This undiscriminating rodent who once shaped so much of North America can
  - Help us restore many of our degraded streams & rivers for cheaper
  - Promote much more dynamic behavior in streams & rivers that will lead to healthier ecosystems and higher rates of biodiversity
  - Help buffer the impacts of climate change

From:
http://www.wildearthguardians.org/site/PageServer?pagename=priorities_wild_places_jemez_mountains_beavers

BUT ITS WHERE THEY BUILD DAMS, THAT WE REALLY CARE ABOUT…

- The dams provide the ecosystem services we're primarily interested in



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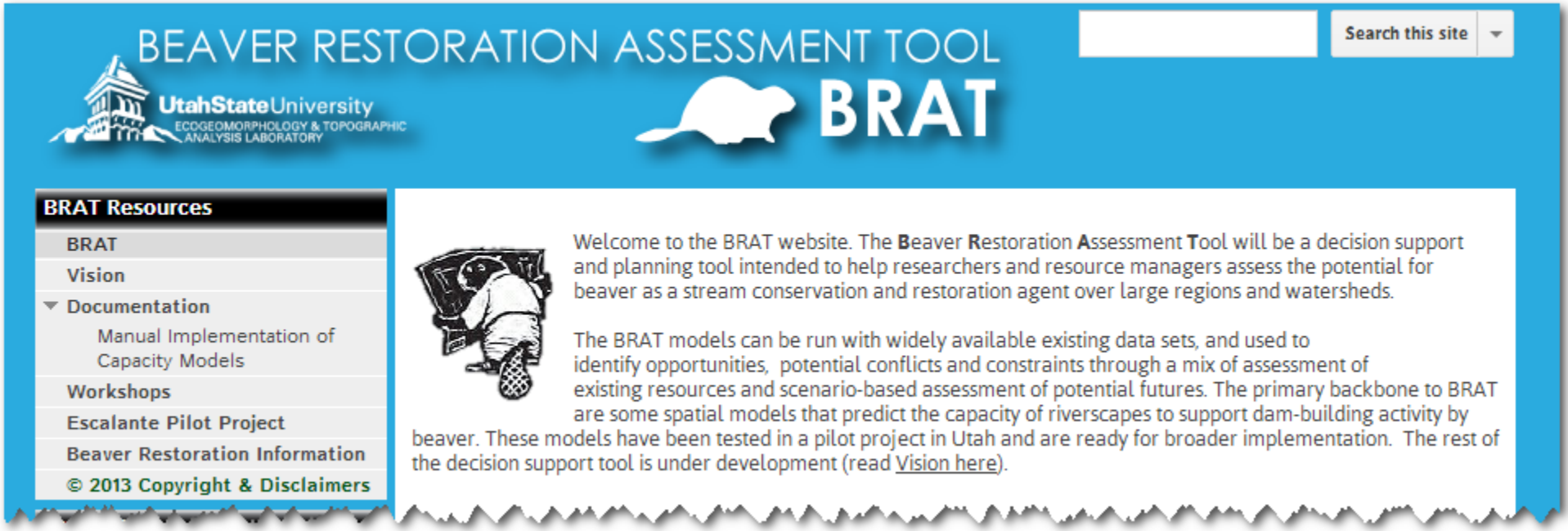
BRAT – BEAVER RESTORATION ASSESSMENT TOOL



Grand Canyon Trust
DEDICATED TO THE CONSERVATION OF THE COLORADO PLATEAU

The WALTON FAMILY FOUNDATION

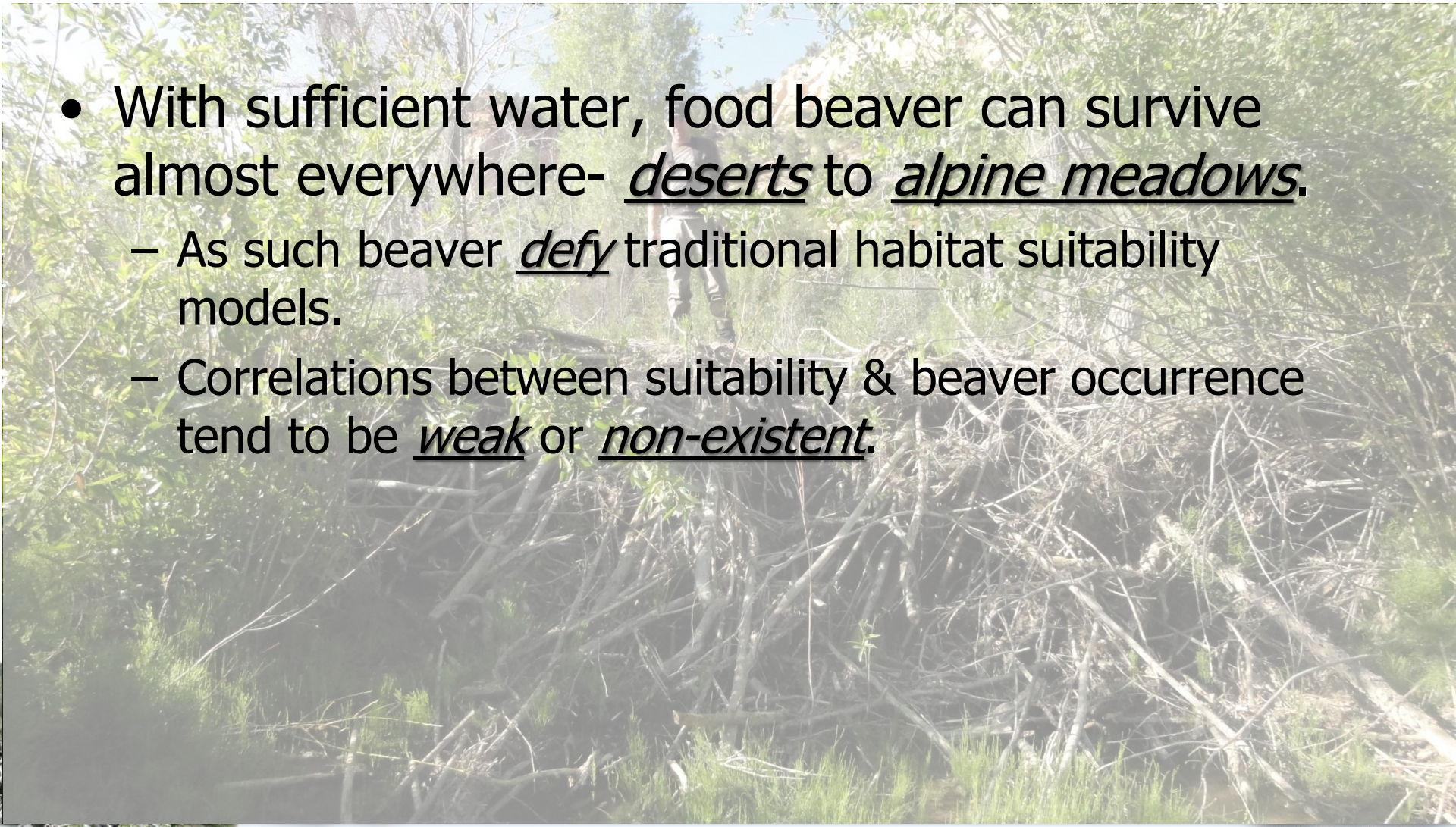
Mary O'Brien

ECOFLIGHT

http://brat.joewheaton.org

UtahState University
DEPARTMENT OF WATERSHED SCIENCES

TRADITIONAL HABITAT SUITABILITY MODELS DON'T WORK FOR BEAVER

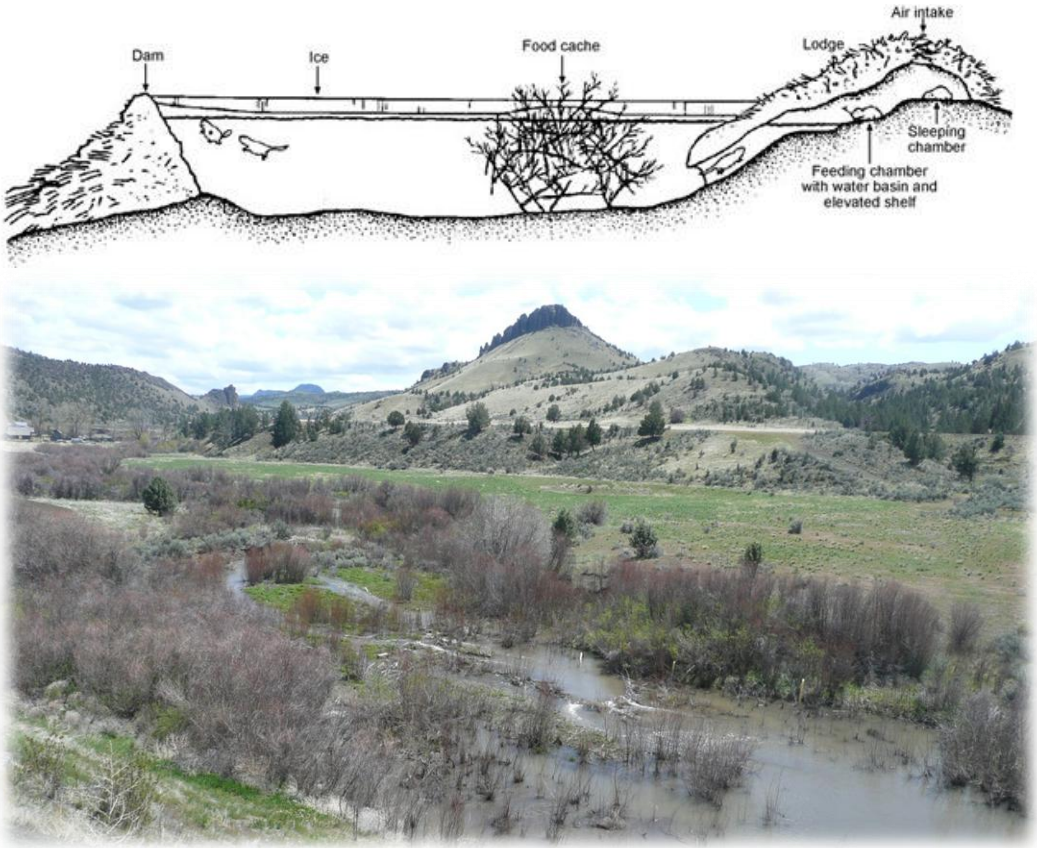


- With sufficient water, food beaver can survive almost everywhere- ***deserts*** to ***alpine meadows***.
  - As such beaver ***defy*** traditional habitat suitability models.
  - Correlations between suitability & beaver occurrence tend to be ***weak*** or ***non-existent***.

AN UNDISCRIMINATING RODENT…

Beaver Habitat Requirements

- Water, Trees



A BETTER APPROACH: DAM-BUILDING CAPACITY MODELING

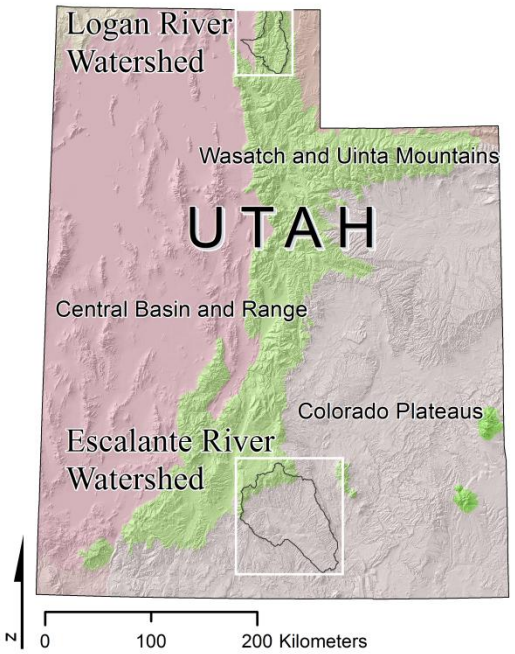
- *Beaver dams* not beaver themselves provide the restoration outcomes.
- While beaver can survive in wide range of conditions, where they *build dams* is more *limited*.
- Dam building activity varies dramatically according to *flow regime* & availability of *dam building materials*.

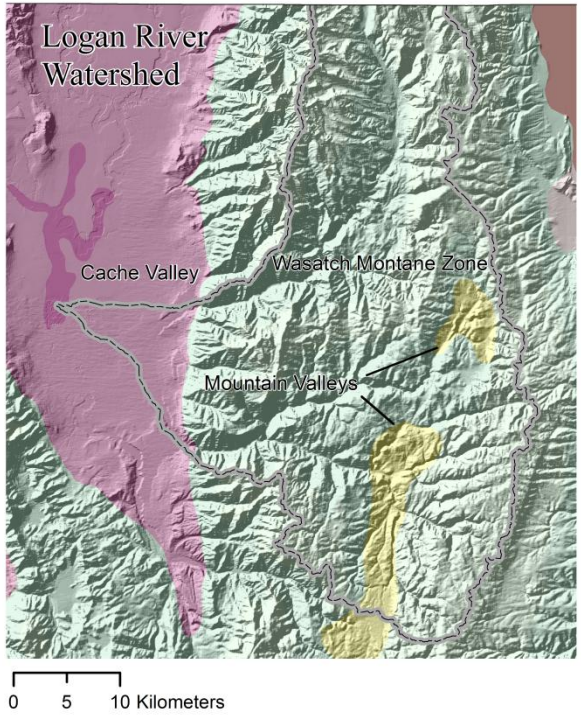
LINES OF EVIDENCE TO ESTIMATE BEAVER DAM DENSITIES AT FULL CAPACITY

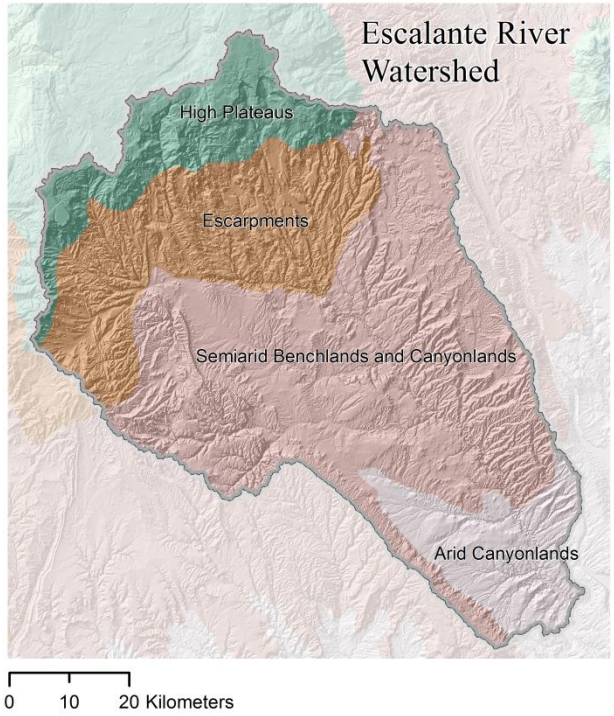
- Evidence of a perennial water source
- Evidence of riparian vegetation to support dam building activity
- Evidence of adjacent vegetation (on riparian/upland fringe) that could support expansion and establishment of larger colonies
- Evidence that a beaver dam could physically be built across the channel during low flows
- Evidence that a beaver dam is likely to withstand typical floods

© ET-AL USU : http://etal.joewheaton.org

TEST-BEDS



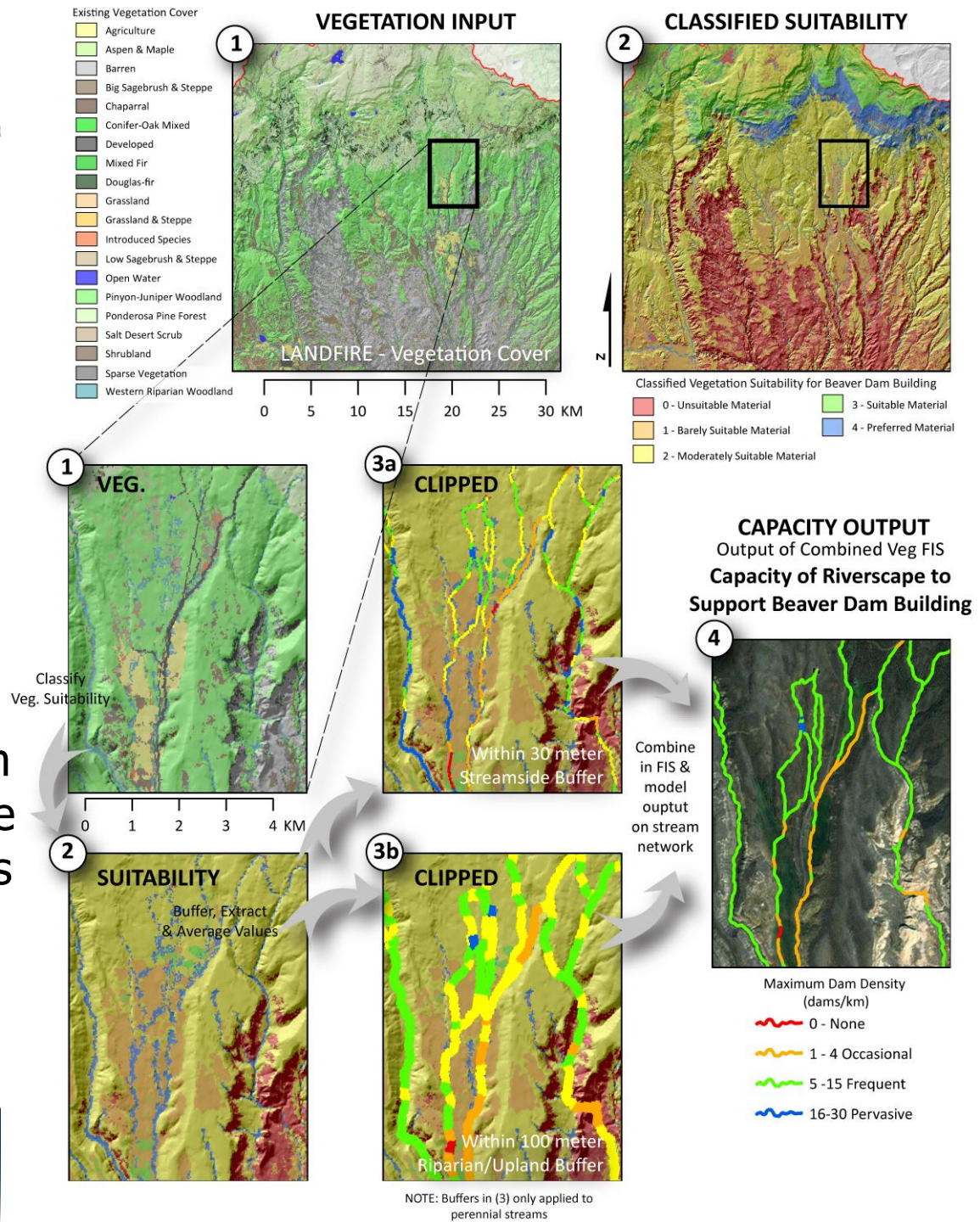




- Escalante Watershed, Utah*
- Logan River Watershed, Utah*
- Greater Yellowstone Ecosystem, Wyoming
- Lower John Day Watershed, Oregon
- Deschutes Watershed, Oregon

WORKFLOW

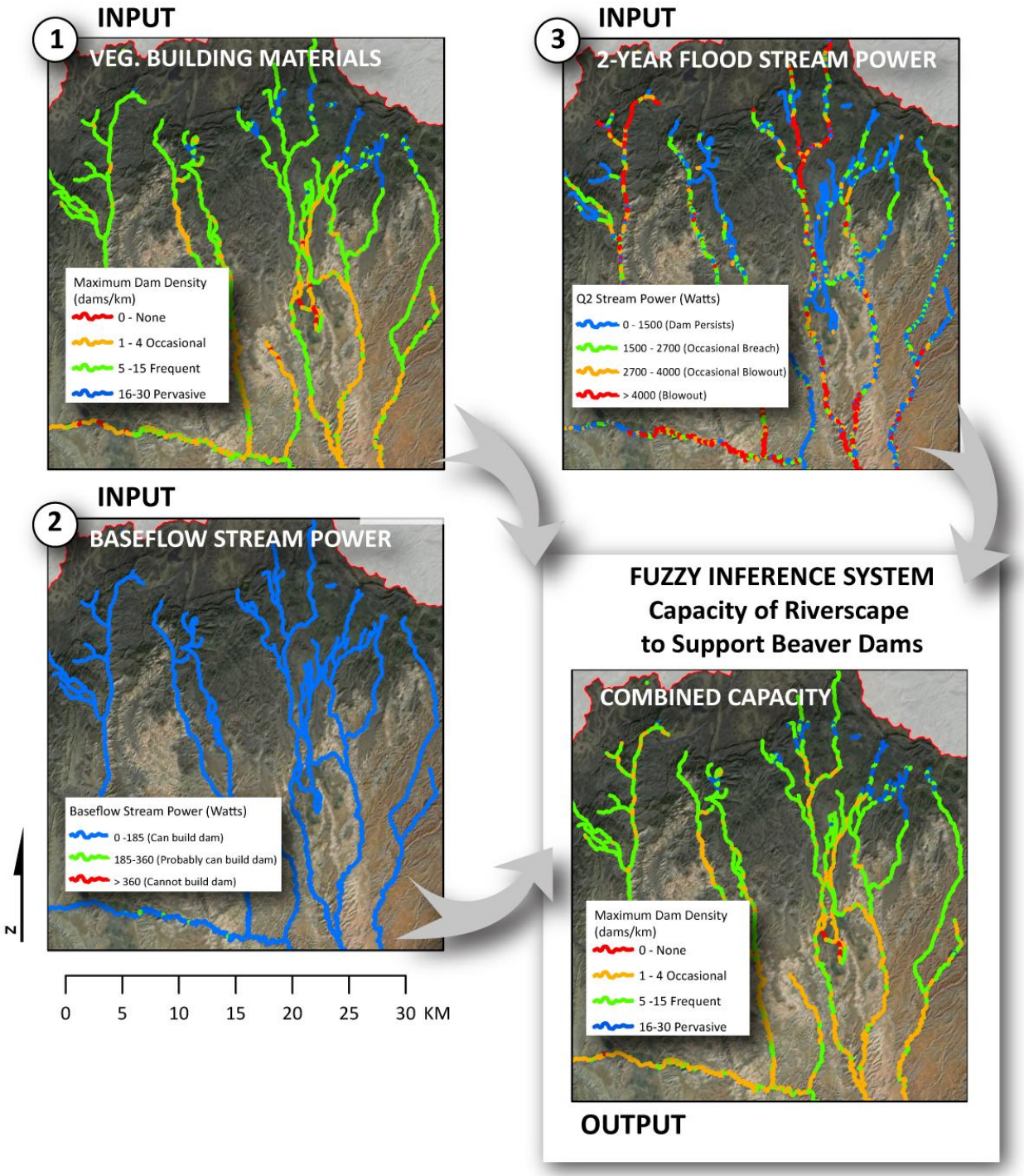
- Get LANDFIRE
- Classify it
- Clip it to streamside and riparian/upland buffers
- Run it through fuzzy inference system
  - Takes inputs and estimates the maximum dam density that can be supported based on this



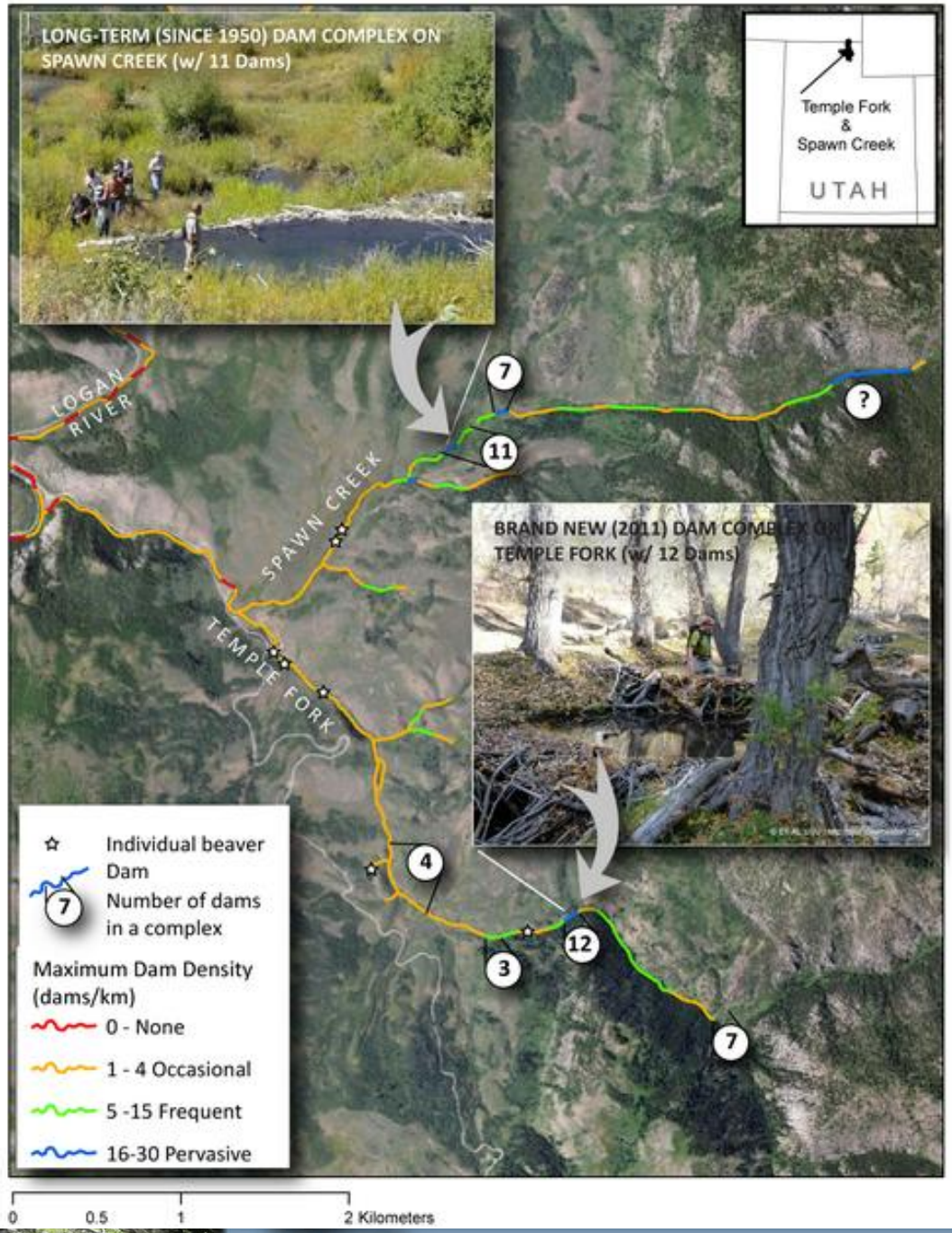
COMBINED

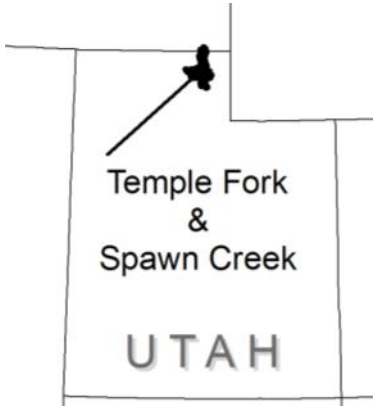
1. Veg FIS
2. Baseflow (can they build a dam?)
3. 2 Year Flood (does dam blow out)

= Resulting Capacity



VERIFICATION



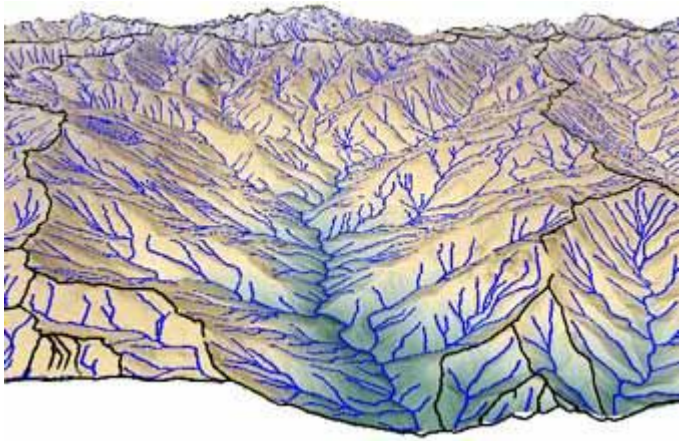


Existing Combined FIS Dams per KM

- 0 (None)
- 1 - 4 (Occasional)
- 5 - 15 (Frequent)
- 16 - 36 (Pervasive)

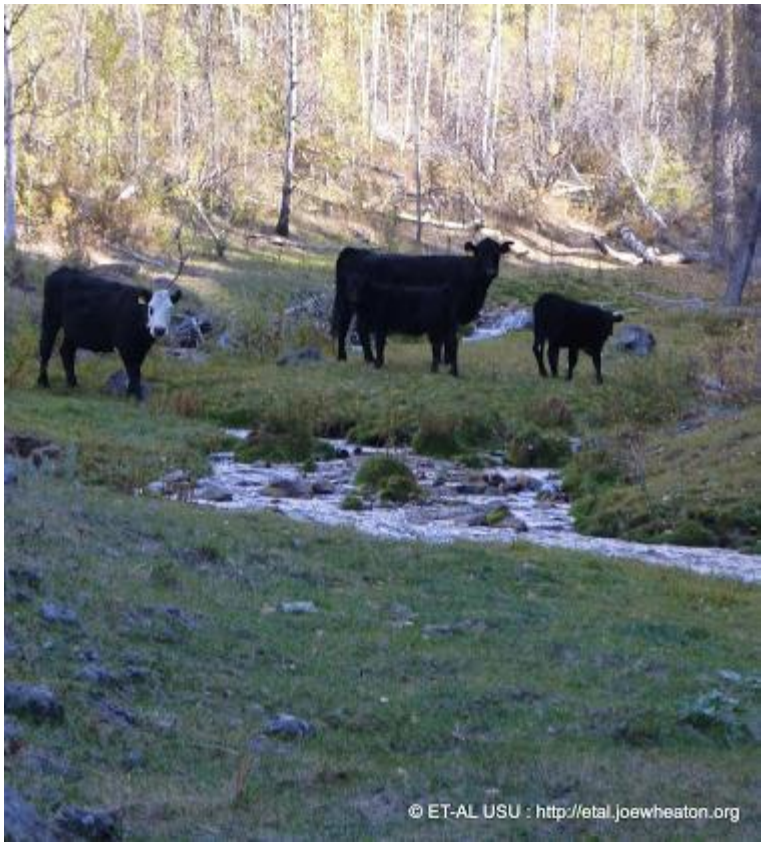
WHAT BRAT WILL DO…

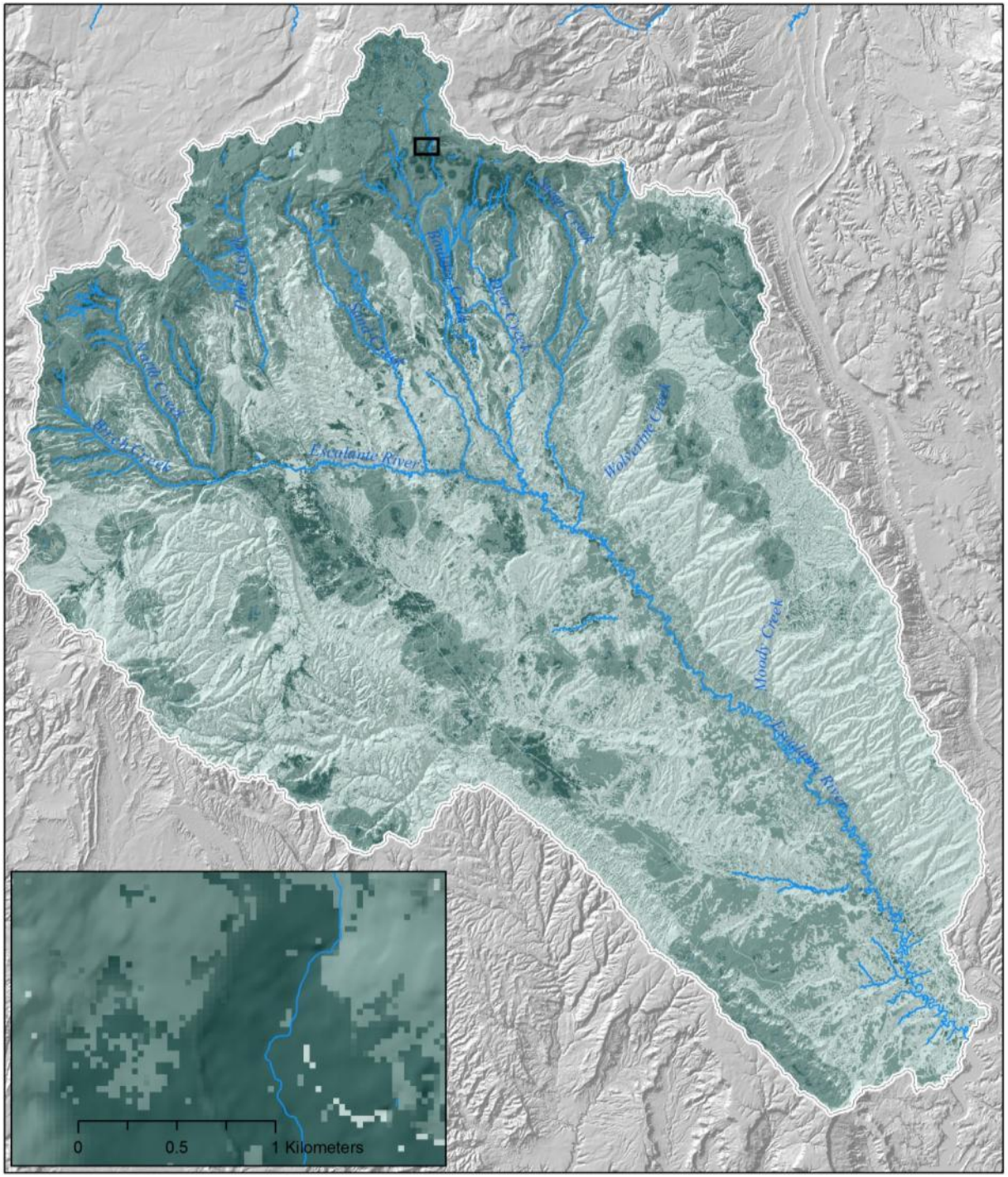
- Classify the drainage network in terms of 'where could they be':
  - Low-hanging fruit streams
  - Quick return streams
  - Long-term possibility streams
  - Unsuitable, Naturally Limited Streams
  - Unsuitable, Anthropogenically Limited Streams



LIMITING FACTORS AFFECTING CAPACITY

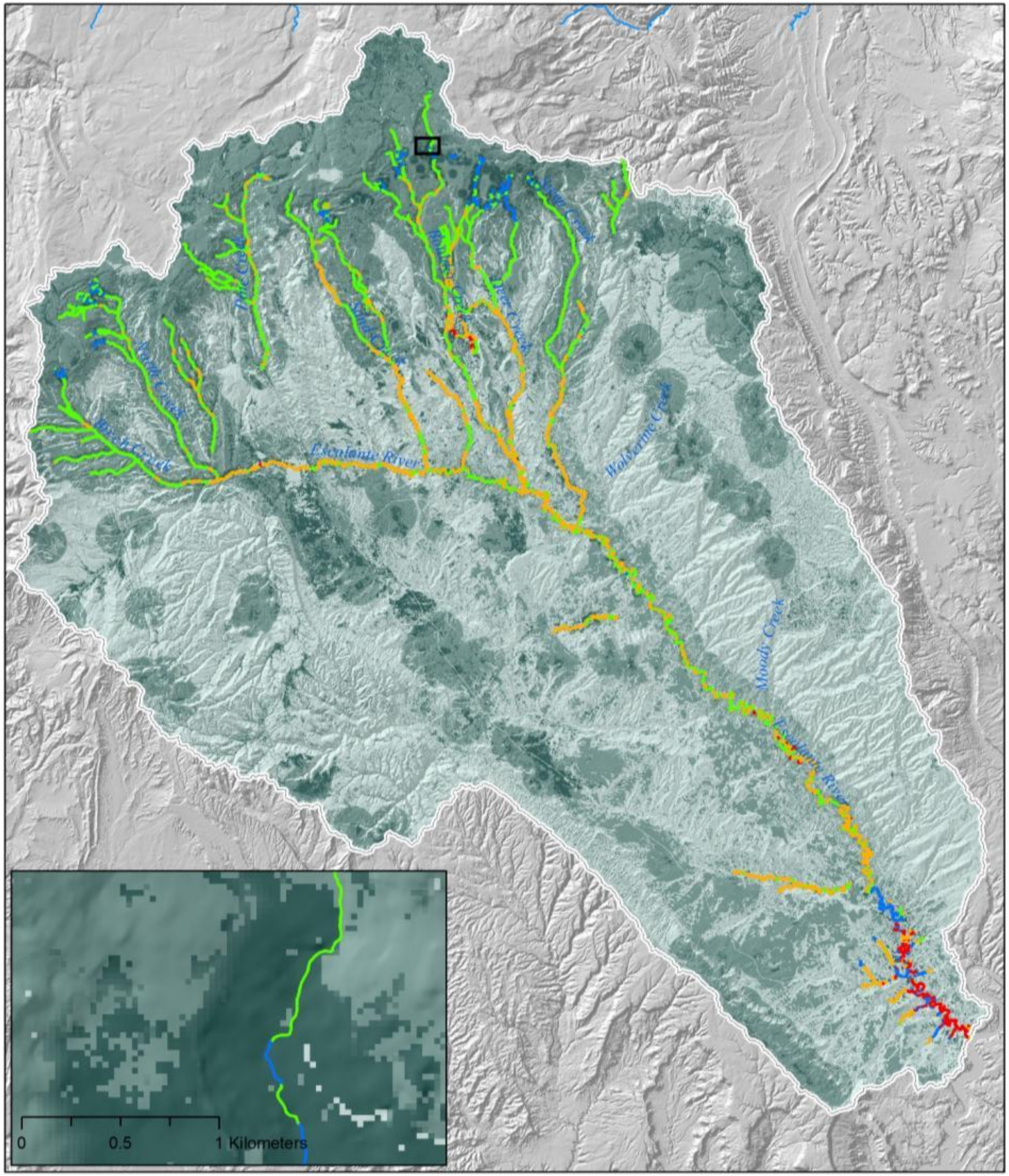
- Overgrazing of riparian zone
- Trapping or predation
- Roads/development
- Timber harvesting
- Natural disturbance (flooding, fire)





What goes in?

- Slope
- Distance from Water
- Vegetation



Probability of Ungulate Utilization

High : 1

Low : 0

Existing Combined FIS Dams per KM

0 - None

1 - 4 Occasional

5 - 15 Frequent

16 - 30 Pervasive

N

0 5 10 15 20 25 Kilometers

© ET-AL 2012

BEAVER MONITORING APP!

- Simple enough 2nd graders can use it
- Sophisticated enough that researchers get useful data streams
- Going to launch statewide monitoring campaign with USU Extension & DWR

EVEN SECOND GRADERS GET IT

- They use the App
- They build their own dams in beaver side channels
- They learn how beaver modify the landscape

TALK PLAN

I. A bit of Background on Beaver
II. Where are beaver a nuisance?
III. Exploiting the Undiscriminating Rodent
IV. Where might this work? - BRAT
V. Beaver in Incised Streams?
    I. Bridge Creek IMW Experiment
VI. Take-Homes

INCISED STREAMS ARE UBIQUITOUS

WAYS TO RECONNECT A FLOODPLAIN

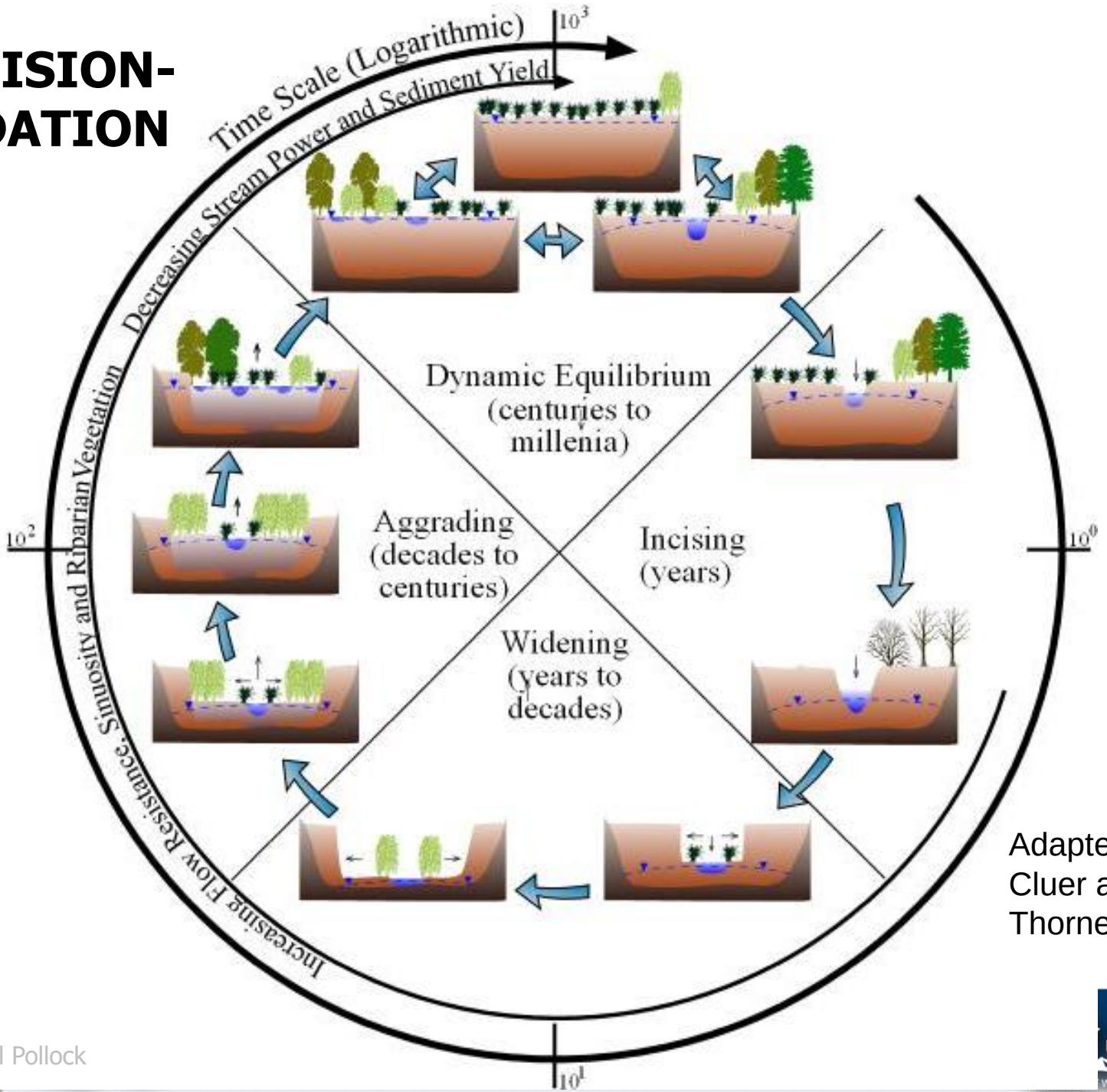
1. Elevate the channel bed (usually with channel realignment as opposed to just filling channel)
2. Lower the adjacent 'former floodplain' (terraces)
3. 'Undersize' the channel dimensions
4. Remove levees

Challenges:

- Always involves major earthworks and grading!
- Fixed elevation head
- Planform constraints
- To provide flood control benefits
- Vegetation establishment/ Dynamics

Back to Motives

THE INCISION-AGGRADATION CYCLE

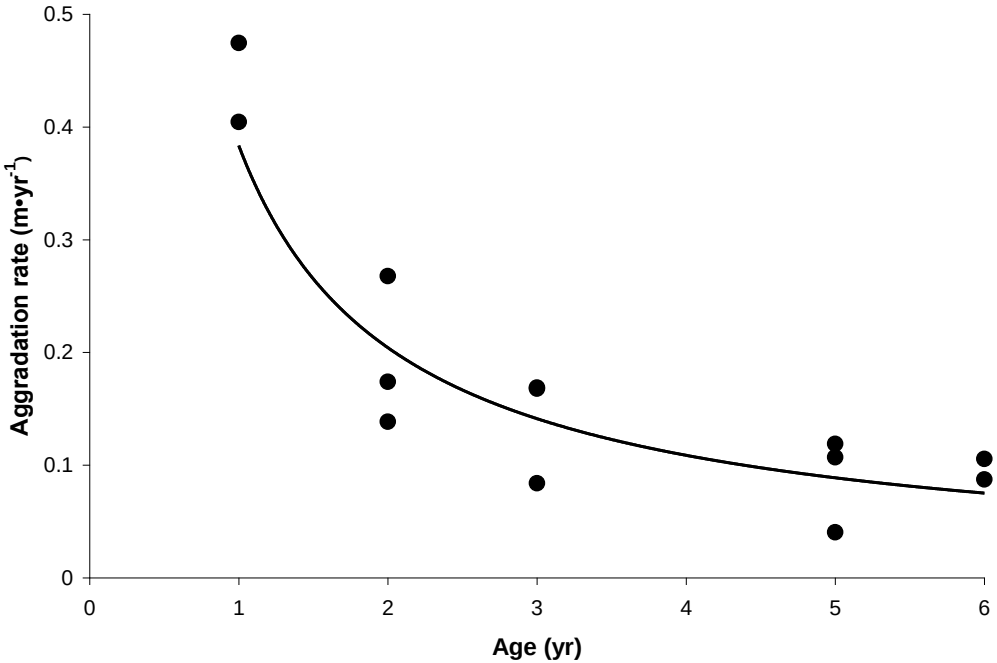


Adapted from Cluer and Thorne 2013

Slide from Michael Pollock

UtahState University WATERSHED SCIENCES

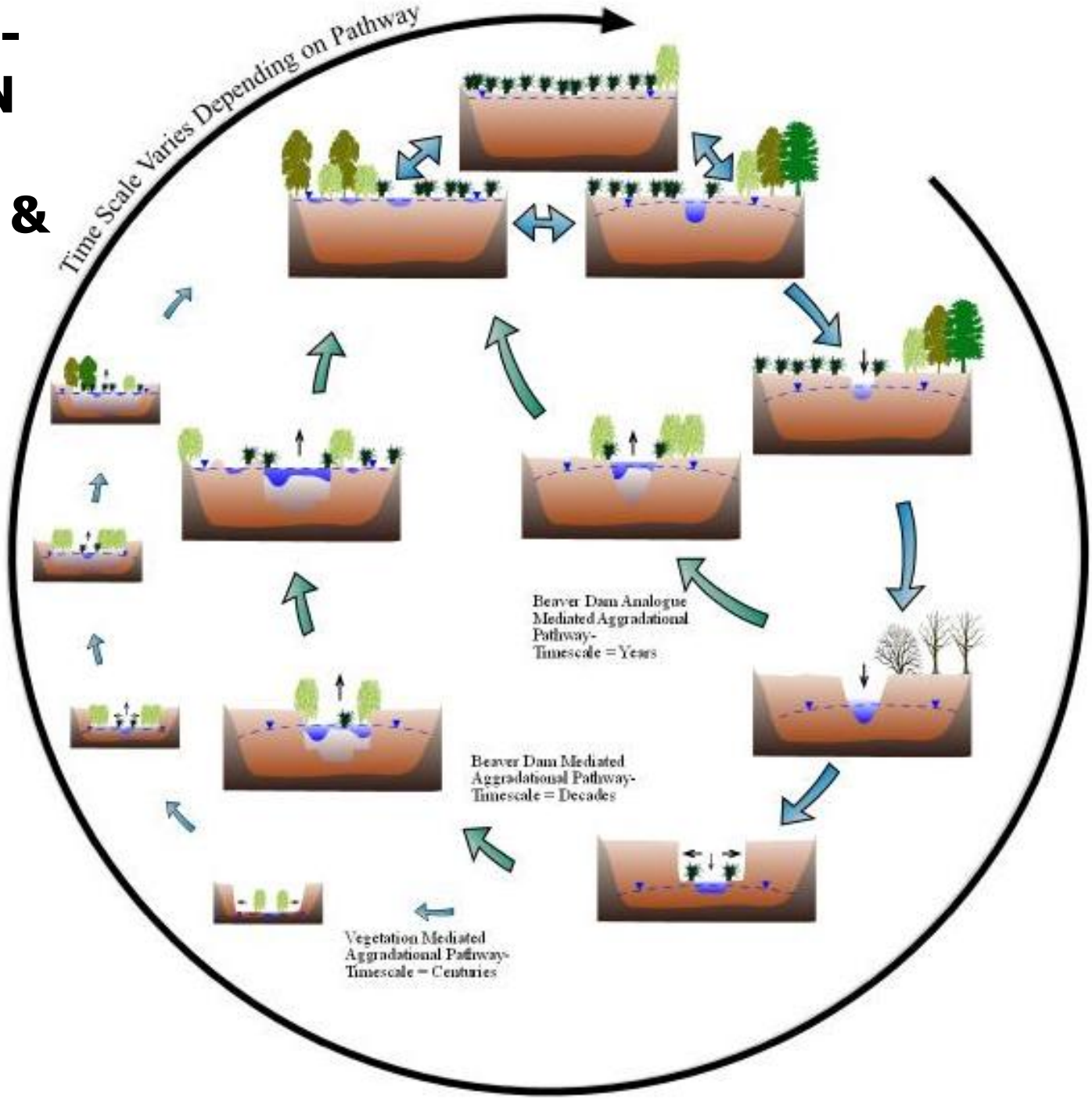
BEAVER DAMS EXPAND RIPARIAN VEGETATION EXTENT AND TRAP SEDIMENT



Pollock et al. 2007

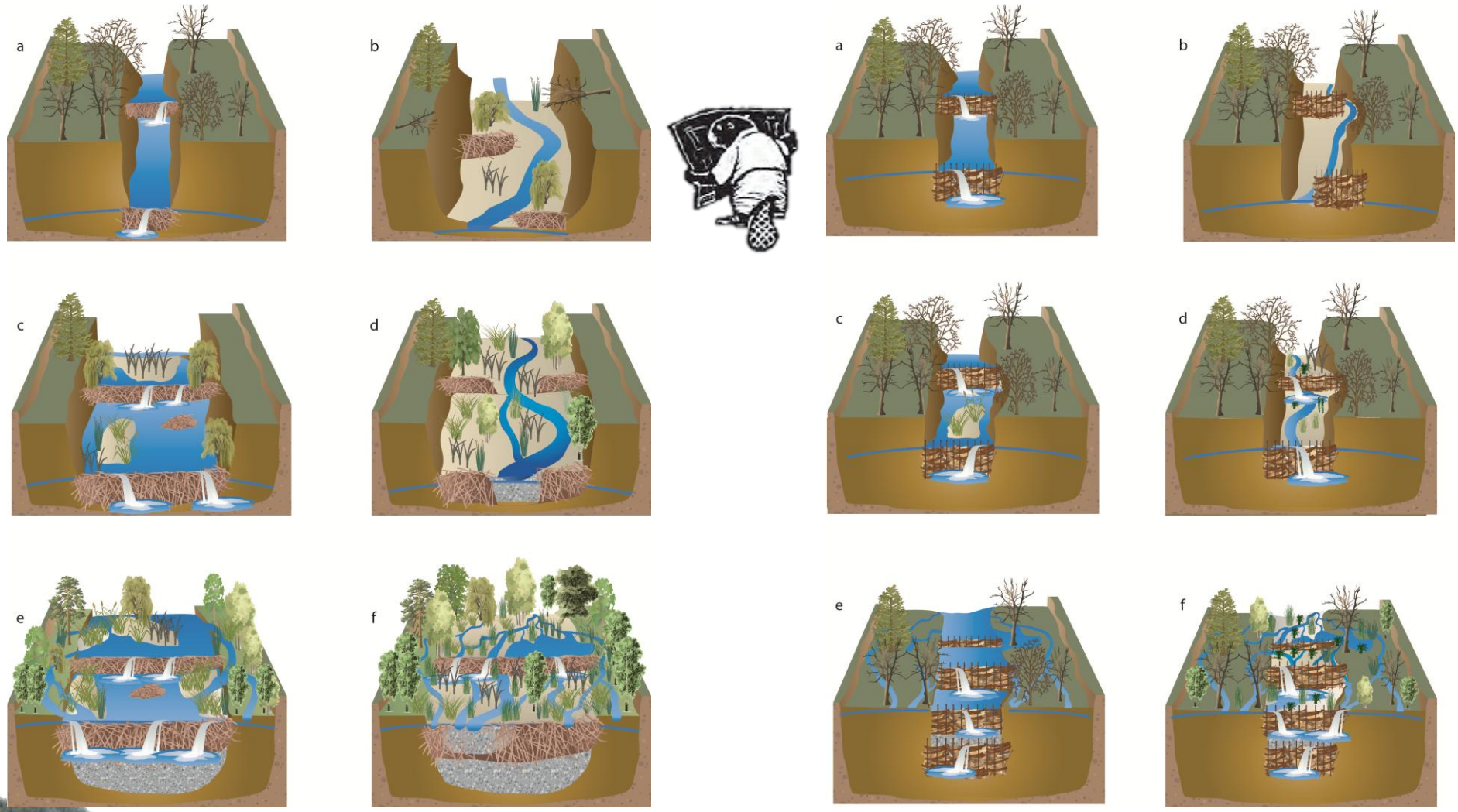
Slide from Michael Pollock

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



From Pollock et al. (In Review)

USING BEAVER TO RESTORE INCISED STREAMS



From Pollock et al. (In Review) –
For submission to Bioscience

TALK PLAN

I. A bit of Background on Beaver
II. Where are beaver a nuisance?
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IV. Where might this work? - BRAT
V. Beaver in Incised Streams?
I. Bridge Creek IMW Experiment
VI. Take-Homes

© Cadel Wheaton

CAN BEAVER DAMS AGGRADE INCISED STREAMS TO THE POINT OF FLOODPLAIN RECONNECTION AND RECOVERY?

Joe Wheaton

Florie Consolati

Kenny DeMeurichy

Nick Bouwes

Michael Pollock

Chris Jordan

Carol Volk

Nick Webber

UtahStateUniversity

NOAA

BRIDGE CREEK ACKNOWLEDGEMENTS…

- Ian Tottenahm (ODFW)
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- Austin Jensen (USU)
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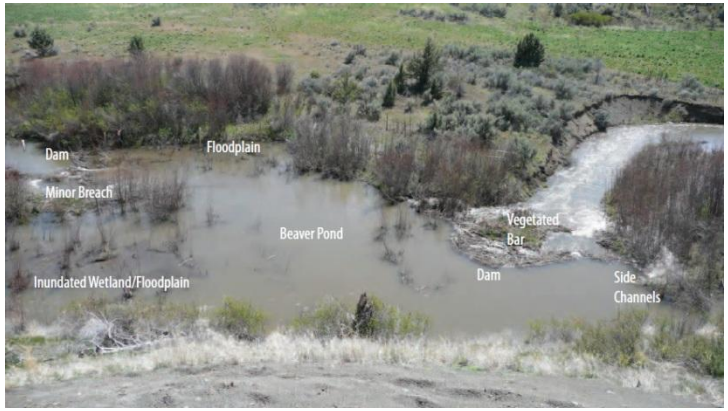
- Jeff Moss (BLM)
- Mike McKay (BLM)
- Alan Kasprak (USU)
- Elijah Portugal (USU)
- CHaMP Field Crews
- Boyd Bouwes (WC)
- Tim Beechie (NOAA)
- And many others…

BONNEVILLE POWER ADMINISTRATION



U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

NOAA Northwest Fisheries Science Center
NOAA Fisheries Service

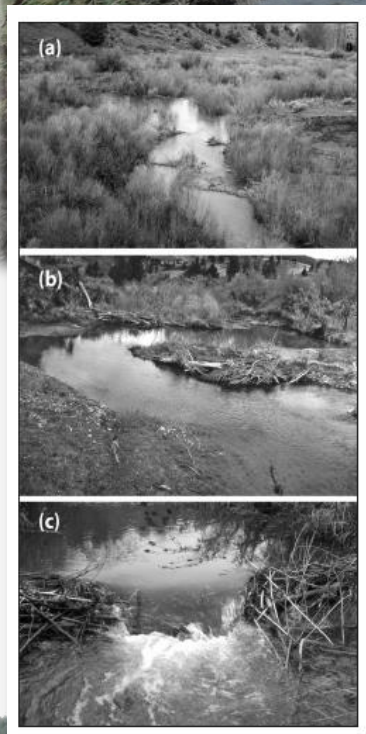
ECOLOGICAL RESEARCH, Inc.

UtahState University
DEPARTMENT OF WATERSHED SCIENCES

BRIDGE CREEK….

Little incision problem…

BEAVER DAMS JUST DID NOT LAST IN BRIDGE



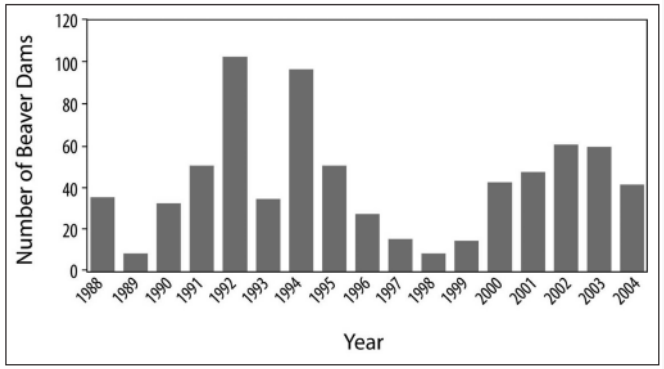


Figure 1. Total number of inventoried beaver dams, by year, along 25.4 km of Bridge Creek in central Oregon.

Rick Demmer, Bureau of Land Management, Prineville, Oregon 97554

and

Robert L. Beschta[1], College of Forestry, Oregon State University, Corvallis, Oregon 97330

Recent History (1988-2004) of Beaver Dams along Bridge Creek in Central Oregon

Abstract

Bridge Creek is a low-gradient stream in the John Day River basin of eastern Oregon. After decades of grazing, riparian vegetation along a 31.7 km reach was sparse and low in diversity, vegetated floodplains were typically narrow, and the stream was relatively wide and shallow. Cattle grazing within this reach was reduced in 1988, irrigation diversion ditches were replaced with culverts in 1989, and beaver (*Castor canadensis*) trapping was discontinued after 1991. Between 1988 and 2004, we inventoried beaver dams and ponds twice a year and estimated their dimensions. Field notes and photographs were used to document habitat use and better understand the potential role of beaver with regard to channel morphology and riparian plant communities. The annual number of beaver dams present in the study reach ranged from 9 to 103. On average, dams were nearly 8 m in length with ponds extending upstream 26 m. We also found that beaver dams/ponds, over time, typically accumulated sediment, improved conditions for establishment and growth of riparian plants, and altered channels. Dams that breached during periods of high flow often contributed to long-term increases in channel complexity through the formation of new meanders, pools, and riffles. Exposed sediment deposits associated with breached dams provided fresh seedbeds for regeneration of willows (*Salix* spp.), black cottonwood (*Populus balsamifera* ssp. trichocarpa), and other riparian plants. Although portions of the study reach were periodically abandoned by beaver following heavy utilization of streamside vegetation, within a few years dense stands of woody plants normally occupied a larger portion of the floodplain. Observations over a period of 17 yrs indicate that beaver facilitated recovery of riparian vegetation, floodplain functions, and stream channels.

Introduction

Although Beaver (*Castor canadensis*) once ranged across nearly all of North America, fur trapping in the 1700s and 1800s decimated their populations across much of the United States (Hill 1982). With the loss of beaver and their dams along streams in the American west, in conjunction with increasing levels of herbivory from livestock, channel incision and widening often occurred causing drastic reductions in subsurface water storage along floodplains and loss of wetland habitats associated with riparian ecosystems (Fouty 2003). In the Ochoco Mountains of central Oregon, Finley (1937, p. 296) observed that, "with no beaver engineers left to take care of the dams, the ponds disappeared; grassy meadows built up by sub-irrigation died out."

Beaver historically have been identified as destroyers of trees, roads, crops, and habitats (Bump 1941, Yeager and Hill 1954, Hill 1982, Avery 1983, DeByle 1985, Beier and Barrett 1987). More recent studies, however, have established their capability to improve watersheds, stream systems, and habitats (Brayton 1984, Naiman et al. 1988, Wright et al. 2002, Baker and Hill 2003). Even with increasing knowledge regarding the ecological benefits of beaver (Kay 1994, Ringer 1994, Sharps 1996, Wright et al. 2002), public agencies and private landowners were often reluctant to protect them from continued exploitation. This was perhaps due, in part, to damage complaints from landowners that occurred when beaver reoccupied portions of their former range (Hill 1986, Luoma 1996).

In the John Day River basin of central Oregon, the effect of beaver on stream systems was controversial in the late 1980s and thus they were widely trapped. Along Bridge Creek, a tributary of the John Day River, trapping kept populations at relatively low levels since ranchers were apprehensive about potential impacts to crops and irrigation facilities (Freilich et al. 2003). Similarly, various local, state, and federal land managers were concerned that failed beaver dams would contribute to bank damage and riparian impacts, especially where cattle grazed in riparian areas. In light of this controversy, we annually monitored

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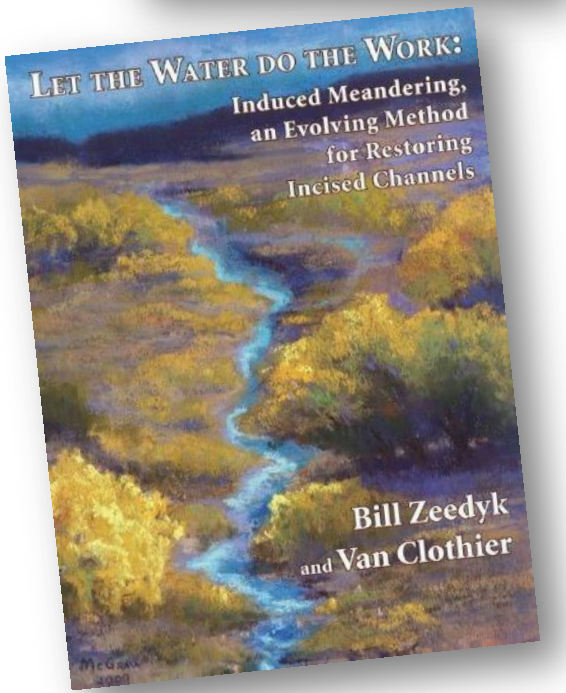
DEPARTMENT OF WATERSHED SCIENCES

SO HELP 'EM OUT… BUY THEM ~~POSTS~~ TIME

COMMON INGREDIENTS

- Structural kick-start (not designed to last… designed to buy beaver time)
- Posts… (3” to 4” diameter)
  - $3 to $8 a post
- Opportunistic placement in field @ high densities
- Non-destructive installation
- Focus on process… ‘letting water do the work’ and/or ‘letting rodent do work’



FOUR 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.

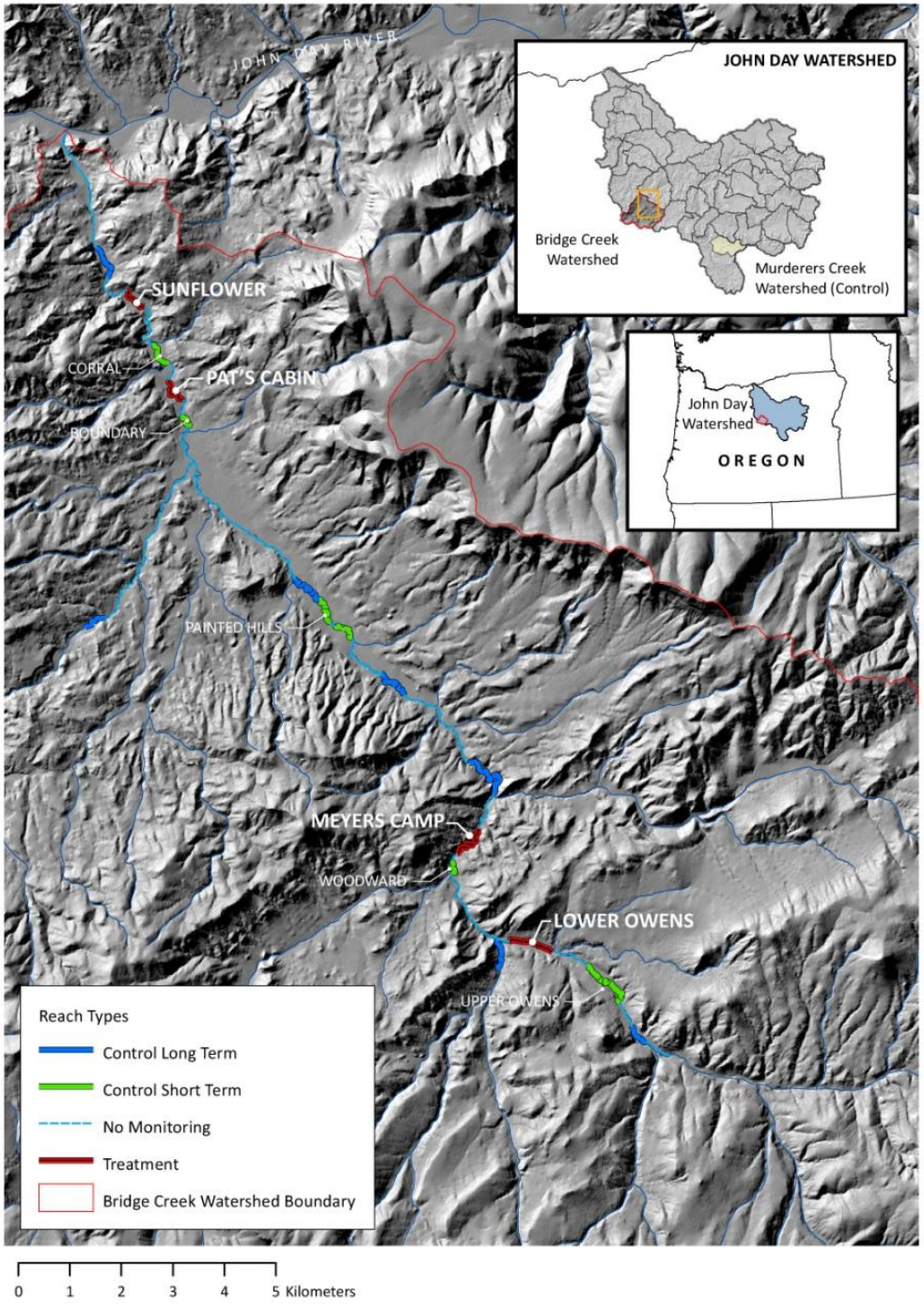
Figure 11. A post line with wicker weave is similar to a starter dam, but acts more like a weir in that water is allowed to flow through the willow branches such that low flows are not over topping the structure and the woven branches may not extend to the top of the posts. These may naturally seal up 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.

TO TEST IDEA…

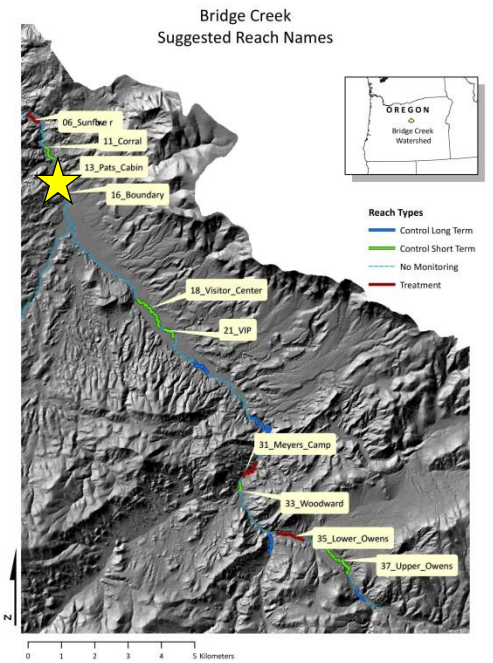
- 4 Treatments & 6 Controls (25 km)
- Slough of things…
  - BDSS Monitoring
  - Repeat Aerial Surveys
  - **Repeat Topographic Surveys**
  - Beaver Monitoring
  - Fish Habitat Surveys
  - **Fish growth, survival & movement**
  - Fish diets



LETS LOOK AT ONE TREATMENT

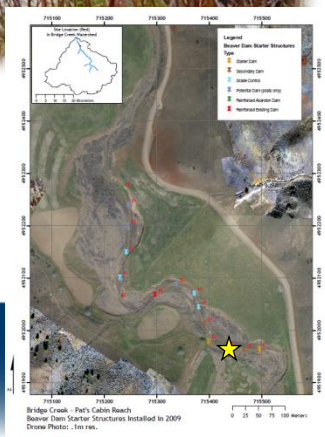
Pat's Cabin Reach

- Can it work? **Can beaver really 'restore' an incised channel and reconnect it with its floodplain?**



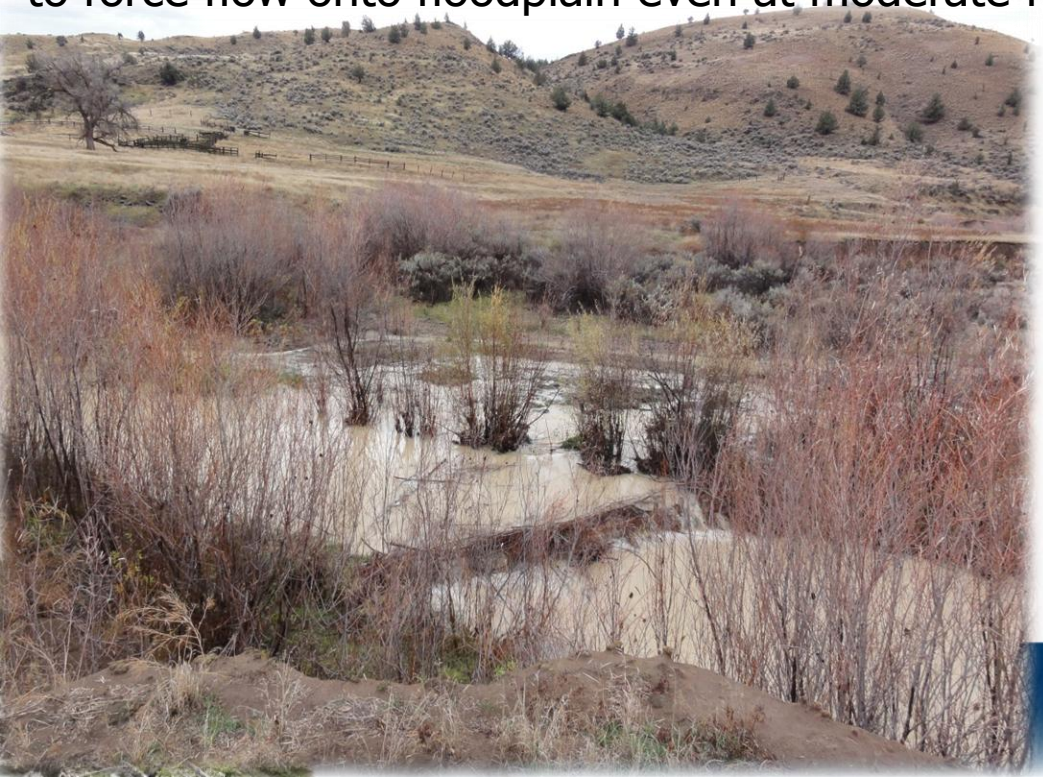
STARTER DAM OCCUPIED…

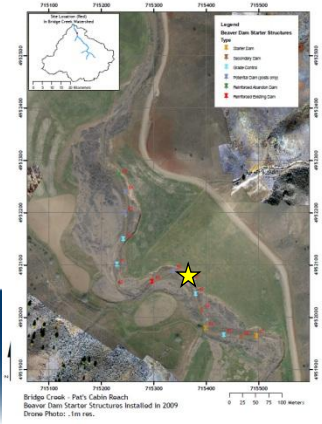
Installed September 2009, Occupied by November 2009



FLOW FORCED ONTO FLOODPLAIN

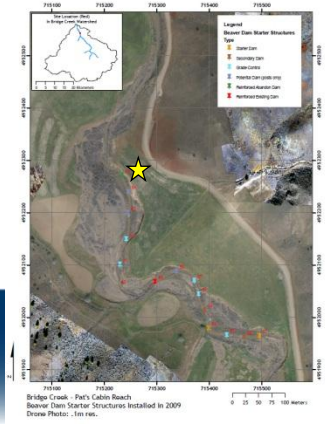
Enough aggradation and dam activity @ secondary dam to force flow onto floodplain even at moderate flows.





STARTER DAM UPSTREAM OF FAILED DAM

- Prior to project there was one abandon, breached dam in this reach…
- One year later, there are eleven (15 BDSS)

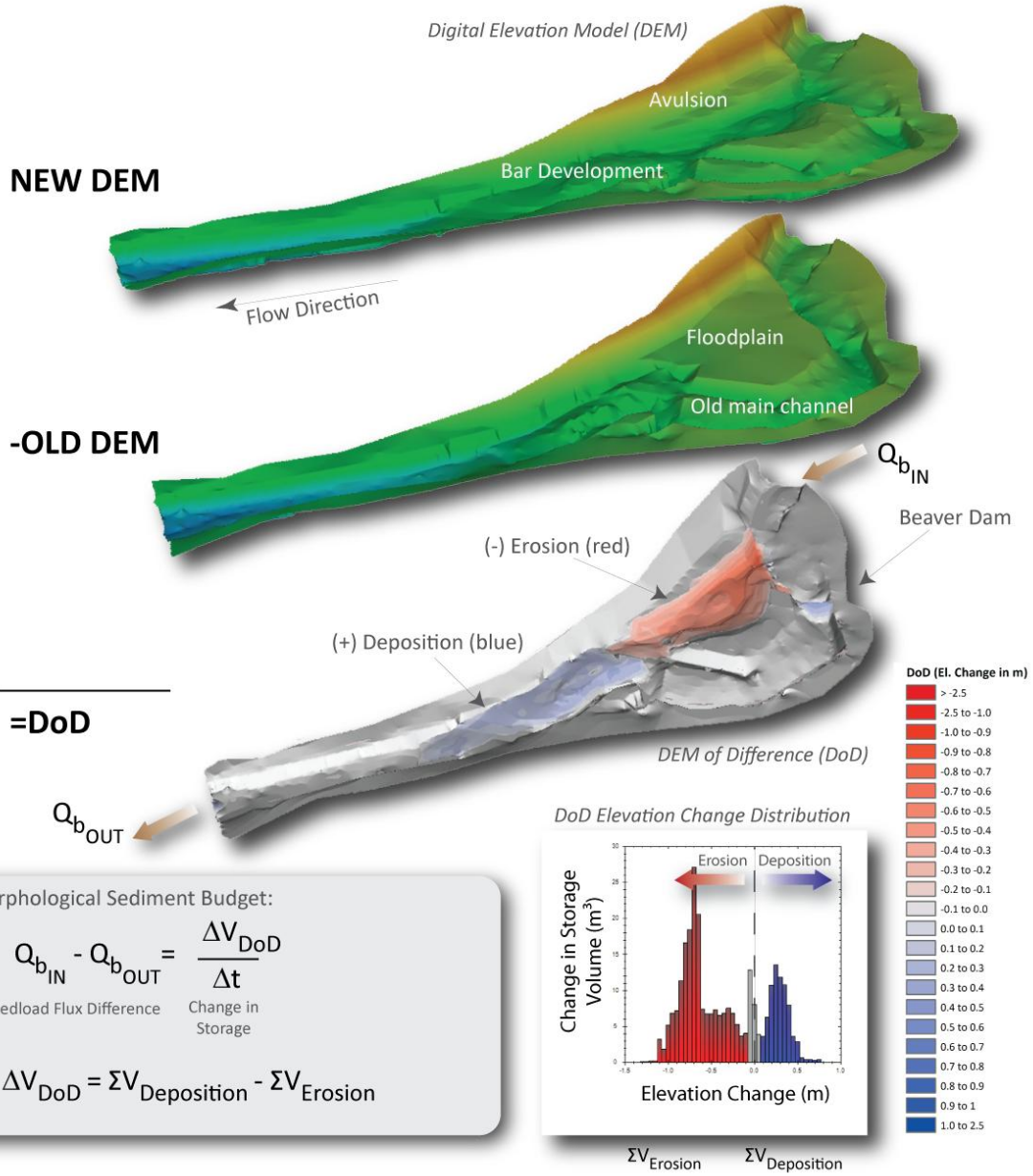


BEFORE & AFTER…

STUDY DESIGN: REPEAT TOPOGRAPHY

GEOMORPHIC CHANGE DETECTION

- What can we do with that repeat topography?
- Develop a direct measure of channel aggradation and floodplain reconnection



Morphological Sediment Budget:

$$Q_{b_{IN}} - Q_{b_{OUT}} = \frac{\Delta V_{DoD}}{\Delta t}$$

Bedload Flux Difference

Change in Storage

$$\Delta V_{DoD} = \Sigma V_{Deposition} - \Sigma V_{Erosion}$$

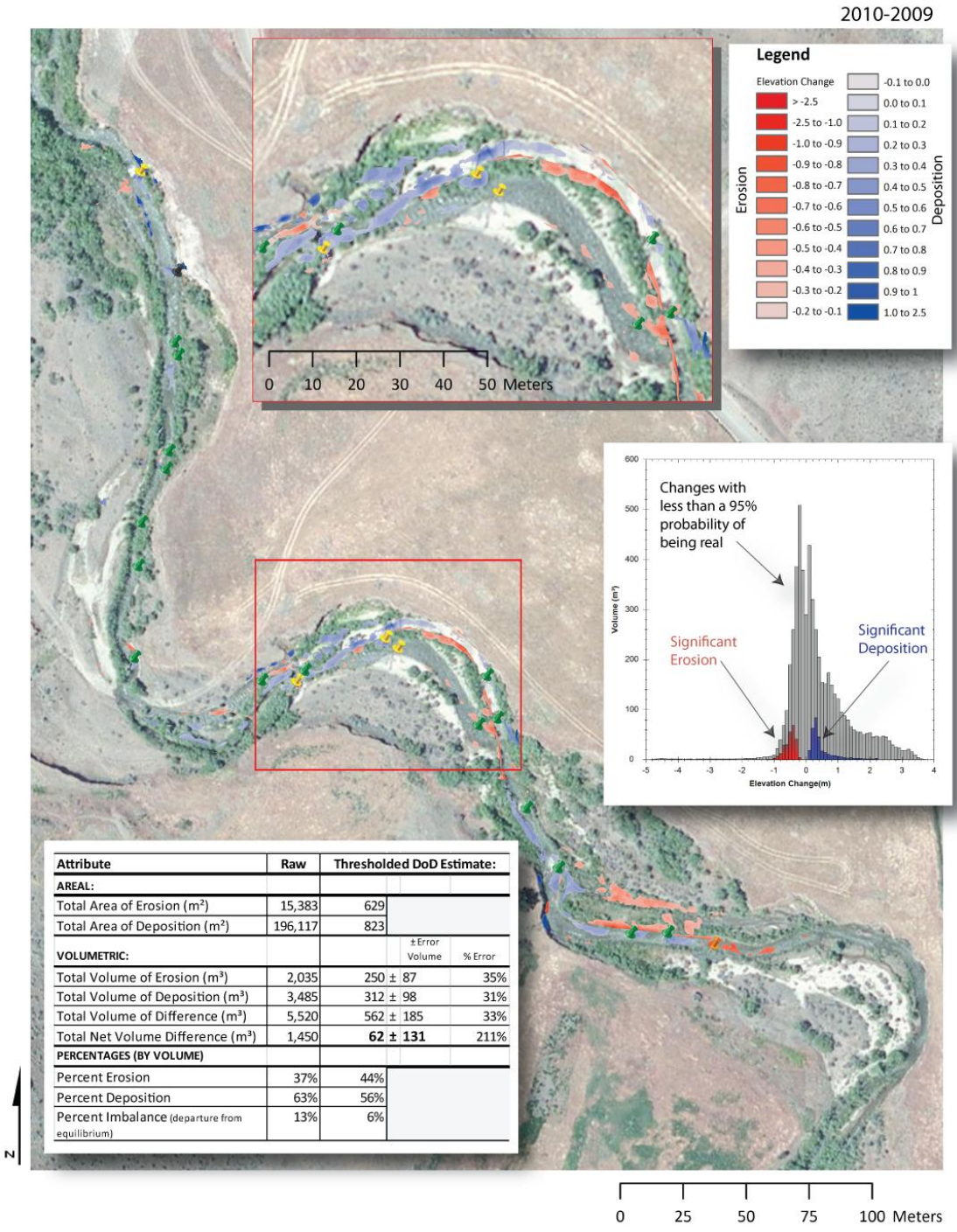
1st YEAR (2010-2009): OVERALL DoD

Deposition:

- Ponds filling up…
- Transverse gravel bars forming

Erosion:

- Scour pools downstream of structures
- Some lateral erosion



Attribute	Raw	Thresholded DoD Estimate:		
AREAL:				
Total Area of Erosion (m^2)	15,383	629		
Total Area of Deposition (m^2)	196,117	823		
VOLUMETRIC:			± Error Volume	% Error
Total Volume of Erosion (m^3)	2,035	250	± 87	35%
Total Volume of Deposition (m^3)	3,485	312	± 98	31%
Total Volume of Difference (m^3)	5,520	562	± 185	33%
Total Net Volume Difference (m^3)	1,450	**62**	**± 131**	211%
PERCENTAGES (BY VOLUME)				
Percent Erosion	37%	44%		
Percent Deposition	63%	56%		
Percent Imbalance (departure from equilibrium)	13%	6%		

Erosion: 250 m^3 +/- 87

Deposition: 312 m^3 +/- 98

NET: + 62 m^3 (+/- 131)

2nd YEAR (2011-2010): OVERALL DoD

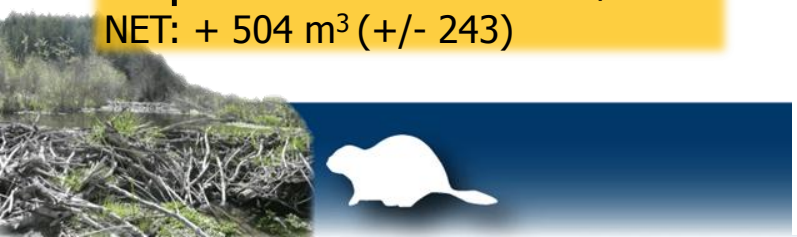
Deposition:

- Ponds filling up even more…
- More gravel bars forming

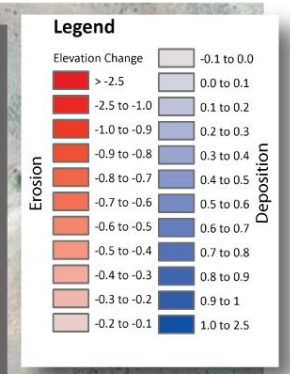
Erosion:

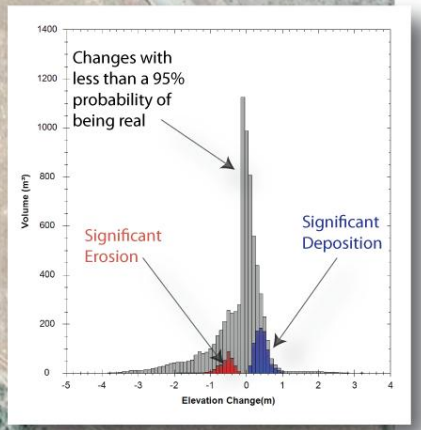
- Headcut with dam blowout
- Avulsion/cutoff…

Erosion: 342 m^3 +/- 83
Deposition: 846 m^3 +/- 228
NET: + 504 m^3 (+/- 243)

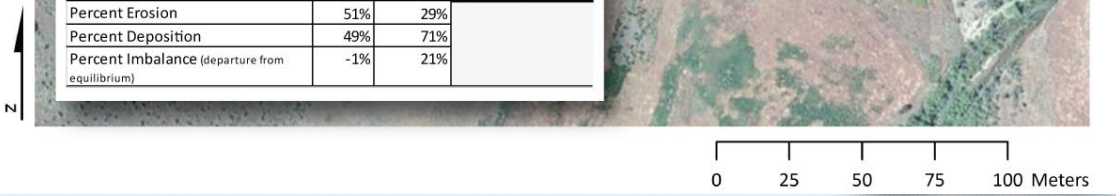


2011-2010



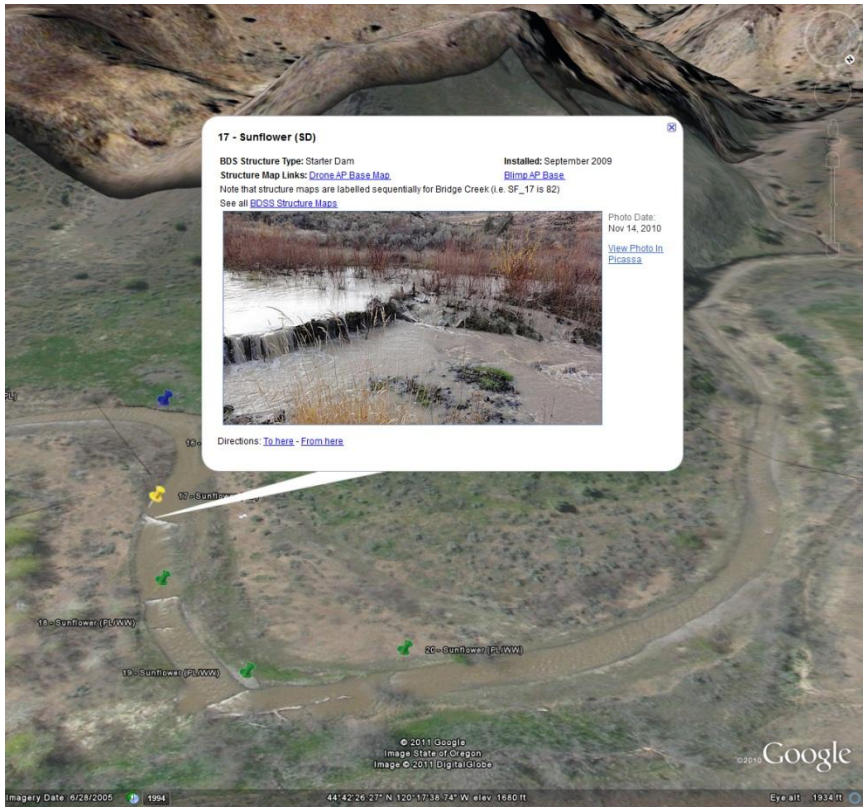


Attribute	Raw	Thresholded DoD Estimate:		
AREAL:				
Total Area of Erosion (m^2)	110,753	767		
Total Area of Deposition (m^2)	100,747	2,121		
VOLUMETRIC:			± Error Volume	% Error
Total Volume of Erosion (m^3)	3,799	342	± 83	24%
Total Volume of Deposition (m^3)	3,698	846	± 228	27%
Total Volume of Difference (m^3)	7,497	1,188	± 311	26%
Total Net Volume Difference (m^3)	-101	**504**	**± 243**	48%
PERCENTAGES (BY VOLUME)				
Percent Erosion	51%	29%		
Percent Deposition	49%	71%		
Percent Imbalance (departure from equilibrium)	-1%	21%		



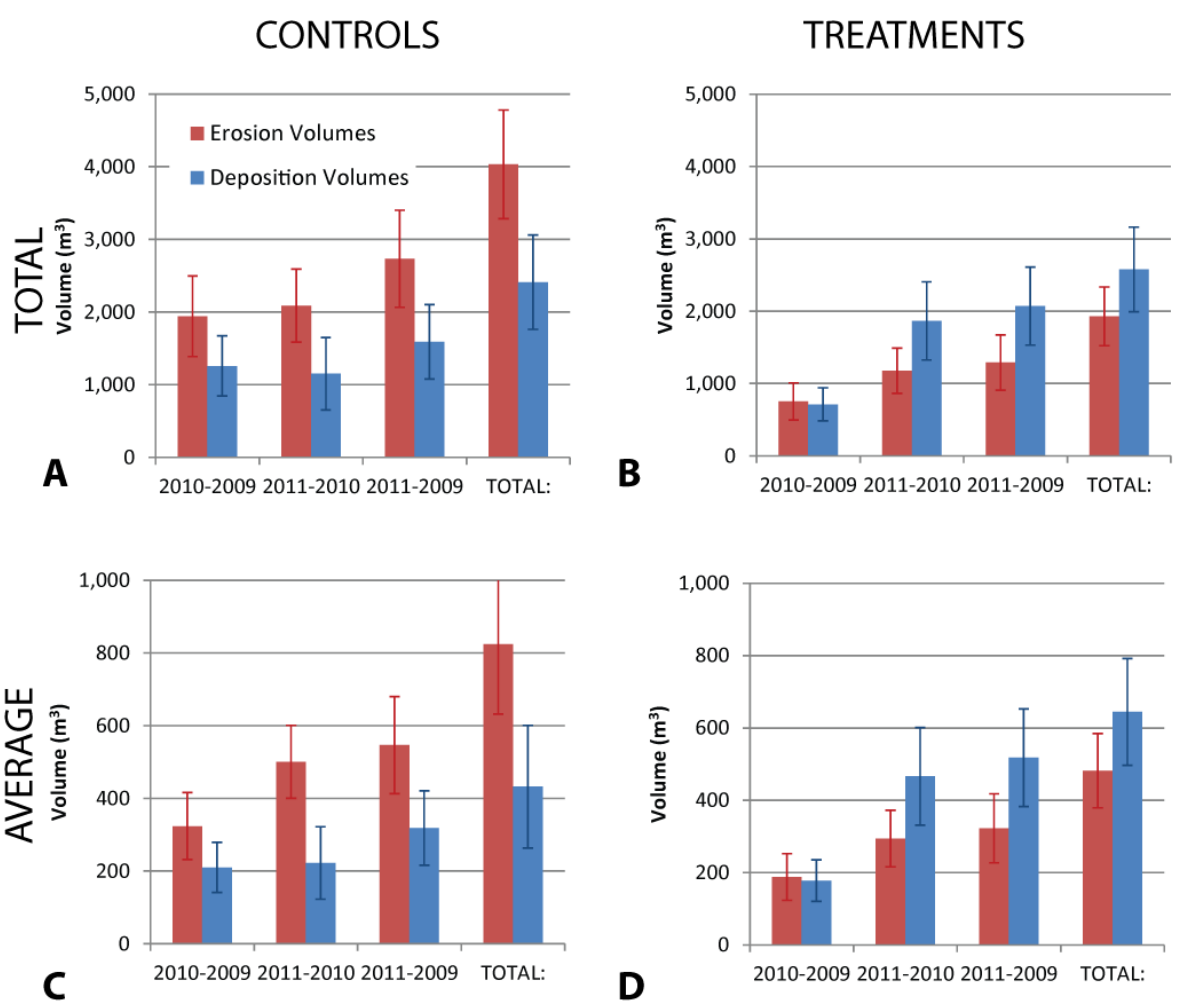
ELSEWHERE… WE SEE SIMILAR RESULTS

- 84 Structures installed in four reaches (in 2009); Now ~120
  - 5 Reinforced existing dams
  - 4 Reinforced abandon dams
  - 10 Starter Dams
  - 44 Post lines with Wicker Weaves
  - 21 Post lines only



SUMMARY NET CHANGE IN STORAGE

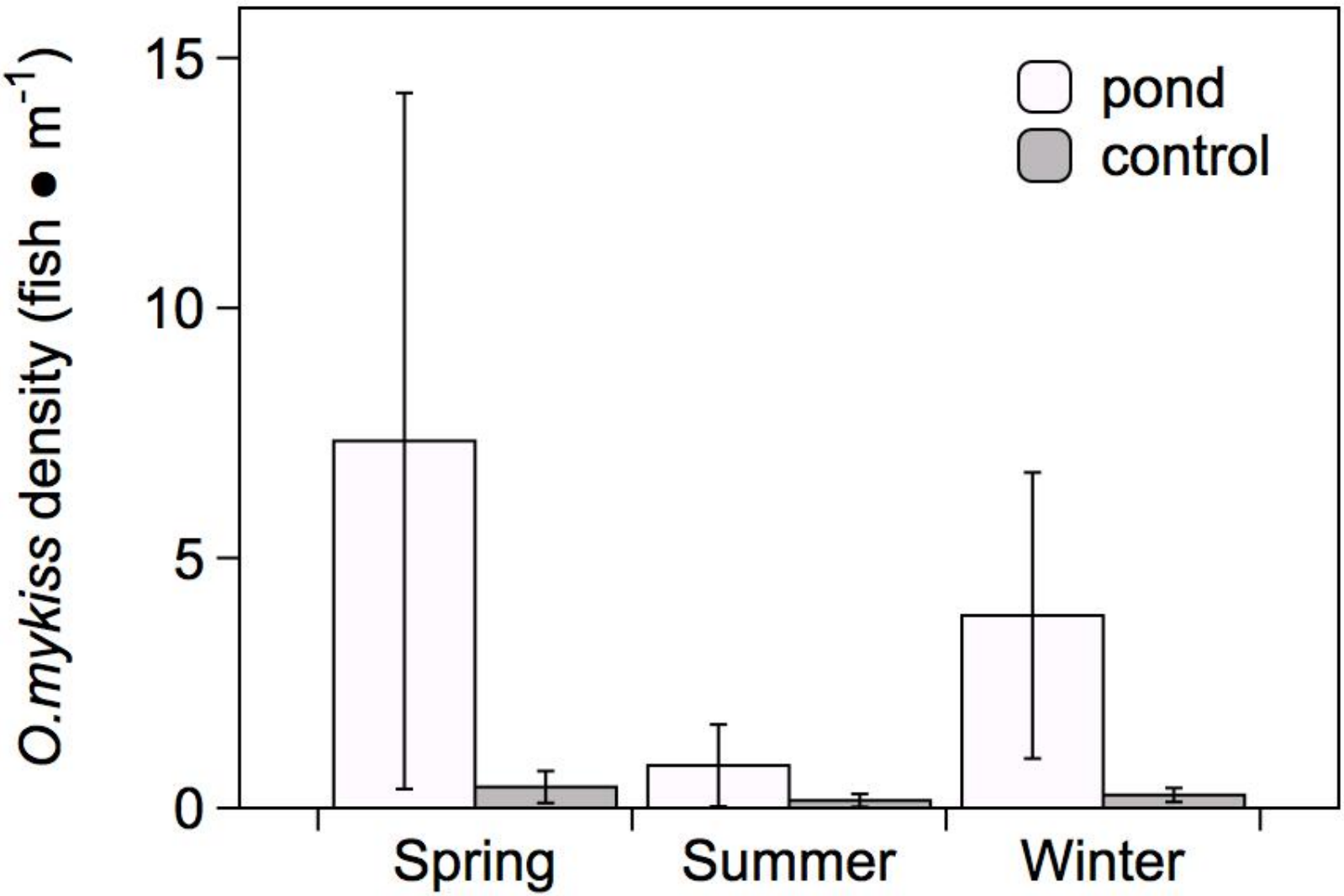
- Controls Net Degradational
- Treatments Net Aggradational
- In short term at least, it works!



WHAT ABOUT THE FISH?

FISH SAMPLING

JUVENILE STEELHEAD HABITAT PREFERENCE



Survival of *O. mykiss* in Bridge and Murderers (trt and cntrl)

Pre-restoration

Post-restoration

O. mykiss survival season

1.20
1.00
0.80
0.60
0.40
0.20
0.00

Bridge (trt)

Murderers (cntrl)

Ratio of Survival *O. mykiss* in Bridge and Murderers (trt/cntrl)

Geomean Ṙ-pre and Ṙ-post restoration (p<0.001)

Pre-restoration

Post-restoration

Ṙ-pre

Ṙ-post

Ratio of *O.mykiss* survival (trt/cntrl)

1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00

Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter

2007
2008
2009
2010
2011
2012

Production of *O. mykiss* of Bridge and Murderers (trt and cntrl)

Pre-restoration

Post-restoration

Bridge (trt)

Murderers (cntrl)

Production (Δg/100m²/season)

450
400
350
300
250
200
150
100
50
0

Difference in Production of Bridge and Murderers (trt - cntrl)

Average Ḋ-pre and Ḋ-post restoration (p=0.10)

Pre-restoration

Post-restoration

Ḋ-pre

Ḋ-post

Difference in Production (trt-cntrl)

400
300
200
100
0
-100
-200

Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter
Summer
Fall
Winter

2007
2008
2009
2010
2011
2012
2012

BRIDGE CREEK FINDINGS…

- Rapid colonization of BDSS after installation
- Rapid geomorphic response working with beaver to restore incised channel & reconnect with floodplain in the right direction…. Will it last?
- Dramatic improvements in habitat complexity
- + Population level fish responses!

CHEAP & CHEERFUL RESTORATION?

- Cheap?
  - Design in field…
  - $13K for 4 km of installation
- Cheerful?
  - Furry rodent…?
  - It WORKS!
- Transferable?
  - Now being used in other incised streams to reconnect floodplain (including in Utah)
  - Need vegetation (dam building materials)
  - Beaver can be used elsewhere… where habitat complexity limiting

TALK PLAN

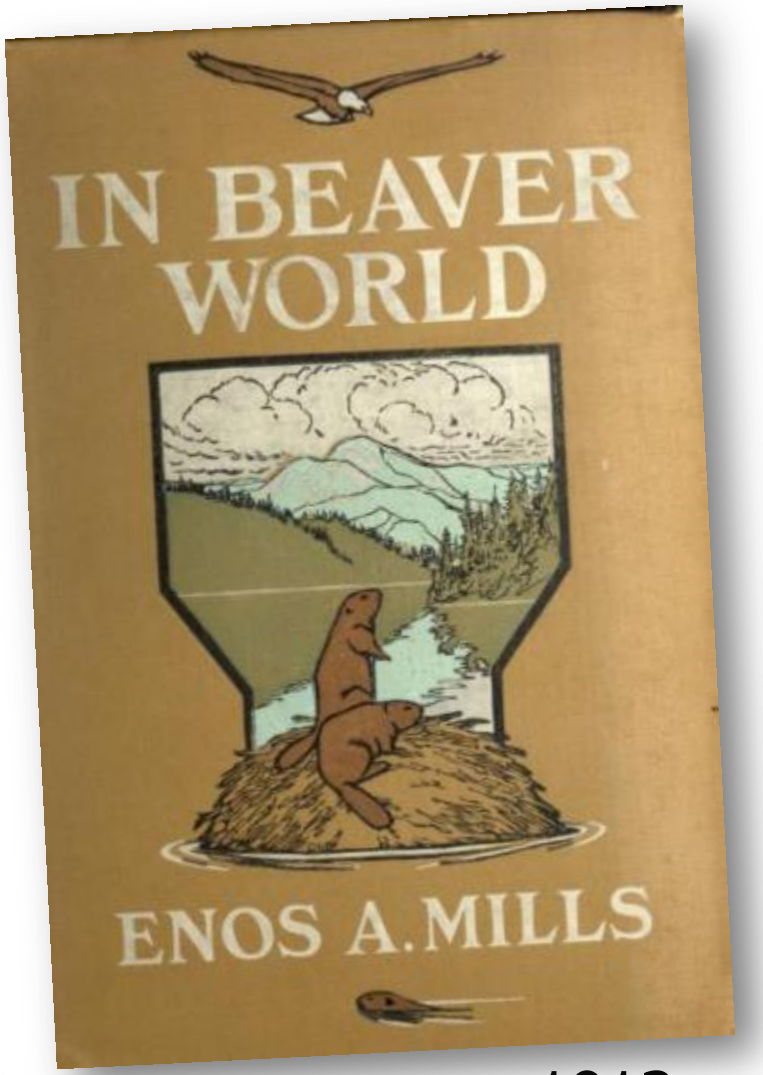
I. A bit of Background on Beaver
II. Where are beaver a nuisance?
III. Exploiting the Undiscriminating Rodent
IV. Where might this work? - BRAT
V. Beaver in Incised Streams?
    I. Bridge Creek IMW Experiment

VI. Take-Homes

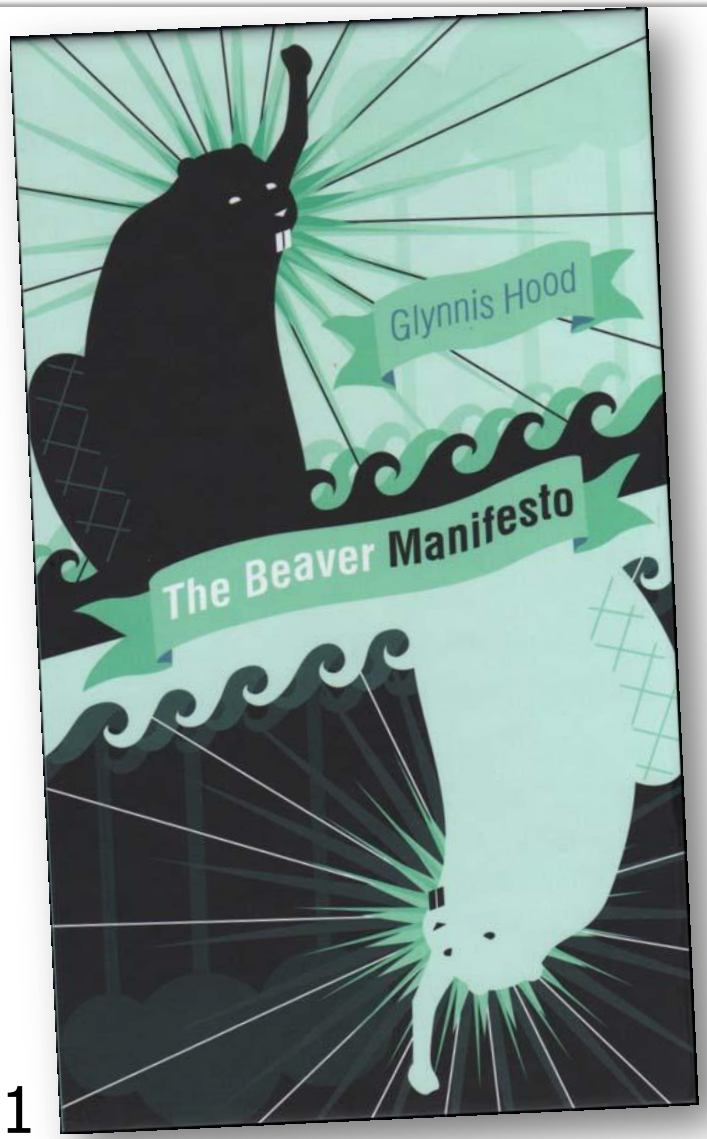
TAKE-HOMES

- Beaver are both a nuisance and a good partner
- Where they are a nuisance, a number of 'living with beaver' mitigation strategies are possible
- Where nuisance beaver cannot be tolerated, live-trapping and relocating to areas for restoration is now a viable strategy
- BRAT can help us manage our expectations about where we might find beaver and where we might use them as a restoration agent
- Incised Stream Restoration with Beaver is working and notably cheap!

TWO FUN READS…



1913 vs. 2011



QUESTIONS?

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

BEAVER RESTORATION ASSESSMENT TOOL
UtahStateUniversity ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY
BRAT

UtahStateUniversity
DEPARTMENT OF WATERSHED SCIENCES

PARTNERING WITH BEAVER IN RESTORATION DESIGN

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