CHEAP AND CHEERFUL STREAM & RIPARIAN RESTORATION WITH BEAVER?

Joe Wheaton

Webinar Organized by Jeremy Christensen

http://grandcanyontrust.org

WEBINAR for National Riparian Service Team
June 25th, 2013
GoToWebinar BASICS...

- We will hold questions until end...
- Raise hand to ask a question verbally at end...
- Or – Type question in question dialog at any time... (we will hold most of these until end)
- Yes, you can multi-task... but just don’t close the GoToWebinar Viewer

Webinar will be recorded & you’ll be sent a link afterwards.
DIVERSE WEBINAR AUDIENCE

171 Registered...

- 37% USFS (*@fs.fed.gov)
- 13% BLM
- 8% NRCS / UDDA
- 8% State Agencies
- 37% Other

[Image of the webpage of the Bureau of Land Management (BLM)]

For over a decade, the National Riparian Service Team (NRST) has been leading implementation of an interagency effort to accelerate cooperative riparian restoration and management, focusing primarily in the Western United States. Under their leadership, a network comprised of teams and individuals with federal and state agency, non-government organization, university, and private affiliation, are implementing the Creeks and Communities Strategy (see Creeks and Communities) at the state and regional scale. Core and adjacent team members have expertise in Hydrology, Ecology, Fisheries, Wildlife, Range Management, Soils and Geology, Forestry, Social Science, Conflict Management, Public Affairs and Communication. Their approach is specifically designed to address the technical dimensions of riparian issues while at the same time recognizing and addressing the social context within which these issues exist. The result is more effective integration of technical information into collaborative problem solving.

The NRST, in coordination with State Riparian Teams and Agency Coordinators (see Network Directory), provide assistance with place-based problem solving, training, assessment, monitoring and grazing management relative to riparian-wetland resources. They are also available for monitoring and coaching. For more specific information on services and requesting NRST assistance, go to [NRST home page].
MAIN PARTNERS... OTHER THAN RODENTS

Nick Bouwes
Michael Pollock
Chris Jordan

Wally MacFarlane
PURPOSE OF TALK

Share some of work we’ve been doing on beaver..

- Too easy to get people excited about beaver as a restoration tool... so need expectation management:
  1. Where could beaver work?
  2. Where are they a problem?
  3. What do we do where beaver alone are not enough?
TALK PLAN

I. State of our Streams Context

II. Ecosystem Services of Beaver

III. Where are beaver a nuisance?

IV. Exploiting the Undiscriminating Rodent

V. Where might this work? - BRAT

VI. Citizen Scientist Monitoring Effort

VII. Beaver to restore incised streams?

VIII. Take-Homes

Talk Available:  
JUST HOW MESSED UP ARE RIPARIAN AREAS?

• We have over 85,000 miles of rivers and streams
  – 81% (65,000 miles) are non-perennial and/or ditches
  – 16,000 miles are perennial
  – 1980 estimate that 4,000 miles had suitable beaver habitat

• Historically...
  – Beaver were pervasive throughout this network
  – Much greater proportion perennial
Even in the West (best of conditions)

- 22% are Fair
- 14% are poor

WHEN YOU THINK OF STREAM RESTORATION
DYNAMIC STREAMS = HEALTHY ECOSYSTEMS

• We *believe* this...
• Lots of studies showing feedbacks and links...

• How do we design a system to ‘be dynamic’?
• (i.e.) What exactly is process-based restoration?
BY CONTRAST, RESTORATION PRACTICE

- Stream/River Restoration:
  - Tied to a fiscal reality that needs to ‘get stuff done’
  - Faces increased scrutiny and diminish budgets
  - Would love to monitor, but can’t secure funding to do it
  - Much more comfortable with static designs
  - Has lots of recipes for locking things down
Table 1. Typical restoration costs

<table>
<thead>
<tr>
<th>Item</th>
<th>High end (cost/river mile)</th>
<th>Low end (cost/river mile)</th>
<th>Reasonable mean (cost/river mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan, design &amp; NEPA</td>
<td>$110,040</td>
<td>$21,833</td>
<td>$68,880</td>
</tr>
<tr>
<td>Materials (trees)</td>
<td>$64,900</td>
<td>$14,747</td>
<td>$20,566</td>
</tr>
<tr>
<td>Mobilization</td>
<td>$8,200</td>
<td>$1,333</td>
<td>$2,777</td>
</tr>
<tr>
<td>Equipment</td>
<td>$122,000</td>
<td>$17,333</td>
<td>$20,800</td>
</tr>
<tr>
<td>Labor</td>
<td>$17,167</td>
<td>$112</td>
<td>$5,000</td>
</tr>
<tr>
<td>Riparian planting/maintenance</td>
<td>$7,646</td>
<td>$3,893</td>
<td>$5,512</td>
</tr>
<tr>
<td>Instream structure maintenance</td>
<td>$24,640</td>
<td>$4,760</td>
<td>$5,600</td>
</tr>
<tr>
<td>Total</td>
<td>$354,593</td>
<td>$64,011</td>
<td>$129,135</td>
</tr>
</tbody>
</table>


- Nationwide (lower 48), Over 130,900 mi are Poor condition
  - (i.e. @ $130K/ mile... over $17 Billion)
CAN WE CONTINUE TO AFFORD THIS?

- The over-cited Bernhardt et al. (2005) paper
  - 38,000 projects
  - At least $15 billion spent since 1990-2003

- Gross Under-Estimate
  - 42,000 projects alone in PNW
WHAT ARE SCIENTISTS CONTRIBUTING?

• Stream/River Restoration

Science Literature has been/is:

– Highly critical of restoration practice
  • Form-based … & No monitoring...
– Vast (over 10,000 articles)
– Repetitive & Preachy
– Includes a lot of half-baked science
– Full of conjecture that gets propagated (cited) as fact
– Misguided in terms of audience

MOST USEFUL CONTRIBUTION: Process Matters!
SO WHAT IS HIS POINT?

Restoration/Conservation Practice:

- Desperately needs some “cheap and cheerful” alternative methods of restoring that are process-based and self-sustaining
- Needs to treat/fix more of the drainage network
- Needs to show its working to justify investment

Restoration Science:

- Stop preaching about what’s wrong and suggest some alternatives... (experiments okay!)
- Provide tools to ‘monitor’ or do ‘maintenance’
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VIII. Take-Home
A HABITAT GENERALIST, AND HIGHLY ADAPTABLE

- Lakes
- Rivers and streams
- Abandoned channels on floodplains
- Wetlands
FROM BOREAL FORESTS....
...TO DESERTS

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

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 stream sides, where it can be harder to escape attack.

ASPENS The number of new sprouts eaten by elk has dropped dramatically. New growth 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

1. Herbivory
2. (Dam building)
3. Raised water tables
4. Moderated flows
5. 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.

<table>
<thead>
<tr>
<th>Negative impacts</th>
<th>Number</th>
<th>% of total citations</th>
<th>Data driven (%)</th>
<th>Speculative (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barriers to fish movement</td>
<td>51</td>
<td>42.9</td>
<td>21.6</td>
<td>78.4</td>
</tr>
<tr>
<td>Reduced spawning habitat</td>
<td>20</td>
<td>16.8</td>
<td>40.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Altered temperature regime</td>
<td>11</td>
<td>9.2</td>
<td>9.1</td>
<td>90.9</td>
</tr>
<tr>
<td>Reduced oxygen levels</td>
<td>12</td>
<td>10.1</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Reduced habitat quality</td>
<td>2</td>
<td>1.7</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Altered flow regimes</td>
<td>4</td>
<td>3.4</td>
<td>75.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Loss of cover</td>
<td>5</td>
<td>4.2</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Reduced productivity</td>
<td>9</td>
<td>7.6</td>
<td>33.3</td>
<td>66.7</td>
</tr>
<tr>
<td>Retarded growth</td>
<td>2</td>
<td>1.7</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Abandonment of beaver settlements</td>
<td>1</td>
<td>0.8</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Reduced water quality</td>
<td>2</td>
<td>1.7</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100</td>
<td>28.6</td>
<td>71.4</td>
</tr>
</tbody>
</table>
DO BEAVER DAMS PREVENT FISH FROM GETTING UPSTREAM?


- Native cutthroats can pass easier than invasive Browns!
Do Beaver Dams Impede the Movement of Trout?

Ryan L. Lukett* and Brett B. Roper
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Abstract

Dams created by North American beavers Castor canadensis (hereafter “beavers”) have numerous effects on aquatic habitat use by native. Many of these changes to the streams are seen as positive, and many stream restoration projects seek either to reintroduce beavers or to mimic the habitats that they create. The extent to which beaver dams act as movement barriers to salmonids and whether successful dam passage differs among species is topics of frequent speculation and warrant further research. We investigated beaver dam passage by larval trout species in two northern Utah streams. We captured 1,317 trout above and below 21 beaver dams, and fitted them with PIT tags to establish whether fish passed the dam and is ideally downstream of upstream passage. If individual trout were observed in both 481 passage of the 21 beaver dams. Native Bonneville Cutthroat trout Oncorhynchus clarki clarki and rainbow trout O. mykiss were passed frequently than nonnative Bonneville Cutthroat rainbow trout and nonnative Brook Trout Salvelinus fontinalis. We determined that upstream timing affected spatial movement, and downstream passage was dependent on species. Movement behavior of such trout species was also correlated to the observed patterns of dam passage. Our results suggest that beaver dams are acting as no barrier to movement barriers for Bonneville Cutthroat trout or Brook trout but may be impeding the movement of invasive brown trout.

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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
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
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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...

- 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

MY FEARS ARE:

- Are we expecting too much from a rodent?
- Responses will be variable... harder to predict...
- Our definitions of failure are inadequate
- Perception matters!

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

From: http://www.wildearthguardians.org/site/PageServer?pagename=priorities_wild_places_jemez_mound_beavers
WHERE COULD WE USE BEAVER?

- This is not a very useful map...
- What about in my watershed, on my stream?

beavers in excess of estimated carrying capacity (Blackwell and Pederson 1993). The predicted beaver habitat in Utah was mapped as part of the 1995 Utah GAP Analysis (Figure 1). Current beaver distribution and abundance is not fully understood, however they are considered common and most of the suitable habitat believed to be occupied.
BUT ITS WHERE THEY BUILD DAMS, THAT WE REALLY CARE ABOUT...

- The dams provide the ecosystem services we’re primarily interested in
- So knowing where beaver are is less important then knowing where they can and are building dams that last!
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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 & beaver occ *weak* or *non*.
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**.
Welcome to the BRAT website. The Beaver Restoration Assessment Tool will be a decision support and planning tool intended to help researchers and resource managers assess the potential for beaver as a stream conservation and restoration agent over large regions and watersheds.

The BRAT models can be run with widely available existing data sets, and used to identify opportunities, potential conflicts and constraints through a mix of assessment of existing resources and scenario-based assessment of potential futures. The primary backbone to BRAT are some spatial models that predict the capacity of riverscapes to support dam-building activity by beaver. These models have been tested in a pilot project in Utah and are ready for broader implementation. The rest of the decision support tool is under development (read Vision here).
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
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
PERENNIAL STREAM VEGETATION & STREAM POWER FIS

INPUTS

PERENNIAL STREAM VEGETATION & STREAM POWER FIS

FUZZY INFERENCE SYSTEM

Type: Mamandi
And Method: Min
Or Method: Max
Implication: Min
Aggregation: Max
Defuzz Method: Centroid

OUTPUT

None
Occasional
Healthy
Mecca
### RULE TABLE

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF Vegetative Dam Density Capacity (FIS), Baseflow Stream Power, 2 Year Flood Stream Power</td>
<td>Dam Density Capacity</td>
</tr>
<tr>
<td>1 None &amp; - &amp; -</td>
<td>None</td>
</tr>
<tr>
<td>2 - &amp; Cannot Build Dam &amp; -</td>
<td>None</td>
</tr>
<tr>
<td>3 Occasional &amp; Can Build Dam &amp; Dam Persists</td>
<td>Occasional</td>
</tr>
<tr>
<td>4 Frequent &amp; Can Build Dam &amp; Dam Persists</td>
<td>Frequent</td>
</tr>
<tr>
<td>5 Pervasive &amp; Can Build Dam &amp; Dam Persists</td>
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<tr>
<td>6 Occasional &amp; Can Build Dam &amp; Occasional Breach</td>
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<td>8 Pervasive &amp; Can Build Dam &amp; Occasional Breach</td>
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</tr>
<tr>
<td>9 Occasional &amp; Can Build Dam &amp; Occasional Blowout</td>
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<td>10 Frequent &amp; Can Build Dam &amp; Occasional Blowout</td>
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<td>12 Occasional &amp; Can Build Dam &amp; Blowout</td>
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<td>13 Frequent &amp; Can Build Dam &amp; Blowout</td>
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<td>15 Occasional &amp; Can Probably Build Dam &amp; Occasional Breach</td>
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<td>16 Frequent &amp; Can Probably Build Dam &amp; Occasional Breach</td>
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<td>19 Frequent &amp; Can Probably Build Dam &amp; Occasional Blowout</td>
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</tr>
<tr>
<td>23 Pervasive &amp; Can Probably Build Dam &amp; Blowout</td>
<td>Occasional</td>
</tr>
</tbody>
</table>
COMBINED

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

= Resulting Capacity
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)
Fuzzy Model Based on:
- Slope
- Distance from Water
- Vegetation
WHAT WE WANT TO DO NEXT...

- Finish decision support elements of BRAT
- Take whole states, regions & basins and run BRAT
TALK PLAN

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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
SO... WHAT WE WANT TO DO NEXT

• Develop a partnership so that citizen science data can be used for BRAT validation & for population estimates

• Customize apps and databases so resource managers and researchers can easily interact with data and use as basis for decision support and management actions
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INCISED STREAMS ARE UBIQUITOUS
THE INCISION-AGGRADATION CYCLE

Adapted from Cluer and Thorne 2013
BEAVER DAMS EXPAND RIPARIAN VEGETATION EXTENT AND TRAP SEDIMENT

Pollock et al. 2007
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
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
BRIDGE CREEK....
Little incision problem...
BEAVER DAMS JUST DID NOT LAST IN BRIDGE

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 central 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 streams was relatively wide and shallow. Cattle grazing within this reach was reduced in 1988, irrigation diversion ditches were replaced with culverts in 1995, and beaver (Castor canadensis) trapping was discontinued after 1991. Between 1985 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 100. On average, dams were nearly 8 m in length with ponds extending upstream 20 m. We also found that beaver dams morphed over time, typically accumulating sediment, improved conditions for establishment and growth of riparian plants, and altered channels. During that broadening during periods of high flow were 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 woody material for regeneration of willows (Salix spp.), black cottonwood (Populus balsamifera), 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 function, and stream channels.

Introduction

Although beaver (Castor canadensis) once ranged across nearly all of North America, fur trapping in the 1790s 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 (Fourt 2003). In the Ochoco Mountains of central Oregon, Finley (1937, p. 596) 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 (Rump 1941, Yeager and Hill 1954, Hill 1962, Avery 1983, DeBye 1985, Baker 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, Sharp 1996, Wright et al. 2002), public agencies and private landowners 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, Lamont 1990).

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 (Frechling 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

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

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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

1. Starter Dam

Figure 10. A typical starter dam (P+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 into the R2 terrace, mimicking a stable beaver dam.

2. Post Line Only

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.

3. Post Line w/ Willow Weave

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 overtopping 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 P/LWW as evidenced by the chewed stems on the raint of the photo shown.

4. Reinforce Existing

Figure 13. Any active dams within the treatment areas were strengthened with posts to lengthen their functional life, since most dams along the initial Bridge Creek have been shown to last less than a year (Dennler and Shipuk, 2018). 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 suitability, 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) – 120 structures
- 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?**
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.
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
1st YEAR (2010-2009): OVERALL DoD

Deposition:
- Ponds filling up...
- Transverse gravel bars forming

Erosion:
- Scour pools downstream of structures
- Some lateral erosion

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 m³ +/- 83
Deposition: 846 m³ +/- 228
NET: + 504 m³ (+/- 243)
ELSEWHERE… WE SEE SIMILAR RESULTS

- Controls Net Degradational
- Treatments Net Aggradational
- In short term at least, it works!
WHAT ABOUT THE FISH?
FISH SAMPLING

electroshocking

Passive Instream Antenna

Pressure Transducer

Mobile Antenna

Slide from Nick Weber
Survival of *O. mykiss* in Bridge and Murderers (trt and cntrl)

**Pre-restoration**

**Post-restoration**

- Bridge (trt)
- Murderers (cntrl)

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

Geomean $\hat{R}$-pre and $\hat{R}$-post restoration ($p<0.001$)

- Pre-restoration
- Post-restoration

Slide from Nick Bouwes
Ratio of *O. mykiss* survival between Bridge and Murderers (trt / cntrl)
Geomean $\hat{D}$-pre and $\hat{D}$-post restoration ($p<0.0001$)
ABUNDANCE DIFFERENCE

Difference of *O. mykiss* density between Bridge and Murderers (trt - cntrl)
Average D-pre and D-post restoration (p=0.007)
GROWTH DIFFERENCE

Difference in *O. mykiss* growth between D-pre and D-post conditions.

Bridge Creek Density Dependent Growth

\[ \gamma = -0.0031x + 0.1871 \]

\[ R^2 = 0.4082 \]
STEELHEAD PRODUCTION

- Production = Survival * Abundance * Growth

![Graph showing difference in O. mykiss production between Bridge and Murderers (trt - cntrl). Average D-pre and D-post restoration (p=0.10).]
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
I. State of our Streams Context

II. Ecosystem Services of Beaver

III. Where are beaver a nuisance?

IV. Exploiting the Undiscriminating Rodent

V. Where might this work? - BRAT

VI. Citizen Scientist Monitoring Effort

VII. Beaver to restore in incised streams?

VIII. Take-Homes

Talk Available:  
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

IN BEAVER WORLD

ENOS A. MILLS

Glynnis Hood

The Beaver Manifesto
WANT TO LEARN MORE?

• Visit [http://beaver.joewheaton.org](http://beaver.joewheaton.org)
QUESTIONS?

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

PARTNERING WITH BEAVER IN RESTORATION DESIGN

In Bend, Oregon
October 25-27
3-Day Workshop

ICRRR
Intermountain Center for River Rehabilitation and Restoration

Take for 1 university credit or Professional development credit

Learn more at:
http://beaver.joewheaton.org

Register on the web:
http://cnr.usu.edu/streamrestoration