USING BEAVER AS A WETLAND
RESTORATION TOOL:
RESTORATION LESSONS LEARNED AND AN
INTRODUCTION TO THE BEAVER
RESTORATION ASSESSMENT TOOL (BRAT)

Joe Wheaton

ASWM WEBINAR
July 29th, 2015
PURPOSE OF TALK
Share a different angle on **restoring wetlands**... and highlight the **role a rodent can play**
I. What beaver do and why – then & now
II. Beaver induced wetlands & potential impacts on water resources
III. The beaver restoration idea
IV. Some of the challenges – western context
V. Better planning & expectation management
VI. Take-Homes
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
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 $12-$20... even in 1700s they went for $30!

Fascinating read Dolin (2011)
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
A HABITAT GENERALIST, AND HIGHLY ADAPTABLE

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

Fred Hirschmann—Science Faction/Getty Images

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

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

Slide from John Stella
…TO DESERTS

http://www.rv-boondocking-the-good-life.com/
EVEN SOME UNLIKELY PLACES...

- Estuaries
- Glacier outwash streams

Mendenhall Glacier, AK (Photo Bob Armstrong)

Beaver Dam Creek, Long Island, NY
COMMON HABITAT INGREDIENTS: WATER + TREES

- Northern tundra and treeline range boundary: wood limitation
- Southern desert range boundary: perennial streamflow and/or wood limitation
SO WHY DO THEY BUILD DAMS?
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 ~85% of winter diet; ~15% of summer diet
A BEAVER FOOD CACHE...
BEAVER ARE LIKE ROTATIONAL CROP FARMERS

- They will *selectively* work an area hard for 2-3 years
- Then let it lay fallow and move upstream or downstream

[Map and images showing river systems and beaver activity]
LODGES

- Bank lodge vs. Central
- Above Ground

Bank den *(Colorado Natural Heritage Program)*

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

Mid-lake lodge

Slide from John Stella
DAMS IN SERIES & PARALLEL
WHY SO MANY DAMS?

- Extend foraging range
- Predation refugia
- Built-in Insurance Policy (avoid domino failure)
- System Resilience
- Not all eggs in one basket
A NUMBER OF DOCUMENTARIES...

Nature: Leave It to Beavers

2014  TV-G  53m

Our best guess for Joe:  4.9 stars
Average of 75,917 ratings:  4.3 stars

This film casts beavers in a new light, exploring how the brilliant hydro-engineers can be used to reverse the effects of water shortages and more.

http://beaver.joewheaton.org/beaver-links/videos-movies
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HOW BEAVERS DRIVE RIPARIAN WETLANDS

Herbivory → (Dam building) → Raised water tables → Moderated flows → Forced Flooding & Inundation → Wetland Habitat

Slide from Nate Hough-Snee
PERCEIVED + IMPACTS OF DAM BUILDING

- Slow snowmelt runoff
- Create ponds, **wetlands** & critical habitat for fish, amphibians, small mammals, vegetation
- Increased groundwater recharge/ elevated water tables
- Dam complexes increase system roughness & resilience
- Increased LWD
- Change timing, delivery and storage or water, sediment and nutrients
- Natural filters for improved WQ

BUFFERED HYDROLOGIC IMPACTS...

- The lag and impact on timing frequently discussed
- Lots of anecdotes
- Some studies... but more needed

Fig. 12. Comparison over time of the calculated curves for inflow ($Q_{in}$) and outflow ($Q_{out}$) in the Chevral beaver dam system. The $Q_{out}$ curve is flattened and delayed as compared to the $Q_{in}$ curve. The dotted horizontal line indicates discharge of 1.2 m$^3$ s$^{-1}$, the upper end of the range of our measurements (Table 4).
IN THEIR ECOSYSTEM ENGINEERING, THEY CREATE STARK CONTRASTS
Figure 7. Beaver activity results in multisuccesional pathways, some of which can affect the landscape for centuries. Shown is our concept of how beaver may be affecting the boreal forest landscape of northern Minnesota.

Table 1. Comparison of beaver and run-of-the-river human dams as an example of human-built replacements of one type of previously discontinuous along the river corridor.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Non-beaver/river dams</th>
<th>Intact beaver dams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Non-ideal, permanent</td>
<td>Ideal, permanent</td>
</tr>
<tr>
<td>Duration</td>
<td>100-3000 years</td>
<td>50-100 years</td>
</tr>
<tr>
<td>Type of water</td>
<td>Clear</td>
<td>Clear</td>
</tr>
<tr>
<td>Location of impoundment</td>
<td>Floodplains, levees</td>
<td>Natural</td>
</tr>
<tr>
<td>Height</td>
<td>200-400 feet</td>
<td>&lt;10 feet</td>
</tr>
<tr>
<td>Width</td>
<td>200-400 feet</td>
<td>&lt;10 feet</td>
</tr>
<tr>
<td>Length</td>
<td>100-200 feet</td>
<td>&lt;10 feet</td>
</tr>
<tr>
<td>Effects on water flow</td>
<td>Flow obstruction</td>
<td>Flow obstruction</td>
</tr>
<tr>
<td>Effects on sediment transport</td>
<td>Reduced</td>
<td>Reduced</td>
</tr>
<tr>
<td>Effects on water quality</td>
<td>Unpolluted</td>
<td>Polluted</td>
</tr>
<tr>
<td>Effects on fish and wildlife</td>
<td>Species-specific</td>
<td>Species-specific</td>
</tr>
</tbody>
</table>

Figure 1. Examples of beaver density types classified in this article: (a) free flowing, (b) beaver meadow, (c) valley beaver impoundments, and (d) in-channel beaver impoundments.
ROLE OF ABANDONMENT & FAILURE

• What happens post dam failure?

• What if abandonment is permanent?

Typical Causes of Abandonment

- Seasonal Migration (temporary)
- Dam Breach/Failure (permanent or temporary)
- Exhaustion of Food/Building Materials (permanent or temporary)
- Decreased Functionality (e.g., pond aggradation; permanent or temporary)
- Predation (natural; permanent or temporary)

Permanent Migration (permanent)
Trapping (human; permanent)
Mortality (natural; permanent)
OUR CLIMATE FUTURE

- Projected Change in Precipitation

- Temp ↑ Tied to Emissions

Melillo et al. (2014)
http://nca2014.globalchange.gov/
DOI: 10.7930/J0Z31WJ2
2050 PREDICTED WATER SUPPLY IMPACTS

- Even with out climate change, water supply impacts inevitable... with its worse!

Water Supplies Projected to Decline

No Climate Change Effects

Water Supply Sustainability Risk Index (2050)
- Extreme (29)
- High (271)
- Moderate (821)
- Low (2020)

Climate Change Effects

Water Supply Sustainability Risk Index (2050)
- Extreme (412)
- High (608)
- Moderate (1192)
- Low (929)

Roy et al. (2010) Tetra Tech

EXAMPLE KEY MESSAGES FOR SOUTHWEST

- Reduced Snowpack and Streamflows
- Increased Wildfire

Projected Snow Water Equivalent

Melillo et al. (2014) DOI: 10.7930/J0Z31WJ2
http://nca2014.globalchange.gov/
BEAVER & CLIMATE CHANGE

- They’ve weathered many ups and downs in climate
- They were pushed to brink of extinction and extirpated and came back
- Their systems have been shown to mitigate impacts of droughts
- They’ve been shown to maintain wetlands through droughts
Adaptation increasingly emphasized

Adaptation refers to action to prepare for and adjust to new conditions, thereby reducing harm or taking advantage of new opportunities. Adaptation planning is occurring in the public and private sectors and at levels of government but few measures have been implemented.

Explore adaptation to climate change.

Melillo et al. (2014)
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WHY ALWAYS TONKA TOYS?

- If you do a google search for restoration, the first images that come up are of Tonka toys in streams
DYNAMIC STREAMS = HEALTHY ECOSYSTEMS

- We believe this...
- Lots of cool studies showing feedbacks and links...

- We know: to get and maintain heterogeneous habitat, we need dynamic systems & wetlands
With Trouble on the Range, Ranchers Wish They Could Leave It to Beavers

Critters, Once Reviled, Gain Popularity With 'Believers'; a Good Rodent Is Hard to Find

A small beaver colony, he says, would raise the water table under his pastures, opening up drinking holes for his herd.
SOME THINGS TO THINK ABOUT…

• The ecosystem engineer is very experienced
• Most the species we care about have co-evolved with this engineer
• The science is conceptually solid... but largely qualitative
• Precautionary Principle?
• The cost is one of the most compelling arguments from a restoration perspective
ITS NOT NEW

• Cheap & Cheerful Restoration
  – Because we don’t have endless budgets and the spatial scope of our problems are extensive
• The example involving this rodent is not new...

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?
AT LEAST 6 TYPES OF ‘BEAVER’ RESTORATION

1. ‘Allow’ beaver to stay & promote/protect them (i.e. living with beaver / conservation)
2. Accidental Beaver Restoration
3. Transplant beaver from one area to an area where they are not currently & let them have at it
4. Riparian restoration & land use changes followed by transplanting beaver
5. In areas where beaver alone are not enough, help out with beaver dam analogues (BDAs), then hope beaver take over maintenance
6. Mimic beaver dam impacts with BDAs and artificially maintain...
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INCISED STREAMS ARE UBIQUITOUS

- One of the places where beaver alone, may not be enough
THE INCISION-AGGRADATION CYCLE

Adapted from Cluer and Thorne 2013

Figure from Pollock et al. (2014) Bioscience: http://dx.doi.org/10.1093/biosci/biu036
THE INCISION-AGGRADATION CYCLE WITH BEAVER DAMS & BEAVER DAM ANALOGUES

Figure from Pollock et al. (2014) Bioscience: http://dx.doi.org/10.1093/biosci/biu036
SO HELP ‘EM OUT... BUY THEM POSTS TIME
FOUR STRUCTURE TYPES (BDAs)

1. Starter Dam

2. Post Line Only

3. Post Line w/ Willow Weave

4. Reinforce Existing

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 FL terrace, mimicking a natural beaver dam.

Figure 11. A post line with willow 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. Some may naturally set up by trapping sediment and organic material moving downstream or they may be utilized by beaver. Note that beaver have started to colonize this FL weir as evidenced by the chewed stems on the rapids of the upstream, slanted 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 mission Bridge Creek have been shown to last less than a year (Glemser and Beschta, 2005). 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.
From Bouwes et al. (In Prep)
BRIDGE CREEK FINDINGS...

- Rapid colonization of BDSS after installation
- Rapid geomorphic response working with beaver to fix incised channel & restoring floodplain connectivity in the right direction.... Will it last?
- Dramatic improvements in habitat complexity
- + Population level fish responses!
LESSONS FROM APPLICATION IN OREGON

- Concepts summarized in BioScience Paper
- Much of findings starting to trickle out in a bunch of papers in prep & review...
A REAL INCISED & INVASIVE CHALLENGE

2-4 m of incision into loess

Major reed canary grass invasion...
PATAH CREEK BEAVER DAM ANALOG

https://vimeo.com/134740002
LATELY... WE’VE BEEN PARTNERING WITH RANCHERS & BEAVER
DOES THIS LOOK LIKE BEAVER HABITAT?
BDAs MAY BE USED PRIOR TO BEAVER TO PROMOTE RIPARIAN RECOVERY
The Beaver Restoration Guidebook

Working with Beaver to Restore Streams, Wetlands, and Floodplains

Version 1.02, July 14, 2015

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

Funded by
North Pacific Landscape Conservation Cooperative

Photo credit: Worth A Dave Foundation (martinezbowers.org)

Dynamic edited volume by Castro, Pollock, Jordan, Lewallen & Woodruff

Supposed to be at:

But can download from:
https://nplcc.blob.core.windows.net/media/Default/2013/Documents/Using_Beavers_For_Climate/BRG%20v.1.0%20final%20reduced.pdf
BEAVER RESTORATION TOOLBOX

• Prepared by Kirk Malcom @ USFS
• Annotated Bibliography and links

BEAVER RESTORATION ACROSS BOUNDARIES

- Prepared by Rachelle Haddock
- Miistakis Institute
- Synthesis of lessons learnt & interviews on Beaver Restoration in Western States & use as a climate change adaptation strategy

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e.g., UTAH... EVEN THOUGH A DRY STATE

- 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

- Historically...
  - Beaver were pervasive throughout this network
  - Much greater proportion perennial
I HAVEN’T MADE THE MAP... BUT

• A HUGE % Intersect grazing lands

Grazing Lands*

BLM – 25 Million Acres
USFS – 7.7 Millions Acres
SITLA – 4 Million Acres
Private Range – 8 Million Acres

*Not all grazing lands are currently in use for grazing.

Source: BLM, USFS, SITLA, DNR.
Cartography by GOPB.

Slide from:
LIVESTOCK & BEAVER?

• We want to partner with both & ranchers ->

"We believe that well planned and managed livestock grazing is the most important landscape scale tool for maintaining healthy rangelands, watersheds, and wildlife habitats."

"Healthy rangelands contribute to a healthy livestock industry and productive rural economies."

Troy Forrest, Program Manager
(435) 279-3603

OUR MISSION

To improve the productivity, health and sustainability of our rangelands and watersheds.
COWS & BEAVER... NOT COWS VS. BEAVER

• Healthy Riparian Ecosystems and Watersheds
• Better forage & watering for livestock
• Healthier riparian for game
• We propose that ‘cheap and cheerful’ restoration (e.g. beaver) combined with well managed grazing is the only way we’re realistically going to recover
• We see
  – beaver as one critical tool
  – sustainable grazing as another critical tool
• We’d like to see some of the enormous amount of cash spent on stream restoration going toward more riders
WHAT ABOUT SAGE GROUSE?

- Restoring beaver, could restore riparian zones, that could act as important **brood rearing** habitat
- Fringe between sage brush and riparian is critical

- Kent Sorenson (UDWR)
- Nate Hough-Snee (USU)
- Erick Thacker (USU)
- Elijah Portugal (USU)
- Tanner Family
WHAT ABOUT PJ – JUNIPER REMOVAL?

- Many upland restoration efforts focused on removing PJ
- Can we use the juniper for posts or fill material?

Mike Kuhns & Darren McAvoy
**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><strong>Total</strong></td>
<td><strong>119</strong></td>
<td><strong>100</strong></td>
<td><strong>28.6</strong></td>
<td><strong>71.4</strong></td>
</tr>
</tbody>
</table>
DO BEAVER DAMS PREVENT FISH FROM GETTING UPSTREAM?

- Native cutthroats can pass easier than invasive Browns!

WHAT ABOUT DECLINING SNOWPACK?

• Could we get enough beaver dams back on landscape to mitigate this?

• We desperately need research to better quantify hydrologic impacts of beaver dams and how they scale up.
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I GOT SCARED...

- Enthusiasm surrounding beaver restoration is encouraging... BUT
  - Beaver restoration can easily not work for many reasons
  - Beaver restoration is not appropriate everywhere
  - People all too quick to jump to the techno-fix (i.e. BDAs) when something simpler may suffice
  - So where could this work, where won’t it work?
THE RANGE MAP IS WRONG!

The historical range of beaver (Castor canadensis) in coastal California: an updated review of the evidence

Christopher W. Lanman, Kate Lundquist, Heidi Perryman, J. E. Asarian, Brock Dolman, Richard B. Lanman*, Michael M. Pollock

Institute for Historical Ecology, 356 Van Buren Street, Los Altos, CA 94024

*Correspondent: ricklanman@gmail.com

The North American beaver (Castor canadensis) is native to the mid- to high-elevations of the western United States, although this mountain range is adjacent to the historical range in the interior. This review challenges those long-held assumptions. New evidence indicates that the beaver has been present in the northern Sierra Nevada (James and Lanman 2012) and is supported by a contemporary and expanded re-evaluation of historical records of occurrence, as well as new sources of indirect evidence including newspaper accounts, geographical place names, Native American ethnographic information, and assessments of habitat suitability. Understanding that beaver are native to the Sierra Nevada is important to contemporary management of rapidly expanding beaver populations. These populations have been shown to have beneficial effects on fish abundance and diversity in the Sierra Nevada, to stabilize stream incision in montane meadows, and to reduce discharge of nitrogen, phosphorus, and sediment loads into fragile water bodies such as Lake Tahoe.

Key words: beaver, California, Castor canadensis, Cascade Range, Central Valley, historical distribution, Nevada, range, Sierra Nevada

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Beaver Range
- Current range
- Historic range
- Outside confirmed historic range
- Tagge (1942) proposed range
- Drainage divide of Sacramento/San Joaquin and South Coast
- Rivers
- Lakes
- County Boundaries

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The historical range of beaver in the Sierra Nevada of the evidence

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California Fish and Game 89(2):165-80; 2013.
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).

- Wally MacFarlane
- Martha Jensen
- Jordan Gilbert
- Jordan Burningham
- Nick Bouwes
- Nate Hough-Snee
- Elijah Portugal
BRAT OUTPUTS IN A NUTSHELL

- Existing & Historic Capacities → Potential Conflict → Management

**Existing Beaver Dam Capacity**

- Actual Beaver Dams
- Maximum Dam Density (dams/km)
  - 0 - None
  - 0 - 1 Rare
  - 1 - 4 Occasional
  - 5 - 15 Frequent
  - 16 - 40 Pervasive

**Potential for Human Beaver Conflict**

- Probability of Conflict
  - 0 - 10%
  - 10 - 25%
  - 25 - 50%
  - 50 - 75%
  - > 75%

**Ecosystem Management**

- Beaver Management Zones
  - Unsuitable: Naturally Limited
  - Unsuitable: Anthropogenically Limited
  - Quick Return Restoration Zone
  - Long-Term Restoration Zone
  - Living with Beaver (Low Source)
  - Living with Beaver (High Source)

0 0.5 1 1.5 2 Kilometers
BRAT OUTPUTS IN A NUTSHELL

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

---

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- 50 - 75%
- > 75%

**Ecosystem Management**

- Beaver Management Zones
- Unsuitable: Naturally Limited
- Unsuitable: Anthropogenically Limited
- Quick Return Restoration Zone
- Low Hanging Fruit
- Long-Term Restoration Zone
- Living with Beaver (Low Source)
- Living with Beaver (High Source)

---

0 0.5 1 1.5 2 Kilometers
BRAT – THE INPUTS...

• Can all be run from freely available, nationally available datasets
• Could be run for entire US or logic applied locally
• Makes a prediction at 250 m long reaches
RESOLUTION OF BRAT

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

- Ran BRAT for whole state
- Created a decision support elements of BRAT in bespoke manner for UDWR

Run Model with Nationally Available Datasets

STATE OF UTAH (> 225,000 km²)

Resolved at every 250 m long reach within State (27,000 km)
Weber Basin
BRAT Model:
Max Capacity:
~ 23,477 dams
Over 2358 km of streams

Avg. Max Density: 10 dams/km
HISTORIC BEAVER DAM CAPACITY

- Weber Basin BRAT Model:
  Max Capacity: 
  ~ 32,409 dams
  Over 2358 km of streams

Avg. Max Density: 14 dams/km
VALIDATION...

- Using 2852 dams in 4 diverse watersheds
MORE FOCUSED VALIDATION...

• Encouraging...
• No dams where there shouldn’t be
• Higher densities in places that are
• Even some events that make sense
BRAT OUTPUTS IN A NUTSHELL

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

---

**Existing Beaver Dam Capacity**

- Actual Beaver Dams
- Maximum Dam Density (dams/km)
  - 0 - None
  - 0 - 1 Rare
  - 1 - 4 Occasional
  - 5 - 15 Frequent
  - 16 - 40 Pervasive

---

**Potential for Human Beaver Conflict**

- Probability of Conflict
  - 0 - 10%
  - 10 - 25%
  - 25 - 50%
  - 50 - 75%
  - > 75%

---

**Ecosystem Management**

- Beaver Management Zones
  - Unsuitable: Naturally Limited
  - Unsuitable: Anthropogenically Limited
  - Quick Return Restoration Zone
  - Long-Term Restoration Zone
  - Living with Beaver (Low Source)
  - Living with Beaver (High Source)

---

0 0.5 1 1.5 2 Kilometers
IN SOME PLACES... THEY ARE A NUISANCE

• 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
BEAVER-HUMAN CONFLICT POTENTIAL

- Very conservative estimate
- Probably far, far less...

Map showing probability of conflict with different color codes for different ranges.
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

From Mike Callahan’s Site:

Working With Nature
Resolve Your Flooding Problems

The Best Beaver Management Practices
Long Term Solutions to Beaver Dam Flooding
EXAMPLE OF HOW TO DO THIS...

Lays out an adaptive management response to beaver problems...
PARK CITY STORY

- Good old days of traditional, undocumented beaver management
- Change of mgmt...
- Beaver come back
- Beaver cause flooding problems
- City removes (traditional mgmt.)
- But people liked the beaver... and complained
- CONFLICT!
• Cheaper and more effective than just lethal treatment everywhere...

**SIMPLE DECISION POINTS — BY WATER COURSE**

**EVALUATION OF WATER COURSES WITH BEAVER ACTIVITY**

1. **START OR RE-EVALUATE ANNUALLY**
   - LEAVE IT ALONE
   - IN A “BEAVER CONSERVATION ZONE”
   - Where is the beaver activity taking place?
   - IN A “LIVING WITH BEAVER” ZONE
   - Is beaver activity causing harm?
   - Yes
   - CONSIDER MANAGEMENT ON DAM-BY-DAM BASIS
   - No
   - LEAVE IT ALONE
   - IN A “NUISANCE BEAVER ZONE”
   - Is beaver activity causing harm?
   - Yes
   - CONSIDER MANAGEMENT ON DAM-BY-DAM BASIS
   - No
   - LEAVE IT ALONE
   - New Opportunities or Risks?
   - Yes
   - CONSIDER MANAGEMENT ON DAM-BY-DAM BASIS
   - No
   - LEAVE IT ALONE
   - Could “Living with Beaver” actions be effective?
   - Yes / Maybe
   - IDENTIFY ANY REACHES THAT MAY REQUIRE MORE REGULAR MONITORING
   - No
   - NEWLY IDENTIFIED POTENTIAL
   - EXIT

2. **IDENTIFY ANY REACHES THAT MAY REQUIRE MORE REGULAR MONITORING**
   - EXIT

**Beaver Conservation Zone**
**Living with Beaver Zone**
**Nuisance Beaver Zone**
**Non-Beaver Bearing**
**Culvert or Bridge**
ADAPTIVE BEAVER MANAGEMENT PLAN

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

PCMC BEAVER ADAPTIVE MANAGEMENT PLAN

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

IDENTIFY PROBLEM
- Nuisance Beaver activity
- Healing of infrastructure
- Undertaking removal of landscape trees

PCMC GOALS & OBJECTIVES (Established in 2013)
- Address damages caused by beaver activity
- Balance habitat needs of beaver and ecosystem services provided by beaver
- With need to protect public and private property and infrastructure.

DEVELOP LIVING WITH BEAVER STRATEGIES & RELOCATION OR RESTORATION STRATEGIES (2013)
(Review Every 5 Years)
- Consider funding sources required to implement plan

IMPLEMENT MONITORING PROGRAM
Basic Annual and Responsive Monitoring

EVALUATION OF REACHES & DAMS
Annually at reaches in spring (prior to spring runoff) & in fall (after peak of dam building and caching)
- DR
At individual dams as triggered by nuisance complaints

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

Legend
- Park City - City Limits
Potential Areas of Management Concern
- Beavers Conservation Zone
- Living with Beaver Zone
- Nuisance Beaver Zone
- Non-Beaver Bearing
- Culvert or Bridge
WALMART – UNLIKELY PARTNERS?
BRAT OUTPUTS IN A NUTSHELL

- Existing & Historic Capacities → Potential Conflict → Restoration
AT LEAST 6 TYPES OF ‘BEAVER’ RESTORATION

1. ‘Allow’ beaver to stay & promote/protect them (i.e. living with beaver / conservation)
2. Accidental Beaver Restoration
3. Transplant beaver from one area to an area where they are not currently & let them have at it
4. Riparian restoration & land use changes followed by transplanting beaver
5. In areas where beaver alone are not enough, help out with beaver dam analogues (BDAs), then hope beaver take over maintenance
6. Mimic beaver dam impacts with BDAs and artificially maintain...
TRANSLOCATION

• Find a source population of nuisance beaver OR area with ample population...

• Relocate to areas with no or limited population & high capacity

Kent Sorenson (UDWR)
SOME EVEN BUILD LODGES FOR BEAVER

- Building a starter lodge for translocated beaver to settle into their new surroundings can increase the chances they do work where you want them to.

http://wdfw.wa.gov/living/beavers.html#preventingconflicts
STATEWIDE?

- Focus on areas deemed ‘suitable’ for restoration
- How much effort?
WHAT ABOUT DECLINING SNOWPACK?

- Could we get enough beaver dams back on landscape to mitigate this?

- We desperately need research to better quantify hydrologic impacts of beaver dams and how they scale up.
CLIP DOWN TO JUST AREAS WITH BEAVER RESTORATION POTENTIAL

Max Capacity:
~ 13,478 dams
Over 921 km of streams

Avg. Max Density: 14 dams/km
WHERE COULD WE GET THOSE GUYS?

- Encourage ‘living with beaver’ strategies where acceptable
- Live trap and translocate otherwise...

Living with Beaver (Low Source)
Living with Beaver (High Source)
IN A MORE LOCALIZED EXAMPLE...

<table>
<thead>
<tr>
<th>Length of Stream</th>
<th>Existing Capacity (Density)</th>
<th>Historic Capacity (density)</th>
<th>Existing Capacity</th>
<th>Historic Capacity</th>
<th>Existing Count</th>
<th>Existing Dam Density</th>
<th>% of Existing Capacity</th>
<th>% of Historic Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logan River HUC8</td>
<td>731</td>
<td>10.1</td>
<td>15.1</td>
<td>7402</td>
<td>11,038</td>
<td>1,313</td>
<td>1.8</td>
<td>18%</td>
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<tr>
<td>Logan River HUC10</td>
<td>211</td>
<td>10.2</td>
<td>15.4</td>
<td>2,146</td>
<td>3,255</td>
<td>449</td>
<td>2.1</td>
<td>21%</td>
</tr>
<tr>
<td>Temple Fork HUC12</td>
<td>14</td>
<td>7.7</td>
<td>11.3</td>
<td>108</td>
<td>158</td>
<td>42</td>
<td>3.0</td>
<td>39%</td>
</tr>
<tr>
<td>Beaver Creek HUC12</td>
<td>25</td>
<td>11.2</td>
<td>16.2</td>
<td>281</td>
<td>405</td>
<td>142</td>
<td>5.7</td>
<td>51%</td>
</tr>
<tr>
<td>Right Hand Fork HUC12</td>
<td>14</td>
<td>7.7</td>
<td>11.3</td>
<td>108</td>
<td>158</td>
<td>42</td>
<td>3.0</td>
<td>39%</td>
</tr>
<tr>
<td>Franklin Basin HUC12</td>
<td>32.7</td>
<td>15.5</td>
<td>17.7</td>
<td>506</td>
<td>578</td>
<td>138</td>
<td>4.2</td>
<td>27%</td>
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<tr>
<td>Red Banks Logan HUC12</td>
<td>43.2</td>
<td>11.3</td>
<td>13.8</td>
<td>488</td>
<td>596</td>
<td>58</td>
<td>1.3</td>
<td>12%</td>
</tr>
<tr>
<td>Blacksmith Fork HUC10</td>
<td>205</td>
<td>9.6</td>
<td>14.7</td>
<td>1,968</td>
<td>2,827</td>
<td>437</td>
<td>2.1</td>
<td>22%</td>
</tr>
<tr>
<td>Logan River HUC14</td>
<td>26.4</td>
<td>10.3</td>
<td>14.7</td>
<td>2,472</td>
<td>3,256</td>
<td>449</td>
<td>2.2</td>
<td>21%</td>
</tr>
<tr>
<td>Temple Fork HUC12</td>
<td>14</td>
<td>7.7</td>
<td>11.3</td>
<td>108</td>
<td>158</td>
<td>42</td>
<td>3.0</td>
<td>39%</td>
</tr>
<tr>
<td>Rock Creek HUC12</td>
<td>26</td>
<td>10.3</td>
<td>14.7</td>
<td>2,472</td>
<td>3,256</td>
<td>449</td>
<td>2.2</td>
<td>21%</td>
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<tr>
<td>City Logan</td>
<td>59</td>
<td>9.0</td>
<td>20.2</td>
<td>533</td>
<td>1,192</td>
<td>42</td>
<td>0.1</td>
<td>1%</td>
</tr>
</tbody>
</table>

Average Dam Density (Dams/Km)
According to BRAT:

- 89% of Curtis Creek has Restoration Potential
- 94% of Rock Creek has Restoration Potential
## CURTIS & ROCK CREEK EXAMPLES

<table>
<thead>
<tr>
<th>Length of Stream</th>
<th>Existing Capacity (Density)</th>
<th>Historic Capacity (density)</th>
<th>Existing Count</th>
<th>Existing Dam Density</th>
<th>% of Total Length</th>
<th>% of Total Existing Dams</th>
<th>Actual Dam Density</th>
<th>% of Existing Capacity</th>
<th>% of Historic Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>km</td>
<td>oCC_EX</td>
<td>oCC_PT</td>
<td>Average Dam Density (Dams/Km)</td>
<td>Total Dams</td>
<td>Total Dams</td>
<td>Total Dams</td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Logan River HUC8</td>
<td>731</td>
<td>10.1</td>
<td>15.1</td>
<td>7,402</td>
<td>11,038</td>
<td>1,313</td>
<td>1.8</td>
<td>18%</td>
<td>12%</td>
</tr>
<tr>
<td>□ Blacksmith Fork HUC 10</td>
<td>205</td>
<td>9.6</td>
<td>13.8</td>
<td>1,968</td>
<td>2,827</td>
<td>437</td>
<td>2.1</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>□ Curtis Creek HUC12</td>
<td>13.5</td>
<td>8.2</td>
<td>13.8</td>
<td>111</td>
<td>186</td>
<td>16</td>
<td>1.2</td>
<td>14%</td>
<td>9%</td>
</tr>
<tr>
<td>□ Rock Creek HUC12</td>
<td>26.4</td>
<td>10.3</td>
<td>14.7</td>
<td>272</td>
<td>388</td>
<td>58</td>
<td>2.2</td>
<td>21%</td>
<td>15%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of Stream</th>
<th>Existing Capacity</th>
<th>Existing Count</th>
<th>Existing Dam Density</th>
<th>% of Total Length</th>
<th>% of Total Existing Dams</th>
<th>Additional Dams</th>
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</thead>
<tbody>
<tr>
<td>km</td>
<td>Total Dams</td>
<td>Total Dams</td>
<td>Dams/Km</td>
<td>%</td>
<td>Compared w/ Whole Watershed</td>
<td>At Full Capacity</td>
</tr>
<tr>
<td>Logan River HUC8</td>
<td>290</td>
<td>4223</td>
<td>664</td>
<td>2.3</td>
<td>40%</td>
<td>51%</td>
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<tr>
<td>□ Blacksmith Fork HUC 10</td>
<td>92</td>
<td>1173</td>
<td>236</td>
<td>2.6</td>
<td>45%</td>
<td>54%</td>
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<tr>
<td>□ Curtis Creek HUC12</td>
<td>12</td>
<td>104</td>
<td>16</td>
<td>1.3</td>
<td>89%</td>
<td>100%</td>
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<tr>
<td>□ Rock Creek HUC12</td>
<td>24.8</td>
<td>262</td>
<td>55</td>
<td>2.2</td>
<td>94%</td>
<td>95%</td>
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<tr>
<td>City Logan</td>
<td>12.8</td>
<td>259</td>
<td>0</td>
<td>-</td>
<td>22%</td>
<td>0%</td>
</tr>
</tbody>
</table>

- What more could beaver do?
  - 36 to 88 more dams in Curtis
  - 76 to 207 more dams in Rock Creek
FUTURE & DOWNLOADS...

- We’re running for as many regions as we can...
- So far, all of Utah, Idaho & parts of Wyoming, Washington, Colorado, Nevada, Oregon, New York, New Mexico

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

I. What beaver do and why – then & now
II. Beaver induced wetlands & potential impacts on water resources
III. The beaver restoration idea
IV. Some of the challenges – western context
V. Better planning & expectation management
VI. Take-Homes

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TAKE AWAYS

• Beaver are an undiscriminating rodent and amazingly industrious ecosystem engineer

• Their dam building activities expand and create wetlands & invoke a variety of feedbacks:
  – Provide Important Ecosystem Services
  – Increase System Resilience
  – May buffer impacts of climate change

• Beaver conservation & restoration could be a ‘cheap & cheerful’ fix in many western streams & rivers

• Expectation management is critical... Won’t work everywhere – use BRAT
MAIN PARTNERS... OTHER THAN RODENTS

Nick Bouwes
Michael Pollock
Chris Jordan

Wally Macfarlane
ACKNOWLEDGEMENTS

Countless Collaborators & Field Crews

- Nick Bouwes (ELR/USU)
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- Chris Jordan (NOAA)
- Carol Volk (SFR)
- Nick Weber (ELR)
- Nate Hough-Snee (USU/ETAL)
- Martha Jensen (USU/ETAL)
- Elijah Portugal (USU/ETAL)
- Kenny DeMeurichy (USU/ETAL)
- Brett Roper (USFS/USU)
- John Shivick (USFS/UDWR)
- Kent Sorenson (UDWR)
- Frank Howe (UDWR)
- Ben Nadolski (UDWR)
- Craig Walker (UDWR)
- Carl Saunders (USU/ETAL)
- Ryan Lokteff (USU/ETAL)
- CHaMP Field Crews
- Tim Beechie (NOAA)
- Mary O’Brien (GCT)
- Ian Tottenahm (ODFW)
- And many others...
THANKS! WANT TO LEARN MORE?

- Visit [http://beaver.joewheaton.org](http://beaver.joewheaton.org)

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