PARTNERING WITH BEAVER IN RESTORATION

WATS 6860
SEMINAR NEXT WEDNESDAY

• Feb 15: 12:30 PM in NR105
• Kendrick Hafen, Water Rights Attorney (Konrad’s Dad)
• Talk: “Utah’s Water Regulatory Agencies in the Context of the Hydrologic Cycle”
RESTORATION ALTERNATIVES WITH BEAVER

Joe Wheaton
Nick Bouwes
IN UTAH...

• We have over 85,000 miles of rivers and streams
  - 81% (65,000 miles) are non-perennial
  - 16,000 miles perennial
• Historically...
  - Beaver were everywhere
• Today...
  - At least 43% of streams are impaired
WHY ALWAYS TONKA TOYS?
• To keep varied habitat, we need dynamic streams
• Yet, we’re not very good at restoring dynamism
WHAT IS BROKEN (RIVERSCAPE-CENTRIC)?

- Hydrology
  - Flooding
  - Water timing / water storage
- Floodplain loss / disconnection
  - Incised Channels
- Riparian degradation
- Wetland loss / degradation

- Impaired Water Quality
- Degraded Habitat
  - Homogenized habitats
  - Aquatic (in channel, fish)
  - Riparian (birds, wildlife)
  - Upland (game, livestock, wildlife forage)

- Threatened & Endangered Species
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)
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
WHAT ABOUT ASPEN REGENERATION?

• Healthy aspen need disturbance
  - Can be fire, can be coppicing, can be disease or....
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
EXAMPLE KEY MESSAGES FOR SOUTHWEST

- Reduced Snowpack and Streamflows

Projected Snow Water Equivalent

Melillo et al. (2014) DOI: 10.7930/J0Z31WJ2
http://nca2014.globalchange.gov/
NOT RIGHT

• The new ‘normal’
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 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 all levels of government but few measures have been implemented.

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

By JOEL MILLMAN
August 30, 2011

Clyde Woolery wants his beavers back.

Mr. Woolery’s ranch on Beaver Creek outside Kinnear, Wyo., has been beaver-free for decades, but he could sure use their help now. A small beaver colony, he says, would engineer dams that raise the water table under his pastures, opening up drinking holes for his cattle.

So the 64-year-old rancher put himself on a waiting list this year hoping state officials would bring him a beaver or two. Wyoming’s Game and Fish Commission periodically plucks the rodents from drainage culverts.

It’s a bit of a turnaround in these parts, where beavers have long been considered something of a nuisance—blamed for

Beavers Offer Solution to Climate Change

by DAVID MALAKOFF
May 02, 2008  4:00 PM

Listen to the Story
All Things Considered

In the Southwest U.S., biologists are talking about returning beavers to rivers they once inhabited in order to fight droughts — which are expected to get worse as the globe warms. Beaver dams create great sponges that store lots of water.

Transcript
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ITS NOT NEW

• 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? •

1. Boxed for travel, this beaver is placed in a crate designed by Scotty Hager, 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.
ACTUALLY WORKED WELL

• Fall 1948, 76 live nuisance beaver from McCall parachuted with only one casualty (Heter, 1950)
• Cost per beaver transplant: < $16/beaver
BEAVER RESTORATION TOOLBOX

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

Available from:
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

BEAVER: DRIVER OF THE RIVER DISCONTINUUM

Table 1. Comparison of beaver and run-of-the-river human dams as an example of human-built replacement of one type of precede discontinuity along the river corridor.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Run-of-the-river human dam</th>
<th>Select beaver dam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter</td>
<td>Impermeable</td>
<td>Scalloped, permeable</td>
</tr>
<tr>
<td>Travel time</td>
<td>10 to 100 years</td>
<td>2 to 100 years</td>
</tr>
<tr>
<td>Number of spawling channels</td>
<td>One</td>
<td>One or more</td>
</tr>
<tr>
<td>Crevet geometry</td>
<td>Steep, usually linear</td>
<td>Comet, irregular</td>
</tr>
<tr>
<td>Hydraulic cross section at the surface level</td>
<td>Unsteady bed and channel</td>
<td>Variable, central bed and channel</td>
</tr>
<tr>
<td>Low flow maintenance</td>
<td>Water continues to pass through dam</td>
<td>Water continues to pass through dam</td>
</tr>
<tr>
<td>Upstream water stage variability</td>
<td>Little to none</td>
<td>Variability over the water year</td>
</tr>
<tr>
<td>downstream area</td>
<td>Narrow</td>
<td>Wide</td>
</tr>
</tbody>
</table>

Figure 1. Examples of headwater segment types classified in this article: (a) free flowing, (b) beaver meadow, (c) valley beaver impoundment, and (d) in-channel beaver impoundment.

The River Discontinuum: Applying Beaver Modifications to Baseline Conditions for Restoration of Forested Headwaters

DENISE BURCHSTEDT, MELINDA DANIELS, ROBERT THORSON, AND JASON VOHOWNI

Billions of dollars are being spent in the United States to restore rivers in a desired, yet unknown, reference condition. In lieu of a known reference, practitioners typically assume the paradigm of a connected watercourse. Ecological and ecological processes, however, create patchy and discontinuous fluvial systems. One of these processes, dam building by North American beavers (Castor canadensis), generates discontinuities throughout pre-existing river systems of northern North America. Under modern conditions, beaver dams create dynamic, dynamic systems of ponds and wet meadows along free-flowing segments. (See beaver impoundment river vs. outflow).width 500 meters along the river. Find the water table, stratigraphy, and functionally alter biogeographic cycles and ecological structures. In this article, we use hierarchical patch dynamics to investigate beaver-modified discontinuities across spatial and temporal scales. We then use this conceptual model to generate testable hypotheses addressing channel geomorphology, natural flow regimes, water quality, and socio-economic importance of these features in the river restoration.

Private and public agencies across the United States spend billions of dollars on river restoration (Stehnke et al. 2003) in attempts to return targeted systems to a state similar to that before disturbance. Our understanding of the pre-disturbance system, however, is framed by recent human alterations (e.g., Weller and Merritts 2008). To successfully implement a project that achieves even partial restoration, it is not only necessary to understand the reference condition (Smith et al. 2006), among other discontinuities. These components increase longitudinal heterogeneity by generating a stepped channel bed profile in place of the continuous slope of the reference condition, with shallower gradients, slower velocities, and the accumulation of sediment upstream of blockages, and with scouring downstream of them. River discontinuities increase lateral heterogeneity by maintaining upstream floodplains, scouring additional downstream channels, and causing channel anabranches.

River modifications and their impacts also vary over time, with the temporal scale depending on the type of discontinuity. Beaver discontinuities are created and destroyed at the longest time scale. Glacial scouring and deposition occurs within the temporal and spatial discontinuities set by bedrock. Following glacial retreat, paraglacial modification continues for tens of thousands of years (Ballantyne 2003). Sediment, debris, and beaver dams modify the river corridor at a smaller scale, with creation and destruction by stochastic events such as fire and floods (Berta et al. 2004) and beaver activity, and time scales of persistence as short as decades.

These discontinuities have been largely removed from rivers in the United States through recent human activities such as bedrock blasting, debris-dam removal, other channel homogenization for log drivers, placer mining, logging of forests that once supplied major debris dams, barrier trapping, and floodplain reclamation (Ludwick 1999, Wohl 2005). Many of the remaining pre-modern discontinuities have been created by humans and man-made river modification. For example, table 1 compares beaver dams with 20% of the river human dams run of the river dams are the most common existing and removed dams in the United States (Poff and Hart 2002). However, rather than viewing...
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 Dau Foundation (worthadaufox.org)

Using Beaver Dams to Restore Incised Stream Ecosystems

Michael M. Pollock, Timothy J. Reebe, Joseph M. Wheaton, Chris E. Jordan, Nick Brown, Nicholas Weber, and Carol Volk

Dams, weirs, and levees are among the many artificial structures that have been built to manage and control water in streams. However, these structures can have significant environmental impacts, including disruption of downstream ecosystems. Beaver dams, on the other hand, can play a crucial role in stream restoration by providing habitat for fish and wildlife, improving water quality, and restoring natural flow regimes. This guidebook provides information on how to work with beavers to restore incised stream ecosystems.

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

Throughout many regions of the world, channel incision is a widespread environmental problem that has caused extensive ecosystem degradation (Wang et al. 1997, Montgomery 2007). The defining characteristics of an incised alluvial stream are a lowered streambed and disconnection from the floodplain (Duryea and Sisson 1999). The resulting loss of physical habitat degrade stream ecosystems (Riska et al. 2014, 2015). Active evidence in the geological record indicates that channel incision occurs naturally and may be related to changes in climate (Bryan 1967, Elmore et al. 1999). However, in many cases, channel incision has been shown to be caused by or to be correlated with changes in land use and climate (Groves and Reeves 1976, Montgomery 2007). Many of these changes are also contemporary with the widespread extinction of beavers (Castor canadensis) in the mid-19th century (Naiman et al. 1998).

In addition to lowered streambed elevations and disconnection from the floodplain, common physical effects of alluvial incision include narrowed gullies and increased water flow. Water quality is also affected by sedimentation and increased turbidity, which can lead to increased nutrient loads and reduced light penetration for aquatic plants. The loss of wetlands, lower summer base flows, warmer water temperatures, and the loss of habitat diversity. Biological effects include a substantial loss of riparian plant biomass and diversity and population decline in fish and other aquatic organisms (for a review, see Clark and Theriault 2013).

Understanding how the ecology of an incised stream changes can be essential for assessing recovery potential. However, most incision-adjacent models describe only those geomorphological changes on the basis of relationships between sediment transport and hydrology. The role of beaver organisms is generally recognized, especially for beaver, live vegetation, and dead wood (Schramm et al. 1984, Semlin and Tippel 1986, Elfreth et al. 1999). The absence of beavers in such models is particularly notable, given their widely recognized role in shaping stream ecosystems (Naiman et al. 1998, Gardner 1998, Pollock et al. 2001, Purchena et al. 2010). More recently, incision-adjacent models have included floodplain complexes as an additional and ecologically destabilizable biogeoecological stage that occurs in some reach ecosystems (see Clark and Theriault 2013). Restoration of complex floodplains is important because such habitat is essential for the maintenance of biogeological diversity, including commercially important species, and for providing other important ecosystem services, such as flood control, groundwater recharge, and carbon storage (Graudal and Galle 2006, Winkler et al. 2006, Jeffries et al. 2008, Winkler et al. 2010, Delaune et al. 2012, Clark and Theriault 2014, Pollock and Winkler 2013).

In this article, we propose an alternative and more comprehensive view of stream evolution as an ecologically more precisely, biogeoecological—process (see Wheaton et al. 2011). We describe a new model for incised stream evolution that describes stream succession as a process dependent on the interaction of living organisms with hydrologic and sedimentary dynamics. We believe that such a model is consistent with recent findings concerning the role of biogeographic features, such as wood and beaver dams, in
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…
RESTORATION & CONSERVATION WITH BEAVER

I. Underlying Principles

II. Various Alternatives

   I. Conservation / Promotion

   II. Accidental Restoration

   III. Transplant to area that with suitable capacity

   IV. Restore riparian -> Followed by Transplant

   V. Help beaver out – Beaver Dam Analogues

   VI. Mimic Beaver…. 

III. Call for Adaptations to Recipes

IV. Take Aways
FIND AN AREA IN GOOD SHAPE

Wrap it up and put a bow on it...

What to look for...

- Area with moderate to high densities of dams & high capacity to support ‘rotations’
- Keep eye on conservation measures to sustain:
  - Grazing management
  - Harvest management/protection
LOOKS GOOD…. BUT...

• Part of this is the result of a grazing exclosure in 2005
• & permitee is still grazing
RESTORATION & CONSERVATION WITH BEAVER

I. Underlying Principles

II. Various Alternatives
   I. Conservation / Promotion
   II. Accidental Restoration
      III. Transplant to area that with suitable capacity
      IV. Restore riparian -> Followed by Transplant
      V. Help beaver out – Beaver Dam Analogues
      VI. Mimic Beaver….

III. Call for Adaptations to Recipes

IV. Take Aways
CURTIS CREEK

- Stream was restored in 2004ish using a Rosgen Restoration…
- Beaver came along and made it better…
Figure 2. A) Aerial image of lower section of Curtis Creek study reach showing the channel in 2006 (before beaver colonization). B) Aerial near infrared image of Curtis Creek study reach in spring 2011 showing new beaver dams, ponds, and flow paths created over the study period.
Figure 1. Aerial image from 2006 and beaver dams (also visible in Figure 2B) constructed between 2009 and 2010. The main beaver dams are numbered from 1 to 10 from upstream to downstream and the time of dam construction is noted in the table. The study reach was further divided into 6 sub-reaches. The spatial scales investigated are illustrated below the map.
Figure 7. Change in discharge (ΔQ) and temperature (ΔT) over the study reach from 2008 to 2010. The %ΔQ and %ΔT are relative to the discharge and temperature at PT515. The %ΔQ were averaged over a one hour interval, while %ΔT represents 5-minute temperature values.
RESTORATION & CONSERVATION WITH BEAVER

I. Underlying Principles

II. Various Alternatives
   I. Conservation / Promotion
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   III. Transplant to area that with suitable capacity
   IV. Restore riparian -> Followed by Transplant
   V. Help beaver out – Beaver Dam Analogues
   VI. Mimic Beaver….

III. Call for Adaptations to Recipes

IV. Take Aways
A FIRST CUT

• Focus on areas deemed ‘suitable’ for restoration
• How much effort?
WHERE TO PLACE?

- Tailor short term expectations to existing capacity
- Consider long term potential capacity with historic capacity and riparian recovery potential
- Don’t overseed beaver relative to capacity…
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)

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

Photo courtesy of William Meyer (WDFW)

http://wdfw.wa.gov/living/beavers.html#preventingconflicts
RESTORATION & CONSERVATION WITH BEAVER

I. Underlying Principles

II. Various Alternatives
   I. Conservation / Promotion
   II. Accidental Restoration
   III. Transplant to area that with suitable capacity
   IV. Restore riparian -> Followed by Transplant
   V. Help beaver out – Beaver Dam Analogues
   VI. Mimic Beaver....

III. Call for Adaptations to Recipes

IV. Take Aways
IS THIS GOOD BEAVER HABITAT?
BDAs MAY BE USED PRIOR TO BEAVER TO PROMOTE RIPARIAN RECOVERY
RESOURCES AVAILABLE NOW
I. Underlying Principles

II. Various Alternatives
   I. Conservation / Promotion
   II. Accidental Restoration
   III. Transplant to area that with suitable capacity
   IV. Restore riparian -> Followed by Transplant

V. Help beaver out - Beaver Dam Analogues
   VI. Mimic Beaver….

III. Call for Adaptations to Recipes

IV. Take Aways
(5) e.g. INCISED STREAMS ARE UBIQUIOUS
USING BEAVER TO RESTORE INCISED STREAMS

Figure from Pollock et al. (Accepted) Bioscience
THE INCISION-AGGRADATION CYCLE

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

Figure from Pollock et al. (Accepted) Bioscience
RESTORATION & CONSERVATION WITH BEAVER

I. Review

II. Underlying Principles

III. Various Alternatives
   I. Conservation / Promotion
   II. Accidental Restoration
   III. Transplant to area that with suitable capacity
   IV. Restore riparian -> Followed by Transplant
   V. Help beaver out – Beaver Dam Analogues

VI. Mimic Beaver....

IV. Call for Adaptations to Recipes

V. Take Aways
SAME AS BDAs, BUT W/O BEAVER

- Key difference is who does maintenance
- Resist tendency to over engineer
- Porosity is everything.... Think about what you want
TAKE AWAYs

• Variety of approaches to ‘use’, ‘partner with’, or ‘mimic’ beaver as restoration and conservation tool

• DON’T apply blanket, uniform approach across landscape

• Tailor solutions and adapt to local constraints/ opportunities

• Results are promising… but not full proof

For more information, visit: http://beaver.joewheaton.org
UTAH’S BEAVER MANAGEMENT PLAN

Joe Wheaton

© Cadel Wheaton
UDWR - BEAVER MANAGEMENT PLAN

- One of most progressive plans in US
- Specifically relies on beaver as a restoration tool

UTAH BEAVER MANAGEMENT PLAN
2010 - 2020

Plan Goal
Maintain healthy, functional beaver populations in ecological balance with available habitat, human needs, and associated species.

INTRODUCTION
The purpose of the Utah Beaver Management Plan is to provide direction for management of American beaver (Castor canadensis) in Utah and where appropriate expand the current distribution to historic range. This purpose is in accordance with the mission statement of the Utah Division of Wildlife Resources (UDWR). The mission of UDWR is:

To serve the people of Utah as trustee and guardian of the state’s wildlife.
Damage Management

Objective 1:

Increase consistency in the response options (lethal and non-lethal) currently in use and increase the frequency of use of non-traditional options (e.g. beaver deceivers, live-trapping) used by UDWR, governmental and non-governmental agencies and landowners for managing beaver causing property damage through 2020.

- Awareness of non-traditional options is already increasing...
- Non-lethal options are being used throughout state
In Utah, translocation is already allowed under UDWR’s Beaver Management Plan.

Nuisance beavers being translocated from Henry’s Fork to High Unitah’s. (Courtesy of Sorenson)
UDWR BEAVER MANAGEMENT PLAN

Outreach and Education

Objective 1:

Increase awareness of and appreciation for the role of beaver in Utah’s ecosystems in 10% of stakeholders (landowners, educators, recreationalists, sportsmen, water rights holders) by 2020.

- Citizen Science can be used to help with Outreach & Education
- Plus, data can help with Population Management

Population Management

Objective 1:

Maintain reproducing beaver populations within their current distribution in appropriate habitat through 2020. (See Watershed Restoration Objective for population expansion)

Strategies:

1. Develop a statewide baseline beaver distribution map to document current status within two years after plan approval by working with UDWR regions, universities, governmental and non-governmental organizations.
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
WHAT WE DID & WHAT WE WANT TO DO

- Ran BRAT for whole state
- Refine decision support elements in bespoke manner for UDWR

2. Identify zones on the map to illustrate appropriate beaver management strategies for given geographic areas, i.e. existing populations (including source populations), unoccupied historical range and areas where the potential for conflict is high.
WHAT SORNO & US ARE DOING...

- Two WRI proposed projects in Box Elder County:
  - One is in year 2 – Basin Creek
  - The other is a new one in Grouse Creek

- Monitoring responses & setting up as showcase

4. Establish at least one showcase beaver management area in each UDWR Region.
TWO REPORTS UDWR PAID FOR...

RECOMMENDATIONS FOR THE UTAH BEAVER MANAGEMENT PLAN

The UUWR report of the most progressive statewide beaver management plans (UDWR, 2014) in the country. This plan paves the way for a more holistic and sustainable approach to beaver management. However, to note, we all have been aware of the plan being implemented on the ground by UDWR personnel and partners as intended, despite large interest from a diverse group of organizations and individuals. We believe this is the case in part because although the plan lays out clear policies, goals and strategies, the specifics of how to implement specific strategies on the ground are lacking. Actively, relocating, removing beaver to parts of watersheds or in the areas in which they could be removed, poses a relative new burden for UDWR staff. Demonstration projects are underway to help evaluate the guidance. We know that the process initiatives are conducted in Utah Beaver Restoration (BRAT). However, we have tailored the BRAT to specifically help UDWR implement the plan. In the Macfarlane et al. (2014) report we provide detailed suggestions on how BRAT can specifically help UDWR to implement the strategies. In other instances, we made specific recommendations to modify the plan. A brief summary of bullet recommendations is provided below by topic:

- Population Management
  - Extend the Google Earth-based beaver dam census statewide used in Macfarlane et al. (2014) report to verify model performance
  - Update the Beaver Management Plan with new maps from the outputs of BRAT
  - Use Beaver Monitoring App to track dams and infer population numbers
  - In partnership with Utah State University's Water Quality Evaluation's Utah Water Watch, we developed an app for citizen science monitoring of beaver dam removals and beaver activity (http://extension.usu.edu/utahwaterwatching/brat/use/monitoringapp.html). The program could coordinate volunteer efforts to target missing parts of the state where we need to know more. The app could also be deployed with UDWR personnel so they can track their observations. We could extend the app to meet UDWR's specific needs and shape the database with UDWR.

- Harvest Management
  - Use BRAT to encourage the growth of beaver populations in areas with low conflict potential and high capacity to support beaver could potentially increase this important recreational and riparian resource.

Both available at: http://brat.joewheaton.org
OUR RECOMMENDATIONS

• Population Management
  – Extend Google Earth dam census statewide
  – Use beaver monitoring app to track populations
  – Replace the ‘baseline map with BRAT outputs

• Harvest Management
  – Use BRAT to encourage growth of beaver populations in areas with low conflict potential and high capacity
  – Balance needs of beaver as fur-bearer and recreational resource vs. restoration agent
  – More research needed to ascertain what defines a ‘sustainable harvest’
OUR RECOMMENDATIONS

• Damage Management
  – Adopt a standard response by developing an ‘Adaptive Beaver Management Plan’

• Statewide Beaver Transplant List
  – Update the transplant list and decision support elements of BRAT to use ‘Low Hanging Fruit Restoration Zone’ and ‘Quick Return Restoration Zone’ as candidate streams for transplanting
  – Make regional prioritization/ranking more transparent or remove
OUR RECOMMENDATIONS

• Watershed Restoration
  – Use BRAT to help scope and initially identify ‘suitable habitat’ for watershed restoration by beaver

• Live Trapping Protocol
  – Implement the COR program to certify trappers
  – Develop a simple App & web-reporting system for tracking translocation activities
  – Replace habitat assessment section with BRAT and its logic
  – Language surrounding ‘source population considerations’ is unnecessarily restrictive
TAKE AWAYs

• Utah is far better positioned than many western states with its Beaver Management Plan to take advantage of beaver as a restoration tool

• Some major progress towards plan goals has been made

• Some practical hurdles to implementing policy exist

• Straight-forward solutions to overcome hurdles being considered
HOMEOWRK QUESTIONS:
BRAT - BEAVER RESTORATION ASSESSMENT TOOL

HOMEWORK
Running BRAT in Matlab
BRAT OUTPUTS IN A NUTSHELL

- Existing & Historic Capacities → Potential Conflict → Management
DAM DENSITY OUTPUT CATEGORIES:

- **None** – 0 dams: segments deemed not capable of supporting dam building activity
- **Rare** – 1 dam/km: segments barely capable of supporting dam building activity; likely used by dispersing beaver
- **Occasional** – 2-4 dams/km: segments that are not ideal, but can support an occasional dam or even a small colony
- **Frequent** – 5-15 dams/km: segments that can support multiple colonies and dam complexes, but may be resource limited
- **Pervasive** – 16-40 dams/km: segments that can support extensive dam complexes and many colonies
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
• 11,038 historic capacity  vs. 7,402 existing capacity
LOOKING CLOSER AT OUTPUT

- Logan & Blacksmith Fork River
  - Max Capacity: 7402 dams
  - Currently 1313 dams
  - Current average of 1.8 dams/km
  - Current capacity of 10.1 dams/km
  - Only 18% of Existing Capacity & 12% of Historic

<table>
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<tr>
<th>Length of Stream</th>
<th>Existing Capacity (Density)</th>
<th>Historic Capacity (Density)</th>
<th>Existing Capacity Count</th>
<th>Historic Capacity Count</th>
<th>Existing Dam Density</th>
<th>% of Existing Capacity</th>
<th>% of Historic Capacity</th>
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<td>Logan River HUC8</td>
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HOW ABOUT A LITTLE WATERSHED?

- 186 historic capacity vs. 111 existing capacity
- 11.3 dams/km historic vs. 7.7 dams/km currently
MORE FOCUSED VALIDATION...

• Encouraging...
• No dams where there shouldn’t be
• Higher densities in places that are
• Even some events that make sense
PERENNIAL STREAM & VEGETATION FIS
MEMBERSHIP FUNCTIONS (*.FIS)

- Simple ascii text file
- Computing w/ words
### THE RULE TABLE...

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<th>OUTPUT</th>
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<td>49</td>
<td>1 2, 2 (1) : 1</td>
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</tr>
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<td>50</td>
<td>2 2, 2 (1) : 1</td>
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<th>Dam Density Capacity</th>
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</tr>
<tr>
<td>3</td>
<td>Moderately Suitable &amp; Unsuitable</td>
<td>Occasional</td>
</tr>
<tr>
<td>4</td>
<td>Suitable &amp; Unsuitable</td>
<td>Occasional</td>
</tr>
<tr>
<td>5</td>
<td>Preferred &amp; Unsuitable</td>
<td>Frequent</td>
</tr>
<tr>
<td>6</td>
<td>Unsuitable &amp; Barely Suitable</td>
<td>Occasional</td>
</tr>
<tr>
<td>7</td>
<td>Barely Suitable &amp; Barely Suitable</td>
<td>Occasional</td>
</tr>
<tr>
<td>8</td>
<td>Moderately Suitable &amp; Barely Suitable</td>
<td>Occasional</td>
</tr>
<tr>
<td>9</td>
<td>Suitable &amp; Barely Suitable</td>
<td>Frequent</td>
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<tr>
<td>10</td>
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</tr>
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<td>Frequent</td>
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<td>14</td>
<td>Suitable &amp; Moderately Suitable</td>
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<td>Occasional</td>
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<td>Moderately Suitable &amp; Suitable</td>
<td>Frequent</td>
</tr>
<tr>
<td>19</td>
<td>Suitable &amp; Suitable</td>
<td>Frequent</td>
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<tr>
<td>20</td>
<td>Preferred &amp; Suitable</td>
<td>Frequent</td>
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<td>Moderately Suitable &amp; Preferred</td>
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<td>24</td>
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</tr>
<tr>
<td>25</td>
<td>Preferred &amp; Preferred</td>
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</table>
VEG MODEL...

1. LANDFIRE Vegetation

2. Classify in terms of suitability for dam building

3. Clip down to 30 m and 100 m stream buffers

4. Run FIS Model to transfer raster to vector...
RUNNING BRAT IN MATLAB PLAN

I. Understanding both FIS
   I. Vegetation Model
   II. Combined FIS
II. Running FIS one row at a time
   I. Vegetation Model
   II. Combined FIS
III. Running whole thing...
IV. Getting it back in GIS
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
### RULE TABLE

<table>
<thead>
<tr>
<th>IF</th>
<th>Vegetative Dam Density Capacity (FIS)</th>
<th>INPUTS</th>
<th>2 Year Flood Stream Power</th>
<th>OUTPUT</th>
<th>Dam Density Capacity</th>
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<td>, then</td>
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<td>- &amp;</td>
<td>-</td>
<td>, then</td>
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<td>3</td>
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<td>Dam Persists</td>
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<td>, then</td>
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<td>Blowout</td>
<td>, then</td>
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<td>Blowout</td>
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<td>, then</td>
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<td>- &amp;</td>
<td>Blowout</td>
<td>, then</td>
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</table>
COMBINED

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

= Resulting Capacity