Workshop Summary:
Using Beaver as a Restoration Agent for Meadows in the Sierra Nevada and Cascades

Occidental Arts and Ecology Center WATER Institute and The Nature Conservancy
Kate Lundquist, Brock Dolman, and Kristen Podolak

St. Bernard Lodge and Childs Meadow
October 25–26, 2014



Brock Dolman's photos from the workshop

Contents

Purpose

Bring together group to discuss approaches to biological and hydrological restoration of meadows, validating the use of beaver as a restoration agent and balancing beaver with livestock grazing. Hear from scientist Michael Pollock about his research on stream restoration and beaver. Beaver were not considered native to the Sierra Nevada until research by James and Lanman (2012) dated buried beaver dam wood in the Feather River to before the Gold Rush and research by Lanman et al. (2012) found historic and ethnographic accounts of beaver in other Sierra locations. Research on beavers in meadows indicate they may have played an important role in meadow formation by storing alluvial sediment, they attract other species by creating new wetland habitat, and their dam building may address channel incision and disconnection between the stream channel and meadow floodplain.

Deliverables

Based on the two-day meeting, develop:

1. A strategy for using beaver at Child's Meadow if deemed appropriate
   TNC will work with Karen Pope (USFS) and Ryan Burnett (Point Blue) and others interested to shape research at Childs Meadow focused on cascade frogs, willow flycatcher, and water/carbon benefits with changes to livestock grazing and other restoration approaches. Suggestion to contact Carol Evans from the BLM to discuss grazing management done and her comments being considered in development of upcoming grazing lease terms.

2. Funding proposal to test using beavers as restoration agents (NFWF or others)
   Discussion of the Department of Fish and Wildlife (DFW) wetlands restoration grant, to be announced in January. Plumas Corporation has a method for measuring carbon change with meadow restoration. There was also brief discussion about the National Fish and Wildlife Foundation meadows grants.

3. White paper outline: beaver as a meadow restoration tool
   A small group is putting together beaver policy recommendations to hopefully help shape California beaver management.

4. Strategies to implement beaver monitoring in meadow restoration
   Rene - Trout unlimited shared habitat condition metrics from Upper Truckee Study. It's an expanded USFS level ½ stream habitat typing plus remote sensing data to quantify how specific habitat types change with restoration.
   Michael P. - Suggested temperature probes for Childs Meadow, highlighted the challenges of accounting for streamflow changes in a meadow.
   Michael S. and Betsy – offered suggestions on livestock grazing management and the need to think about unintended impacts like weed growth with no grazing.
   Karen, Garth, and Jackson - collected cascade frog data during the Sunday workshop and then Karen and Garth returned the next day and found 4 adults, 2 subadults, and 42 metamorphs in the beaver pond area. Exciting news!
   Jason – recommended talking with Carol Evans from BLM about grazing.
   Additional suggestions recorded in the discussion notes from the field tour.

The far side of the beaver dam we observed at Childs Meadow.

5. A future meeting time, location and identify other pilot sites
   There are several interactive workshops on beaver coming up. See flyer below.

Restoring Beaver to Restore Rivers

Five interactive workshops focused on the use of beaver in aquatic restoration will be offered from January through April, 2015. Workshops are intended for land owners/managers, and restoration funders, reviewers, and practitioners who are actively involved in aquatic ecosystem restoration. There will be an opportunity to sign up as a peer reviewer of the draft Beaver Restoration Guidelines at each of the workshops, or request to be a reviewer by e-mailing Janine_M_Castro@fws.gov.

Locations and Dates:

- Everett, Washington, January 14th
- Portland, Oregon, January 21st and 22nd
- Weed, California, February 12th
- Juneau, Alaska, April 14th

Presenters:

Michael M. Pollock, Ph.D., Ecosystems Analyst, NOAA Northwest Fisheries Science Center
Chris Jordan, Ph.D., Mathematical Ecologist, NOAA Northwest Fisheries Science Center
Janine Castro, Ph.D., Geomorphologist, US Fish and Wildlife Service and NOAA Fisheries
Gregory Lewallen, Research Assistant, Portland State University
Mary Ann Schmidt, Director, Environmental Professional Program, Portland State University

To Register: http://epp.esr.pdx.edu/Beaver%20Restoration.html

6. A summary from the meeting to share with the Meadows Working Group
   Check!

Attendee List

Name	Affiliation	Email	Phone
Karen Pope	USFS Pacific SW Research	kpope@fs.fed.us	707-825-2957
Garth Hodgson	USFS Pacific SW Research	ghodgson@fs.fed.us	707-825-2987
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Michael Pollock	NOAA	michael.pollock@noaa.gov	
Kristen Podolak	The Nature Conservancy	kpodolak@tnc.org	703-201-1821
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Jesse Hahm	UC Berkeley	wjhahm@berkeley.edu	
John Sikora	Trout Unlimited - El Dorado	jesikora@sbcglobal.net	916-502-2433
Jann Williams	USFS - El Dorado Nat. Forest	jowilliams@fs.fed.us	530-621-5240
Jason Barnes	Trout Unlimited - Reno	jbarnes@tu.org	775-432-3855
Jackson Shedd	The Nature Conservancy	jshedd@TNC.ORG	760-707-6942
Betsy Stapleton	Scott River Watershed Council	5104stapleton@gmail.com	
Michael Stapleton	Scott River Watershed Council	frenchcreek@gmail.com	530-598-6164
Charna Gilmore	Scott River Watershed Council	charnnagilmore@gmail.com	
Nicholas Vadpey	Central Valley Water Board	nvadpey@berkeley.edu	510-725-2856

Introduction, Interest In Beaver **(alphabetical order by last name):**

Jason Barnes. TU,
Works with Lahontan cutthroat. Here because of Carol Evans, who convinced him this is the way forward. Wants to get folks to move past just killing beavers as they only option.

Charna Gilmore, Scott valley watershed council.
Realtor, has spent 5 years working on "nuisance" beaver issues with the ranchers and their irrigation. Getting some traction with local landowners, and old-time ranchers are coming around. They get water, and are seeing that where there are beavers there are water. She's working on post and weave projects with Michael. Wants to support co-existence of ranchers and beavers.

Rene Henery, Trout Unlimited CA, works with a collaboration from UC Davis and UNR Reno. Assessing meadow restoration benefits for fish. Has field crew monitoring pre/post restoration habitat to quantify what we're doing with these projects. Ended up working on lots of meadows with beaver and saw projects struggle with beavers, and also simulate beaver work with permanent structures and higher cost when they fail.

Mission is better habitat for fish, so interested in Michael's work partnering with beavers.

Garth Hodgson, USFS Pacific SW Research
Doing research out of Arcata for 20 years on amphibians and reptiles, wants to help amphibians in wet meadows

Kate Lundquist, OAEC
WATER Institute, has been working on watershed restoration and salmonid recovery, led to looking at working with beaver as way to achieve both. Bring back the beaver campaign. The idea for this meeting came out of another mountain meadows restoration meeting where nobody was talking about beavers. Wants to better monitor effects of beaver on meadow restoration and restoration in general, and incorporate them into watershed restoration efforts.

Mary Olswang, CADFW
Works in fisheries branch in Sacramento, lived in Yreka, and thus knows SVWC, was there in the beginning trying to convince people to quit killing their beavers. She's here to learn, never heard of plug and pond, wants to hear about plans. Convinced that "we're not moving beavers. Not gonna happen." Did pit tag array work showing that fry can move through and past dams. Works on Sugar Creek, where the landowner was worried about his pasture flooding and so destroyed the dam. Almost done with write-up on data showing that even with the dam broken, the fish stayed in the impoundment, there wasn't a mass exodus. Most of the out-migration was passive displacement during big flows, but some of the fish did find refugia. Sugar Creek is really cold, pond froze, she's wondering about survival under ice, rearing, second-year growth. Hypothesizes that there might be 3-year classes of rearing Coho, based on beaver habitat.

Kristen Podolak, TNC
Funded the meeting. Got interested in beaver while at Independence Lake, saw an old dam and read about Sagehen 1950's PhD study where beavers were removed for LCT fish passage. Came to Childs Meadow and observed lots of beaver activity, discussed TNCs work to build a fence to manage cattle grazing while still allowing beaver to move around and do their thing. Looking for advice from the group regarding restoration approaches using beaver to improve meadow habitat for imperiled species and balancing livestock grazing.

Michael Pollock, NOAA
Invited presenter, scientist. Studying beaver and effects of beaver dams on endangered species. Working on recovery of habitat. Coho need beaver ponds to successfully rear and do their thing. Work in eastern Oregon saw steelhead also moving to beaver ponds.

Karen Pope, USFS Pacific SW Research
Plug and pond is a pretty popular technique, she wants to hear more options for letting natural systems do the work. In the future looking to research meadow restoration for amphibians and whether beavers can work for that.

Jules Riley, USFS Enterprise
Hydrologist, works for dc office in the enterprise program. Got laughed at 20 yrs. ago for supporting beavers. Showed up because meeting was close, synchronicity.

John Sikora. TU from Eldorado chapter in Eldorado County.
Wants to convince USFS to not clearcut and burn. Wanted to study the Caples Creek beaver dam but F&W said "maybe we should knock that down". Wants ammo as to why dams are beneficial. Been doing plug and ponds trying to re-water meadows. Little Truckee was dewatered, as was the Eel and with no beavers in the eel, there was no way to slow down the water. How can we address the drought so we don't end up netting and transporting fish? Do these ponds work? If so, do they need pond liners? We love fish, and want to keep the water there. Talked with people, asked what about an artificial dam? Can you set up an artificial dam and raise and lower it remotely from a desk app based on weather and monitoring stations? Water bladders on the Scott River mentioned.

Michael Stapleton, Scott Valley Watershed Council.
Board member on SWSC, 60-acre ranch w/ beaver and Coho on French creek. Knows ranching and wildlife can go hand in hand. Big proponent of relocating. Wants to help the beavers and Coho.

Betsy Stapleton, newly elected chair of the Scott Valley Watershed Council
Working with Michael Pollock on the Beaver Dam Analogue (BDA)/Post-Assisted Willow Structures (PAWS) project. She wants to get the council to look at restoration watershed-wide rather than project specific. Can we move into meadows?

Kevin Swift, Swift Water Design
Here to take notes for the meeting and support beavers however he can. He's working in California on beaver damage mitigation, doing pond levelers and culvert fences, wrapping trees, any kind of non-lethal management.

Jann Williams, USFS Eldorado National Forest
Working on plug and pond in Indian Valley with Jim Wilcox and Tom Bibicouser(sp??) Dug in channel and brought water back and red-legged frog showed up right away. Beavers seem more natural and a better idea, wants to protect beavers and educate people not to take them away. Has two more projects, Van Vleck and Foster meadows, and is not sure how they're going to restore yet.

Michael Pollock Presentation Discussion Notes

The Bridge Creek monitoring design involved three years of pre-treatment monitoring data and three years of post-treatment monitoring data. They had four treatments and four controls. This system is in the John Day watershed in OR and is not a manipulated system. They installed four different types of structures and have since abandoned the straight up post lines. The starter dams with curved lines increase flow and are good for creating pools but increase scour. They have seen increased sinuosity in response to the starter dams.

Brett Harvey of USFS has been conducting the fish monitoring. The metrics they are using are fish survival and density. While the dams may be restricting movement, they are only doing this during times when fish don't move anyway. They like to move when there is water. One challenge has been that people come in and fish the ones they are monitoring. They have PIT tagged the fish and have 10 PIT tag antennas hooked up to one reader. They have noticed that as the beaver dams diversify the habitat, the life history strategies of the fish diversify as well.

Data comparing Bridge and Murderer's Creek shows higher survival and numbers in Bridge Creek where the restoration treatment took place, and much of the data noise was on the up side, suggesting that the numbers are low. Data keeps trending upward in 2013. Survival is one metric, it would also be good to look at total system/population diversity, but harder to pull out of the info they've got. It's hard to get people to think about systems as dynamic. From the permitting side, the regulators need to know lots of things and the treatment has to respect the regulations.

Dams may occasionally be a passage barrier at some points in the year, but it's allowing flow when there might not otherwise be habitat. When there's enough water to get fish moving, the dams either blow out or are overtopped or the water goes around them—data shows that juveniles at the site studied were able to move upstream and down, day and night, apparently at will. It would be great if they could put the PIT tag antennae in the dams to see where the juveniles are going through. The pitfall of all this monitoring is that while it may be easy to capture the data, you need to analyze and publish the results and there is little funding to do so. One question is how can we better analyze the data beyond survivorship to tease out the nuances of seasonality.

In beaver dams, most of the storage isn't surface water behind the dam—it's groundwater recharge. Certainly there is anecdotal evidence of beaver dams perrenializing streams. No one has properly modeled this process and we need the time and money to do this. We are not making water, we are just messing with the timing of the release. Perrenializing a stream can happen with relatively few dams, especially if they're big ones. Shorter ones, of course, need more stream miles to charge the alluvium enough to add base flows. Aggraded sediment can act as a sponge, but if it's

overly permeable the water can end up draining quickly and/or running beneath the surface, leaving the surface dry.

Rene—One debate in the meadow restoration community—"how much can slowing the water actually do to improve base flows?" answer is, "it depends", because of the variability in the soil composition, vegetation, etc. Cliff Notes: what's the sponge made out of, how much is coming in vs. the sponge volume and what's the surface of the sponge look like? Storage vs. retention/slowdown is a point as well. We're not 'making' water, it's not storage, we're just slowing it down. Michael put in a BDA in the Scott, then the stream dried up, but then in the fall when the rains came, the first place water showed up was behind the structure. And, when there were the fires and there was lots of smoke, there was water behind the structure again for a little while—maybe smoke slowed down evapotranspiration? Paper topic?

Need to be careful not to lead with "meadow restoration creates water storage" when the real answer is "it depends." Perazzo meadow is very controversial, since the project went in and the meadow is still dry—but there's a diversion, so who knows…

Little Truckee project—sponge filled up with 'fire hose' of rain, then a bunch flows through and it looks like nothing happened, but nobody's looking at it during lower flows. Need to look at the whole system effect. It just alters the timing of the water release from the system. Folks in the Scott get this—keep water around as long as possible!

"you can have my water when you pry it from my cold dead fingers…"

Charna—*Gazarino on Sugar Creek, this year during the drought the beavers worked really hard to keep water there, made the channel way more complex, and he was able to sell his water back to the system because his pasture was sub-irrigated so well by the beavers that they stayed green in 100 degree heat. Great evidence that beavers really make a huge difference.*

Mary—*Also a good lesson in gaining trust with landowners, she would always bring the landowner out, they'd put on waders and tag fish together. Dredgers tore up the river, and it's been straightened out, causing a bunch of problems.*

If you're only measuring surface flow you're not capturing the large part of the benefits, because so much of the change is subsurface. Temperature—the temp. thalweg is cooler, and you see a lot of temp. heterogeneity that wouldn't be there otherwise. You've got to have hyporheic exchange if you want to really get water temp. down—just shade alone probably won't do it. In a bedrock channel (which beavers probably wouldn't use) you probably wouldn't see as much change. Some, due to depth of pool, but not as much.

With more food, fish can handle higher temperatures—higher metabolic rates lead to faster growth as long as there's food, literally right up until the fish get cooked by denaturing their proteins it's so hot. Temp. variability allows the fish to seek/find their optimal temp. This is hard to explain to regulators as they have mandates to meet. This is a problem in meadows and the Central Valley. Adult non-eating fish can't withstand hot water but juveniles need to eat so they have a higher temperature tolerance.

Rene—Important point in meadow restoration community is that you need a varied temperature system. In Nevada, there's probably a limit to how much you can cool down the system, so you have to add a bunch of food so the fish can tolerate the temps. "Optimize their bio-energetic experience"

With enough variability in the system, you can allow evolutionary pressures to drive the population toward more high-temp resistant fish.

Many agency folks and landowners are hamstrung by fear of liability, which makes restoring a system tougher. Need to incentivize landowners to get on board by lifting some of the regulatory burden on them.

Dams aggrade sediment really fast, up to half a meter in the first year, but a longer term average of about 10 cm per year or about one meter per decade. Vegetation grows and reduces velocity. Also, the added veg. traps lots of sediment so from a water quality perspective it's a huge benefit. Yes, beavers do cut trees, but the overall total vegetation is greatly increased. Beavers are often called "ecosystem engineers", but they're more like flood-irrigation farmers than engineers. They move around, abandon colonies, they leave, but it's always assumed "they ate themselves out of house and home", ran out of food, but I've never seen any actual data on this. People tend to look at woody veg, trees, etc. but that's just the easy stuff to see and quantify. It's much harder to quantify cattails, dug up roots, grass, emergent veg, and etc.

Charna—I've seen them eating grass, Alfalfa, blackberries,

John—Why do beavers leave? More riparian veg brings more wildlife, which maybe brings predators?

Restoration folks say, "if you bring them in before the ecosystem's ready they'll eat themselves out of food" but nobody's got data. And yes, they do need something to gnaw on for their teeth. Some folks provide big piles of wood—at least something for them to chew on.

Kate—Kent Woodruff in the Methow says they are using available grass as a metric for successful relocation more than anything.

He's using an old hatchery to keep the beavers in, lets them pair up, builds a starter lodge for them, and then releases them. There's some monitoring of the success rate as far as surviving, but it's pretty complicated, they move around a lot, etc. Even with all that, the success rate was around 50% (need to confirm numbers with Kent). Moving beaver is kind of a last resort. In Oregon, scientists released beaver in areas that were thought to be good habitat, but the beavers pretty much got eaten by mountain lions, many in the first week. However, the releases were also done during low flow conditions in the fall, not in the high flow of the spring when beaver typically disperse and when the flows provide more protection.

Betsy—With a known colony, what's their expansion rate?

It turns into a complicated mess, right after release it starts to become complex. There was one area where they quit building dams, then showed up a few miles upstream, then came back downstream the year after that.

ODFW has a rule set, but it's really based on ignorance, since nobody really knows how this stuff works.

Charna—What triggers them to go from dam building to bank burrowing?
Kate—Having enough water they don't need to build a dam
Mary—My beavers left because the pond filled w/ sediment
Charna–There was a beaver that was building a dam with just 3 sticks, a tiny bit of mud and a couple rocks.
Lazy beavers!
Could you bring in a dam building beaver to teach them?
Betsy—We've got bad parenting, long term family dysfunction, these beavers weren't taught properly

A student tagged a bunch of beavers, and they moved around all over the place, they all had different life strategies, just like fish.

The Jack Kerouac beavers! Juveniles that didn't have a good female beaver role model.

The ones that built classic colonies were the hardest to trap, since they knew every inch of their territory.

BDA-design
Bridge creek has 250 structures, half natural/half BDAs, in around 14 km of stream, and the beavers are still building their dams and doing their things.
Elk and deer can be a real problem with the riparian plantings, since they eat a lot of the new plantings. 6-foot plastic grow tubes can work out pretty well, you also have to drill down to the water. We've got around 80% success out in the deserts country of eastern

Oregon, but you have to get them to grow up out of the tubes before they cook in the heat. Grazing is the highest source of mortality, which the tubes prevent.

CDFW is writing guidelines for living with beavers and writing a white paper to articulate their position on beaver management.

Kate —The Mendocino Land Trust in Big River submitted application to FRGP to fund a beaver relocation project.

Betsy—Post line structures is purposefully separate from beavers, it's a completely different issue, strategically, to get the beaver conundrum out of the way.

And if they show up, that's fine. They seem to like them, hang around them, some beavers will manage the flow, even cut notches down to allow more flow. They'll modify the flow according to their needs. They tend to show up where the posts are…

Rene—So you're trying to get them to show up?

No, we're looking more for fish habitat than anything else. And, they tend to work a lot better when they do show up. They'll maintain them, plug them, it's like having a full time groundskeeper, making little trenches to have low/high water.

Rene—Yeah, M&M is always an issue, who's going to pay to keep everything working

We're monitoring over 100 structures and the pathway each one is taking. For many, they aggrade, they're done, you can't even tell they're there except for the markers, or the beaver have flooded them out or built right over the top of them. There's a lot where we've just said we're done monitoring these. Having them around really makes the system hum along a lot better.

Rene—Instead of developing "rules' around implementation, how about moving toward guidelines/intentions/etc. for adaptive management.

There's this dance around regulations, where, 'we're not managing these for beavers, we're doing this for fish." It's a workaround, really-until the rules catch up. Part of it is just getting people comfortable with beaver as a positive effect for change, and the negatives can be mitigated.

Michael Stapleton—Beavers don't like alder, we wrapped our cottonwoods that we didn't want cut down on our ranch.

Charna—it's worth continuing at whatever capacity you can to see if fish and wildlife can change their classification and not call them a 'nuisance'. Their trapping and hunting regs just have to be changed to track how many are being taken out of the system.

To get them to change the paradigm, you have to provide that. Demonstrate and document this, so they have something to shift TO.

Michael Stapleton-who should we talk to in Sacramento to get this shift?

Chuck Bonham

Mary—I've talked to people in Sacramento, and they're very open to change, they've taken beaver off the non-native/nuisance list. It's as if the beaver doesn't even exist in California currently

Kate—beavers got lumped in because some beavers had been transplanted from Oregon and Idaho in 1940, but nobody's proven that there are different species.
In CA beavers were first protected in 1911.

John-why were beavers called 'non-native nuisance?'

Kate—it was farmers and ranchers talking about levees getting busted and other problems. The regs went back and forth for years

Charna-for us to be so pro-beaver in our community, we couldn't alienate ourselves by being so pro-beaver, we had to start out by just offering the help that folks need, the tree cages, the pond levelers, we have to respect the people's ideas and mindsets. We're a very conservative community, and one of the really big ranchers in the area came to the city council and asked for support with his beavers. We've been attacking it by respecting everyone's opinion. Killing them has been the practice.

John-Jason can talk about the Lahontan project, and they've had great success

Jason—You have to decide to be either passive or active, and if you leave it passively, then people will be left with their misconceptions.

Charna-at first we were whispering about this, up here word of mouth travels faster than my car, then we brought Michael down and had 30 people at the meeting, and now we're kind of out of the closet.

Betsy-groundwater is going to be a big deal

Jason—one of two folks in Nevada that had a really positive experience was A.G. Smith, a rancher

Karen—is the Scott project monitoring carbon sequestration? Cap and trade, meadow restoration?

Charna-we've been trying to figure that out.

In that context, Malcolm North presented on wildfires and riparian corridors, riparian areas that were moist tended to tamp down fires. Looked at it as incised vs. not incised, which tended to do better with fires. Follow up on this. When you can say, "beavers are going to help with wildfires" that's a big step for some folks, but that's another great thing to wrap in—the effect of meadow restoration on fire behavior.

Charna-as this drought continues, fire is going to be even more of an issue

Kate—Ellen Wohl is doing studies on carbon sinks. They're looking at submerged logs and wood as carbon sinks. Using Ground Penetrating Radar to find buried/submerged beaver dams in the Rockies and find out what role beavers played in the formation of Rocky Mtn. meadows.

Carbon credits for beavers!!

Karen—the money from the state is for carbon sequestration, so you have to prove your meadow is sequestering carbon.

Rene—since we don't have a protocol for meadows, nor a good set of data as to whether/when they sequester carbon over time. Use the first round of money to study, and then set up a protocol for getting paid back. You'd certainly want beaver included as part of the protocol. Wetlands-sequester at some times of the year, off-gas others, sometimes its methane,

In a trailing reach where there's zero sequestration, it'd be really easy to study.

BDA design
Hydraulic post pounder is low impact, no veg removal, but just get a bobcat in there and do it. You'll lose a little veg, but we've got areas where we're getting repeated scour, especially where there's big cobble and you can't get it that deep. This is for areas where it's badly incised and you need that depth. Question-can you get the water up high enough that is can run off into the surrounding area. Timing-can you get some aggradation and veg before it floods? If you get one quiescent year, it can really make the difference. Hydraulic ram was $2200, power pack was around the same, $3000, posts are $5 each—it's VERY cheap. It's around $500-$1000 per structure. You can do a

kilometer of restoration for $10k, which is really inexpensive. It's more like gardening than a one-off where you go in and "fix " the stream.

Michael Stapleton—we have a different challenge than in the desert, where there are 8k peaks all around, you get massive energy coming down with snow storms in the high country.

In the desert it's been used successfully, it'll be good to see how they do in other environments. We've woven branches upslope a bit, then put a row and weave across where there's not even water yet, so you can build a multi-threaded channel. Scour depth is around the same as the post height, so we put in downstream pieces/berm to reduce scour.

Karen—hydrologically, how's this different than riprap control structures?

It just depends on how lazy you want to be. This allows a 50% success rate and doesn't take too much time or effort

Karen-again, how's it different hydrologically?

VS a u-shaped vortex weir, this mimics a beaver dam better. These are flat across the top, and don't concentrate all the flow toward the center of the stream.

Karen-so can you take what you've learned from beaver and use it in say a rocky system?

In the Mattole watershed where there were people and beavers weren't popular, the folks used log weirs instead. But in contrast to log weirs, BDAs just use small posts and willow branches, so if they are scoured out and moved downstream. It's biodegradable, and so if it scours and goes downstream so what? I wouldn't use this in a Rocky Mtn. stream where you wouldn't see beavers, you have to design for appropriate environments.

Incision/aggradation cycle-incising happens in years, channel widening in decades, aggradation in centuries, and equilibrium in millennia.

Rene-You have to consider what the system was like before, that's why plug and pond is the way it is, because you get this huge spike in pressure and need to have something that can stand the pressure. You used to have these huge log jams at the bottom of the meadow where the grade changes, which would sometimes blow out and force the channel in all these directions. Instead of looking at the tool, look at what drove the equilibrium in the past and mimic that now.

Build in redundancy. In bridge creek they built some huge structures that moved downstream, but they left behind some great scour pools, and that sediment filled in a part of the trench in one shot, and then the beavers colonized it. So it wasn't failure, but they hadn't planned for it either.

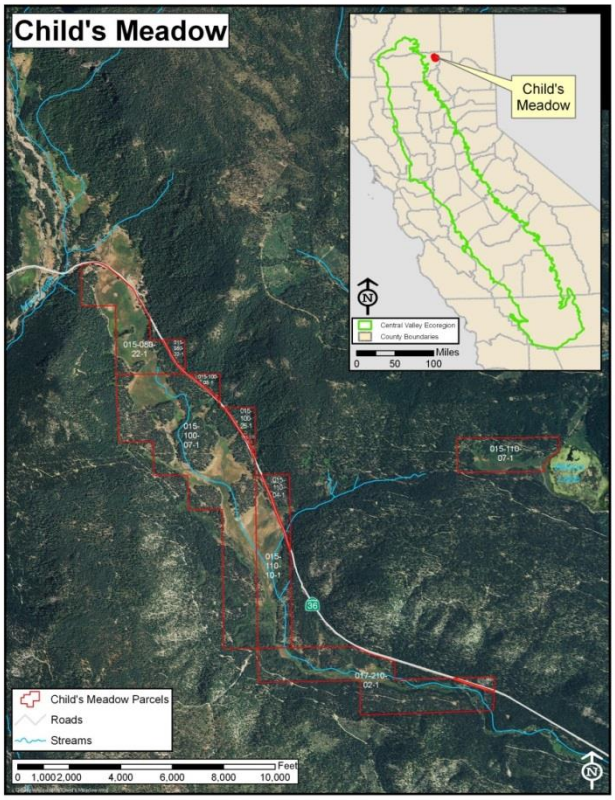
Gut check—are we building something that never existed historically? If so, maybe we should think about it, maybe do something else.

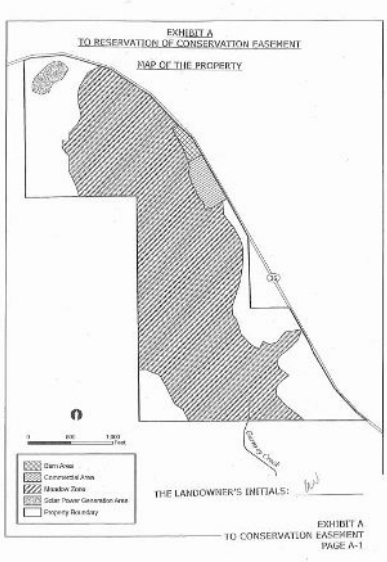
Childs Meadow Field Tour

Stop 1: Childs Meadow Overview (across the street from Childs Meadow Resort)

Childs Meadow is a large wet mountain meadow that rests at an elevation of 5,000 feet near the southwestern entrance of Lassen National Park (~4 miles away). The 1,440-acre property has frontage on State Highways 36. The meadow area is 1,265 acres and Wilson Lake is 111 acres. Gurnsey Creek meanders through the meadow and acts as the headwaters of Deer Creek. The meadow has high ecological value as a headwaters water source for an important salmon stream as well habitat for Willow Flycatcher, Sandhill cranes, and Cascade frogs.

In 2007 the meadow was for sale and marketed as a potentially site for a golf/recreation community. Because of its importance as the headwaters of a critical salmon creek, The Nature Conservancy (TNC) purchased the property in September 2007. In 2011 the upper (north) 174.5 acres of the meadow including the uncompleted lodge/restaurant was sold by TNC to Kevin Wilsey and TNC retained a conservation easement. The easement protects the meadow from development and off road vehicles, allows restoration and the commercial operation of the lodge, a single-family home, and seasonal cattle grazing.





Geology: Childs Meadow is located at the junction of the Sierra Nevada and Cascade ranges and exhibits both glaciation and volcanism. Pleistocene glacial till and outwash are extensive and recent alluvium occupies the Gurnsey Creek watershed. Upper Childs Meadow contains glacial till eroded by glacial outwash that accumulated at the terminal end of the glaciers.

Hydrology: The hydrology of Childs Meadow is associated with the volcanic geology. Snowmelt and precipitation infiltrated into the groundwater where it move laterally sometimes emerging as springs or hot spring where it encounters geothermal zones. The headwaters of Gurnsey Creek form on the easement portion of the property. Gurnsey Creek is a tributary to Deer Creek, 6 miles downstream. There is a 7-acre man made pond – During the 2011 survey a small beaver dam was situated at the outflow channel from the pond.

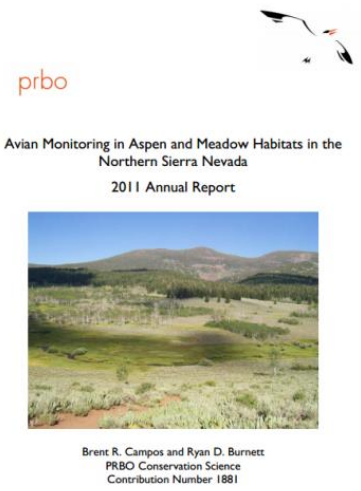
Photo Location 014
Photo 024

View of the edge of the pond and berm with the "lodge" building and designated "Commercial Zone" visible at the upper left of photo. The current level of the pond is in part at least, controlled by a beaver dam constructed at the pond outlet at the end of the berm.
Lat/Long: 40° 21' 18.60" N. Lat, 121° 29' 47.73" W. Long
Direction of View: 040°
Date: June 17, 2011

Grazing: Total animal unit months (AUM) permitted for one year (3 month grazing) is 560. An AUM is defined as the presence of 1 animal unit (AU) for 30 days. We need to reduce this after tails of split rail are done. Season of use June 1-July 15; Oct 1-Nov 15 (6 wks. + 6 wks. = 3 mo.). The tenant is Dick O'Sullivan, he has the 10-yr Forest Service permit signed a year ago. AUM limited to 560, but there are no fences between TNC/USFS/Collins Pine/and Wilsey easement on northern 175 acres. Stocking is set at a 800 pound / acre minimum residual dry matter (RDM). Average RDM is estimated by the Conservancy independently at the end of the grazing season.

Soils:
Chummy soils (Cb), 0-3% slopes, alluvium derived from volcanic rocks including andesite, rhyolite, and basalt. Poor to very poor drainage, runoff is slow and permeability is moderate. Fine textured soils susceptible to soil compaction and gully erosion.

Stop 2: Livestock Exclusion Fence



"Based on long-term monitoring of the Forest Service-owned reach of Gurnsey Creek downstream from the Child's Meadow property, we are confident that efforts to fence off the lower third of Child's Meadow to release it from grazing pressure will improve riparian bird habitat. We also recommend willow planting to expedite the creation of meadow bird habitat by a decade or more. Fencing along the stream corridor for the length of the property in conjunction with additional infrastructure to provide off-stream water should be considered if current grazing levels will continue. The discovery of breeding Cascade frogs on this property in 2011 and the continued presence of several Willow Flycatcher increase the conservation value of this site. Future management decisions should be accordant with best-management practices for these special status species."

PRBO Conservation Science, Spring 2011, Number 164, Ryan Burnett

In several meadows where floodplain function is fairly intact, past and current grazing pressure appear to be limiting the value of these sites to the full complement of meadow dependent bird species. These sites lack deciduous woody vegetation, the nesting and foraging substrate for most montane riparian birds. Hence many of our focal meadow bird species simply do not occupy such meadows.

At a spot where standing water and signs of beaver increased, and willows likewise, my thoughts turned to the possibility of a Willow Flycatcher. This California Endangered Species is one of the rarest breeding birds in the Sierra Nevada. Arriving at my next point, I was thrilled to hear unmistakable *fitz-bew* and *zeeeep* calls—two male Willow Flycatchers in duet atop willows lining the beaver ponds: they were already here! Ryan Burnett

Cooperative Agreement to build fence between USFWS and TNC on May 3, 2010

Project Description: "Most, if not all, wet meadows in the region have been grazed by livestock for over a century. Long-term exposure to heavy grazing shifts meadow vegetation composition away from desired bird habitat, causes associated streams to down-cut lowering the water table, and shifts otherwise wet meadows towards dryer summer conditions. Severely degraded meadows lose their ability to store water, moderate flood flows, and provide slow release of summer flows for fish.

The Service and the Cooperator plan to permanently exclude livestock grazing from the lower ¼ (350 acres) of Childs Meadow by constructing an approximately 2,600 foot cross fence. Removing grazing will encourage the formation of willow thickets, necessary habitat for willow flycatchers. It is anticipated that planting willows will speed the rate at which stream repopulation is able to occur. To that end, and if sufficient funds are available, willows will be planted on each side of Guernsey Creek to increase connectivity between existing willow plants.
Increases in willow cover will encourage beavers, and it is anticipated that the associated flooding of the meadow will help retain more water.

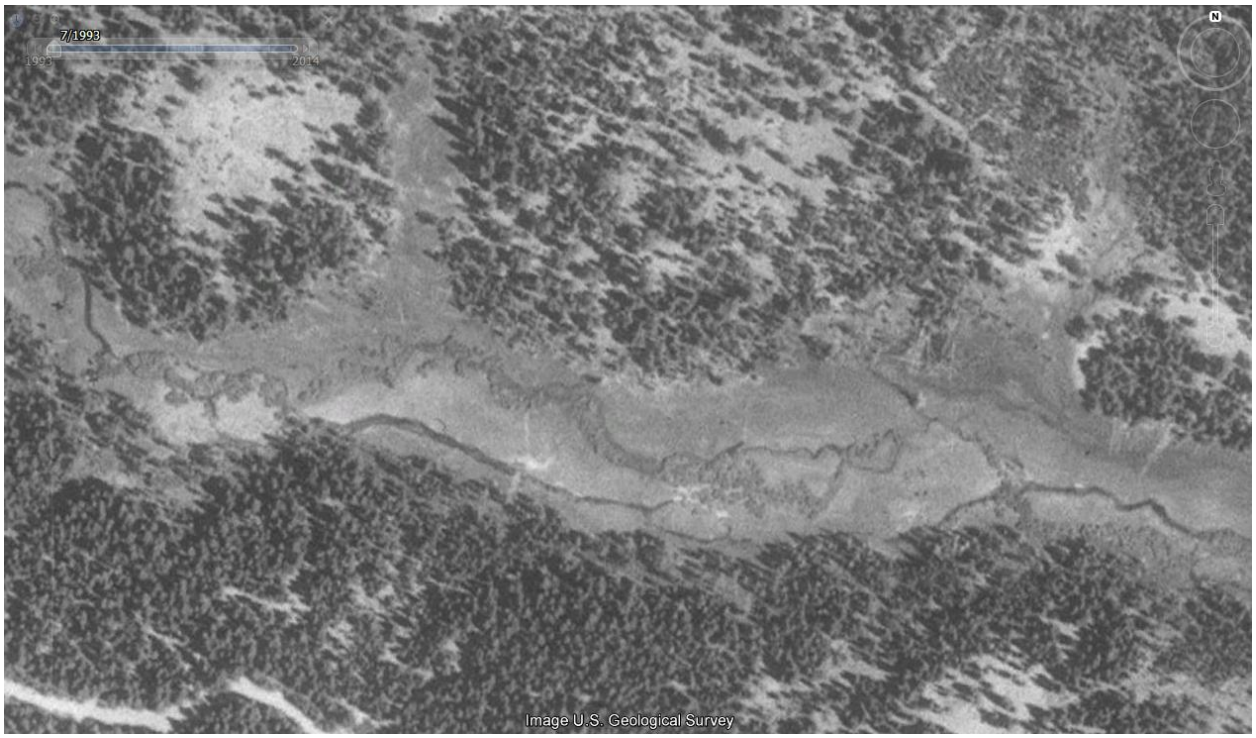
With cattle exclusion, the lower portion of Childs Meadow has the potential to support a significant Willow Flycatcher population and other breeding neo-tropical migrants. The upper portion of the meadow may be able to support breeding Greater Sandhill Cranes (State Threatened; observed but not known if currently breeding) if grazing is managed carefully.

Willow flycatcher

Cascade frog

Sandhill crane

Stop 3: Past and Recent Beaver Activity Downstream of the Fence



1993 – no beaver dams visible

2005 – no beaver dams visible

2014 – 3 beaver dams visible, 2 lodges.

Childs Meadow Field Tour Discussion

Kristen - Provided a description of the purpose of the livestock fence and limiting grazing in area with Cascade frog and Willow flycatcher. The Nature Conservancy is looking for a win-win solution to have sustainable grazing and habitat protection for threatened and imperiled species. What knowledge exists about this balance and interaction between beaver, livestock, and meadows?

Discussion about meadow monitoring metrics:
Rene – stream habitat protocol, shared Upper Truckee report

Gia – rooted depth and focus on the riffles

Betsy – think about unexpected outcomes from reducing grazing like increase in thistle and other weeds

Mark – fence the riparian area and provide off-stream water for cattle

Starker Experimental Forest – good date on long-term interaction between elk, deer, cattle, and riparian areas.

Charna – photo points

Garth – temperature probes in beaver ponds, upstream, and downstream and wetted width

Jason - brook trout… you want to make sure to remove them before restoration, otherwise restoration provides a garden for the trout to increase and expand their habitat.

Michael – whether the headcut is natural or not doesn't matter, decisions need to be made based on objectives, what do you want the landscape to look like consistent with management targets. Suggested we set some goals about biomass production for grazing and raising the groundwater levels through restoration/beaver. Talked about perceived resistance to beaver and people may be changing their minds about them. He suggested to tweak one variable and then measure response. Described why beavers found in the lower reach, but not in the narrow section we walked through where there is a colluvial fan pinching the stream. Valley flooding with beaver ponding is happening naturally and may not require fencing to keep cattle out. Key physical habitat variables for beaver are: valley width, stream size, and stream gradient. Suggested cross sections of groundwater wells.

Rene – you may have to loose seasonal habitat to grazing, but make it transparent. Incentivize the landowner to pay them for the loss of range habitat. There were not

a lot of cows here historically and to restore an ecotype with some cows, compensate grazers to give some up is the key. Perhaps a water trust, keep water instream and compensate to protect the water supply for listed species downstream, quantify the benefits to decreasing grazing and providing x. y. z benefits.

Brock – beaver are a keystone species and create habitat for other animals.

Karen – listed a bunch of other researcher who could be involved in the Childs Meadow study: Ken Tate, missed the others…

Gia - carbon storage (Bonneville Env. $14/sample), sent pdf to Kristen, sampling protocol included discrete sampling at consistent soil depths to determine the vertical distribution of carbon. Studied three restored and three un-restored meadows, the unrestored was used as a baseline for before and after comparison. Data indicate the restored meadows contain twice as much total carbon as the degraded meadows; on average approximately 40 tonnes more carbon per acre.

Jann – track the Lodgepole pines, they indicate saturated conditions or not. Also the USFS is interested in aspen restoration and there may be a conflict with beaver.

Michael – responded to Jann citing studies on wolf reintroduction and coppicing of aspen in response to allelopathy. Studies have shown that plants (e.g. willows) that are browsed often release compounds that make the new shoots less palatable. There is also genetic variation. Some Populus clones are less edible than others. May need to provide some guidance on interactions between beaver and aspen

Brock - Market 'Bovine and Beaver' for meat produced in beaver friendly meadows. Use range riders to move cows around so they don't hammer the riparian corridor, use AmeriCorps or at-risk youth groups.

Next steps:
Letter of support to DFW ahead of their white paper on beaver

DFW whitepaper will sideboard positions, wildlife branch, website on beaver as nuisance pulled, the Fisheries Department is going to have a new Mountain Meadows Branch within the Carbon Sequestration Branch, CA opposed to moving beaver.

Garth Hodgson photos

Michael Pollock's Presentation

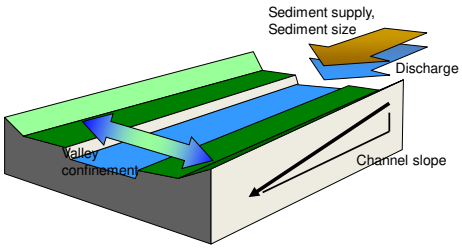
Should we view streams as drainage networks or habitat networks?

Michael M. Pollock
NOAA Fisheries
Northwest Fisheries Science Center
michael.pollock@noaa.gov

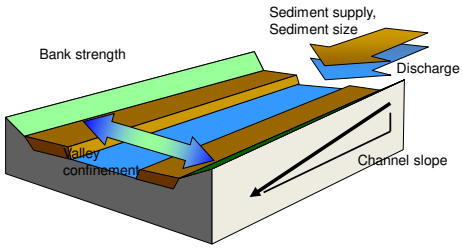
Topics

- Overview-physical controls on stream habitat
- Restoration and monitoring using beaver dam analogues and beaver-an example
- Design of BDAs
- Consideration of network location and goals when using BDAs and other restoration techniques
- Alternatives to BDAs

Controls on Morphology and Habitat



Controls on morphology and habitat



Restoring Drainage Networks Requires Understanding the Relationship Between Hydrology and Sediment

$$Q_s d_{50} \propto QS$$

Lane's Balance

Restoring Fluvial Ecosystems Requires Understanding the Relationship Between Hydrology, Sediment and Biota

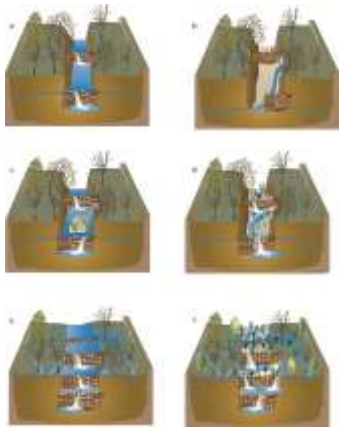
$$Q_s d_{50} \propto \frac{DS}{n}$$

How might biota affect stream evolution and habitat characteristics?

- Increasing Flow Resistance
- Decreasing Slope
- Increasing Sediment Inputs
- Decreasing Depth

Sequential Steps of the BDA "Shortcut" Same effect as BDs, but:

- Applied to narrower trenches
- Longer-lived
- Strategic placement opportunities

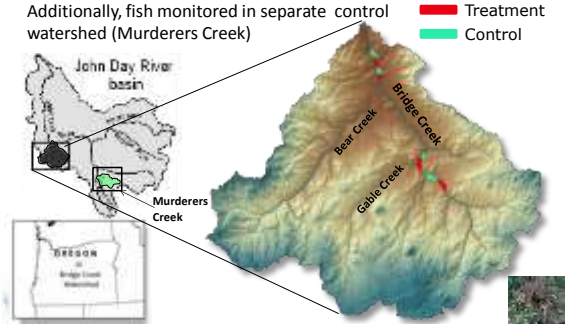


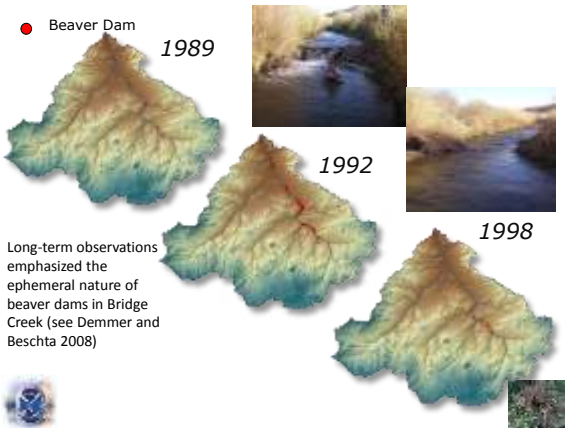
Bridge Creek Monitoring Design

BACI design

- 3 yr pre-treatment data / 3 yr post-treatment data
- 4 set of paired treated-untreated reaches

Additionally, fish monitored in separate control watershed (Murderers Creek)





Long-term observations emphasized the ephemeral nature of beaver dams in Bridge Creek (see Demmer and Beschta 2008)

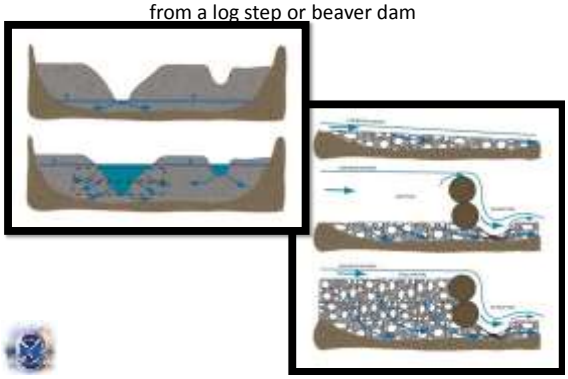
Project Implementation

Installed 114 structures (1000s of posts) in 4 treatment reaches (0.5-1 km) mostly in 2009, and repaired/added as approriate in 2010-2012.

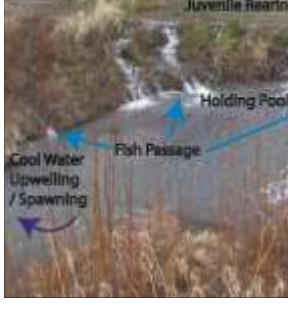
Monitored:

- Juvenile/Adult Steelhead
- Aggradation and Erosion
- Alluvial Water Tables
- Riparian Vegetation
- Instream Habitat

Side view and front view showing hyporheic flow paths from a log step or beaver dam



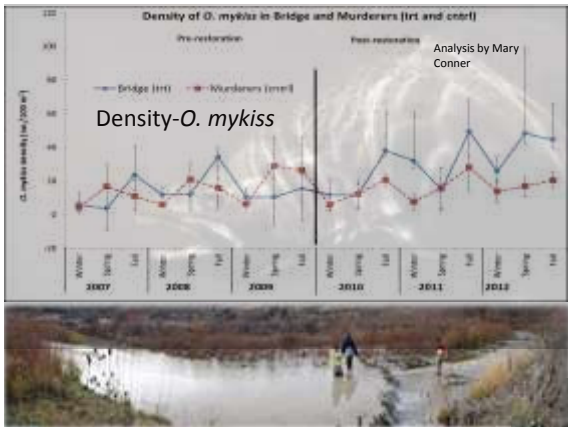
Results

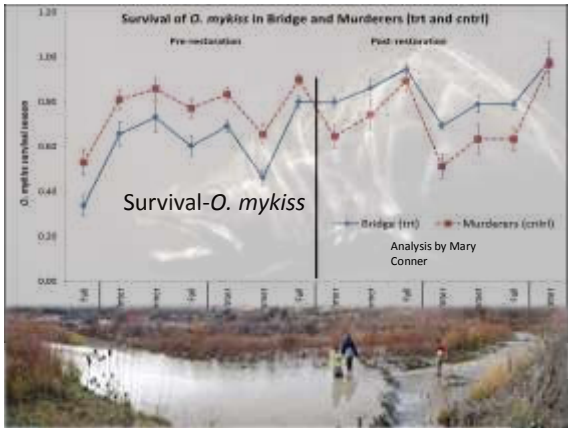


Channel spanning obstructions and complex habitat provide many benefits

How did the BDAs handle high flows?

Under the right conditions, terrace access was greatly increased, and…





Sediment Storage-Complex Response

Upstream:
- Filling above structures

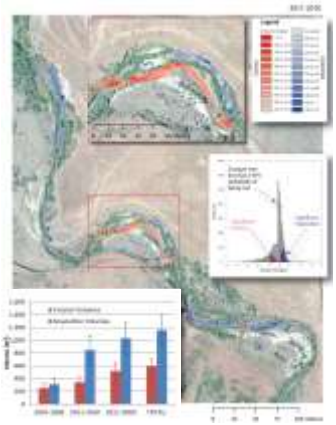
Downstream:
- Scour pools below, followed by depositional bars

Reconnected Terraces
- Erosion from multiple channel formation
- Some overbank deposition, hard to detect

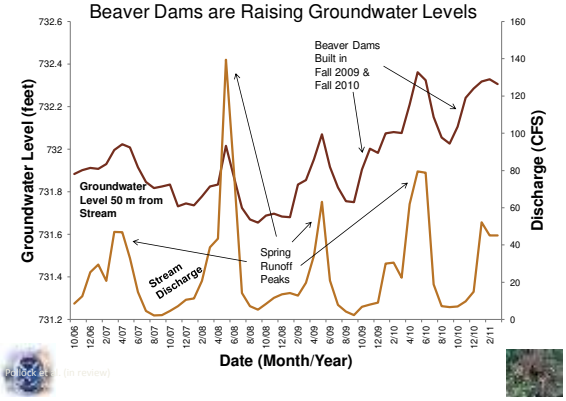
One structure's erosion is another's deposition

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

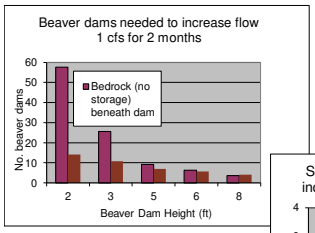
Analysis by Joe Wheaton



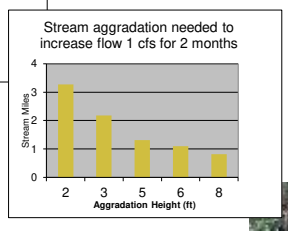
Beaver Dams are Raising Groundwater Levels



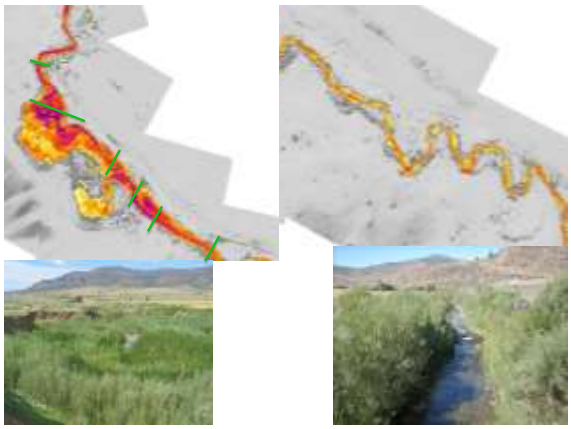
How many instream structures are needed to sustain baseflows?



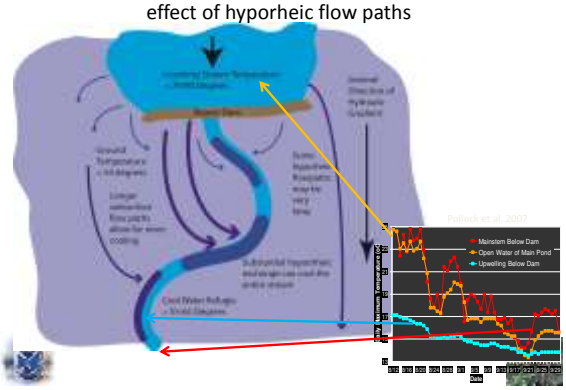
- Calculations suggest that relatively few beaver dams or log steps can restore streamflow through alluvial aquifer recharge. The taller the structure, the fewer that are needed



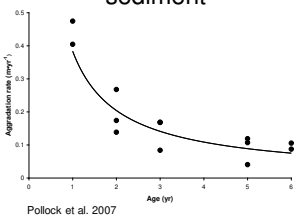
- But groundwater dynamics are very challenging to accurately model-The effect of multiple small dams/steps on flow needs quantifying-empirically



Plan view of a beaver dam (or log step) showing cooling effect of hyporheic flow paths



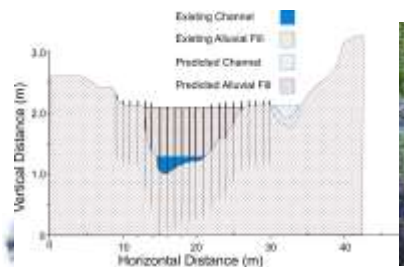
Beaver dams expand riparian vegetation extent and trap sediment



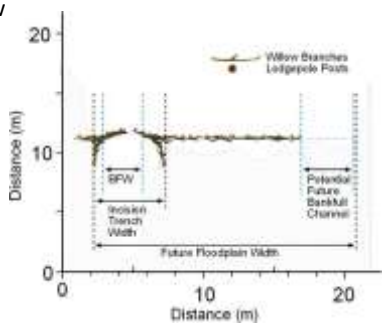
Pollock et al. 2007

Beaver Dam Analogues-Design

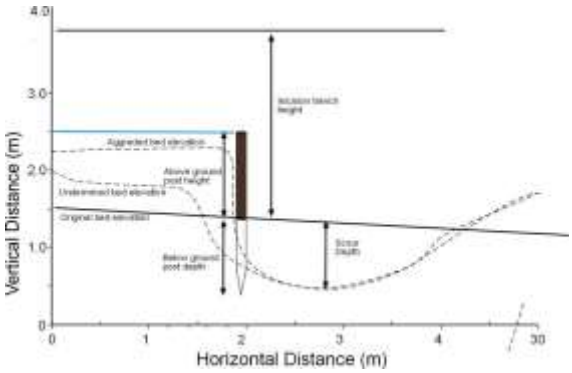
BDA-Front View



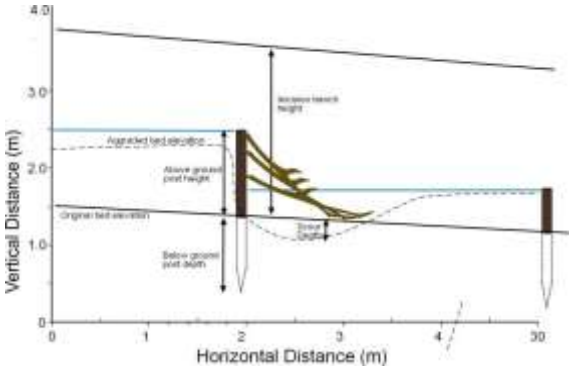
- BDA-Plan View



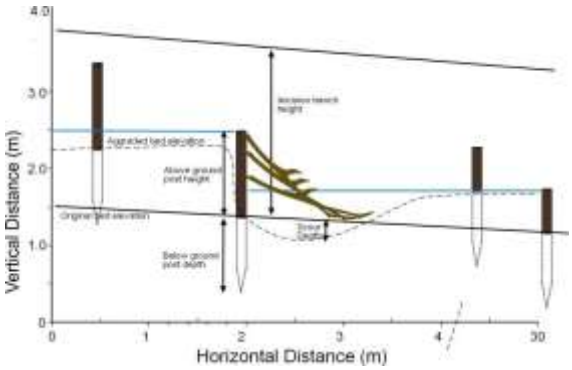
…BDA sideview



BDA-downstream branches



BDA-Round 2



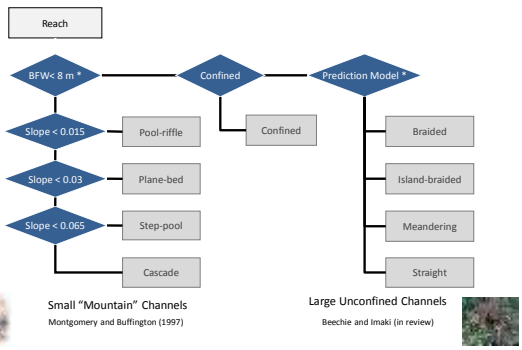
Restoring Streams

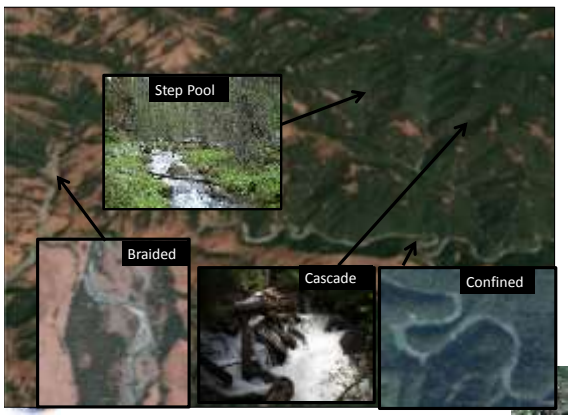
- Goals
- Space
- Time
- Non-BDA options

What are your goals? (coho as an example)

	Beaver Ponds	Valley Jams	Log Steps-OF	Log Steps-UF	Bank Input	Flow Deflection Jams	Bar-Apex Jams	Meander Jams	Log Rafts	Bench Jams	Unstable Wood
Stream size	S	<50m BFW, < 500m VW	S (< 10 m)	S (< 10 m)	All	S, M	M,L	M,L	L	S	All
Slope	<8%	2-20%	1-70%	1-70%	All	<4%?	<3%	<3%	<2%?	6-20%	
Confined/Unconfined/Entrenched	All	C/U/E	C/U/E	C/U/E	C/U/E	U	U	U	U	C	C/U/E
Geomorphology											
Floodplain reconnectivity		X	X						X		
bedrock to alluvium conversion		X	X						X		
Increased planform complexity	X	X			X	X			X		
Increased spawning gravel depths		X	X	s		s	x	x	X		
Decreased spawning gravel mobility		X	X			X			X		
multichannel formation	X	*				s	x		X		
Sediment storage/aggradation	X	XX	XX				X		X	XX	
Hydrology/Hydraulics											
Extensive slow-water habitat	XX								X		
Increased streamflow/GW recharge	X	X	X						X		
Hyporheic exchange	X	X	X	s		x	x	x	X		
Thermal refugia	X	X	X						X		
Upstream backwater pool	X		s						X		
Downstream scour pool	X	X	X						?		
Under or lateral scour pool				X	X	X	X	X	X		
Biology/Other											
Increase riparian vegetation	X	X	X				X		X	xx	
Improved food production	X	X	X						X		
Cover	X	X	X	X	X	X	X	X	X		X
wetland formation	X								X		

Where are you in the network?

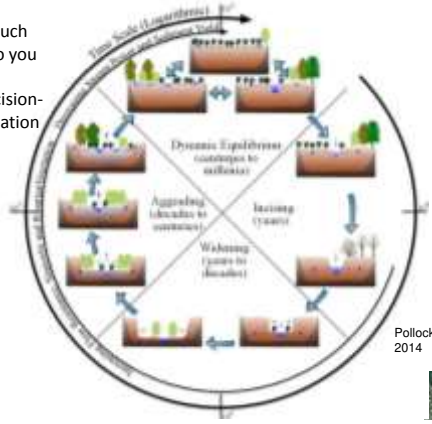




What types of structures are appropriate?

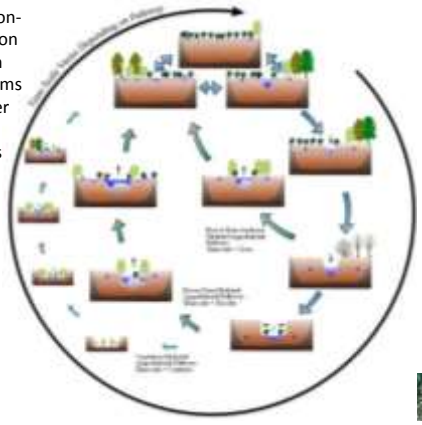
Location	Non-mobile--> Off-channel ponds	Beaver Ponds	log steps, Over-flow	Log steps, Under-flow	Bank Input Debris	Combination--> Valley Jams	Flow Def-lection Jams	Transport--> un-stable logs	bar-apex jams	mean-der jams	log rafts	Debris flow jams
Low-gradient Habitat												
Tributary channel, unconfined, unentrenched	x	x	x	x	x	x	x	x				x
Tributary channel, confined			x	x	x	x		x				
Tributary channel, entrenched			x	x	x	x	x	x				x
Mainstem channel, unconfined, unentrenched	x	x			x	x	x	x	x	x	x	
Mainstem channel, confined					x	x		x				
Mainstem channel, entrenched					x	x	x	x	x	x	x	
Estuary-distributary channels	x	x	x	x			x	x				
Estuary-main channel								x	x	x	x	
Medium Gradient, confined tributary habitat			x	x	x	x		x				
High gradient, confined tributary habitat			x	x	x	x		x				

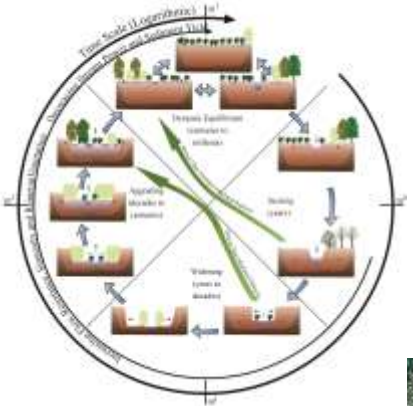
How much time do you have? The Incision-Aggradation Cycle



Pollock et al. 2014

The Incision-Aggradation Cycle with beaver dams and beaver dam analogues





Other Restoration Options

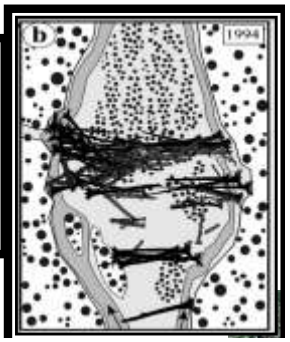
Beaver and riparian vegetation have been part of stream ecosystems for a long-time, so we are currently in a somewhat unique situation

Photos Courtesy of Carol Evans BLM

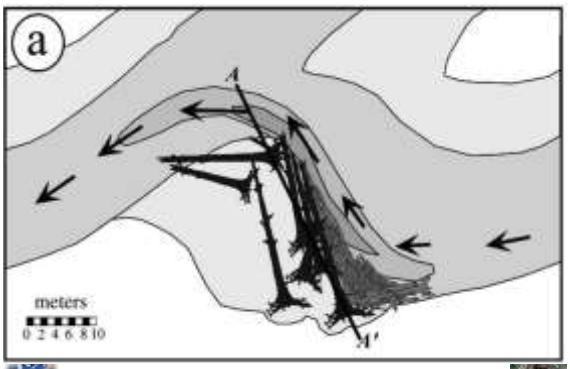
Wood can be strategically placed to maximize positive effects on hydrology, geomorphology and fish

<u>Off-channel ponds also an option (plug and pond w/o the plug)</u>
-immediately create slow water habitat
-Aren't designed to address flow issues
-more expensive

Managing for complexity-channel spanning structures or obstructions are often essential



Complexity restoration does not require channel spanning structures



Questions?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