Beaver Restoration Feasibility Assessment for the North Fork Kern River Drainage

Prepared for California Trout

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INTRODUCTION

Beaver (*Castor canadensis)* are considered a "keystone species" whose dams and associated ponds can augment surface and groundwater storage, enhance water quality, aggrade incised channels, increase floodplain connectivity and create and maintain wetland and riparian habitats (Hood and Bayley 2008, Westbrook et al. 2006). Beaver create habitat complexity and diversity in otherwise simplified stream systems and can prolong critical summer stream flow or provide perennial flow to degraded streams that would otherwise run dry (Jones et al. 1994, Pollock et al. 1994). Beaver ponds increase adjacent riparian, wetland, and wet meadow habitats and can provide significant ecosystem benefits to fish, birds, mammals and other wildlife (Foote et al. 2013, Pollock et al. 2004 and 2007, Bouwes et al. 2016).

Current beaver management policies and practices cite twentieth century zoologists' assertion that beaver were not native to the Sierra Nevada and the southern Cascades above 305 meters (Grinnell 1937 and Tappe 1942). Recent investigations have found evidence that counters this assertion. Samples taken from remnants of two buried beaver dams found in an incised channel of Red Clover Creek (Plumas County) at 1,637 m and 1,671 m were radiocarbon dated to AD 580, AD 1730, AD 1820 and AD 1850 (James and Lanman 2012). This and other evidence suggest beaver may have historically occurred more widely across California than previously believed (Lanman et al. 2012 and 2013).

Nearly extirpated in California by the early twentieth century, beaver's precipitous decline across North America closely followed patterns of European colonization (Dolin 2010), and the loss of hundreds of thousands of square kilometers of wetlands (Dahl 1990). In an effort to address this legacy impact, between 1923 and 1950 the Department of Fish and Game translocated over 1,200 beaver to watersheds across California from the coast to the Sierra Nevada (Tappe 1942, Hensley 1946). While beavers have successfully reoccupied parts of their former range, lack of awareness of beaver's potential value, habitat loss and continued depredation have restricted populations in many areas (Baker and Hill 2003).

In the past decade, recognition has been growing for the role beaver can play in restoring aquatic habitat in salmonid bearing streams of the arid western United States (Pollock et al. 2014). Many western streams have significant bank erosion and widespread loss of riparian vegetation due to extensive land clearing, grazing activities, altered or diminished hydrology, and extirpation of beaver. Marston R.A. (1994) notes that the removal of beaver and their dams from small mountain valleys lowers water table levels, increases river entrenchment and decreases water quality downstream due to greater sediment and nutrient delivery. Pollock et al. (2003) describe similar effects and stress the urgent need for further assessment of the cumulative hydrologic and geomorphic effects of the removal of millions of beaver dams.

Conservationists have begun exploring beaver restoration as an economical means to achieve desired conditions while sequestering carbon in Sierra Nevada and Southern Cascade mountain meadows.

Unconfined valleys in mountain watersheds, while only 25% of the river area, store roughly 75% of total riverine carbon in coarse wood and floodplain sediment (Polvi and Wohl 2012). Analysis of beaver dam impacts on montane valley bottom carbon storage indicates that, historically, actively maintained beaver meadows stored 23% of the carbon in the landscape (Wohl 2013).

In addition to increased carbon storage, beaver dams could improve meadow ecosystem function by aggrading entrenched channels, slowing head cut migration and reducing conifer encroachment. Beaver dams and their resulting overbank flooding have been found to influence groundwater-surface water interactions by extending the depth and duration of flood-related inundation leading to higher groundwater levels at high and low flows (Westbrook et al. 2006).

Beaver habitat modifications can provide critical habitat for other focal species. Recent investigations have demonstrated that constructing Beaver Dam Analogues (BDAs) can accelerate re-colonization and damming of streams by beaver in order to improve habitat for steelhead trout (*Oncorhynchus mykiss*) (Pollock et al. 2014) and cutthroat trout (*Oncorhynchus clarkii*) (DeVries et al. 2012). Lokteff et al. (2011) found in their study on beaver dams and the movement of trout that native Bonneville Cutthroat Trout (*Oncorhynchus clarkii utah)* passed dams more frequently than nonnative trout. Cooke and Zack (2008) found that increased beaver dam density in semiarid regions creates excellent habitat for birds including the Willow flycatcher (*Empidonax traillii*). Re-sprouting beaver felled trees and stumps create high value habitat for Willow flycatcher (Jungwirth et al. 2005).

When discussing beaver restoration, we are referring to the following approaches as defined in the *Beaver Restoration Guidebook* (Pollock et al. 2015):

- Passive actions (regional trapping restrictions and grazing regime changes) to enhance benefit from beaver populations
- Active habitat manipulation (willow planting, BDA installation) to support beaver colonization and dam building
- Active relocation of beaver to support colony establishment in areas where they do not currently occur

Often these approaches are used in combination with one another to ensure the success of beaver restoration efforts. Relocation in particular can benefit from habitat enhancement efforts in advance of the relocation as well as trapping restrictions and the reduction of forage competition through changes in grazing practices after relocation occurs.

Given the potential benefit of beaver to mountain meadow restoration and related focal species, we conducted a beaver restoration feasibility assessment to aid in the *Prioritizing Meadows for Restoration within the North Fork Kern River Drainage* project led by California Trout. The goal of our beaver assessment was to identify which, if any, of the ten priority meadows would be good candidates for beaver restoration treatments as a means to achieve meadow restoration goals.

METHODS

To determine the feasibility of utilizing beaver restoration as a treatment in the ten priority meadows we analyzed historic and current distribution of beaver, relocation data and habitat suitability found in these meadows and watersheds adjacent to the North Fork Kern River watershed. We had intended to incorporate habitat modeling results from the Beaver Restoration Assessment Tool (BRAT) but they were not completed in time due to funding delays.

Knowing where beaver have historically occurred, where they were transplanted, and where they persist in the region today gives us insights into what conditions they favor, the impacts they are currently having, how likely they would be to find these meadows on their own, and where beaver might be sourced were a relocation pilot deemed appropriate. We conducted field surveys to get the most accurate assessment of whether or not current conditions in these meadows could provide suitable habitat for beaver.

HISTORIC DISTRIBUTION (Prior to 1949 Relocations)

To assess what historic distribution data is available in the North Fork Kern River and its environs, we reviewed the scientific literature and interviewed locals, restoration ecologists and resource agency staff.

POST-RELOCATION AND CURRENT DISTRIBUTION (1949 – Present)

We reviewed California Department of Fish and Wildlife records and scanned the literature to determine if any beaver were relocated in and around the project area during the statewide relocation program executed from 1923 – 1950. To assess current distribution in the North Fork Kern River and adjacent watersheds, we interviewed resource agency and

NGO staff who work in the region, reviewed American Rivers Scorecard results, conducted internet searches and looked for relevant observations listed in The Beaver Mapper and iNaturalist. We used a combination of field surveys and remote sensing (Google Earth) to confirm leads on active colonies.

DAM BUILDING CAPACITY OF RIVERSCAPE – BRAT MODEL

In our original beaver restoration feasibility assessment proposal to California Trout we planned to utilize the CASTOR Model to identify suitable beaver habitat in the North Fork Kern watershed. In the Fall of 2017 the opportunity arose to partner with The Nature Conservancy and others in working with Utah State University (USU) to run the Beaver Restoration Assessment Tool (BRAT). The Ecogeomorphology and Topographic Analysis Lab (ETAL) at USU's Department of Watershed Sciences was charged with running the BRAT for 78 HUC 8 level watersheds within four EPA Level III ecoregions in the Sierra Nevada, Cascades, and Klamath mountains of California. This model is a decision-making tool designed to support resource managers in determining where beaver restoration could be most effective (MacFarlane et al. 2016).

ETAL describes the BRAT as a capacity model developed to assess the upper limits of riverscapes to support beaver dam-building activities. The BRAT is not designed as a beaver habitat suitability model since we predominately care about the eco-hydrological benefits of the beaver dams themselves and not habitat suitability for non-dam building beaver populations. Estimates of beaver dam capacity come from five main lines of evidence: (1) a reliable water source; (2) stream bank vegetation conducive to foraging and dam building; (3) vegetation within 100 m of edge of stream to support expansion of dam complexes and maintain large beaver colonies; (4) likelihood that dams could be built across the channel during low flows; and (5) the likelihood that a beaver dam on a river or stream is capable of withstanding typical floods.

Unlike the Methow Beaver Project Release Site Scorecard (described next), the BRAT favors a wider gradient range (0.5 – 15%) because steeper gradients incite beaver to build a higher number of dams.

HABITAT SUITABILITY - METHOW BEAVER PROJECT RELEASE SITE SCORECARD

We conducted field surveys using the Methow Beaver Project (MBP) Scorecard. This scorecard was developed by the Methow Beaver Project in northeastern Washington to determine what sites will best support newly released beaver and the building of dams. The project has successfully transplanted hundreds of beavers to dozens of sites over the past decade, studying the effectiveness and effects of transplants. The MBP scorecard is used to rate the suitability of release sites using a point system based on several factors deemed relevant in their past monitoring studies. These factors include the availability of woody food and building material, stream gradient and flow, availability of existing aquatic escape cover, presence of herbaceous food, stream bottom character, past beaver presence and other factors that could contribute to human-beaver conflicts.

Given that beaver are not currently present in the meadows surveyed, knowing if any of them could function well as release sites in the future could help guide restoration decisions.

We found the qualitative descriptions for the score breakdowns in the 2015 version of the MBP scorecard difficult to assess with accuracy and consistency. We spoke with MBP staff and reviewed other sources that use this scorecard to assign quantitative score ranges where possible. See Appendix C for the revised MBP scorecard we used in the field.

While the MBP scorecard usually has a maximum total of 100 points, we reduced the maximum total possible to 90 since we were unable to assess both high and low flows (see below). Rather than conduct a second set of field visits during high flows, we decided to utilize results from the BRAT modeling to determine which meadows have the best flow regimes to support beaver and their dam building behavior. We will have to integrate the BRAT data once they become available. Where applicable, we utilized Google Earth and stream condition inventory data gathered by project partners from the University of Nevada at Reno (UNR) in September 2017 to augment and validate our scores.

- **Gradient –** We walked the length of each meadow using an inclinometer to measure gradient at roughly 30-meter intervals. The possible points for this factor are: **+10** (≤3%), **0** (4-6%), **-10** (7-9%) and **-30** (≥9%).
- **Stream Flow –** We walked the length of the channel (where present) in each meadow making qualitative assessments of the flow. The total possible points for this factor are arrived at by assessing both maximum and minimum flows. Due to the fact that site visits were conducted during the low flow season alone we noted the points based on the flow at that time but did not include these points into the overall scoring results. We used Beardsley and Doran (2015) to assign quantitative cubic feet per second (cfs) equivalents to the MBP Scorecard qualitative descriptors: 0.1 cfs (about the flow from a garden hose), 0.5 cfs (about the flow from a fire hose), 2.0 cfs (about the flow from a 10" culvert), and 5.0 cfs (about the flow from a 30" culvert).
- **Habitat Unit Size –** This indicates the linear extent of habitat beaver would find favorable under current conditions. We used remote estimates made through Google Earth to determine channel length. The possible points for this factor are: **0** (0-199m), **1** (200-549m), **2** (550-899m), **3** (900-1,249m), **4** (1,250-1609m), **5** (≥1610 m or 1 mile).
- **Woody Food** – We walked the center and perimeter of each meadow to determine presence and extent of favored woody food species (aspen, willow and alder). The possible points for this factor range from **0** (none present) to **18** (hundreds of aspen and willow stems within 10 meters). The points are arrived at by multiplying type of woody food, by proximity, by number of stems.
- **Herbaceous Food –** We walked the center and perimeter of each meadow to determine presence and extent of favored herbaceous food species (i.e. hydric grasses and sedges). The possible points for this factor range between **10** (aquatic and terrestrial grasses and forbs abundant) and **5** (no grass/forbs present).
- **Floodplain Width –** We walked the length of the channel, where present, qualitatively assessing floodplain width. The possible points for this factor range between: **5** (wide stream bottom with a flood plain at least twice the width of the stream) and **0** (narrow "V" channel).
- **Dominant Stream Substrate –** We walked the length of the channel, where present, qualitatively assessing dominant stream substrate. Possible points for this factor are: **5** (Silt/Clay/Mud), **2** (Sand), **1** (Gravel), **0** (Cobble), **-1** (Boulders) and **-3** (Bedrock).
- **Historical Beaver Use -** Easily recognizable physical evidence of historic use alone (chewed trees, remnant dams and lodges) was considered when assessing meadows. Possible points for this factor are: **15** (old structures present) and **0** (no indication of previous occupancy).
- **Lodge and Dam Building Materials -** We walked the center and perimeter of each meadow to qualitatively assess presence of building materials. Possible points for this factor range between: **5** (abundant 1-6" diameter woody vegetation available) and **-20** (no building material present).
- **Browsing/Grazing Impacts -** We walked the center and perimeter of each meadow to qualitatively assess browsing and grazing impacts. Possible points for this factor range between: **5** (No Impact or obvious presence of browsers / grazers) and **-10** (Heavy browsing / grazing).
- **Ease of Access –** We walked the perimeter of each meadow and the length of the channel (where present) noting ease of access for beaver restoration and future monitoring. Possible point for this factor range between: **2** (Easy travel to deliver beavers and monitor) and **-5** (Long hike).
- **Existing Aquatic Escape Cover –** We walked the length of the channel (where present) using a yardstick in select areas to determine depth of pools. Possible points for this actor range between: **10** (Multiple deep pools >1 meter deep present) and **-10** (No pools).

OTHER CONSIDERATIONS

In addition to assessing the habitat for supporting beaver relocation, we noted the physical (i.e. roads, campground infrastructure), land-use, and social barriers (i.e. grazing permittee tolerance) that could reduce the likelihood of beaver restoration success in the meadows surveyed.

RESULTS

HISTORIC DISTRIBUTION (Prior to 1949 Relocations)

The most recent and comprehensive attempt to re-evaluate the historic range of beaver in the Sierra Nevada was carried out by Lanman et al. and James and Lanman in 2012. Physical evidence, historic and ethnographic accounts and place names were all considered in this re-evaluation. We found no references to historic physical evidence within the project area in Lanman et al. (2012) or the other sources we reviewed.

For information about historic accounts of beaver in the Kern River area, we found two references to Wendy R. Townsend's 1979 master's thesis on *Beaver on the Upper Kern Canyon*. During her study, Townsend recorded an historic account from Mr. Roy De Voe, about his deceased friend (Mr. Kenny Keelor) who claimed to have "trapped the Kern Canyon around the turn of 20th century, making his headquarters at Rattlesnake Creek" and that the "'Big Beaver' were trapped out around 1910-1914." Mr. De Voe also indicated he had seen "very old beaver sign on the east side of the river near Lower Funston Meadow in 1946." Both of these accounts predate relocation efforts conducted in 1949.

Townsend notes that while there are no explicit references to beaver in studies of the native Tubatulabal conducted by C.F and E.W Voeglin from 1935 to 1938, these researchers did record a legend about a "mud-diver" from this tribe. C.H. Merriam lists no Tubatulabal word for beaver in his *Indian Names for Plants and Animals Among Californian and Other Western North American Tribes* (1979). While a beaver place name was found in the lower Kern River, none were found in the North Fork.

POST-RELOCATION AND CURRENT DISTRIBUTION (1949 – Present)

We found two sources summarizing beaver transplants conducted by what was then called the California Department of Fish and Game (CDFG) in or near the project area. CDFG records cited in Lynn (1950) and Townsend (1979) indicate 80 beaver were planted at 15 different sites in Tulare and Kern County in 1949 (see Table 1).

While some of these transplants are listed in both source documents, each report has additional records that are not listed in the other. Townsend obtained her records directly from the Department of Fish and Game regional office in Fresno. She notes the records are "deficient," the reintroduction process was inconsistent and that it was "difficult to pinpoint many introductions."

In order to map the relative location of release sites to the project area, we assigned estimated coordinates to each record (see Figure 1). We mapped only those sites whose creek names and corresponding elevation could be located on current maps of named counties. We assigned coordinates nearest the release elevation cited in the records. The markers for modern day "Clicks Creek" correspond with the "Cleiks Creek" and "Upper Cleiks" creek sites mentioned in the relocation records, though we were unable to confirm if these are the same drainages.

The California Department of Fish and Wildlife has not generated beaver distribution data since the California Wildlife Habitat Relationships (CWHR) range map was generated in by Zeiner, et al. (1990). This map does not indicate the presence of beaver within the project area (see CWHR range map overlaid onto The Beaver Mapper at http://www.riverbendsci.com/projects/beavers/public-map).

There are no North Fork Kern River beaver observations listed in The Beaver Mapper (http://www.riverbendsci.com/projects/beavers/public-map) however, there are observations of beaver activity listed for three locations in the Upper South Fork Kern River watershed between 2013 and 2016. Beaver chews and a dam were observed with no signs of current occupancy on the South Fork Kern River above Monache Meadows in 2016. Tree chews were not present in previous years at this site according to the observer who visits annually. Beaver dams in and around this site are visible from 2016 Google Earth imagery. A beaver dam was found on Fish Creek near Rockhouse Basin in 2013. Another observer noted a beaver dam on Fish Creek near Rodeo Flat in 2007. Beaver dams at both of these Fish Creek sites are visible and appear intact in 2013 Google Earth images. Distinct dams and the area of ponded water in both of these sites appear reduced in 2016 Google Earth images. We were unable to confirm active presence for all three of these sites through interviews or by looking at 2017 Google Earth imagery.

Date of Plant	Male/ Female	Total number	County trapped	Elevation trapped	County planted	Elevation planted	Location of plant	Source	Location name found on current maps (Google and/or USGS topo?
5/13/49	3/2	5	San Joaquin	150'	Tulare	6,500'	Freeman Creek	1, 2	Yes
5/13/49	2/2	4	Merced	150'	Tulare	7,000'	Boulder Creek	1, 2	Yes
5/25/49	4/2	6	Merced	180'	Tulare	6,500'	Peppermint Creek	1, 2	Yes
5/25/49	3/2	5	Merced	180'	Tulare	6,500	Tributary to Peppermint Creek	1	Yes
6/3/49	2/2	4	Merced	200'	Tulare	6,000'	Cleiks Creek	1	Possibly - Could this be Clicks Creek?
6/3/49	2/2	4	Merced	200'	Tulare	6,400'	Upper Cleiks Creek	1	Possibly - Could this be Clicks Creek?
7/13/49	4/4	8	Stanislaus	180'	Tulare	7,500'	Pine Canyon Camp Creek	1, 2	No
7/22/49	3/2	5	Stanislaus	300'	Tulare	6,200'	Nobe Young Creek	2	No
8/15/49	2/4	6	Stanislaus	300	Kern	4,000'	Thompson Creek	1	No
8/29/49	3/3	6	Merced	280'	Tulare	7,000'	Long Meadow	1, 2	Yes
8/29/49	2/3	5	Merced	280'	Tulare	8,600'	Peeks Canyon Creek	2	No
9/10/49	2/3	5	Merced	200'	Kern	3,500'	Sage Canyon Creek	1	No
9/11/49	2/3	5	Merced	200'	Tulare	7,500'	Fish Creek	1	Yes
9/30/49	2/4	6	Merced	180'	Tulare	6,000'	Tamarack Creek	1	Not at listed elevation, only at a higher elevation
9/30/49	2/4	6	Merced	180'	Tulare	6,500'	Sheep Creek	1	Not at listed elevation, only at a much lower elevation

Table 1. Beaver transplants by the California Department of Fish and Game in Tulare and Kern Counties. (Source 1: Lynn (1950) Project California 34-D-2 Beaver Transplanting (1923-1949), California Division of Fish and Game. Source 2: Townsend, W. R. 1979. Beaver in the upper Kern Canyon, Sequoia National Park. M.S. Thesis, Fresno State University)

iNaturalist (https://www.inaturalist.org/taxa/43794-Castor-canadensis) lists evidence of beaver in both the North and South Forks of the Kern River. One observer found a beaver skull alongside the North Fork Kern River just below the confluence of Rock Creek in July of 2017. The same observer found older evidence of chewed trees in Rock Creek just east of where it joins with the mainstem North Fork Kern River. It was not possible to confirm this or other evidence through 2017 Google Earth imagery. This site is roughly within a 30-kilometer radius from an active beaver colony in Ramshaw Meadows to the south and east (see Ramshaw description below).

Another iNaturalist observer noted evidence of beaver dams, lodges and three live beaver in the South Fork Kern River near Kennedy Meadows in 2014. This dam is still visible in Google Earth imagery from 2017 though it is not possible to determine whether or not it is currently being maintained by beaver.

Interviews with biologists working in the project area yielded several leads. We were able to confirm with a site visit and through 2017 Google Earth imagery that Fish Creek running through Troy Meadows still has active beaver presence. Photos taken by Sabra Purdy (UNR) in the field and Google Earth imagery indicate there was active beaver

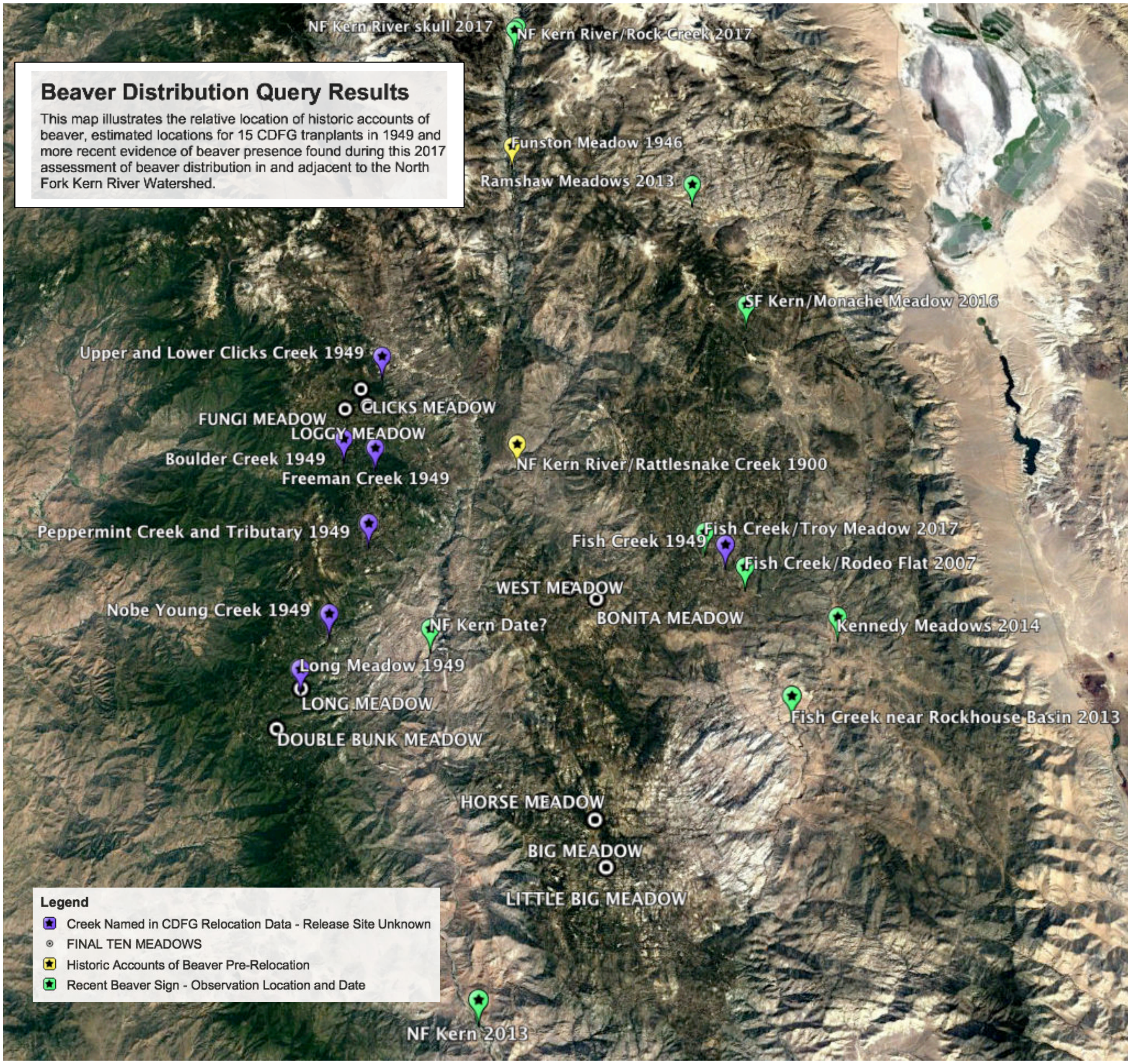

Figure 1. Sequoia Meadows Beaver Distribution

presence in Ramshaw Meadows in 2013. Dams do not appear to be active in 2017 Google Earth imagery. Another source observed live beaver in the mainstem North Fork Kern River in Kernville in 2013. Nina Hemphill (USFS) shared a beaver observation made by her colleague in years past (date unknown) in the mainstem North Fork Kern River above the Johnsondale Bridge. We were unable to detect signs of beaver activity via Google Earth in either of these last two sites.

Stephens et al. (2004) mention in *The California Golden Trout Assessment and Strategy* report the presence of beaver in both upper and lower Ramshaw Meadows. The authors suggest “there are additional, smaller populations of beaver in other locations on the Kern Plateau, but their extent has not yet been surveyed. These populations appear to be expanding to new areas.” They do not, however mention where these smaller populations occur.

Of the thirty-nine North Fork Kern River meadows scored with the American River Meadows Scorecard for this prioritization process, none of the assessments listed beaver as present. None of our interviews or remote sensing indicated otherwise.

DAM BUILDING CAPACITY OF RIVERSCAPE – BRAT MODEL

Due to funding delays, the BRAT model was not completed in time to utilize its outputs for this assessment. Once complete, the BRAT will be made available to the public and provide an important component to the beaver restoration feasibility assessment process.

HABITAT SUITABILITY - METHOW BEAVER PROJECT RELEASE SITE SCORECARD

In September 2017 Kate Lundquist (Occidental Arts and Ecology Center WATER Institute) and Kevin Swift (Swift Water Design) conducted beaver habitat field surveys of the fourteen “Batch V” meadows, none of which are currently inhabited by beaver. For this report we will discuss results from the final ten priority meadows. A summary of these results is provided in Table 2.

UCD Meadow ID	Name	Survey Date	Stream gradient	Stream flow*	Habitat size	Food		Floodplain width	Sub-strate	Historic use	Building materials	Grazing use	Access	Escape cover	TOTAL (-71 min)
						Woody	Herbs								
			-30 - +10	0 - +10	+1 - +5	+1 - +18	+5 - +10	0 - +5	-3 - +5	0 - +15	-20 - +5	-10 - +5	-5 - +2	-10 - +10	(90 max)*
UCDSNM000059	Little Big	9/7/17	10	n/a	1	12	10	4	2	0	5	-5	2	-9	**32**
UCDSNM000068	Big (lower)	9/8/17	10	n/a	1	0	8	5	4	0	-10	-10	1	-10	**-1**
UCDSNM000068	Big (middle)	9/8/17	10	n/a	4	0	8	5	4	0	-10	-10	1	3	**15**
UCDSNM000068	Big (upper)	9/8/17	10	n/a	2	9	8	3	4	0	-5	-5	1	7	**34**
UCDSNM000088	Double Bunk	9/5/17	10	n/a	1	18	10	2	5	0	5	-3	2	-5	**45**
UCDSNM000103	Horse (lower)	9/5/17	10	n/a	1	0	10	3	5	0	-7	-5	2	-10	**9**
UCDSNM000103	Horse (upper)	9/5/17	0	n/a	1	9	10	2	5	0	-2	-5	2	-9	**13**
UCDSNM000111	Long	9/5/17	10	n/a	2	18	8	2	2	0	5	-4	2	-5	**40**
UCDSNM000170	Bonita	9/7/17	5	n/a	1	3	10	3	5	0	-2	5	2	-9	**23**
UCDSNM000183	West	9/6/17	10	n/a	1	0	10	2	5	0	-10	5	2	-10	**15**
UCDSNM000325	Fungi	9/10/17	10	n/a	1	6	10	2	3	0	5	-7	2	10	**42**
UCDSNM000332	Loggy	9/11/17	10	n/a	1	6	10	2	5	0	0	-10	2	-8	**18**
UCDSNM000350	Clicks	9/10/17	0	n/a	1	18	10	1	0	0	5	0	-5	5	**35**

Table 2. Methow Beaver Project Scorecard Survey Results
*Flow not considered in overall scoring (hence total maximum of 90 points)

Except for Big and Horse Meadows, we used the scorecards to rate the meadows as a whole taking note of which parts of the meadows had the most favorable habitat. We defined “Lower Big Meadow” as the section that runs from the southern edge up to the first fence that bisects the meadow. “Middle Big Meadow” runs between that southern fence and the next fence that bisects the meadow to the north. “Upper Big Meadow” runs from the northern fence line to the northern edge of the meadow. “Upper Horse Meadow” begins just north of the narrow section of the meadow, where some conifers bisect the meadow and the gradient begins to notably increase.

With gradients varying from .5% to 9% all but Upper Horse and Clicks have more favorable gradients for establishing dams. We gave Bonita a lower score for this factor since the stream channel in the southern part of the meadow has both a lower gradient and a higher gradient section. Beaver will utilize a variety of gradients but tend to favor those below 3%.

While most meadows had adequate flow at the time of our field surveys (September 2017), these surveys were conducted after a record year of precipitation. Our flow assessment could be greatly affected by this unusually wet year and likely does not reflect the more common drought conditions we are experiencing in California. Once the BRAT model is complete we will have a better sense of water source reliability. This is a crucial factor to consider when planning for beaver relocation as a restoration treatment.

The currently suitable habitat size was relatively small in all but the middle portion of Big Meadow. While all have abundant herbaceous foods available, only Long, Double Bunk and Clicks meadows have sufficient woody foods (in this case willow) to support beaver year round. Little Big was the only meadow where we found aspen growing. It is unclear whether or not the absence of willow is due to overgrazing, soil type, or some combination of the two.

All but Clicks and Upper Horse Meadows have adequate floodplain widths to aid in dam establishment and support floodplain inundation. Favorable substrates and building materials for beaver dam and BDA building are present in all but Clicks meadow. The larger cobbles and boulders in Clicks Creek could make it more difficult to pound posts if BDAs were deemed appropriate. We gave Lower and Middle Big Meadow and West Meadow lower woody dam building materials scores because these materials are far away from the channel, making them more difficult for beaver to utilize.

None of these meadows had easily discernable evidence of historic use by beaver and no current evidence of beaver, thus confirming the American River Scorecard results.

The grazing use was heavy in all but Bonita, West and to a lesser degree Clicks meadows. Both herbaceous cover and willows were impacted.

All but Fungi and upper Big Meadow have insufficient aquatic escape cover. Even with the record precipitation, there was not an abundance of meter plus deep pools in any of these meadows. Fungi had the most numerous and deepest pools of all the meadows, however, the channel was narrow and not heavily vegetated with willow or other shrub overstory.

Access to all but Clicks Meadow is excellent. We deducted a point for Lower, Middle and Upper Big Meadow due to the distance from the road to the channel. While ease of access and proximity to human presence can be favorable for delivering, monitoring and even deterring predation on beaver, it can leave beaver more vulnerable to harassment and poaching by humans. This needs to be taken into consideration when designing a beaver restoration plan.

OTHER CONSIDERATIONS

The land uses with the greatest potential for conflict with beaver restoration are grazing and recreation. While beaver ponds can improve fishing, hunting, birding and watchable wildlife conditions, the proximity of all but Clicks Meadow to roads, campgrounds and the Long Meadow Grove of Giant sequoia trees increases the chances of beaver habitat modifications having an impact on human infrastructure (roads, culverts, campgrounds, etc.).

Of all meadows surveyed, those that currently have the most favorable habitat and the least likelihood of human conflict are Double Bunk, Clicks and possibly upper Big Meadow. If these systems are not sediment starved, beaver dams and beaver dam analogues could aid in aggrading entrenchment and inset floodplains, and mitigating head cuts. The resultant inundation could rehydrate desiccated soils, reduce conifer and sagebrush encroachment, increase the surface area of water and prolong saturation of wet meadows well into the dry season.

DISCUSSION

FEASIBILITY SUMMARY

California is unique among Western states in its lack of agreement on the historic distribution of beaver in the state. Locating evidence of presence prior to relocations can help inform future management actions. Resource managers in California, particularly in the Sierra Nevada, have utilized lethal management of beavers to the degree they have perceived beavers as a non-native nuisance. In cases where new evidence reveals beaver were native to a region, we have found resource managers are increasingly in favor of implementing beaver co-existence and restoration strategies. Knowing the degree to which the native/non-native debate is affecting attitudes towards, and management of, beaver in the Kern River watershed could help direct historic ecology efforts in the future.

We did not find additional evidence beyond the two DeVoe accounts of beaver trapping and signs in the North Fork Kern and the Tubatulabal "mud-diver" legend published by Lanman et al. in 2012. It is unclear, however, how widely known and accepted these findings are by those working in the region. If further corroboration of this evidence is deemed useful, it would be worthwhile pursuing other sources, especially physical evidence as this is considered most reliable by many in the scientific community.

Further investigation of archaeofaunal remains is worthy of consideration. We have discovered that the archeological community has only recently begun to realize the need to locate physical beaver remains in order to better understand the species' historic range. We have also learned not all archaeofaunal collections have been digitally catalogued nor have all remains been listed by their genus, making it more difficult to find *Castor* evidence.

Further analysis using ground penetrating radar to identify buried beaver dams, as has been done in the Rocky Mountains, (Polvi and Wohl 2012) could be instructive. It is unclear if unearthed beaver dams such as those discussed in James and Lanman (2012) are going unrecognized elsewhere in the Sierra Nevada and southern Cascades. More research, outreach and education about what evidence to look for is needed.

Given that there are no beaver present in the meadows we surveyed, if beaver restoration were deemed appropriate, management actions would include:

- Enhance habitat to induce natural beaver immigration and/or support beaver reintroduction in the future (plant woody food sources and use BDAs to encourage colonization in specific reaches and/or create new pools or increase existing pool depth for aquatic escape cover)
- Relocate beaver to most favorable sites

Natural beaver immigration to any of the ten priority meadows from currently known colonies seems unlikely to occur in the near future given the overland distance, topography and aquatic corridor connectivity. It is unclear whether conditions between the beaver colony in Fish Creek (Troy Meadow) and West and Bonita Meadows are suitable enough to support a successful disperser. If planting of woody foods were deemed appropriate for other restoration goals (i.e. increasing Willow flycatcher habitat), it would also serve to support beaver if they immigrate or were relocated to any of these meadows in the future.

BDAs are the latest iteration of channel-spanning structures and are specifically designed to restore stream habitat in areas where beaver are currently present. They can increase the durability and abundance of natural beaver dams and encourage beaver colonization in specific reaches of the system. They can also be used to prepare a site for beaver reintroduction. Some practitioners use BDAs without beaver, however this practice is considered to be the least ideal option. BDAs function best with beaver maintaining them.

If channel spanning structures are identified as a management action to remedy incised channels and/or head cuts in meadows such as Little Big, Big, Horse and Clicks, we recommend a more comprehensive assessment of which bioengineered erosion control techniques would be most appropriate.

Without changes in habitat conditions, land management practices and regulatory conditions, and a greater understanding of the relationship between beaver and Kern River Rainbow Trout and Little Kern Golden Trout, none of these meadows are currently suitable for beaver relocation.

The limiting habitat factors for beaver relocation are the relatively small habitat size in all but Big Meadow, absence of abundant woody food sources and adequate depth and width of aquatic escape cover. In areas that freeze, pool depth is even more critical as beaver need space to move under ice to access cached food. In areas with sufficient woody food supply (Clicks, Double Bunk and Long) year-round aquatic escape cover could possibly be made adequate by installing and maintaining BDAs in advance of beaver relocation.

The Methow Beaver Project is currently studying their sites where released beaver stayed at the release site to better understand factors that drive persistence. Preliminary results indicate that beaver favor low-gradient sites whose channels have adequate flow and are difficult to access due to dense willow cover. Double Bunk and Clicks both have sections like this, though the pool depth in Double Bunk at the time we surveyed was not sufficient.

The small linear extent of favorable habitat in all but Big Meadow raises the question of how long beaver would be able to persist in those locations before needing to move in search of other sources of woody food. Addition of beavers to these meadows could have negative impacts on what little willow and aspen remain especially if there were no changes made to the grazing regime. Focusing beaver restoration efforts in meadows where surrounding riparian corridors and nearby meadows have sufficient woody food supplies would be key.

Except where soil type is responsible for absence of willow, lack of woody food could be mitigated through grazing regime change (reduced intensity and/or duration, riparian exclosures, temporary or long term bans) and willow and aspen planting. Willingness of grazing permittees to coexist with beaver could play a significant role in the success or failure of beaver relocation. Before beaver relocation could be seriously considered, one would first need to conduct thorough outreach among permittees to assess their current attitudes towards beaver. Sharing other ranchers' experiences of the benefits to cattle provided by increased availability of water for stock, and greater forage production due to subsurface flow, could be helpful in this effort. Providing financial support to implement co-existence strategies would increase the success of a beaver restoration plan.

The greatest limiting factor to beaver relocation in these meadows is the regulatory environment. The California Department of Fish and Wildlife (CDFW) currently does not allow beaver relocation. Exceptions have been made, such as the 2008 relocation from Bakersfield to the Tehachapi mountains. While beaver relocation programs are practiced in every other western state, CDFW has expressed concerns about impacts on surrounding landowners, other species and the beaver themselves. We are currently working with those interested in reinstating a relocation program in California to address these concerns. Conducting feasibility assessments such as this one can help lay the groundwork for identifying viable release sites should a pilot be approved in the future. One approach worthy of consideration is to partner with interested tribes who want to exercise their sovereign rights to conduct restoration through moving wildlife on tribal lands.

Finally, and equally important, it is unclear what impacts beaver have on Kern River Rainbow Trout and Little Kern Golden Trout. We were unable to locate any research conducted in the last 60 years on this subject. Muller-Schwarz and Sun (2003) note the accumulation of silt from beaver dams in the Sierra Nevada has a negative impact on golden trout (*Salmo irideus*) spawning gravels. They do not, however, cite their source. The Golden Trout Conservation

Strategy from 2004 notes both “positive and negative effects on beaver” from sources written in 1942 (Tappe) and 1956 (Retzer et al.). While beaver are listed as a threat to the subspecies in the habitat degradation section of the report, the authors cite a contradictory observation that describes beaver dams in Ramshaw Meadow as “trapping sediment, forming extensive pools, and accelerating meadow restoration” and that “no negative impacts by beaver has been observed.” Clearly more information is needed about this interaction.

RECOMMENDATIONS

- Once complete, integrate the Beaver Restoration Assessment Tool (BRAT) results into this prioritization process. Use flow regime results to complete Methow Beaver Project (MBP) scorecard results. Synthesize the two different approaches to better understand if and where beaver restoration efforts would be most effective in the ten priority meadows.
- Pending improvements in habitat, land use impacts (i.e. grazing) and favorable results from studies of the relationship between Kern River Rainbow Trout and Little Kern Golden Trout and beaver, work with California Department of Fish and Wildlife to address their concerns and develop a pilot beaver relocation plan.
- If the above is achieved, and the flow regimes turn out to be favorable to beaver dam building and persistence, we would recommend further consideration of Big/Little, Double Bunk and/or possibly Clicks Meadows as potential beaver relocation pilot sites. The use of BDAs in conjunction with this kind of pilot could help encourage beaver establishment in these meadows. We recommend referring to the Beaver Restoration Guidebook (2015) for guidance on implementation.
- Work with the Tubatulabal and other local tribes to discuss potential beaver restoration collaboration on tribal lands. Tule River Reservation tribal members have expressed interest in beaver restoration in the past.
- Use the BRAT to help guide the consideration of beaver restoration in future mountain meadow restoration prioritization efforts in the region and identify areas that warrant field assessments.
- We recommend the meadow restoration and beaver restoration communities work together to coordinate distribution mapping efforts and develop more rigorous beaver habitat assessment and restoration prioritization tools. Options could include:
  - Adapt and or refer to the following beaver restoration tools to better reflect mountain meadow characteristics and management objectives: the Beaver Restoration Flow Chart and the Beaver Dam Viability Matrix from the Beaver Restoration Guidebook, the Methow Beaver Project and Washington State Site Release Scorecards (see Appendices A-D).
  - Integrate Methow Beaver Project Scorecard questions into stream condition assessments as there is a great deal of overlap.
  - Consider utilizing MacFarlane and Wheaton’s (2013) Beaver Dam and Activity Monitoring Form used in the Escalante River Watershed to better understand the distribution and impacts of existing beaver populations in the region (See Appendix E).
  - Add a more explicit beaver habitat assessment component to the American Rivers Scorecard and other surveys as done in 2016 by the Institute for Bird Populations (see Appendix F).
  - Consider standardizing beaver habitat assessment metrics and develop strategy to aggregate and make survey results easily accessible to others.
- Continue to support inter-disciplinary and inter-agency collaboration and information exchange in these meadow restoration efforts.

FUTURE RESEARCH OPPORTUNITIES

- Research and document existing meadow conditions in adjacent beaver modified habitats (Troy, Ramshaw, etc.) to better understand effects on meadows in this region. There is an excellent UC Davis study currently under way in Child's Meadow in the Southern Cascades whose design and findings could be built upon to develop a Southern Sierra beaver study.

- Conduct thorough assessment of current beaver distribution across the Sierra Nevada and Southern Cascades. Include existing datasets (Beaver Mapper, iNaturalist, AR Scorecard and USFS Proper Functioning Condition meadow or stream assessments) and confer with those interested in doing the same.
- Research impacts of beaver on Little Kern Golden Trout/Kern River Rainbow Trout.
- Explore the use of LiDAR and ground penetrating radar to identify historic buried beaver dams (see Polvi and Wohl 2012).

LESSONS LEARNED

Given the regulatory limitations on relocating beaver in California, it seems most prudent to focus resources on meadows with existing populations while continuing to note those meadows that have favorable beaver habitat when field surveyors encounter them. Given the potential return on investment to meadows by focusing on those with beaver, it may be worthwhile to bring beaver restoration consideration in earlier into this kind of meadow restoration prioritization process.

The Methow Beaver Project (MBP) scorecard was designed with riverine systems in mind, though the project does relocate beaver to mountain meadows as well. Using the MBP scorecard as written brought to light some of its limitations. Some of the descriptors were qualitative and vague which could allow for too wide a variation from one surveyor to another. Adjusting the scorecard to have more quantitative scores helped address this. The grazing impacts factor still needs improvement to make it less qualitative.

The Lands Council's beaver relocation program uses a variation of the MBP scorecard to rank their sites giving greater value to those factors they felt increased their success rate (see Appendix D for The Lands Council Washington State Scorecard). The variation between these scorecards highlighted the need to develop regionally specific scorecards that reflect the ecosystem type being assessed.

While there were no beaver in the meadows we surveyed, it was extremely valuable to conduct these assessments. Working with our project partners helped identify potential improvements in beaver habitat assessment protocols, while offering better context for successfully integrating beaver restoration into the broader field of mountain meadow restoration.

CONCLUSION

Based on our analysis, conditions in the ten priority meadows are not currently appropriate for beaver restoration. Given the changes needed to improve conditions, we would not consider beaver restoration in these particular meadows to fulfill SMART objective qualifications (Specific, Measureable, Achievable, Realistic and Time bound). While specific and measureable, until relocation policy changes, beaver restoration is not currently achievable, realistic or time bound. Focusing on existing populations nearby to better understand and take advantage of their impacts could yield more immediate results. Understanding the relationship between beaver and Kern River Rainbow Trout and Little Kern Golden Trout could aid in determining whether or not beaver restoration is an appropriate management action in meadows where those fish occur. Where appropriate, choosing restoration techniques (i.e. willow recruitment) and land management practices (i.e. grazing regime changes) that also support beaver colonization could help successfully integrate beavers into those meadows with more favorable habitat in the future (Double Bunk, Clicks and possibly Little Big and Big). Integrating these results with those of The Beaver Restoration Assessment Tool will enhance our understanding of the potential for beaver dams to improve conditions in these and other meadows in the region. Working to change regulations on beaver relocation will be necessary to make beaver restoration in these meadows possible.

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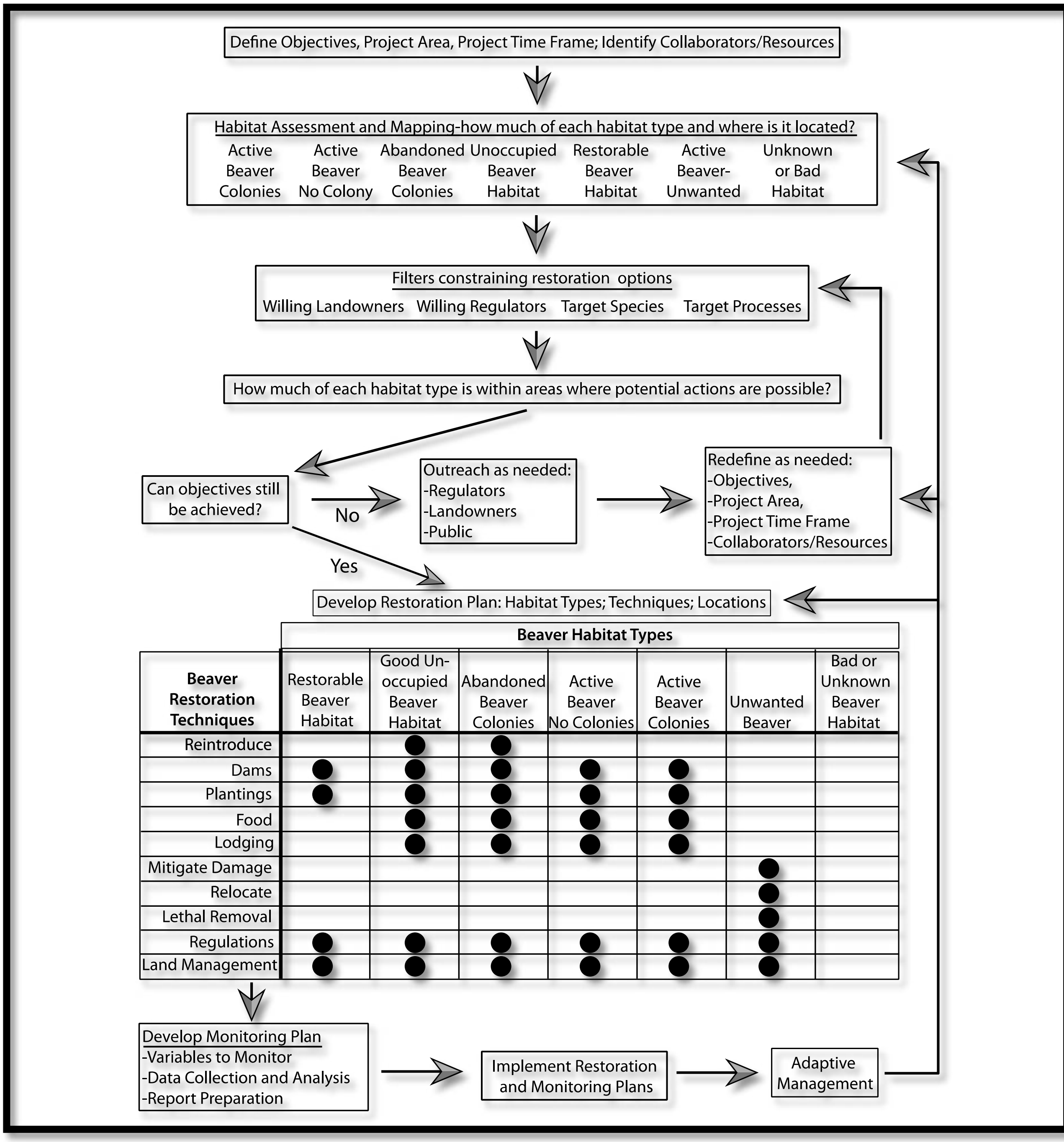
APPENDIX A

Flow chart for data acquisition and decision-making process in beaver restoration projects



Beaver Restoration Techniques	Restorable Beaver Habitat	Good Un-occupied Beaver Habitat	Abandoned Beaver Colonies	Active Beaver No Colonies	Active Beaver Colonies	Unwanted Beaver	Bad or Unknown Beaver Habitat
Reintroduce		●	●				
Dams	●	●	●	●	●		
Plantings	●	●	●	●	●		
Food		●	●	●	●		
Lodging		●	●	●	●		
Mitigate Damage						●	
Relocate						●	
Lethal Removal						●	
Regulations	●	●	●	●	●	●	
Land Management	●	●	●	●	●	●	

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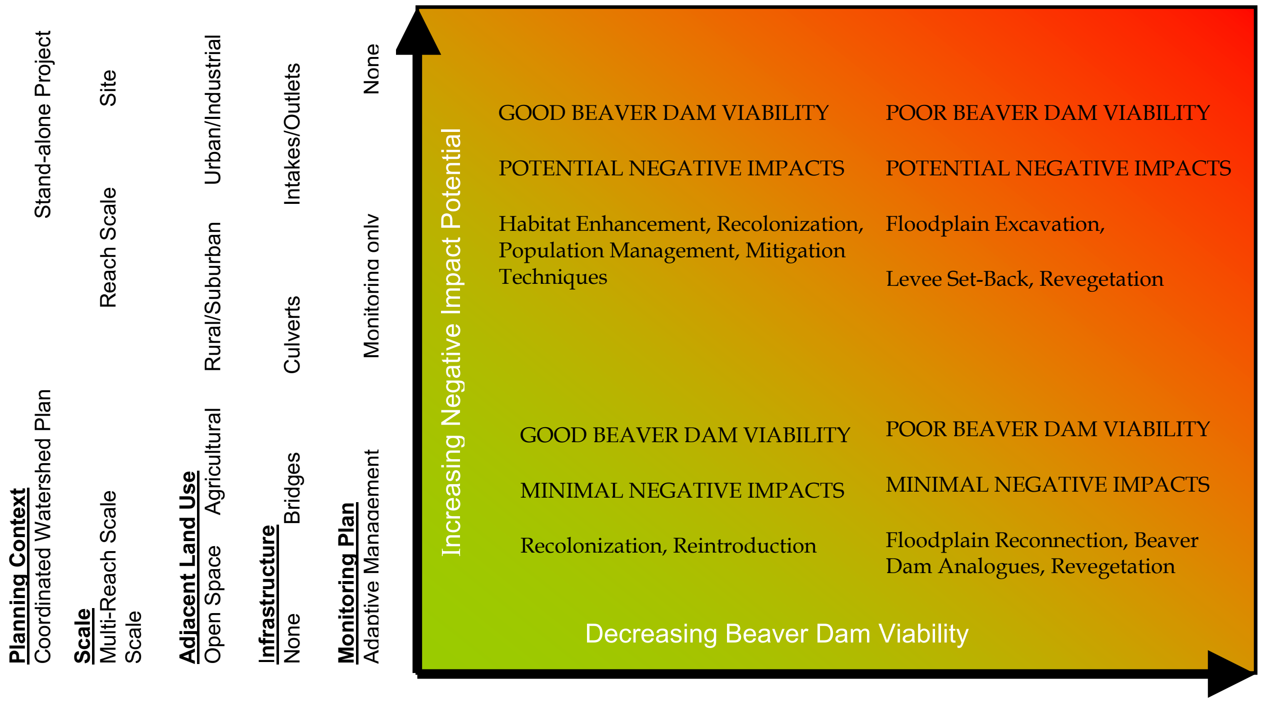
APPENDIX B

Beaver Dam Viability Matrix – By Janine Castro



Stream Slope
<1% 1 - 3% > 3%

Valley Form
Wide floodplain Narrow floodplain Confined channel

Channel Incision
Yearly out-of-bank flow Occasional out-of-bank flow No out-of-bank flow

Riparian Corridor
Continuous/Wide Semi-continuous/Wide Discontinuous/Narrow Urbanized/Leveed

Beaver Presence
Thriving Colony Evidence of Past Occupation No Evidence of Past Occupation

Dominant Hydrologic Regime
Spring-fed Snowmelt Rain Rain-on-snow Convective Thunderstorm

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APPENDIX C

Methow Beaver Project Release Site Score Card (2015 update w/2017 WATER Inst. revisions) Date________________

Site ID______________________________ Observer______________

GPS Coordinates_UTM (NAD 83)__________________________ Subwatershed_____________________________

Lat x Long_____________________________ Location Description ___________________________________

_______ **Gradient of the assessed stream habitat unit** **10**. ≤3% **0**. 4-6% **-10**. 7-9% **-30.** ≥9%

_______ Stream Flow

Max (spring) / **Min (fall)**

	garden hose	**fire hose**	**10"culvert**	**30" culvert**
Fire hose	**1**			
10" culvert	**3**	**4**		
30"culvert	**4**	**5**	**10**	
un-wadeable	**1**	**3**	**2**	**1**

NOTE – Stream flow above or below these parameters limits beaver dam viability

_______ **Habitat Unit Size** (linear stream measure) **5.** Extensive stretch of the stream (≥1610 meters) 4. (1,250-1609m) 3. (900-1,249m) 2. (550-899m) **1.** Small isolated pocket (200-549mm) 0. (0-199m)

Woody Food (select the highest number possible in each line – then multiply lines**)**

a. **3.** Aspen, willow **2**. Alder **1.** Other hardwoods

b. **3**. Within 10 meters **2**. Within 30 meters **1**. Within 100 meters

c. **2**. Large amount (hundreds of stems) **1.** Some (dozens of stems)

_______ **Woody food score = multiply a x b x c**

_______ **Herbaceous Food** **10**. Grasses and forbs (aquatic and terr.) abundant **5.** No Grass/Forbs Present

_______ **Floodplain Width** **5.** Wide stream bottom (at least 2X as wide as stream) **0.** Narrow 'V' Channel

_______ **Dominant Stream Substrate**

5. Silt/Clay/Mud **2.** Sand **1.** Gravel **0**. Cobble **-1**. Boulders **-3**. Bedrock

_______ **Historical Beaver use**

15. Old structures present **0.** No indication of previous occupancy

_______ **Lodge and dam building materials**

5. abundant 1-6" diameter woody vegetation available **-20.** no building material present

_______ **Browsing / Grazing impacts**

5. No Impact or obvious presence of browsers / grazers **-10.** Heavy browsing / grazing

_______ **Ease of access** **2.** Easy travel to deliver beavers and monitor. **-5** Long hike

_______ **Existing aquatic escape cover** **10**. Multiple deep pools (>1 meter deep) present. **-10.** No pools

_______ **Total Score** (100 points maximum)

Release site viability requires securing adjacent landowner support and careful mitigation of human infrastructure conflicts in the vicinity.
Narrative description of site and notes/ Photo ID #s / sketch on back

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APPENDIX D

The Lands Council Washington State Habitat Suitability Scorecard

Used with permission

Release Site Score Card #____________ Date_____________________ Observer________________________

Site ID (Creek)___________________________________ Subwatershed___________________________________

GPS Coordinates-UTM (NAD 83)____

Location Description ____

Please circle answers, then fill in the points

1. Stream Gradient of the defined habitat unit

_________ **5**. ≤3% **3**. 4-6% **1**. 7-9% **0.** ≥9%

2. Spring Time Stream Flow

_________ **5**. Fire hose **1**. Garden hose **-3.** Unwadeable

3. Do you predict there will be year-round stream flow?

_________ **5**. Yes **0**. Unsure **-5**. No

4. Average Stream Depth

_________ **5**. Over knee-high boots **1**. Over sneaker **-3**. Over waist

5. Habitat Unit Size (linear stream length)

_________ **5.** ≥6 acres of riparian vegetation **1.** Small isolated pocket less than 1 acre

6. Woody Food

a. **3.** Aspen, Cottonwood, Willow **2**. Alder **1.** Other hardwoods
b. **3**. Within 10 meters **2**. Within 30 meters **1**. Within 100 meters
c. **3**. Large amount (thousands of stems) **2.** Some (hundreds of stems) **1.** Little (dozens)

________ **Woody food score = multiply a x b x c**

7. Herbaceous Food

_________ 5. Aquatic vegetation (Nuphar, Sagitaria) **3.**Diverse Grass/Forbs Present **0.** Minimal Grass/Forbs Present

8. Floodplain Width

_______ **5.** Adjacent floodplain **0.** Narrow V Channel

9. Dominant Stream Substrate

________ **5.** Silt/Clay/Mud **2.**Sand **1.** Gravel **0**. Cobble -**1**. Boulders **-3**. Bedrock

10. Historic Beaver use

________ **5.** Old structures present **3.** Some old indications (chews) **0.** No indication of previous occupancy

11. Lodge and dam building materials

________ **5**. Variety of 1-6" diameter woody vegetation avail. **-5.** No building material present

12. Are there any roads, culverts, or other damage situations that may result from flooding? (If yes, please expound on below. i.e., how far away is a culvert)

________ **0.** No **-3.** Yes.

13. Are there multiple pools greater than 3 feet in depth present?

________ **5.** Yes. **-10.** No

14. Is there woody debris present in stream (large wood defined as >6 inches at 20 feet from base or a jam)?

________ **3.** Yes. **0.** No

15. Active or Proximity to Active Beaver Colony

________ 5. >1mile -5. <1 mile

16. Browsing/ Grazing impacts

________ **5. No impact or obvious presence of browsers/ grazers** **-3. Heavy browsing/ grazing impacts**

17. Bonus: (5 points each) a. Easy Access from a road b. Recent fire c. Enthusiastic landowner and neighbors

____

________ Total Score **Good Release site 45-95pts** **Bad Release Site 0-44pts**

Other notes, notes are good! (best place to access, added advantages/disadvantages, land ownership/access/permission):

APPENDIX E

Beaver Dam and Activity Monitoring Form used in the Escalante River Watershed

Excerpted with permission from: MacFarlane and Wheaton 2013

BEAVER DAM & ACTIVITY MONITORING FORM

OBSERVATION INFO

Observer Name: ____________________________
Site ID: ____________________________
Observation Date:____________________________

OBSERVATION TYPE:
- o Beaver Dam
- o BDSS
- o Beaver Activity (no dam)

OBSERVATION CHRONOLOGY
- o New Observation of New Feature
- o First Observation of Existing Feature
- o First Observation of Relic Feature
- o Repeat Observation of Existing Feature

STATUS
- o Active
- o Abandon
- o Historic/Relic

CONFIDENCE IN STATUS
- o Certain - Documented Evidence
- o Probable - Strong Evidence
- o Possible - Anecdotal or Inconclusive Evidence
- o Unsure - Just a guess

FLOW CONDITION
- o Baseflow
- o Spring runoff
- o Flood
- o Post Flood

POSITIONAL ATTRIBUTES

GPS UTM Easting: ____________________________
GPS UTM Northing: ____________________________

DAM LOCATION RELATIVE TO CHANNEL(S)
- o On Main Channel
- o On Right Side Channel(s)
- o On Left Side Channel(s)
- o On Left Floodplain
- o On Right Floodplain

PART OF DAM COMPLEX?

Dam Complex ID ____________________________

- o Start of new dam complex
- o Existing dam complex
- o NA - Isolated Dam
- o NA - Non-Dam

DAM ATTRIBUTES AT TIME OF SURVEY (IF APPLICABLE)

Max dam height (m) +/- 0.1 m ___________
Max pond depth (m) +/- 0.1 m ___________

Water Surface Difference (m) (m) +/- 0.1 m ___________
Dam Length (m) (m) +/- 1 m ___________

DISTANCE UPSTREAM OF POND BACKWATER
- o < 5 m
- o 5 - 10 m
- o 10 - 25 m
- o 25 - 50 m
- o 50 - 100 m
- o > 100 m

SIDE CHANNELS
- □ None
- □ Single Left
- □ Multiple Left
- □ Single Right
- □ Multiple Right

POND EXTENT
- o Contained within bankfull channel
- o Expanding out onto floodplain
- o Drained

FLOODPLAIN INUNDATION
- □ During Extreme Floods - River Right
- □ During Extreme Floods - River Left
- □ During Seasonal Floods - River Right
- □ During Seasonal Floods - River Left
- □ Year Round Inundation - River Right
- □ Year Round Inundation - River Left

DAM MATERIALS USED (CIRCLE DOMINANT)
- □Woody branches > 15 cm diameter
- □ Woody branches < 15 cm diameter
- □ Mud
- □ Grass / Reeds
- □ Other organic
- □ Cobble or Boulders

ESTIMATED DAM AGE
- o < 1 year
- o 1-3 years
- o 3-5 years
- o 5 -10 years
- o > 10 years

DAM CONDITION (IF APPLICABLE)

Flow Types

(Specify Value 0-100%; Sum should be 100%)

Flow Over Top ______
Basal Flow ______
Throughflow ______
Flow Around Left ______
Flow Around Right ______
Total Check = 100%?

Dam Breach or Blowout

- ○ In-tact
- ○ Minor breach (< 25 cm height) on left
- ○ Minor breach (< 25 cm height) on right
- ○ Minor breach (< 25 cm height) on center
- ○ Minor basal breach
- ○ Major breach (> 25 cm height) on left
- ○ Major breach (> 25 cm height) on right
- ○ Major breach (> 25 cm height) on center
- ○ Major basal breach
- ○ Blowout (whole height of dam breached)

Pond Capacity

○ Clean ○ Minor Sedimentation
○ Partial Filling (upto 50% of original pond capacity)
○ Major Filling (50% to 95% of original pond capacity)
○ Full of sediment (no longer a pond)

Dominant Substrate in Deepest Part of Pond

○ Fines (clays and silts) ○ Sands
○ Gravels ○ Cobble
○ Food Cache & Fines

Dominant Substrate at Pond Entrance

○ Fines (clays and silts) ○ Sands
○ Gravels ○ Cobble
○ Food Cache & Fines

NOTES:

RECENT BEAVER ACTIVITY:

Only answer all questions with respect to recent (past 6 months)

Dam Expansion

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Dam Construction

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Dam Maintenance

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Scent Mound

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Canal Digging

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Pond Excavation

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Dam Notching

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Draining/Flushing

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Corn on the Cob (Foraging)

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Felling of Trees

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Harvesting of Branches

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Skid Trail Usage

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity
○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Primary Wood Harvested

○ Aspen ○ Cottonwood
○ Willow ○ Other Hardwoods
○ Conifers ○ No active harvesting

Above Ground Lodge Maintenance or Construction

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

Bank Lodge Maintenance or Construction

○ Certain - Documented Evidence ○ Probable - Strong Evidence
○ Possible - Anecdotal or Inconclusive Evidence
○ Unsure - Just a guess ○ No Evidence of Activity

APPENDIX F

Institute for Bird Populations Field Survey Form with Beaver Information

Used with permission

Site Name: date Observer

Record coordinates for most notable beaver sign on site:

Structure: Dam, Lodge, Burrow (D, L, B)	x-coordinate (UTM)	y-coordinate (UTM)	Occupied, abandoned or unknown (O, A, U)	For Dams with upstream ponds estimate		
				Pond Depth[1] (m)	Pond length[2] (m)	Pond Width[3] (m)

[1]At deepest point

[2]Distance flooded upstream

[3]Distance across pond (perpendicular to stream flow)

For entire meadow/site estimate

Total no. lodges	
Total no. dams	
Total no. bank burrows	
% of total meadow or riparian area flooded by beaver ponds	
Meters of stream with noticeable beaver-cut stems	

Forage taxa within 50m of stream area: rank 0-3 where 0 = absent, 1= a few stems scattered about site, 2=moderate patch or loosely scattered across entire site, and 3 = abundant

	Seedling/sapling	Mature
Willow		
Aspen		
Cottonwood		
Alder		