Beaver Recruitment Strategy for Tásmam Koyóm

Prepared for the Maidu Summit Consortium

by Kate Lundquist and Brock Dolman of the Occidental Arts & Ecology Center WATER Institute

with funding from the California Department of Fish and Wildlife, the Resources Legacy Fund and the Patagonia Foundation

June 2020

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[1]Occidental Arts & Ecology Center

The Occidental Arts and Ecology Center WATER Institute develops innovative science-based solutions for communities and the environment to address the legacy of hydrologically destructive land-use practices and policies on California's watersheds, and the urgent need to address the impacts of climate change on the water cycle (www.oaec.org/water). The WATER Institute's Bring Back the Beaver Campaign works to integrate beaver (*Castor canadensis*) management into California policy and regulation in order to improve water quality and quantity, create critical wetland habitat for numerous endangered species and optimize aquatic resource conservation and climate change adaptation strategies. To download our free beaver conservation guidebook "Beaver In California: Creating a Culture of Stewardship" go to: https://oaec.org/publications/beaver-in-california/.

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Cover Photo

Cover - Tásmam Koyóm from the northeast looking to the southwest (Brock Dolman/OAEC)

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Figure 1. Misty morning in Tásmam Koyóm as seen from Soda Springs (Photo: Brock Dolman/OAEC)

INTRODUCTION

This Beaver Recruitment Strategy for Tásmam Koyóm was developed at the request of the Maidu Summit Consortium (MSC). The MSC's mission is "to preserve, protect, and promote the Mountain Maidu Homeland with a united voice. The Maidu Summit Consortium envisions re-acquired ancestral lands as a vast and unique park system dedicated to the purposes of education, healing, protection, and ecosystem management based upon the Maidu cultural and philosophic perspectives, as expressed through traditional ecology." [1]

To understand more about Tásmam Koyóm and the historic land transfer in 2019, we looked to the following description excerpted, with permission, from MSC's website (www.maidusummit.org).

> *Tásmam Koyóm is the Maidu name for the valley that is located in Plumas County, California. This valley was an important Maidu population center within the traditional homeland of the Mountain Maidu for many generations. When Euromerican settlers came to the area, they named it Humbug Valley and established the now abandoned town of Longville.*
>
> *Tásmam Koyóm consists of approximately 2,325 acres, which includes most of the Tásmam Koyóm alpine valley (excluding a private inholding) and certain adjacent hillside forest land. It is contained within four parcels, which are currently used as open space with dispersed recreational activates. The valley is located in northwestern Plumas Country (see Figure 1.)*
>
> *The northwest – trending valley floor contains an alpine meadow that is fairly level with sloping upland forest along the valley edges. Yellow Creek enters the valley at the northwest end and flows southerly exiting the valley through a narrow gorge as it flows toward the North Fork of the Feather River. Humbug Creek and Willow Creek are tributaries to Yellow Creek that empty into the valley from the northeast. The valley contains approximately 1,392 acres of meadow and riparian communities on the valley floor and along the creeks. The remaining 933 acres along the edges of the valley are forested. Approximately 136 acres of the forested portions of the property have been burned and salvage logged, while the remaining 797 acres contain mixed conifer forest. The elevation of the valley ranges between 4,265 and 4,825 feet above sea level.*
>
> *Prior to Euroamerican settlement within Tásmam Koyóm, the land was held in common by the Mountain Maidu people. There were several villages along the western edge of the valley, and the Maidu community flourished in Tásmam Koyóm for thousands of years.*
>
> *Tásmam Koyóm was returned to Maidu Summit Consortium on September 20, 2019, this land transfer was a historical moment in MSC history. Pacific Gas & Electric transferred 2,325 acres of land back to the Mountain Maidu people. The consortium started in 2003 for this purpose, it's been a long wait for the Maidu people, volunteers, and the vision that Farrell Cunningham and the MSC board members had to finally bring our land back home to our people."*[2]

The management of this land will be carried out by tribal members in consultation with co-conservators the California Department of Fish and Wildlife and the Feather River Land Trust.

Recognizing the cultural and ecological importance of beaver, MSC invited the Occidental Arts & Ecology

Center WATER Institute (OAEC) to generate a Beaver Recruitment Strategy for the Tásmam Koyóm Maidu Cultural Park (see Figure 2). Tribal elders remember times when beaver were abundant in the valley and have shared with OAEC their strong desire to see this cultural keystone species returned to Tásmam Koyóm. The goal of this strategy is to identify actions Maidu tribal members and other partners can take to encourage the return of beaver as a vital component in restoring wet meadow and riparian function in the valley. This report contains a summary of the methods, results and recommendations for future actions.

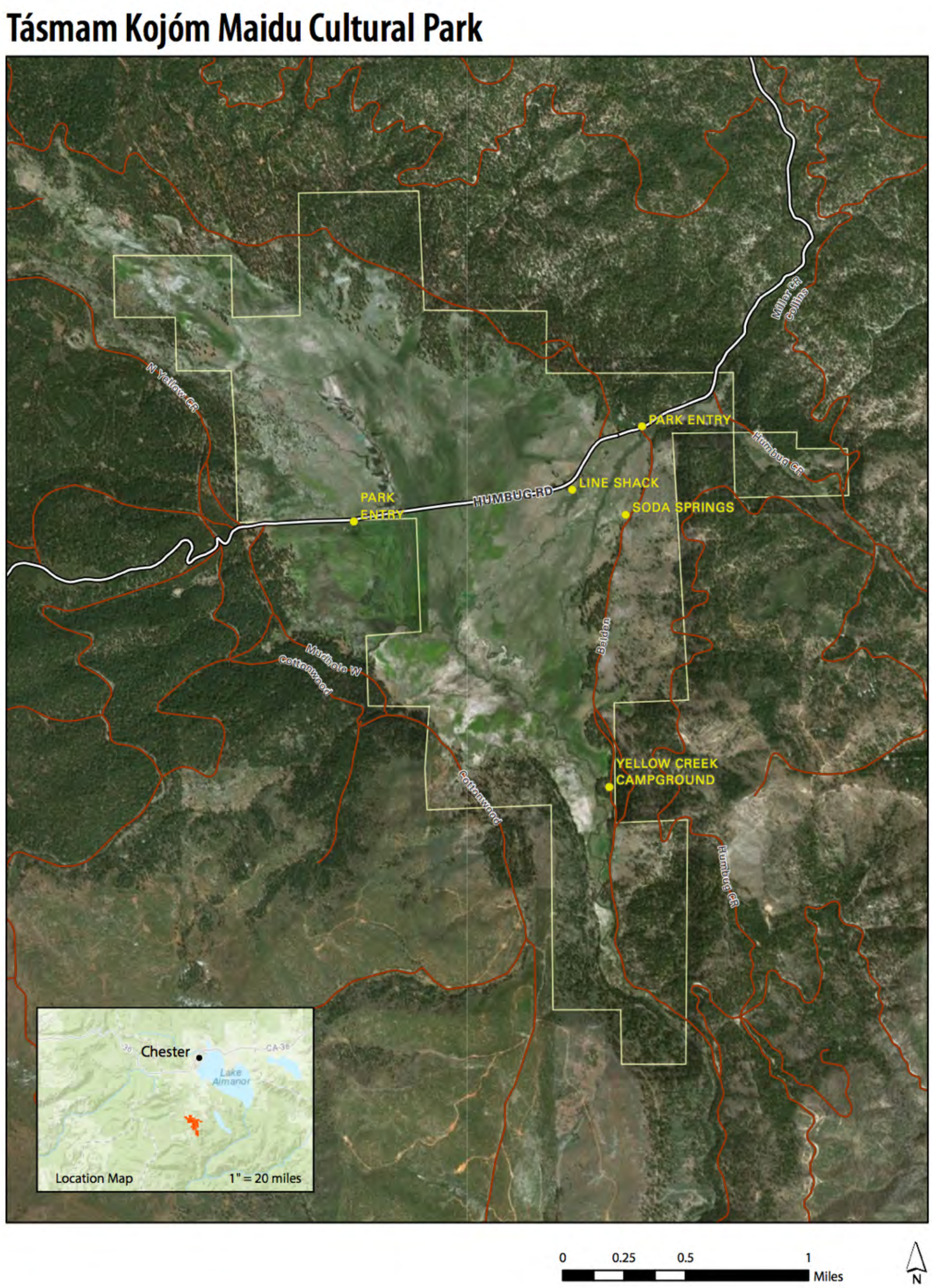


Figure 2. Map of Tásmam Koyóm Maidu Cultural Park (Image courtesy of Maidu Summit Consortium)

The North American Beaver (*Castor canadensis)* is considered a "keystone species" (Figure 3). Beaver dams and associated ponds can increase surface and groundwater storage, improve water quality, repair eroded channels, reconnect streams to their floodplains, sequester carbon and create and maintain wetland and riparian habitats.[3, 4] 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.[5, 6] Beaver dams, canals, burrows and food caches greatly expand off-channel, wetland and wet meadow habitats providing many benefits to fish, birds, mammals and other wildlife. [7, 8, 9, 10]

Figure 3. Live-trapped and relocated beaver swims downstream in Colorado (Photo: K. Lundquist/OAEC)

California wildlife assessments from the 1930s and 1940s led resource managers to believe that beaver were not native to the Sierra Nevada and the southern Cascades above 1,000 feet in elevation.[11] Evidence has since emerged that indicates beaver historically occurred across much of California.[12, 13]

Nearly trapped to extinction in California by the early twentieth century, beaver's rapid decline across North America closely followed patterns of European colonization,[14] and the loss of hundreds of thousands of square miles of wetlands.[15] In an effort to address this legacy impact, between 1923 and 1950 the California Division of Fish and Game (as it was called then) translocated over 1,200 beaver to watersheds across the state from the coast to the Sierra Nevada (Figure 4).[16, 17] While beaver have successfully reoccupied parts of its former range, habitat loss, the killing of "nuisance" beaver and lack of awareness of beaver's importance to watershed health has restricted populations in many areas.[18] Many areas within their historic range have yet to be reoccupied and remain barren of beaver to date.

In the past decade, there has been a heightened recognition of the role beaver can play in the restoration of salmonid streams and montane meadows and riparian rangelands in the arid western United States.[19] Many western streams have significant bank erosion, channel incision and widespread loss of riparian vegetation attributed to extensive land clearing, grazing activities, altered or diminished hydrology, and the removal of beaver. The removal of beaver and their dams from small mountain valleys lowers water table levels, has been shown to increase river entrenchment and decrease water quality downstream due to greater sediment and nutrient delivery.[20] The scientific community has just begun to recognize the cumulative hydrologic and geomorphic effects of the widespread extirpation of this keystone species. This is now being recognized as a critical "legacy impact" that resulted in the loss of millions of dams in the Northern Hemisphere and the multiple benefits those dams provided over the past two centuries.[21]

Tribal communities and other conservationists have begun exploring beaver restoration as a cost-effective and culturally significant means to achieve desired conditions and sequester carbon in Sierra Nevada and Southern Cascade mountain meadows. Unconfined valleys in mountain watersheds store roughly 75% of carbon in coarse wood and floodplain sediment within the river network while only representing less than 25% of the total river length.[22] Analysis of the impacts of beaver dams on montane valley bottom carbon storage indicates that historically actively maintained beaver meadows stored 23% of the carbon in the landscape.[23]

Figure 4. California translocates beaver via parachute in 1950 (source: CDFW)

In addition to increased carbon storage, beaver dams can improve meadow ecosystem function through increasing streambed elevation, slowing of head cut migration and reducing conifer encroachment. Beaver dams keep flood waters on the landscape longer which helps to recharge and raise groundwater levels even into the dry season.[24]

Beaver habitat modifications can provide critical habitat for other species. Research shows that construction of Beaver Dam Analogues or BDAs (Figure 5) and other instream structures can accelerate recolonization and damming of streams by beaver in order to improve habitat for steelhead trout (*Oncorhynchus mykiss*) and cutthroat trout (*Oncorhynchus clarkii*). [25, 26] Looking at beaver dams and the movement of trout, scientists found that native Bonneville Cutthroat Trout (*Oncorhynchus clarkii utah)* passed dams more frequently than nonnative trout.[27] Other studies have found that increased beaver dam density in semiarid regions and re-sprouting beaver felled trees and stumps create high value habitat for birds such as the Willow flycatcher (*Empidonax traillii*) .[28, 29, 30] Recent research at Child's Meadow in Lassen County by US Forest Service researcher Karen Pope has also shown that presence of beaver dams increased density and productivity of the imperiled Cascades frog (*Rana cascadae*).[31]

Beaver restoration is an approach that has been practiced by many in the arid west. Authors of the *Beaver Restoration Guidebook* [32] divide beaver restoration into three kinds of actions:

- 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 reintroduction of beaver to support colony establishment in areas where they are currently absent

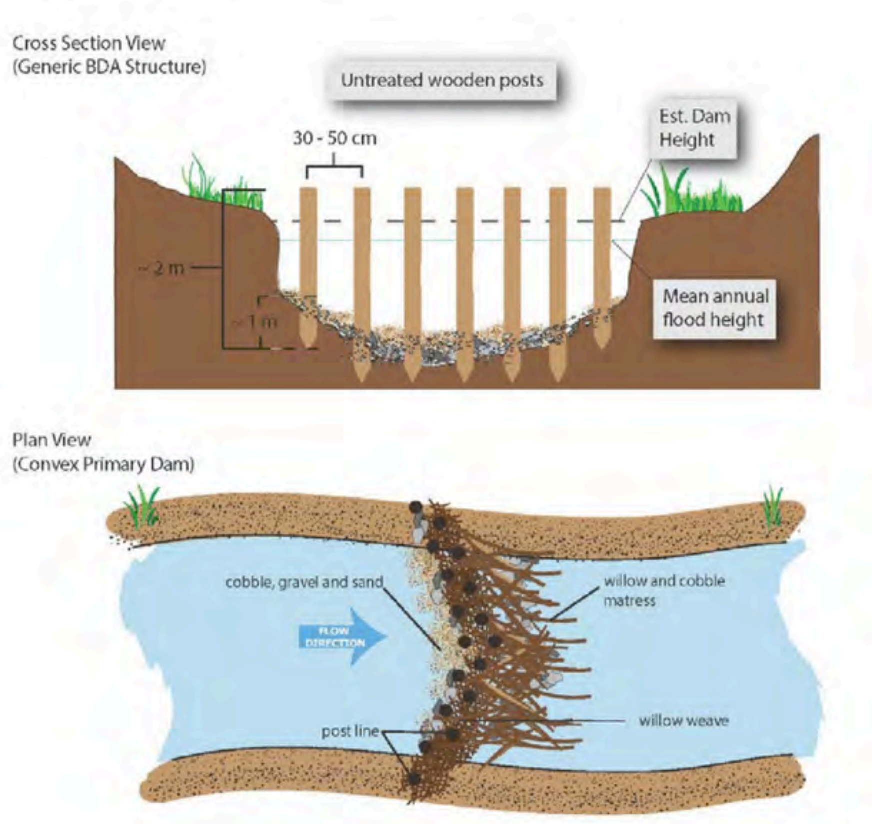


Figure 5 - Illustration of a Beaver Dam Analogue or "BDA" (From Shahverdian et al. 2016).

Often these approaches are used in combination with one another to ensure the success of beaver restoration efforts. Reintroduction 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. Beaver restoration can complement many other forms of restoration and is part of a larger portfolio of low-tech process-based restoration techniques.[33]

METHODS – HOW WE DID OUR ASSESSMENT

To determine the best strategies for recruiting and restoring beaver to Tásmam Koyóm, we collaborated with and drew from the collective knowledge base of the MSC tribal members and other project partners to best determine the role beaver have played in the valley and how to recruit them in the future. We analyzed physical, historic and ethnographic evidence of beaver before they were translocated to the area. We looked at historic translocation data from 1923-1950 to determine where they were released during that time frame. And we queried various sources to determine where beaver occur today. We conducted field surveys to confirm leads and determine habitat suitability in the valley and watersheds adjacent to Yellow Creek. We incorporated dam building capacity modeling results from the Beaver Restoration Assessment Tool (BRAT) and other data to help identify best beaver recruitment practices.

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 and the impacts they are currently having. This information can also help us understand how likely they would return to Tásmam Koyóm on their own and where beaver might be sourced were a relocation pilot deemed appropriate. We conducted field surveys and utilized data from the stream condition inventory and other partner efforts to assess whether or not current conditions in the valley could provide suitable habitat for beaver and identify restoration actions to recruit them in the future.

HISTORIC DISTRIBUTION (Prior to 1923 Accidental Release and 1934-1950 Translocations)

We reviewed the scientific literature and interviewed MSC tribal members, neighbors, locals, restoration ecologists and resource agency staff to determine what historic distribution data is available in Yellow Creek, the Feather River watershed (with a particular emphasis on the North Fork Feather River) and Plumas County in general. We used a physical map when interviewing sources to aid in identifying where beaver might be found (Figure 6).

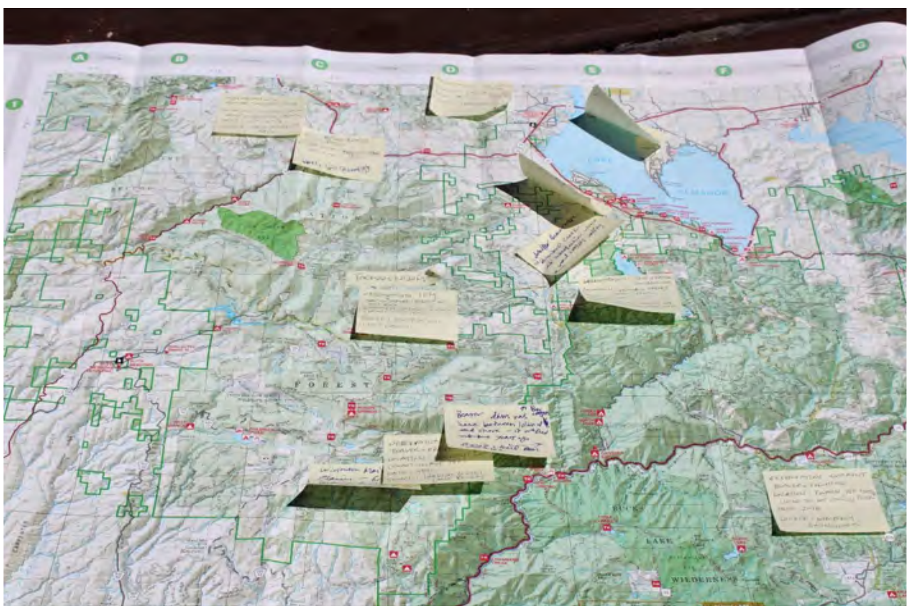


Figure 6. We used a physical map to ask MSC elders and project partners where beaver occurred historically and currently (Photo: Alex Keeble-Toll/The Sierra Fund)

On behalf of this assessment, we asked restoration planning project partners Sabra Purdy M.S. (aquatic restoration ecologist) and Matt Berry (CSU Chico botanist) to look for and collect submerged wood from former beaver dams in the areas they surveyed on Yellow Creek in 2019.

We called on the expertise of Sabra Purdy because as she states in her 'Indications of Beaver and Identification of Remnant Beaver Dams in Tásmam Koyóm' report (Appendix A): "As a restoration ecologist specializing in Montane meadows in the Sierra Nevada, I have observed beaver activity throughout the entire mountain range in hundreds of different meadows in the full range of geomorphic and hydrologic conditions. I have become adept at reading the landscape and channel geomorphology in meadows where there are distinct telltale landforms that indicate past beaver presence as well as seeing thousands of beaver dams ranging from fully intact to just tiny remnants."

With permission from MSC, we sent a sample from one of the remnant beaver dam sites Purdy located to be radiocarbon dated by the Beta Analytics lab in Miami, Florida. This dating could help us determine if beaver were present prior to the initial accidental release of beaver into the Feather River watershed in 1923 and subsequent translocation of 4 beaver into Humbug Creek (a tributary of Yellow Creek) in 1947.

POST-ACCIDENTAL RELEASE AND TRANSLOCATIONS PLUS CURRENT DISTRIBUTION (1923 – Present)

We reviewed California Department of Fish and Wildlife records and scanned the literature to determine if any beaver were relocated in the North Fork Feather River and adjacent watersheds after an accidental release in 1923 and during the statewide translocation program executed from 1934 – 1950. In 1923, twenty-three beaver escaped from a Plumas County fur farm near Taylorsville and were noted to have distributed themselves from that site. Intentional translocations did not begin until 1934.

We interviewed tribal members, resource agency and NGO staff who work in the region, reviewed meadow assessments from the Sierra Nevada Meadows Data Clearinghouse, conducted internet searches and looked for relevant observations listed in the iNaturalist.org database. We used a combination of field surveys and remote sensing (Google Earth) to confirm leads on historic and current distribution.

DAM BUILDING CAPACITY OF RIVERSCAPE – BRAT MODEL

In partnership with The Nature Conservancy, the US Forest Service, Pt. Blue Conservation Science and the Institute for Bird Populations, we contracted the Department of Watershed Sciences at Utah State University to run the Beaver Restoration Assessment Tool (BRAT) model for 78 watersheds in the Sierra Nevada, Cascades, and Klamath mountains of California (Figure 7). This model is a decision-making tool designed to support resource managers in determining where beaver restoration could be most effective.[34]

Figure 7. BRAT Model Project Area (Image: Utah State University)

The backbone of BRAT is a capacity model developed to assess the upper limits of riverscapes (e.g., stream networks) to support beaver dam-building activities. The capacity model produces both an estimate of dam density (i.e. dams per length of stream) and an approximate count of how many dams the conditions in and surrounding a reach could support. Both existing and historic capacity were estimated using freely available spatial datasets to evaluate seven lines of evidence:

- a reliable water source,
- vegetation within 30 m of the stream conducive to foraging and dam building,

• vegetation within 100 m of the stream to support expansion of dam complexes and maintain large beaver colonies,

• the likelihood that dams could be built across the river/stream channel during low flows,

• the likelihood that a beaver dam on a river/stream can withstand typical floods,

• evidence of suitable river/stream gradient, and

• evidence that river is too large for beaver to build dams and/or for dams to persist.

The BRAT is designed to highlight areas that could have the maximum number of dams possible. Given that beavers tend to put in more dams per kilometer in areas where the slope is steeper, this model tends to favors those steeper gradients. To learn more about the California BRAT model, visit www.tinyurl.com/brat-ca.

HABITAT SUITABILITY – FIELD SURVEY AND METHOW BEAVER PROJECT RELEASE SITE SCORECARD

We divided our field surveys into the four following areas within the Maidu Summit Consortium's property boundaries:

- Lower Yellow Creek (from the downstream property boundary up to and including Yellow Creek Campground)
- Middle Yellow Creek (the area above the campground up to the intersection of Yellow Creek and Humbug Road – includes Big Springs and the lower Humbug Creek)
- Upper Humbug (includes the area above the campground road crossing to the property boundary)
- Upper Yellow Creek (the area from where Humbug Road bisects the valley to where it crosses the creek again upstream)

Figure 8. Utilizing the MBP Site Release Scorecard in the field (Photo: Brock Dolman/OAEC)

We walked along the associated reaches within all four areas making observations about which sites might support beaver colonies, what actions could be taken to enhance the habitat for beaver and biodiversity in general and restore ecological function to the valley.

In locations that had conditions conducive to support beaver habitation, we used The Methow Beaver

Project (MBP) Release Site Scorecard to better understand how the site compares to other favorable sites we surveyed in Tásmam Koyóm (Figure 8). The MBP 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 translocated 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 including 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. We used this scorecard to rank what we deemed to be the most favorable sites in the four areas we surveyed. See Appendix B for a copy of the scorecard and a detailed explanation of the range of possible points in each category it contains.

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. rancher tolerance, recreation conflicts) that could enhance or detract from the success of beaver restoration in the areas surveyed.

RESULTS – WHAT WE DISCOVERED

HISTORIC DISTRIBUTION (Prior to 1923 Accidental Release and 1934-1950 Translocations)

The most recent and comprehensive attempt to re-evaluate the historic range of beaver in the Sierra Nevada to date 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. These papers contain several kinds of historic evidence of beaver in Plumas County.

Figure 9. Photograph of remnant ancient beaver dam with multiple sticks and a 12-ounce juice bottle for scale. The dam is 1.5 meters below the surface of a montane meadow on the wall of an incised channel on Clarks Creek 8 km southeast of Antelope Lake (Photo: Jim Wilcox/Plumas Corps., Source: James and Lanman 2012)

In eastern Plumas County, physical evidence was found in 1988 in the form of a previously buried beaver dam discovered on the incised channel of Red Clover Creek, a tributary of Indian Creek which drains to the North Fork Feather and is 45 miles southeast of Tásmam Koyóm.[35] The three samples taken from this dam were radiocarbon dated to AD 580, AD 1730 and AD 1850. In 2011, another buried beaver dam was discovered in Red Clover Creek and was radiocarbon dated to AD 1820. Other buried dam remains have since been discovered elsewhere such as the one on Clarks Creek pictured in Figure 9.

Figure 10. Sabra Purdy, Kate Lundquist, Brock Dolman and other field crew members locate evidence of buried wood in the bank of Yellow Creek (Photo: Alex Keeble-Toll/The Sierra Fund). Note: if gathering samples for radiocarbon dating, do not handle with your bare hands.

During the 18 days Sabra Purdy and her crew spent surveying the meadow and stream channels of Tásmam Koyóm she reports having found "hundreds of remnant beaver dams sticking out from the banks under the surface of the water and landscape geomorphic forms indicating earlier presence of dams consistent with other streams I have surveyed throughout the Sierra Nevada" (Figure 10.)

While beaver are not presently occupying the creek, Purdy notes that "aerial imagery of the site shows extensive networks of small side channels, bank shape and angle in many locations indicates previous beaver dam presence, and habitat, stream gradient, and vegetation community are all ideal for beaver colonization. We knew that beavers had been introduced to the site as an erosion mitigation measure circa 1940 so we expected the dam remnants we were finding in the site to date to around that time or later. However, if we could find conclusive evidence of earlier beaver habitation, we would have a strong argument for reintroduction to the site and an additional piece of physical evidence to support the presence of beavers throughout the Sierra pre-settlement."

To determine where to collect a sample for testing, Purdy "chose an obvious dam remnant that had the telltale beaver dam shape emerging from the river right side of the channel in reach TK-1 channel unit FNRN6 (Figure 11). The remnant was approximately 0.4 m below the surface of the water and about 0.45 m tall and 0.5 m wide at the base. The size and arrangement of the sticks were very typical of beaver dams in the Sierra Nevada with most of the wood ranging in size from about 0.5cm to 3 cm diameter. Since the sticks in the remnant are subject to the stream flows at all levels, they are frequently broken off and do not show distinct beaver sign, but if one were to excavate farther into the bank, it might be possible to recover a stick with more obvious beaver sign, but it is not unusual for remnant beaver dams to have the beaver sign broken off in high flows. There were numerous indications of beaver dams at this channel unit including several islands, trapezoidal shaped remnants covered in sod at the stream margins, and bank shape and vegetation patterns consistent with the earlier presence of a dam. We felt confident that our choice of wood to sample was definitely the remnants of a beaver dam."

This sample was carefully collected without touching the wood itself, bagged, frozen and sent to the Beta Analytics lab to be tested. The results from this test came back with a radiocarbon date of AD 750 +/- 30 years which means this wood is roughly 1,270 years old. See full test report in Appendix C.

Figure 11. Yellow Creek remnant beaver dam sample site below campground - 40.124752°, -121.246635° (Source: Sabra Purdy).

Regarding place names, our review of the literature yielded one beaver place name for Plumas County. We found a place called "Beaver Ponds" on Indian Creek located in the Feather River watershed.[36] We were unable to determine when this place name was established. According to the scholar Erwin Gudde, place names for beaver in California are rare due to the early extermination of beaver.

Mountain Maidu elder Beverly Ogle shared with us that she has a map of Tásmam Koyóm from 1879 that shows a "beaver pond" in the valley. This date occurs well before the 1923 - 1950 beaver translocation era. As of this writing, she is working on locating the map. In 2010, a Mountain Maidu tribal historian shared with us the following pre-European contact word for beaver: "hi-chi-hi-nem." C.H. Merriam lists the Northern Maidu word for beaver as "Too-pen-de" in his *Indian Names for Plants and Animals Among Californian and Other Western North American Tribes* (1979).

POST-ACCIDENTAL RELEASE, TRANSLOCATIONS AND CURRENT DISTRIBUTION (1923 – Present)

Lynn (1950) summarizes beaver translocations conducted in California by the California Division of Fish and Game (now called the California Department of Fish and Wildlife). These translocation records indicate 23 beaver escaped from one site in 1923 and 70 beaver were released at 16 different sites in Plumas County from 1934 until 1949 (Table 1). 1 male and 3 female beaver were released into Humbug Creek in 1947.

Beaver were also released in Butt Creek (1945), just north and east of Yellow Creek. Several more translocations occurred within a 20-mile radius of Tásmam Koyóm. Those occurred in Wolf Creek (1948), Gould Swamp on Lake Almanor (1949), the following two creeks that drain into Lake Almanor, Mud Creek

(1947) and Rock Creek (1946 & 1948).[37] In addition to these release records, Donald Tappe mentions observing signs of abandoned beaver colonies on Wolf Creek in 1940.[38]

Date of Plant	Male/ Female	Total number	County trapped	Elevation trapped	County planted	Elevation planted	Location of plant	Confidence that the creek we found on current maps is the same as the recorded plant location
9/3/23	?	23	Riverside	?	Plumas	3,500'	Indian Creek (escaped from a fur farm 5 miles above Taylorsville)	High
8/27/34	2/2	4	Blaine County, ID	?	Plumas	6,000'	Rowland Creek	High
July 1943	3/2	5	Plumas	?	Plumas	6,000'	Jordan Creek	High
8/30/45	1/1	2	Plumas	3,500'	Plumas	4,700'	Butt Creek above Butt Lake	High
9/15/46	2/2	4	Lassen	6,000'	Plumas	5,000'	Rock Creek Tributary to Lake Almanor	High
8/13/47	1/3	4	Plumas	3,800'	Plumas	5,000'	Humbug Creek, Tributary to Yellow Creek	High
8/20/47	2/4	6	Plumas	3,800'	Plumas	4,600'	Mud Creek	High
9/7/47	1/3	4	Plumas	4,800'	Plumas	5,500'	Long Valley Creek	High
9/15/47	2/2	4	Plumas	4,800' 5,500	Plumas	5,000'	Onion Valley Reservoir, Tributary to Middle Fork Feather River	High
9/23/47	1	1	Lassen	4,100'	Plumas	5,500'	Long Valley Creek	High
6/21/48	2/2	4	Plumas	5,900'	Plumas	5,950	Lookout Creek, near Dixie Mt. Lookout	High
7/13/48	2/1	3	Plumas	6,000'	Plumas	5,000'	Barry Creek near Clio State Fish Hatchery	High
8/2/48	2/2	4	Plumas	3,200'	Plumas	4,000'	Rock Creek Tributary to Lake Almanor	High
8/2/48	3/2	5	Plumas	3.200'	Plumas	3,400'	Wolf Creek, 4 miles north of Greenville	High
8/10/48	3/4	7	Plumas	3,500'	Plumas	4,500'	Hungry Creek near mouth of Taylor Lake	High
8/13/48	4/5	9	Plumas	3,500'	Plumas	5,237'	Haskins Creek near Bucks Lake	High
9/12/48	2/2	4	Plumas	4,000'	Plumas	3,400'	Dooley Canyon Creek	Low (Google maps takes you to a Dooley Canyon on Little Dooley Creek vs. Dooley Creek miles away)
5/14/49	2/2	4	Plumas	3,000'	Plumas	3,500'	Gould Swamp	Medium (Google maps places marker in the water off of the north shore)
5/25/49	3/2	5	Plumas	3,000'	Plumas	3,700'	Chance Creek	Low (There is only a Last Chance Creek in Plumas County)

Table 1. Beaver transplants by the California Department of Fish and Game in Plumas. (Source: Lynn (1950) Project California 34-D-2 Beaver Transplanting (1923-1949), California Division of Fish and Game)

In order to map the relative location of release sites to Tásmam Koyóm, we assigned estimated coordinates to each record (Figure 14). All but three of the descriptions in the translocation records were easy to locate on a modern map and in some cases listed exact mileage from a known landmark. It was not clear where exactly Gould Swamp on Lake Almanor was though Google Maps placed it in the water near the north shore. Dooley Canyon Creek does not exist on today's map. There is a Dooley Creek and a Little Dooley Creek now. Given that Little Dooley Creek has an area called Dooley Canyon, we estimated this to be the release site. Lastly there is no Chance Creek listed for Plumas County. We put the place marker in Last Chance Creek as this is the closest match we could find.

In the spring of 2020, we spoke with Toby Durkee who has been going to his family's cabin in Tásmam Koyóm since he was a child in the 1940s. As a young fisherman, he witnessed a "very dramatic transformation" of Humbug Creek from a stream with easily accessible fishing holes to an impenetrable willow thicket with beaver dams sixty feet long. This occurred in the area above the culvert that passes under the road to the campground. He continued to crawl on his hands and knees to access the area for fishing and noted that "the dams really promoted the fish as they became more numerous, bigger and harder to catch." He said at some point (possibly in the 1970s) the beaver seemed to suddenly disappear, though he did not know why.

Figure 12. Submerged beaver chewed wood found downstream from Big Springs (Photo: Kate Lundquist/OAEC)

We found several signs of former beaver occupation during our 2019 field surveys in Tásmam Koyóm and other watersheds in the area. We found several pieces of beaver chewed wood lying on the streambed in the reach that flows from Big Springs to Yellow Creek (Figure 12). We would recommend samples from this site be radiocarbon dated to determine their age. Beverly Ogle says that Big Springs is really where the beaver were during her lifetime.

In 2019, Jim Wilcox of the Plumas Corporation told us that in 2015 his staff Gia Martynn and Leslie Mink observed two beaver swimming in the pond and plug portion of Yellow Creek that had been installed two years prior. He said "(The beaver) were likely scouting and were not yet drawn to the spot. They have not returned. As the new willows continue to flourish, I suspect they could return and set up shop."

Karen Pope of the US Forest Service Pacific Southwest Research Station told us that a colleague of hers saw beaver in Yellow Creek below the campground within the last few years. In walking both the pond and plug site and below the campground in 2019, we did not see any recent sign of beaver presence.

According to Lorena Gorbet (MSC elder and Board Member) up until 2017 there had been a beaver dam in lower Yellow Creek just above the confluence with North Fork Feather River "between the island and the shore." She says that this dam blew out during high flows. We were unable to walk this part of the creek to locate the site and find signs of former occupation. She also told us that beaver have been seen on the main stem North Fork Feather river a couple of miles upstream of Belden. Kimberly Cunningham (Ben Cunningham Jr.'s wife) told us she has seen beaver on the North Fork Feather between the towns of Twain and Paxton.


Figure 13. One of many beaver-chewed stumps found on Butt Creek in 2019 (Photo: Brock Dolman/OAEC)

Lorena Gorbet also alerted us to there being beaver on Butt Creek to the north and east of Tásmam Koyóm. Walking several miles of the publicly accessible reach upstream of the bridge crossing we found 3-10 year old signs of former beaver presence including peeled sticks and chewed and felled trees (Figure 13). Almost all significant chews were on Black cottonwood (*Populus trichocarpa*). We observed a significant amount of Black cottonwood regeneration along the banks of Butt Creek. Further downstream we did not observe evidence. Remote sensing through Google Earth in the privately-owned reach did not reveal any channel spanning dams, however, it would be worth interviewing landowners to determine if they still persist in that system.

There are some beaver observations listed on the iNaturalist website (https://www.inaturalist.org/taxa/43794-Castor-canadensis) occur in the town of Chester. One observer found a chewed stump on Johnson Creek which we were unable to visit. We did, however find evidence of recent beaver occupation in three areas of the North Fork Feather River inlet to Lake Almanor. We also learned from a local resident that there are currently beaver just above the north shore of Lake Almanor in the town of Clear Creek.

Terri Rust of the Plumas Corporation shared beaver sign observations from 15 locations in and just outside of Plumas County. We used the UC Davis Sierra Meadows Clearinghouse website to locate and review meadow assessments from the area around Tásmam Koyóm and found no mention of beaver. To our knowledge, Sabra Purdy, American Rivers, and more recently the Institute for Bird Populations, are the only entities that regularly track beaver presence/absence in their field surveys.

Further to the west just into Tehama County, there is an active colony of beaver in Guernsey Creek downstream of Child's Meadow. This is where researchers are conducting a multi-year study on the impacts of beaver to biodiversity, water storage and carbon sequestration. Preliminary results indicate the beaver are having beneficial impacts.[39] All of these historic and current distribution data points are included in the Preliminary Beaver Distribution Data for Plumas County map (Figure 14) which is best viewed online.[40]

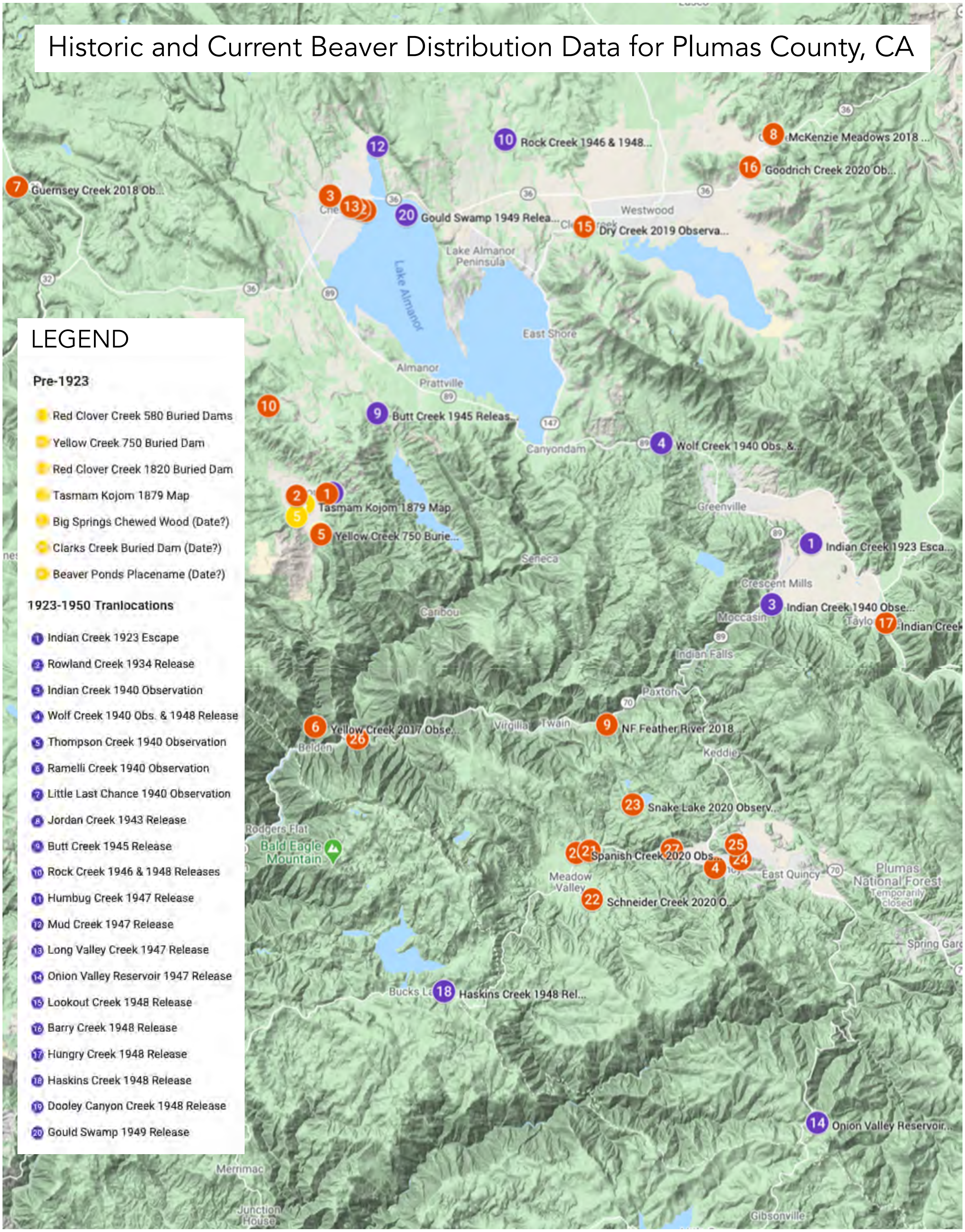
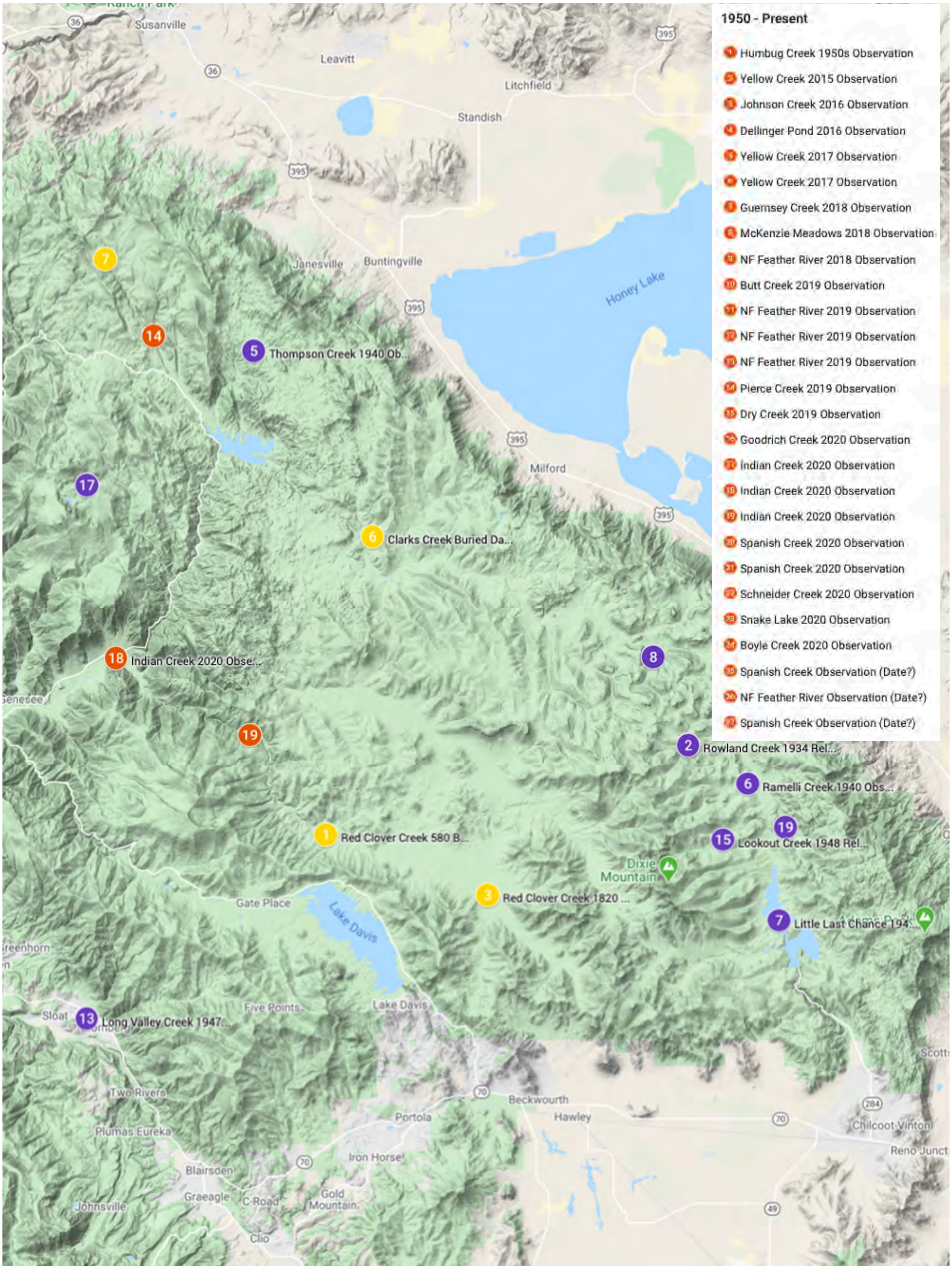


Figure 14. Historic and current evidence of beaver distribution in and just outside of Plumas County. For more details about each location see this map online at https://drive.google.com/open?id=1RkSNXWjIg9UhBYzqXNz3bi9w4Go1VB9-&usp=sharing


1950 - Present
Humbug Creek 1950s Observation
Yellow Creek 2015 Observation
Johnson Creek 2016 Observation
Dellinger Pond 2016 Observation
Yellow Creek 2017 Observation
Yellow Creek 2017 Observation
Guernsey Creek 2018 Observation
McKenzie Meadows 2018 Observation
NF Feather River 2018 Observation
Butt Creek 2019 Observation
NF Feather River 2019 Observation
NF Feather River 2019 Observation
NF Feather River 2019 Observation
Pierce Creek 2019 Observation
Dry Creek 2019 Observation
Goodrich Creek 2020 Observation
Indian Creek 2020 Observation
Indian Creek 2020 Observation
Indian Creek 2020 Observation
Spanish Creek 2020 Observation
Spanish Creek 2020 Observation
Schneider Creek 2020 Observation
Snake Lake 2020 Observation
Boyle Creek 2020 Observation
Spanish Creek Observation (Date?)
NF Feather River Observation (Date?)
Spanish Creek Observation (Date?)
Susanville
Leavitt
Litchfield
Standish
Janesville
Buntingville
Honey Lake
Milford
Thompson Creek 1940 Ob...
Clarks Creek Buried Da...
Indian Creek 2020 Obse...
Rowland Creek 1934 Rel...
Ramelli Creek 1940 Obs...
Lookout Creek 1948 Rel...
Red Clover Creek 580 B...
Red Clover Creek 1820 ...
Little Last Chance 194...
Dixie Mountain
Gate Place
Lake Davis
Long Valley Creek 1947...
Sloat
Five Points
Two Rivers
Plumas Eureka
Portola
Beckwourth
Hawley
Chilcoot-Vinton
Iron Horse
Blairsden
Graeagle
C-Road
Gold Mountain
Johnsville
Clio

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 indicates that Tásmam Koyóm falls within the current range of beaver. The most recent map that best represents both current and historic beaver distribution is that found in Lanman et al. 2013 (Figure 15). This map includes Zeiner's range map, labelled "current range."

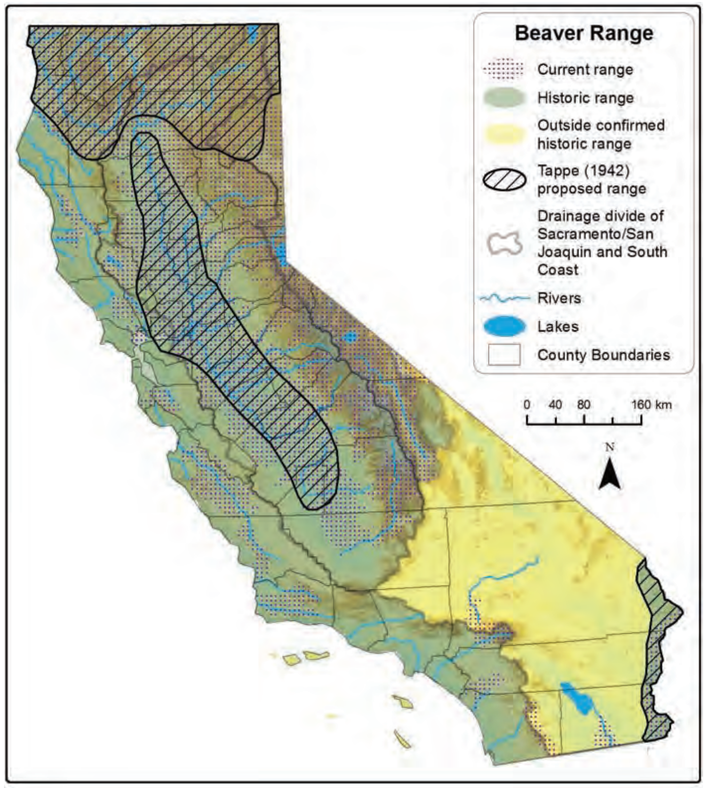


Figure 15. Updated historical range map and current distribution of beaver in California (Source: Lanman et al. 2013)

DAM BUILDING CAPACITY OF RIVERSCAPE – BRAT MODEL

We used the Strategy Map from the California BRAT Model to determine what kind of beaver-based restoration actions would be most appropriate where. The Strategy Map was created by the California BRAT model partners by combining the outputs of the BRAT model with additional information on existing beaver dams and assumptions about which land uses would be suited for different strategies (Table 2).

Strategies to Promote Beaver Dam Building	**Presence of beaver dam** (Yes, No)	**Potential dams** (#/reach)	**Potential dams with vegetation modification*** (#/reach)	**Land use** (Type)
1. Beaver conservation	Y	-	-	no urban or agricultural
2. Highest restoration potential - translocation	N	≥6		public, protected private
3. High restoration potential	N	2-5	-	no urban
3a. Vegetation restoration first-priority	N	≥2	≥1	
4. Medium-low restoration potential	N	≥1, <2	-	
4a. Vegetation restoration first-priority	N	≥1, <2	≥1	
5. Restoration with infrastructure consideration	N	≥1	-	-
6. Restoration with land use consideration	N	≥1	-	urban or agricultural

*The difference between the predicted dam density/reach based on historic vegetation (pre Euro-American settlement vegetation based on biophysical environment and historic disturbance regime) compared to current vegetation.

Table 2. BRAT Strategies to Promote Dam Building

Figure 16. BRAT legend

The approaches include beaver conservation where beaver are currently present, restoration where the model showed a capacity for dams exists, vegetation restoration first-priority where riparian vegetation likely requires improvement before dam building would be supported, and restoration with infrastructure consideration or restoration with land use consideration where infrastructure or land use may limit beaver dam building. The strategies are specific to ~984 ft (300 m) stream reaches. The information represents a snapshot in time of current conditions. The stream reaches included in the map do not contain infrastructure within 100 ft. perpendicular buffer to the stream, except for the stream reaches classified as strategy #5: Restoration with infrastructure consideration (Figure 16).

The results of the Strategy Map from the BRAT model in Tásmam Koyóm (Figure 17) indicate there is a great deal of stream length that has high beaver restoration potential (medium blue). Some of these high restoration potential areas might need vegetation restoration first (light blue). There are some other areas that have a medium-low beaver restoration potential (dark yellow) as well as medium-low restoration areas

Figure 17. Tásmam Koyóm BRAT results

that might need vegetation restoration first (light yellow). When using the BRAT, it is important to conduct field visits to those areas that suggest vegetation restoration occur first. There may in fact be a narrow but adequate amount of vegetation that did not show up in the coarse vegetation data used to make the BRAT model. Similarly, the reaches marked in dark orange require infrastructure consideration. In most cases these areas are near roads. Due to topography, not all of the roads in Tásmam Koyóm would be negatively impacted by beaver presence.

HABITAT SUITABILITY – GENERAL FIELD SURVEYS AND METHOW BEAVER PROJECT RELEASE SITE SCORECARD

In the Lower Yellow Creek segment of the valley we found there to be adequate flow, aquatic escape cover and food sources such as willow and herbaceous plants all of which could support the re-establishment of beaver. The greatest potential constraint to restoring beaver to this area is the adjacency to Yellow Creek Campground, the road, to other human land uses and the neighboring property line.

While beaver could build beneficial bank burrows, the depth and velocity of Yellow Creek in this area, makes it unlikely that beaver would build perennial dams here. Instream structures could help induce dam building and ensure greater dam persistence if reconnecting the creek to its floodplain in this area was desired. This area has a lot of dense stands of conifers that could be thinned and limbed for fuel load reduction. Materials from thinning could be used to build instream structures. Lower Yellow Creek has several spots with buried wood in the stream banks which warrants further investigation and more radiocarbon dating to further add to the collection of evidence we have found (see Appendix A for more details).

In the Middle Yellow Creek area (above the campground up to the intersection of Yellow Creek and Humbug Road, including Big Springs and lower Humbug Creek) we found excellent conditions to support beaver restoration. The confluence area where Big Springs and Humbug Creeks join Yellow Creek in particular has most of the conditions required to successfully restore beaver. The depth and width of the channel provides significant aquatic escape cover. There are many areas that would be easy for beaver to build bank burrows that contain abundant and desirable food sources. There are adequate dam building materials available. If one wanted to return beaver to Yellow Creek, there is easy access on foot or via an ATV from the west side.

Figure 18. Small stand of Black cottonwood on the west side of middle Yellow Creek (Photo: Kate Lundquist/OAEC)

The proximity of Big Springs and Humbug Creek would allow beaver to expand foraging opportunities and seek refuge during high flows in Yellow Creek. There is a small stand of Black cottonwood (Figure 18) in this area that could be enhanced and expanded to both support the return of this culturally significant tree and provide a highly desired food source for beaver.

The beaver habitat quality and wet meadow conditions in this middle Yellow Creek area could be further enhanced through using process-based restoration techniques to reconnect the creek to its floodplains. The remnant floodplain in the Humbug creek outlet on the east side of Yellow Creek presents many excellent opportunities for the use of instream structures to slow the flow, spread it across a wider area and retain water longer to increase wetland habitat.

Figure 19. Signs of multiple years of antler rubbing by elk on this stand of willow in lower Humbug Creek (Photo: Kate Lundquist/OAEC)

Lower Humbug Creek has a lot of potential for light touch and large benefit process-based restoration techniques as well. The channel is not as entrenched as Yellow Creek which could make it easier to aggrade. Where the creek bifurcates into two small confluence areas it creates a very large and valuable wetland with low remnant channels that could easily be reactivated to further enhance and re-wet the meadows/wetlands and increase in-channel water volumes for beaver utilization. This could help create more off-channel refugia for beaver during high flows in Yellow Creek which is currently a limiting factor for year-round beaver occupancy in the main stem. It is near this area that the breeding Willow flycatcher have been detected. Recent research indicates that beaver greatly improve habitat conditions for this imperiled bird.[41,42]

Widely available thinnings from nearby overstocked conifer forest and significant piles of old and intact fence posts/rails throughout these sub-tributaries offer significant opportunities for using onsite materials to build instream structures throughout this area. Of all the areas we surveyed, this area has the greatest concentration and diversity of wildlife signs such as games trails, otter latrines and an elk antler rubbing station (Figure 19). Adding beaver to this area could even further enhance biodiversity here. We saw many wildlife crossings and noted that those areas would be ideal for setting up wildlife cameras to further identify which species are utilizing the area. When considering where to place future interpretive trails, it might be helpful to keep those trails set back from these areas to give the wildlife space.

The Upper Humbug Creek area (above the Yellow Creek campground road crossing to the property boundary) has abundant flow and is populated with dense willow stands. We walked part of the channel just above the culvert and found it difficult to survey due to the impenetrable vegetation. If flow is persistent and the channel is deep enough to provide meter-deep escape cover, beaver could flourish in this area. The limited areas we traversed had adequate flow after a wet winter but the channel was narrow, quite braided and undefined. Beaver tend to prefer inaccessible reaches as this provides greater protection from predators.

Upper Yellow Creek (the area from where Humbug Road bisects the valley to where it crosses the creek again upstream). The current absence of vegetation, exposed off-channel ponds and high flows in mainstem Yellow Creek in the area of the pond and plug treatments make this area less ideal for beaver recruitment. Upper Yellow Creek towards the property line becomes more shallow, rocky and has concentrated high flows. These conditions are not ideal for beaver recruitment. Instream structures to create deeper refugia such as those installed upstream on the US Forest Service property could help provide more favorable beaver habitat.

The small headwater tributaries of Yellow Creek to the north and east of the main stem in the upper valley has good base flow yet is disconnected. We found significant incision and areas where the channel is narrow and deep. We observed several small confluences where head cuts occur below. There are signs of a significant legacy of wet meadow vegetation and peat soils on both sides of the channel. This could be a critical area to re-wet for overall headwaters resilience, peak flow attenuation, wet meadow rehydration and manage sediment transport to maximize aggradation.

Evidence of meadow desiccation is dramatic but the plant communities appear to be persisting and just need to be re-watered. We found several areas of dried out peat soils cracked and eroding which could be contributing to increased carbon emissions. If the goal is to restore wet meadow function and to support future beaver habitat resiliency downstream and in nearby mainstem Yellow Creek, we would recommend prioritizing affordable and low-tech restoration efforts in this area.

Given that beaver restoration and its associated actions could beneficially impact a variety of plant species important to the tribe we took notes on which plants we observed where. We observed significant stands of *Perideridia spp.* along the campground road in lower meadows by grinding rocks and at junction of road above campground. We found large stands halfway to main stem Yellow Creek confluence area along small north draining tributaries from valley crossing (Figure 20).

Figure 20. Patch of Perideridia spp. plants growing (Photo: Kate Lundquist/OAEC)

We also observed large stands of Showy Milkweed near the dispersed campground area in the northern part of the valley and observed a rare Resin Birch at Big Springs. We noted that Elderberry, Black Oak, Chokecherry are all being suppressed in many areas by conifer saplings that could be thinned to release these plants, reduce fuel load and create building materials for beaver restoration.

Throughout valley on both sides in lower, middle and upper Yellow Creek we observed significant amounts of small to mid-diameter over-stocked and encroaching conifers - Ponderosa, Lodgepole, Incense Cedar and White fir saplings. The size and accessibility to these materials could make them useful for beaver habitat creation and other restoration/conservation applications such as exclusion fencing.

Beaver managed wetlands can support a wide array of plant species that prefer wetted areas. The following species from the “Plants Traditionally Harvested in Tásmam Koyóm” list could benefit from beaver restoration in the valley:

Rocky Mountain Maple	Black Elderberry	Tiger Lily
Mountain Alder	Spreading dogbane	Marsh Mint
Pacific Dogwood	Mugwort	Water cress
Aspen*	Blue camas	Western Buttercup
Black Cottonwood*	Miner’s Lettuce*	Sedges*
Chokecherry (on the edges)	Horsetail	Hairgrasses
Thimble Berry*	Cow parsnip	Common Cattail*
Blackberry*	Waterleaf	Common Beargrass
Willow Spp.*	Hartwig’s Iris	

*Table 3. Plants that can benefit from beaver wetlands. *Indicates plants that beaver commonly enjoy eating.*

During September 2019 field surveys we used the Methow Beaver Project release site scorecards in select areas in Tásmam Koyóm. See summary of these results is provided in Table 4. To see the notes associated with these scorecards see Appendix B.

Name	Survey Date	Observers	Lat x Lon	Stream gradient -30 - +10	Stream flow 0 - +10	Habitat size +1 - +5	Food: Woody +1 - +18	Food: Herbs +5 - +10	Floodplain width 0 - +5	Sub-strate -3 - +5	Historic use* 0 - +15	Building materials -20 - +5	Grazing use -10 - +5	Access -5 - +2	Escape cover -10 - +10	TOTAL (-71 min) (100 max)
TK1	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74
TK2	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74
TK3	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74
TK4	9/21/19	K. Lundquist & B. Dolman	40.131061, -121.252019	10	1	5	18	10	5	3	0	5	5	0	10	72
TK5	9/21/19	K. Lundquist & B. Dolman	40.131603 -121.251933	10	10	5	18	10	5	5	0	5	5	0	-10	63
TK6	9/21/19	K. Lundquist & B. Dolman	40.14225 -121.246114	10	10	5	18	10	5	5	0	5	5	2	-10	65
TK7	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	10	5	18	10	5	5	0	5	5	0	-10	63
TK8	9/22/19	K. Lundquist & B. Dolman	40.156873, -121.289721	0	1	5	18	10	5	0	0	5	5	2	5	56
TK9	9/22/19	K. Lundquist & B. Dolman	40.150978 -121.275439	0	1	5	18	10	5	0	0	5	5	2	-10	41
TK10	9/22/19	K. Lundquist & B. Dolman	40.141806, -121.256819	0	5	5	18	10	5	0	0	5	5	2	10	65
TK11	9/22/19	K. Lundquist & B. Dolman	40.139264, -121.257256	10	2	5	9	10	5	5	0	0	5	2	10	63
TK12	9/22/19	K. Lundquist & B. Dolman	40.135044, -121.257344	10	10	5	18	10	5	5	0	5	5	2	10	85

* Note: While evidence of remnant dams were found in many places (including one from 750 AD) we did not find any recent sign of beaver occupation from the past decade.

Table 4. Methow Beaver Project release site scorecard results.

See Figures 21 and 22 for relative locations of these observations and the Methow Beaver Project Release Site scorecards.

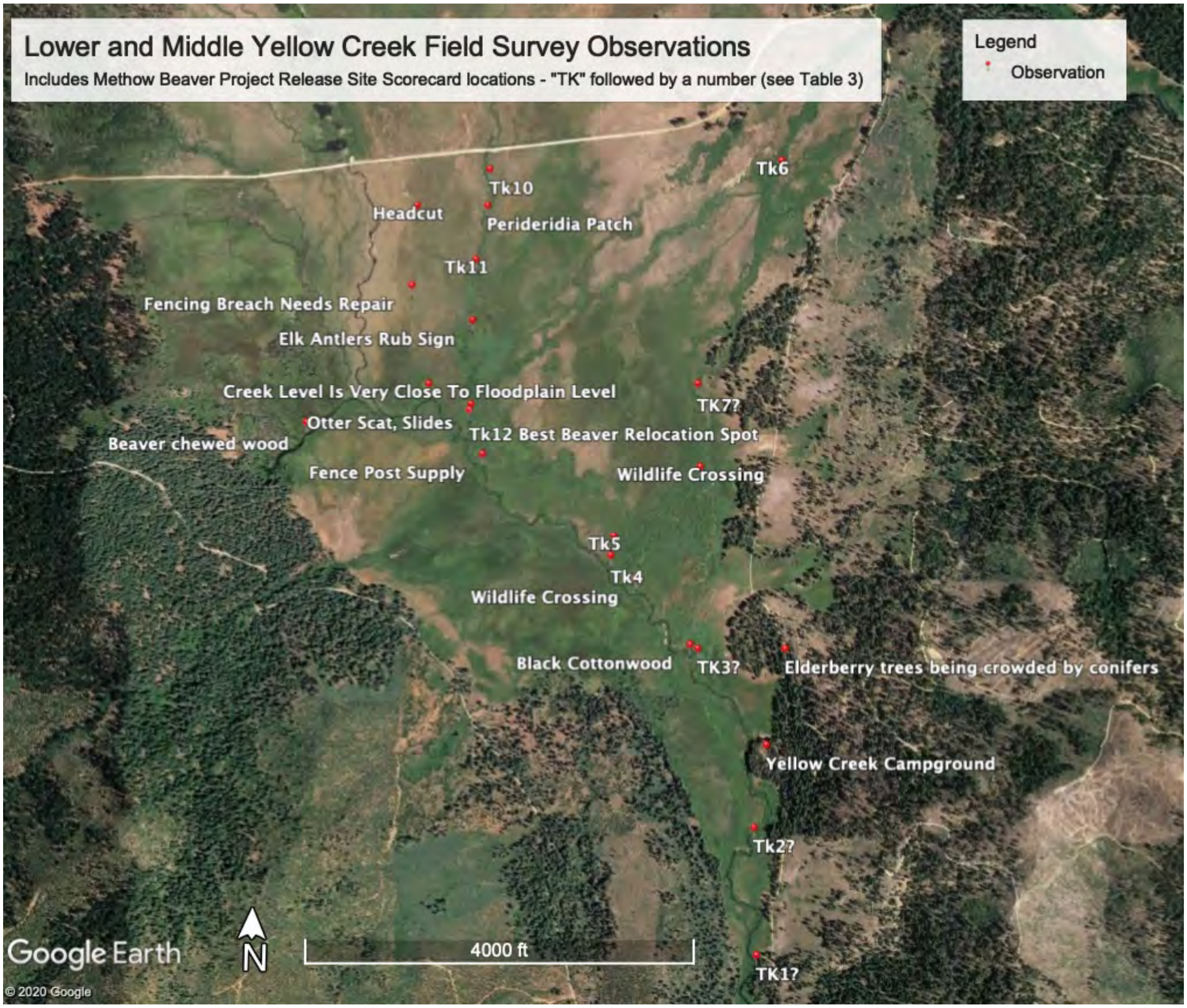


Figure 21. Relative locations of field observations and Methow Beaver Project Site Release scorecards.

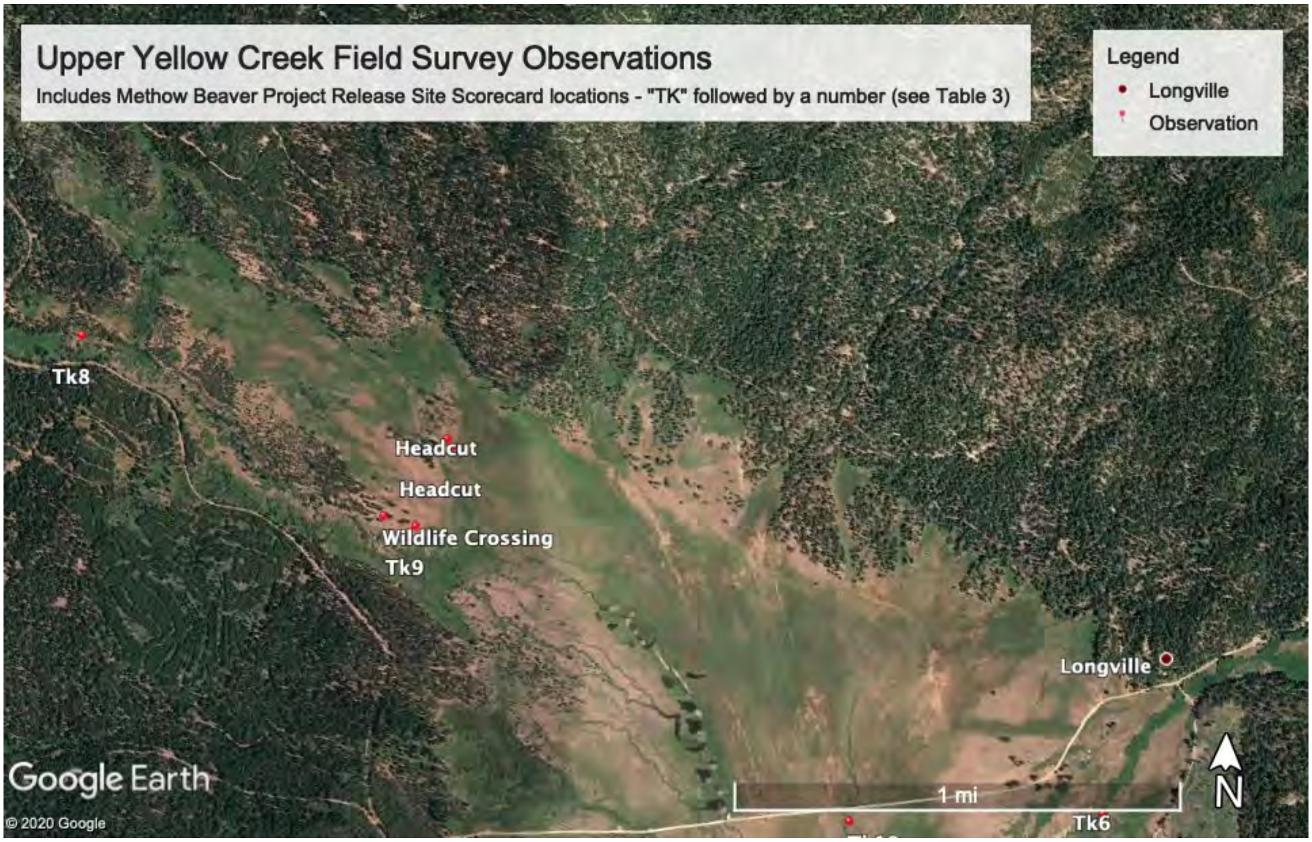


Figure 22. Relative locations of field observations and Methow Beaver Project Site Release scorecards.

DISCUSSION AND RECOMMENDATIONS

The restoration planning for Tásmam Koyóm has revealed a great interest in using process-based restoration techniques to achieve restoration goals. An important component of that strategy includes beaver restoration. Using the results of restoration planning partners work to assess the entire system, identify source problems and develop a plan to best harness space, time, energy help determine where beaver restoration is the right answer to the question of how to best restore stream and meadow function. Taking time to determine where the system is in the cycle of stream channel evolution and where you want to restore it to within that cycle ultimately helps guide these restoration decisions (see Cluer and Thorne 2014).[43]

Given the desire to implement beaver restoration, there are three types of actions one can take (passive, active and reintroduction). These actions depend on whether or not beaver currently occur in the project area. From our assessment, we do not believe they currently occur in Tásmam Koyóm, upper Yellow Creek or its tributaries. Passive actions such as a trapping ban would be an excellent strategy to protect beaver once they are re-established but would be less of a priority now. If grazing is brought back to Tásmam Koyóm as holistic management tool, then working to develop a grazing plan to support beaver presence would be critical. Fencing cattle out of areas where beaver occur can help minimize competition for forage. Active habitat manipulation such as willow and black cottonwood planting and instream structure installation to support beaver colonization and expand off channel habitat could begin immediately. The strategic use of the slash by-products from forest fuel load limbing and thinning projects could provide important materials for mitigating side channel headcutting, channel erosion and for BDA/debris jams. These efforts would be most effective if done in concert with conducting an active reintroduction process to re-establish beaver in Tásmam Koyóm.

We identified several locations where a variety of active habitat manipulation treatments would be worth considering (Figure 23 and 24).

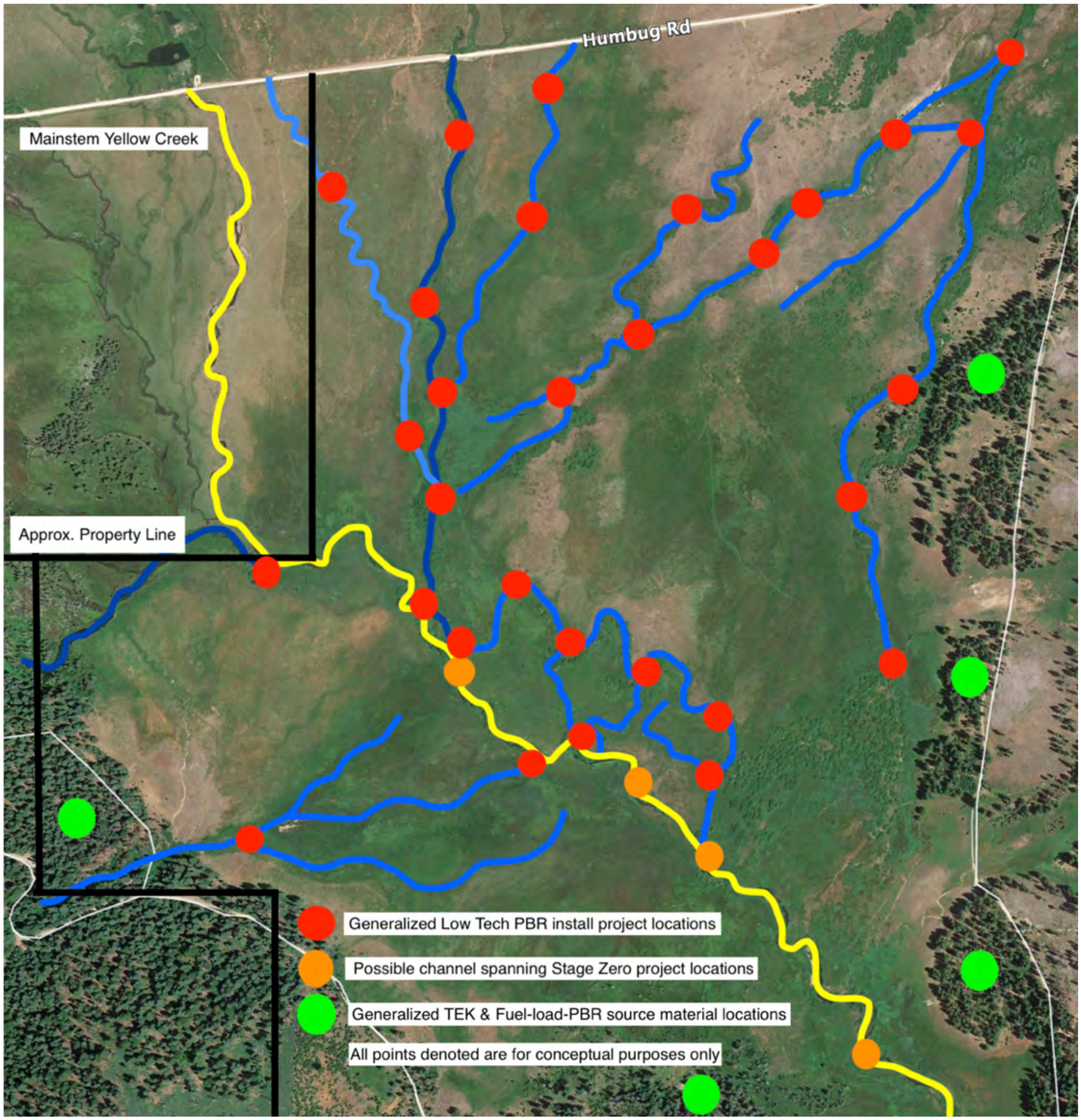


Figure 23. Map of active habitat manipulations in Middle Yellow Creek

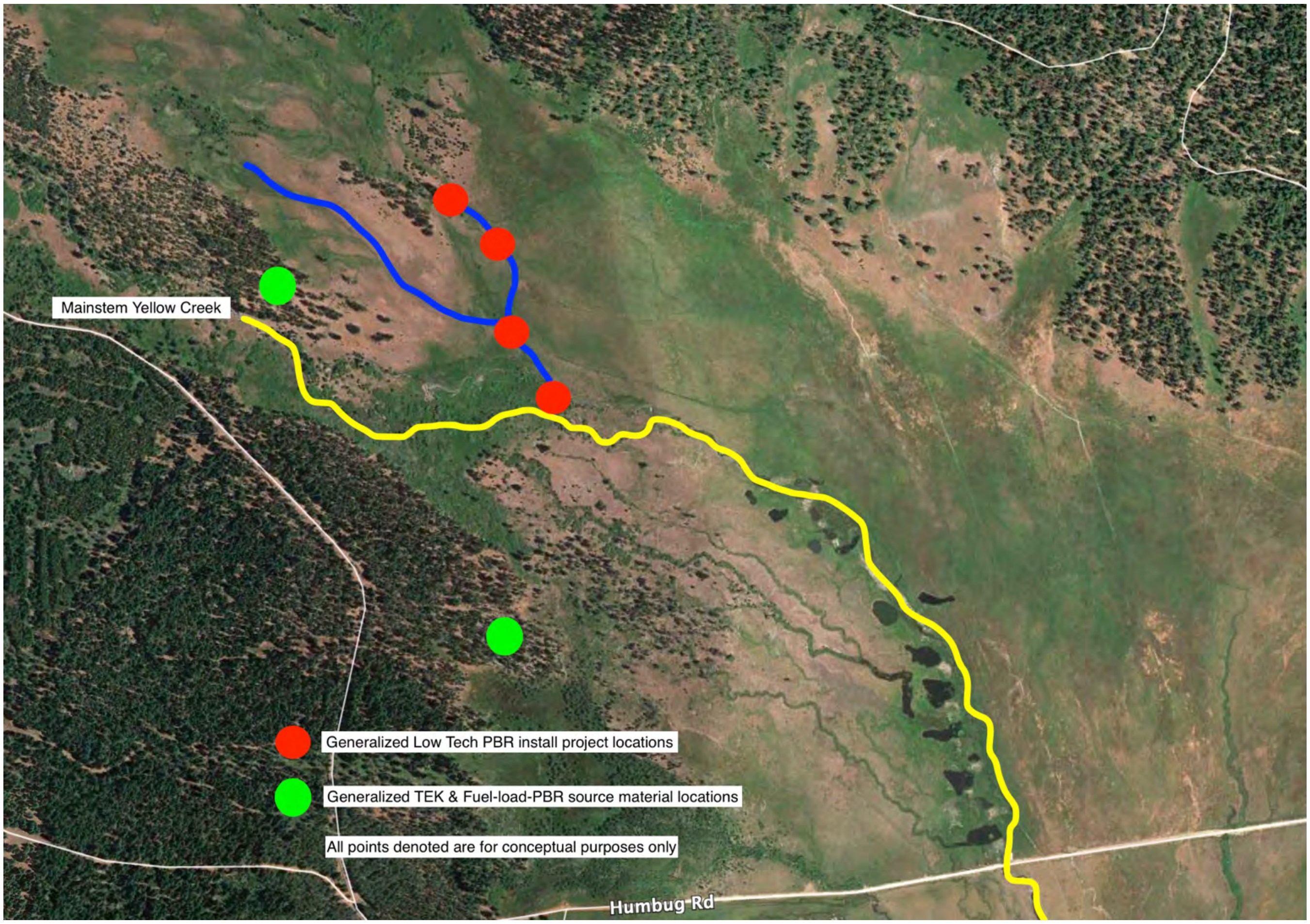


Figure 24. Map of active habitat manipulations in Upper Yellow Creek

The BRAT model results, our field surveys and Methow Beaver Project release site scorecards all indicate that under current conditions, there is plenty of suitable beaver habitat in Tásmam Koyóm. The middle Yellow Creek and upper Humbug creek areas in particular have good to excellent conditions to support beaver recolonization many of which could be further enhanced with the addition of instream structures in key locations. The relationship between beaver and instream structures is mutually beneficial. Beaver can help maintain and even improve the function of instream structures. Putting structures in and reinforcing existing dams can help beaver persist and even accelerate the restoration pace and scale. Beaver left to their own devices to restore channel function can take decades however this time frame can be shortened to years if strategically placed instream structures are employed.[44]

While current conditions in Tásmam Koyóm could support a beaver colony right now, they do not appear to have successfully re-established themselves in the past 50 years since their rumored extirpation in the 1970s. While there are exceptions, dispersing beaver on average travel up to 50 kilometers by water or 20 kilometers over land. The survival rate for dispersing juveniles from other watersheds is roughly 45%. And while there have been and currently are various beaver populations in the surrounding area (lower Yellow Creek and North Fork Feather in the town of Chester), the nearest potential source population in Butt Creek is possibly no longer active and/or not abundant enough to supply regular dispersers. While Butt Creek is the next watershed to the north the potential overland routes for an inter-watershed dispersal from Butt Creek into Yellow Creek do not appear to be very conducive for such movement by beaver (see Figure 25).

The nearest active colony we were able to confirm was to the north and east on the North Fork Feather River at Lake Almanor near the town of Chester (see Figure 25). This colony is 17.7 miles away via Butt Creek and overland travel with an elevation gain/loss of 1,030 feet. This pathway crosses several roads including the four-lane Highway 89. Beaver will travel overland if need be, however they are much more vulnerable to predation when out of the water. They are not as quick on foot and are easily killed by vehicles when crossing roads, especially larger highways.

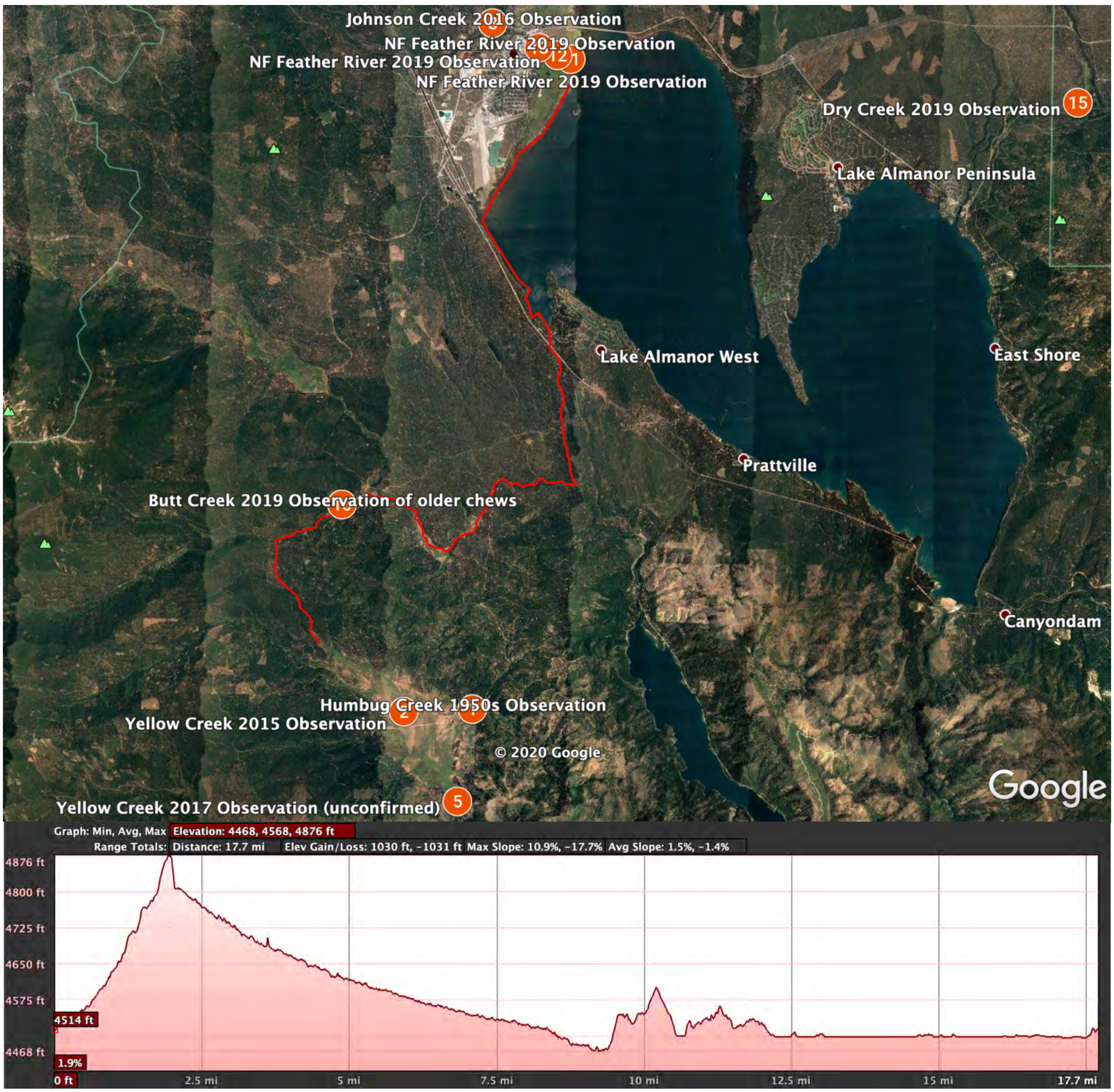


Figure 25. Potential beaver recruitment path from Butt Creek and North Fork Feather River/Lake Almanor confluence to Tásmam Koyóm

The recently active beaver populations to the south at the Lower Yellow Creek/North Fork Feather River confluence is 11.1 miles from Tásmam Koyóm and represents a 1,875 foot gain in elevation. MSC member John Moore confirms there was an active beaver colony and dams on Lower Yellow Creek up until 2018. Mr. Moore has a mining claim on that reach and shared that the terrain between the Lower Yellow Creek/North Fork Feather confluence and Tásmam Koyóm is very steep, rocky and narrow. Google Earth confirms his account. While it is possible for beaver to move up this canyon, there is not a lot of incentive given the flashy nature of this system and absence of adequate escape cover (see Figure 26).

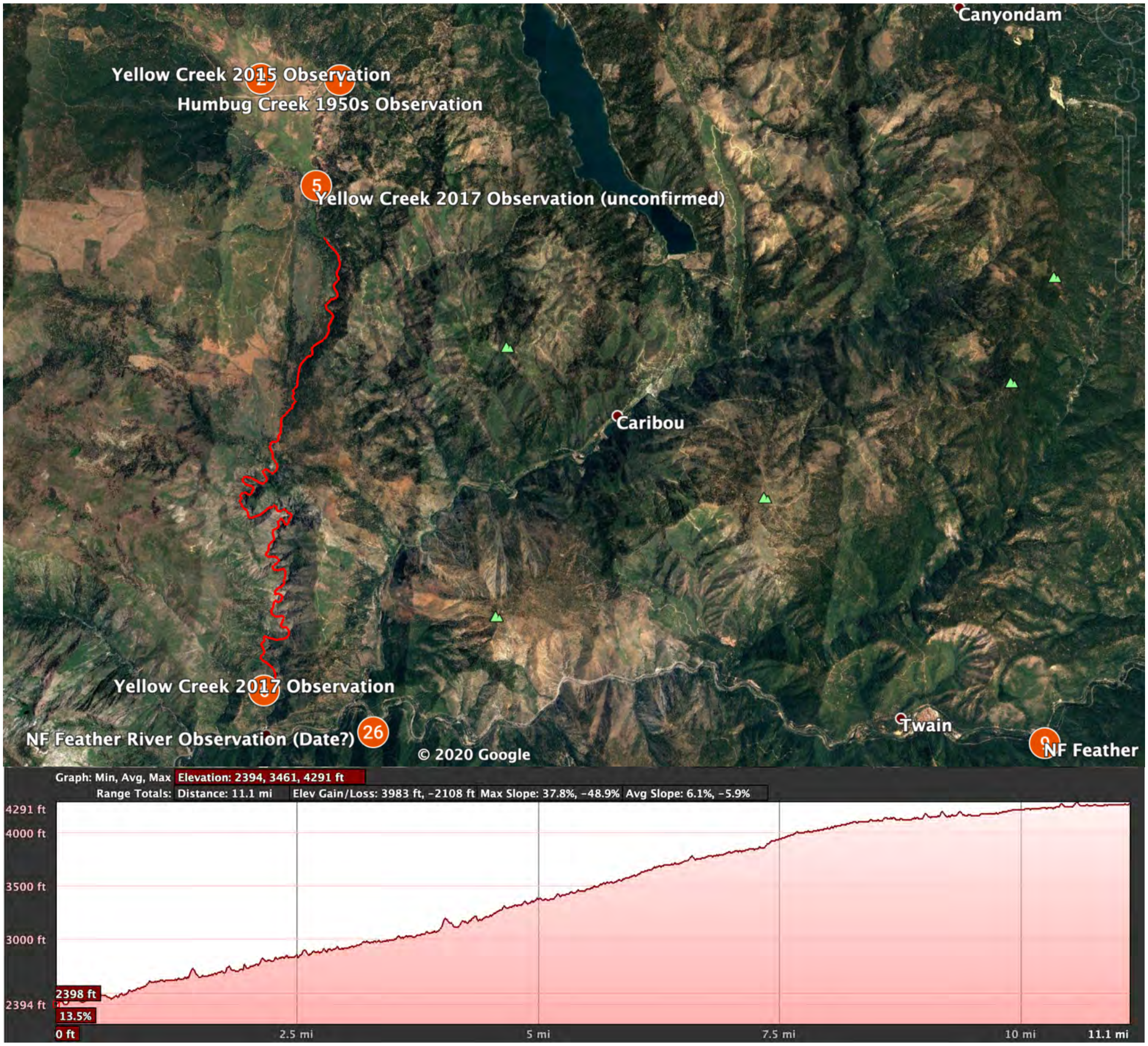


Figure 26. Potential beaver recruitment path from Lower Yellow Creek/North Fork Feather River confluence to Tásmam Koyóm

Regardless of proximity, it seems unlikely that natural beaver immigration from any of these three potential sources into Tásmam Koyóm would occur in the near future given the overland distance, topography and lack of aquatic corridor connectivity from the nearest known active colony.

Given the need to maintain and enhance the critical habitat value Tásmam Koyóm provides to myriad species and the long-held desire by MSC tribal members to see the return of beaver, we recommend working with co-conservators (CDFW and Feather River Land Trust), neighboring public (USFS) and private landowners and supporting agencies to initiate a beaver reintroduction process. Pro-actively reintroducing beaver as opposed to waiting for an unlikely recruitment will significantly increase the pace and scale of riparian and meadow function restoration and focal species habitat enhancement in Tásmam Koyóm. And, most importantly restore relations with a critical "Cultural Keystone" species to the Mountain Maidu people.

Beaver reintroduction to Tásmam Koyóm could:

- Create and maintain critical wetland habitat;
- Improve water quality and quantity and sequester carbon;
- Prolong flow into the dry season, attenuate flooding and increase resiliency to wildfire;
- Create beneficial habitat for native trout, amphibian and bird populations such as Willow flycatcher;
- Increase abundance and help manage ecologically and culturally significant plants such as Black cottonwood, Blue elderberry and Willow stands that are recovering from overgrazing;
- Potentiate the effects of and help maintain other process-based restoration techniques and;
- Satisfy MSC's desire to return a culturally significant species to their ancestral homelands.

A successful beaver reintroduction will require engagement with interested public and private stakeholders and a process by which concerns can be identified and addressed. Given the confusion about the historic distribution of beaver in the state, this report could help inform the process by providing a summary of evidence of pre-settlement presence. We have found that in cases where evidence reveals beaver were native to a region, resource managers are increasingly in favor of implementing beaver co-existence and restoration strategies.

Based on the historic accounts and physical evidence we found, we feel confident that beaver lived in the North Fork Feather River, other nearby watersheds and very likely Yellow Creek before they were reintroduced in the 20th century. Given the novel nature of the 1,270 year old Yellow Creek sample we had radiocarbon dated, we agree with Sabra Purdy's recommendation that more remnant beaver dam samples from Yellow Creek be collected and tested. If other samples have pre-settlement radiocarbon dates these could unequivocally prove that beaver occurred in Tásmam Koyóm prior to their reintroduction in 1947.

Being able to identify signs of remnant beaver dams is an important skill that is not common amongst those working in mountain meadow management and restoration. Sabra Purdy's detection of hundreds of remnant dams in Tásmam Koyóm further highlights the possibility that thousands of remnant dams are going unrecognized elsewhere in the Sierra Nevada and southern Cascades. Training others to recognize this kind of evidence could significantly alter the way beaver are perceived, managed and could aid the efforts to restore them to the montane meadow systems they once occupied. An effort to gather and test more remnant dam samples from Tásmam Koyóm could provide an opportunity to conduct more research, outreach and education and create a field guide on how to identify historic beaver dam presence.

While beaver reintroduction programs are practiced in every other western state, CDFW has expressed concerns about impacts on surrounding landowners, other species and the beaver themselves. OAEC is currently working with those interested in reinstating a reintroduction program in California to address these concerns. In late 2019, the Tule River Tribe decided it is going to carry out a beaver reintroduction planning and implementation pilot on their sovereign lands. We, along with the CDFW, the US Fish and Wildlife Service and the US Forest Service will be partnering with the Tribe to aid in this process. OAEC will work with Tule River Tribe project partners to develop rigorous science-based protocols to guide the reintroduction. This project could provide an opportunity for an inter-tribal collaboration to support the Maidu Summit Consortium in carrying out its own beaver reintroduction process.

RECOMMENDATIONS

To support the re-establishment of beaver while meeting other restoration goals, we recommend the following actions:

- Work with stakeholders to develop and implement a beaver reintroduction plan for Tásmam Koyóm;
- Plant favored woody food sources such as culturally significant willow and black cottonwood (this could also increase habitat complexity for Willow flycatcher currently breeding in Tásmam Koyóm);
- Encourage re-establishment of beaver in specific reaches of middle Yellow Creek and Humbug Creek and expand lower flow off-channel aquatic escape cover through installing process-based instream restoration structures;
- Build low-tech restoration structures with existing onsite materials harvested from fuel-reduction projects;
- Rehydrate uplands and slow erosion through stuffing gullies with materials from fuel-reduction projects;
- Train and provide jobs to tribal members interested in building and monitoring restoration structures;
- Set up a wildlife camera network to guide recreation management planning and interpretive path design;
- Develop a remnant beaver dam field guide to support accurate detection in Tásmam Koyóm and across the Sierra Nevada and southern Cascades;
- Publish a 'Note' in the California Fish and Game Journal on the findings of the radiocarbon dated buried beaver wood from Yellow Creek, and;
- Continue a multi-stakeholder collaboration in support of the Maidu Summit Consortium restoration efforts at Tásmam Koyóm.

FUTURE RESEARCH OPPORTUNITIES

- Gather and radiocarbon date more remnant beaver dam samples across Tásmam Koyóm;
- Conduct a study on impacts of beaver restoration at Tásmam Koyóm (similar to the current Child's Meadow beaver study out of UC Davis Center for Watershed Sciences) including impacts on water quantity and quality, on carbon sequestration and biodiversity and recovery of listed species;
- Research the relationship between beaver and whirling disease;
- Research the relationship between beaver and fisheries in this Wild Trout designated creek and;

- Conduct a thorough assessment of current beaver distribution in California.

In sum, we believe that beaver reintroduction would be a valuable, appropriate and feasible component of a Meadow Restoration Plan for Tásmam Koyóm. Given their prior presence and success in building and maintaining wetland habitat, their capacity to enhance habitat for the Wild Trout Fishery, imperiled Willow flycatcher and other culturally significant species, and their ability to maintain and improve upon process-based restoration treatments, beaver restoration would be a low-cost and high yield strategy to restore and sustain riparian and meadow function to Tásmam Koyóm.

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APPENDIX A

Indications of Beaver and Identification of Remnant Beaver Dams in Tásmam Koyóm

Sabra Purdy, M.S. Aquatic Restoration Ecologist, April 30, 2020

There has been a significant debate regarding beavers in the Sierra Nevada that has raged for more than a century and has resulted in extreme actions including transplanting and releasing animals from out of state followed by decades of eradication programs by California Department of Fish and Wildlife (formerly Fish and Game). However, recent research has uncovered novel physical evidence that beavers (*Castor canadensis)* be native to the Sierra Nevada Range (Lanman et al. 2012).

As a restoration ecologist specializing in Montane meadows in the Sierra Nevada, I have observed beaver activity throughout the entire mountain range in hundreds of different meadows in the full range of geomorphic and hydrologic conditions. I have become adept at reading the landscape and channel geomorphology in meadows where there are distinct telltale landforms that indicate past beaver presence as well as seeing thousands of beaver dams ranging from fully intact to just tiny remnants. However, even when a dam is completely washed out, there are distinct indications still visible in the channel geomorphology such as islands, bank angle, depositional zones in a distinct wedge shape with no current cause, and dams remnants that have had sediment accreted over them and sedge colonize the backwater leaving the hint of the dam shape, but no obvious sticks with beaver sign unless one excavates below the well-developed sod. In many sites, I see hundreds of small remnants of breached beaver dams with just a small butt-end of sticks in the preferred size class and species for beavers. The distinctive pattern of beaver construction is quite obvious once you recognize it. Beaver dams typically have a triangular shape with a wider base and narrower top for stability velocity reduction and beavers lay willow or other sticks in specific orientations and orders that are very easy to recognize in the field. Areas of tributary confluences are very common locations since the dams in those areas inundate a much larger area and beavers are prone to rebuild large dams over and over in the same location. This tends to develop a complex web of channels that are very obvious from aerial photography. I look at the channel geomorphology in the field for additional clues and confirmation. The shape and angle of the banks is very distinctive upstream of a dam that has persisted for several seasons and allowed the development of sod and colonization of sedge holding the banks together. That shape and vegetation cover is persistent even after the dam has washed out for decades or more. Even if the system is actively eroding, this shape indicator is frequently encountered. Long term beaver dams tend to create slow depositional zones both upstream and downstream of the dam. These areas accrete fine sediment and then emergent marsh/wetland communities (typically *Carex* species) colonize these depositional zones. Even after the dam washes out, these depositional areas with their associated vegetation species remain and indicate earlier presence of a beaver dam.

I spent 18 days surveying the meadow and stream channel in Tásmam Koyóm in June through October, 2019. I found hundreds of remnant beaver dams sticking out from the banks under the surface of the water and landscape geomorphic forms indicating earlier presence of dams consistent with other streams I have surveyed throughout the Sierra Nevada. Beavers are not currently present at the site. Aerial imagery of the site shows extensive networks of small side channels, bank shape and angle in many locations indicates previous beaver dam presence, and habitat, stream gradient, and vegetation community are all ideal for beaver colonization. Kate Lundquist of OAEC asked me to find a sample of a remnant dam for radio carbon dating. We knew that beavers had been introduced to the site as an erosion mitigation measure circa 1940 so we expected the dam remnants we were finding in the site to date to around that time or later. However, if we could find conclusive evidence of earlier beaver habitation, we would have a strong argument for reintroduction to the site and an additional piece of physical evidence to support the presence of beavers throughout the Sierra pre-settlement. The lack of beavers in a system that evolved with them constitutes a tremendous shift in ecological forces and processes and should be considered a primary goal for restoration. Cultural references to beavers are abundant in the Mountain Maidu tribal lore and returning beaver to the area is an explicit restoration action the tribe wishes to accomplish (Ogle 1998, Benner-Ogle 2016). There is no question among the tribal representatives that we work with that beaver were historically present at Tásmam Koyóm.

We chose an obvious dam remnant that had the telltale beaver dam shape emerging from the river right side of the channel in reach TK-1 channel unit FNRN6. The remnant was approximately 0.4 m below the surface of the water and about 0.45 m tall and 0.5 m wide at the base. The size and arrangement of the sticks were very typical of beaver dams in the Sierra Nevada with most of the wood ranging in size from about 0.5cm to 3 cm diameter. Since the sticks in the remnant are subject to the stream flows at all levels, they are frequently broken off and do not show distinct beaver sign, but if one were to excavate farther into the bank, it might be possible to recover a stick with more obvious beaver sign, but it is not unusual for remnant beaver dams to have the beaver sign broken off in high flows. There were numerous indications of beaver dams at this channel unit including several islands, trapezoidal shaped remnants covered in sod at the stream margins, and bank shape and vegetation patterns consistent with the earlier presence of a dam. We felt confident that our choice of wood to sample was definitely the remnants of a beaver dam. I had no expectations that the site would yield beaver dam remnants of such ancient pedigree. My hypothesis was that we would not get conclusive evidence of pre-settlement or pre-reintroduction beaver presence. I was extremely pleased and surprised when the results of the carbon dating were unequivocally of such ancient pedigree. However, all scientific endeavors need replication and multiple data points. This single sample is an excellent piece of novel physical evidence of pre-settlement beaver inhabitation at this site. However, it would be best to collect and run additional samples of remnant beaver dams throughout the site to get definitive proof and have more statistically significant data in order to unequivocally prove the historical presence of beaver at this site.

Figure 1. Just downstream from the location where the Beaver Dam remnant sample was taken. The bulging trapezoidal shaped bank on both sides of the channel indicates a buried remnant beaver dam. Beneath the sod and sedges, there are obvious remnant sticks visible under the waterline in the channel.

Figure 2. The remnant sample was taken from the cutbank pictured here near the small sod chunk across the stream channel. There are numerous other indicators of the earlier presence of beaver dams here including sod islands, and the remnants of the emergent marsh habitat created by the dam on river left.

Figure 3. Remnant chunk of beaver dam with sediments accreted on top allowing for grass to colonize. The area where the person in the photo is standing was the emergent marsh habitat created by former beaver dams at this site in Tásmam Koyóm.

Figure 4. Typical "Beaver shaped banks" in Hope Valley, CA, 2017. The shape and vegetation cover are very typical of the area upstream of a beaver dam that remained in place for several seasons allowing sediment deposition upstream of the dam and stabilization of banks due to a higher water table and reduced stream velocity. This distinctive bank shape can persist long after the beaver dam that created them has washed out. A partial dam remnant can be seen in this photo mid-channel with telltale beaver sign sticks at the base.

Figure 5. A remnant dam along the channel. Note the distinctive wedge shape created by the dam itself and the fine sediments leading to emergent marsh habitat on both the downstream and upstream side of the dam. When dams are partially breached like this one, they often create a scour pool where the dam once was. This geomorphic evolution can be observed consistently throughout Sierran Meadows and the landform is very distinctive. Hope Valley, 2017.

Figure 6. The beaver dam here is long gone but the inset floodplain development that occurred due to presence of the dam generating emergent marsh habitat persists and indicates the earlier presence of the dam. Dam remnants at the channel margins confirm the presence of an earlier beaver dam. Photo from Hope Valley 2017.

Figure 7. The beaver dam here was end cut by water creating a distinctive backwater and stream bend pattern that can be seen (and continues to evolve) ubiquitously in Sierran Meadow streams that have had beaver present. Photo from Hope Valley, 2017.

Figure 8. The typical "triangle" shape of a beaver dam with a wide base and narrow top to maximize stability and reduce stream flow. The size and arrangement of sticks within beaver dams is highly consistent and recognizable. Note the multiple flow paths and channels where the stream is backed up into a complex web of channels at a tributary. This dam was breached in winter 2017. Faith Valley, 2016.

Figure 9. A large remnant dam with beaver sticks remaining in the bank. The size and arrangement is distinct and can be instantly recognized, especially with other clues from the geomorphic influence of the former beaver dam on the landscape. Faith Valley, 2016.

Figure 10. After the dam is breached, the geomorphology of the upstream channel shows the unmistakable influence of the former dam. Sediment deposition, sorting, and fine sediments accreted at the dam margins persist after the dam is no longer influencing the channel. Faith Valley, 2016

Figure 11. It is common for beavers to repeatedly build large dams at the same site, particularly at confluence areas where the area of inundation can be very large. This dam was breached in the winter of 2017 and exposed dozens of remnant dams in the same area. Faith Valley, 2016

Figure 12. Sprouting willows from a low, cross valley scratch dam have a visually distinct "line" formation that I describe as beavers row cropping. Forestdale Meadow 2018.

Figure 13. Beaver burrows and tunnels exposed after a dam breach leave a distinctive track that persists for a long period of time. Faith Valley, 2018.

Figure 14. After the dam is breached, this small scratch dam extension across the meadow is left dry and the willows begin to sprout. Faith Valley, 2018.

Figure 15. Beavers consistently build a dam in this zone that tends to breach every 3 to 5 years. When a large functional dam is present here it can inundate more than 13 acres with water. This dam was breached in the winter of 2017 revealing numerous remnants of other large dams in the immediate vicinity. Faith Valley.

Figure 16. Post-Dam breach in 2017. Note the huge amount of sediment that was trapped behind the dam and was then washed downstream and deposited after the breach. These dynamics of dam building, inundation, breaching, sediment capture and distribution, and willow cropping are essential meadow processes that leave distinct visual remains.

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APPENDIX B

Methow Beaver Project Release Site Scorecard Points Description

- **Gradient –** Possible points are: **+10** (≤3%), **0** (4-6%), **-10** (7-9%) and **-30** (≥9%).
- **Stream Flow –** Possible points are arrived at by assessing both maximum and minimum flows using qualitative descriptors. Possible points range from 1 – 10 (see figure below):

Min (fall)

Stream Flow		garden hose	fire hose	10″culvert	30″ culvert
	Fire hose	1			
	10″ culvert	3	4		
Max (spring)	30″culvert	4	5	10	
	un-wadeable	1	3	2	1

- **Habitat Unit Size –** This indicates the linear extent of habitat beaver would find favorable under current conditions. Possible points 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** – Possible points are: **0** (none present), **1** (dozens of stems of other hardwoods within 100 meters), **2** (dozens of stems of other hardwoods within 30 meters or hundreds of stems of other hardwoods within 100 meters), **3** (dozens of stems of other hardwoods within 10 meters or dozens of stems of aspen and willow within 100 meters), **4** (dozens of alder stem within 30 meters, hundreds of alder stems within 100 meters or hundreds of other hardwoods within 30 meters), **6** (hundreds of other hardwood stems within 10 meters, dozens of aspen and willow stems within 30 meters or dozens of alder stems within 10 meters), **8** (hundreds of alder stems within 30 meters)**, 12** (hundreds of alder stems within 10 meters or hundreds of aspen and willow stems within 30 meters**, 18** (hundreds of aspen and willow stems within 10 meters).
- **Herbaceous Food –** Possible points are: **10** (aquatic and terrestrial grasses and forbs abundant) and **5** (no grass/forbs present).
- **Floodplain Width –** Possible points are: **5** (wide stream bottom with a flood plain at least twice the width of the stream) and **0** (narrow "V" channel).
- **Dominant Stream Substrate –** Possible points are: **5** (Silt/Clay/Mud), **2** (Sand), **1** (Gravel), **0** (Cobble), **-1** (Boulders) and **-3** (Bedrock).
- **Historical Beaver Use -** Possible points are: **15** (old structures present) and **0** (no indication of previous occupancy).
- **Lodge and Dam Building Materials -** Possible points are: **5** (abundant 1-6" diameter woody vegetation available) to **-20** (no building material present).
- **Browsing/Grazing Impacts -** Possible points are: **5** (No Impact or obvious presence of browsers / grazers) to **-10** (Heavy browsing / grazing).
- **Ease of Access –** Possible points are: **2** (Easy travel to deliver beavers and monitor) and **-5** (Long hike).
- **Existing Aquatic Escape Cover –** Possible points are: **10** (Multiple deep pools >1 meter deep present) and **-10** (No pools).

APPENDIX B - METHOW BEAVER PROJECT SCORECARD RESULTS FOR Tásmam Koyóm

Name	Survey Date	Observers	Lat x Lon	Stream gradient	Stream flow	Habitat size	Food		Floodplain width	Sub-strate	Historic use*	Building materials	Grazing use	Access	Escape cover	TOTAL (-71 min)	Notes
							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	(100 max)	
TK1	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74	The section closest to the conifers has lots of fine sediments and closer conifers. Dam building materials in this reach would be the limiting factor. High flows would be a limiting factor as well. It is very deep in places and thus beaver would not likely be incduced to build dams. Instream sturctures would be necessary to support damming if that were desireable. If LiDAR shows connected side channels, this area could be good for beaver. Proximity to camppground , roads and other human uses however make this a less desireable release site.
TK2	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74	Area below and including campground. This is the reach that the buried beaver dam from 750 AD was found. . We did not find recent sign, however. While the beaver habitat is currently good, proximity to campground and other human infrastructure could be a limiting factor. We would not release beaver here for those reasons.
TK3	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	1	5	18	10	5	3	0	5	5	2	10	74	More inset floodplains to be back watered and good for beaver. Instream structures in these channels to retain water in these inset floodplains would help create better beaver habitat. Wood for instream structures could be harvested from the forest where proposed new campground is going. Access is feasibile and would have to be on a quad.
TK4	9/21/19	K. Lundquist & B. Dolman	40.131061, -121.252019	10	1	5	18	10	5	3	0	5	5	0	10	72	
TK5	9/21/19	K. Lundquist & B. Dolman	40.131603 -121.251933	10	10	5	18	10	5	5	0	5	5	0	-10	63	Side Channel alongside Yellow Creek. Need instream structures such as BDAs to deepen escape cover. Install close to maintsem Yellow Creek to afford greater eascpae cover until beaver get better established. Much better low flow regime for beaver. Lots of willow for food source. Much harder to access.
TK6	9/21/19	K. Lundquist & B. Dolman	40.14225 -121.246114	10	10	5	18	10	5	5	0	5	5	2	-10	65	Humbug from Soda Springs downstream a bit. Thick willow, perennial flow but no pools for escape cover.
TK7	9/21/19	K. Lundquist & B. Dolman	N/A (GPS malfunction)	10	10	5	18	10	5	5	0	5	5	0	-10	63	Humbug terminus
TK8	9/22/19	K. Lundquist & B. Dolman	40.154997, -121.284703	0	1	5	18	10	5	0	0	5	5	2	5	56	Upper Yellow Creek sediment trap on USFS land just above MSC property line. Only one large pool for escape cover.
TK9	9/22/19	K. Lundquist & B. Dolman	40.150978 -121.275439	0	1	5	18	10	5	0	0	5	5	2	-10	41	Incised but wide historic floodplain.
TK10	9/22/19	K. Lundquist & B. Dolman	40.141806, -121.256819	0	5	5	18	10	5	0	0	5	5	2	10	65	Channel to the east of Yellow Creek just below the meadow intersecting road
TK11	9/22/19	K. Lundquist & B. Dolman	40.139264, -121.257256	10	2	5	9	10	5	5	0	0	5	2	10	63	Further south on the channel to the east of Yellow Creek just below the meadow intersecting road
TK12	9/22/19	K. Lundquist & B. Dolman	40.135044, -121.257344	10	10	5	18	10	5	5	0	5	5	2	10	85	Confluence of Yellow and Humbug Creeks. Lots of river otter signs. Lots of escape cover for beaver. Beaver could escape high flows in Yellow Creek by retreating to Humbug. Cell service is adequate out here to run remote camera traps. Could think about using a PIT tag array here for fish and beaver tracking. Many old fence posts here that could be used for instream structures. Kestrel boxes on fence posts would be really helpful out here.

* Note: While evidence of remnant dams were found in many places (including one from 750 AD) we did not find any recent sign of beaver occupation from the past decade. For this reason we did not give points for historic use

Beta Analytic
TESTING LABORATORY

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ISO/IEC 17025:2005-Accredited Testing Laboratory

April 13, 2020

Ms. Kate Lundquist
Occidental Arts & Ecology Center
15290 Coleman Valley Road
Occidental, California 95465
United States

RE: Radiocarbon Dating Results

Dear Ms. Lundquist,

Enclosed is the radiocarbon dating result for one sample recently sent to us. As usual, specifics of the analysis are listed on the report with the result and calibration data is provided where applicable. The Conventional Radiocarbon Age has been corrected for total fractionation effects and where applicable, calibration was performed using 2013 calibration databases (cited on the graph pages).

The web directory containing the table of results and PDF download also contains pictures, a cvs spreadsheet download option and a quality assurance report containing expected vs. measured values for 3-5 working standards analyzed simultaneously with your samples.

The reported result is accredited to ISO/IEC 17025:2005 Testing Accreditation PJLA #59423 standards and all pretreatments and chemistry were performed here in our laboratories and counted in our own accelerators here in Miami. Since Beta is not a teaching laboratory, only graduates trained to strict protocols of the ISO/IEC 17025:2005 Testing Accreditation PJLA #59423 program participated in the analysis.

As always Conventional Radiocarbon Ages and sigmas are rounded to the nearest 10 years per the conventions of the 1977 International Radiocarbon Conference. When counting statistics produce sigmas lower than +/- 30 years, a conservative +/- 30 BP is cited for the result. The reported d13C was measured separately in an IRMS (isotope ratio mass spectrometer). It is NOT the AMS d13C which would include fractionation effects from natural, chemistry and AMS induced sources.

When interpreting the result, please consider any communications you may have had with us regarding the sample. As always, your inquiries are most welcome. If you have any questions or would like further details of the analysis, please do not hesitate to contact us.

Thank you for prepaying the analyses. As always, if you have any questions or would like to discuss the results, don't hesitate to contact us.

Sincerely,

Digital signature on file

Ronald E. Hatfield President

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REPORT OF RADIOCARBON DATING ANALYSES

Kate Lundquist

Occidental Arts & Ecology Center

Report Date: April 13, 2020

Material Received: April 07, 2020

Laboratory Number	Sample Code Number	Conventional Radiocarbon Age (BP) or Percent Modern Carbon (pMC) & Stable Isotopes Calendar Calibrated Results: 95.4 % Probability High Probability Density Range Method (HPD)	
Beta - 557007	**YellowCreekWoodLowerTasmam**	**1270 +/- 30 BP**	IRMS δ13C: -26.0 o/oo

(92.1%)	**663 - 778 cal AD**	**(1287 - 1172 cal BP)**
(1.7%)	**842 - 860 cal AD**	**(1108 - 1090 cal BP)**
(1.3%)	**792 - 804 cal AD**	**(1158 - 1146 cal BP)**
(0.3%)	**818 - 822 cal AD**	**(1132 - 1128 cal BP)**

Submitter Material:	Woody Material
Pretreatment:	(wood) acid/alkali/acid
Analyzed Material:	Wood
Analysis Service:	AMS-Standard delivery
Percent Modern Carbon:	85.38 +/- 0.32 pMC
Fraction Modern Carbon:	0.8538 +/- 0.0032
D14C:	-146.24 +/- 3.19 o/oo
Δ14C:	-153.43 +/- 3.19 o/oo (1950:2020)
Measured Radiocarbon Age:	(without d13C correction): 1290 +/- 30 BP
Calibration:	BetaCal3.21: HPD method: INTCAL13

Results are ISO/IEC-17025:2005 accredited. No sub-contracting or student labor was used in the analyses. All work was done at Beta in 4 in-house NEC accelerator mass spectrometers and 4 Thermo IRMSs. The "Conventional Radiocarbon Age" was calculated using the Libby half-life (5568 years), is corrected for total isotopic fraction and was used for calendar calibration where applicable. The Age is rounded to the nearest 10 years and is reported as radiocarbon years before present (BP), "present" = AD 1950. Results greater than the modern reference are reported as percent modern carbon (pMC). The modern reference standard was 95% the 14C signature of NIST SRM-4990C (oxalic acid). Quoted errors are 1 sigma counting statistics. Calculated sigmas less than 30 BP on the Conventional Radiocarbon Age are conservatively rounded up to 30. d13C values are on the material itself (not the AMS d13C). d13C and d15N values are relative to VPDB-1. References for calendar calibrations are cited at the bottom of calibration graph pages.

Calibration of Radiocarbon Age to Calendar Years

(High Probability Density Range Method (HPD): INTCAL13)

(Variables: d13C = -26.0 o/oo)

Laboratory number **Beta-557007**

Conventional radiocarbon age **1270 ± 30 BP**

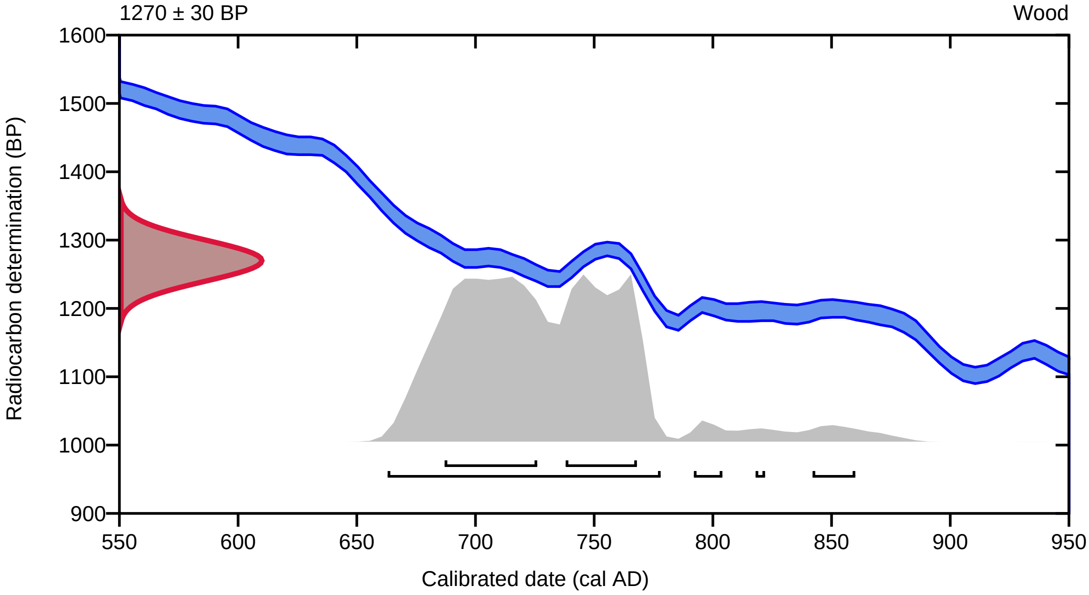
95.4% probability

(92.1%)	663 - 778 cal AD	(1287 - 1172 cal BP)
(1.7%)	842 - 860 cal AD	(1108 - 1090 cal BP)
(1.3%)	792 - 804 cal AD	(1158 - 1146 cal BP)
(0.3%)	818 - 822 cal AD	(1132 - 1128 cal BP)

68.2% probability

(39.1%)	687 - 726 cal AD	(1263 - 1224 cal BP)
(29.1%)	738 - 768 cal AD	(1212 - 1182 cal BP)

YellowCreekWoodLowerTasmam



Database used

INTCAL13

References

References to Probability Method

Bronk Ramsey, C. (2009). Bayesian analysis of radiocarbon dates. Radiocarbon, 51(1), 337-360.

References to Database INTCAL13

Reimer, et.al., 2013, Radiocarbon55(4).

Beta Analytic Radiocarbon Dating Laboratory

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