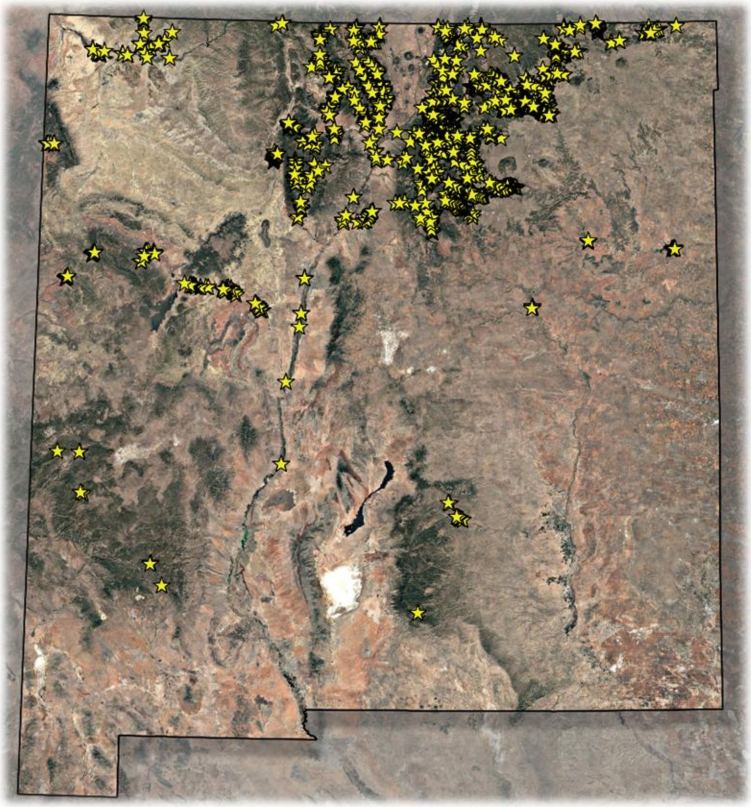
NEW MEXICO STATEWIDE 2020 NAIP IMAGERY-BASED BEAVER DAM CENSUS



Prepared by:

William W. Macfarlane, Chase Gunnell, Alex Fielder, Dallin Baker, Marie Wood, Paige Sargeant and Jordan Gilbert

RIVERSCAPES ASSESSMENT & MONITORING LABORATORY

Utah State University, Department of Watershed Sciences, 5210 Old Main Hill, Logan, UT 84322-5210

Prepared for:

DEFENDERS OF WILDLIFE

Santa Fe, New Mexico

April 2025

Recommended Citation:

Macfarlane WW, Gunnell C, Fielder A, Baker D, Wood M, Sargeant P, Gilbert J. 2025. New Mexico Statewide 2020 NAIP Imagery-Based Beaver Dam Census. Prepared for Defenders of Wildlife. Prepared by Riverscapes Assessment & Monitoring Lab, Department of Watershed Sciences, Utah State University, Logan, UT. 30 pages.

Table of Contents

Table of Figures

List of Tables

Executive Summary

The New Mexico statewide 2020 NAIP imagery-based beaver dam census documented a total of 4,372 beaver dam locations across the state's 21,115 km perennial stream network for an overall dam density of 0.21 per km. There were significant variations in dam densities among the 85 Hydrologic Unit Code (HUC8) watersheds. The northern part of the state exhibited much higher concentrations of dams, particularly in three watersheds—Upper Rio Grande, Rio Chama, and Cimarron—where over half of the statewide dams were found. The findings underscore the need for targeted conservation efforts in areas where beaver populations are thriving, while also identifying regions suitable for restoration initiatives.

The census utilized photointerpretation of high-resolution aerial imagery to efficiently identify beaver dams. The statewide imagery-based census took a total of 305-person hours to complete, which is considerably less than a field-based approach would. Private lands had the largest proportion of the perennial stream network and the highest number of dams, illustrating the importance of working with private landowners to achieve successful beaver-based conservation and restoration. The census identified beaver dams that occurred not only in the classic setting (relatively low gradient, smaller streams) but also within floodplains, on secondary anabranches, and in steep settings, illustrating the importance of these underappreciated beaver dam settings found on floodplains and steep reaches.

Comparatively, a similar statewide beaver dam census for Montana revealed a much higher total of 32,336 dams, indicating regional differences in hydrology and vegetation that support beaver dam building.

The report outlines several recommended next steps following the statewide beaver dam census. These suggestions include conducting an accuracy assessment of the census by ground truthing a sample of the beaver dams. Using beaver dam location points to localize, calibrate, and validate the Beaver Restoration Assessment Tool (BRAT), which predicts the capacity of riverscape reaches to support beaver dam building. This will help identify areas for conserving existing beaver populations and promoting the expansion of beaver dam building.

Overall, this inventory serves as a crucial dataset for planning beaver-based conservation and restoration strategies throughout New Mexico. Final data products include detailed maps and datasets available through the Riverscapes Data Exchange, aimed at aiding conservation and restoration initiatives for dam building beavers.

Introduction

Field-based beaver dam inventorying is time consuming and expensive. It is, therefore, an impractical method for inventorying large geographic areas such as large western US states. Fortunately, photointerpretation is a viable alternative method in many geographies. Photointerpretation of high-resolution satellite and aerial imagery has been used to accurately identify beaver dams across the states of Idaho (Macfarlane et al., 2019a), Montana (Macfarlane et al., 2024), Utah (Wheaton et al., 2014), and Wyoming (Macfarlane et al., 2019b) as well as large portions of California (Macfarlane et al., 2020).

There are a multitude of reasons why inventorying beaver dams is useful. Below is a list of what we believe are the most important reasons:

1. Because beavers are both keystone species and ecosystem engineers, identifying their dam building presence on the landscape allows us to pinpoint where they are having geomorphic, ecological and social impacts on riverscapes. Beaver dams have profound impacts on: (1) ecosystem structure and geomorphology, (2) hydrology and water resources, (3) water quality, (4) freshwater ecology, and (5) humans and society (Brazier et al., 2021).
2. Knowing where and at what densities beaver dams currently exist across a riverscape is critical information for identifying beaver conservation reaches. Specifically, beaver conservation reaches are stream reaches where current beaver dam building is known to be occurring and known to not be causing beaver-human conflict.
3. Conversely, knowing where beaver dams currently do *not* exist across a riverscape is critical information for identifying beaver-based restoration reaches. Beaver-based restoration reaches can take two forms (1) stream reaches that are identified as having the hydrologic and vegetative resources needed to support dam building by beavers *but* are not currently reaches where beavers are building dams or (2) degraded streams that lack dam-building beavers but with proper interventions such as installing Beaver Dam Analogs (BDAs) and Post Assisted Log Structures (PALS), the reaches could support dam building beaver.
4. Knowing where beavers are currently building dams can be useful in prioritizing riverscape restoration projects. For example, if you want beavers to take on the maintenance of BDAs, prioritizing restoration areas that are near existing beaver dam complexes might result in beavers "moving in" and taking on the maintenance of the structures.
5. Knowing where beaver dams currently exist across a given riverscape is critical information for identifying where human-beaver co-existence strategies may be needed.
6. In a semi-arid to arid region like New Mexico, inventorying beaver dams can provide inference on the range limits of dam building beaver as the southern and western portions contain arid regions that are simply too dry to support reliable water sources and woody riparian vegetation used as dam building material by beavers.

Typically beavers build multiple dams in succession over a relatively small reach of stream, creating a stair-step valley and stream profile (Morgan, 1868). This series of dams, or beaver dam complex (Figure 1), consists of flat, ponded areas with abrupt gradient changes at each dam site (Pollock et al., 2003). Multiple dams in a series also helps to dissipate the energy of large flood events and may act as an insurance policy against dam failure: if one dam breaches or blows out, others are still in place (Graham et al., 2022). Furthermore, having multiple dams increases the amount of retained water, which increases the foraging area of the colony and encourages the growth of woody vegetation and herbaceous species used by beavers for both food and construction materials (Cooke & Zack, 2008).

Figure 1: An example beaver dam complex with each beaver dam identified as a red point on the dam crests and the NHD flowline shown as a purple line.

Beaver dam complexes are more resilient to fire (Fairfax et al., 2024), drought and flooding (Hood & Bayley, 2008) (Fairfax & Small, 2018), have better water quality (Dewey et al., 2022) (Bason et al., 2017), more wetlands (Burchsted et al., 2010) (Hood & Bayley, 2008), higher biodiversity (Law et al., 2019), and store more carbon compared to undammed stream reaches (Laurel & Wohl, 2019) (Wohl et al., 2012). Consequently, beaver dam building is increasingly recognized as fundamentally important in the formation and maintenance of healthy riverscapes (Larsen et al., 2021). As such, beaver-based restoration is often celebrated as one of the most cost-effective and sustainable solutions for geomorphic and ecological restoration and climate change mitigation and resilience. Beaver-based restoration refers to the process of mimicking, promoting and sustaining beavers in ecosystems where their populations have declined with the purpose of not only restoring beavers for beaver's sake, but to also restore their positive impacts on maintaining healthy riverscapes. However, due to their nuisance potential in the built environment, and the fact that dam densities vary greatly based on local hydrology and availability of woody plant species, reach selection is critical to restoration success. As this practice gains popularity, there is a growing need for practical guidance about when, where, and how beaver-based restoration can be effectively applied. Identifying where and at what density beaver dams currently occur across riverscapes is an important first step in successful beaver-based restoration.

Bush and Wissinger (Bush & Wissinger, 2016) suggest that riverscapes have three distinctive beaver dam building settings including classic, steep, and floodplain (Figure 2). Our approach in this project was to inventory beaver dams across all three of these settings. Understanding how frequently beavers build dams in these three distinct settings can provide valuable insights for guiding future beaver-based conservation and restoration efforts and potentially open additional areas for restoration previously unconsidered.

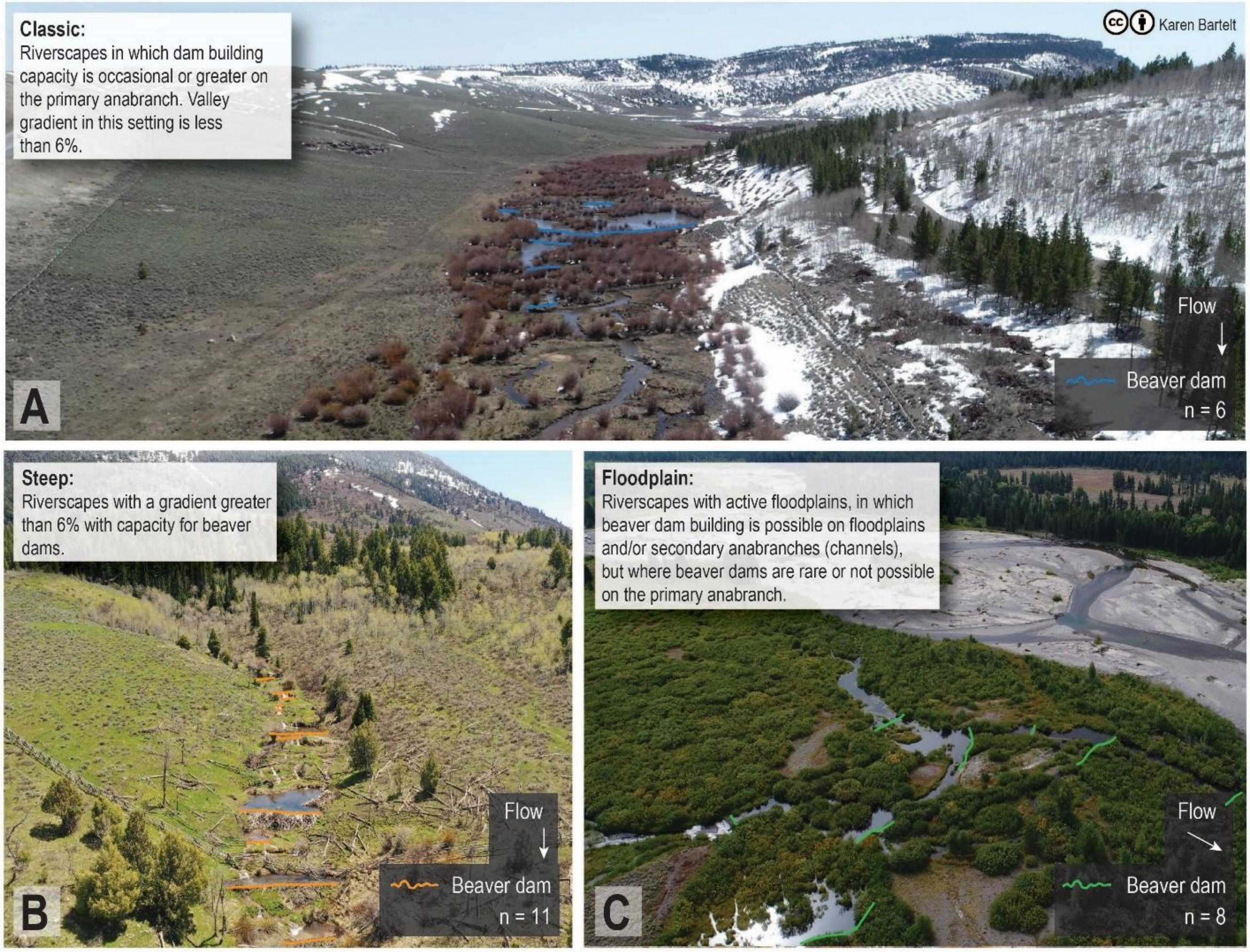


Figure 2. Dominant riverscape dam building opportunities for beaver. A) The classic setting in the top panel represents the beaver dams typically studied in the literature. B) Even though beaver dams in steep riverscapes with gradients over 6% represent over 1/3 of early reported observations in the literature, they are often ignored. C) The floodplain settings along typically larger rivers where beaver dam building is concentrated on the floodplains. This figure was inspired by Bush and Wissinger (2016).

The purpose of this report is to present the findings of the New Mexico statewide 2020 NAIP imagery-based beaver dam census. The census aims to serve as a crucial dataset for planning beaver-based conservation and restoration strategies throughout New Mexico.

.

Methods

Aerial Imagery

We utilized publicly available high-resolution multispectral aerial imagery from the United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) (0.6 m spatial resolution) (*National Agriculture Imagery Program - NAIP Hub Site*, 2024). Imagery was captured in the summer of 2020, in leaf-on conditions. The NAIP imagery was sourced from an ArcGIS REST imagery service used for The National Map, a collection of free geographic datasets provided by the USGS National Geospatial Program.

The NAIP imagery was served over the Internet through a Web Map Service (WMS). The WMS consists of a mosaic of various imagery dates. The NAIP mosaic for New Mexico includes imagery from 2020 and 2021, but the beaver dam observations ended up being in 2020 imagery only. The USGS NAIP Plus imagery service consists of NAIP imagery and high resolution orthoimagery (HRO). The NAIP imagery is a mosaic of primarily 0.6 m resolution 4-band imagery with additional color band configuration template views including 'false color composite', also known as color-infrared (CIR), and Normalized Difference Vegetation Index (NDVI) (Figure 3).

Color infrared is sensitive to red, green, and near infrared wavelengths, making infrared data appear with a red tone, red wavelengths appear green, and green wavelengths appear blue. Healthy green vegetation appears bright red, and ponding from beaver dams appears dark blue. Vegetation material used in beaver dam crests appears noticeably different from surrounding vegetation using this technique. NDVI is used to assess plant health by normalizing the amount of red energy that is absorbed by chlorophyll and the amount of near-infrared energy that is reflected by the cellular structure of the leaf, resulting in a simplified image that allows one to quickly delineate vegetation and vegetation stress.

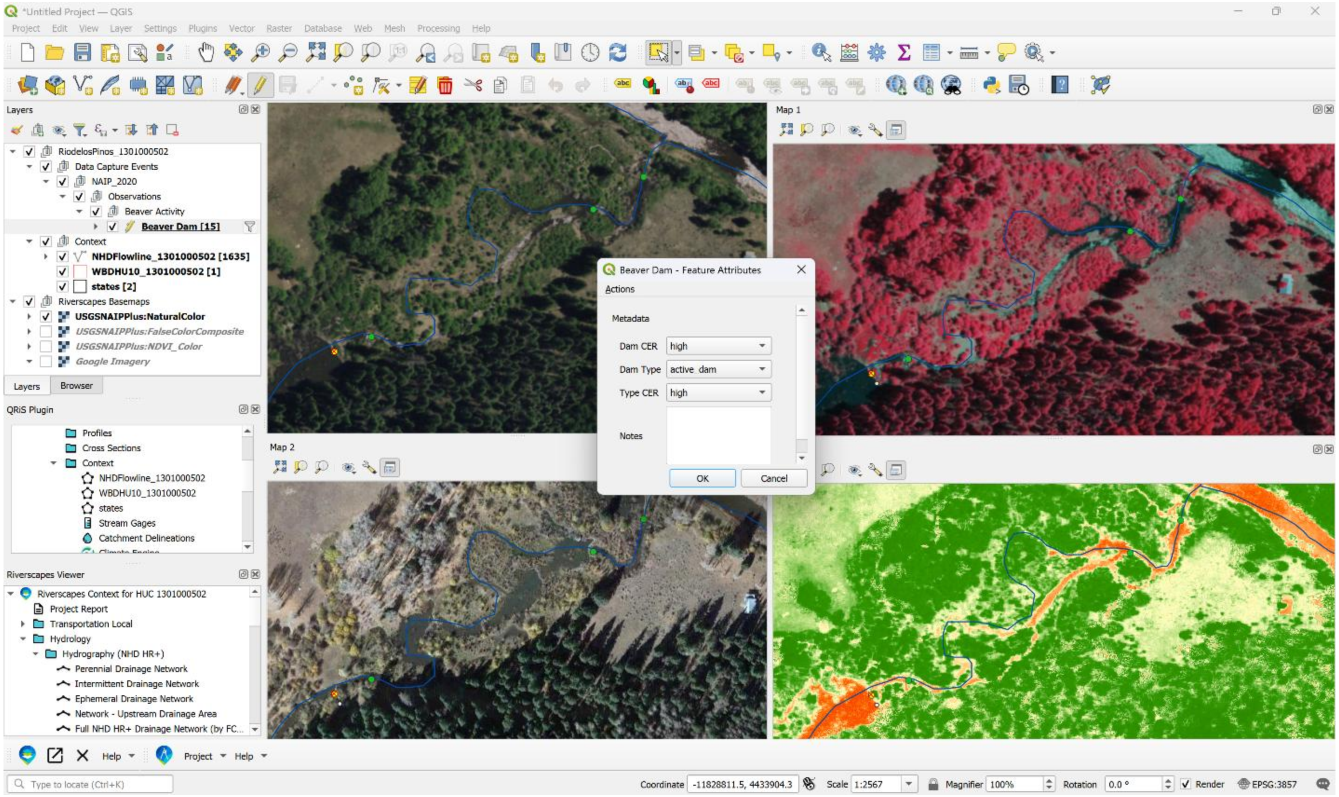


Figure 3. NAIP imagery shown as ‘true color’ imagery on the left and as ‘false color composite’ upper right and Normalized Difference Vegetation Index (NDVI) lower right. Beaver dam points are color coded based on type (active, inactive, relic) and dam certainty and dam type certainty are recoded as high, medium or low.

Sampling Design

To effectively conduct and manage a statewide beaver dam census, analyses were conducted on a watershed basis using watershed boundaries at the 10-digit Hydrologic Unit Code (HUC10) level from the Watershed Boundary Dataset (WBD) (USGS, 2025). We displayed NAIP Imagery and conducted beaver dam inventories using QGIS v. 3.34.14 with the Riverscapes Viewer and QRiS plugins (*Riverscapes Consortium*, 2025). The Riverscapes Viewer allows for the acquisition and exploration of ‘riverscape projects’, which are collections of data related to riverscapes sourced from the Riverscapes Data Exchange (*Riverscapes Consortium*, 2025). Using the Riverscapes Viewer, we accessed datasets generated by the Riverscapes Context Tool to acquire nationally available spatial data, including watershed boundaries from the WBD and filtered perennial streamflow networks from the National Hydrography Dataset (NHD), along with state boundary layers from the MAF/TIGER datasets (*National Hydrography Dataset | U.S. Geological Survey*, 2023). The QRiS plugin facilitates data capture and organization for riverscapes projects, and was used to keep track of our progress. A perennial stream network was derived from the USGS NHD and was split by each HUC10 watershed in New Mexico. To make our analysis and display in tables, figures, and atlases more manageable we aggregated our sampling frame from 575 HUC10s that make up the statewide coverage into 85 HUC8 watersheds.

Aerial Photointerpretation

Beaver dam observations were assessed by photointerpretation of NAIP imagery. Observers surveyed the NHD perennial stream network at a digital altitude of approximately 200 – 800 meters above the Earth’s surface to visually locate beaver dams. A beaver dam is typically a linear feature, which can be relatively easy to identify on aerial imagery, and is constructed of tree branches, mud, and stones that disrupt the flow of a stream or river and causes pooling of water at the foot of the dam.

When a potential beaver dam was identified, additional lines of visual evidence were evaluated to determine validity (conical pond shape, slightly curved or s-shaped crest structure, riparian harvest, skid trails, and lodges). When evidence of beaver activity was determined to be likely, an observation point was placed on the crest of the potential beaver dam. These beaver dam points were then attributed by: (1) confidence level (high, medium or low) on whether the observation is a beaver dam, (2) dam type (active, inactive or relic), and (3) confidence level (high, medium or low) on whether the observation is of a certain dam type (Figure 3 and Table 1).

Table 1. Beaver dam point location attributes.

Variable	Assessments	Explanation
Dam Certainty	Low, Medium, High	The confidence level on whether the observation is a beaver dam
Feature Type	Active Dam, Inactive Dam, Relic Dam	The condition of the dam at the time of imagery capture.
Feature Type Certainty	Low, Medium, High	The confidence level on whether the observation is of a certain dam type

Quality Control

After all beaver dam point locations were collected and their attributes were recorded per HUC10 watershed, the data was reviewed for quality by the project's Principal Investigator who either "signed off" on the census or provided feedback on how the census should be modified.

The initial data cleaning consisted of ensuring points contained all relevant fields, fell within respective HUC10 boundaries, and were not double counted. Points with invalid geometry from incorrect removal following the initial review were additionally removed, bringing the total number of points to the expected count. Data cleaning was performed using QGIS v. 3.40.4 and R v. 4.4.1 (QGIS.org, 2025; R Core Team, 2024).

Quality control included multiple assessments of dam points that fell outside of the Southern Rockies Ecoregion — primarily ones that were distant, single observations, or in unexpected areas. Points that were not removed during the initial review were reevaluated to maintain a consistent standard between observations and observers. The final points were cross-checked with the expected count, assured to not have remaining errors, and were checked off by the project's Principal Investigator.

Analysis

The analyses we conducted using the final aggregated beaver dam points file are as follows: calculating the total number of dams and the number of dams per kilometer of NHD perennial stream network for the entire state, each HUC 8 watershed, Environmental Protection Agency (EPA) level III Ecoregions (US EPA, 2015), and each landowner type. We then calculated the total number and proportion of dam types and dam certainties.

Results

The 2020 NAIP imagery-based New Mexico statewide beaver dam census identified 4,372 dams across the 21,115 km NHD perennial stream network for an overall dam density of 0.21 per km (Figure 4). The photointerpretation took a total of 305-person hours to complete, which equates to assessing 69 km of stream per hour or 14 dam locations per hour. Thus, this remote approach proved to be much quicker than what a field-based approach would take.

Only 26 of the 85 HUC8s that make up the state had dams recorded in them (Figure 4 and Figure 5). Watersheds with large numbers of beaver dams were exclusively located in the northern portion of the state with a high concentration of dams in just a few watersheds in the north central portion of the state (Figure 4 and Figure 5). Specifically, over half (53%) of the statewide dams are in 3 watersheds: Upper Rio Grande (956 dams), Rio Chama (917 dams) and Cimarron (471 dams) (Figure 4, Figure 5 and Table 2).

Beaver dam densities per watershed had a similar spatial pattern to number of dams across the state (Figure 6). The highest densities of dams were found in the northern portion of the state with one exception: Rio Hondo, which is in the southern portion of the state with a relatively high dam density of 0.15 compared to neighboring watersheds (Figure 6 and Table 2). The two HUC8's with the highest number of dams were Purgatorie (1.27 dams/km) and Chinle (0.86 dams/km) (Table 2).

Unsurprisingly, the Southern Rockies ecoregion had the highest number of beaver dams per ecoregion with 2,407 dams as well as the highest dams per km at 0.44 (Figure 7). This mountainous ecoregion has the hydrologic and vegetative resources needed to support beaver dam building and covers the northern central area of New Mexico which, as described earlier, has by far the highest concentration of beaver dams in the state. The Arizona/New Mexico Plateau and Southwestern Tablelands ecoregions had the second largest number of dams, with 892 each, and had similar dams per km at 0.18 and 0.22 respectively. The beaver dam observations in the Southwestern Tablelands were mostly located downstream of the border of the Southern Rockies ecoregion (Figure 7). The High Plains and Madrean Archipelago ecoregions had no dams recorded (Table 3).

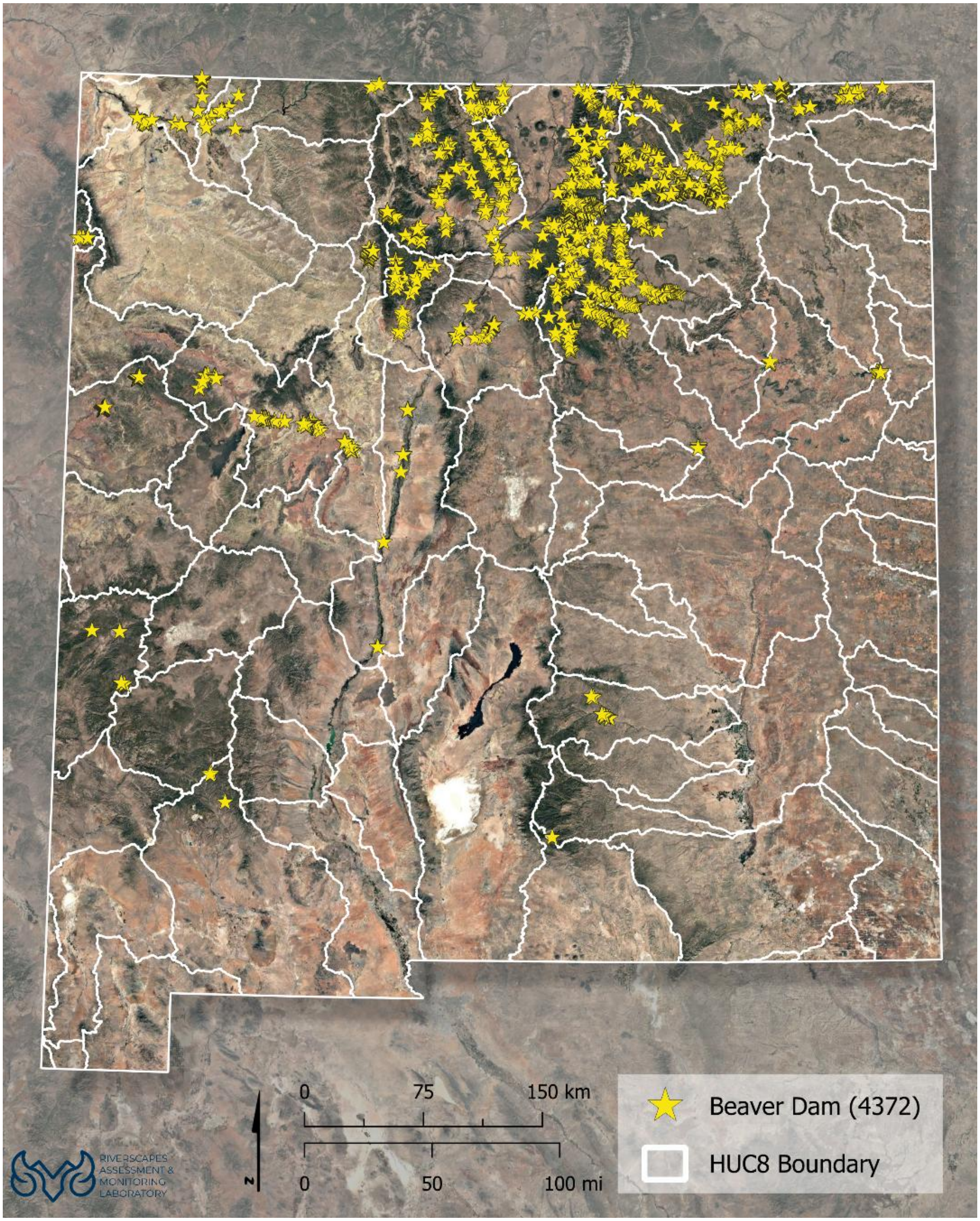


Figure 4. Beaver dam locations based on 2020 NAIP imagery-based New Mexico statewide beaver dam census by HUC8 watershed. New Mexico consists of 85 HUC8s with 33 entirely within the state and 52 with portions in surrounding states.

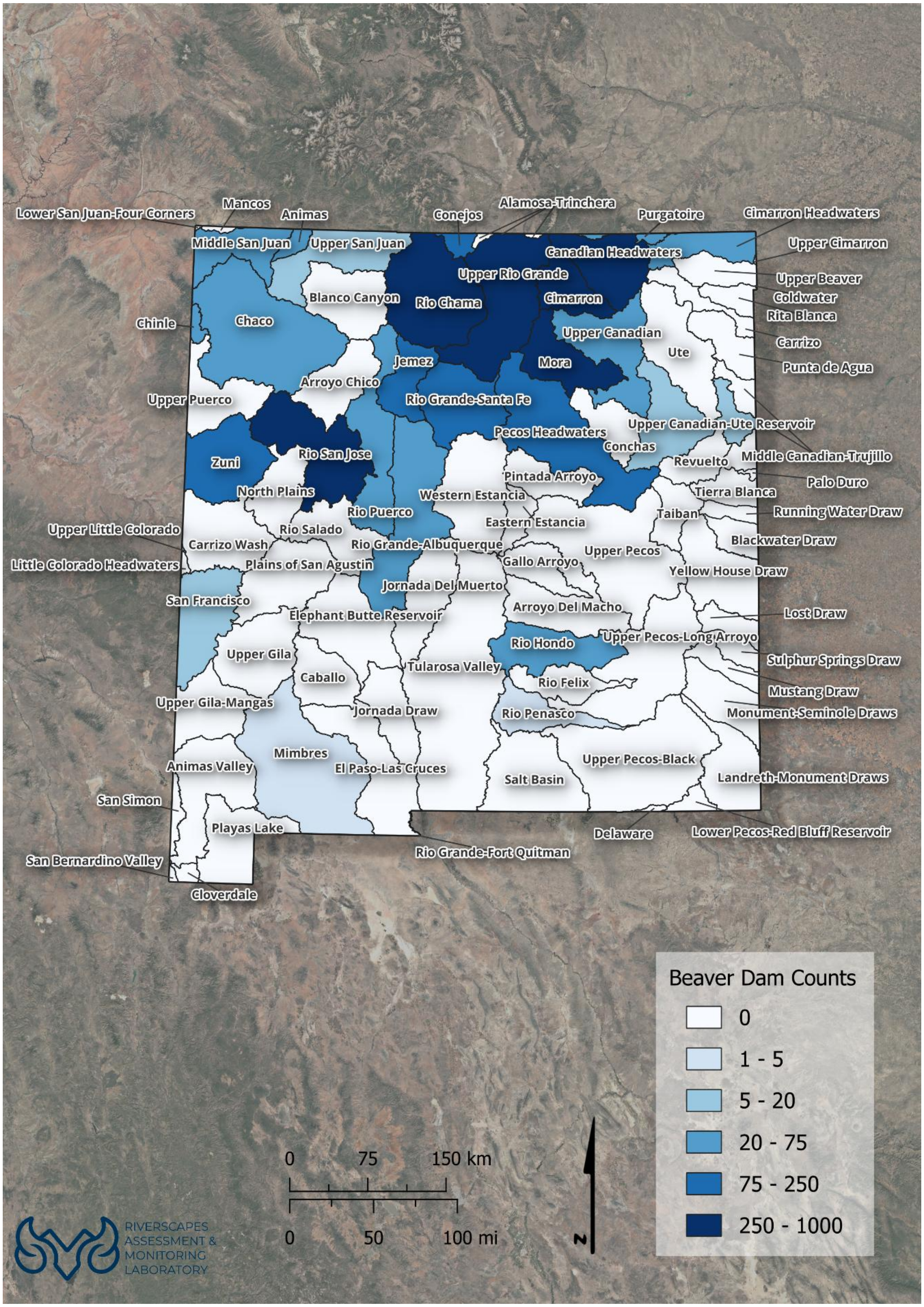


Figure 5. Beaver dams per USGS HUC8 watershed based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

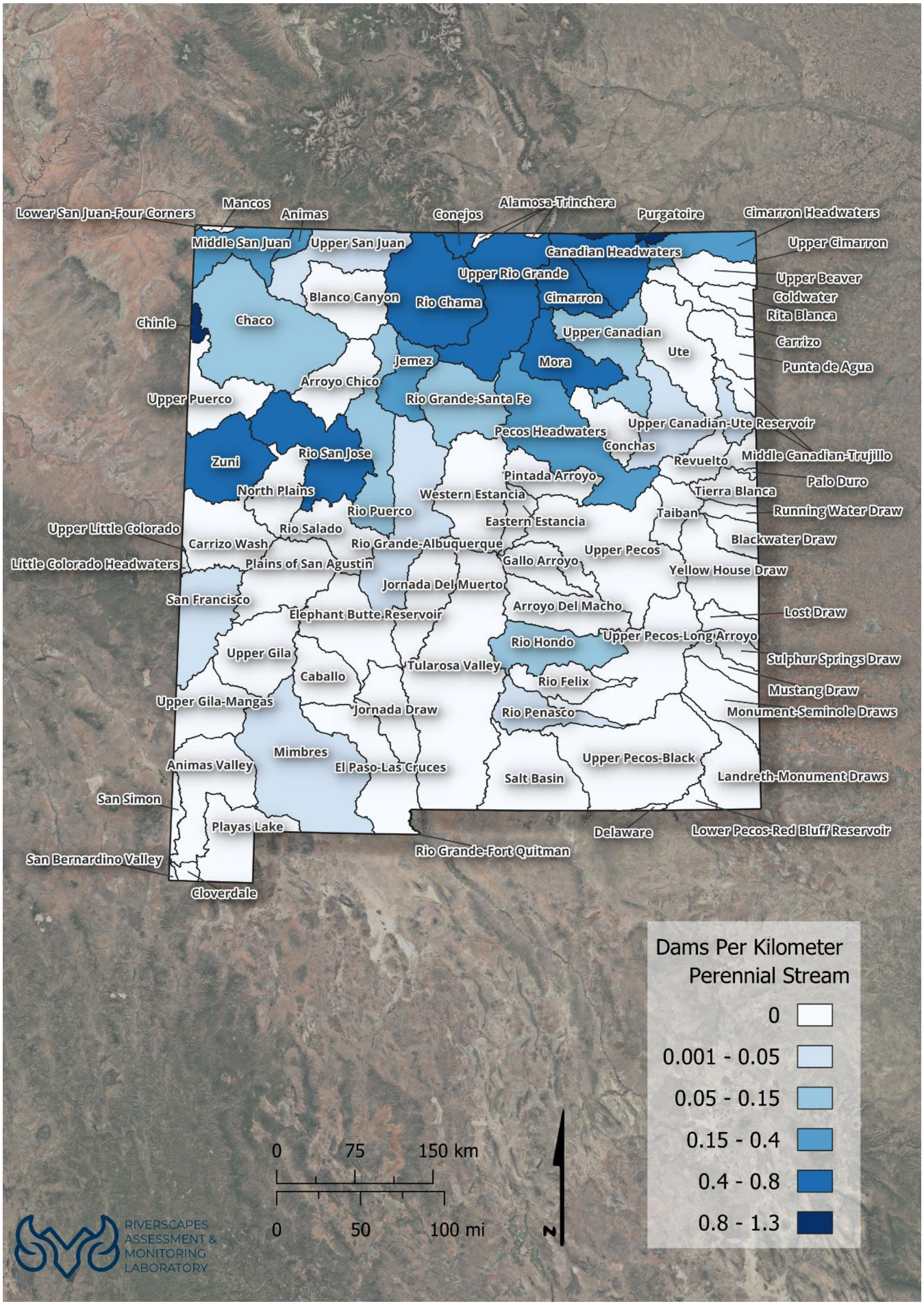


Figure 6. Beaver dams per kilometer of NHD perennial stream network based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

Table 2. The 26 HUC8 with dams recorded by the 2020 NAIP imagery-based New Mexico statewide beaver dam census. The table shows the number of beaver dams and associated dam density per HUC8 watershed. The table is sorted by highest to lowest total dams.

Name	HUC	Area (km^2)	Perennial Stream Length (km)	Total Dams	Dams Per km Perennial Stream
Upper Rio Grande	13020101	8004	2058	956	0.46
Rio Chama	13020102	7964	1537	917	0.60
Cimarron	11080002	2716	660	471	0.71
Mora	11080004	3771	677	409	0.60
Canadian Headwaters	11080001	4327	592	268	0.45
Rio San Jose	13020207	6732	330	258	0.78
Pecos Headwaters	13060001	9009	1262	210	0.17
Jemez	13020202	2690	604	133	0.22
Rio Grande-Santa Fe	13020201	4845	886	115	0.13
Zuni	15020004	5118	189	99	0.52
Conejos	13010005	599	165	86	0.52
Rio Puerco	13020204	5469	747	61	0.08
Cimarron Headwaters	11040001	2555	219	49	0.22
Rio Hondo	13060008	4304	335	49	0.15
Chinle	14080204	375	51	44	0.86
Purgatoire	11020010	331	32	40	1.27
Animas	14080104	584	128	37	0.29
Upper Canadian	11080003	5316	509	36	0.07
Chaco	14080106	11839	360	34	0.09
Middle San Juan	14080105	3196	220	34	0.15
Rio Grande-Albuquerque	13020203	8327	894	23	0.03
Upper Canadian-Ute Reservoir	11080006	5781	531	19	0.04
San Francisco	15040004	4837	682	9	0.01
Upper San Juan	14080101	4677	303	9	0.03
Mimbres	13030202	11725	441	4	0.01
Rio Penasco	13060010	2776	186	2	0.01

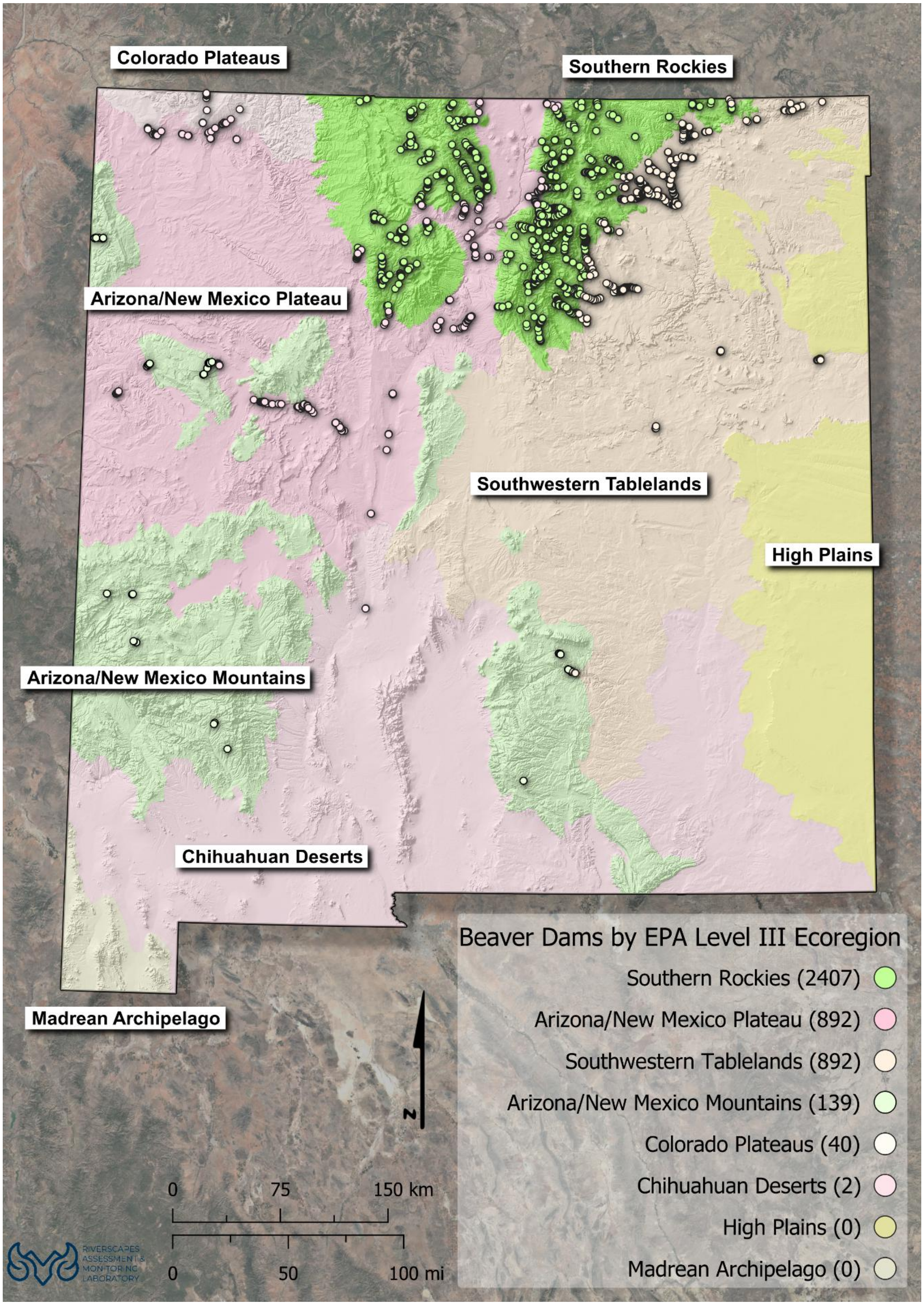


Figure 7. Beaver dams per EPA Level III Ecoregion based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

Table 3. Beaver dam density per Level III Ecoregion based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

Level III Ecoregion	Area (km^2)	Perennial Stream Length (km)	Total Dams	Dams Per km Perennial Stream
Southern Rockies	26480	5445	2407	0.44
Arizona/New Mexico Plateau	60489	4942	892	0.18
Southwestern Tablelands	71040	3990	892	0.22
Arizona/New Mexico Mountains	46891	3137	139	0.04
Colorado Plateaus	3964	362	40	0.11
Chihuahuan Deserts	69905	2978	2	0.001
High Plains	31851	236	0	0
Madrean Archipelago	4330	25	0	0

When we intersect the beaver dam location data with landownership interesting patterns emerge. For instance, tribal lands have the highest beaver dam densities at 0.27 dams per km, followed closely by private at 0.25 dams per km, and US Forest Service at 0.21 dams per km (Table 4). Also, private lands had the largest proportion of the perennial stream network and the highest number of dams illustrating the importance of the need to work with private landowners to achieve successful beaver-based conservation and restoration.

Table 4. Beaver dam density per landownership category based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

Landowner	Area (km^2)	Perennial Stream Length (km)	Total Dams	Dams Per km Perennial Stream
Private	137212	10477	2643	0.25
Forest Service	37278	4554	932	0.21
Tribal Land	33458	2373	646	0.27
State	37620	1169	74	0.06
BLM	54601	2033	62	0.03
NPS	1924	95	13	0.14
FWS	1548	205	2	0.01
Other Federal	11298	212	0	0

Of the three dam types recorded in the survey (active, inactive, and relic), 79% were recorded as active (Table 5). Of the dam certainty types (high, medium and low), each category was similar at 36% high, 30% medium and 34% low certainty (Table 5).

Table 5. Dam type and certainty total counts and the proportion of the total number of records based on 2020 NAIP imagery-based New Mexico statewide beaver dam census.

Dam Type	Count	Proportion
Active	3453	79%
Inactive	821	19%
Relic	98	2%

Dam Certainty	Count	Proportion
High	1586	36%
Medium	1317	30%
Low	1469	34%

The beaver dam census identified beaver dams that occurred not only in the classic setting, but also within floodplains on secondary anabranches (Figure 8), and in steep settings (Figure 9). The occurrence of these dams in floodplain and steep settings illustrates how important these underappreciated beaver dam settings are as habitat.

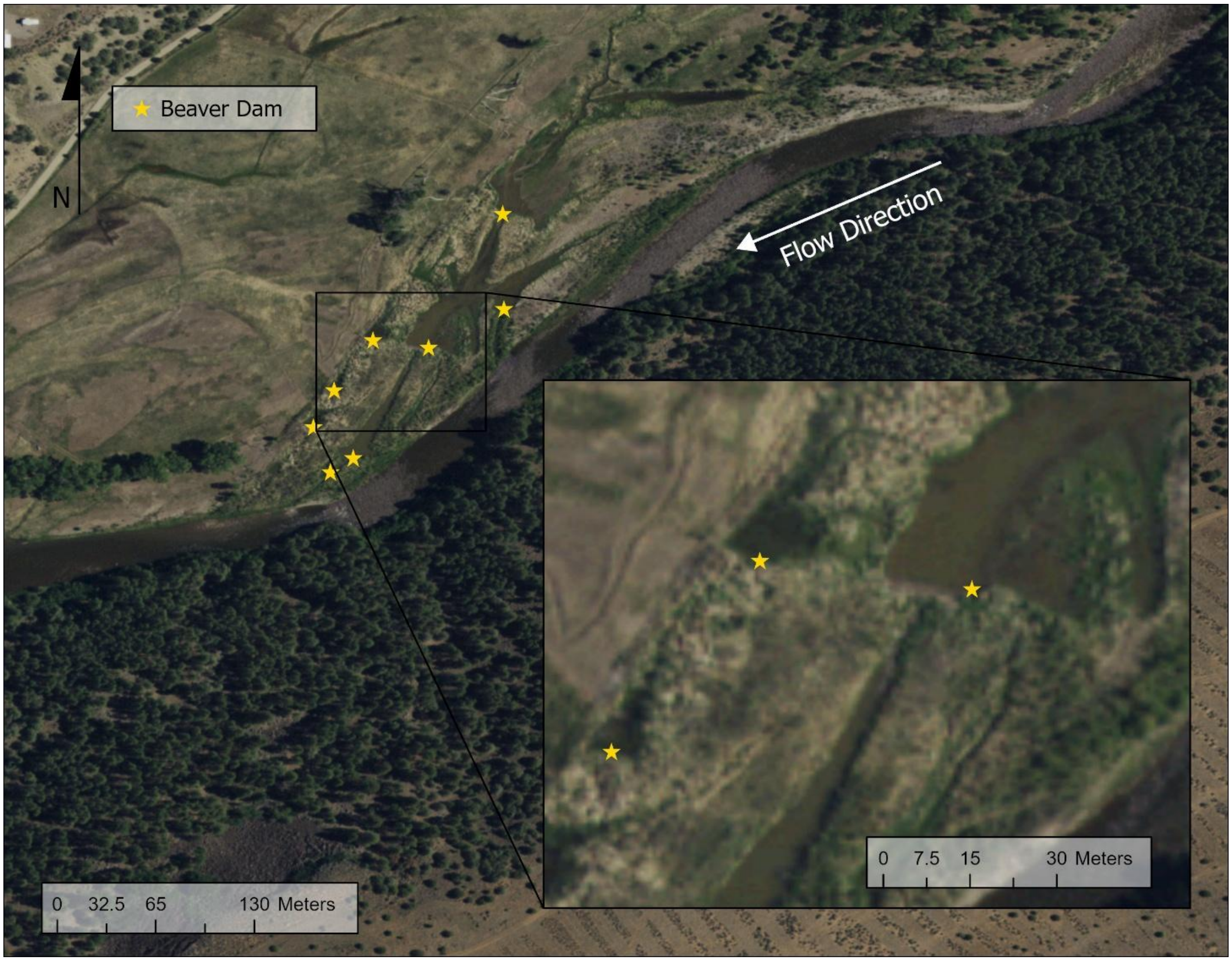


Figure 8. Observed beaver dam locations in a floodplain setting. The inset map shows secondary channels and associated beaver dams in more detail.

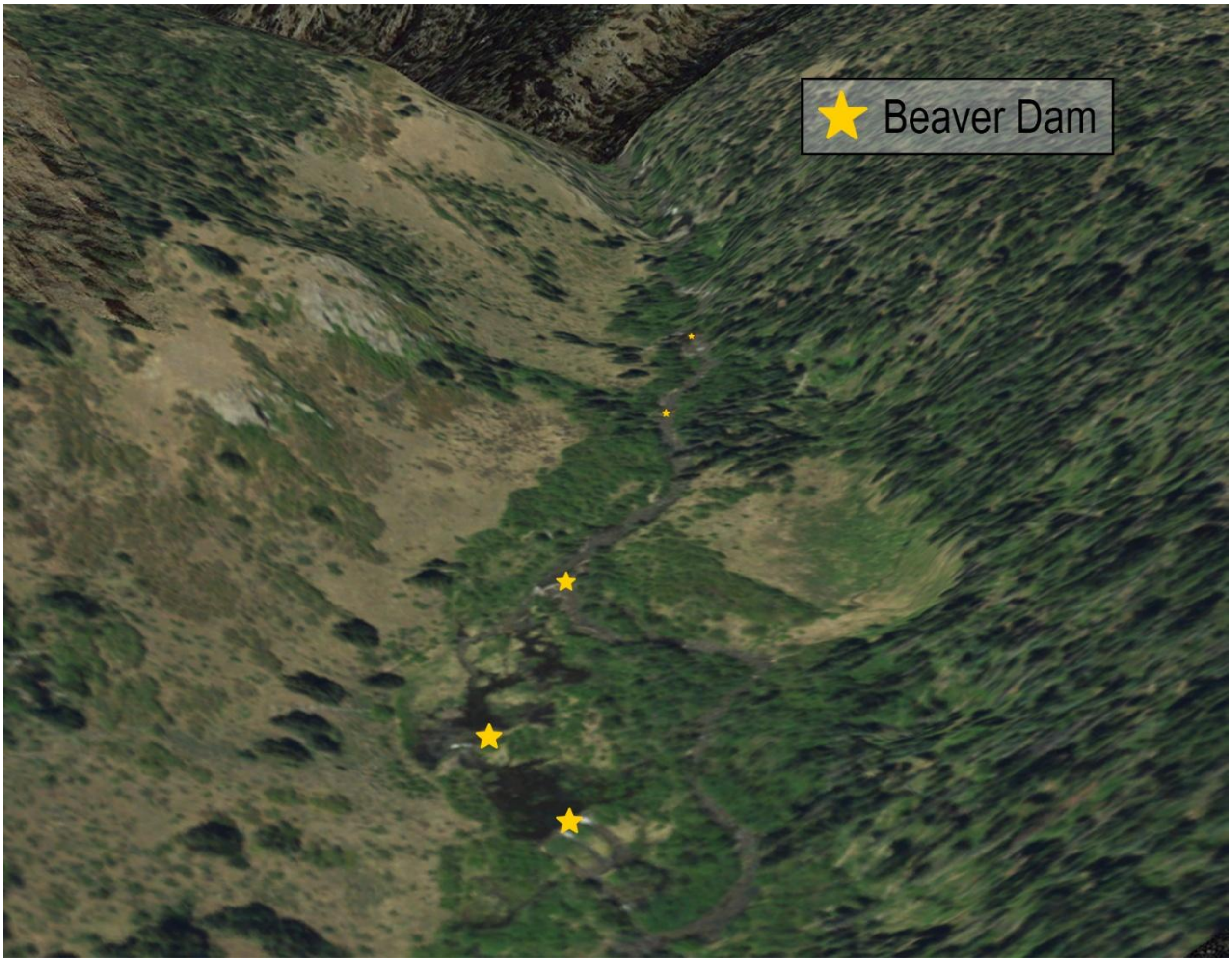


Figure 9. Observed beaver dam locations in a steep setting.

Discussion

Imagery-based Beaver Dam Censusing: Caveats

We refer to this approach of collecting dam locations as 'censusing' because the entire perennial network is sampled. However, it is important to point out that this is not a complete census of beaver dams, it is a sample from a "snapshot" in time based on the date of imagery. Moreover, this imagery-based method generally under-samples total dams, especially in forested ecosystems where it is difficult to see the stream through the forest canopy.

Another caveat to mention is that many of the NHD streams coded as perennial are discontinuous streams that include patches of dry stream bed which we call "land bridges". We define land bridges as exposed, channel spanning bars that are perpendicular to the stream channel. Land bridges are found in several arid, low gradient watersheds throughout New Mexico. Many land bridges, pool water, and look like a beaver pond (Figure 10) but they lack the other evidence of a beaver dam including woody riparian vegetation harvest, lodges, and woody vegetation resources available for dam building.

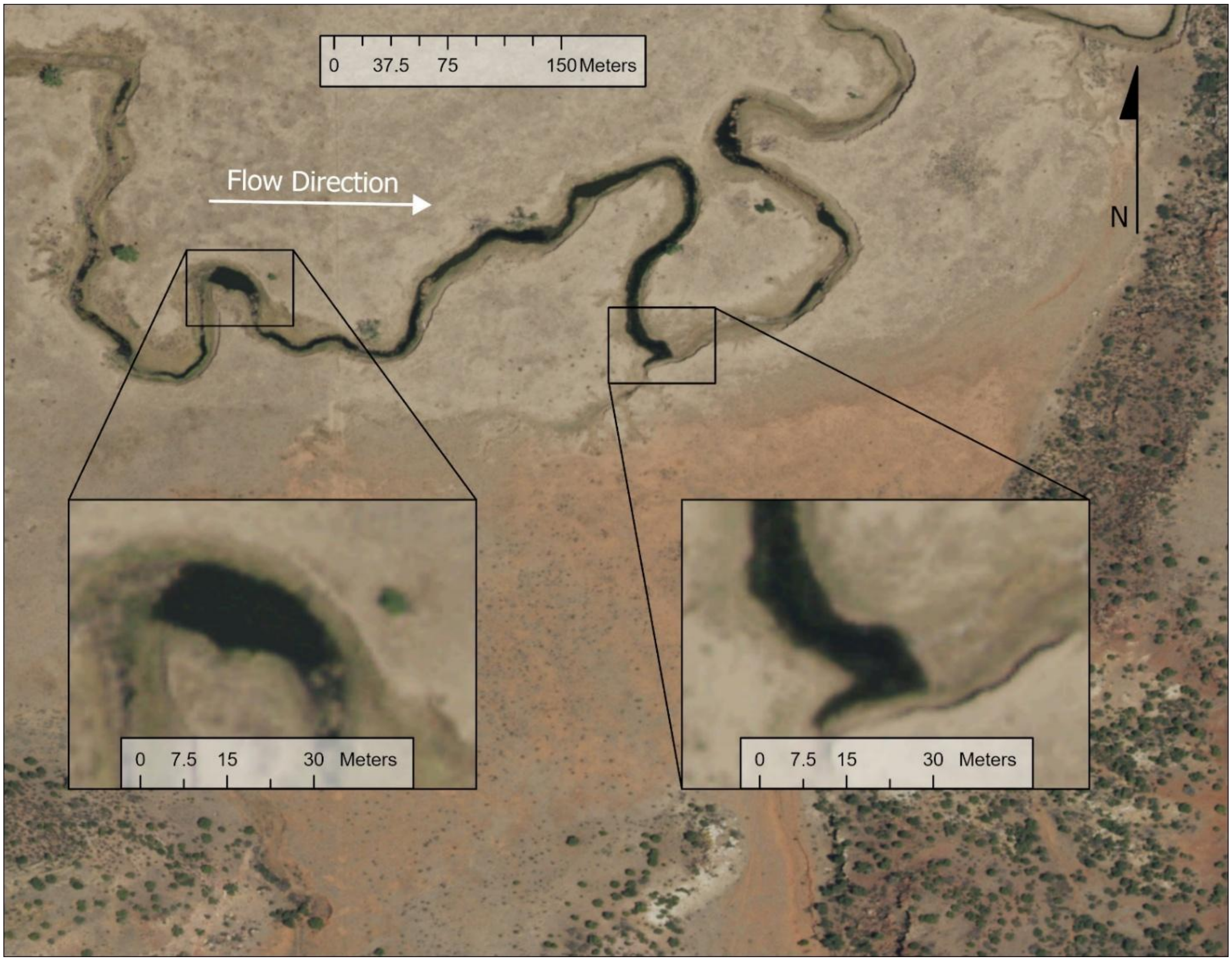


Figure 10. An example of a discontinuous stream that include patches of dry stream bed which we call "land bridges". We define land bridges as exposed, channel spanning bars that are perpendicular to the stream channel. Many land bridges, pool water, and look like a beaver pond.

New Mexico Vs Montana Beaver Dam Numbers

We recently conducted a similar statewide beaver dam census for Montana and identified a total of 32,336 dams over 93,439 km of streams (Macfarlane et al., 2024). The total number of dams inventoried in Montana (32,336 dams) is 640% greater than the amount that was found in New Mexico (4,372 dams). However, the difference in dam density in Montana (0.34) vs New Mexico (0.21) is much less at 61.9 %, which is still substantially higher, but is not surprising given regional differences. Montana is wetter with a greater area of mountains, especially in the western portion of the state, resulting in the hydrology and woody riparian resources needed to support widespread beaver dam building. These states have similarities in that large portions of both states are too arid to support sufficient stream flow and woody riparian vegetation required for extensive beaver dam building.

Recommended Next Steps

Validation of the Beaver Restoration Assessment Tool (BRAT)

In a closely related forthcoming project, the beaver dam locations collected from this census will be used to localize, calibrate, and validate BRAT modeled beaver dam capacity estimates. Specifically, the census data will be plotted against predicted capacity counts. This information will be used to determine how close a given watershed is to predicted beaver dam building capacity.

Assessment of Dam Settings Using BRAT

When BRAT is run it includes, as an output, the dam building setting of each reach of the drainage network ('classic,' 'floodplain,' or 'steep'). When BRAT is run for New Mexico, this will enable quantification of the frequency of these different dam settings across the landscape, which provides insight into the availability of different habitat types. Also, using the locations of dams from this census, the relative frequency of dam building in each of the settings can be calculated to understand how beaver are utilizing these different settings.

Ground Truthing Beaver Dam Locations

We suggest conducting field-based beaver dam surveys that could be directly compared to the beaver dam locations from the census thus providing an accuracy assessment for this project. Field data collection could be done using a beaver dam survey app that we have developed for Esri Survey123. Beaver dam surveys could be conducted along stream reaches that are selected using a random sample approach that are spatially balanced and stratified by ecoregion across all watersheds.

Conclusions

The New Mexico statewide 2020 NAIP imagery-based beaver dam census proved to be a cost-effective method for identifying beaver dams across the riverscapes of the state. In many arid watersheds, this project ended up being a photointerpretation "needle in the haystack" exercise. As we examined over 21,000 km of streams, we found only 4,372 dams or 0.21 dams per km. It appears that many riverscapes simply did not have adequate water and/or the woody riparian resources to support dam building beaver and we speculate that there might be a range limit to beaver dam building in southern New Mexico.

We believe this statewide beaver dam inventory is an important dataset to help plan and prioritize beaver conservation and beaver-based restoration efforts at the statewide, watershed and reach levels. Specifically, this dataset can be used to help define both beaver conservation and potential restoration reaches. Our hope is that this inventory will provide Defenders of Wildlife staff and partners with the information they need to better manage dam building beaver and to identify opportunities for using beaver in riverscape restoration throughout New Mexico.

Final Data Products

Deliverable data include:

1. Beaver dam observation points per watershed (HUC10 scale) available through the Riverscapes Data Exchange (data.riverscapes.net) as 'Beaver Activity' projects (see instructions below).
2. Beaver dam observation points at New Mexico statewide level found here.
3. Beaver dam observation atlas maps by HUC8 watershed in 2 versions (points and cluster points) found here.

Within the Riverscapes Data Exchange, there is a 'Defenders of Wildlife' organization that owns the riverscapes projects related to this project (Defenders of Wildlife). After creating an individual user profile in the data exchange, users can request membership to this organization to be able to see and interact with these projects. Projects can be downloaded for use in GIS software (e.g., ArcPro, QGIS) or viewed online on the Riverscapes Data Exchange.

All individual (HUC10) Beaver Activity projects in New Mexico can be found here. Additionally, a merged Beaver Activity project for all of New Mexico can be found here.

Acknowledgments

We would like to thank Cecil Rich for their help coordinating the project and Defenders of Wildlife for funding this important project.

References

Bason, C. W., Kroes, D. E., & Brinson, M. M. (2017). The Effect of Beaver Ponds on Water Quality in Rural Coastal Plain Streams. *Southeastern Naturalist*, *16*(4), 584–602. https://doi.org/10.1656/058.016.0408

Brazier, R. E., Puttock, A., Graham, H. A., Auster, R. E., Davies, K. H., & Brown, C. M. L. (2021). Beaver: Nature's ecosystem engineers. *WIREs Water*, *8*(1), e1494. https://doi.org/10.1002/wat2.1494

Burchsted, D., Daniels, M., Thorson, R., & Vokoun, J. (2010). The River Discontinuum: Applying Beaver Modifications to Baseline Conditions for Restoration of Forested Headwaters. *BioScience*, *60*(11), 908–922. https://doi.org/10.1525/bio.2010.60.11.7

Bush, B. M., & Wissinger, S. A. (2016). *Invertebrates in Beaver-Created Wetlands and Ponds*. 411–449. https://doi.org/10.1007/978-3-319-24978-0_12

Cooke, H. A., & Zack, S. (2008). Influence of beaver dam density on riparian areas and riparian birds in shrubsteppe of Wyoming. *Western North American Naturalist*, *68*(3), 365–373. https://doi.org/10.3398/1527-0904(2008)68[365:IOBDDO]2.0.CO;2

Dewey, C., Fox, P. M., Bouskill, N. J., Dwivedi, D., Nico, P., & Fendorf, S. (2022). Beaver dams overshadow climate extremes in controlling riparian hydrology and water quality. *Nature Communications*, *13*(1), 6509. https://doi.org/10.1038/s41467-022-34022-0

Fairfax, E., & Small, E. E. (2018). Using remote sensing to assess the impact of beaver damming on riparian evapotranspiration in an arid landscape. *Ecohydrology*, *11*(7), e1993. https://doi.org/10.1002/eco.1993

Fairfax, E., Whipple, A., Wheaton, J. M., Osorio, B., Miller, J., Kirksey, K., Perez, N., Gilbert, J. T., & Jordan, C. E. (2024). Impacts of beaver dams on riverscape burn severity during megafires in the Rocky Mountain region, western United States. In J. L. Florsheim, A. P. O'Dowd, & A. Chin (Eds.), *Biogeomorphic Responses to Wildfire in Fluvial Ecosystems* (Vol. 562, p. 0). Geological Society of America. https://doi.org/10.1130/2024.2562(07)

Graham, H. A., Puttock, A. K., Elliott, M., Anderson, K., & Brazier, R. E. (2022). Exploring the dynamics of flow attenuation at a beaver dam sequence. *Hydrological Processes*, *36*(11), e14735. https://doi.org/10.1002/hyp.14735

Hood, G. A., & Bayley, S. E. (2008). Beaver (Castor canadensis) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. *Biological Conservation*, *141*(2), 556–567. https://doi.org/10.1016/j.biocon.2007.12.003

Larsen, A., Larsen, J. R., & Lane, S. N. (2021). Dam builders and their works: Beaver influences on the structure and function of river corridor hydrology, geomorphology, biogeochemistry and ecosystems. *Earth-Science Reviews*, *218*, 103623. https://doi.org/10.1016/j.earscirev.2021.103623

Law, A., Levanoni, O., Foster, G., Ecke, F., & Willby, N. J. (2019). Are beavers a solution to the freshwater biodiversity crisis? *Diversity and Distributions*, *25*(11), 1763–1772. https://doi.org/10.1111/ddi.12978

Macfarlane, W., Bangen, S., Hallerud, M., Anderson, B., Hafen, C., Albonico, M., Garlick, C., Gibby, T., Hatch, T., Rasmussen, C., Portugal, E., Wheaton, J., Ww, M., Hallerud, B., & Ma, A. (2020). *CALIFORNIA BEAVER RESTORATION ASSESSMENT TOOL Building Realistic Expectations for Partnering with Beaver in Conservation and Restoration Recommended Citation*. https://doi.org/10.13140/RG.2.2.20316.00644

Macfarlane, W., Gilbert, J., Baker, D., Gunnell, C., Gilbert, J., Souza, N., Sargeant, P., & Seeborg, C. (2024). *MONTANA BEAVER DAM CENSUS & BEAVER RESTORATION ASSESSMENT TOOL (BRAT) VERIFICATION*. https://doi.org/10.13140/RG.2.2.14951.05281

Macfarlane, W., Hallerud, M., Bangen, S., Hafen, C., Albonico, M., Garlick, C., Gibby, T., Hatch, T., Rasmussen, C., & Wheaton, J. (2019). *IDAHO BEAVER RESTORATION ASSESSMENT TOOL Building Realistic Expectations for Partnering with Beaver in Conservation and Restoration*. https://doi.org/10.13140/RG.2.2.12641.25447

Macfarlane, W., Hallerud, M., Bangen, S., Hafen, C., Albonico, M., Garlick, C., Gibby, T., Hatch, T., Rasmussen, C., Wheaton, J., & Ww, M. (2019). *GREATER YELLOWSTONE AREA BEAVER RESTORATION ASSESSMENT TOOL Building Realistic Expectations for Partnering with Beaver in Conservation and Restoration GYA BRAT Recommended Citation*. https://doi.org/10.13140/RG.2.2.23671.44964

Morgan, L. H. (1868). *The American Beaver and His Works*. J.B. Lippincott & Company.

National Agriculture Imagery Program—NAIP Hub Site. (n.d.). Retrieved April 11, 2025, from https://naip-usdaonline.hub.arcgis.com/

National Hydrography Dataset | U.S. Geological Survey. (n.d.). Retrieved April 11, 2025, from https://www.usgs.gov/national-hydrography/national-hydrography-dataset

Pollock, M., Heim, M., & Werner, D. (2003). Hydrologic and Geomorphic Effects of Beaver Dams and Their Influence on Influence on Fishes. In *American Fisheries Society Symposium* (Vol. 2003).

Riverscapes Consortium. (n.d.). Riverscapes Consortium. Retrieved April 11, 2025, from https://www.riverscapes.net/

US EPA, O. (2015, November 25). *Level III and IV Ecoregions of the Continental United States* [Data and Tools]. https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states

Wheaton, J., Macfarlane, W., & Jensen, M. (2014). *The Utah Beaver Restoration Assessment Tool: A Decision Support & Planning Tool - Final Report to Utah Divsion of Wildlife Resources*. https://doi.org/10.13140/2.1.3190.0167

Wohl, E., Dwire, K., Sutfin, N., Polvi, L., & Bazan, R. (2012). Mechanisms of carbon storage in mountainous headwater rivers. *Nature Communications*, *3*(1), 1263. https://doi.org/10.1038/ncomms2274

Appendix A: Table showing the number of beaver dams and associated dam density per HUC8 watershed and includes HUC8's with no recorded dams. The table is sorted by highest to lowest total dams.

Name	*HUC*	*Area (km^2)*	*Perennial Stream Length (km)*	*Total Dams*	*Dams Per km Perennial Stream*
Upper Rio Grande	13020101	8004	2058	956	0.46
Rio Chama	13020102	7964	1537	917	0.60
Cimarron	11080002	2716	660	471	0.71
Mora	11080004	3771	677	409	0.60
Canadian Headwaters	11080001	4327	592	268	0.45
Rio San Jose	13020207	6732	330	258	0.78
Pecos Headwaters	13060001	9009	1262	210	0.17
Jemez	13020202	2690	604	133	0.22
Rio Grande-Santa Fe	13020201	4845	886	115	0.13
Zuni	15020004	5118	189	99	0.52
Conejos	13010005	599	165	86	0.52
Rio Puerco	13020204	5469	747	61	0.08
Cimarron Headwaters	11040001	2555	219	49	0.22
Rio Hondo	13060008	4304	335	49	0.15
Chinle	14080204	375	51	44	0.86
Purgatoire	11020010	331	32	40	1.27
Animas	14080104	584	128	37	0.29
Upper Canadian	11080003	5316	509	36	0.07
Chaco	14080106	11839	360	34	0.09
Middle San Juan	14080105	3196	220	34	0.15
Rio Grande-Albuquerque	13020203	8327	894	23	0.03
Upper Canadian-Ute Reservoir	11080006	5781	531	19	0.04
San Francisco	15040004	4837	682	9	0.01
Upper San Juan	14080101	4677	303	9	0.03
Mimbres	13030202	11725	441	4	0.01
Rio Penasco	13060010	2776	186	2	0.01
Revuelto	11080008	2087	158	0	0.00
Upper Beaver	11100101	1945	158	0	0.00
San Simon	15040006	606	18	0	0.00
Upper Cimarron	11040002	16	0	0	0.00

Middle Canadian-Trujillo	11090101	1815	71	0	0.00
Upper Gila	15040001	5141	789	0	0.00
Carrizo Wash	15020003	5005	95	0	0.00
Palo Duro	11120102	108	0	0	0.00
Upper Gila-Mangas	15040002	3932	319	0	0.00
Carrizo	11090104	1626	35	0	0.00
Conchas	11080005	2633	29	0	0.00
Ute	11080007	5504	195	0	0.00
Arroyo Chico	13020205	3564	226	0	0.00
North Plains	13020206	3130	0	0	0.00
Upper Pecos-Black	13060011	11153	308	0	0.00
Upper Puerco	15020006	3527	107	0	0.00
Lower San Juan-Four Corners	14080201	19	5	0	0.00
Plains of San Agustin	13020208	5161	10	0	0.00
Rio Salado	13020209	3617	203	0	0.00
Jornada Del Muerto	13020210	4430	18	0	0.00
Jornada Draw	13030103	3236	30	0	0.00
Western Estancia	13050001	6276	9	0	0.00
Eastern Estancia	13050002	1332	0	0	0.00
Pintada Arroyo	13060002	2666	48	0	0.00
Upper Pecos	13060003	10890	815	0	0.00
Taiban	13060004	2086	11	0	0.00
Arroyo Del Macho	13060005	4844	33	0	0.00
Gallo Arroyo	13060006	2256	38	0	0.00
Upper Pecos-Long Arroyo	13060007	8286	257	0	0.00
Blanco Canyon	14080103	4440	281	0	0.00
Coldwater	11100103	2	0	0	0.00
Upper Little Colorado	15020002	11	0	0	0.00
Delaware	13070002	124	4	0	0.00
Lost Draw	12080001	1347	0	0	0.00
Running Water Draw	12050005	768	0	0	0.00
Punta de Agua	11090102	2374	155	0	0.00
Rita Blanca	11090103	1110	48	0	0.00
Tierra Blanca	11120101	1640	9	0	0.00

Yellow House Draw	12050001	4847	1	0	0.00
Blackwater Draw	12050002	1406	0	0	0.00
Monument-Seminole Draws	12080003	3274	0	0	0.00
Tularosa Valley	13050003	17065	218	0	0.00
Lower Pecos-Red Bluff Reservoir	13070001	681	4	0	0.00
Landreth-Monument Draws	13070007	4002	0	0	0.00
Caballo	13030101	3197	405	0	0.00
Alamosa-Trinchera	13010002	189	0	0	0.00
Elephant Butte Reservoir	13020211	5687	390	0	0.00
Playas Lake	13030201	4365	13	0	0.00
Rio Felix	13060009	2444	50	0	0.00
Mancos	14080107	151	7	0	0.00
Sulphur Springs Draw	12080006	983	0	0	0.00
Cloverdale	15080303	383	0	0	0.00
San Bernardino Valley	15080302	96	0	0	0.00
Animas Valley	15040003	5831	240	0	0.00
Little Colorado Headwaters	15020001	130	11	0	0.00
El Paso-Las Cruces	13030102	6072	610	0	0.00
Rio Grande-Fort Quitman	13040100	0	0	0	0.00
Salt Basin	13050004	6113	115	0	0.00
Mustang Draw	12080004	1461	0	0	0.00