



Photo courtesy of Mike Blakeman- Rio Oxbow Ranch, easement held by Rio Grande Headwaters Land Trust

LAND & WATER

A QUANTITATIVE ANALYSIS OF
LAND CONSERVATION'S IMPACT
ON WATER IN COLORADO

INTRODUCTION

Water has been a prominent concern for agricultural, municipal, and industrial sectors in Colorado for quite some time, and its significance will only continue to increase. Over the last couple of years, conservation proponents have been placing a higher priority on water projects and organizations working with water. After several discussions with various conservation advocates, the Colorado Coalition of Land Trusts (CCLT) realized that, although land trusts and open space programs are associated with land preservation and recreation, we, as a community, are not as strongly inked with water and watershed protection as we can be. The fact is when conservation organizations conserve land, they also protect water. Conserving land around rivers and streams protects valuable habitat and riparian zones that are crucial to a river's health and water quality. Until now, the impact of Colorado land conservation efforts on water and watersheds was not quantified. Though undocumented, Colorado land conservation programs have been protecting water all along. This report quantifies how much water has already been protected by land conservation in Colorado. As funders increasingly focus on water, this knowledge will provide a platform for further protecting Colorado's water through land conservation.

This report quantifies the miles of river corridor protected by conservation easements in the state. The research was performed by CCLT, in collaboration with the Colorado Water Trust, (CWT), and in cooperation with Great Outdoors Colorado, (GOCO). Even though water rights encumbered by easements and in-stream flows held by the state are not included in this report, protecting the land surrounding streams and rivers is a major step in protecting water in Colorado. Land and water are intrinsically linked habitats and environmental systems. Similarly, the land and water communities are intrinsically linked, and connecting their work can only strengthen the efforts of each. Land conservation already has a broad impact on water protection: this report recognizes what has already been done and provides knowledge to allow that impact to continue to grow. Highlighting land conservation's affect on water is another way for land trusts to be strategic about obtaining funds and also to determine how those funds are used. The Rio Grande Headwaters Land Trust has shown the potential of tying land conservation to water with the success of their "Rio Grand Initiative" to protect the Rio Grande River corridor. From local land trusts to GOCO, up to the national level, with the Land Trust Alliance and the Department of the Interior, the information in this report is a valuable tool for prioritizing land conservation on all levels.

SUMMARY

To date, land conservation efforts in Colorado protect:

- **1,286 miles of river corridor 2nd order and larger**
 - 3.5% of all rivers of this size in the state
- **778 miles of river corridor 3rd order and larger**
 - 4.2% of all rivers of this size in the state

Stream order refers to the size of the stream. For purposes of this study, 1st order streams are considered "intermittent" because they are only flowing for part of the year, and have been omitted. Second order streams can be considered "quasi-intermittent" because some only flow for one to two months out of the year, while others are small year-round streams. Streams 3rd order and larger are considered year-round, or "perennial" streams because they have consistent flows throughout the year. See the stream order section below for a more in-depth explanation of stream order.

METHODS

The bulk of the research for this project was performed using the Colorado Ownership, Management, and Protection project (COMap). COMap is a detailed map of all the protected areas in the state of Colorado assembled by the Natural Resource Ecology Lab and the Human Dimensions of Natural Resources Department at Colorado State University. The premise of COMap is that the landscape context of conservation (ownership and management) is important to natural resource management issues. Knowing the location and pattern of various protected areas is a key piece of information to inform management of many natural resources in Colorado. Recognizing its importance, GOCO provided technical assistance and funding for COMap.⁰ The COMap database is a valuable tool because it utilizes Geographic Information Systems (GIS) software, allowing detailed datasets to be easily visualized and manipulated. The vast majority of the data is a result of GIS analysis using COMap, though some of the data for stream miles came directly from individual land trusts and open space program records.

Research for this project was performed using ArcMap GIS software on a computer at GOCO's office in Denver, with the guidance of Chris Yuan-Farrel. The GIS Software enables the user to layer different maps and data together to see how they interact with one another. The first map layer, referred to as a "dataset," was of all the streams and rivers in Colorado – the National Hydrography Dataset from the United States Geologic Survey (Figure 1). The project participants would like to thank John Sanderson and Jan Koenig at The Nature Conservancy for providing a modified version of this dataset, with all ditches and canals removed.

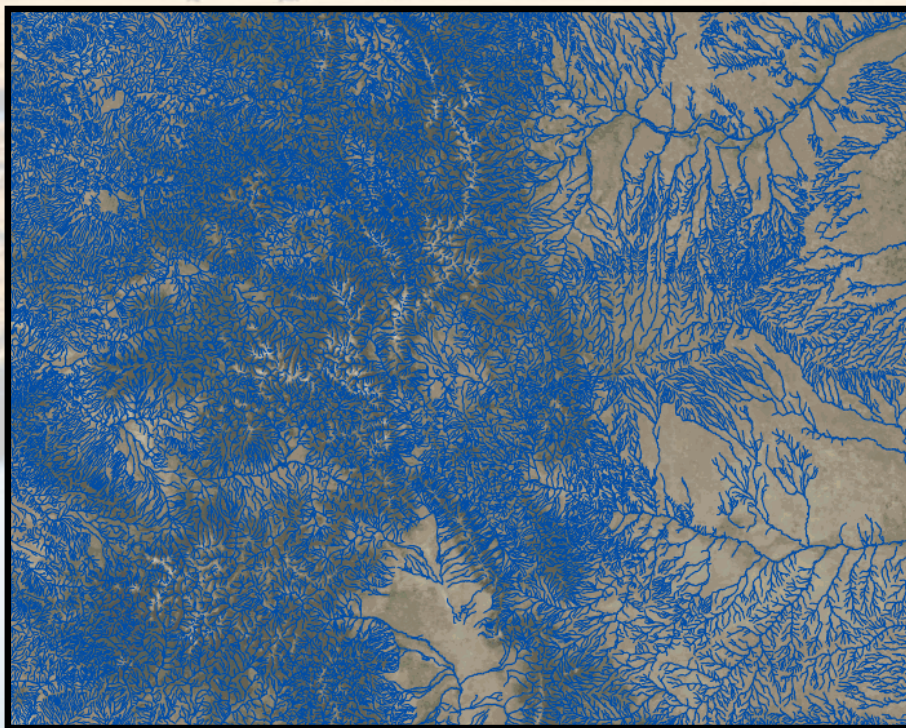


Figure 1: The National Hydrography Dataset for Colorado

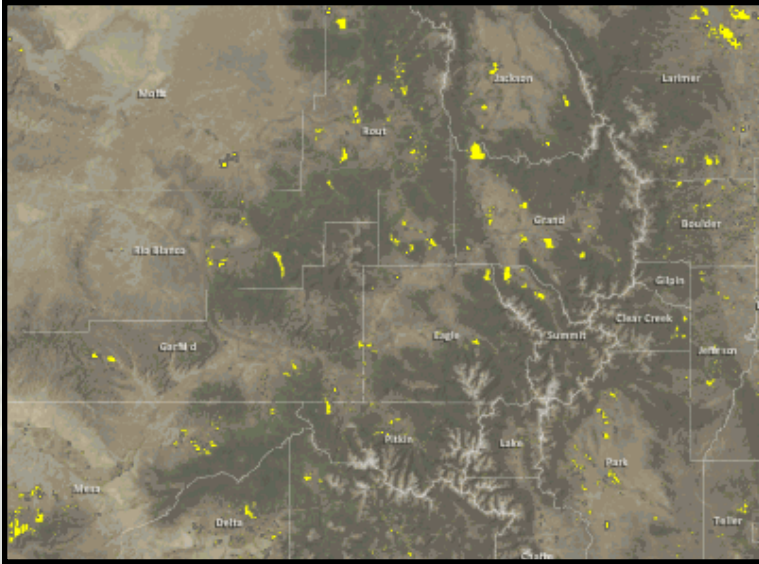


Figure 2: COMap Conservation Easement Dataset

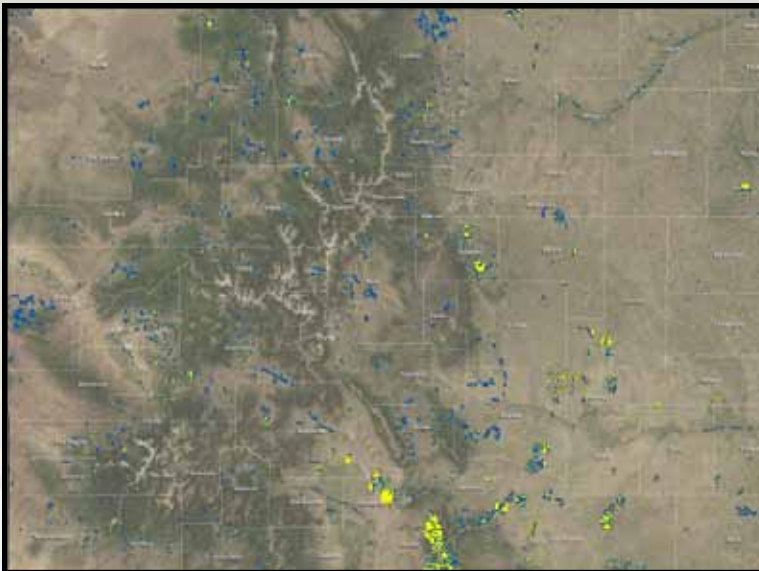


Figure 3: National Hydrography Dataset Rivers "Clipped" to the Boundaries of Conservation Easements

Next, the National Hydrography Dataset was sorted according to stream order for the purpose of excluding intermittent streams. This process is discussed at length below, in the "Stream Order" section. The National Hydrography Dataset was then layered with COMap's dataset for conservation easements in Colorado (Figure 2). In the map at right, the conservation easements are in yellow.

GIS is powerful because the software tracks hundreds of data points for every line on the map. This allows the user to manipulate and pull out very detailed information from these datasets. The program also produces maps, making the information easily understandable.

Once the two datasets were layered together, the streams were "clipped" at the boundaries of the conservation easements. The software used the easement boundaries as a cookie cutter to determine the mileage of river corridor running through conservation easements (Figure 3). After

the rivers were clipped, GIS software calculated the mileage of river corridor protected by conservation easements. It is important to note that the mileage is simply the mileage of the river, or the river corridor, flowing through an easement, as opposed to double-counting the mileage of each stream bank. In order to provide perspective on how much land surrounding rivers is protected, several close-up views of conservation easements surrounding streams and rivers follow.

Figure 4: Trinchera Creek and Trinchera Ranch in Southern Colorado

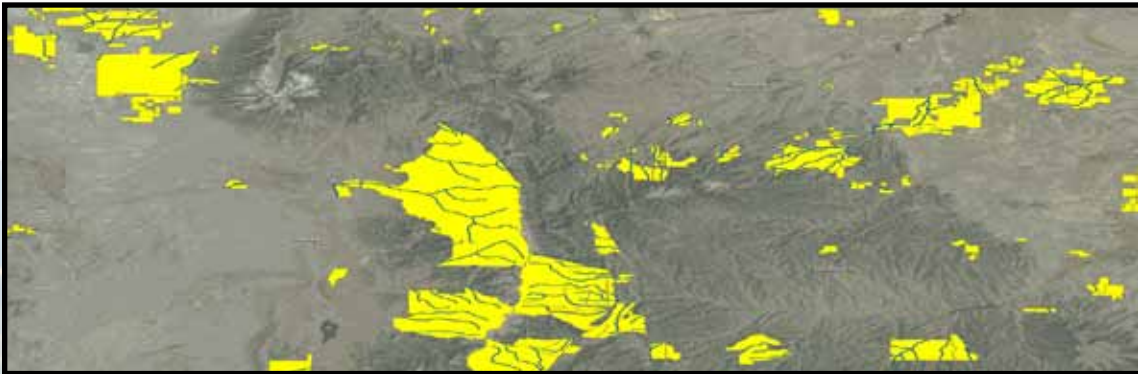


Figure 5: Fountain Creek North of Pueblo



Figure 6: Rio Grande River

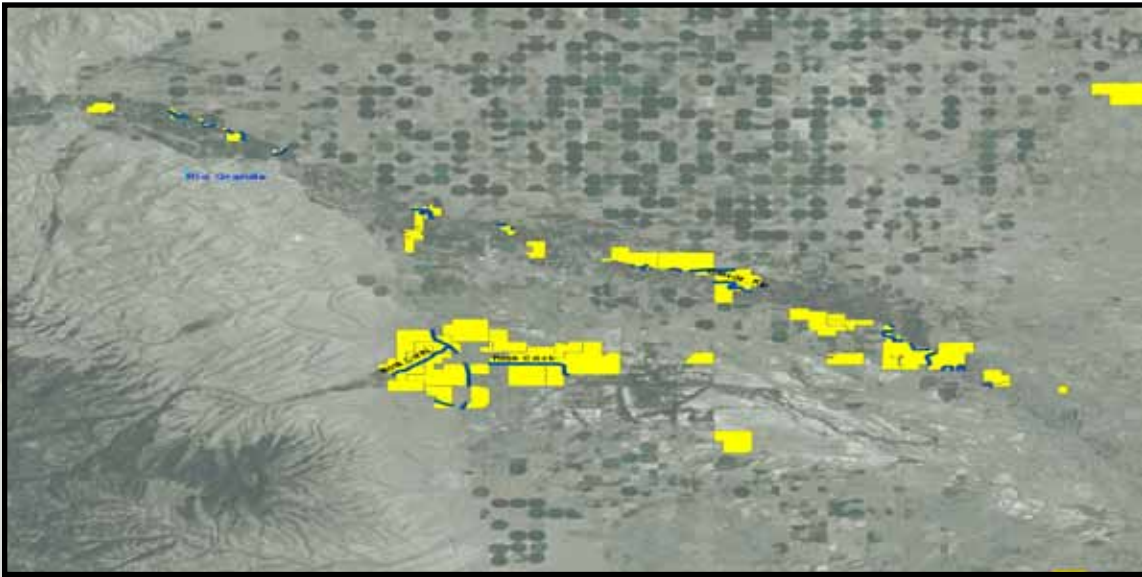
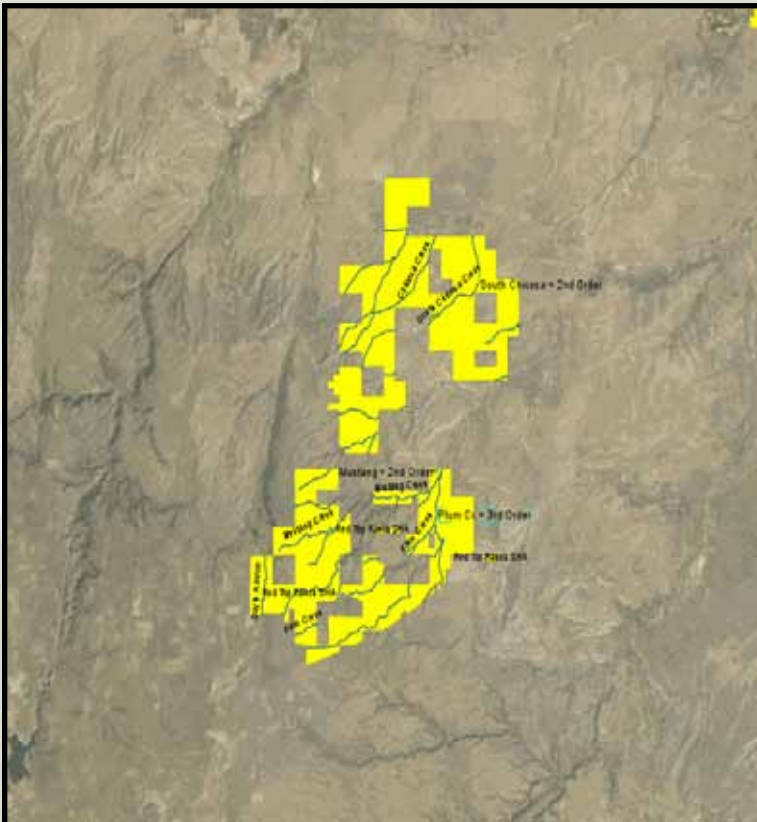


Figure 7: Red Top Ranch Near Pueblo



The analysis above was relatively straightforward; the ongoing challenge is where to draw the line between intermittent and perennial streams.

STREAM ORDER

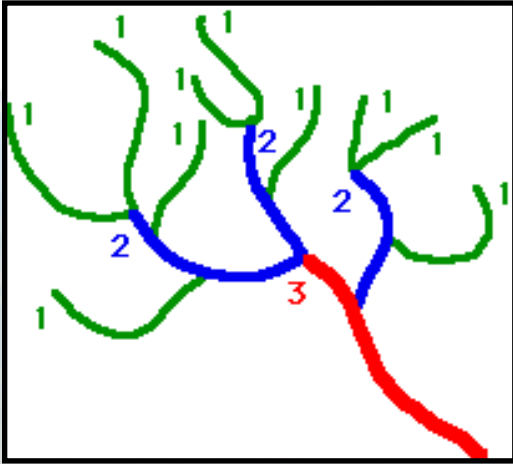


Figure 8: Strahler Stream Order Diagram

Strahler stream ordering is a method for assessing river size and complexity based on the number and hierarchical relationship of tributaries. When determining Strahler order, perennial and intermittent streams are included. The headwater stream (a stream with no tributaries) is considered a 1st order stream. When two 1st order streams join, a 2nd order stream is formed. When two 2nd order streams join, a 3rd order stream is formed, and so on. (Figure 8). The ordering continues downstream within a drainage network. Smaller or lower order streams entering the network will not change the Strahler order of larger or higher order streams. For example, a 2nd order stream entering a 3rd order stream will not change the Strahler order of the 3rd order stream.

The Amazon River is a 12th order river – the largest Strahler order designation in the world. The Mississippi River is a 10th order river when it flows into the Gulf of Mexico. In comparison, the Arkansas, Platte, and Colorado rivers are all 7th order at their largest point when they flow out of Colorado. Below is the National Hydrography Dataset for Colorado, color coded according to Stream Order.

Figure 9: National Hydrography Dataset Color Coded by Stream Order

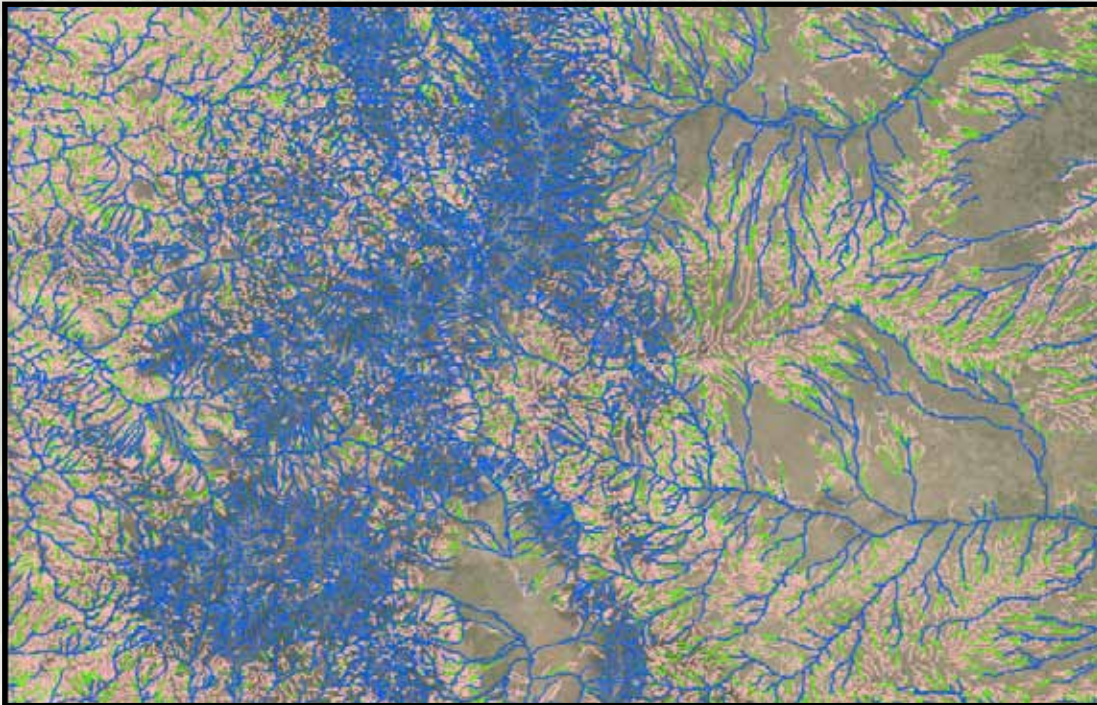


Pink = 1st order streams

Green = 2nd order streams

Blue = 3rd order and larger streams

Figure 10: Close-Up of Trinchera Creek with Stream Order Labeled



The Colorado Division of Wildlife defines an intermittent stream as, “a stream that has flowing water during certain times of the year when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff is a supplemental source of water for intermittent streams.” The United States Geological Survey also defines intermittent streams as only having flows for part of the year from springs, or from snowmelt runoff.⁽¹⁾ First order streams only run for part of the year, so they are considered intermittent for purposes of this study, and have been omitted from the results. The figure above is Trinchera Creek, with 1st, 2nd, and 3rd order segments labeled.

Second order streams can be intermittent or perennial because of the spectrum of stream sizes within 2nd order. Small 2nd order streams resemble intermittent streams, while larger 2nd order streams have significant flows year-round. Therefore, it is difficult to find the exact point at which to differentiate between intermittent and perennial streams based upon stream order alone.

Figure 11 shows pink 1st order streams joining to form green second order streams. And green second order streams joining to form blue third order streams.

RESULTS

The results of this study are presented in 2 ways: protected river corridor miles 2nd order and larger, and 3rd order and larger.

- **1,286 miles of river corridor 2nd order and larger** are protected by conservation easements in Colorado.
 - 3.5% of all rivers in the state of this size
- **778 miles of river corridor 3rd order and larger** are protected by conservation easements in Colorado.
 - 4.2% of all rivers in the state of this size

Figure 11: Colorado Stream Order



This represents a significant portion of valuable habitat and riparian zones that directly affect river health and water quality in Colorado. Land trusts have always protected water; this report quantifies it for the first time, highlighting how much has already been done. These results provide Colorado land trusts and open space programs with another valuable tool with which to obtain funding, increase awareness and prioritize their work. Showing land conservation's impact on water can help land conservation efforts remain relevant for many years to come.

FUTURE RESEARCH

The next logical step of this research would be to include the water rights encumbered by easements to see how many acre-feet of water is protected by conservation easements held by Colorado land trusts and open space programs. Gathering this information can be very time consuming, but the results would be incredibly valuable. While river corridor miles are important, it is equally important to protect wetlands and open water. Expanding this research to include ponds, springs, and wetlands would also be very valuable. This would be an extension of the GIS analysis because the National Hydrography Dataset includes data for these water features as well.

Report by Matt Ashley, for the Colorado Coalition of Land Trusts

ACKNOWLEDGMENTS

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REFERENCES

1. Buechler, Dennis. *Five Case Studies on the Effects of the SWANCC and Rapanos Supreme Court Rulings on Colorado Wetlands and Streams*, Feb. 2010
2. COMap website: <http://www.nrel.colostate.edu/projects/COMap/index.html>
3. Chow, V.T., Maidmen, D.R., and Mays, L.W. (1988). *Applied Hydrology* McGraw-Hill, New York
4. DeWald, Thomas G., McKay, Lucinda D., Pierson, Suzanne M., and Rosenbaum, Barbara J. *Strahler Stream Order and Strahler Calculator Values in NHDPlus*, 2008. Accessed at: ftp://ftp.horizon-systems.com/NHDPlusExtensions/SOSC/SOSC_technical_paper.pdf
5. *Guidelines for Senate Bill 40 Wildlife Certification*, Developed and Agreed Upon by The Colorado Division of Wildlife and the Colorado Department of Transportation, January 2003
6. USGS Website: <http://water.usgs.gov/wsc/glossary.html#Stream>



1245 East Colfax Ave. Suite 203

Denver, CO 80218

Tel. 303-271-1577

Fax: 303-271-1582

www.cclt.org