RETHINKING WATER CONFLICT AND COOPERATION: A RE-ANALYSIS OF INTERVIEWS IN MONTANA AND AN EXAMPLE STUDY FROM THE BIG HOLE RIVER WATERSHED

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Earth Sciences

MONTANA STATE UNIVERSITY
Bozeman, Montana

May 2024

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DEDICATION

This thesis is dedicated to the rivers and people of Montana.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the knowledge and guidance of my advisor and committee chair, Dr. Sarah P. Church. Thank you, Sarah, for accepting me and my ideas with open arms. Your mentorship, support, and confidence in my work have been invaluable. This thesis would also not have been possible without my committee members, Dr. Jamie McEvoy and Dr. Kristal Jones. Thank you, Jamie, for bringing me on as a graduate student and introducing me to the world of water conflict and cooperation. Kristal, thank you for your thoughtful feedback, excitement, and support throughout this project. I would also like to thank my fellow graduate students in the People-Places-Water Lab, Madison Boone, Brennan Radulski, Sale Rhodes, and Elise Cranmer, for providing feedback and making graduate school fun.

Thank you to my father and mother, Roger and Molly Bjorklund, and my grandmother, Virginia Mathews, for your unwavering support of my academic pursuits. Thank you to my best friend, Kelsey Bjorklund, for your emotional support, countless Facetime calls, and trips to Bozeman. To my partner, Logan Winkler, thank you for your steady confidence and love even when I would spend extra hours working while you cooked us dinner. Thank you to the people who contributed to this project by participating in interviews, I am honored that you agreed to share your stories with me. Finally, this research would not have been possible without funding from the Montana Water Center, the National Institutes for Water Resources (NIWR), and the U.S. Geological Survey (USGS).

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LIST OF ACRONYMS

AOC—Alternative and other codes

BAR—Basins at Risk

BHWC—Big Hole Watershed Committee

CCAA—Candidate Conservation Agreements with Assurances

CCC—Conflict and cooperation codes

COPDAB—Conflict and Peace Data Bank

FWP—Fish, Wildlife and Parks

JGRE—JG Research and Evaluation

MT DNRC—Montana Department of Natural Resources and Conservation

MMMR—Multimethod and Mixed Methods Research

USGS—U.S. Geological Survey

ABSTRACT

Climate change heightens the supply and demand imbalance for freshwater, increasing the potential for conflict between water users. However, conflict is not the only outcome, as water demands can also create space for cooperation. The Basins at Risk (BAR) scale is one of the most prominent numerical measurements for analyzing the level of conflict or cooperation in freshwater-related events reported in public news sources. However, few studies in the U.S. West and none within Montana have utilized this method and little has been done to investigate alternative applications of the BAR scale beyond news event analysis. Therefore, this study examines 1) water conflict and cooperation trends in Montana and 2) how interview data can contribute to nuanced understandings of water conflict and cooperation. The intensity and type of issue for water events in Montana were cataloged and analyzed in a re-analysis of 63 interviews conducted for the Montana Drought Vulnerability Assessment. Results revealed that from the perspective of Montanan water stakeholders, cooperation over water resources outweighs conflict, and low-intensity conflictive and cooperative events are more prominent. The re-analysis results informed the selection of an example study utilizing the BAR scale to analyze event data (n=314) and primary interviews (n=11) collected in the Big Hole Watershed, Montana. Event data was sampled from 7 Montana news sources between the years 2007 and 2023. Primary interviews were conducted in February, March, and April 2024 with a variety of stakeholders in the Big Hole River Watershed (e.g., anglers, ranchers, fishing guides, Big Hole Watershed Committee board members, Fish, Wildlife and Parks). These data show the value of including primary interviews in a study utilizing the BAR scale. Moreover, results from this study can help researchers and resource managers monitor and identify water conflict and cooperation, by showing a nuanced understanding of conflict and cooperation.

CHAPTER ONE

INTRODUCTION

Background

The magnitude of hydrologic change in global and local climates has brought major uncertainty to the world's water resources (Milly et al., 2008; Cooley et al., 2014; Whitlock et al., 2017; Hostetler et al., 2021). As uncertainty around the future of water resources increases, so does the potential for water conflicts such as water rights disputes, litigation over instream flow, or protests regarding water-related challenges (Postel & Wolf, 2001; Jarvis et al., 2005; Eidem et al., 2012; Bernauer & Böhmelt, 2020). Although the potential for water conflict may be growing, preliminary studies on water cooperation and conflict tell a different story. For example, internationally, instances of cooperation over shared water outweigh instances of conflict (De Stefano et al., 2010). Research utilizing the Basins at Risk (BAR) scale has found that conflicts over water resources are also less prevalent than cooperation at the subnational level (Eidem et al., 2012). Additionally, a recent synthesis of literature on freshwater conflict and cooperation over transboundary freshwater resources reveals that most studies have been made at the international, cross-boundary level (Bernauer & Böhmelt, 2020). However, this synthesis also finds that climate change and variability in water resources are more likely to lead to local or subnational conflicts as opposed to large-scale, international violence (Bernauer & Böhmelt, 2020), which suggests that more research is needed at the local or subnational scale (e.g., Böhmelt et al., 2014). Indeed, there are few studies assessing conflictive and cooperative water-

related events following the BAR project methods in the western United States (Yoffe & Larson, 2001).

This project uses the BAR scale to understand water conflict and cooperation trends in Montana by quantifying water events and event intensity. The BAR scale is one of the most prominent numerical measurements of event intensity used for analyzing freshwater-related events (Bernauer & Böhmelt, 2020). Intensity measurements correspond to the action that occurred during a water event, from verbal argument to the signing of an international agreement; higher intensities indicate more extreme interactions between stakeholders (Eidem et al., 2012). Intensity rankings provide a method for measuring social behavior, specifically by measuring of intensity of interaction between and among stakeholders (Shellman, 2004).

Water resources in Montana and the West have been largely reshaped by anthropogenic climate change over the last century (Siirila-Woodburn et al., 2021). For example, across the state of Montana and the North American Great Plains, the possibility and intensity of drought are higher today than the devastating 1930s Dust Bowl (Iglesias et al., 2022). Changes in climate may cause conditions currently considered “abnormally” dry to become relatively “normal” (USGCRP, 2017) in regions undergoing aridification, such as the West (Cook et al., 2004). Without changes to current water-resource management, chronic, long-duration drought is increasingly possible in the West (USGCRP, 2017).

As the impacts of a multi-year drought continue to plague Montana citizens (National Drought Mitigation Center, 2023), a question specific to water management arises: do water issues, such as drought, prompt Montanans to respond with more cooperation or conflict over shared water resources? A better understanding of trends leading to and resulting in conflictive

and cooperative events can help water-resource managers improve current management practices to proactively manage water conflicts. To help meet this need, this project will aim to answer the following questions:

1. What is the quantity and intensity of cooperative and conflictive water-related events in Montana?
2. What are the water issue types that result in more conflictive and more cooperative outcomes in Montana?
3. How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than news event data alone?

The geographical focus of this research is Montana and the Big Hole River Watershed. Montana is a critical headwaters state, as the three tributaries of the Missouri River—the Jefferson, Madison, and Gallatin Rivers—are all located in Southwest Montana (Cravens et al., 2021). This project's focus is on Montana because of its significant importance as a headwaters state, and because there is a lack of previous research on subnational water conflict and cooperation in Montana utilizing the BAR scale. The Big Hole Watershed is the focus of the example study primarily because of the area's unique history of water-related issues and cooperation (e.g., Romans, 2013; Davis, 2015; Byington, 2016; *How We Work*, 2016; Murphy et al., 2017; Szabo, 2018; Big Hole Watershed Committee, 2022). This study explores the research question, *how can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than evet data alone*, focusing on the Big Hole River Watershed in Montana.

This project uses a multimethod and mixed methods research (MMMR) approach, including three data separate collection methods: 1) interview re-analysis; 2) event data analysis; and 3) primary interviews. The first data set is a re-analysis of interviews conducted for the Montana Drought Vulnerability Assessment (Walker et al., 2023). Re-analysis of data has many benefits; it is often more convenient and economical and also helps to investigate complex socio-environmental problems (Alexander et al., 2020; Pfaeffle et al., 2022). The interview re-analysis conducted in this project allows for an economical and time-efficient investigation of water conflict and cooperation trends through the lens of water resource stakeholders in Montana (the interview subjects). The BAR scale is one of the most prominent numerical measurements for freshwater-related events (Bernauer & Böhmelt, 2020), and is used in this project to numerically conceptualize water event intensity for all three data sets (i.e., interview re-analysis data, Big Hole River Watershed event data, and Big Hole primary interviews).

The intensity and type of issue for water events in Montana were cataloged and analyzed in a re-analysis of 63 interviews conducted for the Montana Drought Vulnerability Assessment. Results revealed that in Montana, cooperation over water resources outweighs conflict, and low-intensity conflictive and cooperative events are more prominent. The re-analysis results informed the selection of an example study utilizing the BAR scale to analyze event data (n=314) and primary interviews (n=11) collected in the Big Hole Watershed, Montana. These data show the value of using primary interviews to operationalize and add detail to the BAR scale. Moreover, results from this investigation reveal nuances in water conflict and cooperation which can be used to help water managers and decision-makers work towards effective outcomes following water resource challenges.

In the following sections, I will discuss relevant literature to the project starting with a background in water conflict and cooperation through the lens of the BAR project methods followed by alternative conceptualizations of water conflict and cooperation contradictory to the BAR methods. Then I discuss central insights on Montana's water resource challenges followed by a brief geographical background on the Big Hole River Watershed. Chapter two provides a complete and in-depth explanation of the research methods and justification. Chapter three examines water conflict and cooperation trends in Montana through interview re-analysis and utilization of the BAR scale. Chapter four explores how interview data can contribute to nuanced understandings of water conflict and cooperation in addition to event data when using the BAR scale through a mixed-methods study. Finally, chapter five reviews the importance of this research, its results, and possible research directions for future scholars.

Literature Review

Water Conflict and Cooperation—Through the Lens of the Basins at Risk Project Methods

Water resources influence many political, economic, social, and even religious challenges and conflicts, which are expected to intensify with climate change (H. Ingram et al., 2008; Rosa et al., 2020; Chiarelli et al., 2022). The magnitude of hydrologic change in global and local climates has brought major uncertainty to the world's water resources (Milly et al., 2008; Koubi, 2019). For example, anthropogenic climate change has caused a global decrease in seasonal snowpack which may have catastrophic impacts on freshwater availability (Siirila-Woodburn et al., 2021). In addition to changing climates, rising populations and water consumption in the United States have contributed to less available freshwater and a higher demand for it (Elcock,

2010). Increasing demands on water resources and water resource development can lead to increased political and social pressures, a process often referred to as "water stress" (Wolf, 2007). Water stress can arise due to either an excess or deficit of water (Costa de Oliveira et al., 2014). Despite increased water stress, resource degradation, and an imbalance between supply and demand, cooperation over shared water outweighs conflict internationally (De Stefano et al., 2010).

Water event data has been central to previous research on water cooperation and conflict. A water event can be defined as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined, recorded, and publicly available (Eidem et al., 2012). Event data can include publicly available newspapers, articles, government documents, or meeting reports. Previous analysis of event data has revealed that conflicts are less frequent than cooperation in water resource challenges at both an inter- and intranational level (Eidem et al., 2012). Scholars with the Basins at Risks (BAR) project based out of Oregon State University developed a scale from -7 (highest intensity of conflict) and +7 (highest intensity of cooperation) to capture the degree of cooperation and conflict intensity at the international scale (Table 1). As a water event's intensity value becomes more negative or positive, the more intense the interaction between stakeholders is (Eidem et al., 2012). The BAR scale allows researchers to quantify and simplify complex conflictive and cooperative interactions between water stakeholders.

Table 1. The BAR event intensity scale adapted from the Conflict and Peace Data Bank (COPDAB) scale by Yoffe & Larson, 2002 (table adapted from Wolf et al., 2003).

BAR Scale	BAR Event Description
-7	Formal declaration of war; extensive war acts causing deaths, dislocation, or high strategic costs
-6	Extensive military acts
-5	Small scale military acts
-4	Political-military hostile actions
-3	Diplomatic-economic hostile actions
-2	Strong verbal expressions displaying hostility in interactions
-1	Mild verbal expressions of displaying discord in interactions
0	Neutral or non-significant acts for the inter-nation situation
1	Minor official exchanges, talks, or policy expressions—mild verbal support
2	Official verbal support of goals, values, or regime
3	Cultural or scientific agreement or support (non-strategic)
4	Non-military economic, technological, or industrial agreement
5	Military economic or strategic support
6	International freshwater treaty; major strategic alliance (regional or international)
7	Voluntary unification into one nation

The BAR scale is one of the most prominent numerical measurements for freshwater-related events (Bernauer & Böhmelt, 2020). Previous studies using the BAR scale show at the international level, not only is cooperation more prevalent but almost all the conflictive events can be classified in the lowest levels (intensity -1, -2, and -3) of conflictive event categories (De Stefano et al., 2010). However, the intensity and quantity of conflictive and cooperative events determined in all these studies are highly dependent on the type of water issues being addressed.

Previous literature using the BAR project methods suggests a wide range of water issues spurring international conflict and cooperation. On the international scale, some of the key water issues that are most significant in the existing literature stem from challenges in water quantity, form of government, infrastructure, water quality, and upstream or downstream configurations (Bernauer & Böhmelt, 2020; De Stefano et al., 2010). One challenge in assessing the main water issues driving water conflict and cooperation is that different studies measure key issues in divergent ways, cover different time periods, and have varying geographic scales (Bernauer & Böhmelt, 2020). One study found that infrastructure and water quantity seem to consistently drive the most conflictive aspects of international transboundary water management (De Stefano et al., 2010). Conversely, a subsequent study found that population size and precipitation were the main issues driving conflict, while population, the number of governing bodies in the riparian zone, and a country's dependence on external freshwater sources were the main driving issues influencing cooperation (Bernauer & Böhmelt, 2014).

A majority of studies on water conflict and cooperation have been conducted at the international level (Bernauer & Böhmelt, 2020; Hanaan, 2022). However, climate change and variability in water resources may be more likely to lead to local or subnational conflicts as opposed to international conflicts (Bernauer & Böhmelt, 2020). Therefore, there is an urgent need to focus future scientific research on water conflict and cooperation on the local or subnational scale (Böhmelt et al., 2014; Hanaan, 2022).

In the western United States, there are few studies assessing conflictive and cooperative water-related events using the BAR project methods. In one of these studies, Eidem et al. (2012) found that there are more events of water cooperation than conflict in Oregon and the Upper

Colorado River basin (Figure 1). In Oregon, more than half of the cataloged events were cooperative while about a third were conflictive (the remaining events were neutral). Additionally, conflictive events were typically found to have lower intensities than cooperative events in Oregon. Low-level conflictive events (intensity -1) outnumbered low-level cooperative events (intensity +1). While for high-level intensity events, there were twice as many cooperative events as conflictive events. In the Upper Colorado, cooperative water events also dominated with just above fifty percent of events being cooperative. Of the high-level intensity events, 392 were categorized as cooperative and 336 were conflictive. Water event intensity and quantity at the intranational scale are also influenced by the type of water issue (e.g., *water rights, infrastructure, water quality, intergovernmental relations*, etc.).



Figure 1. Eidem et al., 2012 intranational hydropolitical study areas, Oregon and the Upper Colorado River basin (reused with permission from Eidem et al., 2012).

Table 2. Water event examples from the Oregon and Upper Colorado River basin (table adapted with permission from Eidem et al., 2012).

Basin	Date	Event Summary	Issue Type	Intensity
Lower Green (Upper Colorado)	6/3/2004	Members of the Ute Indian Tribe have sued the Bureau of Indian Affairs for allowing non-Indian irrigation companies to divert water off Indian lands	Intergovernmental	-4
Rio Grande-Elephant Butte (Upper Colorado)	8/23/1995	Albuquerque area water plan, focusing on conservation measures, is nearing approval	Conservation	2
Umatilla (Oregon)	4/21/2001	The city of Pendleton and the Umatilla Tribes reached a water rights agreement involving the city's point of diversion in the Umatilla's north fork	Water rights	4
Klamath (Oregon)	7/9/2001	In protest of a federal decision to not release water for irrigation to maintain instream flow for fish, dam head gates have been removed by area farmers	Instream	-5

The primary issue types for all water events found by Eidem et al. (2012) in Oregon were *water quality* and *water quantity*. High-intensity conflictive events fit into five issue types: *water quality, infrastructure, navigation, intergovernmental,* and *fish passage*. Comparatively, high-intensity cooperative events only occurred with *instream water* issues. In Upper Colorado, most events were related to *water rights, water quality, infrastructure,* and *intergovernmental relations*. Most evidently, events related to *water rights* tended to be more conflictive than cooperative. Eidem et al. (2012) also identify several factors contributing to water stress within the hydropolitical system of the West including water infrastructure projects, Native American water rights and claims, transfers of water from agricultural to urban use, and increased instream

and ecological water concerns (Eidem et al., 2012). What many other studies agree on is that as stress on the West's water systems increases, so does the potential for water conflicts (Jarvis et al., 2005; H. Ingram et al., 2008; Eidem et al., 2012; Abrahams, 2020; Bernauer & Böhmelt, 2020). Understanding water conflict and cooperation beyond the regions of Oregon and the Upper Colorado is critical to anticipate and prepare for future water stress in the West.

Alternative Conceptualizations of Conflict and Cooperation

What some of these previous studies do not fully capture is that conflict and cooperation are not always exclusive. Water events are often not exclusively either conflictive or cooperative, but usually include characteristics of both (Zeitoun & Mirumachi, 2008). The examination of *either* conflict *or* cooperation does not reflect the reality of many contexts where cooperation and conflict can co-exist (Zeitoun & Mirumachi, 2008; Böhmelt et al., 2014). Not only can they co-exist, but conflict can even act as a catalyst for future cooperation, something that is often missed in comparative studies using binary indicators of either conflict or no conflict (Böhmelt et al., 2014). These comparative methods also perpetuate the misconception that any conflict is 'bad' and all forms of cooperation are 'good' (Kistin, 2007; Zeitoun & Mirumachi, 2008). In certain instances, conflict may even be necessary to solve the challenge or create lasting change (Kearns, 2021). Many projects and authors recognize the co-existence and complexity of cooperation and conflict but when it comes to analysis, the two are typically treated as separate concepts (Zeitoun & Mirumachi, 2008). The most common analytical tool that previous research relies on is continuum variations (Figure 2), including the BAR scale (Yoffe & Larson, 2001). In placing a relationship between two water stakeholders along a continuum, the analyst is required to simplify the trust, communication, and overall relationship between the two parties (Zeitoun &

Mirumachi, 2008). This use of a continuum may narrow the results and reflections of a study; however, it can serve to simplify extremely complex situations in water conflict and cooperation.

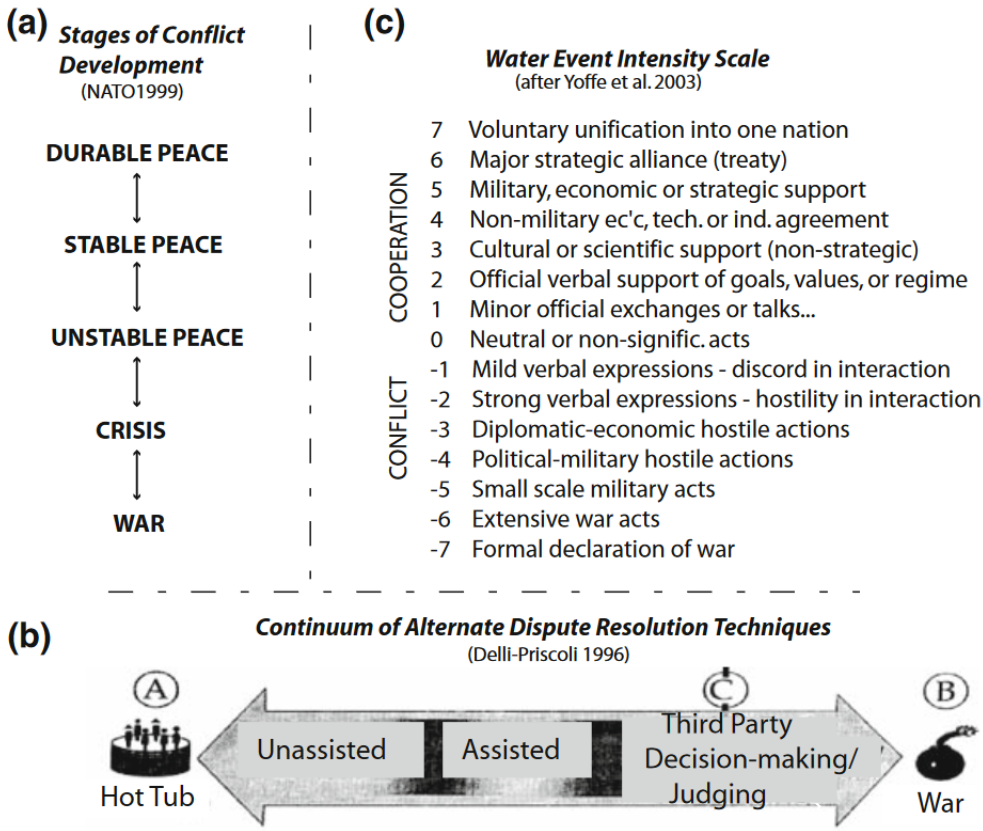

Figure 2. Three variations of conflict and cooperation continuums: a) the Stages of Conflict Development (NATO, 1999), b) the Continuum of Alternative Dispute Resolution Techniques (Delli-Priscoli, 1996), and c) the Basins at Risk or Water Event Intensity Scale (Yoffe & Larson, 2001); (reused with permission from from Zeitoun & Mirumachi, 2008).

Cooperation alone is often more complex than it is typically portrayed. There is a common misconception that all conflict is inherently 'bad' and therefore, all cooperation is 'good.' This is not always the case. As Zeitoun and Mirumachi (2008) state, "not all cooperation is pretty." Cooperative efforts can have unintended negative consequences and in some cases, could lead to unsustainable and inequitable outcomes (Kistin, 2007). When multiple stakeholders

come together to establish a cooperative partnership, they must consider how the benefits and disadvantages of cooperation are distributed among populations over time (Kistin, 2007). Without careful consideration, cooperation may have negative unintended consequences that leave certain individuals at a disadvantage. Cooperative actions can also have hidden, strategic, or political agendas that purposefully exclude certain stakeholders from treaty rights, data sharing, or other gestures of cooperation (Zeitoun & Mirumachi, 2008). The complexity of conflict and cooperation reveals why it is important to approach water conflict and cooperation research with a holistic and non-linear view to present an accurate depiction of reality.

A Note on Collaborative Watershed Management. Other literature on collaboration and conflict over water resources does exist. Specifically, much has been written about collaborative watershed management and its benefits (Prokopy et al., 2014). Collaborative watershed management (also referred to as collaborative watershed governance) is designed to facilitate consensus and cooperation among competing stakeholders at the watershed level as an alternative to centralized, command-and-control policies (Lubell, 2004). In the last three decades, collaborative environmental management has been promoted as a new paradigm in environmental policy (Koontz & Newig, 2014; Yoder et al., 2021).

Literature and research in collaborative watershed management have shown that collaborative processes not only achieve ecological results but also improve community-level cooperation and communication (Yaffee & Wondolleck, 2000). Other benefits include improved conflict management, the translation of knowledge, greater inclusion of diverse perspectives in decision-making, and increased social and institutional capacity (Margerum & Robinson, 2015). However, collaboration in natural resource management is not void of criticism (Yaffee &

Wondolleck, 2000). Some claim that collaborative watershed management may not be beneficial in every watershed (Chess & Gibson, 2001). Regardless, as water management issues become more complex, interest in collaborative partnerships is growing (Margerum & Robinson, 2015).

Literature on water cooperation and conflict and literature on collaborative watershed governance both deal with water-related issues but focus on different aspects of water resource management and governance. Typically, literature on water cooperation and conflict and literature on collaborative watershed governance both have a different scale and focus. While the literature on water cooperation and conflict has mainly focused on scales at the international level (Bernauer & Böhmelt, 2020), literature on collaborative watershed management operates at a more localized scale. Collaborative watershed management typically deals with the management and governance of a specific watershed, engaging local communities, regional governments, and various stakeholders at a smaller geographical level (e.g., Browning-Aiken et al., 2004; Ferreyra & Beard, 2007; Enloe et al., 2014). The focus of these two literatures also varies. Typically, the focus of the literature on water conflict and cooperation is to better understand trends in water resource issues/events, such as water event type, intensity, frequency, and location, to inform future water challenges (e.g., Wolf, 2007; De Stefano et al., 2010; Eidem et al., 2012; Bernauer & Böhmelt, 2014). Alternatively, the overall focus of collaborative watershed management literature is to better understand the benefits, challenges, and intricacies of collaboration to inform and improve collaborative governance options for watershed management (e.g., Yaffee & Wondolleck, 2000; Chess & Gibson, 2001; Lubell, 2004; Margerum & Robinson, 2015).

Collaborative watershed management in practice would produce water events that could be scored by the BAR scale. However, this literature typically does not investigate conflict and cooperation using continuum variations to reveal water event intensity. Although collaborative watershed management literature is important to understanding and implementing collaborative resource governance, it does not use the BAR scale or any other quantitative conflict and cooperation continuum method. Utilization of the BAR scale, or a similar quantitative conflict and cooperation continuum, is essential to answering the research questions proposed in this thesis. Therefore, collaborative watershed management is not considered the main theoretical focus of this research project.

Water in Montana and the West

The western United States has always been a place full of great beauty and great challenges. From the Native Americans who first inhabited the land, to the Lewis and Clark Expedition, to the first White settlers, to those who currently inhabit this area today, there has always been a great appreciation for the arid landscape. Along with great descriptions of its beauty, there must also come a warning about the West: it is no easy place to live. In the past, the western states buffered themselves from harsh climatic swings by making changes to natural landscapes (dams, reservoirs, etc.). However, the West may be unprepared for the effects of future climatic (Ingram & Malamud-Roam, 2013). The West must be prepared for a drier and more extreme future climate (Ingram & Malamud-Roam, 2013). In this section, I will be discussing some of the dominant water issues facing Montana and the western United States, with a specific focus on drought. Not only is drought a very common and challenging issue in the

West, but it is also a significant topic in chapter two, which specifically investigates trends in drought-related water conflict and cooperation in Montana.

Water resources in the West have been largely reshaped by anthropogenic climate change over the last century (Siirila-Woodburn et al., 2021). For example, across the North American Great Plains, the possibility and intensity of drought are higher today than during the devastating 1930s Dust Bowl (Iglesias et al., 2022). Changes in climate may cause conditions currently considered "abnormally" dry to become relatively "normal" (USGCRP, 2017) in regions undergoing aridification, such as the West (Cook et al., 2004). With these changing conditions, the onset of rapid-onset droughts has been occurring faster in the last few decades, leaving water resources particularly vulnerable (Iglesias et al., 2022; Walker et al., 2023).

The term "drought," although widely used, can be ambiguous and difficult to define (USGCRP, 2017). The World Meteorological Organization (2021) defines drought as a prolonged, slow-onset dry period caused by a lack of rainfall. However, to focus solely on precipitation is to exclude several other important factors that affect drought including evaporation, transpiration, lateral inflows, and timing of precipitation events (Lloyd-Hughes, 2014). Additionally, definitions such as these fail to acknowledge the complex interaction of natural and anthropogenic processes that result in a lack of water (Van Loon et al., 2016). For this project, the definition "insufficient water to meet needs," will be used when referring to drought (Redmond, 2002). Although simple, this definition broadens the term 'drought' to include water shortage caused and modified by human processes in addition to natural processes (Van Loon et al., 2016). Regardless of which definition is used, as climate change alters factors such as the timing of precipitation (USGCRP, 2017), trends in drought intensity and frequency

will also change (e.g., Iglesias et al., 2022). Managing drought will become increasingly complex as anthropogenic climate change alters normal conditions across the western United States.

Drought is one of the most complex natural disasters and produces an intricate web of impacts that can extend far beyond the affected region (D. A. Wilhite et al., 2007). The ultimate results of drought are, at times, enormous economic, environmental, and personal hardships (D. Wilhite, 1992). Understanding the impacts of drought is becoming increasingly important as these impacts appear to be growing in complexity and magnitude in the western United States (D. A. Wilhite et al., 2007). Without changes to current water-resource management, chronic, long-duration drought is increasingly possible in the West (USGCRP, 2017). Droughts that develop rapidly and with high intensity can lead to other unanticipated consequences in hydrological, socioeconomic, ecological, agricultural, and other social-environmental processes (Iglesias et al., 2022).

Drought has been, and continues to be, a natural part of Montana's climate history. Drought is a natural, recurring, and cyclic feature of Montana's semi-arid climate (Montana DNRC, 2023). Almost any part of the state can experience drought conditions in any given year (Montana DNRC, 2015). Water supply in Montana is largely controlled by variability in seasonal temperature and precipitation; therefore, water availability can vary drastically from year to year and often changes dramatically within a given year (Montana DNRC, 2015). Evidence suggests that multi-year droughts will continue to be a regular feature of Montana's climate, but increasing temperatures due to climate change will intensify drought when and where it occurs (Montana Department of Natural Resources and Conservation, 2023). Despite the unreliable

nature of Montana's water resources, Montana's economy and quality of life depend on an adequate supply of clean water for everything from food production to industry, to municipalities, to recreation (Whitlock et al., 2017).

A vast majority of Montana's water originates from snowpacks found within the state's borders (Whitlock et al., 2017). Rivers in Montana are mainly snowmelt-fed, with streamflow typically peaking between late May and mid-June (Cravens et al., 2021). Major rivers in Montana export more than 40 million acre-feet of water/year (Whitlock et al., 2017), much of which flows out of Montana into surrounding states. Major rivers in Montana include the three forks of the Missouri River, the Jefferson, Madison, and Gallatin Rivers (Cravens et al., 2021). These unique features are the reason for Montana's designation as a "headwaters state" (Whitlock et al., 2017). This designation indicates that changes to Montana's water resources can have direct ecological impacts on many other water systems in the U.S., including the entire Missouri River Basin.

Like the rest of the western United States, water resources in Montana have faced significant changes over the last century. Multi-year and decadal-scale droughts have been a natural feature of Montana's climate, however, predictions indicate that rising temperatures are likely to intensify drought when and where it occurs (Whitlock et al., 2017). Warming temperatures have caused a decline in Montana's snowpack since the 1930s and are likely to continue reducing snowpack at mid and low elevations (Whitlock et al., 2017). Since streams in Montana are mostly fed by snowmelt (Cravens et al., 2021), a decrease in snowpack could further intensify droughts in the state. In addition to intensified drought, Montanans are likely to see a shift in the timing of runoff due to earlier snowmelt and an increase in rain during late

winter and early spring (Montana DNRC, 2015). Earlier snowmelt and spring runoffs are predicted to reduce late-summer water availability in watersheds that are snowmelt-dominated (Whitlock et al., 2017). Therefore, changes to Montana's snowpack and the timing of spring runoff are likely to increase drought frequency and duration in the late summer and early fall seasons (Whitlock et al., 2017).

Although I have focused on drought thus far, it is not the only water issue that plagues Montana. In addition to precipitation and snowpack, groundwater is an important resource and part of Montana's water cycle (Ferreira et al., 1987; Montana Watercourse & Montana DNRC, 2015; Whitlock et al., 2017). In Montana, the impact of climate change on groundwater resources will depend on whether aquifers exhibit direct sensitivity to climate fluctuations, are protected from climatic influences through certain water-use practices (e.g., irrigation), or are used to fulfill water needs surpassing or substituting surface water provisions (Whitlock et al., 2017). Regardless, the demand for groundwater will likely increase with rising temperatures and changes to seasonal availability as water users will be forced to seek alternatives to traditional surface water sources (Whitlock et al., 2017). Therefore, climatic changes will likely pose challenges for both groundwater and surface water resources.

Climate change is expected to increase spring precipitation in Montana, altering runoff patterns and increasing the potential for flooding (Hostetler et al., 2021). In June 2022, these predictions came to life. An unusually late and heavy spring snowfall ultimately caused the Yellowstone River to rise over three feet beyond its record-high level (Knight, 2022). The state of Montana declared a state of emergency as the flooding caused severe damage to infrastructure near the north side of Yellowstone National Park including roads, wastewater systems, park

facilities, private homes, and trails (*Yellowstone Flooding*, 2023). Floods are a natural part of Montana's water cycle; however, floods such as the 2022 Yellowstone flood are likely to become more common in Montana as climate change increases the amount of winter and spring rainfall (Whitlock et al., 2017).

Another issue facing Montana is the rapid population growth in the past several decades. Montana's population experienced a 9.6% increase (94,810 people) from 2010-2020 (America Counts Staff, 2021). Several Montana counties, including Gallatin, Carter, and Broadwater County, experienced a population increase of over 20% from 2010-2020 (America Counts Staff, 2021). Larger populations lead to a higher demand for freshwater. As the water demand continues to grow, coping with supply and demand imbalances will be a constant feature of water management in Montana (Montana DNRC, 2015).

The Big Hole River Watershed

Results from the Montana Department of Natural Resources and Conservation (MT DNRC) interview re-analysis point to the Big Hole River Watershed as an appropriate example location for examining complexities in water-related conflict and cooperation. When discussing water cooperation and conflict in Montana, many DNRC interview participants pointed specifically to examples in Southwestern Montana and the Big Hole River Watershed. Imagine snow-covered alpine mountain ranges, pristine lakes, and wide-open valleys in every direction. Crystal clear headwater streams and blue-ribbon fisheries. Grassy valley floors filled with more cattle than people. What you are picturing is the Big Hole River Watershed, Montana (Figure 3).

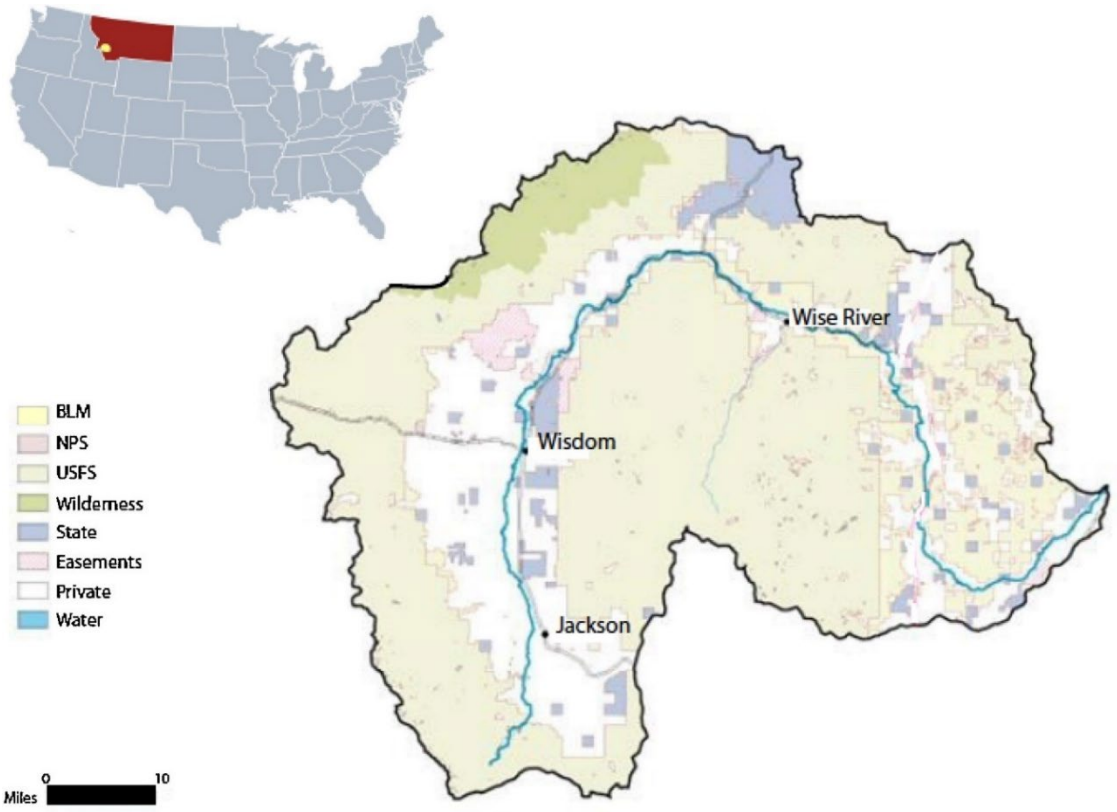

Figure 3. Location of Montana and the Big Hole River Watershed with distribution of land ownership adapted from US Fish and Wildlife (reused with permission from Murphy et al., 2017).

The Big Hole River Watershed, located in Southwestern Montana, is a high-elevation basin at the headwaters of the Upper Missouri River. The watershed is mainly located within Beaverhead County, Montana (Figure 4). Unlike other watersheds in the West, the Big Hole area remains relatively undeveloped (*How We Work*, 2016). Despite being the largest county by area in Montana (5,572 square miles), Beaverhead County has a population of only 9,000 people and an average population density of less than 1.7 people per square mile (Beaverhead County, n.d.). There are nearly 17 times more cattle than people residing in Beaverhead County (Beaverhead County, n.d). The Big Hole River Watershed is well known for its blue-ribbon fisheries and large

amount of public land. In addition to the Big Hole River, this region contains multiple other headwaters of the Missouri River, including the Beaverhead and Red Rock rivers.

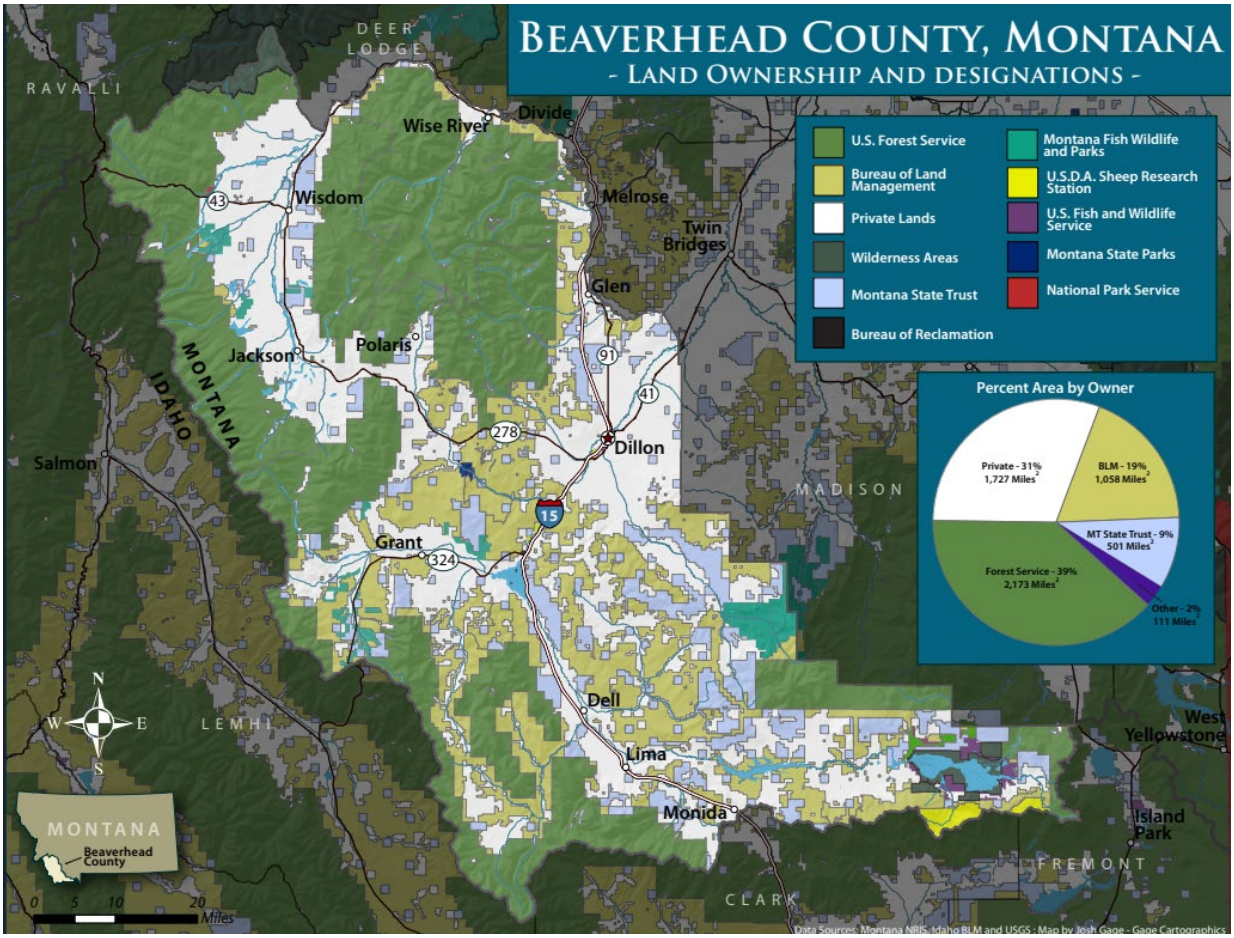

Figure 4. Map of Beaverhead County with the type and distribution of land ownership (image from Beaverhead County, 2012).

The definitions of "rural" vary widely depending on the classification system being used. The U.S. Census defines rural as areas that encompass all population, housing, and territory not included within an urban area where urban areas are those with 50,000 or more people (Bennion, 2020). Using this definition, Beaverhead County can easily be considered rural. In addition, Beaverhead County is unlikely to shift to urban anytime soon. With a low population change

from 1970 to 2021 (16%) compared to Montana as a whole (58.4%), Beaverhead County is likely to remain sparsely populated long into the future (Headwaters Economics, 2023).

Beaverhead County self-proclaims itself as having an agriculturally driven economy (Beaverhead County, n.d.). However, this is not true. Although agriculture is a significant industry in the region and likely has strong cultural ties, it is certainly not the driver of Beaverhead's economy. Data from Headwaters Economics (2023) on earnings in all Beaverhead County industries from 2001 to 2021 provides evidence that the government industry produced earnings more than 3 times that of farming in 2021. Some other noteworthy industries in the area include retail trade and health care/social assistance (Headwaters Economics, 2023).

As mentioned earlier, a large percentage of land in Beaverhead County is federal (Figure 4). The Big Hole Valley bottom is mostly private land ownership, mainly managed by multi-generational family ranchers for cattle and hay production (Murphy et al., 2017). However, beyond the valley floor, almost 60% of the total land area in Beaverhead County is federally owned (Headwaters Economics, 2023). Over half of that federal land is managed by the U.S. Forest Service and the remaining federal land in Beaverhead County is almost entirely managed by the Bureau of Land Management (Headwaters Economics, 2023).

The natural beauty and access to public lands in the Big Hole River Watershed bring in amenity migrants as well as tourists for hunting, skiing, angling, cycling, wilderness trips, and scenic driving (Murphy et al., 2017). This high-elevation region is mainly composed of shrub-steppe landscapes surrounded by lodgepole pine montane forests (Murphy et al., 2017). The Big Hole Watershed is also home to several native fish species including Westslope cutthroat trout and a rare species of fish, called the fluvial Arctic grayling (Szabo, 2018). The Arctic grayling

(*Thymallus arcticus*), a member of the salmon family, has vanished from all of its historical habitat range in the continental U.S. except for a tiny fraction in Montana, which includes the Big Hole River Watershed (Hodge, 2021). In the 1980's and early 1990's, the Big Hole Watershed experienced severe drought leading to declines in Arctic grayling populations and rising tensions among stakeholders (*How We Work*, 2016). Alarming declines in Arctic grayling populations eventually led to the establishment of Candidate Conservation Agreements with Assurances (CCAA) in the upper and middle reaches of the Big Hole River (McEvoy et al., 2018; Montana Fish, Wildlife & Parks, 2021; *Drought Management Plan & Grayling Recovery*, n.d.). According to Montana Fish, Wildlife and Parks (FWP) CCAA "is an agreement between the U.S. Fish and Wildlife Service (USFWS) and any non-Federal entity whereby property owners who voluntarily agree to manage their lands or waters to remove threats to species at risk of becoming threatened or endangered receive assurances against additional regulatory requirements should that species be subsequently listed under the Endangered Species Act (ESA)," (Montana Fish, Wildlife & Parks, 2021, p.3). Today, there are still many efforts in the Big Hole aimed at repairing the deterioration of fish habitat and restoring Arctic grayling populations, including the CCAA (Szabo, 2018).

The Big Hole River Watershed already has a long history of water conflict and cooperation. In addition to tensions around declining Arctic Grayling populations, there have been many cooperative efforts within the Big Hole River Watershed. Some past cooperative conservation initiatives include collaborative drought management through the Big Hole Watershed Committee (BHWC) and candidate conservation agreements with the Department of the Interior's US Fish and Wildlife Service to protect habitat for arctic grayling fisheries

(Murphy et al., 2017). Despite the well-documented history of water-related issues and cooperation in the area (e.g., Romans, 2013; Davis, 2015; Byington, 2016; *How We Work*, 2016; Murphy et al., 2017; Szabo, 2018; Big Hole Watershed Committee, 2022), there has been a lack of research utilizing water conflict and cooperation methods, specifically the BAR scale, within the Big Hole River Watershed. Therefore, this research will utilize the Big Hole River Watershed as an example area for investigating how interview data can contribute to a nuanced understanding of water conflict and cooperation.

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CHAPTER TWO

METHODS AND METHODOLOGY

Overview

This study utilized a multimethod and mixed methods research (MMMR) approach to answer the following research questions:

1. What is the quantity and intensity of cooperative and conflictive water-related events in Montana?
2. What are the water issue types that result in more conflictive and more cooperative outcomes in Montana?
3. How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone?

MMMR is the use of multiple quantitative and/or qualitative techniques for data collection and analysis in a single research project (Knappertsbusch et al., 2021). MMMR can address diverse data, multifaceted issues, and multiple methodologies to answer complex questions (Hesse-Biber & Johnson, 2015). In addition, any weaknesses resulting from using one method can be offset by including another method (Hesse-Biber & Johnson, 2015). Methods used in this project included a re-analysis of stakeholder interviews previously conducted by JG Research and Evaluation (JGRE) for the MT DNRC's Drought Management Plan to both inform the selection of an example location and contribute to a broad understanding of conflict and cooperation surrounding water issues in Montana. The example location investigation included event data and primary interview methodologies to understand how interview data can provide

additional value and a more nuanced understanding of water conflict and cooperation than event data alone. All three data collection methods (interview re-analysis, event data, and primary interviews) were analyzed using similar codebooks, which were developed through collaborative and iterative processes. These codebooks (see Appendix A, B, and C) were informed by 1) literature on conflict and cooperation, 2) the JGRE interview guide and data (see Appendix D), and 3) the BAR Project methods (Yoffe & Larson, 2001). The reliability of the code names and definitions was assessed through multiple iterations and discussions with fellow lab and committee members.

Previous research in water conflict and cooperation that utilizes the BAR project methods has primarily used an event data coding approach (Bernauer & Böhmelt, 2020). A water event is defined as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined, recorded, and publicly available (Eidem et al., 2012). Event data sourced through newspapers, articles, government reports, and other public news sources allows researchers to sample a wide range of water events in a timely and economically conscious manner. Although event data can be a useful tool in data collection, it is heavily constrained by the biases and hyperbole of local media sources and political interests (De Stefano et al., 2010). An event data approach is not always well suited to studying environmental issues (Eidem et al., 2012). Media sources fail to report on many water-related interactions (De Stefano et al., 2010). Event databases have several additional limitations including text quality, misleading or incorrect information, restraints on internet access, human error, and language barriers (Bernauer & Böhmelt, 2020). To avoid some of these biases, in addition to event data, this study used mixed methods that include the interview re-analysis and primary interviews. Incidents of conflict and

cooperation, in addition to the type of water issue, were collected from all the data and analyzed via qualitative coding in NVivo coding software (QSR International).

Table 3. List of general thesis research objectives, methods, and anticipated outcomes.

Research Objectives	Methods	Outcomes and Deliverables
1) Identify trends in water conflict and cooperation (quantity, intensity, and water issue types) across Montana	Interview re-analysis	• Approved and published thesis through Montana State University • 1 peer-reviewed publication on project results • 1 fact sheet for MT DNRC and JGRE • At least 2 presentations of results at conferences or public forums
2) Conduct a study in Montana to examine how interview data can provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone	Event-based data, primary interviews	• Approved and published thesis through Montana State University • 1 peer-reviewed publication on project results • 1 fact sheet for study participants and the BHWC • At least 1 presentation of results at conferences or public forums

Data Collection

Interview Re-Analysis

The MT DNRC recently updated its state-wide Drought Management Plan (Montana Department of Natural Resources and Conservation, 2023). As part of this update, the MT DNRC contracted JGRE to conduct drought stakeholder interviews to provide insight on drought impacts and adaptation. The MT DNRC and JGRE generously granted IRB-approved access to these interviews to conduct a re-analysis to answer the questions outlined in this research project.

Interest in qualitative data re-analysis has grown significantly over the past two decades (DuBois et al., 2023) and for good reasons. The re-analysis of data has many benefits; re-analysis of qualitative data allows researchers to ask new questions and identify new evidence within the original data set (Pfaeffle et al., 2022). Not only is it often more convenient and economical, but it can also help to better conceptualize, investigate, and address increasingly complex socio-environmental problems (Alexander et al., 2020).

The MT DNRC interviews conducted across the state of Montana by JGRE consisted of 63 total transcripts. The participants were part of a purposive and convenience sample including ranchers, farmers, city planners, fishing outfitters, fish biologists, university researchers, legal directors, and other freshwater stakeholders in Montana. It is important to note that indigenous participants were intentionally not included due to jurisdictional issues, neglecting a sizable and vital group of water stakeholders. The interviews were completed in July, August, and September of 2022. Interviews were conducted by one of three interviewers on the JGRE team, either in-person, by phone, or by video call. Most interviews were one-on-one; however, a few included multiple interviewees in the same meeting. All interviews were semi-structured, followed the same interview guide, and included ten questions which were broken into four parts: background information and sensitivity, adaptive capacity, relationships, and personal impacts and reflections (see Appendix D).

The interview reanalysis addressed all the research questions, with a specific focus on the first two questions: 1) What is the quantity and intensity of water conflict and cooperation in Montana? and 2) What are the main issue types leading toward conflict and cooperation in Montana? Each interview was coded independently based on the previously developed codebook

using qualitative methods in NVivo. Once all 63 interview transcripts were coded, references were compiled and analyzed.

Big Hole Event Data

This thesis also conducted an example study in the Big Hole River Watershed to investigate the second research objective: how interview data can provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone. The Montana example study location was determined by the results of the interview re-analysis. Results from the re-analysis revealed one location in the state of Montana with notably more references to alternative conceptualizations of conflict and cooperation (the *alternative* code): Southwestern Montana (Table 4). Specifically, interview participants continually discussed the Big Hole River Watershed located in Southwestern Montana. Therefore, the example study focused on the Big Hole to investigate the research questions on a smaller scale. Specifically, this example study focused on the third research question: *How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone?*

Table 4. References from interview re-analysis coded into the *alternative* code and the corresponding climate region.

Climate Region	Climate region definition	Number of *alternative* references
Region 1	Western Montana	2
Region 2	Southwestern Montana	4
Region 3	North Central Montana	0
Region 4	Central Montana	1
Region 5	South Central Montana	1
Region 6	Northeastern Montana	0
Region 7	Southeastern Montana	0

Before the creation of an interview guide for the Big Hole primary interviews, event data from the area was collected and analyzed to provide additional data and context. Articles, newspapers, and other public news sources used in the event data were sourced from Access World News (News Bank). Access World News is an online database that includes a variety of publications from around the world (*Access World News*, n.d.). These publications include international and national newspapers, blogs, videos, journals, magazines, and more. Access World News is updated daily with current events and publications (*Access World News*, n.d.). Search terms were informed by article publication trends from the past 20 years.

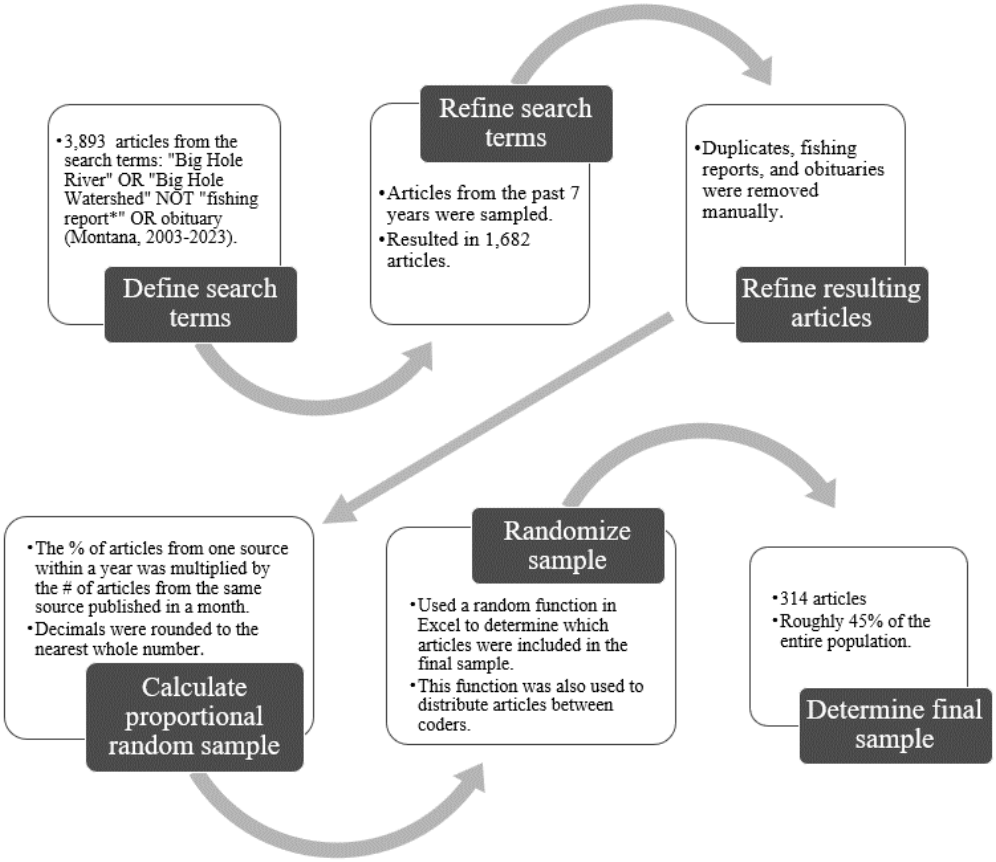

Figure 5. A simplified flow chart depicting the process of defining the Big Hole River Watershed event data search terms and creating the proportional randomized sample.

Initially, event data was found using the following search terms:

"Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2003-2023)

The above search terms produced 3,893 results from Access World News from the past 20 years out of 6 different Montana cities (Billings, Bozeman, Butte, Helena, Missoula, and Sidney). This search focused only on publications from Montana, to narrow the search results. By only including articles from Montana, the resulting event data were more focused on events and stories that were important to the local community. When articles following the search terms were categorized by publication year, the following results were found:

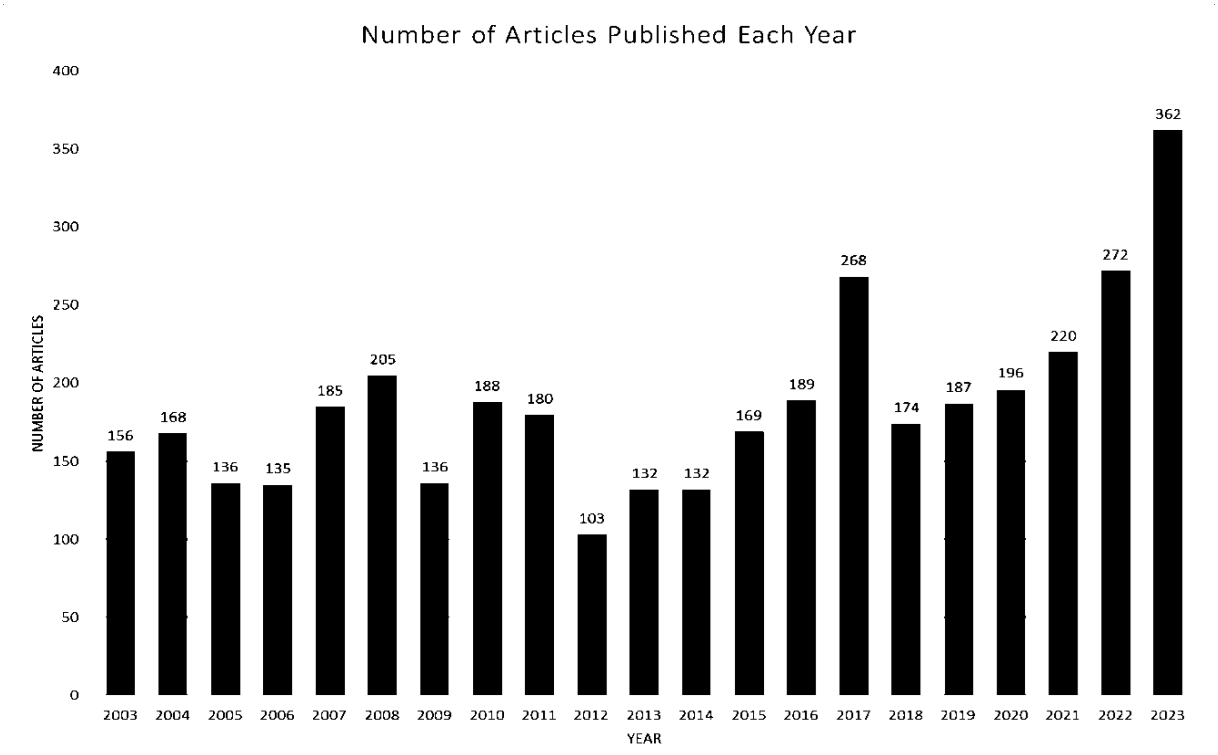

Figure 6. Number of articles published per year following the search terms "Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2003-2023).

Based on these results, only articles from the past 7 years (2017-2023) were coded and analyzed. This timeframe was chosen because it contains the largest spike in articles during the past 20 years. Additionally, this timeframe reflected the short-term memory of JGRE interview participants and primary interview participants. It also ensured that event data and the interviews can be better compared. Leading to the final search terms:

"Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2017-2023)

The final search terms as written above produced 1,682 results, some of which were duplicate articles (the same article published in multiple newspapers) and irrelevant articles (local event postings, obituaries, etc.). Duplicate articles, along with remaining fishing reports and obituaries were removed manually, leaving a total of 701 articles. When selecting which duplicate article to keep, if the article author was affiliated with a specific paper, the article published by the affiliated paper was kept. However, if the author's affiliation was not listed, the paper that printed the article first was the article that was kept.

To make the number of articles to analyze more manageable, a proportional random sampling strategy was utilized. First, articles were sorted in Microsoft Excel by article source (i.e., *Associated Press State Wire, Billings Gazette, Bozeman Daily, Independent Record Helena, Missoulian, Montana Standard, or Sidney Herald*), year (i.e., 2017, 2018, 2019, 2020, 2021, 2022, or 2023), and month. Then, the percentage of articles from one source within a year was multiplied by the number of articles from the same source published in one month of that same year. For example, 36% of articles published by the *Bozeman Daily Chronicle* news source were published in 2023. The number of articles published in September 2023 by the *Bozeman*

Chronicle was 7. The percentage of 36% (i.e., 0.36) was then multiplied by the number of articles published in that year and month (i.e., 7) to get the proportional sample (0.36 x 7 = 2.52). Since it did not make sense to code part of an article, decimals were rounded to the nearest whole number. Therefore, 3 articles published in September 2023 by the *Bozeman Daily Chronicle* were included in the final proportional random sample. To randomize this sample, the Excel function "=RANDBETWEEN( )" was used to determine which 3 articles from September 2023 by the *Bozeman Daily Chronicle* were included in the final sample. This process was repeated for every article source, year, and month. If the proportional sample for a certain source and month was calculated to be less than 1, the value was always rounded up to 1. Therefore, every month had at least one article in the final sample.

Once the proportional random sampling strategy was completed, a final sample of 314 articles remained. The final sample of articles (n=314) was roughly 45% of the entire population of articles, which has been accepted as beyond an acceptable proportion in previous studies sampling news articles (e.g., Liu et al., 2008; Hurlimann & Dolnicar, 2012; Church et al., 2020). Every article was coded independently based on a previously developed plan using NVivo. Articles were randomly distributed between two team members for coding. To randomize the articles, the Microsoft Excel function "=RAND" was used to give each article a random number, and then articles were sorted by their randomly assigned numbers using the "sort Z to A" function in Microsoft Excel. Each coder was then assigned the agreed-upon number of randomized articles (n=100 to one coder, and n=214 to the other coder).

The codebook used for event data was very similar to the interview re-analysis codebook (see Appendix B) as it also included the codes *Conflict*, *Cooperation*, *Alternative*, and *Issue Type*

with their prospective sub-codes. The event data codebook differed from the re-analysis codebook, as it included codes specific to the news articles (i.e., *Paper Name, Year Published, Overall Article, Article Type*). The event data codebook was developed collaboratively between three project members through meetings and discussions on the code names and definitions. It is important to note that regardless of how an article is written, only the *actions* of the parties were coded. This is meant to further avoid biases in the event data set so that events can be evaluated fairly. Once again, final references from the event data were compiled and analyzed to help answer the research question: How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone?

Big Hole Interviews

As mentioned earlier, the example study location, the Big Hole River Watershed, was informed by the re-analysis of stakeholder interviews previously conducted by JGRE for the MT DNRC. In addition to the collection and analysis of event data on the Big Hole, primary interviews were conducted. An interview guide for semi-structured primary interviews was developed by the research team to address water events in the Big Hole and the research questions. The interview guide was informed by the JGRE interview guide (Appendix D), results from the example study event data, literature on water in the West, and literature on water conflict and cooperation. All interviews were semi-structured, followed the same interview guide, and included nine questions which were broken into three parts: background information, conflict and cooperation, and reflections. For the full interview guide see Appendix E. The interview participants were also asked to fill out a short demographic survey (see Appendix E).

Interview participants (n=11) were part of a purposive and convenience sample, including anglers, a fishing guide, a rancher, BHWC members, former and current FWP employees, a former MT DNRC hydrologist, a Trout Unlimited representative, a Montana State University extension specialist, and other stakeholders. Interviews were conducted by the project's primary investigator either by video call or in person (participants were given a choice) during February, March, and April 2024. Each interview took between 40 minutes to an hour. Most interviews were one-on-one; however, one included multiple interviewees in the same meeting.

For convenience and coding purposes, interviews were transcribed using Otter AI. Interview transcripts were coded based on the previously developed codebook (see Appendix C) using NVivo. Once coding was complete, references from the primary interviews were compiled and analyzed to answer the research questions. A specific focus is on the research question: How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone?

Data Analysis

Each data collection method (i.e., interview re-analysis, event data, or primary interviews) used a slightly different codebook in the analysis (see Appendix A, B, and C). The codebook used in the interview re-analysis was developed collaboratively by a team of two. Code names and definitions were discussed and edited until a consensus was reached between the team members. The codebook developed for the Big Hole event data analysis was created by a team of three. Again, Code names and definitions were discussed and edited until a consensus was reached between the team members. Lastly, the codebook used in the analysis of the Big Hole primary interviews was developed solely by the project's primary investigator based on the

discussions, code names, and code definitions from interview re-analysis and event data codebook development.

The following table is not an extensive list of all the codes that were used during the coding process but includes the names and definitions for some of the parent codes that were used to analyze all three data collection methods: re-analysis, event-based, and primary interview data (Table 5). For a full list of all the codebooks including code names and definitions see Appendix A, B, and C.

Table 5. Simplified list of the codebook names and definitions for all the data collection methods.

Code	Definition
Conflict	Any incident of water conflict that does not fit into the BAR scale can be coded into this parent code.
Cooperation	Any incident of water cooperation that does not fit into the BAR scale can be coded into this parent code.
Alternative	Obvious examples of water conflict and cooperation that don't neatly fit into one category or the other (conflict leading to cooperation, conflict and cooperation occurring simultaneously, etc.).
Other	Anything that stands out as important to conflict and cooperation but doesn't fit another code.
Issue Type	Issue categories to classify events according to different aspects of water resources. Events can only be classified into one issue type.

The definitions (Table 5) for the *conflict* and *cooperation* codes (CCC) were informed by the BAR project methods (Yoffe & Larson, 2001). The *alternative* and *other* codes (AOC) along with their definitions, were informed by previous literature on water conflict and cooperation, specifically literature about alternative conceptualizations of conflict and cooperation. These codes were able to highlight non-binary instances of conflict and cooperation in the data. Unlike

the binary CCC, these AOCs allowed for the co-existence of conflict and cooperation to be revealed in the data.

Despite some misconceptions, the absence of violence does not indicate an absence of conflict (Zeitoun & Warner, 2006). Conflictive water events can range from a verbal argument to litigation, to violent protest or war (De Stefano et al., 2010). Similarly, water cooperation also exists along a spectrum, including events such as verbal support, economic support, or freshwater treaties (Yoffe et al., 2003). To quantify this range and intensity of water cooperation and conflict, this study will utilize a modified version of the BAR scale (Yoffe & Larson, 2001) (see Table 6) in addition to the framework in Table 4. The BAR scale allows events to be placed along a continuum, recognizing that conflict and cooperation can co-exist (Böhmelt et al., 2014).

Table 6. Modified BAR intensity scale for intranational conflict and cooperation (modified from Eidem et al., 2012).

BAR Scale Value	Event Description
-5	Small-scale acts of violence, protests, vandalism
-4	Legal action, litigations, appeals of administrative actions
-3	Fines, proposal and permit denials, halting negotiations
-2	Petitions, withdrawal of third-party support
-1	Delays, report reviews, voicing opposition, editorials
1	Voicing opinions of approval, court-forced negotiations, editorials
2	Meetings, third-party support, negotiation requests
3	Permit approvals, fixing violations, negotiations begin
4	Lawsuit settlements, regulation approval, management transfers
5	State bill passage, compacts, or official agreements

The CCCs use the modified BAR scale as sub-codes within these two larger codes, meaning references coded into the conflict and cooperation codes will also be placed into the modified BAR scale when possible. This study will utilize a modified version of the BAR scale (Table 6) from Eidem et al. (2012) revised for intranational conflict and cooperation assessments. The modified scale ranges from -5 (maximum conflict) to +5 (maximum cooperation) to capture the degree of conflict and cooperation in the study area.

Each time an event was coded into an AOC or CCC, it was also coded into one of the *Issue Type* sub-codes. The *Issue Type* sub-codes were informed by and adapted from the study by Eidem et al. (2012) to fit the study location, Montana. These issue types included recreation, instream, intergovernmental, conservation, water rights, fish passage, infrastructure, invasive species, and others. For a full list of the issue types and definitions see Appendix A, B, or C.

The interviews for re-analysis (n=63) and Big Hole Watershed primary interviews (n=11) were coded solely by the project's Primary Investigator. However, due to the mass number of articles in the Big Hole event data (n=314), coding was randomly distributed between two team members. As described in the Big Hole Event Data section, articles were randomly distributed using randomization functions in Microsoft Excel and then coded in NVivo. Once coding by both project members was complete, the NVivo projects were then merged.

To answer the research questions several themes were searched for in the data. First, the proportion and number of conflictive, cooperative, and alternative events for each of the data sets (i.e., interview re-analysis data, event data, primary interview data) were determined to reveal the quantity of conflictive, cooperative, and alternative water events in Montana and the example study area, the Big Hole River Watershed. Next, the number of water events coded into the sub-

codes of *Conflict* and *Cooperation* (the BAR scale values) was reviewed and compared to determine the intensity of cooperative and conflictive water-related events in Montana. Similarly, then the number and type (i.e., conflictive, cooperative, and alternative) of events coded into the sub-codes of *Issue Type* were compared and reviewed to understand the water issue types that result in more conflictive and more cooperative outcomes. Lastly, in the example study, results from the Big Hole River Watershed event data and primary interview data were compared for any similarities and differences to understand how interview data can provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone.

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CHAPTER THREE

DROUGHT CONFLICT AND COOPERATION IN MONTANA: IDENTIFYING TRENDS THROUGH INTERVIEW RE-ANALYSIS

Contribution of Authors and Co-Authors

Manuscript in Chapter 3

Author: Erin Bjorklund

Contributions: Conducted literature review, which provided the theory that guided the development of the codebook. Developed codebook and coded all interview transcripts. Responsible for drafting and finalizing the written manuscript. The primary author of the written manuscript.

Co-Author: Sarah P. Church

Contributions: Suggested salient literature, informed theory development and guided manuscript content and organization.

Co-Author: Jamie McEvoy

Contributions: Informed codebook creation, suggested salient literature, provided feedback on manuscript drafts, and informed theory development.

Co-Author: Kristal Jones

Contributions: Principal investigator of JG Research and Evaluation project in which the data were collected. Supervised the creation of the interview guide, interview administration, and transcript creation. Suggested salient literature, provided feedback on manuscript drafts, and informed theory development.

Co-Author: Erika Burglund

Contributions: Conducted semi-structured interviews with participants and transcribed the recorded interviews.

Co-Author: Willow Grinnell

Contributions: Conducted semi-structured interviews with participants and transcribed the recorded interviews.

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Manuscript Information

Erin Bjorklund, Sarah P. Church, Jamie McEvoy, Kristal Jones, Erika Burglund, Willow Grinnell, Chase Walker

Journal of Contemporary Water Research and Education

Status of Manuscript:
☒ Prepared for submission to a peer-reviewed journal
☐ Officially submitted to a peer-reviewed journal
☐ Accepted by a peer-reviewed journal
☐ Published in a peer-reviewed journal

The Universities Council on Water Resources (UCOWR)

Abstract

The western United States is poised to confront a range of challenges as climate change is expected to diminish freshwater resources while demands for water simultaneously escalate. Globally, droughts, which will intensify and become more frequent due to human-induced climate change, exacerbate the gap between freshwater supply and demand, increasing the likelihood of conflicts. However, conflicts are not the sole outcome, as heightened water demands can also create opportunities for collaboration. One analysis tool commonly used by researchers of water conflict and cooperation is continuum variations, including the well-known Basins at Risk (BAR) intensity scale. Continuum variations allow researchers to place water events along a scale to indicate the intensity of an event rather than only categorizing an event as either conflictive or cooperative. Despite its status as one of the most common tools for evaluating conflictive and cooperative freshwater-related events reported in public news sources, the BAR scale has seen limited utilization beyond news event analysis. Moreover, few studies in the U.S. West, and none specifically within Montana, have employed this method, despite the significant impact of climate change and drought on Montana's water resources. This study examines 1) the quantity and intensity of cooperative and conflictive drought-related events in Montana, 2) which drought issue types result in more conflictive and more cooperative outcomes in Montana, and 3) the complexities of drought-related conflict and cooperation not captured through traditional conflict and cooperation continuums. Drought-related incidents of cooperation and conflict in Montana were cataloged and analyzed in a re-analysis of interviews (n=63) conducted for the MT DNRC Montana Drought Vulnerability Assessment. These interviews were coded using deductive qualitative methods for an adapted BAR scale. The

analysis reveals that drought-related water cooperation largely outweighs conflict in the MT DNRC stakeholder interviews. However, interviewees stated that drought-related conflict still exists in Montana and should be managed through local cooperative efforts. The findings of this project offer valuable insights to assist water researchers and resource managers in Montana in monitoring and identifying patterns of conflict and cooperation. By unveiling trends in water-related conflicts and cooperation within the state, the results underscore a growing desire for local collaborative watershed initiatives aimed at better preparing for drought.

Introduction

The increasing strain on the Earth's water resources has major effects on societal and economic welfare (Cooley et al., 2014). Pressure on the world's water resources is only expected to worsen in response to climate change, population growth, and other global changes (Cooley et al., 2014). As the demands on water resources increase, so does the potential for conflicts over water resources (Postel & Wolf, 2001). With the potential for conflict growing, it becomes increasingly important to understand trends in water conflict and cooperation. Although the potential for water conflict may be growing, previous studies on water cooperation and conflict found that instances of cooperation over shared water outweigh conflict (e.g., Yoffe et al., 2003; Wolf, 2007; De Stefano et al., 2010; Eidem et al., 2012).

As water demands increase and, in certain areas, the overall availability of freshwater declines, the western United States is met with an assortment of water resource challenges (Bernauer & Böhmelt, 2020). However, few studies have examined the prevalence of water cooperation or conflict in many western states, including Montana. As the impacts of a multi-year drought continue to plague Montana citizens (National Drought Mitigation Center, 2023), a

question arises: do water issues prompt Montanans to respond with more cooperation or conflict over shared water resources? This study focused on the following three questions: 1) what is the quantity and intensity of cooperative and conflictive drought-related events in Montana? 2) What drought issue types result in more conflictive and more cooperative outcomes in Montana? And 3) what are the complexities of drought-related conflict and cooperation not captured through traditional conflict and cooperation continuums? Incidents of cooperation and conflict were identified in stakeholder interviews previously conducted by JG Research and Evaluation (JGRE) for the MT DNRC and analyzed using deductive qualitative methods (e.g., Vanover et al., 2021). JGRE is an applied research and evaluation firm based in Bozeman, Montana, and conducted these interviews as part of the MT DNRC 2023 drought vulnerability assessment update. This investigation re-analyzes the MT DNRC interviews to reveal water conflict and cooperation trends, through the lens of water stakeholders in Montana (i.e., stakeholders in the work sectors of agriculture, conservation and land management, energy and industrial use, recreation and tourism, and planning, community development, and municipal water), to help a wide range of managers, decision-makers, and researchers who deal with drought to monitor and identify water conflict and cooperation.

Background

Water Conflict and Cooperation

Fluctuations in global and local hydrological patterns caused by climate change have introduced considerable uncertainty to the world's water resources (e.g., Milly et al., 2008; USGCRP, 2017; Kundzewicz et al., 2018). Despite resource degradation, increasing water stress, and supply and demand imbalances (De Stefano et al., 2010), an analysis of news event data

indicates that cooperation prevails over conflicts in water resource challenges, both domestically and internationally (Eidem et al., 2012).

Widely recognized in the field, the Basins at Risk (BAR) scale is a common conflict and cooperation continuum variation for numerically analyzing freshwater-related events (Bernauer & Böhmelt, 2020). The BAR scale—originating from Oregon State University's Basins at Risk project—is a numerical measurement ranging from -7 (indicating the highest intensity of conflict) to +7 (reflecting the highest intensity of cooperation) to gauge the intensity of conflictive and cooperative events at an international scale (Eidem et al., 2012). As the intensity value of a water event becomes more negative or positive, it signifies intense interactions among stakeholders (Eidem et al., 2012). Previous research employing the BAR scale has not only found a prevalence of cooperation but also classified most conflictive events in the lowest levels (intensity -1 or -2) of conflict intensity (De Stefano et al., 2010).

However, water-related events often embody characteristics of both conflict and cooperation, underscoring their inherent complexity (Zeitoun & Mirumachi, 2008). Viewing conflict and cooperation through a binary lens of *either* conflict *or* cooperation oversimplifies the reality of many contexts where both coexist (Zeitoun & Mirumachi, 2008; Böhmelt et al., 2014). This binary approach also perpetuates the misconception that all conflicts are inherently negative, while all forms of cooperation are positive (Kistin, 2007; Zeitoun & Mirumachi, 2008). Despite recognizing the coexistence and intricacies of conflict and cooperation, many projects and authors using continuum variations, such as the BAR scale, tend to treat them as separate entities during analysis (Zeitoun & Mirumachi, 2008). By positioning the relationship between two water stakeholders along a continuum, analysts simplify the complexities of trust,

communication, and overall relationship dynamics between the parties involved (Zeitoun & Mirumachi, 2008). While the use of a continuum may streamline the analysis of complex situations in water conflict and cooperation, it may also oversimplify the results and conclusions of a study. Recognizing the complexity inherent in conflict and cooperation underscores the importance of exploring novel applications and alternatives of continuums in water conflict and cooperation research to present a more accurate depiction of reality.

Most research on water conflict and cooperation utilizing the BAR scale has focused on water basins at an international level (Bernauer & Böhmelt, 2020). However, climate change and water resource variability are more likely to lead to localized or subnational conflicts, rather than large-scale international disputes (Bernauer & Böhmelt, 2020). In the western United States, few studies have evaluated conflictive and cooperative water-related events using the BAR scale. One study conducted by Eidem et al. (2012) observed a prevalence of water cooperation over conflict in Oregon and the Upper Colorado River Basin. Consequently, there is a need to conduct future research at a local scale, specifically in the western U.S. (e.g., Böhmelt et al., 2014).

Previous literature has also identified a broad spectrum of water issues driving conflict and cooperation, encompassing factors such as water quantity, governance structures, infrastructure, and water quality (De Stefano et al., 2010; Bernauer & Böhmelt, 2020). Eidem et al. (2012) found that *water quality* and *water quantity* were the primary issue types in Oregon, while in the Upper Colorado Basin, events were predominantly associated with *water rights, water quality, infrastructure,* and *intergovernmental* relations. One thing that research on water conflict and cooperation consistently agrees upon is that as stress on water resources in the West escalates, so does the potential for water conflicts (H. Ingram et al., 2008; Eidem et al., 2012).

Drought in Montana

In the following section, I will be discussing some of the dominant water issues facing Montana, with a specific focus on drought. Not only is drought a very common and challenging issue in Montana, it is also the focus of this research because the re-analyzed interviews were conducted for the Montana Drought Vulnerability Assessment. Montana's drought issues are not unique to the state. Many other regions in the western United States face similar drought-related problems to Montana (e.g., Cook et al., 2004; USGCRP, 2017; Siirila-Woodburn et al., 2021; Iglesias et al., 2022). Montana is also a critical headwaters state; Southwest Montana contains all three forks of the Missouri River: the Jefferson, Madison, and Gallatin Rivers (Cravens et al., 2021). Therefore, an extreme increase in drought intensity or frequency has the potential to cause negative impacts across the entire Missouri River Watershed.

The term "drought," although widely used, can be ambiguous and difficult to define (USGCRP, 2017). For this project, the definition "insufficient water to meet needs," will be used (Redmond, 2002). Although simple, this definition broadens the term 'drought' to include water shortage caused and modified by human processes in addition to natural processes (Van Loon et al., 2016). Regardless of which definition is used, as climate change alters factors such as the timing of precipitation (USGCRP, 2017) the trends in drought intensity and frequency will also change (e.g., Iglesias et al., 2022).

Water resources in Montana and the West have been largely reshaped by anthropogenic climate change over the last century (Siirila-Woodburn et al., 2021). Changes in climate may cause conditions currently considered "abnormally" dry to become relatively "normal" (USGCRP, 2017) in regions undergoing aridification, such as the West (Cook et al., 2004). With

these changing conditions, the onset of rapid-onset droughts has been occurring faster in the last few decades, leaving water resources particularly vulnerable (Iglesias et al., 2022).

Increased drought and related water stress intensifies water demand and, therefore, increases the potential for water conflict (Postel & Wolf, 2001). As the potential for conflict in Montana increases, so does the need for water conflict and cooperation assessments. A better understanding of trends leading to and resulting in conflictive and cooperative events can help a wide range of planners and resource managers improve current practices to proactively manage drought-related water conflicts.

Methods

This project investigated water conflict and cooperation utilizing the BAR scale, in a new way. Previous research in water cooperation and collaboration has primarily used an event data coding approach (Bernauer & Böhmelt, 2020). Rather than an event data approach, we used an interview-reanalysis coding approach. Although event data sourced through newspapers, articles, government reports, and other public news sources can be a useful tool in data collection, it is heavily constrained by the biases and hyperbole of local media sources and political interests (De Stefano et al., 2010). An event data approach is not always well suited to studying environmental issues (Eidem et al., 2012). Media sources fail to report on many water-related interactions (De Stefano et al., 2010). Event databases have several additional limitations including text quality, misleading or incorrect information, restraints on internet access, human error, and language barriers (Bernauer & Böhmelt, 2020). To avoid some of these biases, this study used a re-analysis of stakeholder interviews previously conducted by JGRE for the MT DNRC.

Data Collection

The MT DNRC produced an updated state-wide Drought Management Plan in 2023. As part of this update, the MT DNRC contracted JGRE to conduct drought stakeholder interviews to provide insight on drought impacts and adaptation to contribute to the plan's vulnerability assessment. With Montana State University's Institutional Review Board (MSU IRB) approval and permission from MT DNRC and JGRE, we utilized these interview transcripts to conduct a re-analysis to answer the questions outlined in this research project.

The re-analysis of data has many benefits; re-analysis of qualitative data allows researchers to ask new questions and identify new evidence within the original data set (Alexander et al., 2020; Pfaeffle et al., 2022). Not only is it often more convenient and economical, but it can also help to better conceptualize, investigate, and address increasingly complex socio-environmental problems (Alexander et al., 2020).

The MT DNRC interviews conducted across the state of Montana by JGRE consisted of 63 total transcripts. The participants were part of a convenience sample including ranchers, farmers, city planners, fishing outfitters, fish biologists, university researchers, legal directors, and other freshwater stakeholders. It is important to note that indigenous participants were intentionally not included due to jurisdictional issues, neglecting a sizable and vital group of water stakeholders. The interviews were completed in July, August, and September of 2022. Interviews were conducted by one of three interviewers on the JGRE team, either in-person, by phone, or video call. Most interviews were one-on-one; however, a few included multiple interviewees in the same meeting. All interviews were semi-structured, followed the same interview guide, and included ten questions which were broken into four parts: background information and sensitivity, adaptive capacity, relationships, and personal impacts and reflections

(see Appendix D). This research was reviewed and approved by Montana State University's Institutional Review Board: IRB Protocol #449. The original interview project conducted by JGRE for the MT DNRC was approved by the University of Montana's Institutional Review Board.

Data Analysis

The interviews were coded using a deductive analysis in NVivo software (e.g., Vanover et al., 2021). The codebook used in the coding process was collaboratively developed by a team of two researchers. This codebook drew from three key sources: existing literature on cooperation and conflict, studies on drought in the western U.S., and methodologies outlined in the BAR Project (Yoffe & Larson, 2001). Code names and definitions were created through several rounds of discussion and revision until a consensus was reached.

The codebook was used to capture trends in drought-related water events in the interview data. In a pervious study, Eidem et al. (2012) defined a water event as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined and recorded. Therefore, for this project, we define a drought-related water event as any interaction between stakeholders driven by some dimension of drought that is action-defined and recorded in the interviews. It is important to note that regardless of how an interviewee speaks about a drought-related water event (positively, negatively, etc.), only their actions, as described in the interview, were coded. For example, even if a participant discussed a lawsuit in a positive way, the lawsuit was coded as a conflictive event per the definition of a -4 event on the BAR intensity scale. This is meant to further avoid biases in the event data set so that events can be evaluated

fairly. Additionally, an interviewee may discuss multiple events in a single interview; however, the same event will only be counted once even if discussed multiple times.

Table 7 presents a summarized list of codebook names and definitions, which includes *conflict*, *cooperation*, *alternative*, *other*, and *issue type* codes. The definitions (Table 7) for the *conflict* and *cooperation* codes (CCC) were informed by the BAR project methods and included sub-codes of a modified BAR scale from Eidem et al. (2012) adapted for assessing intranational conflict and cooperation (Table 8). The modified scale ranges from -5 (maximum conflict) to +5 (maximum cooperation) to capture the degree of cooperation and conflict in the study area. Events coded into the CCC were placed into the modified BAR scale sub-codes when possible. Coding events of conflict or cooperation onto the BAR scale proved to be more difficult than anticipated when analyzing interviews. Many participants would mention cooperative organizations or other people that they work with regarding water resources in Montana; however, they would not go in-depth on *how* they worked with these other groups or individuals. For example, one participant mentioned "*the bird refuge from National Wildlife Services participate in [a cooperative effort]*" but never expanded on how the bird refuge was participating. These types of events were still coded into the parent code *cooperation*; however, the coding team was unable to place them along the modified BAR scale.

Table 7. Summarized list of codebook names and definitions.

Code	Definition
Conflict	Any incident of water conflict that does not fit into the BAR scale can be coded into this parent code.
Cooperation	Any incident of water cooperation that does not fit into the BAR scale can be coded into this parent code.
Alternative	Obvious examples of water conflict and cooperation that don't neatly fit into one category or the other (conflict leading to cooperation, conflict necessary, etc.).
Other	Anything that stands out as important to conflict and cooperation but doesn't fit another code.
Issue Type	Issue categories to classify events according to different aspects of water resources. Events can only be classified into one issue type.

Table 8. Modified BAR intensity scale for intranational conflict and cooperation (modified from Eidem et al., 2012).

BAR Scale Value	Event Description
-5	Small-scale acts of violence, protests, vandalism
-4	Legal action, litigations, appeals of administrative actions
-3	Fines, proposal and permit denials, halting negotiations
-2	Petitions, withdrawal of third-party support
-1	Delays, report reviews, voicing opposition, editorials
1	Voicing opinions of approval, court-forced negotiations, editorials
2	Meetings, third-party support, negotiation requests
3	Permit approvals, fixing violations, negotiations begin
4	Lawsuit settlements, regulation approval, management transfers
5	State bill passage, compacts, or official agreements

The *alternative* and *other* codes (AOC) along with their definitions (see Table 7), were informed by previous literature on water cooperation and conflict, specifically alternative conceptualizations of conflict and cooperation. These codes highlighted non-binary instances of conflict and cooperation not captured through traditional conflict and cooperation. For the full codebook, see Appendix A.

Each time an event was coded into an AOC or CCC, it was also coded into one of the *Issue Type* sub-codes, adapted from Eidem et al. (2012) to better suit the Montana context. The issue types included a range of issues related to water resources, such as recreation, instream flow, intergovernmental relations, conservation efforts, water rights, fish passage, infrastructure, invasive species, and others. For a full list of the issue types and definitions see Appendix A.

Once all 63 interview transcripts were coded, events were compiled, and several themes were analyzed to answer the research questions. First, the analysis focused on determining the proportion and number of conflictive, cooperative, and alternative events within the interview data. Next, the intensity of cooperative and conflictive water-related events was evaluated by reviewing the number of events coded into the sub-codes of *conflict* and *cooperation* (BAR scale values). Lastly, the distribution and types of events coded into the sub-codes of *issue type* were examined to identify water issue types associated with conflictive and cooperative outcomes.

Results and Discussion

The following section details the major findings from the re-analysis of interview data in the study area, Montana. Drought-related water event quantity and intensity, issue type, and complexities are discussed separately. Lastly, the results from this study are compared with findings from previous research on water conflict and cooperation using the BAR scale.

Quantity and Intensity of Re-Analysis Data

Of the 144 drought-related events coded in the interviews, more events in Montana were overall coded as cooperative (n=84, 59%) than conflictive (n=52, 36%). Events coded as *alternative* were the least common (n=8, 5%) (Figure 7).

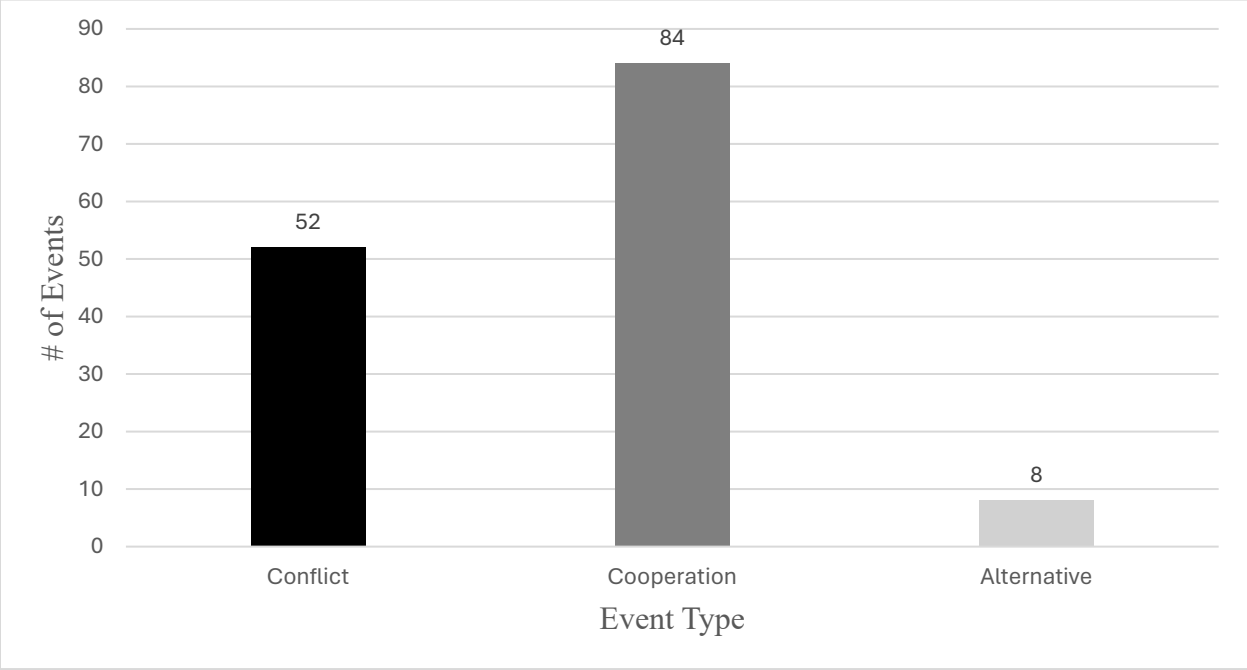

Figure 7. The number of conflictive, cooperative, and alternative events described in the interviews.

An example of a cooperative event is the interview quote, "…*everyone's being conscious about, 'Who's diverting what,' and 'Let's all work together.' And the Upper Big Hole's a little bit of a unique situation… relatively few landowners makes it easier*." This quote, "…*and I was told for my first year and a half here not to work with them because they had such terrible PR in the community. The community really, generally, had a sour taste in their mouth from them…*" is an example of a conflictive event. These results are unsurprising, as they support the results of previous studies on water cooperation and conflict which found that at both the inter- and intranational scale, cooperation over shared water resources outweighs conflict (De Stefano et al., 2010; Eidem et al., 2012).

Not all drought-related water events were able to be placed onto the BAR intensity scale due to a lack of enough context or information to place the event appropriately on the scale (thus

they were only coded broadly as conflict, cooperation, or alternative only). However, for water events that we were able to be placed on the BAR intensity scale (the sub-codes of the *cooperation*, *conflict*, and *alternative* parent codes) mildly conflictive (intensity -1) events (n=20) outnumbered mildly cooperative (intensity +1) events (n=4) (Figure 8).

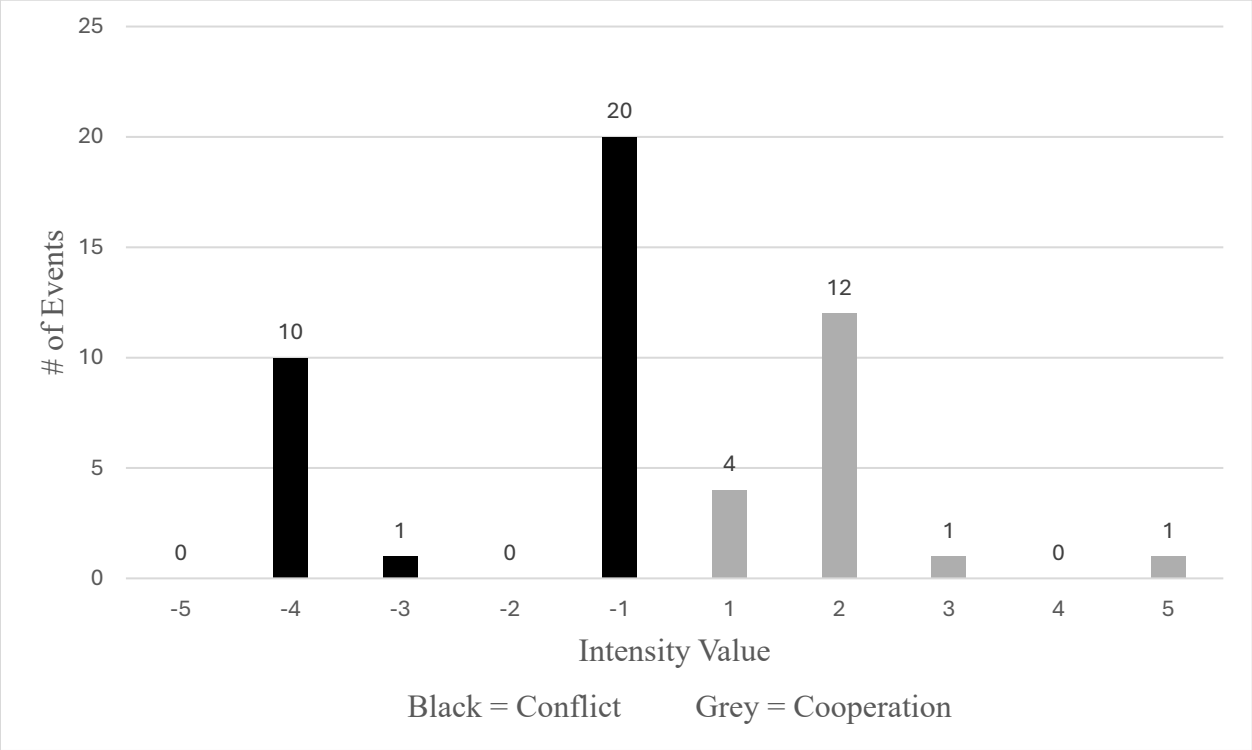

Figure 8. Distribution of events described in the interviews placed along the BAR intensity scale.

However, for events more intense than -1 and 1 (intensity -2 to -5 or intensity 2 to 5) there were more cooperative events (n=14, 56%) than conflictive (n=11, 44%). The extremely cooperative events (intensity +5) (n=1) also outnumber the most intense conflictive events (intensity -5) (n=0). Mildly conflictive (intensity -1) events were the most common conflictive events to be recorded in the interviews (n=20, 38%); mild conflict events include actions like voicing opposition, editorials, delays, or reviews of reports. Surprisingly, highly conflictive (-4

intensity) events were the second most common conflictive events (n=10, 19%); high conflict events include actions such as legal action, litigations, or appeals of administrative actions. Conversely, cooperative events at a level 2 intensity were most common (n=12, 14%), which included meetings, third-party support, or negotiation requests.

Because we were unable to place every water event from the interview data on the BAR intensity scale, Figure 8 results show a higher proportion of conflictive events than shown in Figure 7. This is because Figure 7 included all drought-related water events coded in the interview data into broad categories (i.e., conflict, cooperation, alternative), whereas Figure 8 included only those events with enough context or information to distinguish the intensity scale item. Therefore, the BAR intensity values illustrated in Figure 8 reveal general trends in event intensity as described in the MT DNRC drought vulnerability interviews.

In summary, cooperative events outnumbered conflictive events, and a low proportion were of extreme intensity (-5 and +5). These findings are not surprising; previous research by Wolf (2007) and Eidem et al. (2012) also found a prevalence of mildly conflictive events (intensity -1) over highly conflictive ones (intensity -5) in their study areas. The results support the previous research using the BAR scale, which has found that mildly conflictive events (intensity -1) are more common than extremely conflictive (intensity -5) events (e.g., Wolf, 2007; Eidem et al., 2012). The frequency of mild events (intensity +1 and -1) suggests a regular practice among stakeholders of expressing their disapproval of certain issues and advocating for those they support. These results indicate that in Montana, conflicts over water resources often take on a mild and verbal nature rather than escalating to high levels of conflict that involve extreme actions (e.g., violence, vandalism, legal action, etc.).

Drought-Related Water Issue Types

Through our re-analysis of the interviews, we found most drought-related water events revolved around *instream flows* (n=50, 40%). The second most common issue type was *water rights* (n=26, 21%), followed by *conservation* (n=22, 17%) (Table 9).

Table 9. The three most common issue types for events discussed in the MT DNRC interviews.

Issue Type	# of Events	% of Total Events (n=144)	Example Text
Instream	50	40	"He's busy, because he implements the Jefferson drought plan, and this weekend, what happened on the Jefferson, it is wrecking him, and he's got a hundred angry irrigators calling him, and everybody's mad at every... when you have scarcity, I wouldn't say it causes severe mental health challenges, but it is a lot of stress."
Water Rights	26	21	"Trout Unlimited came in and objected on the Mill Creek water rights because they had standing in the creek because they had leased water. So, there is a lot of anger up there because they had to get attorneys at a tremendous cost, and that's about all I really know about that."
Conservation	22	17	"I met with a group in Helena that, I can't remember what the group was called, but they were interested in changing water rates. And so, I met with them to talk about our conservation-based rate structure, where you kind of the more you use, the more you pay, so outdoor water use costs more and stuff like that."

We found conflict or cooperation emerged consistently as related to certain issue types. Conflictive events often revolved around *instream flow* and *water rights* issues. More specifically, conflictive events with themes of "recreational" interests versus "ag" (agricultural) interests were commonly expressed by interview participants. As one interview participant stated, "*a few years ago when they had the big fish kill on the Yellowstone, that really kind of*

pitted the recreational interests against the ag interests." As another interview participant explained:

> *"It doesn't seem like there's that many options that I'm aware of. If somebody's got a water right. That word 'right', means quite a bit in this world. I don't have a recreational right. They do have a water right. That's kind of a tough rub for fishermen to swallow, but it makes sense."*

Previous research has highlighted similar conflicts between recreationists and agriculturalists in Montana. The nexus of local economies and wildlife on rangelands in Montana pose many opportunities and challenges for ranchers and hunters (Haggerty et al., 2023). Unfortunately, Montana hunter/rancher relations have become increasingly strained over the past several years (Swensson & Knight, 1998). Concerns from hunters about diminishing access to private and public land and changes to established boundary practices alongside concerns from ranchers about increasing wildlife populations in addition to feeling as though their contributions to wildlife habitat are overlooked have led to an increase in conflicts between hunters and ranchers in Montana (Swensson & Knight, 1998; Yung & Belsky, 2007). Other areas in the western U.S. have also experienced similar conflicts. Like Montana, Idaho has experienced a drastic decline in agriculture, ranching, and mining, and a rapid growth in the tourism and recreation sectors which has led to rising tensions concerning the appropriate use of public lands (Smutny & Takahashi, 1999).

Cooperative events often revolved around *instream* flow and *conservation* issues. Drought-related instream flow issues were a common theme that led to cooperative events. As one participant expressed:

> *"At the local level, there's a lot of work with local conservation districts and watershed groups, both trying to plan for and mitigate drought circumstances… My world is getting the resources for the work, but our project managers do a lot of work in terms of building resiliency in the watersheds through their restoration projects, and that shovel in the ground kind of projects, oftentimes improving stream flow, maybe improving irrigation efficiency, keeping water in stream, and then the legal requirements behind that, converting those flows from irrigation savings into permanent in stream flow rates and things like that."*

This sentiment was shared amongst other interviewees who discussed working groups and collaborations in response to and preparation for drought.

The interview data showed that instances of conflict or cooperation were often driven by multiple issue types and themes such as drought, water availability, water rights, and irrigation versus recreational water use. However, these water issue types are interconnected, making it difficult to classify each event into only one type. Like water cooperation and conflict, the water issue types are more complex than they initially seemed, and fixed distinctions may not be a holistic method for interpreting results.

Overall, the key water issue types found in the interview re-analysis were *instream, water rights*, and *conservation*. These results differ slightly from previous research, as the primary issue types for water events in Oregon found by Eidem et al. (2012) were *water quality* and *water quantity,* and in the Upper Colorado River Basin were *water rights, water quality, infrastructure,* and *intergovernmental relations*. *Conservation* and *instream* were not significant water issue types in either Oregon or the Upper Colorado Basin. This suggests that conflicts or

cooperation arising from water issues are often specific to particular states or regions. As a result, water resource managers and decision-makers should adopt a localized approach to resolving conflicts and proactively addressing water disputes.

Since Montana is a headwaters state (Whitlock et al., 2017), Montana's water resources directly influence numerous other watersheds across the United States, notably the entire Missouri River Basin. Therefore, Montanans have a responsibility to monitor and effectively manage Montana's water resources for the benefit of their downstream neighbors.

Complexities Missed in the BAR Intensity and Issue Type Analysis

The *other* code was examined to answer the final research question, what are the complexities of drought-related conflict and cooperation not captured through traditional conflict and cooperation continuums? *Other* is defined as "anything that stands out as important to conflict and cooperation but doesn't fit another code."

We coded 44 quotes from the 63 interviews into the code *other*. Most of the references in this code consisted of interviewees expressing a need for more cooperation over freshwater resources in Montana. Indeed, although interviewees acknowledge cooperative outcomes in terms of drought-related water events, this sentiment that there could be *more* cooperation was prevalent. For example, this interviewee expressed these two ideas during the same interview; midway through the interview the participant stated:

> *"I think historically Montanans have been really good at kind of working together when they need to. It's why we have stream access in Montana that's so robust is because I think landowners recognize, well, we could fight this to the death, but what's the point of that?"*

Yet later in the same discussion the participant added that they would like even more cooperation when they said:

> *"Better coordination and information sharing and involving all those interests, I think at the local level where you can make some kind of different approaches than you can at the state level, I think would be very interesting and worthwhile."*

This participant recognized that cooperation over water resource challenges is already common in Montana, yet would like to see more of it specifically at a local level. Many other participants expressed a similar need for cooperation at a local level and for more collaboration from state agencies. For example, one participant expressed "*I think it would just be helpful to have that higher tier kind of mandatory collaboration.*"

We suggest that water managers and researchers turn to the literature on collaborative watershed management as a resource for implementing local-level cooperative efforts around water resources. Collaborative watershed management (also referred to as collaborative watershed governance) is designed to facilitate consensus and cooperation among competing stakeholders at the watershed level as an alternative to centralized, command-and-control policies (Lubell, 2004). Literature and research in collaborative watershed management have shown that collaborative processes not only achieve ecological results but also improve community-level cooperation and communication (Yaffee & Wondolleck, 2000). Other benefits include improved conflict management, the translation of knowledge, greater inclusion of diverse perspectives in decision-making, and increased social and institutional capacity (Margerum & Robinson, 2015).

Without the inclusion of the code *other* in the codebook, the strong sentiment for further collaboration would have been missed in our analysis. Analyses using only traditional conflict and cooperation continuums would fail to arrive at these more complex and nuanced conclusions. Based on these findings, we suggest that future researchers delve further into exploring modifications to and alternative applications of the BAR scale, aiming to present a more comprehensive and non-linear perspective on water conflict and cooperation.

Conclusions

Results from this project reveal that drought-related water events coded as cooperative overall were more frequent than overall conflictive events in these Montana water stakeholder interviews. However, drought-related conflict still exists in Montana and should be managed through local cooperative efforts. We found that water stakeholders are eager to see more cooperation between state agencies and stakeholders around drought issues. These trends in drought conflict and cooperation can begin to help a wide range of natural resources managers and decision-makers who deal with drought in Montana proactively address drought-related challenges.

This project found that analyses using only traditional conflict and cooperation continuums would fail to capture the more complex and nuanced instances of conflict and cooperation. The inclusion of the codes *alternative* and *other* allowed us to highlight complexities of drought-related conflict and cooperation typically not captured through traditional conflict and cooperation continuums. These complexities are important to highlight when studying water cooperation and conflict, as they help to present a holistic and non-linear view which is a more accurate depiction of reality.

The results from this study also reveal that most conflictive and cooperative events in Montana stem from the issue types *instream*, *water rights*, and *conservation*. These results differ slightly from previous research, which found that the water issue types *water quality, water rights, infrastructure, intergovernmental relations,* and *water quantity* were the most significant issues leading towards water conflict and cooperation in other regions of the western U.S. (i.e., Oregon and the Upper Colorado River Basin) (Eidem et al., 2012). *Water rights* were found to be an important water issue type in both Montana and the Upper Colorado River Basin (Eidem et al., 2012), however, *conservation* and *instream* were not found to be the most significant water issue types in these other regions of the western U.S. This suggests that conflicts or cooperation arising from water issues are often location-specific and vary from state to state. As a result, water resource managers and decision-makers should adopt a localized approach to resolving conflicts and proactively addressing water disputes. Literature on collaborative watershed management (also referred to as collaborative watershed governance) may serve as a starting point for planning and implementing local-level cooperative efforts around water resources.

Managing drought will become increasingly complex as anthropogenic climate change alters normal conditions across the globe. Understanding trends in cooperative and conflictive events related to freshwater resources is one way to help prepare a wide range of resource planners and managers who deal with drought. Freshwater conflict and cooperation literature has mainly focused on international water resource challenges. Although, climate change and variability in water resources are more likely to lead to subnational conflicts (Bernauer & Böhmelt, 2020), little research on cooperative and conflictive water events has been conducted at a local scale. Moreover, there are very few studies on water cooperation and conflict within the

West. The potential for local conflict in Montana increases as climate change-induced drought and increased water demands heighten the stress on freshwater resources. However, conflict is not the only plausible outcome; increased water stress can also create space for cooperation. This project addressed the lack of literature on local drought-related conflict and cooperation in Montana. Future research should continue to focus on water conflict and cooperation at a local or intranational scale, with a specific focus on approaching water conflict and cooperation research with a holistic and non-linear view.

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CHAPTER FOUR

RETHINKING WATER CONFLICT AND COOPERATION: AN EXAMPLE FROM THE BIG HOLE RIVER WATERSHED, MONTANA

Contribution of Authors and Co-Authors

Manuscript in Chapter 4

Author: Erin Bjorklund

Contributions: Conducted literature review, which provided the theory that guided the development of the interview guide, survey questions, and codebooks. Developed event data search terms, downloaded articles from the random sample, and coded a sample of the articles. Conducted all semi-structured interviews with participants, transcribed the recorded interviews, and coded them. Responsible for drafting, finalizing, and administering the demographic survey. Responsible for drafting and finalizing the written manuscript. The primary author of the written manuscript.

Co-Author: Sarah P. Church

Contributions: Informed the development of the event data search terms, created the random sampling strategy, and coded a sample of the articles. Sat in on several primary interviews to provide support and feedback. Provided feedback on the interview guide, informed codebook creation, and guided manuscript content and organization.

Co-Author: Jamie McEvoy

Contributions: Suggested salient literature, provided feedback on manuscript drafts, and informed theory development. Attended and provided input during event data intercoder reliability meetings.

Co-Author: Kristal Jones

Contributions: Suggested salient literature, provided feedback on manuscript drafts, and informed theory development.

Manuscript Information

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Water Policy

Status of Manuscript:
☒ Prepared for submission to a peer-reviewed journal
☐ Officially submitted to a peer-reviewed journal
☐ Accepted by a peer-reviewed journal
☐ Published in a peer-reviewed journal

The International Water Association (IWA) Publishing

Abstract

Climate change and increasing demands for water heighten the supply and demand imbalance for freshwater, increasing the potential for conflict between water users. However, conflict is not the only outcome, as water demands can also create space for cooperation. The Basins at Risk (BAR) scale is one of the most prominent numerical measurements for analyzing the level of conflict or cooperation in freshwater-related events reported in public news sources. However, few studies in the U.S. West and none within Montana have utilized this method and little has been done to investigate alternative applications of the BAR scale beyond news event analysis. Therefore, this study examines: 1) trends in water conflict and cooperation (quantity, intensity, and water issue types) that exist in the Big Hole River Watershed, Montana, and 2) how interview data in addition to event data can contribute to nuanced understandings of water conflict and cooperation using the BAR scale. We utilized the BAR scale to analyze event data (n=314) from 7 Montana news sources between the years 2007 and 2023, as well as primary interviews (n=11) with a variety of stakeholders in the Big Hole River Watershed, Montana (e.g., anglers, ranchers, fishing guides, Big Hole Watershed Committee board members, Fish, Wildlife and Parks). The intensity and type of issue for water events in both data sets (i.e., event data and primary interviews) were cataloged and analyzed in the example study and compared to reveal any advantages to including the interview data. These data show there is value in using primary interviews in a study utilizing the BAR scale in addition to event data, as the interviews provided different results than the event data. Overall, results from this study can help researchers and resource managers monitor and identify water conflict and cooperation, by showing a nuanced understanding of conflict and cooperation.

Background

Water resources influence many political, economic, social, and even religious conflicts (H. Ingram et al., 2008), which are expected to intensify with climate change (Unfried et al., 2022). Changes to precipitation patterns across the globe and in the U.S. due to climate change have brought major uncertainty to the world's water resources (e.g., Milly et al., 2008; USGCRP, 2017; Kundzewicz et al., 2018). Despite increased water stress, resource degradation, and an imbalance between supply and demand, cooperation over shared water outweighs conflict internationally according to research using the BAR scale (De Stefano et al., 2010), which is one of the most common numerical continuums used for measuring water event intensity in public news sources (Bernauer & Böhmelt, 2020).

The western United States faces a wide range of challenges as water demands rise and, in some places, overall available freshwater decreases (Bernauer & Böhmelt, 2020). However, few studies in the U.S. West and none within Montana have utilized the BAR method and little has been done to investigate alternative applications of the BAR scale beyond news event analysis. Therefore, this study begins to fill these research gaps by examining: 1) trends in water conflict and cooperation (quantity, intensity, and water issue types) that exist in the Big Hole River Watershed, Montana, and 2) how interview data in addition to event data can contribute to nuanced understandings of water conflict and cooperation using the BAR scale.

We used the Big Hole River Watershed as an example case to examine differences between events analyzed through newspaper media, and those analyzed through interviews. Montana is a critical headwaters state, as the three forks of the Missouri River, the Jefferson, Madison, and Gallatin Rivers are all located in Southwest Montana (Cravens et al., 2021). The

Big Hole River Watershed, located in Southwestern Montana, is a basin at the headwaters of the Upper Missouri River and already has a relatively well-documented history of water cooperation and water issues (e.g., Romans, 2013; Davis, 2015; Byington, 2016; *How We Work*, 2016; Murphy et al., 2017; Szabo, 2018; Big Hole Watershed Committee, 2022).

Water Conflict and Cooperation Through the Lens of the Basins at Risk Project Methods

Water event data has been central to previous research on water cooperation and conflict. In previous research, a "water event" is defined as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined, recorded, and publicly available (Eidem et al., 2012). The BAR scale is one of the most prominent numerical measurements for freshwater-related events (Bernauer & Böhmelt, 2020). Scholars with the Basins at Risks projects based out of Oregon State University developed the BAR scale which ranges from -7 (highest intensity of conflict) and +7 (highest intensity of cooperation) to capture the degree of cooperation and conflict intensity at the international scale. As a water event's intensity value becomes more negative or positive, the more intense the interaction between stakeholders is (Eidem et al., 2012).

Previous studies using the BAR scale show at the international level, not only is cooperation more prevalent but almost all the conflictive events can be classified in the lowest levels (intensity -1, -2, and -3) of conflictive event categories (De Stefano et al., 2010). However, the intensity and quantity of conflictive and cooperative events determined in all these studies are highly dependent on the type of water issues being addressed. Previous literature using the BAR project methods suggests a wide range of water issues spurring international conflict and cooperation. On the international scale, some of the key water issues that are most significant in

the existing literature stem from challenges in water quantity, the form of government, infrastructure, and water quality (Bernauer & Böhmelt, 2020; De Stefano et al., 2010).

A recent synthesis of freshwater conflict and cooperation literature reveals that most studies on water conflict and cooperation have been conducted at the international level (Bernauer & Böhmelt, 2020). However, climate change and variability in water resources may be more likely to lead to local or subnational conflicts as opposed to international conflicts (Bernauer & Böhmelt, 2020). Therefore, there is an urgent need to focus future scientific research on water conflict and cooperation on the local or subnational scale (e.g., Böhmelt et al., 2014).

In the western United States, there are few studies assessing conflictive and cooperative water-related events using the BAR project methods. In one of these studies, Eidem et al. (2012) found that there are more events of water cooperation than conflict in Oregon and the Upper Colorado River basin. The primary issue types for all water events found by Eidem et al. (2012) in Oregon were *water quality* and *water quantity*. In Upper Colorado, most events were related to *water rights, water quality, infrastructure,* and *intergovernmental relations*. Understanding water conflict and cooperation in the U.S. West beyond the regions of Oregon and the Upper Colorado is critical to anticipate and prepare for future water stress.

Alternative Conceptualizations of Conflict and Cooperation

What some of these previous studies don't fully capture is that conflict and cooperation are not always exclusive. Water events are often not exclusively either conflictive or cooperative, but usually include characteristics of both (Zeitoun & Mirumachi, 2008). The examination of *either* conflict *or* cooperation does not reflect the reality of many contexts where cooperation and

conflict can co-exist (Zeitoun & Mirumachi, 2008; Böhmelt et al., 2014). Comparative methods also perpetuate the misconception that any conflict is 'bad' and all forms of cooperation are 'good' (Kistin, 2007; Zeitoun & Mirumachi, 2008). Many projects and authors recognize the co-existence and complexity of cooperation and conflict but when it comes to analysis, the two are typically treated as separate concepts (Zeitoun & Mirumachi, 2008).

The most common analytical tool that previous research relies on is continuum variations, including the BAR scale (Yoffe & Larson, 2001). In placing a relationship between two water stakeholders along a continuum, the analyst is required to simplify the trust, communication, and overall relationship between the two parties (Zeitoun & Mirumachi, 2008). This use of a continuum may narrow the results and reflections of a study; however, it can serve to simplify extremely complex situations in water conflict and cooperation. It is important to approach water conflict and cooperation with a non-linear and holistic view to capture the complexities of stakeholder interactions and portray an accurate representation of reality.

The Big Hole River Watershed

Imagine snow-covered alpine mountain ranges, pristine lakes, and wide-open valleys in every direction. Crystal clear headwater streams and blue-ribbon fisheries. Grassy valley floors filled with more cattle than people. What you are picturing is the Big Hole River Watershed, Montana (Figure 9).

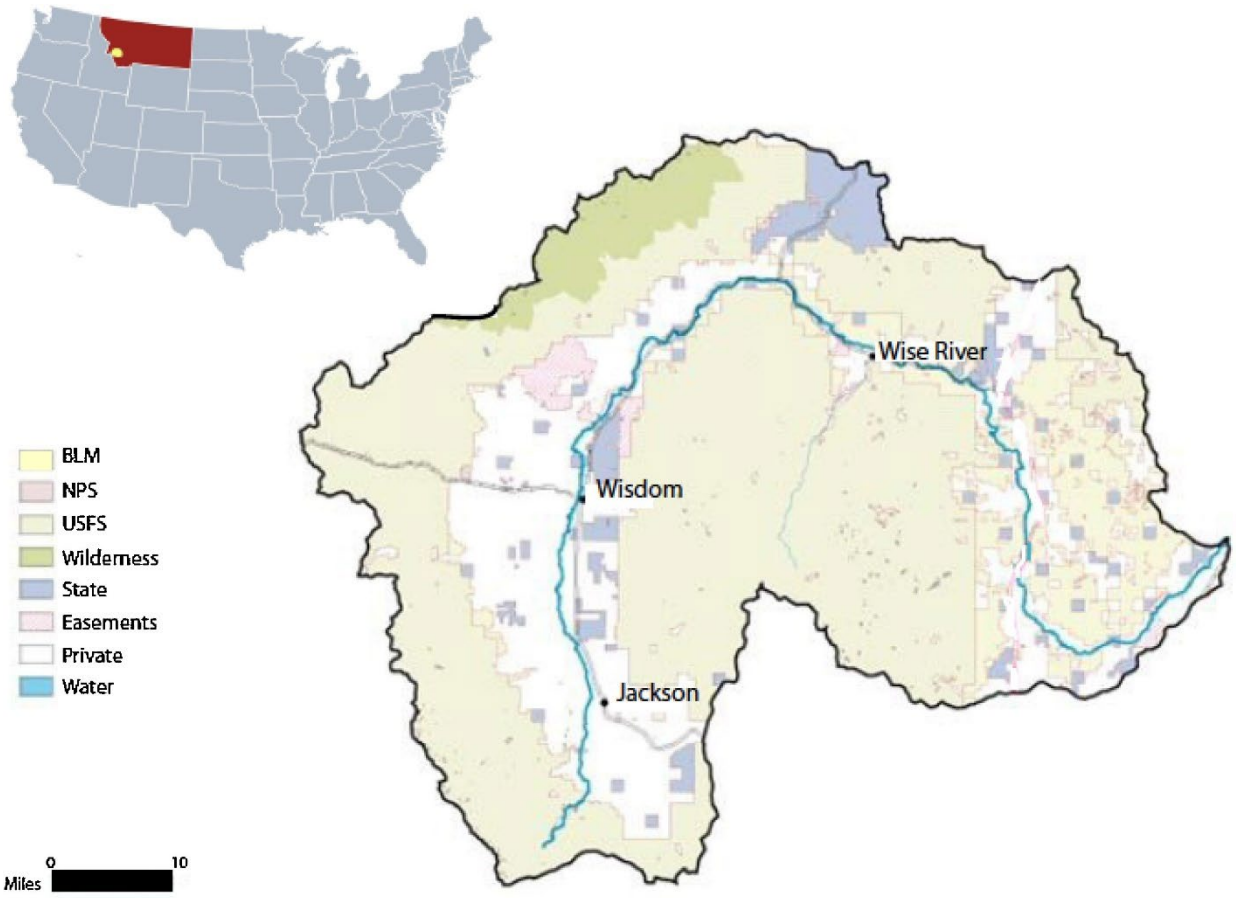

Figure 9. Location of Montana and the Big Hole River Watershed with distribution of land ownership adapted from US Fish and Wildlife (reused with permission from Murphy et al., 2017).

The Big Hole River Watershed, located in Southwestern Montana, is a high-elevation basin at the headwaters of the Upper Missouri River. The watershed is mainly located within Beaverhead County, Montana. Unlike other watersheds in the West, the Big Hole area remains relatively undeveloped (*How We Work*, 2018). Despite being the largest county by area in Montana (5,572 square miles), Beaverhead County has a population of only 9,000 people and an average population density of less than 1.7 people per square mile (Beaverhead County, n.d.). The Big Hole River Watershed is well known for its blue-ribbon fisheries and large amount of

public land. The natural beauty and access to public lands in the Big Hole River Watershed bring in amenity migrants as well as tourists for hunting, skiing, angling, cycling, wilderness trips, and scenic driving (Murphy et al., 2017).

The Big Hole Watershed is home to several native fish species including Westslope cutthroat trout and a rare species of fish, called the fluvial Arctic Grayling (Szabo, 2018). In the 1980's and early 1990's, the Big Hole Watershed experienced severe drought leading to declines in Arctic Grayling populations and rising tensions among stakeholders (*How We Work*, 2016). In addition to tensions around declining Arctic Grayling populations, there have been many cooperative efforts within the Big Hole River Watershed. Some past cooperative conservation initiatives include collaborative drought management through the BHWC and CCAA through the Department of the Interior's US Fish and Wildlife Service to protect habitat for arctic grayling fisheries (Murphy et al., 2017). Despite the well-documented history of water-related issues and cooperation in the area (e.g., Romans, 2013; Davis, 2015; Byington, 2016; *How We Work*, 2016; Murphy et al., 2017; Szabo, 2018; Big Hole Watershed Committee, 2022), there has been a lack of research utilizing water conflict and cooperation methods, specifically the BAR scale, within the Big Hole River Watershed. Therefore, this research utilized the Big Hole River Watershed as an example area for investigating how interview data can contribute to a nuanced understanding of water conflict and cooperation.

Methods

This study used a multimethod and mixed methods research (MMMR) approach to answer the following research questions:

1. What trends in water conflict and cooperation (quantity, intensity, and water issue types) exist in the Big Hole River Watershed, Montana?
2. How can interview data provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone when using the BAR scale?

MMMR is the use of multiple quantitative and/or qualitative techniques for data collection and analysis in a single research project (Knappertsbusch et al., 2021). The methods used in this project included the collection and analysis of event data, primary interview, and survey methodologies to understand how interview data can provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone. Although event data can be a useful tool in data collection, the news events that are published are often influenced by the biases and embellishments of local media sources and political interests (De Stefano et al., 2010), and don't report on all environmental issues (Eidem et al., 2012). To avoid some of these biases, in addition to event data, this study also included primary interviews. Incidents of conflict and cooperation, in addition to the type of water issue, were collected from both sets of data and analyzed via qualitative coding in NVivo coding software (QSR International).

Collection of Event Data

Before the creation of an interview guide for the Big Hole primary interviews, event data from the area was collected and analyzed to provide additional data and context. Articles, newspapers, and other public news sources used in the event data were sourced from Access World News (News Bank). Access World News is an online database that includes a variety of publications from around the world (*Access World News*, n.d.). These publications include

international and national newspapers, blogs, videos, journals, magazines, and more. Search terms were informed by article publication trends from the past 20 years.

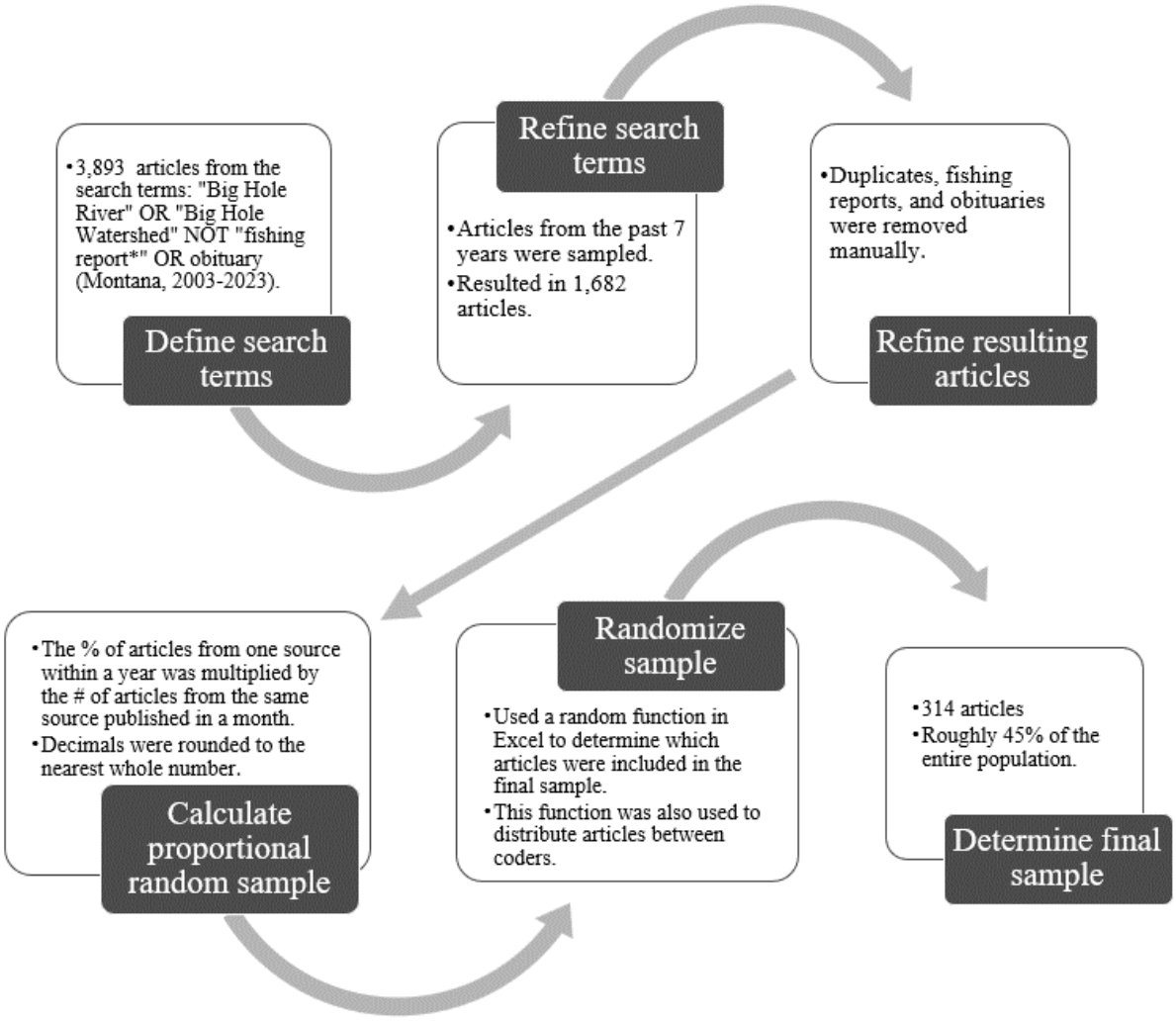

Figure 10. A simplified flow chart depicting the process of defining the Big Hole River Watershed event data search terms and creating the proportional randomized sample.

Initially, event data was found using the following search terms:

"Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2003-2023)

The above search terms produced 3,893 results from Access World News from the past 20 years out of 6 different Montana cities (Billings, Bozeman, Butte, Helena, Missoula, and Sidney). This search focused only on publications from Montana, to narrow the search results and produce articles focused on events that are important to the local community. The articles produced from the above search terms were then categorized by publication year, leading to the following results:

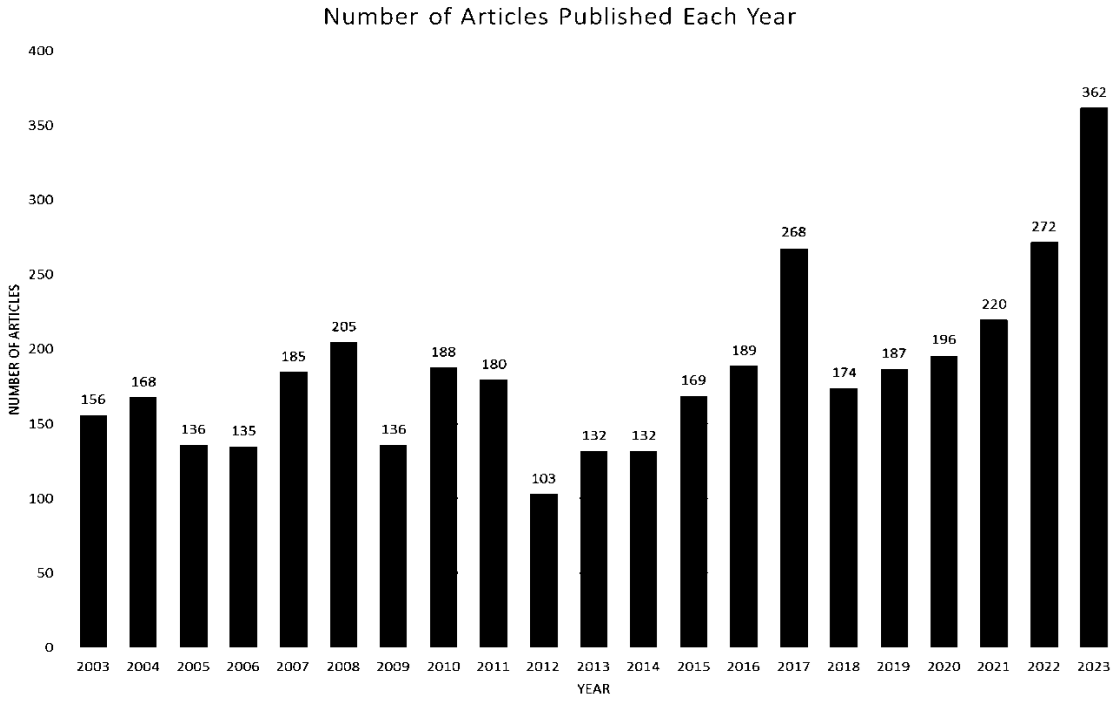

Figure 11. Number of articles published per year following the search terms "Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2003-2023).

Based on these results, only articles from the past 7 years (2017-2023) were coded and analyzed. This timeframe was chosen because it contained the largest spike in articles during the past 20 years. Additionally, this timeframe reflected the short-term memory of the primary

interview participants, which ensured that event data and interview data might reflect similar time scales. This led us to the final search terms:

"Big Hole River" OR "Big Hole Watershed" NOT "fishing report*" OR obituary (Montana, 2017-2023)

The final search terms as written above produced 1,682 results, some of which were duplicate articles (the same article published in multiple newspapers) and irrelevant articles (local event postings, obituaries, etc.). Duplicate articles, along with remaining fishing reports and obituaries were removed manually, leaving a total of 701 articles. When selecting which duplicate article to keep, if the article author was affiliated with a specific paper, the article published by the affiliated paper was kept. However, if the author's affiliation was not listed, the paper that printed the article first was the article that was kept.

To make the number of articles analyzed more manageable, a proportional random sampling strategy was utilized, where we sought to analyze 45% of the total article count. First, articles were sorted in Microsoft Excel by article source (i.e., *Associated Press State Wire, Billings Gazette, Bozeman Daily, Independent Record Helena, Missoulian, Montana Standard,* or *Sidney Herald*), year (i.e., 2017, 2018, 2019, 2020, 2021, 2022, or 2023), and month. Then, the percentage of articles from one source within a year was multiplied by the number of articles from the same source published in one month of that same year. For example, 36% of articles published by the *Bozeman Daily Chronicle* news source were published in 2023. The number of articles published in September 2023 by the *Bozeman Chronicle* was 7. The percentage of 36% (i.e., 0.36) was then multiplied by the number of articles published in that year and month (i.e., 7) to get the proportional sample (0.36 x 7 = 2.52). Since it didn't make sense to code part of an

article, decimals were rounded to the nearest whole number. Therefore, 3 articles published in September 2023 by the *Bozeman Daily Chronicle* were included in the final proportional random sample. To randomize this sample, the Excel function "=RANDBETWEEN( )" was used to determine which 3 articles from September 2023 by the *Bozeman Daily Chronicle* were included in the final sample. This process was repeated for each article source, year, and month. If the proportional sample for a certain source and month was calculated to be less than 1, the value was always rounded up to 1. Therefore, every month had at least one article in the final sample.

Once the proportional random sampling strategy was completed, a final sample of 314 articles remained. This sample of articles (n=314) was roughly 45% of the entire population of articles, which has been accepted as beyond an acceptable proportion in previous studies sampling news articles (e.g., Liu et al., 2008; Hurlimann & Dolnicar, 2012; Church et al., 2020). Articles were randomly distributed between two team members for coding. To randomize the articles, the Microsoft Excel function "=RAND" was used to give each article a random number, and then articles were sorted by their randomly assigned numbers using the "sort Z to A" function in Microsoft Excel. Each coder was then assigned the agreed-upon number of randomized articles (n=100 to one coder, and n=214 to the other coder). During analysis, coders identified articles from this sample that did not discuss water issues in the Big Hole River Watershed (i.e., obituaries, fishing reports, hunting stories, etc.) as not relevant (n=204). This led to a final sample of 110 relevant newspaper articles (16% of the entire population of articles).

Primary Interviews Data Collection

Primary interviews with water stakeholders in the Big Hole River Watershed were developed, conducted, and analyzed to address the research questions. The interview guide was

developed by the research team and informed by results from the case study event data, literature on water in the West, and literature on water conflict and cooperation. All interviews were semi-structured, followed the same interview guide, and included nine questions which were broken into three parts: background information, conflict and cooperation, and reflections. For the full interview guide see Appendix E. Each interview participant was also asked to fill out short demographic surveys (see Appendix E). These data were analyzed using descriptive statistics (Nick, 2007).

Interview participants were part of a purposive and convenience sample, including anglers, a fishing guide, a rancher, BHWC members, former and current FWP employees, a former MT DNRC hydrologist, a Trout Unlimited representative, a Montana State University extension agent, and other water stakeholders. Interviews were conducted by the project's primary investigator either by video call or in person (participants were given a choice) during February, March, and April of 2024. Each interview took between 40 minutes to an hour. Most interviews were one-on-one; however, one interview included multiple interviewees in the same meeting. All interviews were transcribed using Otter AI. This research was reviewed and approved by Montana State University's Institutional Review Board: IRB Protocol #1371.

Data Analysis

Both data collection methods (event data and primary interviews) were analyzed using the same basic codebook, which was developed through collaborative and iterative processes. This codebook (see Appendix B and C) was informed by 1) literature on conflict and cooperation, and 2) the BAR Project methods (Yoffe & Larson, 2001). The reliability of the code names and definitions was assessed through multiple iterations and discussions with colleagues

at Montana State University. The following table is not an extensive list of all the codes that were used during the coding process but includes the names and definitions for some of the parent codes that were used to analyze both data collection methods: event-based and primary interview data (Table 10). For a full list of all the codebook's code names and definitions see Appendix B and C.

Table 10. Simplified list of the codebook names and definitions for all the data collection methods.

Code	Definition
Conflict	Any incident of water conflict that does not fit into the BAR scale can be coded into this parent code.
Cooperation	Any incident of water cooperation that does not fit into the BAR scale can be coded into this parent code.
Alternative	Obvious examples of water conflict and cooperation that don't neatly fit into one category or the other (conflict leading to cooperation, conflict and cooperation occurring simultaneously, etc.).
Other	Anything that stands out as important to conflict and cooperation but doesn't fit another code.
Issue Type	Issue categories to classify events according to different aspects of water resources. Events can only be classified into one issue type.

The codebook was used to capture trends in drought-related water events in the event data and interview data. In event data analysis a water event is defined as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined, recorded, and publicly available (Eidem et al., 2012). For the analysis of the primary interviews, we defined an interview water event as any interaction between stakeholders driven by some dimension of freshwater resources that is action-defined and recorded in the interview.

During the event data analysis, regardless of how an article was written, only the actions of the parties were coded (e.g., what the party actually did, not what the newspaper author thought about that action). This is meant to further avoid biases in the data so that water events can be evaluated fairly. Similarly, while coding the primary interviews regardless of how an interviewee speaks about a water event (positively, negatively, etc.), only their actions, as described in the interview, were coded (e.g., regardless of whether a participant discussed a lawsuit positively or negatively, the lawsuit was coded as a conflictive event per the definition of a -4 event on the BAR intensity scale). Additionally, an interviewee may have discussed multiple events in a single interview; however, the same event was only be counted once even if discussed multiple times.

The definitions (Table 10) for the *conflict* and *cooperation* codes (CCC) were informed by the BAR project methods (Yoffe & Larson, 2001). The *alternative* and *other* codes (AOC) along with their definitions, were informed by previous literature on water conflict and cooperation, specifically literature about alternative conceptualizations of conflict and cooperation. These codes were able to highlight non-binary instances of conflict and cooperation in the data. Unlike the binary CCC, these AOCs allowed for the co-existence of conflict and cooperation to be revealed in the data.

To quantify this range and intensity of water cooperation and conflict, this study used a modified version of the BAR scale revised for intranational conflict and cooperation assessments (Yoffe & Larson, 2001) (see Table 11) in addition to the framework in Table 10. The modified scale ranges from -5 (maximum conflict) to +5 (maximum cooperation) to capture the degree of conflict and cooperation in the study area. The CCCs used the modified BAR scale as sub-codes

within the two larger codes, meaning references coded into the *conflict* and *cooperation* codes were also coded into the modified BAR scale when possible.

Table 11. Modified BAR intensity scale for intranational conflict and cooperation (modified from Eidem et al., 2012).

BAR Scale Value	Event Description
-5	Small-scale acts of violence, protests, vandalism
-4	Legal action, litigations, appeals of administrative actions
-3	Fines, proposal and permit denials, halting negotiations
-2	Petitions, withdrawal of third-party support
-1	Delays, report reviews, voicing opposition, editorials
1	Voicing opinions of approval, court-forced negotiations, editorials
2	Meetings, third-party support, negotiation requests
3	Permit approvals, fixing violations, negotiations begin
4	Lawsuit settlements, regulation approval, management transfers
5	State bill passage, compacts, or official agreements

Coding events of conflict or cooperation onto the BAR scale proved to be more difficult than anticipated when analyzing the event data and interviews. Many articles and participants would mention cooperative or conflictive water events; however, they would not go in-depth on *how* these events played out. These types of events were still coded into the *conflict* and *cooperation* codes; however, the coding team was unable to place them along the modified BAR scale and they were coded into the sub-code *other*.

Each time an event was coded into the *alternative* code or a CCC, it was also coded into one of the *Issue Type* sub-codes. The *Issue Type* sub-codes were informed by and adapted from the study by Eidem et al. (2012) to fit the study location, Montana. These issue types included

recreation, instream, intergovernmental, conservation, water rights, fish passage, infrastructure, invasive species, and others. For a full list of the issue types and definitions see Appendix B or C.

The Big Hole Watershed primary interviews (n=11) were coded solely by the project's Primary Investigator. Event data (n=314) coding was randomly distributed between two team members, who found a final sample of relevant newspaper articles of 110. Once coding by both project members was complete, the NVivo projects were then merged to analyze results and draw conclusions.

To answer the research questions several themes were analyzed. First, the proportion and number of conflictive, cooperative, and alternative events for each of the data sets (i.e., event data and primary interview data) were determined to reveal the quantity of conflictive, cooperative, and alternative water events in the Big Hole River Watershed. Next, the number of water events coded onto the BAR intensity scale was reviewed and compared to determine the intensity of cooperative and conflictive water-related events. Similarly, then the number and type (i.e., conflictive, cooperative, and alternative) of events coded into the sub-codes of *Issue Type* were compared and reviewed to understand the water issue types that result in more conflictive and more cooperative outcomes. Lastly, results from the Big Hole River Watershed event data and primary interview data were compared to reveal any similarities and differences to understand how interview data can provide additional value and a more nuanced understanding of water conflict and cooperation than event data alone.

Results and Discussion

In the following pages, I present results that examine how, if at all, interview data in addition to event data can contribute to nuanced understandings of water conflict and cooperation using the BAR scale. I begin by examining trends in water event quantity, intensity, and issue types for both data sets (i.e., event data and primary interview data). Next, I present a comparison of the results found in the two data collection methods (i.e., event data and primary interview data) to highlight any differences in the results. Analysis of the event data revealed that cooperative water events outweigh conflictive events, which is consistent with previous literature on water conflict and cooperation utilizing the BAR scale. However, the primary interview data analysis presented a different perspective, indicating a similar proportion of cooperative and conflictive events. Therefore, the results of this study suggest that the addition of interview data provides a differing and more holistic picture of water conflict and cooperation trends in the Big Hole River Watershed than event data alone.

Results from the Big Hole Event Data

Quantity of Conflictive and Cooperative Water Events. Within the 110 relevant newspaper articles from the proportional random sample, we identified 193 water events. Of the 193 events coded in the event data, more water events coded in the Big Hole River Watershed were *cooperative* (n=103, 53%) than *conflictive* (n=83, 43%). Events coded as *alternative* (n=7, 4%) were the least common (Figure 12).

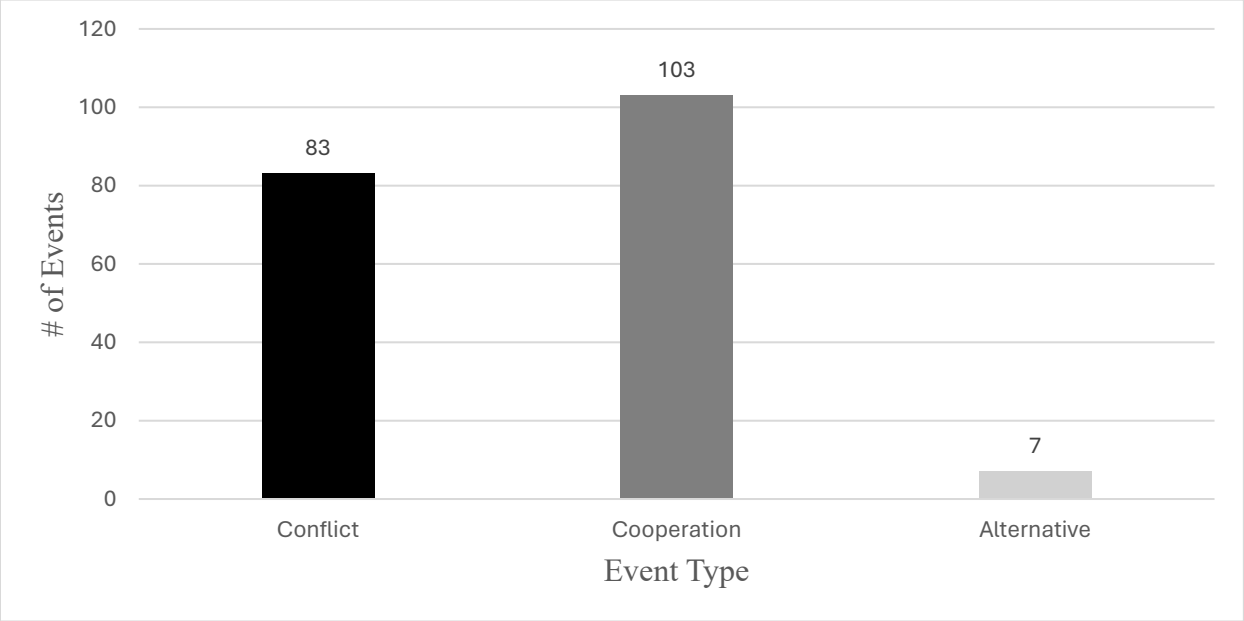

Figure 12. The number of conflictive, cooperative, and alternative events in the event data.

An example of a *cooperative* event is the quote, "*A meeting was held at the Wisdom town hall. Landowners in attendance unanimously agreed, Payne said, that the non-enrollee had rights to that water and was therefore entitled to it — and that there should be no payment*" (Cast, 2022). Whereas this quote, "*Upper Missouri Waterkeeper and Guy Alsentzer, its founder and executive director, have sued the EPA for failing to either approve or reject revisions to the state's water quality standards*" (Adams, 2022) is an example of a *conflictive* event. These results are consistent with previous literature on water conflict and cooperation utilizing the BAR scale, which found that cooperation is more common than conflict over water issues at both the inter- and intranational scales (Eidem et al., 2012).

Intensity of Conflictive and Cooperative Water Events. As mentioned in the *Data Analysis* section of the methods, not all water events were able to be placed onto the BAR intensity scale. Consequently, the BAR intensity value results shown in Figure 8 differ from the

overall number of conflictive and cooperative events shown in Figure 7. Figure 7 shows more cooperative than conflictive events and Figure 8 shows slightly more conflictive events than cooperative events. Figure 8 does not include all the water events coded in the event data due to a lack of context or information to properly place the events on the scale, while Figure 7 includes all event data. The BAR intensity values illustrated in Figure 8 reveal general trends in event intensity as described in the Big Hole River Watershed newspaper event data sample.

For events that were placed onto the BAR scale, mildly conflictive (intensity -1) events (n=60) outnumbered mildly cooperative (intensity 1) events (n=11). However, for events more intense than -1 and 1 (intensity -2 to -5 or intensity 2 to 5) there were more cooperative events (n=62, 73%) than conflictive (n=23, 27%). The extremely cooperative events (intensity +5) (n=5) also outnumber the most intense conflictive events (intensity -5) (n=0).

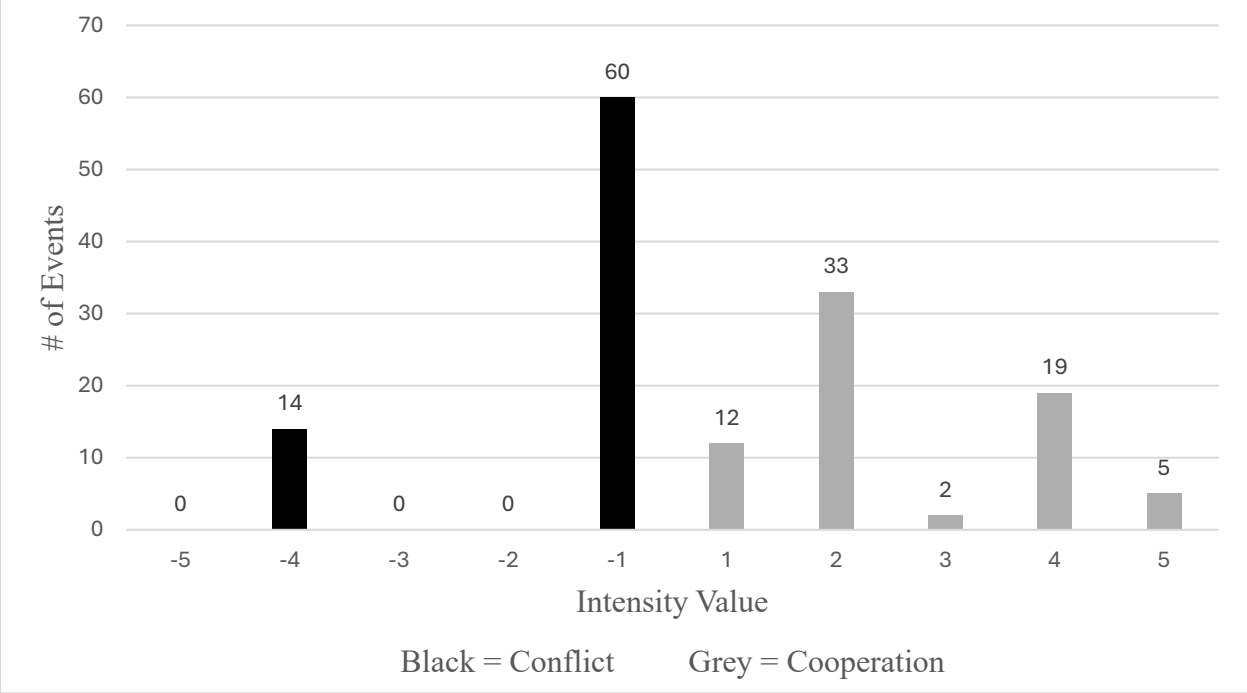

Figure 13. Distribution of events described in the event data placed along the BAR intensity scale.

Cooperative events with an intensity of 2 were the most common cooperative events in the interviews (n=33, 32%), which included meetings, third-party support, or negotiation requests. The second most common was the sub-code *other* (n=32, 31%), defined as "any water event that is determined cooperative but does not fit into any of the Cooperation sub-codes can be placed into this Other code." References coded into this sub-code were typically cooperative water events without enough context to be assigned one of the BAR scale values. For example, one reference from the sub-code *other* read:

> *"Researchers and scientists at the University of Montana; Montana Fish, Wildlife and Parks; and the U.S. Geological Survey have been working together for the past two years to identify genetically pure cutthroats in three pairs of streams. Once that was confirmed, they took three males and three females from each stream and moved them among the streams where genetically pure cutthroats also were documented,"* (Byron, 2019).

This quote clearly depicts a cooperative water event between members of the University of Montana, Montana FWP, and the USGS. However, the action of "*working together… to identify genetically pure cutthroats*" (Byron, 2019) does not easily fit into one of the BAR scale categories for intensity values. Therefore, it was placed in the sub-code *other*.

Cooperative events with an intensity value of 4 were the third most common cooperative events (n=19, 18%); an intensity value of 4 includes lawsuit settlements, regulation(s) approval, or management transfers. An example of an event coded with an intensity value of 4 in the event data is:

> *"In July 2020, the Fish and Wildlife Service announced that Endangered Species Act protections for the Upper Missouri River distinct population segment of the Arctic grayling were not warranted, 'based on a review of the best available science.'*
>
> *The agency said then that critical conservation work completed by partners who included private landowners 'helped address threats to the species, including reduced river flows, degraded riparian areas, fish barriers and entrainment,'"* (Adams, 2023).

Mildly conflictive (intensity -1) events were the most common conflictive events to be recorded in the event data (n=60, 72%). These results support the results of previous research using the BAR scale, which found that mildly conflictive events (intensity -1) are more common than extremely conflictive (intensity -5) events (e.g., Wolf, 2007; Eidem et al., 2012). An example of a mildly conflictive event in the event data is:

> *"For the second time in the past year, there was heated opposition at a public meeting to a Montana Fish, Wildlife & Parks plan to build a fish barrier on French Creek, near Wise River, to clear 40 miles of streams with poison and to reintroduce native species to the drainage,"* (McDermott, 2018).

Following mildly conflictive events (intensity -1), the second most common conflictive events were conflictive events with an intensity value of -4 (n=14, 17%). All the remaining conflictive events were coded into the conflict sub-code *other* (n=9, 11%).

Issue Types of Conflictive and Cooperative Water Events. In the Big Hole event data, most water events revolved around the issue type *conservation* (n=113, 33%). This was followed by the issue types *instream* (n=35, 18%) and *recreation* (n=9, 5%) (Table 12). *Conservation* was the most common water issue discussed in the event data sample and was often focused on the

conservation of trout populations in the Big Hole River Watershed, with specific attention to Artic Grayling conservation efforts (see example text in Table 12).

Table 12. The three most common water issue types in the event data.

Issue Type	# of Events	% of Total Events (n=193)	Example Text
Conservation	64	33	"The success of CCAA collaboration reaches beyond grayling. "They're an indicator of the health of the stream and the riparian areas … if we take care of grayling we're going to be taking care a lot of species, and not only fish," Magee said," (Cast, 2022).
Instream	35	18	"But in the event of a hot, dry summer, the committee's drought management plan coordinates voluntary action for irrigators and water users to reduce water use, maintain minimum river flows and, for the fishing community, to reduce fishing to protect the river," (Staff Writer, 2017).
Recreation	9	5	"But apparently not in the Big Hole, where the ranchers and outfitters seemed to have forged a culture of cooperation. There was even an agreement, he told me, that on one day every weekend the outfitters would limit use of the river so that people from nearby Butte could fish unmolested," (Elliott, 2019).

Overall, the results found that cooperative water events outnumbered conflictive events in the Big Hole, and a low proportion of the events were of extreme intensity (-5 and +5). Events coded *alternative* made up only 4% of the water events revealed in the event data. These results are unsurprising, as they support the results of previous research on water cooperation and conflict. Previous research has found that at both the inter- and intranational scale, cooperation over shared water resources outweighs conflict (Eidem et al., 2012).

The following table (Table 13) provides the number of events, the percentage of the total number of events, and an example text for each of the five most frequent sub-codes in the *issue type*, *conflict*, and *cooperation* parent codes used in the Big Hole event data sample.

Table 13. The five most frequent sub-codes in the event data sample. The top five sub-codes come from parent codes *issue type*, *conflict*, and *cooperation*.

Coding Category	Sub-Code	# of Events	% of Total Events (n=193)	Example Text
Issue Type	Conservation	113	58	"Government oversight isn't prized by the Big Hole ranching community, and the possibility of grayling being listed as a federally threatened or endangered species was catalyst enough to form the agreement in 2006. Participating landowners give up water, but also take advantage of a wide variety of projects designed to create water-use efficiency on their ranches. By protecting grayling they also protect themselves from federal interference in their operations, and liability," (Cast, 2022).
Conflict	Voicing Opposition	60	31	"Over the next couple of hours, the meeting proceeded along similar lines, with people opposed to the project questioning its safety, the agency's motivations, and the fairness of the public process while various agency specialists defended the science and engineering behind the process and explained the benefits of completing the project," (McDermott, 2018).
Issue Type	Instream	35	18	"Water rights holders on the Big Hole River have collaborated to keep minimum instream flows providing a "demonstration strategy for addressing the need for greater drought resilience," the study noted. This type of water conservation is key to the survival of species such as arctic grayling in the Big Hole and could also be important to the survival of downstream pallid sturgeon, an endangered species," (French, 2021).
Cooperation	Meetings	33	17	"A meeting was held at the Wisdom town hall. Landowners in attendance unanimously agreed, Payne said, that the non-enrollee had rights to that water and was therefore entitled to it — and that there should be no payment," (Cast, 2022).

Table 13 Continued.

Coding Category	Sub-Code	# of Events	% of Total Events	Example Text
Cooperation	Other	32	17	"Researchers and scientists at the University of Montana; Montana Fish, Wildlife and Parks; and the U.S. Geological Survey have been working together for the past two years to identify genetically pure cutthroats in three pairs of streams. Once that was confirmed, they took three males and three females from each stream and moved them among the streams where genetically pure cutthroats also were documented," (Byron, 2019).

Results from the Big Hole Primary Interview Data

Interviewee Demographics. The Big Hole primary interviews included 11 participants. Ten of the eleven participants voluntarily shared their demographic information through a survey following their interview. Interviewees who filled out our short demographic survey ranged in age from 38 to 76 with an average age of 49 years. Most respondents identified as male (9, 90%), with only one female survey respondent (1, 10%). All respondents identified their race as White. All respondents held at least a bachelor's degree, while some also held a graduate or professional degree (6, 60%). Respondents included anglers, a fishing guide, a rancher, BHWC members, former and current FWP employees, a former MT DNRC hydrologist, a Trout Unlimited representative, a Montana State University extension agent and other water stakeholders. Most respondents currently or previously worked in the conservation and land management sector (5, 50%) (Table 14).

Table 14. The number of respondents in different work sectors.

Sector	# of Respondents
Agriculture	1
Conservation and Land Management	5
Recreation and Tourism	2
Other	2

Although the interviewees varied in work sector, age, education, and gender, as shown in the survey demographics, the results presented in this paper are discussed as a whole and are not distinguished between interviewee types.

Quantity of Conflictive and Cooperative Interview Water Events. We coded 69 water events in the primary interview data on the Big Hole River Watershed. Of these 69 interview

water events, there are a similar number of events coded as conflictive (n=31, 45%) and cooperative (n=31, 45%). Interview events coded as alternative (n=7, 10%) were the least common (Figure 14).

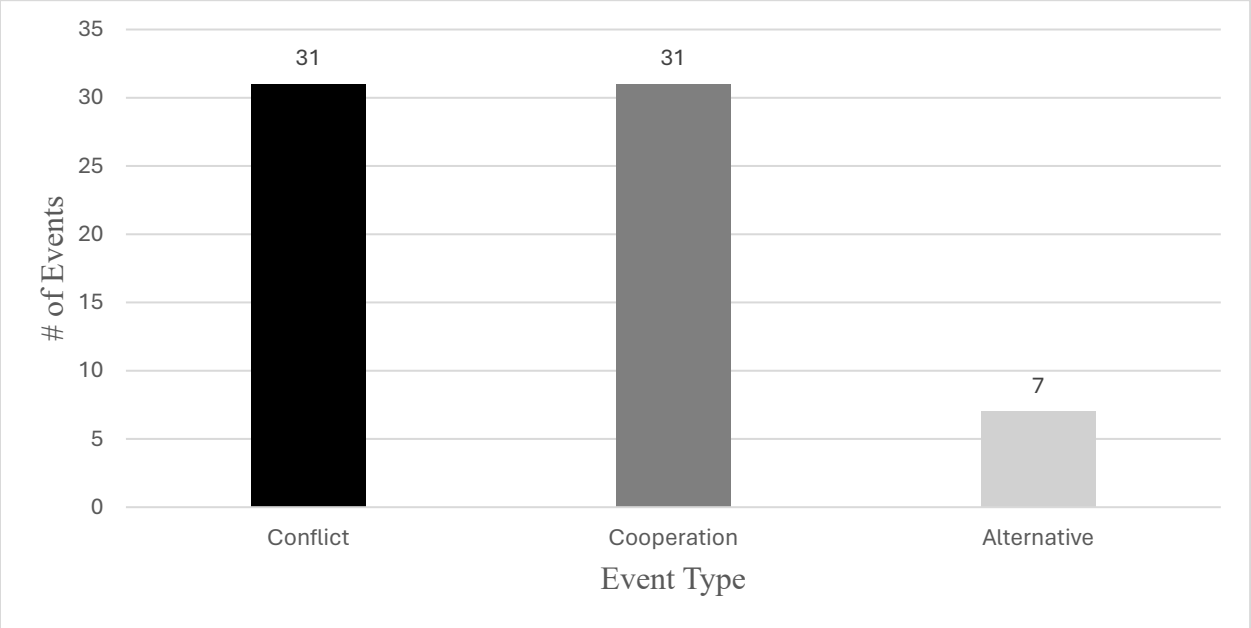

Figure 14. The number of overall conflictive, cooperative, and alternative events coded in the primary interview data.

An example of a cooperative event in the Big Hole River Watershed example is the interview quote:

> *"So, it really came down to sitting down at kitchen tables [different families] … Now, the thing is CCAA is still going. But we initially had, I think, 32 families involved in this plan, which constituted about 70 or 80% of the grayling habitat*."

This quote is an example of a conflictive event:

"After, whatever it was, '90 or 2001 or 2002, I'm like, let's go to court. And which case I threw in with people I had already met, now respected but didn't want to work with at that time, at the Center for Biological Diversity."

These results differ from previous literature on water conflict and cooperation utilizing the BAR scale which found that cooperative water events far outweigh conflictive water events (e.g., De Stefano et al., 2010; Eidem et al., 2012; Bernauer & Böhmelt, 2020).

Intensity of Conflictive and Cooperative Interview Water Events. Not all water events in the interview data were able to be placed onto the BAR intensity scale due to lack of context or information. Nevertheless, for events that were placed on the BAR scale, mildly conflictive (intensity -1) events (n=17) outnumbered mildly cooperative (intensity 1) events (n=2). However, for events more intense than -1 and 1 (intensity -2 to -5 or intensity 2 to 5) there were more cooperative events (n=14, 58%) than conflictive (n=10, 42%). The extremely cooperative events (intensity +5) (n=5) also outnumbered the most intense conflictive events (intensity -5) (n=3).

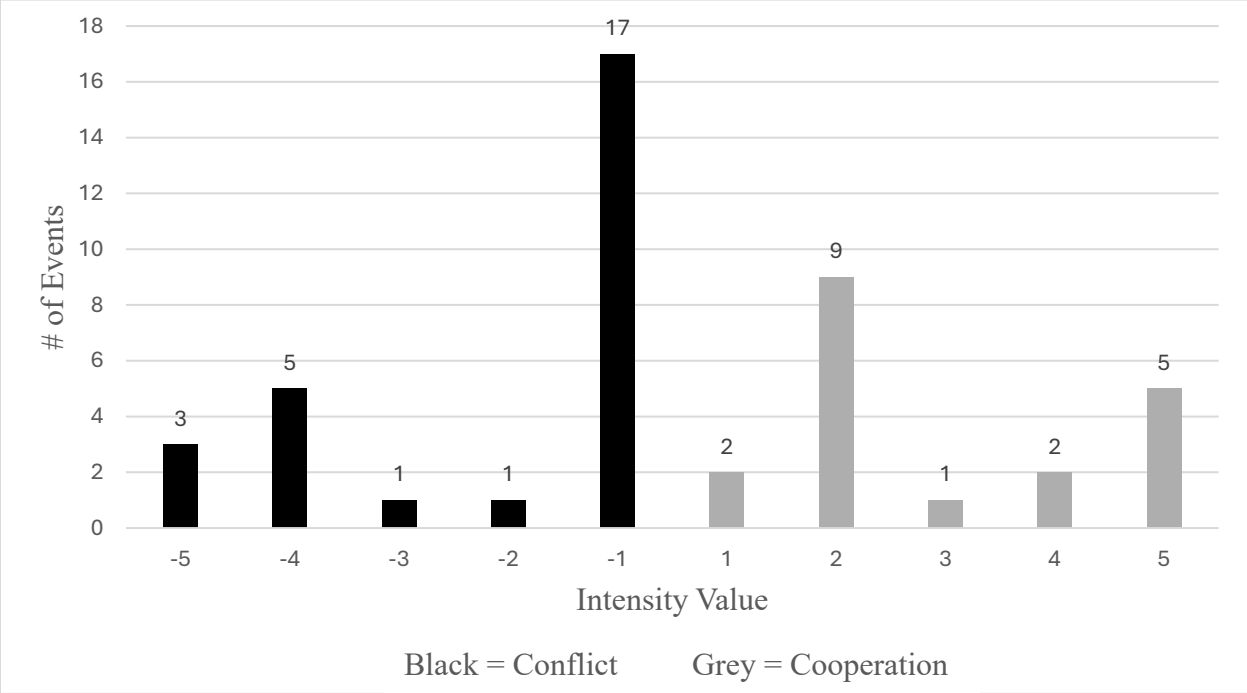

Figure 15. Distribution of events described in the primary interview data placed along the BAR intensity scale.

Cooperative Events. Cooperative events in the sub-code *other* overall were the most common cooperative events in the interviews (12, 39%). References coded into this sub-code were typically cooperative water events without enough context to be assigned one of the BAR scale values. For example, one event from the sub-code *other* read:

> *"We're also working with the US Forest Service and trying to understand and develop the toxicity of the water coming in and out of… the Elkhorn mine, in working with this group that uses mushrooms…[to] run that toxic waste through the tube… and the mushrooms, pull the metal out of it."*

This quote depicts a cooperative water event between members of the U.S. Forest Service, the BHWC, and a "*group that uses mushrooms*." However, the action of "*trying to understand and*

develop the toxicity of the water" does not easily fit into one of the BAR scale categories. Therefore, it was placed in the sub-code *other*.

The second most common cooperative events were those with an intensity of 2 (n=9, 29%), which included meetings, third-party support, or negotiation requests. An example of an event coded as an intensity level of 2 includes the quote: "…*we recruited a couple landowners to go down into Denver, and talk with the Fish and Wildlife Service, reasonable folks down there, to make a case for why [the Arctic Grayling] shouldn't be listed because of all this cooperation*." Cooperative events with an intensity value of 5 were the third most common cooperative events (n=5, 16%); an intensity value of 5 includes state bill passage, compacts, or official agreements.

Conflictive Events. Mildly conflictive (intensity -1) events were the most common conflictive events to be recorded in the interview data (n=17, 55%). Previous research has produced similar results, finding that mildly conflictive events (intensity -1) greatly outweigh extremely conflictive (intensity -5) events such as violence, vandalism, or protests (e.g., Wolf, 2007; Eidem et al., 2012). An example of a mildly conflictive event in the event data is:

> *"You know, I've had people float by me while I'm out collecting bottle samples for nutrients and be like, why are you wasting your time? That's not the problem. It's flow. We need more water in the river and it's like, are both things useful? You know, to understand health of the resource."*

Following mildly conflictive events (intensity -1), the second most common conflictive events in the primary interview data were conflictive events with an intensity value of -4 (n=5, 16%). Water events with an intensity value of -4 include litigations/legal action and appeals of administrative actions.

Issue Types of Conflictive and Cooperative Interview Water Events. In the Big Hole primary interviews, most water events revolved around the issue type *instream flows* (n=24, 35%). This was followed by the issue types *conservation* (n=16, 23%) and *other* (n=12, 17%) (Table 15). Multiple interview participants specifically emphasized the significance of instream flow challenges (e.g., water quantity; drought issues; etc.) in the Big Hole River Watershed. For example, one interview participant emphasized the following, "*the water quantity issues are the are the hardest and are probably the most pointed.*" Another interviewee shared, "*conflicts always seem to arise in the midst of the drought.*" Even a third interview participant stated, "*…when the drought got its grip on the Big Hole in July, August and September, that's where you see these type of conflicts play out.*"

Table 15. The three most common water issues coded in the Big Hole River Watershed primary interview data with definitions and example text.

Issue Type	# of Events	% of Total Events (n=69)	Example Text
Instream	24	35	"But I will say this during low water years, when the water stream flows were low in say, June, or in the season, when they're really irrigating hard. Yeah. That, and then you're coming to them and asking them to cut back because we need some more water in the river. That would lead to some very tense discussions. You know, it's like, look, you signed your plan. You agreed to do this? Yeah, but my neighbor's not, you know, they're not doing it. So, I'm not gonna do it."
Conservation	16	23	"So, it really came down to sitting down at kitchen tables with and we had, I don't know how many they have. Now, the thing is CCAA is still going. But we initially had, I think, 32 families involved in this plan, which constituted about 70 or 80% of the grayling habitat because it's, you know, a little bit up to the upper big hole."
Other	12	17	"In other cases, it's just been ugly social media, BS that makes people look bad, and doesn't help. It makes people dig their trenches deeper and put-up walls. And it's just not effective. I get it, I get that that's an outlet. But it's just not helpful."

In summary, there were the same number of cooperative events and conflictive events in the Big Hole primary interview data. This is inconsistent with previous trends in water conflict and cooperation research utilizing the BAR scale, which found that at both the inter- and intranational scale, cooperation over shared water resources outweighs conflict (e.g., Eidem et al., 2012). Events coded *alternative* made up only 10% of the water events revealed in the event data. Finally, only a small proportion of the water events in the interview data were of extreme intensity (-5 and +5). These results are unsurprising, as they support the results of previous

research which found that mildly conflictive events (intensity -1) are more common than extremely conflictive (intensity -5) events (e.g., Wolf, 2007; Eidem et al., 2012).

The following table (Table 16) provides the number of events, the percentage of the total number of events, and an example text for each of the five most frequent sub-codes in the *issue type*, *conflict*, and *cooperation* parent codes used in the Big Hole event data sample.

Table 16. The five most frequent sub-codes in the primary interview data. The top five sub-codes come from parent codes *issue type*, *conflict*, and *cooperation*.

Coding Category	Sub-Code	# of Events	% of Total Events (n=69)	Example Text
Issue Type	Instream	24	35	"So, a drought management plan was first published in 1997. And it was the first of its kind in the state to use voluntary targets for triggers for irrigators."
Conflict	Voicing Opposition	17	25	"Certainly, from the other side of things, from the angling perspective, and like I say, particularly commercial angling, get a lot of lot of feedback from them as to, you know, when we're when we close the river relay into flow, reopen the river related to flow."
Issue Type	Conservation	16	23	"There's conflicts about who joins the CCA. So if you're irrigator, that agrees to turn down or turn off your diversion. When you're asked to, well, what if the next person downstream isn't part of the agreement? And they just take that, yeah, how you're giving up a lot of money, crops you could have raised and it's not doing anything to the street flow."
Issue Type	Other	12	17	"Oh, another one is we support cloud seeding to help it's not being done in Montana right now it's being looked at the DNRC."
Cooperation	Other	12	17	"We've had some really progressive and great landowners that are that, in some ways, have been leaders of the effort, and then all the state and federal agencies and nonprofits coming together around it again. I think, you know, you have an iconic species like grayling, you know, the last, you know, so last place in the lower 48 states."

Comparison Between Event Data and Interview Data
Results

Generally, there are several similarities between the Big Hole River Watershed event data and the Big Hole primary interview data regarding their event distribution along the BAR scale. For both the event data and the primary interview data, a large proportion of events were low intensity (+2, +1, and -1) and a high proportion of verbal actions (intensity of -1 or +1) were conflictive (-1) in both data sets. For both data sets, the extreme ends of the intensity scale (+5 and -5) were not common (Figure 16). The frequent occurrence of mild events (+1 and -1) highlights that it is a common practice among stakeholders to voice their opposition to certain issues and advocate for those they endorse. These findings suggest that within the Big Hole River Watershed, disputes concerning water resources tend to manifest as mild and verbal rather than extreme.

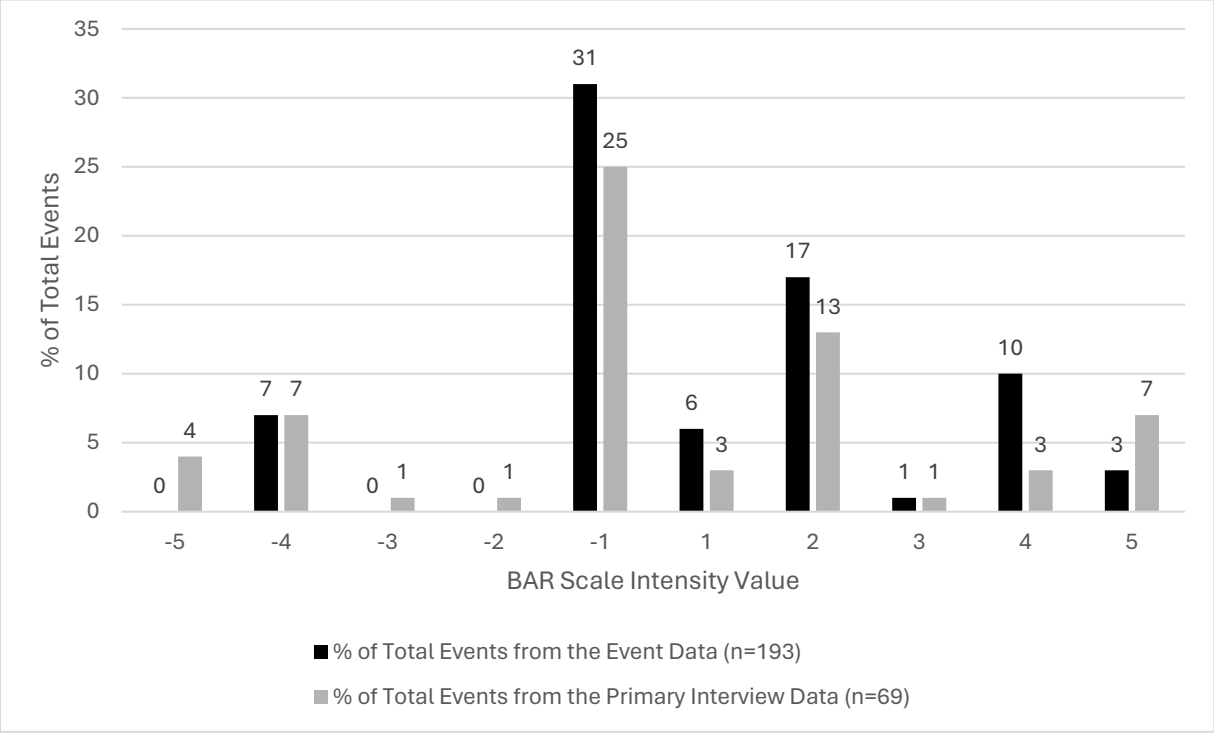

Figure 16. A comparison of events' intensity for both data sets (i.e., Big Hole River Watershed event data and primary interview data). Values are percentages of total events per data set.

Conflictive and cooperative water events driven by the issue type *intergovernmental* were more frequent in the primary interview data than in the event data. Events driven by *intergovernmental* issues are defined in the codebook as "actions concerning who has control over the rules, standards, and allocation of water resources and other related procedural events including formation of municipal water user associations." The opposite pattern occurred for issues of *invasive species* and *recreation*, as these events occurred more frequently in the event data than in the primary interview data. However, for both data sets, actions concerning *conservation* and *instream flows* were the most common (Figure 17).

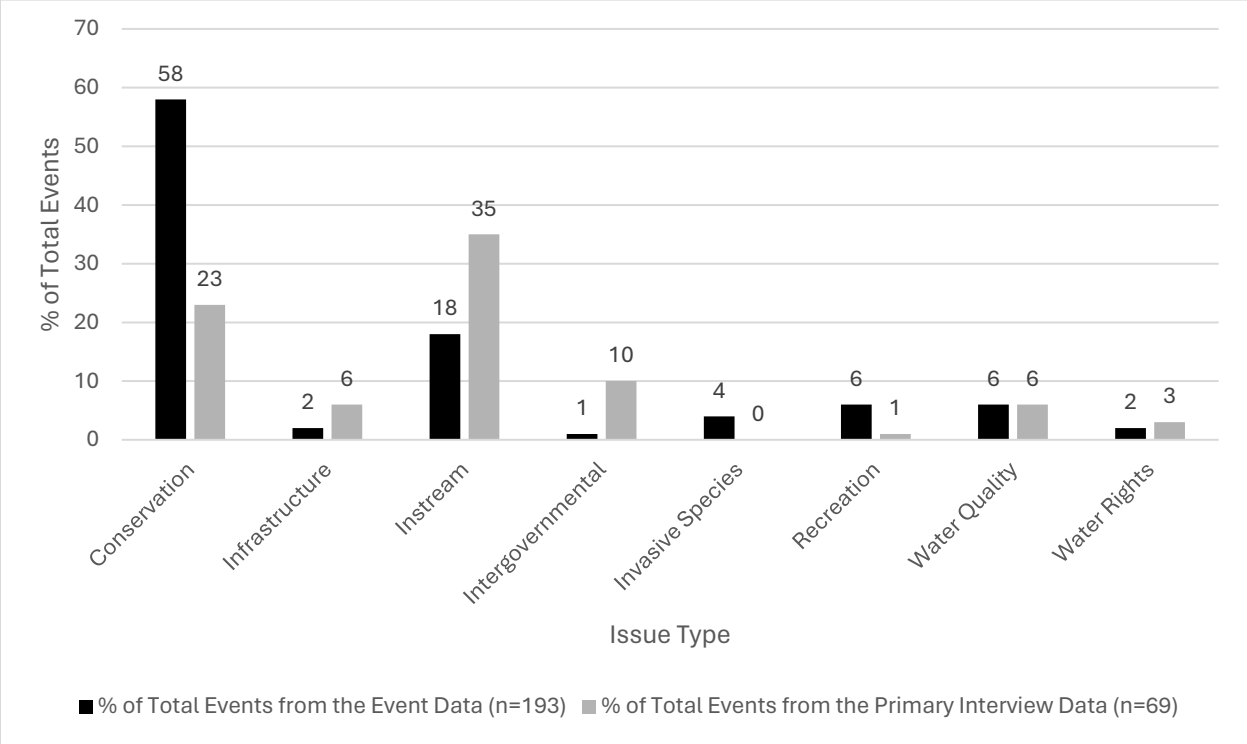

Figure 17. A comparison of events' issue type for both data sets where values are percentages of the total events per data set.

The primary water issue types found in the Big Hole River Watershed for both the event data and primary interview data were *conservation* and *instream* (see Figure 17). These results vary from previous research which found that the primary issue types in other regions of the western U.S. (i.e., Oregon and the Upper Colorado River Basin) were *water quality, intergovernmental relations, infrastructure, water rights,* and *water quantity*. *Conservation* and *instream* were not significant water issue types in these regions. However, *conservation* and *instream* were by far the most prevalent water issues found in the Big Hole event data and interview data. Although Montana shares many of the same water concerns as the rest of the western U.S. (e.g., Cook et al., 2004; USGCRP, 2017; Siirila-Woodburn et al., 2021; Iglesias et

al., 2022), these results suggest that water issues resulting in conflict and/or cooperation are often state or region-specific.

The Big Hole River Watershed is an important upper headwater for the Missouri River Basin. Changes to the ecological makeup of the Big Hole River Watershed's water resources can have direct ecological impacts on many other water systems in Montana and the U.S., including the Missouri River Basin. Our data points to instream flows as a major concern and major water issue in the Big Hole, which could have downstream consequences.

The most surprising difference between the sets of data is that cooperative events did not outweigh conflictive events in the Big Hole primary interviews. Cooperative events were more common than conflictive events in the event data, which is consistent with the results found in previous studies that researched water conflict and cooperation event data utilizing the BAR scale. Previous research concluded that cooperation is more common than conflict over water issues at both the inter- and intranational scales (e.g., Eidem et al., 2012). However, the Big Hole primary interview data did not support those conclusions, as we found an equal number of cooperative and conflictive water events. This may indicate a difference in perspective between the local interviewees and the Montana media sources. Event data is heavily constrained by the biases and hyperbole of local media sources and political interests (De Stefano et al., 2010). To manage a large set of world events, news entities must filter and select the coverage they broadcast, which inherently produces biases (Bourgeois et al., 2018). In fact, many media sources fail to report on a significant amount of water-related interactions (De Stefano et al., 2010). Therefore, primary interviews may be able to capture water events that are not reported by media sources. Previous research and many publicly available sources have documented the

history of water-related issues and praised the cooperative efforts in the Big Hole River Watershed (e.g., Romans, 2013; Davis, 2015; Byington, 2016; *How We Work*, 2016; Murphy et al., 2017; Szabo, 2018; Big Hole Watershed Committee, 2022); less information is available on the water conflicts in the area. These media biases may account for why we found a higher percentage of conflictive water events in the primary interview data than in the publicly available event data. We, therefore, contend that for a more holistic picture of water conflict and cooperation trends in the Big Hole River Watershed, it was important we included both research methods (i.e., event data and primary interviews). From these results we recommend that future researchers continue to explore alternative applications of the BAR scale, to work towards presenting a more holistic and non-linear view of water conflict and cooperation.

Conclusion

The analysis of water events in the Big Hole River Watershed, derived from both event data and primary interviews, offers valuable insights into the dynamics of conflict and cooperation over water resources. The two most common water issue types that led to conflictive and cooperative events in the Big Hole River Watershed were *conservation* and *instream* for both the event data and primary interview data. These results differ from previous research which found that other regions of the western U.S. (i.e., Oregon and the Upper Colorado Basin) had different water issues leading to conflict and cooperation (Eidem et al., 2012). These results suggest water issues resulting in conflict and/or cooperation are often state or region-specific and water resource managers and decision-makers should take a localized approach to solving and proactively preparing for water disputes.

The event data revealed a predominance of cooperative water events, consistent with previous literature on water conflict and cooperation. However, the primary interview data presents a different perspective, showing a similar proportion of cooperative and conflictive events, which differs from established trends that look solely at the content analysis of event data. This suggests a discrepancy between local perspectives captured in the primary interviews and media portrayals reflected in the event data. While cooperative efforts remain prevalent, the equal representation of conflictive events underscores the complexities and divergent viewpoints within the watershed community. The differences between event data and interview data highlight the value of incorporating multiple research methods to capture the multifaceted nature of water conflict and cooperation. The discrepancy in perspectives suggests the influence of biases and interests inherent in different data sources, necessitating a holistic approach to understanding water-related interactions.

MMMR offers researchers the opportunity to use multiple quantitative and/or qualitative techniques in a single research project (Knappertsbusch et al., 2021). MMMR has been praised as important for several reasons including its ability to expand the breadth and depth of a research project, use findings from one method to clarify results from another, and use different methods to identify diverging views (Ågerfalk, 2013). MMMR is not only a promising methodology for future water conflict and cooperation projects but also holds promise in many scientific fields because of the advantages listed above. We suggest that future researchers in academia, public service, industry, and elsewhere continue to experiment in MMMR to find the best ways to present a holistic and non-linear view of water conflict and cooperation in their study area(s).

In conclusion, this study contributes to a deeper understanding of water conflict and cooperation in the Big Hole River Watershed, emphasizing the value of integrating multiple research methods (e.g., primary interviews and event data) to capture a more holistic view of water conflict and cooperation. By acknowledging and investigating multiple viewpoints, researchers can work towards presenting a more holistic and accurate depiction of water conflict anc cooperation in their study area(s). Understanding water conflict and cooperation will become increasingly important as climate change alters water resources and the potential for water conflicts to rise.

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CHAPTER FIVE

CONCLUSION

Summary

Managing water resources will become increasingly complex as anthropogenic climate change alters normal conditions across the globe. Understanding trends in cooperative and conflictive events related to freshwater resources is one way to help prepare water managers. Freshwater conflict and cooperation literature has mainly focused on international water resource challenges, even as climate change and variability in water resources are more likely to lead to subnational conflicts (Bernauer & Böhmelt, 2020). Little research on water conflict and cooperation has been conducted at a local scale. Moreover, there are very few studies on water cooperation and conflict within the West. This project addressed the lack of research on local water resource conflict and cooperation events in Montana.

Results from the first manuscript in this thesis, *Drought Conflict and Cooperation in Montana: Identifying Trends Through Interview Re-Analysis*, reveal that drought-related water cooperation was more frequent in these Montana water stakeholder interviews. However, conflict is still present and must be managed within the state. Indeed, water stakeholders are eager to see more cooperation between state agencies and stakeholders around drought issues. The first manuscript also found that analyses using only traditional conflict and cooperation continuums fail to capture the more complex and nuanced instances of conflict and cooperation. The inclusion of the codes *alternative* and *other* allows the researchers to highlight complexities of drought-related conflict and cooperation typically not captured through traditional conflict and

cooperation continuums. These complexities highlight how important it is to approach water conflict and cooperation research with methods beyond continuum variations and linear analyses of stakeholder interactions to portray a more accurate depiction of reality.

This project also investigated how interview data in combination with event data can contribute to nuanced understandings of water conflict and cooperation using the BAR scale. Results from the second manuscript in this thesis, *Rethinking Water Conflict and Cooperation: An Example from the Big Hole River Watershed, Montana*, reveal several aspects of similarity between the Big Hole River Watershed event data and the Big Hole primary interview data regarding their event distribution along the BAR scale. For both the event data and the primary interview data, a large proportion of water events were of a low intensity. Additionally, the extreme ends of the intensity scale (+5 and -5) were not common in either data set.

The most surprising difference between the sets of data (i.e., Big Hole event data and primary interview data) is that cooperative events did not significantly outweigh conflictive events in the Big Hole primary interviews. In the event data, cooperative events were more common than conflictive events, which is consistent with the results found in previous research. However, the Big Hole primary interview data did not support those conclusions, as there was a relatively equal amount of cooperative and conflictive water events. The discrepancy between the event data and interview data suggests the influence of biases and interests inherent in the different data sources. Therefore, these results highlight the value of incorporating multiple research methods to capture the multifaceted nature of water conflict and cooperation.

Directions for Future Work

The research findings in this thesis suggest that there is value in researching water conflict and cooperation at a local scale and including primary interviews in a study utilizing the BAR scale. However, this work also illuminated several gaps and areas for future research in water conflict and cooperation literature.

Future water conflict and cooperation scholars should: 1) conduct more investigations at the intranational scale, 2) continue to investigate alternative applications of the BAR scale beyond news events, 3) find alterations and alternatives to the BAR project methods to ensure water conflict and cooperation research has a holistic and non-linear view to present an accurate depiction of reality, and 4) clearly distinguish water conflict and cooperation literature and methodologies from similar theories and literature (e.g., collaborative watershed management).

Further, since the literature on water cooperation and conflict that considers conflict and cooperation continuums is a relatively new topic, much is left to be explored. Scholars in the field have many opportunities to expand on existing literature and conduct water conflict and cooperation research in new locations (both locally and internationally). Climate change and increased demands for water heighten the supply and demand imbalance for freshwater, increasing the potential for conflict and cooperation between water users. As the potential for conflict and cooperation over water resources grows, it becomes increasingly important to understand the complexities and trends related to water conflict and cooperation in a holistic and non-linear view.

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APPENDICES

APPENDIX A

INTERVIEW RE-ANALYSIS CODEBOOK

The following table is the complete version of the codebook that was used during the re-analysis of interviews conducted by JGRE for the Montana Drought Management Plan update.

Table A1. Full codebook for the re-analysis of interviews conducted by JGRE for the updated 2023 Montana Drought Management Plan.

Name	Description
Conflict and Cooperation	
Alternative	Obvious examples of water conflict and cooperation that don't neatly fit into one category or the other (conflict leading to cooperation, conflict and cooperation occurring simultaneously, etc.).
Climate Region	The climatic region that each participant is located in the state based on JG Research and Evaluation's analysis. Each participant may only be placed into one climatic region. No participants can be placed in this larger code.
Region 1	Western Montana
Region 2	Southwestern Montana
Region 3	North Central Montana
Region 4	Central Montana
Region 5	South Central Montana
Region 6	Northeastern Montana
Region 7	Southeastern Montana
Conflict	any incident of water conflict that does not fit the baby codes can be coded into this parent code.
Fines	Fines, proposal and permit denials, halting negotiations (-3).
Legal Action	Litigations/legal action, appeals of administrative actions (-4).
Support Withdrawal	Petitions, withdrawal of third-party support (-2).
Violence	Small scale acts of violence, protests, and/or vandalism; -5 on the modified BAR scale (Eidem et al., 2012).
Voicing Opposition	Delays, report reviews, voicing opposition, editorials (-1).

Table A1 Continued.

Name	Description
Cooperation	any incident of water cooperation that does not fit the baby codes can be coded into this parent code.
Meetings	meetings, third-party support, negotiation requests (2).
Negotiations	permit approvals, fixing violations, negotiations begin (3).
Regulations	lawsuit settlements, regulation(s) approval, management transfers (4).
State-wide Action	state bill passage, compacts, or official agreements (5).
Voicing Approval	voicing opinions of approval, court-forced negotiations, editorials; 1 on a modified BAR scale (Eidem et al., 2012).
Issue Type	Issue categories to classify events according to different aspects of water resources. Events can only be classified into one issue type.
Conservation	Includes agriculture, municipal and industrial conservation measures, and water bans. May also include restoration measures that are not focused on invasive species management.
Fish Passage	Dam, hydropower, or irrigation facilities block fish passage or inhibit fish survival due to lowered flows or altered habitat. Related actions could involve fish ladders, dam removal, bypasses, or irrigation pump alterations.
Flood	Flood control and management actions, including delineation of flood plains, flood insurance, floods resulting in destruction of property, and reservoir releases.
Groundwater	Creation of new groundwater supply source, declaration of critical groundwater areas, and other regulations on groundwater pumping. Water table lowering, groundwater use depleting surface water flows, or leading to land subsidence.
Infrastructure	Water conveyance, storage, or treatment systems are non-existent, in disrepair, inadequate, or not predicted to meet future needs due to agricultural or municipal/population growth. Conversely, these systems are being expanded, repaired, or created including new surface water source development and public works project funding.

Table A1 Continued.

Name	Description
Instream	River flows or lake levels are too low to support endangered species, other regulatory requirements, or regular use due to high consumptive uses, diversions, or drought. Instream flow requirements, and obtaining and transferring water rights to instream uses, contractual and water right agreements that may not be met due to instream requirements.
Intergovernmental	Actions concerning who has control over the rules, standards, and allocation of water resources and other related procedural events including formation of municipal water user associations.
Invasive Species	Any non-agricultural species, invasive, exotic, or native, that are detrimental to water quality.
Navigation	River system and structure creation or maintenance; including canals and locks, dredging, and flow requirements for navigational purposes.
Recreation	Recreational access to waterways including access permits.
Water Quality	Surface or groundwater quality does not meet local, state, or federal standards for municipal use or endangered species regulations or stakeholder has water quality-related concerns. Includes illegal discharge, sewage overflows, remediation processes, fluoride additions, and insurance liability claims regarding water quality issues.
Water Rights	Contention over water rights, basin adjudication, Native American Tribal claims, lease and sale of water for consumptive use, and other property rights issues.
Other	anything that stands out as important to conflict and cooperation but doesn't fit another code.
Sector	Participant's area of work based on JG Research and Evaluation analysis. Each participant may only be placed into one sub-code. No participants may be placed into this larger code.
Agriculture	
Conservation and Land Management	

Table A1 Continued.

Name	Description
Energy and Industrial Use	
Planning, Community Development, and Municipal Water	
Recreation and Tourism	

As mentioned in the Methods and Methodology chapter, the definitions (Table A1) for the CCCs were informed by the BAR project methods (Yoffe & Larson, 2001). The AOCs along with their definitions, were informed by previous literature on water conflict and cooperation, specifically alternative conceptualizations of conflict and cooperation. These codes can highlight non-binary instances of conflict and cooperation in the data. Unlike the binary CCC, these AOCs allow for the co-existence of conflict and cooperation to be revealed in the data. Specific to the interview re-analysis codebook, the codes *climate region* (Figure A1) and *sector* were coded based on the data collected by the JGRE team.

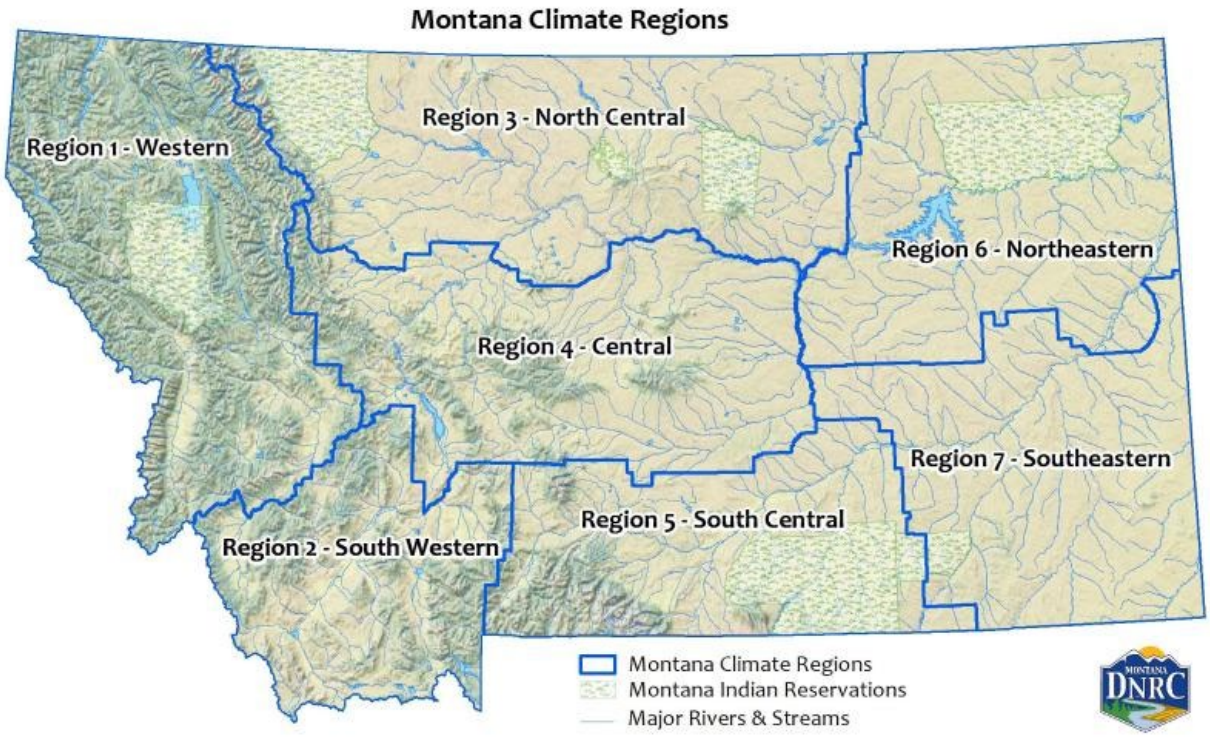

Figure A1. Map of the seven Montana climate regions as defined by the MT DNRC (image from *The Plan & the People*, n.d.).

APPENDIX B

BIG HOLE EVENT DATA CODEBOOK

The following table is the complete version of the codebook that was used during the analysis of the Big Hole River Watershed event data sample.

Table B1. The full codebook used in the analysis of the Big Hole River Watershed event data sample.

Name	Description
Alternative	Obvious examples of water conflict and cooperation (sentences or paragraphs) that don't neatly fit into one category or the other (conflict leading to cooperation, conflict and cooperation occurring simultaneously, etc.).
Article Type	Articles should be coded into one of these Article Type subcodes (entire article). Articles cannot be coded into this parent code.
Opinion Articles	Any articles titled or described as an opinion piece should be coded into this sub-code.
Other	Any articles that are not opinion pieces should be coded into this sub-code.
Conflict	Any incident of water conflict should be coded into one of the sub-codes (sentences or paragraphs). References cannot be coded into this parent code.
Fines	Fines, proposal and permit denials, halting negotiations (-3).
Legal Action	Litigations/legal action, appeals of administrative actions (-4).
Other	Any water event that is determined to be conflictive but does not fit into any of the Conflict sub-codes can be placed into this Other code.
Support Withdrawal	Petitions, withdrawal of third-party support (-2).
Violence	Small scale acts of violence, protests, and/or vandalism; -5 on the modified BAR scale (Eidem et al., 2012).
Voicing Opposition	Delays, report reviews, voicing opposition, editorials (-1).
Cooperation	Any incident of water cooperation should be coded into on of the sub-codes (sentences or paragraphs). References cannot be coded into this parent code.
Meetings	meetings, third-party support, negotiation requests (2).
Negotiations	permit approvals, fixing violations, negotiations begin (3).
Other	Any water event that is determined cooperative but does not fit into any of the Cooperation sub-codes can be placed into this Other code.
Regulations	lawsuit settlements, regulation(s) approval, management transfers (4).
State-wide Action	state bill passage, compacts, or official agreements (5).
Voicing Approval	voicing opinions of approval, court-forced negotiations, editorials; 1 on a modified BAR scale (Eidem et al., 2012).

Table B1 Continued.

Name	Description
Instructions	Do not add any references to this code. All references should be specifically about the Big Hole River Watershed and water issues/events. Any other related content not regarding the Big Hole or water should be ignored. Issues concern people or institutions fighting or working together, not people fighting against inanimate challenges, other species, etc. Lastly, codes only concern current events (in the viewpoint of the article), any past events should be ignored (i.e., outside of the 2017-2023 timeframe).
Issue Type	Issue categories to classify events according to different aspects of water resources (sentences or paragraphs). Events can only be classified into one issue type.
Conservation	Includes agriculture, municipal and industrial conservation measures, and water bans. May also include restoration measures that are not focused on invasive species management.
Fish Passage	Dam, hydropower, or irrigation facilities block fish passage or inhibit fish survival due to lowered flows or altered habitat. Related actions could involve fish ladders, dam removal, bypasses, or irrigation pump alterations.
Flood	Flood control and management actions, including delineation of flood plains, flood insurance, floods resulting in destruction of property, and reservoir releases.
Groundwater	Creation of new groundwater supply source, declaration of critical groundwater areas, and other regulations on groundwater pumping. Water table lowering, groundwater use depleting surface water flows, or leading to land subsidence.
Infrastructure	Water conveyance, storage, or treatment systems are non-existent, in disrepair, inadequate, or not predicted to meet future needs due to agricultural or municipal/population growth. Conversely, these systems are being expanded, repaired, or created including new surface water source development and public works project funding.
Instream	River flows or lake levels are too low to support endangered species, other regulatory requirements, or regular use due to high consumptive uses, diversions, or drought. Instream flow requirements, and obtaining and transferring water rights to instream uses, contractual and water right agreements that may not be met due to instream requirements.
Intergovernmental	Actions concerning who has control over the rules, standards, and allocation of water resources and other related procedural events including formation of municipal water user associations.

Table B1 Continued.

Name	Description
Invasive Species	Any non-agricultural species, invasive, exotic, or native, that are detrimental to water quality.
Navigation	River system and structure creation or maintenance; including canals and locks, dredging, and flow requirements for navigational purposes.
Other	If a water event does not fit into any of the other Issue Types codes is may be placed into the Other code.
Recreation	Recreational access to waterways including access permits.
Water Quality	Surface or groundwater quality does not meet local, state, or federal standards for municipal use or endangered species regulations or stakeholder has water quality-related concerns. Includes illegal discharge, sewage overflows, remediation processes, fluoride additions, and insurance liability claims regarding water quality issues.
Water Rights	Contention over water rights, basin adjudication, Native American Tribal claims, lease and sale of water for consumptive use, and other property rights issues.
Other	Anything that stands out as important to conflict and cooperation but doesn't fit another code (sentences or paragraphs).
Overall Article	Every article (in its entirety) should be coded into one of these subcodes. Articles cannot be coded into this parent code.
Alternative	Articles that predominately discuss an event coded as alternative. The main event discussed in the article is an alternative event.
Conflict	Articles that predominately discuss a conflictive event. The main event discussed in the article is conflictive.
Cooperation	Articles that predominately discuss a cooperative event. The main event discussed in the article is cooperative.
Not Relevant	Articles that were not relevant to the Big Hole and/or water events. Articles that did not have any references coded.
Other	Articles that had references that were coded but the main event discussed in the article is not conflictive, cooperative, or alternative.
Paper Name	Each article will be coded into one of the following sub-codes based on the paper source the article was published by.
Associated Press State Wire	
Billings Gazette	
Bozeman Daily Chronicle	
Independent Record Helena	

Table B1 Continued.

Name	Description
Missoulian	
Montana Standard	
Sidney Herald	
Year Published	Each article will be coded into one of the following sub-codes based on the year the article was published.
2017	
2018	
2019	
2020	
2021	
2022	
2023	

APPENDIX C

BIG HOLE PRIMARY INTERVIEWS CODEBOOK

The following table is the complete version of the codebook that was used during the analysis of the Big Hole River Watershed primary interviews.

Table C1. The full codebook used in the analysis of the Big Hole River Watershed primary interviews.

Name	Description
Alternative	Obvious examples of water conflict and cooperation that don't neatly fit into one category or the other (conflict leading to cooperation, conflict and cooperation occurring simultaneously, etc.).
Conflict	Any incident of water conflict should be coded into one of the sub-codes (sentences or paragraphs). References cannot be coded into this parent code.
Fines	Fines, proposal and permit denials, halting negotiations (-3).
Legal Action	Litigations/legal action, appeals of administrative actions (-4).
Other	Any water event that is determined to be conflictive but does not fit into any of the Conflict sub-codes can be placed into this Other code.
Support Withdrawal	Petitions, withdrawal of third-party support (-2).
Violence	Small scale acts of violence, protests, and/or vandalism; -5 on the modified BAR scale (Eidem et al., 2012).
Voicing Opposition	Delays, report reviews, voicing opposition, editorials (-1).
Cooperation	Any incident of water cooperation should be coded into on of the sub-codes (sentences or paragraphs). References cannot be coded into this parent code.
Meetings	meetings, third-party support, negotiation requests (2).
Negotiations	permit approvals, fixing violations, negotiations begin (3).
Other	Any water event that is determined cooperative but does not fit into any of the Cooperation sub-codes can be placed into this Other code.
Regulations	lawsuit settlements, regulation(s) approval, management transfers (4).
State-wide Action	state bill passage, compacts, or official agreements (5).
Voicing Approval	voicing opinions of approval, court-forced negotiations, editorials; 1 on a modified BAR scale (Eidem et al., 2012).
Issue Type	Issue categories to classify events according to different aspects of water resources (sentences or paragraphs). Events can only be classified into one issue type.
Conservation	Includes agriculture, municipal and industrial conservation measures, and water bans. May also include restoration measures that are not focused on invasive species management.

Table C1 Continued.

Name	Description
Fish Passage	Dam, hydropower, or irrigation facilities block fish passage or inhibit fish survival due to lowered flows or altered habitat. Related actions could involve fish ladders, dam removal, bypasses, or irrigation pump alterations.
Flood	Flood control and management actions, including delineation of flood plains, flood insurance, floods resulting in destruction of property, and reservoir releases.
Groundwater	Creation of new groundwater supply source, declaration of critical groundwater areas, and other regulations on groundwater pumping. Water table lowering, groundwater use depleting surface water flows, or leading to land subsidence.
Infrastructure	Water conveyance, storage, or treatment systems are non-existent, in disrepair, inadequate, or not predicted to meet future needs due to agricultural or municipal/population growth. Conversely, these systems are being expanded, repaired, or created including new surface water source development and public works project funding.
Instream	River flows or lake levels are too low to support endangered species, other regulatory requirements, or regular use due to high consumptive uses, diversions, or drought. Instream flow requirements, and obtaining and transferring water rights to instream uses, contractual and water right agreements that may not be met due to instream requirements.
Intergovernmental	Actions concerning who has control over the rules, standards, and allocation of water resources and other related procedural events including formation of municipal water user associations.
Invasive Species	Any non-agricultural species, invasive, exotic, or native, that are detrimental to water quality.
Navigation	River system and structure creation or maintenance; including canals and locks, dredging, and flow requirements for navigational purposes.
Other	If a water event does not fit into any of the other Issue Types codes is may be placed into the Other code.
Recreation	Recreational access to waterways including access permits.
Water Quality	Surface or groundwater quality does not meet local, state, or federal standards for municipal use or endangered species regulations or stakeholder has water quality-related concerns. Includes illegal discharge, sewage overflows, remediation processes, fluoride additions, and insurance liability claims regarding water quality issues.

Table C1 Continued.

Name	Description
Water Rights	Contention over water rights, basin adjudication, Native American Tribal claims, lease and sale of water for consumptive use, and other property rights issues.
Other	Anything that stands out as important to conflict and cooperation but doesn't fit another code (sentences or paragraphs).
Sector	Participant's area of work based on the demographic surveys. Each participant may only be placed into one sub-code. No participants may be placed into this larger code.
Agriculture	
Conservation and Land Management	
Energy and Industrial Use	
Other	
Planning, Community Development, and Municipal Water	
Recreation and Tourism	

APPENDIX D

JGRE INTERVIEW GUIDE

The following interview guide is the original guide used by the JGRE team during the primary collection of interviews for the Montana DNRC Drought Management Plan 2023 update. These interviews were then re-analyzed for the purpose of answering the research questions of this thesis as described in the Methods and Methodology chapter.

Drought VA Interview Guide:

Date:

Introduction:

Thank you for taking the time to speak with me today. These interviews are part of a drought Vulnerability Assessment that we are conducting on behalf of Montana Department of Natural Resources and Conservation (DNRC) as part of their comprehensive effort to update the state Drought Management Plan. The purpose of the Vulnerability Assessment is to systematically understand the impacts of drought within and across sectors and communities throughout the state. This assessment will be used to support identification of appropriate drought response actions and adaptation strategies that will be useful and accessible to Montana's diverse water users and build Montana's resilience to drought. The data we collect for this project will be summarized and included in the updated Drought Management Plan. Before I get started, a couple logistical things…

1) Are you ok with me recording this? Your responses will be kept entirely confidential--the recording will only be used for analysis purposes and will only be accessed by our research team.
2) As I mentioned, your responses will be confidential and any quotes we may decide to use from you in the report will be anonymous.
3) Please feel free to skip any questions if you don't feel like answering them.
   Do you have any questions for me?

Background information and sensitivity

1. **Tell me a bit about yourself and the main ways that you use water.**
    a. Describe what you do for your primary source of income. Has drought impacted your work and income? Could it in the future?
    b. Are you associated with any other water use sectors in your work? Which ones? Has drought impacted those sectors?
    c. How do you use water in your personal life? Do you see impacts from drought in how you use water?
2. **What resources do you use to gather information about or monitor drought conditions?**
    a. How do you use this information?
    b. Are the information resources adequate? Are they clear or easily understood?
    c. Are there additional types of drought information that would be helpful to you? If so, please describe.

Adaptive capacity

3. **How do you plan for drought in your work?**
    a. Relating to your primary source of income, describe specifically any changes or actions you have taken or other ways you deal with or plan for the direct impacts of drought on your business/operation.
4. **Relating to your primary source of income, describe any public policies, regulatory relief, or grant/payment programs that help you deal with drought impacts.**
    a. How helpful have you found these programs/policies to be?
    b. What could be changed about these programs to make them more supportive in times of drought.

Relationships

5. **In what ways, if any, do you work with other water users to respond to drought?**
6. **Do you feel like other water users impact you or the way you operate? If so, how?**

Personal impacts and reflections

7. **Has drought impacted your mental or physical health?**
8. **What resources or policies would you like to see from the state to help you plan for drought?**
9. **Is there any other information you would like to share?**
10. **Are there other people you think would be good for us to interview?**

APPENDIX E

BIG HOLE PRIMARY INTERVIEW GUIDE

The following interview guide is the guide used for the primary interviews with stakeholders in the Big Hole River Watershed. The interview guide was informed by the JGRE interview guide (Appendix D), results from the case study event data, literature on water in the West, and literature on water conflict and cooperation. These interviews were semi-structured primary interviews, meaning that these questions are not set in their order or phrasing and the interviewer may ask additional follow-up questions.

Water Conflict & Cooperation Interview Guide:

Introduction:

Thank you for taking the time to speak with me today. These interviews are part of my master's thesis research at Montana State University. My thesis research looks at water issues in Montana and how they drive conflict, cooperation, or a mix of both among water users. Ultimately, I hope that this research can create a better understanding of water cooperation and conflict trends in the Big Hole River Watershed. Once complete, the data we collect for this project will be published and publicly available through the MSU library. This research is funded by the U.S. Geologic Survey through the Montana Water Center.

Before we get started, I have a couple of logistical questions for you…

1) Are you okay with me recording this? Recording this interview helps me to reduce note-taking and focus on your responses. Your responses will be kept entirely confidential--the recording will only be used for analysis purposes and will only be accessed by our research team.
2) As I mentioned, your responses will be confidential and any quotes we may decide to use from you in the publication will be confidential. IF HESITANT ABOUT USING QUOTES: If you'd like I'd be happy to share any quotes with you before publication, to make sure I've interpreted your words correctly.
3) This interview is voluntary and there are no right or wrong answers. Also, please feel free to skip any questions if you don't feel comfortable answering them. Proceeding with the interview indicates your consent to participate. Do you have any questions for me?

If you have any questions later, my email is erin.bjorklund@student.montana.edu. The IRB reference number for this project is 1371 and the contact information for MSU IRB is irb@montana.edu.

Background information

1. **Tell me about your personal and professional connection to the Big Hole Watershed.**

Conflict & Cooperation

2. **What professional or personal water-related issues do you deal with in the Big Hole, if any?**
3. **How do you think these issues have changed over time, if at all?**
    a. Would you say there have been any important catalyst events over water in the Big Hole Watershed? (please describe)
4. **I'd like to delve a little deeper into the issues you just spoke about. Which of the issues that you mentioned is the most important to you? Why?**
    a. Would you say that there are conflicts in the Big Hole when working on this issue? (please describe an experience)
    b. What about cooperation? (please describe)
    c. Would you say this issue is still ongoing in the Big Hole?
        i. If so, when did this first become an issue?
        ii. If not, is this issue resolved?
5. **Out of all these issues you mentioned earlier, which ones do you find to be the most conflictive? (please describe)**
6. **Which ones do you find to be the most cooperative? (please describe)**
7. **What was your biggest takeaway from dealing with these issues?**

Before we finish up, I would appreciate it if you could take a few minutes to fill out this demographic survey. In this survey, I ask you a few questions about yourself. This demographic information helps me understand the makeup of those I've interviewed. All answers from this survey will remain confidential.

Prompt for anything missing from the interview that you want to know.

Reflections

8. **Is there any other information about the Big Hole Watershed you would like to share with me today?**
9. **Are there any other people engaged with water in the Big Hole Watershed you think I should interview? Would you be willing to share my contact information with them?**

Thank you for taking the time to talk with me today. If you are interested, I would love to share the results from the interviews with you, so that you can hear what other interviewees were saying about the Big Hole. I can share the results as a report, a full thesis, or a fact sheet, or I can come speak about the results too. What would be the best way to send information to you in the future? Thank you again. Feel free to contact my email if you have any questions or would like to share anything else.

Interview participants were also asked to fill out the following demographic survey. For interviews conducted in-person, the survey was printed out and filled out by the interviewee by hand. For interviews conducted over WebEx, a link to the same survey questions but on Qualtrics (a digital survey program) was emailed to the participant directly following the interview.

Demographic Questionnaire:

We will not share this information outside of our research team.
First and last name:
Date:
Time:
Location:

Introduction:
In this survey, we ask you a few questions about yourself. This demographic information helps us understand the makeup of those whom we interviewed, which helps give a fuller picture of what groups are represented and what voices may be missing in our data. Data from the demographic questionnaire will remain anonymous. Please note you may skip any question in this survey you do not want to answer.

1. How long have you lived in the Big Hole River Watershed, if at all?

2. What is your zip code?

3. What is the highest level of education you completed?
    a. Some formal schooling
    b. High school diploma or GED
    c. Some college
    d. 2-year college degree
    e. 4-year college degree
    f. Graduate or professional degree
    g. Prefer not to answer

4. How would you describe your current employment status?
    a. Unemployed

   b. Working part-time (working less than 40 hours per week)
   c. Working full-time (working 40 hours or more per week)
   d. Retired
   e. Prefer not to answer

5. If you are employed, what is your occupation?

6. Are you Spanish, Hispanic, or Latine?
   a. Yes
   b. No
   c. Prefer not to answer

7. Choose one or more races you consider yourself to be.
   a. American Indian or Alaska Native
   b. Asian
   c. Black or African American
   d. Native Hawaiian or Pacific Islander
   e. White
   f. Prefer not to answer
   g. Other (please describe):

8. What is your gender?

9. In what year were you born? (yyyy format, e.g. 1995)

Thank you!