ENDANGERED WATERS: INTERDEPENDENCY ON MONTANA'S BIG HOLE RIVER

by

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ABSTRACT

The Big Hole River brings life to this arid region of southwestern Montana, but its stream flows annually reach detrimentally low levels. The causes behind the low-flow levels are a direct reflection of Euro-American impacts dating back to the early nineteenth century. This is a story of dependency and scarcity, which presently makes the river the source of political conflict.

INTRODUCTION

Year after year, Jim Forrin suffered only failures. Disgusted, he eventually set the buildings on his farm ablaze. When Marion Oneal, a neighbor, asked why he had burned his farm to the ground, Forrin casually explained, "… we've had a lot of happiness as well as grief on this farm-Christmas celebrations, wood-cutting parties, quilting parties and country dances in the big front room… I'm fixing it so that no matter how hard up we get we'll never be able to come back." Forrin's answer to life on the Big Hole may have been extreme, but he was not alone: seven other families left the area at this time as well, in search of better land. "The high altitude country was harsh," Oneal reflected. "Winter loved the valley and chose to live there nearly nine months of the year." Marion Oneal was among one of these fleeing farmers. She had moved to the Big Hole to educate the youth of this remote valley in southwestern Montana, and like many others in the early twentieth century, she stayed to carve out a Jeffersonian existence by providing for herself and her family. Like Forrin, Oneal eventually left the Big Hole and moved to northwestern Montana, in search of more water.[1]

Oneal moved to the Big Hole Valley for a unique experience. Educated at Tulane University, she aspired to give the wild and deprived children in the rural western Montana valley an education. Oneal chronicled her experiences from teaching and living with the people of the Big Hole Valley. Her article, "The Answer Is Water," is one of her many publications about teaching and, later, farming experiences in western Montana. In 1910, Oneal began publishing articles for several national magazines, her rural elegance

[1] Marion Oneal S, "The Answer Is Water," *The Land: A Quarterly Magazine*, Winter 1941, 1-2.

gracing the pages of *Colliers* and *The Saturday Evening Post*, to name a few. Through her writing, she brought life in the Big Hole to homes across the country.[2]

The Big Hole River flowed through Oneal's property, promising fertile ground and enough moisture to quench the earth during the notoriously dry summers. For Oneal and other farmers, "the water was lifeblood spilling away." In the spring, the river was a beautiful, yet uncontrolled, torrent, relieving the surrounding mountains of their impenetrable snows. However, by late summer, the once-rushing waters nearly vanished. Oneal recalled the time spent by the river: "I stood on its bank, watching the water pouring away unchecked to the sea." She continued, "Into its greedy flood went more land all the time, but especially in the spring." The river carved its own path, continuously cutting into the ground, "until it flowed many feet below the level of the land." She was well aware that the Big Hole shaped her landscape.

Each year, the farmers of the valley attempted to harness the waters in order to support their perennially failing crops. Aridity is synonymous with the American West and the Big Hole Valley is no exception: indeed, it is the prime example of dryness. Nearly always, the farmers' efforts to harness the waters failed. Oneal recalled, "We farmers on its bank had experimented with many devices for lifting the river." Yet nothing worked.

> We tried pumping... Our neighbors tried homemade devices for lifting water with horses and humans for power. My next door neighbor, Jim Forrin, hauled water from the river in old beer barrels and spread it along his rows of corn. But the thirsty earth and winds licked it up so rapidly that after several hours it was impossible for him to tell which of these rows had been watered.

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[2] Montana Historical Society, accessed December 4, 2014, http://nwda.orbiscascade.org/ark:/80444/xv05134.

Oneal and the others soon realized the valley was not meant for farming. The farmers disturbed the natural balance of the area, and the soil disruption only made the dry air that much dustier. Oneal speculated, “If left alone, nature would stitch the land down with sod. Pines on the hill would seed it to trees; and eventually cattle and game and other living creatures would be seen instead of dust devils on those hills again.”[3]

Life in Big Hole country has always presented challenges to its residents. The climate of the 6,000-foot high valley floor descending off the Continental Divide and the shear remoteness of the area made life difficult in the Big Hole. However, many would not consider leaving the breathtaking valley, with its majestic snow-capped mountains and rugged way of life. Even today, stepping into the valley gives one the sense of going back in time. Bustling towns are nearly non-existent in the valley, making the area reminiscent of a scene out of the 1930s. Wisdom is the largest incorporated town in the valley and extremely remote. In fact, high school students in Wisdom and the surrounding valley take a daily, sixty-five-mile bus ride to the nearest high school in Dillon, the Beaverhead County seat. Wealthy outsiders bring most of the modern amenities to the area; building lavish homes, some of which resemble castles, on the banks of the Big Hole, now famous as a world-renowned blue ribbon trout stream.

Trout fishing’s popularity has soared in the recent decades, and the industry helps supplement the area’s agricultural economy. Because irrigation problems, such as those that troubled Jim Forrin, have plagued the agrarian population since the turn of the century, some have welcomed the fishing industry for its financial benefit. Nevertheless,

[3] Marion Oneal S, "The Answer Is Water," 1-2.

it has also brought controversy to the river: on the heels of the trout-fishing boom came the conservation movement. As Oneal noted, the water fluctuation of the Big Hole is drastic, flooding in the spring, while in the late summer being nothing more than a trickle in some spots. In recent years, the question has become; to whom does the water belong? Legally, the water is tied up in Montana's archaic water rights policies of, "first in time, first in right." Economically, low flow equals lost revenues for the fishing community, who often cannot fish the Big Hole in late summer due to lack of water. In August and September, anglers like me, simply scratch the Big Hole off the list for fishing in southwestern Montana, if the state does not shut it down first because of low water levels. In late summer on the Big Hole, low flow levels are the norm, and in years of extreme drought, the river completely dries up in some areas. The disappearance of the water is the culmination of events set into motion by Euro-Americans. This research does not take into account the effects of climate change, because its temporal scope is necessarily narrow. One of the major challenges of the field of environmental history enters into our story here, in the vast spans of time linking the Big Hole of the distant past and the present. Because the relationship between humans and their environment evolves over multiple generations, narratives in the field are often blurred or complicated by extensive durations of time. Vast stretches of time generally elude specificity, and therefore end up summarizing or oversimplifying key details of the topic.

The focus at hand is the Big Hole's low stream flows, exacerbated by over two centuries of Euro-American impacts on the river and riparian ecosystems that surround the Big Hole. My historical methodology is a synthesis of cultural and environmental

analysis. I have organized this work chronologically and it focuses on three major episodes: early Euro-American influence on the Big Hole ecosystem, in particular through the fur-trade; agrarian development in the valley and its dependence on irrigation; and finally, the rise of recreational fishing culture and state management to protect those waters. Ecological studies are also important to this story, and serve as a wellspring of empirical data to illuminate the Big Hole's degradation through modern times. This is a story of interdependent relationships. The majority of the American West, stifled by aridity, has become, here and elsewhere, dependent on waters like the Big Hole. As increasingly more individualistic users, interests and visions compete for control of the Big Hole's pristine waters, the complexity of these questions only deepens.

A River's Importance in Environmental History

Standing on a marshy island, infested by mosquitos and seemingly under attack by large prehistoric aquatic insects, I found myself immersed with questions concerning the condition of the Big Hole. Simultaneously, I developed an infatuation with the river and its mystical surroundings. It was June and the salmon fly hatch was in full swing. Anglers had arrived in droves to fish the tea-colored waters, for which the Big Hole is famous. The river was high with snowmelt from the multiple mountain ranges that surround the valley, but the Big Hole, unlike other rivers, can fish relatively well during high water. The bigger and more flamboyant the salmon fly pattern – some having such crafty names as "Cat's puke" – the better your chances are of hooking into one of the stream's famous monsters. The salmon fly hatch is legendary in these parts, known for

producing large trout on large dry flies, and is easily the busiest time of the year in the valley, even by Montana standards. This event helps explain the popularity of the Big Hole, but does not detract from the scenery. Its wide-open vistas combined with spectacular fly-fishing make this cranny of the state the source of many epic-fishing stories. In a sense, the Big Hole's waters serve as the glue that binds the fishing community together, but also separate the fishing community from other users in the valley.

This is because the river also connects the agriculture-based communities of Jackson, Wisdom, and Melrose, while meandering through the countless cattle ranches and hayfields along the way. For many of these communities today, traditional agriculture economies are supplemented, if not replaced by tourism. Given the growing popularity of fly-fishing for trout, this comes as no surprise. Here the rivers multiple uses turn to conflict. Montana's waters are public domain, because of some of the most liberal fishing access and land use laws in the country. Varying users hold different opinions on the Big Hole's usage. Throughout Euro-American history, but especially in the American west, conflict over water is well-trodden terrain for the historian. The political battles over rivers in the West are a theme explored by several environmental historians, but none more prominent than Donald Worster.

In *Rivers Of Empire*, Worster discusses large-scale government control over natural resources, rivers in particular. Of course, the Big Hole does not draw as much national attention as Worster's main case study, the Colorado River Basin; however, many of his insights are useful for my analysis. Worster separates Euro-American

irrigation practices in the West into three stages. First, he describes the irrigation practices of the mid to late nineteenth-century Mormon colonies in northeastern Utah as *incipience*, relating to the beginning of his three-stage process. Worster writes, "That process was one of ecological intensification-of extracting more and more economic yield from the rivers and their watersheds." The Mormons learned irrigation and fluid dynamics out of necessity, using the Wasatch Range's snowpack to transform the desert floor into the American West's version of the Fertile Crescent. Worster's second process, *fluorescence*, began in 1902 with the passing of the National Reclamation Act. He continues, "the federal government took firm charge of the western rivers, furnishing the capital and engineering expertise to a higher plateau of development." Accompanying this government takeover of waters was profit agriculture, tying private business to the U.S. Government, illustrating yet another form of engineering, this one economic, of western rivers. Lastly, Worster's notion of *empire* brought the private business relationship with the government to the forefront; forever changing the ecology and economies of the West. This final form of cohesion made the western U.S. dependent on thousands of dams, irrigation projects, and other engineered landscapes, which caused endless conflicts over water. But it also caused elevated soil salinity levels that would have wiped out such Native civilizations as the Hohokam almost instantaneously. With cooperation between capital and the federal government, political conflict became a perennial part of life in the U.S. west, particularly as different stakeholders competed over limited water resources.[4]

[4] Donald Worster, *Rivers Of Empire: Water, Aridity, and the Growth of the American West* (New York: Oxford University Press, 1992), 64.

Like the Colorado River Basin, Worster's subject in *Rivers of Empire,* irrigation and agrarian development have led to irreversible conditions on the Big Hole. The simultaneous discovery of gold in Montana and the Homestead Act of 1862 initiated the second wave of stream flow deprivation, with agriculture and humans that depended on irrigation to support crops and livestock. Closely related to Worster's stage of *empire* comes state intervention and fisheries management of the Big Hole. In a discussion that parallels with Worster's idea of *empire*, political scientist James Scott has explored state influence on private land and natural resource use to discuss engineering as a form of "high modernist" intervention. "High-modernist," state intervention of the Big Hole threatens agricultural demands of the water by way of the most all-encompassing environmental protection act, the Endangered Species Act.

In his discussion of government projects, Scott defines state interaction with resource use as high-modernism, and explains it "as a strong version of the beliefs in scientific and technological progress," resulting in "an increasing control over nature (including human nature) commensurate with scientific understanding of natural laws."[5] Undoubtley, many of Scott's thoughts on the high-modernist state can be of use when examining the Big Hole Valley, and the state's efforts to control the land and its resources. However, in the case of the Endangered Species Act (ESA), and protection of the Big Hole's native, Artic grayling, the state's main objective is to restore, or at least maintain, the natural symbiotic relationships of this particular ecosystem. Agriculture and irrigation on the Big Hole, deal with the looming threat of the fish gaining protection

[5] James C. Scott, *Seeing Like A State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, CT: Yale University Press, 1998), 89.

under the act. In the context of the ESA, the state aims to protect a species of fish, not shape its forests or fields for the highest economic yield, as discussed by Scott. These are the same actions, just for different outcomes: a state patriarchal mechanism of management.

The Big Hole is also a geologic force and energy, changing the land by choosing the path of least resistance as it carves its way through southwestern Montana. Even in the early 1900s, Marion Oneal observed the power of the river as it sliced its way through the rich earth. Richard White's river history staple, *The Organic Machine*, describes river functions and the human societies that depend on them. His case study is the herculean Columbia River, which provides energy, in the form of electricity and calories, to millions as it labors its way to the Pacific Ocean. Unlike the Columbia, the Big Hole River of southwest Montana is undammed for its length of some 153 miles, but is not free of human manipulation. The people of the Big Hole depend on the waters for both agriculture and the growing sport fishing economy of the area. The agrarian populations use the water to grow their hay, which in turn feeds the cattle that economically sustains many of the valley residents. Moreover, the fishing community use the Big Hole to get their piece of the roughly $350 million dollars spent by anglers in Montana per year.[6] The residents and visitors of Southwestern Montana are involved with nature firsthand, and therefore are part of the life of the river, a mutual antagonistic relationship.

White argues that manmade machines like rivers are fundamentally natural creations. These thoughts lead directly to his argument that modern humans cannot

[6] Congressional Sportsmen's Foundation, "Montana sportsmen and women," Congressional Sportsmen's Foundation, last modified 2011, accessed November 2014, http://www.sportsmenslink.org/.

separate themselves from nature, because the two are so closely connected. He explains, "we cannot understand human history without natural history and we cannot understand natural history without human history." That is to say, humans have a role in transforming nature as well as nature transforming humans. Humans and their creations are part of nature, whether beneficial or detrimental. White states, "Environmentalists, for all their love of nature, tend to distance humans from it."[7] The Columbia River and its tributaries have functioned as a machine for thousands of years, by carving their way to the Pacific Coast, and supplying food, power and labor opportunities to the inhabitants of the Pacific Northwest for generations, not unlike the Big Hole.[8]

Bringing the Big Hole to Life: Writing River Biographies

Rivers are individual entities, formed from different geological episodes and forces. Although we can compare some natural functions and human manipulations and uses of rivers, especially in the American West, each body of water and the riparian areas that surrounds them is specific in its functions and geologic makeup. Because of the lack of specific research on the Big Hole, some generalities will be used to describe a river's ecosystem function, but, in the below analysis, I have tried to stay as specific to the Big Hole as possible.

One way to explore the geologic uniqueness of the Big Hole requires focusing on its unique geography. Geologist Julianne Leving describes the valley and river path as a

[7] Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York, NY: Hill and Wang, 1995), intro-X.
[8] Richard White, *The Organic Machine,* 3-6.

"broad 'S' curve," comprised of open valleys and canyons, until it converges with the Beaverhead and Ruby Rivers to form the Jefferson River in Twin Bridges, Montana. The Big Hole Valley sits surrounded by prominent mountain ranges: "The Continental Divide coincides with the crest of the Beaverhead Mountains and the Anaconda Range on the west and north sides of the basin." With a valley that runs south to north and mountains on both sides, the river experiences diverse runoff cycles. For example, on the east side of the valley, the Pioneer Mountains release their snow loads earlier in the spring than the east and southern facing slopes of the Continental Divide. Leving writes, "Tributaries to the Big Hole River on the west side…are more numerous and contribute more water than those originating in the Pioneer Mountains."[9] This has the cumulative result of late-spring, peak flows.

The geologic history of the Big Hole coincides with much of the Inter-mountain West, yet the history lends to the uniqueness of the river valley. The mountains surrounding the valley are remnants of thrusting faults, dating back 100 million years, followed by widespread volcanism some 50 million years later. As Leving explains, the "present basin-and-range configuration in southwestern Montana began with a major tectonic episode." Leving dates this current geologic state to "17 million years ago." A period of glaciation followed, one that carved the valley and left several pothole lakes as well as aquatic species such as the storied Artic grayling. Because of these geologic events, the Big Hole River "descends gently northward from 6,900 to 5,900 feet above

[9] Julianne F. Levings, "Water Resources Of The Big Hole Basin, Southwestern Montana," Montana Bureau Of Mines And Geology Memoirs, 59-63, 1986-1992. 6.

sea-level, which corresponds to a gradient of 25 ft. /mi."[10] These events also contribute to the groundwater and draining ability of the valley, making the floor the perfect environment for the camas plant, a staple and major trading good for Native Americans who once harvested the area, and the food of choice for ground squirrels and various ungulates.[11]

The Big Hole Valley, affectionately named by the Flatheads *La-im-tse-la-lik*, or "the place of the ground squirrel," not only used by ground squirrels, the region served as a summer home and highway for many Native American tribes. The valley's extreme winter climate simply did not lend itself to year-round habitation, particularly with the close proximity of milder climates and valleys. For that very same reason, the valley remained treasured to the Native Americans of the area, because the harsh conditions led to delayed white settlement of the area.[12]

The Flatheads or Salish regularly passed through the Big Hole on their way to the Medicine Tree of the neighboring Bitterroot Valley, where they met and traded with Nez Perce, Shoshones, and Bannacks at the annual Spring Festival and Sun Dance. The Big Hole was also a common meeting place and avenue for the three tribes to join forces on their way to the buffalo hunting grounds surrounding the Missouri River in central and eastern Montana. The larger, more territorial and combative tribes of the Blackfeet, Crow, and the Minnetarees also called the Plains of the Missouri home. Bertha Agnes

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[10] Julianne F. Levings, "Water Resources Of The Big Hole Basin, Southwestern Montana," *Montana Bureau Of Mines And Geology Memoirs*, 59-63, 1986-1992. 6 & 7.
[11] United States Department of Agriculture Natural Resources Conservation Service, "Plant Guide: Common Camas Camassia quamash," USDA, accessed January 31, 2015, http://plants.usda.gov/plantguide/pdf/cs_caqub2.pdf.
[12] Bertha Agnes Francis, *The Land Of Big Snows* (Caldwell, ID: The Caxton Printers, LTD, 1955), 48.

Francis' 1955 *The Land of Big Snows*, explains that before large scale, white intrusions, "There was safety in numbers," and the smaller, inter-mountain tribes often joined forces for protection and successful bison hunts.[13] The valley also served as a valuable area to stock up on food stores, mainly camas root, which Native Americans easily transported as a valuable source of energy.

The Nez Perce, in particular, relied heavily on the camas root, and the Big Hole's saturated floor provided the ideal environment for the nutritious plant, the Natives depended on the valley's ecosystem for energy. The Big Hole River today is also a source of energy, not to produce electricity like the Columbia and other large western rivers; rather, its energy is contained in itself. Its waters give life to an extremely arid environment, making agriculture possible and sustaining local economies with the hordes of fisherman that have become the sole source of revenue for a portion of the valley's residents. And herein lies the source of conflicting interests along the Big Hole. On one hand, the agrarian populations of the region need the water to support their farms and ranches. The river mechanizes the hay farms in the valley by irrigation, in most cases floodplain irrigation, an ancient form of water manipulation that involves trapping the spring runoff in its floodplain and allowing the water to soak into the ground for future use.[14] Yet, on the other hand, a burgeoning fishing and sportsmen economy relies on the river's steady flows, and its accompanying riparian areas to sustain trout populations.

Human management has become the name of the game on the Big Hole. Foreign brown and rainbow trout populations stocked in the river since the beginning of the

[13] Francis, The Land Of Big Snows, 22&23.
[14] Julianne F. Levings, "Water Resources Of The Big Hole Basin, Southwestern Montana," 6.

twentieth century, diminished the native populations of the indigenous westslope cutthroat trout and Artic grayling, which for thousands of years have called these waters home. In this regard, fisheries management has become another geological and ecological agent on the Big Hole, constructing the river into a space comprised of naturally occurring and human-induced characteristics. After the valley's agriculture has fulfilled its irrigation needs, the river that remains is left to state and federal agencies, which preside over what species of fish live in the river and determine how aquatic species and their environment are protected.

Strong trees cannot survive without a powerful root system, as is the case with the Missouri – it is only as strong as the tributaries that attribute to its mass. As a region, the American West's irrigation practices rely heavily on streams and rivers. Surface waters account for over 60 percent of agriculture irrigation, especially in high altitude areas like the Big Hole Valley.[15] For these reasons, the Big Hole River is a key indicator and serves as ground zero for debates over water politics in the western United States. Large-scale interdependent relationships base themselves on the function of the river. Farmers in the Big Hole, anglers that visit the region, state economies, and national interest's down-stream on the Missouri, are all benefactors of the Big Hole's health. Because of such magnificent implications, the unprecedented fluctuating levels of the Big Hole deserve a story.

[15] Michael Moore, Aimee Mulville, and Marcia Weinberg, "Water Allocation in the American West: Endangered Fish Versus Irrigated Agriculture," *Natural Resource Journal* Vol. 36. Accessed March 2014. http://www.lawlibrary.unm.edu/nrj/36/.../06_moore_fish.

THE FUR TRADE AS A GEOLOGICAL FORCE

Beaver Beware: Euro-American Encroachment on the Big Hole Valley

Throughout U.S. history, Euro-Americans moved westward, first hunting or trapping for furs, then turning to mineral extraction after the critters that bore the fur became extinct. After the mines dried, homesteaders attempted to strike it rich from the dirt or simply farm for sustenance. The fur trade in Montana, first exploited by the French and British, picked up steam with the Louisiana Purchase in 1803. Lewis and Clark confirmed to the American public what the French had known for years: the American West abounded with valuable fur-bearing animals. The Lewis and Clark Expedition of 1804 and the intensification of the fur trade signaled the first stages of Euro-American-induced ecological and geological change on the waters and lands of the western United States.

Driven by nineteenth-century European hat styles, the beaver ascended to the top of the list in the fur trade. Pierre Choteau Jr., son of the principal founder of the St. Louis Missouri Fur Company, recorded the price of beaver skins in 1856 at two dollars apiece.[16] Early fur trappers in the American west could turn a decent salary while living a life of solitude and adventure. Trapper Louis Rivet recalls, “The wages of a trapper were $300 per year, and he must buy his own clothing and kill his own meat while trapping.” Employed by the American Fur Company in 1829, Rivet “trapped and hunted on the

[16] Pierre Choteau, Jr, "Pierre Chouteau Jr. & Company records, 1844," August 26, 1856, SC 66, Montana Historical Society, Helena, MT.

principal tributaries of the Missouri."[17] Once named the Wisdom River, the Big Hole is one of these principal tributaries, and in the 1800s, it teemed with beaver. Corps of Discovery co-leader William Clark commented in his journal about beaver populations in the Big Hole. On his return trip from the Pacific, Clark crossed into the Big Hole Valley and camped on the river and several of its tributaries. William Clark described the Big Hole and its profitable animal populations in this manner: "This extensive vally surround[ed] with [mountains] covered with snow is extreemly fertile covered [with] esculent plants &ᶜ. and the creeks which pass through it contains emence numbers of beaver &ᶜ."[18]

Many U.S. western historians have studied the demise of the North American beaver, but the geologic importance of the animal on the Big Hole River, both to its human and natural systems, is impossible to ignore. As zoologists Matthew Fuller and Barbara Peckarsky explain, "The ability of the North American beaver (*Castor canadensis Kuhl*) to alter its environment has been appreciated by hydrologists, geomorphologists, and ecologists for decades." The Rocky Mountain West was once a haven for beavers. Because of intensive trapping during the nineteenth century, rivers, once carefully managed by elaborate networks of beaver dams, became uncontrolled torrents of water. Fuller and Peckarsky explain that, "studies suggest that beavers primarily inhabit streams where discharge is low enough for a dam to be stable and adequate food resources are available." Before the trapping out of beaver in the Big Hole,

[17] William F. Wheeler, "William Fletcher Wheeler papers, 1859-1871," 1859-1871, MF 12, Montana Historical Society, Helena, MT.
[18] Reuben Gold Thwaites, LL.D., ed., Journals of Lewis and Clark, from Musquetoe Creek to St. Louis, vol. 5, *Original Journals Of The Lewis And Clark Expedition: 1804-1806* (n.p.: Arno Press, 1905), 253.

the many braids of the upper river provided the environment for successful beaver dam construction, and the animal thrived. The islands that separate those braids also provided ample food supplies and building materials for beavers.

Not unlike humans, beavers create their own environments. The riparian environment made by the beaver dams proved ideal habitat for cottonwood trees and willows, creating a cycle of life for beavers. Today, however, as a result of beaver extirpation, many of these islands wash out with the spring floods because of the absence of beaver and the dams they build. Fuller and Peckarsky explain the importance of beaver dams in this manner: "understanding the influence of beaver-engineered structures embedded in otherwise continuous stream networks is vital for understanding the fundamentals of longitudinal stream processes."[19]

In interviews with geomorphologist Karin Boyd, she discussed at length the critical importance of the reintroduction of beavers to the Big Hole. The numbers are slowly rising, she explains, but mainly on the smaller tributaries where the paddle-tailed engineers can more easily control water. Scientific studies are in the works, one possible solution is geographic placement, reintroducing beaver where their dams will be most productive to stream flows. For example, reintroducing the animals to the tributaries that release their water later in the spring, usually on the north facing slopes of the Pioneer Mountains, looks to be a possible place for reintroduction. Another possibility to help

[19] Matthew R. Fuller and Barbara L. Peckarsky, "Does the morphology of beaver ponds alter downstream ecosystems?" *Hydrobiogia* (n.p.: Springer Science+Business Media B.V., 2011, 35-36.

control water flows and discharge, are artificial beaver dams, or beaver dam analogues; manufactured, earthen dams built into the stream, that help control flows.

Presently identified as a "keystone species," a term coined by famed ecologist Robert Paine; beaver "drive diversity in an ecosystem."[20] Not only do beavers provide habitat for aquatic plant and animal species, they are geological agents. A beaver's role in an ecosystem is essential for stream incision, the geomorphological process of streambed lowering because of increased velocity in water flows. Scientists Michael M. Pollock explains that, although climate change may be a factor in alluvial incision, "Many of these changes are also contemporary with widespread extirpation of beaver in the nineteenth century." He continues, "In addition to lowered streambed elevation and disconnection from the floodplain, common physical effects of alluvial incision include lowered groundwater tables, the loss of wetlands, lower summer base flows, warmer water temperatures, and the loss of habitat diversity." Stream incision and its processes are necessary in understanding the effects of the nineteenth-century fur trade on the Big Hole. As Pollock explains, geology and ecology are clearly linked in stream function and evolution, leading to what he calls an "*ecogeomorphic*-process," which he defines as "dependent on the interaction of living organisms with hydrologic and sediment dynamics."[21]

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[20] Natalie Hisdahl, "An idea that spawned a legacy," Department of Biology, University of Washington e-news, last modified Summer 2013, accessed February 14, 2015, http://www.biology.washington.edu/newsletter/sum13/Paine%20&%20Waters.html.

[21] Michael M. Pollock et al., "Using Beaver Dams to Restore Incised Stream Ecosystems," Volume 64 4 (n.p.: *BioScience*, 2014), 279.

Pollock and his colleagues divide stream incision into four stages, which helps explain the Big Hole's fluctuation levels today:

> "(1) rapid incision lasting from years to decades, in which sediment outputs are greater than inputs; (2) incision trench widening with continued high sediment output; (3) slow aggradation that can last for centuries or longer, in which sediment inputs are greater than outputs; and (4) dynamic equilibrium, in which the average sediment inputs and outputs are approximately equal."[22]

The lack of beaver dams on the Big Hole, in other words, contributes to faster flows, which has the effect of pushing sediment off the streambed and depositing the soils further downstream. Having little impediment, the water flows unchecked, causing the river to become deeper and less wide. Furthermore, the unchecked flows give the river waters little time to seep into the ground table, which causes less riparian vegetation and abundance of ground water for agricultural use along the banks of the Big Hole. These incision processes also hinder the ability of aggradation, or the natural flooding of the river, further diminishing the availability of ground water adjacent to the stream. Below, you will find a diagram displaying stream incision and aggradation.

[22] Ibid. p.282.

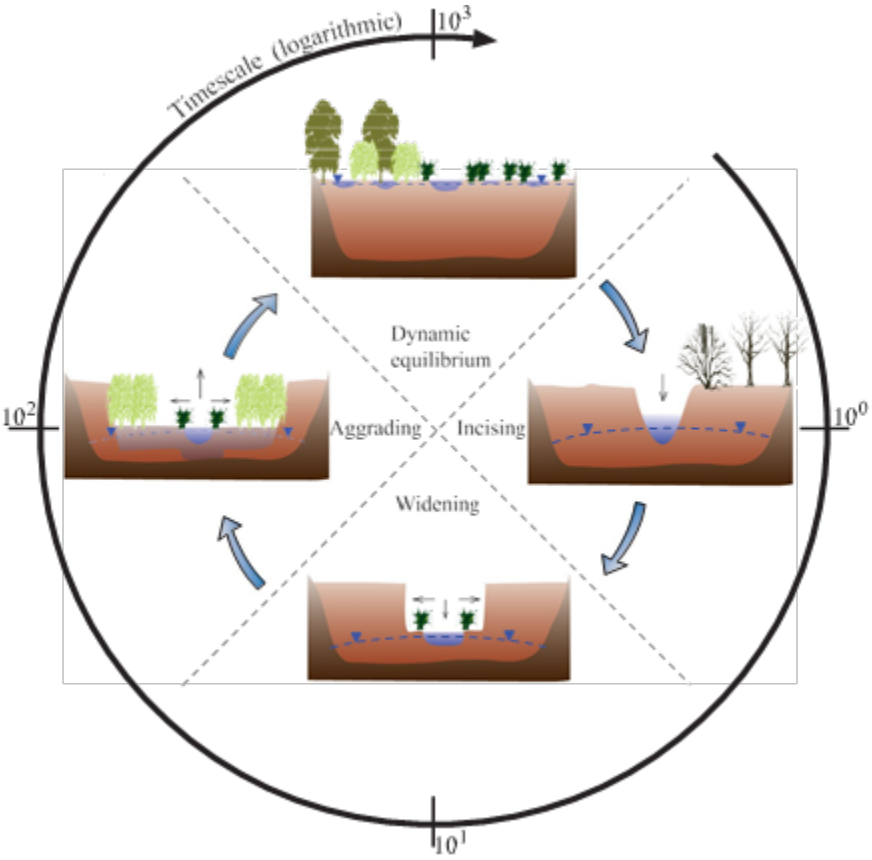

Figure 1. MICHAEL M. POLLOCK, "Using Beaver Dams to Restore Incised Stream Ecosystems."

To look at the relationship between riparian vegetative species on stream flows, we must turn to a new scientific interdisciplinary field called "ecohydrology." The authors of "Ecohydrology of Terrestrial Ecosystems," define the term simply as the "study of the interaction of the water cycle with biota." The streamside vegetation that the beaver subsist from, both for habitation and food, also relates to stream flows. On a global scale, this plays out as processes of evaporation and the connection between rainfall, and "evapotranspiration," the combination of transpiration and evaporation. Yet on the scale of a regional ecosystem such as the Big Hole, or "dryland regions," plants

and animals depend on soil moisture. Paulo D'Odorico explains that soil moisture might indirectly affect plants because of physical processes like "surface runoff and water erosion, which contribute to the spatial redistribution of soil resources."[23] Simply put, the lack of riparian root structures gives soils nowhere to collect, therefore allowing easier runoff of snowmelt without interruption.

Keep in mind, this discussion also applies to the presence of livestock in riparian zones, but the lack of riparian vegetation on the Big Hole begins with the present day lack of beaver. Going back to some of historian Richard White's ideas of incorporating labor and energy into riverian function, plants such as cottonwoods and willows, to name a few, attribute to the river's energy. D'Odorico and his colleagues give this example: "vegetation reduces the energy of water flow, shelters sediment beds, consolidates river banks, and enhances sediment deposition."[24] In the case of the Big Hole, the absence of beaver is a major contributor to the desertification of valley floors. Along with the desertification, agrarian stripping of the soil are also the same practices that caused the dust bowl in the Great Plains, which Donald Worster called "the darkest moment in the twentieth century."[25] Stripping of natural grasses to expose mineral-rich dirt causes erosion that proves almost irreversible. Streamside vegetation is an important link in the water fluctuations of a riparian ecosystem, just as the presence of water is necessary for proper plant development and habitation to these sensitive areas.

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[23] Paolo D'Odorico et al., "Ecohydrology of Terrestrial Ecosystems," *BioScience* 60, no. 11 (December 2010):898 & 899.
[24] Ibid, 903.
[25] Donald Worster, *Dustbowl: the Southern Plains in the 1930s* (Oxford, UK: Oxford University Press, 1979), 4.

Considering the lack of data on the Big Hole River, a fruitful comparison to help flesh out specifics is a study on riparian vegetation in Grand Teton National Park. Separated by only 500 feet or so in elevation and as the crow flies, a couple of hundred miles, Grand Teton is of similar climate and geography. Although exact microclimates in the Inter-mountain West are impossible to replicate, for a historical analysis of riparian processes, this comparison is acceptable. Elizabeth Christina Foy has explored the interdependence of geomorphological function on streamside vegetation, in particular the role of cottonwood trees. She writes, "Cottonwood regeneration typically occurs on recently deposited, damp alluvial surfaces, created by large flood events in early spring."[26] At this point, it is important to keep in mind that the Big Hole has lost much of its historical floodplain and is incising rather than aggrading. In essence, cottonwoods are a key indicator of stream and riparian zone health, much like the existence of healthy beaver populations. Stream flow, cottonwood life cycles, and robust beaver populations are all part of this cyclical, an interdependent relationship. How does the modern human fit into this system?

Ecology provides the tools and terminology to explore these interdependent relationships, in particular how a predator plays a role in altering of a particular ecosystem, or a "trophic cascade." Coined by ecologist Robert Paine, the term has become a lens through which to look at a specific ecosystem and its functions. In Paine's trophic cascade model, a prey species is introduced or taken away, resulting in a "cascade

[26] Elizabeth Christina Foy, "Riparian Vegetation And Forest Structure Of Two Unregulated Tributaries, Compared To The Regulated Snake River, Grand Teton NP, WY" (master's thesis, Montana State University, Bozeman, MT, 2008), 1.

of interactions extending through several trophic levels." Although a trophic cascade typically refers to the domino-like effect that occurs when a predator over exploits its prey, or in some cases underexploits it, nineteenth-century trappers, or capitalist practices can be seen as the predator and the beavers as their prey. Today, the flexibility of interdisciplinary study, particularly in environmental history, is giving further depth to these stories. We can now interlink human, historical developments and practices into these ecological roles. Paine's phrase is presently not the only scientific realm of thought that is enhancing historiographical narratives, especially in the case of the beaver were it is necessary to provide agency to the animal, or interdependence with human needs.

Indeed, the North American fur trade influenced the geology of the continent, and more specifically the geomorphology of the Big Hole River. The Big Hole beaver trade depended solely on foreign, European markets. Industrialization and the growth of competitive capital markets is the only reason trappers waded through waist deep snows, and below zero temperatures to harvest these creatures in the early nineteenth century. The dependence on European markets in relation to the extirpation of the beaver in the United States helps explain the current, geomorphologic state of the Big Hole.

Exact numbers on the nineteenth-century beaver trade are hard to come by, especially when tracking numbers from a specific region, much less a specific river. Fur trappers in the Rocky Mountain West often met at a rendezvous, or places for trappers to trade and celebrate a long stint of solidarity. Many of the origins of these furs were lost at that point. However, some stories of particularity do surface. In 1831, W. A. Ferris, employee of the American Fur Company, claims to have trapped some "forty to seventy

beaver a day" on the Henry's Fork of the Snake River, once again, not far from the Big Hole Valley.[27] Considering most modern-day, humans have more than likely not seen "forty to seventy beaver" in their lifetime, Ferris's numbers are astounding and they give us an adequate reason to examine the fur-trade as a geologic force on Western rivers, and vital part of these trophic cascades, linking all parties.

Even though, W. A. Ferris and many of his trapper companions did not simply use the furs of the beaver to turn a profit, but enjoyed beaver "large and fat" for dinner and found "when well boiled proved to be excellent eating."[28] Not only did the trappers revert into Paine's typical cascading model, European-American business practices profited from the fur-trade: capitalism and overseas markets where the benefactor of beaver extirpation. Historian Carolyn Merchant taps into the ecological consequences resulting from capitalist practices, with unrelenting insight and prose. Further explaining, Merchant writes, "An ecological approach to history asserts the idea of nature as a historical actor. It challenges the mechanistic tradition by focusing on the interchange of energy, materials, and information among living and non-living beings in the natural environment."[29] The cascading ecological process is a top-down approach, in which the predator affects multiple levels of the food chain, thereby causing a change in the entire function of the ecosystem. On the Big Hole River, we see this today, yet it is more than

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[27] W. A. Ferris, *Life In The Rocky Mountains: A Diary of Wanderings on the sources of the Rivers Missouri, Columbia, and Colorado from February, 1830, to November, 1835*, ed. Paul C. Phillips (Denver, CO: The Old West Publishing Company, 1940), 85.
[28] Ferris, *Life In The Rocky*, 85.
[29] Carolyn Merchant, "The Theoretical Structure of Ecological Revolutions," Environmental Review 11, no. 4 (Winter 1987, 267.

just a change in the ecosystem, lack of beaver in the riparian areas has proved to be a geological force, a direct effect of capitalistic ventures.

Through several meetings with geomorphologist, Karin Boyd, the landscape of the Big Hole in the early nineteenth century has become clearer. Karin's knowledge of river functions is impeccable, especially the rivers of southwestern Montana. Karin has been involved with several projects of mapping rivers in the area, including the Big Hole. Interestingly enough, Karin and several other geomorphologists are turning to the journals of Lewis and Clark, and memoirs from the fur-trade to help paint a picture of riparian ecosystems and river layouts in the region, prior to large-scale, white settlement. On inspection of riverbanks of the Big Hole, Karin has found layers of clay instead of river rock, which is typical of most fast flowing streams. These clay deposits are characteristic of slow moving water, or areas were stream flow has slowed enough to form a pond – and beavers are classic pond builders. On some of Karin's recent projects on the Clark's Fork and Red Rock Rivers, she and others have discovered sticks in these clay deposits. The distinctive chew marks discovered on the pieces of wood are obvious proof of the existence of beaver damming, and further suggest the interdependent relationship between beaver and river function.

Many geomorphologists argue that beaver extinction on the Big Hole and similar streams is the largest single contributor to their erratic fluctuation patterns, but as history has evolved on the river and in the valley, other Euro-American actions have distressed stream flows and the riparian ecosystems in the area. The importance of beaver on riparian ecosystems is a major factor in understanding geomorphology. Too often, the

finger points at irrigation and the practices of Big Hole agrarians; they carry the burden of all of the low flow issues on the river. However, they are not solely to blame, the cascading effects of Euro-American actions is not a single moment or action in time. This is not to say that irrigation is not a major contributor to the concerning water levels of the Big Hole, the fur trade and lack of beaver on the river only compound the effects of irrigation. The agricultural development of the Big Hole is the next focus of this story. One does not have to travel to far in time to arrive at the next wave of Euro-American settlement in southwestern Montana. By the 1840s, fur trapping was on the decline because of falling prices and, as we have seen, animal extinction. However, by 1862, the discovery of gold in the Inter-mountain West, and its effects transformed the Big Hole Valley and River once again.

LIVESTOCK, AGRICULTURE AND THEIR EFFECTS IN THE BIG HOLE

Sustainable Gold: Ranching in the Big Hole Drainage

In Montana, mining boomtowns sprouted out of some of the most inhospitable climates and landscapes in the American West. In Southwestern Montana, the discovery of gold in 1862 fostered the development of Bannack. Named after the Bannock Indians of the area, Bannack's success as a mining town earned it the title of territory capital for a short period. Just southwest of the Big Hole Valley, Bannack supported several gold and silver mines and became the epicenter of Euro-American development in the Montana Territory. The land in the area was mineral rich: one Montana Territory newspaper frequently reported mining success stories in the vicinity. For example, in 1866, *The Montana Post* reported that, "Smith & Greater and Captain Wall are doing well. They took out over $1300 [of gold] last week in Dry Gulch, a half mile west of Bannack, and their ground is improving."[30] With such optimistic headlines reaching beyond the U.S., it is not surprising that the lure of gold brought thousands of white settlers to the Montana Territory.

Although few stories of mineral prosperity come from the Big Hole River proper, mining did have its effects on the valley and river. On the heels of a successful mining towns come infrastructure and agriculture, providing miners and their families with sustenance and materials to carve out and maintain a civilized life in extraordinarily uncivilized areas. As early as 1874, the Big Hole and the neighboring Horse Prairie

[30] S. L. D., "Bannack Letter," *The Montana Post* (Virginia City, MT Territory), October 6, 1866.

Valley became prime regions for summer, free- grazing, and the vast amount of cattle provided protein for the miners and Bannack's inhabitants.[31]

No one can better explain this mining-agriculture development better than 1885 territorial governor, S. T. Hauser. In his report to the Department of Interior, Hauser explained, "For ten years the average yield of gold from 'placer diggings' was $12,000,000 to $15,000,000 per annum."[32] Placer minerals existed, "Through being eroded out of the rock, the gold [or other mineral] has been reduced to a loose condition that has permitted it to be transported and abraded by existing or prehistoric streams, which have finally deposited it on sandbars, in gravel banks, or in "potholes" in the stream beds."[33] Placer mining's accessibility to the masses and minimal capital investment caused the extraction of large quantities of gold and other valuable minerals in the area. Placer mining resulted in the abundance of ghost towns in the American West, and helps explain the boom-bust cycle of these areas. In support, Hauser stated, "Mines and mining caused the settlement of this country." But when the placer deposits disappear and the towns wither away, agriculture and livestock live on. Limits to the nineteenth century, Montana, agriculture economy however did exist, "the distance from the markets and the necessity of irrigation," are issues of which Hauser is concerned.[34] In

[31] Al Noyes. *The Story Of Ajax*. New York, NY: Buffalo-Head Press, 1966. 148.
[32] S. T. Hauser, "Report of the Governor of Montana," in *Report Of The Secretary Of The Interior 1885*, comp. United States Department of the Interior (Washington, DC: Government Printing Office, 1885), II: 1001.
[33] Paul, Rodman Wilson. *Mining Frontiers Of The Far West 1848-1880*. New York, NY: Holt, Rinehart And Winston, 1963. 6.
[34] Hauser, "Report of the Governor," in *Report Of The Secretary*, II: 1001.

less than twenty years, cattle ranching and livestock had become a staple of the economy in the territory.

During the same year that miners Smith, Greater, and Captain Wall were unearthing their fortunes, Nelson Story made his famous cattle drive from Texas to Montana. Mostly steers, these cows arrived in southwestern Montana "to feed the horde of hungry miners," said long time Beaverhead County resident, Jim Edwards. The female cows mostly came from Oregon and California, and were more than likely direct offspring of the cattle that made their way west on the Oregon Trail.[35] The natural grasses of the Big Hole Valley quickly became as renowned as the mineral deposits that surrounded Bannack. One report from 1900 explained, "The hay is the best to be found any place. It will fatten without grain, any animal that can be fattened." The article also showed the escalating reach of the Big Hole cattle trade, proclaiming, "Our beef cattle are sent to Chicago, Omaha, Seattle, Tacoma, and last but not least, to Dawson City [a boom town in the Yukon Territory]."[36]

Montana's valleys and grasslands gained attention from the U.S. Geological Survey, and geologist F.V. Hayden thoroughly documented the area in 1871. Made famous for his contributions of the initial geological studies of Yellowstone National Park, and remembered by the valley that bears his name, Hayden saw the promise of the livestock industry in Montana. Hayden excitingly commented, "Without any injustice to any other part of the West, it may truly be said of Montana that it is the best grazing

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[35] Beaverhead County Museum Association, comp., *More History of Beaverhead County Montana* (Dillon, MT: Beaverhead County Museum, 1997), 13 & 14.
[36] Ibid, 69.

section of the Rocky Mountain region." Hayden, possessing a strong grasp on ecological and geological processes further explains the valleys of Montana. He explained that, such valleys as the Big Hole were "covered with rich and nutritious grasses," which not only cover the valley floor, "but also the smooth hills and naked mountain slopes, and the same rich carpet continues even beyond these far up in the timber." Natural processes such as forest fires also contribute to the promise of the livestock industry. Hayden further explained, "Wherever a fire has swept up the mountain side…there springs up, in marvelously short space of time, a tall, green grass covering every possible spot where it can gain a foothold." And those grasses of the Big Hole, that were beginning to get as much attention as the gold discoveries in the territory became documented at length, and broadcasted from coast to coast. Hayden further commented, "the grass cures on the ground instead of rotting, remaining in this state all winter, furnishing, in fact, a better food than if cut and cured." Hayden continued, "There is seldom any difficulty experienced on account of the cold or snows of winter; many who have stock running on the prairies making no preparation for winter-feeding, which is seldom necessary." Hayden saw the promise of the livestock industry in Montana Territory, unlike mining; the grasses constitute a renewable resource, which would support ranching for generations to come.[37]

By the 1890s, cattle began to revolutionize the culinary palates of wealthy Easterners, which meant big business for venture capitalist. Richard White's essay, "Animals and Enterprise," documents the rise of the cattle industry in the American

[37] Hayden, Ferdinand V. *U.S. Geological Survey Of Montana And Adjacent Territory 1871*. Washington, DC: Government Printing Office, 1872. 269.

West, and the big business and popularity of beef in the industrialized East. “Americans came to think that they were living in the ‘Golden Age of American Beef.’” Common meat products such as pork had been deeply rooted in the Anglo-American culture for centuries. Pork was cheap, easily fed and did not need the amount of land cows required. But as White describes by the 1890s pork began to fall to the status of the lower classes of the East. “With cookbooks and magazines dismissing pork as difficult to digest, unwholesome, and unhealthy, fat beef became a health food.” With the combination of Hayden’s discovery of prime Montana grasslands, seemingly up for the taking, and Gustavus Swift’s invention of the refrigerated railroad car, all but guaranteed the Montana cattle industry success and prominence in this new market.[38]

Of course, by 1885, the cattle and livestock industries were a topic of concern in the territorial governor’s office of S.T. Hauser. Reporting to the Secretary of the Interior, Lucius Q. C. Lamar, Governor Hauser boasted that, “Next to mining, stock-raising is the largest and leading industry in the Territory.” Although Hauser admitted, “there are no statistics giving the exact exports” of cattle and other resources worthy of territorial recognition, actual livestock exports can be approximated “through the railroad companies, cattle and sheep organizations, mining companies’ reports…” For the Territory of Montana in 1885, silver was the largest export at an estimated $10,000,000, but beef and wool exports combined to be worth approximately $5.9 million or in today’s dollars well over $150 million.[39] Few could see the negative effects that livestock would

[38] Richard White, "Animals and Enterprise," in The Oxford History Of The American West, ed. Clyde A. Miller, II, Carol A. O'Connor, and Martha A. Sandweiss (Oxford, UK: Oxford University Press, 1994), 256.
[39] Hauser, "Report of the Governor," in *Report Of The Secretary*, II: 1000-1001.

have on the ecosystems and natural processes of these beautiful river valleys today; thoughts on conservation and responsible use of resources were still some time away.

The impact of livestock upon riparian areas is well documented and taught today in many ecology classrooms across the country. *Requiem for the Santa Cruz*, an environmental history told by several environmental scientists, explores the effects of livestock on riparian areas and river flows. Methodologically, the authors stress the importance of interdisciplinary work: "Archives, long the exclusive domain of historians and social scientists, are essential in reconstructing landscapes and climates of the past where conventional or standard measurements are unavailable."[40] The authors continue that, the presence and "role of livestock grazing in modifying watershed characteristics…decrease[s] soil infiltration, thereby increasing runoff and sediment production." In addition, along streams such as the Big Hole, livestock compete with other ungulates for forage, which further depletes riparian vegetation that helps maintain cool water temperatures thus affecting habitats for riverine aquatic species. They also point out that, "Livestock trails in riparian areas, where they are parallel to the channel, may concentrate flow, focusing erosion in the denuded, compacted paths." In other words, livestock trails then become part of the river system, providing water a path of least resistance.[41] Livestock trails become an important part of the natural and unnatural landscape.

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[40] Robert H. Webb, et al., *Requiem for the Santa Cruz: An Environmental History of an Arizona River* (Tucson, University of Arizona Press: 2014), 4.
[41] Robert H. Webb, et al., *Requiem for the Santa Cruz*, 28.

Scientists from federal agencies support these findings regarding the effects of livestock on riparian ecosystems and rangelands. Out of the 307 million acres of federal land administered by the U.S. Bureau of Land Management (BLM) for the purposes of grazing, roughly 159 million of the allotted land is negatively affected.[42] The collaborative article, "The Effects of Livestock Grazing on Western Riparian and Stream Ecosystem," is a comprehensive evaluation on the detrimental effects of livestock watering and grazing in and around streambeds. Carl Armour, Don Duff, and Wayne Elmore are all scientists for different federal agencies, but their views are scientifically based and not biased by the national laws that protect private rancher's livestock grazing rights on public lands. The livestock disturbance of riparian ecosystems is not limited to public lands, but private as well, which encompass most of the Big Hole's streamside property.

The BLM emphasizes "small," in its appraisal of land ownership stating on their website that the agency administers, "A series of small recreation sites [which] are located along a 73-mile stretch of the Big Hole River between Wisdom and Melrose."[43] The valuable, irrigable lands remain in the hands of just a few individuals. The distribution of land in the valley is a of land distribution processes, generations old. As illustrated below, an overwhelming percentage of lands in the Big Hole Valley are public

[42] Armour, Carl, Don Duff, and Wayne Elmore. "The Effects of Livestock Grazing on Western Riparian and Stream Ecosystem." Fisheries: The Monthly magazine of the American Fisheries Society, January 9, 2011, 9.

[43] United States Department of Interior: Bureau of Land Management. "Big Hole Recreation Sites." Last modified August 26, 2014. Accessed February 3, 2015. http://www.blm.gov/mt/st/en/fo/butte_field_office/recreation/big_hole.html.

lands, however the vast majority of land lining the Big Hole River and other tributaries and water sources remains in private hands.

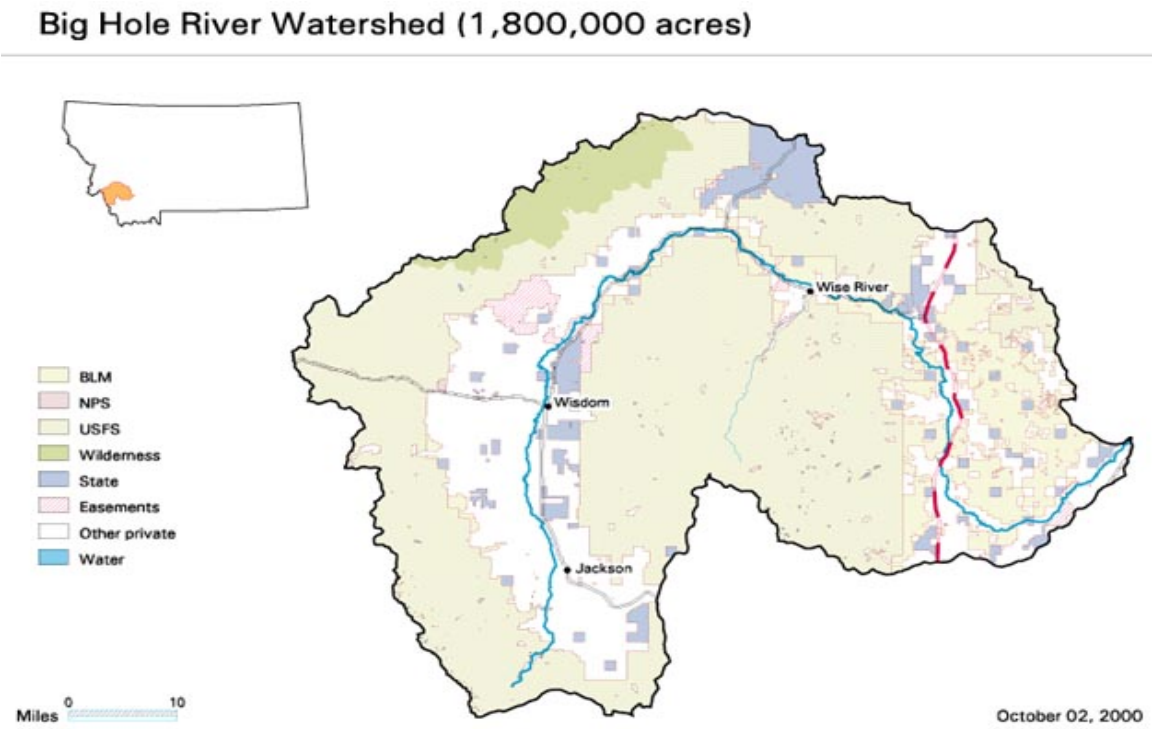

Figure 2. Image courtesy of United States Fish and Wildlife Service. http://www.fws.gov/mountain-prairie/pfw/montana/images/bh1.jpg. Accessed, Feb. 2015.

When speaking of livestock effects on the Big Hole River proper, private, not BLM lands, are the principal concern. In the Big Hole's arid landscape, shade vegetation largely lines the riparian areas of the valley. In warm weather, when the river is most susceptible to disturbances form livestock, and usually at its lowest levels, cattle tend congregate to the streamside, shading their selves from the beating sun. Armour and his colleagues explain, "Overgrazing in stream corridors has been so damaging to habitat that range managers have referred to these sites as 'sacrifice zones.'" Overgrazing is not the

only issue with foraging livestock in riparian areas. Opinions align closely with the authors of *Requiem for the Santa Cruz*. The riparian scientists explain, "Damage includes (1) loss of riparian vegetation by changing the composition and quantity of streamside vegetation and altering stream morphology, (2) lowering the groundwater table and decreasing summer stream flows, and (3) increasing summer water temperatures and winter icing." Foraging livestock easily explains the loss of riparian vegetation. But the vegetation does more than keep the waters in riparian areas cool; the root systems slows water discharge, enabling the groundwater to be collected and dispersed, naturally into the stream. Armour and his colleagues estimate that in the western United States, "more than 50% of the habitat in these ecosystems is damaged by cattle."[44] As we can see, the environmental cost of America's beef obsession goes well beyond what one may think.

D'Odorico and his colleagues explain the transformation of natural lands into farmland: "Anthropogenic disturbances affect nearly all ecosystems on Earth and the resulting changes in land use and land cover modify the dynamics of key hydrological processes." The hydraulic process not only lies in the surface waters, but the groundwater as well, since water sources contribute to stream flow in a river system. Displacing of original vegetation for crops is a highly destructive process to a river. "These changes in land-surface properties lead to decreases in evapotranspiration, precipitation, and water table depth, and increase runoff." Likewise, in most cases, afforestation, or adding planted trees and grasses for erosion control, wind and sun blocks, and aesthetic purposes, is also detrimental to the flow cycles of a river. They continue, "In many

[44] Carl Armour et al. "The Effects of Livestock Grazing on Western Riparian and Stream Ecosystem." 10.

wetland environments land-use change and climate warming cause the drying of historically waterlogged soils, thereby increasing the rates of soil respiration and turning these landscapes into carbon sources."[45] Clearly, the transformation of the Big Hole Valley into agricultural lands has caused detriment to the environment and changed the morphology of the river.

[45] D'Odorico et al., "Ecohydrology of Terrestrial Ecosystems," 900.

Beginnings of Statehood: The Homestead and Succeeding Land Acts

The transformation of the Big Hole Valley into farmlands was an ecological process with historical roots, the prime example of interdependency. The Homestead Act of 1862, the Timber Culture Act of 1873, the Desert Land Act of 1877, the Kinkaid Amendment of 1904, The Enlarged Homestead Act of 1909, and The Stock-Raising Homestead Act of 1916, all played their part in doling out mass tracts of land in the Big Hole and the American West. The overwhelming majority came to this remote section of Montana, not to become ranchers and homesteaders, but as discussed, to mine for gold. However, the passing of these homesteading Acts enabled white settlers to stay after the decline in profitable mining, and create the landscape that we see today. Whether digging and sifting dirt for precious metals and stones, or robbing the lucky ones that struck it rich, mining was the basis of Montana settlement. The BLM's official website states, "If you live by a river or creek, it's more than likely your property was once part of a homestead."[46] Beginning in the 1880s, homestead patents began running up the Big Hole just as explorers Lewis and Clark had half a century earlier.

As the succession goes in homesteading and the reason whites were in Montana to begin with, homesteads usually precipitated from mining claims. While many of the homesteading Acts differed by the amount of land that was available, price, and specific manipulations for use under the Act, all general requirements based themselves on the

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[46] Apple, Mary. "BLM Commemorates Homestead Act." U.S. DEPARTMENT OF THE INTERIOR: BUREAU OF LAND MANAGEMENT. Last modified Winter 2011. Accessed February 2015. http://www.blm.gov/mt/st/en/info/newsroom/steward/11winter/pxburn.print.html.

premise of the Homestead Act. The common criteria for all of the land acts reside in the first section of the Homestead Act, which reads as follows:

> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any person who is the head of a family, or who has arrived at the age of twenty-one years, and is a citizen of the United States, or who shall have filed his declaration of intention to become such, as required by the naturalization laws of the United States, and who has never borne arms against the United States Government or given aid and comfort to its enemies, shall, from and after the first January, eighteen hundred and. sixty-three, be entitled to enter one quarter section or a less quantity of unappropriated public lands, upon which said person may have filed a preemption claim, or which may, at the time the application is made, be subject to preemption at one dollar and twenty-five cents, or less, per acre; or eighty acres or less of such unappropriated lands, at two dollars and fifty cents per acre, to be located in a body, in conformity to the legal subdivisions of the public lands, and after the same shall have been surveyed: Provided, That any person owning and residing on land may, under the provisions of this act, enter other land lying contiguous to his or her said land, which shall not, with the land so already owned and occupied, exceed in the aggregate one hundred and sixty acres.[47]

The Homestead Act of 1862 allowed settlers to acquire and purchase larger tracts of land for half the price of a mining claim. This added to the total responsibility of land improvement or use, dating back to the old usufruct laws of Puritan New England.

Along with allowing some miners to turn their efforts to farming and agriculture, more aggressive land acts, such as the Desert Land Act of 1877, sought to attract easterners to the arid West. Politicians in Washington DC began focusing on revamping the economy after the Civil War. Eyes aimed to improve industrial output in the East to potentially extend into global markets. Abraham Lincoln and the Republican Party based their principles of off these very core elements, agriculture and technology. None of

[47] Act of May 20, 1862 (Homestead Act), Public Law 37-64, 05/20/1862; Record Group 11; General Records of the United States Government; National Archives.

these goals could be accomplished without a strong agriculture center, and what better way to make this possible than the promise of cheaper land and railroads to advance American civilization.

Early on, as Marion Oneal asserted, "The Answer is Water," or, more accurately, the question is where on Earth do you get it? And once found how does one control the snow melt-waters, especially in the aridity west of the 100th meridian? Shortages of land east of the meridian led to exceptions to the original Homestead Act. Swaths of land in the West became available to white settlers, but aridity, not Indians, remained the greatest inhibiter of white habitation. Larger tracts of land available for cheaper prices made the thought of homesteading in the arid West feasible to some. To make western settlement more appealing, "Congress enacted the Desert Land Act of 1877. It authorized entry of up to 640 acres of public land at 25 cents an acre, with patent to follow upon proof that the land had been irrigated." In 1877, irrigation became the principal factor to retaining a patent for the land. Authors of *Federal Public Land and Resources Law* explained that, "Some people received patents after hauling a can of water to the claim and swearing that irrigation had been claimed." In the end, large corporations, who used ghost claimers and "dummies" in order to meet the requirements of the Act, and collected most of the land. Subsequently, failure of private irrigation efforts led to the Reclamation Act of 1906."[48]

The Desert Land Act also helps explain the proximity of private land holdings aside streams and rivers in the West, like the Big Hole Valley. In a 1937 article, John Ganoe explained that, "The [land] entries were for long narrow tracts along the banks of

[48] George Cameron Coggins et al., *Federal Public Land And Resources Law 6th Edition*, (Foundation Press: New York, 2007), 104-106 &113.

streams and if 640 acres could be located in this manner the entrant had a great advantage in irrigating his land." This of course led to fierce competition for irrigable lands, which often led to corruption and fraudulent claims. Ganoe discovered, "W. H. Goucher, the special agent working in California, estimated that only 5 percent of the entries were made in good faith and that 90 percent of those in his district had been made between 1883 and 1885." Problems with the ghost claimers and "dummies" did not only exist in California, but Montana as well.[49]

In his 1885 report, Montana Governor Samuel Hauser explained that along with irrigable land, "cattle accumulate in the hands of a few persons, principally because large herds can be handled at less cost per head than small ones."[50] Costs were high, and even though the land was cheap, if appropriated under the Desert Land Act, large amounts of capital became a necessity for successful irrigation projects. Large investments and rich cattlemen usually had influential representatives in the Capitol. Governor Hauser was willing to attempt to cover up fraudulent land claims under the Act, and did so by saying that federal government interference in breaking up land monopolies actually hurt the poor settler. Ganoe stated, "The Governor of Montana Territory estimated that not over 5 percent of the entries were fraudulent and complained bitterly against the suspension of entries pending investigation, claiming that it was working "untold hardship" on the settlers."[51] Hauser's legacy concerning water manipulation is still evident today: a large dam and reservoir just outside of Helena, the state capitol, proudly celebrates his name.

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[49] John T. Ganoe, "The Desert Land Act in Operation, 1877-1891," *Agricultural History* 11, no. 2 (April 1937): 142 & 143.
[50] Hauser, "Report of the Governor," in *Report Of The Secretary*, II: 1001.
[51] Ganoe, "The Desert Land Act in Operation," 144.

Settlement, Irrigation and the Magnification of River Detriment

To better explain and paint a clearer picture of late nineteenth-century land acquisitions from the federal government and development of the Big Hole Valley, let us turn to the first autobiography ever published in Montana, the story of A. J. Noyes, affectionately called Ajax. Ajax was not a cattle baron of the West, but he did found the town of Wisdom. Noyes, like many others, did not necessarily make a living from western extractive industries, but rather from, the people that these industries attracted. Ajax failed at mining for which he had filled a claim on the Upper Big Hole. The Noyes family history dots the pages of the land patent pages in the late nineteenth century. Ajax and his wife, Hattie, purchased 605 acres in July of 1889 on the banks of the Big Hole, and the town of Wisdom today lies in the original land patent of the Noyes'.[52] The Noyes claim proved to be the first area resembling a community in the Big Hole. However, over the next half century, communities like Wisdom flowed down the valley as effortlessly as the waters of the Big Hole. The communities of Melrose, Dewey and Wise River all had their beginnings in the early twentieth century.

Easily irrigable waters attracted settlement, but the waters of the valley needed to be controlled, before large-scale irrigation could take place. The Big Hole River and its tributaries have experienced many manmade efforts of control. The most infamous and definitely the deadliest occurred on Pattengail Creek in the 1920s. The creek bears the

[52] U.S. Bureau of Land Management, "General Land Office Records," accessed March 12, 2015, http://www.glorecords.blm.gov/details/patent/default.aspx?accession=MTMTAA 071376&docClass=SER&sid=ivr34xe3.dzb.

name of a fairly disturbed Civil War Veteran, George Pattengill, fondly referred to as the "Wild Man of Montana." Upon returning to Wisconsin after the fighting had subsided, he found his wife with another man and shot him, before his wife "dispatched" herself. Pattengill made his home in a wikkiup, and "lived off the land and regularly frightened Butte fishermen until his demise in 1895."[53] The stream lived up to its name bearer's burly reputation and blew out the earthen dam on June 14, 1927, wreaking havoc on the communities below. The dam survived close to thirty years of flood and spring runoff, but met its match that warm, wet day.

Pattengail Creek runs into the Wise River, a substantial tributary on the lower Big Hole. Most likely, settlers dammed the creek as a solution to the lack of water for proper irrigation. The Wise and definitely the Big Hole River are simply too volatile for such a simple construction effort, but Pattengail Creek seemed the most viable option. However, after a season of heavy snows and wet spring the dam blew. A twenty-five foot wall of water surged down the draw, wiping out most structures in the small towns of Dewey and Wise River. The flood was the worst water disaster the area had ever seen, killing four. His hunting dogs discovered trapper Charlie Ferguson dead. Tracey Truman's body was found a week after his wife's, and their son's body never recovered.[54]

Although the incident did result in fatalities, a major environmental disaster could have ensued. The *Bozeman Daily Chronicle* explained, "Chris Norton, an irrigation farmer of Wise River, gave the alarm… With a small truck he managed to keep about 15

[53] Ellen Arguimbau et al., Montana Place Names from Alzada to Zortman (Helena, MT: Montana Historical Society, 2009, 203.
[54] Beaverhead County Museum Association, *More History of Beaverhead*, 863.

minutes ahead of the torrent." Norton headed downstream on the Big Hole to warn everyone in the flood's path. He reached a loaded freight train in Divide, heading south on the Oregon Short Line. "The train was pulling out when he shouted his warning to the station agent. The train was barely halted before the flood passed and took out the track at Maiden Rock three miles below."[55]

The cause of the flood was a lengthy cloudburst, which dropped massive amounts of precipitation, overwhelming the faulty dam construction. The torrent of rain, combined with snowmelt, stressed the patched dam to its limits. When the original dam was decommissioned, "a large V-shaped cut was made in it to release the waters. Farmers, however, closed part of the dam to hold water for irrigation purposes and it was this fill that went out, releasing the flood that caused havoc for a distance of thirty miles down the valley and canyons."[56] The result of this tragedy did not diminish dreams of an irrigated Eden in the Big Hole Basin. As historian Mark Fiege's work *Irrigated Eden* points out, farmers in the early twentieth century connected land manipulation with divinity. He further explains, "irrigators were master technicians whose work realized the inherent potential or purpose of the land."[57] But as we have seen, not in the case of Pattengail Creek. Plans for reservoirs came and went for years to come, but as irrigation conflicts grew through the years, the Pattengail site remained the best possible dam site well into the early 1980s.

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[55] Associated Press, "Wise River Dam Breaks Killing Four," *Bozeman Daily Chronicle* (Bozeman, MT), June 15, 1927, 1&2.
[56] Ibid.
[57] Mark Fiege, *Irrigated Eden: the making of an agricultural landscape in the American West* (Seattle: University of Washington Press, 2009), 23.

Damming the waters in the Big Hole Basin has been a legislative topic in Montana since the turn-of-the century, but narrowly escaped fruition in the 80s. Initiated by the Montana House Joint Resolution 80, a 1979 report by the Montana Department of Natural Resources and Conservation, titled "Potential Off-Stream Reservoir Sites In the Big Hole Basin," explored the history of reservoir site possibilities, state legislation and feasibility of dam sites in the basin. The Big Hole has been a topic at the state level for human control since 1915, before the Pattengail Creek incident. Aside from the abundance of land in the basin, the report states, "soil and climatic conditions… make irrigation an attractive means of increasing and stabilizing agricultural productivity." The report acknowledges the designation of the Big Hole as a blue-ribbon trout stream, but points out that, "In dry years…the dewatering effects of diversion of river water have deteriorated the quality of the fishery." The DNRC suggests that the fishery could possibly "be reversed by augmenting late-season flows." Thirdly, the report suggests that the damaging effects of spring floods could be mitigated in the future by dam construction. Tributary streams, such as Pattengail Creek, would enable the ability of a reservoir to control damaging floods, but damming of the Big Hole proper "could control some of these destructive flows."[58] Irrigation, consistent water flows for the fishery's protection, and flood control continue to cross party lines, and dam control on the Big Hole remains today, a topic of conversation.

Irrigation and agriculture in the Big Hole Valley has always been of special concern, but the growing popularity and monetary benefit of trout fishing to Montana's

[58] Montana Department of Natural Resources and Conservation, Potential Off-Stream Reservoir Sites In The Big Hole River Basin, 45th, 1977 Sess. (Mont. 1979). 1.

economy was reaching the Capitol. Red flags should have been raised in 1966 when "a portion of the river near Twin Bridges became dry, damaging the aquatic ecosystem of large segments of the river." Low flows again, yet not quite as severe, in 1977 "brought attention to the dewatering problems of the river, especially those related to water quality."[59] This event helped prompt House Joint Resolution 80, which are the contemporary origins to the conflict between agriculturalists and the outdoor community, over Montana's streams. Over the next few years, the state legislature would shell out tens-of-thousands of dollars to explore possible reservoir sites in the Big Hole Basin.

Although investigation of projects such as the Reichle Dam proposal of 1958 were funded by the state legislature, the major investigation with the environmental issue of the disappearing Big Hole did not begin until the 1980s. This investigation brings us back to the site of the 1927 flood, to Pattengail Creek. In another detailed report by the DNRC in 1983, Pattengail Creek yet again gained attention as the investigation site out "of 22 possible tributary storage sites," making this the largest funded effort by the Montana Senate, at $75,000.[60]

As a preliminary study, the report consisted of three considerations, environmental effects not being one. "The study included: 1) an analysis of the site's geology to determine its suitability for dam construction; 2) an engineering analysis of the dam structure and reservoir site; 3) an economic assessment, which weighed the costs of building the dam against the benefits that might be derived from it." According to the

[59] Ibid. 7.
[60] Montana Department Of Natural Resources & Conservation, Prefeasibility Report For The Pattengail Dam Beaverhead County, Montana, 48th, 1981 Sess. (Mont. 1983). vi & 1.

DNRC, the Pattengail Reservoir site "would have a total storage capacity of about 12,000 acre-feet." The reservoir site would flood "prime habitat for moose, elk, deer, beaver," as well as disrupt the "excellent fishery."[61] The geology of the Pattengail site, while suitable for a reservoir lacked proximal earthen materials for dam construction, and therefore took the site out of consideration.[62] Conversely, the engineering cost of the dam would be exponentially higher, because of the lack of feasibility of the construction of an earthen dam, costing an estimated $14.4 million dollars.[63] The report goes on to discuss the economic funding for the dam, stating that, "In addition to federal and state sources, some funds might be obtained from private sources." Because of the popularity of the Big Hole's blue-ribbon fishery, the DNRC does contemplate the filling of the "private sources" of funding from sportsmen groups and wildlife advocacy associations.[64] The reasoning behind this is the thought that the dam's ability to augment flows would provide a sufficient water level for sport fish of the river to survive low flow years.

Presently, it is hard to imagine a wildlife advocacy group, or state funded conservation agency promoting the construction of a dam on a stretch of free-flowing water. The Pattengail Dam site, though insightful in some respects did not come to fruition. But the DNRC report gives us a detailed look into the issues surrounding water use on the Big Hole River, and the thinking that goes into the central issue discussed earlier, the present lack of beaver on the river. Slowing the river's flows would help with land irrigation, reduce flood damage, and help raise the water table in the valley.

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[61] Ibid 2 & 7.
[62] Ibid, 16.
[63] Ibid, 23.
[64] Ibid, 47.

Today, the town of Wisdom and the upper Big Hole Valley remains the “Land of 10,000 Haystacks.” The fields are dotted with beaverslides, a clever invention birthed out of necessity and grit, used to stack hay. Hay and alfalfa farming in the valley is essential to keeping livestock alive through the long winters, because of the lack of natural grasses that Hayden documented. Floodplain irrigation is the main form of water manipulation now, giving life to hay crops and in turn, the cattle that depend upon it for life. Irrigation practices on the Big Hole River are the most modern and direct link to the extreme flow and are often solely blamed for the late summer, low flow levels. Recently, the fishing community and the many non-profit, conservation agencies that accompany the sport have brought the Big Hole’s water flows and rare species of fish to the spotlight. This attention has caused state and federal attempts at protecting the waters and the Artic grayling that still call the Big Hole their home. As we will see, management of the river has turned into yet another form of water manipulation. Trout fishing is becoming big business in the treasure state. In order to keep the rivers habitable for the fish, Montana invests heavily in conservation and management.

TROUT, CONSERVATION AND MANAGEMENT

Celebrated Waters of Salmonids

Fishing for trout is a rich tradition in Montana and drove important shifts in local economies, including an astronomical rise in land prices, especially those with stream access attached to them. Moreover, with the birth of the American environmental movement in the 1970s, river conservation became an important theme in the Big Hole Valley. In the early nineteenth century, rainbow and brown trout, even though exotic fish, became a fixture in most Montana streams and rivers. The importation of exotic fish created a conundrum: on one hand, we today see the detriments that invasive species cause to aquatic populations in rivers, yet on the other hand, the fishing community may not have developed into something we see today without the stocking of these foreign fish. Regardless, the combination of all of these events brings us to our third form of humans as natural agents on the Big Hole, fisheries management.

In *An Entirely Synthetic Fish*, journalist Anders Halverson explores the development of trout fishing in nineteenth and twentieth-century U.S. history. With a Ph.D. in aquatic ecology, Halverson knows the scientific development of fish manipulation and stocking in the U.S. first hand. He provides an amazing story to accompany his empirical knowledge. In his book, he tracks the rapid expansion of stocking for the purposes of sport fishing across the country, in particular the stocking of rainbow trout. These fish have transformed the aquatic balance of rivers like the Big Hole, but have also transformed the economies of rural states such as Montana, and

raised conservation awareness by creating a since of romanticism with loyal fishers to their favorite rivers. Although considered an invasive species to most North American rivers, except those within close proximity to the Pacific, rainbow trout have an interesting story of propagation across the United States and the world.

Cousin to rainbows, brook trout are native to the East Coast and for many years were the sport fish of the gentiles in this industrialized area. Yet, as the East continued to develop as an industrial juggernaut, people, especially those that recreated in the woods and fished in the streams began to notice a severely declining fish population in the rivers. Halverson turns to the story of George Perkins Marsh, as being one of the first river advocates in the U.S. A Vermont native, Marsh was an accomplished lawyer and politician, and used this platform to take a stance on protecting the sport fish of the East. Marsh published, *Man and Nature* in 1864, which paralleled his thoughts that he presented to the Vermont Legislature; "human activities were rapidly diminishing the numbers of salmon, trout and other fish in New England." His words displayed some ecological and environmental analysis that was ahead of his time. Declining fish populations, "according to Marsh, was due to a variety of factors." Overharvest, stream pollution, and dams were some of the obvious causes, yet Marsh took a deeper look these causes. "The logging industry and the clearing of the land for agriculture had also done their part." Just as some of the issues the Big Hole has experienced from livestock grazing on riparian areas, Marsh found, "The temperature of the streams had also risen as the trees that had formerly shaded them disappeared."[65] Although fish culturing had

[65] Anders Halverson, *An Entirely Synthetic Fish: How Rainbow Trout Beguilled America and Overran the World* (New Haven, CT: Yale University Press, 2010), 5&6.

already taken root, especially with the popular brook trout, the transformed streams needed a fish that was not as sensitive to wildly fluctuating water temperatures, they looked west for commercial fish transplants yet found the sport fish of their dreams.

In 1871, President Ulysses Grant signed off on the U.S. Fish Commission, which gave federal backing for such an endeavor. The plan however, was to locate a fish that could be used for recreation and more importantly, sustaining the commercial fisheries of the East, the target, salmon. Fish culturing had already sewn roots in the East, so the Commission had a hearty pool of culturist from which to choose. A 1971 Fish and Wildlife Service essay celebrating the centennial of the agency explains the history of government actions involving fish culturing. "Picked for the job of setting up the first Federal fresh water fish hatchery was Livingston Stone, one of the most experienced trout culturists of the day."[66] California salmon runs, although devastated by the gold rush and placer mining in the Sierra Nevada Mountains, were storied as more plentiful than runs of the Atlantic salmon back East. Natives such as the Wintu, still based their subsistence culture off the few runs that remained relatively plentiful, like those of northern California's McCloud River.[67]

According to the USFWS's essay celebrating the history of the agency during its centennial anniversary:

> "Stone and several assistants were instructed to travel to California, find the location of salmon spawning grounds, and there establish a salmon hatchery where eggs could be incubated and shipped to suitable rivers in an attempt to make these giant fish available to people in all parts of the Nation."

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[66] Ben Schley, "A Century of Fish Conservation (1871 - 1971)," U.S. Fish and Wildlife Service, last modified February 21, 2014, accessed March 2, 2015, http://training.fws.gov/history/Articles/FisheriesHistory.html.
[67] Arthur F. McEvoy, *The Fisherman's Problem: Ecology And Law In The California Fisheries 1850-1980* (Cambridge: Cambridge University Press, 1986), 48 & 49.

Along with Chinook salmon, Stone and his assistants found a fine species of trout that seemed more fit and resilient than the eastern brook trout. Stone started yet another hatchery, but not to fill the commercial demands; sport fishing and the economy that accompanied it kept this hatchery and Stone's legacy alive today. "Introduction of McCloud River trout met with success in many places. In addition to successful introductions over a wide area in the United States, rainbow trout were transplanted to the waters of all continents, in many of which they did as well or better than in their native range."[68] With this successful cross-culturization of sport fish, a national trout-demic ensued, which explains the existence of eastern trout in western waters, and western trout in eastern waters.

Much like the gold rush affecting the Big Hole second handedly by the mass introduction of livestock: the late nineteenth century, Butte copper boom, brought anglers, elite Easterners and rainbow trout to the river. As in the East, a long legacy of European aristocratic practices and pastimes, made their way to the Big Hole, but fishing became not just popular to the wealthy, who could afford work absences and forty-eight hour railroad journeys, which Teddy Roosevelt promoted. On the contrary, the railroads brought McCloud River rainbows to the working class of the Butte mines. Just as mining and ranching had defined Montana, fly-fishing gained traction with the masses. Montana historian Jennifer Brown also helps explain that, "The fishing train, with eight full coaches carrying upwards of 500 Butte residents, often disgorged its occupants all along

[68] Ben Schley, "A Century of Fish Conservation (1871 - 1971).

the river."[69] However, the Big Hole fishing boom would not have happened as quickly as it did without the influence of some of Montana's most prominent residents.

When writing a specific history, primary sources are like gold, but Montana historian Jennifer Brown's essay is a valuable source to evaluate the relationship of the turn-of-the-century, Butte fishing community has with the Big Hole. Therefore, Brown explains, "Private individuals and sporting clubs helped the government transform Montana fisheries." The Butte Anglers Club, founded in 1902 helped fulfill the sporting groups half of the transformation. Copper King, William Clark represented the "private individual," that filled the glass. Known for his shiesty political and business practices, Clark "built a fish hatchery at his Columbia Gardens amusement park." Influential in the development of the hatchery, the Butte Anglers Club and its more than one thousand members "poured millions of fish into local streams." Brown further helps explain the occurrences, by saying, "The club's size and actions indicate fishing's popularity in Butte and also illustrate how influential politicians became in local fisheries."[70] This process and the growing popularity of fly-fishing transcend the state of Montana, and would soon engulf American populations from coast to coast.

The Historical Legacy of Water Conservation V. User

The conservation effort is a direct response to the rise in popularity of outdoor recreation, in the case of water protection, a large portion come directly from the fishing

[69] Jennifer Corrine Brown, "The Gamest Fish that Swims: Management of the Big Hole River Fishery in Montana," The Pacific Northwest Quarterly 97, no. 4 (Fall 2006): 171.
[70] Brown, "The Gamest Fish that Swims," 172.

community, and the environmental movement of the 1960s and 70s. Water conservation groups in Montana meet their largest challenge when it comes to irrigation. Entire books discuss water rights in the West, but the issue in Montana comes from the prior appropriation doctrine, a common water usage law in states were mining was the first form of water use and manipulation. This doctrine has a sticky beginning, and Norris Hundley Jr. sums it up best. The California Gold Rush brought Easterners to the areas, the miners were unfamiliar with the climate, weather, and of the boom and bust cycles of water flow. Prior appropriation came to replace the common riparian doctrines based on plentiful, year round water in the East. Hundley explains; "The riparian doctrine guaranteed to the owner of the land bordering a river the full flow of the river… undiminished in either quantity or quality, and he was enjoined from impairing the similar right of other riparians."[71] Water in the East was plentiful, but a landowner's use of it could not interfere with water moving downstream.

Placer mining in the arid, California soil required ingenuity, but more importantly water. Miners "diverted the water from the rivers through flumes and ditches to the waiting sluice boxes, stamp mills, and other hydraulic machinery." The new miners of California, found themselves in a lawless land, thousands of miles from the reach of U.S. statutes. Helping to explain the violence in the gold-rich areas of the West, the miners turned to a new strategy for water use, which like the gold, relied on discovery. Hundley states, ""Priority of discovery, location and appropriation" became the basis of all mining rights, and the principles were applied to water as well as to the mining claim to be

[71] Norris Hundley, JR., *Water And The West: The Colorado River Compact and the Politics of Water in the American West* (Berkley, CA: University of California Press, 1975), 66.

worked."[72] First in time, first in right became the standard for the new territories in the West, which firmly bases itself in the practice of mineral extraction.

First in time, first in right might sound complicated, but it is easily explained. The first property owner has priority over following owners. Say a family homesteaded river frontage during the Desert Land Act; they were the first to extract water from the river, then the water priority belongs to them, and so on. The right to use the water, does not distinguish between years of drought and years of relatively high water flows, and is therefore extremely problematic to the water quality and availability during low flow years. The right holder can use the water for anything of "beneficial use." A collaborative document written by several Montana agencies describes "beneficial use" as "a use of water for the benefit of the appropriator, other persons, or the public, including but not limited to agricultural (including stock water), domestic, fish and wildlife, industrial, irrigation, mining, municipal, power, and recreational uses."[73]

If you are in search of muddy-clear terminology, Section 85 of the Montana Code Annotated may be of some interest. The laws of water use are so fuzzy that Montana, like most western states, employs a Chief Water Judge as well as, regional Water Masters, as the guardians of all things cold and wet. These state employees wade through complex issues of prior appropriation, conservation, and natural causes such as draught on a daily basis. But this merely serves as an example of the weight water issues have in Montana, and the amount of court time water issues consume. Yet the resource belongs to the state

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[72] Norris Hundley, JR., *Water And The West*, 67.

[73] Montana Department of Natural Resources and Conservation, Legislative Environmental Quality Council, and Montana University System Water Center, comps., Water Rights in Montana (n.p.: n.p., 2008), 1.

and its citizens, defined in the Montana Constitution, "[a]ll surface, underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people…"[74] How can so few have the right to use the state's water, especially, when the water belongs to the public?

Although Montana water rights are still on terms of appropriation, there are limits placed on water use by a single permit holder. One can imagine the extent of the water codes in Montana, but one section we should familiarize ourselves with, involves land holdings and acquisitions. First, water rights coincide with land ownership, in other words, if one buys property that before 1973 shows signs of irrigation, you also buy the rights to the water. MCA Section 85-2-311(C) defends the prior water rights holders of the area, stating, "analysis of the evidence on physical water availability and the existing legal demands, including but not limited to a comparison of the physical water supply at the proposed point of diversion with the existing legal demands on the supply of water."[75] New permit applicants have trouble receiving permitted water rights in large-scale agricultural areas. Their issues coincide with the problems pertaining to river conservation in Montana, and require federal statutes to over-ride state issued, water rights.

The water conservation effort is also in a difficult position because it is faced with state laws that are seemingly set in stone. The environmental movement of the 1960s and 70s not only popularized the study of ecology, but also climbed Capitol Hill. New environmental agencies, policies and laws implored to not only learn more about the

[74] Montana Constitution, Article IX, section 3(3)
[75] Mont. Code Ann. §§ 85-2-311 (1971 & Supp. 2014).

natural environment, but also protect it. Water has always been contested and highly sought after in the western United States, but the Endangered Species Act of 1973 added another layer of complexity to the pie for western irrigation. “Known as the “pit bull” of environmental statutes, [it] can be a formidable constraint on a wide variety of federal land uses in certain situations. Helped along the way by many court decisions, the Act arguably has become the most important national land use law.”[76]

Because of the ESA’s all-encompassing approach to protecting not only threatened or endangered species of flora and fauna, but the ecosystems in which they still thrive, makes the Act one of the largest advisories to western irrigation, and one of the most powerful tools of state land control today. Because of the diminishing numbers of fluvial Artic grayling, the ESA came to the Big Hole in the 1990s, to protect the peculiar salmonoids, which remained in the Big Hole and its tributaries after the last glacial retreat 20,000 years ago. Today, the Big Hole is home to the last naturally reproducing, fluvial Artic grayling in the contiguous United States, meaning local, state fisheries do not stock the fish.

After years of ironing out flaws within the ESA, the USFWS has developed several measures to ease the sometimes-harsh reverberations of the Act. One government measure known as a Candidate Conservation Agreement anticipates implementation of the ESA in a specific region. The USFWS defines a CCA as a:

> “voluntary conservation agreements between the Service and one or more public or private parties. The Service works with its partners to identify threats to candidate species, plan the measures needed to address the threats and conserve these species, identify willing landowners, develop

[76] George Cameron Coggins et al., *Federal Public Land And Resources Law 6th Edition*, 271.

> agreements, and design and implement conservation measures and monitor their effectiveness."

A preventative measure, the CCA is a valuable tool to counteract litigation from the public and possibly prevent a species from classification as threatened or endangered. The CCA is a powerful measure, but in the world of agriculture, money talks. Therefore, the USFWS developed an agreement that involves providing monetary supplements to agriculturists, known as the Candidate Conservation Agreement with Assurances. Researchers from Montana Fish Wildlife and Park, Peter Lamothe and Adam Peterson define CCAA in their essay concerning Artic grayling and the Big Hole River of southwest Montana. They define the term as:

> "A Candidate Conservation Agreement with Assurances is an agreement between the U.S. Fish and Wildlife Service (USFWS) and any non-Federal entity whereby non-Federal 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)."[77]

Spring of 2004, the grayling became listed as a "Class 3" candidate for listing on the endangered species list. Because of this listing, a CCAA issued in lieu of countless amounts of lawsuits over irrigation and water rights and their conflicting nature with the ESA. The USFWS offered payments to volunteering landowners in the Big Hole Valley, in hopes that the agriculturists would have a lesser need for irrigation water with monetary, government assistance. Litigation aside, if the CCAA could improve the population of the grayling, then the fish could potentially be delisted as a candidate for

[77] Peter Lamothe and Adam Petersen, Montana Fish Wildlife and Parks, "Candidate Conservation Agreement With Assurances For Fluvial Artic Grayling In The Upper Big Hole River." Accessed March 2014. http://www.fws.gov/endangered/listing/cca.pdf.

the ESA; at least for the short term and in the eyes of the USFWS, the stewards of the ESA.

Authorities have varying opinions on the effectiveness of a CCAA, in particular, on the upper Big Hole River. Recently, biologist and environmentalist, George Wuerthner, claimed “the Service [USFWS] seems to be putting a lot of emphasis on the fact that there are Candidate Conservation Agreements with Assurances (CCAA) and other measures in place, suggesting these will recover the fish without federal intervention or listing. Yet CCAA are voluntary and have no force of law.” Wuerthner’s article, “Politics Appears To Influence Artic Grayling Decision,” questions the legitimacy of the USFWS’ decision to delist the fluvial Artic grayling, which the agency did in August 2014. The USFWS “reversed an earlier 2010 ruling that Arctic Grayling in the Upper Missouri River system of Montana were endangered (but precluded from listing under the Endangered Species Act due to higher priority species).” Wuerthner discusses the agency’s flaws in data collection of the Big Hole’s grayling, one of which being, recording fish populations during high water years and not during years of average flows, which have proven to be detrimental to the river’s grayling populations. Furthermore, Wuerthner points out that, “Recent estimates (during high water years) now put the number of effective breeders at less than 400 fish in the entire 80 plus miles of the Big Hole River drainage where grayling are currently found.” Is this an instance of Richard White’s observation, environmentalists distancing humans from nature? Conversely, is

the USFWS just using the CCAA as a red herring for water compromise with the agrarian populations of the Big Hole?[78]

Current issues on the Big Hole River make the area ground zero for irrigation politics and displays how the ESA can affect local agriculture economies. Nevertheless, the explanation for the need to place the Artic grayling and for that matter the sections of the river, which the grayling inhabit under the restrictions of the ESA is not the direct result of irrigation. The Big Hole has a long history of water, or the lack of it. The words of Marion Oneal and the life of Jim Forrin tell the story of the fluctuation issues before the environmental movement even began. The Big Hole's Euro-American history is the perfect example of dependency, and building consequences from past generations. So, is the grayling the main reason for water contentions in the valley? Alternatively, is the grayling simply a symbol of our ancient past, and the beneficiary of modern, American environmental policy? The grayling is not necessarily the target of sport-fishermen, in fact, most of the fishing traffic occurs further downstream than the fishes' primary habitat of the upper river. The Artic grayling or at least the presence of the fish gives the Big Hole a specific sort of *wildness*, which helps attract visitors as if the river and valley remain untouched by Euro-Americans. This all suggests grayling are the only reason that measures to conserve the Big Hole's water has come into effect. Water is a non-renewable resource, the lack of it causes large-scale panic, and in other regions of the West, we are beginning to see that come to fruition.

[78] George Wuerthner, "Politics Appears To Influence Arctic Grayling Decision." The Wildlife News. Last modified August 28, 2014. Accessed December 24, 2014. http://www.thewildlifenews.com/2014/08/28/politics-appears-to-influence-arctic-grayling-decision.

CONCLUSION

The time has come for change. In August of 2014, the Big Hole's Artic grayling populations found themselves delisted as a species of concern on the ESA. Likewise, so did the waters of the Big Hole. When will we realize the need for irrigation restrictions and water saving legislation in the West? The control of the water resource still lies in the hands of the landowners, and they can use the resource at will. Will it take a situation resembling the one California is facing today before eyes begin to open and action taken? California and the Colorado Basin are facing serious threat from drought, and so are the 40 million people that depend on water from the Colorado River and snowmelt from the Sierra Nevada Mountains. Couple the draught, with some of the largest agricultural demands on water in the world, and you have a ticking, time bomb.

Surface waters supply the majority of irrigation needs in the West, but the problem in California is cyclical. Agricultural production has only begun to slow in California; the current drought is not a new phenomenon, precipitation levels and rising temperatures have been plaguing the state for the past fourteen years. California Governor, Jerry Brown recently passed the first mandatory water restriction in state history, cutting residential water use by twenty-five percent. Dennis Dimick, environmental editor for *National Geographic* explains that this is just the tip of the iceberg.

> "When surface water supplies are low, hidden water supplies beneath the surface in aquifers, or groundwater, are drilled to make up the shortfall. A large aquifer under the Central Valley is being rapidly depleted to make up for shortfalls in surface water supply. A 2011 study indicated that the Central Valley Aquifer is losing an amount of water each year equivalent to

> the nearly 29 million acre-feet of water found in Lake Mead, the nation's largest surface reservoir on the Colorado River."[79]

The cycle to implosion may be well on its way to reality for California. And many other states in the West may experience the same detriments soon.

Agricultural practices in California and the West relies heavily on the snowpack to provide water for irrigation. Studies have shown that once again the problems from agriculture are cyclical in their impact on the snowpack, not unlike the cyclical effects of low water on the Big Hole. Not only do they use the waters, but also farming on dry dirt creates dust that rises into the atmosphere, diminishing the snow's solar reflectivity and causing quicker absorption. Journalist Brian Clark Howard goes on to explain, "That process [absorption] is speeded up even further by dust and black carbon residue from natural and man-made sources, such as plowing and smokestacks, settling over the snow's surface. Such impurities decrease the reflectance and increase absorption of energy." NASA scientist Tom Painter explains that snow absorption is the quickest way to melt snow, not warm temperatures.[80] As we see in California and in events on the Big Hole, the interdependent relationship between modern humans and the non-human, natural world quickly becomes tarnished.

The Big Hole has indeed had a tumultuous past. Today, it is only a remnant of what it once was, a wide, braided stream, meandering its way through the floodplains of

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[79] Dennis Dimick, "5 Things You Should Know About California's Water Crisis." *National Geographic*. Accessed, April, 2015. http://news.nationalgeographic.com/2015/04/150406-california-drought-snowpack-map-water-science/

[80] Brian Clark Howard, "New Technology Measures Snowpack Amid California Drought," *National Geographic*, Accessed April, 2015. http://news.nationalgeographic.com/news/2014/08/140805-yosemite-snowpack-spectrometry-california-drought-science/

the valley, channeling its energy and cutting its way through its multiple canyons. The fur trade did quite a number on this scenic river. Agriculture added further detriment to the hydraulic cycle of the Big Hole Valley and River. In addition, the conservation movement battles long-standing, water use laws, and environmental issues that are seemingly irreversible. The problems on the Big Hole are layered effects of Euro-American usage. The relationship between modern man and non- human nature is clear, and the two serve as interdependent entities. Humans are not separate from the Big Hole's natural environment; they are the single largest contributor to its low flow levels. Human action, knowingly or not, is the largest geological agent- aside from tectonic action- the Big Hole has ever seen.

Unfortunately, there is no clear-cut compromise to the waters of the Big Hole or for that matter, many of the other natural resource conflicts in Big Sky country. However, we can all learn the lessons from our past, and educate ourselves on the causes of our past effects on the world around us. Modern humans now find themselves by pressing environmental issues, whether it is global warming or low-flow levels on a river, these issues do not have one singular cause. These are all cascading effects from previous generations. As humans evolve, so does the changing world. It is irrational to think that societies dependent on petroleum can just simply refrain from its use, likewise, for the ranchers and the farmers of the Big Hole to quit using the waters to merely stay afloat is out of the question. Compromise is the answer. A proper understanding of these generational effects may in turn lead to alternate solutions. At least for the short term,

education, experimentation, and a better overall working relationship between human and non- human nature is necessary to this interdependent existence.

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