

IRRIGATION AND LANDSCAPE CHANGE IN COLORADO'S  
GRAND VALLEY: 1880-1920

by

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Irrigation shapes people and land in the American West. By people I mean the social relations that develop as a result of competition and cooperation for land and water, and the technical knowledge required to manage these resources in an efficient and economically productive manner. By land I mean the natural environment serving as a canvas on which human culture is painted through time.<sup>1</sup> More specifically, the artifacts of irrigation—the areal extent of agriculture, specific crop types, water delivery systems, and other material objects required of food production—reflect interactions between societal relationships and environmental characteristics. Together, social arrangements and natural features merge in irrigated lands of the American West, as everywhere, to form distinctive landscapes.<sup>2</sup>

Besides the broader landscape-related changes brought about by irrigation, there are other specific issues related to its practice that require scrutiny in assessing its transformative effects in different places. Significantly, western irrigation developed with the participation of the federal government in planning and constructing an irrigation infrastructure throughout the region. By establishing various land laws and providing the technical expertise to manage water and enhance crop production, the federal government was instrumental in promoting settlement in the American West.<sup>3</sup> In doing so, the government transformed vague ideals into firm policy goals: who could own western land, how it would be distributed, where it should be irrigated, and what were the acceptable costs—environmental, economic, and social—of such development.

To implement these and other policies a number of bureaucracies were formed to plan water development projects, enhance crop production, control damage caused by crop pests and disease, and distribute government land to settlers and other development

interests. Through time, policies became more entrenched, land and water development efforts intensified, and the financial costs of managing these newly irrigated places escalated.<sup>4</sup> In short, the social and environmental changes wrought by irrigation hardened on individual places forming a new landscape. The purpose of this thesis is to examine and compare how factors associated with irrigation shaped the landscapes of three western places: California's Central Valley, Idaho's Snake River plain, and Colorado's Grand Valley.

The paradox to describing change in different locales, even as a result of similar inputs in each, is that the visible and cultural outcomes are always unique for a specific place. Regarding irrigated agriculture, the scale of the effort required to modify the local environment does much to influence this distinction among places. The number and size of dams, the length and size of flumes and canals, farm size, and requisite labor and equipment needs, vary among places and influence perceptions about just what kind of landscape is being formed. In many cases, irrigation allows communities to maintain features associated with a rural identity: shared labor utilized seasonally, "soft" edges distinguishing arable land from non-irrigated land for pasture or fallow, and small-scale conveyances of water to irrigable crop land. This contrasts with large-scale irrigation efforts where corporations require cheap and efficient labor on-demand, a large, reliable supply of water and a corresponding infrastructure, and the availability of technical experts to help manage the crops and water for efficient production. In such places the landscape connotes a kind of industrial efficiency, where crops grown in monoculture for export crowd out certain iconic elements found in rural settings. In short, scale matters. Both in the amount of land brought into irrigation, and the extent and sophistication of

the required infrastructure, the scale of irrigation shapes people's perceptions about the kind of landscape being formed in a particular place.

Finally, the costs of irrigation, whether they are measured in environmental, financial, or social terms, justify efforts to better understand irrigation practices. The federal effort present in distributing water throughout the West requires a redistribution of revenues that, on balance, favor western water users over easterners and western urbanites. The money is used to pay for the design and construction of dams and other infrastructure, and the salaries of bureaucratic experts to manage the water and ensure proper soil and crop management techniques. Policies related to land distribution, farm size, and the cost of water to be repaid by landowners for its availability and use, all had profound effects on the societal relations formed in newly developed western communities, and remain persistent issues today. The scale and intensity of irrigation have altered the environmental regimes wherever it is practiced. The arrival of crop pests, the proliferation of "weedy" plant species, degraded and salinized soils, the replacement of native fishes with exotics, and the general disruption of river ecosystems, are a few environmental changes associated with irrigation. A collective examination of these costs, including the direct financial costs and the unintended social and environmental outcomes, may offer some useful insights regarding place identity resulting from irrigated agriculture.

Much has been written about western irrigation. Most writing is contextually based, ranging from promotional literature and development propaganda by certain groups and individuals, to exploring the technical possibilities a particular basin or region offered for development, to historical analysis of the various legal, political, and

economic outcomes of irrigated agriculture. Broadly, four literary types, or impressions, for the prospects of western agriculture, characterize the irrigation historiography. The goals and purposes of the different types of writers overlap throughout the periods in which reclamation was undertaken, regardless of its intensity.

### *Technicians and Bureaucrats*

John Wesley Powell undertook the first best effort at systematically defining the numerous western watersheds and calculating their settlement prospects using irrigated water. In 1869, and again in 1871, Powell navigated the mid-section of the Colorado River. Later, he and others on the expeditions published fascinating accounts of adventure and privation. But Powell's primary objectives were to scientifically investigate the geologic and hydrologic forces shaping the regional landscape. Much of his career was spent in the employ of the federal government, which had an interest in opening the West to settlement. Nonetheless, Powell was aware of the limits western aridity and geography imposed on growth throughout the region. He argued for, and pursued in his professional career, a rational and modest approach to settlement, which conflicted with other more ambitious proponents of western growth.<sup>5</sup> Powell was also representative of a growing group of scientific professionals exploring the region's geological and anthropological past in the post-Civil War years. By filling in the last blank spaces on the western map, for articulating the benefits of a systematic course of irrigation development, and in promoting bureaucracies comprised of technical experts committed to resource management, Powell represents an early and persistent type in the irrigation literature.

*Boosterism*

While the writing of technicians—though not in Powell’s case—is often dry and filled with coded language relevant to rock and soil types, the rhetoric of irrigation boosters is altogether different. Although Powell was himself a promoter of western settlement, the kind of boosterism I am implying here reflects a naïve optimism regarding the prospects of irrigated farming and the relatively easy and stable wealth it would provide its practitioners. City chambers of commerce often touted the economic and cultural benefits of irrigation to the would-be settler. One individual, William Ellsworth Smythe, is notable for his intense fervor in promoting irrigated communities throughout the West. An easterner, Smythe traveled west as a journalist working in Kearney, Nebraska, and later, San Diego. He helped launch a national irrigation movement in 1891 by bringing together hundreds of farmers and water users at the first National Irrigation Congress in Salt Lake City, and through the publication of *Irrigation Age*, a topical source for irrigators. In it he also promoted a kind of “new society” based on community development through irrigation. His now classic publication, *The Conquest of Arid America*, outlined in glowing accounts the benefits of irrigation for communities in Colorado, Utah, and California.<sup>6</sup> Throughout his career Smythe maintained a primary interest in promoting and developing “garden communities”, places where a persistent rural identity might co-exist with the best ideals of American industry and egalitarian settlement patterns.

*Conservation Impulse and Scholarly Assessment*

Following on Powell's and other's early efforts, the federal government played an increasing and critical role in helping sustain and grow irrigation for a multitude of purposes. The Bureau of Reclamation, formed after passage of the National Reclamation Act in 1902, established itself by the 1920s as the source for technical expertise on irrigating western land while experiencing mixed results in planning irrigated communities. Early successes led Reclamation to tackle larger projects, introducing new complexities to the irrigation story. For example, the hydroelectric power generated by dams could both pay for the infrastructure and supply regional urban populations with energy. By 1970 a number of large dams and their reservoirs had transformed both the demographics of western settlement as well as the natural environment of the region's watersheds. Two strands of literature matured during this period, mostly as a result of the large scale and intensity by which irrigation was being undertaken. The first arose during the 1950s, when David Brower of the Sierra Club, with help from writer Wallace Stegner, squelched a dam project in Dinosaur National Monument. The dam's reservoir would have flooded the Echo Park area within the monument. Later, the Sierra Club was instrumental in negotiating dam sites with the Bureau of Reclamation concerning projects in Grand Canyon National Park, and at Glen Canyon along the Arizona-Utah border.<sup>7</sup> The Club's successes arose from a growing national conservation impulse bisecting with federal reclamation efforts beginning to decline. As the environmental and social costs of irrigation became clear, both public and political support for it began to wane.

A scholarly assessment of the irrigation movement arose concurrent with the conservation impulse. This was mostly limited to the legal, economic, and agricultural

effects irrigation introduced to the story of national development. How much did irrigation water cost, and who paid for it? Who owned the water and by what right? Which state's gained, and lost, through the rise of irrigation? Questions like these formed the core analyses of scholarly research done on irrigation. Increasingly, the social and environmental costs of widespread reclamation came under scrutiny as well.<sup>8</sup>

Such a historiography is based on literature across a long sweep of time and perspectives. The relevance of each category waxed and waned with its timing in correlation with the irrigation movement. For example, the naïve and idealistic rhetoric corresponding with the promotional literature lost its value in the face of drought and increasingly persistent crop pests. It was an important subtext to early irrigation development, but not what ultimately would sustain the movement widely and during times of hardship. Likewise, the conservation ethic was not initially foremost in irrigation engineers' minds. Only after larger projects threatened whole river ecosystems, were proposed for protected areas, or failed, as with the Teton Dam in Idaho, was irrigation development elevated to a national debate; concerns about the financial costs of continued construction also did so, especially for eastern and Midwestern politicians, who increasingly resented subsidizing western growth. All of this became fodder for scholarly and journalistic investigations, which came forth relatively late in the irrigation story.

*Purpose:*

The purpose of this paper is to assess the influence of irrigation in shaping the landscape of Colorado's Grand Valley. Doing so is important for reasons relating

directly to the trajectory of irrigated agriculture as a practice aiding western settlement. I want to know what choices pioneers had in selecting property, crop types, and irrigation possibilities. How did managing these concerns lead to other issues like labor needs, management of crop pests and soil damage, and competition for agricultural productivity with other places? And how did these, and other factors, influence the valley's social and physical landscape while fueling people's perceptions of this place?

Part of my purpose, too, is determining the specific parameters, including some listed above, useful in comparing and making distinctions among irrigated locales. For example, how do the crop types selected by growers influence the amount of land they can successfully work as individuals, or as family farmers? Is an external labor source available if necessary, and, if so, how does its presence influence the social relations in a particular place? What affect does the scale of the local irrigation infrastructure have on the physical landscape, and what are its environmental consequences?

These and other factors influence perceptions (and concrete effects) of the kinds of landscapes irrigated agriculture might derive. The Grand Valley was transformed from a sparsely settled wilderness into the state's most productive fruit district within a few decades. Even so, it remained a rural outpost at the eastern edge of the Colorado Plateau. While the valley's current landscape reflects the more diverse economic regime in place since the 1940s and 50s, it continues to mix the old irrigation order with the newer retail and manufacturing sectors in a persistently rural setting.

Part of my purpose is also to assess the reality of this perception for the Grand Valley, and how and why this matches with the landscape outcomes for other irrigated regions. Such comparisons are useful in examining our historical understanding of the

irrigation movement, and with informing future policies regarding irrigation and development in specific locales.

*Methods and Research Question:*

One means of assessing what has happened in the Grand Valley is to use other places as models for comparison; in this thesis I use California's Central Valley and Idaho's Snake River plain. For a summary of development in each place, I rely on work by historians Donald Worster and Mark Fiege who address irrigated agriculture in these regions.<sup>9</sup> From class tension and environmental decline in the Central Valley, to accommodation among water users and environmental persistence along the Snake River, these two examples represent a broad range of social and environmental variations deriving from irrigation, and their landscape analyses guide my own examination of the Grand Valley. The disparate conclusions drawn by Worster and Fiege underscore the value of assessing irrigation in the Grand Valley and lead to this paper's central question: Do either Worster's California or Fiege's Idaho serve as templates of landscape change for this place?

I begin by summarizing each author's analysis of landscape changes deriving from irrigation. This is followed by a more detailed outline of development in the Grand Valley, which I then compare with the California and Idaho models. For each place I consider how particular factors, including crop types, farm size, labor needs, and environmental conditions merge to form distinct landscapes. I conclude by reviewing some shared characteristics displayed in each of these places, along with their essential

differences, and what this may suggest about the perceptions people have regarding place identity for each.

*Data Collection:*

Data for this thesis were collected at the Denver Public Library's Western History Department, the Colorado Historical Society, also in Denver, and the Museum of Western Colorado, in Grand Junction. The libraries of Colorado University-Boulder and Colorado State University were mined for additional material. Sources from the State Historical Society of Wisconsin and the Geography Library at the University of Wisconsin-Madison are also included. I also draw on articles published in regional journals, promotional literature, census material, agricultural brochures, and photographs in assessing the Grand Valley landscape.

*Irrigation as Oligarchy: Water Use in the Central Valley*

In *Rivers of Empire*, Donald Worster argues that the persistent use of irrigated water for commercial agriculture creates undesirable social relations and environmental declension. He focuses on the western United States where, he explains, California is the center of an irrigated empire. To develop this assertion in detail he examines western irrigation during three self-described periods: *incipience*, *florescence*, and *empire*. As each period passes, the destructive social and environmental consequences of irrigation accrue throughout the region.

*Incipience* begins with the rise of Mormon agriculture in Utah, in 1847, and is soon followed by irrigated settlements in Colorado and California. During this period

California's Central Valley was swept up in a land-grab by wealthy persons, many of whom turned to cattle ranching and wheat farming. Prior to 1846, when California became a territorial holding of the United States, the Mexican government granted land to settlers, most of which was used for cattle grazing. These allotments, or ranchos, totaled more than 800 parcels state-wide by 1847. The unit of measure used to distribute land was the Spanish league; one square league equaled approximately 4400 acres. In the Sacramento Valley alone, one estimate is that just forty ranchos were established on over 1.3 million acres for an average landholding of 33,222 acres per owner.<sup>10</sup>

Following the American acquisition of California, land within the territory not already owned privately became the property of the federal government. In 1855 a state land commission was formed and it, along with the Homestead Act (1862), facilitated the transfer of government land to private owners. Unfortunately, these institutions and land policies often failed to limit to 160 acres, as stipulated by the act, the amount of valley land acquired by individuals. According to Worster, wealthy land speculators from San Francisco and Sacramento "lied, bribed, hired dummy entrymen, and manipulated laws to amass holdings of gargantuan size."<sup>11</sup> In the Central Valley, the Mexican precedent of large landholdings used for cattle ranches prevailed after American settlement. Besides ranching, wheat farming was the other principal use of valley land beginning at this time. For more than thirty years, from the 1860s until the 1890s, large valley tracts were planted in wheat. The long, dry summers and a flat, treeless plain were ideal conditions for the commercial production of this crop. The extensive landholdings necessary to grow cattle and wheat, and the powerful owners of these estates, delayed until the 1890s any substantive progress of irrigated agriculture in the Central Valley. *As incipience*

closed at the end of the century, the federal government was summoned to aid in the construction of irrigation works on the public land offered for sale throughout the West.

Passage of the National Reclamation Act (1902) marked the beginning of the era of *florescence*. To help prepare public land for private agricultural uses, a new bureaucracy within the federal government, the Reclamation Service (U.S. Bureau of Reclamation after 1917), undertook the financing and construction of irrigation works throughout the West. Early Reclamation projects offered mixed results in fostering agricultural communities through the wide distribution of land to new owners. By 1930 the Bureau faced a real crisis: either to squander its budget building irrigation projects anywhere, many in unproductive areas, or disregard its mandate and secure its future by providing water to private landowners on proven agricultural tracts, notably California's Central Valley. In choosing the latter option, the Bureau exacerbated class tensions between wealthy landowners, migrant laborers, and poor, would-be farmers. It also limited the opportunity for land ownership more widely in the valley.

Worster criticizes the Depression-era Central Valley Project (CVP) as the most expensive government subsidy to private water users in California, and one with dire environmental consequences. Specifically, he is alarmed by the Bureau's intense effort to reshape nature through an enormous irrigation infrastructure. The Project's main features resulted in "an eventual plumbing system of forty dams and reservoirs, twenty-eight hydroelectric plants, and eleven main canals", costing "\$2 billion at a minimum, or an amount roughly equal to the total value of all the farms in the state in 1930."<sup>12</sup> The CVP was the most elaborate scheme of water redistribution in the West, and it was, Worster concludes, how the Bureau "made more rational an irrational nature."<sup>13</sup>

The closing decades of *florescence* and the entire period of *empire* are represented by this increased “rationality”. The Bureau’s success in conquering nature, measured by the number and size of dams it erected along California rivers, resulted in a spoiled or artificial natural condition replacing the ecological diversity once abundant throughout the valley and its surrounding foothills. On this, Worster is unequivocal, using terms like “artifice” and “industrial” to describe the regional landscape emerging in the post-war era. The monolithic dams are “barrels...each with a colorful name but all looking alike, quickly becoming an industry in their manufacture, with industrial sameness in their idea and use.”<sup>14</sup> He exposes the strong relationship between technical experts, or bureaucrats, and large landholding irrigators as a driving force of landscape change throughout the West. Lost are opportunities for small farmers; overwhelmed are the well-being and economic enhancement for agricultural workers. Nowhere is this relationship, or its benefits of accumulated wealth and power, more successful than in the Central Valley.

*Industrial Eden: Irrigated Agriculture in the Snake River valley*

If *Rivers of Empire* represents one interpretation of landscape change resulting from irrigation, *Irrigated Eden* asserts a different set of outcomes for people and nature. In surveying the Snake River plain, Mark Fiege concludes that the potential for damaging social and ecological conflicts are very much a part of the irrigated landscape. Unlike California, however, the outcome is something other than humans dominating nature or exploiting one another. Instead, as irrigators altered the local environment to suit their needs, nature responded in unanticipated ways, forcing humans to rethink their relationship with the natural world and the agricultural possibilities it offered. During

drought years, for example, water shortages prompted conflict resolution and accommodation rather than sharpened social tension and an immense irrigation infrastructure. The landscape forces remade the desert not into an empire but a garden (see chart below).

	Nature	Social Relations	Landscape
Worster	Abused and diminished; replaced by human artifice	Competition and the inequitable distribution of land and water; class tension among laborers/landowners/technocrats	Hydraulic society
Fiege	Ecosystems modified but dynamic and resilient; reflects human influence on nature as a constructive hybrid	Cooperation necessary to develop “community”; accommodation necessary to distribute land and water	Industrial Eden

The water impounded by dams built along the Snake River provided an environmental setting attractive to many plants and animals, including humans. Fiege connects the man-made reservoirs to the garden landscape, where “irrigators planted trees and created parks along the shorelines. Groves of cottonwood, willows, poplars, and other trees provided shady picnic sites where farm families sought respite from work and the hot summer sun.”<sup>15</sup> Lake Walcott, itself a man-made reservoir, “attracted an array of avian species, including white pelicans, great blue herons, cormorants, ducks, and numerous other birds that frequented lakes and wetlands.”<sup>16</sup> Plants, whether weeds like Russian thistle or the farmer’s own sweet clover, went unchecked, taking hold outside farmer’s fields along the banks of canals. The emerging landscape here was not so much ecologically diminished as it was reorganized into a new hybrid condition.

The crop types selected by irrigators added to the complexity of managing this new environment. Hay and wheat were initially grown throughout the valley, but the arrival of the alfalfa weevil by 1920 marked the need for growers to diversify their crops; potatoes and sugar beets increased in importance among growers. One problem with these crops was their need for greater amounts of water. Ecological consequences combined with finite water in straining irrigator's social relations, especially during drought years.

By 1910 growth near Twin Falls created a demand for water nearly equal to that of upstream residents between Rigby and Blackfoot. Jackson Lake Dam, built to store additional water, added to the complexity of water management even as it smoothed out irrigators' concerns over periodic water shortages. Allocating water under such competitive demands required a precise knowledge of water losses through evaporation and seepage, along with any downstream gains in return flow. Engineers found it nearly impossible to determine the amount of water held in the river at given points and to whom the water belonged.

When recurring drought finally forced upstream irrigators, in 1920, to take action against their downstream competitors, they organized to verify the allocation practices in use by government managers. Their findings confirmed that downstream users were benefiting from the current allocation policies. Nonetheless, a more equitable management plan remained elusive. The river, "as the watermasters and engineers had learned, was a capricious entity, mutable and irregular within the confines of its broad seasonal cycles, a living river that humans could neither measure exactly nor regulate fully."<sup>17</sup> As competition for water became more acute, irrigators made arrangements for

conserving and sharing it, and for mitigating the economic and agricultural afflictions caused by drought. One example, the Committee of Nine, worked out an agreement to share water among growers whose timing to water rights was last but who suffered during drought years for lack of available water. The hazard here for senior water users was that by sharing during dry years, they would lose their claim to this water during other years. While water rights were indeed acknowledged, this outcome suggests an understanding by individuals and institutions alike for the need to distribute water widely to sustain regional growth and prosperity.

The need for labor and the tasks it performed varied over time as agriculture evolved to include family farms and industrial production. Small farms where neighbors and relatives shared in the work of digging irrigation ditches and harvesting grain crops were the early prototype of irrigated agriculture in the valley. By the 1890s an industrial mode arose alongside traditional family farms. Instead of irrigators segregating themselves by farm size, however, they often remained near one another. In the initial stages of industrial agriculture small operators often exchanged labor for processing equipment and facilities they could not afford themselves. Later, this arrangement resulted in the exchange of labor for cash wages, which was a crucial step in the transition from grains to more valuable and labor-intensive crops like potatoes and sugar beets.

Each crop required a specific set of social innovations to grow, process, and market in commercial quantities. Sugar beets, for example, required close attention and care throughout the growing season, and once harvested, were sent to processing plants where locals worked in shifts to refine the beets. Potatoes were dug up, cleaned, sorted,

and shipped to consumers in sacks advertising Idaho as their place of origin. The accommodations made to foster such growth—hired labor, machinery, processing plants, marketing strategies, and rail transport—all influenced the social fabric of the landscape in important ways. Thus, labor “reflected a convergence of the family farm ideal and industrialization”, and “linked America’s agrarian past and its onrushing industrial future.”<sup>18</sup> The bounds between nature and technology became muted in an “Industrial Eden”.

In closing this discussion on the models of irrigation development, it may be worth considering the influence of the practice on local landscape appearances, how these differ in each place, and the underlying social or geographical conditions creating these distinctions. In California, the prior use of land and water for ranching slowed the early growth of irrigation development more widely and set a precedent for large landholdings for most types of agriculture. These early land uses required relatively few laborers, and set in motion state water rights limiting its distribution for wider settlement in the Central Valley. Later, the valley landscape became characterized by an extensive and costly irrigation system channeling water from the surrounding mountains to growers of an immense array of crops. The uniqueness of certain crops grown on large farms necessitated their export for profit. The large scale of agriculture and irrigation, the value derived from specialty crops, and the cost involved in owning and managing productive land here, suggests for some the presence of an “industrial” landscape.

In contrast, irrigated agriculture was the first use of Idaho land by Mormon settlers coming north from Utah. Rather than growing crops for export, early irrigators were limited by the available labor and a small irrigation system in producing for local

and regional consumption. Initially, dams were relatively small, earthen structures. Population growth and its resultant demand for water eventually led to the construction of a few mid-size dams and reservoirs along the Snake River. Even as irrigators became specialized in the growth of certain crops for export, the new landscape they created seems not to have diminished altogether the Snake River regions rural character (see chart below).

#### Landscape appearance in California and Idaho

California	Idaho
Initial large tracts in ranches and wheat farms carry over to large irrigation holdings	Smaller landholdings match available labor, early irrigation techniques, and local crops
Diverse crop selection, including fruits, vegetables, nuts, and grains	Relatively limited crop types: mainly fruits, potatoes, sugar beets, and alfalfa
Intensive, complex, and costly irrigation infrastructure; many large dams and canals	Few modest dams and reservoirs along Snake River; extensive but modest canal system
City centers distinct from vast farming districts; absentee landowners a common trait	Towns and cities at the center of agricultural tracts

#### *Water Use and Horticulture in the Grand Valley*

The Grand Valley in west-central Colorado covers approximately 315 square-miles (201,600 acres), about half of which is irrigated. It extends from the mouth of DeBeque Canyon at the valley's northeastern end in a stretched V-shape, ending thirty-five miles to the northwest. This is a much smaller area than the Central Valley (22,000 square-miles) and the Snake River plain (12,000 square-miles).<sup>19</sup> The valley's largest

city, Grand Junction, was founded in 1881 by George Crawford and is located at the confluence of the Colorado and Gunnison rivers; other valley towns, including Clifton, Palisade, Fruita, Loma, and Mack were established later. Ambitious settlers dug canals to water their fields, and agriculture was an instant success. Experiments in horticulture yielded optimistic results, especially for the trio of apples, peaches, and pears. The demand for fresh fruit by regional mining camps combined with the abundant water flowing through the valley, lead to the commercial production of these and other crops. By 1891, a decade after Grand Junction's inception, much of the valley was transformed from a sparsely settled wilderness into a horticultural oasis.

Settlers developed an agricultural regime and infrastructure by capitalizing on the valley's natural advantages. Pacific air masses influence a moderate climate here, giving the valley a longer growing season than in Front Range or mountain communities. The average length of the growing season in Grand Junction is 190 days; it is 172 days in Pueblo, the site of Colorado's second longest growing season.<sup>20</sup> This is an especially important factor in the practice of horticulture, and is also an advantage for other crops. The season-long availability of water, and the relatively small area for which a distributive infrastructure was required, were two other conditions helping settlers to rapidly develop irrigated agriculture here.

The water used for crops came from the Colorado and Gunnison rivers. Few communities, upstream or down from the Grand Valley, drew water from the larger Colorado River at this time. Along the North Fork of the Gunnison River, only a few small upstream communities, notably Paonia and Hotchkiss, withdrew water, mostly for growing apples and alfalfa. The water of the Colorado River, fed in Grand Junction by

the Gunnison and Uncompahgre rivers, passed mostly unused across the state's western border.

Settlers successfully reproduced the infrastructure of irrigated agriculture from elsewhere while merging it with the valley's natural features. The first orchards were planted near Grand Junction. From the time of initial settlement in 1881, and until about 1890, valley residents experimented with a variety of fruit crops, including apples, peaches, pears, cherries, apricots, grapes, and other small-garden fruits like raspberries and strawberries.<sup>21</sup> While these crops all remained in the Grand Valley landscape after 1890, apples, peaches, and pears were selected for commercial production. At first, growers had to carry water from the river to their crops in buckets placed in wagons. To remedy this problem three water projects, the Pioneer (later, Mesa County) Ditch, the Pacific Slope Ditch, and the Grand Valley Ditch (later, Grand Valley Canal), were all under construction by 1882. The Pioneer and Pacific Slope ditches delivered water to only a small part of the valley, just north of the Colorado River and near Grand Junction. These canals were relatively short, six to ten miles long, and were the efforts of neighbors—farmers and ranchmen—working together to ensure the success of the fledgling community. They took only a few months to complete and were in use by the summer of 1882. The projects, though cooperative, were not undertaken as a comprehensive plan for water distribution in the valley. Taken together, the Pacific Slope Ditch and Pioneer Ditch watered only 7000 valley acres. Each group of irrigators sought only to deliver water to a small area proximate to the Colorado River and for mostly private use. These and other lesser ditches were quickly and often poorly built.<sup>22</sup>

Although it too was an early irrigation project, the Grand Valley Canal represented an intermediate stage of water supply coming between small-scale ditches and subsequent federal intervention in the 1910s. The Canal's infrastructure included the Mainline and Fruita Lateral (Highline) canals; these were twenty-four and twenty-five miles long, respectively. Because it was so much longer than other ditches in the valley, it took more time, just over two years, to build. Financing so large a project required investment capital from outside the valley, and money was solicited from investors in Denver, and later, Hartford, Connecticut. Consequently, valley irrigators did not maintain ownership rights to either canal or the water they supplied.<sup>23</sup>

The Grand Valley Canal (Grand Valley Ditch at its inception) was started late in 1881 by a small group of local ranchers in need of an immediate water supply for their crops. Shortly thereafter, this group sold its interest in the project to Matt Arch, an entrepreneur from Gunnison; Arch renamed it the Grand River Ditch. Arch intended the project to irrigate fifty thousand acres of valley land, leading many locals to view it as a comprehensive water plan for community success. Because the valley's future was staked on a reliable water infrastructure, one local newspaper, the *Grand Junction News*, criticized area ranchers building a fourth canal, the Independent Ranchmen's, when Arch's money was running out.<sup>24</sup> In hindsight, this was a predictable response by the paper, or other civic-minded interests concerned about the valley's long-term viability. Arch's project was unusually large for its time and its success hinged on unified local support. The construction of another small canal, delivering water to relatively few individuals, invoked a sense of competition and sharpened the distinction between public and private betterment.

In August 1883, Arch sold his interest in the project to T.C. Henry and the Colorado Loan and Trust Company of Denver. In the spring of 1884 the project, including the lengthy Mainline and Fruita Lateral canals, was complete. Unfortunately, the high cost of maintenance combined with low revenues forced Henry by November 1884, to sell the Grand River Ditch to the Travelers Insurance Company of Hartford, Connecticut. Traveler's assumed responsibility for the Ditch's operation and maintenance costs until September of 1888, when low revenues forced the company to sell the Ditch at auction. Two years prior to the sale all Grand Valley ditches, including the Mesa County, Pioneer (and Extension), and the Independent Ranchmen's were consolidated to sell water rights rather than exact a rental fee on users. This gave farmers ownership rights to the local water supply, which improved water management practices in the valley but did nothing to reduce maintenance costs. At the auction, Travelers offered the winning bid, thereby reacquiring the Ditch, which it renamed the Grand Valley Canal. Valley residents' concerns about the control of water by outside interests were renewed after the sale of the Canal. In a court case filed against Travelers by the Canal's previous owner, Colorado Loan and Trust, the verdict (1892) deemed illegal the recent sale of the Canal and required its return to local interests. In February 1894, the Ditch was once again sold at auction, this time to John Brockway, who subsequently transferred his rights of ownership of the Canal to the new Grand Valley Irrigation Company. Ten years after losing control of water in the valley, local residents once again found themselves in charge of its use.<sup>25</sup> An intermediary between small-scale neighborhood canals, and the larger government Highline Canal, the privately financed

Grand River Ditch secured the valley as an important region of commercial horticulture in Colorado.

The Grand Valley's irrigation infrastructure, represented after 1894 by the Grand Valley Irrigation Company, delivered water to approximately 45,000 acres, mostly north of the Colorado River and east and west from the town of Grand Junction. Later that year, the Kiefer Extension was built near the canal's western terminus, adding another 10,000 acres of irrigated land to the valley's total.<sup>26</sup> After 1902 the federal government undertook irrigation projects throughout the West, including the local Grand Valley Project (GVP). A section of the government Highline Canal (not to be confused with the Fruita Lateral, or Highline Canal, associated with the Grand Valley Canal) delivered its first water to the valley in 1916, marking the first significant addition to local water infrastructure since the Kiefer Extension. When completed in 1917, the government project delivered water to an additional 40,000 acres of valley land, mostly at higher elevations from Palisade in the east to Loma and Mack at the valley's western fringe.<sup>27</sup> From 1921 to 1927 the Bureau of Reclamation undertook a smaller project to move water from the river up onto Orchard Mesa, an upland area east of Grand Junction and of considerable productive value.<sup>28</sup>

As with other isolated western communities, early agricultural planning focused on supplying crops for local consumption. Aside from a typical suite of grains and vegetables, many settlers were particularly eager to experiment with fruit crops. Encouraged by the production of fruit elsewhere in the state, early residents wasted little time planting a variety of fruit trees and small-garden crops. According to one valley historian, by 1886 "almost every farmer had from a few trees to a large orchard."<sup>29</sup>

Valley growers located crops by matching the physiological needs of certain fruit trees with the local topography. Peaches, for example, came to dominate the upper valley around Palisade; the Redlands area, west of Grand Junction, also became a significant peach-growing district by the 1930s. In both places, the nearby cliffs absorbed sunlight by day and reradiated its heat energy at night, protecting the spring blossoms from damage when the temperature dipped below the freezing point elsewhere in the valley. In the lower valley, near Fruita, Loma, and Mack, apples were the dominant fruit crop; potatoes and sugar beets were also grown successfully.<sup>30</sup> Three crops—apples, peaches, and pears—were in great demand, and by specializing in their production growers rapidly transformed the valley into a horticultural oasis (see Table 1, next page). Mesa County by 1900 contributed 16%, 36%, and 45%, respectively, to the state's total production of apples, peaches and nectarines, and pears. Production of each crop rose significantly by 1920 to 28%, 67% (peaches only), and 93%, respectively.<sup>31</sup>

In addition to a water supply, agricultural growth in the valley relied on rail transportation for shipping crops and attracting settlers. George Crawford, Grand Junction's founder, petitioned the Denver and Rio Grande Railroad Company to build a line through the valley in exchange for shares of town company stock. Making Grand Junction the center of all rail operations within the valley was an important early step in establishing the city as a regional economic hub. The first train arrived in the valley in November of 1882, and by 1883 the Rio Grande Western Railroad added a line to Salt Lake City, connecting the valley's produce to additional markets.<sup>32</sup> Fruit was packed in refrigerated cars to preserve it until its arrival at market. The first private ice house was built in Grand Junction in 1882 to store ice cut from the Colorado River during the winter

season. Larger community storage houses were subsequently built to keep pace with the valley's growing fruit shipments.<sup>33</sup> Whole train-car loads of fruit were being shipped to eastern states and to large cities where Grand Valley fruit was often in greater demand than similar products from California.<sup>34</sup> The valley competed favorably with national fruit-growing regions despite its small size. This was true at least for its crop quality, if not sheer quantity.

Table 1- Fruit trees of bearing-age in Mesa County and rank among all CO counties<sup>35</sup>

	Apple	State rank	Peach	State rank	Pear	State rank
1890	3469	7	4434	1	280	3
1900	325,793	2	85,224	2	38,092	2
1910	347,137	2	336,718	2	77,532	1
1920	477,800	2	242,200	1	115,525	1
1930	108,950	3	285,754	1	139,114	1
1940	20,269	7	445,462	1	71,504	1
1959	19,414	2	496,274	1	41,394	1
1978	95,206	2	212,009	1	48,717	1

Farm sizes in Mesa County were generally smaller than others elsewhere in Colorado. Within the county, 26% of farms were less than 19 acres in size; fifty-four percent were smaller than 49 acres. This compares with 8.7% and 15.7%, respectively, for farms of each size elsewhere in Colorado (see Table 2, next page). In fact, agricultural census data for the county is skewed by the inclusion of Grand Valley fruit farms, which are much smaller, and far more valuable than alfalfa and potato farms elsewhere in Mesa County.<sup>36</sup> One example of the prosperity orchard owners extracted from small plots comes from the editor of the Palisade Tribune, who wrote in 1908: "Ten years ago [I] drove over hundreds of acres of land in the Palisade district that is now

bearing the owners from \$300 to \$1000 per acre each year, which at that time...could have been purchased for from \$15 to \$50 per acre. Today the same land is worth \$2000 per acre...".<sup>37</sup> During this same year a three-acre tract of Palisade land was sold for \$13,500.<sup>38</sup> Boosters responded by promoting the Grand Valley as a place where people with little experience in horticulture could make a tidy fortune on small, independent irrigated tracts.<sup>39</sup>

Table 2- Farm acreage comparisons: CO vs. Mesa County<sup>40</sup>

Farm Size (acres)	# of farms in Colorado	% of state total	# of farms in Mesa County	% of county total
Under 3	410	.7	26	1
3-9	2288	4	199	9
10-19	2234	4	354	16
20-49	4449	7	630	28
50-99	5913	10	391	18
100-174	12,139	20	308	14
175-259	4019	7	115	5
260-499	17,592	29	122	5
500-999	7482	12	39	2
>1000	3408	6	23	1
Total	59,934	99.7	2207	99

To keep pace with valley orchards of bearing age, growers needed assistance in harvesting and shipping their crops to market in a timely manner. Once local demand was satisfied, growers sold their surplus crops directly to commissioners outside the valley. Production quickly surpassed growers' ability to seek buyers, negotiate prices, and secure transport space necessary for getting fruit to markets quickly and in good condition. The Grand Junction Fruit Growers Association was established in 1891 to overcome these and other problems related to orchard management. For many years the

Grand Junction association packaged Palisade peaches using its own label, an act resented by Palisade growers. The Palisade Fruit Growers Association was organized in 1903 to advertise the superb peaches grown by its members. By 1923 the United Fruit Growers Association was formed, joining other associations in providing growers with supplies and information on spraying crops, pruning trees, and on general orchard maintenance.<sup>41</sup>

From 1890 to 1920 valley growers engaged in the commercial production of apples, peaches, and pears with much success. The valley's favorable climate combined with abundant water, an effective irrigation infrastructure, and generally reliable packing and transit networks to aid growers in steady increases in annual production. Unfortunately, the changes made to the landscape by irrigation introduced environmental problems that diminished the valley's productivity, especially in apples but also in peaches and pears. The greatest threat to apple orchards, the codling moth, was recognized as early as 1894. Growers worked together to combat this pest by applying arsenate of lead to their apple trees, which was effective at limiting the moths, but required increasingly intensive treatments over time. Scientists investigating dying orchards became concerned about the accumulation of toxic chemicals they found in the soil near the base of trees being treated for the moths.<sup>42</sup> As concerns over the health effects of pesticides increased, growers were required to clean the fruit, which often left it damaged and unappealing to consumers.<sup>43</sup>

Another environmental concern, addressed by USDA engineer Dalton Miller, was the need for drainage in the valley. Irrigators typically over-watered their crops, and as early as 1908 rising groundwater began "flooding" and killing apple orchards in the

valley.<sup>44</sup> A different, though related problem, is caused by irrigation water concentrating salts in soils. Referred to as salinization, this process is harmful to plants and trees if mineral accumulations become too great, especially in the root-zone. Within the valley young trees were set out to replace the dying trees and survived for a time, but were eventually replaced altogether with salt-tolerant crops.<sup>45</sup> Miller proposed a drainage system down-slope from the valley's canal system and parallel to the river. His plan required cooperation to succeed since salt-poisoned subsurface water was independent of landowners' boundaries. Absent cooperation, Miller concluded that drainage would be "complicated", and "in many cases impracticable."<sup>46</sup> After experimental efforts to drain individual orchards succeeded, large-scale remediation began when the Grand Valley Drainage District contracted the Reclamation Service to install a valley-wide system in 1917.<sup>47</sup>

Despite concerted efforts to stem these problems, apple production dropped dramatically after 1920, and thereafter never exceeded more than one-third its previous level; the production of pears also declined after 1930. Fruit growers' associations were not alone in calling for improvements to orchard management. The Agricultural Experiment Station, an extension service of the Colorado Agricultural College in Fort Collins, urged valley growers to better manage their orchards using new techniques and knowledge in the plant, soil, and water sciences. After 1900 the station regularly published bulletins discussing experiments in reducing crop pests, managing soil nitre levels, emphasizing the benefits of clean-cultivation compared with cover-cropping, and clearing weed infested canals, among others.<sup>48</sup> When growers introduced fruits and other crops to the valley they opened a new frontier for plant pests and disease. Many growers

ignored pests at first by setting out new orchards in the valley. Since different tracts were of varying age throughout the valley, when one failed, often one or more others of recent bearing-age replaced its production. The extensive planting of fruit trees resulted in consistent increases in apple, peach, and pear production until the 1920s. After this time, the continued loss of apple orchards to the codling moth, combined with fluctuating crop prices and intense market competition with other fruit-growing regions altered the valley's economic condition. Nonetheless, peaches continued as an important crop until 1960, and by 1978 the number of bearing peach trees was also declining (see Table 1, p.25).

After 1920 local conditions, including Grand Junction's importance as a growing retail and distribution center, regional mining, and the loss of orchard lands to development, converged in reshaping the valley's economic geography. Agricultural diversification was, in part, one response to reductions in fruit crop production.<sup>49</sup> National and international trends toward corporate agriculture, the growth of manufacturing and service sectors locally, and competition from other places, especially California, converged in making horticulture a relatively less important local economic factor. Interest in mining cycled in the region, beginning with coal deposits discovered locally in the 1880s. Coal mining occurred alongside fruit culture and was followed by the exploration of uranium during the 1950s, and of oil shale in the 1970s. When the costs of processing shale oil were deemed too great, oil companies in the early 1980s cancelled their contracts to mine the nearby Piceance Basin, triggering another recession in the local economy.

Changes in Mesa County's population reflect periods of optimism in the agricultural and mining industries. After the county was formed out of neighboring Gunnison County in 1883, its population was estimated at 1991 persons in 1885. This figure doubled by 1890, and did so again in 1900 and 1910, growing to 22,197 people. With the horticultural boom ending, growth slowed considerably from 1910 to 1940. The population did not double again until 1960, when it surpassed 50,000 residents. During the 1970s, in anticipation of the shale-oil boom, the county grew by 33% to 81,530 people; there are currently over 100,000 people living in Mesa County.<sup>50</sup> Today, improvements made to the local infrastructure during the 1970s are amenities for a population moving into the region for lifestyle reasons. A mild climate and reasonable cost-of living make it an attractive locale for people wanting to escape the sprawl of metropolitan areas.

### *Which Model of Change?*

Did irrigators in the Grand Valley control nature, or did natural processes persist in hybrid forms? Were social relations competitive and exclusionary, or did irrigation require cooperation and accommodation to succeed? In fact, some patterns of environmental change, including crop pests and saline soil, occurred in all three locales. Responses to these problems entailed human intervention beyond constructing dams and canals, and included the use of chemical pesticides and subterranean drainage systems, strategies that were universally embraced in the West wherever irrigation was practiced. In Idaho, potatoes and sugar beets replaced tracts of alfalfa damaged by pests. In the Grand Valley, the codling moth greatly reduced apple production by 1930, despite

growers' increasingly intensive use of pesticides.<sup>51</sup> Crop pests were also present in the Central Valley, where Worster notes that growers first used a biological control to thwart the spread of an imported scale on the region's citrus trees. After the Second World War, however, area growers relied increasingly on DDT as the active agent in chemical treatments. By 1978 California accounted for about one-fifth of all annual spending on pesticides.<sup>52</sup> Instead of connecting this problem to a lack of absolute control over biological processes in the valley, Worster gestures at the social and environmental costs associated with chemical use, including sickness among field laborers and nitrate-contaminated groundwater. In fact, the crops requiring treatment and the pests finding nourishment in them were new to the Central Valley, and as with the Snake River and Grand valleys, became part of its shifting environment.

Flooded and salt-loaded soils were additional environmental consequences of irrigated agriculture. Drainage systems were necessary in the Central Valley, as in the Snake and Grand valleys, to mitigate these conditions.<sup>53</sup> The Central Valley's immense size and importance as a region of specialty crops attracted relatively greater attention from bureaucrats and growers in maintaining agricultural productivity above ecological integrity. The desire to control nature here was carried out with more vigor and resolve than elsewhere in the West.

The ambitious water plans implemented by the state are the most conspicuous examples of this control. By the 1930s farmers, engineers, and politicians all realized the valley's agricultural potential and sought to exploit it through the intensive control of California's rivers. The framework for this planning was the Central Valley Project (CVP), a joint effort between state politicians and the Bureau of Reclamation resulting in

the construction of an immense irrigation infrastructure, including the Delta-Mendota and Friant-Kern canals; both conduits remain in use today. The rationale for the CVP was to redistribute the northern Sacramento Valley's abundant runoff to the larger, and drier southern San Joaquin Valley. The Delta-Mendota Canal receives Sacramento River water from the delta, where pumps lift it out and force it 120 miles uphill and south along the San Joaquin River before dumping it into the river to augment its water supply. The Friant-Kern Canal directs a portion of water from the San Joaquin River to farms all the way to Bakersfield, 150 miles southwest of its point of diversion from the river.<sup>54</sup> During the 1940s and 1950s officials in California initiated the State Water Project to further redistribute the state's water supply and to release irrigators from all federal restrictions on the size of landholdings using publicly financed irrigation water. Included were provisions for building the California Aqueduct, a four hundred-forty mile "river" routing water from the delta area east of San Francisco south to the Los Angeles Basin. Along its course, water is lifted 3400 feet, the final 300 feet being a precipitous ascent over the Tehachapi Mountains, before descending into L.A. via the West Branch Aqueduct.<sup>55</sup> To reduce water losses via seepage and evaporation, the canals and the aqueduct are either concrete-lined or enclosed for much of their length. These efforts to "improve" nature's efficiency were unique to California, especially as they attempted to manipulate whole watersheds and defy topographical barriers at a technical and financial scale unparalleled elsewhere.

Irrigators and engineers along the Snake River plain and within the Grand Valley succeeded in transforming their respective landscapes using a comparatively simple irrigation infrastructure. In spatial terms, the Grand Valley Canal and the government

Grand Valley Project remain the most ambitious efforts undertaken to redistribute water within the valley. As previously noted, the Grand Valley Canal included two segments that were each about twenty-five miles long; the Grand Valley Project included a main canal about fifty-five miles in length. For most of their length these canals were either earthen or wood-framed structures following the local topography, but recent work includes lining area canals and laterals to improve their efficiency.<sup>56</sup> Only one dam in Debeque Canyon, site of the government canal's headgate, regulates the Colorado River's streamflow here; the Redlands Diversion Dam is a second smaller dam and remains on the Gunnison River upstream from its confluence with the Colorado. Along with smaller neighborhood canals and lateral ditches, this relatively simple gravity system facilitated the rise of commercial horticulture in the valley.

The irrigation infrastructure along the Snake River delivers water to a much larger area and to a greater number of users. A series of dams and reservoirs, of which American Falls, Milner, Minidoka and Jackson Lake are the oldest, were built along the Snake to store water and to extend its availability to a growing number of users; other dams have been built since 1930. Water is released through the dams according to the rights and needs of downstream users and seasonal variations in runoff. In 1920 this infrastructure delivered water to about two million acres using simple conveyances similar to the Grand Valley.<sup>57</sup> The proliferation of dams and reservoirs in Idaho contrasts with the Grand Valley, and is indicative of the relative demand for irrigation water there.

However one interprets environmental alterations resulting from irrigation, the social consequences of this practice were less harmful in the Grand Valley and along the Snake River than in the Central Valley. Irrigators sought to impose an entirely new

agricultural order onto an established set of land uses and policies in the Central Valley. This contrasts with the Grand and Snake River valleys, where no competing uses of land or water during their respective settlement periods hindered the expansion of irrigation. Other factors influencing distinct social outcomes among these places include local crop types, farm sizes, and the labor requirements accompanying irrigated agriculture (see table below).

Summary of irrigated landscape comparisons<sup>58</sup>

	Central Valley	Snake River	Grand Valley
Area irrigated (acres)	1,516,344	851,610	71,942
Farm size (acres) (average/range)	506.3/1025.3	173.0/137.2	74.4/293.1*
Crops	Very diverse; fruit, nuts, grains, and vegetables	Alfalfa, potatoes, sugar beets, and fruit	Apples, peaches, and pears; general fruits
Scale of water development	Large; Shasta, Friant, and Oroville dams; Delta-Mendota Canal	Modest; Milner, Minidoka, and American Falls dams	Small; DeBeque Canyon Dam, government High-line Canal
Source of money for water development	Varied; Private (local and national), state, and federal	Same as in Central Valley	Same as in Central Valley
Labor needs and sources	Large, on-demand, and reliable; government program by 1940s	Modest; local and state/federal bureaus	Modest; local and state/federal bureaus; varies with crop yields
Environmental impacts	Crop pests/disease; salt-loaded soils; reduced diversity of aquatic/riparian species	Same as Central Valley but muted due to smaller scale and intensity of irrigation	Same as Snake River

The distribution of land in the Central Valley is the result of government policies that enabled a few individuals to acquire vast holdings. Along with the preexisting

patterns of large landholdings characteristic of the previous Mexican government, the sale of agricultural college scrip through the Morrill Act (1862), and grants made to railroad companies facilitated the accumulation of immense valley acreages by a limited group of new American owners. In the Central Valley the Homestead Act, with its 160-acre limit, was only effective in distributing timbered tracts along streams. Until an irrigation infrastructure was built, much of the valley was used for grazing cattle and growing wheat.<sup>59</sup> California's water laws facilitated these traditional agricultural pursuits by benefiting streamside users and did little to stimulate horticulture. One's right to water was wedded to the timing of their acquisition of land, and to the government from which it came: Was it a grant from the Mexican government? Was it purchased from the state or federal government? Was it purchased before or after the Mining Act of 1866? How one answered these questions determined the legal limits to which one was able to redistribute water and, in effect, determined the practical uses of one's land.<sup>60</sup>

Settlement along the Snake River and in the Grand Valley, where irrigated agriculture was the first economic use of valley land, occurred through the distribution of water away from streamside owners. In Idaho, the doctrine of prior appropriation was already in place when Mormons first settled the upper Snake River area during the 1880s and 1890s.<sup>61</sup> As rapid settlement along the Snake River plain occurred from 1890-1920, a foundation for allocating water widely was in place. Prior appropriation was the law in the Grand Valley too, since irrigated agriculture was well established elsewhere in the state by the time settlement began there in 1881. Efforts to relocate Colorado River water to the Front Range in inter-basin transfers did not come about until 1936, when the Fraser River was partially diverted to Denver through the Moffat Tunnel, a railroad portal used

by trains.<sup>62</sup> Nor were there any competing uses of water beyond the level naturally occurring in the river being demanded by downstream interests.<sup>63</sup> There was simply no need to conserve water using a system of dams and reservoirs here as in California and Idaho.

The crop types grown in each region also shaped social relations locally. Two factors, farm size and labor needs, were directly related to the crops selected by irrigators, and converged with different results in each locale. In the Central Valley, where wheat was the commercial crop of choice until the 1890s, a pattern of large-scale mechanized farming emerged prior to irrigation. In fact, wheat farming was ideally suited to the valley's climatic and topographical characteristics. The long, dry summers were perfect for growing the grain, and the flat, open terrain was ideal for operating large teams of horse, and later, steam-powered plowing and planting implements. Finally, wheat required relatively little labor to produce, and once it was planted, growers could leave it unattended for long periods before returning to mechanically harvest it.<sup>64</sup> It was against this established order that irrigators, bureaucrats, and engineers arrived in the valley, hoping to influence water law and redistribute land for settlement more widely. Conflict arose as boosters of irrigated agriculture and potential small-farmers encountered entrenched agricultural interests already present in the valley.<sup>65</sup>

Settlement timing combined with scarce labor and capital locally to limit the size of farms along the Snake, shaping an early agricultural pattern much different from the Central Valley example. Growers here concentrated on alfalfa, potatoes, and sugar beets, irrigated crops requiring smaller farms than in the Central Valley.<sup>66</sup> These crops required financial investments in irrigation and a local labor force, factors unnecessary in

wheat farming. Building an irrigated infrastructure, prior to federal reclamation, was typically financed using local capital, and later, through imported private funds. Irrigation companies sought to make a profit on the sale of water and required a much shorter repayment period than the terms adopted later by the Bureau of Reclamation. Prior to an organized government bureaucracy to build irrigation canals and dams, individuals worked alone or with neighbors to secure a supply of water. Once water was diverted, the infrastructure conveying it required additional investments in annual maintenance and repairs. For the typical Idaho farmer just getting started, the cost of purchasing water and the labor required to manage an irrigated farm limited the extent of farming that one could undertake at any given time.

Managing their crops from planting to harvest, and recruiting an appropriate labor force were additional concerns for Idaho irrigators; potatoes and sugar beets require more water than alfalfa, and sugar beets are a very labor-intensive crop. Idaho irrigators initially worked around this dilemma by cooperating locally at harvest time, and by recruiting summer help from farms in Utah.<sup>67</sup> Later, federal work programs and state labor bureaus reduced the need for growers to organize their labor needs.<sup>68</sup>

Motivations for community development differed in the Grand Valley from the Snake River area, but the need for water and labor was the same in both places. The principal crops of peaches, pears, and apples required an irrigated infrastructure in the Grand from the beginning, which was built and financed privately, just as it was in Idaho. One crucial difference between potato-growers along the Snake River and peach-growers in the Grand Valley was the value per acre they received from their respective crops. This fact was demonstrated earlier by the example of a 3-acre peach orchard in Palisade

selling for \$13,500; peaches are a far more valuable crop than alfalfa, potatoes or wheat.<sup>69</sup> Although this was a celebrated land transfer locally, it was not atypical for Grand Valley fruit growers to own small, high-value orchards.<sup>70</sup> Small tracts allowed denser settlement here, facilitating land ownership widely and fulfilling the very goals Congress and irrigation proponents long hoped to achieve.<sup>71</sup>

Like Idaho, where Fiege illustrates how growers organized locally for their labor needs, Grand Valley irrigators relied primarily on family and neighbors for help in harvesting their fruit crops. According to valley historian Dave Fishell, the Peach Growers Association of Palisade employed local men and women to handle the crop at its local packing shed.<sup>72</sup> Additional evidence indicates cooperation by locals and the use of prison laborers in picking the fruit crops. Even as fruit production declined in the valley after 1920, labor bureaus arrived, as elsewhere, to help with crop production in the Grand.<sup>73</sup>

Cooperation made sense in irrigated regions, especially where capital and labor were scarce. In the Central Valley, where wheat was the first commercial crop, cooperation was not an important factor in developing the region. During this period there was little need to organize labor or consolidate capital for the construction and maintenance of extensive irrigation works. The bonanza wheat farms, financed by urban proprietors, were successful with only minor inputs of labor.<sup>74</sup> The arrival of irrigation did little to enhance land distribution as it had in the Snake and Grand valleys, but the need for assistance in growing and harvesting specialty crops gradually required a large and mobile labor force. The consolidation of land in large holdings limited the opportunity for land ownership more widely and required owners to hire wage laborers,

rather than to trade help among themselves. Neighbors helping one another with the harvest would never work when they were few in number and immense acreages of fruits and vegetables needed immediate attention. Insofar as agriculture shaped disturbing social conditions within the Central Valley, it has attracted the attention of writers and scholars alike.<sup>75</sup>

*Reflections: Understanding Irrigated Landscapes*

Which model of landscape change, the Central Valley or the Snake River plain, better helps us understand changes shaped by irrigation in the Grand Valley? What can we extract from this model about the influence of irrigation on western locales more broadly? I suggest that the Grand Valley landscape shares processes of change—cooperation among local residents and environmental persistence—similar to the Snake River region. In both places a suite of cultural characteristics, including crop types, water laws, farm size, and the organization of labor converged in shaping sustainable agricultural communities. Settlers in each place adopted long-term strategies for sharing water and creating institutions ensuring that irrigated agriculture propped up their communities within the relatively simple regional (and national) economies in place at the time. Today, both places retain their rural identities despite changes to their local economies emphasizing manufacturing, retail sales, and service jobs.

This characterization of development differs from Worster's narrative of development in the Central Valley, where early land policies and the subsequent growth of wheat farms and ranches delayed irrigation. Even after adopting irrigated agriculture, Central Valley landowners rejected the egalitarian benefits of land ownership more

widely in favor of the individual's right to accumulate property. By subsidizing valley growers' water supply, the Bureau of Reclamation was complicit in fostering this rationale among landowners; the Central Valley Project remains the best example of this behavior. Later, the California State Water Project simply expanded irrigation development, and rejected once and for all the ideology that broadening land ownership was a worthy government policy. By limiting the valley's population density, landowners and orchard managers were forced to engage in corporate farming from the start; lost were opportunities for cooperation among neighbors in developing irrigation networks and in sharing the labor of crop production. The bonanza wheat farms, and later, the large-scale individual and corporate fruit and vegetable operations, did little to foster a sense of community here as occurred in other irrigated regions.

Notwithstanding the cultural consequences Worster purports for the valley stemming from irrigation, his conclusions regarding environmental change deriving from an absolute control of nature by humans is inconsistent with the realities of irrigation in most places. True, the scale of irrigated agriculture in the Central Valley required many investments—financial, technical, and chemical—far beyond similar measures taken elsewhere in the West. Humans did much to redistribute water throughout the valley, and indeed, throughout California. After doing so, native habitats were replaced by new landscapes, some of which are less aesthetically, and from an ecological perspective, less functionally, desirable. What remains, however, is a hybrid landscape composed of remnants from an older ecological order mixing with new species of birds, fish, and plant communities all responding to the valley's new hydrologic geography. A more honest and accurate assessment of the Central Valley's landscape must acknowledge this

environmental persistence, even if its primary goal is to demonstrate the loss of “wild” nature to irrigated agriculture.

Regarding the consequences of irrigation on western landscapes more broadly, I suggest caution in ascribing universal outcomes, to nature and social relations, for all places. Worster’s examination of pre-modern and irrigated cultures elsewhere and his extension of the logic motivating their course of development to the American West is suspect in its implications for Americans and our agricultural landscapes. Because the Central Valley is the most intensively developed irrigated region in America, the lesson to readers is that the trajectory of irrigation practices elsewhere in the West, and the ensuing landscape changes, will follow predictably from this example. Studies of the Snake River plain and the Grand Valley weaken this interpretation of irrigated landscapes. Nonetheless, examining other places through these models may further our understanding of how specific environmental and social factors converge in shaping irrigated landscapes elsewhere.

Despite similar patterns of social change and environmental persistence, the irrigated landscapes of Colorado and Idaho were, in fact, different from each other. This was largely due to distinctions in the scale of irrigation undertaken in each place, but also a result of differences in crops types, farm size, the relative competition for water in each place, land values, and perceptions people held about the kinds of landscapes they found themselves striving to create.

As population growth continues in the West and development threatens to remake irrigated landscapes, these places offer us an important lesson. For Worster, the changes wrought by irrigated agriculture alter landscapes so profoundly that we may no longer

recognize their remaining vestiges of nature and natural processes; wherever irrigation is practiced, nature is so thoroughly controlled and dominated by humans that there is little, if anything, we can do to mitigate its environmental abuses. This contrasts with Fiege's reading of Idaho's irrigated landscape, and my own assessment of the Grand Valley, places characterized by ecological persistence despite human tinkering with the environment. These "working" landscapes, where nature remains in hybrid forms, offer people the hope of balancing development goals with maintaining functional ecosystems. In short, they demonstrate the need for humans to act as responsible stewards of nature while serving our economic interests. If this interpretation of irrigated landscapes is true, perhaps the effects of agriculture vis-à-vis other uses of private land throughout the West are relatively mild, and offer some places a means of maintaining their rural identities despite shifting economic forces.

The possibility of maintaining persistent landscapes in irrigated places is based on economic, environmental, and aesthetic considerations. First, the federal presence in the West will continue to influence who is allowed access to water and the technical expertise to use it. Environmental regulations enacted since the inception of an irrigation bureaucracy and an evolving public opinion regarding land use demand an accounting of the social and ecological costs of public land management goals. Just as it did at the outset, the federal government continues to moderate the extent of western irrigation based on a collective measure of acceptable costs. Unlike during reclamation's formative years when the social goals of settlement and agricultural productivity were paramount, it must today consider the negative costs to ecosystems and current social patterns; the financial costs of irrigation are likely of greater concern now, too. The 160-acre limit

required for use of reclamation water, now an essentially discarded feature of the Homestead Act, is an additional factor under federal influence. Probably no other issue has more directly influenced the prevailing social arrangements in western agricultural communities. As has been demonstrated by the Colorado and Idaho examples, where people farm smaller acreages, a more egalitarian distribution of land generally occurs.

Second, the West has been subject to boom and bust cycles since the pre-settlement era. One example, gold mining, had profound impacts on both the development of so-called boomtowns, and in the mountains where the mining took place. These towns were quickly built and often depleted local timber and wildlife resources to sustain themselves in support of an activity that might badly damage area streams in order to operate profitably. Modern examples of western growth include resorts and community development focused on the amenities associated with mobile and retirement lifestyles. All three examples require modifying local landscapes at different scales to facilitate certain development goals. In each case, the immigrant population is to some degree transient, and, consequently, may not well understand the local cultural and environmental conditions, or even care to learn how their presence there affects the local landscape.

Irrigated agriculture, conversely, is place-based. Its practitioners, at least those operating locally, are required to maintain their land in a productive state. Their economic well-being requires both a working knowledge of the local environmental conditions and a willingness to accept or modify, if possible, cultural conditions to meet their productivity goals. And, unlike timber and precious metals, water is a renewable

resource. What is used on crops, evaporates out of reservoirs, or is left in-channel for downstream use, is replenished each winter in the region's alpine snowpack.

In a region with a checkered economic history, irrigated agriculture, in certain places and under careful management practices, remains a sustainable activity existing alongside manufacturing, retail sales, and professional jobs.

A third reason stems from the high economic costs of building and maintaining an irrigation infrastructure, especially as this combines with a reduced national interest in government spending on infrastructure of all kinds. The region's aging dams require maintenance, not only for the persistent demand for water by irrigators, but increasingly for municipal and hydroelectric needs. Whether sustaining the dams and reservoirs will favor the specialty crops grown in California, or the small-scale operators in other areas remains an open question. It is possible that small growers and irrigated communities will benefit as a side-effect of maintaining larger operations. Then again, in an increasingly competitive economy, perhaps efforts to sustain irrigated agriculture will demand concentrating all resources on the most efficient growers. Neither author's analysis helps much here, although the relevance of each rests, in large part, on the persistence of irrigated agriculture at different scales.

There are many ways to tell the story of irrigation development in the American West; this paper focuses on three examples, all of which were successful despite their scalar differences. To the extent that each supports certain truths about landscape patterns resulting from irrigated agriculture, they collectively demonstrate at least three important ideas worth consideration in any landscape analysis. First, the changes sought by humans were not linear in any of these places. This suggests a persistent human

dialectic with nature and willingness by local irrigators to both live within certain environmental parameters, and with each other. Second, there are likely limits to growth, the evidence of which takes the form of increased environmental regulation, rising monetary costs, and widely held aesthetic goals. Together, these factors came to limit the size and location of later dam and reservoir construction, and hint at the difficulty of again planning anything sizable in the West. And, finally, each author's story is told in a way that infers a moral responsibility by its actors to the local landscape and in their interactions with other people. When Worster jabs at people abiding by the tenets of capitalism, it is because he recognizes their tendency to view nature as materialist objects, devoid of any intrinsic value. When Fiege demonstrates empathy towards the water users and technicians attempting to measure it, he is aware of the difficulty in doing so and that cooperation is essential for community stability. For any landscape these lessons should direct us to proceed with care in evaluating the forces of change upon it and its evolution with the passage of time.

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## Notes

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Landscape,” in *Landscapes: Selected Writings of J.B. Jackson*, Ervin H. Zube, ed., (Amherst: University of Massachusetts Press, 1970).

<sup>2</sup> Wallace Stegner, *The American West as Living Space* (Ann Arbor: University of Michigan Press, 1987); Walter Prescott Webb, *The Great Plains* (Boston: Ginn and Company, 1931).

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<sup>4</sup> Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985); Marc Reisner, *Cadillac Desert: The American West and its Disappearing Water* (New York: Viking, 1986).

<sup>5</sup> John Wesley Powell, *Report on the Lands of the Arid Region*, 45<sup>th</sup> Cong., 2<sup>nd</sup> sess., House Executive Document 73 (Washington, D.C.: Government Printing Office, 1878); Frederick Samuel Dellenbaugh, *A Canyon Voyage: The Narrative of the Second Powell Expedition Down the Green-Colorado River from Wyoming, and the Explorations of Land, in the Years 1871 and 1872* (New York: Putnam, 1908).

<sup>6</sup> William E. Smythe, *The Conquest of Arid America*, Lawrence B. Lee, ed., (Seattle: University of Washington Press, 1969).

<sup>7</sup> Elmo Richardson, *Dams, Parks and Politics: Resource Development and Preservation in the Truman-Eisenhower Era* (Lexington: University Press of Kentucky, 1973); Wallace E. Stegner, ed., *This Is Dinosaur: Echo Park Country and its Magic Rivers* (New York: Knopf, 1955); John McPhee, *Encounters with the Archdruid* (New York: Farrar, Straus, and Giroux, 1971).

<sup>8</sup> On the Colorado River Compact, see Norris Hundley, *Water and the West*; Donald J. Pisani, *From the Family Farm to Agribusiness: The Irrigation Crusade in California and the West, 1850-1951* (Berkeley: University of California Press, 1984); Philip Fradkin, *A River No More: The Colorado River and the West* (Tucson: University of Arizona Press, 1984).

<sup>9</sup> Worster, *Rivers of Empire*. Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999).

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<sup>10</sup> Susan Wiley Hardwick and Donald G. Holtgrieve, *Valley for Dreams: Life and Landscape in the Sacramento Valley* (Lanham, Maryland: Rowman and Littlefield, 1996).

<sup>11</sup> Worster, *Rivers of Empire*, 98.

<sup>12</sup> *Ibid.*, 240.

<sup>13</sup> *Ibid.*, 241.

<sup>14</sup> *Ibid.*, 267.

<sup>15</sup> Fiege, *Irrigated Eden*, 46.

<sup>16</sup> *Ibid.*, 45.

<sup>17</sup> *Ibid.*, 111.

<sup>18</sup> *Ibid.*, 140.

<sup>19</sup> These calculations are my own approximations of each valley's size and are provided to give readers a sense of the potential scale of irrigation in each place.

<sup>20</sup> Colorado Department of Agriculture, *Colorado Agricultural Statistics*, Vol. 1, no. 4, January, 1954: 83.

<sup>21</sup> Charles Haskell, ed., *History and Business Directory of Mesa County, Colorado*, (Grand Junction: Mesa County Democrat, 1886): 27, 30-31; Merton Nolen Bergner, "The Development of Fruita and the Lower Valley of the Colorado River from 1884-1937," (Master's thesis, University of Colorado, 1937), 30-32; Mary Rait, "Development of Grand Junction and the Colorado River Valley to Palisade from 1881-1931-Part I," *Journal of the Western Slope* (Summer 1988): 23-24.

<sup>22</sup> Don Davidson, "The Grand Valley Ditch: A Short History of Pioneering Irrigation in Colorado's Grand Valley," *Journal of the Western Slope* (Fall 1986): 1-30.

<sup>23</sup> *Ibid.*

<sup>24</sup> *Ibid.*, 8-10.

<sup>25</sup> *Ibid.*

<sup>26</sup> *Ibid.*, 24.

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<sup>27</sup> William Joe Simonds, "The Grand Valley Project," United States Bureau of Reclamation, Denver, 1994: 28. The GVP made possible the delivery of water to 40,400 acres of valley land; Simonds also cites figures for the amount of project land actually irrigated at different times following completion of the GVP.

<sup>28</sup> *Ibid.*, 24.

<sup>29</sup> Rait, "Development of Grand Junction-Part I," 23.

<sup>30</sup> Bergner, "The Development of Fruita and the Lower Valley of the Colorado River from 1884-1937," 43-47.

<sup>31</sup> U.S. Department of the Interior, Bureau of the Census, *Twelfth Census of the United States, 1900, Agriculture, Part 2, Crops and Irrigation*, (Washington, D.C.: U.S. Census Office, 1902), 626; U.S. Department of Commerce, Bureau of the Census, *Fourteenth Census of the United States, 1920, Vol. 6, Part 3, Agriculture*, (Washington, D.C.: Government Printing Office, 1922), 190, 193.

<sup>32</sup> Rait, "Development of Grand Junction-Part I," 22.

<sup>33</sup> Emma McCreanor and Judy Prosser "Mesa County, Colorado: A 100 Year History-1883-1983", (Grand Junction, Colorado: Museum of Western Colorado Press, 1986): 3; Pamela Bouton, "Solid Cold: A History of the Grand Junction Ice Houses," *Journal of the Western Slope* (Autumn 1990): 36-49.

<sup>34</sup> Marian Hackett, "The History of Palisade, Colorado, Vol. I," 17-18.

<sup>35</sup> U.S. Department of the Interior, Census Office, *Eleventh Census of the United States, 1890, Report on the Statistics of Agriculture in the United States*, (Washington, D.C.: Government Printing Office, 1895), 503; U.S. Department of the Interior, Bureau of the Census, *Twelfth Census of the United States, 1900, Vol. 6: Agriculture, Part 2, Crops and Irrigation*, (Washington, D.C.: U.S. Census Office, 1902), 626; U.S. Department of Commerce and Labor, Bureau of the Census, *Thirteenth Census of the United States, 1910, Vol. 6: Agriculture, Reports by States, with Statistics for Counties Alabama-Montana*, (Washington, D.C.: Government Printing Office, 1913), 214-215; U.S. Department of Commerce, Bureau of the Census, *Fourteenth Census of the United States, 1920, Vol. 6, Part 3, Agriculture*, (Washington, D.C.: Government Printing Office, 1922), 192-193; U.S. Department of Commerce, Bureau of the Census, *Fifteenth Census of the United States, 1930, Vol. 2, Part 3, The Western States*, (Washington, D.C.: Government Printing Office, 1932), 286-287; U.S. Department of Commerce, Bureau of the Census, *Sixteenth Census of the United States, 1940, Vol. 1, First and Second Series States Reports, Part 6, Statistics for Counties*, (Washington, D.C.: Government Printing Office, 1942), 302; U.S. Department of Commerce, Bureau of the Census, *United States Census of Agriculture, 1959, Vol. 1, Part 41, Colorado Counties*, (Washington, D.C.:

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Government Printing Office, 1964), 209; U.S. Department of Commerce, Bureau of the Census, *Census of Agriculture*, 1978, Vol. 1, *State and County Data*, Part 6, *Colorado* (Washington, D.C.: Government Printing Office, 1981), 167-168.

<sup>36</sup> U.S. Department of Commerce and Labor, Bureau of the Census, *Thirteenth Census of the United States*, 1910, Vol. 6, *Agriculture, Reports by States, with Statistics for Counties Alabama-Montana*, (Washington, D.C.: Government Printing Office, 1913), 215. Alfalfa represented 90% of all the “Hay and Forage” acreage in Mesa County at this time, which was valued at \$777,264. Taking 90% of this value and dividing by the acreage of alfalfa in Mesa County (23,842) yields a value of \$29.34/acre for alfalfa.

<sup>37</sup> Hackett, “The History of Palisade, Colorado,” 73.

<sup>38</sup> *Ibid.*, 90e.

<sup>39</sup> For an examination of boosters and boosterism in the Grand Valley, see Michael Eastin, “The Little Empire of the Western Slope: Boosterism in the Early Grand Valley,” *Journal of the Western Slope* (Spring 1988): 28-49. On the prospects of agriculture in Colorado, including the Grand Valley, see William E. Pabor, *Colorado as an Agricultural State* (New York: Orange Judd Co., 1883); William E. Pabor, *Fruit Culture in Colorado: A Manual of Information* (Denver: W.E. Pabor, and Dove and Temple, 1883). Various pamphlets were published between 1899 and 1920 promoting the valley’s resources and economic opportunities, especially as they related to fruit culture. Some of these include: A.A. Miller, “Statement of the Resources and Progress of Mesa County, Colorado,” Authorized by the Board of Commissioners of Mesa County, and the Board of Alderman of the City of Grand Junction (August, 1899); *Fruita Colorado: Climate and Crops, Facts and Figures*, The Fruita Chamber of Commerce (St. Joseph, MO: The Press of the Fruit Grower, 1906); *Mesa County Colorado on the Western Slope of the Rocky Mountains in the World Famed Valley of the Grand and Gunnison Rivers* (Grand Junction Chamber of Commerce, 1917); *Some Facts Regarding Red Lands Farms Adjoining Grand Junction, Colorado*, Denver, The Red Lands Company, 1920.

<sup>40</sup> U.S. Department of Commerce, Bureau of the Census, *Fourteenth Census of the United States*, 1920, Vol. 6, Part 3, *Agriculture*, (Washington, D.C.: Government Printing Office, 1922), 178,181.

<sup>41</sup> For an introduction to the need for cooperative associations in the valley, see Rait, “Development of Grand Junction-Part I,” 36-44. For an example of advertising conflict, see Hackett, “The History of Palisade, Colorado,” 4; also, see Hackett, pp.117-118 for wrapping material used by associations to advertise Palisade peaches, and pp.121 for shipping boxes advertising Palisade peaches.

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- <sup>42</sup> Agricultural Experiment Station of the Colorado Agricultural College, *Arsenical Poisoning of Fruit Trees*. William P. Headden. Bulletin no. 131. Fort Collins, CO, July, 1908.
- <sup>43</sup> Bergner, "The Development of Fruita and the Lower Valley of the Colorado River from 1884-1937", 32-35; Rait, "Development of Grand Junction-Part I," 47.
- <sup>44</sup> Dalton G. Miller, *The Seepage and Alkali Problem in the Grand Valley, Colorado*, United States Department of Agriculture, March 1916.
- <sup>45</sup> *Ibid.*, 38-39. Miller suggested the planting of wheat and alfalfa in areas of mild alkali build-up, and recommended sugar beets, sorghum, barley, and rye for areas with higher salt concentrations. He believed that the planting of these crops over time would restore the soil to its former productive capacity.
- <sup>46</sup> *Ibid.*, 37.
- <sup>47</sup> Simonds, *The Grand Valley Project*, 23.
- <sup>48</sup> Agricultural Experiment Station of the Colorado Agricultural College, *A Fruit Survey of Mesa County*. E.P. Sandsten, T.F. Limbocker, and R.A. McGinty. Bulletin no. 223. Fort Collins, CO, February, 1917; *Reclaiming Nitre Soil in the Grand Valley*. E.P. Sandsten. Bulletin no. 235. August, 1917; *The Identification and Control of Colorado Weeds*. W.W. Robbins and Breeze Boyack. Bulletin no. 251. July, 1919; *Irrigation Water as a Factor in the Dissemination of Weed Seeds*. G.E. Egginton and W.W. Robbins. Bulletin no. 253. June, 1920.
- <sup>49</sup> For promotional literature hinting at the need for crop diversification within the valley, see "Some Facts Regarding Red Lands Farms Adjoining Grand Junction, Colorado," 2; also, see Mary Rait, "Development of Grand Junction and the Colorado River Valley to Palisade from 1881-1931-Part II," *Journal of the Western Slope* (Fall 1988): 52. According to Rait, horticulture was one in a series of "boom and bust" economic activities that occurred in the valley. Also, see Dave Fishell, *The Grand Heritage: A Photographic History of Grand Junction, Colorado* (Norfolk, VA: The Donning Company, 1985), 166.
- <sup>50</sup> For the 1885 population of Mesa County, see Suzanne Schulze, "A Century of the Colorado Census," (Michener Library, University of Northern Colorado, 1976): 1885-1. For population statistics for the period 1890-1910, see U.S. Department of Commerce, Bureau of the Census, *Thirteenth Census of the United States, 1910, Vol. 2, Alabama-Montana*, (Washington, D.C.: Government Printing Office, 1913), 203. For the period 1920-1940, see United States Department of Commerce, Bureau of the Census, *Sixteenth Census of the United States, 1940, Population, Vol. 1, Number of Inhabitants*, (Washington, D.C.: Government Printing Office, 1942), 166. For the period 1960-1980,

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see U.S. Department of Commerce, Bureau of the Census, *1980 Census of Population*, Vol. 1, *Characteristics of the Population*, Chapter A, *Number of Inhabitants*, Part 7, *Colorado*, (Washington, D.C.: Government Printing Office, 1981), 7-12.

<sup>51</sup> Bergner, "The Development of Fruita and the Lower Valley of the Colorado River from 1884-1937," 33-34. According to Bergner, Grand Valley irrigators increased the number of pesticide applications from two to as many as one dozen as a result of the codling moth's increased resistance to chemical treatment.

<sup>52</sup> Worster, *Rivers of Empire*, 318.

<sup>53</sup> On the need for drainage in Idaho, see Fiege, *Irrigated Eden*, 29-35. In the Central Valley, see Worster, *Rivers of Empire*, 323-324.

<sup>54</sup> Worster, *Rivers of Empire*, 240.

<sup>55</sup> Marc Reisner, *Cadillac Desert*, 368-370.

<sup>56</sup> Lawrence J. MacDonnell, *From Reclamation to Sustainability: Water, Agriculture, and the Environment in the American West* (Niwot, CO: The University Press of Colorado, 1999), 110-111. According to MacDonnell, the Government Highline Canal received a concrete lining along 6.8 miles of its length in the western valley, while 38 miles in the eastern valley was lined with an impervious membrane. The Colorado River Basin Salinity Control Act (1974) prompted these improvements. Another significant change was the replacement of 144 miles of open-ditch laterals with pipe.

<sup>57</sup> Fiege, *Irrigated Eden*, 23-24.

<sup>58</sup> For data regarding "area irrigated", see United States Department of Commerce and Labor, Bureau of the Census, *Thirteenth Census of the United States*, 1910, Vol. 6, *Alabama-Montana*, (Washington, D.C.: Government Printing Office, 1913), 177-182, 230, 407-409; for data on "farm size", see pp. 148-153, 200, 203, 390-392. For the Grand Valley, average farm size (74.4 acres) is for Mesa County, and \* indicates average farm size in Colorado.

<sup>59</sup> Richard Allen Eigenheer, "Early Perceptions of Agricultural Resources in the Central Valley of California," (Ph.D. dissertation, University of California-Davis, 1976). For information on land acquisition and the development of wheat farms in the Central Valley, see pp. 312-320, 325-342. Eigenheer discusses the specific implications of the sale of college scrip on pp. 329, 334-335; railroad grants are discussed on pp. 339, 342. On the limits of the Pre-Emption and Homestead Acts in distributing valley lands, see pp. 317, 326, 329.

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<sup>60</sup> Worster, *Rivers of Empire*, 104-111. Worster also examines the locally important court case *Lux v. Haggin* (1886) to demonstrate the convoluted nature of California water law and how its complexity limited the rise of irrigated agriculture in the Central Valley.

<sup>61</sup> Prior appropriation grants the right of ownership of a stream's water to the first person making use of it: he who is first in time is first in right. Prior appropriation was established as law in Idaho in 1881.

<sup>62</sup> MacDonnell, *From Reclamation to Sustainability*, 116. The Fraser River is a tributary of the Colorado River upstream from the Grand Valley.

<sup>63</sup> This changed in 1922 with the Colorado River Compact, which divided the river's drainage basin into upper and lower regions and allocated the rivers discharge to the seven states within the basin. The upper-region states include Colorado, New Mexico, Utah, and Wyoming; Arizona, California, and Nevada are the lower-region states. The U.S. Congress passed legislation enforcing this policy in 1928.

<sup>64</sup> Eigenheer, "Early Perceptions of Agricultural Resources in the Central Valley of California," 344-345. According to Eigenheer, modifications to the Stockton gang plow in the early 1870s allowed "one man and eight horses to plow more land than fifty men could with previous techniques."; Worster, *Rivers of Empire*, 118.

<sup>65</sup> *Ibid.*, On the need for crop diversification, see pp. 302-304. For an examination of land monopolies and how these limited wider development in the valley, see pp. 312-320; also, see Worster, *Rivers of Empire*, 103-111. According to Worster, the period from 1860-1900 was one of active conflict between the competing instrumental uses of water in advancing California's agricultural economy. He examines the court case *Lux v. Haggin*, in part, to demonstrate how competing doctrines of water law impeded the advance of irrigated agriculture in the Central Valley.

<sup>66</sup> Among the Central Valley counties existing in 1890, the smallest average farm size occurred in San Joaquin County and was 414 acres. In Idaho, the average farm size was 191 acres in both Elmore and Ada counties, a region of irrigated agriculture near Boise. In eastern Idaho, Bingham County's average farm size was 192 acres. This changed somewhat once irrigation was adopted in California. By 1920 the smallest average farm size in the Central Valley occurred in Fresno County and was 148 acres. U.S. Department of the Interior, Census Office, *Eleventh Census of the United States*, 1890, *Report on the Statistics of Agriculture in the United States*, (Washington, D.C.: Government Printing Office, 1895), 124, 132; U.S. Department of Commerce, Bureau of the Census, *Fourteenth Census of the United States*, 1920, Vol. 6, Part 3, *Agriculture*, (Washington, D.C.: Government Printing Office, 1922), 345.

<sup>67</sup> Fiege, *Irrigated Eden*, 136-137.

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<sup>68</sup> The “bracero” program, initiated in 1942, is an early example of government-sponsored labor initiatives.

<sup>69</sup> See notes 28,29, and 30 above.

<sup>70</sup> Rait, “Development of Grand Junction-Part I,” 31, 32, 44. A survey in 1917 by the Colorado Agricultural College determined the average size of valley orchards was just less than nine acres.

<sup>71</sup> The Homestead Act (1862) allowed settlers to select up to 160 acres from the public domain and, through “improvements” adding to its productivity, gain ownership of the tract after five years. Other legislation sought to fine-tune the act as settlement expanded in the drier western plains and intermountain West. Most such attempts, including the Timber Culture Act (1873) and Desert Land Act (1877), only improved marginally on the Homestead Act’s success. The Carey Act (1894) transferred as much as one million acres of federal land to each of ten western states and territories, requiring them to establish reclamation projects in advance of the sale of this land to settlers. This act enforced the 160-acre limit and was most successful in Wyoming and Idaho. Passage of the Newlands Act (1902) and the resulting federal reclamation effort probably diminished the Carey Act’s potential long-term effectiveness. The standard reference promoting the democratic ideology through independent irrigated communities is Smythe, *The Conquest of Arid America*.

<sup>72</sup> Fishell, *The Grand Heritage*, 122.

<sup>73</sup> On the issue of prison labor, see Harold Zimmerman, “Harvesting Peaches with German Prisoners of War,” *Journal of the Western Slope* (Winter 1987): 17-21; on labor shortages during World War II, see Kristi Mease, “The Labor Shortage and its Solution During World War II in the Grand Valley of Western Colorado,” (Summer 1992): 1-5; also, see Rait, “Development of Grand Junction-Part I,” 48.

<sup>74</sup> See note 55 above.

<sup>75</sup> For an example of writers addressing the plight of laborers in the Central Valley, see Worster, *Rivers of Empire*, 227-233; also, see Worster, pp.245-251 for academic studies showing unequal land distribution within the valley; and pp.287-290 for an examination of attempts to maintain the 160-acre limit despite the growth of power by agricultural interests in the valley.