Rangeland Ecology & Management 73 (2020) 285–296

Contents lists available at ScienceDirect

Rangeland Ecology & Management

journal homepage: http://www.elsevier.com/locate/rama

Western Ranchers' Perspectives on Enablers and Constraints to Flood Irrigation☆

Mary Sketch [a,*], Ashley A. Dayer [a], Alexander L. Metcalf [b]

[a] Department of Fish and Wildlife Conservation, Virginia Tech, VA 24061, USA
[b] W. A. Franke College of Forestry and Conservation, University of Montana, MT 59812, USA

ARTICLE INFO

Article history:
Received 10 December 2018
Received in revised form 25 October 2019
Accepted 3 December 2019

Key Words:
Community Capitals
conservation
decision making
flood irrigation
rancher
social-ecological systems

ABSTRACT

Flood irrigation on western rangelands is important for diverse social and ecological reasons, providing forage for many agricultural operations and maintaining many critical wetlands across the region. However, recent debate over the efficiency of flood irrigation and resulting transition to other "more efficient" types of irrigation has put many of the working wet meadows sustained by flood irrigation at risk. As the sustainability of these landscapes is primarily dependent on ranchers' management decisions, we sought to gain a deeper understanding of factors influencing ranchers who flood irrigate and how these factors interrelate. We applied the Community Capitals Framework to explore what considerations act as enablers and constraints to maintaining flood irrigation and to evaluate the role of each type of capital in enabling and constraining the coproduction of working wet meadows for ranchers and the environment. Our qualitative analysis of facilitated workshop transcripts and observation notes from two study areas within the Intermountain West showed that ranchers perceived constraining and enabling factors of flood irrigation related to all seven types of community capitals: natural, financial, built, cultural, human, social, and political. The irrigation methods used by ranchers were heavily influenced by environmental components of the landscape rather than reflecting a choice among alternative methods. Other prominent enablers included a commitment toward maintaining the natural history of the landscape and the ranching lifestyle. Primary constraints included the impact of public misperception and the ability to pass their operation on to the next generation. Ranchers weighed multiple considerations simultaneously in a holistic, community-scale approach to management decisions and described how diverse enablers and constraints interacted to determine the viability of flood irrigation and ranching. These results indicate rancher decisions are driven by complex social-ecological considerations and demonstrate the importance of each capital type to rangeland conservation.

Introduction

From preventing habitat fragmentation to safeguarding native species, rangelands have long been recognized for their conservation potential (Huntsinger and Hopkinson 1996; Brunson and Huntsinger 2008). Flood irrigation on private rangelands maintains wetland systems that were historically sustained by natural flooding. Flood irrigation, when water is spread across a field via ditch or pipe system, has been a traditional practice for hay and irrigated pasture production since the early 1900s (Peck and Lovvorn 2001).[1] Today, flood irrigation is still used on working lands across the western United States and is deeply rooted in a long history of water rights and conveyances. The system is fueled by a vast network of reservoirs and ditch systems. Although ditch companies generally own and manage the ditch system, landowners take part in management decisions through associations and cooperatives with annual meetings. Ditch company ownership

☆ This work was funded by the US Dept of Agriculture (USDA) Natural Resource Conservation Service (Oregon State Office) and the US Fish and Wildlife Service (Mountain-Prairie Region) through the US Geological Survey Cooperative Research Unit RWO 174 to Virginia Tech with a subcontract to University of Montana. In addition, the PI of the project and second author (Dr. Ashley Dayer) has another research project studying agricultural producers outside of the study area funded by the USDA Farm Service Agency.

* Correspondence: Mary Sketch, Dept of Fish and Wildlife Conservation, Cheatham Hall, Rm 100, 310 W Campus Dr, Virginia Tech, Blacksburg, VA 24061, USA. 919-402-7241
E-mail address: msketch2@vt.edu (M. Sketch).

[1] In the context of the article, our use of the term *flood irrigation* is inclusive of surface irrigation, which is where ditches are plugged to allow water to flow freely across the landscape.

https://doi.org/10.1016/j.rama.2019.12.003
1550-7424/

and water rights law varies from state to state and region to region (Schreder, personal communication, 10 July, 2019). Across much of the western United States, flood irrigation recharges wetlands as surface water flows from ditch systems and as water percolates from fields and ditches into groundwater (Lovvorn and Hart 2001; Peck and Lovvorn 2001), thus sustaining valuable wildlife habitat on working lands such as foraging habitat for migrating and breeding waterbirds (Petrie et al. 2013) and late summer brood-rearing sage-grouse (Atamian et al. 2010; Donnelly et al. 2016).

A comparison of flood irrigation to other forms of irrigation, primarily center pivot or sprinkler irrigation, where water is sprayed across a field through either a stationary or rotating sprinkler system (USDA Natural Resources Conservation Service 2016), identifies advantages and disadvantages of both. The "efficiency" of the irrigation system, whether flood or center pivot, is largely dependent on diverse landscape features. For instance, flood irrigation is better suited for flat or gently sloping lands, whereas center pivot can function under more sloped topographies (Brown 2008). Flood irrigation is also better suited on finer soils, whereas center pivot may be more advantageous on coarser, rockier soils. In addition, while flood irrigation is often considered less water efficient than center pivot (which applies less, more targeted water), center pivot can lead to increased runoff (Brown 2008). Further, while flood irrigation requires more maintenance and labor, which can be costly, center pivot requires a much greater initial capital outlay and repairs are generally costlier, yet labor needs are far less (Brown 2008). Agronomically, there is minimal research on differences in production yield between the two types of irrigation. However, a study in the Upper Green River Basin of Wyoming found the net value of hay produced by 1 acre with flood irrigation is $45, while switching to center pivot would net approximately $13 per acre (Blevins et al. 2016). Perhaps most notably, much research has documented the ecological benefits of flood irrigation. Flood irrigation maintains working wet meadows, which are an important source of forage for cattle and biologically rich habitat for wildlife. Wet meadows are a unique part of the geography of the West, mosaiced throughout parts of the landscape where snowmelt collects from surrounding mountains (Peck and Lovvorn 2001). Flood irrigation on rangelands mimics and maintains this spreading of surface water (Baker et al. 2014). Across the West, where water scarcity has created a highly modified hydrologic system, these flood-irrigated wetlands are critical for ecological productivity. Although wetlands make up only 2% of the region, 80% of wildlife rely on them (Intermountain West Joint Venture 2013). In summary, in certain landscapes of the West, flood irrigation provides diverse agricultural and ecological benefits that other forms of irrigation may not provide. Although less water is diverted via center pivot and sprinkler irrigation, leaving more water instream leads to increases in early-season water and thus benefitting spring fish spawning (Roberts 2012), the late-season flows from flood irrigation are beneficial to habitat for regional fisheries (Blevins et al. 2016).

Despite the various benefits of flood irrigation, much of the recent focus has been on the claim of flood irrigation as less efficient and more resource intensive (water and labor) than alternative forms of irrigation, primarily center pivot or sprinkler irrigation (Venn et al. 2004). Drought and water shortages across the West have particularly fueled the efficiency conversation and debate (Donnelly et al. 2015). This concern regarding the "efficiency" of flood irrigation versus center pivot or sprinkler, combined with increased demands on the water system from development, has increased pressure to eliminate flood irrigation systems in some portions of the West in recent years (Donnelly et al. 2015; Blevins et al. 2016). Research suggests that surface-irrigated acres in parts of the West have declined ≈23% between 1995 and 2010 (Maupin et al. 2014). Current trends of conversion away from flood irrigation could lead to the loss of half of the current flood-irrigated acreage in some areas of the West (Moulton et al. 2013). However, the ecological and water system recharge benefits of flood irrigation call into question the notion that sprinkler irrigation is always the more efficient method (Peck and Lovvorn 2001) and the overall definition of efficiency. The technical definition of irrigation efficiency is the ratio of the volume of water used to the total volume of water applied (Burt et al. 1997). However, this definition does not account for the social-ecological components of irrigation efficiency. That is, simplifying the definition of efficiency does not account for the social and ecological benefits that can be produced by flood irrigation, such as bird habitat conservation on working wet meadows, groundwater recharge for communities, and in-stream flow for fish. This social-ecological complexity of efficiency has been particularly apparent within western rangelands. For example, earthen stock tanks for cattle in the Southwest have been found to be a primary source of habitat for Chiricahua Leopard Frogs (Jarchow et al. 2016). In addition, leaky water lines have been documented to create habitat for the California Black Rail (Huntsinger et al. 2017). However, the traditional definition of efficiency does not account for the conservation benefits that occur as a result of these systems.

Given water scarcity concerns and increased competition for water resources, information regarding the relative economic, social, and ecological values related to irrigation practices is needed to guide complex conservation and management decisions. Specifically, in parts of the West, where nearly 70% of emergent wet meadow resources occur on private lands, conservation of wet meadow–associated wildlife on private lands and agriculture are inextricably linked (Donnelly and Vest 2012). Long-term conservation success of this habitat requires effectively working with ranchers to conserve the privately owned and managed wet meadow habitats. Although past research has explored the hydrology and ecology of flood irrigation (Peck and Lovvorn 2001), little is known about rancher thoughts and experiences regarding flood irrigation and the factors influencing whether they will continue the practice. A deeper understanding of the human dimensions of this issue may aid professionals as they design and adapt tractable conservation solutions for private lands.

The Community Capitals Framework developed by Emery et al. (2006) offers an approach to understand more deeply the diverse considerations of ranchers that shape the production of working wet meadows from flood irrigation (Fig. 1). This framework is commonly applied in the context of sustainable community development, particularly as it relates to resource-dependent communities (e.g., Katz 2000; Bodin and Crona 2008; Flora et al. 2012). It consists of seven types of capital: natural, cultural, human, social, political, financial, and built (Emery et al. 2006). Although capital types are defined independently, the model emphasizes the importance of evaluating the intersections among all seven capital types to understand the nuances behind the "multidimensional nature of community life" (Beaulieu 2014, p. 1).

Most typical applications of this framework emphasize community-scale assets, with analyses focusing on what fosters the development of each type of capital individually and resilient communities overall. While some research has touched on factors that constrain community capital (e.g., Wellman et al. 2001), few studies have considered the full suite of factors involved in the composition of all seven types of community capital. In order to develop recommendations for conservation programs and policy, evaluating both enablers and constraints as relates to the community capital types, may be more useful as both are needed to develop recommendations for program development and improvement (Shepherd et al. 2013). An enabling factor can be defined as something that is perceived to promote or support the use of flood irrigation, whereas a constraining factor is something

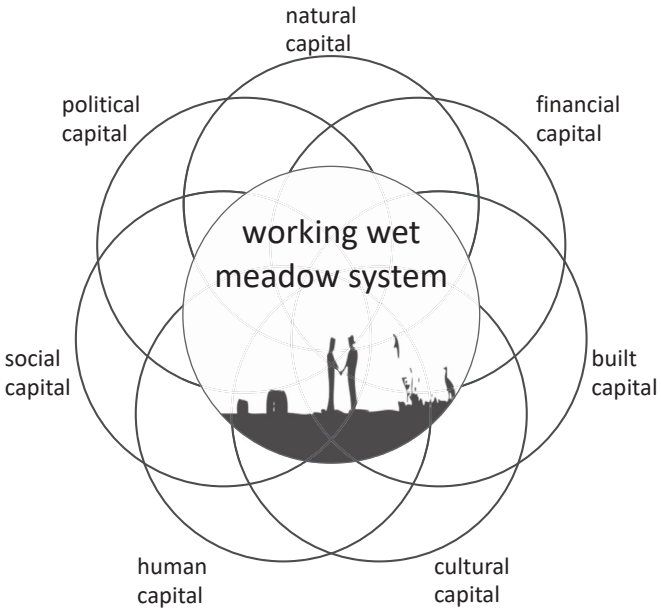

Figure 1. Community Capitals Framework based on Emery et al. 2006 for understanding the interrelated enablers and constraints that impact the coproduction of working wet meadows for ranchers and the environment.

that has the possibility of inhibiting the use of flood irrigation. The concept of enabling (also referred to as *facilitating*) and constraining factors has been applied to past conservation (e.g., enablers of water stewardship behavior of private well owners [Kreutzwiser et al. 2011]).

We applied the Community Capitals Framework to examine the natural, financial, built, cultural, human, social, and political capital considerations that influence the viability of flood irrigation by ranchers and, thus, impact the maintenance of working wet meadows (see Fig. 1). By exploring these seven types of capital and their intersections in relation to flood irrigation, through the perspectives of ranchers, we aim to understand more deeply how working wet meadows are coproduced by humans and the environment.

Methods

Study Areas

We conducted our research in two locations within the Intermountain West region of the western United States. Intermountain West spans 486 million acres across parts of 11 states (California, Oregon, Washington, Idaho, Montana, Wyoming, Colorado, Nevada, Utah, New Mexico, and Arizona), extending from the Front Range of the Rocky Mountains to the Eastern slope of the Cascade and Sierra Nevada Mountains. The ecologically and geopolitically complex region is also home to many rangelands (Intermountain West Joint Venture 2013). The two study areas within the Intermountain West were selected in coordination with the Intermountain West Joint Venture (IWJV), a joint public-private partnership working on bird habitat conservation. We chose sites significant to migratory birds, where flood irrigation was occurring, and where local partners with connections to ranchers were willing to partner on the project. In addition, we chose sites that spanned state and county boundaries to increase the diversity of rancher perspectives included. We held the first workshop in southern Oregon, with invitees from the local area and northeastern California. Ranching is a prominent land use in this region with 28% of the acreage privately owned (Vest, personal communication). This first location is also located within the Pacific Flyway, providing vital habitat for most migratory waterfowl and other waterbirds in the Flyway (Fleskes and Gregory 2010), largely through flood-irrigated rangelands (Petrie et al. 2013). In 2016, the region received $2.6 million through the Natural Resources Conservation Service (NRCS) Regional Conservation Partnership Program for working wet meadow conservation on privately owned, flood irrigated lands (Intermountain West Joint Venture 2016).

We held the second workshop in the Little Snake River Valley of southwestern Wyoming. Ranchers and professionals were invited from the region extending from the Little Snake River Valley extending to the Yampa River, which extends from the Little Snake River, in northwestern Colorado. The primary land use in this region is agriculture, mainly native or cultivated hay crops (Wyoming Game & Fish Department 2014), and private ownership makes up 39% of the region (Vest, personal communication). The region is also home to a large wet meadow complex, which provides habitat for multiple priority bird species (Wyoming Game & Fish Department 2014). Although many of these wet meadows remain viable due to intact livestock ranching operations, they are threatened by commercial and industrial development in the region, such as related to the tourism industry, as well as land subdivision from housing development, particularly given its proximity to Steamboat Springs, Colorado (Wyoming Game & Fish Department 2014).

Landowner-Listening Workshop Methodology

To examine considerations related to flood irrigation among ranchers, we held a landowner-listening workshop (Sketch et al. 2019) in each of the study areas. Landowner-listening workshops are a unique type of participatory process, originated by Partners for Conservation (Partners for Conservation 2013). They follow principles for effective community engagement (Ingles et al. 1999; Kellert et al. 2000; Plummer and Fitzgibbon 2004). A workshop-based interaction offered a unique data collection opportunity by facilitating a more informal and interactive experience than other qualitative methods, such as interviews or focus groups. Qualitative research exploring private landowner conservation behavior, particularly of agricultural landowners, is valuable and on the rise (Prokopy et al 2019; Ranjan et al. 2019).

In addition, the workshops cultivate social exchange among participants (Sketch et al. 2019), fostering an atmosphere that supports active engagement (Kueper et al. 2013). This approach aligned well with our goals to gain a more holistic understanding of ranchers' experiences with flood irrigation and what they consider in making irrigation decisions.

In landowner-listening workshops, the emphasis is on landowners talking while conservation professionals attend and listen to landowners and gain a better understanding of their needs and interests, as well as to answer potential questions that arise. A facilitator from the area follows a semistructured script to guide participant discussion throughout the workshop. The workshops were planned in coordination with regional and local conservation professionals. Researchers worked with IWJV, US Fish and Wildlife Service (e.g., Partners for Fish and Wildlife, Refuges), NRCS, the respective state fish and wildlife agencies, and staff from several nongovernmental organizations to plan the meetings and invite landowners and conservation professionals. We tried to limit bias in the invitation process by providing conservation professionals with a spreadsheet of demographic factors and operation characteristics (e.g., experience with flood irrigation, age, gender, size of operation, involvement in conservation programs, location). We requested they use it while developing landowner invitation lists, thus promoting a diversity of perspectives. Local partners also identified landowners to talk on two panels during each workshop. Finally, with the research team (the authors), we decided on a list of

conservation professionals who they felt had appropriate connection to and interest in the subject of working wet meadow conservation and who would be helpful in answering potential questions during the workshop. In the case of the Wyoming workshop, several additional conservation professionals reached out to local partners to ask if they could participate and then did attend, accounting for the higher number of professionals in this workshop.

Workshops included presentations and panels by ranchers, facilitated discussions of key questions designed for ranchers to answer, discussions between ranchers and conservation professionals, and informal conversations. The workshop consisted of three sections: 1) experiences with flood irrigation, 2) decisions related to flood irrigation, and 3) experiences with programs and policies related to flood irrigation. A professional facilitator from the local area facilitated each workshop, in coordination with the researchers. Question prompts (Appendix 1) associated with each section of the workshop were crafted by the researchers, with feedback from the local partners (including a local rancher in each location) and the facilitator to make sure they were locally and contextually grounded and would resonate with the participants. During the workshops, one researcher was focused on taking notes and participant observations while the other researcher worked closely with the facilitator to ensure questioning was focused on the research objectives, to ask follow-up questions, and to reframe the conversation when necessary to align with our research questions. For more information on this method and our evaluation of it, see Sketch et al. 2019. All data for the purpose of this article were sourced from the transcript of the workshop, focusing on what considerations ranchers consider in their irrigation decision. The case study approach through landowner-listening workshops allowed for deeper access to the issue at hand. Such qualitative methods emphasize contextual components of an issue and place-based nuance, which can be particularly important for rangeland management research (Sayre 2004).

Data Analysis

We audiorecorded and transcribed the workshops and coded them using Nvivo software. As the focus was on understanding what the ranchers thought about flood irrigation, we only analyzed their comments (i.e., we did not include analysis of the more limited comments of conservation professionals). On the basis of five capital models put forth by the Forum for the Future, we based initial coding on the three pillars of sustainability—social, economic, and environmental, which are more commonly referred to as *people, profit,* and *planet* (Forum for the Future, n.d.). During a second iteration, we recoded more specifically within the seven types of community capital (Table 1) as defined by Emery and Flora (2006): natural, financial, built, cultural, human, social, and political capital. Although the Community Capitals Framework generally focuses on catalysts of community development, given the adaption of the model to focus specifically on working wet meadow production, we examined how capitals might facilitate or limit flood irrigation. Thus, the capital types were broadly subcoded as enablers or constraints (Table 2). Enablers included any considerations related to a type of capital that were perceived to positively support and promote flood irrigation, whereas constraints were any considerations that were perceived to have a negative or inhibiting effect on flood irrigation. It is important to note that our focus was limited to ranchers' perceptions of enablers and constraints of flood irrigation, rather than actual benefits or costs thereof. For consistency, all coding was completed by the lead author following a codebook. The codebook was reviewed and discussed by coauthors and adapted to address questions and further understanding. Results were presented to and reviewed by the coauthors, IWJV staff, and regional and local planning partners. The few questions raised by those who reviewed the findings were addressed by querying the coded transcripts and discussion by the lead author and coauthors.

Table 1
Overview of types of community capital.

Type	Definition
Natural	"those assets that abide in a location, including resources, amenities, and natural beauty"
Financial	"the financial resources available to invest in community capacity building, to underwrite business development, to support civic and social entrepreneurship, and to accumulate wealth for future community development"
Built	"the infrastructure that supports the community, such as telecommunications, industrial parks, main streets, water and sewer systems, roads, etc."
Cultural	"the way people know the world and how to act within it and includes the dynamics of who we know and feel comfortable with, what heritages are valued, collaboration across races, ethnicities, and generations, etc."
Human	"the skills and abilities of people, as well as the ability to access outside resources and bodies of knowledge"
Social	"the connections between people and organizations or the social glue that make things happen"
Political	"access to power and power brokers, such as access to a local office of a member of Congress, access to local, county, state, or tribal government officials, or leverage with a regional company"

Source: Emery et al. 2006, p. 5–6.

Results

Twelve ranchers and seven conservation professionals participated in the Oregon workshop. Participants represented three counties in the bistate region with 10 ranchers from Oregon and 2 ranchers from California. The Wyoming workshop was attended by 20 conservation professionals and 19 ranchers (7 from Wyoming, 11 from Colorado, and 1 who ranched in both states). Across both workshops, participants articulated various enabling and constraining factors that influenced the viability of flood irrigation practices on western ranches. These considerations related to all seven categories of community capital (i.e., natural, financial, built, cultural, human, social, and political).

Natural Capital: Watershed-Scale Management

Many ranchers discussed their landscape-scale approach to thinking about their operation, revealing that they manage their land as a part of the greater ecological system, and in line with the natural ecosystem processes therein. For many ranchers, this comprehensive view of the natural environment impacted their rangeland management decisions. The natural capital of the landscape ultimately determined where ranchers can and do flood irrigate. Rather than a decision between flood or sprinkler irrigation, they described irrigation options as dictated by the natural features of the land including slope, elevation, soils, and water availability. A rancher explained, "A lot of these meadows and areas that are flood irrigated are historically areas that have a lot of water and so they evolved with that soil type." Further, on landscapes with natural water flows, ranchers saw flood irrigation as "mimicking Mother Nature," with one rancher explaining, "I consider myself the modern-day beaver. Old beavers dammed 'em up and now we just kinda control the flooding." As relates to their perceptions of natural capital, multiple ranchers communicated that they viewed their occupation as directly in line with an environmentalist ethos. A rancher from the Wyoming workshop explained, "I consider my profession one of the first environmentalists around."

Table 2
Summary of enablers and constraints of flood irrigation.

Capital type	Enablers	Constraints
Natural	Natural history of landscape	Erosion
	Aesthetics of wildlife and habitat	Damage from wildlife
	Land health	Drought
Financial	Better hay production	Labor intensive
	Fit within economic portfolio	
	Minimized capital outlay	
	Dependable form of production	
	Available conservation incentives	
Built	Preexisting infrastructure	Maintenance and upkeep
Cultural	Lifestyle centrality	
Human		Skilled labor
		Future generations
Social	Positive relationships	Development
		Outsiders/negative relationships
	Recreation/tourism	Public misperception
Political	Conservation delivery programs	Regulation and policy (e.g., limited conservation incentives)
	Collaboration	

In line with the landscape-scale lens through which many of the ranchers made decisions, many perceived the benefit of flood irrigation as cooperating with the nature of the land. That is, they felt flood irrigation facilitates the natural flow of water on wet meadows across the landscape. In line with this landscape-scale mindset, several ranchers viewed irrigation as more than the simple application of water to the landscape, acknowledging its role in groundwater recharge, return flows, and other watershed processes. A rancher in Oregon said:

> So, you know instead of it being a bathtub effect where we put the plug in the bottom of the bathtub and fill it up as full as we can get it and leave it just as long as we could possibly leave it and pulling the plug, we're pricking fields and turning water right back to the river so that it goes on to whoever gets it below.

This recognition of the full water cycle was in line with the systems-scale lens through which many ranchers viewed their operations.

Ranchers discussed wildlife habitat benefits from flood irrigation. However, the type of wildlife discussed differed between the two locations. Multiple ranchers in Oregon acknowledged a link between flood irrigation and bird abundance and enjoyed the increased bird presence, respecting the coexistence between their operation and wildlife as part of the overall flood-irrigated system. A rancher described his experience with birds on his fields: "The amount of birds that are through there in the springtime is amazing." The increase of wildlife, particularly in migratory waterfowl, related to flood irrigation on working wet meadows was noticeable to many ranchers. Looking more widely at the benefits to wildlife and the larger ecosystem, a rancher in Oregon explained, "Obviously the flood irrigation has a big impact on how the systems are managed more naturally. A naturally managed system draws in natural creatures like the wildlife." During the Wyoming workshop, ranchers' discussion focused more on big game species, particularly elk *(Cervus canadensis)*. Although birds (e.g., snow geese, *Chen caerulescens*, and ducks and waterfowl more generally) were mentioned occasionally in the workshop as a benefit of flood irrigation, ranchers were much more cognizant of elk and deer habitat on their land. A rancher explained the connection he noticed between flood irrigation and elk habitat: "Environmentally, 'cause we flood irrigate, we have a different species of grass … which of course draws elk and wildlife to us … And if we sprinkled, that would be gone in a heartbeat."

In line with these perceived landscape-scale benefits from flood irrigation, several ranchers in the Wyoming workshop discussed the benefits of flood irrigation to the land as a whole. A rancher explained, "What it does is [it] benefits the ecology of the land by keeping that part from Steamboat down a greenbelt … the water is what's keeping that area green." One rancher even mentioned the specific benefit of flood irrigation in increasing the nitrogen and protein in the grass, which in turn benefited the productivity of his operation.

Although the emphasis was on enablers of flood irrigation related to natural capital, several constraints emerged. A few ranchers, particularly in the Wyoming workshop, discussed the noticeable erosion from flood irrigation practices as a constraint. One rancher said, "We were having real soil erosion issues from the flooding that we just aren't seeing from the pivot 'cause you just aren't putting that volume of water on it." Depending on the slope of the land, the high volume of water spread over the ground from flood irrigation can lead to erosion. In addition, ranchers, particularly in the Oregon workshop, discussed wildlife damage as a constraint related to flood irrigation. Although they appreciated wildlife on their land, several ranchers expressed frustration with losses to their operation from birds feeding on hay crops and disease (i.e., salmonella) transferred from birds to cattle. One rancher explained the forage loss from wildlife: "You know my grass will be this high and I'll have 3 000 snow geese come into a field and it's gone. I'm guessing I'm losing at least 25–30% of my hay production every year." Finally, several ranchers voiced that climatic fluctuations, particularly related to drought and variable annual snowfall, were potential constraints to flood irrigation as well. When asked about drawbacks to flood irrigating, one rancher in Oregon responded, "Might as well put drought on there [a list of issues]. … Gotta have water to put in the ditch."

Financial Capital: Meeting the Bottom Line

Although management decisions did not seem to be purely financially grounded, it was important to most of the ranchers that they meet their bottom line and maintain a financially stable operation in the long term with irrigation practices that maintain productivity. A rancher from the Oregon workshop explained, "It comes down to the money 'cause we don't do it for laughs and giggles. It's a business enterprise and the revenue has to exceed the expense, end of the story in that regard."

Given this bottom-line mindset, ranchers recognized several financial enablers and constraints of flood irrigation. Related to enablers of flood irrigation, one rancher explained his motivation to flood irrigate as improving the productivity of his land: "I mean it's the most productive use of that part of the land, so, yeah, that's a big driver of it." More specifically, several ranchers mentioned how flood irrigation improves the land and forage for their operation,

with a rancher from Wyoming explaining, "We grow better hay crop 'cause we have better use of the water while we have it." The discussion of financial capital considerations extended to how flood irrigation fits within their entire operation portfolio. According to ranchers in the Wyoming workshop in particular, flood irrigation made sense as related to the "economics of cows." That is, for this rancher, the finances of flood irrigation aligned with cattle and commodity prices and other pieces of the production portfolio.

In addition, ranchers felt that there was a long and proven history of flood irrigation working for agriculture in the region. A rancher from the Wyoming workshop explained the tried-and-true nature of flood irrigation:

> Why do we ranch the way we do? From a strictly production point it's pretty much tried and true. It's been tested. You're batting a lot of singles and you're making a solid offense. We might not make our home runs and grand slams, but we're still here. The way we've done it has allowed us to keep the place. … You know it's the value average as a whole that really matters if you want to be there for the length of it.

Several ranchers felt the ability to maintain this steady viability over the long term was an enabler of flood irrigation. That is, financial considerations extended to the security of an operation as a whole.

Some ranchers discussed the role of conservation incentive programs as an enabler of flood irrigation as they help alleviate the financial burden of maintenance and upkeep of flood irrigation. A rancher from the Wyoming workshop explained that conservation program delivery through the NRCS has allowed them to maintain a viable operation, explaining, "Realistically you just plain flat can't get it done with the revenue generated on land." However, involvement with conservation programs and agencies was not for everyone. One rancher in the Wyoming workshop explained, "It was virtually impossible to get anything approved 'cause half my family was very unkind [to NRCS]—signing on the dotted line … it was easier to just not deal with the headache." In the Oregon workshop, several ranchers mentioned concern about the potential repercussions of their involvement including their personal data being shared. They believed information about producers who have signed a contract with NRCS would be accessible due to the Freedom of Information Act. Producers feared that activity such as related to water use may come under scrutiny as a result. A rancher in Oregon described, "With a lot of these NRCS programs and government programs, the Freedom of Information Act gives anybody any piece of information we've had to give those people and there's a lot of us that just don't go that way."

Finally, a constraint to flood irrigation is how resource intensive it can be, as relates to both dollars and hours. Flood irrigation requires more labor than many other more automated types of irrigation. A rancher in Wyoming explained, "We spend a lot of time irrigating. We're out there 8 o'clock in the morning, shoveling, moving water. And we're back out there at 6:30, 7 o'clock at night doing the same thing. … It takes work." Ranchers recognized the drawbacks of these labor demands, especially when access to skilled labor in many of the communities was already limited. Several ranchers hired "ditch riders" to help clean and maintain their ditches. However, depending on the size and demands of the operation, other ranchers kept all of the labor within their family. A rancher in Wyoming explained, "It's most efficient for me to spend the time, the labor, which is myself, so I'm not drawing a significant salary."

Built Capital: Keeping Up with Ditches

Ranchers perceived built capital as both an enabler and constraint. They explained flood irrigation often requires less financial outlay than other forms of irrigation because much of the infrastructure is already in place. This preexisting infrastructure of flood irrigation acted as an enabler. Given water access and established infrastructure, many ranchers saw flood irrigation as the most cost-effective form of irrigation as they are simply paying for their time and any outside labor.

Built capital constraints focused on concerns related to upkeep of flood irrigation infrastructure. Although there was not the initial capital outlay that newer forms of irrigation may require, many of the structures for flood irrigation are dilapidated and require an increasing amount of maintenance. Responding to the question on the primary challenges of flood irrigation, a rancher from the Oregon workshop explained,

> You know, just being able to replace structures and, you know, get the old system back up into place, same time put in some new twists to it, if you will. It's just a pretty tough deal.

As described earlier in the financial capital section, maintenance of flood irrigation ditch systems was perceived by many to be labor intensive and demanding. Although conservation programs helped offset some of the financial demands related to flood irrigation, there was some frustration among ranchers in Oregon with limitations on how conservation funding could be applied related to these infrastructure constraints. For instance, in the Oregon workshop, we heard from several ranchers that they could not use NRCS funding for maintenance or upkeep of infrastructure and it could only be applied to purchase new infrastructure.

Cultural Capital: It's a Way of Life

Cultural capital primarily seemed to function as an enabler of flood irrigation in both workshops. Ranchers identified strongly with the ranching lifestyle, which has positive implications for flood irrigation. A rancher from the Wyoming workshop explained:

> Well, I think a lot of people just keep ranching the way they do now because that's all they know and that's what they enjoy. Most of the time you ain't in a family ranch to get rich; it's a way of life. And what better way of life is there? You know you're out on the land. You make your own decisions … for the most part.

For many, in both workshops, these established ranching practices were seen as foundational to their operation and livelihood and multiple ranchers expressed commitment to maintaining this ranching lifestyle. One rancher alluded to the connection between flood irrigation and lifestyle centrality, explaining: "The reason we go to flood irrigation is because we have one of the oldest irrigation ditches on the Yampa River … we're following a tradition there that our fathers and grandfathers fostered, that they realized the importance of water and spreading that water." For many, flood irrigation has been used on their ranch for generations, and they felt a certain pride in continuing this traditional approach that connects them to their heritage. Some ranchers worked to promote this approach within the next generation as well to ensure the continuation of the tradition. For instance, a rancher in the Wyoming workshop said: "It [flood irrigation] teaches your generation that you're raising moral values and stuff like that—stewardship of the ground." In Oregon, the personal identity component of flood irrigating was also tied to the aesthetics of wet meadows. One rancher explained: "I would hate to see all of the flood-irrigated meadows turn into pivots and wheel lines. I'm sorry they're not as pretty as flood-irrigated meadow, you know. So, for me there's sort of an identity with it or a connection to that." No constraints related to cultural capital emerged from either workshop.

Human Capital: Ensuring Longevity

Ranchers expressed concern over the future prosperity of agriculture in general and flood irrigation specifically. The lack of available, skilled labor was a particular constraint noticed by ranchers. A rancher from Oregon described this necessary skill set, "To take a shovel out there and look at the situation and then make the decision there—well, I'll tell ya that's tough to train somebody to do that." In addition, there seems to be a downturn in skilled labor in many rural ranching communities. A rancher in Oregon explained:

> I think there's a whole set of people who are coming up into the workforce and all they've ever done is played video games, to where they'd be real good with that automation, but they don't know a damn thing about a shovel or even running a piece of equipment. That's scary. It seems to me that's more and more what you run into: nobody knows how to work.

On top of concern with the skillset needed to maintain flood irrigation, there was concern regarding the continuation of many of the operations by the next generation. Many of the ranchers' children realized the difficulties of ranching and were hesitant to continue the tough lifestyle demanded by running such an operation. A rancher in Oregon said:

> If the kids can see value in that, they'll continue with flood irrigation. But if it isn't there, there's too much to fight about or something like that, they'll discontinue it because there's work to it … and there's required knowledge in order to make these systems work out there.

Although some ranchers expressed concerned with their ability to pass their operation on to the next generation, they respect their children's decisions, fully understanding the difficulty of the ranching lifestyle. With this, several ranchers, particularly in the Wyoming workshop, emphasized the need to work to minimize the burden on the next generation in taking over the ranch. A rancher in Wyoming described:

> You just have to have someone who is interested in taking it further. There has to be interest from your children, okay. And to set it up financially so it's not a burden when it does change through estate planning and things like that.

In the face of much of the generational transfer that is impacting ranching and agriculture in the West, ranchers felt it was important to ensure operations are set up correctly for long-term sustainability.

Social Capital: The Community-Shed

Ranchers were cognizant of and integrated with their larger social community, including both other ranchers and all neighbors connected to the water system. They acknowledged the community impacts on their operations. With a mindset beyond his individual operation, a rancher from the Oregon workshop said:

> Our neighbor's irrigation is largely dependent on the way we irrigate, too, and so it is kinda a community thing … if we weren't flood irrigated we would have to do, you know, quite a project to keep from getting wet 'cause it is a flood SYSTEM.

Ranchers recognized that their irrigation decisions were not independent of their neighbors as water flow is not limited to their fields. This requisite connection with the community tended to be an enabler when ranchers have longstanding, trusting relationships with their neighbors. A rancher voiced:

> Our two ditches that we're on really communicate really well. Everybody texts, texts when we're turning on more water or somebody's turning down their ditch and the rest so that really works pretty good … and I think it starts off making sure you have a good ditch company or good meetings.

These positive relationships seemed to promote coordination, communication, and making decisions together, promoting the use of flood irrigation.

Ranchers also identified constraints related to new landowners coming into the area who do not necessarily understand the nature and nuances of the water system. Ranchers discussed noticeable impacts from rural sprawl and related development that is putting pressure on water supplies, fragmenting landscapes, and thus affecting agricultural operations. A rancher from Oregon explained a negative experience he had related to the water use of those upstream of him:

> What bothers me or concerns me is when somebody comes in and all of a sudden takes that ditch that went along the side of the hill and puts that water right out in the middle of the field. That not only affects him, but it could affect me and we've had several of those you know 'where'd our water go?'

The upstream-downstream connection between water users was strongly recognized among Wyoming and Colorado ranchers. Ranchers face the vulnerability that comes with the open nature of the watershed and the impact of upstream user decisions on the water availability and use of those downstream.

Although some ranchers perceived outsiders to be a constraint to flood irrigation, in the Oregon workshop, tourism was largely perceived as a community asset. Although not necessarily beneficial to their individual operations, ranchers noted the positive cascading effects of tourism for their small, rural areas as it brought jobs and income to the community. Several ranchers also expressed favorable attitudes toward the birdwatchers coming in, such as for the annual bird festival in the area, taking pride in the natural beauty and capital of their community. A rancher explained, "I mean just for small communities, that influx of tourism you can definitely see a benefit because it doesn't take much to see the influx in such small communities."

A primary perceived constraint to flood irrigation was the impact of public misperception of ranching. Ranchers discussed the negative attitudes of others (e.g., general public, environmental advocates, policy makers) toward flood irrigation specifically and agriculture as a whole. Many felt that the public did not see the full picture of agriculture and were making evaluations based on misinformation. A rancher from the Wyoming workshop elucidated, "There is a lot of population, I'm sure, in my county that thinks we're all incompetent, we're ruining the land out there, we are using those shovels to do bad things." Ranchers felt much of the general public thinks flood irrigation is an inefficient, unsustainable use of water. One rancher referred to this mindset as the "myth of efficiency," explicating that the public fails to look at the system-wide level and account for the role of flood irrigation on the landscape in recharging the aquifer and maintaining a functioning watershed.

Political Capital: Telling the Story

Rancher considerations surrounding political capital had strong connections to the enablers and constraints of social capital outlined earlier. Particularly in the Wyoming workshop, we had

several ranchers present who were particularly plugged into the political arena, which seemed to fuel much of this conversation. Ranchers saw positive local relationships with conservation professionals as an enabler of political capital related to flood irrigation. One rancher explained, "When Fish and Wildlife comes to this valley, it's 'let's go do some stuff.' And so, what we've been able to figure out here is partnerships work a lot better than confrontation." Ranchers realized the need for partnering and appreciated the role of such relationships in their communities.

Related to the intersection of public misperception and regulation constraints, ranchers were frustrated they did not have a stronger voice in the decision making arena, calling for necessary education of the public. As discussed earlier, related to natural capital, ranchers described themselves as being stewards of the land and having a deep understanding of landscape-scale needs. One rancher from the Wyoming workshop called for other ranchers to join the conversation:

> We better do a little better job of partnering with our conservation partners and start telling a better story of what this means not just in the Yampa and not just in the Little Snake but what it means to those tens of thousands of people that go to the National Wildlife Refuge south of Albuquerque to go look at cranes … because that's the ecology that you guys buy and we don't tell that story.

However, the focus of policy and regulation discussion differed between the two workshops. In Wyoming, the focus on water law and policy was very strong. Many ranchers were frustrated with the regulations and policy surrounding water rights. This social complexity of water in the region translated into frustration with state- or federal-level water policy. One rancher described:

> As far as the pressure to be more efficient … our administration has mentioned to me a couple times that they were concerned about the puddling of some of the fields in the irrigation district. But a lot of those fields you can't irrigate without a puddle and you're actually more efficient if you get a puddle 'cause you can get in there and get over the wide spots and be done.

In Oregon, although there was discussion of water regulations, the conversation focused heavily on policies ranchers felt limited their freedom and breached their property rights such as the Endangered Species Act and Freedom of Information Act. One rancher explained, "If we lost our permits because of the sage-grouse, whatever bird you wanna come up with, what's the beneficial use of that ground then?"

Several ranchers also expressed frustration with funding available only for "efficiencies projects," which often refers to incentives for newer technologies such as sprinkler irrigation. Some ranchers felt that pressure for increased water savings is pushing funding to be directed toward these types of projects, negatively impacting flood irrigation. For instance, one rancher in Wyoming pronounced:

> When you go to the head of the Ag Committee and say thanks for all the money for efficiency, which is real money, right, its real money coming out. We're gonna go ahead and say 'wait a minute, efficiency isn't the ultimate deal.' … But right now, the dollars are on the efficiency side, not on the irrigation side.

Despite the frustration, ranchers discussed the role of collaboration among conservation partners and ranchers in countering the constraints of regulation and policy. Also, the ranchers alluded to the long history of collaboration among stakeholders in the regions, working together to manage complex resource-related issues. One rancher in the Oregon workshop discussed the role of collaboration:

> We've made inroads in the past 15 yr that are absolutely unbelievable. But it takes honest people sitting around, getting over their biases, their agendas and listening to one another and doing the right thing.

However, there seemed to be differing levels and types of collaboration with different organizations, particularly in different places and communities.

In looking specifically at the policy ramifications of collaboration, one California rancher explained the unique collaboration in his region:

> I belong to our irrigation district and there's about 20 users and we're a united front. Everything we do, we do together and we go right after the Department of Water Resources. … So, we have better success by doing it that way.

Although collaboration was happening on the Oregon side of this region, this specific type of collaboration related to agricultural advocacy seemed unique to this California rancher's community. Other ranchers in the workshop were unaware of this specific model, asking clarifying questions on the approach, such as if the members of the collaborative pay dues and how they come to decisions.

Discussion

Although irrigation efficiency is often evaluated narrowly in terms of amount of water used of the water applied, the decision of which irrigation system is most efficient and appropriate for a rancher's operation involves multifaceted social-ecological considerations that vary from operation to operation. For instance, across many landscapes of the Intermountain West, flood irrigation maintains critical habitat for birds in historically flooded wet meadows (Lovvorn and Hart 2001; Peck and Lovvorn 2001). These working wet meadows can be seen as social-ecological services (Huntsinger and Oviedo 2014) coproduced by humans and the environment, as in California rangelands where both native plant and animal species benefit from sustainable cattle grazing (Huntsinger and Oviedo 2014). Thus, a deeper understanding of the social-ecological complexity of irrigation efficiency and the recent debate around the transition from flood irrigation to alternative forms of irrigation, primarily center pivot and sprinkler irrigation (Donnelly et al. 2015; Blevins et al. 2016), is necessary to better appreciate the social-ecological complexity driving these decisions.

We applied the Community Capitals Framework to understand more deeply rancher decision making in the context of flood irrigation and working wet meadows, evaluating what enablers and constraints influence their decisions. In summary, we found that ranchers consider complex, multifaceted factors across the social-ecological system when approaching irrigation decisions. Enablers and constraints related to all seven types of capital (i.e., natural, financial, built, cultural, human, social, and political).

Conservation professionals often reduce ranching to a predominantly economic endeavor, assuming that profit maximization is the primary motivator of rancher decisions (Kreuter et al. 2006; Willcox and Giuliano 2011). However, we found that the enablers of ranching decisions were multifaceted, complex, and interrelated, involving components of all seven types of community capital (i.e., natural, financial, built, cultural, human, social, and political). Our results reinforce the many advantages and disadvantages of the social, ecological, and environmental components of a ranching operation that are largely variable across the landscape (Brown 2008). That is, given the social-ecological complexity of the Intermountain West, irrigation decisions are not one size fits all.

However, our findings provide insight into other considerations, especially social, cultural, and political enablers and constraints that play into irrigation decisions and are important in understanding the intricacies beyond the technical definition of efficiency.

Most ranchers in our workshops were not purely profit maximizers when it came to making decisions about their land. For instance, several ranchers mentioned that they consider themselves "environmentalists" or "wildlife biologists," managing the landscape in consideration of the larger environmental system, particularly as relates to their irrigation practices. This intimate connection with the environment has been seen in other ranching communities (Sheridan 2007; Knapp and Fernandez-Gimenez 2009; Willcox et al. 2012) and has been found to influence land management decisions (Cross et al. 2011; Willcox and Giuliano 2011). Similarly, we found the ecological context within which ranchers operate often had a strong impact on their irrigation decisions. That is, the irrigation methods used by ranchers were often determined by environmental components of the landscape such as slope, water availability, and soil type.

Further supporting the multifaceted nature of rancher decisions, one of the most prominent areas of discussion among ranchers reflected cultural capital. Ranchers repeatedly came back to the importance of maintaining a ranching culture in rural communities. Lifestyle centrality, or "the strength with which a landowner identified him or herself as a rancher" (Sorice et al. 2012, p. 145), can impact landowner motivations for decisions on their land (Sorice et al. 2012). Past research supports this finding that ranchers are not purely financially motivated and are willing to trade monetary gain for maintaining a traditional lifestyle (e.g., Didier and Brunson 2004; Willcox and Giuliano 2011; Brain et al. 2014; Yung et al., 2015). This commitment to ranching has been found to be particularly strongly associated with traditional agricultural practices (Yung et al. 2015). Flood irrigation—a practice important in the west for over a century (Peck and Lovvorn 2001)—fits this characterization. Flood irrigation is unique among conservation practices often studied on private lands in that ranchers are not taking on something new; instead, the conservation activity (for the sake of wet meadow wildlife habitat) is continuing with the old despite technological innovation (i.e., sprinkler irrigation). Therefore, it is not surprising that we found lifestyle centrality to be an enabler of conservation, rather than a constraint as in other research where the conservation behavior requires innovation adoption (e.g., Didier and Brunson 2004). However, in an effort to maintain the ranching culture in their communities, ranchers expressed concern about the ability to pass their operation on to the next generation. As ranchers age, they face the challenge of keeping their operation alive (Travis 2007; Brunson and Huntsinger 2008). Support in succession planning, through workshops or technical assistance, may be needed to ensure sustainability of ranching and thus of flood irrigation in many of these rural communities.

Although profit maximization alone does not explain the decision making context for flood irrigation for most ranchers, financial issues were highly salient. That is, ranchers needed to be able to meet the bottom line to remain viable. For many ranchers, flood irrigation was important as a financially viable approach to forage production. Yet the labor demands of flood irrigation became a financial burden for some ranchers and had to be weighed. Similarly, there is a human capital constraint in that enough skilled labor must be available for landowners to flood irrigate, a practice that traditionally requires a higher labor demand (Food and Agriculture Organization of the United Nations, n.d.). In summary, related to financial, human, and built capital, ranchers must consider these various challenges in managing their operations and ensuring long-term sustainability. In addition, related to built capital, financial and time demands of maintaining old and dilapidated infrastructure (e.g., ditches) were primary constraints to flood irrigation. This finding certainly has implications in the design and application of conservation programs in the future, particularly given the interrelated nature of wildlife habitat, floodplain function, and forage production from flood-irrigated wet meadows.

Social and political constraints also influenced ranching operations as a whole and flood irrigation specifically. For instance, ranchers, particularly in our Wyoming workshop, were faced with development pressures that were impacting their communities and operations. Past research has also found that ranchers feel the impacts of development pressure on their operations (Rissman and Sayre 2012; Brain et al. 2014). Related to the potential impacts of these social pressures on ranching communities, recent research found that upwards of 45% of US ranches are being sold every decade (Gosnell and Travis 2005). While research is limited on the impacts of development on ranches of flood irrigators specifically, potential changes to the landscape can be socially significant, such as altering community networks (Yung and Belsky 2007), and ecologically impactful, such as pressure on water resources (Hansen et al. 2002) and fragmentation of habitat (Brunson and Huntsinger 2008).

Both workshops revealed approaches to rangeland management overall, and irrigation practices specifically, that extended beyond the individual operation. This community-scale, system-wide perspective of ranchers extended into all seven types of capital. In evaluating the intersectionality of the seven types of capital, ranchers often had to balance various enablers and constraints in managing their operations and evaluated potentially conflicting considerations and interests as related to flood irrigation. That is, ranchers had to consider how various enablers and constraints interplayed with each other across the spectrum of community capital when making management decisions. For instance, several ranchers balanced natural and financial capital related to wildlife damage. Although they had to maintain an economically viable operation, many were willing to limit profits if doing so contributed to the provision of natural capital. This was true of other ranchers who sought to balance financial interests with cultural outcomes. Many expressed a deep love of ranching and an enduring commitment to keeping agriculture alive, aspirations for which they were willing to make financial concessions. These intersections between types of capital suggest that the decision whether or not to abandon flood irrigation in favor of sprinkler systems is by no means simple or linear, involving a multifaceted set of considerations among the different types of capital. For instance, while flood irrigation demands much more labor than center pivot (human capital), it demands less large, fixed capital outlay (financial capital). This interplay between types of capital implies the difficulty in directly comparing the two types of irrigation such as through the linear definition of efficiency.

Our finding of the social-ecological complexity of rancher considerations suggests the importance of integrating the full spectrum of enablers and constraints from all seven types of community capital into conservation design and delivery. For instance, as called for in other studies, our findings from the two locations support the idea of moving away from simply financial incentives to promote sustainable private land conservation (Langpap 2006; Ramsdell et al. 2016). Yet we do not recommend fully abandoning financial incentives. Instead, it is crucial that they continue to be one of the conservation tools available and that they be designed to ensure ranchers can meet the bottom line while considering the diverse commitments and constraints they face. Thus, conservation incentive program success might be improved by appealing to the specific constraints of ranchers while emphasizing financial viability.

Although the Community Capitals Framework has been applied to agricultural communities related more broadly to community

development (e.g., Salamon et al. 1998; Flora et al. 2012), our application of the framework was unique in evaluating the full suite of enablers and constraints related to all types of capital. That is, we evaluated the various factors that enable flood irrigation (enablers) and those that are barriers to it (constraints). Given that many environmental processes transcend property boundaries, ranchers are often driven to consider a diversity of factors, both social and environmental. Use of this approach within ranching communities can help identify and inform conservation research and ensure delivery is grounded in local social and ecological context that incorporates rancher needs and interest. Our application of the framework to flood irrigation and working wet meadows helped us gain a nuanced view of a full range of enablers of flood irrigation to better understand rancher decisions and their effects on working wet meadows. Further, in providing insight into the intersection between the various types of capital, the Community Capitals Framework is effective in highlighting the complexity in the decision whether or not to convert to sprinkler irrigation systems. Beyond flood irrigation, the framework could be applied to other conservation issues within rangelands, such as soil regeneration, woody plant encroachment, and water conservation to evaluate the diversity of factors at play in rangeland management. In community planning, Flora et al. (2012) emphasize incorporating place-specific elements in each step of the process. On the basis of our application, analyzing these place-based nuances using the Community Capitals Framework would likely be beneficial applied to rangeland management. However, future research evaluating the factors that play into the production of social-ecological services could benefit by looking at how the Community Capitals Framework applies at multiple spatial scales, such as pasture, ranch, and landscape scales (Huntsinger and Oviedo 2014).

While our research revealed a great deal of similarity between two locations, the case study nature of the research also presents a potential limitation. Care should be taken in extending these insights beyond the two specific areas in which we worked: southern Oregon/northeastern California and the southwestern Wyoming/northwestern Colorado regions. However, our results do begin to paint a broader portrait of the flood irrigation conversion conversation that is occurring across many other parts of the Intermountain West. Further, these two case studies allow for deeply exploring the context and nuances of the research topic. We also acknowledge that our insights are shaped by those who attended the workshop. Given that our approach involved local conservation professionals determining which ranchers to invite, there was potential that the invitation process was limited to ranchers whom they already knew or ranchers already involved in environmental programs. However, the use of a spreadsheet of diverse demographic factors and operation characteristics hopefully helped limit bias (for more discussion of the spread of participation, see Sketch et al. 2019).

In summary, our research highlights the many factors that ranchers consider in their irrigation decisions and thus why the technical definition of efficiency does not adequately incorporate their needs. We found that there is much at play in the decision to maintain flood irrigation or switch to center pivot systems, from shortage of skilled labor to infrastructure demands to lifestyle factors. However, these considerations are often hidden under the veil of water efficiency. The conservation of the full social-ecological landscape of the Intermountain West calls for a deeper engagement of these various enablers and constraints.

Implications

Applying the Community Capitals Framework to understand rancher perceptions surrounding their irrigation decisions revealed diverse and complex enablers and constraints that span across all seven capital types. Ensuring these multifaceted considerations are accounted for can be achieved through communications efforts, partnership development, and conservation programs and policy. Related to communications, our findings reiterate the importance of acknowledging and communicating to various audiences the awareness that many ranchers have of their local environments and their potential role in landscape-scale conservation in their communities. Many ranchers felt they were not being appreciated for their role in providing food to people, downstream water, and wildlife benefits, particularly related to flood irrigation. Those in surrounding communities (as indicated in the Oregon workshop, a closed system); urban areas downstream (as indicated in the Wyoming workshop); or those moving into rural areas (e.g., resort town new residents) are important audiences for these communication efforts. This could be done through various formats, such as a story map of rancher stewardship stories or publications in diverse outlets (e.g., the news media, conservation organization magazines). In addition to public communications and mass media, potential audiences could include policy makers who make water decisions that influence water availability to ranches (e.g., local water districts/boards and state legislators).

Further, to fully address the social-ecological complexity of rancher decisions into programs and policies, conservation efforts need to be grounded in the context of the individual place, moving away from a one-size-fits-all approach of many large-scale conservation programs. Thus, it is critical that those on the ground delivering conservation programs, such as partner biologists, are versed in local, place-specific constraints and considerations. The value of partner biologists is extended when they are supported in gaining the skills and allocated the time required to build relationships with ranchers. Further, relationships among ranchers and conservation professionals are an important part of the multifaceted context within which ranchers operate and make decisions. An awareness of the multifaceted, contextual factors influencing ranchers' decision making among diverse audiences, from conservation professionals to policy makers to the general public, can lead to stronger communication, partnerships, and ultimately conservation outcomes.

Acknowledgments

We would like to thank the landowners and conservation professionals who attended and participated in our workshops. The Intermountain West Joint Venture staff collaborated on funding proposals for the project, as well as coordinating workshop logistics and informing the project design, methods, and recommendations. We would also like to thank Dr. Michael Sorice and Dr. Dean Stauffer for their review of a previous version of the manuscript. We also appreciate their reviews of this manuscript. Further, we thank three anonymous reviewers and Corinne Noel Knapp, Associate Editor at *Rangeland Ecology & Management,* for their constructive feedback that greatly improved this manuscript. In addition, we appreciate the local and regional partners who helped plan and implement the workshops: Community Agriculture Alliance; Ducks Unlimited; the High Desert Partnership; Ladder Livestock Company, LLC; Lake County (OR) Soil and Water Conservation District; Little Snake River Conservation District; Oregon State University Extension; Oregon Watershed Enhancement Board; Partners for Conservation; Sublette County (WY) Conservation District; USDA Natural Resources Conservation Service; US Fish and Wildlife Service; and Wyoming Game and Fish Department.

Data Statement

The raw data for this project is transcripts of two workshops with ranchers. We are not sharing it to protect the anonymity and

confidentiality of our human subjects, according to our Institutional Review Board approval. Although de-identified, it may still be possible to identify who was speaking based on the thoughts and experiences they describe.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rama.2019.12.003.

References

Atamian, M.T., Sedinger, J.S., Heaton, J.S., Blomberg, E.J., 2010. Landscape-level assessment of brood rearing habitat for greater sage-grouse in Nevada. Journal of Wildlife Management 74, 1533–1543.

Baker, J.M., Everett, Y., Liegel, L., Van Kirk, R., 2014. Patterns of irrigated agricultural land conversion in a western U.S. watershed: implications for landscape-level water management and land-use planning. Society for Natural Resources 27 (11), 1145–1160.

Beaulieu, L., 2014. Promoting community vitality and sustainability: the community capitals framework. Purdue University. Available at: https://www.pcrd.purdue.edu/files/media/Community-Capitals-Framework-Writeup-Oct-2014.pdf. Accessed July 10, 2018.

Blevins, S., Hansen, K., Paige, G., MacKinnon, A., 2016. Valuing the non-agricultural benefits of flood irrigation in the Upper Green River Basin. University of Wyoming Extension. Available at: http://www.wyagresearch.org/research/fdb/2016-offstation-valuing-the-non-agricultural-benefits-of-flood-irrigation.pdf. Accessed June 15, 2018.

Bodin, Ö., Crona, B.I., 2008. Management of natural resources at the community level: exploring the role of social capital and leadership in a rural fishing community. World Development 36, 2763–2779.

Brain, R.G., Hostetler, M.E., Irani, T.A., 2014. Why do cattle ranchers participate in conservation easement agreements? Key motivators in decision making. Agroecology Sustainable Food Systems 38, 299–316.

Brown, P.W., 2008. Flood vs. pivot irrigation for forage crops: what are the advantages and disadvantages? Proceedings, 2008 California Alfalfa & Forage Symposium and Western Seed Conference; 2-4 December, 2008; San Diego, CA, USA, 9. Available at: https://alfalfa.ucdavis.edu/+symposium/proceedings/2008/08-141.pdf. Accessed November 1, 2019.

Brunson, M.W., Huntsinger, L., 2008. Ranching as a conservation strategy: can old ranchers save the new West? Rangeland Ecology & Management 61, 137–147.

Burt, C.M., Clemmens, A.J., Strelkoff, T.S., Solomon, K.H., Bliesner, R.D., Hardy, L.A., Howell, T.A., Eisenhauer, D.E., 1997. Irrigation performance measures: efficiency and uniformity. *Biological Systems Engineering: Papers and Publications* 28. Available at: https://digitalcommons.unl.edu/biosysengfacpub/38. Accessed May 05, 2019.

Cross, J.E., Keske, C.M., Lacy, M.G., Hoag, D.L.K., Bastian, C.T., 2011. Adoption of conservation easements among agricultural landowners in Colorado and Wyoming: the role of economic dependence and sense of place. Landscape Urban Plan 101, 75–83.

Didier, E.A., Brunson, M.W., 2004. Adoption of range management innovations by Utah ranchers. Journal of Range Management 57, 330–336.

Donnelly, J.P., Dreitz, V., Naugle, D.E., Vest, J.L., Ecologist, S., West, I., Venture, J., Service, W., Region, P., Program, W.B., 2015. Water scarcity and working lands: linking wetland dynamics to landscape carrying capacity for migratory bird conservation. Available at: https://iwjv.org/sites/default/files/donnelly_et_al._sonec_wetland_dynamics_proposal.pdf. Accessed January 16, 2018.

Donnelly, J.P., Naugle, D.E., Hagen, C.A., Maestas, J.D., 2016. Public lands and private waters: scarce mesic resources structure land tenure and sage-grouse distributions. Ecosphere 7, 1–15.

Donnelly, J.P., Vest, J.L., 2012. Identifying science priorities 2013–2018: wetland focal strategies. Intermountain West Joint Venture Technical Series 2012-3. Intermountain West Joint Venture, Missoula, MT, USA.

Emery, M., Fey, S., Flora, C., 2006. Using community capitals to develop assets for positive community change. Community Development Practice 1–19.

Fleskes, J.P., Gregory, C., 2010. Distribution and dynamics of waterbird habitat during spring in southern Oregon-Northeastern California. Western North American Naturalist 70, 26–38.

Flora, C., Bregendahl, C., Renting, H., 2012. Collaborative community-supported agriculture: balancing community capitals for producers and consumers. Journal of Sociology and Agriculture 19, 329–346.

Food and Agriculture Organization of the United Nations, n.d. Choosing an irrigation method. *In:* Irrigation water management, training manual no. 5, irrigation methods.

Forum for the future. n.d. The five capitals. Available at: https://www.forumforthefuture.org/the-five-capitals. Accessed June 01, 2018.

Gosnell, H., Travis, W.R., 2005. Ranchland ownership dynamics in the Rocky Mountain West. Rangeland Ecology & Management 58, 191–198.

Hansen, A.J., Rasker, R., Maxwell, B., Rotella, J.J., Johnson, J.D., Parmenter, A.W., Langner, U., Cohen, W.B., Lawrence, R.L., Kraska, M.P.V., 2002. Ecological causes and consequences of demographic change in the New West. Bioscience 52, 151.

Huntsinger, L., Hopkinson, P., 1996. Viewpoint: sustaining range social and ecological process landscapes: a social and ecological process. Journal of Range Management 49, 167–173.

Huntsinger, L., Hruska, T.V., Oviedo, J.L., Shapero, M.W.K., Nader, G.A., Ingram, R.S., Beissinger, S.R., 2017. Save water or save wildlife? Water use and conservation in the central Sierran foothill oak woodlands of California. Ecology and Society 22, 2.

Huntsinger, L., Oviedo, J.L., 2014. Ecosystem services are social–ecological services in a traditional pastoral system: the case of California 's Mediterranean rangelands. Ecology and Society 19, 8.

Ingles, A. W., Musch, A., Qwist-Hoffmann, H., Valli, C., and Joseph, G. 1999. The participatory process for supporting collaborative management of natural resources: an overview.

Intermountain West Joint Venture, 2013. Identifying science priorities 2013-2018: Wetland focal strategies. Available at: https://iwjv.org/sites/default/files/iwjv_3_science_wetlands_2013-2018.pdf. Accessed March 16, 2018.

Intermountain West Joint Venture, 2016. Working wet meadows of Southern Oregon-Northeastern California: Regional Conservation Partnership Program. Intermountain West Joint Venture, Missoula, MT. USA.

Intermountain West Joint Venture, 2013. 2013 Implementation plan: strengthening science and partnerships. IWJV, Missoula, MT, USA.

Jarchow, C.J., Hossack, B.R., Sigafus, B.H., Schwalbe, C.R., Muths, E., 2016. Modeling habitat connectivity to inform reintroductions: a case study with the Chiricahua Leopard Frog. Journal of Herpetology 50, 63–69.

Katz, E.G., 2000. Social capital and natural capital: a comparative analysis of land tenure and natural resource management in Guatemala. Land Economy 76, 114–132.

Kellert, S.R., Mehta, J.N., Ebbin, S.A., Lichtenfeld, L.L., 2000. Community natural resource management: promise, rhetoric, and reality. Society for Natural Resources 13, 705–715.

Knapp, C.N., Fernandez-Gimenez, M.E., 2009. Knowledge in practice: documenting rancher local knowledge in northwest Colorado. Rangeland Ecology & Management 62, 500–509.

Kreuter, U.P., Nair, M.V., Jackson-Smith, D., Conner, J.R., Johnston, J.E., Johnstons, J.E., 2006. Property rights orientations and rangeland management objectives: Texas, Utah, and Colorado. Rangeland Ecology & Management 59, 632–639.

Kreutzwiser, R., De Loë, R., Imgrund, K., Conboy, M.J., Simpson, H., Plummer, R., 2011. Understanding stewardship behaviour: factors facilitating and constraining private water well stewardship. Journal of Environmental Management 92, 1104–1114.

Kueper, A.M., Sagor, E.S., Becker, D.R., 2013. Learning from landowners: examining the role of peer exchange in private landowner outreach through landowner networks. Society for Natural Resources 26, 912–930.

Langpap, C., 2006. Conservation of endangered species: can incentives work for private landowners? Ecology and the Economy 57, 558–572.

Lovvorn, J.R., Hart, E.A., 2001. Irrigation, salinity, and lanscape patters of natural palustrine wetlands. In: McKinstry, M.C., Anderson, S.H., Hubert, W.A. (Eds.), Wetland and riparian areas of the Intermountain West: their ecology and management. University of Texas Press, Austin, TX, USA, 105–130.

Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., Linsey, K.S., 2014. Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405. Available at: https://dx.doi.org/10.3133/cir1405. Accessed July 3, 2019.

Moulton, C., Carlisle, J., Brenner, K, and Cavallaro, R. 2013. Assessment of White-faced Ibis near two important breeding colonies in eastern Idaho. Idaho Department of Fish and Game.

Partners for Conservation, 2013. Partners for Conservation: improving the landscape through communication. Available at: https://www.fws.gov/arkansas-es/docs/PFW/Partners-for-Conservation-_Vision-concept-paper_6.29.2010.pdf. Accessed April 10, 2018.

Peck, D.E., Lovvorn, J.R., 2001. The importance of flood irrigation in water supply to wetlands in the Laramie Basin, Wyoming, USA. Wetlands 21, 370–378.

Petrie, M., Vest, J., Smith, D., 2013. Chapter 4: Waterfowl, Intermountain West Joint Venture Implementation Plan 2013. Intermountain West Joint Venture, Missoula, MT, 4.1–4.58.

Plummer, R., Fitzgibbon, J., 2004. Co-management of natural resources: a proposed framework. Environmental Management 33, 876–885.

Prokopy, L.S., Floress, K., Arbuckle, J.G., Church, S.P., Eanes, F.R., Gao, Y., Gramig, B.M., Ranjan, P., Signh, A.S., 2019. Adoption of agricultural conservation practices in the United States: evidence from 35 years of quantitative literature. Journal of Soil Water Conservation 74 (5), 520–534.

Ramsdell, C.P., Sorice, M.G., Dwyer, A.M., 2016. Using financial incentives to motivate conservation of an at-risk species on private lands. Environmental Conservation 43, 34–44.

Ranjan, P., Church, S.P., Floress, K., Prokopy, L.S., 2019. Synthesizing conservation motivations and barriers: what have we learned from qualitative studies of farmers' behaviors in the United States? Society of Natural Resources, 32, 1171–1199.

Rissman, A.R., Sayre, N.F., 2012. Conservation outcomes and social relations: a comparative study of private ranchland conservation easements. Society for Natural Resources 25, 523–538.

Roberts, M., 2012. Conversion from flood to sprinkler water supply impacts. Montana Department of Natural Resources and Conservation. Available at: http://dnrc.mt.gov/divisions/water/water-rights/docs/new-appropriations/presentations/flood_sprinkler_conversion.pdf. Accessed September 12, 2018.

Salamon, S., Farnsworth, R.L., Rendziak, J.A., 1998. Is locally led conservation planning working? A farm town case study. Rural Sociology 63, 214–234.

Sayre, N.F., 2004. Viewpoint: the need for qualitative research to understand ranch management. Journal of Range Management 57, 668.
Sheridan, T.E., 2007. Embattled ranchers, endangered species, and urban sprawl: the political ecology of the new American West. Annual Review of Anthropology 36, 121–138.
Sketch, M., Dayer, A.A., Metcalf, A.L., 2019. Engaging landowners in the conservation conversation through landowner-listening workshops, Society & Natural Resources, 1–12.
Travis, W.R., 2007. New geographies of the American West: land use and the changing patterns of place. Island Press, Washington, DC, USA, 312.
USDA Natural Resources Conservation Service. 2016. Chapter 11 Sprinkler irrigation. *In:* National engineering handbook. USDA, Washington, DC, USA, 202.
Venn, B.J., Johnson, D.W., Pochop, L.O., 2004. Hydrologic impacts due to changes in conveyance and conversion from flood to sprinkler irrigation practices. Journal of Irrigation Drainage Engineering 130, 192–200.
Vest, J. L., personal communication. Human dimensions project area land ownership summary.
Wellman, B., Haase, A.Q., Witte, J., Hampton, K., 2001. Does the Internet increase, decrease, or supplement social capital? Social networks, participation, and community commitment. American Behavioral Science 45, 436–455.
Willcox, A.S., Giuliano, W.M., 2011. Cattle rancher and conservation agency personnel perceptions of wildlife management and assistance programs in Alabama, Florida, Georgia, and Mississippi. Wildlife Society Bulletin 35, 59–68.
Willcox, A.S., Giuliano, W.M., Monroe, M.C., 2012. Predicting cattle rancher wildlife management activities: an application of the theory of planned behavior. Human Dimensional Wildlife 17, 159–173.
Wyoming Game & Fish Department. 2014. Upper Little Snake Valley wetlands complex: regional wetlands conservation plan.
Yung, L., Belsky, J.M., 2007. Private property rights and community goods: negotiating landowner cooperation amid changing ownership on the Rocky Mountain Front. Society for Natural Resources 20, 689–703.
Yung, L., Phear, N., Dupont, A., Montag, J., Murphy, D., 2015. Drought adaptation and climate change beliefs amongst working ranchers in Montana. American Meteorology Society 7. Available at: https://doi.org/10.1175/WCAS-D-14-00039.1. Accessed October 1, 2018.