THESIS

WILDLIFE HABITAT AND AGRICULTURAL COMMODITIES: ORGANIZING A COMMON PROPERTY RESOURCE IN NORTHERN COLORADO'S PHANTOM CANYON

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY ANNIE EPPERSON ENTITLED "WILDLIFE HABITAT AND AGRICULTURAL COMMODITIES: ORGANIZING A COMMON PROPERTY RESOURCE IN NORTHERN COLORADO'S PHANTOM CANYON" BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS.

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ABSTRACT OF THESIS

WILDLIFE HABITAT AND AGRICULTURAL COMMODITIES:
ORGANIZING A COMMON PROPERTY RESOURCE
IN NORTHERN COLORADO'S PHANTOM CANYON

Colorado surface water, an intensively-managed common property resource, has been allocated to serve primarily agricultural and municipal needs rather than ecological needs. This thesis inductively explores a case study in which two organizations, a mutual irrigation company (North Poudre Irrigation Company) which distributes common property irrigation water, and an environmental organization (The Nature Conservancy) protecting habitat for fish and wildlife, a collective good, forged a relationship. This organizational arrangement produces instream flows for habitat during fall, winter, and spring months, transcending individual rationality and creating organizational rationality as an agent of social and environmental change. Organizational variables, synthesized from the work of Elinor Ostrom (1990) and David Freeman (1989), are proposed as necessary for the successful creation of social capital in the form of an agreement between the two organizations. Qualitative methods, using in-depth interviews and document review, showed that the expected organizational variables were indeed present. Clear boundaries, equitable rules, and local control, were shown to contribute to the social construction of the agreement which resulted in the provision of a new good, with properties of both a collective good and a common property resource.

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DEDICATION

This thesis is dedicated to two individuals of passion, intelligence and humor.

❖ Dr. G. Z. Jacobi, whose work with benthic macroinvertebrates helps people, including me, appreciate the importance and complexities of living on a water planet. His example and encouragement continue to guide me.

❖ James A. Epperson - I long for his counsel.

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CHAPTER 1 - INTRODUCTION

Research Question and Method

Human beings depend upon Colorado surface water for irrigation of crops, domestic uses, and industry. Wildlife and other parts of ecosystems evolved with water as a necessary element of the natural environment. Mismanagement of water resources has negative repercussions for both humans and wildlife species. Water managers are challenged to provide for ever-increasing human needs while also maintaining healthy ecosystems. Water that is diverted and impounded for irrigation of commodity crops or municipal use is not available as streamflow upon which wildlife, including fish, depend. This thesis describes and analyzes one way that challenge has been addressed by water managers in northern Colorado. This thesis employs the case study method to examine the interaction of two organizations in the late 20th century that produced a new form of social capital–an agreement that provided instream flow for winter fish habitat without compromising irrigation deliveries to commodity producers. I start by noting:

1. The Nature Conservancy (TNC) owns and manages property in northern Colorado, with a goal of providing collective goods in the form of habitat for fish and wildlife and preserving a remnant of the Front Range ecosystem. In order to achieve these goals The Nature Conservancy needed to secure access to surface water, a scarce and tightly-controlled commodity in Colorado.

2. The North Poudre Irrigation Company (NPIC) has a 100-year tradition of providing the common property good of irrigation water to satisfy the agricultural agenda of its northern Colorado constituents. Until the late 20th century's rising concerns for ecological damage and loss of habitat became an inescapable feature on the political landscape; the provision of collective goods such as instream flow had never been part of their agenda.

Given this, I formulated the following research question:

> What organizational variables and relationships account for how two organizations, one a provider of collective goods and the other with a common property resource agenda, came together in an agreement that resulted in an outcome that neither could have achieved on their own, namely the creation of continuous instream flow for the purposes of habitat preservation and ecological restoration? In other words, how was a new good with properties of both a collective good and a common property resource created?

The two local organizations have formed an agreement that provides water to species over-wintering along a stretch of the Poudre river. The thesis is that specific sociological features of these local organizations made the production and management of this new good possible.

The Nature Conservancy is an international organization which strives to protect remnant landscapes, ecosystems and habitat in order to protect biological diversity. Local chapters expedite this mission through locally-appropriate methods such as conservation

easements, coalition-building and avoiding litigation. North Poudre Irrigation Company is a mutual company made up of shareholders who collectively hold rights to water in the Poudre river watershed. Operating for more than 100 years in Larimer county, NPIC has a long tradition of maximizing use of Poudre river water to grow commodity crops and contributing to the local economy.

The case study method was used to gain an understanding of just how the agreement came into being, and how it has evolved over time. The case study consisted of in-depth interviews with key informants from each organization and local officials as well as document review to trace the origins and evolution of this agreement in north-central Colorado.

Concepts and theory

Property is commonly classified by theorists as either *private, public,* or *common* property (Freeman (1989), and Hanna, Folke, and Mäler (1996: 2-5)). Distinctions between types of property are made based upon two characteristics: *rivalness of consumption* and *excludability* (Samuelson, 1947), which are defined within the context of types of goods in the following paragraphs.

Private goods have a high degree of rivalness of consumption and excludability, and are used, consumed or owned exclusively by the investor. As stated in Freeman (1989: 16), "Private goods are exemplified by possessions such as clothing, automobiles, home appliances, and personal work tools—an individual invests in them and enjoys the benefits of ownership." An individual who invests in a personal computer enjoys its high

degree of rivalness of consumption—what the investor "consumes" is not available for others to consume, and high excludability—those who do not invest in the computer are easily excluded from its use.

At the other end of the property spectrum is the public, or collective good, which exhibits low degrees of rivalness and excludability. Street lighting is an example of this type of good—if lighting is available to one person, all others may enjoy the benefits without effecting use by others (rivalness is low) and there is in fact no way to ensure that those benefitting from the lighting have contributed investment necessary to provide it (low excludability). Freeman (1989:16) states that "a good is 'public' or 'collective' if its benefits cannot be denied to those who do not help to bear the costs ('free riders')."

These examples of private and public goods represent two extremes on the conceptual continuum. Between the two extremes are common property goods, with varying degrees of rivalness and excludability. In light of the differentiating criteria of Freeman (1989), Freeman and Angin (1999), and Hanna et al. (1996: 2-5), common property goods have moderate rivalness of consumption because a non-trivial portion of what one uses can be made available to another. Also, excludability (the ability to exclude potential non-contributing free-riders from using the good) is moderate. According to Freeman (1999: 97), common property "benefit streams cannot be 'owned' by any one party and must be thereby shared with others."

This thesis addresses common property, that is, property owned by a group of interdependent investor-users, and has characteristics of rivalness of consumption and excludability that distinguishes it from public property and private property (Ostrom,

1990: 30-33). In some cases the terms *common property good,* and *common pool resource* (or *common pool good*) are used. An example of a common property good is irrigation water stored in a reservoir or flowing in a canal. In this example, irrigation water has only moderate rivalness of consumption (as one irrigator applies water to a field, a non-trivial portion percolates through the soil or runs off, and becomes available to another user) and moderate excludability (it is costly for one individual to prevent free-riding). Table 1 summarizes the attributes of three types of property according to these two characteristics.

Table 1 Types of property as defined by physical characteristics and typical provider

	Rivalness of consumption	**Excludability**
Private (Market)	High	High
Public, or Collective (State)	Low	Low
Common	Moderate/Variable	Moderate/Variable

Significance

This thesis is not an attempt to test a hypothesis but rather to generate hypotheses which additional research might test. This thesis employs existing theory about common property resource (CPR) organizations to organize and interpret information obtained through a case study of an agreement that provides for year-round flow in a North Central Colorado stream. It will attempt to reveal essential elements of such an organizational adaptation, as derived from CPR theory. The lessons learned from careful examination of

this case have relevance to sociological theorists, policy makers and natural resource managers contending with a multitude of conflicting demands.

Across the land, many natural resources, including water, are often mis-managed and overused to the point of total loss, consumption, or degradation. Without appropriate local organization, they are vulnerable to over-appropriation, over-consumption and eventual destruction. Because rational unorganized actors are likely to exploit resources with no concern for the potential results of long term deterioration, resources are susceptible to irreversible harm, damaging not only the ecology of the resource but also the collective social good. Destruction of wildlife habitat, and loss of endangered or threatened species has ramifications for all, not only those who enjoy fly-fishing, or depend on crop production for a livelihood. A society that recognizes the interactions of ecosystems with each other and with social systems strives to formulate and implement policies that allow each to thrive. For example, insufficiently organized resources must be protected by social beings organizing to prevent the destructive tendencies noted above.

As growth of human impact continues along the Front Range of Colorado, wildlife habitat is fragmented, reduced or eliminated. Habitat protection is mandated in the case of species listed as endangered or threatened under the Endangered Species Act of 1973. Therefore, provision and preservation of habitat requires the formulation and implementation of policy on local and regional levels. Increasing human impact on CPRs around the globe and throughout the American west calls for a better understanding of how to better construct social capital to manage resources upon which life depends. This

thesis presents a case study that can inform future policy makers regarding integrating environmental agendas with human commodity production.

Employing the concept of *social capital* is one way of theorizing the social organizations necessary for protection of natural resources. Social capital is generally understood as the strength found in networks of individuals, and is formed and continually reinforced through the exchange of obligations and trust. It provides organized groups the wherewithal to accomplish tasks beyond the capacity of a lone individual. For example, cooperative groups can manage common property natural resources for satisfaction of human needs and conservation of wildlife.

Common property resources have been the subject of conflict since the time of Aristotle–individual self-seeking rationalists often use property and make choices without regard for collective rationality or the long-term sustainability of the resource. Tragic consequences can occur when policies are formulated without regard for common property nature of a resource, including wildlife and ecosystems dependency upon the resource. When a source of water is entirely depleted or degraded, for example, human beings dependent upon that supply lose their means of producing crops, either for the market, or sustenance for the family and community. This loss of a source of water can also lead to a greater tragedy, namely the extinction of a wildlife species. However, through social communities, human beings can organize to produce long-lasting CPRs that provide water, and other natural resources, in a sustainable, equitable and adaptive way. This thesis explores one such organizational adaptation. The case described herein

focuses on the flow of water in a stream-bed, however it has implications for the management of all natural resources, throughout the world.

Summary

In summary, this thesis examines a case study of two local level organizations, The Nature Conservancy and North Poudre Irrigation Company, for variables derived from CPR theory. It explores how people with conflicting interests came together to provide a good that could be produced by neither alone, by building on social capital found in networks of rational individuals. The analysis of this case is of interest to sociological theorists, those in applied social policy, and natural resource managers.

CHAPTER 2 - LITERATURE REVIEW

Introduction

Common property resource theory focuses on organizations devised to manage and provide common property resource benefits while concurrently making some arrangement for the costs of providing those goods (See Freeman, 1989; and Ostrom, 1990). Common property natural resources such as water can be abused, destroyed, or mismanaged for two reasons: 1) either an effective CPR organization does not exist to manage the resource properly, leaving it in a condition of open access to free riders; or 2) CPR organizations in place have not included environmental considerations in a traditionally narrow agricultural commodity production agenda. The situation investigated in this research consists of the creation of a new good, with characteristics of both collective goods and CPRs.

Background to Water in the West

Water is a critical component of the ecological processes upon which all known life depends. Human beings use water to consume as drinking water, to irrigate food crops and produce commodities, to carry away waste products of domestic and industrial activities, and for aesthetic and recreational uses. Natural systems are intimately linked with hydrological processes that vary spatially and temporally. Mismanagement threatens

ecological processes that support plant, animal and human life on the local, regional, national and international level.

Organizations that manage water are often focused on only one use (e.g. irrigation) rather than the multiple uses and roles that water plays within human and natural systems (Worster, 1985; Reisner, 1986). However, irrigation water running in a canal or ditch, or applied to a field with subsequent return flows, is not isolated from the rest of the ecological environment; rather it interacts with the biotic web. Water percolates through the soil and recharges groundwater, as it runs off and forms wetlands that attract wildlife. The initial removal of water from a river to satisfy human needs deprives the natural system of a necessary component for proper ecologic function. Irrigationists have long allocated water without sufficient attention to these other needs and uses. However, it is appropriate for irrigators to be accountable to other uses because their uses are usufructory–meaning that withdrawal by one user is dependent upon not harming the rights of another (Radosevich *et al.*, 1976: 21). This usufructory element is a central tenet of the Prior Appropriations Doctrine, which serves to protect water which is the property of the citizens of the state of Colorado, while allowing for its beneficial use. Therefore it is imperative that Colorado organizations manage water as a CPR; they own rights to use the water but not harm or lose it.

Donald Worster (1985) wrote that state-financed industrial-level irrigation of the arid west had abstracted water from the ecosystem, removing it from the ecological and social environment. Water moved on a grand industrial scale from one region to another, under the control of Bureau of Reclamation administrators: "a small power elite reigning

over a large, anonymous, dependent population" (Worster, 1985: 261). Worster (1985: 310) concludes that, under large-scale water development "three sets of environmental vulnerabilities appeared: a water quantity problem, a decline in water quality under ever more intensive use, and a potentially irreversible degradation of the pristine ecological communities of the West." Worster does not recognize local level organizations that operate on a scale which allows water to interact with its environment and the society from which the organization originated initially.

This thesis demonstrates that adaptive local organizations in Colorado answer Worster's charge by keeping water connected to the ground, and connected to the society that manages it. Indeed the agreement to be presented here is an example of a negotiated adaptation to return river water in its native channel and maintain it. Human beings have devised organizational systems that manage water and provide for uses such as irrigation, domestic municipal and industrial use; many social scientists have studied these organizations (Maass and Anderson, 1978; Freeman, 1989; Ostrom, 1990; and Postel, 1999). These management systems often frame water as a common property good–owned by all and the responsibility of those that make use of the water and its benefits. Two of these local level CPR organizations, TNC and NPIC, are the subject of this thesis.

Lack of appropriate organizational agendas contributes to environmental destruction around the globe. A lack of clean drinking water and basic sanitation technology results in millions of deaths each year from water-related diseases (Gleick, 1993: 3), that could be ameliorated, at least in part, through social organization. Wildlife

species and ecosystems also suffer the consequences of mismanagement of water resources: "Species do not simply replace each other's functions when some are lost to extinction. Impoverishment of biotic diversity can lead to less productive, less stable habitats. Moreover, species have intrinsic and aesthetic values that transcend their ecological and economic productivity" (Covich, 1993: 40). Appropriate organization could do much to protect the collective good found in biological diversity.

Agriculture is responsible for nearly two thirds of water use around the globe (Postel, 1993: 57), which results in dewatering of natural systems through diversion, declines in water quality, salinization of fertile soils, and erosion of soil and sedimentation of waterways, among other consequences. In the United States of America, irrigation water is critical for continued, predictable agricultural production, particularly west of the 100th meridian in the Great Plains, where irrigation is needed for at least some part of the growing season (Postel, 1993: 56). A United States Interagency Task Force on Irrigation Efficiencies (1979:3) declared "Irrigated agriculture has been and continues to be a major economic enterprise in the West. Values from irrigated agriculture are woven throughout the economic and social structure of the western United States." In 1999, the sustainability of the current civilization, as dependent upon irrigated agriculture, was called into question by Postel (1999: 6). Given that many prehistoric and historic civilizations around the world rose with increased dependence on increasingly more complex irrigation systems, and fell when the forces of nature overcame the technological advances of each society, Postel's premise is that our now-global dependence on vast monocultural crop fields, irrigated with ever-scarcer supplies of

water, may end in catastrophe. She states, "The overriding lesson from history is that most irrigation-based civilizations fail. As we enter our third millennium A.D., the question is: Will ours be any different?" (Postel, 1999: 12).

Dependency upon irrigation water shaped the physical and social landscape of the American West as European settlers first developed infrastructures for the diversion and delivery of surface waters, and then created reservoirs for the capture and storage of winter precipitation for use during times of need in the growing season (Fiege, 1999). Development and use of western water resources during the long phase of settlement and economic development of the area has been "a major factor in the decline of [native] fish species," according to a report filed by the Western Water Policy Review Advisory Commission in 1998 (WWPRAC 1998: 5-31). As long as the rivers of Colorado were open access public resources, little stood in the way of short- or long-term mismanagement, for both wildlife and human needs.

Reisner (1986) describes the transformation of the American west by the quest for water. The formation of the Bureau of Reclamation, and its subsequent projects throughout the west, have left a legacy that Reisner sees as: " a uniquely productive, creative vandalism. Agricultural paradises were formed out of seas of sand and humps of rock. Sprawling cities sprouted out of nowhere . . . millions of people and green acres took over a region that, from appearances, is unforgivingly hostile to life." Reisner is mostly concerned about the environmental degradation resulting from western water development: "The costs of all this, however, was a vandalization of both our natural

heritage and out economic future, and the reckoning has not even begun. Thus far, nature has paid the highest price" (Reisner, 1986: 503).

Human mismanagement of natural resources around the world has been shown to result in degradation of the resource, to the point of compete destruction, in some cases. Postel (1999) demonstrates that the very civilizations founded on inappropriate dependence on irrigation systems cannot be sustained indefinitely. Great cities arose along the banks of rivers, sustained by agriculture that diverted river water for irrigation. Floods, sedimentation and drought, as well as over-exploitation of the surrounding region, are the inevitable result of thoughtless river bank settlement. Natural ecosystems, made up of flora and fauna, are possibly even more sensitive to the destructive effects of mismanagement. Individual species have been eliminated from the earth, with the causes lying in resource mismanagement, primarily habitat destruction (Field, 1994:443). The Dodo will never again be seen, while in America, the passenger pigeon is gone. Many species came close to extinction just prior to the passage of the United States Endangered Species Act in 1973. This landmark legislation prompted a substantial change in the way that landowners and public land managers can make use of the lands under their care.

Policies to protect plant and animal species have been established as a result of poor management practices in the past. With the aid of the federal government, the American west was put to work producing new lives for settlers and agricultural commodities for the nation, through the massive projects necessary to provide water to municipalities and irrigationists in the arid landscape (Worster, 1985: 12). Assistance from the federal government eventually came in the form of the Reclamation Act of 1902,

which provided the means for construction of "high dams" (Pisani, 1992: 322). Projects that satisfied many needs, such as the Colorado-Big Thompson project providing Colorado River water to the eastern side of Colorado's Rocky Mountains, were undertaken with federal dollars through the Bureau of Reclamation. Environmental degradation and social injustices were among the byproducts of this tremendous infusion of capital investment and engineering expertise (Reisner, 1986). Powerful interests harnessed water, using the power of eminent domain to gain access to land and resources as needed to further their ends, including the importation of cheap labor to work under deplorable conditions (Worster, 1985: 227).

In Colorado, gold and silver mining shaped the use of water in the early years of European settlement, followed closely by the demands of agriculture for the provision of market crops to feed the miners. The earliest recorded use of a ditch for crop irrigation in Colorado is 1859 (Dunbar, 1983: 19). By the turn of the nineteenth century, most of the land using surface water was "under a ditch" (Maass and Anderson, 1978: 275). Foreign investors contributed to the construction of some canals, including English investment in the "High Line Canal" which drew water from the Platte River (Pisani, 1992: 58). Early diversion infrastructure had been created through the labor and investment of local farmers themselves, however the late 1870s marks the beginning of Colorado's "corporate phase of water development" concurrently with increased access by rail (Pisani, 1992: 209). Prior to 1878, vegetables and grains were the chief crops; after that time the cultivation of alfalfa began in eastern Colorado. This transition is important because the earlier vegetable and grain crops depended upon water diverted early in the

summer, at times of peak flow on most rivers; Alfalfa needed water much later in the growing season. Other important crops after 1878 with late water needs included potatoes and beets. This demand for late water increased the need for reservoirs to impound early season runoff, for late summer application (Pisani, 1992: 57). Dunbar (1983) describes early development of impoundments in northern Colorado, particularly in the valley of the Cache la Poudre River: "during the 1890s irrigators . . . transformed natural depressions at the base of the mountains into storage reservoirs to irrigate potatoes and other crops that mature late in the summer" (p. 37).

As development of water storage and conveyance structures increased, the naturally seasonal streams and rivers became the tools of the irrigation company, and were only allowed to flow when necessary to water a given crop, or halted in a reservoir until the moment the water was needed at some point downstream. River basins began to be described in terms of the running, or irrigation season, which comprises the warm months of the year when crops are receiving water. When water was not flowing to crops, the cooler months were described as the storage season, and some irrigators (or their representative organizations) held rights to completely stop the flow of a river in order to store water in anticipation of the next growing season. As Worster (1985: 92) describes it, to "divert part or all [of a river's] current, whether for mining or irrigation, Coloradans (*sic*) insisted that it was essential to do so for settlement." As colonization of the west progressed, more and more water was diverted, stored, and applied to human needs. The increasing human needs left less room, or water, for fish and other wildlife

components of the ecosystem that had existed in place with the free-running rivers prior to development.

In Colorado, irrigators' power to manipulate water is entrenched in the law of prior appropriation, in which "first in time, first in right" is the basic rule (Maass and Anderson, 1978: 275). Junior rights-holders are cut off to supply water to those senior to them in times of shortage. This rather tight constraint has led irrigation organizations to resolve deficiencies of junior water appropriators by adopting flexible solutions. One of these adaptations provides the substance of this thesis. Reservoirs that impound spring snowmelt provide one adaptation for security of junior water appropriators. However, containment of winter flows and spring snowmelt changes the ecological dynamics of a river system and contributes to loss of habitat for fish and other wildlife species. For example, Halligan Dam on the North Fork of the Poudre River was built in the early 1900s, creating Halligan Reservoir. This reservoir has been managed to capture as much winter and spring flow as legally allowed, thereby dewatering the canyon below Halligan Dam. This loss of habitat, both below Halligan Dam and along Colorado streams in general, contributes to pressures on wildlife as human populations and urbanization rise along the Front Range of Colorado.

The costs of mismanaging natural systems include pollution of waterways and loss of ecological diversity (Reisner, 1985: 503), which can be directly related to the lack of empowering local level CPR organizations. Ostrom (1990:112) observed that often there is little incentive for individuals to form an organization for the mitigation of negative consequences until a crisis point is reached. Given changes in natural systems

(pollution and over-fishing completely destroying a fishery, for example), or changes in policy (Endangered Species Act, 1973), and resulting requirements of nature or human society, organizations may form to answer these newly-perceived needs. But organizations must effectively provide benefits proportional to the costs assessed of members and participants and allow room for long-term environmental concerns as a fundamental component of operations. The next section describes essential theoretical literature regarding how individually-rational human beings organize to provide for common needs. Primarily, this thesis relies on rational choice theory; however, I begin with a related literature. Social capital contributes to this thesis as a conceptually-appropriate underpinning to much of the sociological theory to follow.

Social Capital

In ascendency over the past decade, social capital embodies ". . . the set of resources that inhere in family relations and in community social organization . . ." (Coleman, 1990: 300). In other words, social capital is found in the social networks, interrelationships, and obligations that transcend individuals and shape the collective society. Individuals mobilized to achieve a collective goal both build on and benefit from social capital.

For this thesis, social capital is seen as the social networks that consist of enforceable norms and mutual obligations that mobilize individuals to achieve collective tasks for the benefit of the community (Coleman: 1990, 310-12; Flora, 1998; Wall, Ferrazzi and Schryer, 1998; Warner, 1999). Local level organizations such as mutual

water companies or local chapters of environmental groups embody this notion, empowering people to pursue and accomplish an agenda that transcends individual self-seeking rationality.

Muldavin (1996: 246-9) discusses the importance of state investment in social organization in situations of limited or declining capital. His work centers on agrarian reform in China, but his conclusions apply to many other cases in which state investment denies the importance of supporting local organizational capacities for problem solving. A misdirected state can undermine long-standing local collectives, resulting in "progressive impoverishment" and a "village completely dependent on state relief" (p. 248). Warner (1999) discusses the role that the local state can take in building or undermining social capital either directly or as a participatory intermediary. In light of globalization, she sees an opportunity for local government to address the "mismatch between the current enthusiasm for social capital and the scale and depth of community development problems" (p. 389).

Conceptually, social capital helps form a theoretical link between individual-oriented rational choice theory in which much CPR theory is based, the state, and the larger community created from interacting social individuals. Muldavin's and Warner's work underscores the importance of adequate support from, and autonomy from, the state to empower individuals to invest in social capital for the benefit of entire communities and regions. For more thorough reviews of the theory and its applied dimensions, see Coleman, 1990; Wall, Ferrazzi and Schryer, 1998; and Ostrom, 1994. Common property resource theory establishes the challenge–how can rational self-serving individuals and

organizations empower themselves to undertake collective action and constrain free-riders? People respond to the CPR challenge by organizing themselves, i.e., they create forms of social capital that empowers them to do collectively what cannot be accomplished individually.

The goal of this research is to contribute to the discussion of how best to manage natural resources such as water in ways that contribute to human welfare and social justice, while improving ecological integrity in natural systems upon which life depends. A review of CPR theory will support understanding of the theoretical framework.

Individual and Collective Action–Theories and Models

Garrett Hardin's (1968) seminal work "The Tragedy of the Commons" concluded that individual rational decisions regarding resource use would lead to collectively-irrational outcomes. His example was of an open-access pasture destroyed by individuals maximizing their own gain by introducing more and more grazing animals, because the costs of each successive animal was borne by the collective group, rather then the individual shepherd. Production of sheep and wool at the expense of the finite grazing resource, and the entire group of shepherds, resulted in long term tragedy. Hardin concludes that the only way to rationally manage open-access resources is to convert them to private goods and let the market rule, or have them managed by the state.

Theorists have explored a variety of ways to manage the tragedy of the commons, rooted as it is in the neoclassical idea that atomized rational individuals act without consideration of collective welfare, including possible degradation of the natural

environment upon which all endeavor depends. The following section discusses the different views of the tragedy of the commons. One group of theorists puts their faith in the market, thinking that privatization of resources is the best way to allocate benefit and obligation. Another group of theorists proposes that a strong central state should provide and manage resources. There are also those theorists who take a reductionist view, who see individuals as capable only of concern for themselves, while yet another group is optimistic about the capacity of individuals for organization and social solutions to the tragedy of the commons.

One option for dealing with the tragedy of the commons presented in the literature is embodied in the privatization of resources. Markets, managing resources such as water as a private good, bring to bear concepts of supply and demand, including the idea that manipulation of prices can help manage resources. According to Anderson and Snyder (1997: 7), "Experience around the world has demonstrated over and over again that the only successful way to avoid . . . shortages is to rely on free-market pricing and allocation." MacDonnell (1999: 252) argues that internalizing external costs of irrigation infrastructure operations to mitigate the harmful environmental effects of their water use would be the best way to encourage more efficient use of water. "To require water users to pay these costs is simply to treat them in the same manner as industries and businesses that are required to install expensive equipment to clean up their air and water discharges."

Traditional water users, including irrigation companies, are threatened by increasingly vociferous demands for environmental consideration. As MacDonnell

(1999:254) observes: "they resent being forced to make changes in the manner in which rivers and their water are used, a matter traditionally under their control. They resist having to pay for these changes. . . . the result is often protracted confrontation, endless studies, even more endless negotiations–with little real incentive to reach resolution short of a court order to do so". Markets offer one way of providing wildlife habitat protection, as a private good available only to those who invest, and closed to those who do not. Irrigators are understandably disgruntled about shouldering the full burden of providing a resource from which all benefit, even indirectly. If one landowner provides habitat for an endangered species, without investment or contribution from others, then all others are free-riding on the goodwill of the landowner.

However, a second option for dealing with the tragedy of the commons may be found in the designation of resources as public goods to be provided by the central state. The state may be able to offer ways that may minimize some conflict over issues of equity and the common good. Some feel that the state is the appropriate provider of environmental protection, including provision of wildlife habitat. "The presumption that an external Leviathan is necessary to avoid tragedies of the commons leads to recommendations that central governments control most natural resource systems" (Ostrom, 1990: 9). In the United States, the state already participates in providing habitat management and support of wildlife populations, on a national, state and local level through a network of parks, forests, wildernesses and grasslands. Additionally, Federal agencies uphold laws protecting threatened and endangered species, management of migratory and game animals, water quality standards, and pollution controls.

Despite this seemingly vast coverage of environmental concerns by government entities, significant areas lack coverage. Local-level, site-specific plans are time- and money-intensive to devise and implement. Employees of government agencies are trained in nomothetic principles of generalizable scientific methods and management goals, which may not appropriately match the needs of small-scale projects. Indeed, the particulars of a given state (and its laws regarding water) creates inherent difficulties in providing instream flow policies and implementation. "Because beneficial use is the basis for the prior appropriation system, such changes to state law create a property claim rather than a public interest claim" (WWPRAC, 1998: 5-11). Environmental protection, including habitat provision for threatened and endangered species, cannot be ensured by creation of further public goods, with low levels of excludability and rivalness of consumption leading to high susceptibility of free-riding.

A third option that addresses the tragedy of the commons suggests managing resources as CPRs and collective goods. In the decades since Hardin's 1968 essay, a great deal of discussion has centered on CPRs and problems associated with their management. Many natural resource and environmental problems have the attributes of CPRs. Theorists from a multitude of disciplines have expounded on various elements of the nature of CPRs, appropriate measures for management of those resources, and possible consequences and implications of human behaviors (Bromley, Taylor and Parker, 1980; Bromley, 1998; Freeman, 1989, 2000, Freeman and Wilkins Wells, 2000; McCay and Acheson, 1987; Noonan, 1998; Ostrom 1990, 1998; Ostrom, Feeny and Picht, 1993; O'Toole, 1998). These social scientists, among others, have sought greater

understanding of the mechanisms and social structures that allow for management, distribution and sustainable use of common property natural resources.

Freeman (1989), Freeman (1999, 2000), and Ostrom (1990), working in the tradition of CPR theory expand upon the roots of Olson and Samuelson, finding that individuals acting collectively can create social organizations to provide common property natural resources in sustainable, ongoing ways. A complete review of the body of thought on rational choice theory and CPRs is well beyond the scope of this paper. However, an overview is necessary to clarify the position taken here. Among rational choice theorists, a central problem is the free-rider, as traced from Samuelson's (1947) work identifying free-riders as those who do not contribute and yet benefit. Mancur Olson (1965:2) observed that, without coercion or some other powerful incentive, "*self-interested individuals will not act to achieve . . . common or group interests*" (emphasis original). Olson's primary focus was on individuals within small groups, because he thought that, even in large groups a small core of individuals would coalesce as a core of influential members. Beyond this point, theorists tend to take one of two directions: reductionists such as Elster (see below), and those who see the collectivity as a means for transcending individual rationality such as Ostrom and Freeman.

Elster (1982) focuses on the role of individual rationality at the expense of larger, collective organizations. He argued that as a rational individual orders preferences hierarchically, and individual actions and benefits take precedence over those actions which benefit others, including a group to which the individual belongs. Elster's view is so reductionist that he overlooks the important role of social structures that influence

decision-making by individual actors. He takes a strongly individualistic approach to rational choice, with virtually no room for collective organization or action as serving common goals of groups of any size. Typically, sociological approaches prefer to integrate social structures and influences into an analysis of decision-making, rather than viewing actors as isolated calculators of benefits and costs. Reductionism can be seen as a challenge to those who feel that collective action is not only possible, but occurring every day in places like Larimer County, Colorado. Hardin, Olson, Elster, and others were not hopeful that individual rational actors could organize into groups to provide collective goods.

The reductionist's rather negative view is countered by those on the other side of rational choice theory, who see hope in social organizations that sustain collective action. Ostrom, Bromley and Freeman belong to this camp, and this is where the most useful work is found for this thesis. All of these theorists see social organizations as providing ways that groups of individuals can act collectively and further some group interest, including the provision of a CPR. Organizations can institutionalize control of free-riders, and provide ways for individuals to transcend the narrow constraints of decisions made in isolated benefit/cost analyses.

Freeman (1989), Freeman (1999), and Ostrom (1990) have taken a more theoretically optimistic approach to social organization and successful collective management of resources. Rather than relying solely on individual reductionist approaches, strict free market ideas, or reliance on central government, they describe positive, long-enduring local level organizations operating within the market, and within

the purview of the central state. The goal here is to describe a case study that explores propositional components necessary for ensuring sustainable and just distribution of common property natural resources, as derived from the theoretical perspectives of Elinor Ostrom and David Freeman. The case study reports an instance when commodity producers joined environmentalists in an agreement that provides more ecological sustainability in a segment of a river, possible only via re-envisioning and re-operating a traditional local-level agricultural water users organization. This work thereby contributes to the sociological understanding of organizational arrangements that successfully manage common property natural resources.

This third option for dealing with the tragedy of the commons—that local-level self-managed organizations are a more effective, socially-just, and ecologically sustainable way to provide natural resources such as water for wildlife habitat and irrigation, is supported by other analysts. These analysts have looked at resource-user communities that depend upon natural resources such as water, soil, timber, or wildlife for economic sustenance as well as for a defining "sense of place." Many of these natural resources are managed as CPRs. For example, fishing communities along the coasts of the United States (McCay, 1987), livestock producers using rangelands in the interior West (Anderson and Hill, 1977), and irrigation water users are all groups that share resources communally (see also Bromley *et al.* 1980; and Tang, 1991). Often these resource-dependent individuals have organized under a management regime that addresses free-riding and equitable distribution. Because of growing human population

and increasing levels of consumption coincident with globalizing capitalism, sustaining natural resources such as water, soil and air is becoming even more important.

Common Property Resource Theory - Key Concepts

The following section briefly reviews CPR terminology and expands upon key concepts of the theory used in this thesis. Common property resources or goods can best be understood through explanation of the concepts of private and collective (public) goods, as seen previously in Table 1. These categories of goods are distinct from one another in relation to two concepts—rivalness of consumption and excludability (Samuelson, 1947). Freeman (1989), Freeman (1999), and Hanna, Folke, and Mäler (1996:2-5), differentiate these three types of goods by their degrees of "rivalness of consumption" and "excludability," which are defined as follows:

A *private good* is used and owned exclusively by the investor (the person who pays for it). "Private goods are exemplified by possessions such as clothing, automobiles, home appliances, and personal work tools—an individual invests in them and enjoys the benefits of ownership" (Freeman 1989: 16). Private good possess high "rivalness of consumption"—what one person consumes is not available for others to consume. Also, there is high "excludability," in that those who do not invest in (or pay for) the private good are easily excluded from using it.

On the other hand, a *public* or *collective good* is categorized by the fact that one person's use does not effect another person's use. Public goods possess "low rivalness of consumption." For example, anyone can benefit from street lights without effecting

others. Also, people cannot be excluded from using a public good if they have not paid for it, demonstrating low "excludability." For example, there is no way to prevent non-investors from making use of street lighting. Freeman (1989: 16) state that "a good is 'public' or 'collective' if its benefits cannot be denied to those who do not help to bear the costs ('free riders')."

Common property is the third type of good. Common property goods are conceptually situated between private goods and public goods on the continuum of ideal types. Differentiating between goods according to criteria set out by Freeman (1989), Freeman (1999), and Hanna et al. (1996: 2-5), common property goods have moderate "rivalness of consumption" because "a non-trivial portion of what one uses can be made available to another" (Freeman, 1999). Also, "excludability" (the ability to exclude potential free-riders from using the good) is moderate. And, "it is costly to deny a portion of the benefit of one's investment to another" (Freeman 1999).

Free-riding is defined as the use or acquisition of a benefit of a collective good by those who do not bear the cost of producing that good (Samuelson, 1947). Free-riding is at the core of CPR and collective good problems because, according to Hardin (1968), rational individuals will always act in self-interest and withhold contributions, with the assumption that others will contribute adequately for provision of the collective good to all. This pessimistic view contends that individuals will not act in the interests of the greater community, and leads to the conclusion that individuals will not act collectively to further group ends. Other theorists see individuals working only in self interest as well.

Private goods, with high rivalness and excludability, are typically provided by or through the market. Public goods, with low rivalness and excludability, are often provided by government entities: municipal, county, state, or federal agencies. As described here, private and collective goods are ideal types, representative of the two extreme possibilities in property rights theory. Resources having completely open access are subject to free riders because of the lack of organization that disciplines individual rationality—open access goods subject to organizational constraints become common property goods. Common property lies between the two types on the ideal type continuum, having moderate degrees of rivalness and excludability. Neither the market nor the state is the sole appropriate provider of common property goods.

Irrigation water often falls under the category of a CPR. Investors in an irrigation works capture some return on investment in infrastructure, but a non-trivial portion of what one irrigator uses can be made available to another (Freeman, 2000: 126). For example, irrigation contributes return flow to rivers and ditches, subsurface recharge, and maintenance of wetlands. Thus rivalness of consumption is only moderate. In addition, excludability is only moderate because it is costly to deny a portion of the benefit of one's personal investment in a canal segment to another. For example, constant monitoring of free-riders and policing miles of irrigation canals and ditches would be extremely costly for an individual to undertake; however, when members of an organization work collectively to monitor the system, those costs can become reasonable.

Many scholars have commented on the management of free-riders and the equitable distribution of CPRs. Some have emphasized the importance of community

between the actors involved (Singleton and Taylor, 1992). Others have taken a more institutional approach, as have Bromley *et al.* (1980) in their adaptation of Rawls' A Theory of Justice. McCay and Acheson (1987) advocated a "thickening" of the analysis of CPR issues and solutions, exploring the various roles of the state, the definitions of the resource, and the effects of development agency work. Later McCay (1996:117) saw those who attempted to resolve CPR issues as participating in a "comedy of the commons," reflecting the classic Greek sense of actors' recognition that "something is wrong, and try, for better or worse (often "comically"), to do something about it." Sociologists often address CPR issues in the context of environmental sociology (Redclift and Woodgate, 1997), with an emphasis on global environmental issues such as the atmosphere and species extinction. The work of two theorists is of particular interest for this thesis: Elinor Ostrom and David Freeman have both examined local level CPR organizations to determine what variables might be present in organizations that stand the test of time, adapt to changing internal or external conditions, and provide goods efficiently.

Common Property Resource Models

Ostrom's work incorporates groundwater issues, management of communal grazing and timber lands, as well as fisheries, from around the globe. Freeman's concentration is greatest in irrigation projects, in the United States and on the Indian subcontinent. Each of them has formulated a set of variables or principles whose presence or absence is indicative of long-term success in managing CPRs. These two sets

of variables contribute to a series of propositions that I draw out as being of primary importance.

Ostrom (1990: 88-102) described a set of eight principles necessary for the ongoing successful delivery of a common property good (Table 2), of which two can be readily applied to this case study. Ostrom would expect to see all eight principles fulfilled in a long-enduring CPR institution, and indeed all may be present in the case

Table 2 Ostrom's design principles illustrated by long-enduring CPR institutions

1. Clearly defined boundaries
2. Congruence between appropriation and provision rules and local conditions.
3. Collective choice arrangements
4. Monitoring
5. Graduated sanctions
6. Conflict-resolution mechanisms
7. Minimal recognition of rights to organize
8. Nested enterprises (For CPRs that are part of larger systems)

(Source: Ostrom, 1990: 90)

study. However, only the first two will be discussed in this analysis (See Ostrom 1990 for broad utility of these principles with examples from marine fisheries to pastures in the Swiss Alps.):

1. *Clearly defined boundaries.* The boundaries of the resource must be precisely defined so that future actions are within set jurisdictions and will benefit only those who work within its physical boundaries. Access to the resource must be limited to those who participate, assume risk, and benefit. As Ostrom (1990: 91)

states: "Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself." This is a preliminary step in organizing individuals into a group ready for collective action. It is necessary to clarify who will risk by contributing time, effort, materials or funds for the common goal, and who will not. Concurrently, those who risk are those who will benefit.

2. *Congruence between appropriation and provision rules and local conditions.* Rules that define how the resource is procured and provided to users must recognize particularities of terrain, climate, markets, local culture, and the needs of the group in order to be sustained by the participant resource-users. Ostrom (1990: 92) asserts: "Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, materials, and/or money." Rules or directives set by a central government, or according to some large-scale management plan, cannot accommodate the complexities of each site-specific situation under which most CPRs are utilized.

Ostrom (1990) contends that individuals organized to provide goods from a CPR will have greater success over a longer period of time if the principles outlined above are fundamental to the organizational structure. The greater the clarity of boundaries, both of the resource and of the participants to whom the resource is available, as well as the greater the congruence between rules and local conditions, the higher degree of long term success can be anticipated for the organization and sustainable use of the resource.

Freeman (1989: 25) has also formulated a set of strategic variables and propositions advanced as being necessary for ongoing success in the equitable distribution of CPRs (Figure 1). Common property resource irrigation projects that embody these propositions, and thus allow for "incorporating irrigators into project life"

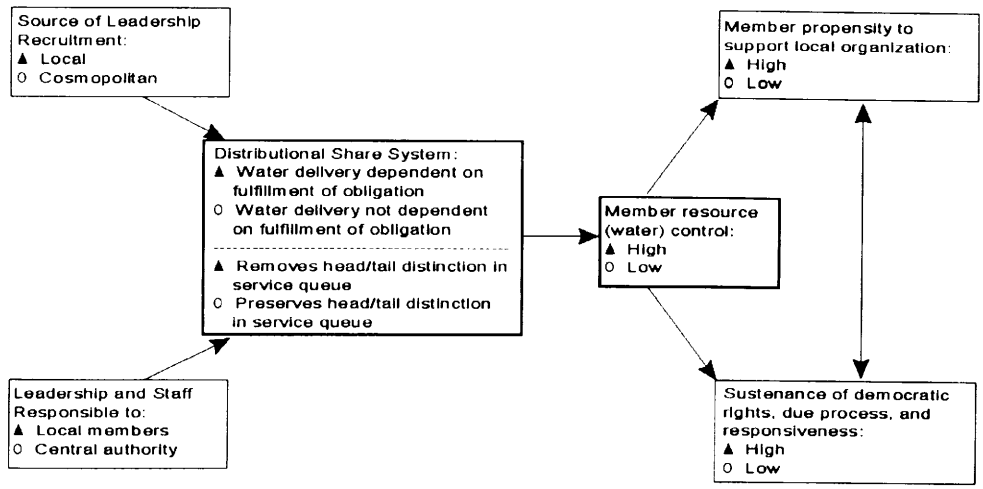


Figure 1 Component parts of a distributional share system (Source: Freeman, 2000: 36)

have a better chance of succeeding than those that do not, according to Freeman and Angin (1999: 102). Of Freeman's seven variables (within boxes in Figure 1), three are most readily applied here, of which two are integral to the concept of a distributional share system. The distributional share variable reflects Freeman's work in irrigation water and is central to his overall argument (Table 3). The share system is "a two-sided concept: (1) it confers legitimate access to the water resource within certain pre-arranged rules, and (2) it imposes on the user a specific obligation to share in paying the water management costs" (1989: 27). This organizational system unites obligation with benefit,

Table 3 Proportionality of costs and benefits of a distributional share system
(Source: Freeman, 2000: 37)

I.	Distributional Shares Involve:	
	A. A right to a proportion of benefit–e.g. Water	
	B. An assessment obligation to pay costs of organizational provision of the benefit	
II.	Share/Benefit	Share/Cost
	1/100	1/100
	1/300	1/300
	1/1000	1/1000
	1/10,000	1/10,000
III.	Members vote their shares in conduct of organizational business	
	A. Member X - owns 9 shares out of 100; votes 9 shares.	
	B. Member Y - owns 7 shares out of 100; votes 7 shares.	

ensuring that only those who contribute to the costs of providing the CPR are the beneficiaries of the benefit stream. The distributional share system was modeled after local mutual irrigation companies in the American West and successful CPR organizations in Spain and Asia. It depends upon investment proportional to benefits received in the form of membership within the mutual company, and assessment of shares proportional to the amount of irrigation water received. The mutual company also serves the important function of interacting with the state agency on behalf of all members as well as the mutual needs of the group. The three variables found in Freeman's work that are of most interest in this thesis (See Figure 1) are described below:

1. The first of two components of the Distributional Share System, *water delivery dependent on fulfillment of obligation*, means that access to the resource is limited to those who satisfy an obligation toward the costs incurred by provision of the

resource. For example, members of a mutual irrigation company are assessed annual fees for the costs of maintenance of infrastructure, management, and bookkeeping. Those who do not pay this assessment are not eligible to receive water until the assessment is paid.

2. The second component of the Distributional Share System addresses equity in the service queue in irrigation parlance; it *removes head/tail distinction in the service queue*. Close proximity to the head or source of water for irrigation systems can be a position of power, while those located at the tail of a ditch can be at a disadvantage for delivery of water. The distributional share system manages the entire ditch as one unit, and therefore those at the head are equally interested in equitable delivery for those at the tail. If service to the tail is compromised, it is in the interest of all to work together to correct the problem. Thus, those at the head are on equal standing with those at the tail and there is little or no distinction between the head and the tail in the service queue (For more in-depth discussion, see Freeman, 1989).

3. *Member resource (water) control* is part of ensuring ongoing success in management and delivery of a CPR. Freeman (1989) states that the site-specific local knowledge of the farmer and the more general knowledge of the state bureaucrat must be combined to ensure successful delivery of CPRs. Farmers have site-specific knowledge of climate, soils, ditch loss and so on, which is necessary to efficiently deliver and make use of water on the field. This local knowledge is crucial to local control of the resource.

According to Freeman, the greater the relationship between fulfillment of obligation and delivery of the good, the less distinction of position within the service queue, and the greater the control of the resource by locals, the more effective the organization will be. A CPR organization that reflects these characteristics will also possess the necessary flexibility to adapt to changing conditions over time, including the incorporation of alternative uses for the good or service being provided.

Synthesis of Models

By comparing and combining elements of Ostrom's and Freeman's work, three propositions can be advanced to guide analysis of the case study presented in this thesis (Figure 2):

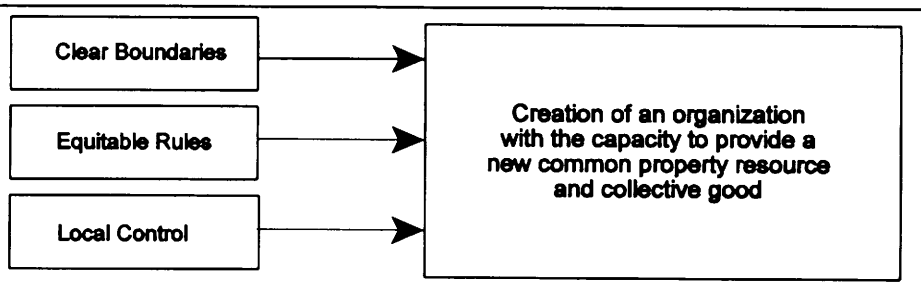


Figure 2 Proposed factors in organizational innovation

- Boundaries of the resource must be clearly defined, as must the participants–who is "in" or "out." This must be understood by all involved with the common property good in order to control free-riding. Freeman (1989) agrees and addresses these in his formulation of the distributional share system: those who do not help bear the costs of providing the good are not recipients of its benefits.

Ostrom's (1990) emphasis on the importance of this is evident in her clear selection and labeling of boundaries as a principle illustrating long-enduring CPR institutions. Also, units of goods deliverable comes under the concept of boundaries. Water is fairly easily measured, in volumes such as acre-feet or flow over time (cubic foot per second).

- A system that clearly establishes rules of appropriation and allocates the resource equitably, such as the distributional share system, must be in place to insure local accountability. Ostrom (1990: 90) states that rules for appropriation and provision must reflect local conditions, including restrictions on "time, place, technology, and/or quantity of [the] resource . . . and . . . labor, material, and/or money." All of these components are found within the concept of the distributional share system, wherein a chosen board of directors works administratively to provide benefits to all members of the share organization. A responsible board ensures that maintenance is performed and that the costs of maintenance are borne and fulfilled by shareholders in the organization. Each member holds title to proportionally different shares of the company, so do they pay and benefit differently. In addition, a lack of head-tail distinction is supported by this placement of responsiveness upon fulfillment of obligation rather than geographic advantage. These rules are simple and clearly identify those who are entitled to enjoy the benefits of water delivery.

- Local control of the resource allows organizations the autonomy to operate independently of the central state and make possible rapid adaptation to changing needs at the local level. Autonomous local control creates social space for organizations to interpret general principles of resource management, operating within local opportunities and constraints. Ostrom discusses this element in her principles of monitoring (#4 in Table 3) and recognition of rights to organize (#7) as well as the congruence of rules to local conditions. Freeman sees this primarily in his component of member resource control, but it is also present in his leadership components, in which leader recruitment and responsibility is locally-oriented. Site specific knowledge allows local managers to organize distribution of resources most equitably, as well as empowering them to adjust the system to adapt to changing demands.

The general thesis is that without these three elements of an organization, it would not be possible to negotiate contracts and agreements, or secure trust between various individuals who are striving to work together and provide a collective good from a CPR.

Summary of Literature Review

This case study examines an agreement between the North Poudre Irrigation Company and The Nature Conservancy. It explores the uses and limits of a synthesis of Ostrom and Freeman's models, determining the importance of clearly defined boundaries, systematically equitable rules of distribution, and local control. The two organizations, a traditional mutual irrigation company and an environmental conservation

group whose interest is in preserving habitat for wildlife, have worked together for over ten years, providing wildlife habitat without sacrificing commodity production. The irrigation company, with its roots in agricultural commodity production, has been able to adapt to changing demands on the western landscape. This adaptation has allowed traditional livelihoods of farming and ranching to continue while accommodating wildlife habitat and the protection of endangered species. With the right combination of the proposed organizational characteristics, local people effectively create the opportunity to define a new resource without dependence on either private markets or a central state, but provide their own organization that can accommodate, and encourage, sustainability of both commodity production and habitat.

CHAPTER 3 - METHODS

Introduction

This thesis discusses a qualitative case study that examines the dynamics of forging an agreement between the North Poudre Irrigation Company (NPIC) and The Nature Conservancy (TNC), in order to explore the research question, which is:

> What organizational variables and relationships account for how two organizations, one a provider of collective goods and the other with a common property resource agenda, came together in an agreement that resulted in an outcome that neither could have achieved on their own, namely the creation of continuous instream flow for the purposes of habitat preservation and ecological restoration? In other words, how was a new good with properties of both a collective good and a common property resource created?

The case study method is often used to explore the specifics of CPR problems and solutions (for example, Freeman and Angin, 1999; Freeman, 1989; Ostrom, 1990, and Baden and Noonan, 1998). This method allows for exploration of the detailed instances where organizations have formed to administer CPRs, and determines the variables present, or absent, in those organizations showing long-term success. The case study

method encourages the use of multiple methods of data collection, including in-depth interviews, document review, and participant observation.

Qualitative methodology allows for deeper exploration of the questions under investigation, as well as providing the opportunity for inductive, theory-generating analysis. Neuman (2000: 16) states that the "qualitative style" of research allows the social scientist to "construct social reality," focus on interactive processes," allows values to be "present and explicit" and is dependent upon context; in other words, it allowed me to look closely at the agreement between TNC and NPIC, ask open-ended questions to encourage informative responses that the subjects were comfortable giving, explore the process that went into the formation of the agreement and its subsequent evolution and adaptation, and permitted the generation of hypotheses consistent with the situation, rather than attempt to be removed in an objective, "scientifically-detached" sense.

The Case Study Method

Strengths of the case study method include the use of multiple forms of data, which serve to reveal intricacies that would be difficult to determine in a statistical exploration of large populations. Typically, the case study method can provide an in-depth examination of a bounded situation, producing rich insights and deep understanding (Cresswell, 1998). This makes for good hypothesis formulation, but poor testing of hypotheses. Limits to the case study include lack of generalizability and potential bias in interpretation by the researcher. Site-specificity is a limit to the applicability of the findings, as well, since data from case studies cannot support generalization. Document

review improves triangulation in areas where misinterpretation may occur. The intent of this particular project was to explore the presence or absence of the theoretical propositions synthesized from Ostrom and Freeman, not to justify broad generalizations. Therefore, it contributes information and data pertinent to the design of future studies that may have a broader application.

Interviewing as a form of data collection has uses and limits as well. Among the strengths of interviewing are the access to "accurate and complete information immediately," assurance of accurate interpretation of the area of inquiry, flexibility and control in the order of questioning, and the opportunity for evaluation of the validity of information by gauging non-verbal behavior of the respondent (Gorden, 1975: 76). Limitations of interviewing, according to Cannell and Kahn (1953: 331-32) include the possibility of interviewer bias, "inability of the respondent to provide certain types of information," and the bias of the respondents' memory, particularly as time since the events in question becomes longer. Additionally, the specialized jargon of a social group can be difficult to understand, or, as Gorden (1975: 70) says: "often not clearly intelligible to outsiders." Part of the interview process involves gaining familiarity with the language used by respondents, and ensuring that interpretation of specialized terms is accurate.

Qualitative methods such as interviewing, document review and participant observation make use of "*Logic in practice* [which is] relatively messy, with . . . ambiguity, and is tied to specific case and oriented toward the practical completion of a

task" according to Neuman (2000: 122). The potential for "messiness" in qualitative research, such as in-depth interviewing in this project, includes the following:

1) concerns about reciprocity or sharing the work and findings with the research subjects (Wax, 1952)
2) validity issues, grounded in unintentional biases in note-taking, coding and interpretation, as well as in the types of questions posed (Whyte, 1982 and Sanjek, 1990)
3) intentional biases such as side-taking by the researcher (Becker, 1967)
4) limitations of interviewing in the field, including issues of privacy, physical comfort, time constraints, and deception (Spradley, 1979 and Weiss, 1995)
5) issues of access and entry to respondents, in cases where individuals may be reluctant to answer questions of a sensitive nature (Thorne, 1980)
6) concerns of exploitation and harm as structurally defined by the university's policy on "informed consent," as well as
7) less well-understood issues of gender, for example when a female researcher interviews male respondents (Denzin, 1989).

I learned first-hand how to accommodate all of these issues, from attempting to set aside my own filters or biases when transcribing field notes, to filing the correct paperwork with the Colorado State University Human Subjects Committee, to accepting that some respondents simply did not wish to contribute to my research and I had to find another source that could answer questions from that perspective.

Data Collection

This case study primarily made use of in-depth unstructured interviews of key informants for collection of data (See Appendix for the interview guide). Respondent selection began in Autumn 1999 with a gatekeeper (an individual with significant knowledge of the case) and was continued using the "snowball method," (asking respondents to suggest others who might help in understanding) to the point of saturation in Spring of 2000. A total of fourteen individuals were identified and contacted by telephone to arrange confidential interviews in person. A majority of the informants represented each of the two organizations, with the remainder representing both environmental concerns and the issues of commodity production. Interviews were held in locations where the informants felt comfortable: in their homes, offices, or coffee shops. Two brief interviews less than 10 minutes, were conducted over the telephone. One interview lasted half an hour, one was more than three hours, and most of the interviews were around an hour and a half long. One interview resulted in a guided field trip to the site of the study. Another visit to the study site was made as part of a nature walk advertised in the local newspaper as open to the public.

Protection of Respondents

Interview protocols followed a pattern of informed consent and voluntary participation. In keeping with the requirements of the Human Subjects Board (HSB) at Colorado State University, initial contact followed a telephone script (See Appendix), informing potential subjects of the general nature of the study, assurance that

participation would be held in confidence through the use of a code to protect their identity, and requesting that the respondent select an appropriate time and place to meet for an hour or so. Upon meeting, the interview would begin with a review of the HSB-approved informed consent form (See Appendix), requiring signatures of both the interview subject and the researcher. One signed copy of this form was left with the subject, and one retained for the researcher's files. A letter outlining the purpose of the study (See Appendix) was also given to the respondent for their files at the time of the interview.

Materials used to triangulate with interview responses included newspaper accounts, in-house publications (contracts, annual reports and brochures) by the two key organizations, maps, and government documents. Documents were secured from interview subjects, public kiosks, and the Morgan Library at Colorado State University, a repository for federal documents.

CHAPTER 4 - BACKGROUND AND SETTING

The River

The Cache la Poudre River originates from the snowpack of northern Colorado's Rocky Mountains (Figure 3). Headwaters of the main stem flow from Milner Pass (10,758' elevation), a half-mile east of the Continental Divide in Rocky Mountain

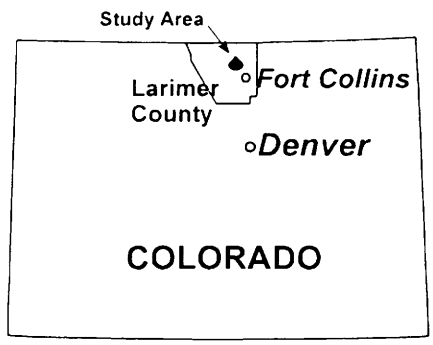


Figure 3 Map locating the study area within Colorado

National Park. The North Fork of the Cache la Poudre originates in the Laramie Mountains, a southern extension of the Medicine Bow Mountains. Phantom Canyon, site of the case study, is located approximately 30 miles northwest of Fort Collins, on the North Fork of the Cache la Poudre. The main stem of the Cache la Poudre and its tributaries flow to the north and east, join together in a canyon northwest of Fort Collins, and then shifts to a southeasterly course. The Poudre drains more than 1,850 square miles by the time it reaches the South Platte River near Greeley, Colorado. Its watershed lies

mainly in north-central Colorado, with a small portion extending into Wyoming. This watershed is defined by the United States Geological Survey catalogue as part of the South Platte Basin, unit 10190007 (USGS Web Page). The Environmental Protection Agency rates water quality within the watershed as 1: high quality (EPA Web Page).

Topography within the Cache la Poudre watershed is highly varied, ranging from elevations of more than 12,000 feet to 4,610 feet. Watershed precipitation averages less than 15 inches annually, with extremes ranging from less than 7 to greater than 25 inches within one ten-year period (Maass and Anderson, 1978: 275). The majority of precipitation occurs in winter and early spring. Late summer thunderstorms often fall with such intensity that infiltration is minimal compared to runoff. The frost-free irrigation season at the mouth of the Poudre averages 130 days, from April to September (Maass and Anderson, 1978: 275).

Hydrologic cycles of the Cache la Poudre are typical of Rocky Mountain streams, with relatively low flows throughout the year except for high run-off generated by late-spring snowmelt. The peak of this run-off flow occurs typically in mid-June. However, spring rains can alter peak flow, or low snowfall can reduce the total volume of water in the watershed. Recreational uses of the river include kayaking, rafting, fishing and hiking on nearby trails. The State of Colorado ensures protection of wildlife habitat with management plans that limit parking, camping and picnicking along the river's banks.

History

Traditionally agricultural, the area below the mouth of the Poudre canyon has seen dramatic increases in urbanization in recent decades. The population of Fort Collins has increased from 59,000 to more than 118,000 since 1978, and nearby communities have experienced similar growth. With the shift from rural to urban land-use, economic importance of agriculture has been reduced. Crops irrigated by the Cache la Poudre include alfalfa, corn, sugar beets, barley, wheat and oats, dry beans, potatoes and vegetables (Maass and Anderson, 1978:281, and NCWCD, 1994). Dryland production consists mainly of grazing, with small amounts of grain production. Livestock operators include hog farms as well as beef feedlots and horse operations. As municipalities expand, farmland is going out of production and is being developed to satisfy residential or industrial needs. Irrigation water no longer used on agricultural crops is available to satisfy increasing municipal demands such as drinking water, sewage processing, and landscaping. The overall effect of this transfer of water on the shifting economic landscape is the reduction of agricultural demands for water in the Cache la Poudre region of Colorado.

Concurrently, environmental concerns have become evident with national awareness of human threats to wildlife species and habitat. Because of an increased understanding of the importance of these and other species, the federal Endangered and Threatened Species Act of 1973 was passed, mandating the protection of species on the brink of extinction. Traditional uses of water, including irrigation through diversion and ground-water extraction, significantly reduce the flow of the Cache la Poudre River and

its tributaries in the later summer months causing harmful effects on populations of insects, fish, birds, and mammals. These new demands are being answered, in part, organizationally, as described below.

Water Administration

The State of Colorado is divided into seven hydrological units, based on the major watersheds and basins, each administered by a Division Engineer. The divisions are further subdivided by streams into districts which are overseen by a River Commissioner (Maass and Anderson, 1978: 294). This system allows some autonomy for every relatively self-contained river system, and provides a locally-oriented state level official who allocates water annually to a spectrum of permittees. The Division I District 3 water commissioner represents the central authority on the Cache la Poudre River.

In Colorado, water is allocated according to the prior appropriation doctrine, which can be summed up as "first in time, first in right," the most critical element of which is that " . . . junior appropriators are cut off from irrigating with stream flow in order to supply water to senior appropriators" (Maass and Anderson, 1978: 275). In the 1800s a free-for-all "open access" approach to water diversion resulted in disasters for many early settlers (Dunbar, 1983: 86-98), generating a crisis that led to adjudication of rights to water based on priority of diversion from the river, rather than position on the stream. In keeping with Elinor Ostrom's (1990: 112) findings, crisis was necessary before people organized to manage the CPR of water. The conclusion of this dispute was a call for individuals, irrigation companies and municipalities to come forth with proofs

of diversion of the river "for beneficial use," and the establishment of seniority of water rights. An earlier proof of diversion yielded a more senior right to appropriate water. The earliest adjudicated legal right on the Cache la Poudre is dated 1 June 1860. Subsequent ditches or reservoirs that withdrew water from the river also had to receive certification of priority and water may only be drawn in the order of priority.

Today, the Cache la Poudre River is appropriated "in excess of 4000 cfs" (Maass and Anderson 1978: 281), which is ten times the typical flow of 400 cfs or less. More than 20 organizations are pulling water out of the Poudre, as authorized by the commissioner who oversees allocations headgate to headgate.

Appropriators are allowed to divert water according to the amount of water in the river, as supervised by the commissioner, who determines the rate of flow and keeps track of seniority rights. Each headgate, which turns water from the river into a canal, is monitored by a gauge equipped with a recorder. Records are maintained on the time and volume of water diverted to each canal. If any user diverts beyond legal appropriation, the commissioner has sanctioning power, including recourse to the Division Water Court.

One way that more water can be secured for use is through the water market, in which actual water is rented or sold, rather than permanent exchange of rights to water. In this "spot" market, if an irrigator has rights to more water than will be needed for a given year's crops, then that irrigator may offer surplus water available for rental. This system creates flexibility within the constraints of the Prior Appropriations Doctrine. According to Anderson and Snyder (1997: 103), the water market in northern Colorado is "very active," offering a way for shares of water to transfer from one user to another

within a smooth efficient operation with low transaction costs. This market evolved out of a need to correct "continuing small imbalances of water supply among farmers" (Maass and Anderson, 1978: 303), and are managed on the basis of stock in water companies, rather than water rights themselves. To explain: Water rights were originally the property of individuals or speculators who had dug the ditches and diverted the water, however, in time organizations were consolidated to allow more efficient water development and management (Hutchins, 1929: 4-5). When a group of individuals aggregated themselves into a corporation (mutual company), they pooled their water rights and were issued shares of company stock proportionally to what each had originally brought to the organization (Hutchins, 1929: 9). These shares of water can be rented on the spot market, a smoothly-running system that offers a method of temporary transfer of ownership for a season, or fraction thereof, with ownership reverting back upon completion of the transaction. The spot market is open to anyone within the river basin with the means to make beneficial use of Poudre River water.

The base flow of the Cache la Poudre River is inadequate to provide the level to which the river has been appropriated, necessitating the construction of reservoirs to capture the peak flows of early summer. Stored water is then used in late summer and fall, increasing irrigators' water security. Reservoirs facilitate another adaptation to the prior appropriations doctrine; that of the water exchange.

An exchange is a trade of water between two or more users from one point of diversion to another (Freeman and Wilkins-Wells, 2000). Figure 4 depicts a typical situation. In this example, Organization A has an opportunity to store water in a surface

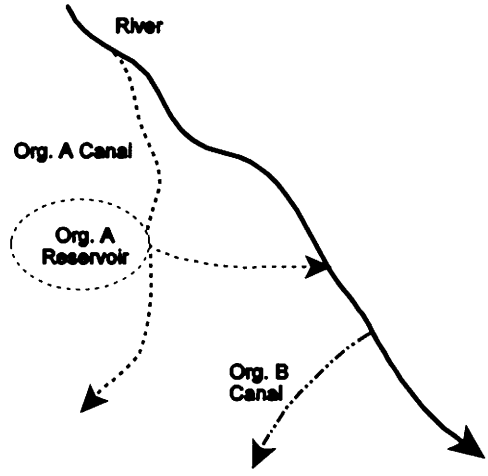


Figure 4 Water Exchange (Source: Freeman & Wilkins-Wells, 2000: 125)

reservoir which can be filled by gravity by its supply canal. However, the surface is too low for Organization A to release that reservoir water back into its own canal. Rather than invest in expensive capital equipment such as pumps to lift stored water up to A's supply ditch for its shareholders, Organization A releases water back to the river when requested by Organization B, which has a downstream headgate capable of taking the water by gravity flow. Organization B works with the river commissioner (the local official responsible for administration of the prior appropriation doctrine) to allow Organization A to take B's water knowing that at a mutually agreed upon time Organization A will pay its water debt to B in equivalent volume. Both parties are better off. Organization A has developed water in storage to use as trading stock, and Organization B has gained flexibility and control that comes from having a water bank in A's reservoir. Thus, water has moved uphill from B to A and back again to B. Social capital has substituted for money and physical energy. Cache la Poudre River irrigators

have devised more than 100 exchanges which, strictly speaking, are out of priority under appropriation doctrine. However, with the approval of the river commissioner such out-of-priority exchanges are recognized and legal. The commissioner requires that exchanges be recorded in order to "keep the river whole" so that no junior appropriator imposes loss on a senior rights-holder. The mechanism of exchanges is an essential part of the agreement described in this case study.

Environmental Problem – Need For a New Common Property Resource

While low winter flows are not uncommon in natural rivers that drain mountain precipitation, usually at least a small amount of water would continue moving through an un-dammed river. This trickle would keep pools recharged with fresh water, thereby maintaining habitat for fish over-wintering in those pools. Contemporary concerns about habitat for wildlife, including fish, see this year-round flow as important and necessary for sustenance of the natural ecosystem. Fish that survive the winter provide breeding stock for future spawning, thereby contributing to the ongoing health of the river as a whole. The challenge to natural resource organizations is in devising a way to maintain flows through the winter while not penalizing those who depend upon the river for their livelihoods–namely the farmer-irrigators who are members of NPIC. Rather than a physical, engineering, or hydrological response, people have found a way to satisfy both the needs of fish and the needs of crops. Social capital, in the form of water exchanges, is part of the solution.

Local Organization - The Nature Conservancy

The Nature Conservancy (TNC) is an international organization that strives to "save the best of the rest," specifically natural areas, "plants, animals, and natural communities" open space, and unique natural features not otherwise protected (Weeks, 1997: 14). General principles that shape the activities and influence of TNC in protection of biodiversity include:

8) They act "through non-confrontational means toward tangible and lasting results;"

9) Pragmatic "vision and resourcefulness" drive their decisions;

10) An "entrepreneurial spirit and adaptability to change" allow flexibility; and

11) A strong commitment to "continuity of purpose" maintains a steady progression toward their goals of preservation of biodiversity through habitat preservation.

TNC's over-arching concern, since incorporation in 1951 (Weeks, 1997: 14) is with preserving biodiversity in terrestrial and aquatic systems around the world. The Nature Conservancy achieves its goals on the local level by making use of resources already in place in the area of concern, through conservation easements, outright purchase, in particular avoiding litigation as a means to an end. They strive to create partnerships with local, regional and state agencies within whose jurisdiction the area of concern is found. The Nature Conservancy also works with federal agencies to achieve its goals of preservation. They often sell acquired areas to the Bureau of Land Management, the US Forest Service, and the U.S. Fish and Wildlife Service for continued protection under a TNC-assisted management plan (Table 4). The Nature Conservancy has "through ownership, conservation easements, and reselling land to public agencies, . . . preserved

Table 4 Strategic ownership of land within the United States protected by The Nature Conservancy

Percent of All TNC-protected Acres	Protection Strategy and Ownership
10	TNC-owned nature preserves
20	TNC leased or managed
40	Gift, sale, or assistance to local, state, or federal government entities
15	Public land under enhanced conservation management
7.5	Private ownership (other than TNC), protected through permanently-conveyed development rights
7.5	Other conservation organizations and universities

Adapted from Weeks, 1997: 14-15

11.6 million acres in the United States" (Margolis, 2000: 16). As the country's largest conservation organization, and one of the largest private landowners in the U.S., TNC owns 1.3 million acres (Margolis, 2000: 16). Most of that land was purchased with funds raised from among the 1.1 million member/contributors, as well as from corporate donations and support (Margolis, 2000: 16). The Nature Conservancy has revenues of $780 million (Margolis, 2000: 16). The Nature Conservancy has, in fact, been criticized by "greener" groups for having close relationships with government agencies, developers and ranchers: "ultimately they have more in common with . . . developers." (Suckling, *in* Margolis, 2000: 16). Ranching, logging and development interests own much of the land TNC sees as needing protection, and TNC is willing to bargain with those groups, including allowing continuation of previous uses such as grazing by livestock. According to Weeks (Margolis, 2000: 16): "Our organizational ethic is pragmatic and solution-oriented. We want to work with every community of people who live in rural areas. The

long-term conservation of areas depends on the people that live in and around them." The Nature Conservancy also works with "government officials [who] are considered and treated as colleagues and partners" (Weeks, 1997: 17). This incorporation of local people, corporations, and government representatives reflects TNC's commitment to "involve all sectors of society, public and private" (Weeks, 1997: 17).

Originally, TNC concentrated on protecting fairly small areas with particularly rare or endangered species of plants or animals. Recently, however, the focus has shifted to "protect more biodiversity more securely. . . . [TNC has] also begun to believe that conserving and restoring characteristic ecological processes was essential to . . . biodiversity goals and that large conservation projects would often be required to sustain ecological processes" (Weeks, 1997: 4). This push to protect larger areas, called the "Last Great Places Campaign" essentially proposes to protect somewhere between 20 and 30 percent of the land area in the United States (Margolis, 2000: 16). In addition to working with federal agencies and private landowners, TNC has partnered with other environmental groups, such as The Wilderness Society (Weeks, 1997: 5). By "the establishment of staffed units in each state" TNC was consciously progressing toward conserving biological diversity in the United States (Weeks, 1997: 9). Weeks (1997: 10) also stated that "The Conservancy had an organization-wide plan that provided reason, context, and guidance to the work of its state directors." The Nature Conservancy depends upon experts from a wide variety of fields, acting in advisory positions, as "outside reviewers" of management plans, as well as holding positions within TNC as staff scientists, regional managers, and serving on the Board of Directors or the Science

Board (Weeks, 1997; Margolis, 2000). Weeks says that, lacking availability of "a knowledgeable but less invested reviewer" he "recommend[s] a review of the plan by the planners themselves after a vacation, a weekend, or even an afternoon of flyfishing" (Weeks, 1997: 11). Certainly, many of the advisors and contributors to TNC are also avid outdoors enthusiasts (Weeks, 1997: 106-108).

After securing a tract of land, TNC formulates a science-based management plan that attempts to preserve biodiversity through an ecosystem approach (Weeks, 1997: 34). The intent is that, whether the property continues under TNC's control or is sold, leased, or donated to other organizations, that land will be managed under the agreed-upon management plan. For example, if a tract of land once supported buffalo and other grassland species, cattle may be permitted to continue grazing in order to simulate the effects of the native species, now extirpated from the site and ecosystem. A prominent characteristic of the Last Great Places campaign is the incorporation of cooperative planning for human economic needs on a new level: not only is TNC promoting continued traditional uses, now they are advocating new sustainable uses, such as ecotourism opportunities, for-profit "footloose" (non-site specific) enterprise, and other creative applications of "compatible economic development" (Weeks, 1997: 101-129). This approach is particularly important in international efforts being "brought to bear on millions of . . . acres of parkland in Latin America and the Caribbean through Nature Conservancy assistance to partner organizations based in those regions. In recent years the Conservancy has . . . established conservation programs in a number of Pacific island nations and in Indonesia" (Weeks, 1997: 14). International efforts often strive to protect

areas in impoverished countries with relatively pristine areas of high degrees of biodiversity.

In the United States, local chapter offices often establish and manage preserves through the use of willing buyer/seller markets and conservation easements. In the mid 1980s, the Colorado chapter of TNC acquired 1,700 acres of property, which is part of what is known as Phantom Canyon Ranch, located approximately 30 miles northwest of Fort Collins on the North Fork of the Cache la Poudre River. The preserve is a steep-sided canyon, roadless and verdant, in contrast with surrounding area of arid foothills dominated by scrub and grassland (Figure 5). This isolated canyon, approximately six

Figure 5 Phantom Canyon, looking south-southeast

miles long, is the last remnant of essentially undeveloped land along the Front Range of the Rocky Mountains in Colorado (www.tnc.org). The river has eroded pools in the granite substrate, some pools as much as 25 feet deep. These pockets carved out of solid

stone provide habitat for large fish, including rainbow and brown trout, popular with sport anglers (Figure 6).

Figure 6 Habitat for fish and wildlife in the canyon

The canyon offers potential habitat for many Front Range species of wildlife that are losing territory as human impact increases with rapid development on the eastern slopes of Colorado. A rare type of parsley listed under the Endangered Species Act, the *Larimer aletes*, is found on the rocky canyon walls. Ecologically, the canyon is an area of transition, an *ecotone,* within which the dryland grasses of the eastern plains intermingle with the lower elevation forests of the Rocky Mountains to the west. Animal and plant species are abundant in ecotones, finding the elements necessary for life: food, water and cover, available. With meadow areas interspersed with woodlands, punctuated by rocky outcroppings and laced through by the river, Phantom canyon is a precious rare remnant of geologic time, providing a glimpse of the Front Range ecosystem as it was before

colonization and development by European settlers. Mountain lions, golden and bald eagles, mule deer and elk all continue use of the canyon, as well as smaller species of fauna, migratory songbirds, and uncounted species of small fishes. The river itself is home to primarily brown and rainbow trout, however native cut-throat trout could also be restored to the river in the future.

The Nature Conservancy has a mandate to manage the area as a wildlife and fishery preserve (Wilkins-Wells, 1997: 1), and for open space preservation (www.tnc.org). As a part of this charge, TNC has arranged for year-round flow in the North Fork of the Cache la Poudre with the North Poudre Irrigation Company, which holds a legal right to impound water immediately upstream from Phantom Canyon.

Local Organization - North Poudre Irrigation Company

The North Poudre Irrigation Company (NPIC) services approximately 30,800 acres of farmland, through 212 miles of canal and 16 reservoirs (NPIC, 1999). This organization is a non-profit locally controlled, quasi-public mutual company, owned and operated by the 550 farmers and municipalities who own shares of the water. The command area of NPIC is comprised of benchlands north of Fort Collins, extending east toward into Weld County, and north of Greeley. When organized into its present form inthe early 20th century, NPIC issued 10,000 shares: each share can draw 1/10,000th of the water available in a given year, and is assessed an obligation for 1/10,000th of the cost of running the company (see Table 3, page 33). Since 1912, in its current configuration, the company has delivered on average more than four acre feet per share annually (NPIC,

1986; 1999) (Table 5). Shareholders' annual assessments cover the operational costs of delivering the water. Operational costs include construction, maintenance, and repair of facilities as well as the support of a small staff. The mutual is operated by a member-

Table 5 Summary of costs and deliveries of water shares, North Poudre Irrigation Company

Year	Assessment per Share ($)	Acre Foot per Share	Cost per Acre Foot ($)*
1912	5.00	3.1	1.61
1920	11.00	3.0	3.69
1930	8.25	3.1	2.66
1940	7.25	0.8	9.60
1950	12.00	1.8	6.66
1960	14.50	5.3	2.73
1970	20.00	7.0	2.86
1980	55.00	4.7	11.70
1985	100.00	11.5	11.11
1990	75.00	4.5	16.74
1995	75.00	3.9	19.23
1999	85.00	4.0	21.20
Average Annual Acre Feet per Share		**4.4**	

(Source: NPIC Annual Reports 1986; 1999) *Actual dollars, not adjusted for inflation.

elected volunteer board of directors and staff: a president, vice president, operations manager and secretary (Figure 7). The operations manager and staff represent the only personnel to whom wages are paid. Those who benefit from the resource also control the organization: members vote their shares in the company. This proportional democracy keeps the organization locally-concerned and responsive to local needs. The office staff

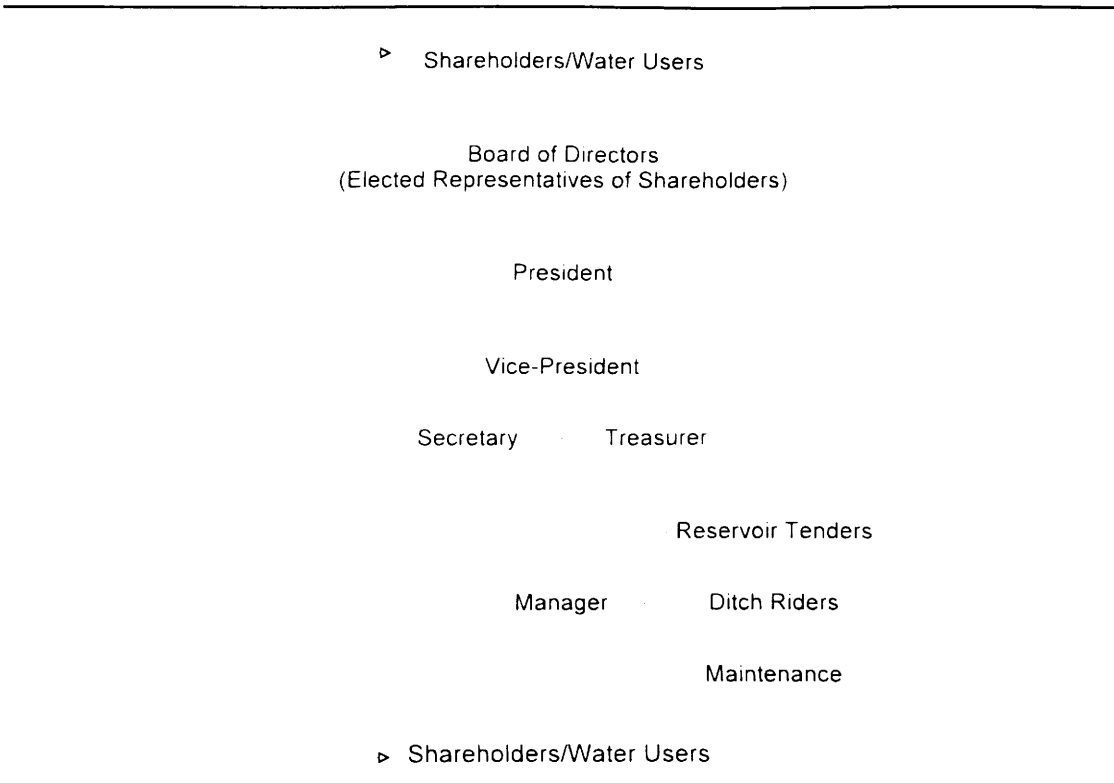


Figure 7 Organizational chart of North Poudre Irrigation Company
Adapted from Freeman and Wilkins-Wells, 2000

performs such work as taking orders for water, and the operations manager ensures that a crew maintains the reservoirs and ditches, and delivers water to the beneficiaries.

A share of the company does not yield a static volume of water to the shareholder, year after year. Rather, each water year brings a proportional share of the companies' allocation of water as allowed by the River Commissioner and as allocated by the Northern Colorado Water Conservancy District in which NPIC owns and receives a share of an even larger share system. In the course of a typical water year, company managers assess the amount of snow that has fallen in the high country (snowpack), compare that amount to previous records, and estimate spring runoff. Conservative estimates reflect

agricultural restraint - a farmer who cannot count on a good water year will not overextend crop planning. Thus, early estimates might be less than half of an average yield per share, or 2 acre feet per share (Table 5). However, if spring rains bring adequate water, the share yield can be raised, even exceeding the average, as did 1985 in Table 5. If the year is a poor one, the early conservative estimate may have been overly generous, and the final year's yield can actually be less than anticipated, as in 1940. Each member of the organization benefits in good years, proportionally to the number of shares owned, and each loses along with the company in times of drought. In bad years water enters the spot market at high prices, allowing some farmers to sell water for revenue and others to bring in a harvest. As long as a member is able to meet their assessment for the year, they retain ownership in the company. Thus, shares provide varying amounts of water from year to year, depending on precipitation and market fluctuation.

Originally NPIC was primarily owned by, and served, agricultural water users. However, now, in 2001, the City of Fort Collins (the City) owns somewhat more than 50% of the company's shares. In 1999, an independent auditor reported that "The Company [NPIC] provides water for agricultural uses to approximately 600 shareholders in the Northern Colorado Front Range" (NPIC, 1999: 14), and in fact, only 24% of deliveries were municipal (NPIC, 1999: 6). This suggests that one half of the shares of water owned by the City are leased back to agriculturalists, rather than used for municipal supplies. The attorney's report to NPIC shareholders expresses an "interest in water to use on open space" (NPIC, 1999: 7), representing a new form of use of water. In 1999, "the City provided approximately 3,800 acre feet of raw water to a number of parks, golf

courses and other City facilities. An additional 16,000 acre feet of surplus raw water was rented to area irrigators" (CFC website). Not all of this water was obtained as a part of Fort Collins' holdings in NPIC. However, this does represent Fort Collins' interest in water for environmental uses as well as agriculture.

In addition, Fort Collins holds an option to purchase Halligan Reservoir from NPIC. The reservoir, immediately upstream from Phantom Canyon on the North Fork of the Poudre (Figure 8), is one of a handful of sites being considered by the City for increased municipal storage capacity as demand for municipal supply increases with the rapid influx of new residents to Larimer County, Fort Collins, and surrounding areas. North Poudre Irrigation Company stores water in Halligan Dam on the North Fork of the Poudre, sending the water through diversion canals to plains reservoirs in early spring. Halligan reservoir is an essential element in providing water security to the shareholders of NPIC. North Poudre Irrigation Company has legal right to impound the capacity of Halligan Reservoir between November 1 and March 31, which results in an essentially dry riverbed below the dam for much of the winter season.

The Two Organizations Come Together

The North Poudre Irrigation Company's Halligan Dam (Figure 8) was completed in 1911, and the reservoir has been retaining water each winter since. This is a storage right, not a diversion right, so if the company allows water to flow past, it is not entitled to that by-passed water which is lost, but can only hold the full reservoir's capacity of 6428 acre feet. Storage season runs from approximately November 1 to March 31, but

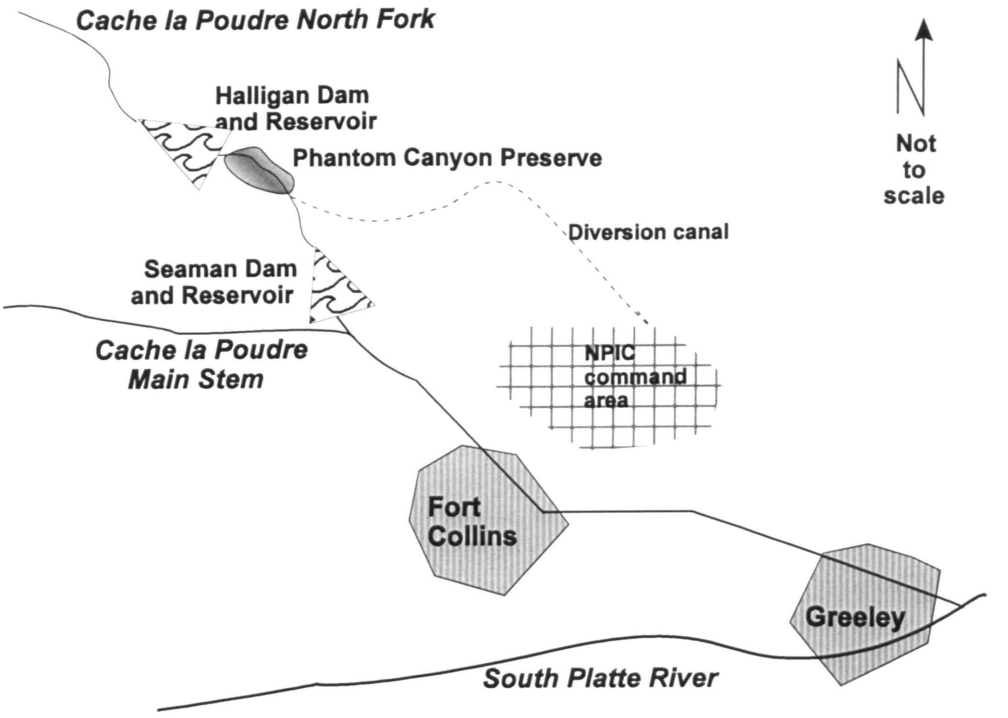


Figure 8 Halligan Dam and Reservoir and Phantom Canyon Preserve, Northern Colorado

NPIC often moves Halligan water, either to plains reservoirs or as early water to fields, as early as February or March. In addition, NPIC would run as much water as possible out of Halligan reservoir at the end of the irrigation season, to stockpile water in plains reservoirs over the course of the winter. After draining Halligan as low as possible, the gates would be closed, and virtually all river flow water would be held in the reservoir. Small amounts of water may have seeped through or around the gates, but essentially the river was dry below the dam from the end of October to late winter or spring, when the reservoir filled, and excess water spilled over the top, or the irrigation company started moving water out. Water released from Halligan reservoir runs out of a gate at the bottom of the dam face and into the bed of the North Fork of the Poudre to flow through

Phantom Canyon. From there, it can be diverted from the river bed into a tunnel that carries the water northeast to the highest, northernmost lands irrigated by NPIC.

In the 1970s, a local speculator purchased land on both sides of the North Fork below Halligan dam. He was a member of NPIC's board of directors. Around this time NPIC filed with the state engineer's office for the provisional right to store more water on the North Fork. The plan was to enlarge Halligan Dam and Reservoir, for water storage as well as generation of hydro-electric power. This happened during the energy crisis of the late 1970s, and the federal government was offering incentives for energy development. The provisional decree of storage rights to the additional water on the North Fork was granted. The speculator-member that owned the land also financed the legal actions necessary for this provisional right to the water, in exchange for joint ownership in the water rights. Halligan Reservoir legal right is to impound 6,428 acre feet. The proposed expansion would have brought the total volume of storage to 30,000 acre feet. The option to enlarge Halligan Reservoir, not yet acted on in 2001, is still an important component of the city of Fort Collins' future water supply.

In the early 1980s the speculator sold his share of the conditional water rights to the City of Fort Collins, which had been working with NPIC to increase holdings of water for the city. The Irrigation Company and the city of Fort Collins had previously traded reservoir and canal ownership in such a way that each benefitted, either through a decreased shrink (loss of water because of long distances in leaky ditches or river beds as well as evaporation), or improved access to irrigable acres. The City of Fort Collins was working to secure a greater supply of water for municipal use, because of projections of

strong growth for the front Range of Colorado in the near future. Ownership of provisional rights to water less than 30 miles away in Halligan reservoir was only one of many arrangements made by the City during this period.

At approximately the same time, the speculator put a tract of land below Halligan Dam on the market. Originally there was interest by then-Colorado Governor Lamm, among others, to purchase the land as a state park, for preservation of its pristine representation of the foothills ecosystem. When acquisition by the state did not materialize, TNC became aware that Phantom Canyon was available. A 1,700 acre portion of the property, including the steep-walled granite canyon, was purchased by TNC in the mid 1980s for preservation of habitat and protection of this remnant of the foothills ecosystem.

Political Context - Bypass Flow Controversy

Negotiations between TNC and NPIC, that resulted in the agreement analyzed in this thesis, were conducted in the shadow of a larger political context in which wildlife habitat and commodity production were pitched against one another in the 1980s and 1990s. A property rights battle regarding the United States government's right to require instream flows for habitat and stream channel maintenance was waged on the main stem of the Cache la Poudre River. This heated legal and political battle was closely watched by commodity producers and environmental groups alike, and set the precedent for non-litigious resolutions of conflicts over differing demands upon surface water in Colorado.

The provision of water for environmental needs, such as habitat for fish and wildlife, or to maintain channel structure, has been gaining importance in policy circles, influencing how National Forests manage public holdings (Neuman and Blumm, 1999: 4). Maintaining flowing water has other benefits that could be perceived as directly threatening agricultural interests as well. Recreational uses of waterways such as boating and swimming, and land-based uses such as picnicking, camping and wildlife viewing, are gaining importance to the general American public, who may see diversion of water to irrigation or mining as in opposition to their values and beliefs (Gillilan and Brown, 1997: 2-4). Conflicts between users may make local press. However, changes in policy, such as the granting of permits, have more far-reaching implications. The Poudre River basin was the scene of a precedent-setting step regarding the provision of instream flows upon public lands.

In March of 1995, the City of Greeley, the City of Fort Collins, and Water Supply and Storage Company, an irrigation mutual company, signed a memorandum of understanding entitled "Joint Operations Plan" (JOP). This plan concluded more than five years of conflict prompted by the proposed bypass flow conditions upon water users to "enhance the aquatic environment of the Cache la Poudre River" (JOP, 1995: 1). The JOP is a small part of a larger, extremely complex (and ongoing at the date of this writing) conflict over the use of water for wildlife and habitat preservation in the South Platte river basin, part of which is the Cache la Poudre. This larger conflict involves a multitude of federal and state agencies, private landowners, stakeholder groups, and municipalities, including the City of Denver. Federal, state, and private property rights

and responsibilities were all being debated in the heated political climate within which the JOP was negotiated. While NPIC and TNC were not parties to the JOP, both would have been well aware of what transpired in the resolution of this new demand for water. A brief description of the JOP's evolution is necessary to highlight its importance in this case study.

The United States Department of Agriculture Forest Service is "responsible for overseeing and protecting public lands . . . but it must also respect private property rights" (Jones, 1997: 3). This conflicting federal responsibility is at the heart of the issues that resulted in the JOP. Essentially, National Forests serve as a watershed supply and recharge area for numerous reservoirs which provide water for irrigation as well as other uses. These privately-owned reservoirs are located on Federal public land and their use is made possible through the issuance of special use permits, right-of-way grants and title easements permits for which are normally issued for ten to twenty year periods (Jones, 1997: 5). It is important to recall that water rights do not carry with them the right to access public land; these federal permits and other instruments serve as potential constraints on the actions of irrigators and other reservoir permittees. The permits allowing access to reservoirs owned by Greeley, Fort Collins and Water Supply and Storage Company came up for renewal in 1991, at a time when the Forest Service was in the process of revising their Forest Plan. As part of the new plan, the Forest Service wanted to make permits for access "conditional on the imposition of instream 'bypass' flows" (Wallop, in Jones, 1997: 7) in order to enhance the aquatic environment, protecting habitat and vulnerable species. When the Forest Service began to review the

management plan for the forest at the headwaters of the Poudre River in the late 1980s, the condition of bypass flows was required, in part to satisfy habitat requirements (Neuman and Blumm, 1999: 4). Forest managers proposed that minimum flows would "bypass diversion structures and remain instream" (Neuman and Blumm, 1999: 4), ensuring adequate water to protect aquatic habitat.

Permittees were concerned that their rights of impoundment would be curtailed by requiring bypass flows, threatening their abilities to capture and use their legally allowable amounts of water (Neuman and Blumm, 1999: 4). From the federal agency's perspective *bypass flows* are desirable, because they provide habitat by retaining water in the natural system. For Colorado water users, bypass flow is a legal term in which water is lost, and historic yield is reduced, thereby reducing the amount of water to which a holder of a water right is entitled.

Under Colorado law, bypass flow water is lost to the user, and cannot be recovered for use at a later time; therefore the Plan was perceived as a "taking." Because water rights are based on historic yield, loss to drought or bypass of flows is significant to water rights holders. Historic yield must be preserved in order to preserve the property rights of water users. Bypassed water is not considered part of the river's yield, and thus is lost to the system. This water was seen as irreplaceable and absolutely necessary for the continued operation of the reservoir owners interests. The initial Plan set off a flurry of negotiations which resulted in the JOP, a hard-won compromise. Other irrigation companies with reservoirs located on public lands became concerned about what the necessary steps might be for renewal of their own permits when the time came.

Some irrigation companies felt threatened, and saw the proposed Forest Service Plan as the first battle in a war over water for environmental uses, in which they stood to lose the most. The disparity between rights conferred by the State of Colorado and the rights of Federal agencies to manage public lands was at the heart of this conflict. Permittees demanded that their congressional representatives protect their rights to water originating on Forest Service land. A Congressional task force, clearly sympathetic with preservation of state appropriation doctrine, was formed to study the conflicting claims; the final report of which advocates for the primacy of water users over Federal land managers (Neuman and Blumm, 1999: 28). Neuman and Blumm's (1999: 28-9) analysis of the task force report concludes that it represented "a disturbing division among westerners. . . . [with a] 'take no prisoners' approach," between water users and federal agencies. The JOP seems to be an equitable solution to a conflict over water for wildlife habitat and endangered and threatened species, in that it allows local-level organizations to devise a solution that meets the common-pool needs of both the Forest Service (flowing water for habitat and wildlife), and the private property needs of the irrigators and municipalities. Through the mechanism of water exchanges (Figure 4), between the Cities of Fort Collins and Greeley and the Water Supply and Storage Company, water flowing in the river is ensured, without loss of yield or reduction of rights of property owners.

The operational details of the JOP are rather complex, and will not be elaborated here. Essentially, the City of Fort Collins has agreed to open a gate high in the river system, releasing water to the river. Farther downstream that water is recouped through a

series of exchanges with the other two participants in the JOP. This reflects the conclusions of Neuman and Blumm (1999: 28-9), that "cooperative efforts among private water user and the federal agencies" would be the best way to protect both private water supplies and public resource protection. The JOP is careful to make clear that bypass flows, or the loss of water by diverting it around impoundments, is unacceptable, and should be avoided to protect the permittees' legal rights to water. The legal language of *bypass flows* is assiduously avoided.

This is the charged socio-political context within which the agreement between NPIC and TNC was forged. While neither of these two organizations was directly effected by the proposed Forest Service Plan, they were intent observers of its resolution in the JOP. The Nature Conservancy was interested in determining a method for providing enhanced habitat for fishes, while NPIC, as a holder of water rights within the Poudre River basin was concerned that demands for habitat flows would set a precedent to their disadvantage. For NPIC, the JOP/bypass crisis created a very sensitive political problem, in which water users felt vulnerable to uncertain federal action. For TNC, the JOP illustrated a possible solution to the habitat crisis embodied in the need for winter water. The JOP's peaceable resolution, ensuring the rights of water users as well as satisfying the needs of wildlife, was encouraging to both TNC and NPIC.

CHAPTER 5 - FINDINGS

Introduction: Social Capital and the Creation of a New Common Property Resource

This thesis describes one way to provide instream flow to enhance wildlife habitat while continuing commodity production with irrigation water. The research question was:

> What organizational variables and relationships account for how two organizations, one a provider of collective goods and the other with a common property resource agenda, came together in an agreement that resulted in an outcome that neither could have achieved on their own, namely the creation of continuous instream flow for the purposes of habitat preservation and ecological restoration? In other words, how was a new good with properties of both a collective good and a common property resource created?

The Nature Conservancy and NPIC had conflicting needs for water in the North Fork and Phantom Canyon during winter months. North Poudre Irrigation Company could legally impound enough water to fill Halligan Reservoir for storage and application to crops during the growing season. They also felt the need for an environmentally-sensitive ally

in the changing face of natural resource management by federal agencies, as well as the possible expansion of the Reservoir. The Nature Conservancy had a need for flowing water in Phantom Canyon during the winter months, improving fish survival and reproduction rates. In addition, TNC wanted to establish good relations with their powerful upstream neighbor. The possibility of enlarging Halligan Dam and Reservoir was of interest to TNC, because that action would invite scrutiny from a wide variety of stakeholders, including state and federal agencies and local environmental groups. The Nature Conservancy wanted to be involved in the earliest planning stages of any changes to the Dam, to ensure that their needs, the needs of habitat, would be satisfied. Both organizations saw partnership as answering these divergent objectives.

The purpose of the study was to describe the processes and organizational variables that culminated in two organizations' creating a new good comprised of the CPR of commodity production concurrent with the collective good, instream flow that enhances habitat.

Formation of the Agreement–Constructing Social Capital for Managing a CPR

Shortly upon taking ownership of the land, TNC initiated contact with their upstream neighbor NPIC (Figure 5). The Nature Conservancy wished to manage their acquisition as a nature preserve, in order to protect the remnant ecosystem. "Preventing destruction or injury to habitats and keeping them in the right state to enable the most varied and plentiful plant and animal life to flourish in them," is a basic tenet of the mission of the national Nature Conservancy (TNC, 1959: 2). As such, continuous in-

stream flow throughout the winter months was necessary for fish and other aquatic organisms to thrive. Impoundment of water for storage in Halligan Dam, immediately upstream from the Preserve, prevented flow for some months after November 1st. The Nature Conservancy wanted to explore options regarding the flow regime of the North Fork as managed by NPIC at Halligan Dam.

Specifically, TNC negotiated with NPIC for a small flow of water through the canyon throughout the storage season. Winter season native flows are estimated to have been 20 to 30 cubic feet per second (cfs), during average-precipitation years. However, 2.5 cfs was the agreed-upon in-stream flow until Halligan Reservoir filled and NPIC began moving water out for diversion to the plains reservoirs. Water flowing at 2.5 cfs per 24-hour day results in just a bit less than five acre feet per day (Dunne and Leopold, 1978: 799) flowing through Phantom Canyon. Over the course of the storage season 600 acre-feet of water would be released from Halligan Reservoir to maintain habitat in Phantom Canyon. In exchange for providing continuous winter flows, NPIC required that TNC pay twice the amount of water lost to winter flow if Halligan Reservoir failed to fill completely by July 1. In other words, TNC would reimburse NPIC by twice the amount of water not in Halligan attributable to winter flow releases by the end of the runoff season. Winter flows of 2.5 cfs equals about 5 acre feet per day; in an average year the amount of water released before Halligan fills is 600 acre feet. If the Reservoir fails to fill by the first of July then the amount not filled is due in double amounts to the company, up to a total of 1,200 acre feet.

The Nature Conservancy rents shares of water from a variety of sources to satisfy repayment to NPIC. The City of Fort Collins holds shares in NPIC that act as drought protection, and are not used except in the driest of years–therefore the City would place those shares on the rental market. Eastman Kodak also contributed shares to the rental market, having bought shares in excess of their industrial needs when they first came to the Poudre valley in the 1970s. Many industries over-buy water when entering the valley, both as drought insurance and to hold as investment for future expansion. These sources of water, and others, could be counted on by TNC to have shares available on the rental (spot) market in all but the driest years.

The initial agreement was entered into on a year-by-year basis beginning in the fall of 1987. Each organization used legal counsel in the drafting of the agreement. However, the agreement has never been filed on record with any legal entity, at the request of NPIC. The agreement has been renegotiated and renewed continuously up to the present. In later agreements the term was extended to three years. Either party can propose changes or terminate the agreement. Social capital has formed bonds between the two organizations that provide each with a sense of knowing the other, and relying on the mutual satisfaction of both.

Changes to the agreement were made during each renegotiation. In the second year, NPIC required that TNC pay a bonus of 500 acre feet of water as a cost of doing business. The Nature Conservancy would pay for access to winter water by purchasing shares of water accessible to NPIC and not taking delivery. This water would then be available to the company's shareholders for use. Also in the second year, TNC proposed

that rather than shutting the gates down suddenly at the end of irrigation season, NPIC would step the flow down over the course of some number of days. They asked for stepped down reduction of flows at the end of the irrigation season, and again step-ups in February or March when the Company began moving water. This would mimic natural flow patterns to a greater extent and minimize shock to fish and invertebrate insects, which would adapt to lowering water levels over time, rather than become stranded when the gates were abruptly closed. This provision was integrated into the agreement by the third year, at which time TNC agreed to pay a set fee of $50 for each trip by the reservoir employee to adjust the gates over the step-down and -up periods.

In exchange for the extended period of shutting down irrigation and the in-stream flows, NPIC required that TNC pay for "shrink," water lost (to seepage and evaporation) in the diversion tunnel and canal over the step-down (or -up) periods. Canals and ditches are typically earthen—lined with cement only where soil permeability is high enough that ditch-bank stability is threatened. Seepage into the surrounding soil and substrata lessens the volume of water ultimately delivered to the destination field or intake. This accounts for canal delivery efficiencies of about 74% along 220 miles of NPIC ditch. As a simplified example, if 100 acre feet were released along an average NPIC ditch, 26% of that water would be lost to "shrink," and only 74 acre feet would arrive at the intended destination of a farmer's out-take ditch into a field. North Poudre Irrigation Company's concern regarding shrink in the step-up and -down provision is that if they cut off or started up again in a single step loss would be minimized, as the ditch wetting (and

shrink) is a factor of time as well as volume. Thus, NPIC required reimbursement for this increased loss to inefficiency.

The Nature Conservancy could make payment for losses with either money or water. The simplest solution was to arrange to rent shares of NPIC water and not take delivery. For the "doubled risk payment," if Halligan Reservoir failed to fill, it was more complex: shares of water would be rented on the speculation (or spot) market if the winter were dry and it seemed that inadequate precipitation would produce a light runoff in the spring. If the weather turned, then TNC would be left not needing those shares and could re-rent them on the spot market. The previously described robust water market in Northern Colorado is an integral component of the agreement.

In the early 1990s another party entered the agreement: the City of Greeley agreed to provide storage space in Seaman Reservoir, some miles downstream from Halligan Dam and Phantom Canyon Preserve. In-stream winter flows released by NPIC were not diverted into the canal below Phantom Canyon but continued on down the river to the Milton Seaman Reservoir (See Figure 8). The Nature Conservancy could now exchange the same water collected in Seaman Reservoir back to NPIC in partial repayment of winter losses, should Halligan Reservoir fail to fill. The Nature Conservancy would use these accumulated shares of water as trading stock on the local market to repay NPIC for winter flows. The City of Greeley provides storage space for NPIC to essentially store their water, which allows the agreement to become a coordinated release for the transfer of stored water. This facilitated the return of water to NPIC, since shares of water can be exchanged with downstream exchange partners as illustrated above in Figure 3. As a

party to the JOP memorandum of understanding discussed earlier, the City of Greeley was eager to enter into this agreement with TNC; it provided another pool of flexible water with which Greeley could satisfy its part of that agreement. In addition, Greeley was happy to build a coalition with an environmental group. The location of Seaman Reservoir, on the North Fork just upstream from the confluence with the main stem of the Poudre, was ideal for both TNC and Greeley. The Nature Conservancy would have easily accessible water for any exchange partners, and Greeley's vulnerability in operating a large reservoir close to Fort Collins could be mitigated by their building social capital in participation with NPIC and TNC.

The City of Greeley is protected in the agreement, as well. When Seaman reservoir fills completely so that water spills out, the water stored for NPIC and TNC spills first–it is "on top." This works for all concerned because Halligan Reservoir always fills before Seaman. Halligan is smaller and higher up in the watershed, as well as being more senior in priority. Table 6 summarizes the agreement between TNC and NPIC.

Table 6 Operational Details of the Agreement

At present the agreement stipulates the following:

- At the end of irrigation season NPIC reduces flows from Halligan dam over the course of a few days to a week. For example, they might step down from 300 cfs delivery to 200 cfs for a few days, and then 100 cfs for 24 hours, and then reduce to 50 for two days, and finally close the gate down to 2.5 cfs for the winter. When transfers of water are made from Halligan Reservoir through the Canyon and the Irrigation Company's diversion, the flow is managed in a similar step-wise procedure.

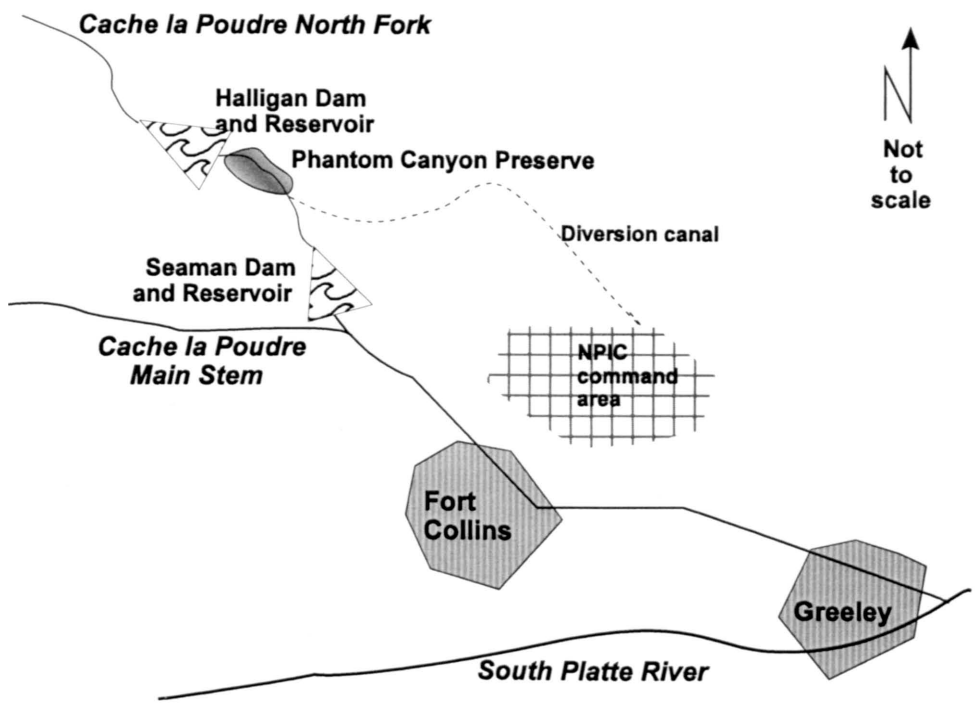
- The Nature Conservancy pays a $50 fee for each trip necessary to adjust the gate over the step-down and step-up periods.

- The 2.5 cfs flows continue until Halligan Dam fills to the point at which water spills over the top, or until NPIC begins moving water out of Halligan Reservoir to replenish plains reservoirs.

- The 2.5 cfs water accumulates in Seaman Reservoir, as partial credit to be returned to NPIC in the event that Halligan fails to fill, up to 1200 acre feet. If Seaman fills to the point of spilling (in which case Halligan has already filled completely), then no repayment to NPIC is needed for in-stream winter flows.

- The Nature Conservancy pays, each year, a bonus of 500 acre feet of water to NPIC to offset the costs of doing business.

- The most recent agreement covered a three year term, up for renegotiation in 2001.



An Important Test - Release of Sediment from Halligan Reservoir

During the last week of September 1996, NPIC reservoir operators released the remaining water from Halligan Reservoir, in preparation for maintenance work on the gates of the dam, which are situated in the base. Periodic inspection of these gates is required by the State Engineer, to ensure that safety standards are met. As the water level on the reservoir was lowered, sediments that had accumulated in the deeper regions of the reservoir basin also flowed through the gates, and into Phantom Canyon Preserve. Seven thousand five hundred cubic yards of sediment then filled pools in the bottom of the river bed as finer silts settled in the gravel beds of the riffle areas of the river. Insects, fish eggs, and fish themselves were smothered and killed by this flow of "clay-to-gravel sized sediment" (Zuellig et al., 2000: in press), which was more than 10 feet deep in some places. Fish habitat along more than three miles of river was "killed, and another 3 miles was hurt severely" (Obmascik, 1996). Within days of the incident, scientists began assessing the level of impact, as well as formulating ways to restore the river by moving the sediment out as quickly as possible. Thirteen months after the incident, "80 percent of the sediment [had] been removed" and fish populations were showing some recovery (Blumhardt, 1997). The Colorado Division of Wildlife (DOW) is charged with managing and protecting the State's wildlife, including fish species. They have the authority to sanction actions that harm those species through fines. However in this case no fines were levied against NPIC.

This incident, variously referred to as "the incident," "the spill," and "the kill," served as a test of the relationship between NPIC and TNC, as well as of the agreement

which is the subject of this thesis. It also provided an opportunity for the various bureaucracies and agencies involved with water management in Colorado to come together and establish a protocol regarding "unusual actions" in future water operations. Prior to this event, the effects of requirements of various state agencies were sometimes at cross-purposes with each other. The State Engineer required periodic drainage and inspections of dams and other infrastructure, while the Colorado Division of Wildlife prohibited actions that would significantly harm the populations of the State's wildlife. Capture of sediment is inherent in the operation of reservoirs, shortening their useful lives and causing damage to structures such as gates and valves. In order to comply with State Engineer requirements, as well as perform necessary maintenance on their property, dam owners such as NPIC must occasionally flush sediment. Prior to this incident, no clear chain of communication existed for dam operators to notify interested parties (including the various state and federal agencies) of their intent to drain sediment from reservoirs. Typically sediment was flushed at the end of summer, when water was already low in the reservoir and inspection of the entire dam could be performed.

After the sediment release incident of 1996, representatives of NPIC, TNC, the Colorado State Engineers' Office, the Colorado Division of Wildlife, and the Water Quality Control Division of the Colorado Department of Natural Resources, as well as advocates from a few environmental groups, met and formulated a protocol of notification regarding "unusual actions" necessary for water management. Many of these actions are not really unusual, only infrequent, such as draining a reservoir for maintenance and repairs. Other actions that would require application of the notification

protocol include rerouting water for work on a diversion, or discontinuing a management regime that had been in effect for a long time. The three main concerns, as represented by the State agencies, are: 1) protection of water rights; 2) protection of water quality for the environment and human uses; and 3) protection of the wildlife of the State of Colorado, including insects and fish. The protocols that arose from NPIC sediment release appear to provide for better communication between all three agencies, and improve interactions with those agencies for the water users of the state. In addition, research is being conducted that addresses the very problem of sediment build-up in reservoirs. One recommendation from the research is to flush sediment when water is high, so that flow is sufficient to move the material well along the river and prevent large-scale build ups down stream (Rathburn and Wohl, 2001). At best this is a short-term solution to a long-term situation inherent in damming rivers.

The fishery of Phantom Canyon was decimated in 1996, and, while nearly fully recovered in late 2000, is still less than optimal. No fish in the canyon were known to be an endangered or threatened species. However some fish were a genetic cross of an introduced sport fish, the rainbow trout, and a native species, which is the State Fish of Colorado, the green-backed cutthroat (*Oncorhynchus clarki stomias).* This colorfully-marked cross, often referred to as the *cutbow,* originated in the North Fork and many other rivers in the West, as rainbows were increasingly introduced to enhance sport fishing. The introduced rainbow and native green-backed cutthroat would interbreed, producing the cutbow hybrid. This hybrid and the rainbows successfully out-competed the native fish, until native populations were eliminated. The green-backed cutthroat is

listed as threatened under the Endangered Species Act, and has been considered for reintroduction into the North Fork of the Cache la Poudre River. Prior to siltation the river "supported trout abundances comparable to the best rivers in the state," similar to Gold Medal streams throughout Colorado (Fausch, 1996).

These fish populations had provided a strong incentive to TNC for their original interest in the Phantom Canyon property. The general public could participate in a lottery system for fishing the river, and TNC used the amenity value of fishing for large, attractive trout in a virtually untouched stretch of river as a premium for high-level donors. Fly-fishing is an elite form of recreation, and the opportunity to fish a high-quality trout stream close to Fort Collins serves to nudge the wealthy into larger donations. With the sediment filling the pools in which the fish over-wintered, and the spaces in the gravel in which trout build their *redds* (nests), this amenity was utterly destroyed.

As a test of the relationship between NPIC and TNC, the sediment release revealed the attitude of solidarity held by TNC toward NPIC. Rather than suing NPIC, or encouraging the DOW to levy appropriate fines, TNC rallied around NPIC, supporting them at a time when the fishing community and advocates of water quality, wildlife, and the environment were up in arms, hostile and calling for strong negative sanctions. Ultimately, the two organizations each contributed support to a study for recommendations on the optimal flow volumes and timing required for removal of the sediments in as short a time as possible, without further damage to the river. This mutual support undoubtedly served to cement the relationship between the two organizations.

North Poudre Irrigation Company is regarded as a fairly environmentally-friendly irrigation company because of its willingness to work with TNC. Other irrigation organizations are more conservative, and are suspicious of groups with an environmental agenda because of concerns over property rights and fears of litigation. While another environmental group might have sued NPIC for damages and insisted on a fine being levied by the DOW, TNC sought to build on their social capital with NPIC by supporting a coalition of interested groups that could learn from the experience. The strong stand that TNC took alongside NPIC may also serve as an indicator to other irrigation organizations; that environmentalists can be good partners in times of adversity.

And finally, the sediment spill illustrates the flexibility of the agreement between NPIC and TNC. Because the stretch of river effected by the sediment release needed to be managed carefully to remove the sediments, the agreement was temporarily suspended to allow the optimal volume and timing as recommended in the commissioned study. The following early winter proved to be wetter than usual, and the sediment moved out to a large degree without manipulation of the gates by NPIC. Fish began migrating back into the upper reaches of the river within a year after the incident. By summer 2000, habitat was largely restored and the DOW notified TNC that fishing could once more be sustained on the river.

Consequences of the Agreement for Both Parties

The agreement between TNC and NPIC has both positive and negative consequences for each of the parties. The primary benefits for TNC are an enhanced

collective good: 1) Phantom Canyon receives needed winter water, providing enhanced habitat for important game fish species; 2) The amount of water needed to repay NPIC even in dry years is small and should be available at affordable prices; 3) Most years there is no need to secure water as repayment for a lack of water in Halligan Reservoir. Negative consequences for TNC are: 1) The spot market always sets the price of water needed to cover shrink and any repayment, leaving TNC vulnerable to rapidly rising prices in times of drought when they need water most; 2) The location of Halligan Dam, immediately upstream presents an ongoing need to address siltation and the need to ameliorate this problem. Alternatives to flushing are costly and might be met with resistance by NPIC.

Consequences for NPIC include these positives: 1) A partnership with an environmental group that works *with* NPIC to achieve goals, rather than relying on litigation or federal law. In the politically-charged atmosphere under which the JOP was negotiated, habitat-friendly activities reflect well on the irrigation company; 2) The mechanism of exchange allows recovery of the winter flow; 3) A reliably supportive partner in TNC when Halligan Dam is being considered for expansion by the City of Fort Collins and NPIC. As expansion plans are formulated, the agenda of TNC can be incorporated, institutionalizing the provision of habitat and removing the onus from NPIC, while at the same time supporting the enlargement project, which could greatly benefit NPIC shareholders. Negative consequences for NPIC include siltation of the reservoir, which will always be a problem, exacerbated by the presence of a sensitive protected ecosystem immediately downstream from Halligan Dam. The Nature

Conservancy provides both a problem and a possible ally in resolving this inherent difficulty.

The consequences addressed above describe not only the basis for formulating the agreement initially, but also the strengths that have arisen in its evolution over the years. Flexibility and ongoing interest in fostering this relationship by the two organizations has resulted in an agreement with enduring qualities for sustained commitment. Social forces at work include TNC's needs for habitat at a reasonable cost, and NPIC's needs for a cooperative political ally which could support NPIC in times of adversity, such as when State of Colorado or Federal agencies become interested in securing water for habitat on the North Fork of the Cache la Poudre, or in the rivers to which it is tributary. In a sense this agreement forestalls a situation such at that which culminated in the JOP, through enhanced social capital.

To summarize, the agreement between NPIC and TNC provides a small flow of water in Phantom Canyon through winter months of water storage. The water is not lost to NPIC, because TNC repays it if precipitation is inadequate to fill Halligan Reservoir in the subsequent spring. Water released from Halligan during winter months is stored in Seaman reservoir, and used as exchange stock to satisfy the needs of NPIC shareholders. North Poudre Irrigation Company and the City of Greeley each gain an environmentally-friendly relationship with TNC, while TNC is able to enhance ecological integrity of this foothills ecosystem remnant. Social organization has made possible a win-win outcome that creates a new resource with characteristics of both common property and collective goods.

CHAPTER 6 - SIGNIFICANCE, IMPLICATIONS, HYPOTHESES AND CONCLUSION

Significance

The agreement between NPIC and TNC with the City of Greeley as adjunct partner, provides a new good with characteristics of common property and collective goods: 1) The CPR is continuous stream flow without harm to the agricultural agenda; 2) The Collective good is strikingly improved winter habitat for fish and other aquatic species in the North Fork of the Cache la Poudre River. This agreement, between organizations with different agendas, and forged in a highly politicized environment, has withstood not only a potentially devastating test, but also the test of time.

Social organization serves to resolve difficulties created by physical, legal and climatological realities in such a way as to continue production of traditional agricultural commodities, provision of municipal water supplies, and support of a healthy fishery in an unspoiled stretch of river on the Front Range of Colorado. Rather than depending upon either a strong central state that mandates habitat preservation or upon privatization of the resource and dependence solely on markets, the efforts of two organizational entities have provided habitat for fish and wildlife and preservation of a remnant of pristine foothills ecosystem, requiring neither the state nor the market.

Social capital consisting of social bonds allowed these two organizations to meet and resolve differing agendas in order that both of them achieve their respective goals. A new CPR (continuous winter flow of water that maintains the agricultural agenda) and a new collective good (habitat and preserved ecological integrity) have been created, benefitting all citizens of the state, the region, the nation and the planet. Something new has been created; social capital had been created that sustains instream flows while protecting agricultural producers. This stretch of the North Fork of the Poudre river now has people organized around it in a new way.

Preservation of the natural ecosystem benefits more than just the members of TNC or NPIC. Remnant population of fishes, birds, plants and mammals are supported by the continued flow of water through the canyon. The agreement provides indirect benefits even to those who do not contribute; citizens everywhere are ensured of a sliver of land remaining undeveloped, free of houses and other evidence of urban sprawl.

Implications for Sociology

Two concepts have been taken from their respective literatures and traditions, and brought together in this thesis: CPR theory and social capital have been integrated to make the central argument. Environmental problems and CPR problems present challenges which can be met by social capital structured to manage a CPR, including the variables identified: clear boundaries, equitable rules and local control. Social capital theorists are invited to turn their attention to CPR problems, while CPR theorists, in turn, are invited to see solutions to the tragedy of the commons in appropriately-shaped forms

of social capital. Effectively constituted local organizations that include the three variables will have a greater chance of success, supporting the theories put forth by Freeman and Ostrom. Social capital, found in the networks of relationships between individuals and organizations, provides a possible solution to CPR problems. This thesis has presented an example of success.

The agreement between TNC and NPIC shows many of the elements called for in the set of propositions, as drawn from the work of Ostrom and Freeman. These propositions, as illustrated in Figure 2, Chapter II, included the need for boundaries of both the resource and participants; rules of allocation and appropriation; and local control as necessary for equitable formulation of solutions to changing demands. At this point, the observations of the case study must be compared to each of these proposed conditions.

Clear Boundaries. The boundaries of the CPR are quite clear: TNC and NPIC are the primary participants, with the City of Greeley as a member necessary for optimally efficient operation. The Nature Conservancy provides insurance and improved security against drought to NPIC shareholders. North Poudre Irrigation Company provides improved stream habitat with continuous winter flows. The City of Greeley provides a convenient, efficient storage place for the released winter flows, and holds that water as trading stock for TNC and NPIC to complete necessary exchanges. No other individual, organization or agency can influence the flows of the river, harm the stockholder's irrigation water supply, or effect the fish habitat, without receiving approval of the three participants. Likewise, the physical boundaries of the agreement are clearly defined: the

area directly effected by the agreement is approximately six miles in Phantom Canyon, while the overall area effected encompasses nearly 15 miles of river total.

Equitable Rules. The share system ensures systematic rules for crediting and repaying units of water for both the winter flows stockpiled in Seaman reservoir and as units of exchange for the 500 acre feet annual payment, as well as payment for failure to fill Halligan Reservoir, should that be the case. The Poudre River provides irrigation water to 20 mutual companies, each of which operates on a share system and many of which provide a potential market for water from the North Fork. Therefore, TNC is assured opportunities for rental, trade (exchange), or purchase of water with which to satisfy its obligations to NPIC. Proportionality is central to the share system, ensuring that TNC is assessed a fair obligation for its requested winter in-stream flow. In addition, the rules of the share system ensure that those water long-term users present within the valley, and having invested time, energy and risk in the irrigation system, are protected from harm by contemporary concerns regarding fish habitat, ecosystem health, and preservation of endangered species. The share system allows for water rental as payment to NPIC, as well as facilitating the exchange between the City of Greeley's Seaman Reservoir and NPIC's shareholders. Indeed, protection of the shareholders was a central concern of all respondents, whether representing NPIC, TNC, or the Colorado state bureaucracy. The Nature Conservancy does pay a higher rate in some years but considering the nature of the environmental benefit this cost can be easily paid. North Poudre Irrigation Company is willing and able to adapt and work with an environmental

group, demonstrating local leadership's understanding of site-specific needs, accountability to the local level, and rational, congruent rules.

Local Control. Local control, allowing autonomous operations separate from a heavy-handed central state, is clearly evident in the agreement between TNC and NPIC. In fact, such an agreement could not have been conceived by a central state, nor could it have been provided by the market. The agreement was devised and implemented by those locals with an interest in environmental protection and continued commodities production. Local control of the resource is also evident in that TNC requests that water be available at a time different from all other deliveries, and their request is honored. Lawyers were needed to clarify points of law and to draw up contracts, but the decisions involved the members of the board of NPIC and shareholders and were supported by the river commissioner, further reflecting the removal of this decision-making process from either the central state or market forces. The agreement is sanctioned by the central state's representative (the river commissioner) who approved the agreement with regards to the requirements of Colorado's prior appropriations doctrine, and whose office manages paperwork involved with exchanges.

Over a relatively short period of time (1986 - 1988) a traditional irrigation organization adapted to changing demands from water users and local citizens. Rather than depending upon an edict from a central bureaucracy to dictate what must or must not be done for winter flows, these creative organizational beings were able to craft their own response in light of a demand for improved wildlife habitat. As time passed, the agreement evolved to incorporate adjustments needed by each party; these evolutionary

shifts were duly accepted and supported by the local state bureaucracy, providing further evidence of local control.

An important implication of this component of local control is that of agency. Human agency in this case of social change is at the level of organization, especially local, non-profit organizations managed for the purpose of providing CPRs (NPIC) and collective goods (TNC). This study demonstrates that traditional water users, who are historically not friends of environmental agendas, have organized to pursue an environmental issue. It is possible to speculate that, based on key informant interviews, had a survey of attitudes of individual water users been administered in the early 1980s, strong negative attitudes regarding environmental concerns would have been revealed. However, opinions held by individuals about environmental concerns do not account for the agreement, but rather the organizational needs in the context that the politically-charged JOP discourse produced the agreement. In this case the needed agency for social change was vested at the organizational level. This leads the sociological researcher in the arena of social change to consider social capital in the form of local organizations such as studied here as the unit of analysis where useful work is done.

The agreement reflects the presence of three proposed characteristics derived from the CPR work of Elinor Ostrom and David Freeman. It shows that boundaries, of both the resource and participants, are needed to ensure equitable effective control of free-riding. It benefits from the presence of a system of allocation dependent upon proportional obligation, with no preference for those near the source of the resource. It also demonstrates the creative ways that two very different organizations can work

together to forge a new CPR. It demonstrates what can be done by local level organizations empowered to act in flexible, proportional, democratic ways and respond to needs not adequately addressed by either the market or the central state.

Only a local level organization with clear boundaries on the resource and participants, and a system that allocates resource provision proportional to investment, and the autonomy to act independently of the central state could forge a new resource such as this, with characteristics of both common property and collective goods. The agreement between NPIC and TNC, with the City of Greeley as adjunct partner demonstrates the presence of the three proposed characteristics necessary for successful, ongoing, sustainable, and just provision of common property natural resources. The agreement demonstrates both physical and participant boundaries, makes use of a system that ensures proportional accountability of participants, and illustrates the flexibility possible with local control. It allows NPIC to fulfill its needs for agricultural irrigation, unharmed by the needs of fish and ecological concerns, while supporting TNC's mission of providing improved habitat along a pristine stretch of river on Colorado's rapidly-developing Front Range.

Hypotheses

At this point it may be appropriate to postulate some hypotheses, based upon the findings of this case study:

1. The distributional share system provides resource users with a flexible organizational structure for equitable management of natural resources, including irrigation water and habitat for wildlife.
    a. Shares of water can be measured with accuracy, facilitating trade and exchange, as well as accounting of debts and payments.
    b. The share system provides for member participation—by democratically voting their shares members connect to civic life, transcending individual rationality. As new neighbors bring new agendas into the community this civic environment allows for incorporation of new needs.
    c. The more explicit the share system, the greater the capacity to calculate precisely gains and losses and the greater capacity to define the terms of negotiation.

The rationale for Hypothesis 1 is this: Reflecting back on the findings of this thesis, North Poudre Irrigation Company had clear ways to see and defend their benefit stream. The good provided, water, is easily divided into units, facilitating acquisition, trade, and negotiation. The Nature Conservancy's collective good, on the other hand, was less clearly bounded, with less clearly definable benefits. How much habitat is enough? What, exactly is habitat? And, which species dominates a management scheme? The collective good in the form of ecosystem integrity must necessarily be more problematic

from a measurement perspective than irrigation water as a CPR. The CPR organization was in a stronger position to define and defend their needs and benefits in the continuing negotiation of this agreement. Future researchers may want to explore these disparities of position in negotiations conferred by the respective types of goods.

2. The sustainable use of natural resources can be advanced by creating and managing organizations which, in turn, are usefully examined in the light of CPR theory.

    a. Organizations empower people to do together what cannot be accomplished by individual actors.

    b. Share systems—balancing proportional costs with benefits—are essential to private and public actors in calculating their respective returns on investment.

    c. Sociological attributes of CPR and collective good organizations are as important as any biological or environmental attribute in formulating plans or agreements to provide habitat or manage natural resources.

These hypotheses offer arenas for further exploration of the ways that rational actors can work together and collectively sustain ecosystems and resources upon which all life depends.

Since Hardin's 1968 paper set off the debate that polarized theory regarding CPRs, many social science analyses fall into two camps--calling either for privatization and markets or for administration by the central state. Natural resource users have struggled with the solution to providing CPRs in ways that are responsive to local needs

and still address issues of environmental sustainability. The models of Ostrom and Freeman contribute significantly to the debate by advancing a third possibility: local organization, adapted to specific environmental niches, as creative agents of environmental sustainability and resource management. This case study demonstrates, in part, how local people can effectively manage CPRs without dependence on either private markets or a central state, yet provide their own organization that can accommodate, and encourage, sustainability of both commodity production and habitat.

Implications for Policy

The Cache la Poudre River is fairly typical of many arid land rivers. It has been managed largely for irrigation and other commodity-producing interests, but that focus is changing. The agreement between North Poudre Irrigation Company and The Nature Conservancy is an example of the flexibility of local CPR organizations, employing the share system and adapting to accommodate contemporary concerns for habitat and species preservation, as well as other environmental problems. Displaying components of Ostrom's principles and Freeman's variables, the agreement illustrates these theoretically-based concepts in concrete ways. As human impacts increase along the Front Range of Colorado and around the world, successful examples of locally managed, sustainable organizations which deliver clearly bounded CPRs through collective action, local control, and the use of share systems, will become more and more important. This case has implications for policy formation and serves as a primer for future investigation of the creation and management of local CPRs.

Freeman's model of distributional shares offers more than is addressed in this thesis. However, the presence of equitable distribution of costs proportional to benefits as a central theme is absolutely key. Both mutual companies and environmental organizations are stronger if rewards are proportional to the necessary efforts of achievement. Mutual organizations that incorporate distributional shares have weathered changes of policy and implementation in Colorado, and throughout the world (Freeman, 2000: 49). As noted by Freeman and Angin (1999:102), those organizations that utilize distributional share systems increase productivity, equity, sustainability, and effective linkages between local level resource providers and state-level administrators.

Policy makers should: 1) learn about the local organizational actors existing across the landscape; 2) incorporate the needs and capabilities of these organizations into their assessments of policy; 3) provide and protect organizational social space so that they may enhance organizational capacity to provide CPRs and collective goods; and 4) hold local organizations accountable for following standards of democratic governance, fiscal accountability, and environmental stewardship.

Conclusion

Human beings depend upon Colorado surface water for irrigation of crops, domestic uses, and industry. Wildlife and other parts of ecosystems evolved with water as a necessary element of the natural environment. This thesis explored a situation in which two organizations came together and forged an agreement that provides a new good: instream flow for wildlife habitat, without negative repercussions for the

agriculturalists that make that habitat possible. The TNC and NPIC agreement is an example of careful management of water for both human beings and wildlife species, balancing human needs with healthy ecosystems. Water managers at NPIC worked with TNC to meet TNC's goal of providing collective goods in the form of habitat for fish and wildlife and preserving a remnant of the Front Range ecosystem, by securing access to surface water, a scarce and tightly-controlled commodity in Colorado. NPIC, with a 100-year tradition of providing the common property good of irrigation water, adapted to the changing political climate's emphasis on environmental integrity, as well as the agricultural agenda of its northern Colorado constituents.

The research question included the elements as "the organizational variables and relationships" that might allow or encourage such an agreement as has been outlined here. The three suggested propositions involved clear boundaries, equitable rules and local control. Using the case study method, in-depth interviews and document review, each of these was found in this particular instance of organizational adaptation, supporting the thesis that specific sociological features of these local organizations made possible the production and management of this new good.

The story told in this thesis has charted a fundamental change in NPIC, traditionally a long-standing commodity-oriented organization. This organization, operating in the political context that resulted in the JOP, served as the agent of social change, forging a social network that was able to transcend the primary mission of providing irrigation water. The City of Greeley was eager to facilitate the agreement, in part to improve their own political standing. The Nature Conservancy, in pursuing its

goals, is providing to NPIC an added level of security in a rapidly changing world. Thus, the two organizations each contributed social capital to a situation that serves as a model for future, similar, natural resource management decisions.

This case study illustrates the importance of considering social constructs, such as clear boundaries, equitable rules, and local control of the resource, when assessing natural resource management challenges. Sociological analysis offers a substantial contribution, alongside biologists and hydrologists, in the formulation of policy and projects for environmental enhancement. Local level organizations, supported by the state and operating within the market, can respond effectively to environmental challenges by providing CPRs and collective goods for the benefit of human beings and ecosystems.

REFERENCES

Anderson, Terry L., and P. J. Hill. 1977. "From Free Grass to Fences: Transforming the Commons for The American West." In *Managing the Commons*, Garrett Hardin and John A. Baden, eds. San Francisco: W. H. Freeman Publications.

Anderson, Terry Lee, and Pamela Snyder. 1997. *Water Markets: Priming the invisible pump.* Washington, DC: Cato Institute.

Baden, J.A. and D.S. Noonan eds. 1998. *Managing the Commons.* Bloomington: Indiana University Press.

Becker, H. S. 1967. "Whose side are we on?" *Social Problems.* 14, 239-247.

Blumhardt, Miles. 1997. "Poudre River making rapid recovery from sediment spill." *Fort Collins Coloradoan.* 15 November: A1.

Bromley, D. W. 1998. "Determinants of cooperation and management of local common property resources: Discussion paper." *American Journal of Agricultural Economics.* 80 (3): 665-668. (August).

Bromley, Daniel W., Donald C. Taylor and Donald E. Parker. 1980. "Water Reform and Economic Development: Institutional Aspects of Water Management in the Developing Countries." *Economic Development and Cultural Change.* 28: 365-387.

Cannell, Charles F., and Robert L. Kahn. 1953. In *Research Methods in the Behavioral Sciences.* Leon Festinger and Daniel Katz, Eds. New York: Dryden Press.

CFC (City of Fort Collins) Website
http://www.ci.fort-collins.co.us/water/more-sources.asp Accessed 7 Sept 2000.

Coleman, J. S. 1990. *Foundations of social theory.* Cambridge MA: The Belknap Press of Harvard University Press.

Covich, Alan P. 1993. In *Water in Crisis: a Guide to the World's Fresh Water Resources.* Peter H. Gleick, ed. New York: Oxford University Press.

Cresswell, John W. 1998. *Qualitative Inquiry and Research Design: Choosing Among Five Traditions.* Thousand Oaks CA: Sage Publications.

Denzin, Norman K. 1989. *The Research Act: A Theoretical Introduction to Sociological Methods.* Englewood Cliffs, N.J.: Prentice Hall.

Dunbar, Robert G. 1983. *Forging New Rights in Western Waters.* Lincoln, NE: University of Nebraska Press.

Dunne, Thomas and Luna B. Leopold. 1978. *Water in Environmental Planning.* New York: W.H. Freeman and Co.

Elster, Jon. 1982. "Marxism, Functionalism, and Game Theory." *Theory and Society.* 11: 513-520.

EPA (United States Environmental Protection Agency) 2000. Web site accessed 18 March 2000. http://www.epa.gov/surf2/hucs/10190007.

Fausch, Kurt. 21 October 1996. Memorandum to Heather Knight, Nature Conservancy: "Effect of sediment on trout in Phantom Canyon."

Fiege, Mark. 1999. *Irrigated Eden: the Making of an Agricultural Landscape in the American West.* Seattle, WA: University of Washington Press.

Field, Barry C. 1994. *Environmental Economics: An Introduction.* New York: McGraw-Hill, Inc.

Flora, J. 1998. "Social Capital and Communities of Place." *Rural Sociology.* 63 (4): 481-506.

Freeman, David M. 1989. *Local Organizations for Social Development: Concepts and Cases of Irrigation Organization.* Boulder, CO: Westview Press.

Freeman, David M. 2000. "Wicked Water Problems: Sociology and Local Water Organizations in Addressing Water Resources Policy." *Journal of American Water Resources Association.* 36 (3) June 2000.

Freeman, David M. and Zeynep Angin. 1999. "Local Irrigation Organization in Turkey's Southeast Anatolia Project (GAP): A Proposal." *Water International.* 24 (2): 95-103.

Freeman, David M. and John Wilkins-Wells. 2000. "Organizational Engines of Water Productivity, Social Justice, and Environmental Sustainability in the Poudre River Basin of Northeastern Colorado." Proceedings, 2000 USCID International Conference, poster presentation. Volume II: 117-131.

Gerth, H. H. and C. Wright Mills, translators and editors. 1946. *From Max Weber: Essays in Sociology.* New York: Oxford University Press.

Gillilan, David M. and Thomas C. Brown. 1997. *Instream Flow Protection: Seeking a Balance in Western Water Use.* Washington, DC: Island Press.

Gleick, Peter H. ed. 1993. *Water in Crisis: a Guide to the World's Fresh Water Resources.* New York: Oxford University Press.

Gorden, Raymond L. 1975. *Interviewing: Strategy, Techniques and Tactics.* Homewood, IL: Dorsey Press.

Hanna, Susan S., Carl Folke, and Karl-Goran Mäler, eds. 1996. *Rights to Nature: Cultural, Economic, Political, and Political Principles of Institutions for the Environment.* Washington, DC: Island Press.

Hardin, Garrett. 1968. The Tragedy of the Commons. *Science.* 162: 1243-1248.

Hutchins, Wells A. 1929. *Technical Bulletin #82: Mutual Irrigation Companies.* Washington, DC: US Department of Agriculture.

Joint Operations Plan Memorandum of Understanding. 1995.

Jones, David P. 1997. *Market Rationality v. Social Rationality: Conflict of the Cache la Poudre River.* Unpublished paper: Colorado State University, Fort Collins, CO.

Maass, Arthur and Raymond L. Anderson. 1978. . . . *and the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments.* Cambridge, MA: MIT Press.

MacDonnell, Lawrence J. 1999. *From Reclamation to Sustainability: Water, Agriculture and the Environment in the American West.* 'In cooperation with the Natural Resources Law Center' Niwot, CO: University Press of Colorado.

Margolis, Jon. "Remembering an Establishment Revolutionary." *High Country News.* 11 Sept. 2000

McCay, B. J. 1987. "The Culture of the Commoners: Historical Observations on Old and New World Fisheries." In *The Question of the Commons: the Culture and Ecology of Communal Resources*. McCay, B. J. and Acheson J. M. eds. Tucson, AZ: University of Arizona Press.

McCay, Bonnie J. 1996. "Common and Private Concerns." In *Rights to Nature: Ecological, Economic, Cultural and Political Principles of Institutions for the Environment.* Hanna, Susan S., Carl Folke, and Karl-Goran Mäler, eds. Washington, DC: Island Press.

McCay, B. J. and Acheson J. M. Eds. 1987. *The Question of the Commons: the Culture and Ecology of Communal Resources*. Tucson, AZ: University of Arizona Press.

Muldavin, Joshua S. S. 1996. "The Political Ecology of Agrarian Reform in China" In *Liberation Ecologies: Environment, Development, Social Movements.* Richard Peet and Michael Watts, eds. London: Routledge.

Neuman, W. Lawrence. 2000. *Social Research Methods: Qualitative and Quantitative Approaches.* Boston, MA: Allyn & Bacon.

Neuman, Janet C. and Michael C. Blumm. 1999. "Water for National Forests: the Bypass Flow Report and the Great Divide in Western Water Law." *Stanford Environmental Law Journal,* 18:3.

Noonan Douglas S. 1998. "International Fisheries Management Institutions: Europe and the South Pacific." In *Managing the Commons.* Baden, J.A. and Noonan D.S. eds. Bloomington: Indiana University Press.

North Poudre Irrigation Company. 1986. *Annual Report.* Wellington, CO.

North Poudre Irrigation Company. 1998. *Annual Report.* Wellington, CO.

North Poudre Irrigation Company. 1999. *Annual Report.* Wellington, CO.

Northern Colorado Water Conservancy District. 1994. *Water News.* Spring. Loveland, CO.

Obmascik, Mark. "Drain-off kills 4,200 trout: silt devastates famed fishery." *Denver Post.* 11 October 1996: B1.

Olson, Mancur, Jr. 1965. *The Logic of Collective Action: Public Goods and the Theory of Groups.* Cambridge, MA: Harvard University Press.

Ostrom, Elinor. 1990. *Governing the Commons.* New York, NY: Cambridge University Press.

Ostrom, Elinor. 1998. "International Forestry Resources and Institutions Research Program: A Methodology for Relating Human Incentives and Actions on Forest Cover and Biodiversity." In *Forest Biodiversity in North, Central and South America, and the Caribbean: Research and Monitoring.* Dallmeier, F. and J.A. Comiskey eds. New York : Parthenon.

Ostrom, Elinor. 1994. "Constituting Social Capital and Collective Action." *Journal of Theoretical Politics.* 6 (4): 527-561.

Ostrom, Vincent, David Feeny and Hartmut Picht, eds. 1993. *Rethinking Institutional Analysis and Development: Issues, Alternatives, and Choices.* San Francisco, CA: Institute for Contemporary Studies Press.

O'Toole, Randal. 1998. "The Tragedy of the Scenic Commons." In *Managing the Commons.* Baden, J.A. and Noonan D.S. eds. Bloomington: Indiana University Press.

Pisani, Donald J. 1992. *To Reclaim a Divided West: Water, Law and Public Policy, 1848–1902.* Albuquerque, NM: University of New Mexico Press.

Postel, Sandra. 1993. "Water and Agriculture." In *Water in Crisis: a Guide to the World's Fresh Water Resources.* Gleick, Peter H. ed. New York: Oxford University Press.

Postel, Sandra. 1999. *Pillar of Sand: Can the Irrigation Miracle Last?* New York: W.W. Norton & Company.

Radosevich, G. E., K. C. Nobe, D. Allardice, and C. Kirkwood. 1976. *Evolution and Administration of Colorado Water Law: 1876-1976.* Littleton, CO: Water Resources Publications.

Rathburn, S.L., and Wohl, E.E. 2001. "One-dimensional sediment transport modeling of pool recovery along a mountain channel after a reservoir sediment release." *Regulated Rivers Research and Management.* 17 (3): 251-273.

Redclift, Michael, and Graham Woodgate, eds. 1997. *The International Handbook of Environmental Sociology.* Cheltenham, UK: Edward Elgar Publishers.

Reisner, Marc. 1986. *Cadillac Desert: the American West and its Disappearing Water.* New York: Viking Penguin.

Samuelson, Paul A. 1947. *Foundations of Economic Analysis.* Cambridge, MA: Harvard University Press.

Sanjek, Roger, ed. 1990. "A Vocabulary for Fieldnotes." In *Fieldnotes: the Makings of Anthropology.* Ithaca: Cornell University Press.

Singleton, Sara and Michael Taylor. 1992. "Common Property, Collective Action and Community." *Journal of Theoretical Politics.* 4 (3): 309-324.

Spradley, James P. 1979. *The Ethnographic Interview.* New York: Holt, Rinehart and Winston.

Tang, Shui Yan. 1991. *Institutions and Collective Action: Self Governance in Irrigation.* San Francisco, CA: ICS Press.

The Nature Conservancy. 1959. *The Nature Conservancy: the First Ten Years.* London.

The Nature Conservancy. 1996. *Phantom Canyon Profile.* In house publication.

The Nature Conservancy 1999. Web site accessed 25 April 1999. http://www.tnc.org/.

Thorne, Barrie. 1980. "'You Still Takin' Notes?' Fieldwork and Problems of Informed Consent." *Social Problems.* 27: 284-297.

USGS (United States Geological Survey) 2000. Web site accessed 14 May, 2000. http://webserver.cr.usgs.gov/nawqa/splt/gis/retfig1.html

United States Interagency Task Force on Irrigation Efficiencies. 1979. *Irrigation Water Use and Management : an Interagency Task Force Report.* United States Department of the Interior. Washington: U.S. Government Printing Office.

Wall, Ellen, Gabriele Ferrazzi, and Frans Schryer. 1998. "Getting the Goods on Social Capital." *Rural Sociology.* 63 (4): 300-323.

Warner, Mildred. 1999. "Social capital construction and the role of the local state." *Rural Sociology.* 64: 373-393.

Wax, R. H. 1952. "Field Methods and Techniques: Reciprocity as a Field Technique." *Human Organization.* 11: 34-37.

Weeks, W. William. 1997. *Beyond the Ark: Tools for an Ecosystem Approach to Conservation.* Washington, DC: Island Press.

Weiss, Robert S. 1995. *Learning From Strangers: the Art and Method of Qualitative Interview Studies.* New York: The Free Press.

Western Water Policy Review Advisory Commission. June 1998. Commission chair: Denise Fort. *Water in the West: The Challenge for the Next Century.* Springfield, VA: National Technical Information Service.

Whyte, William Foote. 1982. In *Field Research: a Sourcebook and Field Manual.* Robert G. Burgess, ed. London: George Allen and Unwin.

Wilkins-Wells, John. 1997. *Mutual Irrigation Company and/or Irrigation District Case Study #1: Innovation with Non-governmental Resource Concerned Group Regarding In-stream Flow Protection.* Technical report; Fort Collins, Colorado: Colorado State University, Department of Sociology.

Worster, Donald. 1985. *Rivers of Empire: Water, Aridity and the Growth of the American West.* New York: Oxford University Press.

Zuellig, Robert E., Boris C. Kondratieff, and Howard A. Rhodes. 2001. "Benthos Recovery after an Episodic Sediment Release into a Colorado Rocky Mountain River, USA" Western North American Naturalist. In press.

APPENDIX

Interview Materials

Telephone Script

Letter of Introduction

Consent Form

Interview Guide

Telephone Script

My name is Annie Epperson and I am a student working with David Freeman in the department of sociology at Colorado State University.

I am very interested in water resources and have learned about the innovative arrangement with north Poudre irrigation company and the nature conservancy, about water in phantom canyon. I want to explore what makes arrangements like this work - particularly because they seem to strengthen local organizations and increase our ability to manage water in the landscape.

You were recommended to me as a thoughtful person with an understanding of the agreement and a perspective that could help my understanding.

Could I get together with you sometime in the next week or so?

Our conversation should not take more than an hour or so.

Thank you!

Letter of Introduction
Printed on CSU Letterhead

July 31 1999

Dear Participant:

I thank you for your participation in this study, which focuses on the Phantom Canyon agreement between North Poudre Irrigation Company and The Nature Conservancy. Your assistance will be most valuable in my gaining an understanding of how this agreement came to pass, and how it has been maintained over the years.

Your participation in this interview is completely voluntary, and you may discontinue participation at any time. Your name, identity, contact information, and all other information that could connect you to the study will be held in the strictest confidence. I will not attach your name to my notes, rather I will use a code that only I know. The data gathered will only be used in the aggregate, there-by further protecting your identity.

You may contact me at any time if you have questions, comments or concerns. I will be a student at CSU until I graduate in May, 2000. You may also contact my advisor, Dr. David Freeman, who is closely supervising my research. Contact information for both of us is printed at the bottom of this letter.

You are part of an historic agreement, a success story that may help guide other organizations like yours to similar achievement. Again, thank you for your cooperation.

Sincerely,

Annie Epperson

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Consent Form

COLORADO STATE UNIVERSITY
INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

Title: Preserving Wildlife Habitat While Continuing Commodities Production: Colorado's Phantom Canyon

Principal Investigator: Dr. David Freeman
Co-investigator: Annie Epperson
Contact for Questions and Concerns: David Freeman 970-491-3881
Sponsor: None

Purpose of the Research: To explore the origins and elements of the Phantom Canyon agreement between North Poudre Irrigation Company and The Nature Conservancy

Methods: Loosely structured interviews will be conducted with persons knowledgeable of the agreement. Handwritten notes will be taken.

Risks in the Procedures: There are no known risks to this activity. It is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks.

Benefits: An understanding of the agreement may allow for others to formulate similar pro-active conflict-reducing agreements in the future.

Confidentiality: Identities of participants will be concealed through the use of a code known only to the researcher. Reference to information gathered from participants will be made only in the aggregate. No names, positions, titles, or identifying information will be used in the final report.

Liability: The Colorado Government Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury. Questions about subject's rights may be directed to Celia S. Walker at 970-491-1563.

Participation: Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.
Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing one page.

Participant name (printed)_____Date_____

Participant signature _____Date_____

Annie Epperson (Co- Investigator)_____Date_____

Interview Guide

Phantom Canyon Agreement

3. First I would like to thank you for meeting with me, and taking your time to answer my questions. I assure you that anything you share with me in our conversation today will be held in strictest confidence, and that your identity will not be revealed in any future reference. This information will not be used to reveal your identity or embarrass you in any way.

4. Perhaps we could begin by your telling me something about your connection with the North Poudre Irrigation Company/Nature Conservancy.

    a. How did you come to [farm in Larimer County? Could you draw a map of your farm, the fields and crops, and let me see how the water reaches your crops?] work in conservation in Larimer County?
    b. Now can you tell me about your involvement with the North Poudre Irrigation Company/The Nature Conservancy and the agreement around Phantom Canyon?

5. Can you give me an overview of the history or organization of the agreement at Phantom Canyon -- how the agreement came to pass?
    a. About when was this? Do you recall who . . . ?
    b. I have heard it said that . . . .
    c. Were you involved in the drawing up of the contract, or have you ever seen it?

6. Key Variables
    a. What part of the NPIC/TNC is most involved in the agreement?
    b. Can you describe for me the responsibilities of the agreement for the NPIC/TNC? For example, how much water is involved, at what time, and so on?
    c. Who is giving and who is getting in this agreement? (When; How; Why)

7. When you think about the agreement:
    a. What are the costs, or risks, associated with the agreement for the NPIC/TNC?
    b. And what are the benefits of those costs?

8. How about for the Nature Conservancy/North Poudre Irrigation Company?
    a. What are their costs, or risks?
    b. And what benefits do they receive?

Interview Guide, continued

9. And now, I'll ask you to evaluate the agreement:
   a. What is working best, or is there a problem here? (Expand)
   b. What will be the biggest challenge in the next few years?
   c. What might be the key issues when it comes time for renegotiation?
   d. What might put the agreement in jeopardy, or the greatest danger, in that renegotiation?

10. Can you recommend who else I ought to see about this? Or, are there any documents that I ought to see?

11. Before we wind up our conversation, I have some very simple questions:
   a. May I re-contact you in the future for clarification of any points made here today?
   b. Would you like an executive summary of my paper?
   c. And, is there any thing else that you would like to tell me, or that we have missed in our discussion?