THE PAST, PRESENT AND FUTURE OF WATER POLICY IN THE SOUTH SASKATCHEWAN RIVER BASIN, ALBERTA, CANADA

by

Jeremy J. Schmidt
Department of Geography
McGill University, Montreal
August, 2007

A thesis submitted to the Faculty of Graduate Studies and Research, McGill University in partial fulfillment of the requirements for the degree of Master of Arts

Your file Votre référence
ISBN: 978-0-494-38467-1
Our file Notre référence
ISBN: 978-0-494-38467-1

ABSTRACT

This thesis presents an account of water policies in Alberta's South Saskatchewan River Basin in reference to the historical factors influencing past decisions, the claims supporting present reforms and implications for future policy directions. I begin by investigating the historical factors surrounding early water policies and consider their influence on water development in the 20th century. Next I critically examine the policy reforms from 1996-2006 and consider both how early policy decisions influence contemporary plans and the claims offered in support of current management decisions. I then look to the future of water policy in southern Alberta and the planned implementation of adaptive management systems. I analyze adaptive management theory in the policy context of Alberta and find the normative claims of adaptive management insufficient. I then suggest a more robust normative framework to supplement adaptive management theory.

RÉSUMÉ

Cette thèse présente un compte-rendu des politiques de gestion des eaux dans le bassin hydrographique sud de la rivière Saskatchewan en Alberta en référence à une suite de facteurs historiques affectant des décisions passées, des réclamations soutenant des réformes présentes, ainsi leurs implications en terme de future gestion des eaux. L'analyse commence par identifier les facteurs historiques entourant les débuts politiques en matière de gestion des eaux, avant d'examiner leurs développements au 20e siècle. J'examine ensuite des réformes politiques plus récentes, entre 1996-2006, et examine comment celles-ci jouent un rôle en justifiant des plans présents ainsi que certaines réclamations concernant la gestion des eaux. Finalement, un regard est porté sur le futur de gestion des eaux dans ce contexte, ainsi que sur le potentiel d'un système de gestion environnemental adaptatif. Une analyse plus profondie de la théorie de gestion adaptative suggère que les réclamations présentes sont insuffisantes. En contraste, j'offre ici un cadre normatif plus robuste afin de compléter la théorie de gestion adaptative.

ACKNOWLEDGMENTS

This work would not have been possible without the supervision and support of Dr. Peter G. Brown in McGill University's Department of Geography. I would like to thank Dr. Brown for the insightful comments he has made on my work and for the open and engaging atmosphere he has fostered during my graduate studies.

In addition to Dr. Brown's supervision, Dr. Karen Richardson and Dr. Donald Smith have provided valuable and instructive comments as members of my thesis committee and the time they have taken to further my academic pursuits is appreciated.

I am very thankful for the encouragement of my fiancé Rachel Harvey, who consistently offered both editorial and emotional support to me during my studies at McGill and during our time here in Montreal.

Many faculty and fellow students in the department of Geography at McGill University have provided helpful criticisms of this work during its progression. I am especially thankful to Peter Johnson, Gill Green and Dr. Garry Peterson for offering critiques of my ideas and presentations. The work of Maria Marcone deserves special attention as she was very helpful in guiding this work through the appropriate administrative channels. I would also like to thank Claire Tugault-Lafleur for translating the abstract.

Financial support was received from the Social Sciences and Humanities Research Council (SSHRC) from September 2005 to August 2006 (scholarship) and September 2006 to April 2007 (grant).

All defects in scholarship and style are my own.

TABLE OF CONTENTS

List of Abbreviations

AENV.....Alberta Environment
AIPA.....Alberta Irrigation Projects Association
BAC.....Basin Advisory Committee
FOR.....Friends of the Oldman River
IFN.....Instream Flow Need
IJC.....International Joint Commission
IO.....Instream Objective
MA.....Millennium Ecosystem Assessment
PFRA.....Prairie Farm Rehabilitation Administration
SORAC....Strategic Overview of Riparian and Aquatic Condition
SMRID.....St. Mary's River Irrigation District
SSRB.....South Saskatchewan River Basin
WCO.....Water Conservation Objective

List of Figures

List of Tables

TIMELINE: WATER AND POLICY IN THE SSRB

YEAR.....EVENT/LEGISLATIVE ACT

1857-59...Captain John Palliser's expedition

1879.....First irrigation in Alberta

1883.....Railroad complete across Alberta

1886-87....Drought followed by harsh winter

1894.....Northwest Irrigation Act

1905.....Alberta becomes a province of Canada

1909.....Boundary Waters Treaty with United States

1915.....Irrigation Districts Act

1930.....Alberta Natural Resources Act

1931.....Water Resources Act

1935.....Prairie Farm Rehabilitation Administration created

1968.....Irrigation Act

1986.....Construction of the Oldman River dam begins

1991.....Alberta Regulation 307/91

1996.....Water Act

2002.....Management plan for the SSRB: Phase I

2003.....Water for life: Alberta's strategy for sustainability

2006.....Approved management plan for the SSRB

Chapter One
Introduction

1.1 Overview

Meeting water demands in Alberta's South Saskatchewan River Basin (SSRB) has been a perennial problem since western settlement began in the 19th century. The region is semi-arid, winters can be harsh, and the annual variability in precipitation frequently humbles even the most adapted human and non-human inhabitants. Despite the obstacles, the region was settled on an agenda ensuring would-be settlers of sufficient water and land for a prosperous future. However, as settlement and development expanded throughout the 20th century, southern Alberta's limited water resources were subscribed far beyond sustainable limits.

A Malthusian collision between population increase and limited water resources seemed to be only a matter of time until sweeping changes were made to Albertan water policy during the ten year period from 1996-2006. The result of these changes has been new legislation, a provincial strategy for sustainable water use and a new management plan for the SSRB. This study investigates whether the changes will allow for successful navigation through southern Alberta's problems of over-allocation, ecological deterioration, decreasing water quality and warming climate. A careful assessment of the historical factors influencing policy decisions, the claims supporting current management plans and the future directions of water policy warrant serious caution. This thesis outlines why.

The remainder of chapter one is an introduction to the study itself. Chapter two considers the historical economy of water in the push for Canadian sovereignty over the west and the settlement of the SSRB. It ties the history of water policy decisions in the SSRB to the institutional developments of the 20th century that have rendered water increasingly scarce. Chapter three situates Alberta Environment's new management plan for the SSRB within the legislative framework in Alberta, the province's *Water for Life* strategy and the background studies that contributed to the development of the management plan. Chapter four is an analysis of the new management plan for the SSRB approved in two phases

in 2002 and 2006. Chapter five assesses Alberta's goal of implementing adaptive management strategies in the SSRB in the future. Chapter five concludes by suggesting how normative guidelines for water management in the SSRB may be of value both for preserving aquatic and riparian ecosystems and also for increasing the benefits of adaptive management techniques. The thesis concludes by summarizing the implications of my findings and outlines areas in which future research is needed.

1.2 THE SSRB

Further details on the SSRB are provided throughout the study but here a basic orientation is given to provide some of the key facts regarding the SSRB. The SSRB is a large watershed in southern Alberta draining 121 095 km^2 or 24.7% of Alberta through four large sub-basins. The Red Deer River comprises 41% of its total area, the Oldman 22%, the Bow 21%, and the South Saskatchewan 16% (see Figure 1.1). The combined runoff of the SSRB totals 9.28 million cubic decameters annually and includes 43.6% from the Bow basin, 38% from the Oldman, 17.9% from the Red Deer and 0.4% from the South Saskatchewan (AENV, 2003f).

The contribution of glacial melt to river runoff represents a small portion of total annual flow but in dry years can be up to 13% of the annual flow and 56% of the flow in August (Hopkinson & Young, 1998). The remainder of the runoff is generated by the large alpine snowpack accumulating each year in the Rocky Mountains to the west which accounts for 87% of average annual flow (Schindler, 2001). The climate of the SSRB is classified as semi-arid with potential evapotranspiration exceeding average annual precipitation (Schindler and Donahue, 2006).

The highly variable, and often sparse, rainfall in southern Alberta has made irrigation an attractive option in the agricultural sector. Two physical factors make irrigation in southern Alberta successful: First, Southern Alberta's irrigation water is extracted from surface waters generated by runoff from the Rocky Mountains which has relatively low salinity concentrations (Buckland et al.,

2002). Second, this good quality water allows irrigation to take place without contributing to soil salinization problems (Chang et al., 1985). The risk of soil salinization, a condition where salts accumulate on or near the surface of the soil and impede the normal growth and development of plants, has led to a risk index that classifies the different soils in the SSRB and estimates their susceptibility to salinization (see Eilers et al., 1997). Overall, the favorable conditions for irrigation farming in southern Alberta have resulted in a large irrigation industry and the SSRB currently houses 60% of Canada's irrigated land (Coote and Gregorich, 2000).

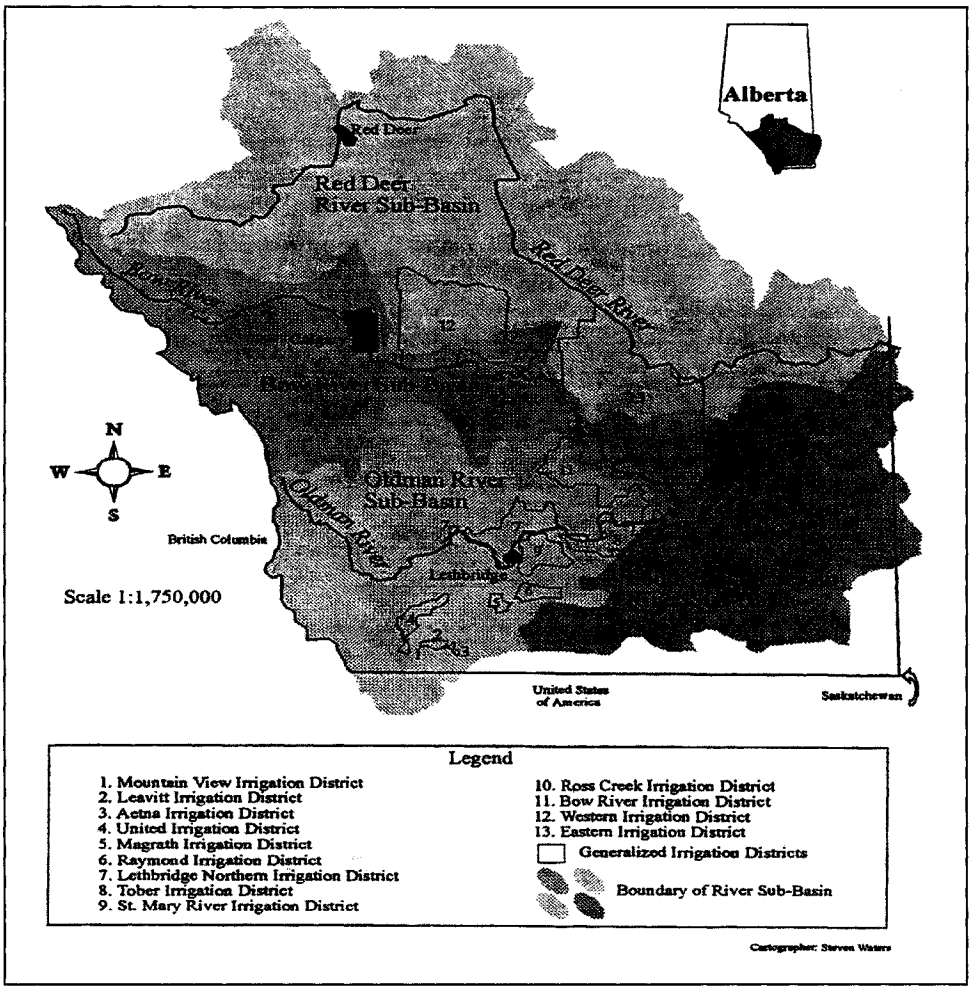

Figure 1.1 Alberta's South Saskatchewan River Basin. The four sub-basins and the title rivers of each are shown as well as the thirteen irrigation districts in the SSRB watershed (source: Horbyluk and Lo, 1998).

The population of the SSRB in 1996 was roughly 1.5 million, but due to unprecedented immigration the forecast for 2021 is a population of 2.1 million; by 2046 the population may be over 3.1 million (AENV, 2003b). In addition to the human population in the SSRB, approximately 2.9 million cattle, 900 000 hogs, 134 000 sheep and some 4.3 million chickens lived in the watershed as of 1996 (AENV, 2002d). Unmitigated agricultural growth has led to increased fecal matter and pesticide concentrations, especially during peak runoff events, in livestock intense regions of the SSRB such as the Oldman River Basin (Byrne et al., 2006). The over 400 000 ha of irrigated land in Alberta currently accounts for seventy five percent water use in the SSRB. The remaining twenty five percent is divided between municipal, commercial and other uses as shown in Figure 1.2.

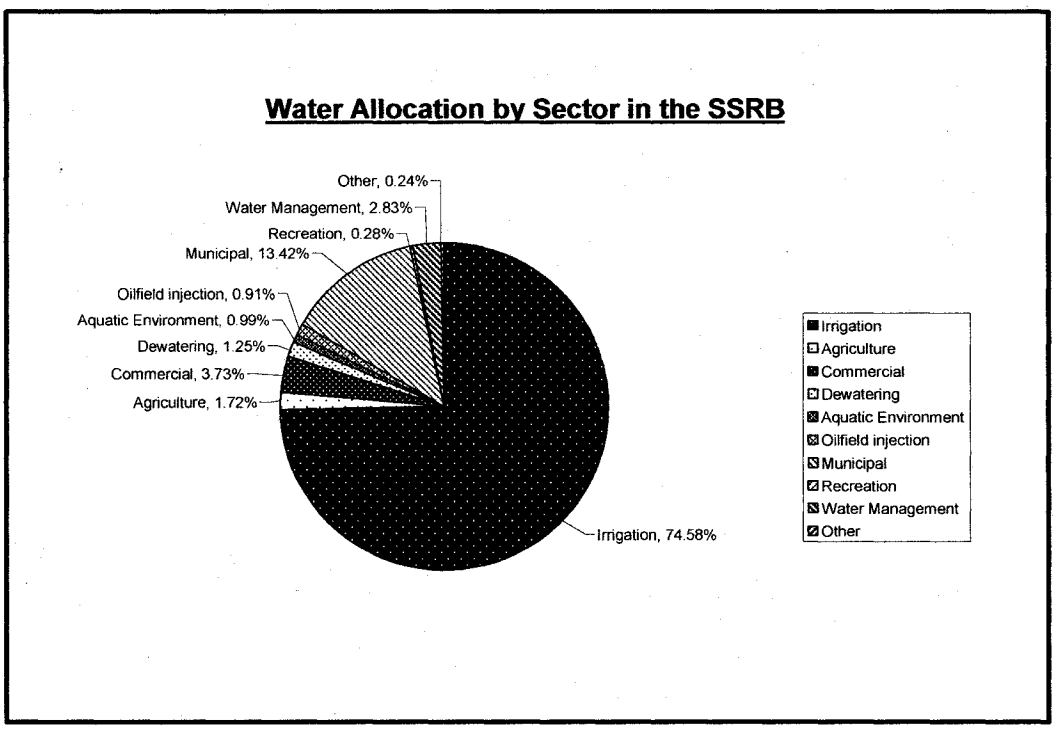

Figure 1.2: Water allocation by sector in the SSRB (adapted from AENV, 2005a). Note that "agricultural" uses are classified as non-irrigation and include activities like stock-watering.

Thirteen irrigation districts in the SSRB hold nearly all of the licenses for irrigation water. Under the *Irrigation District Act* of 1915, farmer owned irrigation development has resulted in thirteen cooperative irrigation projects (shown in Figure 1.1). Natural water supply has been increased through

infrastructure developments and dams exist on several rivers in the SSRB including the Bow, the Oldman and the St. Mary's River. The St. Mary's is the SSRB's only transboundary river. It originates in Glacier National Park, Montana and flows north into Canada where it contributes ten percent of the annual flow in the Oldman River. All of the water in the SSRB naturally flows east to Saskatchewan and under the 1969 *Master Agreement on Apportionment* Alberta is required to deliver at least half of that natural flow to the provincial border. The Master Agreement is also applicable to groundwater. However, water use in Alberta is overwhelmingly concentrated on surface water with groundwater accounting for only 3% of water withdrawals (AENV, 2005b).[1] Although the interprovincial and international contexts of water in the SSRB will be discussed where they bear on water policies in Alberta, this study is limited to an examination of water policies in Alberta.[2]

1.3 METHODS AND LIMITATIONS

This thesis uses case study research methods to examine water policy issues in the SSRB for two reasons. First, case studies allow for exploration into water policy through a variety of data collection methods (Orum et al., 1991; Meyer, 2001). Second, case studies are a valuable tool when there is no clear distinction between what gives rise to a phenomenon (i.e. water scarcity) and the context in which that phenomenon arises (Yin, 1993). By creating spatial and temporal boundaries appropriate to the problem of interest, case studies allow for discrimination between phenomenon and context (Cresswell, 1998). Qualitative research often makes use of case studies to explain why actors within the case behave the way they do and to understand what factors produce change (Bradshaw & Elaine, 2005). Accordingly, this project attempts to show how various factors converge within the context of the SSRB, their influence on

---

[1] It is important to note that in the future groundwater withdrawals may become a larger policy issue in Alberta. These withdrawals would be subject to the 1996 *Water Act* and the 2003 "Water for Life" strategy where applicable.

[2] Information on the differences and similarities between Alberta and other jurisdictions in Canada and the United States can be found in Percy (2005), Boyd (2002), Bakker (2007) and Dworsky and Utton (1993).

dilemmas regarding water and the policies that result. The remainder of the methods section provides a synopsis of the materials and approaches used in each chapter of the thesis are designed to explain developments in water policies for the SSRB.

Chapter two traces the development of western settlement and the effects of political agendas on the water resources in the SSRB. Given this research position, a broad range of sources were consulted regarding activities that affected the development of early water policies. Numerous secondary historical sources were consulted and, in some instances, primary documents were used as well such land-grant advertisements from the National Archives of Canada. This approach carries the defect of excluding research into activities that, as reflected in the primary and secondary sources consulted, were not clearly associated with water. For instance, the effects of coal mining in Lethbridge, Alberta are not clearly associated with their effects on water or policy in the historic record, but the railroad brought in to allow for coal and agricultural products to reach eastern markets is. By focusing case study research this way, one gets a clear picture of water-related issues, but this does not give an extensive treatment of the history in the SSRB. This is a noted limitation to the study and a valid caveat to the entire project given its stated preoccupation with water policies. It is also important to note the general exclusion of other natural resource policies in the analysis. This is reflective of the general lack of integration of water policies with other natural resource policies such as agriculture, forestry and mining in Canada at large (see Boyd, 2003).

Chapter three concentrates on presenting the current aspects of water policy in Alberta. It targets three main developments. The first is new government *legislation*, the second is Alberta's provincial *strategy* for sustainable water use and the third is the development of water *management* plans for the SSRB. There is a case to be made that in each of the three areas significant insight into water policy could be gained if one were to concentrate on the processes and negotiations in each of the legislative, strategic and managerial developments. However, this study looks only at the processes involved with the management

plans for the SSRB. This decision was made for two reasons. First, the SSRB management plans have been designed by the Alberta Government as open-ended documents subject to revision and addition as seen fit. As a result, a study of recent managerial developments is necessarily procedural. Second, the legislative and strategic developments in Alberta, although certainly open to amendment, are finalized documents. So although the procedural aspects of their development pose interesting problems, the chief concern of this research is how their final assembly bears on water use decisions in current management planning.

Chapter four presents an analysis of the two-phase management plans approved for the SSRB in 2002 and 2006. Here the specific constraints of both historic developments from chapter two and policy reforms from chapter three are analyzed. The analysis distinguishes between environmental, economic and social factors following the general rubric of Falkenmark and Rockström (2004), the Millennium Ecosystem Assessment (2005), and Pigram (2006). Accordingly, Alberta's water policies are examined given the sources and accuracy of data relevant to the modeling of future water supply and demand scenarios (environment), the effectiveness of market instruments (economic) and the decision to scale planning decisions to the SSRB watershed (social). The social aspect is the least straightforward portion of the analysis and, in this respect I concentrate on assessing how social considerations such as public consultations and political jurisdictions may affect the effectiveness of water policy in the SSRB. The analysis focuses on a comparison between the data used to guide decision-making and the data available in academic literature.

Chapter five looks critically at the future of water policy in Alberta's SSRB. In this respect, it does undertake an analysis of the future processes that Alberta's legislative regime, its Water for Life strategy and the management plans for the SSRB may undergo. This aspect of the case study is more philosophically oriented in the sense that it attempts to shed light on the assumptions in both early policy decisions and the more recent reforms that are relevant to future planning activities. The sources for this chapter draw on the adaptive management

literature as Alberta's provincial water strategy indicates this is the policy direction Alberta will take in the future (AENV, 2003a).

There are several challenges to case study research that require mentioning. The first is a general claim in the literature that case studies provide insight into the causal relationships that lead to a certain phenomenon, such as a water crisis. However, several authors (Massey, 1999; Harvey, 1996; J. Brown, 2004) argue that the spatial and temporal boundaries used to delimit case studies influence what factors appear as either causes or effects. This leads to a second difficulty because it implies that relationships identified in case study research are constructed and not simply mirrored facts about an external reality (Castree, 2003). Further, in some cases boundaries may reveal multiple causal relationships so complicated that identifying causes from effects is virtually impossible (Raper and Livingstone, 2001). Policy discourse is a good example because words like "sustainability" are frequently and inconsistently used during policy making (Rydin, 2005). These three difficulties all rely on philosophical critiques of realism (the idea that there are objective facts in the world) and an appeal to social constructionism as an explanation for how spatial and temporal boundaries cause phenomenon at various scales to emerge (see also Marston, 2000).

In this case study I do not attempt to draw direct causal links due to the narrow scope of the project. As a result, the philosophical criticisms leveled at case study research can be handled by recognizing that the findings of this thesis are not necessarily transferable to other regions, even those experiencing similar water related problems. The links that I draw are analytical and rely on attempting to understand the historical factors influencing early water policies and the place of these policies in contemporary reforms. Further treatment is given in the literature review, specifically in section 1.5.2.

1.4 Objectives

This thesis has three main objectives in examining water policy in Alberta's SSRB. The first is to identify the historical factors that influenced initial

policy decisions affecting water in southern Alberta. The second is to attempt to link the influence of these historical factors to contemporary policy in a manner suggestive of how contemporary policies may be improved. The third is to assess how the combination of historical policy influences and contemporary policy decisions may influence future policy directions in southern Alberta. To accomplish these three objectives this study engages in the historic, analytic and philosophic work necessary for improving Albertan water policy. As the study progresses, it thereby attempts to provide a coherent picture of the past, present and future of water policy in Alberta's South Saskatchewan River Basin.

1.5 LITERATURE REVIEW

The trajectory of this thesis considers the past, present and future of water policy in Alberta. In keeping with this structure, the literature review begins by presenting an account of why historical factors are influential in water policy decisions. It then considers the relevance of policy studies for addressing present concerns. The literature review concludes by outlining how previous geographic work in policy analysis finds its place in a broader tradition of water policy discussions regarding the future.

1.5.1 Policy Past: The importance of history in water policy

Policy decisions create institutional paths that affect future decision makers. Sociologists refer to this phenomenon as 'path dependence'. Path dependence constrains decision makers because the costs of pursuing different policy options are relative to the existing institutions and not purely a matter of choosing the best, or most efficient solutions (Mahoney, 2000). Unfortunately, many of the existing institutional frameworks for water policy began by assuming that the basis for water policy was primarily to enable development. In general, enabling development has meant increasing infrastructure such as dams and irrigation works to increase water supply (Pigram, 2006).

Institutional paths in water management are created through policies reflecting the mutual conditioning of social, economic and ideological factors that

are favorable to development (Hassan, 2003). In the southwestern United States, for example, the push to settle the west was driven by the potential for social and economic prosperity and an ideology legitimizing the harnessing of water to secure those ends (Reisner, 1993). The optimism associated with continued development of water supplies, however, is waning. Postel (1997) argues that policies promoting water supply increases through infrastructure development will not only be unsuccessful because of natural factors, but also because they promote a misguided normative framework legitimizing the ideology underlying such policies. More recently, Marq de Villiers (2003) has argued that continued development of water supplies has often led to unforeseen environmental consequences that, in turn, have actually reduced supply.

The alternative to increasing water supplies through policies that promote development is to reduce demand through water policies that promote efficiency (Postel, 2000). The institutional paths created in such cases are considered 'soft' and contrast with 'hard' paths that incur high demands for infrastructure that increases water supply (Gleick, 2002). Given the history of water policy decisions, however, the transition from hard to soft paths is complex because it requires reconditioning the social, economic and ideological relationships forged historically. There are several policy options that reorient supply and demand relationships with water. These options generalize into command and control and collaborative approaches.

Command and control governance operates by establishing regulations and enforcing compliance (Kahn, 1998). Water policies derived under these types of strategies have not fared well historically because they tend to effectively regulate large scale projects but fail to capture the cumulative effects of small scale actors (Schlager, 2004). By contrast, collaborative governance strategies operate through the devolution of control from state bureaucracy to local stakeholders. Management approaches such as Integrated Water Resources Management (IWRM) and Adaptive Management are examples of governance approaches that aim at increasing water use options without focusing on increases in supply.

Although command and control strategies and collaborative governance approaches differ operationally both operate on the acceptance of some measure of natural capacity. In Canada, numerous jurisdictions measure natural capacity using the watershed as the appropriate geographic scale for governance (Senecal and Madramootoo, 2005). The watershed is an effective scale for measuring the natural capacity of water resources for two reasons. First, watershed management uses the natural boundaries of hydrologic processes to define the area included in estimating water resource availability. Second, the available water resources within the watershed limit ecologic and social processes dependent on water (Wallace *et al.*, 2003).

Despite the advantages of watershed management it remains difficult to transition out of historically contingent yet environmentally detrimental institutional paths. This is the case because it is difficult to ascertain, and to prove, which water problems are causally linked to previous policy decisions and not to other historically relevant events such as war, drought, or pestilence. A potential way out of this milieu is to use history itself to frame water policy decisions. Priscoli (2000) convincingly argues that, in contrast to arguing about historical contingencies, history can be used to provide a sense of realism that identifies how previous policy assumptions failed to map on to ecological and social constraints. The result of consulting traditional policy decisions, suggests Priscoli (2000), is the construction of a normative frame of reference to guide future policy decisions with a sense of ecological realism. That is, ecological reality operates to inform how future water policy decisions should be made. The influence of traditional knowledge as a guide for justifying how future water use decisions should take place finds strong empirical support (Trawick, 2001; Ohlsson *et al.*, 2004) and could benefit water governance in Alberta; Especially in assessing and adjusting to new environmental and social conditions.

To conclude, Alberta's history can be characterized, as is shown in chapter two, as a command and control approach to policy. However, Alberta has recently developed plans to adopt adaptive management systems by the period 2010-2014 (AENV, 2003a). Adaptive management emerged in the late 1970s as a framework

emphasizing that natural systems are characterized by change and do not, as previously assumed, gravitate towards stable equilibrium (Holling, 1978). It emphasizes an experimental approach to policy making and more frequent revisions to environmental planning based on the results of experimentation (Walters, 1986). A more thorough introduction and review is given in chapter five of the implications that adaptive management has for arranging pragmatic concessions between Alberta's institutional paths and concerns regarding ecological reality.

1.5.2 Policy present: Expected results from geography

Approaches to policy studies in geography are divided. One approach suggests that the primary purpose of policy studies is to reflect, or mirror, empirical facts to policy makers (Markusen, 2003). A second approach is critical of realist assumptions and bases policy studies on an iterative process where what counts as a "fact" is constructed and conditioned through various layers of use and meaning associated with words like "sustainability" (Rydin, 2005). Without exacerbating the disciplinary arguments over these issues noted by others (Hoggart, 1997), some telling insights have come out of these discussions. The insights relevant to this study reflect on the relationship between policy decisions and environmental impacts both causally and at different scales.

Martin (2001) argues that policy analysis requires attention to both the methodology and quality of evidence if findings are to be relevant. To be relevant, in this sense, is to demonstrate where socioeconomic welfare can be improved by directing policy initiatives towards alleviating negative causal factors. In the following analysis of Alberta's water policy, Martin's (2001) suggestion is taken seriously and empirical evidence from a variety of sources is used to draw attention to how environmental indicators could improve policy.

Geographers such as Massey (1999) and Raper and Livingstone (2001) are quick to point out that identifying clear causal links depends largely on the scale used in analysis. The effects of scale on causal relationships involves policy research in a process of constructing the "facts" that are then reported to policy

makers (Castree, 2003). As a result, policy relevance turns on identifying policy options at a scale that is congruent with policy decisions (Marston, 2000). In the case of environmental policy, the construction of scale carries relevant consequences for marshalling empirical facts either for or against policy decisions (Jones, 2002). Similarly, this study shows how the scale at which empirical facts are applied to policy decisions has been, and continues to be, a central problem to resolving water management issues in southern Alberta.

1.5.3 Policy future: Law, society and the environment

Geographers have been investigating how environmental factors affect resource use since at least the early 1930's (Hartshorne, 1964). More recently, geographers have focused on the fit between law, society and the environment in order to understand how that relationship is changing. There has also been an increasing focus on how historical conceptions of morality and social justice have a practical influence on policy decisions (Kobayashi & Proctor, 2003).

Research into legal geography has been especially critical of how property rights conceptualize the environment as "territory." Territory, in this sense, refers to the division of a continuous landscape into discrete units whose boundaries form the basis for establishing property claims (Ford, 2003). Territorial conceptualizations of the natural world can be detrimental to understanding that the law works within an environmental framework and not in an environmentally abstract context (Sax, 2003). For instance, property surveys and entitlement claims in Canada have traditionally been made based on land surveys (Blomley, 2003). However, this has created a special set of problems because water transgresses conventional boundaries of property law, in Alberta and elsewhere, that work primarily on establishing relationships to land not water (Percy, 1977).

The relationship between owner and property was one of the targets in Aldo Leopold's (1966) arguments for a "land ethic" where he argues that relationships between owners and property should respect the integrity of ecological systems. By turning attention towards how property claims affect aquatic systems, Butler (1986; 2000) highlights how normative assumptions in

legal precedent may not protect aquatic ecosystems when water is extricated from natural cycles. Canada's legal system has been criticized at large for its failure to adequately protect water resources (Boyd, 2003). Alberta is not exempt from these criticisms as legal publications reveal several deficits regarding environmental protection and stewardship of the public interest (Wenig, 2005; 2006). Investigations into water policy decisions in southern Alberta therefore benefit from taking into consideration the conceptual, normative and legal premises that have shaped behaviors towards water in the past and their implications for the future.

1.6 *A NOTE ON SCARCITY*

One of the assumptions of this thesis that needs clarification is that water problems in the SSRB arise because water is scarce. Technical definitions of water scarcity, such as Falkenmark et al. (1989), reflect ratios between the amount of renewable water and the human population. However, purely technical calculations do not account for the relative nature of water demands or pollution caused by water use. For instance, Postel (1997, 2000) emphasize the demands on water relative to different patterns of production and consumption, which themselves are driven by social and physical factors. Similarly, Wolfe and Brooks (2003) hold that scarcity includes at least three factors including biophysical water availability, socioeconomic distribution mechanism and the values guiding decision makers.

It is important to recognize that standardized measures of water scarcity often harbor problematic assumptions by simplifying complex processes into basic metrics. Molle and Mollinga (2003) cite no fewer than 25 possible categories for handling scarcity conditions arising from different combinations of water use (drinking water, environmental needs, etc.) and water limits (i.e. physical scarcity, scarcity from mismanagement, etc.). They also outline how standardized scarcity metrics carry conceptual deficits in what indices are used for data collection and the arbitrary nature of the weights given to these indices (Molle and Mollinga, 2003). For instance, Canada's Policy Research Initiative

(2007) recently released their report outlining the Canadian Sustainable Water Index (CWSI). The report details 15 indices that are grouped into 5 categories and averaged to produce an overall ranking but does not clearly identify why averaging water quantity or quality alongside, for instance, the number of days water service is disrupted, is justified.

One alternative to these measures is to estimate water stress based on watershed capacity as per the Organization for Economic and Co-operative Development (OECD). This measure provides the ratio of surface freshwater intake to actual streamflow or renewable groundwater and considers high water stress to take place in any watershed "in which greater than 40% of the available renewable water within the watershed is used by humanity for industrial, agricultural or personal uses" (http://www.ec.gc.ca/water/en/manage/use/e_ratio.htm). According to this measure, Environment Canada estimates the South Saskatchewan River Basin is experiencing "high water stress" and is the only region in Canada where human withdrawals exceed the OECD standards requiring at least 60% of the natural flow remain for ecosystem functioning.

It should be noted, however, that even this measure does not include water quality and insufficiently recognizes how different ecosystems respond to different levels of water availability. It is also focused on "gross abstractions," or total withdrawals, as a measure of water use "intensity" and does not clearly indicate whether return flows are included in its definition (see OECD, 2004). Despite these shortcomings, the OECD framework has the benefit of including humans and ecosystems in a shared framework and avoiding the basic anthropocentric bias of metrics that do not. Moreover, studies show that in the SSRB 85% of natural stream flow is required for healthy ecosystem functioning which is considerably above the OECD standard of 60% (AENV, 2003d).

To clarify, when the term "scarcity" is used in this thesis it should be understood within the context of the discussion at hand. In chapter two the discussion of scarcity reflects policy concerns related to a lack of water for development while in chapters three and four scarcity relates to the limited water available for both human developments and watershed capacity.

Chapter Two

The Past: Water, Sovereignty and Settlement

2.1 INTRODUCTION

Water on the Great Plains of North America – the area stretching west from the 100th meridian to the Rocky Mountains – has historically been shrouded in as much myth as fact (Schama, 1995). Scientific theories regarding the water cycle remained tightly wed with natural theology well into the 19th century (Tuan, 1968). And where religion failed, technology succeeded. "Rain follows the plough" was not only a slogan for encouraging cultivation in the hopes of increased rainfall on the parched prairies, it was gospel truth until severe droughts hit in the 1880s (Kevles, 1999). By that time, however, relatively high rainfall and expansionist national policies in both Canada and the United States had created increased demands for water, particularly in a region just east of the Rocky Mountains known today as the South Saskatchewan River Basin (SSRB).

The history of water policy in the SSRB, which lies predominantly in Canadian territory, reveals several political memes that persist into the present. This chapter shows how the political decisions made just over a century ago have created a cycle of water scarcity in the SSRB that rests on the political dogmas of sovereignty and settlement. The cycle, illustrated in Figure 2.1, arose as the government began exercising sovereignty over water by allocating it to incoming settlers. This created an increase in water demand that was met by increases in water supply. As was often the case, increases in supply exceeded existing demand for water and this, in turn, allowed for further allocation of water thereby increasing water demand in the long term.

This chapter discusses the three key factors that drive this cycle. The first was the acquisition of control over water by the Canadian and Albertan governments. This control made possible the second factor, a union between water and development that increased water demand. And finally, increases in demand created water shortages that were met through investments in water infrastructure. As this cycle played out in the 20th century, it created a unique set

of problems for policy makers that are critical to understanding later policy developments in the SSRB.

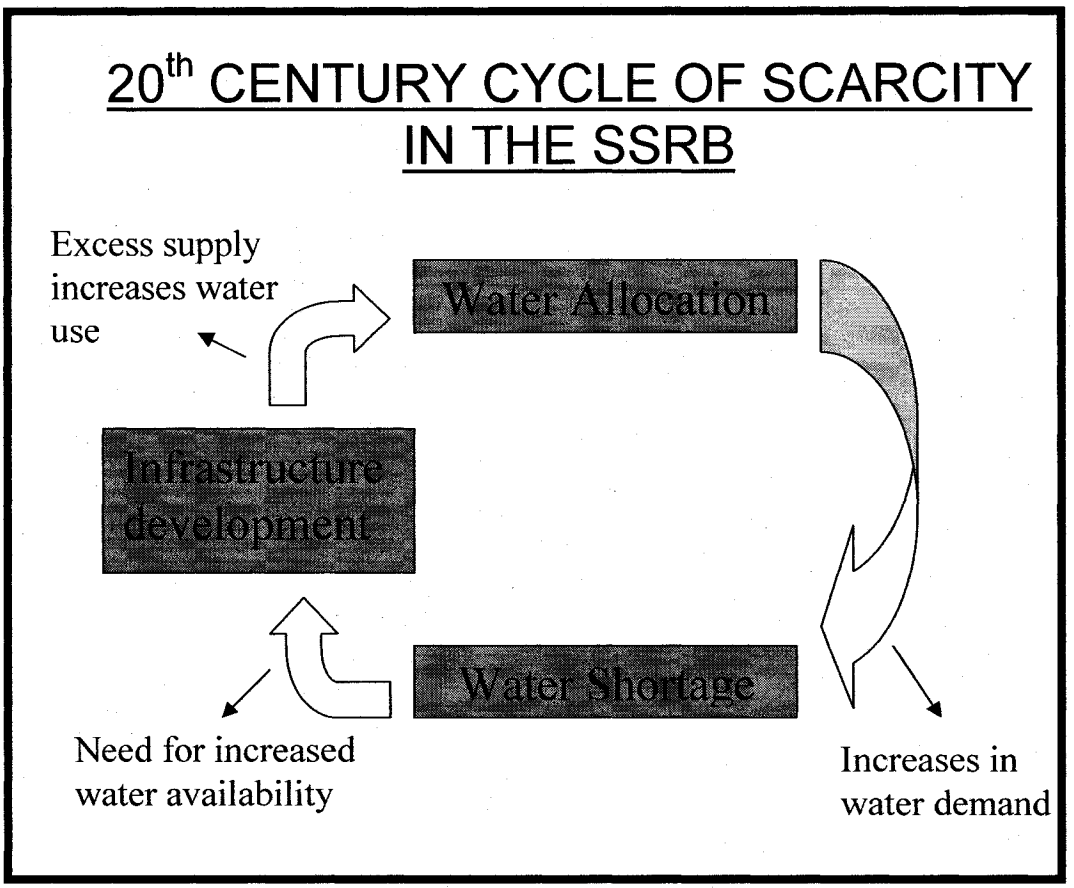

Figure 2.1: 20th century cycle of scarcity in the SSRB. A conceptual schematic of the cycle driving water scarcity in the SSRB during the era of supply-side water development and infrastructure building.

2.2 SOVEREIGNTY AND SETTLEMENT

The agendas of sovereignty and settlement presented complimentary objectives for the Canadian government in the 19th century. As Evan's (1975) notes, Canadian sovereignty was secured largely by inundating the west with Canadian settlers who served the "purposes of the Dominion" by establishing Canada's claim to western territory. In meeting the agendas of sovereignty and settlement however, decision-makers treated water resources largely *ad hoc* and this is demonstrated in the historical record. This section outlines the developments prior to the creation of water policies in Western Canada and the

SSRB. It establishes how water polices were created to meet specific conditions that had arisen prior to any official attempts to integrate concerns regarding water with other activities, most notably ranching, in the SSRB.

2.2.1 European settlement: The SSRB until 1886-87

The establishment of the Canadian territory was largely accomplished by the exploratory survey of John Palliser's expedition for the British crown from 1857-1859 (Spry, 1963). Palliser himself saw little potential in the southern latitudes of present day Manitoba, Saskatchewan and Alberta. In his report he referred to them as a nondescript wasteland of "level, sandy, arid plain" comprising the "least valuable portion of the prairie country" (Palliser, 1860). In fact, the region is still known colloquially as "The Palliser Triangle" in recognition of its dry climate (see Figure 2.2).

Despite Palliser's initial assessment, the Federal Government of Canada encouraged settlement of the SSRB. The success of settlement efforts coincided, in the years between 1860 and 1886-87, with a period of relatively high rainfall. Between 1881-1886 large scale ranching began in the SSRB and the number of cattle rose from fewer than ten thousand to over one hundred thousand, largely as the result of American interests moving north (Evans, 1975). Abundant rainfall allowed ranchers and settlers to rely on the long prairie grasses of summer to sustain cattle, livestock and wildlife during the winter. It is not uncommon for the region to experience warm west winds, known as "chinooks," that evaporate snow cover and expose fodder for animals during the winter.[3] Along with favorable climatic conditions, the success of cattle ranching in southern Alberta was due to the fact that the Canadian government offered very favorable lease conditions to land. The enticement of cheap land with few competing interests led to large leases being taken out by ranching operations. As the government did put a limit

[3] Chinooks occur as moist air masses rise (and cool) at the wet adiabatic lapse rate on the western side of the Rocky Mountains, precipitate at altitude, then descend (and warm) at the dry adiabatic lapse rate on the eastern side. The result is a very warm air mass descending on the southern prairies.

on the total amount of leased land, ranchers were active in making "speculative" lease agreements to lands that they planned to lease a later date (Potyondi, 1992).

The harsh, semi-arid conditions documented by Palliser returned in 1886-87, but by this time the SSRB had become home to numerous large ranching operations and small settlements whose survival that year was tenuous (Breen, 1983). Preceded by a summer of drought, the winter of 1886-87 had unusually high snowfall with very few Chinooks and below average temperatures. The results for local ranchers were devastating; cattle, literally frozen in the snow, and herd losses ranging from 25-60 percent (Potyondi, 1992). This catastrophic event was a turning point in the history of water use in the SSRB because it created an increased interest in irrigating land to secure hay for feeding livestock in the winter. But it was also important in another sense because it occurred just three years after the transcontinental railroad had crossed Alberta in 1883.

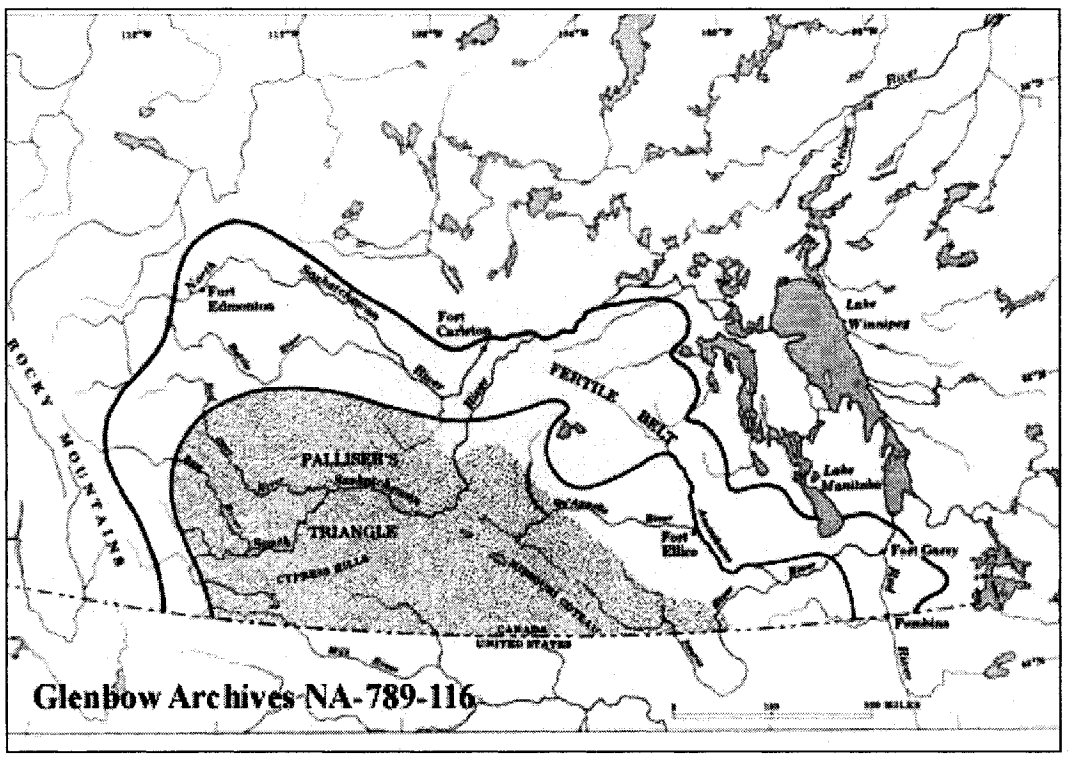

Figure 2.2: Palliser's Triangle. The "Palliser Triangle" comprises the semi-arid plains identified by John Palliser as unsuitable for settlement yet bordered by a potentially prosperous belt of loamy soil and reliable precipitation to the north. Source: Glenbow Archives, Calgary NA-789-116.

2.2.2 The transcontinental railroad

The development of the transcontinental railroad across southern Alberta was key to meeting the double objective of sovereignty and settlement. These agendas combined to put new pressures on the naturally available water in the SSRB and the result was an institutional path where it was necessary to both control water and guarantee it to settlers if the western development project was to continue.

To secure Canadian sovereignty over the western prairies, large federal land grants were given to railroad companies who were enticed to lay tracks towards land that, once accessible, they could turn a profit on through sale to settlers (Hedges, 1971). An original syndicate of railway barons was granted twenty five million dollars and twenty five million acres[4] of land to develop the Canadian rail system. This syndicate was initially headed by J.J. Hill, an American who intended to route the transcontinental railway through his existing lines in the western United States and to further develop his own rail line through Montana and up into southern Alberta (Wolfe, 1992).

When Hill's plans were exposed he was forced out of the Canadian railway syndicate by Sir John A. MacDonald and William Cornelius Van Horne, then General Manager of the Canadian Pacific Railway. In the interests of Canadian sovereignty, Van Horne's "single consideration in making the decision to build in the south [of the prairies] was his determination to stop Hill from gaining a foothold north of the 49th parallel" (Mitchner, 1971 p. 9). It is thus more than a historic footnote that Canada's transcontinental railway pushed across the dry southern prairies rather than coursing north along the North Saskatchewan River towards present day Edmonton where both trading and agriculture were more promising (along the "fertile belt" in Figure 2.2). Rather, it was a deliberate act to secure Canadian sovereignty against American interests and one that was made with little regard for the limits to water in the SSRB.

With railroad development concentrating in Alberta's south, and to encourage settlement in general, the federal government downplayed the need for

[4] 25 000 000 acres is equal to 10 117 141 hectares.

irrigation in the region. The government's official position was a refusal to acknowledge the issue on the orders of conservative Canadian Prime Minister Sir John A. MacDonald. The refusal assuaged large cattle ranchers who leased government lands and were wary of settlers infringing on "their" land. Coincidentally, the political support of western ranchers had been instrumental in the Conservative party's victorious election in 1878 (Graybill, 2005). As the railroad pushed west in the early 1880's however, the government was compelled to renegotiate lease agreements with ranchers in order to ensure the lands promised to the rail syndicate would be available for incoming settlers. The relationship between the railroad and population growth can be seen in Figure 2.3.

2.2.3 Allocating a scarce resource

When understood together, the drought of 1886-87 and the large influx of settlers combined to put pressure on the limited water resources of the SSRB. On the one hand, ranchers were concerned that as land was granted to settle commitments to the railroad that they would see large reductions in their lease lands. Once the railroad companies sold their land grants to settlers, the ranchers were also concerned about limited access to water as the amount of private property increased. To insure themselves against this scenario, ranchers immediately sought, and obtained in 1886, federal legislation creating "water reserves" that protected traditional watering holes for cattle. On the other hand, the political power exercised by large ranchers was increasingly threatened by the onslaught of immigrant settlers who sought support from Ottawa in wresting land from leases held by cattlemen (Potyondi, 1992). The failure of the federal government to act on the demands of the settlers led to open rebellion in 1895.

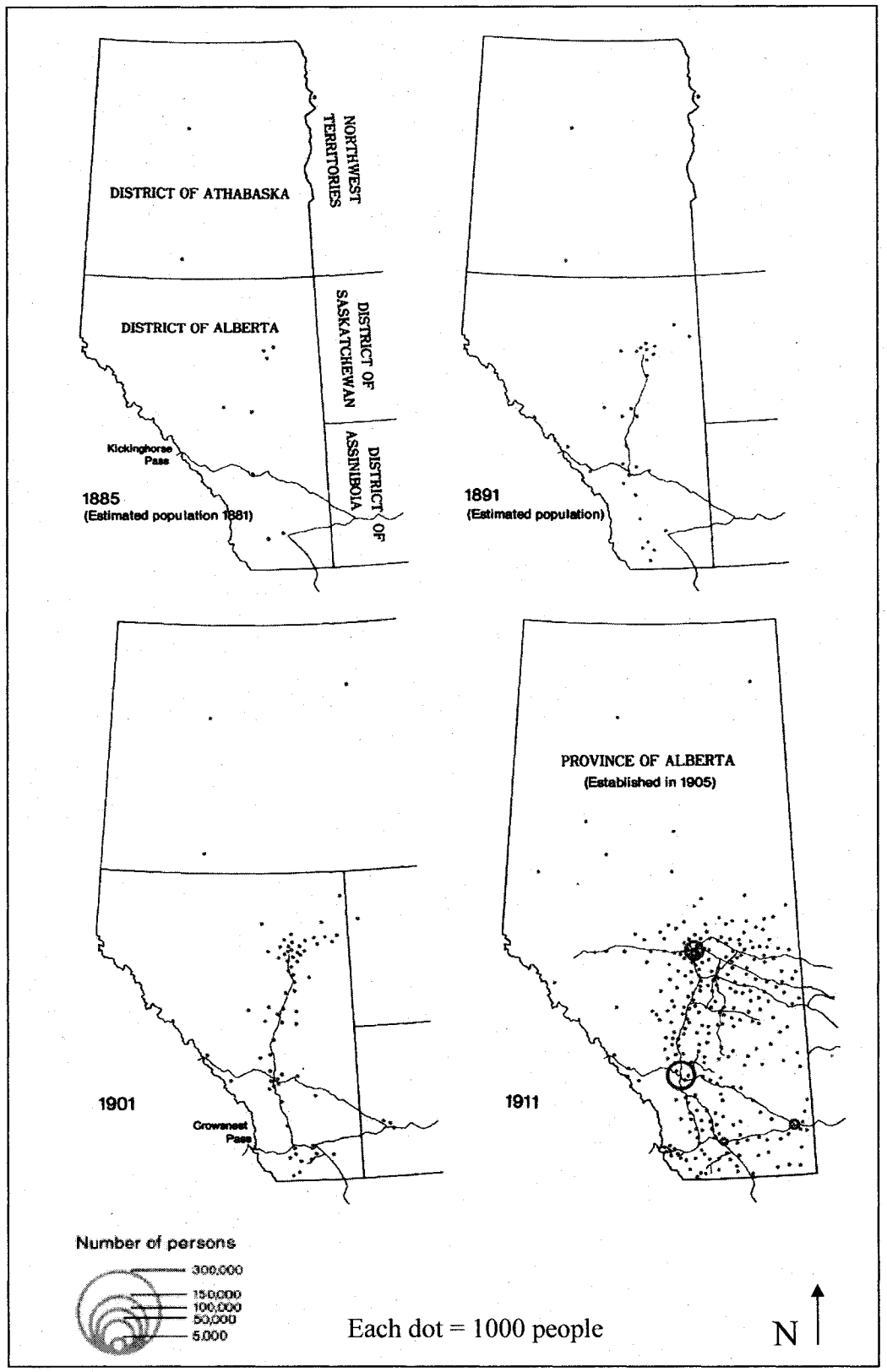

Figure 2.3: Railroad development and population in Alberta 1885 to 1911. Source: Atlas of Alberta (http://railways-atlas.tapor.ualberta.ca/cocoon/atlas/).

To quell the uprising in the SSRB, the Canadian government cancelled the speculative lease agreements of cattlemen and this substantially increased the amount of land available for settlement. Ottawa's decision appeased the settlers and, because it only concerned speculative leases and left the ranchers existing lease claims intact, did not affect existing cattle operations (Potyondi, 1992). The increases in lands available for settlement and the push for control over land, however, increased pressure on water (Evans, 1975).

As conflicts in the SSRB became apparent, there was a realization that if the push to settle the western Prairies and to protect Canada's territories from American interests was to continue, it would need a new foundation: irrigation. Irrigation would enable ranchers to secure enough summer forage for wintering livestock and increase the amount of arable land for settlers. All that was required for irrigation was to put the water flowing idly by in the rivers of the SSRB to use. And when irrigation for hay production began on a large scale after the winter of 1886-87 the chief federal agent in Canada's Northwest Territories, William Pearce, began urging the federal government to enact legislation that would structure water allocation (Wolfe, 1992).

Federal legislation for allocating water required recognizing that there was a "problem" with water in the SSRB, and on the southern prairies in general, and defining this problem required political tact. Having denied that there was a paucity of water in the region the government now had to secure water for settlers who had headed west as well as to those it still hoped would do so. At the same time, the government needed to respect its existing agreements with ranching interests in the SSRB. The solution to this problem came largely from William Pearce whose knowledge of irrigation, water management, and the context of the SSRB combined to put water to new and beneficial uses under a legislative regime.

Pearce's influence is immense and his definition and solution to the problem of securing water in the SSRB remains firmly entrenched in water policy to this day. Before entering in on Pearce's formulation of water policy for the entire Northwest Territory it is important to understand the factors that influenced

Pearce and his belief in the potential for developing water. For one, Pearce thought that economic prosperity in the Northwest Territories turned on irrigation and he, "felt certain that the settlers would not permit the surplus of water to reach the oceans unused once they were aware of the benefits of water diversion" (Mitchner, 1971, p. 208). In Pearce's view, the benefits of irrigation for ranchers and settlers would provide increased profits while shared water licensing procedures through adequate legislation could avoid conflicts over water in the future.

The existing land claims and economic activity in the SSRB, and in the Canadian west more generally, were important factors in the development of water policies in the late 19th century. William Pearce was very aware of the context in which water policies would be implemented and, in this respect, looked to regions in the United States where conditions were similar as a means to developing adequate policies for Canada. To accomplish this task, Pearce worked together with J.S. Dennis, another federal agent in the Canadian government. And, while Pearce began drafting legislation in 1892, Dennis traveled throughout the dry regions of Utah where he observed the American experiences with irrigation and water management (Percy, 2005). Mormon irrigation activity was a significant part of the American experience and Major John Wesley Powell, former head of the US Geological Survey, was also influential in the development of American water policy. Mormon irrigation experiences and the ideas of Powell influenced William Pearce and J.S. Dennis and it is important to understand the role of each in the development of water policies in the SSRB.

2.3 MORMONS AND MANAGEMENT

Canadian water policy in the west, and its western settlement policy in general, were influenced by the American settlement experience. Historians often note that law preceded settlement in Canada while in America the opposite was true (Hedges, 1971). And William Pearce's beliefs on how to effectively allocate and divert water were similarly influenced through observing the American experience and a desire to avoid the pitfalls he saw south of the 49th parallel.

These pitfalls included: no official administration in place to limit water allocation and water rights based on prior use that tended to decrease efficiency by encouraging people to claim more water than was needed (Wolfe, 1992). These observations were especially valuable given the similarities between southern Alberta, Utah and Colorado that were appealed to in attracting settlers from America (see Figure, 2.4). Two important facets of Canadian water policy turned on analogies drawn from the American experience: 1) The arrival of Mormon settlers in Alberta; and 2) The need to allocate scarce water resources.

2.3.1 The Mormons

Perhaps somewhat fortuitously, Mormon settlers began arriving in the SSRB in 1887 and with them came a wealth of irrigation experience accumulated in the dry regions of Utah. By 1890, small irrigation works were in place and in 1893 the first large scale irrigation works began with the purchase of a 700 000 acre[5] land option by Mormon leaders Charles Card and John Taylor (Graham, 2001). The Mormon's had been engaged by railway developers to develop this project which, being the first of such magnitude, ushered in a new era of land conversion in southern Alberta (Thompson, 1993). The influence of the Mormon community on irrigation and farming in southern Alberta was significant in determining how the Canadian government negotiated land claims with railroad developers and in identifying suitable areas for irrigation.

When the federal government began negotiating with the Canadian Pacific Railway to settle the issue of land grants promised to the railroad developers, the experience of Mormon irrigators in southern Alberta helped shaped policy decisions. The initial method of settling land grants was through a system of alternating sections where sectional plots of 360 acres[6] were granted in checkerboard fashion to railways. But the Mormon irrigation project, under a land grant to the Alberta Railway and Irrigation Company, was successful in getting approval for alternating townships, the equivalent of 36-section blocks (Den

[5] 700 000 acres is equal to 283 280 hectares.
[6] 360 acres is equal to 146 hectares.

Otter, 1990). This effectively opened the door for railroad companies to seek larger and more continuous parcels of land from the government. And, in later negotiations, the inefficiencies of alternating townships in the irrigation systems developed by Mormons proved the point of the Canadian Pacific Railway: land grants should be made in continuous blocks (Hedges, 1971). As a consequence, blocks of land covering up to three million acres[7] were granted to the railroad for irrigation development and formed large parts of Alberta's irrigation districts (see Figure 2.5). The continuous blocks of land allowed for more efficient use of canals and ditches transporting water for irrigation and allowed railroad companies to develop and control entire swaths of land on the prairies and increase profits through land sales to settlers. Nowhere else in Canada were such large and continuous blocks of land granted to railroads and in this respect the early efforts of Mormon irrigators established a precedent peculiar to the SSRB.

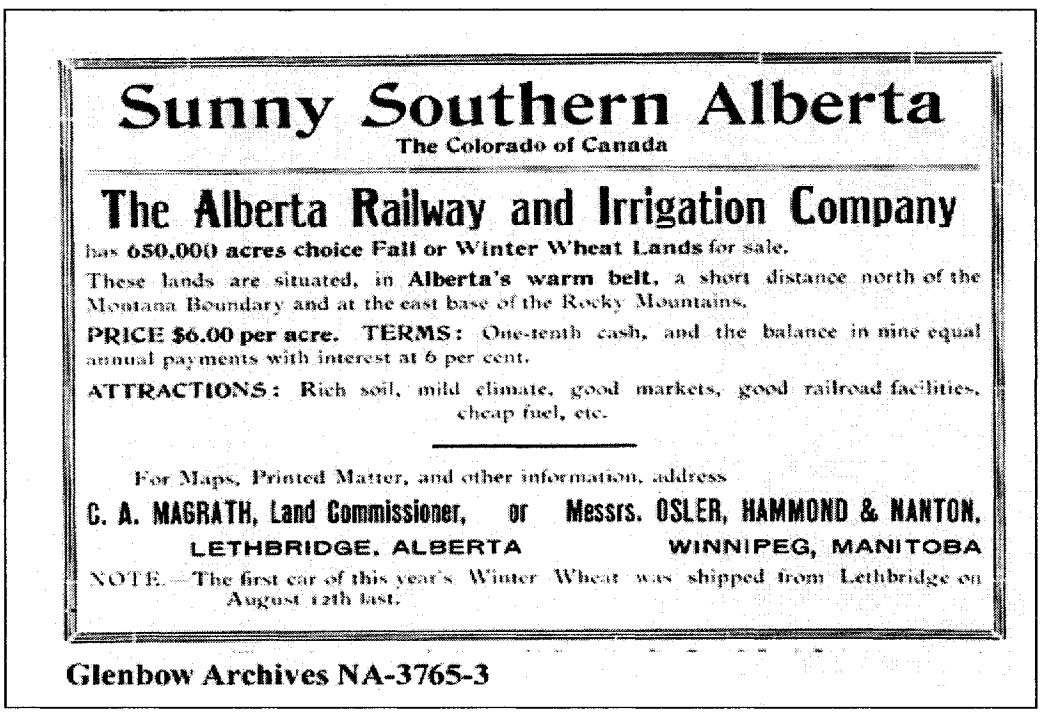

Figure 2.4: The Colorado of Canada. Advertising southern Alberta as the "Colorado of Canada" was a means of attracting setters west and promoted a common perception that the regions were similar in both landscape and the potential for prosperity during settlement in the late 19th and early 20th century. This advertisement is from 1907. Source: Glenbow Archives, Calgary NA-3765-3.

[7] 3 000 000 acres is equal to 1 214 057 hectares.

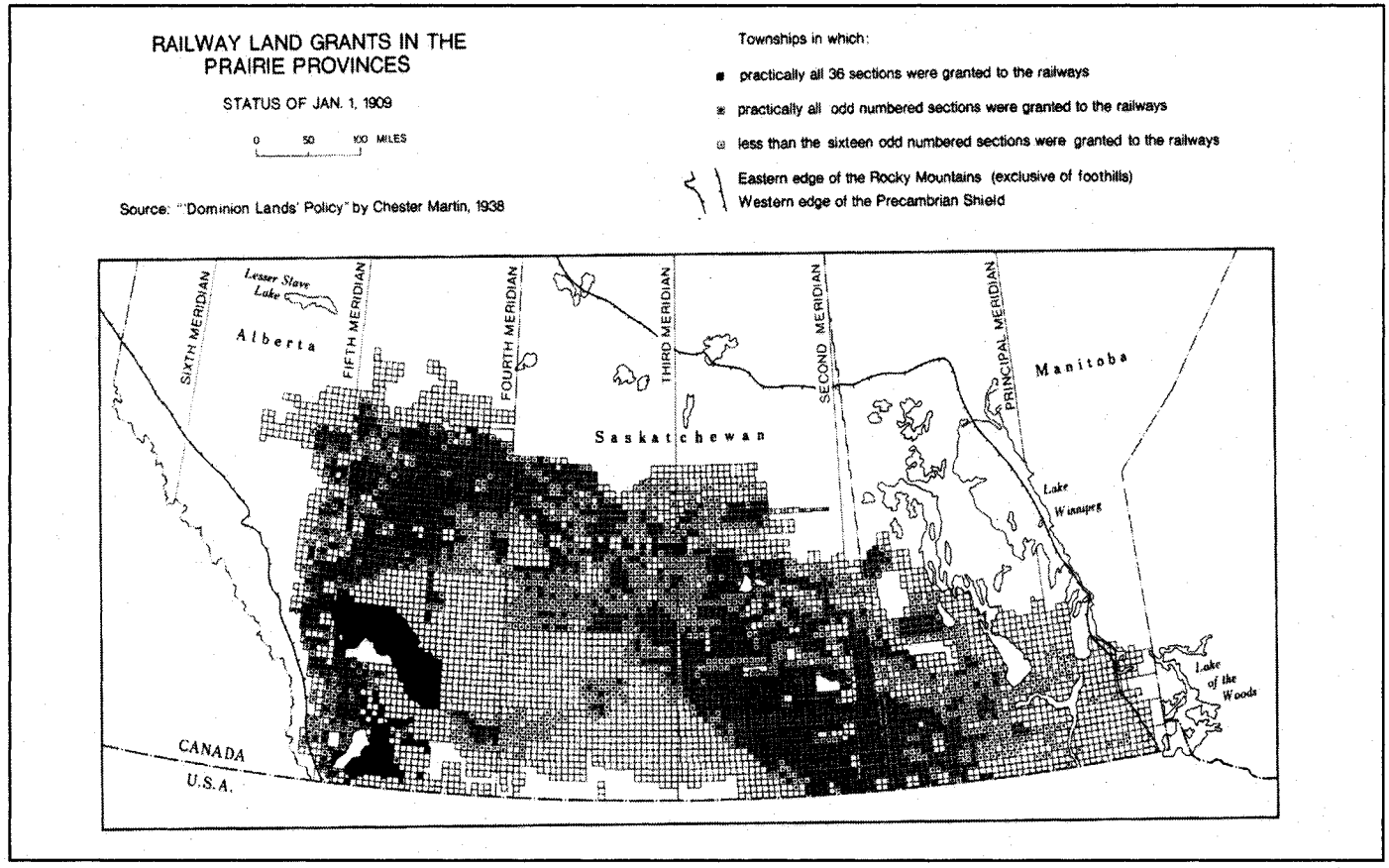

Figure 2.5: Railway land grants in the prairie provinces. The large continuous blocks are located only in southern Alberta, largely as a result of Mormon influence in early irrigation projects. Source: Atalas of Alberta (http://railways-atlas.tapor.ualberta.ca/cocoon/atlas/).

Another important contribution by Mormon settlers was that certain Mormons, notably Asael E. Palmer, influenced official positions on which lands were suitable for agriculture (Palmer and Palmer, 1990). As an advisor to the Canadian Pacific Railway, Palmer was influential in establishing what is now the Eastern Irrigation District (Palmer and Palmer, 1990). The Eastern Irrigation District is Alberta's largest irrigation district at 1.5 million acres,[8] an area larger than the province of Prince Edward Island that has been successfully irrigated for nearly a century (Eastern Irrigation District, www.eid.ab.ca).

As a result of Mormon experience with irrigation and expertise in farming under water stressed conditions, the context of the SSRB was influenced considerably by Mormon activity. During the early 1890s when Pearce was drafting legislation for Canadian water policy in the region, the settlement of land grants in large continuous blocks and the determination of lands suitable for agriculture were important to a government looking to make land attractive to settlers. Also important was the role that the government would play in providing such suitable land for agriculture. A central influence on Pearce in regards to this latter issue was in the work of Major John Wesley Powell.

2.3.2 Major John Wesley Powell

While the Mormon experience buttressed Pearce's position that irrigation could be valuable in the SSRB, it was the ideas of Major John Wesley Powell, a prominent figure in the development of American water policy, that influenced how Pearce thought water diversion should take place. Powell had also followed Mormon developments in the western states closely (Resiner, 1993) and had argued that water was the limiting factor in the settlement of the West (Kevles, 1999). The observations of the American experience by both Dennis and Pearce, the over-allocation problems occurring south of the border and the lessons from Powell on water management crystallized Pearce's beliefs on how to address water management in Canada's Northwest Territories. Pearce subsequently

[8] 1 500 000 acres is equal to 607 028 hectares.

adopted three of Powell's principles of water management as the basis for introducing water legislation to Canada (Mitchner, 1971):

1) The government was to assume title to water resources and deny riparian rights to landowners in order to stop the wasteful competition that resulted from the 'use it or lose it' conditions in appropriative rights.
2) The government was to conduct a thorough inventory of water resources and potential development sites.
3) The government needed to establish stringent regulations to provide for the maximum efficient use of available water.

In 1893, when Pearce drafted what was to become Canada's *Northwest Irrigation Act* the three principles above provided its impetus. But these management principles also provided the structure for developing water resources and preventing the "surplus" and "unused" water from flowing wastefully into Hudson's Bay. Pearce's vision was great. He once remarked that when water resources were fully developed the streets of Calgary would be navigable by boat (Mitchner, 1971). Given Pearce's admiration of Powell's approach to developing natural resources this is perhaps not surprising. For instance, in a lecture to the Philosophical, Biological and Anthropological Societies of Washington Powell (1888) remarked that,

> "Man [sic], so far as he is superior to the beast, is a master of his own destiny, and not the creature of the environment. He adapts the natural environment to his wants, and thus creates an environment for himself."

Whether Pearce's remark was merely a quip or reflective of a deeper commitment to fully exploit all water resources for beneficial uses it is not far off from Powell's remark that "man" [sic] should develop the environment and adapt it to his wants. In either case, the management principles set out by Powell laid the foundation for governing water when the *Northwest Irrigation Act* was drafted and water use in the SSRB became regulated.

2.4 THE NORTHWEST IRRIGATION ACT

The *Northwest Irrigation Act* was introduced to parliament in 1893 but shelved until 1894. While the Act sat dormant many copies were made available for public scrutiny but when the legislation was passed by parliament in 1894 no significant changes were made (Mitchner, 1971). The *Northwest Irrigation Act* came into force in 1898 and was structured on a combination of Australian and American law. From Australia's state of Victoria the legislation vested water, as property, solely in the Crown and this included all rights to allocate water diversions. The American contribution to the *Northwest Irrigation Act* was the doctrine of prior appropriation, a 'first in time—first in right' method of establishing the priority of water rights. The adoption of the principle of prior appropriation was modified from the American model where rights to water were claimed based on when actual water resources were put to use. The Canadian version replaced the actual diversion of water with a system where the date of application for a water license established the priority of water rights (Percy, 1977). Under the system of prior appropriation those who held senior rights were entitled to the full amount of their claim before the holders of junior rights received water.

Vesting water solely to the Crown and adopting the system of prior appropriation were critical to solving the existing conflicts between ranchers and settlers in the SSRB and in this respect were largely *ad hoc* solutions to water problems. Prior to the *Northwest Irrigation Act,* water claims in the SSRB were established based on the riparian doctrine of British common law. Under the riparian doctrine, those owning the land directly adjoining a watercourse such as a river or lake held rights to water. As the *de facto* method of establishing rights to water in the SSRB, British common law made the retraction of large cattle leases an imminent problem for ranchers when land sequestered for settlers or railroad land grants adjoined a river or lake. To solve this problem the *Northwest Irrigation Act* protected the rancher's "water reserves" set up in 1886 but also introduced the system of prior appropriation for establishing new claims to water for owner's of private property. As a result, traditional watering holes were kept

open for ranchers while water diversions for irrigation were granted to new applicants. As land was sold to new settlers the riparian doctrine retained priority over new licensees but no riparian challenge was ever brought to court in Alberta so no precedent exists for resolving disputes (Percy, 1977).

2.4.1 Water allocation mechanisms

The *Northwest Irrigation Act* also established the mechanisms for obtaining water rights. Those wishing to obtain rights were required to apply for a license that was granted provided the applicant met a number of criteria. Applicants had to meet "stringent licensing procedures that required incorporation, a detailed survey, proof of beneficial use of water, public review, expedient implementation and operations consistent with approved plans" (Clarke, 1988; cited in Wolfe, 1992). Percy (1977) notes that the nature of the water rights obtained under this system was less than a full property right since the amount of water received could be reduced under certain conditions and the license was not freely transferable. In fact, water rights were granted indefinitely, tied directly to both the land and use dictated under the regulations of the particular license and were transferable only through acquisition of the land to which they were appurtenant (Percy, 1997). The reason for this strict regulatory connection between land, water use and water license was in recognition of the fact that the federal land grants given to entice railroad companies to lay track westward would be worthless if water rights could not be guaranteed to the settlers to whom railway lands were sold.

2.5 AFTER THE ACT: A PATH TO SCARCITY

The struggle over water between cattlemen and settlers did not completely subside under the new licensing system. And when the Liberal Party was elected in 1896 Pearce found his position atop Palliser's triangle less stable than under Conservative rule. The number of land disputes in the SSRB had been increasing and Pearce's diplomacy was less than admirable as land in the region continued to be advertised to settlers which forced Pearce to make tough decisions regarding

water distribution between settlers and cattlemen (Breen, 1983). The Liberal victory in 1896 also resulted in Clifford Sifton being named the Minister of the Interior and in this position Sifton inaugurated an immigration policy that saw unprecedented numbers of immigrants flood the western prairies (Thomas, 1975). Little changed after Alberta became a province of Canada in 1905 as land continued to be advertised as attractively, though not as honestly, as possible. For example, in Figure 2.6 all aspects of southern Alberta, including water, are advertised attractively despite the semi-arid conditions that prevail in the region. And in Figure 2.7, images of maple leaves are used to enshrine the possibilities of establishing prosperous homes in the west even though maple trees are native to the east and the maple leaf was not adopted as symbol of Canada until the mid 20th century.

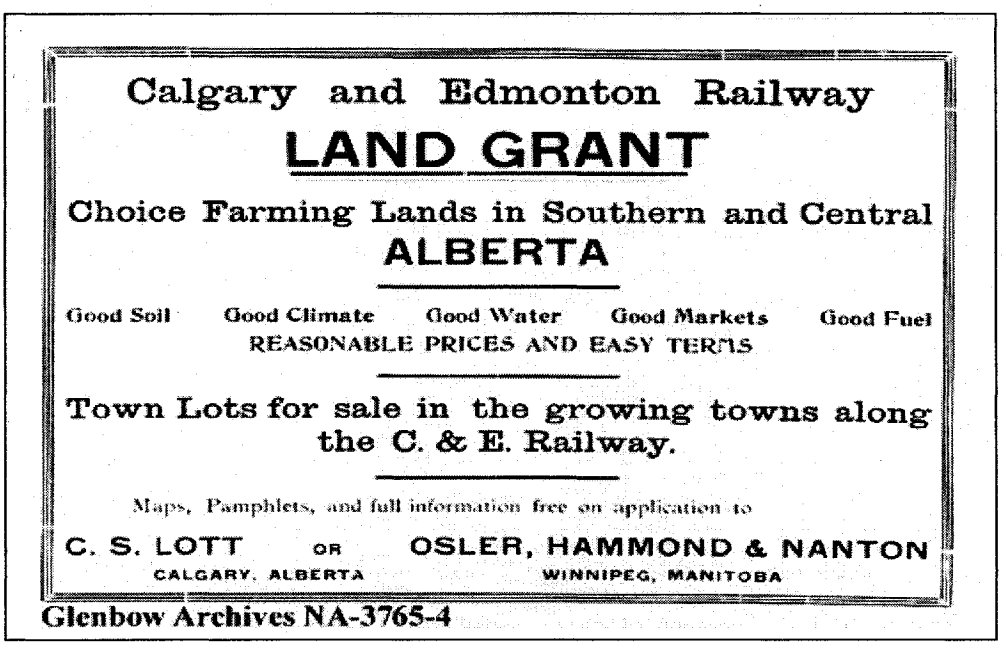

Figure 2.6: Land grants in southern Alberta. All aspects of farming in the region, including water, are advertised attractively in the region, 1907. Source: Glenbow Archives, Calgary, NA-3765-4.

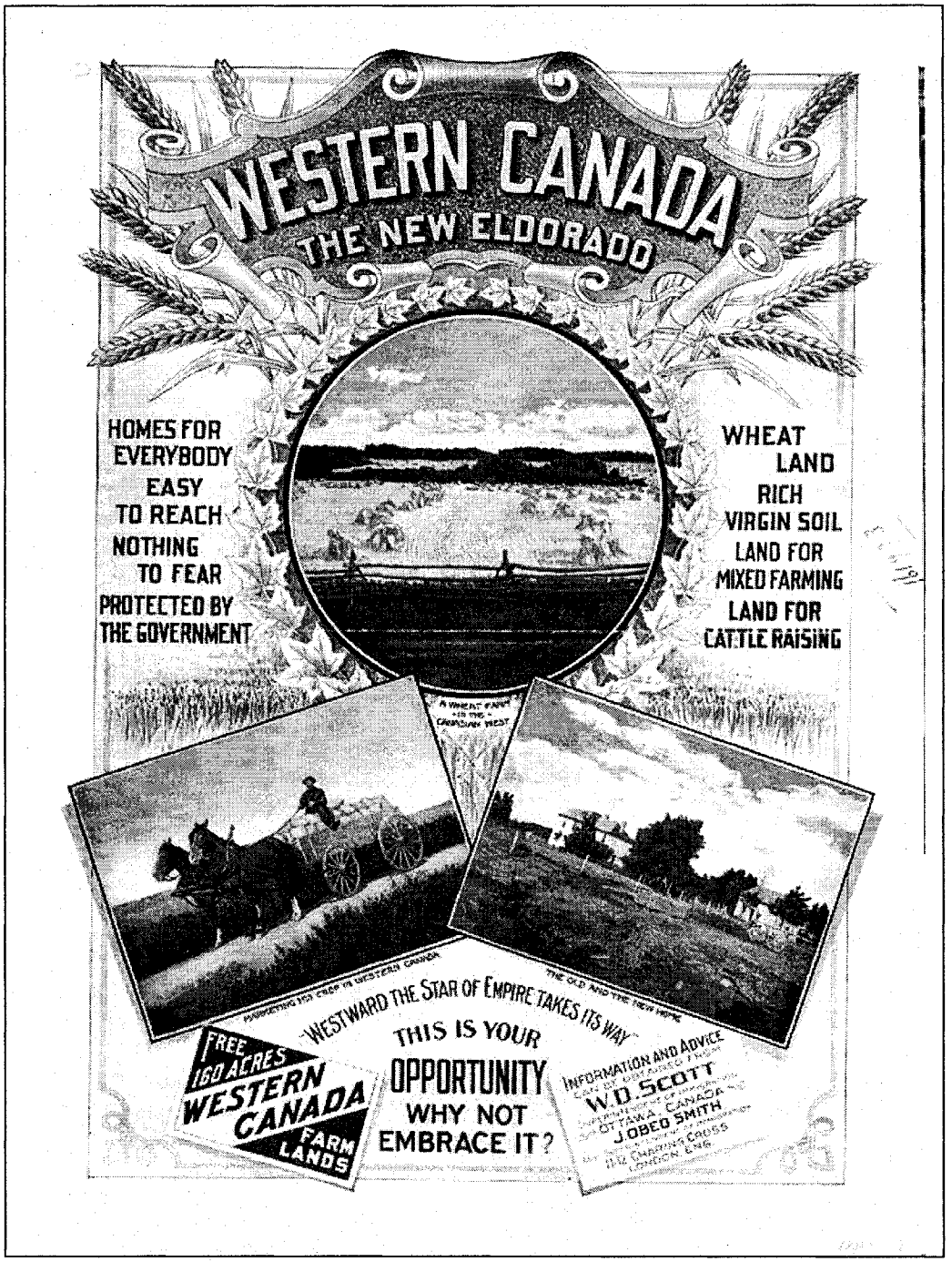

Figure 2.7: The new Eldorado. An advertisement promoting western immigration from 1908-1918 promising government protection. The opportunity of plentiful wheat crops is depicted in a ring of maple leaves that are native to Eastern Canada, but not to the semi-arid west (Source: Library and Archives Canada, 085854).

2.6 WATER IN ALBERTA: 1905-1995

The large number of settler's heading west on promises of good land, a government guarantee and good water coalesced the two agendas of sovereignty and settlement into a single unit that increased pressure on water in the SSRB. Increasing pressure on water resulted in a cycle of scarcity where meeting demands for water was both idealized as a task central to development and ignored in water policy decisions for nearly a century.

2.6.1 1905-1921

Perceptions towards water changed dramatically at the turn of the 20th century. In a seminal essay, then secretary of the US Inland Waterways Commission, W. G. McGee (1909) argued that where water had once been viewed as occurring in great excess and as the basis for life that the advances of modern society could finally and completely render it a resource; water could now be properly valued in the progress of western civilization.

As a resource, McGee saw the supply side of water management as critical to development, and this bore on the water in the SSRB. McGee (1909 p. 38) argued that,

> "No more significant advance has been made in our history than that of the last year or two in which our waters have come to be considered as a resource—one definitely limited in quantity, yet susceptible of conservation and of increased beneficence through wise utilization. The conquest of nature, which began with progressive control of the soil and its products and passed to the minerals, is now extending to the waters on, above and beneath the surface. The conquest will not be complete until these waters are brought under complete control."

The increasing focus on water supply in the United States and burgeoning demand for water in Northern Montana required special attention in the *Boundary Waters Treaty* struck in 1909 regarding the transboundary waters flowing between Canada and the United States. The St. Mary's river, which flows into Canada from Glacier National Park as part of the SSRB was allotted on the principle of

prior appropriation – 75% to Canada, 25% to the United States. The race to settle the SSRB and put water to use, it would seem, was well run since prior claims to water figured prominently in the rationale for the treaty. A second river in the region, the Milk River, was allotted using the same principle of appropriation but reversed each country's share with 75% to the United States and 25% to Canada. In each case a prior appropriation of 500 cubic feet per second[9] (cfs) was granted to the country with the larger share of the river during the irrigation season.

It did not take long before a challenge to the *Boundary Waters Treaty* was submitted to the International Joint Commission (IJC), an organization created expressly to settle matters of dispute. The challenge was based on how to interpret and implement the prior apportionment of waters. Canada's position was that the prior apportioned waters should not be shared and that Canada should be entitled to its full 500cfs before the United States received its entitlement. The United States held the opposite position. After a series of hearings from 1915-1921 the IJC issued an Order in 1921 that upheld Canada's position and also increased the prior appropriation to 666cfs[10]. The importance of the decision cannot be overstated in the history of Alberta's development. For example, almost one hundred years later in 2004, a similar challenge by Montana resulted in this response from Alberta,

> "Based upon the certainty provided by the 1921 Order, Alberta has made significant investments to store, convey and deliver water for farms, industry and power generation. This includes a system of diversion canals, storage reservoirs...and irrigation canals" (AENV, 2004a).

The certainty provided by the 1921 Order however, did not curtail growing domestic water problems in the SSRB. Alberta had carried the basic structure of water licensing from the *Northwest Irrigation Act* over into provincial legislation and defects became readily apparent as settlement increased during the early 20th century. First, water licenses were granted for indefinite periods of time and as the number of licenses increased it became obvious that water resources would soon be over allocated. Second, the difficulty of transferring existing water

---

[9] 500 cubic feet per second is equal to 14.2 cubic metres per second.
[10] 666 cubic feet per second is equal to 18.9 cubic metres per second.

rights to new areas of demand created problems as growing municipal and industrial centers sought to acquire sufficient water. Upon recognition of these two problems the legislation was amended in 1920 to prioritize water uses in such a way that transferring water licenses to a higher priority use would be possible (but not vice-versa) without also obtaining the land to which the original license was connected (Percy, 1977). Under the new system water uses were prioritized in order of importance beginning with domestic use, and subsequently down through municipal, industrial, irrigation, and "other uses" (Percy, 1997).

The 1920 amendment forestalled water problems but did little substantive work in relieving the growing problem of water scarcity in southern Alberta. The amendment left unchanged the problem of how new users could acquire water rights in regions that were already fully allocated and, as social values changed over time, water resource allocation could not continue apace (Percy, 1986). In addition, water licenses that were no longer being fully used, or those being inefficiently used, locked water resources into rigid allocation patterns with no possibility of recovery for more efficient or beneficial uses (Percy, 1986). This proved a persistent issue as Canada's west continued to be advertised as a veritable promised land for agricultural development (see Figure 2.8).

The 1921 Order issued by the IJC and the licensing system implemented in the SSRB operate on principles of certainty that guaranteed water supply. The principles, legitimated by the sovereignty exercised over water and instantiated through the use of water by settlers, provided the basis for development throughout the 20th century. By 1920 the pressure on water resources in the SSRB were already requiring a perceptual shift in the nature of water allocations and recognition of changing social uses for water. Meeting the growing demand in the SSRB during the 20th century took on an idealized form as increasing supply became synonymous with the development of the region's economy and communities. Being committed to an institutional path focusing on maintaining secure water supplies, however, required a vision for development that ignored the limits of available water for agricultural, industrial and municipal growth.

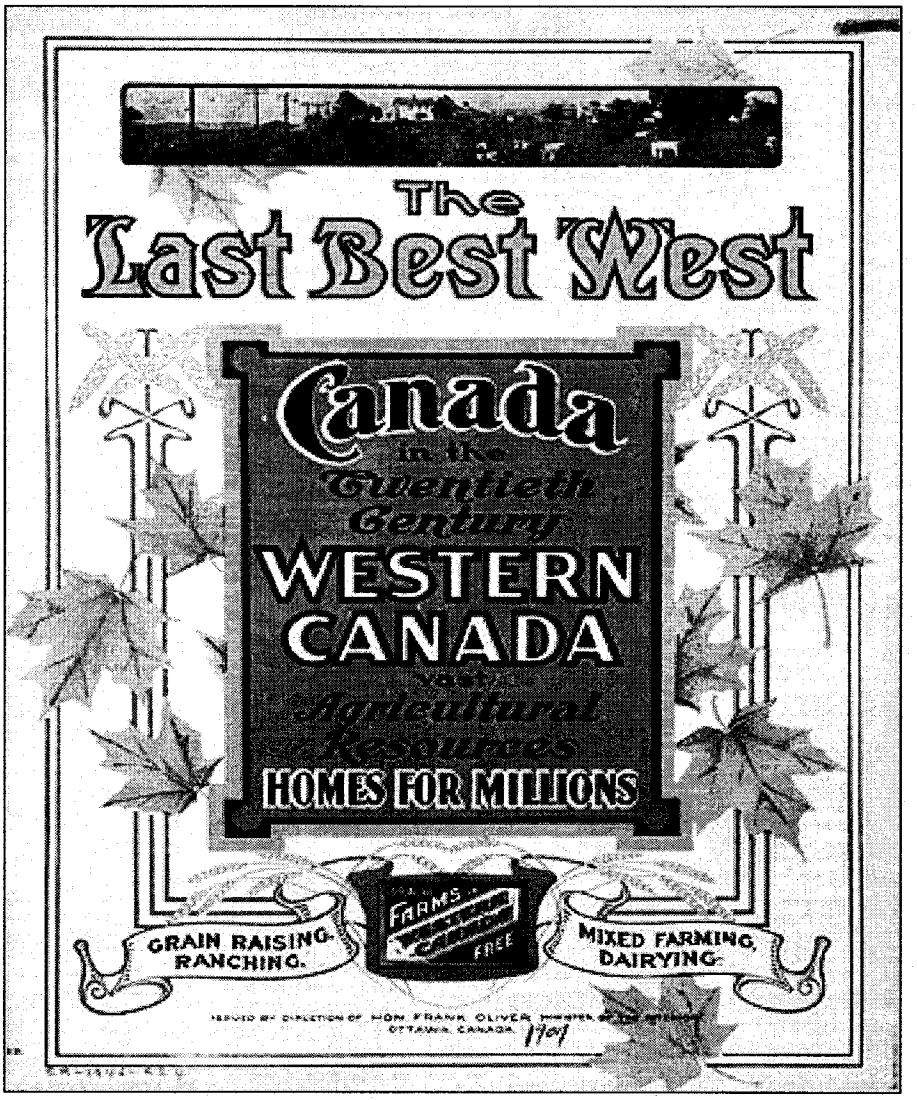

Figure 2.8: The Last Best West. Settlement promotion in 1907. Source: Library and Archives Canada, C-030621.

2.6.2 1921-1950

During the period from 1921-1950, the development of water resources in southern Alberta concentrated on irrigation. The 1915 *Irrigation Districts Act* and promises of strong returns on capital investment in infrastructure resulted in a number of being projects financed through aggregate cooperatives known as irrigation districts (Alberta Irrigation Projects Association [AIPA], 2002). Initial optimism quickly faded as capital returns were low, a cycle of drought dominated

the 1930s and the North American economy crashed, which significantly reduced commodity prices (Potyondi, 1992). As concerns regarding development grew, a legislative restructuring was also in the works.

Jurisdiction over Alberta's water passed from the federal government to Alberta under the *Alberta Natural Resources Act* in 1930. In 1931, Alberta passed the *Water Resources Act* and continued the water policy tradition it had inherited from the federal government. However, the dire situation caused by falling commodity prices and droughts in the 'dirty 30's' required federal assistance to avoid the complete collapse of irrigation in southern Alberta. In 1935 the Prairie Farm Rehabilitation Administration (PFRA) was created to assist in the development of irrigation systems (AIPA, 2002). In 1943 the provincial and federal governments agreed to heavy federal investments to increase capacity for irrigation with Alberta promising to eventually take over infrastructure maintenance (AENV, 2004b). These federal-provincial arrangements, combined with the clearly held control over water in southern Alberta, combined to produce an era of intense expansion after 1950. The success of the PFRA through the 1940s and the increased role of local management in irrigation districts that resulted from farmer initiatives proved, it seemed, that meeting scarcity problems could be met through the development of infrastructure increasing water supply (see AIPA, 2002).

2.6.3 1950-1986

The uncertainty surrounding development began to wane as weather patterns returned rains to the SSRB and federal–provincial partnerships increased the infrastructure available for securing water supplies after 1950. Soon after the passing of the *Irrigation Act* in 1968 the total number of irrigation districts in Alberta totaled 13, all of which are located in the SSRB. During the 20th century, irrigation districts amassed licenses to roughly seventy-five percent of total water allocations in the SSRB (AENV, 2005a). None of the licenses have expiry dates (AIPA, 2002).

In 1975, the transfer of control over irrigation infrastructure passed completely to Alberta. The increases on water demand during the period from 1970-1980 was roughly 50% as the total area of irrigated land grew from 279 877ha to 419 730ha (AIPA, 2002). Meeting the burgeoning demand was accomplished through increases in supply, specifically through the construction of dams. Unabated increases in supply, however, began to be seriously questioned on both social and environmental grounds during the period surrounding construction of the Oldman Dam in 1986. In many ways, the Oldman Dam is the quintessential act that brought into question what I outlined earlier as the SSRB's cycle of scarcity. It is in the construction of the Oldman Dam that the agendas of sovereignty and settlement combine and public concerns over water bring an end to unabated infrastructure development in the SSRB.

2.6.4 1986-1995

In 1986, construction began on the Oldman River dam. The importance of the Oldman River for trout habitat, a unique cotton-wood riparian ecosystem and the proposed flooding of a 43km stretch of valley upstream of the dam drew protest from environmentalists, Native American's and the public at large (Glenn, 1999). Legal action against the province was taken by the Friends of the Oldman (FOR) to stop the dam. The federal court of appeal upheld the position of FOR and ordered that an environmental assessment be completed for the dam in 1990 which had the effect of making any further construction on the dam illegal, pending the results of the assessment (Glenn, 1999). Construction of the dam did not cease. Rather, the Alberta government cited public safety concerns for settlements below the dam during spring floods as reason for continued construction (Glenn, 1999). And although the court's ruling firmly established the requirement of the Alberta government to gain federal approval in accordance with the *Navigable Water's Protection Act* (*Friends of the Oldman River Society v. Canada*, [1992] 1 S.C.R. 3*)* the federal government did not issue a stop work order when construction continued illegally. The dam was completed in 1992.

In the spring of 1991, the provincial government released a new water management policy for the SSRB, Alberta Regulation 307/91. The regulation established new limits to total water allocations and total irrigated land areas in the Oldman Basin and the rest of the SSRB. However, the new limits included expanding the total irrigation area to 14 000 ha more than that recommended even with the new dam in place (Glenn, 1999). As a result, even though the intense opposition and federal court rulings did not prevent the dam, the Alberta government did cap water allocation and the expansion of irrigation in the SSRB. This has effectively ended the era of infrastructure development in the SSRB as no major dams have been built since. In terms of the cycle of scarcity described at the outset of this chapter we might now conceptualize it without supply-side developments in water infrastructure as in Figure 2.9.

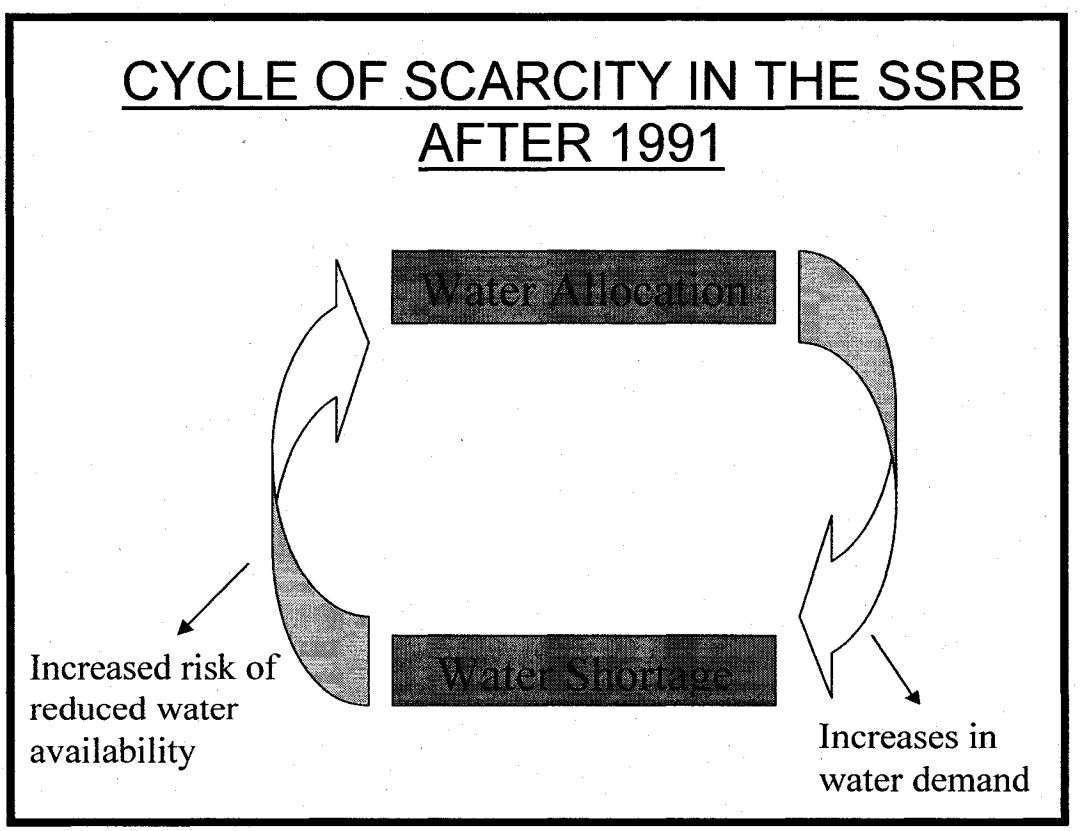

Figure 2.9: Cycle of scarcity in the SSRB after 1991. A schematic of the cycle driving water scarcity in the SSRB after the era of supply-side water development and infrastructure building ended. Increases in water allocations translate into increased risk for license holders.

2.7 *CONCLUSION*

Meeting water scarcity concerns through increases in supply reached a crisis point during the mid 1980s and has persisted as a key feature of water management in Alberta into the 21st century. The catalyst for the crisis was the Oldman Dam but the impetus is rooted firmly in the perception that the institutional paths created under the agendas of sovereignty and settlement are stalwart pillars of water development. The allocation of water in the SSRB has been based on control of water through the establishment of sovereignty and on legitimizing development through settlement. Settlement, in turn, creates pressure to increase water availability through supply-side development and completes a positive feedback loop when increased development encourages further population growth and water demand increases.

The limits to water allocation in the SSRB watershed have now been reached or exceeded. The southern most rivers, the St. Mary's, Belly and Waterton rivers have 118%, 80%, and 75% of their median annual flows allocated (AENV, 2005a). The Oldman and Bow Rivers have 70% and 68% of their flows allocated with only one river, the Red Deer, remaining relatively unscathed with 18% of its flow allocated (AENV, 2006b). The extensive over-allocation is due in part to the fact that under the initial allocation system "Instream Objectives" (IOs) were used as measures of acceptable allocation but based solely on agricultural, municipal and industrial factors without accurate determination of their environmental consequences (AENV, 2003e). And, without physical limits to allocation there was no reason to deny licenses to new applicants (Percy, 1987).

By the time the *Water Act* was passed in 1996 and came into effect in 1999 some twenty thousand licenses made claims on the water in the SSRB (AENV, 2005a). Then, in 2001, a severe drought demonstrated the extent of over allocation when total allocations exceeded total available water for the first time ever in the SSRB (AENV, 2005a). However, the *Water Act* is constrained by the history of water policy and the commitments made to maintain control over water for the purposes of development. The next two chapters present and examine water policy decisions that have taken place since the *Water Act.*

Chapter Three

The Present: From Water Needs to Water Risks

3.1 Introduction

By the late 20th century there was widespread recognition that the limits to water supply and allocation had been reached in the SSRB. Limits to supply, however, did not deter optimism that development could continue apace through a commitment to Pearce's indelible path to institutional success. In fact, the commitment is explicit and Alberta's present water policy: 1) Retains crown ownership of water, 2) Continues the system of prior appropriation and licensing and 3) Allocates water to promote development (AENV, 2005a). The limits to supply, however, meant adjusting the rationale for water licensing such that water in the SSRB can continue to provide the basis for municipal and economic growth. This chapter outlines how this has been accomplished in the SSRB.

In chapter one I argued that the agendas of sovereignty and settlement ultimately led to water scarcity concerns providing the rationale for controlling water resources in the service of development. I suggested that this history could be seen as a cycle of scarcity where a positive feedback loop of increased supply, increased allocation and increased demand resulted in both perennial scarcity and an insatiable need for water in the SSRB. This chapter argues that the recognized limits to water supply in the SSRB have created a new rationale for water licensing and shifted the locus of concern from need to risk. This argument builds on the institutional history of water licensing in the SSRB through a presentation of three key policies approved between 1996 and 2006. 1) Alberta's *Water Act*; 2) Alberta's provincial *Water for Life* strategy; 3) The two phase management plan for the SSRB approved in 2002 and 2006. The transition from need to risk, can be seen as an attempt to rectify the defects of earlier policy decisions within the constraints of Alberta's historic water path and to do so in a way that allows continued development with a limited water supply.

3.2 THE WATER ACT

Alberta's 1996 *Water Act* retained some features of the 1931 *Water Resources Act* but also introduced new mechanisms for relieving water scarcity. The *Water Act* retained the system of prior appropriation (sec. 18) and also retained the vesting of all water resources as property of the Crown (sec. 3). The *Water Act* also created new opportunities to conserve and more effectively use water by altering the conditions placed on water licenses. Three critical changes to the *Water Act* provide new rationale for water management and allocation in Alberta:

1) When the *Water Act* came into effect in 1999, the transfer of water licenses became possible under section 81. This change directly addresses the pitfalls in previous legislation of having water licenses appurtenant to both the land and use specified in the original license. Now, water licenses may be transferred in whole or in part on both permanent and temporary terms. However, transfers must be approved by the province.

2) The *Water Act* also introduced a mechanism for reclaiming portions of licenses during the transfer of a water allocation in section 83. This change addresses the problem of issuing licenses for indefinite periods of time by making it possible for the government to reign in allocations that overextend water resources. This is accomplished through the enforcement of a 'conservation holdback' that allows the government to remove up to 10% of a water license during a water allocation transfer.

3) Along with the technical changes mentioned above, a major change to the implementation of water management plans was instituted in the new legislation. Under sections 7-15 of the *Water Act* provincial control over water resources devolves from the provincial scale to local (i.e. watershed) scales of management. At local scales, water management plans must include public consultation if water conservation objectives for

> the preservation of biodiversity are established. Management plans must be approved by the government under sections 7 and 8 of the *Water Act*. Under section 7 management plans may also include: 1) Identification of the water management principles being employed; 2) The geographic area that falls within the plan's ambit; 3) A plan for local and regional involvement in the establishment and revision of the plan; 4) Criteria for ordering different components of the plan; and 5) Integration of the water management plan with other plans for land and resource development. The legal language of these five conditions is not mandatory.

The framework created under the *Water Act* directly impacts the SSRB as this region is at the highest risk of licenses not receiving their full allocation of water. The three changes highlighted here do not encompass all of the changes made under the *Water Act.* Rather, the ability to transfer licenses, the mechanism for holding back water for conservation purposes and the devolution of water management to local and regional scales represent changes in perception towards water resources. For example, with Canadian sovereignty secured, and the lands of the western Prairies under a stable tenure regime, there is no reason for water rights to remain appurtenant to land claims. The transference of water rights, therefore, provides a way to increase the net benefits available from water resources, as it is no longer necessary to guarantee water rights that encourage settlers to head west.

The "conservation holdback" mechanism represents a similar shift in perception. Conserving water for environmental protection reflects a perception of water resources as part of the biophysical systems that ensure the long-term viability of water resources and ecosystem services. That is, after fulfilling the need to establish control over water, the locus of concern turns to mitigating long-term risks. Similarly, the devolution of water management plans from a 'one size fits all' provincial plan to the watershed scale reflects a perception that

management plans need to fit with the specific and changing conditions of different social and ecologic regimes within Alberta. The risk of not doing so is no longer a failure to guarantee needed water to railroad investors or would be settlers but a determination of probable economic outcomes should physical limits not be respected or social values ignored. This process of conditioning water behavior towards sustainability and away from increasing the risks of overexploitation finds a counterpart in Alberta's provincial *Water for Life* strategy.

3.3 WATER FOR LIFE: ALBERTA'S STRATEGY FOR SUSTAINABILITY

Alberta's *Water for Life* strategy was published in 2003. The process of developing the strategy involved a significant amount of collaboration with concerned Albertans. It attempts to secure long-term action plans for sustainable water use in three main categories: 1) Safe and secure drinking water supply; 2) Healthy aquatic ecosystems; and 3) Reliable, quality water supplies for a sustainable economy (AENV, 2003a). The strategy constructs short, medium and long-term plans to meet these goals and describes the need for such a strategy as follows,

> "Alberta is facing significant pressures on its water resources. Population growth, droughts and agricultural and industrial development are increasing demand and pressure on the province's water supplies, and the risk to the health and well-being of Albertans, our economy and our aquatic ecosystems.
>
> In the past, Alberta has been able to manage our water supply while maintaining a healthy aquatic environment because there has been a relatively abundant, clean supply to meet the needs of communities and the economy.
>
> However, fluctuating and unpredictable water supply in recent years has stressed the need to make some major shifts in our approach to managing this renewable, but finite, resource." (AENV, 2003a).

Increasing risks to Albertans, the economy and aquatic ecosystems are dealt with comprehensively in the strategy according to key water management principles that emerged during the public consultation process (see Table 3.1). The planning principles, according to the strategy, provide shared boundaries and a platform for

Table 3.1: "Water for Life" management principles (AENV, 2003a).

- All Albertans must recognize there are limits to the available water supply.
- Alberta's water resources must be managed within the capacity of individual watersheds.
- Citizens, communities, industry and government must share responsibility for water management in Alberta, and work together to improve conditions within their local watershed.
- Knowledge of Alberta's water supply and quality is the foundation for effective decision-making.
- Albertans must become leaders at using water more effectively and efficiently, and will use and reuse water wisely and responsibly.
- Alberta must preserve the "first-in-time, first-in-right" principle for granting and administering water allocations, but water allocations will be transferable to ensure societal demands and needs can be met.
- Healthy aquatic ecosystems are vital to a high quality of life for Albertans and must be preserved.
- Groundwater and surface water quality must be preserved in pursuing economic and community development.
- Alberta will continue to be a leader in drinking water quality and standards to ensure Albertans have safe, secure drinking water.

cooperation for moving towards watershed management plans for the major river basins in Alberta such as the SSRB (AENV, 2003a). At the same time the strategy also provides three key directions to facilitate collaboration in the areas of: knowledge and research, stakeholder partnerships and conservation (AENV, 2003a). The strategy is both ambitious and measured in its attempt to provide a comprehensive framework for water management that will meet the demands for water in Alberta and minimize the risks associated with mismanaged water resources.

Alberta's *Water for Life* strategy is explicit about instituting a new regime in management where there is,

> "... a shift to shared responsibility through a network of partnerships, use of outcome-based approaches, and collaboration in delivery of services" (AENV, 2003a).

The use of outcome-based approaches is a recognition of risk, or the probable consequences of not achieving some desired future state. The *Water for Life* strategy is an important policy step in Alberta as it shifts perceptions towards sustainability and motivates sustainable action by appealing to risk avoidance through collective action. The water management plan for the SSRB, in both

phases I and II follows suit by recognizing the limits to Alberta's water and directly addressing the defects of previous policy decisions that did not do so.

3.4 THE WATER MANAGEMENT PLAN FOR THE SSRB

The management plan for the SSRB was approved in two phases. Phase I was approved in 2002 to create the conditions for more effective transfer and use of licenses and also put an interim closure on new allocations on the southernmost rivers. Subsequent to the Phase I plan a number of background studies were prepared in order for Phase II to be able to meet its mandate of balancing human consumption with environmental conservation. The background studies were released in 2003 and the final approved management plan for the SSRB was released in August of 2006.

3.4.1 Phase I

Phase I was approved in 2002 and created a market for water allocation transfers in the SSRB. Under the new market structure water licenses that are transferred retain their original level of priority and are subject to the approval of a provincial water Director. The Director approves the transfer if the criteria of section 82 of the *Water Act* are met. Some of these criteria include: no harmful effects on aquatic environments, adequate water quality being maintained for household and traditional users, no public safety threats, and minimal interference with infrastructure arrangements. Water allocation transfers may be negotiated between parties as permanent sales or leases for all, or a portion of, the original license. Transfers are not affected by changes in water use such as a purchase of an irrigation license for municipal use (AENV, 2002a).

The market for water allocation transfers "enables a new or existing water user to acquire an allocation with a level of risk acceptable to the user's requirements" (AENV, 2002a). The introduction of market mechanisms will, according to some economists, have the effect of transforming "historical licenses into marketable commodities" (Horbulyk and Lo, 1998). This transformation will take place under the watchful eye of the province as the Director must approve of

transfers that are in line with approved management plans. The transformation will also have other effects that are not reflected in market transactions, the benefits and costs of which will be externalized and born by society (Appelgren and Klohn, 1999). Nonetheless, the potential benefits of Alberta's water market should increase water use efficiency and economic output (Horbyluk, 2005).

Phase I also recommended an interim closure to new water licenses on the Oldman River and its southern tributaries (the St. Mary's and Belly River) subject to the conclusions reached during phase two of the management plan for the SSRB. Under the new plan irrigation districts are unable to market the water licenses granted to them by the province unless they hold a public plebiscite under section 11 of Alberta's *Irrigation Districts Act*, which was passed in 2000. Licenses within irrigation districts may be transferred between irrigators within each district.

The approval of Phase I and the recognition that Phase II would contain key recommendations for managing water in the SSRB meant that the transition towards reducing risks in the SSRB was indeed taking place under a new rubric of shared responsibility outlined by the *Water for Life* strategy. Phase I was guided by a special steering committee in consultation with existing legislative requirements, scientific reports, and the public (AENV, 2001). For each of the four major sub-basins in the SSRB, a Basin Advisory Committee (BAC) was set up to represent a cross-section of stakeholder concerns in the SSRB, to conduct one plenary information session on water transfers and to host open houses for interested members of the public (AENV, 2001). The public consultation process involved roughly 250 participants (AENV, 2002b).

While it wasn't clear to some members of the public why freely granted licenses should now be profitable commodities without a more democratic distribution (AENV, 2002c), the imminent risks in the SSRB prompted the Phase I plan to state that "the importance of the water management issues in the SSRB is justification to continue without delay on a water management plan" (AENV, 2002a). A market for allocation transfers and a moratorium on new licenses was

a common sense matter of fact for water policy makers attempting to mitigate the risks of water scarcity in the SSRB.

3.4.2 Phase II Background Studies

The second phase of the management plan was approved in August, 2006 and focuses on balancing water consumption and environmental conservation. Through a series of background studies the plan is directed at three primary areas: 1) Consumptive water use by humans; 2) Non-consumptive water use by the aquatic environment; and 3) Modeled projections of future allocation scenarios.

Consumptive water use is "the balance of water taken from a source that is not entirely or directly returned to that source" (AENV, 2003b). In the SSRB consumptive water use by the non-irrigation sector is expected to grow the most in the Red Deer basin as it remains the only river in the SSRB that is not heavily allocated. Included under consumptive uses are the "non-irrigation" uses including municipal, industrial, wastewater, and agricultural uses unrelated to irrigation such as stockwatering (AENV, 2002d). Consumptive water use is forecast to increase between 35% to 67% in the SSRB due to industrial expansion and a burgeoning population in the SSRB that is expected to grow from roughly 1.3 million in 1996 to 2.1 million by 2021 (AENV, 2002d).

Conservation measures and demand side management are expected to reduce per capita use of water and to promote greater efficiency. However, the aggregate increases in development and population will lead to an increase in consumptive use in all four major sub-basins in the SSRB through the entire forecast period of 1996-2046 (AENV, 2003b). By 2046 the forecasted population in the SSRB is estimated to be above three million with increases in consumptive water demands of 63% to 132% above current levels (AENV, 2003b).

Non-consumptive water use by the aquatic environment was determined by calculating how much water is needed for aquatic and riparian ecosystems in two respects. The first assesses the current ecological status of river reaches in the SSRB, the second defines Instream Flow Needs needed to maintain healthy aquatic ecosystems.

The Strategic Overview of Riparian and Aquatic Condition (SORAC) report was designed to provide the background information needed to make recommendations for Water Conservation Objectives. Only one of the thirty three river reaches in the SSRB is currently at acceptable levels in all categories. The remaining 32 river reaches vary from "moderately impacted" to "degraded," indicating that the long term health of most rivers is in decline (AENV, 2003b).

The qualitative assessments in the SORAC report were provided by experts from various fields of the sciences and government but many participants had poor response rates on issues of biodiversity and riparian needs as they did not feel sufficiently knowledgeable to respond to questions on these issues (AENV, 2003c). Ecological status was evaluated by asking participants to comment on whether the trend for specific river reaches was towards increasing or declining river health based on their best estimates for the last 5-10 years (AENV, 2003c).

The second aspect of non-consumptive water use by the aquatic environment was determined by calculating Instream Flow Needs (IFNs). IFNs are "the quantities of water and water quality conditions needed to sustain riverine processes and associated ecosystems over the long term" (AENV, 2003b). A technical study was prepared using a weekly time step from 1912-1995 to determine IFNs for four variables: water quality IFN, fish habitat IFN, riparian IFN, and channel structure IFN (AENV, 2003d). Determining IFNs was based on the assumption that river ecosystems are "adapted to, and dependent on, the natural range of flow variability to sustain the ecological processes and diversity within the system" (AENV, 2003b). No new studies were conducted in order to determine IFN values but with improvements to models and the refinement of previous findings the IFN report "is believed to be comprehensive by today's standards" and acceptable for achieving a high level of aquatic protection (AENV, 2003d).

In addition to consumptive and non-consumptive uses, the background studies modeled future allocation scenarios in the SSRB. The Alberta government's Water Resources Management Model was used to model eight

different allocation scenarios in order to estimate the availability of waters in the SSRB to meet allocation and IFN demands (AENV, 2003e). The model scenarios are run on a weekly time-step that calculates the total demand against the total supply of water for a 68 year period from 1928-1995 using collected runoff data and existing infrastructure capacity (AENV, 2003e). In cases where water deficits arise the model begins removing water from junior licenses until all senior water licenses receive their allocations in full (AENV, 2003b). The results of the model scenarios are referenced to the deficits that occur in dry years and, accordingly, the fewer deficit years the better.

The scenarios can be grouped and explained as three sets. The first represents a base case where current water allocations and the Instream Objectives (IOs) of the management regime in place prior to the Phase I and II plans are retained. The second set of scenarios plot the trajectory of water resources in the SSRB under the existing regulatory regime guiding the maximum acreage limits for irrigation in the SSRB. The limits established in the early 1990s under Alberta Regulation 307/91 have almost been reached and the model therefore considers a number of potential development scenarios (AENV, 2003e). The third set of scenarios is exploratory. Since the effect of IOs on environmental protection is not known the first scenario in this set explores replacing IOs with the IFNs values (AENV, 2003e). The next scenario gives priority to IFNs over existing licenses and the third scenario models the effects of reducing consumption in the SSRB by 20%. The fourth scenario in this set considers how much more water would be available for consumption if both the Red Deer River and the Saskatchewan delivered 50% of their natural flows to the Saskatchewan border as per the 1969 *Master Agreement on Apportionment* between the two provinces. The final scenario considers the effects of replacing IOs with IFNs on new allocations and backfitting IFNs onto old licenses where possible.

The conclusions of the model scenarios are interesting. In the base case scenarios IOs are usually met, except in certain portions of the Bow River and in the southern tributaries where frequent and substantial deficits exist given the current level of allocation. In the second set of scenarios, those assessing

potential development, deficits require further water allocations for irrigation expansion in the Bow sub-basin under the existing regulatory framework while the Oldman and Saskatchewan rivers begin experiencing deficits as increased pressure is put on the storage capacity of reservoirs. After fifty years of development there are substantial deficits for all junior water license holders and the western irrigation district in the Bow sub-basin has a significant deficit (AENV, 2003e).

The exploratory scenarios, which replace IOs with IFNs, indicate that when IFNs for the aquatic environment are applied they cannot be met given current allocation levels (AENV, 2003e). Even if there was a 20% reduction in water consumption there would only be moderate relief as most of the water returned would be claimed by junior licenses previously deprived. By fixing fifty percent of the Red Deer's natural flow the junior Oldman and Saskatchewan license holders would experience frequent large deficits as more water is required to meet the interprovincial agreement with Saskatchewan (AENV, 2003e). This would have a substantial influence on allocations as the Red Deer River currently makes up any deficits that the waters farther south in the SSRB may have regarding the interprovincial arrangements.

The results of model allocation scenarios, which combine historic water availability with current levels and projected levels of water use in the SSRB, indicate that the risks of water scarcity in the region present a significant problem in balancing human use and environmental conservation in the SSRB. Finding a sustainable solution to this problem is the central task of the approved management plan for the SSRB.

3.5 THE APPROVED WATER MANAGEMENT PLAN – 2006

The *Approved Water Management Plan for the South Saskatchewan River Basin* carries forward the high expectations created by Phase I and the Phase II studies that the limits of water supply can be managed to reduce risks to economic development without compromising environmental quality. To wit,

> "Water transfers, within the basin, will allow already allocated water to move to new demands and will allow for continued economic development, while improving the aquatic environment through water conservation holdbacks."
> – Phase I (AENV, 2002a)

> "Alberta Environment is leading the development of the province's first water management plan to maximize the benefits of water use in the South Saskatchewan River Basin (SSRB) in a sustainable and environmentally responsible way." – Phase II Background Summary Report (AENV, 2003b)

The 2006 management plan does not disappoint. In fact,

> "The Approved Water Management Plan for the SSRB is critically important at this time. It defines how water should be respected now and into the future. It brings clarity to questions that have been posed for many years. The aquatic environments of all the rivers have a demonstrated need for protection, while the economy of Southern Alberta depends on water for its life blood." (AENV, 2006a).

So introduced, the plan outlines a "publicly acceptable" strategy for establishing Water Conservation Objectives (WCOs) and reviews the current regulations guiding water licensing in the SSRB (AENV, 2006a). The recommendations of the plan include setting WCOs at 45% of the natural flow rate of rivers or the existing Instream Objective plus 10%, whichever is greater; this is a goal that will take "many years" to reach (AENV, 2006a). It recommends that no new applications for allocations be accepted anywhere in the SSRB except for the Red Deer River Basin and recommends repealing the 1991 regulation on water allocation with the present plan superseding previous regulations.

The Red Deer River receives special attention in the management plan as it is the only river that has the potential for further allocation and is therefore in a position to be developed in a sustainable fashion. The management plan recommends that allocation on the Red Deer rise from the current level (18%) to 45% or 600 000 cubic decameters which will support future growth for the next 40 years (AENV, 2006a). Once the limit to allocation is reached a review is to be conducted on the state of the aquatic environment.

In addition to establishing new management strategies for the SSRB, the new plan makes recommendations on both market allocation transfers and the *Water Act*. The conservation holdback of 10% during allocation should be universally applied to recoup water for environmental needs and the *Water Act* should be amended such that: 1) Private parties can hold licenses expressly for the purposes of conservation; 2) Parts of licenses can be cancelled; and 3) Unallocated water would become part of a Crown Reservation to be used for the "greatest benefit to society" (AENV, 2006a).

The new water management plan continues the traditional system of prior appropriation for water allocation and does not recommend that any licenses be cancelled for the sole reason of "accomplishing recommended outcomes of the water management plan" (AENV, 2006a). Rather, the plan prioritizes possible outcomes by emphasizing the risks of receiving or not receiving water and recommends that an inter-basin coordinating committee be set up to facilitate matters of common concern during periods of water shortage (AENV, 2006a).

3.6 Conclusion

The shift of concern from controlling water supply in the SSRB to managing the risks associated with limited water resources has been outlined in three key policies in the SSRB. The *Water Act*, Alberta's *Water for Life* strategy and the 2006 approved management plan for the SSRB reflect a new approach to water management in Alberta. This transition has been accomplished within the main constraints of the legislative framework initiated by Pearce in the late 19th century as the government retains water as property of the Crown and rights to water are granted on a system of prior appropriation. However, by replacing the rationale for water use decisions the method for implementing water policies through allocation transfers and environmental conservation employ risk as the motivator for sustainability. Chapter four critically assesses whether risks have been correctly and democratically calculated as this is a prerequisite for sustainability and for sharing the risks of water scarcity at a level acceptable to users.

Chapter 4

The Present: Sustainability and Risk in the SSRB

4.1 INTRODUCTION

In just over a century Alberta's south went from a din of ranchers and whiskey bootleggers to a fully industrialized agricultural hub. The growth has been unprecedented and immigration to major urban centers such as Calgary has likewise increased water demand apace. The increased pressure on water in the SSRB is now being handled through new legislation, the province's *Water for Life* strategy and new management plans for the SSRB watershed. Critical to the success of Alberta's revisions to public policy is how policy decisions reflect and respond to the empirical facts, economic institutions and social values that have shaped the SSRB prior to, and during, western settlement.

Chapter three presented Alberta's new management plan for the SSRB in reference to the provincial framework for water policy in Alberta. I argued that the limits to water supply created a new rationale for water policy decisions based on the risks of scarcity should limits not be respected. In this chapter I question whether the limits, and consequent risks, of water in the SSRB have been correctly assessed. I argue that a critical assessment of the empirical history, institutional and environmental needs and social concerns guiding water allocation in Alberta reveal alarming miscalculations. Some of the consequent problems have been inherited from previous policy decisions, others are the result of more recent errors, but their cumulative effect is a management plan that is sustainable only on a best-case scenario.

4.2 SURFACE WATER AVAILABILITY

Alberta's management plan for the SSRB uses the period from 1928 – 1995 to model future allocation scenarios. The credibility of model results, in turn, depends on whether the time period used adequately represents likely future conditions (Jakeman & Letcher, 2003). The utility of model scenarios for

attaining sustainability is therefore critically linked to the history of water availability in the SSRB. That history however, is contested.

After a severe drought in 2001 Alberta Environment commissioned a study to assess whether the trend towards lower flows reported by citizens and farmers was empirical fact or nervous fiction. The results of the study for three major rivers in the SSRB (the Bow, the Red Deer and the Oldman), concluded that no trend towards increased or decreased streamflows existed for the period 1912-2001 (AENV, 2004c). Shortly after the Alberta Environment study was published, a similar study was published claiming that there has in fact been a negative trend in stream flow during the 20th century and that the southernmost of Alberta's rivers are experiencing the sharpest declines (Rood et al., 2005). By extending a premise shared by both studies perhaps some clarity for future policy decisions may be found. Both studies agree that concerns over streamflow decline stem from uncertainty regarding variability in streamflow at longer time scales such as centuries or millennia. Fortunately, the relatively short instrumental record available for the 20th century in the SSRB can be supplemented by proxy measures available for reconstructing empirical flows at time scales relevant to resolving long-term concerns.

4.2.1 The empirical evidence

Paleoecological studies using both tree ring records and saline diatom deposits in lake sediments demonstrate that conditions in southern Alberta have been drier in the past than in 20th century. Case and MacDonald (2003) traced tree ring histories in the prairies of Alberta and determined the mean flow during the 20th century for the South Saskatchewan River Basin (SSRB) for a 522-year period. In the SSRB the mean flow was 6.5 percent higher in the 20th century than during any of the last five centuries with the period from 1912-1967 showing an average above the rest of the (already wet) 20th century (Case & MacDonald, 2003). These relatively high flows were interspersed with relatively short droughts, such as those of the "Dirty 30's" that turned much of the western prairies into a large dust bowl. Similarly, saline diatom records show that at

multi-centennial scales the western prairies experience prolonged periods of intense drought brought on by dramatic climate shifts not uncommon to the region (Laird et al., 2003). Many of these droughts were longer and more severe than any seen since western settlement and correlate strongly to oceanic events such as the Pacific Decadal Oscillation that brings warm water to the west coast of North America and dry conditions to Alberta (MacDonald & Case, 2005).

The history of streamflow in the SSRB and the climate of the western Prairies in general reveal that the 20th century streamflows came at a high period in geologic terms. But what about the future? The impacts of climate change on areas already under water pressure could exacerbate water shortage problems and further compound effective management. It is therefore worth examining how well the SSRB management plan prepares for climate change effects.

4.2.2 Climate change forecasts for the SSRB

The SSRB management plan does not consider the potential effects of climate change claiming that models contain too much uncertainty to inform policy decisions (AENV, 2006a). But given the empirical evidence for flows in the SSRB even a cyclical return to drier flow conditions from recurring climatic cycles could have serious impacts. And of the existing climate model scenarios, most are in agreement that the prairies will experience an increase in temperature in the 21st century (Schindler & Donahue, 2006). Although the effects of climate warming on runoff in the rivers of the SSRB are less certain, the literature presented below suggests that changes in climate will affect precipitation, potential evapotranspiration and glacial ablation, each with the effect of lowering overall streamflow in the SSRB.

Winter snowpack in the Rocky Mountains generates most of the critical flows needed during periods of high water demand in the summer. Climate models suggest that increased temperatures will shift the precipitation regime in the SSRB towards thinner snowpacks but increased total precipitation in the form of rain (Lapp et al., 2005). Because rainfall is a much less effective producer of runoff than snow melt the overall result of precipitation changes in the SSRB is a

net reduction in streamflow, especially the streamflow needed during the critical summer months when water demand is highest and precipitation is lowest. Increased temperatures in the SSRB is also projected to increase potential evapotranspiration demands such that increased precipitation will likely be exceeded by increases in potential evaporation; this in a region where actual streamflow in the summer has been reduced by 84% in the 20th century from anthropogenic withdrawals (Schindler & Donahue, 2006).

Compounding the problem of declining runoff and increasing evaporation rates is the declining buffer provided by glacial melt during the late summer and early fall when snowpacks are gone and precipitation is low. Alberta's alpine glaciers have retreated considerably in the 20th century and have traditionally contributed between 13-56% of the streamflow in summer. Alberta's southernmost river, the St. Mary's, finds its headwaters in Glacier National Park, Montana where the remnants of hundreds of glaciers formerly found in the park have a predicted extinction date near 2030 (Hall and Fagre, 2003). The results for the ecology and economy of southern Alberta could be severe as the St. Mary's River contributes 10% of the annual flow in the Oldman River, is used to irrigate some 150 500 ha and is the most heavily subscribed river in the province with 118% of its median annual flow allocated for withdrawal or diversion through 2060 km of conveyance infrastructure (AENV, 2005a; St. Mary's Irrigation District, http://www.smrid.ab.ca/).

4.2.3 Implications

The empirical evidence and model forecasts unanimously indicate that 20th century streamflows in the SSRB do not represent likely future conditions. Despite these facts the management plan for the SSRB takes what historically has proved to be a best-case scenario in terms of streamflow and offers it as the basis for all subsequent management decisions on sustainable water use in the SSRB (AENV, 2006a). There is good reason to reign in this optimism. First, the management plan for the SSRB models future allocation scenarios using the period from 1928-1995 even though the 20th century averaged 6.5% more runoff

than previous centuries (Case and MacDonald, 2003). Second, the effects of climate cycles, precipitation changes, evaporative demands and glacial retreat are not considered singularly or cumulatively in the management plan (see AENV, 2006a). Third, recent estimates forecast that sustainable growth in cities like Calgary will require a reduction in per capita water use by 50% over the next sixty years due to increased water demand from both climate warming and population increase (Chen et al., 2006). Readjusting expectations regarding future water availability is critical to successful water management in the SSRB, yet woefully neglected. Although the plan recommends monitoring flows to "confirm water modeling results" there is no time scale given to accomplish this task. Moreover, given the model inputs, such confirmation is unlikely.

4.2.4 Policy recommendation

Alberta must prepare for a period of lower flows than any experienced during western settlement. It is therefore recommended that Alberta's Water Resources Management Model be rerun on a weekly time step using a randomly generated set of mean values from available paleoecological data sets for the SSRB. Due to the fact that paleoecological records only make yearly data values available it is recommended that season patterns in the historical record from 1928-1995 be used to derive proxy time steps for wet and dry years.

4.3 MARKETS, LICENSES AND INSTREAM NEEDS

As we saw in the previous chapter, the management plan for the SSRB is premised on meeting a double objective of increased environmental protection and continued economic development. A necessary step in this process is the implementation of policies that prevent further environmental degradation while at the same time respecting existing economic interests. In this section I present a critical assessment of the key features of the management plan that are aimed at accomplishing this objective.

4.3.1 Environmental needs and economic allocation

One of the central tasks of the management plan for the SSRB is to balance human consumption and environmental conservation. However, adding environmental conservation and the preservation of biodiversity to the management schedule will require significant adjustments. This is mainly due to the fact that previous allocation limits, the Instream Objectives, provided target goals for limiting allocation but the environmental consequences of meeting or exceeding Instream Objectives are not known on portions of, and even entire rivers in the SSRB (AENV, 2003e). As a consequence there is little baseline data available for estimating environmental impacts due to allocation. The new management plan showed promise, then, when it commissioned a set of background studies that provided a scientific basis for setting Instream Flow Needs (IFNs). However, the IFN report failed to manifest in the management plan and consequently the ecological needs in the SSRB are unlikely to be met.

The targets for environmental flows in the management plan are set at forty-five percent of the natural flow, or the existing Instream Objective plus ten percent, whichever is greater (AENV, 2006a). This target is well below the IFN report which concluded that eighty-five percent of natural streamflow was required for maintaining biodiversity and riparian health (through, for example, adequate water quality and maintaining channel structure). Moreover, in the remaining river system where ecological integrity could be preserved the target amount of water required for environment flows does not meet the requirements of the IFN report.

Only one of thirty-three rivers in the SSRB, the Red Deer, is estimated to be in acceptable ecological condition as allocations total just eighteen percent of the natural flow. Even in this case the SSRB plan fails to deliver a framework for balancing human consumption with environmental conservation. In fact the plan fails to acknowledge that any ecological targets above forty five percent of the natural flow are workable and states that this target represents a Water Conservation Objective (WCO) that "will permit diversion for economic development in the Red Deer River Sub-basin, while limiting negative impacts on

the aquatic environment" (AENV, 2006a). Upon reaching the allocation limit the plan requires an environmental review in order to set an absolute limit on water allocation (AENV, 2006a).

The new management plan also replaces the 1991 regulation for allocation limits. However, the new plan does not implement a policy that prevents environmental degradation on the Red Deer River because it prioritizes economic development over environmental conservation. The rationale for future allocations on the Red Deer River is indicative of economic development trumping environmental concerns. The plan states, "In the case of the Red Deer River, it is felt that economics could dictate whether further allocations for any purpose should occur, until a Crown reservation is created for specific purposes." Crown reservations establish water uses beneficial to society but with no limit set for allocations on the Red Deer River and the recommendation for establishing such limits not occurring until after allocations on the Red Deer River surpass those recommended for maintaining healthy ecosystems in the Instream Flow Needs report (see AENV, 2006a), the new management plan's reliance on economics alone is inadequate. Relying on economics alone will not create a management regime that balances human consumption with environmental conservation because rights to water in the SSRB have ideological and practical defects.

The ideology underlying claims to water, such as those in Alberta's system of prior appropriation, harbor assumptions that are ecologically tenuous. Klug (2002, p. 697) argues that,

> "Whether property rights are understood or justified in terms of the doctrine of first possession (Rose 1985) or in terms of Locke's 1698 natural rights theory (Locke 1980); the basic assumption of the common law as shaped by Blackstone's 1766 Commentaries (Blackstone 1979) is that human beings are both outside of nature and the proprietors of the earth (see White 1967) and all its resources. It is this basic notion of human entitlement that is being challenged by the ecological events that have signaled the limits of our uncontrolled exploitation of the earth and its bounty."

Klug (2002) goes on to argue that narrowly perpetuating the current property rights regime within a single discipline, such as economics, limits the implementation of environmentally sustainable practice in water management. Butler (2000) makes a similar case for rethinking the effect of property rights on water resources by arguing that parsing water into discrete units for trade or sale fundamentally misunderstands the role of water in sustaining healthy aquatic ecosystems. Alternative approaches to property law, and the subsequent rights granted to owners, suggest that the long-term stewardship of water resources requires establishing limits to private actions that are detrimental to ecosystems and that have negative effects on the interests of society (P. Byrne, 1990). In addition to the ideological problems with carrying over Alberta's system of prior appropriation into new management plans and market transfers, there are practical constraints on the likely success of market activity.

Alberta's system of prior appropriation creates a certain type of right to water, the nature of which is a key factor in the success of economic determinants for achieving optimal allocation (Horbyluk and Lo, 1998). In the SSRB however, there are practical obstacles to successful water market activity. One is the current level of over-allocation in the SSRB. Even if twenty percent of *total* allocated water was recouped through conservation holdbacks only a marginal increase would be seen in environmental flows because most recouped water would be used to fill junior allocations that do not receive their full allocations in dry years (see AENV, 2003e). Another obstacle is the distribution of current water licenses. Seventy five percent of total water allocations are held in licenses owned by thirteen irrigation districts in the SSRB. None of these licenses have expiration dates and participation in market activity by irrigation districts is unlikely given the dependence of these cooperatively managed districts on water for irrigation (AENV, 2005a). Zilberman and Schoengold (2005) note that there are few incentives for those holding senior rights to water to partake in market activity, especially under conditions where water is underpriced. Alberta's commitment to maintain the system of prior appropriation is therefore ideologically problematic and pragmatically deficient as a tenet of the new management plan for the SSRB.

4.3.2 Implications

Balancing environmental conservation with human consumption cannot be achieved for long-term sustainability without maintaining adequate water supplies for riparian and aquatic health in the rivers of the SSRB. Despite the fact that the environmental consequences of using Instream Objectives to guide allocation decisions is unknown, the management plan does not implement target goals for the protection of biodiversity laid out by the Instream Flow Needs report and mandated by the *Water Act*. The barriers to implementing policies that would restore the ecological resilience of watersheds in the SSRB are not addressed. In the remaining watershed where significant gains could be made the method for determining allocation is based on economics without the compliment of empirical evidence that could offer higher likelihood of achieving sustainability.

4.3.3 Policy recommendation

Young and McColl (2005) argue that a robust water market system works on *shares* of water available for allocation, not on absolute allocation values. On the Red Deer River in particular, Alberta has the opportunity to create an initial distribution of licenses based on shares of total water allocations. However, this requires establishing an initial limit to allocations and then deriving shares accordingly. To achieve this, the SSRB management plan should therefore be amended to set a limit to total water allocations on the Red Deer River that preserves water for maintaining healthy aquatic ecosystems. In addition, Alberta has made the mistake of grandfathering water licenses granted prior to policy reforms that have taken place over the last ten years. Incorporating prior licenses into a share system based on requirements for environmental flows is needed to achieve sustainability.

4.4 WATERSHED SCALES

One of the key innovations in Alberta's new provincial "Water for Life" strategy, the legislative framework provided by the *Water Act* and the management plan for the SSRB is the introduction of watershed management.

Watershed management practices are not unique to Alberta and several other Canadian jurisdictions employ watershed management techniques to harness the advantages of scaling management concerns according to the geographic boundaries of natural processes (Senecal and Madramootoo, 2005). The reason for implementing watershed management is the increased ability to ensure that the capacity of individual watersheds is not exceeded as hydrologic inputs and outputs at watershed scales provide direct measures of natural capacity (Wallace et al., 2003). Successful watershed management in Alberta is therefore necessarily committed to policy decisions that protect the capacity of individual watersheds, a commitment reaffirmed in the *Water for life* strategy as a key principle in sustainability (AENV, 2003a). The commitment to watershed management, however, is a normative commitment because the physical boundaries of the SSRB are not congruent with the jurisdictional boundaries that the SSRB management plan operates within. In this section the normative claims underlying watershed management in Alberta are examined.

4.4.1 Problems of scale

Despite the strong *prima facie* commitment to watershed management in Alberta the management plan for the SSRB fails to institute policies that operate within the capacity of individual watersheds. According to the Strategic Overview of Riparian and Aquatic Condition (SORAC) report, the ecological health of most rivers in the SSRB is in a state of long-term decline (2003c). Independent research confirms that the intense livestock operations in the SSRB also contribute to increased counts of bacterial pathogens such as *E. coli* and salmonella in both irrigation and river water (Gannon et al., 2004).

In addition to empirical concerns, watershed management practices integrate social concerns into institutional arrangements in recognition of the fact that local level action is one of the most effective means of relieving water problems. Alberta's new management plan solicited public involvement in establishing plans that operate within the natural capacity of watersheds and are also socially acceptable. Although only a fraction of one percent of the population

in the SSRB (181 of 1.5 million people) was involved in the public consultation process there was considerable concern expressed regarding the failure of the plan to institute any actual measure of watershed capacity (AENV, 2006b). The proposed Water Conservation Objectives (WCOs) of 45% of the natural flow received majority support (51%) in only one of the four sub-basins of the SSRB (AENV, 2006b). Quite interestingly, forty-four percent of public responses indicated that the WCO set for the Red Deer River was unacceptable, while only twenty-seven percent found it acceptable and twenty-eight percent were unsure (AENV, 2006b). Despite this result and numerous comments by the public expressing concern over the environmental consequences and social commitments of the proposed WCOs for the SSRB they were not changed. But public concern is not unwarranted. Available scientific evidence suggests that future declines in water quality or quantity could eliminate options for ecological restoration on highly impacted areas in the SSRB (Rood et al., 2003). Even though the Red Deer is not presently an area of high impact, the IFN report suggests a natural flow of 85% is required for environmental protection (AENV, 2003d).

One of the most formidable obstacles to establishing and enforcing measures of watershed capacity is found in the management plan's commitment to preserve the current system of prior appropriation for water licenses in the SSRB. Beginning with this premise, it unlikely that human consumption and environmental conservation can be balanced considering the current state of over-allocation in the SSRB. Under the system of prior appropriation only one method of water recovery is currently available in the SSRB management plan: conservation holdbacks during market allocation transfers. In practical terms, however, this avenue of recovery has very limited potential. For example, in order to increase the flow on the St. Mary's River by one cubic foot per second over 35% of the allocated water in the St. Mary's would need to be transferred (AENV, 2005a). Moreover, as was mentioned above, even a twenty percent recovery of the *total* water in the SSRB would lead to only marginal increases in environmental flows as recouped water would be used to meet junior water licenses that do not receive their full allocations in dry years (see AENV, 2003e).

During the first three years of market operation only eight licenses have been transferred in the entire SSRB (AENV, 2006b) and research indicates that considerable work will need to be done to increase market activity (Nicol, 2005).

4.4.2 Implications

Maintaining conditions that lead to ecological degradation reduces the capacity of watersheds to support necessary ecological processes. The management plan for the SSRB precludes options for significantly reducing allocations because it stipulates that the system of prior appropriation for water licenses be retained and that no licenses be affected for the sole purpose of accomplishing Water Conservation Objectives (AENV, 2006a). The lack of mandatory language in Alberta's *Water Act* means that even though public consultation is required during the establishment of Water Conservation Objectives, there is no requirement that Water Conservation Objectives be set for individual watersheds in Alberta. It remains to be seen, therefore, whether the commitments of Alberta's watershed management plan will retain enough natural and social capacity in individual watersheds to deal with future constraints.

4.4.3 Policy recommendation

The obligation to manage watersheds within their individual capacity is not met under the management plan for the SSRB. One reason for this is the decision to treat the entire SSRB as a single unit in meeting interprovincial agreements. An alternative would be to ensure that each individual watershed in the SSRB contributes 50% of its natural flow to the meeting of provincial requirements. This would both increase the effectiveness of achieving watershed management goals and increase the amount of water in ecologically stressed watersheds as deficits in one part of the SSRB would not be compensated for elsewhere. A second recommendation is to reconsider the historical and political rationale for the system of prior appropriation. As chapter two demonstrated the agendas of sovereignty and settlement have been achieved and there is little warrant for continuing Alberta's system of prior appropriation simply to maintain

the status quo. Making these two adjustments requires a more robust normative framework in the SSRB management plan as public participation and ecological status of watersheds would translate into direct obligations for water use decisions. Matthews et al. (2007) criticize Alberta's Water for Life strategy for failing to indicate how obligations to preserve environmental integrity fit with obligations to direct human interests and, in the next chapter, the task of investigating how Alberta's future management commitments fit with ethical obligations is taken up more directly.

4.5 CONCLUSION

The management plan for Alberta's SSRB ignores historical flow trends and possible effects of climate change in its estimation of future water availability at its own peril. Increased hydrological forcing on riparian and aquatic ecosystems is likely as flows decrease and allocation levels remain unchanged. The potential for reducing allocations for long-term sustainability is small and current evidence suggests that despite public opposition the remaining river available for allocation will be allocated without respect to streamflow levels necessary to maintain the health of riparian and aquatic ecosystems.

These findings are alarming. Public policy decisions regarding water in Alberta's SSRB fail to limit or reduce the impacts of over-allocation of water despite a direct commitment to do so in both the provincial *Water for Life* strategy and the management plan for the SSRB. There have been numerous warnings that new policy decisions in Alberta are desperately needed (Schindler & Donahue, 2006) and that basing decisions on the flows of the 20th century is misguided (Rood et al., 2005). Yet the new management plan maintains the status quo, expects sustainability to be achieved within the current institutional framework and plans only for a best-case scenario.

Chapter Five

The Future: Alberta's Water and the Potential for Adaptive Management

5.1 INTRODUCTION

Although future water availability in southern Alberta is contested there is virtual consensus that whatever water is available, it will be subject to Alberta's highly variable patterns of precipitation. The SSRB management plan offered itself as a model for future water management but warrants serious caveats. Alternately, Alberta's *Water for Life* strategy offers a long-term approach to water management that involves instituting a method of increasing social and ecological capacity to adapt to the highly variable nature of water availability in the SSRB. The approach is known as adaptive management and Alberta is committed to implementing adaptive techniques by 2010-2014 (AENV, 2003a).

This chapter presents the adaptive management framework and argues that Alberta's long-term goal of implementing adaptive management systems will meet with limited success. The problem stems from the theoretical basis for adaptive management and is due to the fact that the normative claims in adaptive management theory fail upon close scrutiny. As a result, when the adaptive management framework is applied to the Albertan context it fails because of conflicting commitments that promote adaptive capacity but do not provide leverage against existing institutional constraints. The chapter concludes by proposing how a more robust normative framework may be constructed for meeting Alberta's obligations to provide water for social and ecological systems within its commitment to using adaptive management techniques in the future.

One further note on this chapter is in order. The first four chapters of this thesis progressed through historical and empirical evidence in an examination of the current management plans for the SSRB. But this chapter looks to the *future* of water management in Alberta and this necessitates a shift in the style of argumentation. As a result, this chapter compares the theoretical claims of adaptive management to policy realities in Alberta. At the same time, this chapter extends the principles in Alberta's *Water for Life* strategy, and Alberta's

legislative framework more broadly, to assess the ethical implications of adopting adaptive management practices in the SSRB. The tone for the chapter is therefore more philosophic in its evaluation of normative premises in adaptive management theory and their implications for the future of water policy in southern Alberta.

5.2 ADAPTIVE MANAGEMENT THEORY

Adaptive management strategies reject 'command-and-control' approaches to resource management; the critical errors of which generalize into two main problems. The first is the separate, often exclusive policy strategies towards managing social and ecologic systems, and the second is the assumption that ecological processes respond in a linear fashion to disturbances and are therefore controllable (Folke *et al.* 2002). The adaptive management alternative is to assume change, recognize that ecological systems are complex adaptive systems exhibiting non-linear responses to disturbances and to relearn resource management (Gunderson *et al.*, 1995). Rather than attempting to control for surprising or unpredictable events, the "Golden Rule" of adaptive management is to, "strive to retain critical types and ranges of natural variation in ecosystems" (Holling & Meffe, 1996). The rule, patterned on Aldo Leopold's (1966) work, argues that minimal intervention in ecosystem management is the default position until it is proven that manipulating an ecological system will not undermine the resilience[11], or in Leopold's words, the stability of the entire system.

With the burden of proof resting on knowledge of how human activity will affect ecological systems, adaptive management theory has increasingly emphasized one of its central tenets: social learning (Walters, 1986). Social learning is a term that describes the varying scales of agency, competence, time and resources available to decision makers (see Gunderson *et al.*, 1995). It is a

---

[11] The resilience of an ecological or social system refers to its capacity "...to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker et al., 2004). The concept of resilience has evolved considerably since it was first introduced in the early 1970s but has grown to include facets of social learning and organization that increase the capacity of resource managers to make sustainable decisions (Folke, 2006).

dynamic process where management is viewed as a process of regional experimentation and where observations of both social and ecologic systems aid managers in rectifying managerial inadequacies. The economy of the approach is considerable because it recognizes the uncertainties surrounding the effects of human disturbances on ecological systems and provides flexibility to managers in responding to knowledge gained through experimentation.

In addition, adaptive management extends the social learning process outwards through both cooperation and collaboration in community based management systems (adaptive co-management) (Folke *et al.* 2005). Cooperative approaches to environmental management problems seek environmentally viable outcomes to shared problems and they organize stakeholders that could be potential adversaries around common concerns (Ali, 2003). In situations where water resources are cooperatively managed, the benefits from cooperation, by some accounts, are a win for economic, political and ecologic systems and incur few, if any, losses (Sadoff & Gray, 2002). Adaptive comanagement facilitates cooperative success through the social learning process as institutional arrangements and policies are conditioned by new ecological knowledge and reorganized accordingly (Folke *et al.*, 2002).

In adaptive co-management the learning process includes both the structural aspects of ecological and social systems and the organizational dynamics affecting the implementation of management plans (Olsson *et al.*, 2004). In this way the linkages from observations of ecological responses to managerial readjustment and social capacity building all contribute to the learning process. The end result is a coupling of social and ecological systems within a management strategy that drives the social learning process in concert with ecological changes. This process allows the different hypotheses available for cooperative arrangements to be tested and for inadequate policies to be revised.

5.2.1 How social learning works

Gauging the success of adaptive management experiments is not an entirely straightforward process. The main difficulty lies in the comparison of the

premises used to create management experiments, or "institutional premises," and observed ecological responses (Lee, 1993). The difficulty lies in the fact that adaptive management strategies start off by employing existing knowledge to form institutional premises that are then translated into plans for regional experimentation. At the end of the 'experiment', managers compare institutional premises to actual ecosystem responses and revise management plans as needed. But which institutional premises need revision?

It would be a formidable task to tally all observations of an ecosystem from time T_1 to time T_2, locate responses to change and then delineate which are the effects of human or ecological causes, especially considering the complex and often non-linear responses of systems to disturbances. So adaptive management shifts the focus of social learning to an assessment of how changes in human behavior affect ecological responses (Lee, 1999). This does a considerable amount to shore up difficulties because the assessment of managerial experiments comes with the knowledge of human behavior gained experientially.

However, the problem of how to revise institutional premises persists because human knowledge is incomplete and any new decisions must be made under conditions of uncertainty. Uncertainty in adaptive management arises as the result of surprises that may come through: 1) Unexpected discrete events; 2) Long-term discontinuities between expectations and ecologic responses; or 3) The emergence of new information (Gunderson, 2003). But regardless of the type of surprise, a certain amount of uncertainty plagues the social learning process. Lee (1993) suggests that we can understand these uncertainties as either social or technical uncertainties that are resolved by respective social or technical communities. In the social learning process what becomes critical is that the social, technical and (often) political communities are able to manage uncertainty collectively, but this is an area of research that remains unresolved as most successes in adaptive management result from temporary, pragmatic arrangements (Gunderson, 2003). One suggestion for navigating through uncertainty is the incorporation, where possible, of the 'traditional knowledge' accumulated across generations by cultures that have been able to adapt

successfully to ecological changes (Berkes *et al.,* 2000). Failing such knowledge, however, uncertainty remains.

In what follows I am concerned primarily with finding a criterion that can gauge successful social learning and serve as a guide for revising premises in the process of communal decision-making. That is, I am concerned with understanding what it is that adaptive experiments tell us we should do in the future. That there are normative claims justifying adaptive management has been recognized before (McLain and Lee, 1996) and I examine three possible ways that social learning makes recommendations for how management ought to take place in the future.

5.3 FINDING A CRITERION FOR SOCIAL LEARNING

This section presents a theoretical discussion of the potential for social learning in adaptive management strategies through three arguments, two of which are directly applicable to the Alberta policy context taken up afterwards. The measure of a successful argument, I submit, is that it provides us with at least *a* criterion that allows us to decide what institutional premises (if any) need revision during the evaluation of management experiments. The criterion will be successful if it returns knowledge regarding how, or if, our uncertainties bear on our institutional premises. Under this definition of success the criterion will provide the justification for how knowledge gained through managerial experiments should be marshaled in future decisions. It will allow us to know when the "Golden Rule" has been met.

5.3.1 Cooperation is the key

One argument for a social learning criterion in adaptive management is that cooperation and collaboration sufficiently gauge the evaluation of management experiments. On this account cooperative revisions to management plans ensure that the distribution of resources is in some sense fair or equitable for all involved. If the distribution of resources is unfair, cooperation dictates compensation and a new cooperative framework for addressing the uncertainties

that led to undesirable results. In cases where uncertainty is irreducible techniques like scenario planning can construct sets of plausible futures and provide options for action. Peterson *et al.* (2003) suggest that through stakeholder convening during scenario planning a focal issue "should emerge from negotiation among participants in the planning process" and implicitly define the system we are interested in learning about. The key to success, on this argument, is that cooperation justifies the implementation of new management plans because the measured effects of human behavior are determined collectively.

But is cooperation the key to success in social learning? It seems that if cooperation serves as a criterion for gauging success in social learning that it would be circular to assert that it can also serve as the basis for forming future institutional premises. If that were the case we would face an interesting conclusion: The inference suggesting that social learning will increase our ability to recoup managerial inadequacies would simply be an innocuous stipulation that cooperation will work.

In scenario planning, for example, appealing to cooperative selection as the criterion for defining a system of interest as Peterson *et al.* (2003) suggest is merely stipulating that all stakeholders agree on the terms, or referent, for a given problem space. While an account of plausible futures is a good extension of what we may presently agree on it is not also a substitute for guiding our cooperative efforts to buffer against uncertainty because we may still exclude investigating scenarios that we should be concerned with and that only appear implausible because of our (cooperatively agreed upon) institutional premises. This type of cooperation suppresses precisely what is at issue.

5.3.2 Perennial change, seasonal gains

A second argument for gauging social learning is to identify the continually changing nature of ecological systems. From this premise we can infer that social learning requires multiple iterations of regional experimentation to determine the scale of ecological changes. Once the scale of changes is determined the relationship between ecological responses and institutional

premises is clarified and opportunities for learning arise. Getting to this point involves a considerable amount of self-correction and flexible institutions are those that are good at identifying signals of change (Holling, 1996). That is, notwithstanding our present epistemic deficits, the way to provide a criterion for assessing social learning is to find a way to choose between the various hypotheses that could explain the gap between observations of ecosystem responses and our institutional premises but developing techniques to further this end takes time (Walters & Holling, 1990). The conclusion? Expect the social learning process to be slow and ongoing as ecological systems change but also expect epistemic gains to punctuate the process on occasions where experiments capture relevant aspects of ecologic systems.

This argument makes an excellent point because there is no way to guarantee that any learning process will get it right the first time. Yet it leaves open the question, what are we adapting to? If social learning requires multiple iterations of experimentation to determine the scale of ecologic changes, then the evaluation of what social learning is taking place doesn't get us very far in determining whether we've started out anywhere near the problem. Rather, all it does is let us know that, given our starting point A, we are X distance from A. In terms of adaptation we could envision an extremely long learning cycle. Consider how many revisions were made to Ptolemy's theory of heavenly bodies before his epicycles were replaced with Copernicus' heliocentric theory. In a similar vein, there is no reason to assume *a priori* that sustainability revolves around social learning or that explicitly focusing on social learning *now* is the best long-term strategy for successful social adaptation. The upshot is that without a thorough consideration of constraints to initially implementing adaptive management strategies, very little social learning may be able to take place. This problem is highlighted in the Albertan case study below.

5.3.3 The fatally open mind

A third argument for a social learning criterion suggests that the value of any management experiment is in the avoidance of unnecessarily positing criteria

that may limit future adaptation. Social learning, on this argument, is a process of perpetual adaptation because ecologic systems are a moving, sometimes unpredictable target. A constantly changing ecological reality requires both perpetual adaptation and reevaluation of our managerial efforts during management exercises in recognition that social learning is never complete (Carpenter et al., 2002). In fact, it is desirable to perpetuate the learning cycle in a way that mirrors the adaptive cycle of ecosystems because the slow (i.e. geologic) to fast (i.e. biologic) scales in ecosystem dynamics do not lend themselves to any particular set of institutional premises (Holling and Gunderson, 2002). Further, trying to carve out a particular scale for problem solving is often successful for narrow concerns but can create more problems and further complicate the management of larger systems. Westley et al. (2002) suggest that although human beings have the ability to transcend the boundaries of their social system and to take up a reflexive position for decision making, it is the generation of novel solutions in the face of uncertainty and surprise that have allowed humans to successfully adapt to previous environmental crises. As a result, while it may appear (*prima facie*) fruitful to define some criterion that gauges the success of social learning, it is not necessary to do so because living without uncertainty is not the goal. What is valuable is finding institutional premises that forward social learning by creating opportunities for management practices to drive institutional change in concert with our observations of ecological changes.

But what if we ask, what is adaptive management for? This line of questioning concedes the point that positing a criterion in the present to help us learn in the future later may not be all that useful given the epistemic privileges that will be afforded to us at a later date. But it also raises a further difficulty because if the basis for social learning in adaptive strategies is to avoid positing a criterion that would *reduce* our ability to adapt then we receive very little guidance for how to employ the knowledge that we have gained in making decisions about the future. Perpetual adaptation may be a necessary feature of managing ecological systems but without a criterion for gauging successful outcomes social learning is evacuated from an epistemic process and conceived of

as the best adjustment we can make in the face of change (i.e. Falkenmark, 2003). The upshot is that social learning allows us to continually revise institutional premises but still fails to provide guidance on how knowledge gained should be used in the future.

Without a way to justify employing knowledge in the service of adaptation it is conceivable that we could be running a highly entropic race and that there is a set of initial premises that would allow us to run entirely oblivious to our fate. That set of premises would only need to establish a framework that we all assent to, implicitly or explicitly, that places our adaptive management exercises in a position where marshalling enough adaptive capacity is simply not possible. If such were the case, it would expose a further difficulty to those holding that adaptive management will *ipso facto* lead to social learning that increases adaptive capacity.

Circumstances preventing increases to adaptive capacity arise quite subtly in many cooperative exercises and, if they are to be corrected, require more than maintaining that perpetual adaptation will eventually lead to increased social and ecologic resilience. The standard platform for cooperation is to assume that one or another system provides the basis, or is the 'host', to which others must adapt. Unfortunately, negotiation processes often assume that humans have rights that include appropriating resources through some notion of ownership (whether communal or individual) and the rights accompanying ownership act as the host system to which our cooperative arrangements must adapt. This assumption makes it possible to begin the process of cooperation between stakeholders. Why? Because cooperative exercises vis-à-vis ownership rights means that we always tacitly agree on the boundaries for a resource base. The shared boundary of ownership implies that whatever the resources are, they are *ours* in some sense. If they weren't, there would be conflict over ownership and we would not have a basis for cooperation, whether adaptive or otherwise.

If we object that our shared notion of entitlement doesn't host the systems we are cooperatively managing, and there is no conflict, then we must give an account of why *any* of our uses of natural resources trump the uses of those

resources in their present ecological, hydrological, or biogeochemical systems (see Brown, 2004). This type of criticism has been made in another form in legal discussions suggesting that there are often negative effects of ownership rights on ecosystem health, especially where water resources are concerned (Stone, 1974; Butler, 2000; Klug, 2002). It also follows directly from the fact that if natural systems evolve as moving targets then social systems dependent on the natural world also evolve as moving targets. For instance, if we don't assume that water resources are here *for us* then we must spend considerable energy establishing a cooperative basis for defining the boundaries of what counts as part of a given resource base and what does not. For example, how do we find sufficient grounds for agreeing on how much of the global freshwater base should be used by humans without some notion of entitlement? Postel *et al.* (1996) calculated that humans appropriate around fifty percent of the earth's available freshwater. Is that too much? Too little? Should we take more or should the growing number of people without freshwater simply be ignored? What about other species?

The inference from systems being a moving target to the conclusion that we must constantly adapt to change is suspect in the context of determining a criterion for social learning. It only makes sense if we assume a constant position for one of the systems we are trying to integrate. So at the very least we must readjust the claim that 'systems are a moving target' to the claim that '*other* systems are a moving target.' But this leaves us with an unsatisfactory conclusion because if we manage social and ecological systems to ensure the success of a stationary variable (like entitlement) we inevitably create a rigid institution that could become less robust and more likely to collapse, the exact situation adaptive management practices seek to avoid (Holling and Gunderson, 2002). This problem is very apparent in water policy decisions for Alberta's SSRB and will constrain the ability of adaptive management systems to provide long-term water solutions.

5.3.4 Summary: criticisms of social learning through adaptive management

Before presenting the Albertan case study it is worth summarizing the basic objections to social learning through adaptive management that have been raised. *Cooperation is the key:* if social learning turns solely on cooperation then future management experiments needn't be premised on ecologic concerns to fulfill social learning requirements. *Perennial change, seasonal gains:* if social learning has no way to point us towards management experiments whose outcomes are desirable then social learning does not insure that increased adaptive capacity will lead to the type of adaptive capacity needed. *The fatally open mind:* if social learning does not posit a criterion gauging the success of managerial experiments it is also left without justification for leveraging new knowledge against existing constraints that management plans operate within.

The claim that adaptive management will serve as an adequate guide for how future plans should operate fails upon close scrutiny because the normative claims do not provide an adequate criteria for assessing when actions meet or do not meet the "Golden Rule." Suggesting, as Holling and Meffe (1996) have done, that a particular management plan will, "strive to retain critical types and ranges of natural variation in ecosystems" requires justification, but the three positions presented here do not offer an adequate criterion for accepting this normative claim as satisfactory.

5.4 ADAPTIVE MANAGEMENT AND SOCIAL LEARNING IN THE SSRB

In chapter three I outlined the *Water for Life* strategy for sustainable water use in Alberta. Here I reiterate a few of the main points that are relevant to assessing the potential for adaptive management strategies in the future. The *Water for Life* strategy has three main goals: 1) Safe and secure drinking water supply; 2) Healthy aquatic ecosystems; and 3) Reliable, quality water supplies for a sustainable economy (AENV, 2003a). To meet these goals, the strategy develops short, medium and long-term goals that each culminates in the establishment of adaptive management systems by the period 2010-2014. Adaptive management systems will allow the government to partner with

communities, industry and stakeholders in order to identify issues, gather information, develop and implement action plans, and evaluate management actions (AENV, 2003a).

Alberta's *Water for Life* strategy is committed, among other things, to recognizing both the limited nature of Alberta's water supply and that individual watersheds ought to be managed within their specific "capacity" (AENV, 2003a). These limitations are used in tandem with the shared nature of responsible water management between "citizens, communities, industry and government" to implore these sectors to work together at the watershed scale (AENV, 2003a). Working together involves official partnerships, information sharing, and collaboration between the various water dependent sectors in Alberta. This cooperative approach to water management in Alberta is new. It represents a significant departure from government controlled water management systems and was made possible in large part by the passing of Alberta's *Water Act* in 1996 and its coming into force in 1999.

Alberta's *Water for life* strategy identifies information and knowledge as the most critical element to effective water management in the province (AENV, 2003a). The unpredictability of water supplies in the province results from climate variability, new scientific knowledge on the effects of land use changes and emerging water quality issues (AENV, 2003a). As has been hinted at in this discussion, there is reason to question whether Alberta will be able to increase its adaptive capacity through social learning and effective knowledge uptake given the policy constraints adaptive managers will face. The following two sections of the discussion pick up on the latter two arguments regarding adaptive management (sections 5.3.2 and 5.3.3 above).

5.4.1 Alberta: Perennial change, seasonally feigned

Earlier in this chapter I tried to show why we need a criterion that points increased adaptive capacity towards something we want. I argued that if social learning has no way to point us towards management experiments whose outcomes are desirable then it does not insure that increased adaptive capacity

will lead to the type of adaptive capacity needed. How this might take place empirically can be found, unfortunately, in the context of Alberta's SSRB.

The present management plan for the SSRB states that in many parts of the watershed water is fully allocated (AENV, 2006a) and the *Water for Life* strategy reaffirms Alberta's commitment to "preserve the 'first-in-time, first-in-right" principle of prior appropriation for granting and administering water allocations" (2003a). For practical purposes the preservation of this principle could hinder the ability to learn about whether social water concerns are near ecological reality because increasing adaptive capacity under this policy framework is limited. Under the historic conditions of prior appropriation, water licenses were granted indefinitely in order to entice settlers to head west and, as the 20th century played out, this has led to severe over-allocation (Percy, 2005). At present, some twenty thousand licenses make claims on rivers in the SSRB whose southern most rivers have anywhere from 75-118% of their median annual flows allocated (AENV, 2005a).

In the remaining region where water is not fully allocated the SSRB plan states that, "In the case of the [not fully allocated] Red Deer River, it is felt that economics could dictate whether further allocations for any purpose should occur..." (AENV, 2006a). But this leaves unasked some very important questions that future adaptive managers will face. Namely, what latitude is there for revisiting management plans to secure long-term ecological viability when water allocation is determined through economic mechanisms? A common set of economic assumptions guiding water allocation may not allow revisions to management plans that reduce allocation, because the framework guiding management action stipulates that water concerns begin with economic determinants and adapt accordingly. Walters (1997) points out that there is no economically objective way to determine the costs of policy changes that alter the status quo and recommends that an additional ethical component to resource management arguments is needed to fairly determine water allocation.

Alberta's problem, however, runs even deeper because at its root the management plan for the SSRB contains contradictions. For while the SSRB

management plan is committed to using the "full suite of tools in [Alberta's] *Water Act"* (which includes cancelling or suspending licenses under section 43) it also states that "no license be cancelled for the sole reason of accomplishing recommended outcomes of the water management plan" (AENV, 2006a). This is another potential difficulty for future adaptive managers since the SSRB management plan is also responsible for setting Water Conservation Objectives (WCOs) such as instream flows requirements. The result of setting WCOs on over-allocated rivers while stipulating that conservation objectives may not override existing allocations in any case is that the enforcement of WCOs within the existing water allocation regime limits flexibility for future adaptive managers to adjust water allocations if ecological observations should so dictate.

Future adaptive managers in Alberta will face several constraints as historic licenses are grandfathered out of new managerial restrictions and WCOs attempt to operate within riparian ecosystems that are, in the main, over-allocated. Relief from the situation may be possible by applying the resource manager's "Golden Rule" and appealing for a change away from detrimental allocation regimes. But this appeal would involve supplying justification from an adaptive management experiment that has gained epistemic purchase on the type of adaptive capacity that is needed. In short, it would need some criterion that provides warrant for the "Golden Rule" being the correct rule.

Moreover, the argument would need to show *a priori* that exhausting all options for adaptation under Alberta's current allocation regime will not lead to increased resilience. Why switch from Ptolemy's epicycles to Copernicus' theory when adding another epicycle might just do the trick? If the default position of adaptive management is that learning is a long-term process of testing different managerial hypotheses and adapting accordingly then the warrant for how to employ new knowledge depends on the criteria converting new knowledge into new management institutions. If, as in Alberta's case, there are few options for adaptation within a system of prior appropriation that has been recognized as flawed since the 1920's (Percy, 1977) adaptive managers will need a way to build a case for long-term success that isn't purely a case of adaptation. The argument

will be normative, and it will need to be normative in a very comprehensive way as it attempts to reconcile obligations to both social and ecologic systems.

5.4.2 Alberta: Blind eye, fatally open mind

In the third argument (*5.3.3* above) I tried to establish that perpetual adaptation without positing a social learning criterion leaves little justification for leveraging new knowledge against existing constraints to management plans. The argument centered on the notion of human entitlement to natural resources and the effects of understanding resources as ubiquitously disposable for human ends. In the SSRB, the terms of human entitlement are clear but the purpose of entitlement in recent management decisions is very ambiguous. Future adaptive mangers will most certainly confront the question: what is adaptive management for?

Management plans in Alberta are approved under the legislative framework of the province's *Water Act.* In section three of the *Water Act,*

> "The property in and the right to the diversion and use of all water in the Province is vested in Her Majesty in right of Alberta except as provided for in the regulations."

This property regime has been in place since 1894 when it was first instituted under the *Northwest Irrigation Act.* Owning property includes rights of use, exclusion and disposition (or transfer), rights that the province of Alberta has had since it gained jurisdiction over its water resources in 1930. In 1969, Alberta signed the *Master Agreement on Apportionment* with neighboring provinces and the federal government of Canada. As part of the agreement one half of the natural flow in the SSRB flows east to the province of Saskatchewan. In order to meet this agreement the new management plan for the SSRB treats the entire watershed as a "single unit" (AENV, 2006a). This decision, however, makes Alberta's water property system a very inhospitable host to learning about long-term health of SSRB watersheds through adaptive management strategies. It also creates a difficulty in meeting the *Water for Life* commitment to manage individual watershed's within their specific capacity because it quite ambiguous regarding what constitutes an "individual" watershed.

The management plan for the SSRB defines a watershed as "An area of land that catches precipitation and drains into a body of water, such as a marsh, stream, river or lake" (AENV, 2006a). The SSRB management plan recognizes thirty three "river reaches" that collectively contribute to the geographic area governed under the province's jurisdiction and the purview of the SSRB management plan (AENV, 2003b). The thirty three "river reaches" each include an area of land that catches precipitation and drain into a river. Each of the "river reaches" meets the definition of a watershed. These "river reaches" also compose four sub-basins, each catching substantial amounts of water and draining into rivers and lakes; also "watersheds" under the above definition. And the entire SSRB is itself only a portion of the larger "watershed" draining much of North America into the Hudson's Bay. Another equally valid geographic categorization of these different areas would be to say that there are small, medium, and large "watersheds" in Alberta. But this is not the case. Rather, the ambiguous term "watershed" is applied for significant political economy in managing only certain water issues, and those only to the extent that they affect Alberta.

Alberta's ambiguous use of the term "watershed" subverts the ecological appropriateness of treating watersheds as representative of acceptable or unacceptable management practices. Under Alberta's *Water Act* (sec. 7, 8) management plans, such as the present SSRB plan, must operate in conjunction with existing legislation and biodiversity conservation objectives. At present, only one of the thirty three smaller watersheds, (the "river reaches") in the SSRB is currently estimated to be in an ecologically acceptable condition. The remaining thirty two river reaches vary from "moderately impacted" to "degraded," indicating that the long term health of most rivers is declining (AENV, 2003b). The culprits could be the return flows from irrigation, industrial development, stock-watering in southern Alberta's infamous "feedlot alley" or just simple over allocation (Byrne, 2005). If things were to remain as they are the continued degradation of riparian ecosystems in the SSRB may continue despite the efforts of some (i.e. Schindler and Donahue, 2006) to raise awareness

regarding Alberta's poor track record in protecting its waters. This begs the question: What is watershed management in Alberta for?

Without a criterion for identifying and measuring how activities negatively affect watersheds like the SSRB there is good reason to be skeptical about how much actual environmental protection will take place through the current watershed management framework (Wenig, 2005). And when adaptive management systems are instituted they will be severely constrained in their ability to adapt management plans to ecological reality because the property system hosting allocation decisions means that there is a limited capacity for adaptation so long as the SSRB is treated as a single unit that is used primarily to meet inter-provincial agreements (see also Wenig, 2006). The question of scale remains: Does the ecological health of the SSRB depend on the overall health of a single watershed unit co-extensive with Alberta's jurisdictional boundaries or on the ecologic responses of physical watersheds to management plans? Answering this question requires taking a normative stance on what water management is for, and this will require future adaptive managers to take a normative position on water management issues. Having a well reasoned position, I submit, could go a considerable distance in supplementing adaptive strategies when social learning requires applying knowledge to beliefs about whether water ought to be available for social or ecologic demands.

5.5 Conclusion

Throughout this chapter I've attempted to expose a suspect inference that social learning automatically begets acceptable management praxis in adaptive management. I've focused on water management concerns and suggested that a normative framework for adaptive managers could prove valuable for decision making when adaptive capacity cannot be increased due to social or legal constraints. I conclude by sketching a normative framework compatible with adaptive management strategies. In general, the framework must integrate social and ecologic concerns in a space where social learning readjusts knowledge to

concerns of distributive justice, interspecies fairness, social poverty etc. without compromising adjustments to new areas of uncertainty.

As mentioned above, Holling and Meffe (1996) suggested that the 'Golden Rule' of adaptive management is to "strive to retain critical types and ranges of natural variation in ecosystems." The Golden Rule of adaptive management is patterned on Aldo Leopold's (1966) arguments that right actions are those that tend to enhance the beauty, integrity and stability of the ecosystem and wrong actions tend otherwise. One way to further integrate Aldo Leopold's ethical framework into adaptive management is to conceive of ethics as analogous to the process of social learning.[12] In so doing, the ethic of adaptive management may be more fully explicated without eliminating either the experimental or empirical attractiveness of adaptive management theory.

Before beginning, it should be noted that the following discussion leaves several unresolved issues aside such as general concerns related to environmental ethics and interpretations of Leopold on the whole. For instance, whether Leopold's ethic commits one to anthropocentrism or non-anthropocentrism is not discussed. And although the philosophical arguments regarding why a Leopoldian argument is superior or inferior to other ethical viewpoints carry important consequences, this discussion focuses on how Alberta may adopt Leopold's thoughts where they offer sound directions for supplementing adaptive management theory. Since Alberta has no explicit "water ethic" the presentation of Leopold's arguments presents a highly influential and practically applicable ethic that, as adaptive management theorists suggest, provides sound management principles as well. In this respect Leopold's ethical thoughts are offered because they are readily accessible to the adaptive decisions that Alberta's future policy makers will face.

Leopold (1966) argued that the evolution of ethical thought (in the West) has been to extend moral consideration outward from humans to society, and then to the natural world. On this analogy the social learning process evident in the

---

[12] A second way to integrate Leopold with adaptive management is to view ethics through a pragmatic lens and to conceive of ethics as itself a social learning process. Norton (2005) takes such a view.

history of ethical thought suggests that the extension of moral consideration comes through increased knowledge regarding the obligations that our ethical and ecological systems place on us. Notwithstanding the charge that the social learning evident in the evolution of ethical thought remains deficient, the analogy is clear: Our ethical systems reflect a process of social learning if we are willing to conceptualize our ethical system as the best hypothesis for right action that we can presently formulate. As such, ethics can be understood as analogous to the types of 'experiments' that adaptive managers formulate for best management practices.

There is considerable support for reading Leopold as a forerunner of experimental management whether adaptive or otherwise. For instance, in his essay *The Round River,* Leopold (1966, p. 188-202) makes a series of claims regarding the effects of management decisions in a process akin to experimentation. Leopold begins by claiming that, "To learn the hydrology of the biotic stream we must think at right angles to evolution and examine the collective behavior of biotic materials." This type of thinking is accomplished, for Leopold, on a very basic premise. "To keep every cog in the wheel is the first precaution of intelligent tinkering." Taken together, it appears that Leopold does not condemn the act of manipulating natural systems but argues that justified actions should not take place through a reductive lens where individual 'cogs' are viewed apart from their role in the collective behavior of functioning ecosystems.

Leopold (1966, p. 196) continues by arguing that each act of manipulation "is accompanied by a readjustment in the circulating system of the land. We do not understand or foresee these readjustments; we are unconscious of them unless the end effect is bad." The idea that management actions always return an effect, and that we are relatively ignorant *a priori* of what that effect will be, leads Leopold to a necessary assessment of what we might call the management experiment.

> "Hydrologists have demonstrated that the meanderings of a creek are a necessary part of the hydrologic functioning. The flood plain belongs to the river. The ecologist sees clearly that for similar reasons we can get along with less channel improvement on Round River…Now to appraise

> the new order in terms of two criteria: (1) Does it maintain fertility? (2) Does it maintain a diverse fauna and flora?" (Leopold, 1966 p. 198).

Leopold's criteria are followed by the most explicit statement he makes that is akin to the adaptive management enterprise of securing resilience through management experiments. Leopold (1996, p. 200) concludes that, "diversity and stability are so closely intertwined as to seem two names for one fact."

The cycle of experimentation and learning in Leopold's thought is evident in numerous other passages of Leopold's writings and has been expounded on comprehensively by Norton (2005). Norton suggests that Leopold's ethic is both compatible with adaptive management and driven by a pragmatic philosophy that is itself a process of social learning because it emphasizes that truth is "that which prevails in the long run." So understood, Norton argues that Leopold's normative claims reinforce the process of social learning where the line between fact and value is obscured, if not removed. Arising in its place, for Norton (2005), is an emphasis on place-based values and community commitments that allows social learning to make epistemic gains relative to those involved in the experiment itself (i.e. social and technical communities). Since I have dedicated considerable space to the idea that social learning is not complete without an ethic I will outline a brief argument against Norton for how we can understand Leopold's ethic as akin to adaptive management but not as a pure case of social learning.

The type of experimentation envisioned by Leopold does not indicate that ethics and social learning are synonymous because Leopold remains hesitant to relinquish all values to the processes of social evolution. For one, Leopold considers human actions to be of a different order than non-human evolutionary changes. So even though Leopold purposely frames his argument as a "product of social evolution" he does not indicate that if social evolution turned towards ecologically violent behavior that our experiments ought to follow suit. The difference for Leopold is that social evolution involves positing a set of rules for social approbation or disapproval whenever actions harm or support ecological systems while the entire set of rules is either validated or invalidated by empirical criteria. Leopold's experimental method turns on reasoning both between

communities (i.e. one community's rules are more or less reflective of empirical precedent than another) and within a particular community (i.e. an ethic limits individual freedom in the struggle for existence between members of different species). The economy of Leopold's approach can be seen in the following quote,

> "An ethic may be regarded as a mode of guidance for meeting ecological situations so new or intricate, or involving such deferred reactions, that the path of social expediency is not discernible to the average individual. Animal instincts are modes of guidance for the individual in meeting such situations. Ethics are possibly a kind of community instinct in-the-making." (Leopold, 1966 p. 239)

Leopold's experimental philosophy turns on an ethic of analogy just as the animal instinct turns on recognizing situations of threat or advantage, not on an individual's experience in new situations per se. The upshot is that, just as moral consideration was extended from one human to another, the process of extending moral consideration to the land is one of analogy where relationships between members of different species are analogous because they share a common ecological structure. That is, they are all members of a larger ecological community. I would argue that by basing his claims in analogy Leopold escapes the epistemic burdens that I identified in the adaptive management literature by recognizing that ecological responses to management experiments may be new, intricate or deferred but that ethics is not a species of social knowledge. Rather, it is a method for experimentation and one that the average individual may follow in relative ignorance.

In support of the preceding argument I offer the following counter argument to Norton who, I believe, overstates the pragmatist leanings of Leopold. To start, it isn't immediately clear that Leopold's stated ethic subscribes to the pragmatist principle that "truth is that which prevails in the long run." I think we can understand Leopold's contempt for the Abrahamic conception of the land[13] as recognition of its prevailing influence, an influence that would qualify it as "true" in pragmatic terms, and yet Leopold maintains that it is wrong. As I understand

[13] The Abrahamic conception of the land is one in which humans hold dominion over the earth. Legitimated in the biblical creation account, Leopold argues that the Abrahamic conception treats the world as "property" rather than treating the world with moral consideration.

Leopold the Abrahamic conception is wrong, not because it's historical tenure has run out (which would beg the issue from a pragmatist stance since Leopold is writing because it has not!) but because it denies the common structure that human activities share with other members of the ecological community. As a result, there is a disjunct in how human actions are analogous to those of non-humans even though evolution suggests that there is no *empirical* basis supporting such separation (i.e. the entire set of the Abrahamic community's rules are less reflective of empirical precedent than the evolutionary community's rules). More importantly, the inability to draw analogies between humans and other species is morally relevant for Leopold because there is no epistemic warrant for drawing a line between behaviors that affect the human species and those that affect non-human species (i.e. The Abrahamic ethic does not limit individual freedom in the struggle for existence between members of different species). To paraphrase Leopold, the land ethic is not an evolutionary possibility because there are some things we need to learn more about, it is an ecological necessity because the effects of human action are never fully known.

Leopold's land ethic has three practical implications for social learning through adaptive management. First, it provides a cooperative method for generating and choosing management hypotheses by offering community obligations, not implicit agreement, as an ethical guide under situations of uncertainty. Second, it proposes a method for experimentation that will produce desirable results because it tests hypotheses regarding how we ought to manage aspects of the environment. An important aspect of these results is that we needn't be overly burdened by knowing how to reconcile all of our uncertainties. Rather, what is important is that we are able to see where our ethical obligations lie vis-à-vis the empirical results of management experiments. Third, Leopold's land ethic offers a criterion for assessing social learning by constraining it with empirical claims and in so doing offers leverage against institutional inertia that limits adaptive capacity. Because Leopold is not a pure pragmatist there is room within his ethical framework to question existing institutional norms and to posit a better

route to improving adaptive capacity, one that is both empirically grounded and evolving.

As Alberta plans to implement adaptive management techniques under its *Water for Life* strategy it will revisit management actions and hypothesize regarding future management experiments. Aldo Leopold provides a normative framework compatible with adaptive management techniques and at the same time enhances some of the aspects of adaptive management theory that are inadequate. There has been considerable social learning in southern Alberta regarding the variable and sporadic nature of available water resources but there is a recurring commitment to retain historical allocation decisions despite their negative effects on Alberta's watersheds. As formal and informal partnerships begin to form for managing Alberta's water, Leopold's ethic offers a framework for partnership that is: 1) Managerially consistent with adaptive techniques; 2) Ecologically sound and; 3) Ethically defensible.

Chapter Six

Conclusion: Implications for Policy

6.1 SUMMARY

This thesis has looked at the past, present and future of water policy in the South Saskatchewan River Basin of Alberta, Canada. As mentioned in the introduction, the narrow constraints of the project restrain the types of conclusions that may be drawn. Nonetheless, several conclusions can be reached in reference to understanding how historical factors influenced early policy decisions and how early policy decisions continue to influence contemporary planning. Further, more speculative conclusions may also be drawn based on how future planning activities, such as the implementation of adaptive management systems, do or do not account for the existing policy context in southern Alberta.

The main argument of chapter two was that historical factors, specifically the political agendas of sovereignty and settlement of the Canadian west, led to water policies that focused on supply-side developments in southern Alberta. These developments allowed for increased allocations and licenses of water that increased long-term water demands creating a cycle of water scarcity. The supply-side cycle of development ended in southern Alberta with the construction of the Oldman Dam. However, as policy reforms began to take shape they were constrained by previous policy decisions that had led to considerable over-allocation of the surface waters in the SSRB.

Chapter three presented a synopsis of the provincial water policy changes in Albertan legislation, the 1996 *Water Act*, and in its 2003 *Water for Life* strategy. It was argued that these two documents had the effect of shifting policy in Alberta from decisions based on water needs to those based on risk. This, I submitted, was possible because the policy agendas of sovereignty and settlement were no longer pressing but had also left their mark on the water allocation and licensing procedures at work in the SSRB. The chapter then considered how the management plans specific to the SSRB fit with the broader provincial agendas

for water reform in Alberta. The shift in policy rationale from need to risk set up the analysis in chapter four of whether risks had been correctly calculated.

Chapter four examined the water management plans for the SSRB in three areas. Surface water, markets and allocation and the scale at which watershed management plans were applied. It found significant miscalculations with the forecasted water supply in Alberta because the SSRB plans are premised on abnormally high streamflows of the 20th century. It also identified limits to using market trading as a method for recovering water through "conservation holdbacks." Regarding the scale of watershed management practices, the study revealed problems related to how the health of watersheds was estimated and the allocation decisions approved for the SSRB. The chapter made several suggestions for how policy may be improved by: 1) Using more accurate inputs to estimate future water availability; 2) Shifting allocation entitlements to shares of river flow rather than absolute values and; 3) Ending the practice of treating the SSRB as a single unit in meeting interprovincial water agreements and ensuring that each individual watershed within the SSRB is managed in a manner preserving the health of aquatic and riparian ecosystems.

Chapter five concluded the thesis by looking at Alberta's future plans of introducing watershed management systems. The chapter presented adaptive management theory and closely examined its normative assumptions both theoretically and within the policy context of Alberta. The chapter focused on the idea of "social learning" and the difficulties associated with ascertaining how the knowledge gained through adaptive policy exercises should be marshaled in future decisions. I argued that adaptive management theory ultimately fails to deliver an adequate normative framework and suggested, following the lead of adaptive management theorists, that the ethic of Aldo Leopold may provide a more robust framework for policy. I excluded arguments related to the merits of Aldo Leopold's work in reference to other ethical theories in exchange for a clear presentation of principles that Alberta has yet to adopt in its water policy framework. These principles include: 1) Ensuring that cooperative exercises in adaptive management meet obligations to both humans and ecosystems; 2) Those

principles needed when existing institutional constraints require revision and; 3) The need for ethical deliberation that does not circumvent the uncertain conditions decisions must be made under.

This thesis began with three main objectives: 1) To identify the historical factors that influenced initial policy decisions regarding water in southern Alberta; 2) To attempt to link the influence of these historical factors to contemporary policy in a manner suggestive of how contemporary policies may be improved and; 3) To assess how the combination of historical policy influences and contemporary policy decisions may influence future policy directions in southern Alberta. Each of these objectives was met in the thesis by tracing the past, present and future of policy in the SSRB. The thesis, however, also raises several pressing questions regarding water policies in the SSRB which are taken up below.

6.2 AREAS OF FUTURE RESEARCH

Further research into Alberta's water policy context would be beneficial if it aims to meet several goals. First, research is needed into future water availability with respect to climate change and land use change in southern Alberta. Second, innovative research is required for transitioning out of institutional paths in Alberta that are unsustainable. This is especially the case in attempting to reduce water allocations on rivers that are heavily subscribed. Research is needed into how social values of water are changing relative to the current system of water licensing in Alberta and ingenuity is needed for supplementing the current mechanism of recuperating water through market transfers and conservation holdbacks. Third, a robust normative framework for water management is needed that scales environmental, economic and ethical interests to policy decisions that do not exceed the capacity of watersheds in the SSRB. Water demand in the SSRB is expected to increase and if approaches to management do not adjust to the increasing complexity of water consumption patterns, southern Alberta may enter a water crisis.

Bibliography

AENV (Alberta Environment) (2001). *Terms of reference, South Saskatchewan River Basin Water Management plan : First phase*. Permanent URL: http://www3.gov.ab.ca/env/water/regions/ssrb/phase_one.asp

AENV (Alberta Environment) (2002a). *South Saskatchewan River Basin Water Management Plan: Phase One, water allocation transfers*. Publication No. T/661. Edmonton, Alberta.

AENV (Alberta Environment) (2002b). *South Saskatchewan River Basin Water Management Plan: Phase One, water allocation transfers appendices*. Publication No. T/665. Edmonton, Alberta.

AENV (Alberta Environment) (2002c.) *South Saskatchewan River Basin Water Management Plan: Phase One, water allocation transfers: Results of consultation with Basin Advisory Committees and general public*. Permanent URL: http://www3.gov.ab.ca/env/water/regions/ssrb/phase_one.asp.

AENV (Alberta Environment) (2002d). *South Saskatchewan River Basin – Non-irrigation water use forecast.* Hydroconsult and Canadian Resource Economics Ltd. Permanent URL: http://www3.gov.ab.ca/env/water/regions/ssrb/studies.asp.

AENV (Alberta Environment) (2003a.) Water for life: Alberta's strategy for sustainability. Publication No. I/955. Edmonton, Alberta.

AENV (Alberta Environment) (2003b). South Saskatchewan River Basin water management plan phase two: background studies. Publication No. I/943. Edmonton, Alberta.

AENV (Alberta Environment) (2003c.) Strategic overview of riparian and aquatic condition of the South Saskatchewan River Basin. Golder Associates, Calgary. Permanent URL. http://www3.gov.ab.ca/env/water/regions/ssrb/studies.asp.

AENV (Alberta Environment) (2003d). *Instream flow needs determination report for the South Saskatchewan River, Alberta, Canada.* Publication No. T/719. Edmonton, Alberta.

AENV (Alberta Environment) (2003e.) *South Saskatchewan River Basin water management plan, Phase 2: Scenario modeling results, Part 1*. Publication No. T/710. Edmonton, Alberta.

AENV (Alberta Environment) (2003f). *South Saskatchewan River Sub-basin contributions to international and interprovincial water-sharing agreements.* Publication No. 703. Edmonton, Alberta.

AENV (Alberta Environment) (2004a). *Sharing the waters : Alberta's perspective on the 1909 Boundary Waters Treaty.* Publication No. I/977. Edmonton, Alberta.

AENV (Alberta Environment) (2004b). *Water management operations, Alberta Environment submission to the International Joint Commission, August 2004.* Permanent URL: http://www.ijc.org/rel/pdf/84_stmary-milk_letter.pdf.

AENV (Alberta Environment) (2004c). *Trends in historical annual flows for major rivers in Alberta.* Publication No. T/749. Edmonton Alberta.

AENV (Alberta Environment) (2005a). *South Saskatchewan River Basin water allocation (revised).* Regional Services, southern region. Permanent URL: http://www3.gov.ab.ca/env/water/regions/ssrb/studies.asp

AENV (Alberta Environment) (2005b). Focus on groundwater. Publication No. I/704. Edmonton Alberta.

AENV (Alberta Environment) (2006a). *Approved water management plan for the South Saskatchewan River Basin (Alberta).* Publication No. I/011. Edmonton, Alberta.

AENV (Alberta Environment) (2006b). *South Saskatchewan River Basin: consultation on draft water management plan, October 2005 to January 2006.* Permanent URL: http://www3.gov.ab.ca/env/water/regions/ssrb/plan.html.

AIPA (Alberta Irrigation Projects Association, Water Management Study Committee) (2002). *South Saskatchewan River Basin: Irrigation in the 21st century. Volume 1: Summary Report.* Lethbridge, Alberta.

Ali, Saleem H. (2003). Environmental planning and cooperative behaviour: catalyzing sustainable consensus. *Journal of Planning and Education Research,* 23:165-176.

Appelgren B. and W. Klohn (1999). Management of water scarcity : a focus on social capacities and options. *Phys. Chem. Earth (B),* 24 (4): 361-373.

Bakker, Karen (ed) (2007). *Eau Canada: the future of Canada's water.* Vancouver: UBC Press.

Bartlett, Richard H. (1986). *Aboriginal Water Rights in Canada: A study of aboriginal title to water and Indian water rights.* The Canadian Institute of Resources Law: Calgary.

Berkes, Fikret, Johan Colding and Carl Folke (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications,* 10(5): 1251-1262.

Blomley, N. (2003). Law, property and the geography of violence: the frontier, the survey and the grid. *Annals of the Association of American Geographers*, 93(1): 121-141.

Boyd, David R. (2003). *Unnatural law: rethinking Canadian environmental law and policy.* UBC Press: Vancouver.

Bradshaw, Matt & Stratford Elaine (2005). Qualitative research and design. In Hay, Iain (ed) *Qualitative Research Methods in Human Geography.* Oxford: Oxford University Press.

Breen, David H. (1983). *The Canadian prairie west and the ranching frontier 1874-1924*. University of Toronto Press: Toronto.

Brown, James D. (2004). Knowledge, uncertainty and physical geography: towards the development of methodologies for questioning belief. *Transactions of the Institute of British Geographers*, 29, 367-381.

Brown, Peter G. (2004). Are there any natural resources? *Politics and the life sciences,* 21 (1): 11-20.

Buckland, G.D., D.R. Bennet, D.E. Mikalson, E. de Jong, and C. Chang (2002). Soil salinization and sodication from alternate irrigations with saline-sodic water and simulated rain. *Canadian Journal of Soil Science*, 82: 297-309.

Butler, Lynda L. (1986). Defining a water ethic through comprehensive reform: a suggested framework for analysis. *University of Illinois Law Review*, 439-480.

Butler, Lynda L. (2000). The pathology of property norms: living within nature's boundaries. *Southern California Law Review,* 73: 927-1015.

Byrne, James M. (2005). Pages 173-189 in Trevor W. Harrion (ed), *The return of the Trojan horse: Alberta and the new world (dis)order.* Black Rose Books, Montreal.

Byrne, J. S. Kienzle, D. Johnson, G. Duke, V. Gannon, B. Selinger and J. Thomas (2006). Current and future water issues in the Oldman River Basin of Alberta, Canada. *Water, Science & Technology*, 53(10): 327-334.

Byrne, Peter J. (1990). Green Property. *Constitutional Commentary*, 7: 239-249.

Carpenter, Stephen R., Willinam A. Brock, and Donald Ludwig (2002). Pages 173-193 in Lance H. Gunderson and C.S. Holling (eds), *Panarchy: Understanding transformations in human and natural systems.* Island Press, Washington D.C.

Case Roslyn A. and Macdonald, Glen M. (2003). Tree ring reconstructions of streamflow for three Canadian prairie rivers. *Journal of the American Water Resources Association*, 39(3):703-716.

Castree, Noel (2003). Environmental issues: relational ontologies and hybrid politics. *Progress in Human Geography,* 27 (2): 203-211.

Chang, C., G.C. Kozub and D.C. Mackay (1985). Soil salinity status and its relation to some of the soil and land properties of three irrigation districts in southern Alberta. *Canadian Journal of Soil Science*, 65: 187-193.

Chen, Z., S.E. Grasby, K.G. Osadetz and P. Fesko (2006). Historical climate and stream flow trends and future demand analysis in the Calgary region, Canada. *Water, Science & Technology*, 53(10): 1-11.

Coote, D.R. and L.J. Gregorich (eds) (2000). *The health of our water: toward sustainable agriculture in Canada.* Publication 2020/E. Agriculture and Agri-food Canada: Ottawa.

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

Den Otter, A.A. (1990). A congenial environment: Southern Alberta on the arrival of the Mormons. In Card, Brigham Y., Herbert C. Northcott, John E. Foster, Howard Palmer and George K. Jarvis (eds), *The Mormon Presence in Canada.* Edmonton: The University of Alberta Press, pp. 53-74.

De Villiers, Marc (2003). *Water: the fate of our most precious resource*. Toronto: McLelland & Stewart Ltd.

Dworsky, Leonard, B. & Utton, Albert E. (1993). Assessing North America's management of its transboundary waters. *Natural Resources Journal*, 33 (2): 413-459.

Eilers, R.G., W.D. Eilers and M.M. Fitzgerald (1997). A salinity risk index for soils of the Canadian prairies. *Hydrogeology Journal,* 5(1): 68-79.

Evans, Simon (1975). Spatial aspects of the cattle kingdom: The first decade, 1882-1892. In Rasporich and Klassen (eds), *Frontier Calgary*. McClelland and Steward West: Calgary.

Falkenmark, Malin (2003). Freshwater as shared between society and ecosystems: from divided approaches to integrated challenges. *Philosophical Transactions of the Royal Society of London B,* 358: 2037-2049.

Falkenmark, Malin and Carl Folke (2002). The ethics of socio-ecohydrological catchmentmanagement: towards hydrosolidarity. *Hydrology and Earth System Sciences,* 6 (1): 1-9.

Falkenmark, Malin and Johan Rockström (2004). *Balancing water for humans and nature: the new approach in ecohydrology.* Earthscan, Sterling, VA.

Falkenmark, M., J. Lundqvist and C. Widstrand (1989). Macro-scale water scarcity requires micro-scale approaches: aspects of vulnerability in semi-arid development. *Natural Resources Forum,* Nov:258-267.

Folke, Carl (2003). Freshwater for resilience: a shift in thinking. *Philosophical Transactions of the Royal Society of London B,* 358: 2027-2036.

Folke, Carl (2006). Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*, 16:253-267.

Folke, Carl, S. Carpenter, T. Elmqvist, L. Gunderson, C.S. Holling, and B. Walker (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *Ambio*, 31:437-440.

Folke, Carl, Thomas Hahn, Per Ohlsson, and Jon Norberg (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources,* 30: 441-473.

Ford, Richard T. (2003). Law's territory (a history of jurisdiction). In, Holder J. and C. Harrison (eds), *Law and Geography*, New York: Oxford University Press, pp. 200-217.

Gan, Thian Yew (2000). Reducing vulnerability of water resources of Canadian prairies to potential droughts and possible climatic warming. *Water Resources Management,* 14(2): 111-135.

Gannon, V.P.J., T.A. Graham, Susan Read, Kim Ziebel, Ann Muckle, J. Mori, J. Thomas, B. Selinger, I. Townshend, J. Byrne (2004). Bacterial pathogens in rural water supplies in southern Alberta, *Canada. Journal of Toxicology and Environmental Health*, 67: 1642-1653.

Gleick, Peter H. (2002). Soft water paths. *Nature*, 418: 373.

Glenn, Jack (1999). *Once upon an Oldman.* UBC Press: Vancouver.

Graham Robert M. (2001). The Mormon cultural landscape at Stirling Agricultural Village, Alberta. *APT Bulletin*, 32(2/3): 47-56.

Graybill, Andrew B (2005). Rural police and the defense of the cattleman's empire in Texas and Alberta, 1875-1900. *Agricultural History*, 79(3): 253-280.

Gunderson, L. (2003). Adaptive dancing: interactions between social resilience and ecological crises. In F. Berkes, J. Colding and C. Folke (eds), *Navigating Social-Ecological Systems.* Cambridge University Press: United Kingdom, pp. 33-52.

Gunderson, Lance H., C.S. Holling and Stephen S. Light (eds) (1995). *Barriers & Bridges to the renewal of ecosystems and institutions.* Columbia University Press, New York.

Hall, Myrna H. and Fagre, Daniel B. (2003). Modeled climate-induced glacier change in Glacier National Park, 1850-2100. *Bioscience*, 53(2): 131-140.

Hartshorne, Richard (1964). Robert S. Platt, 1891-1964. *Annals of the Association of American Geographers,* 54 (4): 630-637.

Harvey, David (1996). *Justice, Nature, & the Geography of Difference.* Cambridge, Massachusetts: Blackwell Publishers Inc.

Hassan, Fekri A. (2003). *Water management and early civilizations: from cooperation to conflict.* United Nations Educational, Scientific and Cultural Organization, Paris, 14 pp.

Hedges, James B. (1971). *Building the Canadian west: the land and colonization policies of the Canadian Pacific Railway.* Russell & Russell: New York.

Hoggart Keith (1997). Uncertainty washed with conviction in the investigation of public policy. *Progress in human geography*, 21 (1): 109-118.

Holling, C.S. (1996). Surprise for science, resilience for ecosystems, and incentives for people. *Ecological Applications,* 6(3): 733-735.

Holling, C.S. (ed) (1978). *Adaptive environmental assessment and management.* John Wiley & Sons, New York.

Holling, C.S. and Lance H. Gunderson (2002). Pages 25-62 in Lance H. Gunderson and C.S. Holling (eds), *Panarchy: Understanding transformations in human and natural systems.* Island Press, Washington D.C.

Holling C.S. and Gary K. Meffe (1996). Command and control and the pathology of natural resource management. *Conservation Biology,* 10(2): 328-337.

Hopkinson, Chris and Gordon J. Young (1998). The effect of glacier wastage on the flow of the Bow River at Banff, Alberta, 1951-1993. *Hydrologic Processes,* 12: 1745-1762.

Horbulyk, Theodore M. (2005). Markets, policy and the allocation of water resources among sectors: constraints and opportunities. *Canadian Water Resources Journal*, 30(1): 55-64.

Horbulyk, Theodore M. and Lynda J. Lo (1998). Welfare gains from potential water markets in Alberta, Canada. In *Markets for Water: potential and performance*, Easter, K. William, Rosegrant Mark W. and Arial Dinar eds. Boston: Kluwer Academic Publishers.

Jakeman, A.J and R.A. Letcher (2003). Integrated assessment and modeling: features, principles and examples from catchment management. *Environmental modeling and software,* 18:491-501.

Jones, Samantha (2002). Social constructionism and the environment: through the quagmire. *Global Environmental Change,* 12: 247-251.

Kahn, James (1998). *The economic approach to environmental and natural resources,* 2nd edition. Fort Worth, Texas: Dryden Press.

Kevles, Daniel (1999). A fistful of wishful thinking. *Nature*, 401: 215.

Klug, Heinz (2002). Straining the law: conflicting legal premises and the governance of aquatic resources. *Society and Natural Resources,* 15: 693-707.

Kobayashi, Audrey, and James Proctor. (2003). How far have we cared? Recent developments in the geography of values, justice, and ethics. In *Geography in America at the dawn of the 21st century*, G. Gaile and C. Wilmott (eds), NewYork: Oxford University Press, 721-729.

Laird, K.R., B.F. Cumming, S. Wunsam, J.A. Rusak, R.J. Oglesby, S.C. Fritz and P.R. Leavitt (2003). Lake sediments record large-scale shifts in moisture regimes across the northern prairies of North America during the past two millennia. *Proceedings of the National Academy of the Sciences*, 100(5): 2483-2488.

Lapp, Suzan, Byrne, James, Townshend Ivan and Kienzle, Stefan (2005). Climate warming impacts on snowpack accumulation in an alpine watershed. *International Journal of Climatology*, 25: 521-536.

Lee, K. N. (1993). *Compass and Gyroscope: integrating science and politics for the environment*. Island Press, Washington, D.C.

Lee, K. N. (1999). Appraising adaptive management. *Conservation Ecology,* 3(2):3.

Leopold, Aldo (1966). *A sand county almanac: with essays on conservation from Round River.* Oxford, New York.

MacDonald, Glen M., and Case, Robyn A. (2005). Variations in the pacific decadal oscillation over the past millennium. *Geophysical Research Letters*, 32 (8).

Mahoney, James (2000). Path dependence in historical sociology. *Theory and Society*, 29 (4): pp. 507-548.

Markusen, Ann (2003). Fuzzy concepts, scanty evidence, policy distance: the case for rigor and policy relevance in critical regional studies. *Regional Studies,* 37: 701-717.

Marston, Sallie A. (2000). The social construction of scale. *Progress in Human Geography,* 24 (2): 219-242.

Martin, R. (2001). Geography and public policy: the case of the missing agenda. *Progress in Human Geography,* 25 (2): 189-210.

Massey, Doreen (1999). Space-Time, 'Science' and the relationship between physical geography and human geography. *Transactions of the Institute of British Geographers*, 24 (3): 261-276.

Matthews C., R.B. Gibson and B. Mitchell (2007). Rising Waves, Old Charts, Nervous Passengers: Navigating toward a new water ethic. In *Eau Canada: the future of Canada's water*, Karen Bakker (ed). (Vancouver: UBC Press) 335-358.

McGee, W.J. (1909). Water as a resource. *Annals of the American Academy of Political and Social Science,* 33(3): 37-50.

McLain, Rebecca J. and Robert G. Lee (1996). Adaptive management: promises and pitfalls. *Environmental Management*, 20(4): 437-448.

Meyer, Christine Benedichte (2001). A case in case study methodology. *Field Methods*, 13(4): 329-352.

Millennium Ecosystem Assessment, (2005). *Ecosystems and human well-being: wetlands and water synthesis.* Washington, DC: World Resources Institute.

Mitchner, Alyn E. 1971, William Pearce and federal government activity in western Canada 1882-1904. Unpublished PhD Thesis: University of Alberta.

Molle, Francois and Peter Mollinga (2003). Water poverty indicators: conceptual problems and policy issues. *Water Policy,* 5: 529-544.

Nicol, L. (2005). Irrigation water markets in Southern Alberta. Unpublished MA Thesis: University of Lethbridge.

Norton, Bryan G. (2005). *Sustainability: a philosophy of adaptive ecosystem management*. Chicago: The University of Chicago Press.

OECD (Organization for Economic Co-operation and Development)(2004). *Key environmental indicators.* Paris: OECD, 38 pp.

Olsson, Per, Carl Folke and Fikret Berkes (2004). Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management*, 34(1): 75-90.

Orum, Anthony M., Feagin, Joe, & Sjoberg, Gideon (1991). Introduction: the nature of the case study. In Feagin Joe. R., Orum, Anthony M., & Sjoberg, Gideon (eds.) *A case for the case study.* United States: The University of North Carolina Press.

Palliser, John (1860). *Further papers relative to the expedition under Captain Palliser of that portion of British North America which lies between the northern branch of the river Saskatchewan and the frontier of the United States; And between the Red River and Rocky Mountains, and thence to the Pacific Ocean.* London: George Edward Eyre and William Spottiswoode.

Palmer B. and C. Palmer (1990). Mormons in western Canadian agriculture: from irrigation to agribusiness. In Card, Brigham Y., Herbert C. Northcott, John E. Foster, Howard Palmer and George K. Jarvis (eds), *The Mormon Presence in Canada.* Edmonton: The University of Alberta Press, pp. 234-259.

Percy, D. (1977). Water Rights in Alberta. *Alberta Law Review*. 15: 142-165.

Percy D. (1986). Water rights law and water shortages in Western Canada. *Canadian Water Resources Journal*, 11(2): 14- 22.

Percy, D. (1987). *The regulation of groundwater in Alberta.* Environmental Law Centre, Edmonton.

Percy D. (1997). Seventy-five years of Alberta water law: maturity, demise & rebirth. *Alberta Law Review*, 35: 221-241.

Percy D. (2005). Responding to water scarcity in Western Canada.. *Texas Law Review*, 83: 2091-2107.

Peterson, Garry D., Graeme S. Cumming, and Stephen R. Carpenter (2003). Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology*, 17(2): 358-366.

Pigram, John J. (2006). *Australia's water resources: from use to management.* CSIRO Publishing, Collingwood, Australia, 226 pp.

Policy Research Initiative (2007). *Canadian water sustainability index: project report*. Ottawa: Policy Research Initiative, 33 pp.

Postel, Sandra L. (1997). *Last oasis: facing water scarcity*. W.W. Norton, New York, 239 pp.

Postel, Sandra L. (2000). Entering an era of water scarcity: the challenges ahead. *Ecological Applications*, 10(4): 941-948.

Postel, Sandra L., Gretchen C. Daily and Paul R. Ehrlich (1996). Human appropriation of renewable freshwater. *Science* 271: 785-788.

Potyondi, Barry (1992). *Where the rivers meet: A history of the Upper Oldman River Basin to 1939*. Robins Southern Printing Ltd.: Lethbridge, Alberta.

Powell, Major John Wesley (1888). The course of human progress. *Science* 11(275): 220-222.

Prato, Tony (2003). Adaptive management of large rivers with special reference to the Missouri River. *Journal of the American Water Resources Association,* 39(4): 935-946.

Priscoli, J. (2000). Water and civilization: using history to reframe water policy debates and to build a new ecological realism. *Water Policy,* 1(6): 623-636.

Raper J. and Livingstone D. (2001). Let's get real: spatio-temporal identity and geographic entities. *Transactions of the Institute of British Geographers*, 26 (2): 237-242.

Reisner, Marc (1993). *Cadillac Desert: The American west and its disappearing water, revised edition*. Penguin Books, New York, 582 pp.

Rood S. B., C. Gourley, E.A. Ammon, L.G. Heki, J.R. Klotz, M.L. Morrison, D. Mosley, G.G. Scoppettone, S. Swanson and P.L. Wagner (2003). Flows for floodplain forests: a successful riparian restoration. *BioScience*, 53: 647-656.

Rood S., G.M. Samuelson, J.K. Weber and K.A. Wywrot (2005). Twentieth-century decline in streamflows from the hydrographic apex of North America. *Journal of Hydrology*, 306: 215-233.

Rydin Y. (2005). Geographical knowledge and policy: the positive contribution of discourse studies. *Area*, 37 (1): 73-78.

Sadoff, Claudia W. and David Grey (2002). Beyond the river: the benefits of cooperation on international rivers. *Water Policy*, 4: 389-403.

Sax, Joseph L. (2003). Property rights and the economy of nature: understanding *Lucas v. South Carolina Coastal Council*. In, Holder J. and C. Harrison (eds), *Law and Geography*, New York: Oxford University Press, pp. 221-236.

Schama, Simon (1995). *Landscape and Memory.* Vintage Books: New York.

Schindler, D. W. (2001).The cumulative effects of climate warming and other human stresses on Canadian freshwaters in the new millennium. *Canadian Journal of Fisheries and Aquatic Sciences*, 58: 18-29.

Schindler, D.W. and W. F. Donahue (2006). An impending water crisis in Canada's western prairie provinces. *Proceedings of the National Academy of the Sciences,* 103(19):7210-7216.

Schlager, Edella (2004). Common-pool resource theory. In *Environmental governance reconsidered* R.F. Durant, D.J. Fiorino and R. O'Leary (eds). Cambridge: MIT Press.

Senecal, Catherine and Chandra Madramootoo (2005). Watershed management: review of Canadian diversity. *Water Policy*, 7: 509-522.

Singer, Peter (1979). *Practical Ethics*. Cambridge University Press, New York.

Sneddon, Chris and Colleen Fox (2006). Rethinking transboundary waters: A critical hydropolitics of the Mekong basin. *Political Geography*, 25:181-202.

Spry, Irene M. (1963). *The Palliser expedition: an account of John Palliser's British North American expedition, 1857-1860.* MacMillan, Toronto.

Stone, Christopher D. (1974). *Should Trees have standing? Towards legal rights for natural objects.* Avon Books, New York.

Thomas, Lewis G. (ed) (1975). *The prairie west to 1905: the Canadian sourcebook.* Oxford University Press: Toronto.

Thompson, Mary C. (1993). Southern Alberta's Cadillac desert. *Great Plains Research,* 3(2): 305-319.

Trawick, Paul (2001) The moral economy of water; equity and antiquity in the Andean commons. *American Anthropologist*, 103(2): 361-379.

Tuan, Yi-Fu (1968). The hydrologic cycle and the wisdom of God. Toronto: University of Toronto press.

Walker B., C.S. Holling, S.R. Carpenter and A. Kinzig (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and society*, 9(2): 5.

Wallace, J.S., M.C. Acreman and C.A. Sullivan (2003) The sharing of water between society and ecosystems: from conflict to catchment-based co-management. *Phil. Trans. Roy. Soc. Lond. B,* 358: 2011-2026.

Walters, C. (1986). *Adaptive management of renewable resources.* Macmillan, New York.

Walters, C. (1997). Challenges in adaptive management of riparian and coastal ecosystems. *Conservation Ecology*, 1(2): 1.

Walters, C. and C.S. Holling (1990). Large-scale management experiments and learning by doing. *Ecology*, 71 (6): 2060-2068.

Wenig, Michael M. (2005). Making sense of new terms. *Law Now*, 30 (2): 40.

Wenig, Michael M. (2006). Who's minding the water in southern Alberta? *Law Now*, 30 (3): 47.

Westley, Frances, Steven R. Carpenter, William A. Brock, C.S. Holling, and Lance H. Gunderson (2002). Pages 103-119 in Lance H. Gunderson and C.S. Holling (eds), *Panarchy: Understanding transformations in human and natural systems.* Island Press, Washington D.C.

Wolfe, Mary Ellen (1992). The Milk River: Deferred Water Policy Transitions in an International Waterway. *Natural Resource Journal*, 32, pp.55-76.

Wolfe, Sarah and David B. Brooks (2003). Water scarcity: an alternative view and its implications for policy and capacity building. *Natural Resources Forum*, 27: 99-107.

Vitousek, Peter M., Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo (1997). Human Domination of Earth's Ecosystems. *Science,* 277: 494-499.

Yin, Robert K. (1993). *Applications in Case Study Research.* New Bury Park, California: Sage Publications.

Young, M. and J. McColl (2005). Defining tradable water entitlements and allocations: a robust system: *Canadian Water Resources Journal,* 30(1): 65-72.

Zilberman, D. and K. Schoengold (2005). The use of pricing and markets for water allocation. *Canadian Water Resources Journal,* 30(1): 55-64.