TARGETING OF ECOSYSTEM GOODS AND SERVICES:

DIRECTING AGRI-ENVIRONMENTAL POLICY INNOVATION

A Thesis

Submitted to the College of Graduate Studies and Research

In Partial Fulfilment of the Requirements

For the Degree of Master of Science

In The Department of Bioresources Policy, Business and Economics

University of Saskatchewan

By

Lilani Samarakoon

PERMISSION TO USE

In presenting this thesis in partial fulfilment of the requirements for a graduate degree from the University of Saskatchewan, I agree that Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis/dissertation or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Request for permission to copy or to make other uses of materials in this thesis in whole or part should be address to:

Head of the Department of Bioresource Policy, Business and Economics

University of Saskatchewan

Saskatoon, Saskatchewan S7N 5A8

ABSTRACT

There has been active development and implementation of agri-environmental policies dealing with the provision of ecosystem goods and services over the years. However, these policies have often not been directed towards certain lands with the greatest potential for producing environmental benefits and those areas where the benefits are greater relative to cost. The limited budgets allocated to agri-environmental programs, and the often large and heterogeneous nature of agricultural landscapes, makes policy efficiency an important consideration. Incorporating targeting mechanisms in the design of agri-environmental policy instruments could improve the efficiency of such policies.

This thesis illustrates the efficiency gains from policy targeting, by applying three targeting protocols and a hybrid method using representative wildlife habitat conservation policy approaches that set-aside land from crop production by purchasing or leasing land. The GIS land selection models developed for this research assessed the net benefits for wildlife based on the opportunity cost of idling land from agricultural production. As indicated by the results, policy delivery using targeting mechanisms selectively enrolls significantly greater areas of wetlands and natural vegetative cover. Thus, targeted policy enrolled land will provide greater wildlife habitat and other environmental benefits compared to the baseline landscape which represents a non-targeted land enrollment and hence increase the environmental benefits of the program for a given budget.

ACKNOWLEDGEMENT

I would like to extend my sincerest thanks and appreciation to number of people who helped me to complete this thesis. I am deeply indebted to my supervisor Dr. Ken Belcher whose help, stimulating suggestions and encouragement helped me in all the time of research and writing of this thesis. This thesis would not have been possible without his professional insights and impressive kindness and patience throughout the process. Besides my advisor, I would like to thank my advisory committee members, Dr. Dick Schoney and Dr. Scott Bell for their encouragement, insightful suggestions and expertise. I would also like to thank Peter Joyce for serving as external examiner. His professional and insightful comments were much appreciated.

I would further like to express my gratitude to the Saskatchewan Ministry of Agriculture for providing me with financial assistance through Alliance for Food and Bio products Innovation (AFBI) Scholars Program of University of Saskatchewan. I wish to acknowledge all the faculty, staff and all my friends in the Department of Bioresource Policy, Business and Economics for their generous support and encouragement during my graduate study. Special thanks go to Lori Hagen, Deborah Rousson and Barb Burton for their invaluable help.

I deeply thank my parents, Samarakoon Banda and Minnett Jayathilake for the emotional support and timely encouragement despite the long distance between us. Finally and most importantly, I would like to thank and dedicate this thesis to my husband Chamara Silva and my lovely daughters Poornima and Sanuthi for their understanding and endless patience during my graduate study. I could never have made it this far without my family's constant encouragement and support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1 INTRODUCTION

1.1 Background

Agriculture uses a significant share of land and natural resources in Canada. As reported in the 2011 Census of Agriculture, total farm area accounts for 7.2% of total land base in Canada (Statistics Canada, 2011). The latest national estimates indicate that agriculture accounts for 9% of total water use in Canada (Soulard et al, 2008). As Agriculture has altered the original balance of the natural environment it can yield both beneficial and harmful environmental effects. Agriculture land provides environmental benefits, sometimes called ecosystem services, such as soil formation, nutrient cycling, water accumulation and flood control, carbon sequestration, and aesthetic beauty. But, increasing food demand has led to increased pressure on the natural resources used by agriculture. The increased agricultural production has been enabled by management changes such as increased field sizes, increased fertilizer and pesticide application, increased water use and the adoption of shorter crop rotations (Joint Working Party on Agriculture and the Environment (JWP), 2004).

Agricultural intensification has yielded many harmful environmental effects such as water and air pollution, loss of wildlife habitats and landscape features, water depletion, soil degradation, etc (JWP, 2004). In the Canadian agricultural landscape an important environmental impact of agriculture includes the influence on water quality including pollution from nutrients, pesticides and pathogens. Plant nutrients, and in particular, nitrogen (N) and phosphorus (P) and animal manure added to the crops in order to increase crop yield can contribute to ground and surface water contamination (AAFC, NDa). Further, the risk of water contamination which was assessed by five indicators for N, P, pesticide and coliforms[1] from 1981 to 2006 showed an increasing trend.

A number of environmental impacts of agriculture in Canada can be linked to the influence of land development and management on wetlands located within agricultural landscapes. Since, European settlement an estimated area of 20 million hectares, about 85% of Canada's wetlands located in settled areas, have been lost due to conversion to agricultural uses (Wiken et al., 2003). As discussed by Ducks Unlimited Canada (2008), wetland loss negatively affects Canada's environment. These studies have shown that drainage of wetlands has triggered increased nutrient flows to major lakes and rivers in the absence of natural filtration by wetland systems. It has also been shown that when wetlands are deteriorated, the landscape's ability to store carbon will be reduced and a significant amount of greenhouse gases will be released (Ducks Unlimited Canada, 2008). As such the ecosystem goods and services provided by wetland that are important to human health and economic well-being are deteriorated with wetland loss that is significantly influenced by agricultural development and management.

Wetlands provide unique habitat for many different animal and plant species. For example, wetlands provide habitat for more than 200 bird species including 45 species of waterfowl and over 50 species of mammals in Canada (Natural Resources Canada, ND). More

---

[1] The potential for contamination of water by animal fecal material is assessed by the presence of thermo tolerant coliforms, rod-shaped bacteria that are normally found in the colons of humans and animals and universally found in animal feces (Bitton, 2005).

importantly, one-third of the species at risk listed by the committee on the Status of Endangered Wildlife in Canada (COSEWIC) depend on wetlands (Natural Resources Canada, ND). Habitat loss, fragmentation and degradation are among the major threats to Canadian wildlife (Federal, provincial and territorial governments of Canada, 2010). In a specific study examining the impact of wetland loss on amphibians, Hecnar (2004) reported that wetlands in the Great Lakes basin support more than 30 species of amphibian showing high species richness. Historically the basin has lost over 50% of its wetlands, with habitat loss found to be the primary reason for the decline of 60% of amphibian species while habitat degradation by pollutants accounting for 43% of the reduction. In Canada, during 1985 to 2005, the small and shallow seasonal wetlands in agricultural region that provide habitats for a greater number of aquatic birds, had a higher rate of impact and showed slow recovery rate as compared to larger ones (Federal, Provincial and Territorial Governments of Canada, 2010). Some aquatic bird species that depend on prairie potholes[2] have declining populations over the Canadian Prairies (North American Bird Conservation Initiative Canada, 2012). Wetland drainage and degradation of wetlands caused by high intensity farming practices are among the major threats for these bird species.

Wildlife resources are important to society due to the ecological, economic, recreational and aesthetic values associated with natural habitats and wildlife populations (U.S Fish and Wildlife Service (USFWS), 2002). As reported by Javorek and Grant (ND) agricultural landscapes

[2] The millions of shallow water filled depressions formed in central North America thousands of years ago are commonly known as Prairie Potholes. The region covered by these depressions is referred as Prairie Pothole Region (PPR). The southern portions of Manitoba, Saskatchewan and Alberta are covered by PPR (Wrubleski and Ross, 2011).

of Canada are a mosaic of cultivated land, natural and semi-natural land. As discussed in the Federal, Provincial and Territorial Governments of Canada (2010), 7% of Canada's land is covered by agricultural landscape and that provides habitat for more than 550 species of terrestrial vertebrates. The ability to support wildlife is highest in natural and semi natural cover types, followed by improved pasture and tame hay whereas, cropland supports relatively few species. Over the period of 1986 to 2006, the proportion of Canadian agricultural land classified as cropland has increased from 46% to 53% resulting in a decline of potential capacity of agricultural landscape to support wildlife.

1.2 Agri-Environmental Policy

Driven by public concerns over the environmental impacts of agriculture many policy instruments have been introduced, primarily by the federal or provincial governments, to either directly or indirectly encourage environmentally beneficial management or discourage environmentally damaging management practices. Many of the instruments used in agri-environmental policies are designed to encourage farmers to either change their land use or retire their land from crop production. For example, in the United States the mechanism of some of these agri-environmental policies is to provide farmers with payments to help offset the costs of adopting specific best management practices (BMP) (USDA, 2001). BMPs are farming methods that are helpful in minimizing the risks to the environment without sacrificing economic productivity (Hilliard and Reedyk, 2002). The environmental problems such as phosphorus pollution, eutrophication, algal blooms and water quality depletion have been addressed by BMPs in the U.S and worldwide (Sharpley et al., 2000; D'Arcy and Frost, 2001; Sharpley et al., 2001; Wang et al., 2006; Zeimen et al.,2006; Way 2007; Keipert et al.,2008).

The Conservation Reserve Program (CRP) and Wetland Reserve Program (WRP) are two examples of land retirement programs that have been implemented in the United States (USDA, 2001). The CRP was introduced in 1985 by the federal government in order to take marginal and erodible crop land out of production by establishing permanent cover on those lands (Bangsund et al., 2002). As discussed by these authors, the primary objective of the program was to reduce soil erosion on highly erodible cropland while reducing the supply of farm commodities, provide income support for the program participants, improve environmental benefits (reduced sedimentation, improved water quality, additional wildlife habitats) being the secondary goals. The CRP provided annual land rental payments to farmer for retiring land from crop production.

While the CRP represented a policy approach that provided environmental improvements on annually cropped landscapes, the USDA also delivered policy aimed specifically at the agricultural impacts on wetlands. Wetland restoration on agricultural land was addressed with the Wetlands Reserve Program (WRP) which was launched as a long term or permanent easement (USDA, 2001). The WRP is a voluntary program that provides technical and financial support to land owners to protect, enhance and restore wetlands on their land (USDA, NDa). The program goal was to improve wetland functions thereby enhancing wildlife habitats.

In addition to the CRP and WRP initiatives, the US government also implemented other programs that use incentive based approaches to encourage changing land use such as the Agricultural Conservation Program (ACP) and its successor the Environmental Quality Incentives Program (EQIP), and the Wildlife Habitat Incentives Program (WHIP). These programs initially focused on soil erosion but later were expanded to incorporate other environmental attributes (USDA, 2001). The Agricultural Conservation Program (ACP) was implemented in order to reduce soil loss and water pollution by agricultural operations. The program provides cost-share funds for practices including establishing permanent vegetative cover, restoring shallow water areas or developing new ones, and installing water control structures. EQIP is a voluntary program that provides financial and technical assistance to farmers to implement conservation practices to improve soil, water, plant, animal, air and related resources on agricultural land and non-industrial private forestland. The financial and technical assistance is provided through long term contracts up to a maximum term of ten years (USDA, NDb). WHIP is a voluntary program that encourages farmers to enhance wildlife habitats on agricultural land, nonindustrial private forest land, and Indian land (USDA, NDc).

In Canada, prior to implementation of the more comprehensive suite of agricultural policies in the Agricultural Policy Framework (APF) in 2003 there were few specific agri-environmental programs. Two such measures that were implemented were the Permanent Cover Program (PCP) and the Prairie Shelterbelt Program (PSP) which addressed agri-environmental problems. The PCP was implemented in 1989 by the government of Canada through the Prairie Farm Rehabilitation Administration (PFRA) within Manitoba, Saskatchewan and part of Alberta, with the objective of reducing soil degradation on land under annual cultivation with high risk of soil erosion (Vaisey et al., 1996). Furthermore, soil conservation objectives were met on these lands by converting them from annual cultivation to perennial vegetative cover such as perennial forages or trees. Under this program, farmers were provided initial financial compensation to convert land and then additional compensation was provided for a 10 – 21 year land use agreement after the cover was established. Under the first phase of the PCP 168,000 ha of annual cropland was converted to forage cover in western Canada

(Vaisey et al., 1996). Another early agri-environmental program in Canada was the PSP which was an ongoing program in Canada implemented through Agriculture and Agri-Food Canada's in 1901 (Kulshreshtha et al., 2003). The PSP provided technical assistance and tree and shrub seedlings for shelterbelt establishment while agroforestry and conservation projects are also supported by the program primarily in the Prairie Provinces (AAFC, NDb).

In 2003 the Agriculture Policy Framework (APF) established a suite of agricultural policies, including agri-environmental policies. The National Farm Stewardship Program (NFSP) was introduced under the APF and has continued under the subsequent Growing Forward program, established in 2008, which has become the primary government policy approach to address agri-environmental issues in Canada. The APF was developed with the collaboration of the Government of Canada, provincial and territorial governments working with the agriculture and agri-food industry and interested Canadians. The APF was comprised of such agri-environmental initiatives as Environmental Farm Planning (EFP), National Farm Stewardship Program (NFSP), Green cover program and, National Water Supply Expansion Program (NWSEP) (AAFC, NDc). These programs were implemented in order to ensure the environmental sustainability in agriculture and agri-food sector particularly in the areas of soil, water, air and biodiversity. The environmental programs implemented under APF were revised in 2009 with the Growing Forward program. The Growing Forward program was also coordinated through a Federal, Provincial and Territorial initiative that continues for five years until the spring of 2013 (AAFC, NDd). In September of 2012 Growing Forward 2 was signed by the provincial, territorial and federal ministers of agriculture. Growing Forward 2 will be in effect from 2013 to 2018 but details of the program have yet to be negotiated.

While there has been active development of agri-environmental programs in Canada, it is important to note that the measures have not been specifically directed, or targeted, towards certain land characteristics or features that may increase the environmental benefits of the program or reduce the cost of the program. Agri-environmental programs are implemented using a limited budget and as a result it is important to consider policy approaches, or methods to deliver policy, that enable greater environmental benefits provided at lower cost. This becomes even more important when delivering agri-environmental programs on often large agricultural landscapes that are very heterogeneous in terms of socioeconomic and biophysical characteristics. As a result, policy efficiency is an important consideration. An aspect of agri-environmental policy delivery that may have an impact on the efficiency of a program or set of programs is policy targeting. It has been highlighted in this literature that within a heterogeneous agricultural landscape the level of environmental benefits provided by an agri-environmental measure will depend on a number of biophysical factors and economic characteristics of the land. In the literature, many authors have argued that incorporating targeting mechanisms in the design of policy instruments can increase the efficiency of such policies (Ribaudo ,1989; Carpentier et al., 1998; Wossink et al., 1999, Khanna et al., 2003).

Targeting has been applied at certain levels in some of the agri-environment program that have been delivered. For example, the Conservation Reserve Program (CRP), as discussed in (Yang et al., 2004), determined eligibility of land for CRP based on the potential for reduction of on-site erosion where the fields that were two third highly erodible were considered to be eligible for the CRP. The eligible land that were offered to the program for a rental rate below the maximum acceptable rental rate, set by the U.S Department of Agriculture for the state or the sub-region, were enrolled into the CRP. This approach was shown to maximize area goals but was not shown to maximize the environment benefits (Babcock et al., 1997). According to these authors, in order to maximize environmental benefits from agri-environmental policy, for a given budget, a targeting method should provide environmental amenities that show higher benefit relative to cost being purchased until the budget limit is reached, although this rule is not often practiced by agri-environmental programs. The literature suggests that through policy that targets land with the most potential for producing environmental benefits, and those areas where the benefits are greatest relative to the costs, environmental benefits can be increased while reducing the cost of the conservation program.

1.3 Problem Statement

The delivery of agri-environmental policy that has an objective of maintaining or increasing wildlife habitat on agricultural landscapes may be more cost-effective, or even efficient, if delivered using an approach that targets the policy measures to specific land cover characteristics. This study will evaluate the influence of targeting methods on agri-environmental program delivery and the performance of the programs in terms of environmental outcomes. The focus of this research is to evaluate the effect of different agri-environmental targeting approaches on the provision of wildlife habitat within an agricultural landscape.

1.4 Research Objectives

The research problem will addressed using the following specific objectives presented in order of completion during the research program:

- Review existing agri-environmental policy instruments and policy targeting initiatives to understand approaches and to inform an appropriate approach for the study region
- Evaluate wildlife habitat outcomes and assess the relative economic performance of targeted policy approaches relative to non-targeting delivery.

1.5 Organization of the Thesis

The thesis has been organized in five chapters with a brief description provided below. The next chapter is focused on developing an understanding of agri-environmental policy and its targeting, with a particular focus on wildlife habitat outcomes, based on a review of the relevant literature. A conceptual framework for targeting theory is also introduced in the second chapter. The third chapter presents the research methodology including a discussion of the specific methods which have been undertaken for the study followed by the GIS data base developed for the study. The next chapters present a detailed discussion of the results with a focus on presenting the insights provided by the research. The final chapter presents a conclusion with a discussion of the importance of the research, research limitations and the importance of the findings for future agri-environmental policy development.

1.6 Summary

This chapter discusses the motivation for the research, the problem and the objectives of the study. Within the Canadian agricultural landscape there is evidence of environmental impacts that are caused by existing agricultural management practices. Loss, fragmentation and degradation of habitat for wildlife are among core issues caused by agricultural related management practices. In Canada various agri-environmental policies have been developed and implemented to directly, or indirectly mitigate these negative effects of agriculture. However, the delivery of these polices have used approaches that may not be able to select land based on the identified benefits or cost of the land. The next chapter will develop a review regarding the existing agri-environmental policy instruments and policy targeting initiatives found in literature. Some discussion is dedicated to summarise the theory around the policy targeting.

CHAPTER 2 LITERATURE CONTEXT AND THEORETICAL FRAMEWORK

2.1 Introduction

There has been a range of research that helps to understand many aspects of the targeting of agri-environment policy. This chapter focuses on the current literature on targeting in agri-environmental programs. The evidence of targeting in US and Canadian agri-environment policy will be discussed analyzing the manner that targeting has been incorporated into those programs.

The first section of this chapter briefly reviews the major (agri-) environment programs in Canada and then identifies the extent to which the current policies in Canada have addressed the provision of wildlife habitat. Also this section reviews the policy targeting in the current environment policies in North America and reviews how these programs have become more cost effective when targeting is incorporated by giving examples from recent literature. Then the section briefly reviews targeting mechanisms that have been included in past and existing agri-environmental policies and programs and discusses how these approaches have increased the effectiveness of the program delivery. The next section of this chapter discusses the role of spatial data and GIS models to enable the targeting of policy. In this thesis, the theoretical framework is presented as part of the literature review as it is developed using the theory from the recent targeting literature and identifies the different methods used in policy targeting. This final section of the chapter provides a background for the targeting methods and land selection approaches that will be discussed in the methods chapter (Chapter 3).

2.2 Targeting of Agri-Environmental Policy

2.2.1 Major Agri-Environmental Programs in Canada

In Canada the national farm stewardship programs that were introduced under the Agricultural Policy Framework (APF) and have continued under the Growing Forward program have become the primary policy approach to address environmental issues within the agricultural regions of Canada. The Growing Forward program is a shared Federal-Provincial funded policy model delivered in the provinces as part of Farm Stewardship (CSFS) program. Within the province of Saskatchewan, according to PCAB (NDb) several policies are delivered which promote land use decisions that can decrease the environmental impact of agricultural production or even improve environmental conditions. These policies include Environmental Farm Planning (EFP), Agri-Environmental Group Planning (AEGP) and the adoption of Beneficial Management Practices (BMPs). The EFP is a process where agricultural producers are encouraged to systematically identify environmental risks and benefits on their lands and develop action plans to eliminate those risks (PCAB, NDa). The AEGP is a more recent program to be developed which has a similar approach to EFP except that instead of individual producers, farmer groups identify the common problems of their land by completing an assessment. In order to become eligible to apply for cost-share funding for the adoption of appropriate BMPs under the farm stewardship program, agricultural producers must complete an EFP or an AEGP. The farm stewardship program provides cost share-funding and technical assistance to farmers to adopt BMPs (Saskatchewan ministry of Agriculture et al., 2011). Examples of BMPs that were funded through farm stewardship program include relocation of livestock facilities away from stream banks and lake shores, fencing to limit direct access of livestock to environmentally sensitive watering sites, planting permanent covers and shelterbelts in erodible area and drift reduction and precision farming applications to decrease environmental hazards in pesticide application (Saskatchewan ministry of Agriculture et al., 2011).

Agri-Environmental Group Plans (AEGP), which in Saskatchewan have been implemented through the PCAB Watershed Awareness Initiative, is a parallel program to the Environmental Farm Planning (EFP) process (Lower Souris Watershed, ND).There are two main differences between AEGP and EFP with the AEGP being applied to specific geographical area, often at the watershed or sub-watershed scale, and are intended to resolve specific local environmental issues. This program allows producers to implement BMPs to resolve environmental issues identified within their watershed (Gulka, 2009).

PCAB works with several bodies including government organizations such as the Saskatchewan Watershed Authority (now Saskatchewan Water Security Agency) and non-government organization such as Ducks Unlimited Canada within the Watershed Awareness Initiative[3]. Through these sources the initiative contacts producer groups such as grazing clubs and RM councils. The producers expressing interest to improve their watershed through their collective action will then appoint a committee of producers to head the group. When the issues

[3] The Watershed Awareness Initiative (WAI) was introduced in 2008, and it is presently funded by the federal and provincial governments. The main objectives of WAI are to increase watershed awareness and to develop the capacity of local producers and stakeholders in a watershed in order to increase the effectiveness of group plan (PCAB, NDc)

in the watershed are determined by the group, the action plan is made with the help of group plan coordinator. Then the group will be able to apply funds under CSFS program and execute the approved projects (Gulka, 2009). One example AEGP that have been implemented in Saskatchewan is the group plan adopted in Lower Souris watershed. The major objectives of that AEGP are related to protecting surface water from agricultural production. Therefore the most common BMPs adopted by farmers within these areas include such management approaches as wintering site management and riparian area management (Lower Souris Watershed, ND).

2.2.2 Wildlife habitat conservation policy approaches in Canada

As discussed earlier, the Canada Saskatchewan Farm Stewardship Programs (CSFS) currently implemented through the Growing Forward program are the primary government policy approaches to address agri-environmental issues in Canada. The protection of wildlife has been considered in designing BMPs. Some of the benefits gained from the adoption of BMPs are related to direct, or indirect, positive impacts on wildlife and wildlife habitat. For example, the objective of a number of BMPs is improved surface or ground water quality, including improvements to livestock management and manure management (Saskatchewan ministry of Agriculture et al., 2011). These BMPs can help to reduce ground and surface water contamination and thereby help to protect aquatic and dry land species (plant, animal, and insects) in stream banks, shorelines and riparian ecosystems and thereby mitigating the agricultural impact on biodiversity. (Saskatchewan ministry of Agriculture et al., 2011). In addition, BMPs can improve land management (ex. increase land cover) by providing incentives to establish permanent covers and shelterbelts in erodible areas and planting vegetation to protect riparian land can also improve wildlife habitat. (Saskatchewan ministry of Agriculture et al., 2011).

Driven by increasing interest in waterfowl and other migratory birds in North America, The North American Waterfowl Management Plan (NAWMP) was established in 1986 by Canada and the United States, and expanded to include Mexico in 1994 (U.S Fish and Wildlife Service, 2009). The objective of the NAWMP was to restore waterfowl populations through habitat protection, restoration and enhancement. As described by the U.S Fish and Wildlife Service (2009), in 1998 the vision of NAWMP was extended to include a biological planning process into the NAWMP. The NAWMP actions were further refined by ongoing evaluations and the landscape conditions needed for the survival of waterfowl and other birds by partner organizations in collaboration with other bird conservation measures at the national level (U.S Fish and Wildlife Service, 2009). As given in the U.S Fish and Wildlife Service (2009), implementation of NAWMP is done at the regional level using partnerships called joint ventures made from federal and local governments, businesses, conservation organizations and individual citizens.

In 2000, the NAWMP Science Support Team was established to provide technical advice and consultation to the NAWMP which consists of a representative of each country and members from associated joint ventures and flyway councils (Fish and Wildlife Service, 2009). The program was officially launched in Canada in 1989 setting up the Eastern Habitat Joint Venture with partnership of provincial governments of the eastern provinces (Ontario, Quebec, Newfoundland and Labrador, Nova Scotia, New Brunswick and Prince Edward Island), the Canadian Wildlife Service, Ducks Unlimited Canada, and Wildlife Habitat Canada (Environment Canada,2008). The goal of the venture was to protect and enhance wetlands in eastern Canada. Currently, four habitat joint ventures have been implemented including Pacific Coast, Canadian Intermountain, Prairie Habitat, and Eastern Habitat and three species joint ventures focusing on Arctic Goose, Black Duck and Sea Duck (Environment Canada, ND).

The implementation of the NAWMP uses strategic conservation planning of habitat management that involves geographic prioritization, representing a form of targeting, at continental, regional, and local scales (North American Waterfowl Management Plan, 2004). Joint ventures are implemented using model-based regional strategic conservation plans that provide biological input into management decisions by partners. The scale of the project in terms of the sites to secure and the suites of management options are decided by considering the priority birds to their habitats (North American Waterfowl Management Plan, 2004). The biological planning of NAWMP uses biological models which relate species to their habitats at site and landscape scales. In the strategic planning process maps are made using special data from the biological models and used as decision support tools to prioritize areas for conservation actions (North American Waterfowl Management Plan, 2004).

2.2.3 Policy targeting in the current agri-environmental programs

Although agri-environment policies have been implemented with the intention of achieving environmental improvements, some programs have shown limited success considering the amount of money spent. Environmental benefits and economic costs of policies may vary across the landscape due to differences in land quality, topography, location relative to water bodies or transportation corridors, and the management practices of landowners (Yang et al., 2005). Therefore, the environment benefits and opportunity cost of particular agri-environment policy also varies with the locality. Many authors such as Ribaudo(1989), Carpentier et al.(1998), Wossink et al.(1999) and Khanna et al.(2003) have shown that the efficiency of an agri environment policy can be improved by employing policy targeting mechanisms. According to Babcock et al. (1997) a targeting scheme is a decision rule that can be used to select the land, or other resources, for a particular policy. In the literature there is evidence to show that the targeting mechanisms could also increase the environmental and economic efficiency of an agri-environmental program. Wilson (1996) argued that targeting a specific area for preserving environmental amenities is important since budgets and resources are usually limited and therefore the desired environmental amenities should be prioritized. In the literature these authors have shown the contribution of targeting methods to achieve cost effectiveness in agri environmental programs. At the same time, the agri-environment programs which have not employed any targeting mechanism have enrolled areas of land that may not contribute to the environmental objectives of the policy. According to Babcock et al. (1997) the U.S Bureau of reclamation manages millions of acres of land much of which provides few environmental amenities.

Much of the research on policy targeting has been done on US agri-environmental programs. As an example of the potential effect of targeting policy measures is the land selection by United States Department of Agriculture (USDA), Conservation Reserve Program

(CRP). As discussed by Yang et al. (2004), the CRP was designed to reduce soil erosion and initially focused on onsite soil erosion abatement. As a result, eligibility for the program required two-thirds of the subject parcel to have soil classified as being highly erodible. However, the program accepted all offers below the maximum acceptable rental rate and ended up achieving the program acreage enrolment goal (Shoemaker, 1989). The selection mechanism used for CRP enrollment was not able to achieve erosion reduction per acre that could have been achieved within the given budget (Ribaudo,1986; Reichelderfer and Boggess,1988).

Following the initial delivery of the CRP the objectives of the program were revised in the 1990 USDA Farm Bill with both onsite and offsite environmental benefits being considered to determine land eligibility (Yang et al., 2004). The USDA developed a comprehensive strategy that enabled the selection of parcels of land with specific desirable characteristics thereby representing a type of targeting strategy. The strategy developed was called the Environmental Benefit Index (EBI); which was a weighted indicator of multiple on-farm and off site environmental benefits associated with the prospective parcels of land (Yang et al., 2004). The EBI was used to evaluate and rank the CRP offers from farmers, and each parcel of land offered was assigned points based on the expected environmental benefits based on the parcel characteristics in terms of soil resources, water quality, wildlife habitat, and other resource concerns at the time of land enrollment into the program (USDA, 1999). The EBI rates the relative environmental performance of a land parcel based on six environmental factors: 1) wildlife benefits 2) water quality benefits, 3) on farm erosion, 4) enduring benefits (ex.

likelihood of certain practices to remain in place beyond the contract period), 5) air quality benefits from reduced wind erosion, 6) benefits from locating in "State or National Conservation Priority Areas (CPA)"[4] and a cost factor (USDA, 1999). Under the cost factor, the amount of the per-acre rental rate and how much that is below the maximum acceptable rental rate is considered. At the same time whether the enrollment is requesting a government cost share is also considered.

As described by the USDA (1999), the EBI evaluates the environmental benefits of each parcel based on its location. As an example, the score for wildlife benefits was based on the suitability of the habitat land for federal or state-listed threatened and endangered migratory species and the proximity of the land relative to nesting or wintering sites of these species (USDA, 1999). In addition, the EBI score is influenced by the proximity of the offered land parcel to permanent water sources and protected wildlife habitat. This enables land parcels that can serve as quality habitats and those that can provide water quality benefits to be prioritized in the land enrollment process. The enduring benefits of land were evaluated based on the possibility of continuation of certain practices and qualities of the land after the expiry of the contract. Restoration of rare and declining habitats, shrub planting, continuation of CRP practices, presence of cultural resources and historical places (listed in National Register) were considered under the enduring benefits. Also the location of land compared to CPA was considered. Including the EBI into the CRP delivery process enabled policy delivery agencies to

[4] Conservation priority areas are regions targeted for enrollment such as Prairie Pothole region, an area adjacent to the great lakes, the Chesapeake Bay and other valuable designated areas. In addition, Farm Service Agency State Committees could designate up to 10% of a State's cropland as a state conservation priority area (USDA, 2004a).

give priority to specific land parcels with higher environmental benefits. At the same time under the cost factor, the cost of the enrollment is also considered. The land parcels were given higher rating when the parcels are offered for lower rent and when no government cost share is requested. Also, the land parcels were rated for dollar amount below the maximum acceptable payment rate. The EBI score for each land parcel was compared with other parcels before the offers of enrollment to the CRP program are approved (USDA, 1999).

The EBI has been used as a targeting strategy to select the best land, as reflected by the index, which enables an enrollment pattern that will increase the benefit to cost ratio of those selections. Yang et al. (2004) argued that after introduction of EBI as a selection tool, CRP has been able to maximize the benefit to cost ratio of the selected land parcels compared to previous selections. Burger et al.(2006) discussed the environmental benefits of policy targeting and argued that through targeting, conservation investments can be directed to the land with the most potential for producing wildlife benefits, and those areas where the benefits are greatest relative to the costs. As a result, these authors argue that targeting can increase the environmental benefits while reducing cost of the conservation program.

In a study of the Conservation Reserve Enhancement Program (CREP) in Illinois, Yang et al.(2005) argued that rather than enrolling land parcels on a first come basis, the cost effectiveness of CREP in Illinois could be improved by employing a competitive selection process that takes environmental benefits and cost into consideration. In the same study, the authors examined the efficacy of a specific simplified targeting tool based on a predicted sediment abatement benefit of land parcels using regression analysis. Yang et al. (2004) examined the cost effectiveness[5] of enrolling eligible land in relation to the CREP in Illinois. They reported that in the CREP the USDA had targeted three categories of cropland namely cropland within 100 year flood plains[6] of the Illinois river, cropped wetlands and highly erodible cropland adjacent to enrolled riparian area. Also the CREP program did not specify any mechanism to select the eligible lands. These criteria were able to select over 5 million acres (20,234 km^2) of cropland eligible for enrolment in the CREP but were not able to ensure enrollment of land with higher environment benefits to opportunity cost ratio (Yang et al., 2004). Thus, according to these authors selection based on geographical targeting alone does not create differential incentive for enrollment among land parcels within the eligible region and cannot guarantee cost effectiveness of the program. Their research suggested that even within the eligible region, the program should be further selective by targeting, for example, land parcels that are highly sloping, close to water bodies, receiving higher upland sediment inflow, generate more onsite erosion and have lower rental payments. By targeting these land characteristics, the research suggests that the program will achieve, for example, greater erosion abatement goals at a lower cost. Further Yang et al. (2004) demonstrated designing of a differential incentive by varying rental payments based on observable characteristics of land such as on-site erodibility and distance from water body.

[5] The cost effectiveness of the program was defined by the environmental benefits to opportunity cost of the enrolled parcels (Yang et al., 2004).

[6] A floodplain is a flat or nearly flat land adjacent a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (Goudie, 2004)

A study by Khanna et al. (2003) examined a cost effective targeting method using an integrated framework that combined spatial and physical attributes of land by employing a hydrological model and an economic model to target crop-land in a riparian buffer land retirement program. This program was established with an objective of meeting specific off-site sediment abatement goals in a cost effective way. The results of the study suggested targeting of highly sloping and highly erodible land parcels can achieve cost effective erosion abatement. The study also analyzed the design of a rental payment policy instrument to create market based incentives to ensure a cost effective pattern of land retirement.

In Illinois the CRP delivery was developed to accept all bid offers below the government determined maximum acceptable land rental rates. According to Babcock et al. (1996; 1997), this type of policy could create an incentive for enrollment of land in the program with low opportunity cost but not necessarily lands with the highest ratio of sediment abatement benefits to opportunity cost. These authors showed that the parcels expected from a particular targeting mechanism can be achieved by employing differential payments. In addition, Khanna et al.(2003) argued that parcel specific payments will create an incentive for land owners to retire their land and policy makers would be able to achieve environmental objectives of the program. Further, they have suggested that since parcel specific rental policy would increase the administrative cost of policy delivery, the rental payment could be modified based on a few observable dimensions such as slope and location of land. Yang et al. (2004) showed that a differential incentive payment based on the observable characteristics of the land parcel, which are related to extent of environment benefits, would increase the cost-effectiveness of an environment protection program.

Another CRP variation established by the USDA under the Continuous Conservation Reserve Program (CCRP) was called the Conservation Practice Habitat Buffers for Upland Birds, or "bobwhite buffers" (CP – 33). The program established native grass and forb cover on less productive land in the perimeters or edges of agricultural fields in order to provide habitat for variety of wildlife species. According to USDA (2004b), under CP-33 environmentally desirable land devoted to certain conservation practices could be enrolled in CRP at any time under a continuous sign-up. Offers for continuous sign-up were not subject to competitive bidding and were automatically accepted provided the land and producer met certain eligibility requirements representing a form of program targeting. A number of studies have analyzed the CP-33 program and found it to be a cost effective policy (McConnell, 2011). According to Barbour (2006), this buffer system was easily adopted by producers and was able to replace parts of fields with limited profit potential with a conservation practice supported by government financial incentives. As a result, land parcels which had higher benefits for wildlife were targeted. At the same time, those targeted lands were less productive for agricultural commodities and as a result usually imposed lower opportunity costs. Thus the program enabled higher benefit-to-cost ratio for the land parcels enrolled to the program.

It is important to note that the enhancement of wildlife habitat was not considered in the land enrollment criteria for initial versions of the CRP program. In related research Cihacek (1993) argued that benefits to wildlife should be addressed through the CRP. Further, he suggested the potential to enhance wildlife benefits by targeting high value habitat areas. A study done by Lakshminarayan et al. (1996) showed that targeting cropped palustrine wetlands[7] (which are prone to seasonal flooding and occasional crop failure) would increase the habitat benefits in the land enrolled for CRP as compared to enrolling land solely based on erodibility criteria. Further, these same authors pointed out that securing wetland for wildlife also provides a range of co-benefits such as absorption of nutrient run off, thereby increasing water quality. Lakshminarayan et al.(1996) argued that the land parcels selected for enrolment in CRP should be further targeted to areas of wetlands to potentially increase the benefits to cost ratio of the targeting scheme. These authors have argued that targeting could cut down program cost while broadening the benefits of the program.

To understand the characteristics of a policy targeting method there has been some research evaluating the opportunities for integrating nature conservation and agricultural policy. For example, Webstor and Felton (1993) examined the need for targeting to ensure cost-effectiveness and through this analysis they highlight the need to consider the regional differences in wildlife and different qualities of habitats that fit the farm systems to achieve more effective targeting. As an example, if wildlife habitats are peripheral to the farming system (when the majority of the resources are fragmented), habitat restoration should be targeted to buffer and can enhance the capacity of farm areas to support wildlife species (Webstor and Felton, 1993). In contrast, where wildlife habitat is integral to the existing farmland including

[7] This wetland category includes non-tidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens or lacking such vegetation and having an area less than 8 ha and water depth less than 2m in deepest part of the basin, lacking bedrock shoreline features and containing ocean-derived salts in concentrations of less than 0.05% (Cowardin et al, 1979).

habitats and features such as hedge rows, wetlands and woodlands, these should be targeted and enhanced while lands suitable for potential habitats should be targeted to expand the existing semi natural habitats.

Research has also examined the impact of different criteria used as the focus of the targeting, including the cost of program delivery or the benefits provided by enrolled land. In a study examining policy focused specifically on biological conservation, Polasky et al.(2001) showed that if land costs vary across a region then improving the efficiency of the conservation program is a budget constrained problem rather than a site constrained problem. According to these authors if it is a budget constrained problem, the program can secure any number of sites within the budget and will secure cheap lands first which is analogous to a cost targeting method. However, if there is a limit to the number of sites which can be secured by a program it is necessary to secure lands which provide maximum benefits, which is consistent with what would be considered a benefit targeting method. For the CRP program in Illinois Yang et al. (2005) also showed that since sediment abatement benefits vary more than the economic costs across parcels a targeting mechanism should focus on sediment abatement benefits rather than land enrollment cost. In the same study they demonstrated that even a simplified tool based on few observable physical characteristics of land used for targeting can achieve 95% of the benefits that would be obtained from a more complex approach incorporating, for example, hydrological models.

In Australia policy models such as the Investment Framework for Environmental Resources (INFFER), Eco Tender and Bush Tender programs have directed environmental investments specifically towards certain lands that may increase the environmental benefits of the program or reduce the cost of the program. For example, INFFER is an environmental planning tool that assists decision makers to assess and rank environmental or natural resource projects comparing aspects such as value for money, degree of confidence in technical information and likelihood of achieving stated goals (Strang et al ,2010). INFFER can be used to develop projects to conserve or manage the specific areas of natural environments such as wetlands, coastal dunes etc. and assets such as endangered species, threatened plants (as long as their physical location can be described) with high value from public perspective (Strang et al, 2010). INFFER assessments have been used by state governments in Western Australia, Victoria and New South Wales. The INFERR approach has also been piloted in the Canadian provinces of Manitoba, Saskatchewan and Alberta during 2011. According to Strang et al (2010), the goal of the INFFER decision support system is to achieve more environmental outcome by allocating the available resources well.

The INFFER approach to policy delivery involves a seven step process which begins with identifying valuable assets followed by project development, project assessment, project selection and monitoring, evaluation and adoptive management. Project assessment process of INFFER captures the information about the assets, the threats it faces, the goals that the project will achieve and the actions needed to achieve the goals (Strang et al, 2010). Further, the likelihood of success in terms of technical feasibility and community and government support are also considered in the process. The information collected in the project assessment process is used to calculate the Cost-Benefit index and provides practical support to determine the best type of delivery mechanism to use for the project such as positive incentive mechanisms, negative incentives, extension, technology development and informed inaction. According to Strang et al (2010), INFFER supports environmental decision making by highlighting the funding required to achieve particular environmental outcomes, builds on existing knowledge, integrates biological, physical, social and economic factors with institutional and political risks, and costs to assess the cost-effectiveness of actions. The INFFER helps to direct environmental investments towards environmental resources considering the amount of benefit relative to cost and hence represents an approach to targeting of policy and programs.

An alternative approach applied in Australia is the Eco Tender pilot, including the Bush Tender, initiative developed in central Victoria, Australia. Bush Tender focused only on terrestrial biodiversity and Eco Tender includes multiple environmental goods namely terrestrial biodiversity, saline land, aquatic function and carbon sequestration (Eigenramm et al., 2005). According to (Eigenramm et al., 2005), the consideration of several environment goods in the auction mechanism can be justified using two factors. First, if a land owner who plants trees on his land can jointly supply environmental goods including mitigating saline land, aquatic function and carbon sequestration. Secondly, as the auction mechanism required site visits it will be more economical to visit the land owner only once in relation to all goods compared to visiting them separately for each environmental good.

Stoneham et al. (2003) reports the results from Bush Tender pilot auctions and argues that the approach, which uses an auction mechanism to procure terrestrial biodiversity management from private land owners, is cost –effective and transparent and demonstrated significant cost saving compared to other grant based approaches. When accurately implemented, auctions help to overcome the common problem of asymmetric Information between the land owner and the funding agency (Eigenramm et al., 2005). This auctions mechanism encourages land owners to reveal their cost of undertaking specified actions that provide environmental outcomes. As described in Eigenramm et al. (2005), in the Eco Tender program, the government is the sole purchaser and the land owners in north Central Victoria are the potential sellers. First the Department of Primary Industries (DPI) communicates with the land owners in the identified areas and conduct site assessment of land owners that have registered their interest and meet the base criteria. Landowners can submit a bid identifying a set of actions that would provide environmental outcomes and the amount of funds they will require to adopt as estimated by the department. All the bids are assessed according to the total environmental benefits divided by cost of each bid. This process ensures the auction achieves the most cost-effective results for the given budget of the DPI (Eigenramm et al.,2005). As described in Eigenramm et al. (2005), using the total environmental score and the dollar value of the bid a supply curve was derived and marginal cost of supplying environmental outcome in the pilot area is calculated. Using the supply curve, the cumulative cost of purchasing environmental outcomes can be calculated. The bids were selected on a value for money basis, where the lowest cost bid is selected first until the budget is exhausted. Thus in the Eco Tender due to the ability to discover the price of supplying environmental outcomes the resources can be allocated in a cost-effective manner. Through price discovery, Eco Tender specifically selects lands that are able to produce environmental goods at lower cost hence represents another approach to target policy.

2.2.4 Policy targeting in the current agri-environmental programs in Canada

As described above, policy targeting has been directly incorporated into agri-environmental policy in programs in the U.S. and Australia. Existing Canadian policy also incorporates targeting, at a limited level. For example, both EFP and AEGP which were implemented under the farm stewardship program have involved policy targeting to some degree. As described earlier in this chapter, EFP is a program that encourages individual producers to identify the environment risk associated with their farm and develop their own action plan to address those risks by completing the Environment Farm Plan. Once a producer completes an Environment Farm Plan he will become eligible to apply for the cost-shared funding to implement appropriate BMPs (PCAB, NDd) . Therefore under the EFP the funding from the farm stewardship program will be spent to implement the BMPs in the identified areas that have higher potential of providing environmental benefits. As such the EFP targets program to some degree by identifying farmsteads with greater environmental risks. Similarly, under AEGP, the group of stakeholders in the watershed identify the areas that have environmental risks in their watershed and make their action plan to solve these problems. Once they have identified the environmental problems they will become eligible to get cost share funding under farm stewardship program in order to implement the BMPs to solve those problems in the watershed. Therefore, the AEGP process enables a limited level of targeting within the relevant watersheds by identifying those areas where greater benefits could be gained.

The effective targeting of agri-environmental policy requires information reflecting factors such as the economic and environmental characteristics of the landscape. In particular, this information needs to reflect the variation of these characteristics across the landscape to enable the targeting of the policy to the economic and environmental aspects of the land. The importance of this spatially explicit information was clearly demonstrated by the earlier discussed targeting examples in the U.S., Australia and these Canadian policy approaches.

2.3 The Application of GIS to Policy targeting

As discussed earlier, the effective targeting of agri-environmental policy requires information reflecting factors such as the economic and environmental characteristics of the landscape. In particular, this information needs to reflect the variation of these characteristics across the landscape to enable the targeting of the policy to the economic and environmental aspects of the land. Geographical Information System (GIS) is a tool which can be used to analyze spatial data and it is able to support policy targeting exercises. This section begins with a discussion of the application of GIS in policy targeting studies by examining some examples presented in the relevant literature and developing an understanding of the methods used for land selection.

2.3.1 Policy Targeting Examples Using GIS

There are examples in the literature where GIS databases and technology have been used explicitly to enable the targeting of environmental policy on agricultural landscapes. For example, in the study of cost effective targeting of land retirement to improve water quality, Khanna et al.(2003) combined GIS data with a hydrological model to quantify the sediment transport process in order to gauge the interdependence of sediment deposition and land use decisions on land parcels. GIS data on location of streams, the watershed boundaries, and soil data were used to analyse slope, distance from nearest water body and erodibility for each land parcel. These authors showed that slope and location can be used as targeting indicators to improve the efficiency of the targeting exercise. In a related study of the CREP Yang et al (2005), combined GIS data on site specific characteristics, a hydrological model and agricultural non-point source pollution in order to determine the erosion abatement benefits of enrolling specific land parcels. In the same study, GIS tools were used to organize all land parcels in the watershed to analyze the abatement achieved by retiring land parcels.

The employment of GIS in targeting can improve the performance of agri-environmental programs as the spatial contiguity of lands can be assessed. For example, selecting contiguous land using GIS for an agri-environmental program could help to increase the overall environment benefits of the program. In a study of inter farm co-operation for an agri-environmental program Macfarlane (1998), used GIS to map the farm boundaries, the regional landscape, the characteristics of the environmentally sensitive areas and designated conservation sites in the study area. In addition, GIS was used to classify farms with respect to the willingness of farmers to adopt collaborative management agreements. In this study GIS was used to identify contiguous farm holdings which can be secured under the eligibility criteria of the program. This research showed that land management programs can be enhanced by redirecting the present focus of agri-environment policy from individual farm holdings to broader geographical coverage.

Neumann et al. (2009) analysed the potential of spatial modeling for the development of agri-environment policies. According to these authors, although GIS based analysis methods are well established for ecological modelling, the spatial data sets at the national level usually lack detailed information about ecological quality and thereby makes this information not useful in models assessing ecological indicators. As an example Neumann et al. (2009) showed that the data set representing an environmental feature for a region, such as hedgerows, may not encompass the information about habitat quality for a given species. Therefore, in order to address the lack of ecological information in spatial data, the authors developed two indicators in GIS which can be used to describe landscape functions. The two indicators were habitat accessibility[8] and landscape fragmentation[9] which were used in combination to select lands for habitat quality.

According to Lee et al.(2002), the site selection for conservation and expansion of habitats has been done on an ad hoc basis not paying attention to the possibility of enhancing habitats by enlarging existing habitats using the surrounding landscape. In their paper Lee et al.(2002) discussed a targeting system for establishing new woodland in association with existing woodland in Chiltern Hills, United Kingdom. In the study, data bases developed in GIS were used to identify woodlands with greater potential for expansion based on their spatial location and size. The targeting method used was able to secure larger woodland patches representing a variety of habitats for different woodland species by expanding and connecting existing woodlands. Targeting enabled this policy measure to be an effective tool in habitat

[8] The mean of the Euclidean distance was calculated as the indicator for the habitat accessibility (Neumann et al, 2009).

[9] Landscape fragmentation was measured using the area of effective mesh size, which describes the degree of coherence of landscape (Neumann et al, 2009).

restoration. Lee et al.(2002) showed how spatial targeting of wildlife policy helps to secure ecologically valuable sites effectively.

According to Wu et al.(2002), only a few studies have assessed the impact of environmental factors on the CRP, or evaluated GIS to help improve the technical management of the CRP. In the study of Wu et al.(2002), available data sources and GIS were used to assess the impact on environmental factors on CRP enrollments. In order to evaluate land enrolled in the CRP, GIS layers representing land use and land cover factors including an erodability index (EI), soil associations, surface and ground water, oil and gas fields, physiography and topography were used. To evaluate how the distribution of the CRP was affected by land characteristics enrolled lands were overlaid with each of the above listed biophysical characteristic layers. The study was able to determine that there is a strong relationship between the aquifer thickness along with the location of gas and oil fields and the distribution of CRP land. The factors such as soil, aquifer depth, physiography and slope had minor effects on the CRP enrollments. In the same study, the potential of using GIS to evaluate bids for new CRP enrolments was illustrated (Wu et al., 2002). The study analysed the pattern of EI with soil associations using GIS and showed that EI was an excellent indicator to evaluate suitable lands for CRP. In this analysis the authors were able to spatially identify priority areas for CRP by targeting environmental sensitive sites thereby suggesting that GIS can be a useful to assess and manage an agri-environmental program such as the CRP.

A number of studies show how the application of GIS databases and decision support techniques that focus on wildlife population dynamics based on landscape ecology can improve the performance of wildlife policy. Nikolakaki (2004) presented a method that involves a GIS site selection process for habitat creation focusing on deciduous woodland in England. Using GIS, the connectivity of habitat patches were estimated. The lands were assigned a value ("cost" value) and ranked considering the quality of land cover and ability to disperse by an umbrella species[10]. Further, the land patches were prioritised in terms of the ability to act as a core for habitat creation considering the spatial context and size of the parcel. The study was able to demonstrate an approach to select lands which fulfill the requirements for habitat expansion.

2.4 Targeting Theory

Within the targeting literature there are a number of different approaches identified that prioritize certain characteristics of the land with these targeting mechanisms shown to provide different types of outcomes. The type of targeting mechanism used has an impact on the effectiveness of agri-environmental policy through cost savings and environmental benefits gained. Policy targeting can be based on such factors as environmental benefits, land opportunity cost and land characteristics. Babcock et al.(1997) evaluated three major types of targeting mechanisms used to secure agricultural land in a set-aside type program: benefit maximizing; cost minimizing, and maximizing the benefits-to-cost ratio. In this research, the authors defined benefit maximizing as focusing on purchasing land with the highest per-unit environmental value (benefits per hectare) regardless of the per-unit costs (dollars per hectare). The cost minimizing method targets the least expensive lands (eg. lowest cost in $ per

[10] Umbrella species is species whose conservation confers protection to a large number of naturally co-occurring species (Roberge and Angelstam, 2004).

hectare) with no consideration given to the environmental benefits that could be provided by the land parcels. Finally, maximizing the benefit-cost ratio focuses on acquiring land, or resources, based on the ratio between the environmental benefits and land costs. The discussion in this section will focus on explaining how each of these targeting methods differs and how the parcels set-aside will be influenced by the targeting mechanisms applied.

The efficiency of the provision of environmental benefits from a given agri-environmental program can be increased by incorporating targeting tools to the program. However the relationship between land values, as represented by the payments required to direct the land management, and the capacity of the land to provide environmental benefits will have an influence on the outcome of the targeting method. For example, Babcock et al.(1997) examined the influence of cost and environmental benefit trade-offs on the performance of alternative targeting mechanisms. The relationship between the environmental benefits and the cost of enrollment of land parcels can vary. According to Babcock et al (1997), the extent to which the targeting schemes resulted in different outcomes depends upon the correlation of the environmental benefits and costs of land parcels. When benefits and costs are positively correlated, those parcels that can provide the greatest environmental benefits are also the parcels that have the greatest cost of enrollment due to, for example, greater opportunity cost as determined by agricultural productivity. When benefits and costs are negatively correlated, those parcels that can provide the greatest environmental benefits are the parcels with the lowest cost of enrollment. Babcock et al. (1997) showed that when costs and benefits are negatively correlated, all three targeting schemes (benefit targeting, cost targeting and benefit-cost targeting) would purchase the same land area. Thus, outcomes from three targeting criteria will tend to converge. In contrast, when environmental benefits and costs , as represented by agricultural productivity, are positively correlated different land areas are targeted under the three strategies. This effect will now be discussed in greater detail.

A simple model has been used to demonstrate that the correlation between environmental benefits (or foregone environmental costs) and adoption costs will have a significant impact on the outcomes of policy targeting. In the model developed by Babcock et al.(1997) it was assumed that, due to differences in bio-physical and economic conditions across a landscape, there will be range of opportunity costs (C), which represent the level of payment required to set aside the parcel of land (or alter the management as dictated by a BMP). The land will also represent a range of environmental productivity or environmental benefits (B) meaning that different parcels of land will provide different quantity or quality of the range of ecosystem services (Figure 2.1). In this Figure, environmental benefits increase along the B axis while cost of enrollment (opportunity cost of the land) increases along the C axis. In this Figure, B* is assumed to represent the minimum per acre environmental benefits that would be accepted under a particular environment policy while C* represents the highest adoption cost (or opportunity cost) that would be paid through a particular environment policy. It is important to recognize that in Figure 2.1 B* and C* are arbitrarily chosen to demonstrate the impact of targeting. Likewise, Y* represents arbitrarily defined threshold level of the benefit-cost ratio. The value of these B*, C* and (Y*) can vary with the biophysical characteristics and the economic values, often dependent on the agricultural productivity of the land.

Based on this model, it can be shown that different targeting methods will secure different land parcels within the landscape. The cost targeting strategy will select land with relatively low opportunity costs as represented in Figure 2.1 as the parcels to the left of C* including land in areas D, G, I and H. In contrast the targeting of land providing greater environmental benefits is represented in Figure 2.1 as the parcels located above B*including land parcels represented by areas D, G, E, and F. Finally, benefit to cost targeting will enroll land that represents greater benefit to cost ratios as represented by the parcels located above the Y* line in Figure 2.1, represented by land in area I, D and E . Based on this simple model it can be seen that while there are common parcels of land secured by all targeting methods, such as parcels in area D, other parcels of land will only be secured using one or two of the targeting methods.

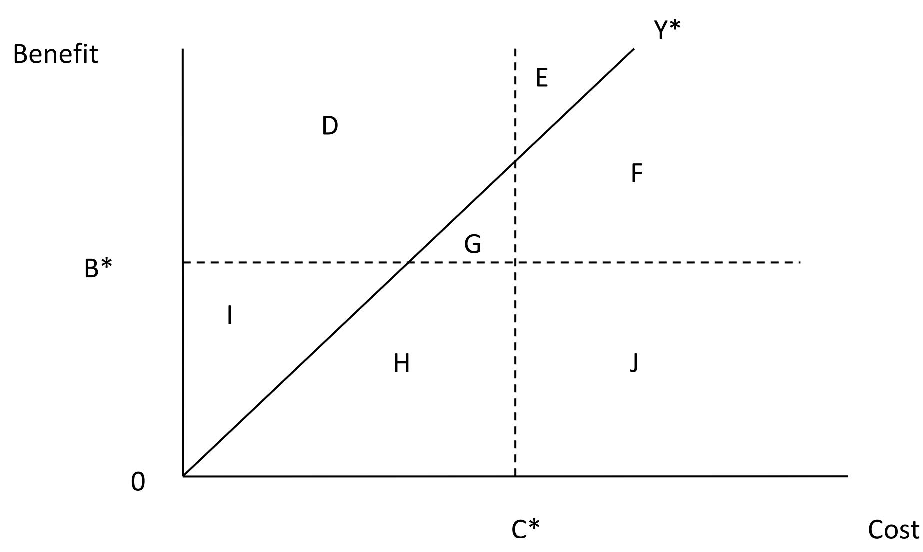


Figure 2.1 Land parcels selected under cost targeting, benefit targeting and benefit to cost targeting

Now that the range of land parcels identified by each targeting method has been designated this model can be further used to understand the selection of parcels that may be enrolled using a specific policy approach. As indicated earlier, the effect of a targeting strategy is dependent on the correlation of opportunity cost with environmental benefits. The influence of the correlation on the outcome also has been described by (Babcock et al., 1997) (Figure 2.2). When there is a negative correlation between B and C such that the land providing greatest environmental benefits have the lowest opportunity costs, and thereby lower cost to enroll in the environmental program, and the land with the greatest opportunity cost have the lowest potential for providing environmental benefits, the available lands can be designated generally within the dotted area. Alternatively, if there is a positive correlation between B and C, such that lands with the greatest opportunity cost also can provide the greatest environmental benefits and *vice versa*, the available lands can be generally represented by the cross hatched area. When B and C are negatively correlated, much of the available land will be present in area D and J. In this situation the model indicates that all three targeting schemes target land in area D (high environmental benefits and low cost) and none include land in area J (low environmental benefits and high cost). Therefore, when costs and environmental benefits of land are negatively correlated the three targeting schemes target the same land parcels. In contrast, when environmental benefits and costs are positively correlated much of the available land will be in areas E, F, I and H. Benefit targeting would capture land in E and F (high environmental benefit and high cost), cost targeting would obtain land in I and H (low environmental benefit and low cost) while benefit-cost targeting would gain land in D (high environmental benefit but low cost) E (very high environmental benefit and moderately high cost) and I (moderately low environmental benefit and low cost). Therefore, as demonstrated by the model, when land opportunity costs and environmental benefits are positively correlated, the lands enrolled under the three targeting strategies are somewhat different. Given heterogeneous agricultural landscapes, as the levels of environmental benefits and cost resulting from the three targeting strategies are different, the importance of selecting the proper targeting strategy increases when opportunity costs and environmental benefits of land are positively correlated.

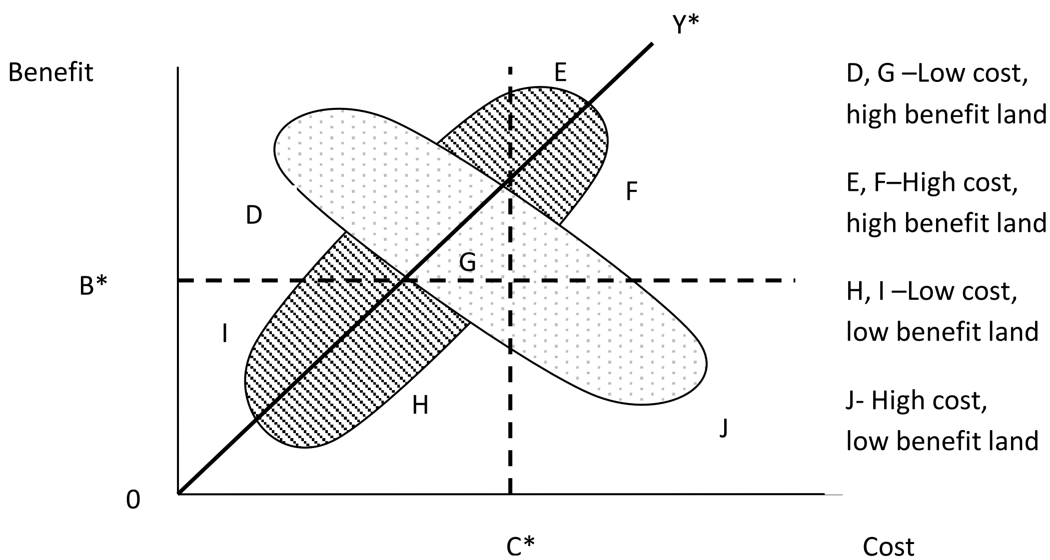


Figure 2.2 Impact of correlation on land selection from different targeting schemes

Based on this analysis, Babcock et al. (1997) argued that a positive correlation between environmental benefits and land enrollment costs tends to increase the outcome disparity.

Thus, a positive correlation increases the importance of selecting the proper targeting tool. Yang et al.(2005) explained that if there is a positive correlation between environmental benefits and opportunity cots, maximizing benefit targeting would purchase land with high benefits but also with high costs. In contrast, cost targeting would purchase land with low cost but with low benefits. Accordingly to the above arguments the selection of a targeting mechanism should be done based on the nature of correlation between benefits and cost on the land parcels.

While the above analysis is useful to understand targeting outcomes in a theoretical sense, it is important to discuss the relationships found on actual agricultural landscapes. There is a limited research done revealing this relationship and therefore this limitation suggests the importance of this research in addressing this gap. In a study of effectiveness of targeting the CREP in Illinois, (Yang et al., 2005) reported that the opportunity cost of enrollment and potential for sediment abatement benefits in the eligible area were negatively correlated and showed that the result from selecting land parcels either on the basis of benefit maximization or benefit/cost maximization were almost identical.

Research has shown that other than correlation between the environmental benefits and opportunity cost, the variability of those two factors also should be considered to achieve efficiency. Babcock et al. (1997) showed that the amount of spatial variation in costs relative to benefits also influence the magnitude of the efficiency. They report that an increase in cost variability increases the efficiency that can be obtained from cost targeting and has no effect on the efficiency that can be obtained from benefits targeting when benefits and costs are not correlated. The opposite also holds true. Their results show the importance of selecting the optimal targeting instruments under alternative assumptions about the level of variability of benefits and costs and correlation between the two. Yang et al. (2005) also argued that the efficiency losses from benefit targeting or cost targeting as compared to benefit to cost targeting depends not only on the correlation between the benefits and cost but also on the spatial variability of benefits and costs. Further, they argue that, when cost variability is low there is no change in efficiency whether benefit targeting or benefit to cost targeting is employed irrespective of the direction of correlation. Therefore, different targeting mechanisms have been used in different instances to achieve a higher efficiency.

2.5 Summary

This chapter presented a review of the literature focused on targeting of policy in agri-environmental programs. The theoretical background for policy targeting was laid. In most cases agri-environmental programs in U.S and Canada have not often enrolled land based on specific features, particularly environmental features, of the land. As an example in USA targeting has been incorporated into CRP by EBI while in Canada limited level of targeting is used in EFP and AEGP processes. The inclusion of targeting for agri-environmental programs can increase environmental benefits that can be gained for a limited program budget. In the literature, three major categories of targeting criteria are evaluated for agricultural landscapes. Different targeting mechanisms can result in very different outcomes in terms of the cost and benefit characteristics of the land selected. In selecting a targeting tool, correlation between environmental benefits and enrollment cost should be taken into consideration. However there is limited research available on to the nature of this correlation in agricultural landscape. GIS is a tool that can be used in targeting policy to enable understanding of the correlation of benefit and cost of land as well as the effectiveness of different targeting methods. The next chapter will develop a representative wildlife conservation policy approach to meet conservation objectives. Also the methodology of applying the habitat conservation policy approaches to the identified agricultural region using different targeting protocols will be discussed.

CHAPTER 3 METHODS

3.1 Introduction

There is a demand from society for policy to encourage the increased provision of ecosystem goods and services on agricultural landscapes. In the analysis of these types of policies it has been argued that the targeting of policy instruments can improve their efficiency and effectiveness. This chapter will provide details of an approach to assess the effectiveness of different targeting methods in a hypothetical agri-environmental program using land set-aside to increase, or limit the decrease, of ecosystem goods and services provided by prairie wetlands and adjacent uplands. This chapter is structured in the following way. The study site that is used for the analysis is described in the next section, followed by a brief account of the GIS data base used for the study. Following this the chapter focuses on describing the land selection criterion and policy targeting methods developed for this study. Finally, a detailed description of specific GIS techniques adopted and developed to carry out the policy targeting study are described.

3.2 Study area

The study area is located in the north central region of the agricultural region of Saskatchewan, approximately 100 kilometres north-west of the city of Saskatoon (Figure 3.1). The study area is the Redberry Lake Rural Municipality (RM) 435 and represents a relatively typical agricultural landscape within this area of the province of Saskatchewan in terms of land use patterns. The Redberry RM makes up a significant proportion of the area of the Redberry Lake Biosphere reserve (Figure 3.2). The Redberry lake biosphere reserve, designated by

UNESCO in the year 2000, has been recognized for its biodiversity and also is a provincially designated bird sanctuary (Prairie Wild Consulting Co, 2010). The other RMs in the Biosphere reserve includes Blaine Lake (RM 434), Douglas (RM 436), Great Bend (RM 405), Mayfield (RM 406) and Meeting Lake (RM 466). The Redberry RM includes the town of Hafford and the village of Krydor. The closest rail road is located south east of the Redberry RM passing through the North Battleford and Mayfair RMs.

The RM of Redberry was chosen for the analysis of agri-environmental targeting in this thesis due to a number of factors. The existing Biosphere Reserve means that there is more data available on land use, wildlife presence and other study relevant characteristics that may not be available for other RMs. In addition, the presence of the biosphere reserve may also result in a local population that may be interested and willing to contribute to the work. Secondly, the area falls within one or more Agri-Environmental Group Plans discussed earlier as part of the agriculture policy framework and initiated by the Saskatchewan Watershed Authority.

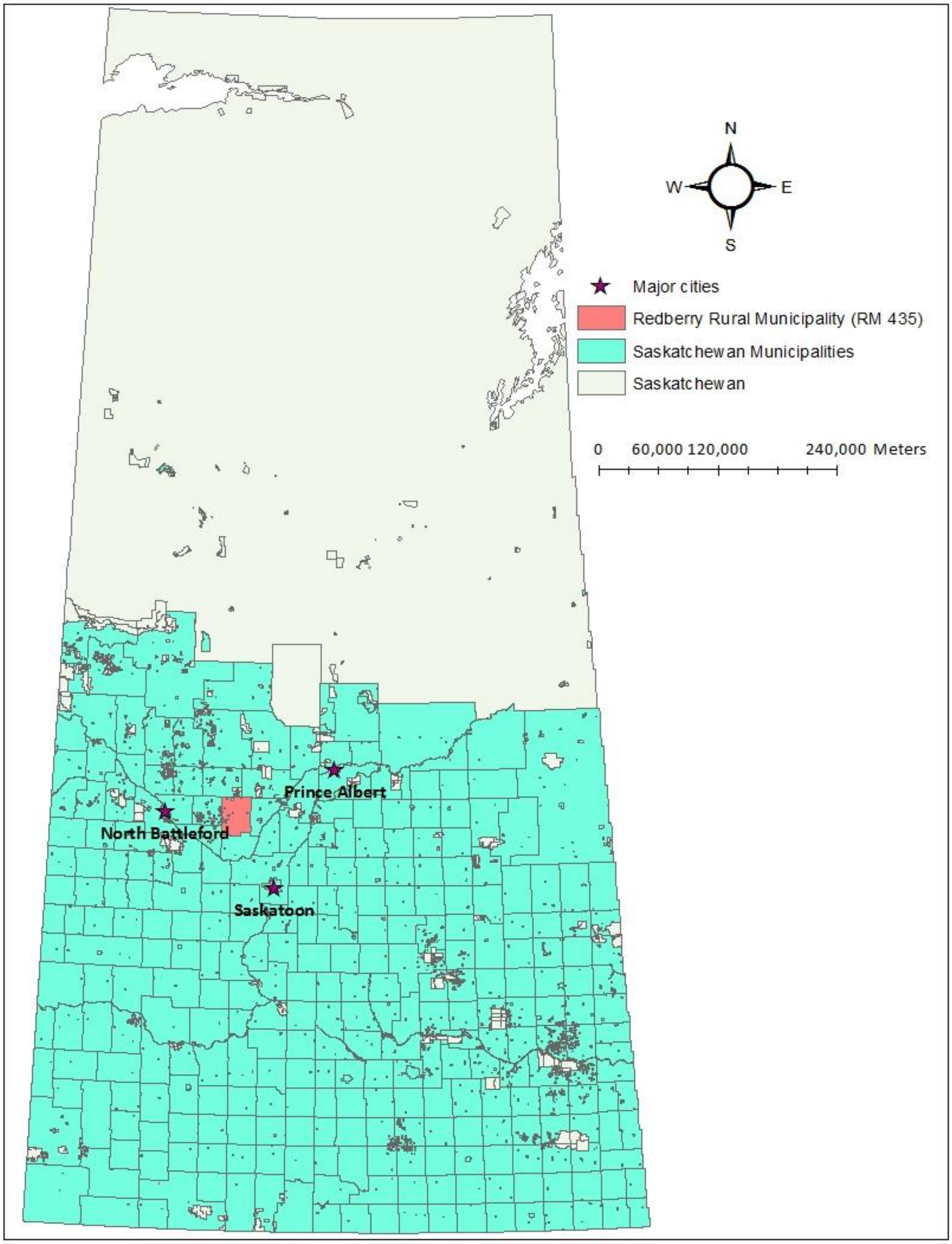


Figure 3.1 The study region location within the province of Saskatchewan.

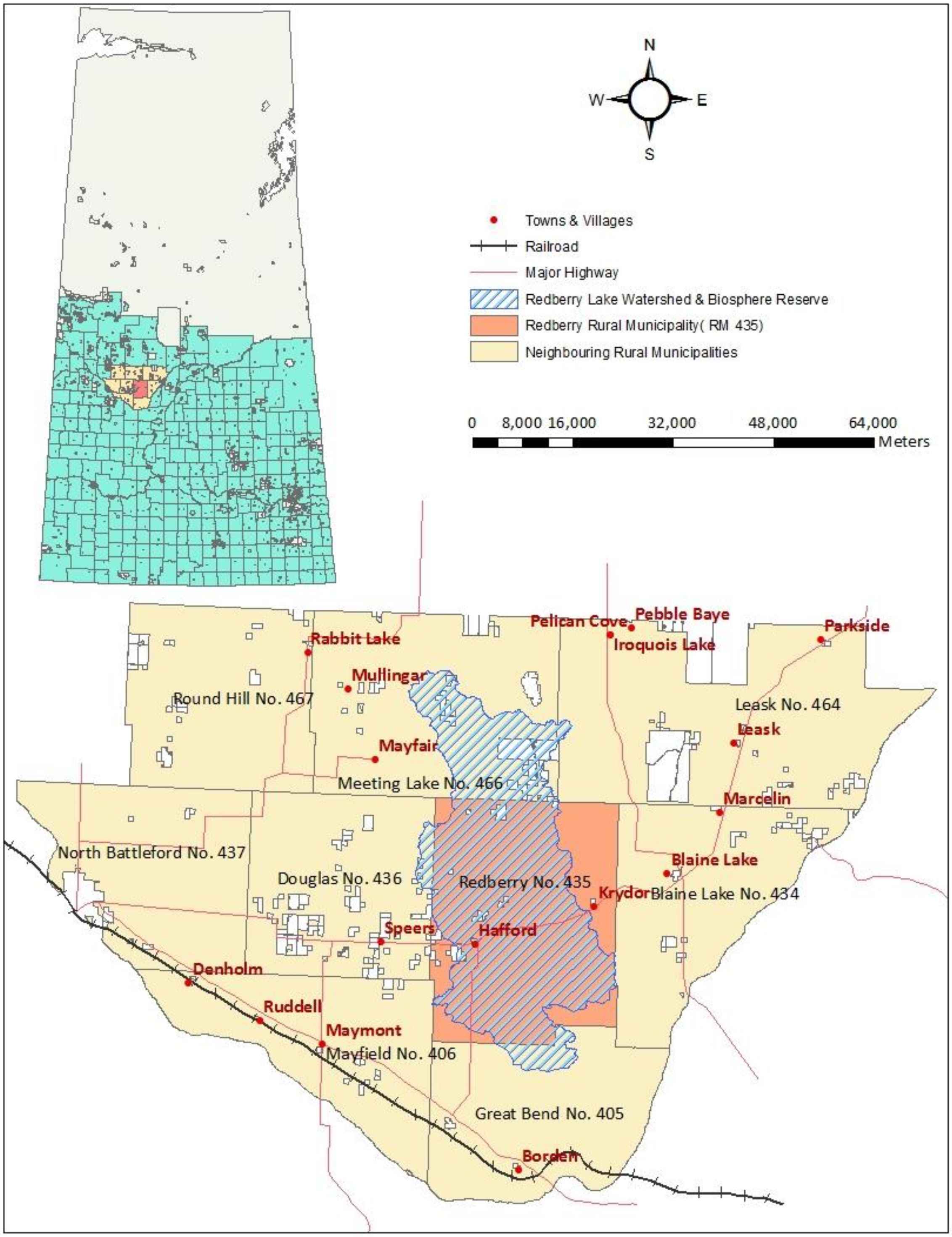


Figure 3.2 The study region in relation to neighbouring rural municipalities and the Redberry Biosphere Reserve.

In the presence of these Environmental Group Plans there will be more available information and, again, interest from the local Community. Also with the presence of the biosphere reserve it is relevant to develop an environmental policy in order to enhance the habitats for wildlife.

The Redberry RM covers 101,553 ha (1,015.53 km^2) with a total population of 372 people as of 2011 (Statistics Canada, 2012). Approximately 34% of residents (greater than 15 years old) have attained some level of post-secondary education including apprenticeship, college or university education, while 40% of residents have a high school education (Figure 3.3). As expected agriculture is the primary industry in the Redberry RM with agriculture being the primary source of employment with 54% of labour force engagement (Figure 3.4). Secondary industries include manufacturing (13% work force), health care and social services (13%), and business services (7%).

Table 3.1 Characteristics of the population of the Redberry RM (435)

Source: (Statistics Canada, 2012)

Feature	Number, Area (ha)
Population in 2011	372
Population in 2006	451
2006 to 2011 population change (%)	-17.5
Total private dwellings	239
Population density per square kilometre	0.4
Land area (ha)	101,553

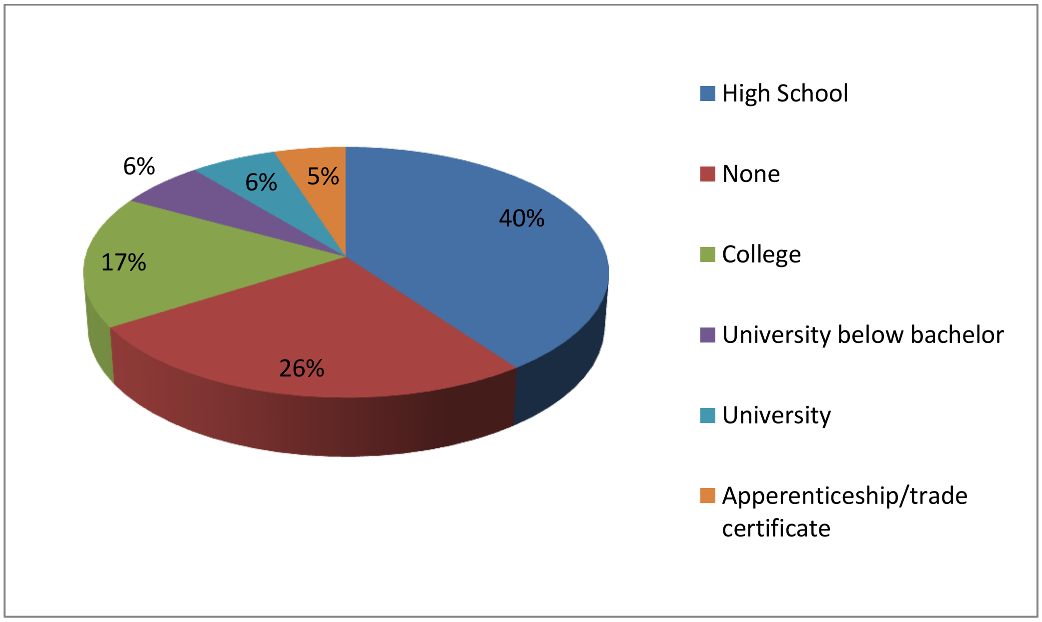


Figure 3.3 Redberry RM educational attainment of the population 15 years and over in 2006

Source: Statistics Canada (2007)

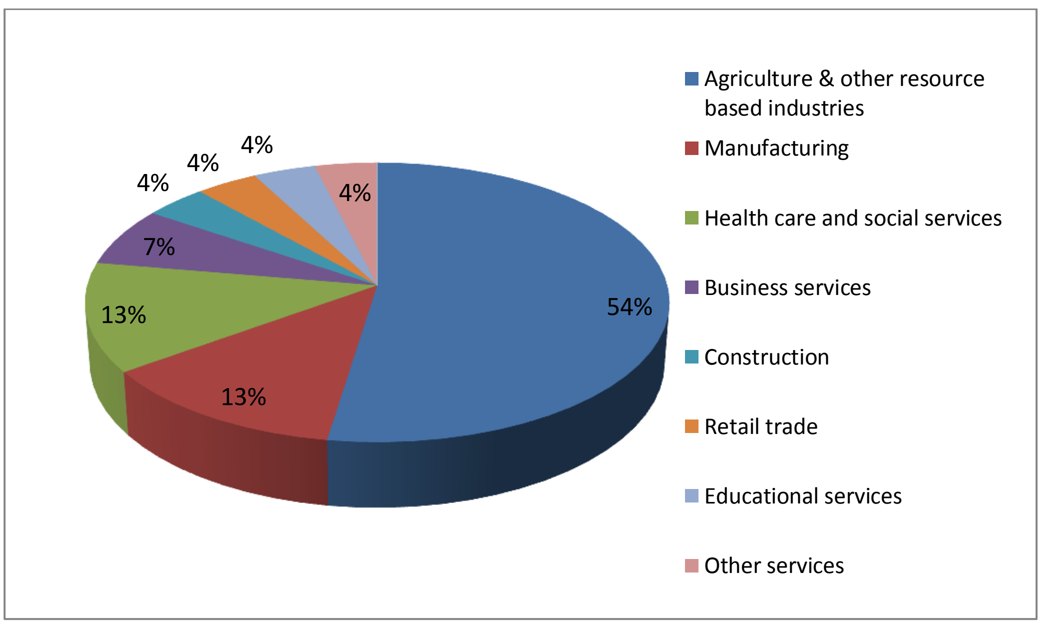


Figure 3.4 Redberry RM, work force by industry of the population 15 years and over in 2006

Source: Statistics Canada (2007)

Approximately, 63% of the land in the study area is cultivated while 16% of the area is natural vegetation and wetland (table 3.2). Other important land use includes seeded pasture and natural pasture. Wheat and Canola are the major crops grown in the Redberry RM (Figure 3.5) (Statistic Canada, 2011). The other important component of agriculture and land use within the study RM is livestock production with only cattle being produced in significant numbers with total cattle populations of 10,000 head in 2011 (Statistic Canada, 2011). The size of farms in the Redberry RM , in terms of area of land managed, range from approximately 4 to 1425 ha. However, the majority (70%) of farms manage a land area between 97 and 906 ha (Figure 3.6) with an average farm size of 434 ha.

Table 3.2 Characteristics of land use in the Redberry RM (435)

Source: Statistics Canada (2011)

Feature	Number, Area (ha)
Number of farms	139
Land in crops (ha)	51,888
Summer fallow land (ha)	3,522
Tame or seeded pasture (ha)	9,069
Total cultivated land (ha)	64,479
Natural land for pasture (ha)	7,827
Woodlands and wetlands (ha)	4,475
All other land (ha)	1,395

Source: Statistics Canada (2011)

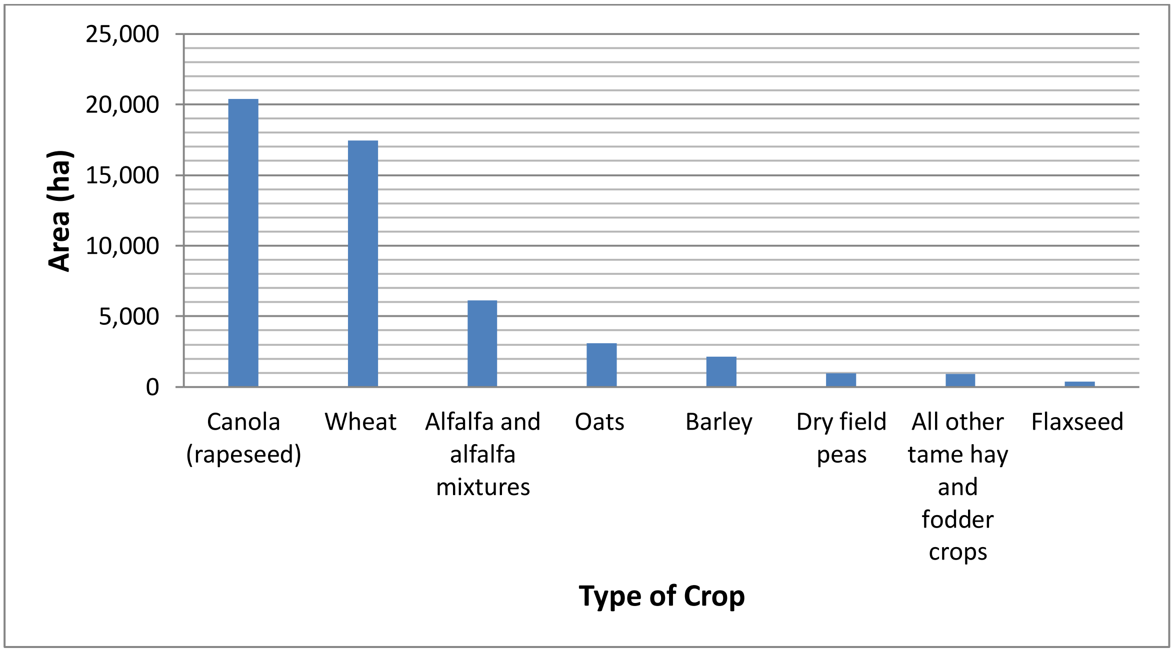


Figure 3.5 Area of land allocated to the primary crops cultivated in the study area

Source: Statistics Canada (2011)

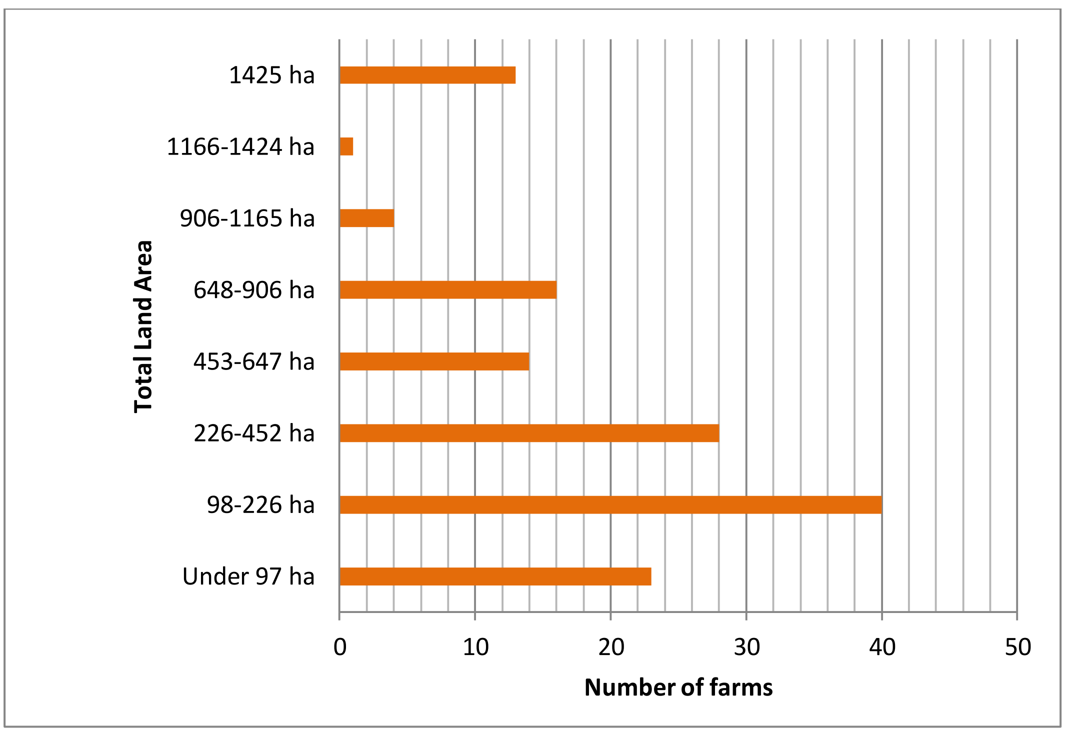


Figure 3.6 Number of farms classified according to land area

Source: Statistics Canada (2011)

3.2.1 Land Cover in the Study Area

The study area is a rolling landscape dominated by annual cropland but interspersed with wetlands, shrub land and small stands of primarily deciduous forest (Figure 3.7). The range of cover types are not uniformly distributed across the study area with a band of non-cultivated land running from the south west to the north east dominated by grassland in the south west and more forest and shrub in the north east. Annual cropland dominates the east and south east as well as the western sides of the RM. When considering the total land area used for the study, approximately, 67% of the land is cultivated while one third of the total area remains in natural vegetative cover[11] (Figure 3.8). While wetlands are a relatively important component of this landscape the wetland complement is not evenly distributed with only about 2% of the land area being covered by wetland with these wetlands being primarily small basins of, on average, 1.5 ha. Only 581 (out of 1655) quarter sections contain wetlands with each of these land units containing, on average, about two wetlands. Each quarter section that contains wetlands, on average, holds 2.6 ha of wetland area. Many of the wetlands are located within the area more dominated by natural vegetation which, as described earlier, is represented by a central band running from the south west to north east corners of the RM (Figure 3.7). According to the GIS land cover data from (GeoBase, NDa) there are approximately 1,034 polygons that are identified as permanent or semi-permanent wetland basins in the study area.

[11] In the analysis the area of lake is excluded due to the fact that the data base of SAMA (Saskatchewan Assessment Management Agency) which contains assessment value has excluded that area. Therefore, all the calculations have been done excluding the lake. The area used for the study is similar to the area given in Figure 3.7.

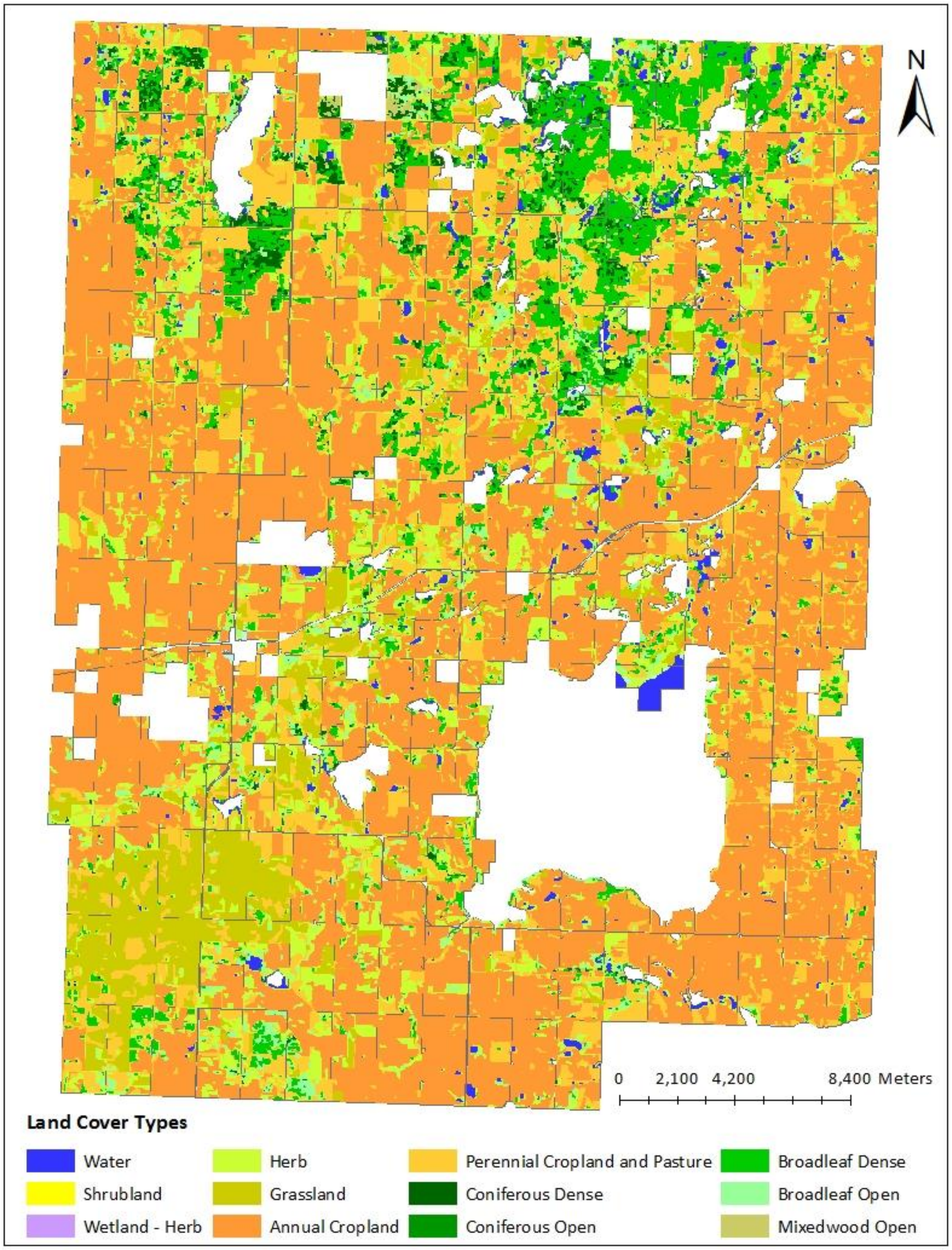


Figure 3.7 Land-cover distribution in the Redberry RM study area

Source: (Geobase, NDb)[12]

[12] GeoBase is a portal of geospatial data for Canada and it is a federal, provincial and territorial government initiative overseen by the Canadian Council on Geomatics (CCOG).

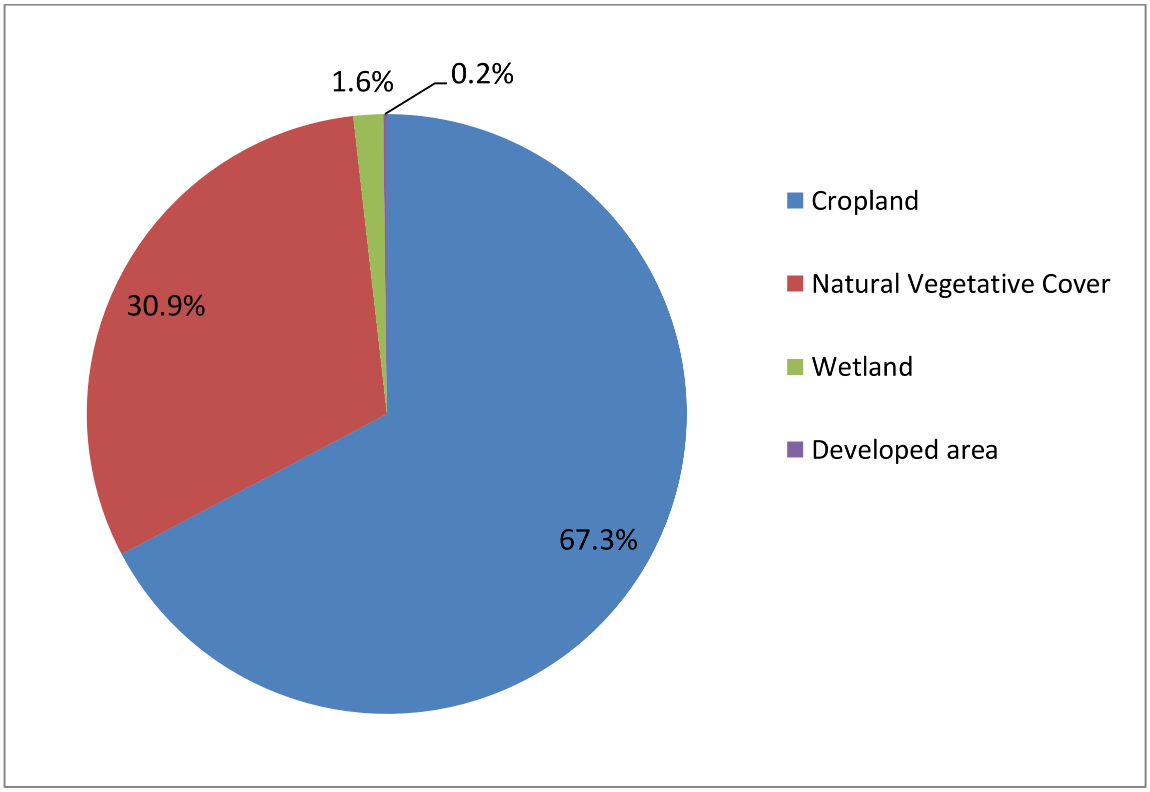


Figure 3.8 Composition of the landscape of the Redberry RM study area

Source: authors calculation based on Geobase Land cover data

3.3 GIS Databases and Techniques

As discussed in chapter two, GIS has been shown to be an effective tool to enable policy targeting. In the study, to execute a targeting analysis using GIS an accurate representation of the study area with appropriate data layers is required. The analysis will use a land cover layer, the administration boundary layer and the land assessment values to identify landscape characteristics that are important for different types of policy.

3.3.1 GIS Layers Secured for the Study

The GIS data base used to perform the research for the present study was assembled from GIS data layers collected from different sources. The primary layers used for this study are land cover information and land values (Table 3.3). In order to develop a simple land selection framework and policy targeting criteria, the land cover data could be used to represent the potential of the land parcel to provide the specific environmental good or service and the land use change that may be required to meet the policy objectives. To represent land opportunity cost land assessment values were used as a reasonable, and relatively available, proxy for the expected economic returns provided by the land based on agricultural productivity estimates. The land cover data and assessment values which were the basic layers used for the study are described in detail in the rest of the section.

Table 3.3 Description of GIS data base layers

Data Types	Source	Description
Base map		
Saskatchewan[a] Municipal Boundary Map	Municipal boundaries datasets include municipality, upper municipality and municipal regional Area. Current Saskatchewan Provincial Borders Current Saskatchewan Rural Municipalities Current Saskatchewan Urban Municipalities	
Saskatchewan[b] Township Fabric Map	This includes township shape files, section shape files, quarter section shape files Saskatchewan Quarter Sections 2009 Saskatchewan Sections 2009 Saskatchewan Townships 2009	
Environmental and social characteristics		
Land Cover[a] Classification	The land covers classification consists with almost 45 land cover types. 80% of the Land Cover base comes from 1999 to 2001	
Satellite imagery[c]	Flysask WMS layer – from 2.5 m high-resolution imagery. This includes Sask grid, national road network, flysask orthophotos 2008-2010, national topographic system, administrative boundaries	
Economic data		
Land Assessment[d] Values	Include information about the tax class, property use and assessed value y quarter section in RM435.	

[a](GeoBase, NDa)
[b] (GeoSask, ND)[13]
[c] (FlySask, ND)[14]
[d] (Saskatchewan Assessment Management Agency (SAMA), 2011)

[13] Geosask is a public web portal for different types of maps and geographic information related to Saskatchewan land from various government sources.

[14] Flysask is a website managed by Saskatchewan Geospatial Imagery Collaborative (SGIC) for remotely sensed satellite and aerial photographic imagery.

3.3.2 Base Map

The base map was established using Saskatchewan Municipal Boundary Map and Township Fabric Map. The Municipal Boundary Map was developed to show a series of municipal features or bounded areas within the provinces or territories of Canada (Geobase, NDa). These municipal boundaries correspond to administrative areas built according to a geographic hierarchy which involve three levels, namely municipal regional areas, upper municipalities and municipalities. The Township Fabric Map is a dataset which consists of a standardized provincial grid for land parcels (defined by legal location) developed using surveyed base data from the southern provinces and theoretical northern data (GeoSask, ND). These administration boundaries are important to identify the land parcels that are available to secure by different targeting methods in the study. The land cover information and assessment values will be attached to land parcels in order to identify the characteristics of land.

3.3.3 Land Cover Layer

The land cover layer is an integrated Land Cover database produced from various available classified satellite data (Geobase, NDb). The Land Cover database is based on information from the period 1996 to 2005; however 80% of the Land Cover data comes from 1999 to 2001. The land cover classification consists of 45 land cover types but within the target study area there were about 20 major land cover classes. Land Cover data are derived from vectorizing raster thematic data from several sources. Because this Land Cover classification was produced using classified imagery, the accuracy of Land Cover vector data depends on the underlying thematic data accuracy related to the image classification process[15]. Therefore it is possible that some polygons may not represent the correct classes. For example, a wetland polygon may be overlapping an agricultural area and therefore the wetland polygon in the map shows a larger area than the actual wetland. These variations may either be temporal variations or classification errors (Geobase, NDb).

The raster thematic data originated from classified Landsat 5 and Landsat 7 ortho-images for agricultural and forest areas of Canada, and for Northern Territories. The forest cover has been created by the Earth Observation for Sustainable Development (EOSD) project, an initiative of the Canadian Forest Service (CFS) with the collaboration of the Canadian Space Agency (CSA) and in partnership with the provincial and territorial governments (Geobase, NDb). The agricultural coverage is developed by the National Land and Water Information Service (NLWIS) of Agriculture and Agri-Food Canada (AAFC) (Geobase, NDb). Northern territories land cover was developed from the Canadian Centre of Remote Sensing (CCRS). Land Cover data legend was developed from a collaboration between several partners and was classified according to a harmonized legend build from the partner's legends. This legend is principally based on EOSD legend which CFS and AAFC collaborated (Table 3.4) (Geobase, NDb).

[15] The image classification is a process that converts multiband raster imagery into a single-band raster with a number of classes.

Table 3.4 Definition of the land cover classifications represented in the Redberry RM study area.

Class	Description
Exposed land	<5% vegetation. River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cut banks, moraines, gravel pits, tailings, railway surfaces, buildings and parking, or other non-vegetated surfaces.
Water	Lake, reservoirs, rivers, streams, saltwater.
Herb	Vascular plant without woody stem (grasses, crops, forbs, gramanoids). Minimum of 20% ground cover or one third of total vegetation must be herb.
Wetland-Herb	Land with a water table near, at or above the soil surface for enough time to promote wetland or aquatic processes. The majority of vegetation is herb.
Coniferous-Dense	>60% crown closure. Coniferous trees are 75% or more of total basal area.
Coniferous-Open	26-60% crown closure. Coniferous trees are 75% or more of total basal area.
Broadleaf- Dense	>60% crown closure. Broadleaf trees are 75% or more of total basal area.
Broadleaf- Open	26-60% crown closure. Broadleaf trees are 75% or more of total basal area.
Mixed Wood-Open	26-60% crown closure. Neither coniferous nor broadleaf trees account for 75% or more of total basal area.

Source: (Geobase, NDc)

3.3.4 Economic Values of Land

The land assessment values for the Redberry RM were purchased from Saskatchewan Assessment Management Agency. The SAMA data represents an estimated economic value of each parcel of land from June, 2006 based on the application of a formula and rules given in the 2006 Base year Saskatchewan Assessment Manual (SAMA, 2007). This data provides land values for all land parcels within the study area to serve as a proxy value for the cost of compensating farmers to change their land use or to idle areas of land. The data base consists of several fields which are described in Table 3.5.

Table 3.5 Attributes of the SAMA assessment values data base

Field	Description
PID	Property Identifier
Assessment ID	Municipality Code followed by a 9 digit number useful for SAMA reports.
LLD	Legal location
LLD_type	Designates format for the legal location
Tax Class	8 tax classes in the province used for tax purposes.
Property Use	Code describing the use of the property
Assessment Value	Assessed value for the quarter section

3.4 Targeting Landscape Characteristics: Wetlands

The research assesses the effectiveness of different targeting methods in a land set aside type agri-environmental program focused on wildlife habitats provided by prairie wetlands and the adjacent uplands. Therefore, the policy delivery must include a process to identify wetland basins and the surrounding riparian zone comprised of upland native and planted vegetation within the study landscape. As discussed by Semlitsch and Bodie (2003), terrestrial areas surrounding wetlands are core habitats for many semiaquatic species to complete their life cycles. The literature shows the importance of the interconnection between terrestrial and aquatic habitat in the maintenance of wetland viability. Wetzel (1990), Mitsch and Gosselink (1993) and Burke and Gibbons (1995) have suggested that in the attempts to preserve the biodiversity associated with wetlands, preserving buffer zones around wetlands should be mandatory while considering the wetland habitat as core area for preservation. Hence, in the present study wetland and the adjacent riparian buffer was used as the key areas for conservation. The further identification of land parcels for conservation will be discussed in the next section.

Within the GIS land cover classification layer, there were two categories, water and wetland, considered equivalent to permanent and semi-permanent wetlands within the landscape. Permanent wetlands can be defined as any water body that, in an average precipitation year, can hold water through the summer seasons while the semi-permanent wetlands could hold the water until late spring or early summer. To demonstrate the wetland distribution, a part of the study area is provided to illustrate the landscape characteristics (Figure 3.9). This was developed based on aerial photographs of the study site (Flysask WMS layer – from 2.5 m high-resolution starlight imagery) with the shaded patches representing the permanent and semi-permanent wetlands extracted from land cover classification of Geobase. Detailed descriptions of these data are given in the Table 3.3. As shown in Figure 3.9 there is often a relatively clear transition of vegetation from wetland plants to dry land plants. For the present research it is expected that these variation in vegetation will provide a variety of habitats for different wetland species and at different stages of their life cycles. The proposed policy tool for this research focuses on conserving these areas, through a set-aside process, and thereby conserving important habitat components for the wetland related species of the landscape.

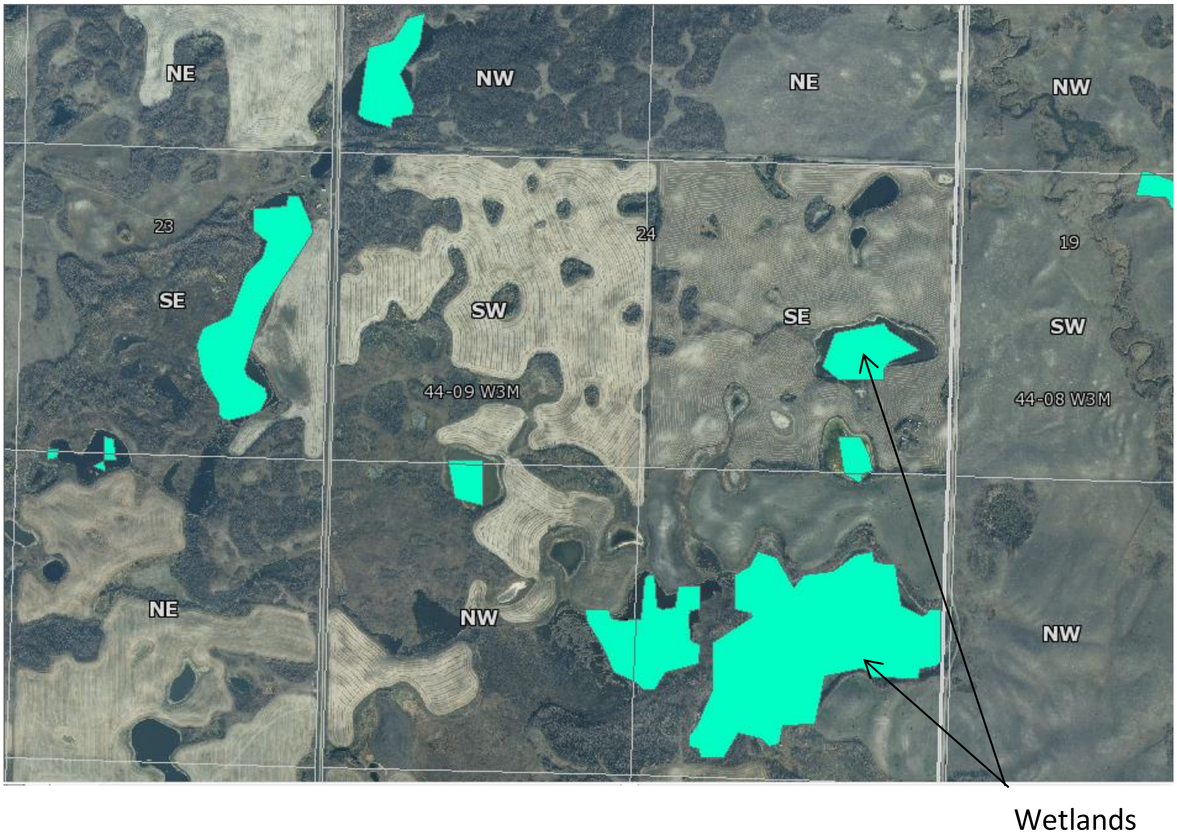


Figure 3.9 Distribution of wetland patches in a sample part of the study area

Source: Aerial photograph -Flysask WMS layer (FlySask, ND); Wetlands - Land cover layer (GeoBase, NDa)

To enable the specification of the wetland and upland habitat, the riparian areas were delineated as a 100m wide buffer zone established around each wetland based on the GIS data base. To identify these potential habitat areas within the target landscape, initially the wetlands (water and semi-permanent wetlands cover categories) were identified in the Red berry lake RM using the land cover layer. Using the GIS tools a buffer, or riparian, zone of 100m width was established around each identified wetland basin. Then these wetland and buffer areas that fall within a given quarter section were added together. These land areas are referred as "identified habitats" hereafter. Figure 3.10 illustrates a sample part of the study area with the 100m buffer zones established and displaying the variety of land cover types represented in the delineated riparian areas based on aerial photographs as described above. The distribution of these delineated buffer zones in the study area is provided in the Figure 3.11. These habitat patches are used as the basic areas to develop the targeting scenarios which are described later in the section.

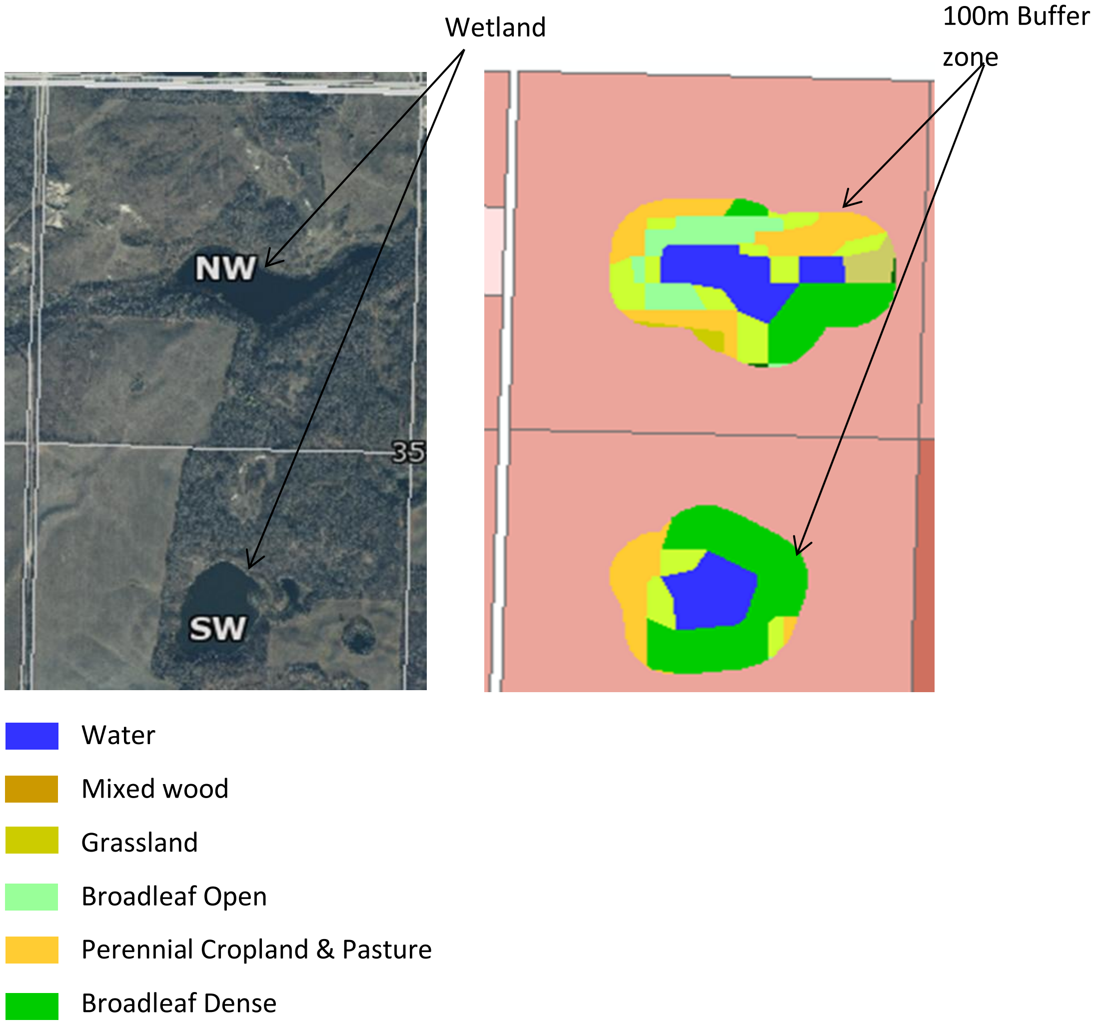


Figure 3.10 Sample wetland and defined riparian areas, and the cover types contained, for 2 sample quarter sections within the study area.

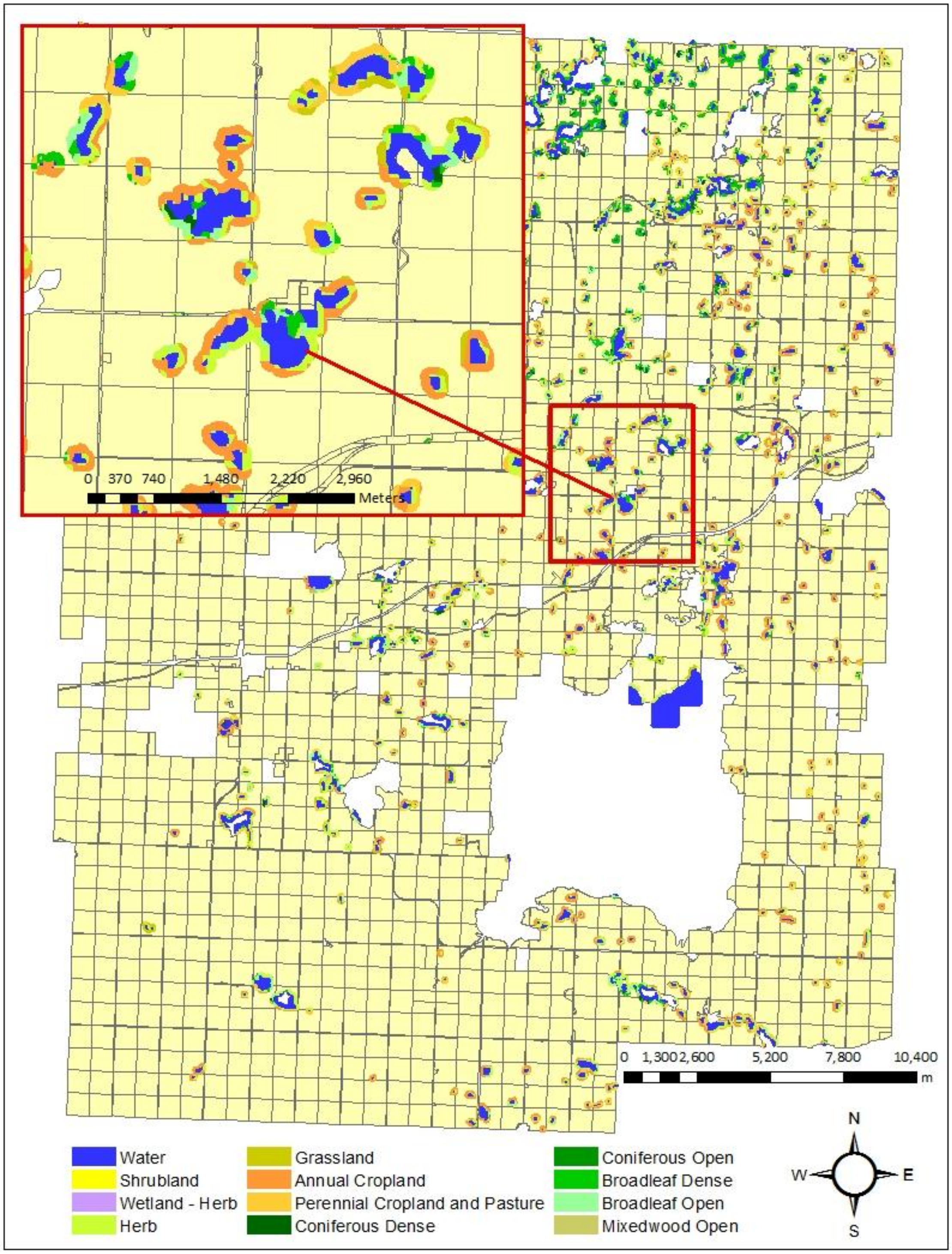


Figure 3.11 GIS simulated 100m buffer zones around the water and semi-permanent wetland cover categories within the Redberry RM.

3.4.1 Targeting Landscape Characteristics: Value

The proposed land set aside policy to be applied in this research will focus on taking the target land out of annual crop production to be managed for wildlife habitat benefits. In this study, two types of programs were evaluated: 1) a one-time purchase approach and 2) a long-term lease method. The only difference between these two approaches is that the one-time purchase method secures the land forever while the long-term lease method leases the land from the land owner for a fixed period of time with annual payments provided. In the purchase program, the landowner is paid to transfer land title to the policy delivery body at the time of purchase whereas for the lease program the lease is paid annually for a fixed period of time. The SAMA land assessment values were used to represent the purchase price of the land paid to the landowner ($/hectare) under the one time purchase approach. Annual lease rates were estimated based on the land assessment values and used in the simulation of the long-term lease program.

The relationship between the asset value of land, as represented here by the purchase price, and the annual lease rate should be considered when comparing lease and purchase programs. According to (Lawson, 2009) the leasing rate for agricultural land depends heavily on the land use (e.g grazing, hayland, annual cultivation or native vegetation) and other factors such as fencing and watering facilities. The following section describes the theory related to determining annual land lease rates based on the market price of land.

According to Ely and Wehrwein (1940), there is a yield for marginal[16] land and therefore the competition occurs for the right to own it and use it. In this competition price of land is established which tends to hold a relationship to economic rent[17]. The land market value and the rent of land reveal a relationship that is expressed by the "Capitalization Formula" (equation 3.1). This is the commonly used formula for capitalizing series of anticipated annual income into land value (Ely and Morehouse (1924), Ely and Wehrwein (1940), Renne (1946)). Therefore the rent of the land is given by equation 3.2.

$$V = a / r \tag{3.1}$$

$$a = V * r \tag{3.2}$$

Where:

V- market value of land

a-annual rent

r-capitalization rate

---

[16] Land can be classified into marginal, super-marginal and sub-marginal. The marginal land will produce common wages to the occupant, when the average amount of labor and capital is applied. The Super-marginal land will produce an excess value in addition to the wages (and interest) upon the labor and capital applied (Harrington, 1938).

[17]" *The rent of land may be defined to be that portion of the value of the whole produce which remains to the owner of the land after the outgoing belongings to its cultivation of whatever kind have been paid, including the profits of the capital employed , estimated according to the profits of agricultural capital at the time being*" (Ely and Wehrwein, 1940).

The above approach is known as "Income capitalization method" which is one of the major approaches for land valuation. Income capitalization method[18] is widely used in United States (Renne, 1946).

According to Ely and Morehouse (1924), the capitalization principle is the relationship between the net annual income and the capital value which expresses the price of land. This net annual income represents interest earned on a sum of money invested in the land. Therefore the value of the land for the land owner is equal to a sum of money which would yield him an income as interest. In other words, the land owner transforms the series of expected land income into a single figure which is represented by the capital value (Ely and Morehouse, 1924). The Capitalization formula is a reduction of a complex one which shows, algebraically, the value of each expected annual increment discounted to present value[19] (Renne, 1946).

According to the SAMA (2006), to calculate capitalization rate the typical rental rate for a property is divided by the typical sales price. A provincial capitalization rate is calculated by

---

[18] The province of Alberta, and the states of Colorado, Montana, North Dakota and Wisconsin use a valuation model which is considered to be a "modified income approach". This valuation model is based upon the capitalization of allowed income from cash crops that can be expressed as, Assessment Value =Net Income /Statutory Capitalization Rate (SAMA, 2006). The above provinces use legislated capitalization rate (SAMA, 2006).

[19] If a given number of dollars *a* due in *n* years and if the interest is compounded annually at the rate of r the present value is determined by, $\frac{a}{(1+r)^n}$ This formula is derived from : *x* dollars compounded at a rate of *r* would be, $X(1+r)^t$ and if $X(1+r)^t=a$, $X=\frac{a}{(1+r)^t}$ therefore, if the net income or economic rent of a piece of land is \$a, its value could be expressed by a succession of expected annual income discounted to present value and added which is given by, $V=\frac{a}{(1+r)^1}+\frac{a}{(1+r)^2}+\frac{a}{(1+r)^3}\ \dots\ \frac{a}{(1+r)^n}$ The limit of sum of such a series is $\frac{\frac{a}{1+r}}{1-\frac{1}{(1+r)}}$ which can be reduced to $V=\frac{a}{r}$ (Renne, 1946).

Or much simpler, $=\sum_{n=1}^{\infty}\frac{a}{(1+r)^n}$, as $n\to\infty, PV=\frac{a}{r}$.

dividing the provincial wide average rent by the provincial wide average sales price (SAMA, 2006). As given in (SAMA, 2006) , in parts of the[18] US and Canada capitalization rates have been legislated rather than using capitalization rates developed from the sales price of agricultural land. As discussed in (SAMA, 2006), when sales information is not available "investment valuation method[20]" can be used. In this method, the capitalization rate is a combination of discount rate[21] and the effective tax rate (SAMA, 2006). The following model illustrates the relationship between differences in the total value of land and differences in the market price (Niskanen, 1998).

$$P = (R - TP)/i \tag{3.3}$$

P – market price of land

R-annual rental value of land

T-effective property tax rate

i-real opportunity cost of capital to private owner

Therefore the capitalization rate is given by,

$$\frac{R}{P} = (i + T) \tag{3.4}$$

$$R = P(i + T) \tag{3.5}$$

---

[20] There are two approaches used to develop the capitalization rate namely direct capitalization and investment method (SAMA, 2006).

[21] "*The discount rate is developed by determining the required rate of return for borrowed fund and equity or determining and adding together the safe rate, risk rate, liquidity rate and investment management rate*" (SAMA, 2006).

There are no fixed values for factors that can be used to calculate discount rate. Therefore in this study *i* was assumed to be approximately 3 to 5% and *t* was assumed to be 0.5%. Thus, 4.5% was selected and used to calculate the annualized land lease rate using equation 3.5. For example, if the assessment value of a quarter section of land is $20,700, the annual lease rate of that land is $ 931.50.

For any agri-environmental policy program, including a land acquisition program, there will be budgetary constraints limiting the amount of money that can be spent on program delivery. For the present research budget limits were selected for the purchase program to represent a spending ceiling for land acquisition. To enable a more direct comparison of the results of the purchase and lease programs, the budget level of the lease program was set to a level which would set aside an equivalent area of land as the purchase approach.

3.4.2 Specific Policy Targeting Scenarios

The three major types of targeting methods evaluated in (Babcock et al., 1997), were adopted in the present analysis of set-aside[22] type habitat conservation programs in order to evaluate the effect of targeting in terms of environmental benefits for a dollar spent. In order to do this a series of land selection frameworks has been developed. Under each land selection framework the three targeting methods namely, cost targeting; benefit targeting and benefit-cost targeting were implemented. The frameworks described below were used to identify the characteristics of the land conserved for habitat benefits under the agri-environmental

[22]This approach of land set aside from crop production is a policy approach that is used in U.S programs such as CRP and CREP.

program. A land selection framework in combination with the targeting approach is collectively called a targeting scenario hereafter.

- **Quarter Section Focus Approach (QSFA)** – This approach focuses on selecting entire quarter section based on the cost and habitat characteristics of each quarter section. The selection was done from all quarter sections within the study area. The full description of the method is given in section 3.4.2.1.

- **Specific Habitat Focus Approach (SHFA)** – This approach focuses on selecting specific land area which are identified as suitable habitat for wetland dependent species. The habitat sites are defined based on the identified wetland basin and the delineated 100m wide buffer area. The buffer area provides upland habitat to complement the adjacent wetland for a range of wetland wildlife species in the different stages of their life cycle. The full description of the method is given in section 3.4.2.2.

- **Habitat and Surrounding Quarter Section Approach (HSQA)** –This approach also focuses on the habitat sites identified in the specific habitat focus method described above. However, rather than securing just the wetland and the associated 100 meter buffer area, the entire quarter section that contains the habitat site is secured. This approach was included to reflect the fact that famers may prefer to set aside entire quarter sections instead of smaller parcels within a quarter section. The full description of the method is given in section 3.4.2.3.

The land selection methods described above are designed to be straightforward to implement under practical conditions. As an example, land acquisition under the Quarter Section Focus Approach is easily done based on the administrative boundaries of a quarter section. However, purchasing only wetland area may be less feasible as the process requires identifying the legal boundaries of the wetland basin. This would require more technical expertise and therefore would incur more administrative cost. The Habitat Focus Approach has been developed by delineating 100m buffer around wetland basins in order to secure specific land parcels that contain wetlands. A summary of the land selection approaches and targeting methods that were developed for this study is provided in Table 3.6.

As discussed earlier, the primary objective of this research was to evaluate the performance of policy targeting. To enable this evaluation I will assess the characteristics of the land enrolled under a benefit targeting, cost targeting and benefit-cost targeting within the three land selection approaches discussed here. The procedures used to apply the targeting methods to the land selection approaches will now be discussed in some detail.

3.4.2.1 Policy Targeting based on the Quarter Section Focus Land Selection

To simulate benefit targeting under the Quarter Section Focus Approach it was expected that quarter sections containing "identified habitats" likely provide more wildlife benefits. Therefore, benefit targeting was implemented by selecting quarter sections containing relatively larger areas of "identified habitats". To enable this process, the areas of "identified habitats" were divided by the total area in the quarter section to calculate a "habitat land ratio". For example "habitat land ratios" of 0.453, 0.510 and 0.864 would represent quarter sections where approximately; 45%, 51% and 86% of the land area allocated to "identified habitats". The quarter sections within the study area were then ranked according to the "habitat land ratio" with the quarter section having the greatest proportion of habitat getting the highest rank. Based on this ranking the benefit targeting method involved selecting land parcels with higher ranking selected first. Quarter sections were selected by descending rank until the total budget was committed.

Table 3.6 Land selection approaches and targeting methods adopted under purchase method and long-term lease method

Land selection approach	Targeting method	Acronym for targeting scenario
<u>One-time Purchase Method</u>		
Quarter Section Focus Approach	1. Benefit targeting	QSFA-BT
	2. Cost targeting	QSFA-CT
	3. Benefit-cost targeting	QSFA-BCT
	4. Combined method	QSFA-Com
Specific Habitat Focus Approach	1. Benefit targeting	SHFA-BT
	2. Cost targeting	SHFA-CT
	3. Benefit-cost targeting	SHFA-BCT
Habitat and Surrounding Quarter Section Approach	1. Benefit targeting	HSQA-BT
	2. Cost targeting	HSQA-CT
	3. Benefit-cost targeting	HSQA-BCT
	4. Combined method	HSQA-Com
<u>Long-term Lease Method</u>		
Quarter Section Focus Approach	1. Benefit targeting	QSFA-BT
	2. Cost targeting	QSFA-CT
	3. Benefit-cost targeting	QSFA-BCT
Specific Habitat Focus Approach	1. Benefit targeting	SHFA-BT
	2. Cost targeting	SHFA-CT
	3. Benefit-cost targeting	SHFA-BCT

To simulate cost targeting using the Quarter Section Focus Approach required the quarter sections to be ranked in ascending order of per hectare assessment value. Then, quarter sections of land were selected based on the assessment value of the quarter section, beginning with the lowest assessment, until the budget was committed. For example, a quarter section with a per hectare assessment value of $256.04 /ha would be ranked high compared to another quarter section with a per hectare assessment value of $269.57/ha. These quarter sections could be purchased for $16,600 and $17,500 respectively.

To simulate benefit cost targeting using the Quarter Section Focus Approach the quarter sections with higher habitat land ratios and with lower assessment values would be selected. To rank the land in the study area, the "habitat land ratio" was divided by the per hectare assessment value. The quarter sections that contain "identified habitats" were then ranked based on the cost effectiveness ratio (QSFA)[23] and the land parcels were then selected according to the rank until the total budget was committed. As an example, a parcel having a comparatively low assessment value such as $106.43 /ha which has a habitat land ratio of 0.77 resulted in a Cost effectiveness ratio (QSFA) of 0.0072.

3.4.2.2 <u>Policy Targeting with the Specific Habitat Focus Land Selection</u>

To simulate benefit maximising based on the Specific Habitat Focus Approach it was assumed that native vegetative cover (native grass, shrubs and trees) within the delineated wetland buffer zones provided higher quality habitat than tame grasses (tame forage cover type) or cultivated land. Based on this assumption the total area of natural vegetative cover that was located inside the "identified habitats" buffer zones were calculated for each quarter section. Then, "identified habitats" were ranked based on the area of natural vegetative cover within the "identified habitats". In other words, those delineated 100 m riparian zones with greater areas of native cover types where ranked as having greater habitat value. It should be noted that only the total area of native habitat was considered, no mechanism was used to ascribe greater value to the different native vegetative cover types including grass, shrub and

[23] Cost effectiveness ratio (QSFA) $=\frac{Habitat\ Land\ Ratio}{Per\ hectare\ assesment\ value}$

trees. The benefit targeting method then prioritized the selection of land parcels based on the area of native vegetation rank until the total budget was allocated based on the land assessment value of the "identified habitats". Under this targeting scenario a land parcel ("identified habitat") with an area of 50.24 ha from which 44.81 ha was covered by natural vegetative cover was ranked high compared to a land parcel of 58.18 ha from which 40.11 ha was natural cover.

Cost minimizing targeting using the Specific Habitat Focus Approach was carried out by ranking the "identified habitats" riparian zones based on land assessment values. The land was then selected beginning with the lowest per unit assessment value continuing until the budget was committed. It is important to recognize that in the cost targeting approach the area of native vegetation within the selected parcels had no influence on whether the land was selected or not. Therefore, in this targeting scenario a habitat site which is assessed at $277.09/ha that contains, for example, 3.42 ha of native cover would be selected over a habitat site which is assessed at $304.56/ha that contains 5.32 ha of native cover.

Benefit-cost maximizing targeting using the Specific Habitat Focus Approach was carried out by calculating the ratio of the area of natural vegetative cover and assessed land value of the "identified habitats" for all parcels of land within the study area. The "identified habitats" with the cost effectiveness ratio (SHFA)[24], were selected until the total budget was committed,

[24]Cost effectiveness ratio (SHFA) $=\frac{Area\ of\ natural\ vegetative\ cover}{assessment\ value}$

based on the specific assessment value for the habitat area. For instance, a land parcel ("identified habitat") of 13.54 ha containing an area of native vegetative cover of 1.16 ha that has an assessment value of $437.73/ha would have a cost effectiveness ratio (SHFA)of 0.00019 ha/$. In contrast, a parcel of 60.70 ha containing an area of native vegetative cover of 51.78 ha that has an assessment value of $255.49/ha would have a cost effectiveness ratio (SHFA)of 0.00333 ha/$. In that case, the parcel described second would be selected first under this targeting scenario.

3.4.2.3 <u>Policy Targeting with Habitat and Surrounding Quarter Section Land Selection</u>

In this method, rather than securing just the specific parcel of habitat land within a quarter section (e.g. wetland and 100 meter riparian zone) as in the previous approach, the entire quarter section that contains the relatively high quality habitat land parcel was secured. In other words, this approach is similar to the Quarter Section Focus Approach (which prioritizes habitat area) in that it enrolled the entire quarter section but differs in that the selection of the land prioritizes habitat quality. To simulate benefit targeting under this land selection approach the "identified habitats" [25] were again ranked based on the area of natural vegetative cover, then the quarter sections that were ranked higher were selected until the total budget was committed, based on the assessment value of quarter sections. In the Habitat Focus Approach, under benefit targeting the habitat site ("identified habitats") that had a native cover of 40.11 ha should be purchased for $19,160.72 (assessment value of habitat area), but under the

[25] The wetland and buffer areas that fall within a given quarter section were added together and these areas were referred as "identified habitats".

targeting scenario described here, that same parcel was selected but the entire quarter section of land could be purchased for $21,400 (assessment value of habitat area).

The cost targeting method for the Habitat and Surrounding Quarter Section Approach used the same steps described in cost targeting method under the Quarter Section Focus Approach and as a result the same set of land area was captured.

Benefit-cost targeting for the Habitat and Surrounding Quarter Section Approach used similar steps to those described in the benefit-cost targeting method under the Specific Habitat Focus Approach, but rather than securing just the delineated buffer zone ("identified habitats"), those entire quarter sections that contain "identified habitats" were selected. The selection process prioritized land with higher ratios of natural vegetative cover to land assessment values (cost effectiveness ratio (SHFA)) until the budget was committed. For example, a habitat area ("identified habitats") that had the benefit to cost ratio of 33.38 in the earlier example under the Specific Habitat Focus scenario would be purchased for $15,510.36 (assessment value of habitat area) while under this method, the total quarter section that contains this habitat area with benefit to cost ratio of 33.38 would be purchased for $16,500 (the assessment value of that quarter section).

3.4.3 Long-term Lease Method

For most agri-environmental policies that employ a land set-aside approach purchasing or leasing of the land parcels are the most common methods of land acquisition. As with the land purchase scenarios described above, a selected budget was used to pay the private landowner an annual lease rate to set aside the land to meet the environmental objectives of the policy (the calculation of lease rates are described in section 3.4.2). The targeting and land selection approaches used to secure land under long term lease method were the same as those described earlier in the land purchase scenarios. Estimates of the total area of land secured under the three targeting methods are provided in the next chapter.

3.4.4 Combined method

In order to develop targeting protocols to take advantage of the proximity characteristics of land and wildlife habitat within agricultural landscapes, targeting methods and land selection procedures can be used in combination. For example, the benefit targeting could be augmented by identifying the highest benefit quarter sections and then using the GIS database to select relatively low cost quarter sections that are located in close proximity or adjacent to the initially selected habitat quarter sections. This approach may enable a more cost effective mechanism to secure larger areas of high quality habitat that provide the additional benefits that become available with larger and contiguous habitat patches. According to Reid and Murphy (1995), in managing land development and mitigation of adverse impact on the connectivity of habitats, the conservation principles should be followed including "blocks of habitat that are close together are better than blocks that are far apart". By way of securing larger areas of contiguous habitat the environmental benefits may be increased and the transactions and administrative costs may be decreased when dealing with fewer or adjacent landowners than is possible when securing smaller parcels that are more widely distributed across the landscape.

To enable this "Combined Method" in the present research, first, land parcels were selected based on the habitat land ratio as described above for the benefit targeting.

Specifically, using this ranking quarter sections were selected until approximately 50% of the total budget was committed. At this point the remaining budget was used to select low-cost quarter sections that are adjacent to or in close proximity to the initial high quality habitat quarter sections selected. To carry out this process using the GIS database lands which were located within 50m of the boundary of those high quality habitat quarter sections were first identified. These proximate quarter sections were then ranked in the ascending order based on the per hectare assessment value. Then, the proximate quarter sections with the lowest assessment were selected until the remaining 50% of the budget was committed. This approach selects a number of quarter sections containing high quality habitat and in some cases, one or more adjacent quarter sections that may or may not contain high quality habitat but could be managed to supply supporting habitat for the high quality habitat that does exist in the area.

3.4.5 GIS Techniques Used

The Redberry Lake (RM 435) study area was represented by a GIS database that was developed with land "Assessed value QS"[26] from the Saskatchewan Assessment Management Agency with each quarter section having an assessment value attached to it. This layer was linked to land cover data from Geobase using the intersection tool. The resulting layer contained the land cover types found in each quarter section area and was used as the "basic layer" to extract features for the analysis.

For the policy targeting analysis carried out in this research the first step to identifying habitats for wildlife involved extracting wetlands from the "basic layer" and exporting to GIS as

[26] "Assessment value QS" was a grid of quarter sections.

a separate layer. Based on these identified wetlands a buffer zone of 100 meter width was established around the water (cover type 20, EOSD Classification) and wetlands (cover type 83, EOSD Classification) and added as a separate layer to GIS. In order to represent the cover types in the buffer zone, this layer was joined with the land cover map using the intersection tool. Each of the buffer areas were comprised of different land cover patches and each represents the assessment value of the quarter section it comes from (saved as “buffer rings”). These buffer rings were used as the potential habitats for the study (Figure 3.12). Then the buffer area which belongs to same quarter section was joined using the dissolve tool (“identified habitats”). The layer that was developed here was comprised of one entry for one quarter section and under each quarter section the land area representing the buffer area was given. This layer was then joined to the original quarter section layer which included land assessment values (“Assessed value QS”). In the analysis, under the Habitat Focus Approach land would be purchased as habitats areas (buffer zones).Therefore the value for the buffer area should be known. In order to calculate the assessment value for the buffer area, assessed value per square meter[27] was calculated using the assessment value for quarter section. Then the assessed value for the buffer area was calculated.

To implement the Quarter Section Focus Approach, the “identified habitats” layer was used and since the attribute table within the GIS database contained the assessment value of the quarter section the amount of quarter sections which could be purchased under the total budget could be calculated. Also, as the same layer contained the land area for each quarter

[27] Assessed value per square meter can be scaled up to represent assessed value per ha by multiplying $ per square meter value by 10000.

section and land area in buffer zone, the percentage of the quarter section that is covered by the buffer zone could be calculated. This value has been used as the habitat land ratio. To simulate the benefit targeting and benefit - cost targeting method parcels were selected under the given budget and extracted as separate layers from the “identified habitats” layer. Then, by joining these extracted layers back to the “Assessed value QS” layer, the quarter section which contained the identified parcels could be extracted. In this procedure the quarter section which contains a greater area of the “identified habitats” were selected (Figure 3.12)

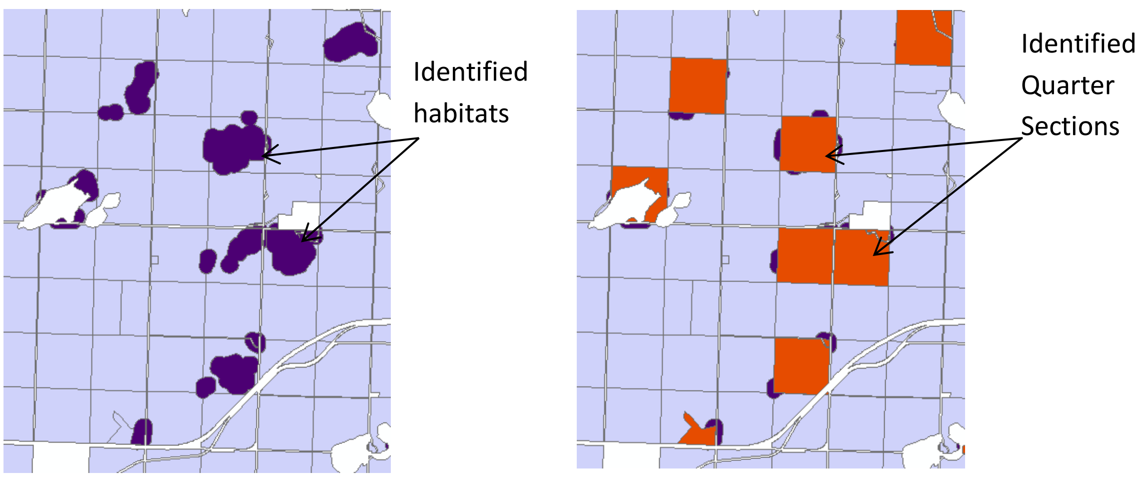


Figure 3.12 Identification of quarter section which contained the selected buffer areas

Under the Specific Habitat Focus Approach the “identified habitats” layer was used. The Cost targeting method was implemented using the buffer area in each quarter section and the assessment value for that delineated buffer area within the quarter section. The land with natural vegetative cover was identified and extracted from the “buffer ring”[28] layer and labelled

[28] “buffer ring” layer is the original layer that contained the wetland and delineated 100m buffer. This layer was joined to the land cover layer to identify the composition of the buffer zones.

as ("non-ag buffer"). Then the "non- ag buffer" land which belongs to same quarter section was joined using dissolve tool ("non ag_dissolve"). Benefit targeting and Benefit - cost targeting were carried out using this layer. The identified parcels under each targeting mechanism (from the "non ag_dissolve") layer was extracted separately. Then each layer was joined back to the "identified habitats" layer and the parcels ("identified habitats") which contained the selected non-ag buffers was extracted (Figure 3.13).

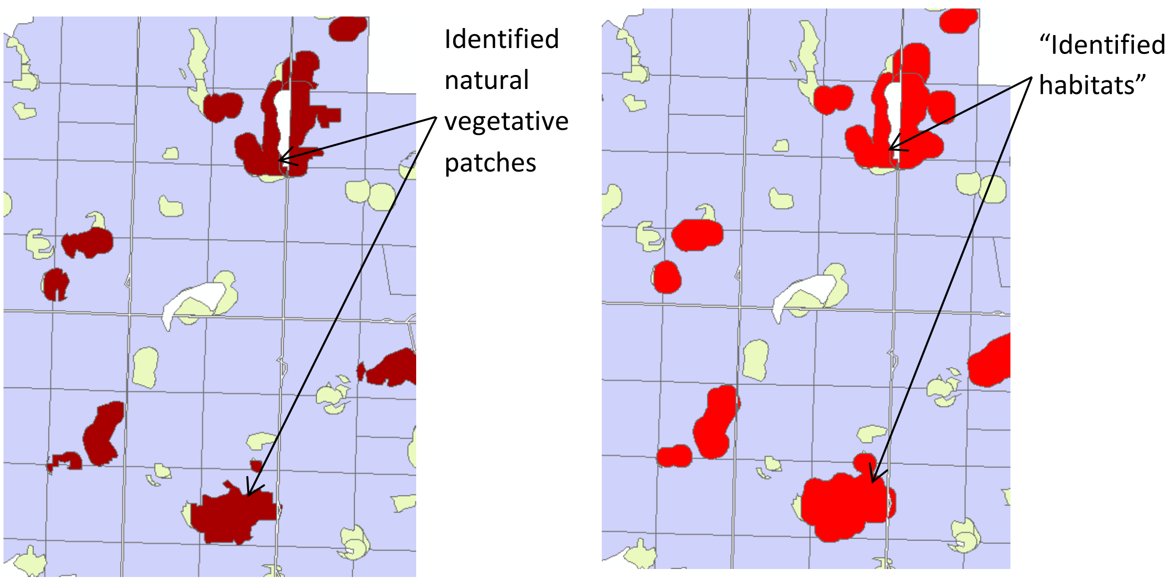


Figure 3.13 Selection of identified habitats which contained the selected natural vegetation cover

In the Habitat and Surrounding Quarter Section Approach, the "identified habitats" layer was used and since the attribute table contained the assessment value of each quarter section, the number of selected quarter sections which could be purchased under the total budget was identified. Under each targeting method, parcels were selected under the given budget and extracted as separate layers. Then these layers were joined back to the "Assessed value QS" layer and those quarter sections which contain the selected parcels were extracted. This method is very similar to the procedure described under Quarter Section Focus Approach.

The Combined method which was implemented under the Quarter Section method and Habitat and Surrounding Quarter Section method was implemented using the following techniques. First the quarter sections with greater habitat benefits[29] were identified using the benefit targeting method described under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach and labelled in the database as "High benefit" layer. Then the following specific steps were carried out in order to identify the lowest cost quarter sections that are adjacent to the quarter sections with greater benefits.

1. Those quarter sections within 50m distance of the selected "High benefits" quarter sections were selected using the location selection tool and the criteria of "target layer features are within a distance of source layer feature". ("High benefit" layer was chosen as source layer while "Assessed value QS" layer been the target layer).The resulted layer was labelled as "quarter sections_50m[30]".

2. In order to select the quarter sections which belong to both "High benefit" layer and "quarter sections_50m" layer spatial selection criteria called "target layer features are within (clementini) the source layer feature" was used.

3. Then the above selection was inverted to identify those quarter sections which are adjacent to the "High benefit" layer. The resulting layer was labelled as the "adjacent quarter sections". From that layer the quarter sections which had low assessment value per hectare were selected.

[29]Quarter Sections with greater benefits were identified by high habitat ratio in Quarter Section Focus Approach and greater area of native cover in habitat area in Habitat and Surrounding Quarter Section Approach.

[30] "Quarter sections_50m" layer also contained quarter sections which were belonging to "Most benefit" layer.

In this chapter, two types of land acquisition programs used in the study were discussed. The size, nature and characteristics of administrative cost of agri-environmental programs have been studied in the literature (Heimlich, 2005). The following section will discuss the potential differences in the administrative cost of agri-environmental programs.

3.5 Administration Cost of Land Acquisition Programs

The delivery of any agri-environmental program imposes a range of costs on the delivery organization. As discussed above, the primary cost of any habitat securement or set aside program is the cost to take these parcels out of intensive agricultural management. Another cost that must be considered is the administration cost of the program. According to Heimlich (2005), administrative cost is part of the implementation cost of a program and the primary agency involved in running the program is usually accountable for that. Identification of the beneficiaries which would include the targeting of the specific parcels of land and landowners who will be involved in the program, processing applications and contracts, litigation and processing payments are some of the components of implementation costs. Identifying and targeting resources to be protected and developing conservation cover plans requires trained resource staff and therefore incur significant costs (Heimlich, 2005). In the following section the administration cost of land set aside policies will be discussed. Approximate estimation of administration cost for one-time purchase program and long-term lease program will be given in the next chapter.

As discussed by Heimlich (2005), the establishment of long term easements such as the WRP, involves considerable technical assistance cost because of the need to establish a legal easement on the area to be restored to wetland. In contrast, in a program like the CRP, simple contracts needed to be established between the producer and government agency. According to the analysis of Heimlich (2005), cumulative acres enrolled into the program is important as when the administrative cost is spread across greater area the administration cost per acre will be lower. Heimlich (2005) has also argued that when the reduced number of contracts could lower the administration cost per acre. Also, in recent years the administrative support cost of CRP has been reduced by significant amount due to reduced demand for field staff because of restructuring of the bid selection process and standardizing rental rates. Heimlich (2005) discussed that GIS enabled administrative tools for managing CRP could have decreased administration costs. In the CREP continuous sign up, the riparian buffers filter strips and vegetative corridors are accepted. Therefore the original fixed administrative and technical cost over larger acres per contract was divided between fewer acres per contract, and thereby the administration cost of the program increases.

In this study, the land acquisition has been done using different land selection approaches and targeting methods. Therefore, it is intended that the different targeting scenarios will show different patterns of land selection and hence the administration cost of those will be variable. A comparison between administration costs of different targeting scenarios will be discussed in the next chapter.

3.6 Summary

In this chapter the research procedures and methods were described in detail. The chapter explained the GIS database developed to represent the study region. Representative wildlife habitat conservation policy approaches were developed to meet conservation objectives. According to GIS data bases, the study area is characterised by large areas of cultivated land with some parts of the land allocated to natural vegetation cover such as grassland, trees, shrubs and wetlands. Land cover data and land assessment data have been used as the primary GIS data layers for the study. In order to implement cost targeting, benefit targeting and benefit - cost targeting, three land selection frame works were developed. Both a purchase and long term lease method were developed in order to use assessment rates which represent a reasonable proxy for land prices and lease rates and therefore land opportunity cost. Finally in order to incorporate proximity characteristics of riparian habitats a "combined method" was developed for land selections which were a combination of cost targeting and benefit targeting. The next chapter will present and discuss the results of the habitat conservation policy approaches applied to the identified agricultural region using the different targeting protocols.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

The previous chapter described the research methods adopted in this study to evaluate the effect of different agri-environmental targeting methods on the provision of habitat for wildlife. The aim of this chapter is to present and discuss the results from applying the land selection approaches to the study area to evaluate the performance and effectiveness of the targeting methods. The chapter will also present research results that enable a review of wildlife habitat outcomes and assess the relative economic performance of policy and targeting outcomes. This will include a discussion of the administration cost of targeting delivery for the execution of land purchase method and land lease method. This chapter has been organized in the following way. The chapter begins with the results of the analysis concerning the economic values of the land. Following this, the results of land selection approaches is provided with a comparison of the habitat outcomes from different targeting methods. Next, results of an economic analysis of two land acquisition programs are provided. A discussion of the empirical results is presented in the section 4.6. The chapter concludes with a summary of the most important findings of the research.

4.2 Economic Value of Land

As presented in the previous chapter, the value of land varies significantly across the study area. Within the Redberry RM, assessment values range from $12,600 to $85,800/quarter section with a mean of $44,773 (Figure 4.1). The assessed value of agricultural land was determined by a wide range of socio economic and biophysical characteristics. Within the study area, it is unlikely that the variation of land value based on socio economic characteristics such as the proximity to transportation corridors (e.g. highways, railroads) had a large impact on land values since the study area is only 1,015.53 km^2. However, there are significant differences in land value across parcels due to variation in productivity of land. The assessment value of land in the study area was most significantly influenced by the soil productivity rating which corresponds to the expected economic returns from the production of agriculture commodities (SAMA, 2007). Soil characteristics such as organic matter content, soil texture and depth were taken into account in determining productivity of land. For the purpose of the present research the assessment value represents the opportunity cost of setting aside this land, therefore providing a good proxy for the payments required to idle these areas.

The range of assessed land values in the study area are not evenly distributed (Figure 4.1). For example, lower assessed land is found primarily in a band running diagonally across the middle of the RM (SW to NE) with higher assessed land being found mostly in the west and North West of the RM and along the east side. The area that is found diagonally across the middle of the RM that represented higher assessed parcels are covered with forest cover and grassland (Figure 4.2). This variation in the economics value of land is important for any implementation of agri-environmental policy, and in particular for the present study as this pattern influenced the land enrollment that will be discussed later in this chapter.

In the study area, the majority of the land was characterized as having one of four cover types. The primary cover types were cropland (67%), herb or plants without woody stem including grass and forbs (12%), forest including conifer dense, broadleaf dense, broadleaf open and mixed wood (12%) and grass (7%). There is a relationship between land use and land assessment value in the study area. Relatively low assessed land has lower potential agricultural productivity and is often used for pasture. For example, in the Redberry RM, 89% of the grassland, 75% of wetland and 64% of pastures are on lands assessed below $40,000. In contrast, much of the cropland is on relatively highly assessed land. Approximately 71% of annual croplands are located on lands which are assessed between $40,000 to $80,000, while all of the most highly assessed land ($80,000 to $100,000) in the RM was allocated to the production of annual crop (Figure 4.3).

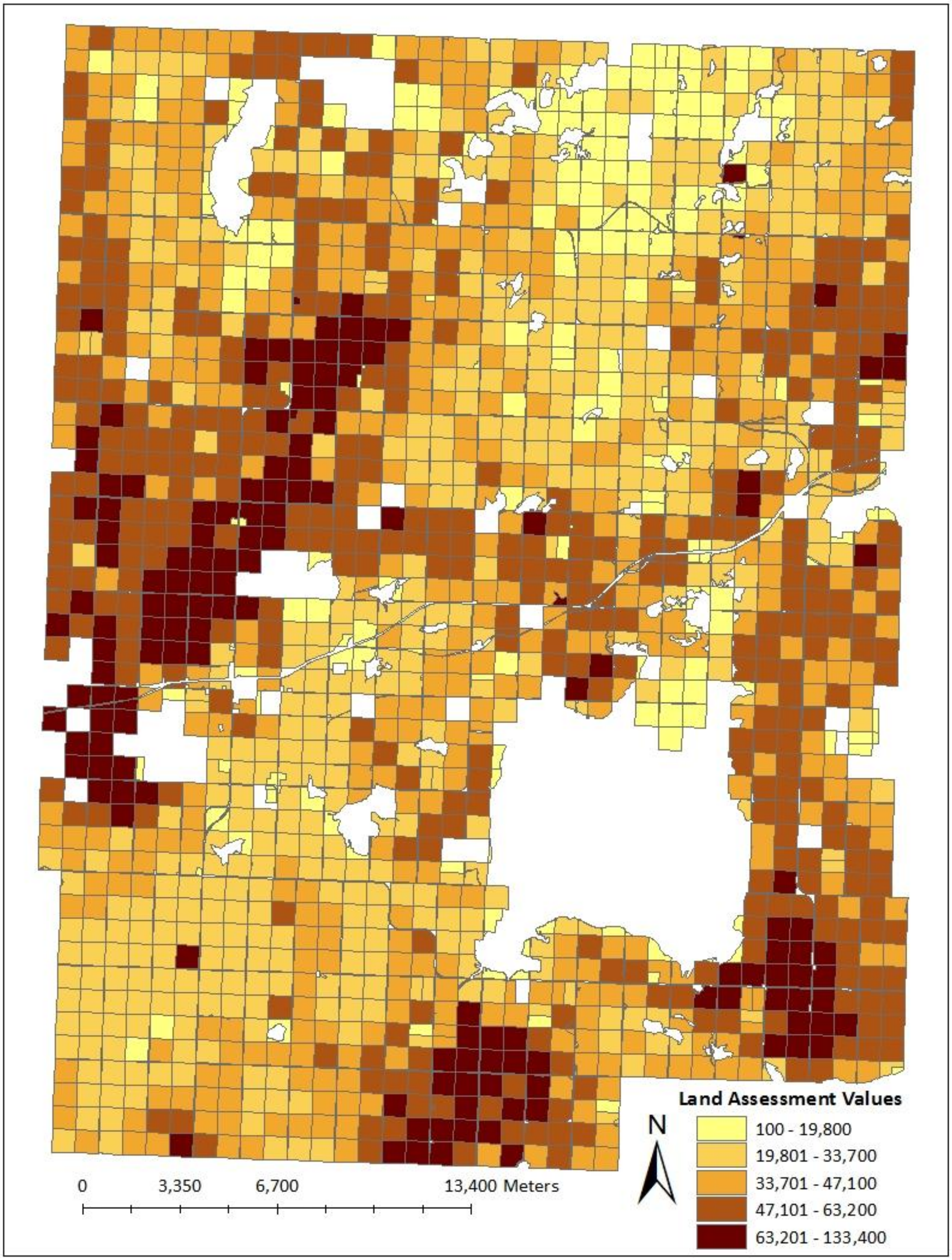


Figure 4.1 Land assessment values in the Redberry RM study area

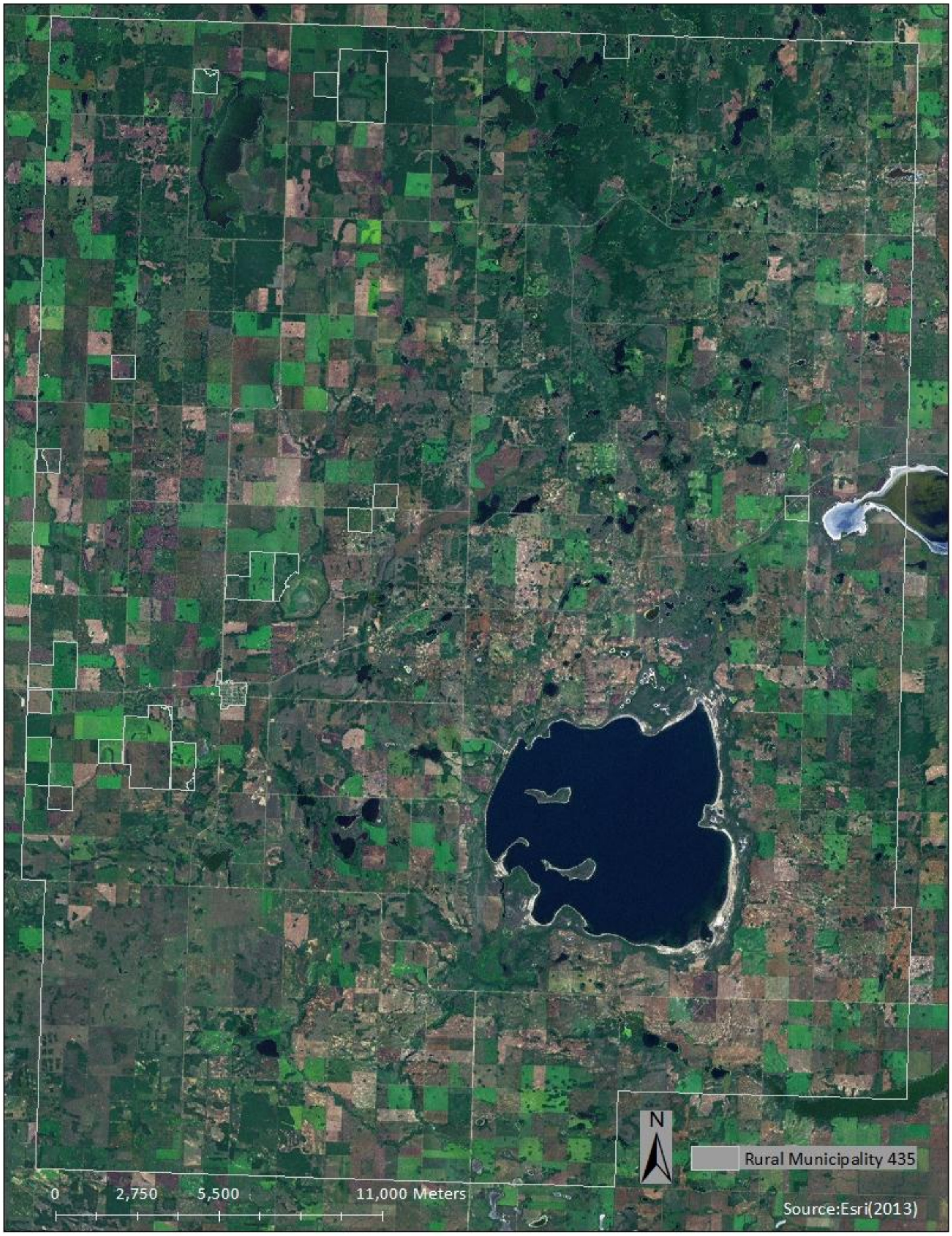


Figure 4.2 Satellite imagery of land cover characteristics in the Redberry RM study area

To help illustrate the relationship between assessment value and land use, study area land parcels were plotted against the proportion of those parcels allocated to annual crop production (Figure 4.4). There was a relatively strong positive correlation between quarter section assessment value and the proportion of the quarter section that was annually cropped. The land allocation, as represented in this data by vegetative cover type, represents an economic decision for the highest and best use of these parcels. Therefore the relationship between the land assessment value and land use was relevant in the present research. As an example, the less productive lands which were primarily allocated to natural cover types had lower opportunity cost for the production of other goods, including wildlife. In contrast, the land used for cropland that often had higher assessment values, if allocated to conservation purposes, would impose higher opportunity costs on the landowner (Figure 4.4).

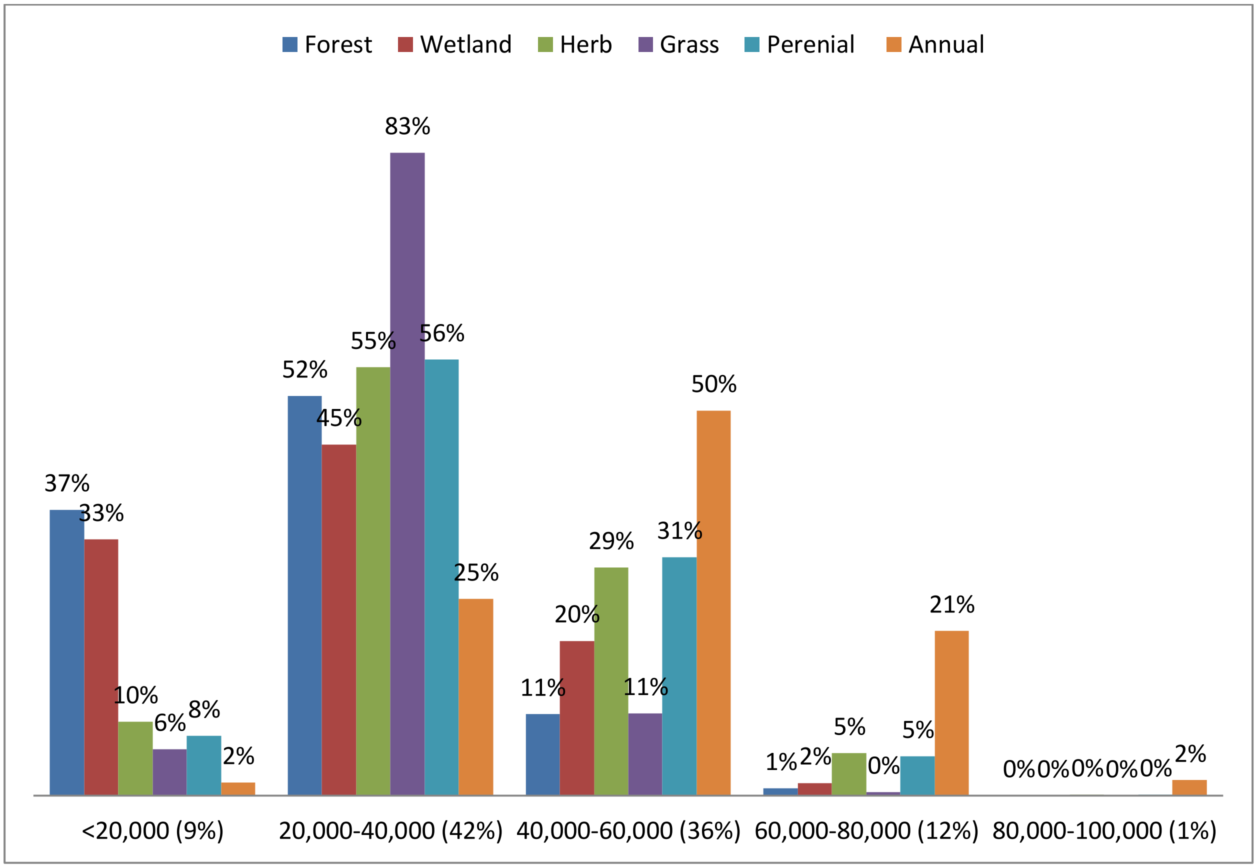


Figure 4.3 The proportion of selected cover types of Red berry RM by land assessment values ($/quarter section).[31]

[31] The cumulative of land area for different land assessment value category is taken considering different land cover types.

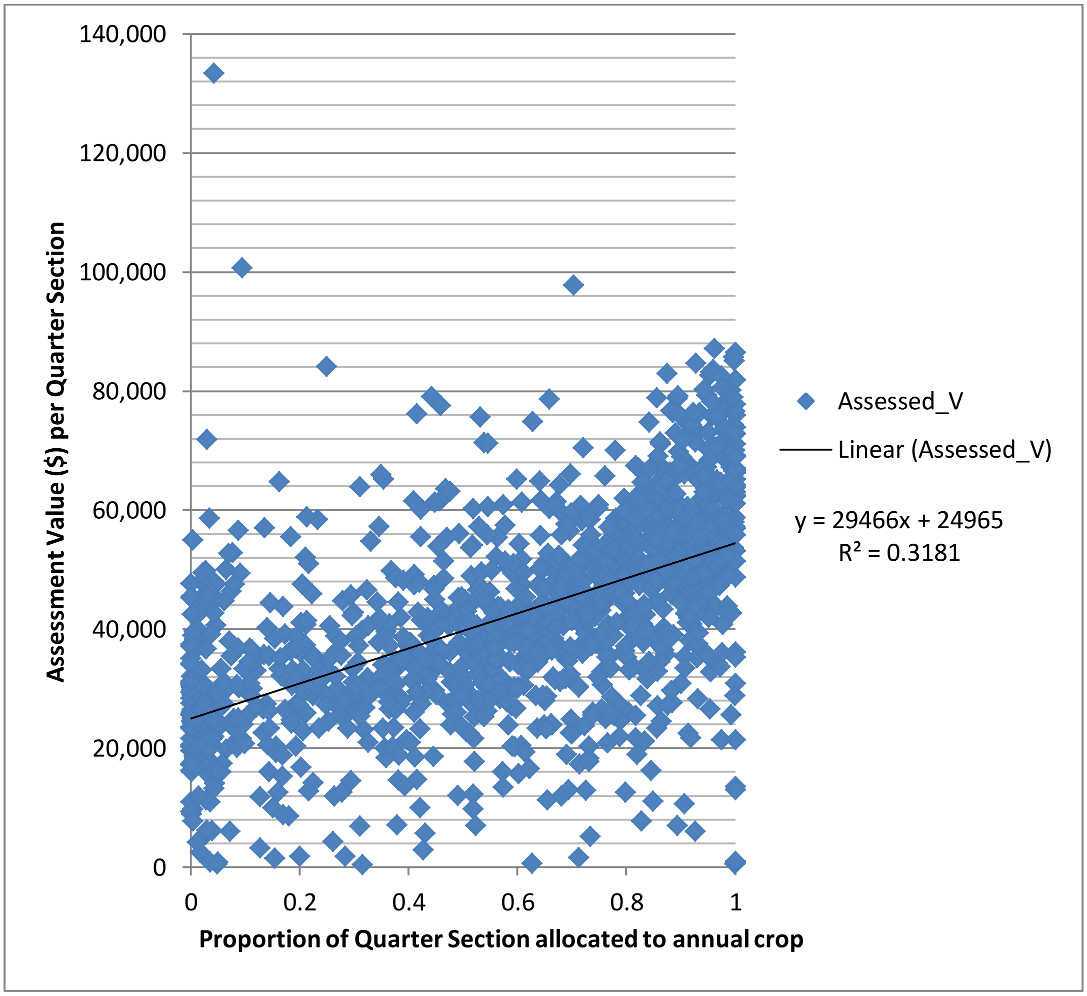


Figure 4.4 The Proportion of the quarter section allocated to annual cropland within the Redberry RM against the land assessment value ($/quarter section)

4.3 Analysis of Targeting Approaches

In the analysis of targeting approaches a few assumptions were necessary as summarized in Table 4.1. As discussed above, as land assessment values are a reasonable representation of the opportunity cost of land, assessment values represent a good proxy for the payment, or monetary compensation, required for farmers to agree to idle land. Therefore, the assessment value has been used to represent the payment levels provided within the hypothetical agri-environmental program in this research. The land selection frameworks described in Chapter 3 have been developed based on the environmental benefits distinguished by the land cover types represented in the study area. The targeting methods were implemented based on the assumption that targeting benefits can be represented by the land cover types and that targeting costs can be represented by land assessment values reflecting opportunity costs. For any agri-environmental policy, including a land acquisition program, there will be budgetary constraints which make the application of a targeting method relevant. In this study an arbitrary budget amount of $ 1.5 million was selected only to represent a spending ceiling for a one-time purchase program. This budget amount was assumed only to represent a budget limit to enable comparison calculations and was intended to roughly correspond to an appropriate agri-environmental budget limit.

Using the cost targeting, benefit targeting and benefit-cost targeting method to deliver the hypothetical land set-aside policy, the three land selection frame works were used to identify lands for the agri-environmental program. A detailed description of the land selection frameworks was provided in Chapter 3. However, briefly the frameworks used were 1) the Quarter section Focus Approach, which selected entire quarter sections of land based on cost or habitat characteristics of the land parcel, 2) the Specific Habitat Focus Approach, which selected specific land parcels by delineating a 100m wide buffer around each wetland and lastly, 3) the Habitat and Surrounding Quarter Section Approach which selected habitats by first identifying

Table 4.1 Summary of assumptions made for the analysis

Assumption	Objectives of the assumption
1. Assessment values represent the opportunity cost of land in one-time purchase method.	To represent the payments provided by the agri-environmental program to the land owners for idling land from crop production.
2. Land lease rates calculated using assessment values represent the opportunity cost of land in long term lease method.	To represent the annual payments provided by the agri-environmental program to the land owners for idling land from crop production.
3. The land cover types on the land represent the benefits of land.	To represent the habitat benefits for the wetland dependent species.
4. Budget amount for the purchase program is $1.5 million.	To represent a budget limit for the agri-environmental program.
5. Annual budget amount for lease program is $ 65,000/year.	To represent a budget limit for the agri-environmental program.

the 100m buffer and then securing the entire quarter section in which the habitat area is located. In order to implement the land selection frameworks, different land selection indicators such as habitat land ratio, per unit assessment value were developed using the land cover and land assessment value data layers in the GIS data base. The calculation of these indicators has been described in Chapter 3. The following section will describe the results from applying the land selection frame works and targeting mechanisms within the Redberry RM study area.

Since the cost targeting method explicitly secured land with lower assessment values, for the given budget cost targeting secured the greatest area of land under all three land selection approaches (Table 4.2). In contrast, the benefit targeting method did not consider land assessment values and was instead focused on securing the land with the greatest wildlife habitat benefits. Benefit targeting secured the smallest area of land under all three land selection approaches. The benefit-cost targeting method secured an area of land midway between these two extremes under all three land selection frameworks. This section only reports the general trend of the results while a complete discussion of the results is provided in Section 4.4.

To further illustrate the results the distribution of the land parcels selected by the three land selection frame works are presented on maps of the study area in Figures 4.5, 4.6 and 4.7. When comparing the location of secured land in different targeting methods it is clear that Specific Habitat Focus Approach selected lands were more scattered throughout the study area than the land secured under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach. Due to the similarity of the approach adopted under cost targeting method, in both Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach the parcels were identical for both methods. There was an overlap between the parcels of benefit targeting and benefit-cost targeting in Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach. The Specific Habitat Focus Approach captured a large number of small parcels in all three targeting methods compared to Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach. The quarter sections that were selected by the Benefit targeting method under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach were located where there were more wetland habitats. Due to the fact that the cost targeting method under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach did not consider the amount of wetlands in the quarter section, the quarter sections that were selected by cost targeting in both approaches sometimes did not contain wetland habitats. As an example, 31 quarter sections that were selected by cost targeting[32] under the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach did not contain any wetland habitats.

Table 4.2 Area of land secured in the Redberry study area under the three targeting methods using the different land selection approaches.

Targeting method	**Quarter Section Focus Approach (ha)**	**Specific Habitat Focus Approach (ha)**	**Habitat & Surrounding Quarter Sections Approach (ha)**
Benefit targeting method	3,386	3,633	3,992
Cost targeting method	5,919	4,194	5,919
Benefit-cost targeting approach	4,732	4,083	5,295

[32] 107 quarter sections were selected under cost targeting method of both Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach.

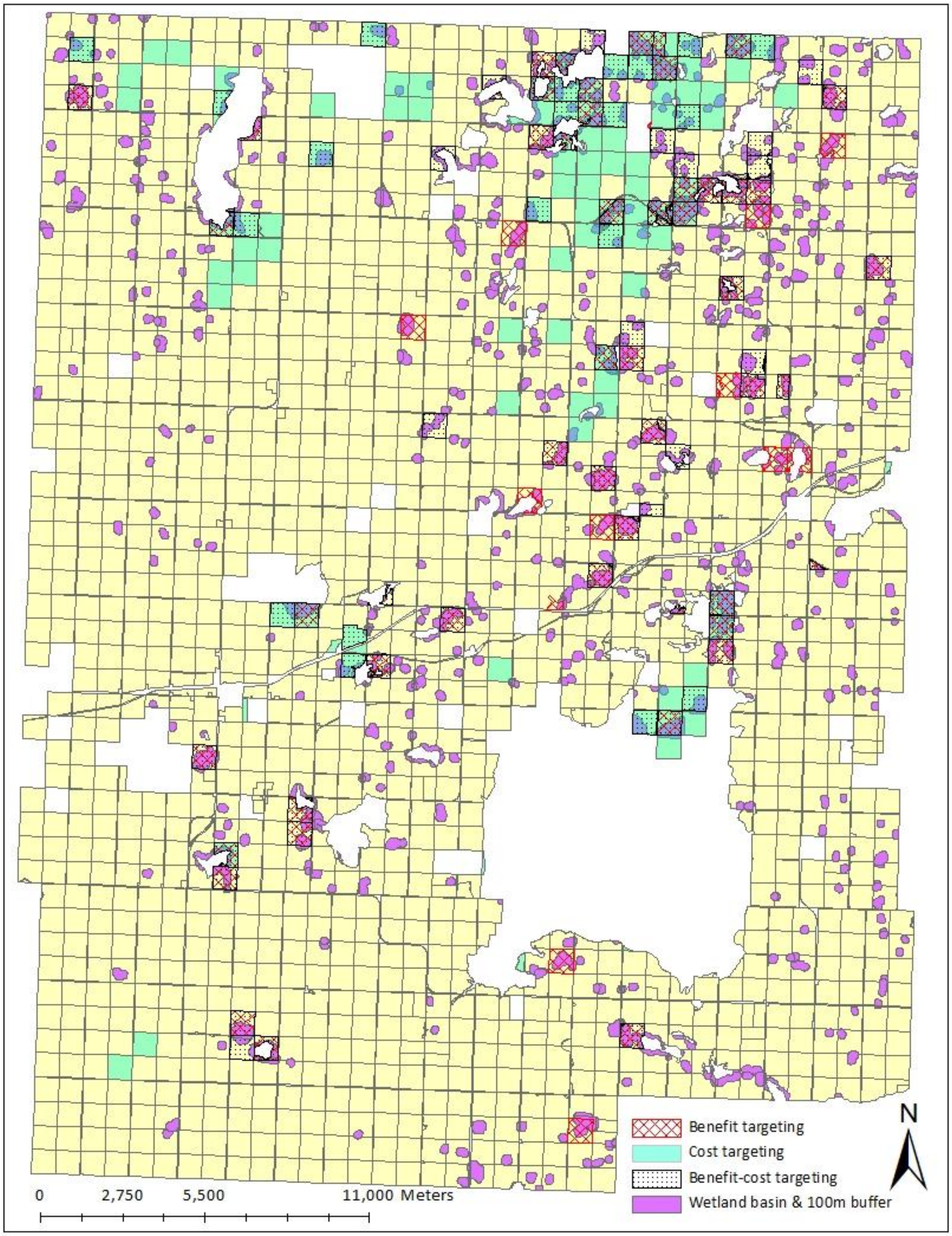


Figure 4.5 Land parcels selected under Quarter Section Focus Approach using the three targeting methods.

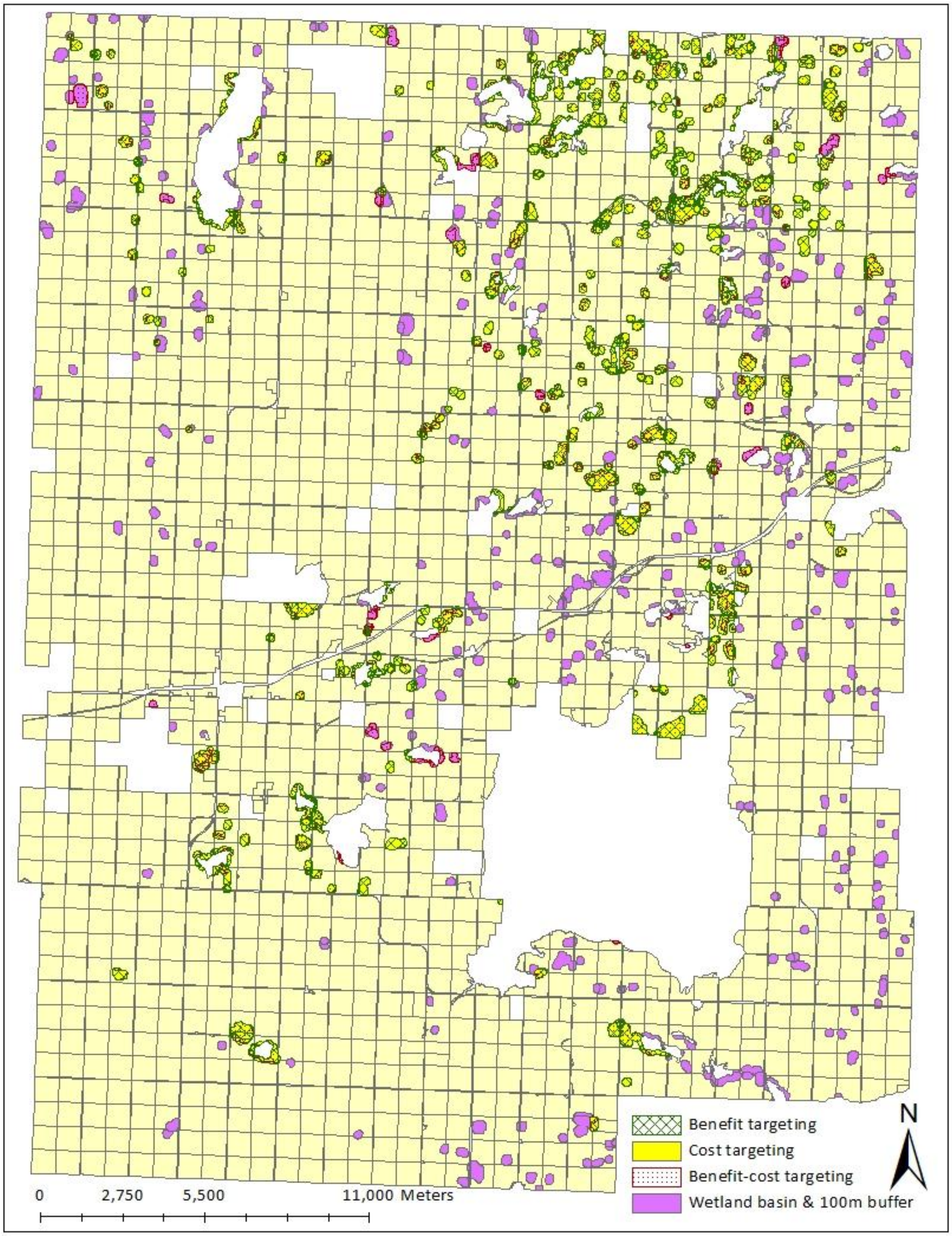


Figure 4.6 Land parcels selected under Specific Habitat Focus Approach using the three targeting methods.

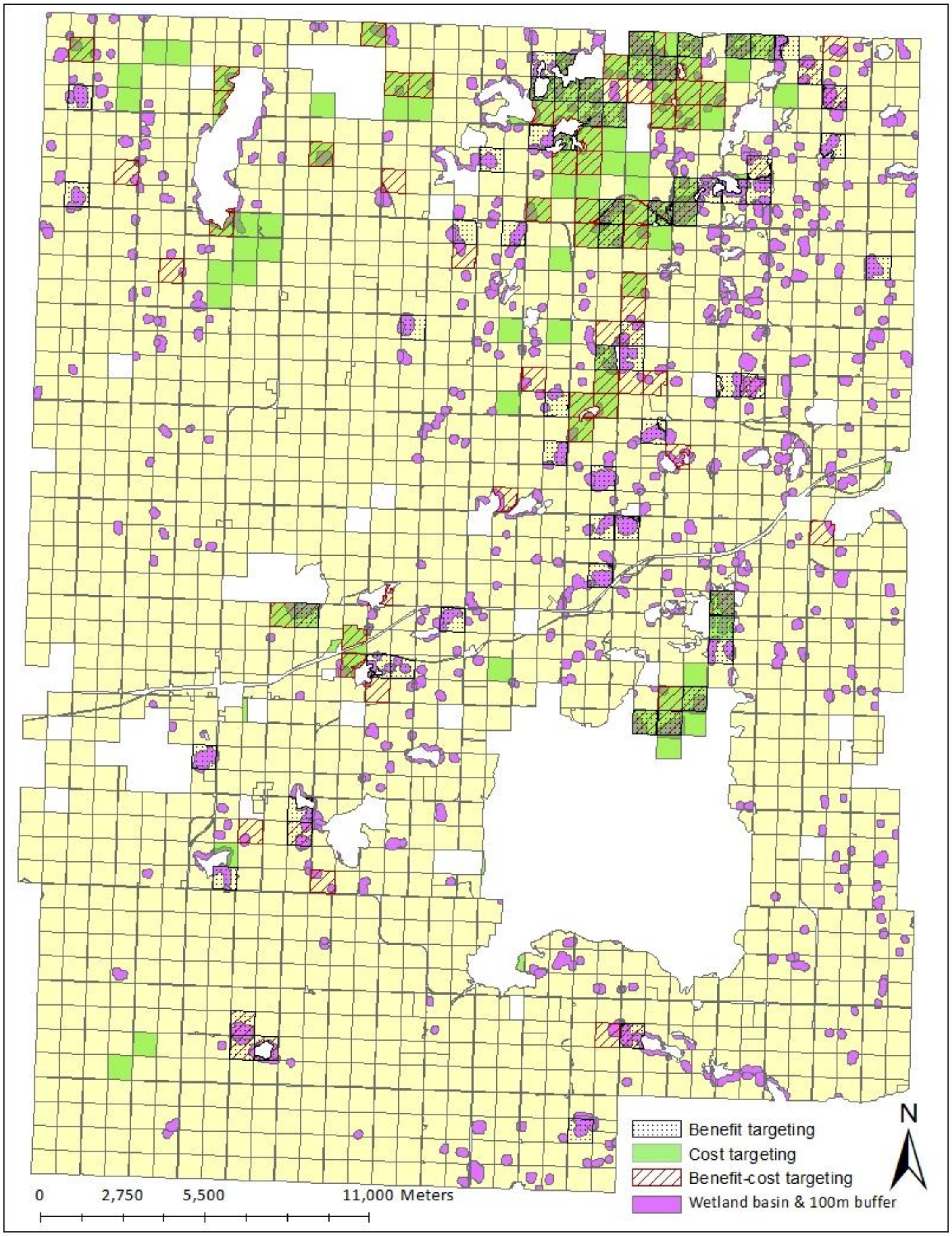


Figure 4.7 Land parcels selected under Habitat and Surrounding Quarter Section Approach using the three targeting methods.

4.3.1 **Combined Method**

The combined habitat selection approach was developed using benefit targeting and cost targeting in combination to secure larger areas of land that are closely connected geographically. This hybrid approach potentially allowed the policy to capture the benefits available with larger contiguous habitat areas. Because this targeting scenario was designed to acquire land in quarter sections, it was implemented only for the quarter section focus and habitat and quarter section land selection frameworks. This approach secured an area of land midway between the area secured under benefit targeting and cost targeting in both Quarter Section Focus and Habitat and Quarter Section land selection frameworks (Table 4.3).

In both the benefit-cost targeting method and combined method, benefits and cost were taken into account and it was expected that both methods would result in similar areas of land being secured. However, under the combined method less area was selected compared to benefit-cost targeting method under both Quarter Section Focus and Habitat and Quarter Section focus Approach. However, the area selected under combined method had closely connected land parcels. Therefore, the combined approach may be a more cost effective mechanism to secure larger areas of high quality habitat that provides benefits available with larger contiguous habitat parcels. As the benefit-cost targeting method considered the environmental benefits and opportunity cost simultaneously, low assessed land could be selected under that method. In contrast, in the combined method the quarter sections with higher quality habitat were acquired first, without considering the cost of the land. As explained earlier this approach involved spending 50% of the budget in the first stage, and then allocated the remainder of the budget to secure the relatively low cost quarter sections in close proximity or adjacent to the high quality habitat quarter sections. Therefore, the quarter sections with higher assessment values could be selected in the combined method. To further illustrate these results the distribution of the land parcels selected by the two combined land selection frame works are presented on maps of the study area in Figures 4.8 and 4.9. As revealed in the maps, the combined approach under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach secured quarter sections that contain more wetland habitats by identifying the lands with more benefits and then secured adjacent quarter sections that may or may not contain wetland habitats. The combined method under both land selection approaches was able to secure large blocks of contiguous habitats.

Table 4.3 Area of land secured under combined method

	Quarter Section Focus Approach (ha)	**Habitat & Surrounding Quarter Sections Approach (ha)**
Acquiring land with high benefit	1,700	2,163
Acquiring adjacent cheap land	2,692	2,771
Total	4,392	4,934

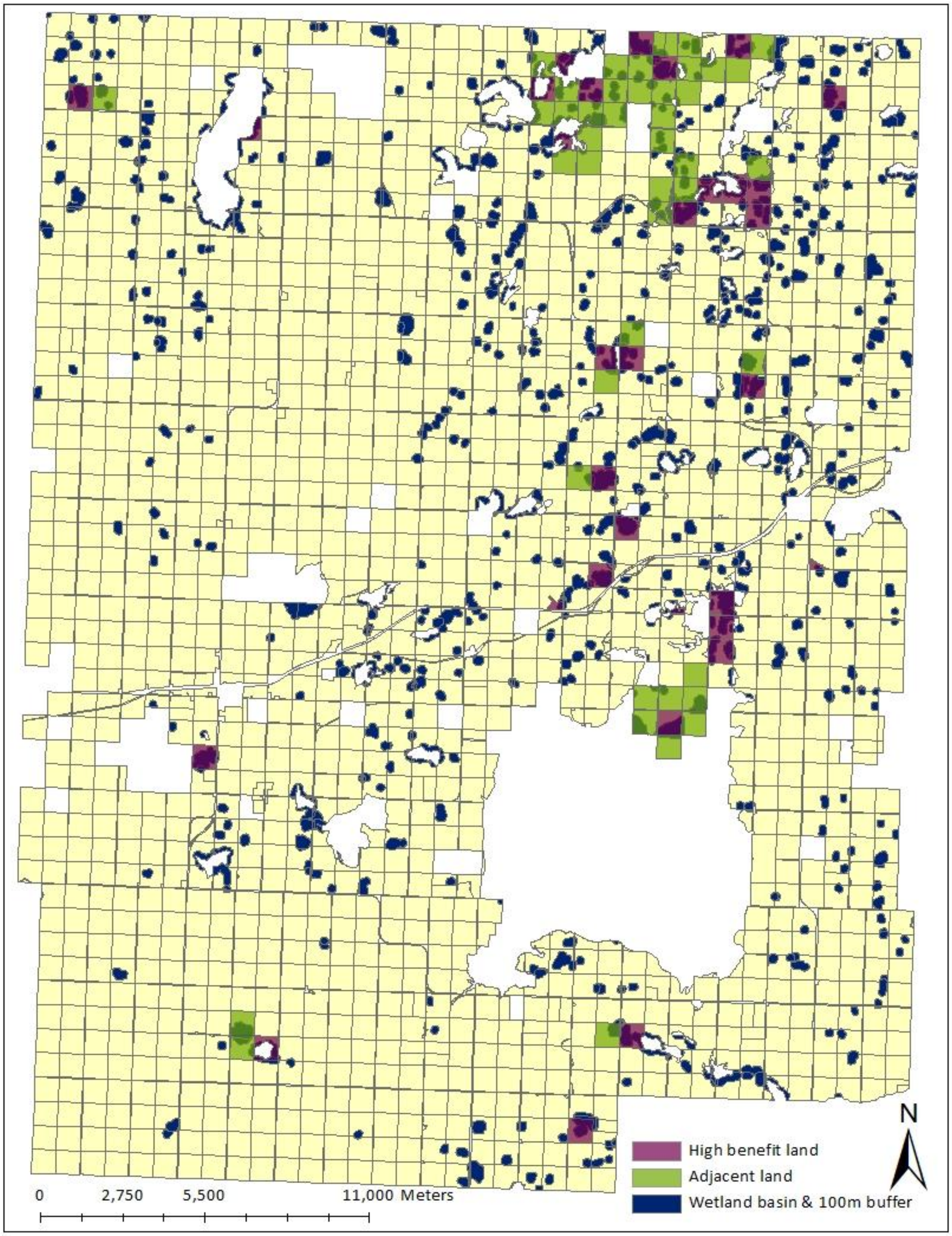


Figure 4.8 Land parcels selected under Combined method for Quarter Section Focus Approach.

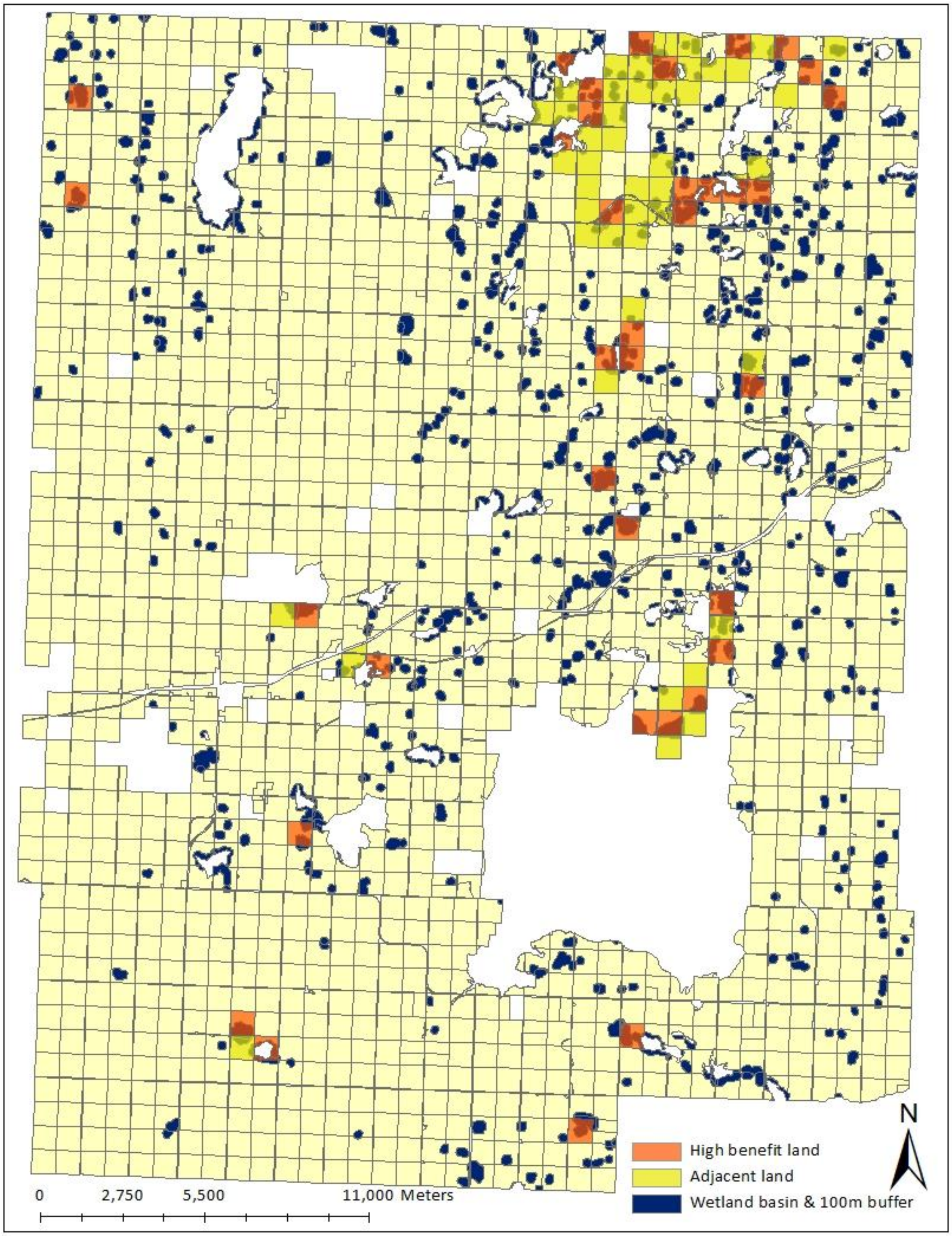


Figure 4.9 Land parcels selected under Habitat and Surrounding Quarter Section Approach for Combined method.

4.4 Examination of the Results

The following discussion presents an analysis of the results of policy targeting under different land selection approaches. In order to provide a quantitative and qualitative assessment of the parcels of land secured under each of the targeting method and land selection frame works, the composition of secured lands has been analysed based on the land cover data base.

The policy targeting method applied in combination with the land selection approaches adopted can have a significant influence on the characteristics of the land secured by the agri-environmental program. By comparing the characteristics of the land secured under different targeting scenarios with the baseline landscape, in this case the Redberry RM, the influence of the targeting can be demonstrated. For the purpose of the analysis, it was expected that policy delivery without any targeting mechanism would secure land with characteristics similar to the baseline landscape. In other words, a set of non-targeted policies will tend to secure land with characteristics in similar proportions to those represented in Redberry study area. Therefore, comparing the makeup of the baseline landscape with the characteristics of the parcels secured under each of the targeting scenarios provides insight into the effect of the targeting mechanisms on the proportion of land secured with different characteristics.

4.4.1 Quarter Section Focus Approach

When examining the results of the cost targeting method under the Quarter Section Focus land selection approach, 78% of the land secured was classified as natural area, compared to 31% of the baseline landscape classified as natural area (Figure 4.11). In contrast, of the land secured by the benefit targeting method under the Quarter Section Focus Approach, only 49% was classified as natural area. Both targeting methods secured a larger proportion of natural area as compared to the baseline landscape (non-targeting situation). It is interesting to note that the area of natural cover in the parcels secured under cost targeting was greater than benefit targeting. These results follow the relationship between the land cover type and land assessment presented in section 4.2. As discussed, land that had relatively low assessed value, based on its lower potential productivity for agricultural commodities, was often characterized as having more natural cover such as pasture or forest. Thus, as the cost targeting method secured low valued lands, the quarter sections tended to have more natural vegetation cover (Figure 4.10). In contrast, the benefit targeting method within the Quarter Section Focus Approach selected quarter sections containing greater areas of “identified habitats” with no consideration of cost. As discussed in the previous chapter, the “identified habitats” were recognized based on wetland and 100m buffer around the wetland which can consist of different land cover types found on the landscape. The design of the benefit targeting method in combination with the Quarter Section Focus land selection approach did not allow the targeting of a wide range of natural cover. However, the benefit-cost targeting method and combined method secured comparable proportions of natural area. This finding can be explained by the similarity of benefit and cost criteria in both methods.

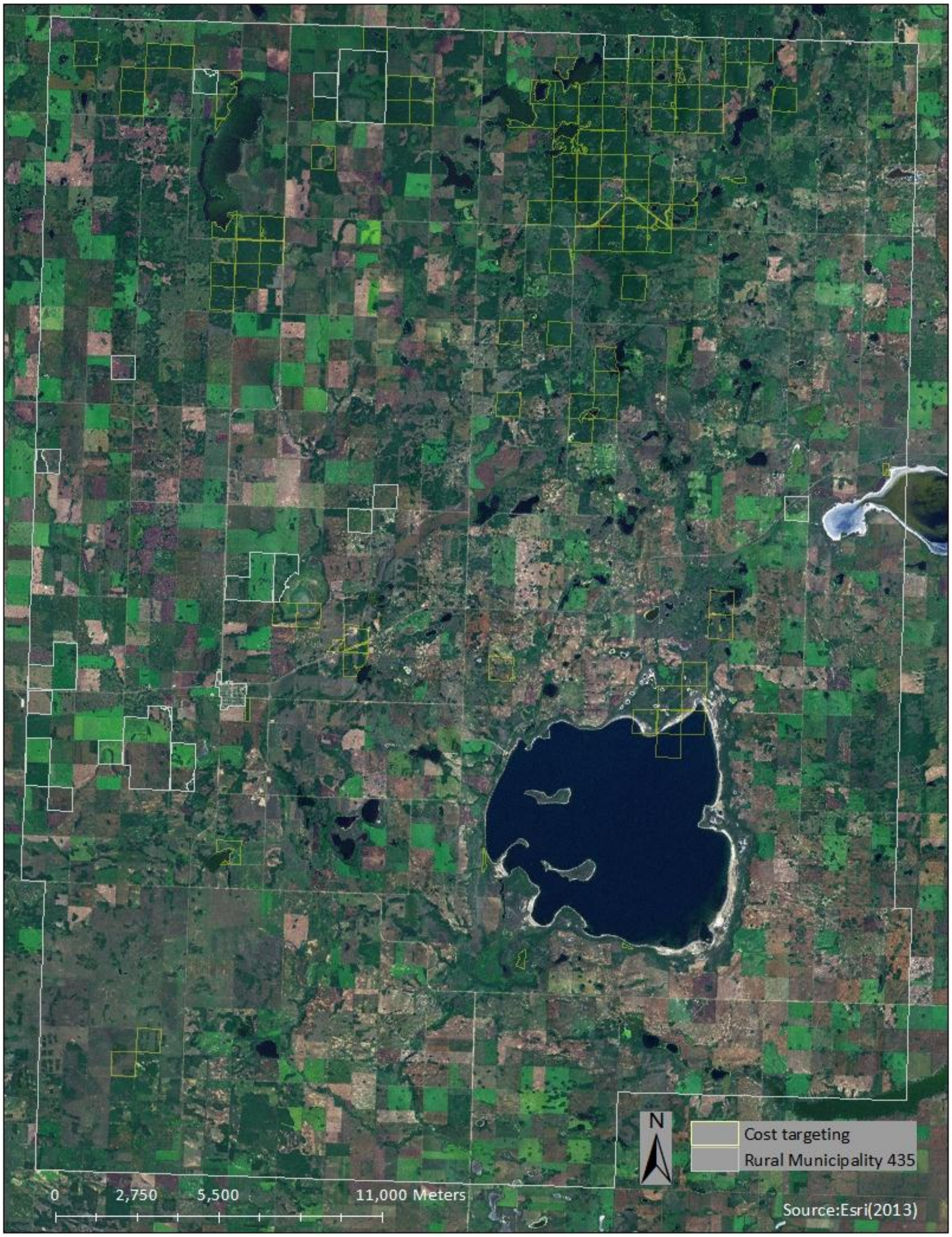


Figure 4.10 Satellite imagery showing the land parcels selected by cost targeting under Quarter Section Focus Approach.

While the area of natural cover secured was greater under the cost targeting, the proportion of land secured that was classified as wetland was significantly higher in benefit targeting, benefit to cost targeting and combined method compared to the percentage of wetland in the baseline landscape (Figure 4.11). In the benefit targeting and benefit-cost targeting method, quarter sections containing greater areas of “identified habitats” were prioritized and secured and in the combined method quarter sections with more “identified habitats” were secured when spending the initial half of the budget. Since the focus of habitat selection was on wetlands it was expected that land secured under the benefit targeting, benefit-cost targeting method and combined method would contain more area of wetland (Figure 4.11). The proportion of land secured that was classified as wetland under benefit-cost targeting and combined methods were similar as both considered benefits and cost for targeting land.

As discussed earlier, the benefit targeting method was implemented by selecting the quarter sections containing greater areas of “identified habitats”(wetland and 100m buffer which can consist of different land cover types), with no consideration of cost. Therefore, the benefit targeting could secure more annual cropland under the Quarter Section Focus Approach since the focus was on the wetlands, not the cover types on the rest of the subject quarter section. In contrast, cost targeting, benefit- cost targeting and to some extent the combined method secured quarter sections with low assessment value, and hence could secure quarter sections containing greater areas of natural vegetation, but less wetlands, and less area of annual cropland (Figure 4.11).

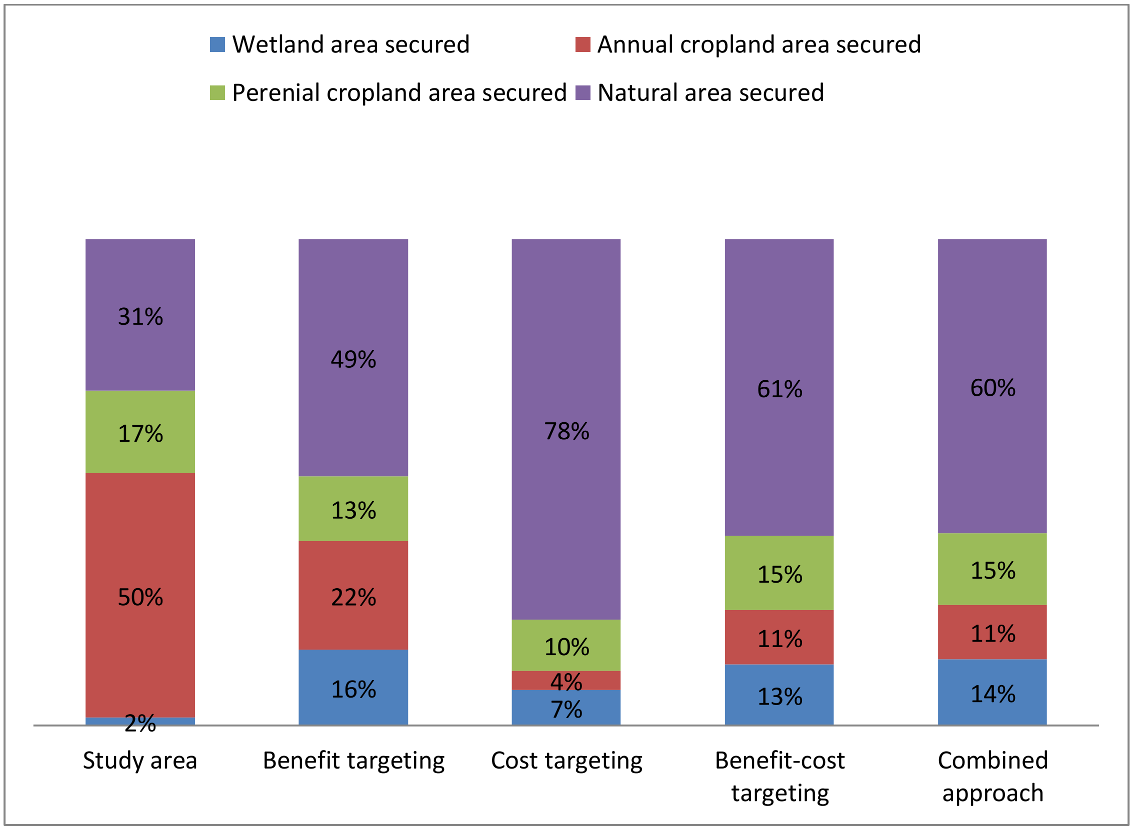


Figure 4.11 Land cover for the Redberry RM study area and the composition of the land secured by three targeting methods under the Quarter Section Focus Method

4.4.2 Specific Habitat Focus Land Selection

All three targeting methods under the Specific Habitat Focus Approach secured land based on wetlands and 100m riparian zones. According to the results, the targeting mechanism made little difference to the cover type composition of secured land under the Specific Habitat Focus Approach (Figure 4.12). Compared to the baseline landscape all of the targeting methods secured land parcels with greater proportions of natural vegetation and lower proportion of cropland. This is because the wetland associated 100m riparian zones contained some natural vegetation cover in most cases. Also, the results were very similar for the three targeting mechanisms, which was different from the previous scenario (Figure 4.12). This can be explained in two ways. The first would be the design of the land selection approach based on the wetland and 100 m wide buffer zone. In this approach land selection was done using the targeting methods considering “identified buffer zones” as the available lands. Thus, the lands with more habitat benefits were identified before execution of the targeting methods and therefore the characteristics of available land for targeting had the same make up in terms of land cover types. As a result the Specific Habitat Focus Approach secured lands that could provide quality habitats for wetland dependent species irrespective of the targeting method used. Secondly, it was evident that the parcels secured under all three targeting methods were mostly located in the north east part of the study area (Figure 4.6) which contained larger areas of natural cover. As discussed in section 4.2, lower assessed land was found primarily in a band running diagonally across the middle of the RM (SW to NE). The cost targeting method secured wetland buffer zones based on the per acre assessment value of those parcels. The benefit targeting method secured parcels of land with greater areas of native cover types in the wetland buffer zone. Benefit-cost targeting also considered the amount of natural vegetation and the assessment value of the wetland buffers. Due to the negative correlation between the presence of natural vegetation and the assessment value, all three targeting methods secured the same parcels of land to a large extent. Therefore the proportions of the cover types in the enrolled lands should be similar in all the targeting methods under Specific Habitat Focus Approach.

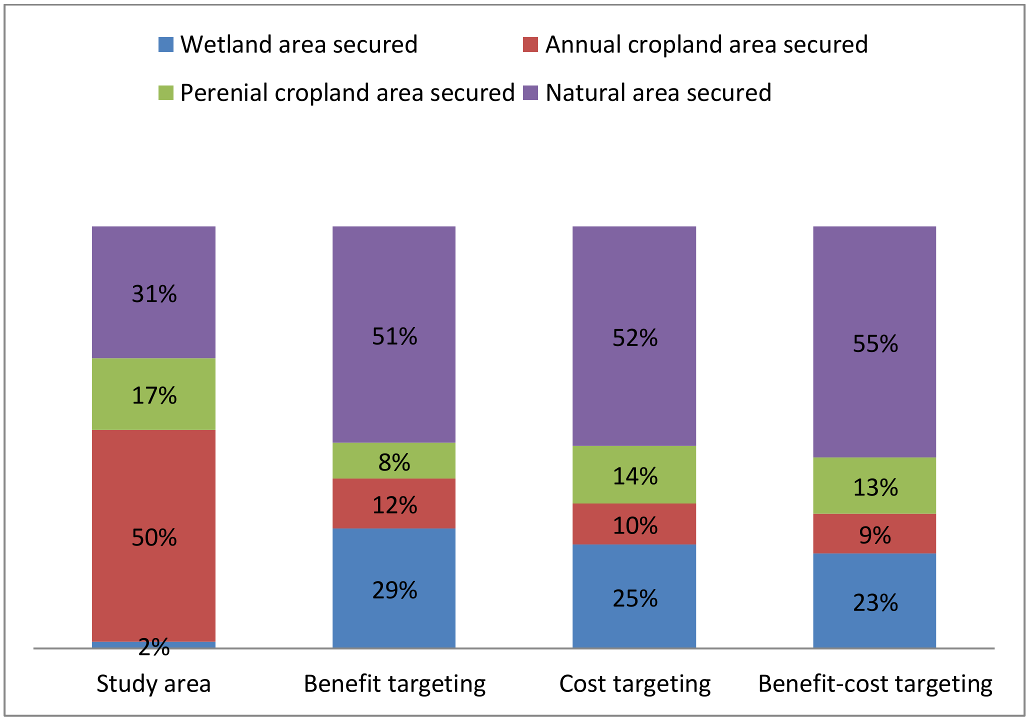


Figure 4.12 Land cover for the Redberry RM study area and the composition of the land secured by the three targeting methods under Specific Habitat Focus Approach

4.4.3 Habitat and Surrounding Quarter Section Approach

The results of Habitat and Surrounding Quarter Section Approach were similar to the Quarter Section Focus Approach (Figure 4.13). Cost targeting was identical for the two land selection scenarios because, both scenarios incorporated similar selection and targeting processes. However, benefit, benefit-cost and the combined method secured more natural area, slightly less perennial cropland, less annual cropland and less wetland. In the Habitat and Surrounding Quarter Section Approach the “identified habitats” were selected first and then the full quarter section bearing the selected “identified habitats” were secured. Therefore, as discussed earlier, when the full quarter section was secured more natural cover was also secured when the “identified

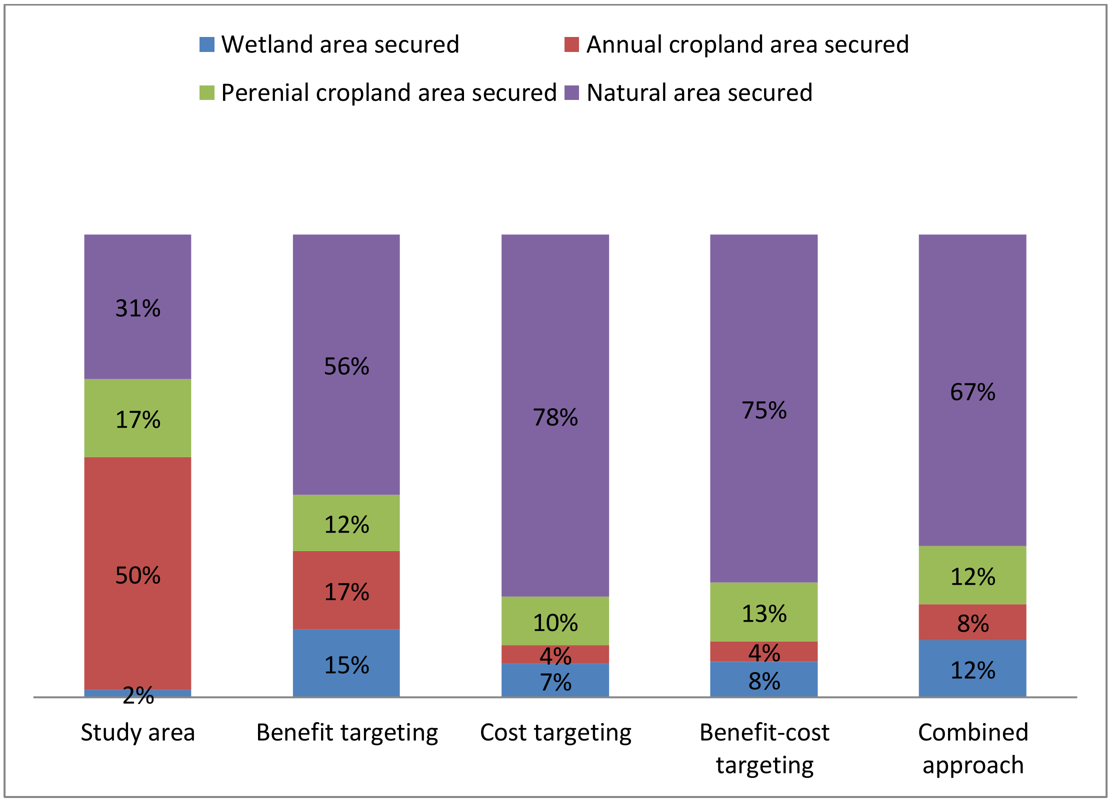


Figure 4.13 Land cover for the Redberry RM study area and the composition of the land secured by the three targeting method under Habitat and Quarter Section Approach

habitats" were found in quarter sections with more natural cover. Also, when the full quarter section was secured the ability to purchase more "identified habitats" was limited and this resulted in the area of wetlands secured being comparatively low. Because most of the secured parcels were found across the middle of the study area (SW to NE), where a greater proportion of the land is allocated to natural area (Figure 4.7), there was a tendency to select greater area of natural cover types than cropland. On the other hand, in the Quarter Section Focus Approach, selection of quarter sections for benefit targeting and benefit -cost targeting and combined method was done considering the habitat quality of quarter section based on the “identified habitats”. This could result in more highly assessed land being selected which may contain more cropland and less natural area.

4.5 Comparison of Land Selection Approaches

In general, the simulation results show that the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach secured a larger area of land compared to Specific Habitat Focus Approach (Figure 4.14). This was due to the fact that in the Specific Habitat Focus Approach land parcels were selected based on identified wetlands and the described 100m wide buffers around the wetland, and did not allow for securing the full quarter section, which results in very different securement patterns. As discussed earlier (Section 4.2), approximately 22% of the wetlands within the Redberry RM study area were located on lands which were assessed at $40,000 to $80,000 per quarter section. The land in a quarter section which contains wetlands and has a low assessment value was not enrolled by the targeting scenario. However, although the amount of land secured under the Specific Habitat Focus Approach was less, it is apparent that the land that was secured has land cover characteristics that would provide greater habitat quality.

The amount of land secured by cost targeting under both the quarter section and Habitat and Surrounding Quarter Section Approach were identical, due to the fact that they employed a similar approach (Figure 4.14). The Habitat and Surrounding Quarter Section Approach secured greater area using benefit targeting, benefit cost targeting and combined method compared to those targeting methods under the Quarter Section Focus approach.

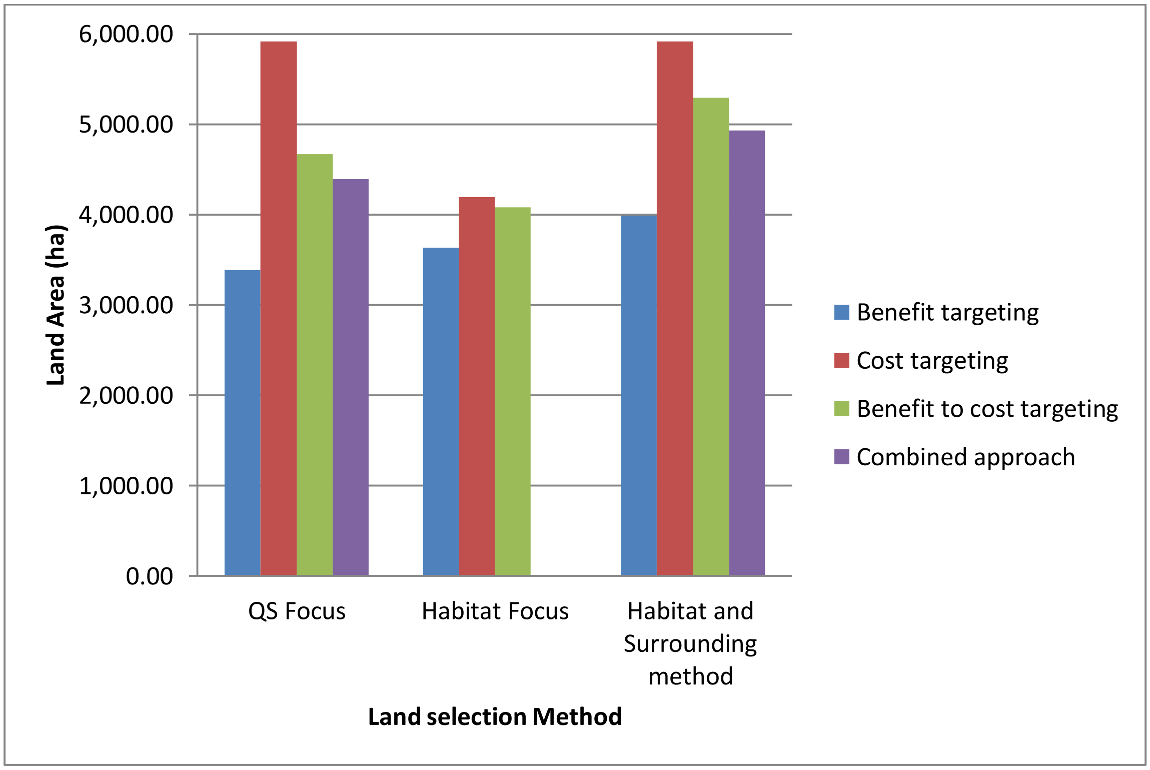


Figure 4.14 Comparison of the area of land secured under land selection approaches and policy targeting methods for the Redberry RM study area.

For all these targeting methods under the Habitat and Surrounding Quarter Section Approach the “identified habitats” were selected first and then the full quarter section bearing the selected “identified habitats” were secured. As discussed earlier, the majority of the secured parcels were found across the middle of the study area (SW to NE) where there was a higher proportion of natural cover. As discussed earlier, due to the negative correlation between the amount of natural vegetation and land assessment value securing quarter sections with greater amount of natural cover, lower assessed land can be captured and thereby more land can be purchased within the given budget.

4.5.1 Long-term Lease Program

The analysis of agri-environmental policy targeting applied two mechanisms to compensate the land owner for their land set-aside to enable a simple comparison of the economic and land characteristic outcomes. The results of the purchasing program were described above and that of the long-term lease program is reported in this section. The major difference between the two programs is that under the long-term lease program the land owner continues to hold the title of the land compared to transferring the title to the policy delivery organization under purchase program. This additional analysis was included to compare program delivery options. In many wildlife habitat policy initiatives purchase or long term lease are the primary options used. The assumptions made in the analysis for one-time purchase method are similarly applied for the long-term lease method (Table 4.1).

In the long-term lease simulations lease rates were calculated using the formula described in Chapter 3 and were based explicitly on the assessment values for the subject parcel of land. A total annual budget for the lease program was set at $65,000. This budget was selected as it resulted in similar quantity of land as selected under purchase program to enable comparisons of the economic and environmental performance of the two programs. Also informing the selection of an annual lease budget of $65,000 was that over a 29 year long-term lease program, the total dollars allocated to the policy was equivalent to the budget of $1.5 million in the one-time purchase program[33] . Based on these budget values the capitalization rate was approximately 0.0433. However, rounding this value up resulted in a capitalization rate

[33] Present value of the money that would be spent annually over a 29 years was calculated using discount rate of 0.02.

of 4.5% used to convert land values (which were given by assessment value) to annualized lease rates (Chapter 3).

The implementation of long term lease program was executed only for the Quarter Section Focus Approach and the Specific Habitat Focus Approach. These two approaches were used due to the different results developed for the two approaches in the land purchase scenarios. Estimates of the total area of land secured under the long-term lease program for the three targeting methods in the Quarter Section Approach and Specific Habitat Focus Approach are provided in Table 4.4 below. As expected, under both land selection frameworks the benefit targeting method secured the smallest area of land while the cost targeting method secured the greatest area of land. The benefit-cost targeting method secured an area of land midway between these two extremes. To illustrate the pattern of land securement under the long-term lease the results are provided on a map of the Redberry RM study area (Figure 4.15 and 4.16).

Table 4.4 Area of land secured under three targeting methods and the Quarter Section Focus and Specific Habitat Focus Approaches for long term lease method

Targeting method	**Quarter Section Focus Approach (ha)**	**Specific Habitat Focus Approach (ha)**
Benefit targeting method	3,270	3,511
Cost targeting method	5,789	4,089
Benefit-cost targeting approach	4,606	3,977

The land parcels selected for the long term lease program under all three targeting methods were very similar to that selected under the land purchase program (compare figure 4.15 and 4.16 with figure 4.5 and 4.6). Thereby, the makeup of the landscape in terms of land cover types of the parcels secured under the targeting scenario for the long term lease program was similar to the purchase program. However, the approaches are distinctly different in terms of management of the land and the incentives to the participating land owners. For example, under the land purchase method, the policy delivery organization holds title to the land such that when crop prices go up the parts of the land that are productive for annual crops could be leased back to farmers considering the contribution of the areas of land to the wildlife objectives of the policy. These lease-back portions of the land may be a management tool that could be used by the policy delivery organization to offset the cost of the program. In contrast, under the long term lease program farmers do not lose title, hence they have the choice of enrolling to the program annually according to the crop prices and opportunity cost of land. However, an annual adjustment to the lease contract would impose significant additional administration costs as well as limiting long term habitat benefits.

4.6 Patterns of Land Securement under Policy Delivery Options

The earlier discussion of the policy delivery scenarios focused on reporting the differences in the characteristics of the land, in terms of land cover, secured under the range of targeting methods and land selection approaches. However, to evaluate the policy delivery options it is also useful to present the pattern of land selection relative to other characteristics of the landscape. In this section the land selection pattern was evaluated relative to the land value, as represented by land assessment levels. As discussed earlier, the assessed value of the quarter sections in the study area ranged from $12,600 to $85,800 per quarter section.

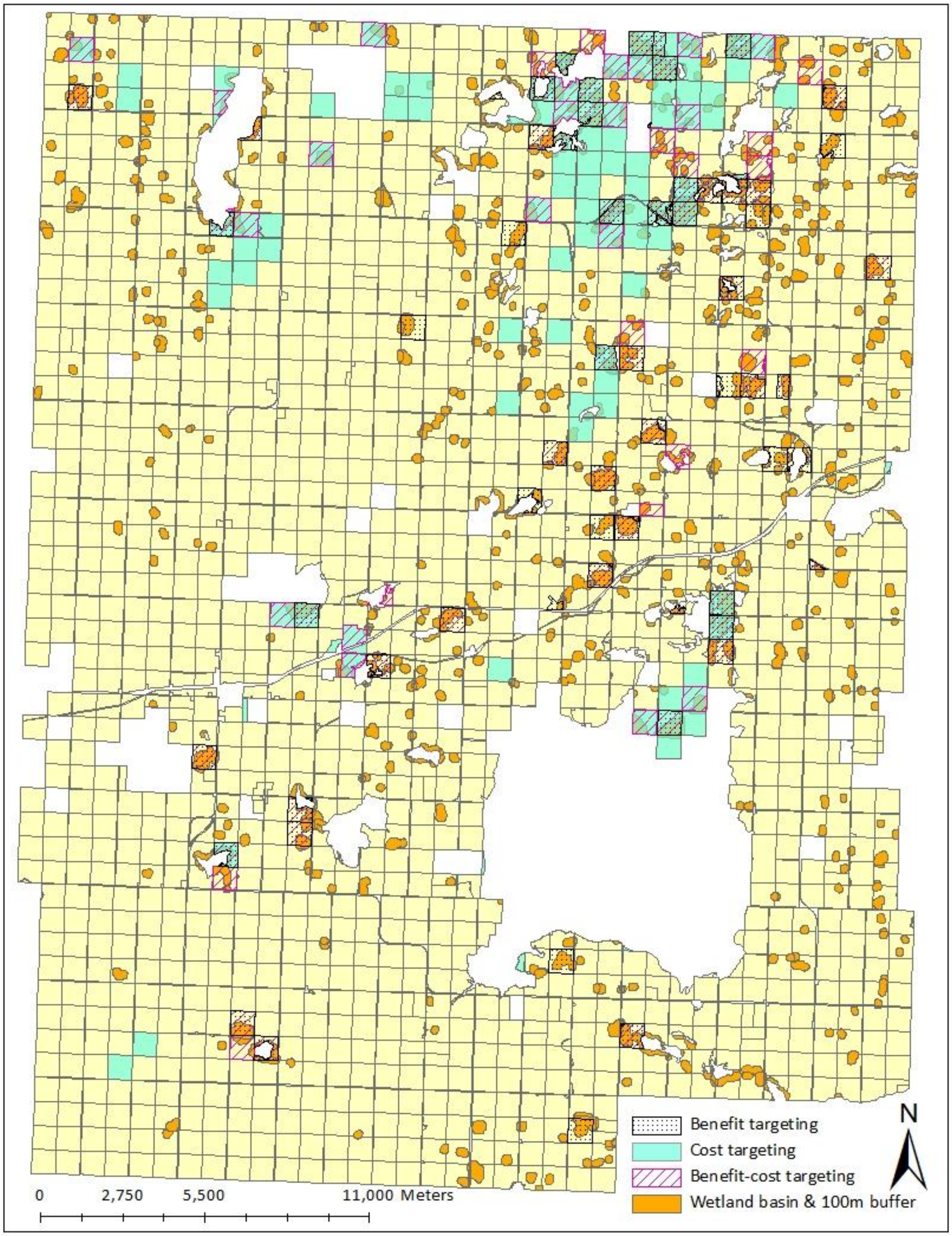


Figure 4.15 Land Parcels Selected Under Quarter Section Focus Approach for Lease Method using the three targeting methods in the Redberry RM study area.

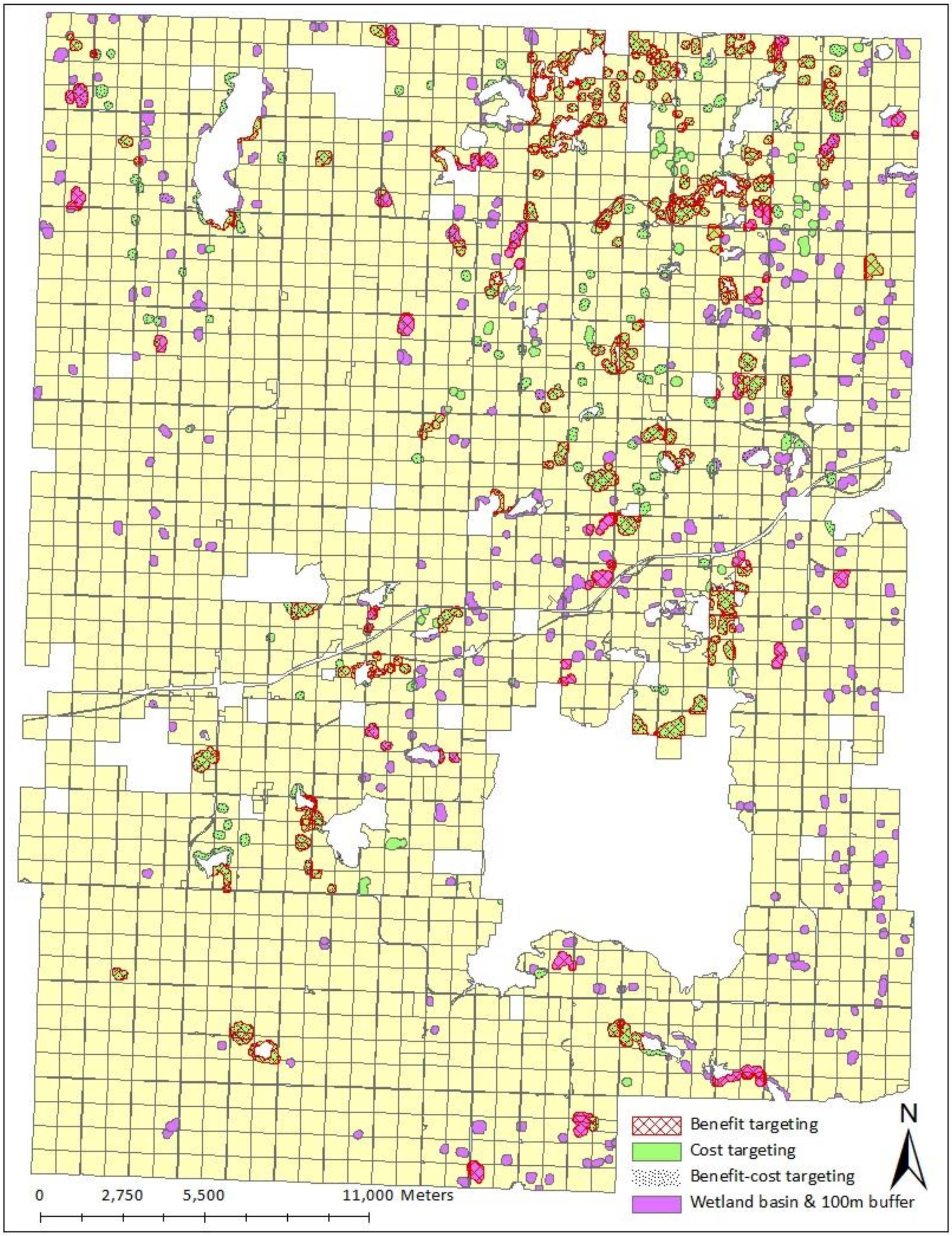


Figure 4.16 Land Parcels Selected Under Specific Habitat Focus Approach for Lease using the three targeting methods in the Redberry RM study area.

The Quarter Section Focus Approach and the benefit targeting method captured land from a greater range of assessment values including both higher and lower assessed land whereas, as expected, the cost targeting captured only the lower assed land (Appendix A). This pattern can be demonstrated by calculating the standard deviation of the assessment value of the selected parcels for each land selection approach. According to this analysis, the assessment values of the land that was selected under benefit targeting showed higher variation than under cost targeting (Table 4.5). In contrast, the benefit-cost targeting and combined method captured land parcels which had assessment values that were between those secured by the benefit targeting method and cost targeting method. These two methods secured land taking benefits and cost of the land into consideration, and in either method it is not possible to screen lands with higher benefits or low assessment value.

It was evident that certain quarter sections were selected by multiple policy delivery approaches indicating that different targeting tools can secure the same parcels of lands. As illustrated in Figure 4.17, under the Quarter Section Focus Approach the quarter section labeled A was secured by both the cost targeting and benefit-cost targeting method, the quarter section labeled B was secured by the benefit and benefit-cost targeting method whereas the quarter section labeled C was selected only by the benefit-cost targeting method. Under the Quarter Section Focus Approach, 74% of the area that was secured by benefit targeting was also selected by the benefit-cost targeting method. Specifically a total of 3,385 ha of land was secured by benefit targeting, and of those lands 2,266 ha was also secured by the benefit-cost targeting method. However, only 18% of the low cost land that was selected under the cost targeting was also selected under the benefit targeting. Specifically, of the total of 5,918 ha of land that was secured by cost targeting only 1,058 ha was also selected by the benefit targeting method (Table 4.6). The benefit targeting method selected quarter sections by considering more habitat benefits while, benefit-cost targeting selected land based on the habitat benefits and cost ratio. Therefore, there was a greater chance of selecting the same quarter sections with more habitat benefits by both methods. However, the cost targeting method selected land by screening land with low assessment value while benefit targeting method secure land with higher

Table 4.5 The mean and standard deviation of land assessment values ($/quarter section) of selected land parcels under different targeting methods using the Quarter Section Approach

	Benefit Targeting($)	Cost Targeting($)	B/C Targeting($)	Combined Targeting scenario	
				High benefit QS($)	Adjacent QS($)
Mean	22,628	13,867	16,977	21,635	16,839
Standard Deviation	14,546	5,670	7,756	17,273	5,862
Minimum	2,100	100	700	2,100	100
Maximum	100,700	19,900	38,600	100,700	24,700

Table 4.6 Overlap of land parcels selected by three targeting methods in Quarter Section Focus Approach (% of land parcels common)

	Benefit Targeting	Cost Targeting	B/C Targeting	Combined Targeting scenario
Benefit Targeting	-	31%	74%	56%
Cost Targeting	18%	-	38%	40%
B/C Targeting	53%	48%	-	56%
Combined Method	43%	54%	60%	-

habitat benefits but was not influenced by the land having relatively high or low assessment values. Therefore, only if there is a strong negative correlation between land cost and environmental benefits are the lands selected by both methods.

The above analysis can be extended to evaluate how the policy delivery scenarios perform relative to the available wildlife habitat, in this case the wetlands and their associated upland buffers that are located across the study area. The calculated assessment values for the wetland buffers[34] ranged from $114 to $429,747 per habitat buffer. The results showed that only the benefit targeting method secured wetland and riparian zones on land with higher assessed values (Figure 4.18). Therefore the mean assessment value of quarter sections selected under benefit targeting was higher than under the other targeting methods. However, the selected parcels revealed a large range of assessment values and thereby a higher standard deviation of assessment values (Table 4.7). In addition, under the Specific Habitat Focus Approach the land parcels selected by one targeting method were also selected by the other methods (Figure 4.18). In the Specific Habitat Focus Approach all secured lands were wetlands and the delineated wetland buffers. It was evident that the cost targeting and benefit-cost targeting methods selected the same parcels in most cases. As an example, 91% of the land selected under the benefit-cost targeting method was also selected under cost targeting (Table 4.8). This was because in benefit-cost targeting and cost targeting the land cost was taken into account in selecting the land. At the same time in benefit-cost targeting the land with more "identified habitats" were targeted, as explained in Section 4.2, the land in natural area or low productive

[34] As described in chapter 3 the buffer zones belongs to same quarter section were added together in order to get connected habitat for conservation.

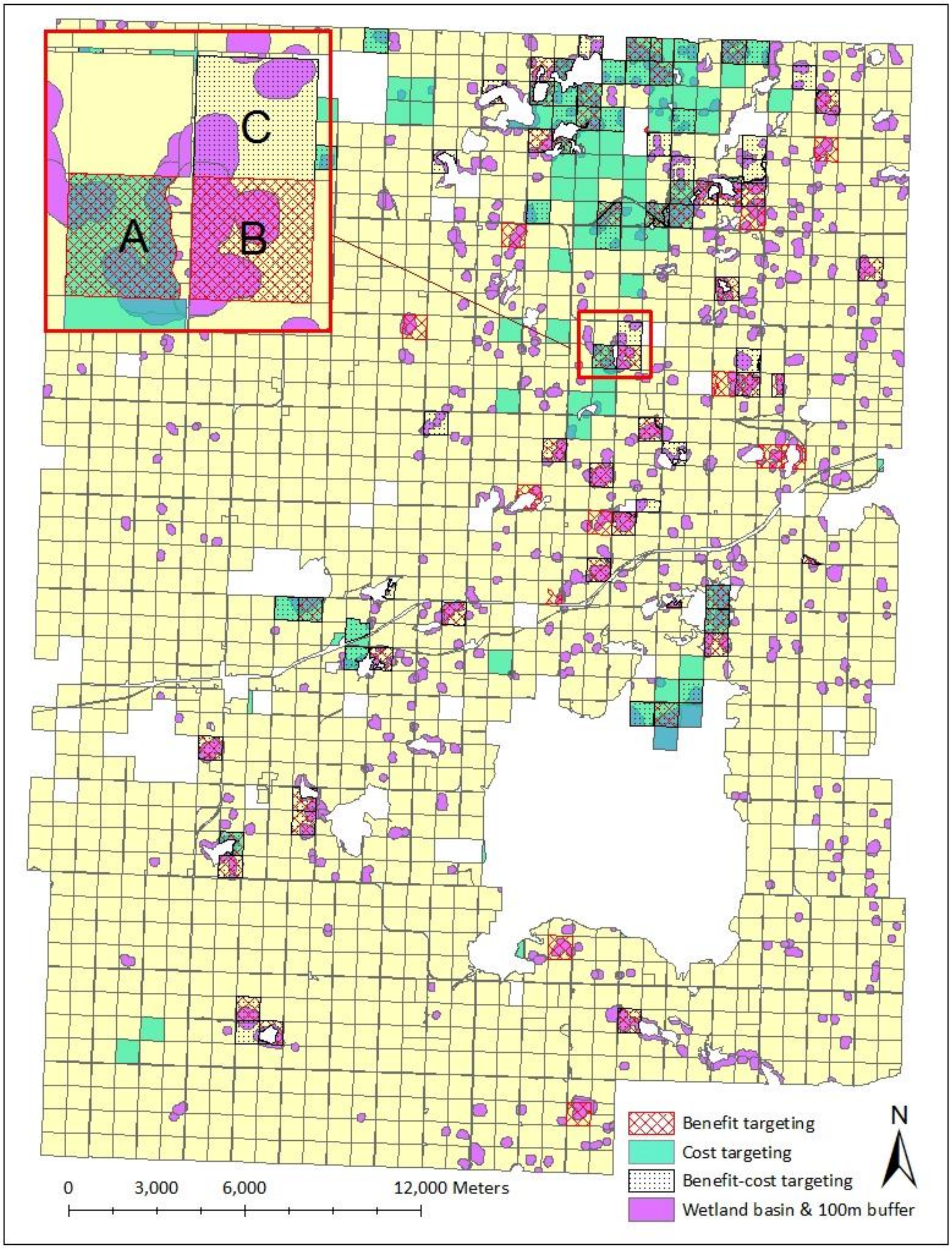


Figure 4.17 Land parcels selected by the three targeting methods under the Quarter Section Focus Approach.

land were often lands with a relatively low assessed value. Thereby, when selecting land

Table 4.7 The mean and standard deviation of land assessment values ($/quarter section) of selected land parcels under the Specific Habitat Focus Approach based on the three targeting methods.

	Benefit Targeting($)	Cost Targeting($)	B/C Targeting($)
Mean	11,274	6,094	6,366
Standard Deviation	5,664	4,184	4,414
Minimum	370	223	223
Maximum	28,965	20,602	21,973

Table 4.8 Overlap of land selection among three targeting methods in Specific Habitat Focus Approach (% of land parcels in common)

	Benefit Targeting	Cost Targeting	B/C Targeting
Benefit Targeting	-	76%	81%
Cost Targeting	66%	-	88%
B/C Targeting	72%	91%	-

based on benefit -cost ratios of the land, there is no methodology to screen land based on cost or benefits. Therefore some parcels with low assessed value that were selected by cost targeting could also be selected by the benefit-cost targeting method. Only 66% of the land selected under the cost targeting approach was also selected under benefit targeting. This can be attributed to the fact that benefit targeting only selected land based on identified habitat benefits with no consideration of cost, while cost targeting secure land solely on cost of the land.

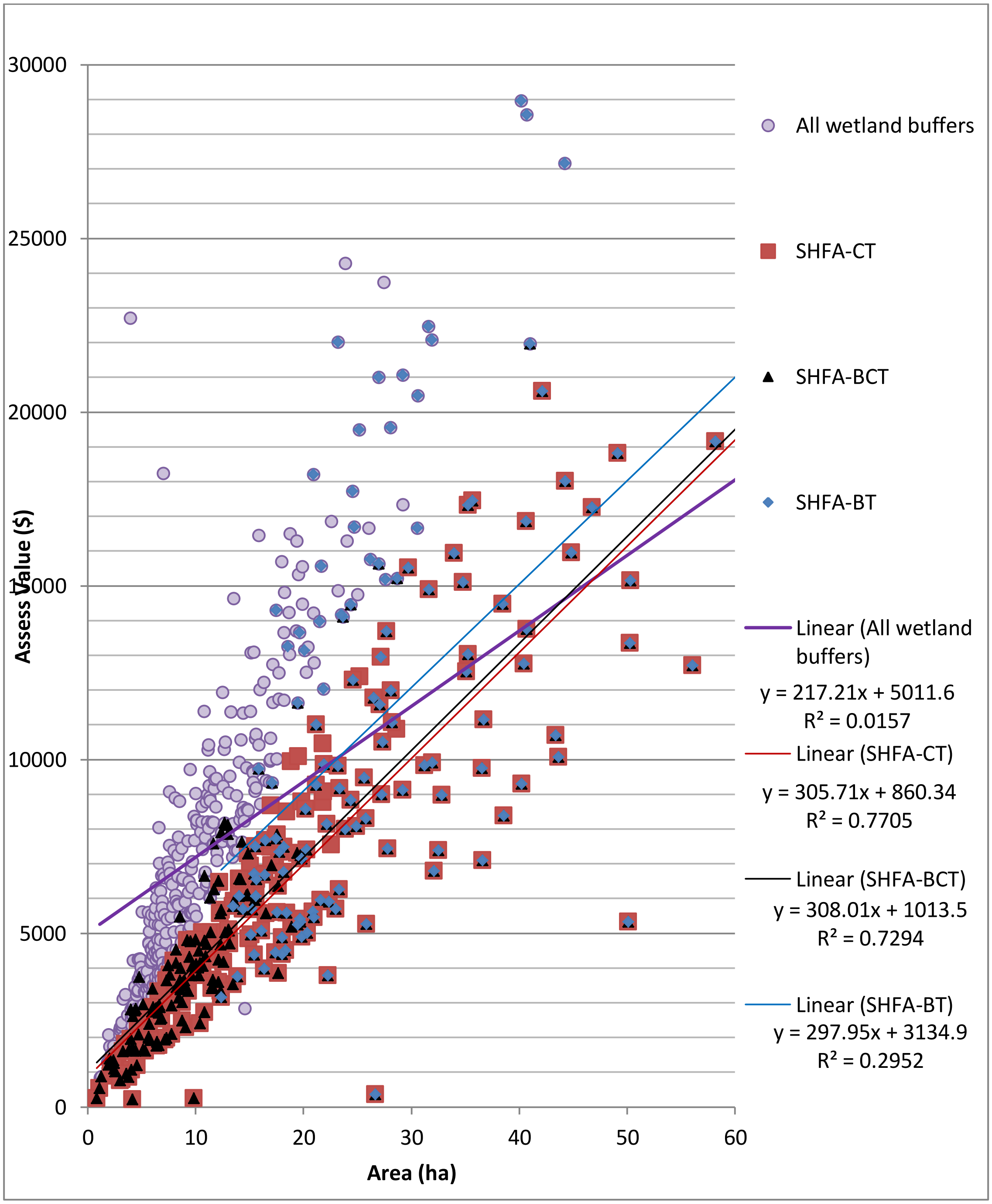


Figure 4.18 Land assessment value ($/habitat patch) plotted against land area (of wetland buffers) within the Redberry RM showing land[35] secured under three targeting methods for the Specific Habitat Focus Approach

[35] 80% of all wetland buffers contain an area below 20 ha.

Continuing the earlier analysis, the land selection pattern was evaluated for the Habitat and Surrounding Quarter Section Approach. Benefit targeting tended to secure both higher and lower assessed land parcels while cost targeting secured quarter sections that had a relatively narrow range of assessment values (Table 4.9) (Appendix B). Therefore the standard deviation of assessment values of secured wetland buffers under benefit targeting was higher than for the land secured under the cost targeting method (table 4.9). Benefit-cost targeting and the combined method selected land parcels which had assessment values that were between those secured by the benefit targeting and cost targeting methods. Some targeting methods secured the same land parcels. For example, benefit targeting and the combined method selected the same quarter sections in most cases. Approximately, 70% of land selected under benefit targeting also was selected under the combined method (Table 4.10). Since benefit targeting secured quarter sections with high environment benefits, while the combined method also secured quarter sections with high quality lands first, some quarter sections selected under the benefit targeting method were also selected by the combined method under Habitat and Surrounding Quarter Section Approach. It is interesting to note that only 25% of land that was selected under cost targeting was also selected under benefit targeting because the two methods only consider land cost and environment benefits respectively.

Table 4.9 The mean and standard deviation of land assessment values ($/quarter section) of selected land parcels under the Habitat and Surrounding Quarter Section Approach based on the three targeting methods.

	Benefit Targeting ($)	Cost Targeting ($)	B/C Targeting ($)	Combined Targeting scenario	
				High benefit QS ($)	Adjacent QS ($)
Mean	22,668	13,867	16,614	20,436	15,726
Standard Deviation	10,093	5,670	5,486	9,603	5,243
Minimum	900	100	700	900	100
Maximum	46,600	19,900	26,400	46,600	22,900

Table 4.10 Overlap of land selection for three targeting methods in Habitat and Surrounding Quarter Section Approach (% of land parcels in common)

	Benefit Targeting	Cost Targeting	B/C targeting	Combined method
Benefit Targeting	-	37%	51%	70%
Cost Targeting	25%	-	59%	52%
B/C targeting	38%	66%	-	63%
Combined Method	56%	63%	67%	-

The above section provides a discussion focused on reporting the differences in the types of land in terms of land cover secured under the range of targeting methods and land selection approaches. The analysis also evaluated the policy delivery options in terms of the pattern of land selection relative to other characteristics of the landscape. When all targeting scenarios are considered, the targeting scenarios could increase the environmental benefits of the land enrolled as compared to the baseline landscape. In most cases targeted land had significantly greater areas of wetlands and natural vegetative cover, which provide greater wildlife habitat and other environmental benefits. Therefore, the targeting methods in combination with the land selection frameworks were able to secure land with more habitat benefits.

According to the above analysis, certain land parcels were selected by multiple policy delivery approaches which suggests that different targeting tools will secure the same parcels of land. In other words, the targeting approach used was of little importance. As discussed in the conceptual framework earlier in the thesis, the possibility of selecting the same parcel of land by multiple targeting tools is influenced by the correlation between the environmental benefits and opportunity cost of land, or in some instances, by the similarities between the targeting tools. Comparing all targeting scenarios, the benefit targeting and combined targeting method tended to select land from a greater range of land values, whereas cost targeting and benefit to cost targeting tended to secure land from a smaller range of assessment values.

In section 4.2, it was discussed that there was a distinct relationship between land use and land assessment values in the study area. The land that had relatively low assessed value was often characterized by greater areas of native cover types. Therefore, the land with low assessed value often had greater potential for providing habitats for wildlife. As a result, there was a negative correlation between the assessment value and habitat benefits in the study area. As discussed in Babcock et al. (1997) when benefits and costs are negatively correlated those parcels that can provide the greatest environmental benefits are the parcels with the lowest cost of enrollment. Babcock et al. (1997) showed that when costs and benefits are negatively correlated, all three targeting schemes (benefit targeting, cost targeting and benefit cost targeting) would purchase the same land area. In this study, although there was an apparent negative correlation between the amount of natural vegetation on the land and the assessment value of the land, the results of three targeting methods adopted under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach were somewhat different due to the approach used to identify benefits. For the Quarter Section Focus Approach, the percentage of identified habitat in a quarter section (habitat land ratio) was used to measure the benefits. Although there was a negative correlation between the amount of natural cover and land assessment value, there was no such correlation between the amount of wetland habitat area and assessment values. Therefore, the three targeting mechanisms have selected different land parcels with few overlaps.

In the Specific Habitat Focus Approach, the area of natural cover in the wetland buffer area was taken as an indicator of higher environmental benefits. When considering the benefits, the buffers with more natural habitats were associated with the quarter sections containing more natural cover that have low assessed value. As a result, there was a strong negative correlation between the benefits and cost as identified. Due to the presence of negative correlation between the amount of natural cover and land assessment value all three targeting method and the combined method secured the same parcels of land, to a large extent. It is also evident that the nature of land selection approach also influenced the relatively similar pattern of land securement demonstrated by the results.

In the Habitat and Quarter Section Approach, the selection of habitats was similar to Specific Habitat Focus Approach. However, rather than securing habitat buffers, the full quarter sections were secured by the former approach. As described earlier, in the Specific Habitat Focus Approach the buffers with more natural habitats were located within the quarter sections containing more natural cover. Also, those quarter sections generally had relatively low assessment values. Therefore, while there was a strong negative correlation between the benefits and cost in some land parcels, the budget was not sufficient to purchase more wetland buffers as the approach secured full quarter sections. Therefore, the results of the three targeting methods were not very similar. The land selection procedure in the Quarter Section Focus and Habitat and Surrounding Quarter Section Approaches tended to mask the correlation effects resulting in results not being generally consistent with the patterns suggested by the conceptual framework presented in Chapter 2.

4.7 Administration Cost Comparison

In this section an estimated value of administration cost for the one-time purchase program and a long-term lease program is presented. This will be followed by a brief discussion of the potential advantages of the features of the specific programs and the variations of administrative cost with regard to targeting scenarios.

According to (Heimlich, 2005), there would be a contrast between the establishment and ongoing cost of long term easements, like the Wetland Reserve Program (WRP), where the technical assistance cost in initial years has been estimated to be approximately US $106.93 /acre as compared to US $93.38 /acre in later years. As explained by the author, the technical assistance needed for land retirement occur in the first year or two to get conservation cover established, but payments go on for a period of years. As a result, the cost of technical assistance would be higher in the first few years. In contrast, the average administration cost of the Green Cover Program of Canada was estimated to be $2.08 /ha/Year (Olewiler, 2004). Applied to the present research 3,269.64 ha of land were enrolled under benefit targeting in the Quarter Section Focus Approach for long term lease program. Based on this administration cost provided by Olewiler (2004) a rough estimate of the administration cost for this program would be approximately $197,224 for the entire period of the lease program. This is the cost above and beyond the payment to the landowner to set aside the specific parcel of land, and represents a very rough estimate and is reported only to provide some insight into the overall costs of such a program.

According to Heimlich (2005), the administration cost for land retirement programs in U.S has been estimated to be between 5 to 10% of the expenditures from rental or easement and cover establishment cost sharing. In the simulations I developed approximately $1,470,800 was spent on land purchase under the benefit targeting in the Quarter Section Focus Approach. Based on the Heimlich (2005) administrative cost estimates, the approximate administration cost for the purchase program would range from approximately $75,000/year to almost $200,000/year.

The two land payment programs in the present research, namely “one time purchase program” and “long term lease program”, have unique characteristics that influence administrative cost. In the “one time purchase program,” the government has to bear the administration cost upfront when the land title is legally transferred. In contrast, for the lease program only lease contracts need to be established which may be less costly contracts to establish. The cost targeting method may incur lower per acre administration cost compared to other targeting method as the cost targeting method tend to target more hectares resulting in a lower per hectare administrative cost. The Quarter Section Focus Approach and the Habitat and Surrounding Quarter Section Approach enrolled larger areas thereby reducing the number of contracts to be established and hence would decrease the administrative cost at the per hectare level. In this study, under the Specific Habitat Focus Approach, smaller habitat patches were enrolled into the program compared to the larger parcels in the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach. Then the number of contracts needed to be processed would be increased and therefore the administration cost of the Specific Habitat Focus Approach would be greater than that of the other two land selection frame works.

The literature shows that administration costs for targeted programs are higher than for non-targeted programs but it is argued that the environmental benefits from targeted programs can be far greater compared to non-targeted land retirement (Heimlich, 2005). Therefore, it is important to identify the trade-off between these benefits and costs associated with the delivery of targeted and non-targeted agri-environmental program. The above discussion showed how the different aspects of targeting scenarios adopted can influence administrative cost of the program. In this study, the identification of suitable land for the policy (targeting of land) has been done using GIS. Also standardized rental rates calculated based on assessment values has been used for the long term lease program. Therefore the adoption of targeting has been done with an objective of incurring lower administration costs.

4.8 Summary

This chapter evaluated the effect of different agri-environmental targeting scenarios on the provision of habitat for wildlife. The influence of different targeting methods on program delivery and environmental outcome with respect to the program cost was analysed. When all targeting scenarios are considered, the targeting scenarios could increase the environmental benefits of enrolled land (more wetland and natural vegetative cover) compared to the baseline landscape which is assumed in this research to be equivalent to non-targeted policy delivery. When all targeting scenarios are considered, the cost targeting method secured more land area. Due to the negative correlation between the presence of natural vegetation and assessed values of land, the land parcels enrolled by cost targeting tend to contain more natural area. When compared to cost targeting, benefit targeting captured land with more wetland area. Therefore, the targeting methods employed in the study not only had an influence on the area that was secured, it also had an influence on the quality of land that was secured (Figure 4.19). Therefore, the targeting methods applied made the difference in the results. When the policy objective is to secure more area, the program could use a targeting scenario that applied cost targeting under the Quarter Section Focus Approach (QSFA) and the Habitat and Surrounding Quarter Section Focus(HSQS). In contrast, when the objective is to secure good quality habitat, for wetland dependent species for example, the policy can be implemented using a targeting scenario that applied benefit targeting and benefit-cost targeting under Specific Habitat Focus Approach (SHFA) such as those that are located in the middle to lower region of Figure 4.19. The next chapter will discuss the conclusions that can be derived from the study in detail.

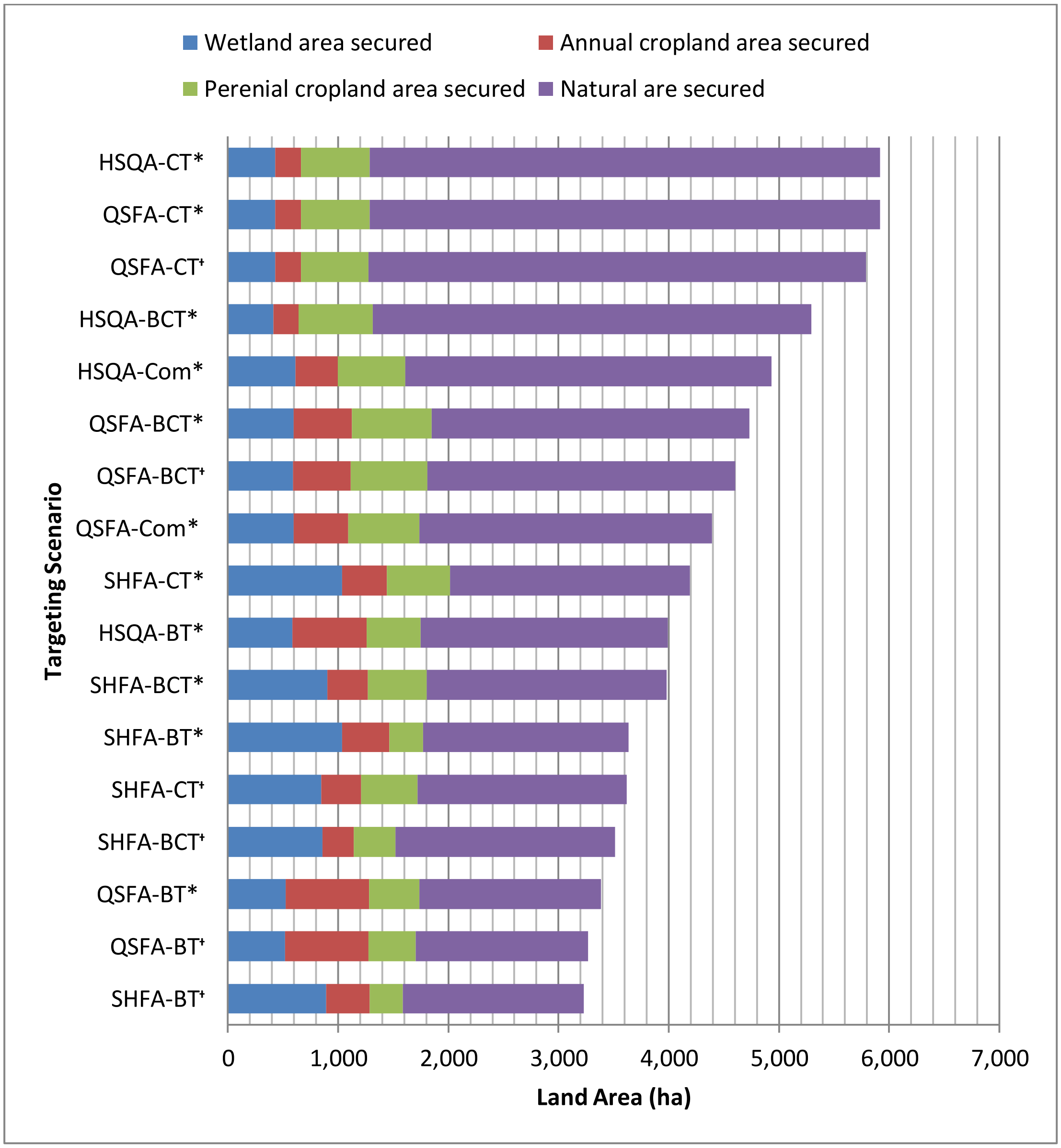


Figure 4.19 Ranking of targeting scenarios based on amount of land secured

*One-time purchase program

ᵻ Long-term lease program

CHAPTER 5 SUMMARY AND CONCLUSION

5.1 Introduction

The purpose of this chapter is to review the major findings from the results section of the thesis. First, the key results from the policy targeting analysis will be reviewed. This will be followed by the policy implication from the research study. The chapter concludes with the study limitations and recommendations for future research.

5.2 Summary

There has been a significant development of agri-environmental programs in North America. However, the literature explored in Chapter 2 highlighted that these programs have not been specifically targeted towards certain environmental and/or economic characteristics that may increase environmental benefits of the program or reduce the cost of the program. As an example, initial CRP enrolled land with low rental rates and was not able to maximize erosion reduction per acre that could have been achieved with given budget (Riboudo,1986; Reichelderfer and Boggess,1998). The CREP selected land on the basis of geographical location without specifying any mechanism to select eligible land and therefore have not guaranteed the cost effectiveness of the program (Young et al., 2004). Many authors argue that incorporating targeting mechanisms in the design of policy instruments can increase the efficiency of such program (Ribaudo et al., 1989; Carpentier et al., 1998; Wossink et al., 1999; Khanna et al., 2003). In the literature there are studies that show the importance of the policy targeting in order to improve the efficiency of environmental programs. Canadian environmental programs, such as the Farm Stewardship Program use policy targeting at a limited level. The Geographical Information System (GIS) is a tool which can be used to analyze spatial data and it is able to support policy targeting exercises. Chapter 2 introduced a graphical model that provides a basic frame work to identify the land for different targeting policies and explain the differences in the results when there is positive or negative correlation between environmental benefits and opportunity cost.

Chapter 3 described the methods used in the study focused on investigating the influence of the targeting mechanisms on the delivery of agri-environmental policy that has an objective of maintaining or increasing wildlife habitat within an agricultural landscape. A GIS data base was assembled to represent the agricultural landscape of the Redberry RM study area. To illustrate the efficiency gains from the policy targeting, three land selection approaches where developed to address wildlife conservation and these were incorporated with different targeting protocols. The three approaches are Quarter Section Focus Approach, Specific Habitat Focus Approach and Habitat and Surrounding Quarter Section Method. The study applied the three major targeting methods (cost targeting, benefit targeting and benefit cost targeting) introduced by Babcock et al. (1997). In addition, a combined method was developed which represented a hybrid approach combining benefit targeting and cost targeting to evaluate how to secure habitats with greater connectivity. These policy delivery approaches were developed in a way that could be applied in actual agri-environment landscapes. Both one-time purchase method and long term lease method has been analysed representing common land set aside policies in North America.

In Chapter 4 the wildlife habitat outcomes were reviewed and the relative performance of targeted policy approaches were assessed relative to non-targeted delivery. The results showed that compared to the baseline landscape all targeting methods under different land selection approaches were able to secure land with greater habitat benefits. As an example wetlands represented only 2% of the study landscape while cropland represented 50% of the land allocation in the base line landscape while the policy delivery selectively enrolled more wetlands and less cropland in all targeting scenarios. This reflects that targeting of agri-environmental policy can improve the environmental benefits obtained from a fixed policy delivery budget.

The comparison between land selection approaches enabled the following insights to be developed. To enable the implementation of the targeting tools, the wetlands and 100m buffer area were selected within the study landscape. Therefore the selection of land has been done from the lands that have good habitat quality. The Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach secured more land when compared to the Specific Habitat Approach. As the Specific Habitat Focus Approach selected the wetland habitats, as opposed to securing whole quarter sections in the other two approaches, there was less chance of selecting larger areas of lands with relatively low assessment values. The Specific Habitat Focus Approach secured land parcels by identifying wetland habitats which secured more parcels of land that were scattered throughout the study area. However, the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach secured more land in order to capture the wetland habitats. Some parcels secured by cost targeting under the above two land selection approaches did not contain any wetlands. For example, 31 out of 107 (29%) quarter sections that were selected by cost targeting under the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach did not contain any wetland habitats. Due to the specific delineation of habitat components the secured land parcels from all three targeting methods showed expected land cover composition for wetland habitats. As an example there were 23% to 29% wetland area and 51% to 55% natural area in the land enrolled by three targeting methods under Specific Habitat Focus Approach compared to 2% of wetland and 31% of native cover in the baseline landscape. Therefore, given the limited budget, the Specific Habitat Focus Approach was able to secure land that had land cover characteristics that would provide greater habitat quality for an agri-environmental policy with objective of maintaining or increasing wildlife habitat for wetland dependent species. On the other hand the Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach secured greater area under the given budget compared to Specific Habitat Approach.

When comparing the three targeting methods plus the combined method using the different land selection approaches the following findings can be summarized. As expected, cost targeting was shown to secure more land compared to other two targeting methods, as the cost targeting method captured land that had relatively low assessment rates. For example, 5,919 ha were secured by the cost targeting compared to 3,386 ha secured by benefit targeting under the Quarter Section Focus Approach. However, the cost targeting method, under Quarter Section Focus Approach and the Habitat and Surrounding Quarter Section Approach secured lands that contained less wetland area compared to benefit targeting and benefit-cost targeting and combined method. However, benefit targeting was able to capture more wetland habitats than cost targeting. For example, 7% of the enrolled land had wetland area under cost targeting compared to 16% wetland area in the land enrolled by benefit targeting under Quarter Section Focus Approach. However, due to the correlation effect between the amount of natural vegetation and the assessment value, cost targeting secured parcels with more natural area compared to the other targeting methods under the Quarter Section Focus and Habitat and Surrounding Quarter Section Approach. For example, 78% of enrolled land was natural area under cost targeting compared to 49% natural area under benefit targeting for the Quarter Section Focus Approach. The benefit-cost method secured more wetlands compared to cost targeting and more natural area compared to benefit targeting in both Quarter Section Focus and Habitat and Surrounding Quarter Section Approach.

Due to the design of land selection in the Specific Habitat Focus Approach and the negative correlation between the presence of natural vegetation and the assessment value of land all three targeting methods performed relatively similarly. The combined method developed in the study was able to secure parcels of land which are contiguous and as a result have the potential to provide desirable habitat for wetland dependent species..

When comparing land selected by the three targeting methods under a given land selection approach, the variation in assessment values shows the expected pattern. The benefit targeting selected land based on the identified habitat benefits without considering the cost of land, and hence contained a wide range of assessment values. In comparison, cost targeting secured land from a narrow range of assessment values as the cost targeting is focused on land with low assessment values. Benefit-cost targeting and the combined method selected relatively low valued land parcels that also provide some level of wildlife habitat resulting in a range of land assessment values that a range between the benefit targeting and cost targeting methods. In the analysis of the land selection overlap by the three targeting methods, certain land parcels were selected by multiple policy delivery approaches suggesting that different targeting tools will secure the same parcels of land.

There were greater levels of land selection overlap in benefit targeting and benefit- cost targeting under the Quarter Section Approach. For example, 74% of the area that was secured by benefit targeting was also selected by the benefit-cost targeting method. There was also significant overlap in land securement under benefit-cost targeting and cost targeting under the Habitat Focus Approach. For example, 91% of the land selected under the benefit-cost targeting method was also selected under cost targeting. There was also approximately a 70% overlap of the benefit targeting and combined method under Habitat and Surrounding Quarter Section Approach. In contrast, only 18% and 25% of the low cost land that was selected under the cost targeting was also selected under the benefit targeting under Quarter Section Focus Approach and Habitat and Surrounding Quarter Section Approach respectively. However, 76% of the land selected under the benefit targeting was also selected under the cost targeting in the Specific Habitat Focus Approach. The possibility of selecting the same parcel of land by multiple targeting tools was driven by the correlation between the environmental benefits and opportunity cost of land, or in some occasions by the similarities between the targeting tools.

Targeting theory has shown that when costs and environmental benefits of land are negatively correlated the three targeting schemes target the same land parcels. Within the Redberry Lake RM study area land cost and the habitat benefits are negatively correlated however the results of the targeting methods show varying levels of overlap due to a few characteristics. In the Quarter Section Focus Approach the benefits are measured by the amount of identified habitat in a quarter section, which focused on wetland habitat. While the amount of natural cover and land assessment value are correlated, there was not a strong correlation between the amount of wetland habitat area and assessment values. Therefore, the results of three targeting methods in this study are somewhat different. In the Specific Habitat Focus Approach, due to the negative correlation between the amount of natural vegetation and the assessment value of the wetland buffers, all three targeting methods secured largely the same parcels of land. The nature of the land selection approach also influenced the similarity of the results to some extent. In the Habitat and Quarter Section Approach while focusing on securing habitat buffers the full quarter sections were secured. In this case, although there is a correlation between the benefits and cost the budget is spent to capture full quarter sections to secure identified wetland. Therefore, different targeting tools captured different land parcels and ultimately the results of the three targeting methods are not similar. Put simply, the identification of benefits is different in the Quarter Section Focus and Habitat and Surrounding Quarter Section selection approaches; thereby the correlation between the assessment value and the extent of natural vegetative cover has not led to similar results. Only the Specific Habitat Focus Approach was able to show the expected results predicted by the conceptual framework.

When considering the administrative cost of different land selection approaches, since the Specific Habitat Focus Approach secured higher number of parcels compared to the other land selection approaches the number of contracts needed to be processed would be high. Therefore the administration cost of the program would be greater than other two land selection frameworks. According to the literature, the administration costs for targeted programs are higher than for non-targeted programs but it is argued that the environmental benefits from targeted programs are greater (Heimlich, 2005). In the current study, the targeting of suitable land for the wildlife policy was done using GIS using models that can be adopted with relatively modest effort thereby having the capacity to decrease program administration cost.

5.3 Policy Implications

When program budgets are limited, targeting of resources has the potential to yield greater environmental benefits. The selection of the proper targeting tool is important for policy efficiency. As suggested by the study any targeting method could increase the environmental benefits over what could have been achieved in a non-targeted policy situation (base line). As shown by the current research, cost targeting can secure more land compared to the other two targeting methods given a fixed budget. However, due to the fact that the cost targeting method captures low assessed land without considering the environmental benefits it could capture lesser quality land with respect to the environmental benefits. Compared to the cost targeting, benefit targeting is able to capture more environmental benefits using the same policy budget. Also, the consideration of cost and benefits at the same time (benefit-cost targeting) also could result in higher environmental benefits compared to cost targeting method and more land area compared to benefit targeting.

The selection of the targeting method should be done considering the correlation between the environmental benefits and costs of delivery of these benefits, when there is positive correlation between the benefits and costs. However, as informed by the study, the identification of benefits and cost in designing a policy is more important to get greater effectiveness in policy targeting. The combination of targeting methods as developed in the combined method can be used to capture parcels of land that are closely connected and have greater habitat quality. Also securing lands as larger areas (Quarter Section Focus Approach and Habitat and Quarter Section Approach) may provide certain benefits as compared to securing land scattered through an area as this would also save the administrative cost of the conservation program.

5.4 Limitations of the study

The analysis presented in this thesis was based on results in an actual agri-environment landscape and this is one of the few studies done investigating the effect of targeting in an agricultural landscape. Due to budgetary limitations, this study was done only for the Redberry RM. If the analysis could have expanded to the Redberry Watershed, which is a more natural boundary for the region, the results would represent landscape patterns and economic characteristics of a larger watershed. There are a total of 5 RMs in the Redberry Biosphere reserve including Blaine Lake (RM 434), Douglas (RM 436), Great Bend (RM 405), Mayfield (RM 406) and Meeting Lake (RM 466). These RMs have different land cover compositions and land assessment values. If the study was completed done in another RM, the results should have been compared with the results of the current study.

The usage of GIS data applied in the present study is primarily limited to land cover with a policy focusing on improving or conserving habitats for wetland dependent species. Applying more specific or a broader range of GIS data would enable a more complete description of the biophysical characteristic of the study area including the suitability of habitats for a particular species or benefits of land could have been measured more specifically. Therefore, the study could have focused on increasing or preserving habitats for a particular species. Then the results of the current policy could be used to redirect the habitat conservation policy which is focusing on a particular species, to use targeting approaches.

For the cost side, only the opportunity cost as expressed by the assessment value was used. The land assessment value from SAMA was estimated based on the productivity for agricultural commodities. The opportunity cost of land is also influenced by other socio-economic factors. For example, the opportunity cost of land that is situated closer to transportation corridors such as a railway would be higher as the transportation of agricultural produce is less expensive compared to a land parcel that is far from the rail track. In addition, the assessment values could not reflect the value of land for other uses such as recreational use or other natural resource use such as gravel extraction or oil and gas development. As the study was confined to a relatively small geographical area it was not possible to incorporate those impacts on land price. If the study was completed for a larger area, the location effects on land price could be incorporated.

As discussed earlier, although research has shown that the environmental benefits from targeted programs can be greater compared to non-targeted programs, the administration costs for targeted programs are higher than for non-targeted programs. Therefore it is useful to calculate the administrative costs associated with the delivery of targeted policy. There were not enough data to effectively estimate the administrative cost of the implementation of agri-environmental policy in the current research. If there were available data for administrative cost of an agri- environmental program for the study area a more complete analysis of the relative costs and trade-offs of the different targeting approaches could have been developed.

5.5 Further Research

There are many opportunities for future research on the targeting of agri- environmental policies. The correlation between benefits and cost of land is highly variable across different geographical locations. As discussed in Chapter 2, the extent to which the targeting schemes resulted in different outcomes depends upon the type of correlation between the environmental benefits and costs of land parcels. Therefore, similar targeting schemes could be replicated in three geographical areas in the presence of different types of correlation between environmental benefits and opportunity cost of land: 1) presence of significant positive correlation, 2) presence of significant negative correlation and 3) absence of any significant correlation. Based on this analysis a more complete understanding of the effect of correlation on policy targeting could be gained.

According to the literature the different targeting tools can result in very different outcomes in terms of the cost and benefit characteristics of the land selected. Therefore the same targeting tools can be implemented in different geographical locations in order to observe the outcome of policy targeting in different landscapes. Then the outcome of targeting tools in actual agricultural landscapes could be better understood.

Some geographical areas can have more data to represent the potential wildlife benefits provided by the landscape. Integrating this information with land cover data, and other types of information, would enable an analysis to more specifically evaluate the performance of policy aimed as particular species or groups of species. This type of study would be better able to demonstrate the outcome from the different targeting mechanisms on particular wildlife conservation policy.

Although policy targeting improves the benefits from a limited budget of the environment program that also incur higher administration cost compared to non-targeted policy. Therefore, it is important to understand the benefit-cost trade off from the policy targeting. The administration costs of implementing a similar targeting policy should be studied in detail enabling understanding the environmental benefits that can be achieved by a dollar spent in a policy targeting compared non-targeting.

Finally, the study analysed a land set-aside policy, but in Canada there are other policies which provide land owners, for example, a cost share incentive payment. As discussed in the Literature Chapter, the Canadian Farm Stewardship Program provides cost share incentive payments for land owners to adopt BMPs on their lands. The lands that can produce higher environmental benefits are captured by the EFP and AEGP process and represent a type of targeting mechanism. However, any estimation of the environmental benefits relative to the cost of the program was not found in literature. Therefore a study which could be completed showing how a targeting approach used in a program like the Canadian Farm Stewardship Program could increase the environmental benefits for a given budget compared to non-targeted policy.

WORKS CITED

Agriculture and Agri-Food Canada (AAFC).(NDa). Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series - Report No. 3.Water Quality. http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1296058294687&lang=eng, Reviewed: August 2012

Agriculture and Agri-Food Canada (AAFC). (NDb). Prairie Shelterbelt Program. http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1286907236630&lang=eng Reviewed: August 2012

Agriculture and Agri-Food Canada (AAFC). (NDc). Environmental programs. http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1256652100794&lang=eng Reviewed: October 2012

Agriculture and Agri-Food Canada (AAFC). (NDd). Agricultural Policy Framework. Agriculture and Agri-Food Canada: http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1200339470715&lang=eng
Reviewed: October 2012

Babcock, B.A., P.G. Lakshminarayan, JunJie Wu and D. Zilberman. (1996). The Economics of a Public Fund for Enviornmental Amentities: A Study of CRP Contrcacts. *American Journal of Agricultural Economics.*78:961-71.

Babcock, B.A., P.G. Laksminarayan, J Wu and D. Zilberman. (1997). Targeting tools for the purchasing of environmental amenities. *Land Economics.* 73(3):325-339.

Bangsund, D.A., L.Leistritz and N.M.Hodur. (2002). Rural Economic Effects of the Conservation Reserve Program in North Dakota. Agribusiness and Applied Economics Report No.497-S.

Barbour, P.J (2006). Ecological and economic effects of field boarders in raw crop agriculture production systems in Mississippi. Dissertation, Mississippi State University, Starkville, USA.

Bitton, G. (2005). Microbial Indicators of Fecal Contamination: Application for Microbial Source Tracking. University of Florida. Gainesville.

Burger, L.W.Jr., W.D. McKenzie, R. Thackston, and S. Demaso. (2006). The role of Farm Policy in achieving large scale conservation: bobwhite and buffers. *Wildlife Society Bulletin.* 34(4):986-993.

Burke, V.J. and J.W.Gibbons. (1995). Terrestrial Buffer Zones and Wetland Conservation: A Case Study of Freshwater Turtles in Carolina Bay. *Conservation Biology.* 9(6):1365-1369.

Carpentier, C.L., D.J. Bosch and S.S. Batie. (1998). Using spatial information to reduce costs of controlling agricultural nonpoint source pollution. *Agricultural Resource Economics Review.*27(1):72-84.

Cihacek, L.J. (1993). Selection Criteria for retention of CRP land in permanent cover. In Proceeding of the Great Plains Agricultural Council. Annual meeting, June 2-4, 1993. Rapid City. South Dakota, pp.41-88.

Cowardin,L.M.,V.Carter, F.C.Golet and E.T.LaRose.(1979). Classification of wetlands and deepwater habitats of the United States. U.S Department of the Interior, Fish and Wildlife Service, Northern Prairie Wildlife Research Centre. Jamestown,Washigton, D.C.

D'Arcy, B. and A. Frost. (2001).The role of the best management practices in alleviating water quality problem associated with diffuse pollution. *Science of the Total Environment*. 265:359-367.

Ducks Unlimited Canada. (2008). The impact of wetland loss. http://www.pcap-sk.org/docs/5_resandlit/Impact_of_Wetlands.pdf Reviewed: March,2012.

Eigenramm .M., L. Strappazzon, N.Landsdell, A.Ha, C.Beverly, J.Todd (2005).Eco tender: Auction for multiple environmental outcomes. National Action Plan for Salinity and Water Quality, national market base Instruments pilot program. Project final report. Department of Primary Industries.

Ely, R.T. and E.W. Morehouse. (1924). Elements of Land Economics. The Macmillan company. New York. 363 pp.

Ely, R.T. and G.S. Wehrwein. (1940). Land Economics. The Macmillan Company. New York.512pp.

Environment Canada (ND).Partners/Joint Ventures. http://www.nawmp.ca/eng/part2_e.html Reviewed: May,2013.

Environment Canada (2008). North American Waterfowl Management Plan (NAWMP) http://web.archive.org/web/20080529122203/http:/www.qc.ec.gc.ca/faune/sauvagine/html/nawmp.html Reviewed: May,2013.

Federal, Provincial and Territorial Governments of Canada. (2010). Canadian Biodiversity:Ecosystem Status and Trends 2010. Canadian Council of Resource Ministers. Ottawa. ON. vi+142 pp.

FlySask.ca. (ND). FlySask v2.0service, Saskatchewan Geospatial Imagery Collaberative (SGIC) Satellite or AirPhoto Imagery.

http://www.flysask.ca/
Reviewed: August 2011

GeoBase. (NDa). Municipal Boundries description.
http://www.geobase.ca/geobase/en/data/municipal boundries
Reviewed: August 2011

Geobase. (NDb). Land Cover description.
http://www.geobase.ca/geobase/en/data/landcover/csc2000v/description.html
Reviewed: August 2011.

Geobase. (NDc). Earth Observation for Sustainable Development (EOSD) project Legend Report.
http://www.geobase.ca/doc/specs/pdf/EOSD_legend_report-v2.pdf.
Reviewed: July 2012.

GeoSask. (ND). SaskGrid Township Fabric Map
https://www.geosask.ca/Portal/
Reviewed: July 2012.

Goudie, A.S. (2004). *Encyclopedia of Geomorphology, vol. 1.* Routledge, New York.

Gulka, S. (2009). The Process and Benefits of Agri-Enviornmental Group Planning. *Prairie Update,Saskatchewan Watershed Authority*. vol 40.page 1.

Harrington, J. (1938). The Natural Law of Rent. Reprinted from Land and Freedom, March-April 1938. http://www.cooperativeindividualism.org/harrington-john_natural-law-of-rent-1938.html
Reviewed: January 2013

Hecnar, S. (2004). Great Lakes wetlands as amphibian habitats: A review. *Aquatic Ecosystem Health and Management.* 7(2):289-303.

Heimlich, R.E. (2005). The Policy-Related transactions Costs of land Conservation in the United States: Evaluation Over Time and Comparison Between Programs. Reoprt:Workshop on Policy Related Transaction Costs,20-21 January 2005,OECD,Paris.

Hilliard, C. and S. Reedyk.(2002). Agricultural Best Management Practices, *Water Quality Matters*, Prairie Farm Rehabilitation Administration, Agriculture and Agri-Food Cananda.

Javorek, S.K. and M.C.Grant. (ND). Environmental Susutainability of Agriculture, Agri-ENvironmental Indicator Report Series-Report no 3, Wildlife habitat capacity on farmland, national coverage 1986-2006. http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1296055210770&lang=eng
Reviewed: August 2012

Joint Working Party on Agriculture and the Environmnet (JWP). (2004). Agriculture and the Environment : Lessons from a decade of OECD work, JWC.

Keipert, N., D. Weaver, R. Summers, M. Clarke, and S.Neville. (2008). Guiding BMP adoption to improve water quality in various estuarine ecosystems in Western Austaralia. *Water Science Technology.* 57:1749-1756.

Khanna, M., W.Yang, R.Farnsworth and H.Onal.(2003). Cost-effective targeting of land retirement to improve water quality with endogenous sediment deposition coefficients. *American Journal of Agricultural Economics*. 538-553.

Kulshreshtha, S. and E. Knopf. (2003). Benefits From Agriculture and Agri-Food Canada's Shelterbelt Program: Economic Valuation of Public and Private Goods. Agriculture and Agri-Food Canada, 198 pp.

Lakshminaraya, P.G., B.A.Babcock and R. Kellogg. (1996). CRP targeting for wildlife habitat: a new indicator using the 1992 national resource inventory.

Lawson, P. (2009). The Lowdown on Leasing Land. *Farming Ahead No.207* ,Kodinin Group.

Lee, J.T., N. Bailey and Thompson. (2002). Using Geographic Information Sysytem to identify and target sites for creation and restoration of native woodlands: a case study of Chiltern Hills, UK. *Journal of Environmental Management.* 64: 25-34.

Lower Souris Watershed. (ND). Lower Souris Agri-Environmnetal Group Plan.
www.lowersourisriverwatershed.com/files/AEGP_Info3.doc
Reviewed August,2011

Macfarlane, R. (1998). Implementing agri-environmental policy: a landscape ecology perspective. *Journal of Environmental Planning and Management.* 41(5):575-596.

McConnell, M.D (2011). Using Precision Agricultural Technology to evaluate environmental and economic tradeoffs of alternative CP-33 enrollments. Marster's Thesis. Department of Wildlife, Fisheries and Aquaculture, Missisippi State University, Missisippi.

Mitsch, W.J. and J.G.Gosselink. (1993). Wetlands. Van Nostrand Reinhold, New York. xii+722pp

Natural Resources Canada. (ND).
http://atlas.nrcan.gc.ca/site/english/learningresources/theme_modules/wetlands/index.html
Rreviewed August 2012

Neumann,B., M.Lutz, B.Schupbach and E. Szerencsits.(2009). Spatial modelling for the development of agri-environmental programs. *Regional Environmental Change.* 9:197-207.

Nikolakaki, P. (2004). A GIS site-selection process for habitat creation: estimating connectivity of habitat patches. *Landscape and Urban Planning.* 68:77-94.

Niskanen, W.A. (1998). Policy Analysis and Public Choice: Selected Papers. Northampton, US: Edward Elgar Publishing. 413 pp.

North American Waterfowl Management Plan, Plan Committee. (2004). North American Waterfowl Management Plan 2004. Implementation Framework: Strengthening the Biological Foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, 106 pp.

North American Bird Conservation Initiative Canada. (2012). The State of Canada's Birds 2012. Environment Canada, Ottawa, Canada, 36 pp.

Olewiler, N. (2004). Agricultural Case Studies. In The Value of Natural Capital in Settled Areas of Canada.Ducks Unlimited and Nature Conservancy. pp 36.

Provincial Council of Agriculture Development Board of Saskatchewan (PCAB).(NDa). Environmental Farm Plan (EFP) Overview. http://saskpcab.com/environmental-farm-plan/efoverview/ Reviewed August 17, 2012.

Provincial Council of Agriculture Development Board of Saskatchewan (PCAB).(NDb). Farm Stewardship Overview. http://saskpcab.com/farm-stewardship/overview/ Reviewed August 17, 2012.

Provincial Council of Agriculture Development Board of Saskatchewan (PCAB). (NDc). Watershead Awareness. http://saskpcab.com/watershed-awareness/ Reviewed August 17, 2012.

Provincial Council of Agriculture Development Board of Saskatchewan (PCAB).(NDd). Farm Stewardship Overview. http://saskpcab.com/environmental-farm-plan/efp-faq/ Reviewed August, 2011.

Polasky,S., J.D. Camm and B. Garber-Yonts.((2001). Selecting biological reserve and cost effectively: An application to terrestrial vertebrate conservation in Oregon. *Land Economics.*77(1):68-78.

Prairie Wild Consulting Co. (2010). Redberry Lake Biosphere Reserve Region, Draft Community Mapping Report. Prairie Wild Consulting Co, 39 pp.

Reichelderfer, K.H and W.G. Boggess. (1988). Government Decision Making and Program Performance:The Case of Conservation Reserve Program. *American Journal of Agricultural Economics.* 70: 1-11.

Reid, T.S. and D.D. Murphy . (1995). Providing a regional context for local conservation action:A natural community conservation plan for the southern California coastal sage scrub . *BioScience Supplement*. pp. 84-90.

Renne, R.R. (1946). Land Economics :Principals , problems and policies in utilizing land resources. Harper and brothers, New York. pp.736.

Ribaudo,M.O.(1986). Conservation of Off-site Impacts in Targeting Soil Conservation Programs. *Land Economics.* 62:402-11.

Ribaudo,M.O. (1989). Targeting the conservation reserve program to maximize water quality benefits. *Land Economics*, pp.320-332.

Roberge, J.M and P. Angelstam. (2004). Usefulness of the Umbrella Species concept as a Conservation Tool. *Conservation Biology.* 18(1):76-85.

Saskatchewan Assessment Management Agency (SAMA). (2006). Agricultural land review committee Final report and recommendations; recommendations for the 2009 agricultural land assessment model. SAMA.

Saskatchewan Assessment Management Agency (SAMA). (2007). Saskatchewan Assessment Manual 2006 Base year. http.//www.sama.sk.ca/sama/06manual/index1.html Reviewed: March 2012

Saskatchewan Assessment Management Agency (SAMA). (2011).

Saskatchewan ministry of Agriculture et al. (2011). Guide to the Canada-Saskatchewan Farm Stewardship Program (CSFSP) 2011-12.

Semlitsch, R.D. and J.R. Bodie. (2003). Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. *Conservation Biology.* 17(5):1219-1228.

Sharpley, A.N., P.J.A. Kleinman, and R. McDowell. (2001).Innovative Management of agricultural phosphorus to protect soil and water resources. *Communications in Soil Science and Plant Analysis.* 32:1071-1100.

Sharpley, A.N., B.Foy, and P.Withers. (2000). Practical and innovative measures for the control of agricultural phosphorus losses to water: An overview. *Journal of Environmental Quality*. 29:1-9.

Shoemaker, R. (1989). Agricultural Land Value and Rents under Conservation Reserve Program. *Land Ecoomics.* 65:131-35.

Soulard, F., M.S. Beaulieu and C. Fric. (2008). Agricultural Water Use in Canada, Statistics Canada.
http://www.statcan.gc.ca/pub/16-002-x/2008001/10541-eng.htm#fn1
Reviewed: February, 2013.

Statistic Canada. (2011). Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE
http://www.statcan.gc.ca
Reviewed: July,2012.

Statistics Canada. (2012). Redberry No. 435, Saskatchewan (Code 4716018) and Saskatchewan (Code 47) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE.
http://www.statcan.gc.ca
Reviewed: July,2012.

Statistics Canada. (2011). 2011 Farm and Farm Operation Data: Snapshot of Canadian Agriculture. http://www.statcan.gc.ca/pub/95-640-x/2012002/01-eng.htm.
Reviewed: February,2013.

Stoneham, G., V.Chaudhari, A.HA, L. Strappazzon (2003) auction for conservation contracts: an empirical examination of Victoria's Bush Tender trial. *Austrailian Journal of Agricultural and Resource Economics.* 47(4): 477-500.

Strang, M., Pannell, D., Roberts, A., Park, G., Alexander, J., and Marsh, S. (2010). Introduction to INFFER, INFFER Working Paper 1004, University of Western Australia, Perth.

U.S Fish and Wildlife Service (USFWS). (2002). 2001 national survey of fishing,hunting and wildlife –associated recreation:national overview. U.S Fish and Wildlife Service (USFWS),Washington,DC.

United States Fish and Wildlife Service (2009).North American Waterfowl Management Plan.
http://www.fws.gov/birdhabitat/NAWMP/index.shtm
Reviewed: May 24,2013.

U.S. Department of Agriculture (USDA). (1996). 1996 Farm Bill
http:/www.usda.gov/farmbill/index.htm.
Reviewed: June, 2012.

U.S. Department of Agriculture (USDA). (1999). Conservation Reserve program Sign-up 20, Environmental Benefit Index. Fact sheet, Farm Service Agency, September 1999.

U.S. Department of Agriculture (USDA). (2001).Agri-Environmental policy at the cross road: Guide posts on a changing landscape. Economic Research Service,Washington, DC.

U.S. Department of Agriculture (USDA).(2004a). Illinois Conservation Reserve Enhancement Program. Final Programmatic Environmental Assessment. USDA Farm Service Agency.

U.S. Department of Agriculture (USDA).(2004b). Nortice CRP-479 Practice CP-33, Habitat Buffers for Upland Birds.

U.S. Department of Agriculture (USDA). (NDa). Wetland Reserve Program. Natural resource conservation service. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands
Reviewed October, 2012.

U.S. Department of Agriculture (USDA). (NDb). Environmental Quality Incentives Program. Natural resource conservation service. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
Reviewed : October, 2012.

U.S. Department of Agriculture (USDA). (NDc). Wildlife Habitat Incentive Program. Natural resource conservation service. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/whip/
Reviewed: October, 2012.

Vaisey, J.S, T.W.Weins and R.J.Wettlaufer. (1996). The Permanent Cover Program-Is Twice Enough? Soil and Water Conservation Policies: Success and Failures. Prague, Czech Republic: Agriculture agri-Food Canada.

Way, P.L. (2007). Development of a functional widely accepted and adopted BMP program in response to government regulations. *American Journal of Potato Research.* 84:39-46.

Webstor, S. and M. Felton. (1993). Targeting for nature conservation in agricultural policy. *Land Use Policy.* 10(1):67-82.

Wetzel, R.G. (1990). Land-water interfaces: metabolic and limnological regulators. *International Association of Theoretical and Applied Limnology: negotiations.* 24 : 6-24.

Weiken, E., J. C. Mars, M. Padilla, H. Moore, and C. Latsch. (2003). The state of Canadian Wetlands. Background paper prepared for the national conference on Canadian wetlands.

Wilson G.A. (1996). Farmer environmental attitudes and ESA participation. *Geoforum. 27(2)*:115-131.

Wossink, J., J. van Wenum, C. Jurgens and G. de Snoo. (1999). Co-ordinating economic, behavioural and spatial aspects of wildlife preservation in agriculture. *European Review of Agricultural Economics.*26(4):443-460.

Wrubleski, D.A. and L.C.M.Ross. (2011). Aquatic Invertibrates of prairie wetlands:Community composition. Ecological roles and Impacts of Agriculture. *Arthropods of Canadian Grassland (Volume 2): Inhabitants of Changing landsape.* pp.91-116.

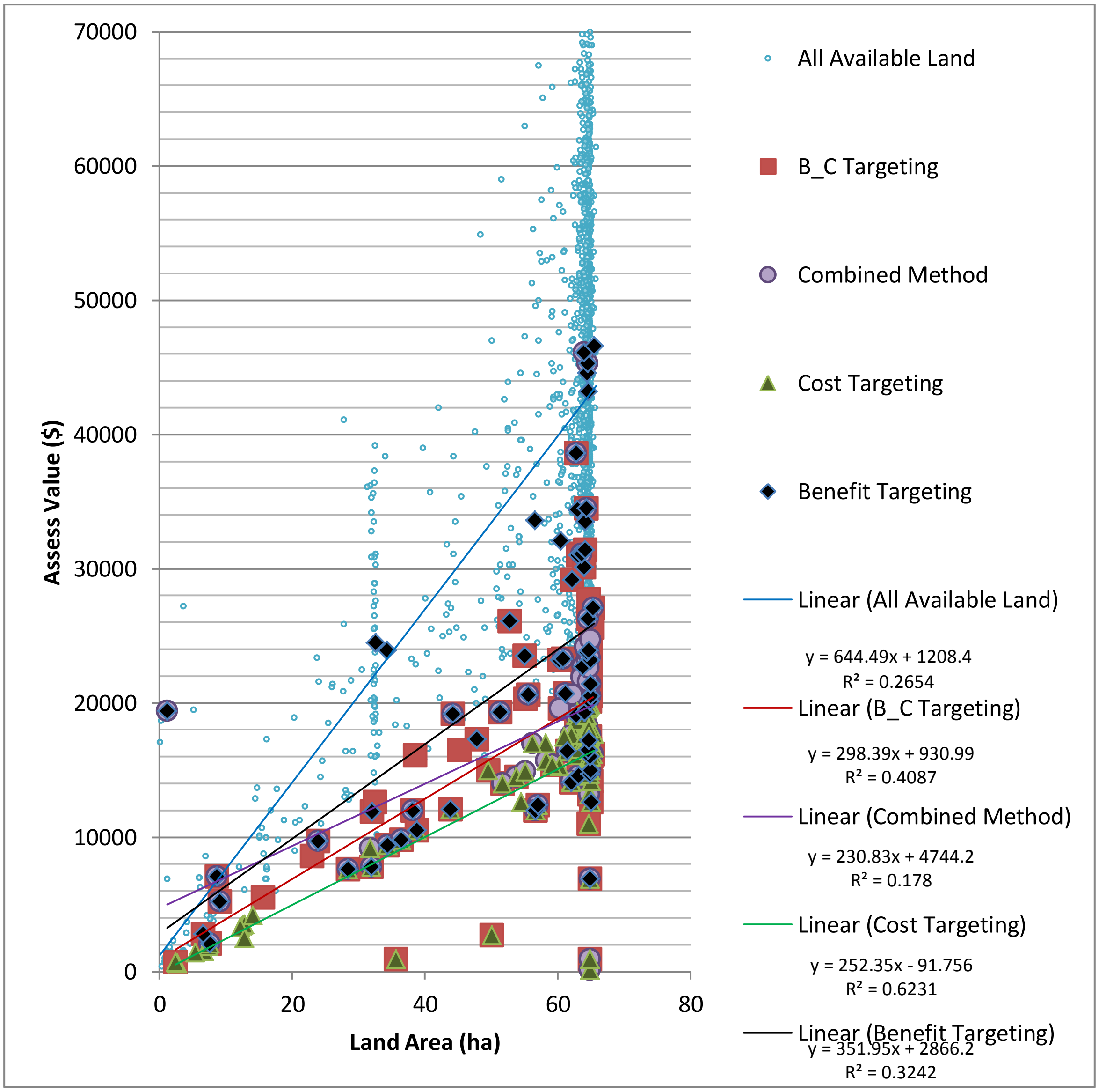
Wu. J., M.D. Ransom, M.D. Nellis, G.J. Kluitenberg, H.L., Seyler, and B.C. Rundiquist. (2002). Using GIS to Assess and manage the Conservation Reserve program in Finney Country, Kansas. *Photogrammetric Engineering and Remote Sencing.* 68(7):735-744.

Yang,W., M. Khanna, R. Farnsworth and H. Onal. (2004). Is geographical targeting cost effective? The case of the conservation reserve enhancement program in Illinois. *Review of Agricultural Economics*. pp. 70-88.

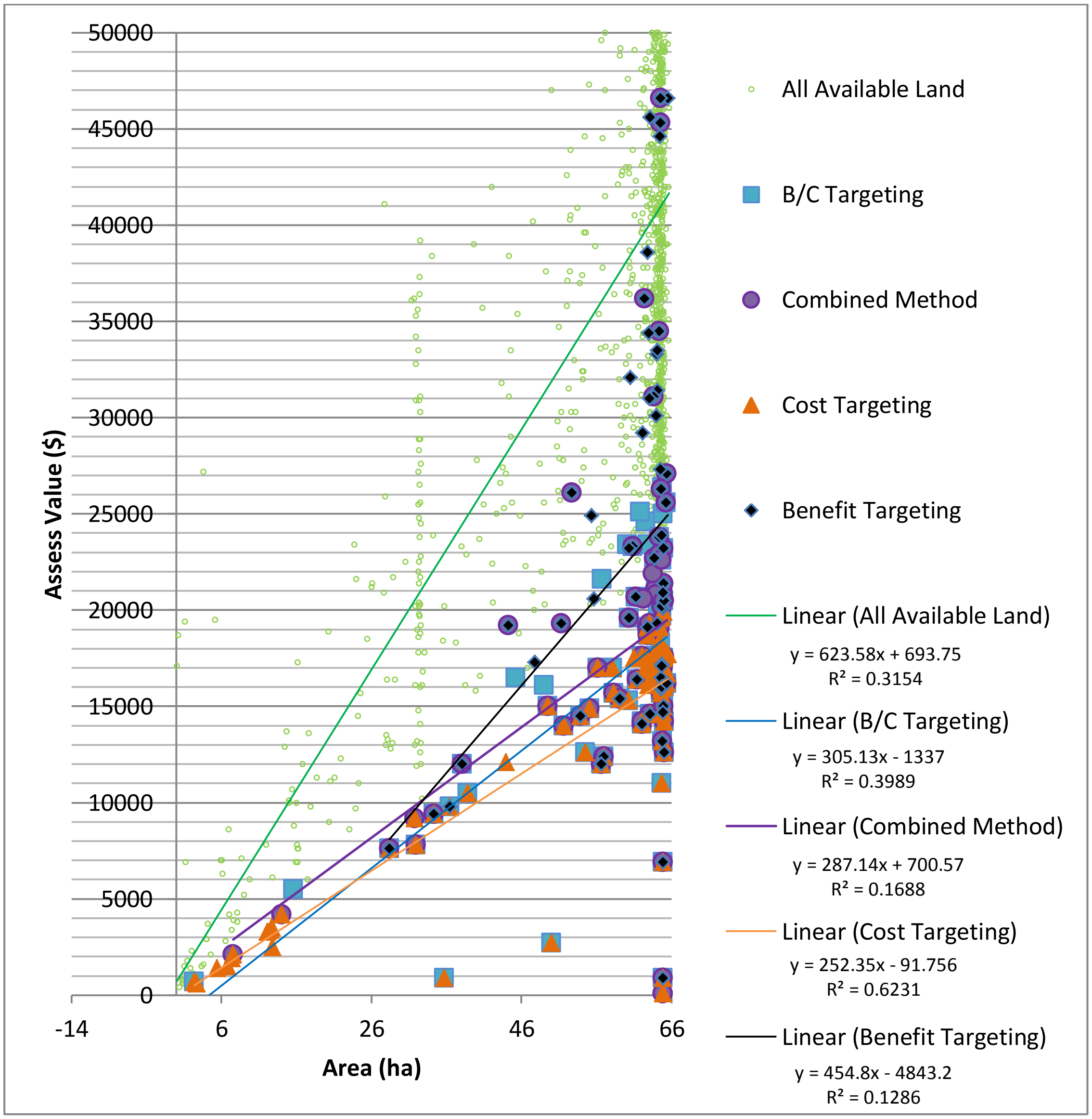
Yang,W., M. Khanna, and R. Farnsworth. (2005). Effectiveness of conservation programs in Illinois and gains from targeting. *American Journal of Agricultural Economics.*87(5):1248-1255.

Zeimen, M.B., K.A.Janssen, D.Sweeney, G.M. Pierzynski, K.R.Mankin, D.L.Devlin, D.L.Regehr, M.R. Langemeier, and K.A. McVay. (2006). Combining management practices to reduce sediment, nutrients, and herbicides in runoff. *Journal of Soil and Water Conservation.* 61:258-267.

APPENDIX A – Relationship between land assessed value and land area in secured parcels



Land assessment value ($/quarter section) plotted against land area (of quarter sections) within the Redberry RM showing land secured under targeting approaches under the Quarter Section land selection.



Land assessment value ($/habitat patch) plotted against land area (of quarter sections) within the Redberry RM showing land secured under targeting approaches under the habitat and surrounding quarter section focus land selection.