

A SPATIALLY-EXPLICIT ANALYSIS OF THE COSTS AND BENEFITS OF MANAGING AND CONSERVING WILD BIRD HABITS IN THE HELENA VALLEY

MONTANA



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1. Introduction

Conservation in all areas of the world is important to protect and preserve the natural ecosystem so human, animal, and plant life can thrive in the present and for many generations to come. Whether you are conserving one part of the system, or the entire ecosystem, it still has multiple effects on the environment and other forms of life. Montana has many different organizations that focus on conservation and how they can improve Montana and its communities. Specifically, an organization in Helena, The Last Chance Audubon Society (LCAS). LCAS focuses on wild bird conservation and each year they grant funds to Helena area projects for habitat protection, enhancement, and restoration. They are interested in people and organizations undertaking conservation projects in Helena and are advocates for the sport of bird watching.

The Last Chance Audubon Society in Helena came to Carroll College students to request a project that aligned closely with their organization's mission statement. "Promoting understanding, respect, and enjoyment of birds and the natural world through education, habitat protection, and environmental advocacy." With my interest in conservation and finding ways to preserve natural environments to their full potential, I designed a project that aligned with my interests and the LCAS mission statement. I will be analyzing the costs and benefits of conserving wild bird habitats in eight different areas in Helena. This analysis will be from the perspective of the community of Helena as a whole, including people and the environment. The policy decision is: conserving wild bird habitats is important to Helena, but only in select areas where it is practical, i.e. where the benefits outweigh the costs. The analysis would parcel out the Helena area and show where the benefits of conservation and management are higher than the costs (and places where the costs might exceed the benefits). The results of this analysis could be used by the LCAS to identify possible locations across the Helena Valley where conserving and managing habitats make the most sense—from an economics perspective.

This project is relevant to natural resource economics because it will be evaluating the natural resources and environment of the Helena area and calculating the costs and benefits of conservation in certain areas. Looking at birds specifically is important because they play a huge role in the ecosystem for plants, other animals, and humans. Natural resources and the

conservation of ecosystems go hand in hand together because if we don't protect our natural resources, then we won't have life.

This report is organized as follows. Section 2 discusses the history of Audubon societies and conservation in the United States. Section 3 discusses the study perspective, current standing, and alternatives. Section 4 includes the model framework for the cost and benefits and the assumptions that were made for the analysis. Section 5 goes into the details of the results and provides a sensitivity analysis for these results. Finally, section 6 concludes the report with some final thoughts.

2. Background

The history of Audubon societies is one based on a strong passion for birds. The National Audubon Society was created in memory of James Audubon, a naturalist and artist who documented 1,065 species of birds in the United States. It was founded by George Bird Grinnell in 1886 and primarily focuses on birds, but additionally protects other animals and their habitats. The National Audubon Society now has over 600,000 members and 500 chapters just in the U.S. The Last Chance Audubon Society was also founded on passion in 1971 by Vince Yannone, Sid Martin, Bob Cooney, and Virginia Bompert. They pledged to "organize field trips; to conduct a Christmas bird count; to educate the public on the need to protect wild birds, animals, trees and other plants and to promote a better public understanding of the inter-dependence of these natural resources" (LCAS website). Today, they have nearly 400 members and have stayed true to their original pledge. Audubon Societies depend mostly on fundraising and volunteers for their funding.

It is also important to discuss the history of conservation in the United States. Conservation was forever changed and became a bigger priority in 1901 when Theodore Roosevelt became president. John Muir is also a very important person at this time because he was known as the leading advocate for wilderness preservation. "Thousands of tired, nerve-shaken, over-civilized people are beginning to find out that going to the mountains is going home; that wildness is a necessity; and that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life" (John Muir, Our National Parks). During Roosevelt's presidency, he "creat[ed] the United States Forest Service (USFS) and establish[ed] 150 national forests, 51 federal bird reserves, 4 national game preserves, 5 national parks, and 18

national monuments by enabling the 1906 American Antiquities Act. During his presidency, Theodore Roosevelt protected approximately 230 million acres of public land” (National Park Service Website). If Roosevelt never became president, conservation may have come a lot later or not even exist at all, as many people saw our natural resources as never ending no matter how we treated them, and he pushed for them to be protected and valuable.

With the history of conservation and the United States’ future endeavors protecting wildlife and the environment, it is important that we keep moving forward to keep these places protected. However, this needs to be thought out strategically and in a way that is nonbiased. The goal of this analysis is to provide unbiased information on conservation of wild birds and their habitats because it is greatly underrepresented. With more and more natural land being industrialized and developed, the United States needs analyses that tell us exactly where conservation makes the most sense for the environment and for humans, because in reality you can’t start a conservation project anywhere. This analysis seeks to answer the question of: where do the benefits outweigh the costs in Helena for undertaking conservation projects for wild bird habitats?

3. Scope

Study perspectives and standing

This analysis is conducted from the perspective of the Helena community. It is important to take into consideration many different interests when conducting such an analysis. Developers, conservationists, and other members of the community all have a stake in conservation projects. From an environmental perspective, the vegetation, water, air, soil, and inhabiting animals all have an impact or are impacted by environmental decisions. While it may be hard to pinpoint every different group of people and ecosystem residing in the Helena area, this analysis does its best to represent all groups. It should also be noted that the project calculated the costs and benefits over the span of 10 years.

Alternatives

The Last Chance Audubon Society currently “grants funds to Helena area projects for habitat protection, enhancement or restoration. Funds for these community projects are raised through fund raising efforts including the LCAS Birdathon, November/December (Not a) Silent Auction, sale of birdseed and LCAS membership” (LCAS Website). Therefore, the status quo is not

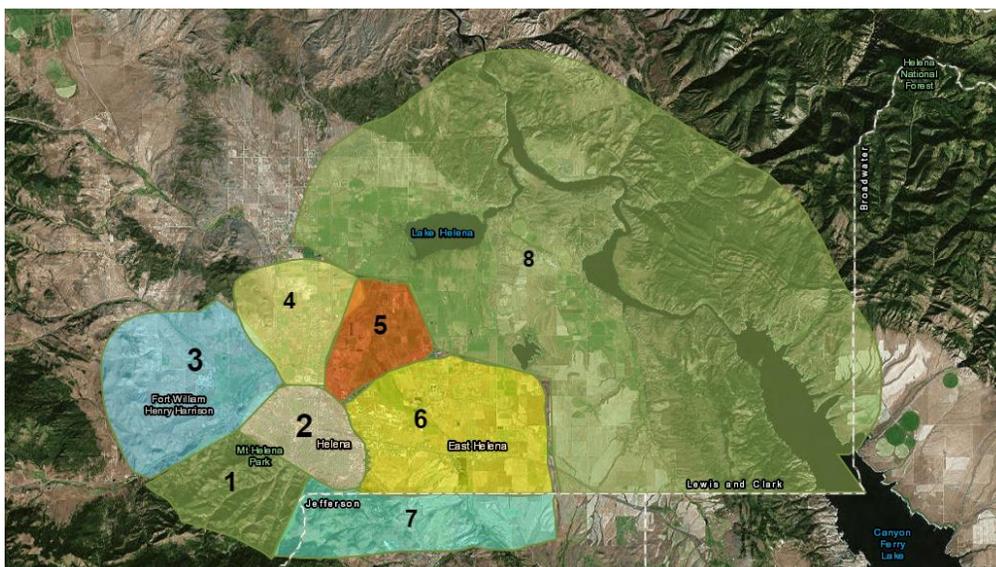
issuing a grant or conducting a conservation project. With this analysis, LCAS will have the option to now find specific areas in Helena that the benefits outweigh the costs of conducting a conservation project. They could potentially do their own projects or guide habitat grant applicants to these specific areas for future projects.

4. Model Framework

This analysis evaluates eight different areas in Helena and pinpoints the costs and the benefits of issuing a grant in each area. Thus, the final spatially explicit analysis details each area and provides a reasoning why a conservation project would or wouldn't be beneficial in that area, in the form of a GIS map and discussion. A general map of the designated regions is pictured below.

The modeling of costs for a conservation project are monetized into four different categories: (1) the cost of implementing a conservation project; (2) the time spent implementing the project as well as management for the many years after; (3) labor costs for construction and management workers; and (4) the opportunity cost of potential development in the area where a conservation project is chosen instead. These categories will be explained in detail in section 4.3- Modeling of costs.

The modeling of benefits for a conservation project are monetized into three different categories. (1) Existence and bequest value to humans; and (2) ecosystem services. These categories will be explained in detail in section 4.4- Modeling of benefits.



Division of Helena into subregions for this analysis

Key Assumptions

There are a few key assumptions that should be discussed for this analysis. Monetization of the costs and benefits are in 2019 dollars. Predictions for costs and benefits go out 10 years and are all discounted back to the 2019 dollar value and totaled where applicable, i.e. time and future management, labor, opportunity to develop, and all benefits. It is also assumed that the environment and industrial components of Helena are evaluated in their current state as of May 2019. The cost of labor and land are all calculated as if they were being purchased or utilized in 2019. The current estimated population in Helena is 31,429 people with 10,034 households, and this is the number used throughout this analysis when necessary. It is also assumed all costs are calculated per acre and they increase as the acreage increases. This is especially important for costs such as employees and facilities, because they increase with the acreage allowing for expanded facilities and more salaried employees to work on implementation and management of the area. Table 1 below provides a basic overview of the projected costs and benefits when deciding to pursue a conservation project.

Variable	Issue a Conservation Project Grant
Initial Costs	Cost
Time and Future Management	Cost
Labor	Cost
Opportunity for Development	Cost
Existence and Bequest Value	Benefit
Ecosystem Services	Benefit

Table 1: Cost/Benefit Categories Under Consideration

Data sources

For this analysis, a large amount of data was considered to have as much accuracy as possible. Although sources are cited throughout, there is a table provided in section 7, Data Source Appendix. This provides exactly where a source came from and what it was used for when inputting numbers into the equations discussed in the modeling of costs and benefits sections. It is also important to mention the difficulty of placing a monetary value on most of the benefits of conserving wild bird habitats; however, this analysis attempts to justify such a value. A list of formal references at the end of the analysis is also included for further reference.

Modeling of costs

Cost of implementing a conservation project

There are three major cost categories that are considered in the beginning stages of implementation of a conservation project. The cost of the land, facilities, and grants or gifts from outside organizations. The land cost was calculated by finding the costs of current land for sale in each of the eight subregions. An average per subregion was found and the price for land is different for each region. The costs included in facilities are recycled plastic benches, interpretive signs, trash cans, and a small painted and paved parking lot. The average grant amount awarded in the Helena area was calculated by averaging the grants the Last Chance Audubon Society has awarded over several years. Donation estimates from larger organizations were calculated by looking at the donations Northwestern Energy has made towards conservation projects. The equation used for this cost category is shown below.

$$\textit{Capital Cost} = \textit{Land Cost} + \textit{Facilities} - \textit{Grants and Donations}$$

Time and Future Management

Conservation projects are always ongoing even after the implementation of the project is completed. There are two main costs involved each year for a conservation site. Parking lot maintenance will need to be done once a year. This number was found from ProMatcher that found the average parking lot implementation and maintenance costs. The average dollar amount of maintenance was assumed to be an allotted amount each year per acre. Another cost to consider is stream restoration management if one is present on the land, but this will be discussed in the policy recommendation and is not considered for the original analysis. The basic formula used for this section below. Additionally, these costs are in the future after the project is implemented, and the discounting formula will need to be used to discount these costs to present values. The equation is also shown below. “r” represents the chosen discount rate and “n” represents time in years. The chosen discount rate is 4%. This formula is also used for all costs and benefits besides cost of implementation since the analysis looks at conservation projects for the next 10 years.

Time and Future Management Equations

1) *Time and Future Management = Parking lot maintenance + Management per year*

$$2) \text{ Net Present Value (NPV)} = \frac{\text{Future Value}}{(1 + r)^n}$$

Labor Costs

Non-profit organizations such as LCAS and PPLT rely heavily on community support in the form of volunteers. For this analysis it is assumed that the volunteers bring their own lunch and small snacks and beverages will be provided each day. An average salary for the paid staff was calculated by averaging the salaries for careers in environmental jobs that involve working towards conservation. It was assumed there were three full time staff members. For bigger projects, contractors are often hired to get the project done more efficiently, but for the analysis it is assumed no contractor is needed due to the small size of potential projects and the increasing number of volunteers and salaried employees per acre. The equation used for this cost category is shown below.

$$\text{Labor Costs} = \text{Volunteer Hospitality} + \text{Potential Contractors} + \text{Employee Salaries}$$

Opportunity cost of potential development in the area where a conservation project is chosen instead

When evaluating areas in Helena to implement a conservation project, the opportunity cost for development in that area needs to be taken into consideration. To find the opportunity cost the article, *Economic Benefits and Costs of Industrialization in Rural Texas Communities* was the primary source. They looked at the economic benefits to a rural community if it were expanded by industrialization. Their final calculation included the average net benefit from the School District, Municipal Government, and Private sectors of local rural communities. This was used as an opportunity cost for this analysis because if a conservation project is implemented Helena may be losing benefits from potential business and industry development to the city as a whole. This article is from 1976 and costs were inflated to 2019 dollars. All subregions were

calculated as if they could potentially be developed. The equation used for this cost category is shown below.

$$\text{Rate of Inflation} = \frac{CPI_{x+1} - CPI_x}{CPI_x}$$

$CPI_x = \text{Initial Consumer Price Index}$

Modeling of benefits

Existence and bequest value to humans

Existence and bequest values are very important to consider for conservation projects. The existence of places for Helena residents to bird watch and recreate are essential. The bequest value of future generations to be able to come to these areas is also important to people. However, it is very hard to put a dollar value to these things. To assign a dollar value to existence and bequest values, one article has been the main source so far: *Economic Aspects of Wilderness Valuation and Recreation Uses by Aboriginal Households: A Case Study of Prince Albert* by Kulshreshtha. He conducted surveys of non-aboriginal and aboriginal household's willingness to pay (WTP) for wilderness preservation. This includes many activities such as: viewing wildlife, walking, photography, hiking, camping, and many others which can be referenced in the article. He concluded that the annual WTP per household was \$61 for non-aboriginal and \$81 for aboriginal which was valued at \$100 per hectare in 1996. This price was inflated and then converted to acres. It was then corrected for the number of households in Helena to better estimate the WTP per all households per year per acre in the Helena area specifically. The equations used for this benefit category are below.

$$\text{Rate of Inflation} = \frac{CPI_{x+1} - CPI_x}{CPI_x}$$

$CPI_x = \text{Initial Consumer Price Index}$

$1 \text{ hectare} = 2.47105 \text{ acres}$

$\# \text{ of households in Helena} = 10,034$

Ecosystem Services

There are many ecosystem services that exist when conserving an area of the environment and they are benefits to humans and the environment. There are four broad categories of ecosystem services that will be evaluated: Provisioning, Regulating, Cultural, and Supporting services. Provisioning services are products that we get from ecosystems such as energy. Regulating services are benefits seen from ecosystem processes such as flood prevention and the control of pests. Cultural services are benefits that are nonmaterial such as education and recreation. Supporting services are the foundation of the ecosystem such as nutrient recycling and biodiversity maintenance (“Ecosystem Services”, n.d.). For this section a 2007 study is referenced: *Global Estimates of the Value of Ecosystems and their services in monetary units* conducted by Rudolf Groot and many others who are listed in the data appendix. They looked at all four ecosystem service categories and ten different biomes. For this analysis, only the Inland Wetland, Fresh Water (rivers/lakes), Woodlands, and Grasslands biomes were taken into consideration. The ecosystem service categories include the following. Provisioning services: food, water, raw materials, genetic, medicinal, and ornamental resources. Regulating services: air quality, climate, disturbance moderation, water flows, waste treatment, erosion prevention, nutrient cycling, pollination, and biological control. Supporting services: nursery and genetic diversity. Cultural services: esthetic information, recreation, inspiration, spiritual experience, and cognitive development. It should be noted that this study used international dollars per hectare per year in 2007. For this analysis, the price was inflated to 2019 dollars and converted to acres per day. The equation used for hectare to acre conversion is shown below.

$$1 \text{ hectare} = 2.47105 \text{ acres}$$

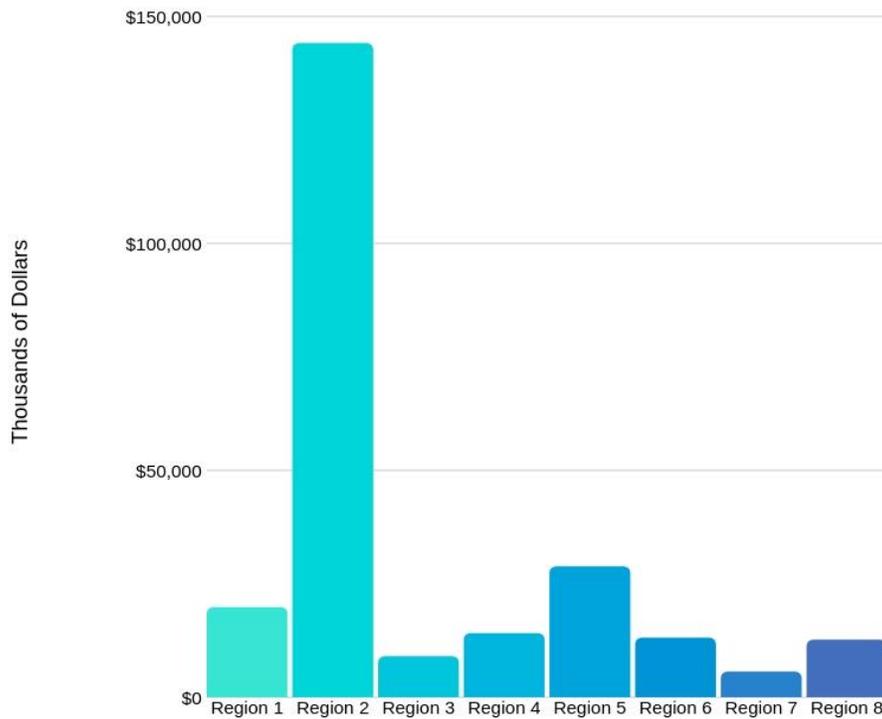
5. Results

Predicted Costs

A graph for total costs is shown below with labor and opportunity for development being the highest costs. Land price was excluded from this graph due to the variability of cost. The land cost is the average price of land per acre in each region respectively. A separate graph below shows the estimated cost per acre per region. Notice region two has a significantly higher cost per acre because most of the land available for purchase is development and subdivision lots. Facilities costs were estimated based on four park benches, two interpretive signs, and two trash

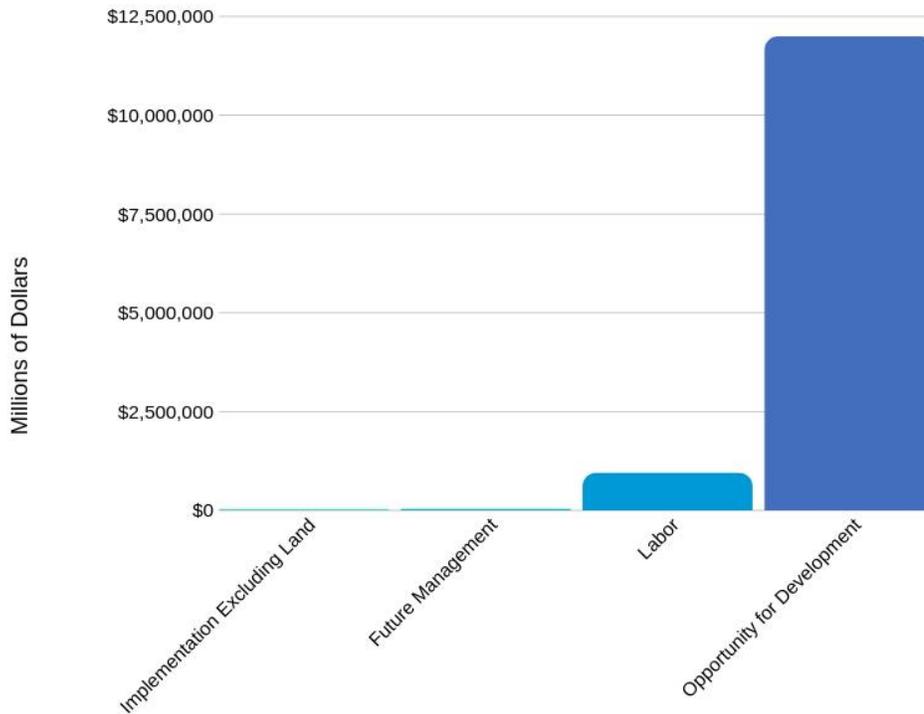
cans regardless of the size of the conservation area. The parking lot was calculated with 20 regular parking spots and two handicap accessible spots. Parking lot maintenance was calculated at four times per year. Allotted management cost per acre per year was assumed to be \$2,000 per year. Labor was calculated to be roughly \$98,933 for 2 employee salaries and \$4,000 for volunteers for 1 year. It was assumed that there are 40 days a year that volunteers do maintenance on the land and help with project implementation. The opportunity of development was estimated to be \$1,314,902 per year. All costs except implementation costs were projected over a 10-year time period, discounted to 2019, and added together. All prices change as the acreage increases as seen in table 4 labeled “Quantified Costs and Benefits Regarding Acreage of Proposed Conservation Area.” It should be mentioned that all costs are estimates and unexpected costs will most likely occur with a conservation project. These factors will be tested in the sensitivity analysis.

Acre Cost Per Region



Per acre cost of land per region

Total Costs Excluding Land



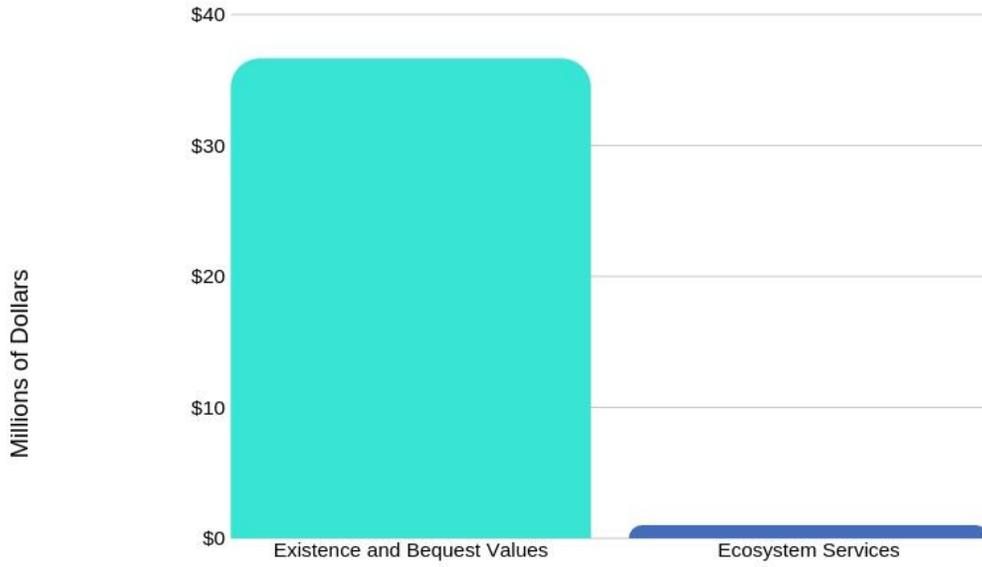
Total costs excluding land cost due to variability per acre

Predicted benefits

Below is a graph showing the total benefits for undergoing a conservation project. The details of each category were mentioned in the modeling of benefits section. The existence and bequest values were based off a study in Canada. Calculations were made per acre per household. This was then multiplied by the number of households in Montana to obtain the per year per acre designation. The total existence and bequest values for the Helena area over the next 10 years is \$36,600,358.25. Ecosystem services are based off the value provided from each conservation acre per year totaling \$944,335.69 over 10 years. Both Existence and bequest values and ecosystem services were calculated off a per year basis to keep consistency throughout the costs and benefits. Acreage was also adjusted for below in the “Quantified Costs

and Benefits Regarding Acreage of Proposed Conservation Area” table 4. The total benefits are estimated at \$37,544,694 and will also be tested in the sensitivity analysis.

Total Benefits



Total Benefits over 10 years

Policy Recommendation

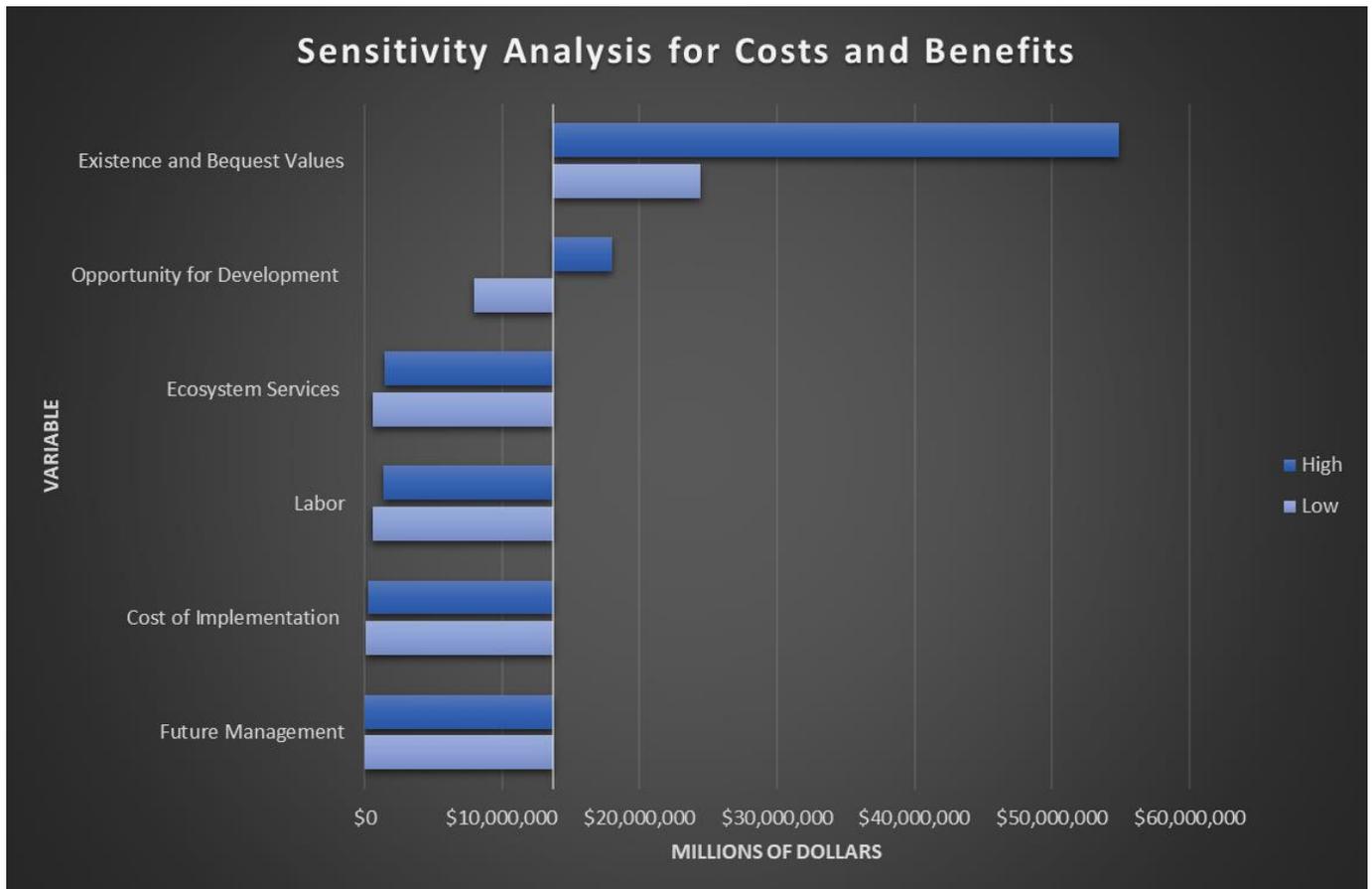
After calculating all estimated costs and benefits of implementing a conservation project the benefit to cost ratio is approximately 2.8 for all scenarios as seen in the previous table. Since it is larger than 1, the best option would be to start issuing grants for conservation projects. From an economics perspective, implementing conservation projects make perfect sense for Helena Residents. With current numbers, it should be done if its 1 acre or 300 acres. However, there are some key factors that impact these calculations. The costs for these projects can easily increase if unexpected events happen. For example, Nate Kopp from PPLT said that their stream restoration conservation projects sometimes require invasive weed removal and other programs if the area is in bad condition. These treatments cost approximately \$250,000 to \$300,000 which makes the cost of maintaining a project go up a lot for a small piece of land.

Another factor is the facilities. The costs calculated are very basic amenities for a nature site. You may want to add restrooms and/or fencing around the area. You may also need a bigger parking lot if you have a lot of visitors to your site. The calculations were made basic based on current sites in Helena and their amenities. Even though the facilities expand and increase per acre with the model, it is worth mentioning that the more non-basic amenities you want, the faster the cost is going to increase.

The sensitivity analysis will test these potential extra costs and find the limit at where the conservation projects still make sense and where they may not make sense any longer. The sensitivity analysis will also test a decrease in existence, bequest, and ecosystem service values to account for a situation where Helena residents don't value these projects as much or if the ecosystem doesn't reach its full benefits.

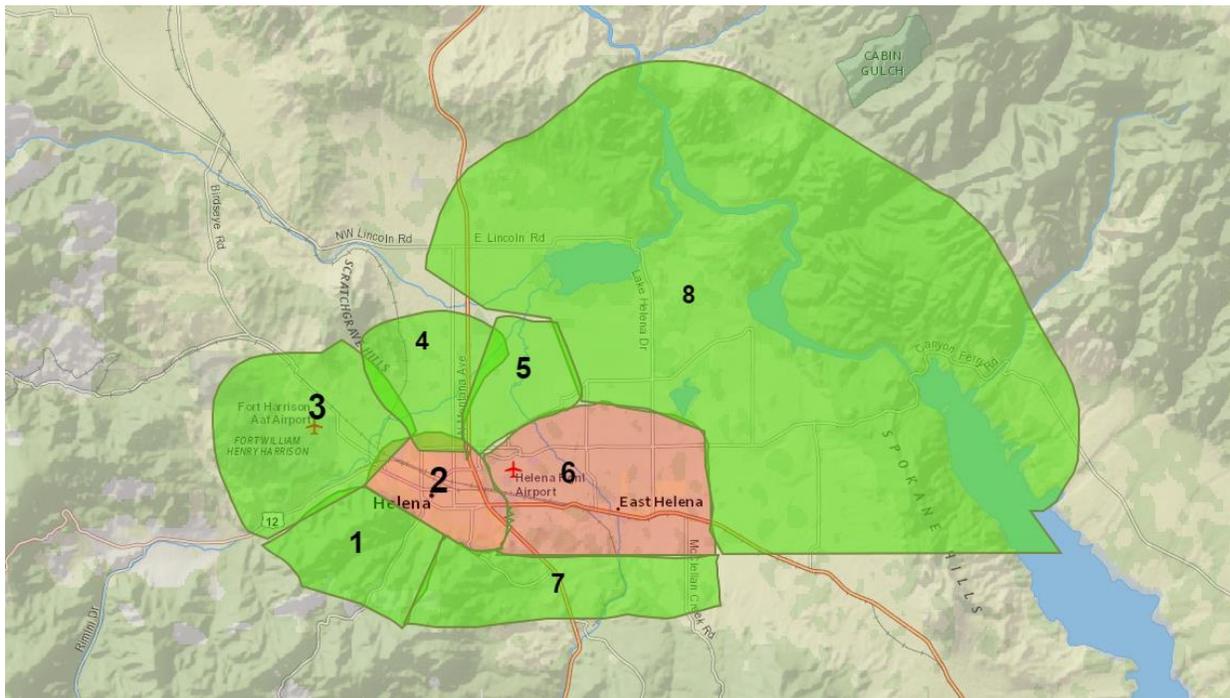
Sensitivity Analysis

The sensitivity analysis was based off current estimated numbers. The high and low numbers for each variable were found by increasing and decreasing each variable by one and a half of each estimated cost and benefit. A tornado analysis below shows the sensitivity of each variable in this analysis. Variables are ranked in order from top to bottom – most sensitive to least sensitive. While all factors in this analysis are important, the model is most sensitive to changes in existence and bequest values and opportunity for development costs. This means that the sensitivity analysis suggests these factors play the largest role when deciding to undergo a conservation project. The chosen discount rate of 4% was also tested for sensitivities and it can be concluded that the discount rate has a nominal impact on the benefit to cost ratio because it never falls below one, even when the discount rate is 99%. Ultimately, if the monetary value of benefits decreases below the monetary value of the costs, the benefit to cost ratio will fall below one and a conservation project should not be done.



6. Conclusion

Based on this analysis, economically a conservation project can be implemented in any region in Helena. Realistically, regions two and six may not be the best places for such a project. These regions are heavily populated and hubs for residential and business development with a higher cost for land. A map below shows the ideal (green) and not ideal (red) regions when considering a conservation area based on mainly economic impacts but social impacts are considered as well. Ultimately, Helena residents greatly value being able to go outdoors for various reasons, and this outweighs the cost of a conservation project over 10 years.



Division of Helena into subregions showing ideal (green) and not ideal (red) regions when considering conservation projects

6.1 Model Improvement

Although this analysis considers a wide range of costs and benefits, there are areas of improvements if such an analysis was done in the future. The following are areas of improvement for this analysis.

- The analysis focuses on the broad topic of conservation, a future analysis would focus on bird species in Helena specially to find more accurate results of their impacts on Helena even though they are still included in this analysis.

Improvements Continued

- There were limited studies conducted and referenced that related closely to this topic. A future analysis would incorporate more sources that relate closely to Helena's environment and community goals to obtain more accurate numbers.
- Sending out surveys to residents would allow for more accurate willingness to pay values for Helena residents and their views on outdoor activities and conservation sites.
- More research can be conducted on every cost that goes into implementing and maintaining a conservation site. While there are several costs considered, there are most likely missing costs.
- Conservation easements and contractors were not considered in this analysis, but they would add costs and benefits to this analysis and should be considered in the future.

Data Source Appendix

	Variables	Source
General	LCAS mission and goals	The Last Chance Audubon Society. (2019). Retrieved from
	Prickly Pear Land Trust project specifics and phone call with Nate Kopp	Prickly Pear Land Trust. (2019). Retrieved from https://pricklypearlt.org/
	Audubon Society history	Zimmer, C. (n.d.). Audubon Society
	Conservation history	Conservation Timeline 1901-2000. (n.d.), Theodore Roosevelt and Conservation. (n.d.)
Land Cost	Cost of land in each region	Helena, MT Land for Sale & Real Estate. (2019). The Last Chance Audubon Society. (2019). Retrieved from
Grants/Donations	LCAS grant awards	Prickly Pear Land Trust. (2019). Retrieved from https://pricklypearlt.org/
	Prickly Pear Land Trust grants	Protecting the Environment Madison River. (n.d.)
	Northwestern Energy donation amounts for conservation	Recycled Plastic Benches. (n.d.).
Benches	Cost for benches	Low Profile Exhibit Bases. (n.d.).
Signs	Interpretive sign cost	Parking Lots Costs & Prices. (n.d.).
Parking	Putting in a parking lot and yearly maintenance cost	Catalog)
Trash Cans	Trash can cost	Estimation
Management per Year	Allotted amount of extra funds for upkeep each year	Average The Trust for Public Land Salary. (n.d.).
Salaried Employees	Average salary of public land employees	Estimation
Volunteers	Volunteer food, water, etc.	Reinschmiedt, L., Floyd, R., & Jones, L. (1976). ECONOMIC BENEFITS AND COSTS OF INDUSTRIALIZATION IN RURAL TEXAS
Opportunity for Development	Opportunity cost of industrialization inflated to today's cost	Loewen, & Kulshreshtha. (1995)
Existence and Bequest Values	WTP for wilderness preservation	International, B. (n.d.). Ecosystem Services
Ecosystem Services	Definition	Groot, R. D., Brander, L., Ploeg, S. V., Costanza, R., Bernard, F., Braat, L., . . .
	Service Values	

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