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ASSESSING SOCIAL-ECOLOGICAL FEASIBILITY OF LAND ACQUISITION FOR REFUGE EXPANSION

By

Amanda A. McDonald

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ABSTRACT

ASSESSING SOCIAL-ECOLOGICAL FEASIBILITY OF LAND ACQUISITION FOR REFUGE EXPANSION

By

Amanda A. McDonald

To better protect biodiversity, it is desirable to purchase land to expand the boundaries of protected areas such as wildlife refuges. Unfortunately, an acquisition project may not be able to achieve the stated objectives even after a lot of time, energy, and money have been invested. Using Shiawassee National Wildlife Refuge as a case-study, I conducted a feasibility assessment on an on-going acquisition project. First, I conducted a survey of the private landowners within the acquisition area. The survey indicated that only 49.5% of the respondents would be willing to sell and only 38.9% would be willing to sell at an appraised market value. In addition, I found that a higher percentage of landowners who had owned their land for less than 21 years were willing to sell than other landowners and that a higher percentage of wetland owners were willing to sell than non-wetland owners. Non-sellers were also predisposed to refusing to work with the refuge to manage their land or to enter into a conservation easement. The most expressed reason for not selling was simply that the landowner had no reason to sell. Furthermore, the non-sellers hold 50.4% of the land area interspersed within the total acquisition area disrupting habitat connectivity. Next, I created a model that would simulate land purchases

within the acquisition boundary. Employing hypothetical incentive levels, I found that increasing the incentive to sell increased the amount of land that was purchased. I also found that increasing the number of landowners contacted with purchase offers shortens the time required to complete the acquisition and if the survey information is assumed to be true across time, the expansion of Shiawassee National Wildlife Refuge will take approximately 250 years to complete. In the end, I found that less than half of the acquisition area would be purchasable without using incentives of some sort. To facilitate the acquisition project, the United States Fish and Wildlife Service should increase the number of annual purchase offers made and offer non-monetary incentives to the landowners for selling their land.

In loving memory of my grandfather,

LeRoy McDonald

who saw me as greater than I am.

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TABLE OF CONTENTS

List of Tables ix

List of Figures x

Chapter 1

Introduction 1

Land Acquisition 1

The Expansion of Shiawassee National Wildlife Refuge 4

Overview of Thesis 6

Literature Cited 7

Chapter 2

Attitude Assessment of Landowners within the Acquisition
Boundary of a National Wildlife Refuge in Southern Michigan 10

Abstract 10

Introduction 11

Methods 14

Study Area 14

Survey 15

Results 19

Discussion 30

Acknowledgements 36

Literature Cited 36

Chapter 3

A Socio-ecological Simulation Model of Land Acquisition
to Expand a National Wildlife Refuge 39

Abstract 39

Introduction 40
Methods 42
Study Area 42
Simulation Model 43
Landowner Attitudes 45
Acquisition Scenarios 48
Results 51
Sensitivity of Non-Respondent Probabilities of Sale 53
Hypothetical vs. Survey–Derived Probabilities of Sale 54
Incentives 58
Effects of Attempted Purchases on Time Required for Completing the Acquisition 60
Discussion 63
Acknowledgements 65
Literature Cited 65

Chapter 4

Conclusions and Recommendations 68

Literature Cited 71

LIST OF TABLES

Table 2-1. Frequency and percentage of landowners that answered yes, no, or undecided to selling their land to the USFWS based on age, occupation, or length of ownership.

Table 2-2. Landowners' willingness to sell in relation to the type of land they own.

Table 2-3. Frequency and percentage of landowners responses to the alternative questions of whether they would be willing to work with the USFWS to manage their land or to enter into a conservation easement compared to their responses to the original question of whether they would sell their land.

Table 2-4. Frequency and percentage of landowner responses compared between the two alternative questions of working with the USFWS to manage the land for wildlife or entering a conservation easement. The percentages within the columns are of the column total, and likewise, the percentages within the rows are of the row total.

Table 2-5. Frequency of high-score answers (4 or 5 on a scale of 1 to 5) and overall mean scores (n= 35) of expressed reasons for not selling property to USFWS.

Table 2-6. Quantification of the responses to the question of selling to the USFWS by evaluating the areas of the parcels in question. These values are compared to the total area accounted for by the survey responses and the total proposed acquisition area.

Table 3-1. Examination of the sensitivity of the non-respondent probability of sale. The numbers represent the average values (±s.d.).

Table 3-2. Simulation results to examine survey importance. The numbers represent the average values (±s.d.).

Table 3-3. Simulation results using limited purchase attempts per year.

LIST OF FIGURES

Figure 1-1. Location of Shiawassee National Wildlife Refuge in Michigan.

Figure 1-2. Map of Shiawassee National Wildlife Refuge and the proposed acquisition.

Figure 2-1. Frequency of landowner responses (yes, no, or undecided) to the question of whether or not they would sell their land to the USFWS.

Figure 2-2. Frequency of landowner responses (yes, no, or undecided) to the question of whether or not they would sell their land to the USFWS with an adjustment for people who would sell, but not at appraised value.

Figure 2-3. Frequency distribution of landowner responses to the question of when they would be willing to sell their land.

Figure 2-4. Map of Shiawassee National Wildlife refuge and the acquisition area (from U.S. Fish and Wildlife Service, 1996) with the parcels owned by survey respondents and responses highlighted.

Figure 3-1. Example of spatial distribution of purchased parcels resulting from land acquisition simulation.

Figure 3-2. Amount of each land type purchased. The simulations were executed using a low (0.333) and a high (0.500) hypothetical probability of sale as well as probabilities of sale derived from a previously conducted survey.

Figure 3-3. Hydric versus non-hydric soil areas purchased. The simulations were executed using a low (0.333) and a high (0.500) hypothetical probability of sale as well as probabilities of sale derived from a previously conducted survey.

Figure 3-4. Purchased amounts of existing land types resulting from the land purchase simulation investigating the effects of incentives. Three incentive levels were used: no incentives, low incentives, and high incentives.

Figure 3-5. Hydric versus non-hydric soil areas purchased during the land purchase simulations investigating the effects of incentives. Three incentive levels were used: no incentives, low incentives, and high incentives.

Figure 3-6. Relationship between the number of attempted purchases per year and the time required to purchase all of the land owned by willing sellers.

Chapter 1

Introduction

Land Acquisition

Land acquisition has historically been used by special interest groups and conservation organizations to establish and expand wildlife reserves and recreational areas. These groups include Ducks Unlimited (Ducks Unlimited 2000), The Nature Conservancy (Press et al. 1996), the United States Fish and Wildlife Service (USFWS; United States Fish and Wildlife Service 1996), and the United States Park Service (National Park Service 2000), as well as state conservation organizations such as the Michigan Department of Natural Resources (Michigan Department of Natural Resources 1996). Usually, these reserves are created to counter habitat degradation and destruction (Reinecke et al. 1989, Terbough and Schaik 1997, Liu et al. 1999) and offer protection for wildlife and the natural systems that they require, as well as recreational opportunities for the public (DellaSala et al. 1996, Turner and Rylander 1997).

In creating or expanding these reserves, a land acquisition project is initiated. An acquisition project consists of two steps: the planning process and the acquisition process. In the planning process, objectives for the reserve are defined, an acquisition boundary is developed, and money is appropriated for the purchases. After the planning is completed, the acquisition process begins where the landowners are contacted with purchase offers for the management rights to their land. The purchase offers can take any of several forms since

there are several ways that the management rights to the land can be acquired. Two of the methods commonly employed are the direct purchase of the title fees and the establishment of conservation easements (Meeks 1990, Press et al. 1996). Of the two methods, direct purchase of the title fees may be the oldest method of land acquisition (Meeks 1990) and would be the preferable method because it involves a single payment of a predetermined amount, which is usually the lowest possible fair price (Kershow 1975). In addition, there are no restrictions on the authority of the acquiring agency over the management of the acquired land (Ramsey and Addison 1996, Press et al. 1996).

Time is an issue when dealing with objectives related to the conservation of biodiversity, and an acquisition project can take several years to complete. Obviously, it would be desirable to immediately acquire the land and begin restoration and/or protection of the habitats contained within the area of interest. Therefore, it would be beneficial to accelerate the acquisition project. Wright and Tanimoto (1998) have suggested using geographic information systems (GIS) to prioritize the land parcels within an area of interest based on habitat complexity. This method would facilitate the planning process, but that is only part of an acquisition project.

After the planning process is over and the acquisition process has begun, the landowners are contacted with offers to buy their land. How the contacts are done differs depending on which organization or agency is doing the acquiring. It has been suggested by Ramsey and Addison (1996) that mass mailings of purchase contracts to all the landowners and an assembly line method of

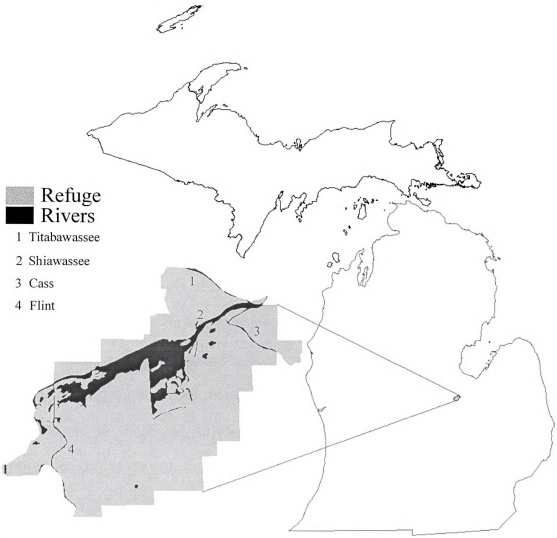

Figure 1-1. Location of Shiawassee National Wildlife Refuge in Michigan.

handling the contract responses would facilitate the acquisition process. However, this can be labor intensive and financially inefficient, especially for government agencies that have a lot of regulations that need to be met.

Finally, after years of execution, the acquisition project may or may not have been successful in meeting the objectives that were originally defined for it. If the acquisition project was not successful, then money has already been invested and effort spent to no avail. Regardless of whether or not the acquisition project will be accelerated, the first questions for an acquisition project should always be about whether or not the acquisition is feasible and whether or not it should be undertaken.

The Expansion of Shiawassee National Wildlife Refuge

In examining the feasibility of an acquisition project, I chose to use a national wildlife refuge, Shiawassee National Wildlife Refuge (hearafter refuge), which is currently undergoing an expansion. The refuge is located in Saginaw County, Michigan, near Saginaw Bay (Figure 1-1) on the juncture of four rivers: the Shiawassee, the Titabawassee, the Cass, and the Flint Rivers. The refuge was initially established in 1953 by the USFWS to provide a migratory staging area for waterfowl and to serve as a flood containment unit, but presently, the goals also include maintaining the biodiversity of the area and providing habitat for the native endangered species of the area (United States Fish and Wildlife Service, 1996).

Currently, the refuge consists of 3680 contiguous hectares, a third of which are classified as wetlands. The USFWS decided to attempt an expansion of the refuge (United States Fish and Wildlife Service, 1996). An acquisition boundary was drawn around 317 land parcels (3035 ha); and it extends outwards on three of the rivers: the Shiawassee, the Titabawassee, and the Cass (Figure 1-2). Each parcel of land has been classified as high priority, medium priority or low priority based on its evaluated habitat potential for both upland and wetland species (United States Fish and Wildlife Service, 1996).

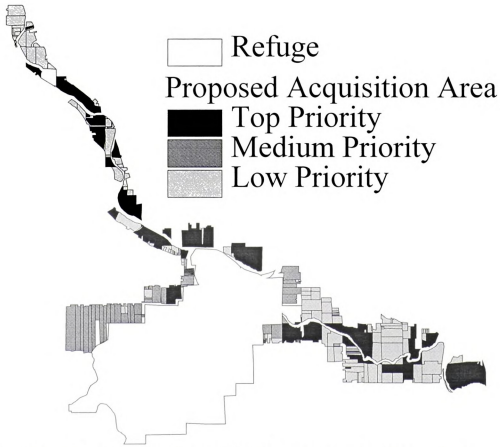

Figure 1-2. Map of Shiawassee National Wildlife Refuge and the proposed acquisition.

The USFWS followed the National Environmental Policy Act protocols for planning this acquisition project (United States Fish and Wildlife Service 1996). Public meetings were held to identify and discuss potential issues with the proposed acquisition.

Now that the acquisition proposal was approved and some funding was appropriated, landowners are being selectively contacted with offers to buy their land. By selectively, I mean that the realty division contacts landowners based on the refuge manager's recommendation of who might be willing to sell (John Connors, *pers. comm.*). It must be kept in mind that not all of the landowners have been contacted or are even aware that the USFWS is planning this expansion (John Connors, *pers. comm.*; McDonald, *unpublished data*).

Overview of Thesis

It was my goal to create a simulation model that would project the results (e.g., area purchased, habitat purchased, and distribution of purchases) of an acquisition project. These results would then be used to assess the feasibility of the acquisition project. To do this, I chose to use Shiawassee National Wildlife Refuge as a case study since it was trying to expand. The work was divided into two sections. The first was an assessment of the landowners' attitudes within the acquisition area towards selling to the USFWS. This could be considered a preliminary feasibility assessment and is described in Chapter 2. The next step was to incorporate the landowners' attitudes into a simulation model that would project the amount of land purchased, the amount of different habitat types

purchased (both existing and potential), and the distribution of the purchased parcels. The model and the information that it needed are described in Chapter 3. Both Chapters 2 and 3 are written in manuscript format, so there is a little repetition of information between these two chapters.

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Chapter 2

Attitude Assessment of Landowners within the Acquisition Boundary of a National Wildlife Refuge in Southern Michigan

Abstract

To better protect biodiversity, it is desirable to purchase land to expand the boundaries of protected areas such as wildlife refuges. Unfortunately, an acquisition project may not be able to achieve the stated objectives if the landowners are not willing to sell their land. Therefore, it is necessary to assess the landowners' willingness to sell their land as part of the feasibility assessment effort. As a case study, I conducted a survey of landowners within the proposed acquisition boundary of Shiawassee National Wildlife Refuge in Southern Michigan. The United States Fish and Wildlife Service approved the proposal for the expansion of the refuge, but heretofore, the feasibility of purchasing from the adjacent private landowners was unclear. My survey results indicate that only 49.5% of the respondents would be willing to sell and only 38.9% would be willing to sell at an appraised market value. Furthermore, I found that a higher percentage of landowners who were younger than 60 years old were willing to sell than the older landowners, that a higher percentage of landowners who had owned their land for less than 21 years were willing to sell than other landowners, that a higher percentage of wetland owners were willing to sell than non-wetland

owners, and that there were no large differences in willingness to sell among occupations. Non-sellers were also predisposed to refusing to work with the refuge to manage their land or to enter into a conservation easement. The most expressed reason for not selling was simply that the landowner had no reason to sell. Without additional incentives, only 13.7% of the 1215 ha accounted for in the survey will be purchasable. Furthermore, the non-sellers hold 50.4% of the land area interspersed within the total acquisition area disrupting habitat connectivity. This study demonstrates how managers can assess the potential success of an acquisition project before a lot of time and money is invested. I suggest that this type of survey should also be useful to other land acquisition projects for wildlife conservation.

Introduction

There is a continuing decline in biological diversity around the world because wildlife habitats have become increasingly fragmented and degraded, resulting in smaller and smaller populations of animals (DellaSala et al. 1996, Terbough and Schaik 1997). To counter this habitat degradation and destruction, many protected areas, such as wildlife refuges, have been created (Reinecke et al. 1989, Terbough and Schaik 1997, Liu et al. 1999). These areas offer protection for wildlife and for the natural systems that the animals require, as well as recreational opportunities for the public (DellaSala et al. 1996, Turner and Rylander 1997). Unfortunately, many of the protected areas are too small (Fitter and Scott 1978). Generally speaking, the larger the area of protection, the

more the core area is buffered from human disturbances (DellaSala et al. 1996) and the better the core area is for wildlife habitat, especially for species that are very specialized in their habitat requirements (Saunders et al. 1991). To protect these specialized species and biodiversity in general, many protected areas would need to be expanded.

An expansion of protected areas could be accomplished through purchasing the title fees, leasing, or contracting easements (Meeks 1990, Press et al. 1996). Direct purchase of titles may be the oldest method of conservation (Meeks 1990). It would be the most appealing approach since it concerns a single payment of a predetermined amount, usually the lowest possible price (Kershow 1975), and there are no restrictions on the authority of the agency over the management of the purchased land (Ramsey and Addison 1996, Press et al. 1996). Also, a direct purchase can be the best way to safeguard the land from the pressure of economic development (Press et al. 1996). Land purchasing is a practice that has been employed by organizations such as the Nature Conservancy (Press et al. 1996), the United States Fish and Wildlife Service (USFWS) (United States Fish and Wildlife Service 1996), and state conservation agencies (Michigan Department of Natural Resources 1996) to establish and expand managed areas.

The first step of a land purchase project is usually to define the area of interest and assess the ecological value of the parcels. The assessment enables the acquiring agency to prioritize the land parcels within the acquisition boundary for wildlife habitat (Wright and Tanimoto 1998). Then, the landowners have to

be contacted and given an offer for their land (Ramsey and Addison 1996). Land parcel by land parcel, decisions are made regarding the purchase of the parcel depending on its rated priority and the money available to complete the acquisition. Sometimes, high priority land parcels are passed over to acquire more acreage. Landowners usually have to be contacted several times before a final decision is made. Because there are few predetermined guidelines, deciding which parcels to purchase can make land acquisition a long, time-consuming process. This process may continue until all the land within the acquisition boundary is purchased or the funding for the project runs out.

One problem with the acquisition process that was realized through conversations with area land managers is that while planning the project, the willingness of the specific landowners to sell is often not assessed. Some land addition projects are doomed to failure because some landowners will never sell their land, some high value areas will not be attainable for social or economic reasons, or not enough of the acquisition area would be attainable to produce effective results. This type of project is not even worth attempting because the applied effort would vastly outweigh the benefits. The feasibility of a project should be assessed before lots of energy, money, and manpower are invested in it.

One way to evaluate the feasibility of an acquisition project is to consider the attitudes of the landowners towards selling. Previous research has indicated that many people think there is a need for wildlife conservation and management (Kellert 1978, Gill 1996), but how many individuals would give up their land for

such a purpose? To answer this question, I conducted a survey of the landowners within the proposed boundary of an ongoing acquisition project administered by the USFWS. The goal of this survey was to assess the attitudes of the landowners towards selling to determine whether or not the acquisition would be feasible. It is my hope that the approach used in this study can also stimulate socio-economic feasibility assessment for other similar land purchase projects.

Methods

Study Area

My study area was the Shiawassee National Wildlife Refuge (hereafter refuge) in Saginaw County, Michigan that was designed to be a migratory bird sanctuary and flood containment unit. The refuge was authorized in 1953 and consists mostly of managed wetlands. It is located near Saginaw Bay of the Lower Peninsula of Michigan at the junction of four rivers: the Shiawassee, the Titabawassee, the Cass, and the Flint (Figure 1-1). Presently, the goals of the refuge include maintaining the biodiversity of the area, providing habitat for the native endangered species of the area, as well as the original goals of providing a migratory staging area for waterfowl and flood containment (United States Fish and Wildlife Service 1996).

Currently, the refuge consists of 3680 ha. The USFWS is interested in purchasing land for an expansion of the refuge (United States Fish and Wildlife Service 1996). The area of interest for the acquisition has been bounded and

consists of 3035 ha extending outwards from the refuge along three of the rivers: the Shiawassee, the Titabawassee, and the Cass Rivers (Figure 1-2). The majority of the lands in question either encompass wetlands or are within the flood plain of the rivers since these lands are the most useful for the purposes of the refuge. Each parcel of land has been classified as high priority, medium priority or low priority based on its evaluated habitat potential for both upland and wetland species (United States Fish and Wildlife Service 1996). The landowners are being selectively contacted for the land acquisition project and decisions about purchases are being made based upon the available monies for the project.

Survey

To assess the attitudes of landowners towards the acquisition project, a survey was conducted of the landowners within the acquisition boundary of the refuge. A questionnaire was developed to assess the attitudes of the owners towards selling their land to the USFWS and to gather some general information about the owner and the status of the land. The primary question was whether or not they would sell their land to the USFWS. Then, the owners were asked some other information such as age, occupation, and how long they have owned the land, to help analyze their attitudes in relation to the profile of respondents. If the owner said that they were willing to sell their land, they were then asked to describe how much of their land they would sell and were given the options of selling all, all but the residential, or only a specified part of their land. Following

this line of questioning, they were asked if their property was currently on the market, if they would sell for appraised value, and when in the next twenty years they would be willing to sell. They were given six categories to choose from for the time of sale: now, 1-2, 3-5, 6-10, 11-15, 16-20 years.

I wanted to know for what reasons people would not be willing to sell their land, so I could assess the obstacles to the acquisition project. Thus, for the people who responded that they would not sell their land or the people that would not commit to an answer, several conditions were presented, and the respondent was asked to rate each one as to its influence on the decision of whether or not to sell. The conditions were: having children at home, farming the land, having owned the land for generations, using the land for recreation purposes, not agreeing with the USFWS practices, not being able to sell for the amount they think the land is worth, and having no reason to sell. I offered a scale of 1 to 5 for the respondent to evaluate each condition with 1 being the least important and 5 being the most important.

Some background information was collected to look at trends and profiles. The owner's year of birth and occupation were requested. Then, the owners were asked how long they had owned the land in question and were given six categories to choose from. The categories were ≤5 years, 6-10 years, 11-15 years, 16-20 years, 20-24 years, and 25+ years. Following the length of ownership question, the owners were asked to describe their land. They were given land type categories in which to fill out the acreage they own. The categories were the total land owned, agricultural land, wetlands, forested lands,

open fields, residential land, and unclassified lands. This question was included to identify any significant differences in response associated with owning a certain type of land.

Two alternatives to selling were presented in the questionnaire. These alternatives were to work with the USFWS in managing the land or to enter into a conservation easement and allow the USFWS to manage the land while the owner receives some form of remuneration (e.g., annual payments, tax write-offs, or both). These will be important variables if the USFWS cannot appropriate enough funding to complete the proposed acquisition. It was expected that some of the people questioned would not know what a conservation easement entails and would therefore answer "undecided."

The survey began in May of 1998 and ended in August of 1998. A mailing list of the 198 private owners of potential acquisition lands was obtained from the USFWS. The list was a year old so some of the lands had already changed hands. A letter was mailed to the recipients informing them that the survey would be following. Thirteen of the letters were returned because the owners had moved or the address was incorrect. In the two cases where the owners had moved but the address was to the actual parcel of land, the address was changed to "current owner." However, for the 11 incorrect addresses or returned letters that were not sent to the actual parcel, these addresses and names were removed from the list. One person wrote back that the land in question had been sold and gave me the name and address of the new owner. This new owner was already on the list so I added that parcel to his holdings.

Of the 187 questionnaires that were sent out, 104 (56%) were returned. Nine of these responses were notification that the recipient had already sold the land either to the Michigan Department of Natural Resources or to someone else. The remaining 95 (51% of the total questionnaires sent out) were reported for this study. Unfortunately, the addresses were my only available method for contacting the landowners, so no non-response follow-up was possible.

From the responses, I examined the number of respondents who answered yes and no to the question of whether or not they would be willing to sell. I also analyzed their willingness to sell at appraised value and how much land they would sell. To search for response patterns, I examined the ages, occupations, and lengths of ownership against their willingness to sell at appraised value. The ages were grouped into five-year classes because of the small population. Occupations were divided into four groups: laborer, professional, self-employed, and retired. The laborer category consisted of factory workers and other labor-intensive occupations, while the self-employed category consisted of farmers and people who stated they were self-employed. The professional category included businessmen, doctors, teachers, and any other white-collar jobs. There were only three cases where the household had two occupations, but for each, both occupations fell within the same category so this was not a problem.

The reasons for not selling were analyzed in two ways. First, I compared the average rated importance placed upon the condition. If a respondent left a reason for not selling blank, but rated at least one of the others, I assumed that

the blank reason held no importance and inserted a value of 0 into the data set. Secondly, using an answer of 4 or 5 to suggest that the reason held meaningful importance, I examined the frequency of a meaningful rating.

The types of land people owned were compared to their willingness to sell at appraised value. Since most of the parcels contain more than one land type, the percentage of willing sellers was calculated for each land type independently of the others, meaning that most landowners will be in more than one group. The opposite of each group (e.g., agriculture vs. non-agriculture) was also calculated for comparison so there were 10 groups total for the land type analysis.

Results

An overall profile of the respondents showed that the ages ranged from 32 to 91 years old with an average of 58.9 (s.d. = 14.1). For occupations, 65% of the respondents were quite evenly distributed between the categories of laborer, professional, and self-employed. The remaining 35% were retired. Regarding the length of land ownership, half of the respondents have owned their land parcels for more than 20 years. Furthermore, 38.2% of the respondents have owned their parcels for over 25 years.

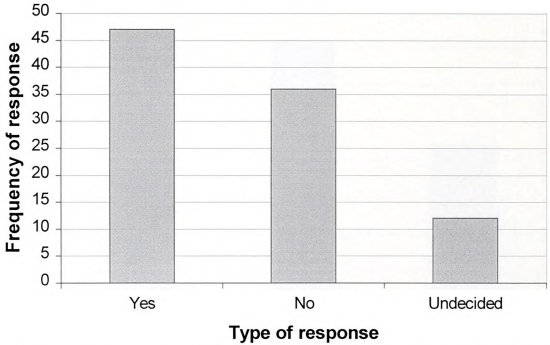

Figure 2-1. Frequency of landowner responses (yes, no, or undecided) to the question of whether or not they would sell their land to the USFWS.

Forty-seven of the respondents (49.5%) said that they would be willing to sell at least a portion of their land to the USFWS (Figure 2-1). Thirty-six (37.9%) replied that they would definitely not sell their land to the USFWS. Twelve (12.6%) did not commit to one answer or the other. However, if the answers to the initial sell question were analyzed in conjunction with whether or not they would sell at appraised value, the distribution evened out (Figure 2-2). Ten of the people who answered yes to whether or not they would sell also answered no to selling for appraised value, which puts them into the conditional category meaning that there was no commitment to a yes or no answer and incentives for selling may be necessary.

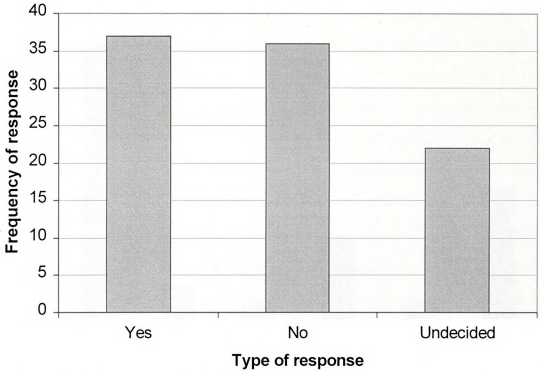

Figure 2-2. Frequency of landowner responses (yes, no, or undecided) to the question of whether or not they would sell their land to the USFWS with an adjustment for people who would sell, but not at appraised value.

Of the people that said they would be willing to sell their land, 20 (42.5%) said that they would definitely sell all of their land, 4 (8.4%) said all they would sell was the non-residential portion of their land, and 2 (4.3%) said that they would only sell a specific part of their land, usually the wetland portion of their property. The rest remained non-committal as to the amount of land that they would sell. In reply to when they would be willing to sell, nearly fifty percent (17 of 35) of the respondents answered "immediately" (Figure 2-3). Only two respondents answered that their property was currently on the market. One of the two said that he or she would sell to the USFWS, while the other was uncertain.

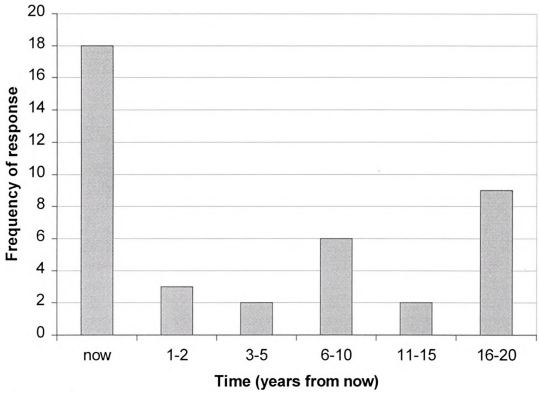

Figure 2-3. Frequency distribution of landowner responses to the question of when they would be willing to sell their land.

To examine response patterns, the age of the owner, occupation of the owner, the length of ownership (Table 2-1), and the type of land owned were analyzed (Table 2-2). The ages were grouped into two groups because of the small sample size. Since the median age of 58 was close to the senior citizen delineation of 60 years old, I chose 60 years old as a dividing point. The respondents under the age of 60 showed a greater number of willing sellers and only a few uncertain responses (Table 2-1). The respondents over the age of 60 showed similar numbers for each answer.

After grouping the occupation responses, I found that the occupation category that received the most responses was the retired category (Table 2-1). Of the 85 people who responded to the occupation question, 30 (35.3%) were

Table 2-1. Frequency and percentage of landowners that answered yes, no, or undecided to selling their land to the USFWS based on age, occupation, or length of ownership.

		Type of Response			
	Response group	Yes	No	Undecided	Total
Age(years old)	30-59	23 (48.9%)	19 (40.4%)	5 (10.7%)	47
	60-91	12 (30.0%)	15 (37.5%)	13 (32.5%)	40
Occupation	Self-employed	3 (15.0%)	8 (40.0%)	9 (45.0%)	20
	Labor	11 (61.1%)	5 (27.8%)	2 (11.1%)	18
	Professional	7 (41.2%)	7 (41.2%)	3 (17.6%)	17
	Retired	10 (33.3%)	13 (43.3%)	7 (23.4%)	30
Years of Ownership	<21 years	24 (53.3%)	14 (31.1%)	7 (15.6%)	45
	21+ years	11 (25.0%)	19 (43.2%)	14 (31.8%)	44

retired. The greatest difference in response was for the laborer group with 11 answering yes, 5 answering no, and 2 undecided. The self-employed group had a low number of sellers but was split almost evenly between no's and undecided's. The professional group was similar with the yes's and no's receiving equal support. Occupation was not an indication of whether or not the landowner would sell.

The responses to the question about the length of ownership (n=89) had a median that fell within the 21 to 25 year category so two fairly even groups could be formed using 21 years as the dividing line (Table 2-1). The number of willing sellers who have owned their land for less than 21 years was twice the number of willing sellers who have owned their land for more than 21 years. The lower percentage of sellers within the people who owned their land for 21 or more years could reflect sentimental value of the land to the owners.

After examining the different land types (Table 2-2), I found that the wetland category had a higher percentage of willing sellers. Fifty-six percent were willing to sell. The higher percentage of willing sellers for wetland owners may be a result of legislation that limits their activities involving the wetland portions of their land. The non-residential group had a higher percentage of willing sellers, which might be related to the idea that the land is non-essential to them if they do not live on it. The other land type groups were more even in their distribution among the answers.

In the two alternative choices to selling (working with the USFWS or the conservation easement), a total of 74 people responded, but not all 74 answered

Table 2-2. Landowners' willingness to sell in relation to the type of land they own.

Land type	Type of Response			Total
	Yes	No	Undecided	
Agriculture	11 (32.4%)	15 (44.1%)	8 (23.5%)	34
Non-agriculture	24 (44.4%)	19 (35.2%)	11 (20.4%)	54
Wetland	13 (56.5%)	4 (17.4%)	6 (26.1%)	23
Non-wetland	22 (33.8%)	30 (46.2%)	13 (20.0%)	65
Forested	13 (38.2%)	12 (35.3%)	9 (26.5%)	34
Non-forested	22 (40.7%)	22 (40.7%)	10 (18.6%)	54
Open fields	7 (35.0%)	8 (40.0%)	5 (25.0%)	20
Non-open	28 (41.2%)	26 (38.2%)	14 (20.6%)	68
Residential	23 (35.4%)	26 (40.0%)	16 (24.6%)	65
Non-residential	12 (52.2%)	8 (34.8%)	3 (13.0%)	23

Table 2-3. Frequency and percentage of landowners responses to the alternative questions of whether they would be willing to work with the USFWS to manage their land or to enter into a conservation easement compared to their responses to the original question of whether they would sell their land.

Answer to original question	Work with USFWS			Conservation easement		
	Yes	No	Undecided	Yes	No	Undecided
Yes	13	9	15	13	7	16
	35.1%	24.3%	40.6%	35.7%	17.9%	46.4%
No	5	14	8	1	15	12
	18.5%	51.9%	29.6%	3.6%	53.6%	42.8%
Undecided	2	2	5	1	3	4
	22.2%	22.2%	55.6%	12.5%	37.5%	50.0%
Total	20	25	28	15	25	32
	27.4%	34.2%	38.4%	20.8%	34.7%	44.5%

both questions (Table 2-3). The most frequent answer was "undecided" in either case (Table 2-3). When asked whether they would work with the USFWS, 25 (34.2%) said no, 20 (27.4%) said yes, and 28 (38.4%) said they were undecided. Comparing these answers to the original question of selling (Table 2-3), I found that people who would not sell their land were more likely not to want to work with the USFWS in managing their lands with 51.9% (14 out of 27) answering negative. When the landowners were asked whether they would be interested in entering a conservation easement, 25 (34.7%) said no, 15 (20.8%) said yes, and 32 (44.4%) said they were undecided (Table 2-3). The higher number of undecided's in the easement question may be the result of ignorance of what a conservation easement entails. Again, the people who answered no to the original question were predisposed to answering no to entering into a conservation easement with over 50% answering no (Table 2-3).

Comparing the two alternative choices, I found that the same number of individuals responded no to each question (Table 2-3). However, only 19 of them responded no to both questions (Table 2-4). About half (9) of the people that would be interested in working with the USFWS responded "no" or "undecided" to the easement. Only five of the people who would not work or were undecided about working with the USFWS would agree to the easement. Three of the people who were undecided about working with the USFWS gave a definitive negative to entering the conservation easement and allowing the USFWS to manage their land. The only category that was not found to have a large variation in the distribution was the group of people who answered yes to

Table 2-4. Frequency and percentage of landowner responses compared between the two alternative questions of working with the USFWS to manage the land for wildlife or entering a conservation easement. The percentages within the columns are of the column total, and likewise, the percentages within the rows are of the row total.

Response to working with the USFWS	Response to the conservation easement			
	Yes	No	Undecided	Total
Yes	10 (52.6%)	3 (15.8%)	6 (31.6%)	27
	(26.7%)	(12.0%)	(64.5%)	
No	1 (4.0%)	19 (76.0%)	5 (20.0%)	25
	(6.7%)	(76.0%)	(16.1%)	
Undecided	4 (14.8%)	3 (11.1%)	20 (74.1%)	19
	(66.6%)	(12.0%)	(19.4%)	
Total	15	25	31	71

Table 2-5. Frequency of high-score answers (4 or 5 on a scale of 1 to 5) and overall mean scores (n= 35) of expressed reasons for not selling property to USFWS.

	Frequency of high-score answers	Mean score (sd)
Having children at home	5	1.057 (1.679)
Land is being farmed	15	2.486 (2.228)
Land has been in family for generations	12	2.029 (2.203)
Land is used for recreation	4	2.286 (2.283)
Do not agree with the USFWS strategies	13	2.114 (2.259)
Cannot sell for perceived value	9	1.686 (2.153)
No reason to sell	28	4.171 (1.618)

working with the USFWS (Table 2-4). The people who responded no to either question were more likely to respond no to the other question with more than 70% answering no (19 out of 25). People who responded yes to the conservation easement were more likely to work with the USFWS with two-thirds answering yes (10 out of 15).

Among the expressed reasons that landowners would not sell (Table 2-5), having no reason to sell was the most frequent response (28 rated 4 or higher). The reason that received the lowest response was that they had children living at home. Since nearly half of the people who responded were over 60 years old and past the typical child-rearing age, this answer was not surprising. There were no noticeably large differences between the frequencies of meaningful responses (4 or higher) among that the land was being farmed, that the land had been in the family for generations, that the land was used for recreational purposes, and that the respondent did not agree with the USFWS's management practices. Having no reason to sell had the highest mean (Table 2-5) and having children at home had the lowest, corresponding with the results from the frequency of meaningful responses.

Discussion

The results indicate that without extra measures (e.g. incentive), completion of the proposed acquisition project will not be feasible since only 50% of the survey respondents said that they would be willing to sell their land and only 38% would be willing to sell at the appraised value. It should be kept in

mind that these percentages refer to the number of landowners willing to sell, but give no indication of the amount of land that would then be acquired. By linking the survey response data with land parcel data and assuming that sellers will sell all of their land, I found that of the 1215 hectares that can be accounted for with the survey, at most 166 ha could be purchased at appraised value (Table 2-6). This represents only 13.7% of the acreage accounted for by the survey (1215 ha) and 5.5% of the total acquisition area (3035 ha). Adding in the people who would positively be willing to sell for more than appraised value only brings the number up to 21.4% of the surveyed acreage and 8.6% of the total. In addition, based

Table 2-6. Quantification of the responses to the question of selling to the USFWS by evaluating the areas of the parcels in question. These values are compared to the total area accounted for by the survey responses and the total acquisition area.

Response to question of selling	Area accounted for by survey (ha)	% of the surveyed area	% of the total acquisition area
Yes, at appraised value	165.9	13.7	5.5
Yes, but not at appraised value	260.3	21.4	8.6
Total of the yes's	426.2	35.1	14.0
Undecided	176.9	14.6	5.8
No	611.5	50.3	20.1

on my survey data, 612 ha will not be available for purchase because it is owned by the non-willing sellers (Table 2-6).

Parcels that cannot be purchased are interspersed within the matrix (Figure 2-4) in a way that is not helpful for habitat connectivity. Unfortunately, while a survey like the one presented in this study allows wildlife managers to assess the attitudes of the respondents towards selling, the survey gives no indication of how much land and what kind of land will be available for purchase from the non-respondents. If managers assume that the respondents are representative of the non-respondents, they can calculate the percentage of parcels available for purchase, but they cannot determine which parcels will be purchased using the survey information alone. If more information is needed to decide the feasibility of an acquisition project, the managers would either need a definitive response from every landowner or a method to predict which parcels could be purchased.

For prediction purposes, a determinant that can be specified down to the landowner of each land parcel is needed. This determinant would allow for individual predictions to be made about the purchasability of each parcel. In this particular case, the length of ownership, age of the owner, and type of land could be used to project a probability of sale onto each parcel if the respondents are representative of the non-respondents. Using general information that could be easily collected about the owner or the property would aid in determining where

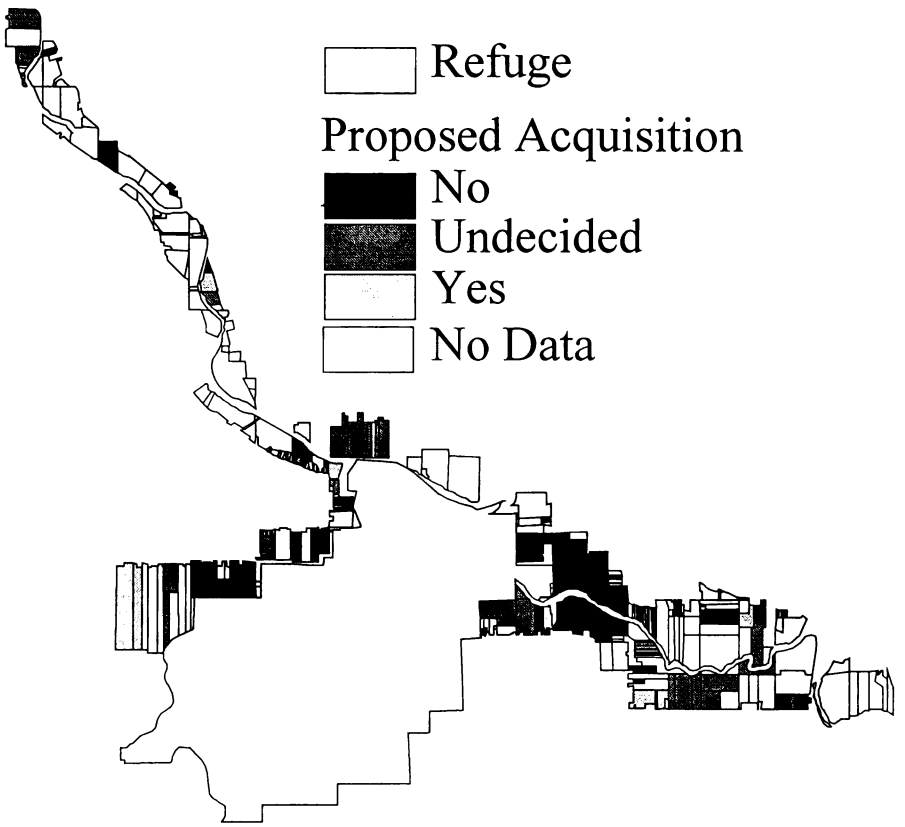

Figure 2-4. Map of Shiawassee National Wildlife refuge and the acquisition area (from U.S. Fish and Wildlife Service, 1996) with the parcels owned by survey respondents and responses highlighted.

the gaps would be inside the acquisition boundary, what the resulting refuge would look like, and how much useful wildlife habitat would be added. It would also allow for the assessment of the effectiveness of the acquisition towards the initial objectives, in this case, wildlife production and habitat conservation.

This survey also allows the planners to evaluate the reason landowners would not sell their land and to develop strategies for targeting these issues. Since the most stated reason for not selling was that there was no reason to sell, the planners could begin to develop persuasive arguments to counter this. I am not suggesting a devaluation of the property or condemnation; instead, I recommend educating the owner as to why the acquisition is important, why their land is beneficial to wildlife, and how difficult management of habitat tends to be. Also, services desired by the landowner could be traded as extra incentive. Some of the comments written on the survey suggest that landowners in this area are concerned with the decreasing access to public lands for recreational purposes. Programs could be initiated to address this decreasing access, and perhaps, the landowners would feel a little more sympathetic to the goals of the refuge. This method could possibly work if the only obstacle is lack of motivation to sell.

It was unfortunate that the landowners who would not sell their land were also less disposed to letting management occur on their land. This does not necessarily imply that the owners are not interested in managing their lands to improve wildlife habitat. It may be that the owners are not interested in letting the USFWS have any involvement with their land. This aversion to the USFWS

managing private property may stem from a feeling of distrust or imposition, or it could come from a perceived lack of credibility. To overcome this obstacle, more effort would have to be made on the part of the agency in public relations.

To facilitate the execution and planning of an acquisition project, some methods have been suggested, such as using Geographic Information Systems (GIS; Wright and Tanimoto 1998) and predefined contracts in organized mailings (Ramsey and Addison 1996). However, both of these proposed methods are used after the planning is initiated. With these previous methods, an agency has to execute the acquisitions before they find out whether or not the expended effort will result in a new reserve that will meet their expectations and objectives. To determine whether an acquisition is worth pursuing, it is necessary to understand the attitudes of the landowners. A survey similar to the one conducted in this study would provide the information needed to assess the feasibility of a potential acquisition before all the time and effort are spent. It would also provide some information that could be used to plan strategies for persuading landowners to sell or cooperate in the management of the area.

The next step in this direction of inquiry is to create land acquisition simulation models in order to facilitate the entire planning process. Wright and Tanimoto (1998) have already suggested that GIS could be used to prioritize the land parcels based upon such characteristics as physical location and land use to facilitate the planning process of an acquisition project. Ramsey and Addision (1996) have proposed a method for facilitating the actual purchases through generalized pricing and mass contacts. However, to truly facilitate a land

acquisition project, a dynamic simulation model needs to be created that includes biological, geographic, economic, and sociological features. A model would allow the planners to know when to proceed, how feasible and effective the project would be, when to give up and cut their losses, and what the long-term consequences of different alternatives would be (Liu et al. 1995). This attitude survey is a step towards the goal of simulation models that can be used as guidance for agencies as they contemplate expansions for their management areas.

Acknowledgements

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Chapter 3

A Socio-ecological Simulation Model of Land Acquisition to Expand a National Wildlife Refuge

Abstract

Land acquisition is a common practice for expanding nature reserves such as wildlife refuges. However, the feasibility of executing an acquisition project is rarely assessed before a lot of time and energy has been spent in the project. My goal was to create a simulation model that would allow land managers to assess the feasibility of an acquisition project before the project is executed. Shiawassee National Wildlife Refuge in Lower Michigan was used as a case study. The model used information on the landowners' attitudes to project the land purchases and reported the types of land that were purchased (i.e. agricultural or forested). It also used a soil map to determine how much of hydric and non-hydric soil areas were purchased in the simulation. I found that the information on the landowners' attitudes is important because it can affect the types of land purchased as well as the amount of land that is purchased in the simulation. Using hypothetical incentive levels, I found that increasing the incentive to sell increased the amount of land that was purchased, but the non-hydric areas showed more increase than the hydric areas did. I also found that increasing the number of landowners contacted with purchase offers shortens the time required to complete the acquisition. However, the relationship is not

linear so there would be a limitation where the cost of increasing the number of contacts made would outweigh the shortening of the project duration. If the survey information is assumed to be true across time, the expansion of Shiawassee National Wildlife Refuge will take an average of 249.7 years to complete. I found that less than half of the acquisition area would be purchasable without using incentives of some sort. To facilitate the acquisition project, the United States Fish and Wildlife Service should increase the number of purchase offers made per year and offer non-monetary incentives to the landowners for selling their land.

Introduction

Purchasing land for biodiversity conservation and management is a common practice (Ramsey and Addison 1996, Wright and Tanimoto 1998). Land acquisition is a technique used both by private and public conservation organizations to create reserves, such as wildlife refuges, which attempt to counter habitat degradation and destruction (Reinecke et al. 1989, Terbough and Schaik 1997, Liu et al. 1999). The Nature Conservancy, United States Fish and Wildlife Service (USFWS), and state organizations such as the Michigan Department of Natural Resources have all used land acquisition to establish protected areas for wildlife (Press et al. 1996, United States Fish and Wildlife Service 1996, Michigan Department of Natural Resources 1996). Once the land is under the control of a management agency, the natural habitats can be restored and protected from future development (Press et al. 1996). It seems

that, after a wildlife refuge is established, it is often desirable to acquire more land to expand the area of protection. Larger reserves, generally, buffer the core area from human disturbances more than smaller reserves (DellaSalla et al. 1996) and, therefore, contain better wildlife habitat, especially for species that are very specialized in their habitat requirements (Saunders et al. 1991). Unfortunately, the process of acquiring land has uncertain results. For organizations with limited financial resources and a desire to funnel their energies towards extracting maximum benefits, it is necessary to assess the feasibility of an acquisition project fulfilling its objectives before money is invested into purchasing the land parcels.

A preliminary feasibility assessment of a land acquisition project can be executed through examining the attitudes of the landowners within the acquisition area (Chapter 2). A survey of the landowners can reveal the percentage of landowners that may sell and which landowners will definitely not sell their land. However, rarely will all of the landowners respond to the survey, so it is impossible to determine what the exact configuration of the final purchases will be. To assess the feasibility of an acquisition project using more information than just the number of parcels purchased (e.g., connectivity and restorable habitats), a spatial simulation model needs to be constructed.

The goal of this paper was to present a simulation model that can be used for evaluating the feasibility of a land acquisition project beyond the attitude assessment of the landowners. To demonstrate the method, I have chosen to perform a feasibility assessment on a land acquisition project that is currently

underway. My specific objectives were to examine the distribution of resulting purchases and to project the types of habitats that would be purchased and could be restored. In addition, I was interested in examining potential methods of facilitating the acquisition process (e.g., incentives for selling and mass contacting).

Methods

Study Area

Shiawassee National Wildlife Refuge (hereafter refuge) in Saginaw County, Michigan is attempting an expansion. The refuge was initially authorized in 1953 as a migratory bird sanctuary and flood containment unit. It consists mostly of managed wetlands located at the juncture of four rivers: the Shiawassee, the Titabawassee, the Cass, and the Flint (Figure 1-1). Presently, the goals of the refuge include maintaining the biodiversity of the area, providing a migratory staging area for waterfowl and flood containment (United States Fish and Wildlife Service 1996).

The refuge consists of 3680 ha, and the USFWS is interested in purchasing land for an expansion of the refuge (United States Fish and Wildlife Service 1996). The area of interest for the acquisition has been bounded and consists of 3035 ha extending outwards on three of the four major rivers for the area: the Shiawassee, the Titabawassee, and the Cass Rivers (Figure 1-2). The majority of the land parcels in question encompass wetlands or are, at least, within the flood plain of the rivers since these lands are the most useful for the

objectives of the refuge. Each parcel of land has been classified as high priority, medium priority, or low priority based on its evaluated habitat potential for both upland and wetland species (United States Fish and Wildlife Service 1996). The landowners are being selectively contacted for the land acquisition project and decisions about purchases are being made based upon the available monies for the project.

Simulation Model

A script was created to simulate land purchases within the proposed acquisition boundary using the programming language Avenue (Arcview 3.1, Environmental Systems Research, Inc., 1996). The script combined spatial data contained in geographic information systems (GIS) map layers with landowners' attitudes towards selling to determine which parcels would be acquired. Since expansions such as the one proposed for the refuge are usually initiated with objectives related to habitat management, more information was needed than just which parcels would be purchased. Four map layers were used: the individual land parcels within the acquisition area, the boundary of the refuge, a land-use layer, and a hydric soil layer. The first two map layers were acquired from the USFWS. The hydric soil layer was derived from a digital soil map of Saginaw County (Soil Survey Geographic Database) acquired from the United States Department of Agriculture (USDA). Hydric soil areas represent places that were historically "wet", meaning that the refuge could restore some form of wetlands in these places if the current habitat was not already wetlands. In

technical terms, a hydric soil is one that "formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (Soil Survey Staff 1999). This information is important for land managers because they need to know what soils they have to work with in restoration. The hydric/non-hydric layer identifies potential wetland vs. upland restoration sites.

The land-use map was digitized from 1997 aerial slides acquired from the USDA Farm Service Agency in Saginaw County and corrected against a digital land-use map of 1978 Saginaw County created at the Center for Remote Sensing, Michigan State University. Since the area had not changed overly much, the 1978 land-use map was able to be used to determine classifications that were difficult to ascertain from a visual inspection of aerial photos. The older map also aided in the determination of wetland habitats. However, forested wetlands were still difficult to identify so they were simply classified as forested lands. I also drove through the area to compare the map layer with what was actually present on-site to prevent errors such as classifying a housing development as forested because of the neighboring woody vegetation. The final land-use map had 5 categories of land use:

Developed/urban lands – patches of land that have been built upon by humans (houses, factories, parking lots, etc.)

Agricultural lands – patches of land that appear to have been farmed with obvious disturbance to the natural vegetation and top soil (tractoring and plowing).

Grasslands – patches of land that contain non-wet, non-forested, and non-farmed lands that have no evident tall woody vegetation.

Forested lands – patches of land that contained clumped trees with a dense canopy.

Non-forested wetlands – patches of land that are seasonally or permanently inundated, but have no tall woody vegetation. This category contains both emergent marshes and deep-water systems.

This land-use map was combined with the hydric soil layer to create a new map layer that depicted each of the land-use categories broken down into hydric and non-hydric subunits. Two of the categories did not have the split subunits. These categories were the developed lands and the non-forested wetlands. Wetlands have hydric soils and, therefore, lack a non-hydric counterpart. The developed lands were consistently non-hydric. The combined layer allowed me to determine how much of each land-use type would be purchased, how much of each land-use type is potentially (if not currently) wet, and how much land-use change could be initiated through the acquisition (e.g., agricultural lands changed to wetlands).

Landowner Attitudes

The simulation requires that the land parcels have established probabilities associated with whether or not they can be purchased. Without information about the landowners' attitudes toward selling, one could hypothesize

on the number of parcels that would be purchased, but all of the parcels would have the same probability of being purchased resulting in a randomly scattered accumulation of acquired land parcels. For a more realistic representation, a predictive criterion specific to the individual parcels would be needed to weigh the purchases so that the result would not be purely random. To address this issue, I conducted a survey of the landowners within the acquisition boundary. In the survey, I asked whether or not they would be willing to sell their land parcel and when over the next 20 years they would be willing to sell (Chapter 2). What the survey found was that a higher percentage (56.5%) of responding landowners with parcels that included some wetlands were willing to sell their land parcel than the landowners with non-wetland parcels (33.8%). Overall, 49.5% of the respondents replied that they would be willing to sell their land.

There was no way to conduct a non-respondent follow-up, so I did not ascertain whether the non-respondent attitudes would match the respondent attitudes. As there was no other information available, I was forced to project a probability of sale to all the land parcels by assuming that the respondents were representative of the non-respondents in terms of their willingness to sell. Because this is not an ideal assumption for simulation modeling, I explored the sensitivity of the non-respondent probabilities of sale to address the lack of a non-respondent follow-up. I set the respondents' probabilities to 1 or 0 in accordance with their survey response (1 representing a sale and 0 representing no sale) and varied the non-respondent probability of sale. I used three sets of values. The first was a uniform non-respondent probability of sale of 0.500

where there was no difference between wetland-containing parcels and non-wetland parcels. The second was a non-respondent probability that equaled the respondent probabilities where wetland owners were more willing to sell. Finally, the third value was a probability where the non-respondents' attitudes were opposite to those of the respondents (wetland-containing parcel and non-wetland parcel probabilities are switched, i.e. non-wetland parcels = 0.565 and wetland parcels = 0.338). An analysis of variance was used to determine significant differences between the results. Tukey's test was used to determine where the differences lay.

The importance of the survey information was examined in two ways. The first way was a comparison between hypothetical probabilities of sale and the survey derived probabilities of sale. Specifically, I compared the total amount of land purchased, the number of parcels purchased, the distribution of land types purchased, and the amount of hydric and non-hydric soil areas purchased. I used two hypothetical values, 0.500 and 0.333. The survey-derived probabilities were 0.565 for wetland-containing parcels and 0.338 for non-wetland parcels which yielded a total of 38.9% of the parcels being purchased.

The second examination of importance was to compare between two simulation scenarios where the total number of parcels purchased were held constant for both scenarios but the probabilities of sale were different. The purpose of these simulations was to examine the amount of land purchased and the distribution of land types purchased within an equal number of parcels. The first scenario used the survey derived probabilities which differed between

wetland and non-wetland parcels, while the second had a uniform probability for all land parcels (no difference between wetland and non-wetland containing parcels). A simple un-paired T-test was used to determine significant differences between the number of parcels purchased, the total area purchased, the existing wetland area purchased, and the hydric-soil areas purchased.

Acquisition Scenarios

Three acquisition scenarios were simulated. The first scenario was to introduce hypothetical incentive levels. To do this, I increased the survey-derived probabilities of sale to include a portion of the landowners who responded "undecided" to the question of whether or not they would sell. Since these landowners have not definitely said no to selling, they could potentially be persuaded to sell given sufficient encouragement. Two incentive levels (low and high) were used. The low incentive level assumed that half of the undecided landowners would sell. For example, 26.1% of the landowners with wetland-containing parcels were undecided. Half of this number (0.130) added to the original probability of 0.565 for the landowners that would sell yielded 0.695 (0.565 + 0.130) for the new probability of sale. Similarly, the new non-wetland parcel probability of sale was 0.438 (0.338 + 0.100). The high incentive level assumed that all of the undecided landowners would sell giving a probability of sale of 0.826 for wetland-containing parcels and 0.538 for non-wetland parcels. Of course, I expected that the total amount of land purchased would increase, but I was interested in the amount of each land type purchased under the

incentive levels. Existing wetlands and hydric areas were of great interest since the refuge is maintained primarily as a migratory staging area for waterfowl.

The next two scenarios operated at a no-incentive level and incorporated a temporal aspect into the simulations. To do this, I had to first derive an annual probability of sale. Since the original survey question was whether the landowner would be willing to sell within the next 20 years, the survey-derived probability of sale represents the probability that each parcel would be purchased within 20 years. Therefore, I divided the original probabilities down to an annual probability that would compound back to the original after 20 years. To do this, I used the following formula,

$$P_n = 1 - (1 - p)^n$$

where P_n represents the probability of an event occurring within n years and p represents the probability that an event will occur in a single year. Using this formula, I determined that the annual probabilities of sale were 0.041 for wetland-containing parcels and 0.020 for the non-wetland parcels. Using these probabilities, I could then determine the length of time required to complete the acquisition.

The first temporal scenario mimicked the acquisition project conducted by the USFWS where landowners are selectively and individually contacted with purchase offers. I assumed that only a specified number of parcels would be purchasable in the end. The number of parcels purchased was determined by the percentage of landowners willing to sell found in the survey. Also, I assumed that only a limited number of purchases would be attempted each year since

personnel limitations would prevent mass contacting of every landowner within the acquisition area. Since it had been suggested that facilitating the contacting of landowners with purchase offers would accelerate the acquisition process (Ramsey and Addison 1996), I opted to test this theory with my model. I ran the simulations with 5, 10, 15, 20, and 25 as the limits on the number of attempted purchases and compared the length of time that was required to complete the acquisition (only willing sellers have sold). It should be kept in mind that the USFWS selects the landowners to contact based upon an impression that the landowner would be willing to sell while the simulated contacts were randomly selected. This random selection would lengthen the time required to purchase the parcels from the willing sellers.

Whereas the first scenario assumed that only a number of landowners were contacted each year and only the land owned by willing sellers were purchased, the second scenario assumed that all of the parcels were contacted each year and that all of the parcels were purchasable given sufficient time. In other words, if the USFWS were persistent and patient, eventually, they would be able to buy all of the land parcels within the acquisition boundary. The simulation was run until all land parcels had been purchased to examine the length of time that would be required to completely purchase the acquisition area.

Each scenario was simulated 20 times because of the stochastic nature of the model. The results from each simulation were averaged for presentation in this paper.

Results

In all simulations where only the willing sellers sold, the acquired parcels were scattered within the acquisition area creating a matrix of purchased and non-purchased parcels at the end of the simulation (Figure 3-1). This is consistent with the results from the survey (Chapter 2) which suggested that at least 612 ha would not be purchasable and these parcels would be interspersed throughout the acquisition area. The intermixing of purchased and non-purchased parcels would limit the total wetland area that could be restored (hydric but not currently wet areas) because of, among other things, the high cost and the inefficiency of managing small units (Harold Prince, *pers. comm.*).

Obviously, if none of the landowners sell, the refuge would remain the same as it was before the attempted expansion. The refuge would consist of 3680 ha with approximately 850 ha of wet areas. If all of the landowners sell, the refuge would have added the entire 3035 ha within the acquisition area, nearly doubling its pre-expansion size. This 3035 ha includes 284 ha of developed lands, 1287 ha of non-hydric agricultural lands, 546 ha hydric agricultural lands, 144 ha non-hydric grasslands, 36 ha hydric grasslands, 590 ha non-hydric forested lands, 65 ha hydric forested areas, and 83 ha of non-forested wetlands. This gives a maximum of 582 ha for restorable wet areas if one assumes that the hydric forested areas are already wet.

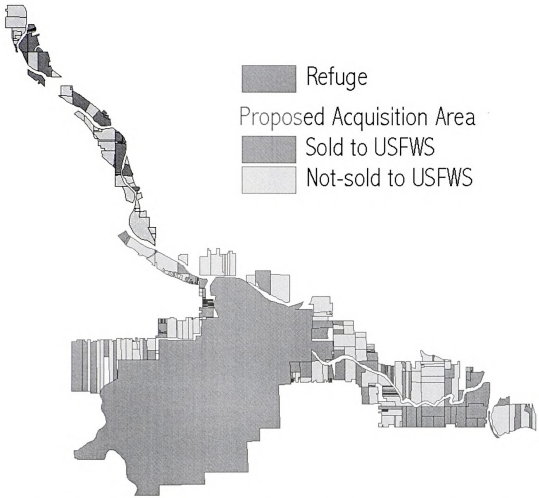

Figure 3-1. Example of spatial distribution of purchased parcels resulting from a land acquisition simulation.

Sensitivity of Non-Respondent Probabilities of Sale

In examining the sensitivity of the non-respondent probability of sale, I compared the total amount of acreage purchased, the amount of existing non-forested wetlands purchased, and the amount of hydric areas purchased (Table 3-1). The results from the reversed non-respondent probabilities were different from the other two ($p<0.05$). On the average, the total purchased hectares using the reversed non-respondent probabilities were over 100 ha lower than either of the other two even though the average number of parcels purchased fell between the values for the other two scenarios. The total acreage purchased and the existing wetland hectares purchased with the reversed non-respondent probability were significantly lower ($p<0.05$) than in those other two scenarios. The hydric-soil hectares purchased under the reversed probabilities were significantly lower than under the uniform non-respondent probability but was not

Table 3-1. Examination of the sensitivity of the non-respondent probability of sale. The numbers represent the average values (±s.d.).

Probability of sale	Number of parcels purchased	Total hectares purchased	Hectares of existing wetlands purchased	Hectares of hydric-soil areas purchased
Non-respondents equal to respondents	111.1± 6.0	1058 ± 265	34 ± 7	248 ± 30
Non-respondents opposite from respondents	115.6 ± 6.4	914 ± 264	24 ± 5	235 ± 26
Non-respondents uniform	120.6 ± 8.0	1087 ± 258	31 ± 6	285 ± 35

significantly lower ($p>0.10$) than under the survey-derived probabilities. A comparison between the survey-derived non-respondent probabilities and the uniform non-respondent probability shows no significant differences ($p>0.10$) in the amount of land purchased: total, wet, or hydric (Table 3-1). However, the number of parcels purchased with the survey-derived probabilities was significantly less ($p<0.01$) than the number purchased with the uniform probability.

Hypothetical vs. Survey-Derived Probabilities of Sale

The total amount of land purchased using each of the probabilities was consistent with the probabilities. Since the survey-derived probabilities of sale fell between the hypothetical percentages, the total area purchased also fell between those under the hypothetical simulations, with the low hypothetical probability of sale yielding 1107 ha, the survey-derived probabilities yielding 1400 ha, and the high hypothetical probability yielding 1595 ha. However, examining the land types purchased shows that the survey-derived probabilities result in a different distribution of land types (Figure 3-2). In the non-hydric agricultural, grass, and forested lands, I found a steadily increasing trend from the low hypothetical probability to the survey-derived probabilities to the high hypothetical probability where the survey-derived probabilities resulted in a value halfway between the values for the hypothetical probabilities. In the developed and hydric grassland categories, the survey-derived probabilities resulted in more

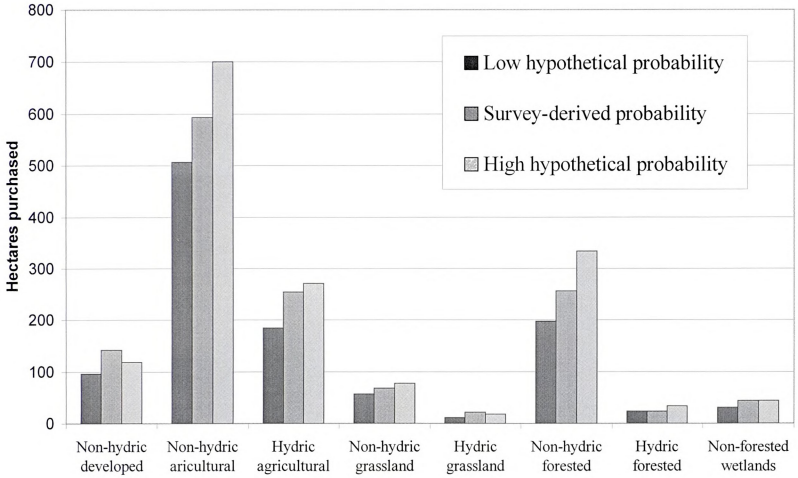

Figure 3-2. Amount of each land type purchased. The simulations were executed using a low (0.333) and a high (0.500) hypothetical probability of sale as well as probabilities of sale derived from a previously conducted survey.

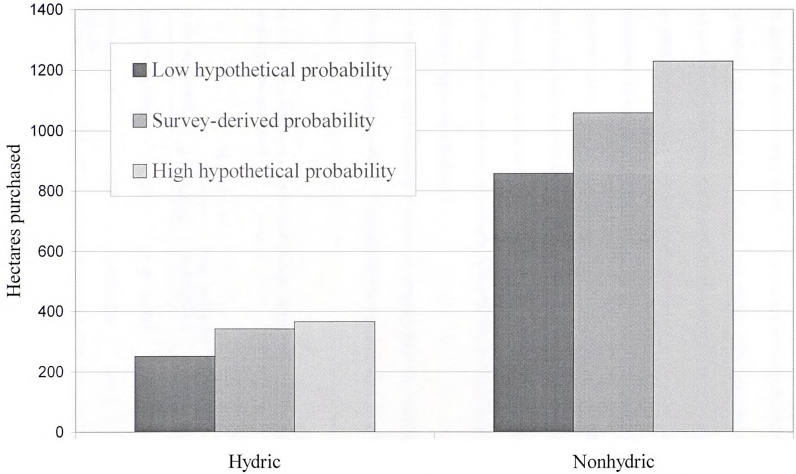

Figure 3-3. Hydric versus non-hydric soil areas purchased. The simulations were executed using a low (0.333) and a high (0.500) hypothetical probability of sale as well as probabilities of sale derived from a previously conducted survey.

land being purchased than the hypothetical probabilities. In the hydric forested lands and the non-forested wetlands, the survey-derived probabilities gave the same results as the high hypothetical probability. Grouping the categories into hydric and non-hydric areas (Figure 3-3), I found that, overall, the non-hydric areas steadily increased between the hypothetical and survey-derived probabilities. However, the hydric areas show that the survey-derived probabilities gave results more similar to the high hypothetical probability than the low hypothetical probability. This shows that the survey information is necessary if one wants to project the area purchased because the probability of sale influences the number of parcels sold and the distribution of the acreage across land type classifications.

In the second simulation scenario where I held the number of parcels purchased constant (n=124), I found that the total acreage purchased was

Table 3-2. Simulation results to test survey significance. The numbers represent the average values (±s.d.).

Type of Probability	Number of parcels purchased	Total hectares purchased	Hectares of existing wetlands purchased	Hectares of hydric-soil areas purchased
Uniform probability	124	1167 ± 227	32 ± 5	326 ± 64
Survey-derived probability	124	1400 ± 281	44 ± 10	341 ± 45

significantly higher ($p<0.05$) with the survey-derived probabilities which favor wetland-containing parcels (Table 3-2). The amount of existing wetlands that was purchased was also significantly higher with the survey-derived probabilities than with the uniform probability. Differing from this trend, though, was the amount of hydric-soil areas purchased. Between the two probabilities, the hydric areas purchased did not differ ($p>0.5$).

Incentives

As expected, the total amount of land purchased increased with the increasing incentive levels, going from 1326 ha to 1695 ha to 2045 ha. However, to evaluate whether or not it would be worthwhile to pursue incentives, I had to examine the different land types, both existing and potential, purchased using the different incentive levels. For the existing land types (Figure 3-4), the amount of agricultural land purchased increased the most. This was to be expected since the proposed acquisition area falls within a highly agricultural community. All of the land types, except for the non-forested wetlands, showed an increase in the amount of land purchased with the increasing incentive levels. The non-forested wetlands, surprisingly, did not increase with the low incentive level. Grouping the categories into hydric and non-hydric areas (Figure 3-5) showed that the areas purchased increased with increasing incentives. However, the increase of hydric areas was nearly linear while the increase in the non-hydric areas was not linear.

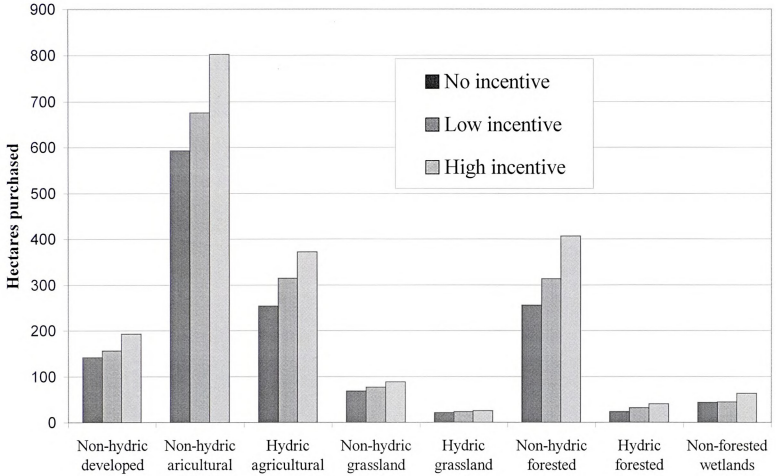

Figure 3-4. Purchased amounts of existing land types resulting from the land purchase simulation investigating the effects of incentives. Three incentive levels were used: no incentives, low incentives, and high incentives.

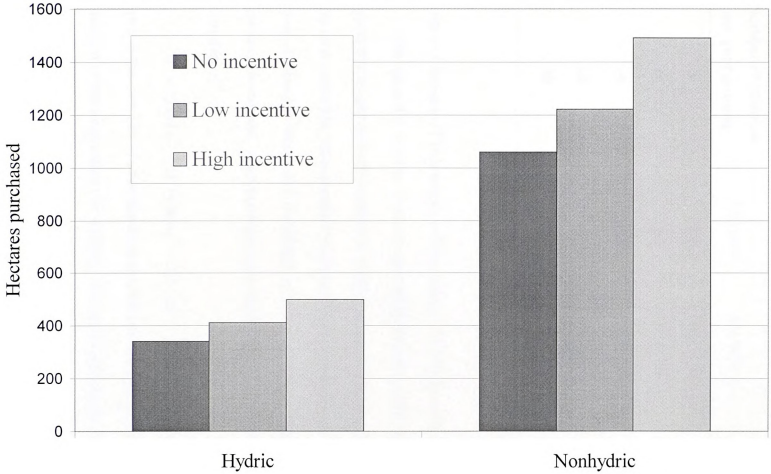

Figure 3-5. Hydric versus non-hydric soil areas purchased during the land purchase simulations investigating the effects of incentives. Three incentive levels were used: no incentives, low incentives, and high incentives.

Table 3-3. Simulation results using limited purchase attempts per year.

Number of attempts per year (parcels)	Years to completion of acquisition project		
	Minimum	Average (s.d.)	Maximum
5	759	830 (62.1)	925
10	402	437 (22.3)	470
15	234	297 (36.2)	345
20	198	222 (21.7)	260
25	154	177 (12.9)	196

Effects of Attempted Purchases on Time Required for Completing the Acquisition

Changing the number of attempted purchases per year significantly changed the length of time required to complete the acquisition to the point when all the land owned by willing sellers had been purchased (Table 3-3). As the number of attempts increased, the length of time required to complete the acquisition decreased. A polynomial regression (Figure 3-6) yielded a relationship of

$$Y = 0.01x^4 - 0.7496x^3 + 21.3x^2 - 285.71x + 1813.4$$

where x is the number of attempted purchases per year and Y is the years to completion of the acquisition ($R^2 = 0.98$). This finding supports the claim that facilitating contacts would accelerate the acquisition process (Ramsey and Addison 1996). However, a decision would need to be made on where the

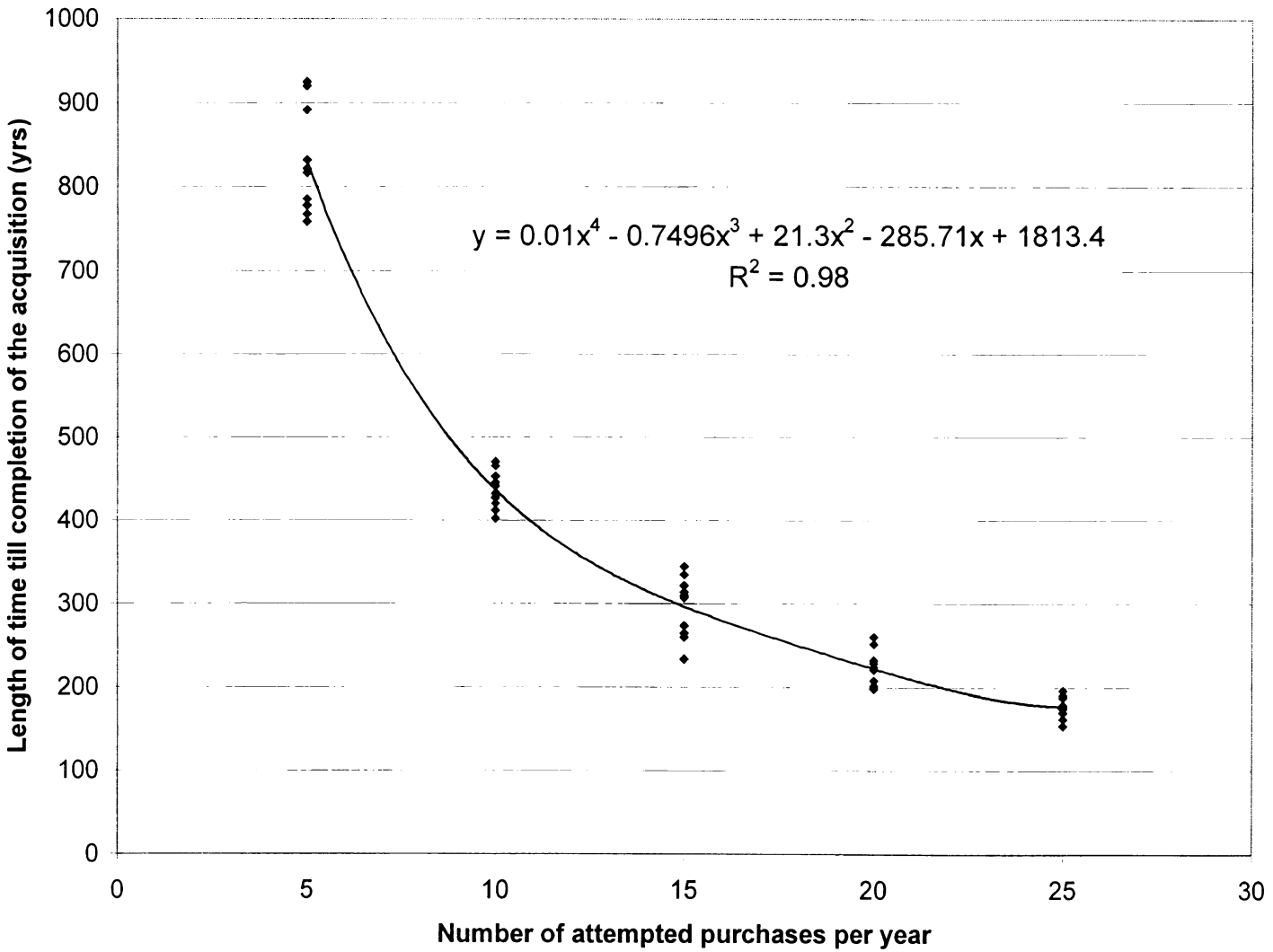

Figure 3-6. Relationship between the number of attempted purchases per year and the time required to purchase all of the land owned by willing sellers.

burden of the added effort and manpower required would discourage the desire for a shortened time frame.

Assuming that all parcels would be purchasable given sufficient time, I found that the acquisition project could be ongoing for many years, even if the USFWS manages to contact every landowner every year. The time frame ranged from 202 years to more than 300 years, and the average was 249.7 years (s.d. = 37.9). The average length of time required (249.7 years) is slightly lower than it should be because, in 2 of the 20 simulations, not all of the parcels had been purchased in 300 years. Since 300 years was the duration of the simulation, I have no data about how much longer than 300 years it would take to complete the acquisition. However, since this only happened in 2 of the simulations and because my purpose was only to demonstrate that the time frame was lengthy, I decided to forego any further analysis.

Discussion

The survey results were important for the land purchase simulations. The survey-derived probabilities of sale produced different distributions of the types of land purchased than did the hypothetical probabilities of sale. Also, the non-respondent probabilities were shown to be influential in determining the number of parcels purchased, the total area purchased, and the distribution of existing and potential land types purchased. Therefore, the lack of information on the non-respondents could have significantly affected the results. A consideration for other studies on the feasibility of acquisition projects would be to ensure that a

non-respondent follow-up can be accomplished. A non-respondent follow-up would provide more information for the simulation and ensure an improvement in accuracy of the simulation results.

The simulation results using the survey information show that less than half of the acquisition area would be purchasable without using incentives of some sort. Furthermore, the purchased parcels were interspersed with the not-purchased parcels, affecting the continuity of the newly expanded refuge (Figure 3-1). Small isolated units may be too costly and difficult to manage for the USFWS, so some of these small isolated units would not be managed until more land could be purchased around them (Harold Prince, *pers. comm.*). In addition, the acquisition project could take as many as 250 years to complete.

If the USFWS should decide to proceed with the acquisitions, the results also show that the USFWS should offer incentives to selling and increase the number of purchase offers made to landowners per year. Financial incentives that offer extra payment directly to the landowner would be impossible because the USFWS's policy is to buy land at the appraised value. Furthermore, offering more money to one landowner would necessitate an equal remuneration for other landowners to prevent disputes. Kershow (1975) states that incentives for selling should come in the way of services and not money. For instance, the relocation assistance offered by the USFWS would qualify as an incentive. Whatever incentives the USFWS chooses to use, the incentives would have to be tailored to each landowner for the greatest effectiveness.

Acknowledgements

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Chapter 4

Conclusions and Recommendations

The landowner survey suggested that less than half of the landowners within the acquisition area of Shiawassee National Wildlife Refuge would be willing to sell their land without incentives, and landowners who owned portions of wetlands would be more willing to sell than landowners who did not. Also, the survey indicated that at least 612 ha of the land within the acquisition boundary would not be purchasable for various reasons. The simulation model showed that less than half of the land area would be purchased without some incentives, and that the acquisition project would take over 200 years to fully complete. In addition, over two-thirds of the area purchased would be non-hydric and only manageable as upland habitat. While this may be good because it increases habitat connectivity, upland habitat is not optimal for waterfowl management. Furthermore, both the survey and the simulation model suggested that there would be non-purchased parcels interrupting the overall continuity of the expanded refuge. While continuity may not overly affect waterfowl that can fly to other locations and are not dependent upon land corridors, it can be a requirement for affordable management if the area is actively managed (meaning that the units are constantly maintained at defined conditions). Small units are extremely expensive to restore and manage (Harold Prince, *pers. comm.*); therefore, they probably would not be managed until other land around them could be purchased.

The proposed acquisition for the expansion of Shiawassee National Wildlife Refuge (refuge) will not fulfill the objectives of the United States Fish and Wildlife Service (USFWS; objectives can be found in United States Fish and Wildlife Service 1996). However, should the USFWS wish to continue with the acquisition project and facilitate it, they can increase the amount of land purchased by offering incentives for selling.

Also, the comments from landowners written on the survey questionnaires indicated that some of the landowners who would not sell were not against selling. They were just against selling their land to the USFWS because they did not agree with the practices of the USFWS or felt that the USFWS abused its power during the original establishment of the refuge. Communicating with these landowners about the purpose of the expansion, the issues surrounding the conservation movement, and the current methods employed by the USFWS could sway these landowners into selling their land.

One way to overcome the bias against the USFWS is to acquire the land through another agency. Currently, there exists a cooperation between the Michigan Department of Natural Resources (MDNR) and the USFWS to acquire and exchange land (James Dastyk, *pers. comm. 1999;* Brian Vogl, *pers. comm.* 1999). The MDNR operates a neighboring state game area and is interested in acquiring a piece of the refuge that is excellent for goose hunting. The agreement is that the MDNR will acquire an equal amount of land from the acquisition area and then trade it to the USFWS. Using the MDNR to purchase the land overcomes the barrier of landowners disliking the USFWS. In addition,

the MDNR can more conveniently pursue sales. The MDNR is housed within the state with the main headquarters located approximately 90 miles away from the refuge. This is much closer than the USFWS realty offices in Minnesota, which are handling the refuge's expansion. Further partnerships where another organization is used to initiate the sales could expedite the acquisitions.

Another recommendation would be to alert the landowners within the acquisition area that they are within the acquisition boundary. Since I received comments back on the survey that indicated several landowners had been unaware of the acquisition plan and several of these landowners solicited me for USFWS contact information to discuss sales, I would assume that the number of sales per year would be increased if all of the landowners knew that the refuge was attempting to expand. This would at least provide more names to negotiate with than just the people with whom the refuge manager has contact.

Finally, the sales should be approached using a spatial priority system to address the issue of connectivity. One example of a spatial priority system would be purchasing parcels immediately connected to the refuge and then moving outwards. A purchase priority system of this type would ensure that any purchases could be immediately incorporated into the management of the refuge and would eliminate the small isolated units that would present difficulties for managers.

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