2015

How Wildlife Information, Recreation Involvement And Demographic Characteristics Influence Public Acceptability Of Development

Jessica Espenshade
University of Vermont, jespenshade@gmail.com

Follow this and additional works at: http://scholarworks.uvm.edu/graddis

Part of the Natural Resources Management and Policy Commons

Recommended Citation

This Thesis is brought to you for free and open access by the Dissertations and Theses at ScholarWorks @ UVM. It has been accepted for inclusion in Graduate College Dissertations and Theses by an authorized administrator of ScholarWorks @ UVM. For more information, please contact donna.omalley@uvm.edu.
HOW WILDLIFE INFORMATION, RECREATION INVOLVEMENT AND DEMOGRAPHIC CHARACTERISTICS INFLUENCE PUBLIC ACCEPTABILITY OF DEVELOPMENT

A Thesis Presented

by

Jessica Lyn Espenshade

to

The Faculty of the Graduate College

of

The University of Vermont

In Partial Fulfillment of the Requirements for the Degree of Masters of Science Specializing in Natural Resources

October, 2015

Defense Date: June 11, 2015

Thesis Examination Committee:

James D. Murdoch, Ph.D., Advisor
Ruth M. Mickey, Ph.D., Chairperson
Therese M. Donovan, Ph.D.
Robert E. Manning, Ph.D.
Cynthia J. Forehand, Ph.D., Dean of the Graduate College
ABSTRACT

Increasing development like roads and houses will alter the future landscape of Vermont. Development provides important resources for people and society, but also results in consequences for wildlife and opportunities for recreation. Managing development requires information on the public’s acceptability of development and how acceptability is shaped by information on various consequences. In this study, I examined three questions: 1) What is the public’s acceptability of development? 2) Does wildlife information influence public acceptability of development and 3) Is the maximum amount of acceptable development influenced by views about wildlife, involvement in recreation, and demographic factors? I surveyed 9,000 households in Vermont by including a questionnaire which asked about development, wildlife, recreation, and demographics. I assessed acceptability of amount of development using social-norm curves and used parametric significance tests and mixed-effects models to examine the influence of wildlife, recreation, and demographic factors. The survey response rate was 44%. The maximum acceptable amount of development was slightly more than 32 households/km², and not meaningfully influenced by the broader consequences of development on seven common wildlife species. The public demonstrated a strong preference for clustered development over sprawled development, which became unacceptable at 20 households per km². Maximum acceptability of development was significantly influenced by views on some species, including bear, bobcat, and fisher, but not by others such as deer, fox, raccoon, and coyote. Similarly, those involved in common forms of outdoor recreation, including birding, ATVing, hunting, fishing and camping, were significantly less accepting of development relative to those not involved in these forms of recreation. Maximum amount of development was also affected by demographic factors, including town density, respondent age, home ownership and location of birth. The results provide a baseline measure of the public’s acceptability of development, which can be used to guide decision-making about amount and pattern of development, wildlife management, and efforts to promote recreation in the state.
ACKNOWLEDGEMENTS

First, I would like to thank the Northeastern States Research Cooperative for providing funding for the project. Specific thanks goes to Dr. Breck Bowden and Kate Baldwin for their support on the grant. I would like to thank my advisor, Dr. James Murdoch for his assistance and guidance throughout my Master’s degree process. I would like to acknowledge Dr. Therese Donovan for her support and modeling expertise. Additional thanks goes to Dr. Ruth Mickey for agreeing to be my committee chair and providing statistical guidance. Dr. Robert Manning was invaluable for his social science expertise, especially in the realm of recreation. I would also like to acknowledge Charles Bettigole, who without his initial project and ideas, there would be no baseline for this project. Michelle Brown and Christopher Hansen were instrumental in the initial stages of GIS assistance and support. Thank you to Bill Valliere with his assistance through the human subject review, Dr. Scott Merrill for assistance with R, and Chris Bernier for providing his expert opinion on species distribution models. Additional thanks goes to the Vermont Cooperative Fish and Wildlife Research Unit and the Rubenstein School of Environment and Natural Resources. Thank you to all readers and reviewers of the manuscripts for your helpful comments and to the Rubenstein Wildlife Graduate Lab Group for your continuous support. Finally, thank you to my family and friends for their unwavering support throughout this process.
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS.................................................................................................................. ii

LIST OF TABLES.................................................................................................................................. v

LIST OF FIGURES............................................................................................................................. vi

CHAPTER 1: INTRODUCTION.......................................................................................................... 1

1.1. Overview of Thesis Sections ....................................................................................................... 1

1.2. Significance of Research ........................................................................................................... 1

CHAPTER 2: REVIEW OF RELEVANT LITERATURE................................................................... 2

2.1. Overview....................................................................................................................................... 2

2.2. Increased Human Development................................................................................................ 3

2.3. Effects of Development on Wildlife.......................................................................................... 4

2.4. Development Policy History in Vermont .................................................................................... 8

2.5. Occupancy Modeling................................................................................................................. 11

2.6. Recreation Involvement and Wildlife Interest.......................................................................... 13
2.7. Public Acceptability ........................................................................................................ 15

2.8. Public Surveys .................................................................................................................. 16

2.9. Linear and Mixed Effect Modeling ................................................................................... 17

2.10. References ......................................................................................................................... 19

CHAPTER 3: RESEARCH ARTICLE ......................................................................................... 24

3.1. Introduction ....................................................................................................................... 25

3.2. Methods ............................................................................................................................ 28

3.3. Results ............................................................................................................................... 37

3.4. Discussion ........................................................................................................................ 40

3.5. Acknowledgements .......................................................................................................... 45

3.6. References ......................................................................................................................... 45

3.7. Figure Legends. ................................................................................................................. 50

COMPREHENSIVE LITERATURE REVIEW ............................................................................ 65

APPENDICES .......................................................................................................................... 72
Table 1. Predictive models for minimum acceptable condition of development by respondents surveyed in Vermont, USA. All subsets of fixed values, including population of county (Pop), whether the respondent’s primary residence was in Vermont (VT primary), whether the respondent was born in Vermont (VT born), whether the respondent owned their home (Own house) and the year the respondent was born (Year born) are listed with model parameter estimates and AICc scores.
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3.1</td>
<td>Additional questions on a questionnaire sent to households in Vermont included documenting preference, most like town, displacement (not want to live), and regulation (max allow). The answers were based on six illustrations depicting the following housing densities (#households/km²): 1 = 1.71, 2 = 4.58, 3 = 12.57, 4 = 32.86, 5 = 88.06 and 6 = 235.83. The average response for each question was graphed to obtain a multidimensional understanding of development acceptability and management implications.</td>
<td>54</td>
</tr>
<tr>
<td>Figure 3.2</td>
<td>Wildlife information legend for the illustrations in the wildlife treatment group. A check mark indicated the species was present in the illustration. A blank space indicated that the species was not present in the illustration.</td>
<td>55</td>
</tr>
<tr>
<td>Figure 3.3</td>
<td>Survey illustrations portraying varying amounts and spacing of housing development. Illustrations A and B show 50 houses, illustrations C and D show 100 houses, and illustrations E and F show 150 houses. Left-side illustrations depict a clustered housing arrangement and right-side illustrations depict a sprawled housing arrangement.</td>
<td>56</td>
</tr>
<tr>
<td>Figure 3.4</td>
<td>Example of a norm curve from Manning (2007). Respondents rated acceptability of number of groups encountered along a trail per day based on a visual preference survey from -4 (completely unacceptable) to +4 (completely acceptable). The highest point on the curve is the optimum condition. Where the line crosses zero is the minimum acceptable condition. The range of the values represents the salience. I used norm curves to evaluate acceptability of development and influence of wildlife information and involvement in recreation activities.</td>
<td>57</td>
</tr>
<tr>
<td>Figure 3.5</td>
<td>Additional questions on a questionnaire sent to households in Vermont, USA included documenting preference, most like town, displacement (not want to live), and regulation (max allow). Responses were based on six illustrations depicting the following housing densities (#households/km²): 1 = 1.71, 2 = 4.58, 3 = 12.57, 4 = 32.86, 5 = 88.06 and 6 = 235.83. The average response for each question was graphed to obtain a multidimensional understanding of development acceptability and management implications.</td>
<td>58</td>
</tr>
</tbody>
</table>
Figure 3.6. Social norm curves of acceptability of development by treatment group based on a visual preference survey sent to households in Vermont, USA. Respondents were asked to rate acceptability of six illustrations showing different amounts of development on a scale of -4 (completely unacceptable) to +4 (completely acceptable). Illustration 1 had the lowest amount of development (1.7 houses/km²) and subsequent illustrations increased exponentially in housing density to Illustration 6 (238 houses/km²). The ‘wildlife’ treatment represents responses to surveys (n = 1,783) that included information on the presence/absence of seven species in each illustration. The ‘control’ treatment represents responses (n = 1,846) to surveys that did not include wildlife information. Each value on the curves is the mean acceptability score across respondents. The minimum acceptability point, x when y is zero, is slightly more than illustration 4, which had a density of 32 households per km². There was no statistical difference between the treatment groups ...

Figure 3.7. Acceptability of housing density and distribution based on a visual preference survey sent to households in Vermont, USA. Respondents (n = 3,629) were asked to rate the acceptability of illustrations showing three different housing densities arranged in clumped and sprawled arrangements on a scale of +4 (completely acceptable) to -4 (completely unacceptable). Values represent mean scores across respondents. When a bar crosses zero representing a negative value, the amount and pattern combination is no longer acceptable...

Figure 3.8. Salience levels of development and range of development acceptability based on a visual preference survey of households in Vermont, USA are compared for different species acceptability scores. Salience scores represent the degree of intensity of interest in development according to their views on seven common wildlife species. Trend lines are added to portray the relationship between species acceptability and interest in development amount...

Figure 3.9. Mean (± SE) minimum acceptability of development by views of seven common wildlife species based on a visual preference survey of households in Vermont, USA. Acceptability of development represents the point where a social norm curve crosses zero. Acceptability is compared for respondents who found species acceptable (acceptability ratings of +4 to +1) or unacceptable (acceptability ratings of -1 to -4)...

Figure 3.10. Salience levels of acceptability of development based on a visual preference survey of households in Vermont, USA. Salience scores represent the degree of intensity of interest in development according to involvement in recreation activities...
Figure 3.11. Mean (± SE) minimum acceptability of development by involvement in common recreational activities based on a visual preference survey of households in Vermont, USA. Acceptability of development represents the point where a social norm curve crosses zero. Acceptability is compared for respondents who participated in each recreation type versus those who did not. There was a significant difference (p<0.05) for ATV, birding, fishing, hunting and snowmobiling.
CHAPTER 1: INTRODUCTION

1.1. Overview of Thesis Sections

This thesis is comprised of three sections:

1) A review of relevant literature;

2) A scientific article written for publication focusing on the influence of wildlife
   information, recreation involvement and demographic characteristics on
   development acceptability; and

3) A comprehensive bibliography

1.2. Significance of Research

With increasing human population there will be increased pressure to manage
for the environmental effects of development. Public opinion often shapes environmental
legislation; however there is a lack of understanding for what influences public opinion
on development. Previous research has shown that perception of wildlife and
involvement in recreation can affect environmental attitudes and behavior, but it is
currently unknown how these factors influence acceptability of development.
Understanding the influence of these factors will assist in landscape planning and
decision making and how to influence public support for development in the future.
CHAPTER 2: REVIEW OF RELEVANT LITERATURE

2.1. Overview

Increasing human development presents many challenges for the future. Consequences of development include altering wildlife habitat and opportunities for recreation through habitat fragmentation, conversion, and loss (Bennett and Saunders, 2010; Lindenmayer and Fischer, 2013). Since the 1970s there has been an increase in development regulations in Vermont including regulations on sprawl and amount (Glitman and Perkins, 1999; Herrick, 2014b). To fully understand the impacts that development has on wildlife and recreation, managers can quantitative assess how land use changes will impact wildlife presence and patterns. Occupancy modeling is one tool that can be used to create predictive models to assess the change of wildlife occupancy under different development scenarios (MacKenzie et al., 2006).

The public are stakeholders in development decisions and their attitudes guide public policy (Page and Shapiro, 1983; Agnone, 2007). An individual has a greater interest in protecting environmental values when they are involved in outdoor recreation. These values may change the support for future development projects. Surveys can assess the acceptability of development for multiple stakeholders. The results of the surveys can be used to create social norm curves and predictive models, such as linear mixed effect models, to help guide future development.

This thesis focuses on the influence of three factors on public acceptability of development, including acceptability of wildlife, involvement in outdoor recreational
activities, and demographic characteristics. The following sections provide a review of literature relevant to the main topics and themes of the thesis.

2.2. Increased Human Development

Increasing human populations have led to increasing development such as roads, houses and infrastructure (White et al., 2009). From 1982 to 2003, developed land in the United States increased by 48%, which equates to 680,000 hectares of converted rural land developed annually (U.S. Department of Agriculture, 2007; White et al., 2009). This increasing development trend is happening across the entire country, even in states with currently low levels of development (White et al., 2009).

Vermont is currently the second least populated US state. However, over the past century, the estimated population of Vermont almost doubled in size according to the United States Census Bureau (United States Census Bureau, 2013). This increasing population changed the scenery and composition of the Vermont landscape due to development such as roads and houses (Lindenmayer and Fischer, 2013). In the mid-1800s, landscape cover in the New England states reached a record low percentage of forest cover at 30% due to industrialization (Lindenmayer and Fischer, 2013). However as people moved from agricultural-based work to more industrial work, abandoned farming land regenerated back into 2nd generation forest cover, but lacked the vegetation complexity of the 1st generation forest cover (Lindenmayer and Fischer, 2013). In 2003, the state was once again 78% forested (Wharton et al., 2003). Even though the total amount of forest is not predicted to experience large declines in the next 20 years in
Vermont, the fragmentation of existing forests represents a concern (Schmiegelow and Monkkonen, 2002; Wharton et al., 2003; Stein et al., 2005).

Forest fragmentation is increasing and expected to impact the health of forest ecosystems (Lindenmayer and Fischer, 2013). The trend of development is favoring suburban housing projects which decrease the amount of undisturbed land and increase the amount of small patches of land (Lindenmayer and Fischer, 2013). Increased parcelization of previously undisturbed land has become a large problem over the past 35 years in Vermont (Fidel, 2008). Twenty-four million acres became parcelized in the northern Vermont forest between 1980 and 2005 (Fidel, 2008). This parcelization has effects for future conservation efforts since there are so many landowners involved in forest management, which may not use forest best management practices (Fidel, 2008).

2.3. Effects of Development on Wildlife

Development often affects the distribution of wildlife by decreasing the total amount of habitat, as well as fragmenting intact habitat (Theobald et al., 1997). Fragmentation not only changes the size and isolation of forest patches, but also changes the physical and biological characteristics of fragments (Saunders et al., 1991; Bennett and Saunders, 2010). Changes in forest extent due to development and fragmentation are estimated to affect habitat quality for up to 80% to 90% of all mammal, reptile, bird, and amphibian species that are found in forest habitats in the United States, 28% of which are listed as endangered (USDA Forest Service, 1997; USDA, 2011). Minimizing and
isolating wildlife habitat will impact individual species distribution, species richness and genetic composition of populations (Quinn and Harrison, 1988; Dudash and Fenster, 2000; Dixo et al., 2009; Zipkin et al., 2009; Gotelli and Colwell, 2010).

*Island Biogeography*

Development splits forest into smaller parcels and consequently into ‘island populations’, in a process called fragmentation (Saunders, 1991). Consequences of fragmentation are often explained by the theory of island biogeography (MacArthur and Wilson, 1967). Island biogeography was originally intended to predict species richness, total number of species in an area, on an island (Gotelli, 1991; Zipkin et al. 2009, ). However the theory of island biogeography also applies to an isolated area such as a mountain top or fragmented landscape (Quinn and Harrison, 1988). The equilibrium theory of island biogeography is based on the balance between immigration and extinction (MacArthur and Wilson, 1967). When immigration and extinction rates of species on an island are the same, it is considered to be in a state of equilibrium, which is a state of stability (MacArthur and Wilson, 1967).

Area of a fragment directly affects species richness (Quinn and Harrison, 1988; Gotelli and Colwell, 2010). Species richness is a measure of the environmental health of an area (Zipkin et al., 2009). Species richness has a log-log relationship with fragment size (Quinn and Harrison, 1988). This relationship indicates that the smaller the patch of land, the less species richness present because there is less habitat for species to occupy (Quinn and Harrison, 1988). Size of a patch also influences the target effect
because larger patches or “targets” have a higher chance of discovery by a species (Gotelli, 1991; Gotelli and Colwell, 2010). Isolation of a habitat patch also affects species richness because the farther away the fragment, the harder it will be for species to reach it, which will subsequently reduce the rate of immigration (Saunders et al., 1991; Fahrig, 2003). The overall rate of change can be determined through the number of colonizing species over time minus the number of species going extinct on the island over time. The rates of immigration and extinction are dependent on the amount of species in a fragment or island and the number of species in a mainland source (Harris, 1984; Gotelli, 1991; Gotelli and Colwell, 2010). Size and isolation of fragments is a direct effect of the amount and spacing of development (Theobald et al., 1997). However, criticism does exist for the extent that island biogeography predicts species richness consequences for areas other than actual islands that are surrounded by water. Consequences for fragmentation could differ because forest fragmentation does not necessarily impede movement between patches the same way that movement would be restricted on an island (Mendenhall et al., 2014). Therefore it is important to be cautious when making predictions about fragmentation effects in terrestrial systems when relying solely on size and isolation factors (Mendenhall et al., 2014).

Effect of parcelization on fragment composition

Fragmentation alters the structure of forest parcels, including climate, light intensity, and vegetation composition (Saunders et al., 1991; Bennett and Saunders, 2010; Lindenmayer and Fischer, 2013). Cleared areas increase the heat in the soil due to an
increase of direct sunlight (Saunders et al., 1991). Many native forest interior plant species cannot thrive under direct sunlight or changes in the microclimate of the soil (Geiger, 1965; Saunders et al., 1991). These micro-scale to macro-scale changes will decrease variation in plant composition over time because there will be less variation throughout the parcel (Geiger, 1965; Milthorpe and Moorby, 1974; Saunders et al., 1991). This homogenization will affect species of wildlife that depend on vegetation variety for dietary requirements, such as bears (*Ursus americanus*) as they prepare for hibernation (Reynolds and Beecham, 1980; Saunders et al., 1991; Amstrup, 1993; Andren, 1994; Fahrig, 2003).

*Genetic Effects*

Smaller and remote fragments have a decreased opportunity for gene flow between populations and consequently an increased chance of inbreeding depression, reduced biological fitness as the result of population inbreeding (Dudash and Fenster, 2000; Frankham et al., 2002). Small fragments can only provide enough resources for smaller populations, and will therefore have a fewer number of individuals (Dudash and Fenster, 2000; Dixo et al., 2009; Lindenmayer and Fischer, 2013). If fragments are isolated, there is a limited chance of introducing new individuals into the area and dispersal ability will decrease (Quinn and Harrison, 1988). This decrease in dispersal, will negatively impact gene flow (Frankham et al., 2002; Coulon et al., 2004). Therefore increasing the population through breeding without increasing genetic diversity, will lead to a more homogeneous population (Dudash and Fenster, 2000; Coulon et al., 2004).
Some genetically homogeneous populations will have a decreased ability to survive changes in their surrounding or disease outbreaks and therefore a more limited chance of success (Dudash and Fenster, 2000; Dixo et al., 2009).

2.4. Development Policy History in Vermont

Currently, 80% of Vermont forests are privately owned with only 6% being directly managed by the federal government (Wharton et al., 2003; Vermont Monitoring Cooperative, 2009). There are certain statewide policies that dictate which patterns of development should be further regulated. Beginning in the 1970s, Vermont adopted many policies to reduce fragmentation caused by development, otherwise known as development sprawl. These policies were created with the overall goal of reinforcing the general character of planned growth patterns that will maintain the historic settlement pattern of compact villages and urban centers separated by rural countryside (Glitman and Perkins, 1999).

Act 250 was first enacted in 1970, which required a public review process to manage the environmental, social and fiscal consequences of land subdivision and development in Vermont. Permits under Act 250 are necessary for all construction projects that take place on more than 10 acres of land, include 10 or more housing units or subdivide land into 10 or more lots (The State of Vermont, 1970). There are additional situations such as the drilling of an oil or gas well or any withdrawal of more than 340,000 gallons of groundwater per day that also require an Act 250 permit (The State of Vermont, 1970).
In 1987, the Vermont General Assembly established the Vermont Housing and Conservation Board (VHCB) to respond to the increasing pace of development, which was changing the landscape and consequently affecting quality of life in the state. This board administers grants to municipalities, nonprofits, housing co-opts and qualifying state agencies that seek to conserve agricultural lands, natural areas, recreational lands and historic properties (Libby, 1990; VNRC, 1999; Libby and Bradley, 2000; Libby, 2010). The Vermont Housing and Conservation Trust Fund Act has been influential in the development and conservation of public land (Wagner, 2013).

Act 200, otherwise known as the Growth Management Act of 1988, sought to fill a gap from Act 250. Its goal was to incorporate public planning and public participation before the permit application process began. The planning purposes included the creation of policy plans supported by public participation and comments as well as the consideration of both community welfare and resource usage, including wildlife habitat (Vermont Housing Finance Agency, 1988). Unfortunately, according to a review 15 years after implementation, there was a lack of coordination between state government and planning. Failed planning follow through and an overall lack of funding, has labeled this act a policy failure (Glitman and Perkins, 1999; Agency of Commerce and Community Development, 2003).

In 2002, there was a legislative push to provide private landowners with technical, educational and financial assistance in managing forests on a sustainable basis (Division of Forestry, 2006). This assistance was provided by the Forest Land Enhancement Program (FLEP), which was part of the federal Farm Bill (Division of
Forestry, 2006). Landowners with between 10 and 1,000 acres of contiguous forest are eligible for cost shared practices including reforestation, improving forest health, water quality improvement and fish and wildlife habitat improvement. The program requires 10 years of landowner involvement in the program. This assistance allows for the implementation of continuous and consistent forest practices, which are normally lacking when land is parceled by private ownership (Division of Forestry, 2006; Fidel, 2008).

A recent act passed in 2014 by the Vermont legislature regulates development within 250 feet from a lake’s mean water level for all lakes greater than 10 acres in size. This act, the Vermont Shoreland Protection Act, was established to protect the degradation of water quality in lakes and preserve habitat for terrestrial and aquatic animals (General Assembly of Vermont, 2014). Development can take place in the protected shore land area, which is within 100-250 feet of the water’s edge, however the act requires a maximum of 40% cleared area and no more than 20% impervious surfaces. The act does not apply to existing development that are not undergoing changes to the land or property (Vermont Department of Environmental Conservation, 2014).

In February 2014, bill H.823 was introduced into the Vermont legislature to change the Act 250 permitting process to encourage downtown and development adjacent to existing development. A main aim of the bill was to scale back strip development and only encourage development in areas that need revitalization. The bill lifts the strict regulations of Act 250 to allow more housing development and expedite the permitting process in certain areas. There was controversy surrounding this bill from both environmentalists and developers. Developers were worried about how out-of-town
development would be limited or stalled, since many development projects resemble strip development. Environmentalists were concerned about how streamlining the permitting process may be taken advantage of by developers both within urban and rural areas (Herrick, 2014b, a). However the executive director of the Vermont Natural Resources Council, Brian Shupe and other employees (McCarthy, 2014) believed that the bill struck a good balance between development and environmental protection and if the bill had more environmental stipulations, there would be no chance of enactment (Herrick, 2014b). After only 3 months of debate, the bill was signed into law on May 27, 2014.

Act 200 and Act 250 have a pro-environmental stand on development management, but they do not have directives regarding sustainable wildlife population numbers or opportunities for recreation. Vague or indirect legislation leaves room for interpretation (Stone, 2011). Wildlife protection needs to be specifically addressed in new legislation to create metrics for wildlife and recreation impacts from development.

2.5. Occupancy Modeling

Land cover changes often affect the distribution of species. To successfully manage wildlife populations, managers need to understand how occupancy patterns of various species will change under different management scenarios (Kareiva and Wennergren, 1995). Occupancy modeling is a tool which allows for the estimation of presence in an area (MacKenzie et al., 2002). Occupancy data can then be used to inform decision-making (Long et al., 2011; Zeller et al., 2011). For example, identification of the habitat characteristics through detection surveys for the movement and breeding patterns.
of the wood frog (*Lithobates sylvaticus*) allowed researchers to predict with modeling what area needed to be protected to increase the chance of a successful frog breeding season (Baldwin et al., 2006).

Occupancy modeling is based on detection and non-detection information (MacKenzie et al. 2006). This information can be used to predict the probability of occupancy and the probability of detection, rather than assuming perfect detection (MacKenzie et al., 2006). With the use of site and survey covariates, such as forest percentage, elevation, temperature, the developed model can be applied to any given site with the landscape where that information is known (MacKenzie et al., 2006).

Occupancy modeling is based on maximizing the multinomial likelihood function (MacKenzie et al., 2006). The function determines the most likely values of Ψ (occupancy) and p (detection), based on encounter histories (MacKenzie et al., 2006). The covariates will be taken into account when they are identified as predictors of either detection or occupancy. Researchers can then develop a model set that represents a-priori hypothesis that explain occupancy probability (Burnham and Anderson, 2002).

Akaike’s Information Criterion (AIC) is then used to rank each model (Bozdogan, 1987; Burnham and Anderson, 2002). AICc can also be used with an additional bias-correction for small sample sizes (Burnham and Anderson, 2002). The model with lowest AIC value has the highest likelihood of being the best model in the set. Delta AIC and model weights may also be used to evaluate the model set (Bozdogan, 1987; Wagenmakers and Farrell, 2004). Once a model is selected, the model parameter estimates (betas) can be applied to any given location in the landscape to estimate the
probability of occupancy. The model can also be applied to simulated landscapes to explore the impacts of change on a species (MacKenzie et al., 2006).

Occupancy models have been used to plan for development impacts in Vermont. Black bear, fisher (Martes pennanti) and bobcat (Lynx rufus) are especially sensitive to habitat changes (Long et al. 2011). Occupancy models identified important habitat covariates including percentages for forest, core, conserved, wetlands and developed land, for these three sensitive species (Long et al., 2011). The betas from the occupancy models allow researchers to determine occupancy probability as these covariates change under different circumstances (Long et al., 2011). Similar research has been conducted on various bird species and eastern newts (Notophthalmus viridescens) across Vermont (Rinehart et al., 2009; Schwenk and Donovan, 2011; Brown et al., 2014).

2.6. Recreation Involvement and Wildlife Interest

People all have a value set regarding wildlife (Kellert, 1992). Eight distinct types of wildlife values have been described (Kellert, 1992). Aesthetic value has a focus on the physical and symbolic appeal of animals. Dominionistic value has a focus on the control of wildlife, specifically for sport. Ecologist value has an emphasis on the environment as a system including wildlife and their habitat. Humanistic value is concerned with individual animals with anthropomorphic associations. Naturalistic value is focused on the direct experience of wildlife in a recreation setting, such as bird watching or photography. Negativistic value is an avoidance of wildlife due to indifference or fear. Scientist value is focused on the physical functioning of animals.
and lastly, *utilitarian* value is the use value of wildlife. Each of these values influence the baseline for how an individual experiences the natural world on a daily basis (Kellert, 1984; Kellert, 1992, 1996). The influence of wildlife values on attitudes can be modified by perception of individual species or general understanding. For example, if an individual has a negativistic value of grizzly bears (*Ursus arctos horribilis*), they may be indifferent to conservation measures. However an individual with an aesthetic or ecologic value of grizzly bears, would have a higher appreciation and would be more supportive of conservation, both idealistically and monetarily (Kellert, 1984; Kellert, 1992, 1996).

Numerous studies have shown that outdoor recreationists are more environmentally concerned in their value sets and in pro-environment behaviors (Bryan, 1977; Theodori et al., 1998; Teisl and O'Brien, 2003). Environmental political agendas have used the support of recreation groups to document support when seeking to protect open lands (Teisl and O'Brien, 2003). These agendas can be successful promoted to individuals most affected by the outcome. Specific recreation protecting agendas can consequently rely on the support of recreationists because of their concern for protection of the pursuit of specific outdoor activities (Teisl and O'Brien, 2003). As individuals become more involved in a resource-oriented or recreation activity, the concern for natural resources increases (Bryan, 1977). According to Daigle et al. (2002), type of recreation greatly influences a recreationists wildlife-related values and attitudes. In this study, hunters differed from wildlife viewers and other outdoor recreationists due to their
placed importance on consumptive needs versus intrinsic value; however all groups acknowledged the value of wildlife-oriented recreation benefits. A study by Theodori et al. (1998) examined the relationship between outdoor activities, such as camping, hiking, biking and skiing, and pro-environment behaviors and found that there was a positive association. There was no difference between consumptive and non-consumptive activities, which indicated that recreation in general increases pro-environment behaviors.

2.7. Public Acceptability

Types of public opinion include acceptability, preference or displacement (Manning and Hallo, 2010). Acceptability can be ranked on an ordinal scale from -4 to +4, with -4 being completely unacceptable and +4 being completely acceptable. These rankings allow for the development of a social norm curve (see Fig. 3.4 on page 57 for an example). Social norm curves provide a framework for assessing ranges of acceptability and estimating minimum acceptable levels (Manning and Hallo, 2010; Bettigole et al., 2014a). Social norm curves became a main stream measurement for natural resources management acceptability as a way to combat the Tragedy of the Commons (Hardin, 1968). To understand how to preserve natural public land, social norm curves became a way to select conditions that were acceptable to all of the stakeholders involved, giving everyone a part in regulation (Sethi and Somanathan, 1996).

The range of the answers within the curve indicates the intensity of interest in the measurement as an indicator. The range is referred to as the salience level. For example, if a respondent thought that crowding in a national park was an important
indicator and measurement of experience, they would have a higher range in their responses for acceptability of differing crowding levels (Manning, 1999; Krymkowski et al., 2011). Preference is the level that people believe that they like the most. Displacement is the level that would be so disagreeable that the individual would leave the situation. Each of these indicators allow for a multidimensional understanding of public attitude, which can then be used in management scenarios (Manning, 1999; Manning, 2007; Bettigole et al., 2014).

### 2.8. Public Surveys

There are several techniques for assessing public opinion (Lax and Phillips, 2009; Manning and Hallo, 2010). Surveys have been regularly used to assess opinions on land use changes such as clear-cutting, alternative energy development, and management strategies such as burning (Cortner et al., 1984; Paquet and Belanger, 1997; Wolsink, 2007). Surveys can be designed in multiple ways. Research has indicated that visual preference or stated choice surveys are more clarifying and representative of public opinion than a purely quantitative survey (Manning, 2007).

When designing a survey, it is important to tailor the survey to the audience. Every detail of the survey design matters including the text, figure formatting, location, appropriate groupings, ease of understanding and question formatting (Dillman, 2007). If the survey is too technical, too long or not visually appealing, respondents will not take the time to complete the survey (Dillman, 2007). It is also vital not to bias the readers
towards a certain answer, so that the results will be objective for analysis (Dillman, 2007).

Response rates for mail surveys are often between 15 and 20% (Dillman, 2007). However studies have shown that including a monetary incentive, even of small value, can double the response rate (James and Bolstein, 1990; Lesser et al., 2001; Dillman, 2007; Bettigole et al., 2014). Pre-paid response envelopes and clear directions are also imperative to increase response rate. The chances of response increase if the recipient does not need to expend more energy than they feel compensated for, either monetarily or internally (Dillman, 2007).

2.9. Linear and Mixed Effect Modeling

Linear modeling is a tool which allows the researcher to display a relationship between two measurable variables (Winter, 2013). There are fixed and dependent variables. Fixed variables have a given and known distribution across an entire population (Winter, 2013). If research shows there is a direct relationship between the maximum amount of development that a town should allow and the age of the respondent, it can be linearly modeled. It would be phrased in a function such as ‘max amount development ~ age’. The max amount development is the dependent variable, otherwise known as the factor measured during the experiment. The age would be the independent or explanatory factor which is fixed.

However the formula also needs to include an additional factor which is an error term. No direct relationship can control for all of the variables (Winter, 2013). For
example, the max amount of development may change based on a person’s life experiences or preferences, not just their age. An error term allows for the random and uncontrollable to be taken into account in this relationship (Winter, 2013). Therefore the actual formula would be (max amount development~ age + e).

There are a few assumptions in the linear model which must be tested to determine if this is the correct test for use for a given data set. The most important assumption is independence. In the example above, each answer for the dependent variable must come from a separate person and be based on the same scenario. If the assumption of independence is not met, a mixed effect model may be effective (Winter, 2013).

A mixed effect model allows for additional random effects that assume a different baseline for each subject and therefore each subject is assigned a different intercept value (Winter, 2013). In the mixed effect model, these random effects give more structure to the error term by using random effect variables (u) for each subject (Baayen et al., 2008; Crawley, 2012; Winter, 2013). A mock formula could look like (max amount of development ~ age + e + u). The random effect is something that can be expected to have an unpredictable influence. Setting a different baseline for each individual within the model will offset the lack of independence and will result in a reliable relationship for many possible terms and predictive values (Baayen et al., 2008; Winter, 2013).
2.10. References


Division of Forestry. 2006. State programs supporting healthy forests, UVM Extension, Montpelier, Vermont, USA.
Fidel, J. 2008. Seeing the forest for the trees: Reducing forest fragmentation in Vermont, Vermont Natural Resources Council, Montpelier, Vermont, USA.
Geiger, R. 1965. The climate near the ground. Harvard University Press, Cambridge, Massachusetts, USA.


Vermont Department of Environmental Conservation. 2014. The Vermont Shoreland Protection Act, Montpelier, Vermont, USA.


Winter, B. 2013. Linear models and linear mixed effects models in R with linguistic applications, University of California, Cognitive and Information Sciences, Irvine, California, USA.


How Wildlife Information, Recreation Involvement and Demographic Characteristics Influence Public Acceptability of Development

Jessica L. Espenshade
Rubenstein School of Environment and Natural Resources
University of Vermont
Burlington, Vermont, USA

Increasing development like roads and houses will alter future landscape. Development provides important resources for people and society, but also results in consequences for wildlife and opportunities for recreation. Managing development requires information on the public’s acceptability of development and how acceptability is shaped by information on various consequences. In this study, I examined three questions: 1) What is the public’s acceptability of development? 2) Is acceptability of development influenced by wildlife presence information? and 3) Is the maximum amount of acceptable development influenced by views about wildlife, involvement in recreation, and demographic factors? I sent a visual-preference survey to 9,000 households in Vermont that asked questions about development, wildlife, recreation, and demographics. I assessed acceptability of amount of development using social-norm curves and used parametric significance tests and mixed-effects models to examine the influence of wildlife, recreation, and demographic factors. The survey response rate was 44%. The maximum acceptable amount of development was slightly more than 32 households/km², and not meaningfully influenced by the broader consequences of development on seven common wildlife species. The public demonstrated a strong preference for clustered development over sprawled development, which became unacceptable at 20 households per km². Maximum acceptability of development was significantly influenced by views on some species, including bear, bobcat, and fisher, but not by others such as deer, fox, raccoon, and coyote. Similarly, those involved in common forms of outdoor recreation, including birding, ATVing, hunting, fishing and camping, were significantly less accepting of development relative to those not involved in these forms of recreation. Maximum amount of development was also affected by demographic factors, including town density, respondent age, home ownership and location of birth. The results provide a baseline measure of the public’s acceptability of development, which can be used to guide decision-making about amount and pattern of development, wildlife management, and efforts to promote recreation in the state.

Keywords: development, public acceptability, recreation, Vermont, wildlife
Target Journal- Society & Natural Resources
3.1. Introduction

Increasing human populations have led to increasing development such as roads, houses and infrastructure (White et al., 2009). From 1982 to 2003, developed land in the United States increased by 48%, which equates to 680,000 hectares of converted rural land (U.S. Department of Agriculture, 2007; White et al., 2009). This trend of development is predicted to continue with an additional 10 million hectares of forested land being converted from 1997 to 2030 (Alig and Plantinga, 2004; White et al., 2009).

Development leads to seemingly small scale changes in the environment, such as altering the structure of vegetation, increasing the light composition along a forest edge (Bennett and Saunders, 2010) or restricting wildlife access to important resources (Amstrup, 1993). However these small changes from development lead to loss, degradation, and fragmentation of wildlife habitat and often result in large cumulative effects for biodiversity, soil, air and water quality (Theobald et al., 1997).

Changes in forest extent due to development and fragmentation are estimated to affect habitat quality for up 90% of all mammal, reptile, bird, and amphibian species that occur in forest habitats in the United States, many of which (28%) are endangered (USDA Forest Service, 1997; USDA, 2011). For forest interior species, the effect of fragmentation may have an even greater negative effect on population size (USDA Forest Service, 1997; Bender et al., 1998; Riitters et al., 2002). However not all species are affected negatively and have adapted to co-existence with humans (Theobald et al., 1997). Development provides certain wildlife, such as raccoons (*Procyon lotor*), coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*) with increased feeding opportunities, a
variety of structures for shelter, and a decrease of more development sensitive predators and competitors (Haspel and Calhoon, 1989; Theobald et al., 1997; Fuller et al., 2010; Gehrt and Riley, 2010; Hadidian et al., 2010).

Development not only affects wildlife habitat, but also affects opportunities for outdoor recreation. Outdoor recreation, such as bird watching, cross country skiing and hiking require open undeveloped land for an acceptable recreation experience due to the value of scenic beauty (Tahvanainen et al., 2001). Satisfaction and enjoyment from a recreation experience may be directly correlated to the amount of people seen or distance from development (Jackson, 1986; Manning and Freimund, 2004).

Public opinion is a motivator in shaping environmental policy (Agnone, 2007). Politicians often will not address environmental issues without the support of public opinion and consequently, environmental policy is created around the passions and criticisms of the public (Agnone, 2007). Large policy changes are especially pervasive when there is a stable public opinion shift on salient issues (Page and Shapiro, 1983).

Information has been shown to influence public opinion when the information is easily accessible, relevant, easily understood and credible (Page et al., 1987). Therefore information and fact sheets have been used in the past to alter public opinion and behavior especially for environmental issues such as water use and recycling (Stern, 1999; Bernedo et al., 2014). However simply presenting information may not create a behavior change (Ester and Winett, 1982; Stern, 1999); instead the information needs to be framed in a way that connects to the individual on a personal and relevant basis (Seligman et al., 1981; Stern, 1999).
To understand public support for future environmental policy initiatives, public opinion needs to be measured and assessed (Stern and Dietz, 1994; Stern, 1999). There are several techniques for assessing public opinion (Lax and Phillips, 2009; Manning and Hallo, 2010). Surveys have been regularly used to assess opinions on land use changes such as clear-cutting, alternative energy development, and management strategies such as burning (Cortner et al., 1984; Paquet and Belanger, 1997; Wolsink, 2007). Two types of survey approaches are regularly used to understand public preference and acceptability. Surveys can either use an informational questionnaire approach (Zhang et al., 2008) or a visualization method approach (Tahvanainen et al., 2001). Research has indicated that visual preference or stated choice surveys are more clarifying and representative of public opinion than a purely quantitative survey (Manning and Freimund, 2004). Perceived crowding and perceived conditions can be very different than actuality and are therefore more important since perception relates directly to how the person feels and acts in a situation (Manning, 2007).

Types of public opinion include acceptability, preference or displacement (Manning and Hallo, 2010). Acceptability can be ranked on an ordinal scale of -4 to +4, with -4 being completely unacceptable and +4 being completely acceptable. These rankings allow for the creation of a social norm curve. Social norm curves provide a framework for assessing ranges of acceptability and estimating minimum acceptable levels (Manning and Hallo, 2010). Also the range of conditions within the curve indicate the strength of feelings surrounding that particular topic, indicated by the salience level (Manning, 2007). Preference is the level that people believe that they like the most and
displacement is the level that would be so disagreeable that the individual would leave the situation (Manning, 1999). These indicators allow for a multidimensional understanding of public attitude, which can then be used in management scenarios (Manning, 1999; Manning, 2007; Bettigole et al., 2014).

With increasing human populations there will be increased pressure to manage for the environmental effects of development. Public opinion is a shaping force of environmental legislation; however there is a lack of understanding for what influences public opinion on development. Perception of wildlife and involvement in recreation can shape environmental attitudes, but it is currently unknown how these factors influence acceptability of development. I examined three questions 1) What is the public’s acceptability of development? 2) Is acceptability of development influenced by wildlife presence information? and 3) Is the maximum amount of acceptable development influenced by views about wildlife, involvement in recreation, and demographic factors?

3.2. Methods

Study Area

The study area was the state of Vermont. Vermont is currently the second least populated US state. However, in the past century, the population of Vermont has almost doubled in size according to the United States Census Bureau (United States Census Bureau, 2013). Landscape development in Vermont mainly impacts forests, which represent the dominant land cover (80%) in the state (Vermont Monitoring Cooperative,
Development is projected to convert natural state land at a rate that is 260 times faster than the rate of population growth (Vermont Forum on Sprawl, 1999). The additional influence of wildlife and recreation impacts on development is especially significant in Vermont because over 62% of the population is involved regularly in a type of wildlife-related recreation and ranks third in the country for percentage of public involvement (U.S. Fish & Wildlife Service, 2012).

**Research Context**

Bettigole et al. (2014) conducted a study in 2011 that examined public acceptability of development in Vermont using a visual preference survey. The survey presented a series of visual illustrations with varying amounts of development. Respondents were asked to rank each illustration on a scale of -4 to 4, with -4 indicating that the illustration was completely unacceptable and 4 was completely acceptable. Bettigole et al. (2014)’s results indicated that Vermonter’s were willing to accept an 11% increase in development in their towns. My survey builds on the foundations of this study by using the same illustrations to evaluate a baseline for development acceptability.

The survey consisted of six illustrations visually altered to show different amounts of development (Fig. 3.1). The original town used as a baseline for these images was Colrain, Massachusetts, USA. This town resembled a typical Vermont town and was selected to avoid town recognition from the respondents, which may induce bias. Illustrations 1 to 6 depicted the following housing densities: 1.71, 4.58, 12.57, 32.86, 88.06, and 235.83 households per km², respectively (Fig. 3.1). Housing density over the six illustrations increased exponentially (Bettigole et al., 2014).
Survey

My survey was divided into two treatment groups: control and wildlife. The control group received the original illustrations from the Bettigole et al. (2014) study with no alterations. The wildlife group received the illustrations that included a legend with wildlife information (Fig 4.2). The legend included presence-absence information for seven common and recognizable species, including black bear (*Ursus americanus*), deer (*Odocoileus virginianus*), bobcat (*Lynx rufus*), fisher (*Martes pennanti*), raccoon (*Procyon lotor*), fox (*Vulpes vulpes*) and coyote (*Canis latrans*). Some of the species, especially black bear, bobcat and fisher are sensitive to habitat changes (Long et al., 2011).

I estimated presence of each species in each illustration based on occupancy models. I used detection/non-detection data from 60 camera-traps deployed in the Champlain Valley of northwestern Vermont to develop a single season occupancy model for each species (for camera-trapping details see: Williams, 2012). Occupancy modeling uses the multinomial maximum likelihood function to estimate model parameters and accounts for imperfect detection (MacKenzie et al., 2006). I developed a model set consisting of 48 models (Appendix 2), applied the set to each species, and used model selection techniques to rank each model (Burnham and Anderson, 2002). Each top model was then applied to each pixel (30 m x 30 m) of a National Land Cover Database (2006) raster of the illustration scene using Geographic Information Systems (GIS) software (ArcGIS, v. 10, ESRI, Redlands, California, USA). I averaged occupancy probability across all pixels for each species, and considered the species ‘present’ at the mid-point
after the ranges had been standardized across all species. The legend showed a check mark by the species if the animal was present and left blank if the species was absent (Fig. 3.2).

An additional page of illustrations (Fig. 3.3) was included after the original six illustrations. This page depicted the same landscape with different spacing and amount of development. The first two illustrations had 50 houses placed on the landscape. One showed the houses clustered together around roads and existing development. The other showed houses sprawled out across the entire landscape. Two other pairs were illustrated with the same pattern comparison, but the second pair had 100 houses and the third pair had 150 houses.

There was an individual ordinal ranking scale for each of the illustrations to determine development acceptability. Respondent were asked to circle a number on the scale for each of the illustrations. Additional questions about the illustrations were asked, including preference, displacement and most like. There were also acceptability scales for the spacing question. Each illustration with varying spacing and amount was individually ranked on the scale.

To determine wildlife values, individuals were asked, “How acceptable would it be to have the following animal live in or near your town?” Respondents chose a number on the acceptability scale for each of the species. This question was asked to determine if there were differences in species acceptability, outside of the wildlife legend. Respondents were also asked, “Do you believe there should be a change in the amount of
wildlife in your town”? The individual could select an answer from a scale of -4 to 4, with -4 being less wildlife, 0 being no change and 4 being more wildlife.

Recreation involvement was determined through the question, “Which of the following outdoor activities do you participate in?” Eight common outdoor recreation activities were listed, including birding, hiking, hunting, fishing, off road ATVing, farming/gardening, snowmobiling and camping. Respondents also had the opportunity to select “other” and write-in another activity or select none of the above.

In addition to the six visual preference illustrations and spacing illustrations, I included a questionnaire sheet and a pre-paid and addressed envelope for responses. The questionnaire included questions about the respondent’s demographics including whether they were born in Vermont, whether they considered Vermont to be their primary residence, what year they were born and their highest level of education. The survey response sheet consisted of one page front and back to ensure ease of response (Dillman, 2007). Only the response sheet was placed in the return envelope to be mailed back to the researcher.

**Survey Distribution**

Participants were selected at random, and selection was stratified by county size to have a representative state-wide sample. Participants were required to be over 18 years of age, with no restrictions on demographic factors such as residence, ethnicity, homeowner or gender. The mailing addresses were selected and maintained through a subscription to ListGIANT held by the University of Vermont Center for Rural Studies (Burlington, Vermont, USA).
I sent 9,000 surveys, 4500 of each treatment type, to participants between September and November 2014. A pre notification post card was sent to all participants three days prior to the full survey. After the pre notification post card, the full survey was sent with identification numbers for tracking purposes. Three days after the survey mailing a post survey reminder post card was sent to the same individuals as a reminder to complete the survey. To increase the response rate, 1800 of the non-respondents (20% of the original survey) received the entire survey again after a period of one month from the first survey (Dillman, 2007).

Response rates for mail surveys are often between 15 and 20% (Dillman, 2007). However, studies have shown that including a monetary incentive, even of small value, can double the response rate (James and Bolstein, 1990; Lesser et al., 2001; Dillman, 2007; Bettigole et al., 2014). A monetary incentive of one US dollar was included to increase the response rate.

Analysis

Public opinion

Types of public opinion include acceptability, preference or displacement (Manning and Hallo, 2010). Acceptability can be ranked on an ordinal scale from -4 to +4, with -4 being completely unacceptable and +4 being completely acceptable. These rankings allow for the development of a social norm curve. Each illustration number is plotted along the x-axis and the corresponding average acceptability is plotted along the y-axis. The resulting curve provides a framework for assessing ranges of acceptability.
and estimating minimum acceptable levels (Manning and Hallo, 2010; Bettigole et al., 2014a).

The range of the answers within the curve indicates the intensity of interest in the measurement as an indicator. The range is referred to as the salience level. For example, if a respondent thought that crowding in a national park was an important indicator and measurement of experience, they would have a higher range in their responses for acceptability of differing crowding levels (Manning, 1999; Krymkowski et al., 2011). Preference is the level that people believe that they like the most. Displacement is the level that would be so disagreeable that the individual would leave the situation (Manning, 1999; Manning, 2007; Bettigole et al., 2014).

**Public acceptability of development**

I averaged the results for each of the development scenarios to determine a social norm curve for development. A social norm curve for combinations of spacing and amount was estimated to identify acceptable spacing. Average values were plotted to show how acceptability varied according to percent developed. A value of zero indicated that the percent developed is no longer acceptable to the public (Manning, 1999). To determine where the curve of the social norm curve crosses zero, I fit the curve with a 3rd degree polynomial. I mimicked the curve by plotting 1,000 points using the parameter values for the polynomial. I then selected the point that came closest to the y equaling zero and returned that x value. Responses that did not cross the zero point at any point along the curve were not included in the minimum acceptable level analysis, but were included in other analysis. After the average acceptability levels for each illustration were
calculated, I estimated the average scores for the control (only development) and plotted them. This provided the baseline for public acceptability of development. I performed all statistical analysis using R programming language (R Core Team, 2013).

Wildlife Information Influence

Average acceptability scores for the control were compared to scores from surveys with wildlife information. The average minimum acceptability score was compared to draw conclusions about whether wildlife information influences public acceptability of development.

To consider whether species acceptability affected development interest and acceptability, salience scores and categorical relationships were analyzed. To determine the interest that a respondent had in development amount, the intensity or norm salience was calculated. Norm salience is the strength of the respondent’s feelings about the importance of a potential indicator of quality. This was determined by calculating the range of responses above and below the zero line. The greater the salience score, the more strongly respondents feel about the condition being measured (Manning, 2007). The salience score was calculated for individuals who responded with an acceptability score for wildlife species. The average salience score was plotted for each acceptability score for each of the species. If there was a relationship between wildlife acceptability and development salience, I concluded that wildlife acceptability influenced strength of interest in development measures.
The minimum acceptability point for respondents who found a certain species acceptable, with a ranking of 1 to 4 were compared against the minimum acceptability point for respondents who found a certain species unacceptable, with a ranking of -1 to -4. Any difference indicated that specific wildlife species may have an effect on acceptability of development. Data were evaluated for normality and T-tests with unequal variance were used to determine statistical difference. Comparisons were considered statistically different when p <0.05.

Recreation Involvement Influence

The salience score was calculated for recreation involvement. The average salience for all participants for each recreation type was calculated. If there was a relationship between recreation involvement and development salience, I concluded that recreation influenced strength of interest in development measures. The minimum acceptability point for respondents who participated in recreation activities were compared against respondents who were not involved in those activities. Any difference indicated that recreation involvement may have an effect on acceptability of development. Overall involvement in any type of recreation and specific types of recreation were considered.

Demographic Characteristic Influence

Fixed variables such age, county density, Vermont born, Vermont primary resident and home-owner were considered as predictive factors for development acceptability. Using all subsets of the fixed variables, 31 linear mixed effect models were evaluated using the R package lme4 (Bates et al., 2014). The random effects included
were treatment group and respondent id. The models were ranked using Akaike’s Information Criterion with bias-correction (AICc). AICc is normally used as a bias-correction for small sample sizes, but is used as the standard with MuMIn R package rankings (Barton, 2015). An AICc score was calculated with the R package MuMIn (Barton, 2015) to rank the models to best predict the requested y variable (minimum accepted condition). I evaluated models using AICc, then considered models with $< 2 \Delta$ AICc to have strong empirical support (Burnham and Anderson, 2002).

3.3. Results

**Overall**

The survey had a response rate of 44% (n=3,629), after the non-deliverables (n=724) were subtracted from the total number of surveys sent. The control treatment had a total response rate of 45% (n=1,846) and the wildlife treatment had a total response rate of 43% (n=1,783). The second round of mailings had a response rate of 19% (n=167) and 16% (n=146) for control and wildlife, respectively. There were no statistical differences between the first and second mailing when comparing rates of home ownership, age, residence and location of birth. There was statistical difference when comparing education attainment, which was consequently left out of analysis. County response rates ranged from 40% to 46% for all 14 Vermont counties. A total of 1% of the respondents deleted their identification number and therefore could not be matched with location information.

Slightly more than 99% of respondents considered Vermont to be their primary
place of residence. However, only 47% of respondents were born in the state, with 91% of respondents owning their homes. The highest amount of respondents came from Chittenden county with the lowest response rate coming from Essex county. The average year of birth was 1958, which equated to 57 years old. The average attained education levels were 2% none, 30% high school, 5% technical, 12% associate, 26% bachelors, 17% masters, 4% doctorate and 4% professional.

For the additional questions, the preference level for development was the lowest compared to most like town, not want to live and max amount that should be allowed (Fig 3.5). Amount of wildlife change desired was 0.96, which indicated a desired increase of wildlife in the respondent’s town. Recreation involvement was indicated by 95% of respondents. The majority of respondents considered themselves hikers or farmers/gardeners, 68% and 67%, respectively. Snowmobiling and ATVing participants were the least numerous, with 12% and 13%, respectively.

**Public Acceptability of Development**

Public acceptability of development showed an optimum level at illustration 2 for both the control and wildlife treatments. The difference of means between the treatment groups was 0.42, 0.32, 0.50, 0.41, 0.06 and 0.30 for illustration 1 through six, respectively (Fig. 3.6). The trend indicated that illustrations 1-4 were considered acceptable, with the minimum acceptable condition being 4.19 for control and 4.30 for wildlife surveys. Illustrations 5 and 6 were considered unacceptable.

Clumped development spacing was significantly more acceptable than sprawled housing development for each of the presented amount levels of 50 (t = 24.41, d.f. =
of 100 houses (t = 31.05, d.f. = 7047, p < 0.05) and not significant for the other species.

Recreation Involvement Influence

The salience scores for recreation involvement were higher for those involved in an activity compared to those not involved in the activity (Fig. 3.10). The minimum accepted condition was lower for recreationists than non-recreationists (Fig. 3.11). The difference of means was 0.13, 0.18, 0.05, 0.04, 0.13, 0.03, 0.22, 0.17, 0.12 for ATVing, birding, camping, farming, fishing, hiking, hunting, snowmobiling and none, respectively. These differences were significant for ATVing (t = -2.72, d.f. = 534, p < 0.05), birding (t = -5.08, d.f. = 1757, p < 0.05), fishing (t = -3.96, d.f. = 2611, p < 0.05),
hunting ($t = -5.98$, d.f. = 1569, $p < 0.05$) and snowmobiling ($t = -3.42$, d.f. = 470, $p < 0.05$).

**Demographic Characteristic Influence**

Out of the 31 mixed effect models, 8 had weights above 0 (Table 4.1). Three of the models had empirical support with a $\Delta AIC_c$ value under 2. The model that best fit the prediction for the minimum accepted condition, taking the degrees of freedom into account, contained the county density, whether or not the respondent owned their home, whether or not the respondent was born in Vermont and the year they were born. The model indicated that if the respondent was born in Vermont, it had a negative effect on development acceptability. The other model factors of county density, home ownership and year born all had a positive effect on development acceptability.

### 3.4. Discussion

Increasing human development will alter natural landscapes across the United States. Legislators and planners will be tasked with the responsibility of designing development strategies that involve the least number of negative impacts, with the guidance of public opinion. Recreation involvement and wildlife interest have a direct influence on public opinion regarding development acceptability. The minimum acceptability point can additionally be predicted with known demographic factors for all locations in Vermont.

The public’s acceptability of development is the same as it was four year ago (Bettigole et al., 2014). The minimum acceptable condition was 4.19 for both the 2011
and 2015 surveys. Even though the development of Vermont is increasing, the minimum acceptable condition has not changed. This is important for managers to consider as the Vermont landscape of 11 households per km$^2$ (United States Census Bureau, 2013) nears the point of unacceptable conditions. It is possible that respondents were unable to evaluate development amount from an aerial point of view, as shown in the illustrations. Future research should examine the relatability of aerial photography perception to actual town densities.

As development increases, public acceptability levels clearly indicate that clustered development should be a priority over sprawled development. This will not only further develop community centers, but will increase walkability and decrease the need for transportation and highway development (Daniels, 2001). Decreasing sprawl will also have a positive impact on wildlife, due to the decrease in potential fragmentation of the landscape (Vermont Forum on Sprawl, 1999).

The addition of a wildlife information evaluated if information changed an individual’s acceptability of development. Social norm curves for the control treatment and wildlife information treatment were statistically different, but the acceptability difference was so small that it may not have management implications. There are several possible rationales for this result. Development convenience could outweigh support for continued wildlife presence for the general public when individuals consider the cost-benefit analysis of development. It is also possible that personal experiences with individual species could alter the wildlife perception and consequently lower the value of
wildlife overall. Lastly if the information presentation was too complex or non-relatable, this conclusion may be different in other studies.

Even though wildlife information did not alter the acceptability of development in the expected fashion, species values affected development acceptability. This supports research that indicated that a relationship between individual value sets concerning wildlife and environmental concern exists (Kellert, 1984; Theodori et al., 1998; Hall et al., 2010). Every individual has a value set regarding wildlife (Kellert, 1992). There eight distinct types of wildlife values, these include positive intrinsic associations such as aesthetic value, negative associations such as fear based value or use associations such as utilitarian value (Kellert, 1992). The influence of wildlife values on attitudes can be modified by perception of individual species or general understanding (Kellert, 1992). Species acceptability strongly influenced the intensity of opinions on development. Salience levels showed that individuals with high wildlife acceptability believe that development amount is an important metric for planning. Specifically people who are strongly accepting of wildlife species, especially black bears, fishers and bobcats, are less accepting of development overall. Results were significant for black bears, fishers and bobcats, which represent iconic species in the state of Vermont and are also sensitive to habitat development (Long et al., 2011). This information is of value for wildlife managers because it identifies stakeholders in wildlife interest groups and the importance of individual species to the public.

Recreationists were also concerned with development amounts. This could be due to increased value of environmental aesthetics and health, as well as the recognition
of increased recreation opportunities with decreased development (Kotchen and Reiling, 2000; Ojea and Loureiro, 2007). Numerous studies have shown that outdoor recreationists are more environmentally concerned both with their value sets and with pro-environment behaviors (Bryan, 1977; Jackson, 1986; Theodori et al., 1998; Teisl and O'Brien, 2003).

Salience levels for recreationists indicated that there was an increase in the perceived importance of development as a metric for environmental management. This increase in perceived development importance did not depend on the type of recreation. Traditional consumptive recreation versus intrinsic recreation have shown value differences in other studies (Daigle et al., 2002). However in this study, non-intrinsic recreation such as ATVing and snowmobiling, had similar salience scores to the intrinsic birding recreationists. The minimum acceptable condition was also lower for recreationists, indicating that recreationists are less accepting of increased development than non-recreationists. This is important for future development planning to identify recreation areas for protection.

Predictive modeling can be used directly by development planners. The county population, home ownership status and age of individual are known variables through the US Census Bureau. The parameters from my model can be applied by development planners and legislators to identify the minimum acceptable conditions for any area in the state. This will allow planners and legislators to strategically plan for developing below this identified acceptable development level to meet living standard goals.
Land use planning or development decisions are usually made to ensure public goals like the ‘maintenance of quality of life’ (Theobald et al., 1997). Land use planning decisions take many factors into consideration including economics and social factors (Theobald et al., 1997; Manning, 2013). To ensure quality of life, managers and developers should take the needs and desires of the public into account, which includes factors outside of economics, such as wildlife attitudes and opportunity for recreation.

Environmental political agendas have utilized the support of recreation and wildlife centered groups to document support when seeking to protect open lands. These agendas can be successful promoted to the individuals most affected by the outcome. (Decker et al., 1996; McFarlane and Boxall, 1996; Teisl and O'Brien, 2003). To allow for the continuous support of stakeholders in wildlife and recreation management, development planning can consider the impacts that future projects will have on wildlife populations and recreation opportunities.

Future research should examine the intensity of recreation involvement and the rationale behind an individual’s wildlife value set for different species. Future surveys could also include economic and legislative components, which would establish stakeholders’ willingness to pay for wild land protection and willing to participate in the legislative process. Results could also differ with the examination of multiple taxa including birds, amphibians and reptiles to assess is differing taxa information influences acceptability in alternate ways.
3.5. Acknowledgements

I thank the Northeastern States Research Cooperative for providing the funding for this project. The project also received support from the University of Vermont and Vermont Cooperative Fish and Wildlife Research Unit. I am grateful to C. Bettigole for helpful comments on the project design, S. Merrill for assistance with R and C. Hansen and M. Brown for their assistance with GIS. C. Bernier of the Vermont Fish and Wildlife Research Unit also provided expert opinion on species models. I also thank the University of Vermont Print and Mail Service for their assistance with survey distribution.

3.6. References


Vermont Forum on Sprawl. 1999. Economic, social and land use trends related to sprawl in Vermont, Burlington, Vermont, USA.


Williams, S. 2012. Factors affecting carnivore occupancy in forest fragments of an agricultural landscape, University of Vermont. Master of Science thesis, Burlington, Vermont, USA.

Table 1. Predictive models for minimum acceptable condition of development by respondents surveyed in Vermont, USA. All subsets of fixed values, including population of county (Pop), whether the respondent’s primary residence was in Vermont (VT primary), whether the respondent was born in Vermont (VT born), whether the respondent owns their home (Own house) and the year the respondent was born (Year born) are listed with model parameter estimates and AICc scores.

<table>
<thead>
<tr>
<th>Model</th>
<th>Int</th>
<th>Pop</th>
<th>VT Primary</th>
<th>VT Born</th>
<th>Own House</th>
<th>Year Born</th>
<th>DF</th>
<th>logLik</th>
<th>AICc</th>
<th>Delta</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop=Vt.born+Own.house+Year.born</td>
<td>-18.00</td>
<td>0.005</td>
<td>-0.094</td>
<td>0.067</td>
<td>0.011</td>
<td>7</td>
<td>-4003.08</td>
<td>8020.2</td>
<td>0.00</td>
<td>0.434</td>
<td></td>
</tr>
<tr>
<td>Pop+Own.house+Year.born</td>
<td>-17.56</td>
<td>0.005</td>
<td>-0.090</td>
<td>0.072</td>
<td>0.011</td>
<td>6</td>
<td>-4004.73</td>
<td>8021.5</td>
<td>1.30</td>
<td>0.226</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Vt.born+Own.house+Year.born</td>
<td>-17.76</td>
<td>0.005</td>
<td>-0.24</td>
<td>0.072</td>
<td>0.011</td>
<td>8</td>
<td>-4002.91</td>
<td>8021.9</td>
<td>1.67</td>
<td>0.188</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Own.house+Year.born</td>
<td>-17.31</td>
<td>0.005</td>
<td>-0.27</td>
<td>0.078</td>
<td>0.011</td>
<td>7</td>
<td>-4004.25</td>
<td>8022.5</td>
<td>2.35</td>
<td>0.134</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Vt.born+Year.born</td>
<td>-17.28</td>
<td>0.005</td>
<td>-0.23</td>
<td>-0.092</td>
<td>-0.011</td>
<td>7</td>
<td>-4007.12</td>
<td>8028.3</td>
<td>8.09</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.born+Year.born</td>
<td>-17.55</td>
<td>0.005</td>
<td>-0.095</td>
<td>-0.011</td>
<td>6</td>
<td>-4008.18</td>
<td>8028.4</td>
<td>8.19</td>
<td>0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Year.born</td>
<td>-16.81</td>
<td>0.005</td>
<td>0.26</td>
<td>-0.011</td>
<td>6</td>
<td>-4009.49</td>
<td>8031.0</td>
<td>10.81</td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pop+Year.born</td>
<td>-17.11</td>
<td>0.005</td>
<td>-0.091</td>
<td>0.067</td>
<td>0.012</td>
<td>5</td>
<td>-4010.81</td>
<td>8031.6</td>
<td>11.44</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Vt.born+Own.house+Year.born</td>
<td>-18.65</td>
<td>-</td>
<td>-0.091</td>
<td>0.067</td>
<td>0.012</td>
<td>6</td>
<td>-4051.60</td>
<td>8115.2</td>
<td>95.03</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Own.house+Year.born</td>
<td>-18.25</td>
<td>-</td>
<td>-0.25</td>
<td>-0.088</td>
<td>0.073</td>
<td>7</td>
<td>-4053.04</td>
<td>8116.1</td>
<td>95.91</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.primary+Vt.born+Own.house+Year.born</td>
<td>-18.40</td>
<td>-</td>
<td>-0.28</td>
<td>-0.078</td>
<td>0.011</td>
<td>6</td>
<td>-4052.51</td>
<td>8117.1</td>
<td>96.86</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.primary+Year.born</td>
<td>-17.99</td>
<td>0.006</td>
<td>-0.076</td>
<td>-0.011</td>
<td>-0.011</td>
<td>6</td>
<td>-4055.34</td>
<td>8122.7</td>
<td>102.52</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.secondary+Vt.born+Year.born</td>
<td>-17.91</td>
<td>-</td>
<td>-0.23</td>
<td>-0.089</td>
<td>0.011</td>
<td>5</td>
<td>-4055.38</td>
<td>8122.8</td>
<td>102.60</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.born+Year.born</td>
<td>-18.20</td>
<td>-</td>
<td>-0.092</td>
<td>-0.011</td>
<td>5</td>
<td>-4056.54</td>
<td>8123.1</td>
<td>102.91</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Vt.born+Own.house</td>
<td>4.41</td>
<td>0.006</td>
<td>-0.30</td>
<td>-0.071</td>
<td>0.017</td>
<td>7</td>
<td>-4054.61</td>
<td>8123.3</td>
<td>103.06</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.primary+Year.born</td>
<td>-17.48</td>
<td>-</td>
<td>0.27</td>
<td>-0.011</td>
<td>5</td>
<td>-4057.51</td>
<td>8125.0</td>
<td>104.84</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year.born</td>
<td>-17.78</td>
<td>-</td>
<td>-0.32</td>
<td>0.024</td>
<td>-0.011</td>
<td>4</td>
<td>-4058.93</td>
<td>8125.9</td>
<td>105.69</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Own.house</td>
<td>4.39</td>
<td>0.006</td>
<td>-0.32</td>
<td>0.024</td>
<td>-0.011</td>
<td>4</td>
<td>-4057.38</td>
<td>8126.8</td>
<td>106.60</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pop+Own.house</td>
<td>4.08</td>
<td>0.006</td>
<td>-0.017</td>
<td>0.017</td>
<td>-0.011</td>
<td>6</td>
<td>-4058.42</td>
<td>8126.9</td>
<td>106.66</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary+Vt.born</td>
<td>4.42</td>
<td>0.006</td>
<td>-0.074</td>
<td>0.007</td>
<td>0.011</td>
<td>6</td>
<td>-4063.28</td>
<td>8138.6</td>
<td>118.39</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.born</td>
<td>4.13</td>
<td>0.006</td>
<td>-0.077</td>
<td>-0.011</td>
<td>5</td>
<td>-4065.03</td>
<td>8140.1</td>
<td>119.88</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pop+Vt.primary</td>
<td>4.41</td>
<td>0.006</td>
<td>-0.32</td>
<td>0.024</td>
<td>-0.011</td>
<td>4</td>
<td>-4069.97</td>
<td>8150.0</td>
<td>129.77</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Pop</td>
<td>4.09</td>
<td>0.006</td>
<td>-0.073</td>
<td>0.010</td>
<td>-0.011</td>
<td>4</td>
<td>-4075.26</td>
<td>8158.5</td>
<td>138.33</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.born+Own.house</td>
<td>4.22</td>
<td>-</td>
<td>-0.068</td>
<td>0.016</td>
<td>-0.011</td>
<td>5</td>
<td>-4108.89</td>
<td>8227.8</td>
<td>207.60</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Vt.primary+Vt.born+Own.house</td>
<td>4.52</td>
<td>-</td>
<td>-0.33</td>
<td>0.022</td>
<td>-0.011</td>
<td>5</td>
<td>-4110.61</td>
<td>8231.2</td>
<td>211.04</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Own.house</td>
<td>4.18</td>
<td>-</td>
<td>-0.015</td>
<td>-0.015</td>
<td>4</td>
<td>-4111.68</td>
<td>8231.4</td>
<td>211.18</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vt.primary+Vt.born</td>
<td>4.53</td>
<td>-</td>
<td>-0.071</td>
<td>-0.011</td>
<td>5</td>
<td>-4116.59</td>
<td>8243.2</td>
<td>223.01</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vt.born</td>
<td>4.23</td>
<td>-</td>
<td>-0.075</td>
<td>-0.011</td>
<td>4</td>
<td>-4118.47</td>
<td>8245.0</td>
<td>224.76</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vt.primary</td>
<td>4.52</td>
<td>-</td>
<td>-0.33</td>
<td>-0.011</td>
<td>4</td>
<td>-4123.11</td>
<td>8254.2</td>
<td>234.04</td>
<td>0.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.7. Figure Legends.

**Figure 3.1.** Visual preference illustrations used in the survey of development that was sent to households in Vermont, USA. Each survey included six illustrations depicting the following housing densities (#households/km$^2$): 1 = 1.71, 2 = 4.58, 3 = 12.57, 4 = 32.86, 5 = 88.06 and 6 = 235.83.

**Figure 3.2.** Wildlife information legend for the illustrations in the wildlife treatment group. A check mark indicated the species was present in the illustration. A blank space indicated that the species was not present in the illustration.

**Figure 3.3.** Survey illustrations portraying varying amounts and spacing of housing development. Illustrations A and B show 50 houses, illustrations C and D show 100 houses, and illustrations E and F show 150 houses. Left-side illustrations depict a clustered housing arrangement and right-side illustrations depict a sprawled housing arrangement.

**Figure 3.4.** Example of a norm curve from Manning (2007). Respondents rated acceptability of number of groups encountered along a trail per day based on a visual preference survey from -4 (completely unacceptable) to +4 (completely acceptable). The highest point on the curve is the optimum condition. Where the line crosses zero is the minimum acceptable condition. The range of the values represents the salience. I used norm curves to evaluate acceptability of development and influence of wildlife information and involvement in recreation activities.
Figure 3.5. Additional questions on a questionnaire sent to households in Vermont included documenting preference, most like town, displacement (not want to live), and regulation (max allow). Responses were based on six illustrations depicting the following housing densities (#households/km$^2$): 1 = 1.71, 2 = 4.58, 3 = 12.57, 4 = 32.86, 5 = 88.06 and 6 = 235.83. The average response for each question was graphed to obtain a multidimensional understanding of development acceptability and management implications.

Figure 3.6. Social norm curves of acceptability of development by treatment group based on a visual preference survey sent to households in Vermont, USA. Respondents were asked to rate acceptability of six illustrations showing different amounts of development on a scale of -4 (completely unacceptable) to +4 (completely acceptable). Illustration 1 had the lowest amount of development (1.7 houses/km$^2$) and subsequent illustrations increased exponentially in housing density to Illustration 6 (238 houses/km$^2$). The ‘wildlife’ treatment represents responses to surveys (n = 1,783) that included information on the presence/absence of seven species in each illustration. The ‘control’ treatment represents responses (n = 1,846) to surveys that did not include wildlife information. Each value on the curves is the mean acceptability score across respondents. The minimum acceptability point, x when y is zero, is slightly more than illustration 4, which had a density of 32 households per km$^2$. There was no statistical difference between the treatment groups.
Figure 3.7. Acceptability of housing density and distribution based on a visual preference survey sent to households in Vermont, USA. Respondents (n = 3,629) were asked to rate the acceptability of illustrations showing three different housing densities arranged in clumped and sprawled arrangements on a scale of +4 (completely acceptable) to -4 (completely unacceptable). Values represent mean scores across respondents. When a bar crosses zero representing a negative value, the amount and pattern combination is no longer acceptable.

Figure 3.8. Salience levels of development and range of development acceptability based on a visual preference survey of households in Vermont, USA are compared for different species acceptability scores. Salience scores represent the degree of intensity of interest in development according to their views on seven common wildlife species. Trend lines are added to portray the relationship between species acceptability and interest in development amount.

Figure 3.9. Mean (± SE) minimum acceptability of development by views of seven common wildlife species based on a visual preference survey of households in Vermont, USA. Acceptability of development represents the point where a social norm curve crosses zero. Acceptability is compared for respondents who found species acceptable (acceptability ratings of +4 to +1) or unacceptable (acceptability ratings of -1 to -4).

Figure 3.10. Salience levels of acceptability of development based on a visual preference survey of households in Vermont, USA. Salience scores represent the degree of intensity of interest in development according to involvement in recreation activities.
Figure 3.11. Mean (± SE) minimum acceptability of development by involvement in common recreational activities based on a visual preference survey of households in Vermont, USA. Acceptability of development represents the point where a social norm curve crosses zero. Acceptability is compared for respondents who participated in each recreation type versus those who did not. There was a significant difference (p<0.05) for ATVing, birding, fishing, hunting and snowmobiling.
<table>
<thead>
<tr>
<th>Animal</th>
<th>Illustration Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Black Bear</td>
<td>√</td>
</tr>
<tr>
<td>Fisher</td>
<td>√</td>
</tr>
<tr>
<td>Raccoon</td>
<td></td>
</tr>
<tr>
<td>Deer</td>
<td>√</td>
</tr>
<tr>
<td>Bobcat</td>
<td>√</td>
</tr>
<tr>
<td>Coyote</td>
<td>√</td>
</tr>
<tr>
<td>Fox</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.2.
Figure 3.3.
Figure 3.4.
Figure 3.5.
Figure 3.6.

Illustration
Figure 3.7.

- Clumped
- Sprawled

Acceptability

Amount
Figure 3.8.
Figure 3.9.

![Bar chart showing minimum accepted condition for various species: Bear, Bobcat, Coyote, Deer, Fisher, Fox, Raccoon. The chart distinguishes between acceptable and unacceptable conditions with error bars indicating variability.](image-url)
Figure 3.10.

Salience

<table>
<thead>
<tr>
<th>Activity</th>
<th>Participation</th>
<th>No Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hiking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Snowmobiling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 3.11.
COMPREHENSIVE LITERATURE REVIEW


Division of Forestry. 2006. State programs supporting healthy forests, UVM Extension, Montpelier, Vermont, USA.


Fidel, J. 2008. Seeing the forest for the trees: Reducing forest fragmentation in Vermont, Vermont Natural Resources Council, Montpelier, Vermont, USA.


Geiger, R. 1965. The climate near the ground. Harvard University Press, Cambridge, Massachusetts, USA.

66


Stein, S. M. et al. 2005. Forests on the edge: housing development on America's private forests, Department of Agriculture, Forest Service, Pacific Northwest Research Station Portland, Oregon, USA


Vermont Department of Environmental Conservation. 2014. The Vermont Shoreland Protection Act, Montpelier, Vermont, USA.

Vermont Forum on Sprawl. 1999. Economic, social and land use trends related to sprawl in Vermont, Burlington, Vermont, USA.


Wharton, E. H. et al. 2003. The forests of the green mountain state, USDA Forest Service Northeastern Research Station, Newtown Square, Pennsylvania, USA.

Williams, S. 2012. Factors affecting carnivore occupancy in forest fragments of an agricultural landscape, University of Vermont.

Winter, B. 2013. Linear models and linear mixed effects models in R with linguistic applications, University of California, Cognitive and Information Sciences, Irvine, California, USA.


APPENDICES

Appendix 1. A survey was distributed across Vermont (n=9000) to examine public acceptability of development and the influence of wildlife information, wildlife acceptability, recreation involvement and demographic characteristics. Each survey included a visual booklet with an introduction letter, six illustrations with exponentially increasing development (Fig. 3.1) and a response sheet. The survey was divided into two treatment groups, control (n=4500) and wildlife (n=4500). The differences between the treatment group materials included wildlife information legends for the wildlife group illustrations (Fig. 3.2.) and a directive to the respondents on the response sheet to pay attention to the amount of development and the wildlife legend. All of the other materials were identical for the survey treatments.
Appendix 1.

August 25, 2014

Greetings,

I am writing to ask for your help in an important research study to understand how Vermonters feel about changes in the landscapes of their towns and cities. The study is a collaboration between the Rubenstein School of the Environment and Natural Resources at the University of Vermont and the Vermont Department of Fish and Wildlife.

You have been selected at random to participate in this study. We are asking you to evaluate six illustrations of land use in a typical Vermont town and answer a brief series of questions. Your responses are important in helping us determine how Vermonters view the issues associated with changing landscapes.

Development in Vermont is accompanied by a diverse set of trade-offs. Development can lead to increased housing availability, more affordable housing, new schools, more retail space, and better infrastructure, such as roads, sewers, and sidewalks. However, development can also increase vehicle traffic, reduce access to traditional land use practices like farming, forestry, hunting and fishing, and alter habitat for wildlife species. Many of these trade-offs are often overlooked in the planning and development process.

Your responses are confidential and will be included in our study results only in summary form. Upon completion of the survey, your name will be permanently deleted from this mailing list.

If you have any questions or problems completing this survey, please email Jessica Espenhade (jessica.esphenhade@uvm.edu) or write to the address above.

Thank you for your time and effort. We have enclosed a small token of appreciation along with this survey as a way of thanking you for your involvement in our study. Your participation is greatly appreciated!

Sincerely,

Jessica Espenhade
Master’s Degree Candidate
University of Vermont
Questionnaire

Your responses are confidential

Please answer all 14 questions to the best of your ability. When you have completed the questionnaire, fold and send this sheet only in the enclosed pre-paid return envelope. If you do not wish to complete this survey, please return only the pre-paid return envelope.

1) Please look at the six numbered illustrations that accompany this questionnaire. Each illustration shows a different level of development in a Vermont town. Please rate the acceptability of each illustration, paying special attention to the amount of development. A rating of -4 means the illustration is "very unacceptable" and a rating of +4 means the illustration is "very acceptable". Please circle one number for each illustration.

<table>
<thead>
<tr>
<th>Very Unacceptable</th>
<th>Very Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 1</td>
</tr>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 2</td>
</tr>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 3</td>
</tr>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 4</td>
</tr>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 5</td>
</tr>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td>Illustration 6</td>
</tr>
</tbody>
</table>

2) Look again at the six illustrations. Which illustration shows the level of development that you prefer? (Please choose one answer)

Illustration number ________

3) Which illustration looks most like the town you live in? (Please choose one answer)

Illustration number ________

OR

☐ None of the illustrations look like my town

4) Which illustration shows so much development that you would not want to live in this town? (Please choose one answer)

Illustration number ________

OR

☐ I would live in any of the illustrated towns.

5) Which illustration shows the maximum level of development that a town should allow? (Please choose one answer)

Illustration number ________

OR

☐ None of the illustrations show enough development to need regulation.

☐ Development should not be regulated.

6) Is Vermont your primary residence?

☐ Yes ☐ No

7) Were you born in Vermont?

☐ Yes ☐ No

8) Do you own the dwelling you live in?

☐ Yes ☐ No

9) What year were you born?

Year ________
10) Please look at the six images labeled Illustration A through E on the last page of the attached booklet. Each illustration shows a different amount and pattern of development.

Please rate the acceptability of each illustration, paying special attention to the amount and pattern of development. A rating of -4 means the illustration is “very unacceptable” and a rating of +4 means the illustration is “very acceptable”. Please circle one number for each illustration.

<table>
<thead>
<tr>
<th>Very Unacceptable</th>
<th>Very Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illustration A (50 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Illustration B (50 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Illustration C (100 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Illustration D (100 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Illustration E (150 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Illustration F (150 houses)</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
</tbody>
</table>

11) Do you believe there should be a change in the amount of wildlife in your town? (Please circle one answer)

<table>
<thead>
<tr>
<th>Less Wildlife</th>
<th>No Change</th>
<th>More Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12) Which of the following outdoor activities do you participate in? (Please check all that apply)

- [ ] Birding
- [ ] Hiking
- [ ] Hunting
- [ ] Fishing
- [ ] Off road ATVing
- [ ] Farming/Gardening
- [ ] Snowmobiling
- [ ] Camping
- [ ] Other ________
- [ ] None of the above

13) How acceptable would it be to have the following animal live in or near your town?

<table>
<thead>
<tr>
<th>Very Unacceptable</th>
<th>Very Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Bear</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Fisher</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Raccoon</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Deer</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Bobcat</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Coyote</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
<tr>
<td>Fox</td>
<td>-4 -3 -2 -1 0 1 2 3 4</td>
</tr>
</tbody>
</table>

14) What is your current completed level of education? (Please choose one answer)

- [ ] High School/GED
- [ ] Associate Degree
- [ ] Bachelor’s Degree
- [ ] Master’s Degree
- [ ] Doctorate Degree
- [ ] Technical School
- [ ] Professional Degree
- [ ] None of the above

Thank you for helping us with our study.
Your participation is greatly appreciated.
Appendix 2: Camera trapping data were collected in Vermont in 2011 for seven species: black bear, bobcat, coyote, deer, fisher, fox and raccoon. Detection and non-detection data, as well as site covariates, were used to develop occupancy models for each species. Models were then used to estimate species presence or absence in each illustration presented in the visual preference survey. Black bear data were not robust enough to model, so I used a model from Long et al. (2011). Each covariate name listed habitat type within a predefined area (1K or 5K). The beta estimates (β), standard errors (SE) and 95% confidence intervals (CI) are listed for each species’ top model.
<table>
<thead>
<tr>
<th>Species</th>
<th>Covariate</th>
<th>$\beta$</th>
<th>SE</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black bear</td>
<td>INTERCEPT</td>
<td>0.957</td>
<td>1.016</td>
<td>-1.033</td>
<td>2.948</td>
</tr>
<tr>
<td></td>
<td>%FOREST-5K</td>
<td>3.059</td>
<td>1.444</td>
<td>0.229</td>
<td>5.888</td>
</tr>
<tr>
<td></td>
<td>%DECIDUOUS-5K</td>
<td>0.018</td>
<td>0.299</td>
<td>-0.567</td>
<td>0.603</td>
</tr>
<tr>
<td></td>
<td>%DEVELOPED-5K</td>
<td>-1.847</td>
<td>0.754</td>
<td>-3.324</td>
<td>-0.370</td>
</tr>
<tr>
<td>Bobcat</td>
<td>INTERCEPT</td>
<td>0.662</td>
<td>1.872</td>
<td>-3.007</td>
<td>4.331</td>
</tr>
<tr>
<td></td>
<td>%FOREST-5K</td>
<td>-0.069</td>
<td>0.036</td>
<td>-0.140</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>%PASTURE-5K</td>
<td>0.156</td>
<td>0.101</td>
<td>-0.182</td>
<td>0.354</td>
</tr>
<tr>
<td></td>
<td>%DEVELOPED-5K</td>
<td>-0.016</td>
<td>0.047</td>
<td>-0.108</td>
<td>0.076</td>
</tr>
<tr>
<td>Coyote</td>
<td>INTERCEPT</td>
<td>-2.958</td>
<td>1.562</td>
<td>-6.020</td>
<td>0.104</td>
</tr>
<tr>
<td></td>
<td>%PASTURE-5K</td>
<td>0.245</td>
<td>0.098</td>
<td>0.053</td>
<td>0.437</td>
</tr>
<tr>
<td></td>
<td>%DEVELOPED-5K</td>
<td>0.033</td>
<td>0.043</td>
<td>-0.051</td>
<td>0.117</td>
</tr>
<tr>
<td>Deer</td>
<td>INTERCEPT</td>
<td>-2.750</td>
<td>2.991</td>
<td>-8.612</td>
<td>3.112</td>
</tr>
<tr>
<td></td>
<td>%PASTURE-5K</td>
<td>0.057</td>
<td>0.074</td>
<td>-0.088</td>
<td>0.202</td>
</tr>
<tr>
<td></td>
<td>%DEVELOPED-5K</td>
<td>1.333</td>
<td>1.068</td>
<td>-0.760</td>
<td>3.426</td>
</tr>
<tr>
<td>Fisher</td>
<td>INTERCEPT</td>
<td>-1.699</td>
<td>1.061</td>
<td>-3.779</td>
<td>0.381</td>
</tr>
<tr>
<td></td>
<td>%FOREST-5K</td>
<td>0.046</td>
<td>0.019</td>
<td>0.009</td>
<td>0.083</td>
</tr>
<tr>
<td></td>
<td>%PASTURE-5K</td>
<td>-0.013</td>
<td>0.022</td>
<td>-0.056</td>
<td>0.030</td>
</tr>
<tr>
<td>Fox</td>
<td>INTERCEPT</td>
<td>-1.240</td>
<td>1.590</td>
<td>-4.356</td>
<td>1.876</td>
</tr>
<tr>
<td></td>
<td>%DEVELOPED-1K</td>
<td>0.741</td>
<td>1.151</td>
<td>-1.515</td>
<td>2.997</td>
</tr>
<tr>
<td>Raccoon</td>
<td>INTERCEPT</td>
<td>0.736</td>
<td>1.747</td>
<td>-2.688</td>
<td>4.160</td>
</tr>
<tr>
<td></td>
<td>%FOREST-5K</td>
<td>-0.081</td>
<td>0.042</td>
<td>-0.163</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>%PASTURE-5K</td>
<td>0.581</td>
<td>0.380</td>
<td>-0.164</td>
<td>1.326</td>
</tr>
</tbody>
</table>