Seeing Biodiversity:
Exploring the factors that influence perception

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Senior Comprehensive Exercise

Advised by Tsegaye Nega and Dan Hernandez
Environmental Studies
Carleton College
March 2015

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*Senior Comprehensive Exercise 2015*
*Environmental Studies*
Abstract

Urbanization is the leading cause of biodiversity loss due to land use change. However, the general population is disassociated with this loss, viewing it as a distant rather than localized issue that does not apply to them directly. This dissociation is due in part to various levels of understanding about what the term “biodiversity” means. Biodiversity conservation rarely takes into account the knowledge, perception, and needs of the average citizen. It is important to understand the associations people have with biodiversity given the linkages between understanding and willingness to become involved with conservation efforts. This study uses visitor employed photography (VEP) in Nerstrand Big Woods State Park (Nerstrand, MN) to assess Carleton College (Northfield, MN) students’ perceptions pertaining to the term “biodiversity” and its applications. Our findings indicate that participants have varying perceptions of biodiversity depending on background information. Binomial logistic regression revealed the following variables to be statistically significant: hometown classification, previous outdoor experience, and academic domain. Further descriptive analysis revealed that these variables impacted the use of various themes such as “human influence,” object “origins,” and “utility” in participant descriptions of biodiversity.

Acknowledgements

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We would like to thank the 30 Carleton College volunteer participants who volunteered their Sundays to walk through Nerstrand and help us with our comps. We would not have been able to complete this study without all of your photo and survey contributions.

Finally, we would like to thank our fellow ENTS seniors as well as friends and family for reading various scraps and drafts of our comprehensive project. Thank you all so very much.
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I. Introduction

Urbanization is a rapidly growing cause of many environmental issues (Benfield et al., 1999). Studies have identified that the destruction of habitat as a result of urban development is one of the greatest threats to biodiversity loss (McKinney, 2002). This has become an increasingly pertinent topic as research has explicited the relationship between biodiversity and ecosystem functions (Rapport et al., 1999). Furthermore, the availability of information regarding threats to biodiversity leads the majority of Americans to associate biodiversity loss with removed, and often unfamiliar, landscapes. Rather than distancing ourselves from the consequences of biodiversity loss, it is important to consider the native species in the increasingly urbanized environments in which 80% of the United States’ population resides (Schwartz, 2006).

People’s responses to the decline of biodiversity have been demonstrated to be dependent on their knowledge and perception of the term and its various applications. Biodiversity has been defined in various ways, but the term is most generally understood to mean species richness (the number of species present) (Hooper et al., 2005). However, a significant portion of the general population cannot define the term “biodiversity,” and therefore are likely unaware of the importance of maintaining it (Hunter and Brehm, 2003). The participation of the public in environmental management and decision-making is necessary for the success of conservation efforts. Therefore, the significance of public understanding of environmental issues, and of the terms associated with those issues, cannot be overstated (Fischer and Young, 2007)

To develop this understanding, it is useful to take into account the values embedded in everyday meanings of the term “biodiversity.” This is because these values inform perceptions that shape the way people look at, interact with, and attach meaning to the natural world (Fischer and Young, 2007). To involve the public in environmental issues, we must connect conservation conversations and initiatives to people’s interests and day-to-day lives, and find a way to personalize nature in an increasingly urbanized world (Rosenzweig, 2003).

One of the ways in which people might begin to internalize an understanding of biodiversity is to involve them in citizen science, which is understood as having the potential to bridge the gap between public and scientific understandings. Participation in citizen science is believed to increase environmental stewardship by engaging stakeholders in informal science education (Cooper et al., 2007; Louv et al., 2012). Given the weight placed on the potential of education to increase stewardship and public knowledge of environmental issues, it is curious that the role of environmental education in institutions of higher learning has yet to be comprehensively investigated.

The aim of education is to shape human behavior by increasing awareness and participation (Hungerford and Volk, 1990). However, the extent to which education, in addition to variables such as prior outdoor experience and degree of hometown urbanization, influence people’s understandings and actions remains largely unexamined. The purpose of this study is to further explore these variables using Carleton College students as a sample population. Specifically, our research seeks to investigate student perceptions of biodiversity and to reveal which factors influence them. We expect that our data will inform further research to examine the connections between biodiversity perception and particular demographics (e.g. academic domain, hometown classification, level of outdoor experience, level of education achieved) in order to facilitate more effective public involvement in issues related to conservation.
Objectives
This study seeks to determine which factors have the most influence over an individual’s perception of biodiversity. The variables examined include class year, academic domain, age, gender, level of hometown urbanization, and degree of outdoor experience. More specifically, our methodology is directed towards answering the following questions:
1. How do Carleton College students conceptualize biodiversity?
2. How do academic domains influence an individual’s perception of biodiversity?
3. How does the level of urbanization of an individual’s hometown influence their perception of biodiversity?
4. How do varying degrees of outdoor experience influence an individual’s perception of biodiversity?

II. Analytical Framework
Conceptually, our research draws from several scholarly works on biodiversity, perception, and influences on people’s perceptions of biodiversity. In the following section, we briefly discuss this literature beginning with the meaning of the term “biodiversity” and how the public understanding relates to, and deviates from, the scientific definition. Next, we address the significance of this relationship to biodiversity conservation and policy. We also draw upon research that demonstrates the relatively unexplored complexities embedded in human perceptions of biodiversity.

We then describe the possible influences on these perceptions, specifically exploring three variables that are most relevant to our study population: hometown classification, outdoor experience, and academic domain. These variables have not been studied to the extent that they may be relevant to a more complete understanding of undergraduate students’ perceptions of biodiversity. Given the weight placed on the potential of education to increase stewardship and public knowledge of environmental issues specifically, it is curious that the variety of educational sources and lived experiences that may inform this understanding have yet to be comprehensively researched. We intend to engage in a meaningful conversation about the interrelated importance of understanding perceptions and their origins. In order to recognize public perceptions, it is not enough to ask what they are; a more comprehensive understanding of where these perceptions originate is required to involve the general public in biodiversity education and, subsequently, conservation policy.

Biodiversity and its Importance
Biodiversity can be defined in many ways, including as genetic and as ecosystem variability. However, given the purpose of this study, we will use the definition of biodiversity as the variety of life, which is most commonly measured by species richness (number of species in an area) and species evenness (the degree to which the abundances of species are similar) (Cardinale et al., 2012). Concern over the loss of biodiversity began in the 1980s, as research revealed that the number of different species within an ecosystem could influence that ecosystem’s functions and services. An ecosystem function is a process that controls fluxes of nutrients and energy (e.g. nutrient cycling, decomposition), while an ecosystem service refers to benefits humans derive from the ecosystem (e.g. renewable resources, pollination, and water filtration) (Cardinale et al., 2012).

The future of biodiversity is dependent on its proper valuation, which can only happen if the public is able to conceptualize why it relates to them specifically (Rosenzweig, 2003).
Therefore, an understanding of ecosystem services as they relate to the sustainability of human societies is essential to the development of an understanding of, and concern for, the importance of biodiversity among the general public.

**Biodiversity Education**

The term “biodiversity” is generally unfamiliar to the public because it is considered a vague buzzword that is used to garner public support, but is not understood conceptually (Adams, 2007; Fischer and Young, 2007). Studies have demonstrated that the theoretical meaning of biodiversity is scientifically complex, and difficult for the average person to grasp or have interest in (Adams, 2007; Fischer and Young, 2007; Hunter and Brehm, 2003). This general lack of understanding and subsequent lack of interest has been cited as a primary reason the public fails to engage in citizen science. Citizen science is a way to increase environmental stewardship by engaging motivated citizens in research and informal science education (Cooper et al., 2007). However, Fischer and Young (2007) asserted that assuming individuals cannot grasp the notion of biodiversity operates under the premise that a scientific understanding of the term is the only one a person can have. Therefore, the ways in which the public may conceive of biodiversity, biodiversity loss, and how these understandings might enhance biodiversity management are rarely considered.

Education on the meaning of “biodiversity” is considered limiting to public understanding. Hunter and Brehm (2003) argued that in response to this perceived lack of engagement with conservation, efforts at biodiversity education must include the scientific rationale behind these conservation measures. More importantly, they concluded that expanding the framework of biodiversity education must inform science and policy makers on the varying perceptions associated with it. This more integrative understanding could work to lessen the scientific rigidity and terminological complexity of the concept of biodiversity. Van Weelie and Wals (2002) suggested that lacking a specific definition for biodiversity works to strengthen the link between science and society. They stated that varied definitions leave room for students to develop a common language and value system through which to discuss multifaceted issues of biodiversity and conservation. Thus, in order to improve upon public support for biodiversity management, biodiversity education must encompass different aspects of scientific definitions of biodiversity, while simultaneously being informed by the diverse values and experiences of the public (Fischer and Young, 2007).

Influences on public perceptions of biodiversity occur in both formal and informal educational settings, from ecology classes to outdoor adventure programs (e.g. NOLS). However, it has been suggested that the traditional classroom may not be the optimal setting for students to learn about biodiversity and other environmental issues. A 2008 study conducted by Lindemann-Matthies and Bose revealed that few participants thought of their school education as a pertinent source of information on biodiversity. Additionally, Bogner and Wiseman (1997) cited several studies that noted that an individual’s participation in outdoor education is assumed to foster a sense of environmental literacy and nurture a willingness to take positive environmental action. According to Fazio and Zanna (1981), this may be due to the fact that attitudes based on direct experiences with an object are more influential, predictive of behavior, and tend to result in higher attitude-behavior consistency.
Biodiversity Perception

Perceptions inform the ways in which people internalize auditory, tactile, and visual information. Perceptions are often influenced by previously obtained knowledge and experience, and visual perception, the focal point of this study, is often produced by unconscious inferences and associations (Hatfield, 2001).

Several studies have emphasized the importance of environmental perception, and many focus specifically on public valuation (Bell et al., 2005; Heyman et al., 2011; Nielsen et al., 2007). The majority of the public has not had the experiences or opportunities that foster perceptions of biodiversity independent of the scientific definition. Some of the ways in which biodiversity is valued are categorized by environmental, economic, and aesthetic incentives, each with a different utility to human populations and natural systems (Hunter and Brehm, 2003). Recently, this focus on value has been deconstructed, with studies now attempting to examine its origins. For example, a study by Fischer and Young (2007) explored the mental constructs that exist surrounding biodiversity and its management in order to determine what factors might influence public acceptance or rejection of conservation initiatives. In order to do so, the authors stated they utilized the methodologies of previous sociological and psychological research on similar issues. These studies suggest public perceptions are best understood in their “cultural, social, and individual contexts,” rather than using scientific definitions to categorize engagement with concepts as either “right” or “wrong.”

Through the use of interest group discussions and drawings, participants in the study were able to express complex mental concepts that incorporated diverse understandings of biodiversity and the role of humans in the natural world (Fischer and Young, 2007). Specifically, these concepts included recurring themes such as interconnectivity of nature and several negative versus positive notions (for example human influence versus natural areas, with the first being the negative) (Lindemann-Matthies et al., 2010). Fischer and Young (2007) argued that these results represented complex understandings of biodiversity, regardless of the scientific knowledge of the participants. They and others also posit that these types of perceptions are crucial to examine because they operate as the basis for public opinion and action on biodiversity conservation (Buijs et al., 2008; Fischer and van der Wal, 2007; Fischer and Young, 2007). However, these studies did not explore the underlying influences of these different conceptions of biodiversity.

Influences on Biodiversity Perception

Several studies, such as those conducted by Martín-López et al. (2007) and Swanwick (2009) sought to understand what characteristics and experiences influence perceptions of biodiversity. Many factors were found to contribute to these perceptions, such as past and present interactions with particular species, cultural factors (religion, ethnicity), social factors (socioeconomic status, level of education), upbringing and residence (particularly whether urban or rural), education and environmental value orientations, and outdoor experience. For the purpose of our study, we will be focusing on three variables found to be either important in the perception of biodiversity, or relatively unstudied: (1) hometown classification; (2) undergraduate academic domain; (3) level of outdoor experience.

Hometown Classification

In order to classify hometown as urban area, urban cluster, or rural, we used the U.S. Census Bureau’s definitions of these areas by population count (DeNavas-Walt et al., 2008).
This classification, as argued by Swanwick (2009), can also be a factor that influences an individual’s level of outdoor experience and therefore his or her perceptions of nature. This was revealed through a related study, which found that people brought up in rural settings are more likely to interact with the natural world (Hinds and Sparks, 2008). Specifically, the study demonstrated that there are significant differences between urban and rural participants in terms of how each group engages with the natural environment. Study participants from rural hometowns had more positive emotional connections and stronger identification with, as well as more positive attitudes and behavioral intentions towards, the natural world than did participants with urban childhoods (Hinds and Sparks, 2008). This variable is therefore important to study, as it has been found to be influential to the public's perception of nature. The influence of this variable on perceptions of biodiversity explicitly, as opposed to nature or the environment in general, has not been studied.

**Academic Domain**

Academic domain refers to categories of academic discipline. Our study seeks to understand the perceptions of students from a variety of majors, including those who are not biology or general science majors. However, there is scarce information in the existing literature about the influence of undergraduate academic domain on perceptions of biodiversity. Studying the various ways in which college-aged students view biodiversity is necessary because recipients of at least an undergraduate level of education are more likely to be involved in future decisions pertaining to policy making and, more specifically, ecological conservation (NSB, 2010). The studies that have been conducted revealed a trend that biology majors tend to be more familiar with the concept of biodiversity than non-biology majors (Adams, 2007; Turner-Erfort, 1997). This may be because natural science majors are more likely to be exposed to one type of definition of biodiversity over another. However, in our study, we seek to acknowledge the variety of definitions that possibly originate from education within various academic disciplines (Fischer and Young, 2007; Gayford, 2000).

**Outdoor Experience**

Outdoor experience is an important factor in the development of biodiversity perception (Wells and Lekies 2006). Several studies asserted that childhood engagement with nature acts as a key influence on environmental knowledge and behavior later in life (Swanwick, 2009; Tanner, 1980; Wells and Lekies, 2006). However, these studies maintain the notion that in order for an outdoor experience to be significant, it must have had occurred during childhood or early adolescence. Other studies have examined adults. For example, one study investigated adults who held positions such as conservationists and environmental educators and professionals. They were asked about the most influential experiences in their lives, and despite being given the option of including experiences from adulthood, many still cited outdoor activities during their youth (Chawla, 1999; Corcoran, 1999; Palmer, 1993; Peterson, 1982; Sward, 1999; Tanner, 1980). This variable is important to study as it has been found to be influential in the participant perceptions of the natural world, but has not been investigated as it relates to biodiversity specifically.
III. Methodology

Study Site

We chose to conduct our study in Nerstrand Big Woods State Park, located 13 miles south of Carleton College in Northfield, Minnesota. This site was chosen because it is one of the last remnants of Big Woods vegetation. The park highlights this feature as significant in Nerstrand’s history, making it an area in which biodiversity conservation is prioritized (Nerstrand Big Woods State Park). We also chose this site instead of a closer diverse area (such as the Carleton College Arboretum) because the vast majority of students at Carleton have limited to no experience in Nerstrand, therefore eliminating any bias based on prior knowledge.

Volunteer Employed Photography

There are a number of ways to research perceptions of biodiversity. For example, past studies have utilized surveys, focus groups, and interviews (Adams, 2007; Fischer and Young, 2007; Hooper, 2005; Lindemann-Matthies and Bose, 2008). However, volunteer employed photography (VEP) is the most appropriate methodology for the purposes of our study. It is defined as “an experience recording technique” and has previously been used in studies of landscape preference, tourism, outdoor recreation experiences, and community planning (Balomenou et al., 2010; Garrod, 2008). This study employs an approach similar to that of Fischer and Young (2007) by emphasizing the importance of understanding individuals’ constructs of biodiversity in their cultural and social contexts as opposed to specifically their scientific knowledge.

Studies indicate that it is crucial for participants to engage, both physically and mentally, with the environment because this allows individuals to directly apply their knowledge (Garrod, 2008). This is why other methods, such as a survey, would be less effective. Given that the focus of this research was on individuals, it was important that our methodology allowed for an environment in which participants could think and answer questions independently of us or of their peers, eliminating focus groups and interviews as potential methods. Thus, VEP reduced biases present in other methodologies that might have affected a participant's answer, while simultaneously allowing them to interact directly with an environment as a stimulant.

VEP has been credited with empowering research participants, as they are able to address and express what interests them about the topic chosen by the researcher, as well as to communicate ideas and feelings that might otherwise be difficult to verbalize (Garrod, 2008). Specifically relevant to our study, previous research has found that insecurity with technical terminology can limit a participant’s expression of his or her individual perceptions (Fischer and Young, 2007). Therefore, VEP serves as an important tool to overcome these potential discomforts with the subject.

Recruitment

Our participants were selected using convenience sampling as it raised the likelihood that students would volunteer. A random sample is not the most effective way of developing an understanding of complex issues related to human behavior and perceptions (Marshall, 1996). Emails explaining the study were distributed to an assortment of Carleton College campus email lists intending to reach students from different backgrounds and areas of study. Interested students responded with their availability and information. Additionally, a consent form was provided on the same sign-up document. A total of 30 Carleton College students participated, a sample size typical of VEP studies (Garrod, 2008; Table 1).
In our convenience sampling, we chose to only contact freshmen, juniors, and seniors, excluding sophomores. This is because both juniors and seniors have already declared their majors and therefore the effect of being in a particular field of study on a student’s perception of biodiversity may be explored. In addition, having this varied group of class years among participants served to demonstrate how experience and time spent at Carleton affects a student’s understanding of biodiversity.

Although we used convenience sampling as our method of recruitment, we still aimed for a diverse group of people. Based on domains of academic disciplines, we sought an array of major types amongst our junior and senior study subjects. Although Carleton College does not have a designated list of academic domains, we utilized the domains of St. Olaf College, an institution of similar size and discipline types. We also aimed for diversity in the level of hometown urbanization amongst our subjects, in addition to a range of outdoor experience, as these are other variables that could affect participant perception. A trial run, which involved 5 students, indicated that this recruitment method would yield a diverse sample population.

**Table 1:** Summary of the background information of the 30 participants who participated in this study.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domain</strong></td>
<td></td>
</tr>
<tr>
<td>Fine Arts</td>
<td>5</td>
</tr>
<tr>
<td>Humanities</td>
<td>3</td>
</tr>
<tr>
<td>Natural Science</td>
<td>8</td>
</tr>
<tr>
<td>Social Science</td>
<td>6</td>
</tr>
<tr>
<td>Undecided</td>
<td>7</td>
</tr>
<tr>
<td><strong>Hometown Classification</strong></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>4</td>
</tr>
<tr>
<td>Urban Area</td>
<td>21</td>
</tr>
<tr>
<td>Urban Cluster</td>
<td>5</td>
</tr>
<tr>
<td><strong>Outdoor Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>8</td>
</tr>
<tr>
<td>Intermediate</td>
<td>15</td>
</tr>
<tr>
<td>High</td>
<td>7</td>
</tr>
<tr>
<td><strong>Class Year at Carleton</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

**Data Collection**

Volunteers were asked to walk a 0.8 mile loop on the Hidden Falls trail in Nerstrand Big Woods State Park in November of 2014 (Figure 1). Ten flags were placed at areas we chose for their diversity (or lack thereof) and subjects were asked to stop at each flag to take one photo, for a total of 10 photos per person. It was made clear that they could take pictures of anything they wanted to at each stop as long as by the end of the loop, each participant had 5 photos of
something they considered to be biodiverse and 5 photos of things they believed were not biodiverse, allocating these photos as they saw fit throughout the trail. The intention of having participants take photographs was to narrow their frame of focus so that we could understand what each participant chose to take a picture of specifically and why, as opposed to allowing them to assess their general surroundings.

**Figure 1:** Map of Nerstrand Big Woods State Park with coordinates of each stop along Hidden Falls trail.
When sending subjects out on the trail, we separated each participant by five minutes and instructed them not to discuss the study with other subjects if encountered along the way, so as to avoid social bias or influence. Some subjects walked the trail in the opposite direction in order to avoid potential bias of all subjects walking the trail in the same direction. For example, trial participants explained that they felt the need to “save” the photographs of biodiversity for the end of the trail in case they saw something particularly biodiverse. Thus, sending subjects in two directions neutralized this bias.

Additionally, we established the ten specific stops in order to have an efficient method of comparing photographs between subjects. Participants were also told to write down what they took a photo of and why they believed that it either was or was not biodiverse because participant reasoning may differ between photographs of the same scene or object (Garrod, 2008; Sugimoto, 2011). Supplementary written statements further revealed their understanding of biodiversity. Responses were collected on site and participants were asked to email the photographs to a closed email account. Those that did not have a smartphone with a camera were provided with a camera from the Carleton cinema and media department.

Survey

Upon arriving at the study site, each participant was asked to fill out a survey (Appendix C). The surveys primarily served to gather information on the following variables: the student’s major, amount of time spent at Carleton College in number of terms as well as what class year he/she was, categorization of hometown (urban area, urban cluster, or rural based on zip code), degree of prior outdoor experience (low, intermediate, or high), and definition of biodiversity. Gender and age were considered supplementary.

Coding

Each survey and photo log (from here on referred to solely as “survey”) was typed into an individual document where the name of the participant was replaced with a number so as to avoid researcher bias. We began by representing our data in a word cloud. A word cloud is a visual representation of text in which the size of the word indicates the frequency of its use. We typed up surveys and created a new document compiling all survey responses. We made all singular word variations into plural for simplicity (e.g. changing all “tree” responses to “trees” for continuity). The first word cloud observed consisted of all 30 participants. The six most used words were noted as a baseline comparison. We then decided to observe the data based on the different variables, such as domain, outdoor experience, hometown classification, and class year (Appendix A). We compared the word clouds across the different variables and noted the words that were similar or different, including the six most used words. We then used this to inform our coding process.

Based on these word clouds we were able to see the main themes and ideas present in participant responses. This then informed our coding process, in which we aimed to see on a participant basis, which themes were most prevalent. The coding process began with each of us coding five of the same surveys together in order to understand and record the initial emergence of patterns. In order to avoid coder bias, we then divided the surveys into three groups, with each of us taking two different groups for a total of twenty surveys per researcher. This was in order to have two researchers for each coded survey and a third party participant who did not code that survey present to observe, ask questions, and weigh in on disputes or concerns about codes. After comparing and discussing codes for all thirty surveys and coming up with a definition for each
code, we each coded every survey (Table 2). We then solidified our final codes for all surveys and created an Excel document with a binary model expressing whether or not the code applied to each participant at each stop.

Table 2: Coding themes present in participant surveys as decided by the researchers. Also included is the definition of a code and examples of the context in which a participant used them.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
<th>Key words</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility</td>
<td>Indication of usefulness of an object or a species</td>
<td>“contributes,” “nourishes”</td>
</tr>
<tr>
<td>Living</td>
<td>Life and death</td>
<td>“decaying,” “decomposing,” “rotting,” “growing,” “thriving”</td>
</tr>
<tr>
<td>Origins</td>
<td>Where an organism or object came from</td>
<td>“placed here,” “naturally,” “occurring,” “native”</td>
</tr>
<tr>
<td>Human influence</td>
<td>anything involving humans interacting with or impacting nature</td>
<td>“man-made”</td>
</tr>
<tr>
<td>Coexist</td>
<td>Two or more species or systems inhabiting/surviving in a similar ecosystem</td>
<td>“together,” “growing around”</td>
</tr>
<tr>
<td>Species Interactions</td>
<td>Two or more species identified as cooperating or living together</td>
<td>“growing on,” “living in,” “sitting on,” “dominating”</td>
</tr>
<tr>
<td>Variety</td>
<td>Either a lack or presence of species diversity</td>
<td>“same,” “different,” “many”</td>
</tr>
<tr>
<td>Variety: Aesthetic</td>
<td>Something physical that caught their eye and contributed to variety</td>
<td>“thin trees,” “colorful bushes”</td>
</tr>
<tr>
<td>Variety: Age</td>
<td>Indicating different ages of plants; different stages of the life cycle</td>
<td>“young trees,” “saplings”</td>
</tr>
<tr>
<td>Variety: Commonality</td>
<td>Something that is similar to another area</td>
<td>“same everywhere,” “all the same on this hill”</td>
</tr>
<tr>
<td>Variety: Rarity</td>
<td>Something is unique and hasn’t been seen elsewhere in the park</td>
<td>“new,” “unique”</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Expression of any doubt, questions, unsure of knowledge</td>
<td>“maybe,” “I’m not sure”</td>
</tr>
<tr>
<td>Agency</td>
<td>Anthropomorphizing the amount of autonomy that an inanimate organism has</td>
<td>“the tree didn’t choose to have the moss grow,” “deliberately”</td>
</tr>
</tbody>
</table>
Data Analysis

Proportions of responses were separated by themes and participant background information. This allowed for each theme to have a probability, or the probability that an individual with X background variables will use Y theme at a given stop. Participants were able to use multiple themes at each stop, so the sum of probabilities is not always one. The relationships between variables and themes were first observed in exploratory plots, which gave us an idea of the general trends based on different background information. All graphs were made in R Studio (Version 0.98.977 – © 2009-2013 RStudio, Inc.). The responses to the themes “variety-aesthetics,” “variety-age,” “variety-commonality,” “variety-rare,” and “agency” were not used in these visual representations, as the response rates were so low that it skewed the graphs. With these graphs we made notes of interesting trends and differences among background variables.

Using these visual representations, we proceeded from descriptive methods to statistical analysis. Statistical analyses on visual methodologies such as VEP are not evident in existing literature. We performed a binomial logistic regression analysis on these data using R Studio (Version 0.98.977 – © 2009-2013 RStudio, Inc.). The goal of running this specific type of statistical analysis was to determine which background variables had the most influence on an individual using a given theme. The results of running these tests provided a formula in which we could predict the probability, based on certain variables, of an individual using a certain theme. This allowed us not only to observe which variables are most important in determining the use of a theme, but also provided information when comparing results among variables, such as a rural participant and an urban participant, and the difference in the odds of them using a particular theme. Although our participant size was low, this analysis was still appropriate.

The variables academic domain, time at Carleton, outdoor experience, and hometown classification were run for each coding theme. First, the models were run with all of the background variables. However, after viewing which themes were significant and which were not, we removed insignificant variables and reran the model. This resulted in a model that best fit the data, rather than one that included unnecessary variables.

IV. Results

Summary of Themes

Participants, when discussing an array of species types or objects, used the theme “variety.” Overall, the theme “variety” was most frequently used among all types of background variables (Figure 2, 3, 4, Table 2). Upon further statistical examination, it does not appear that there are any specific variables that influence the use of this theme. Examples of words used by participants that were coded as “variety” are “many,” “different,” and “same.”

Another commonly used theme was “coexist,” which refers to two or more species or systems inhabiting or surviving in the same area (Table 2). An example of this in participant responses was “growing around.” The binomial logistic model for this theme did not reveal any significant background variables. The theme “species interactions” is similar to “coexist,” but specifically identifies two or more species living together. After examining this theme through both a descriptive and statistical lens, there do not appear to be major differences in how background variables influence its use.

The themes “origins,” “human influence,” “utility,” and “living” all had significant results statistically and descriptively. They are described in more detail below.
Figure 2: Percent of total responses that were coded for each theme subset by academic domain. Results are shown as the percent of responses at each stop that contained a certain theme. The themes are representative of idea trends that were expressed in participant surveys when they were considering what was and was not biodiverse (see Table 2 for more complete descriptions of themes).

Figure 3: Percent of total responses that were coded for each theme subset by outdoor experience. Results are shown as the percent of responses at each stop that contained a certain theme. The themes are representative of idea trends that were expressed in participant surveys when they were considering what was and was not biodiverse (see Table 2 for more complete descriptions of themes).
Figure 4: Percent of total responses that were coded for each theme subset by hometown classification. Results are shown as the percent of responses at each stop that contained a certain theme. The themes are representative of idea trends that were expressed in participant surveys when they were considering what was and was not biodiverse (see Table 2 for more complete descriptions of themes).

“Origins” and “Human Influence”

Participants used words indicative of the themes “origins” and “human influence” to describe similar aspects of the environment in which this study took place (Table 2). “Origins” refers to when a participant acknowledges where a species or object comes from. For example, participants often used phrases such as “placed here” when referring to a park sign, or “native” and “non-native” when referring to species. “Human influence” involves participants associating human involvement with something they observe. Generally this theme was indicative of a human interacting with or impacting nature. An example of a participant response coded as “origins” and “human influence” is a description of a swing set as “man-made”.

The statistical model on “human influence” indicates that academic domain and outdoor experience are the most influential in determining when a participant uses terms related to this theme in a response (residual deviance: 45.428, df=24, Table 3). The odds of an individual with a high level of outdoor experience using the theme “human influence” was 3.54 times the odds of someone with a low level of outdoor experience using the same theme. Additionally, We are 95% confident that the odds of a participant with a humanities major using the theme “human influence” was between 2.09 and 1.33 times greater than for the other domains. Hometown classification appears to be the most influential in determining when a participant uses “origins” (residual deviance: 75.359, df=27, Table 3). Based on the coefficients for the model, the odds of an individual from an urban cluster using the theme “origins” is 127.99 times greater than someone from a rural background, and 2.24 times greater than someone with an urban area background.
Participants in the humanities used these themes most frequently (Figure 2). Additionally, those with the highest level of outdoor experience used both of these themes more than the other two levels (Figure 3). The language used by participants with the most outdoor experience also suggested a deeper level of understanding. For example, Participant 13, in regards to a metal sign, wrote:

*This is a man-made substance and has never been alive* (Participant 13, Stop 4).

Another participant focused on roped trail markers and explained they were man-made. Conversely, a participant with high outdoor experience used these themes when correctly identifying black knot fungus and horsetails, explaining they are native to the area. Another participant with high outdoor experience, in looking at a farm beyond Nerstrand, stated:

*These sorts of industrial farms usually specialize in one or two crops (in this case corn) and all other life (plants, bugs, etc.) are gotten rid of through weeding and chemical pesticides + herbicides (commonly)* (Participant 4, Stop 9).

In contrast, Participant 14, who ranked themselves as lowest on the scale of previous outdoor experience, cited this same notion at the same stop by saying,

*Several types of trees and grasses, farm is not biodiversity* (Participant 14, Stop 9).

**“Utility”**

Participants used the theme “utility” when indicating the usefulness of an object or a species to the environment. When coding for this theme, we looked for key words such as “contribute” and “nourishes.” This theme was typically used when participants described a species or object depending on or benefitting another one, indicating the importance of that species or object to the ecosystem.

The binomial logistic model on “utility” indicates a significant interaction between academic domains, level of outdoor experience, hometown classifications, and class year at Carleton (residual deviance: 43.006, df=19, Table 3). Based on the model for “utility,” we are 95% confident that the odds of a natural science major using this theme is between 2.9 to 7.59 times greater than the other domains using it, keeping the other variables constant. Additionally, the odds of a participant using language indicative of the theme “utility” with a high degree of outdoor experience is 20.22 times greater than the odds of someone with a low degree of outdoor experience.

Those in the natural sciences used the theme “utility” more frequently than other academic domains (Figure 2). When discussing this theme, the language used by participants also varied. Those in the natural sciences utilized language that suggests a more comprehensive understanding of the ecological connectivity of the species they were observing, such as a dead log providing refuge for species. For example, Participant 30, a natural science major described,

*Not only is this tree a living, thriving thing in itself, but it also supports numerous other forms of living organisms and biodiversity that rely on it for survival* (Participant 30, Stop 4).

Those that were not natural science majors tended to reference utility directly observed in the photo, like Participant 7, an undecided first year who stated,
You can see all of these different layers of life, and water adds a new element (Participant 7, Stop 6).

This indicates a variance in the level of engagement different academic domains have with this theme. Additionally, those with intermediate outdoor experience tended to use “utility” more than those with high or low levels or experience (Figure 3).

“Living”

The code “living” refers to a participant discussing the life and death of a species. There was a great variety in the types of words used depending on the context, but examples include “rotting,” “thriving,” and “decomposing.” This theme was also present when participants referenced an idea such as moss growing on a rock, which is life existing with an inorganic object.

The model on the theme “living” indicates that hometown classification was the most important factor in participants referencing this theme (residual deviance: 45.114, df=27, Table 3). Based on the model coefficients, the odds of a participant from an urban cluster using the theme “living” is 23.11 times greater than the odds of a participant from a rural area, and 2.18 times greater than the odds of someone from an urban area.

Participants from urban clusters used the theme “living” more often than other hometown classifications (Figure 4). The responses of participants from urban clusters tended to use this theme in reference to something they considered to be not biodiverse. For example, one participant observing leaves said,

Everything seems dead (Participant 18, Stop 8).

Another, noting leaves on the ground as not biodiverse, said that biodiversity must be an entire organism, not just its pieces. This differs from those in urban areas that used this theme in conjunction with something that was living and biodiverse. For example, one participant wrote,

Moss growing on rocks (Participant 14, Stop 6).
Table 3: Binomial logistic models based on the proportion of times a various theme was present in participant surveys and his or her background information.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Estimate</th>
<th>Std. Error</th>
<th>Odds Ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“Human Influence”</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
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<td>0.73</td>
<td>0.03</td>
<td>1.07e-06***</td>
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<td>0.72</td>
<td>4.41</td>
<td>0.038*</td>
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<tr>
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<td>0.68</td>
<td>2.11</td>
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</tr>
<tr>
<td>Social Science</td>
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<td>0.69</td>
<td>2.33</td>
<td>0.2254</td>
</tr>
<tr>
<td>Undecided</td>
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<td>0.66</td>
<td>3.31</td>
<td>0.068</td>
</tr>
<tr>
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<td>0.08</td>
<td>1.15</td>
<td>0.071</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td>0.05</td>
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<tr>
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<tr>
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</table>

Signif. codes:  p < 0.001 ‘****’  p < 0.01 ‘***’  p < 0.05 ‘**’

V. Discussion

Perception differed the most within our variables in regards to the following themes and codes: “origins,” “human influence,” and “utility.” Our other codes represent a more straightforward understanding of biodiversity (e.g. that the word “diversity” is synonymous with “variety”), such is the case with “living,” whereas these three variables characterize some of the more challenging and unacknowledged components of the public’s understanding of, and subsequent care for, biodiversity and its conservation. Specifically, our results suggest that there are differences between academic disciplines in regards to understandings of, and engagement with, the concept of biodiversity. They also serve to highlight the importance of outdoor experience in its ability to influence understandings of biodiversity and surrounding environmental issues, specifically in terms of human interference. Lastly, our results demonstrate the general lack of association between biodiversity, its utility, and how both relate to humans across all variables. In sum, our findings serve to illuminate some of the potential influences on
participant understandings of the relationship between biodiversity and humans, which is crucial to consider when working towards effective public participation in biodiversity conservation.

“Origins” and “Human Influence”

The themes “human influence” and “origins” were significant to biodiversity perceptions of participants with varying levels of outdoor experience and different academic domains. Within academic domain, participants in the humanities used the theme “origins” most frequently, often stating that an object was man-made, and therefore not related to biodiversity. This is in direct contrast to the ways in which the same theme of “origins” was addressed by natural science majors, who referenced the native versus non-native status of an organism when discussing biodiversity. This coincides with existing literature that stated that there are several barriers to the integration of social and natural sciences, such as a general lack of common vocabulary (Drew and Henne, 2006; Fox et al., 2006).

This difference may also speak to the varied understandings held by science and non-science majors about how humans affect biodiversity. Both considered an object or organism that does not “belong” in the environment as not biodiverse. However, the groups differed in terms of how and what they identified as foreign to the area. This finding, along with the overall influence of undergraduate academic domain on biodiversity perception, has been largely unexplored in previous literature. However, our results contribute to this research. Adams (2007) demonstrated a notable difference between the ways in which students of different academic domains think about biodiversity. Based on our sample population, students who study the humanities consider man-made objects to be examples of “human influence” more readily than native versus non-native organisms because the latter requires a deeper level of familiarity with species identification. Additionally, humanities majors are trained to view the world through the lens of human culture, and therefore are more likely to perceive landscapes through this framework (Milvain, 2008).

The importance of outdoor experience to participant consideration of human influence in relation to biodiversity was also significant. This was made evident by the varying degree of detail and familiarity expressed in the responses of participants with high and low levels of previous outdoor experience, indicating a range of understanding about how humans affect the landscape. Our findings are consistent with existing research that found that the degree of personal exposure to the natural world is a determinant of sensitivity to environmental issues (Savard et al., 2000). Specifically, Shwartz et al. (2012) cited several initiatives that combine outdoor activities with emotional, aesthetic, and creative involvement, which have been found to have positive effects on individual awareness of biodiversity. Further, Bogner (2002) stated that these experiences play a role in fostering environmental literacy, which includes understandings of the ways in which humans impact the landscape as a whole. Much of the existing literature, however, focused on outdoor experiences and education in a participant’s youth or adolescence. Findings on the influence of outdoor conservation education for adults, as elucidated by Shwartz et al. (2012), complicate the implications of our results. Adult participants who were exposed to conservation education did not demonstrate continuing interest in conservation efforts. This may be indicative of the ways in which different types of outdoor experience at different stages in people’s lives can be influential. However, our findings cannot speak to how influential experience can be, given that we did not inquire about the nature of the experience or the age at which it occurred.
The frequency with which “human influence” and “origins” were cited in participant perceptions of biodiversity is significant because the differences within and between each variable speak to the variety of ways in which this particular aspect of biodiversity, the one most relevant to biodiversity loss, can be understood. Acknowledging and having a more comprehensive understanding of the ways in which the public approaches the human-biodiversity relationship is instrumental in involving more people in conversations and subsequent action regarding biodiversity conservation.

“Utility”

The prevalence of the theme “utility” introduces the notion of biodiversity in terms of its economic value, which is frequently cited in existing literature on biodiversity conservation. However, in our survey we did not ask each participant how they value biodiversity, so our results instead reflect how “utility” plays into their definitions of biodiversity rather than their valuations of it.

Our results indicate that participants across all three variables referenced “utility” when thinking about biodiversity and did so in very similar ways. The prevalence of statements about utility in relation to biodiversity among urban students contradicted our expectations based on previous literature. For example, Buijs et al. (2008) posited that natural resources are often the basis of rural livelihoods, and therefore we can anticipate that participants from rural areas will acknowledge the human-nature relationship in terms of use value more frequently. This was not the case in our study. We instead found that urban cluster participants used the theme the most. On the other hand, our finding that natural science majors had a more in-depth understanding of the role of utility in biodiversity coincides with previous research and general assumptions that science majors have a more comprehensive knowledge of biodiversity and associated ecosystem intricacies (Adams, 2007).

Even so, neither rural participants, natural science majors, nor any other participants in the study cited the “utility” of nature to humans specifically. There is relatively little existing research on the perceptions of biodiversity in terms of “utility.” However, economic valuation of biodiversity has been studied in depth, specifically through “willingness-to-pay” methodologies. Although our methods clearly deviate, the results of our study may be supported by previous research similar to Costanza et al., (1998), who asserted that ecosystem services are not fully captured in commercial markets and are subsequently not given the appropriate weight in policy decisions and public consideration. It is possible that the overall failure to recognize the human utility value of biodiversity by our participants is indicative of the degree to which economic markets do not adequately capture valuations of biodiversity. It may also reveal a general lack of understanding of ecosystem services by those who are not educated in the natural sciences.

“Hometown Classification”

An initial examination of results revealed that hometown classification was not as influential in determining the use of the themes “human influence,” “origins,” or “utility” when compared to academic domain and outdoor experience. However, this result coincides with existing literature on hometown classification that, like our data, did not reveal clear trends for the variable (Berenguer et al., 2005, Bogner and Wiseman, 1997). Generally, this research has emphasized the difference in these populations in terms of expressed environmental action versus environmental behavior (Berenguer et al., 2005). Our results do not contribute to this conversation, but coincide with the general lack of significant difference between responses of
participants with differing hometown classifications in regards to biodiversity (Bogner and Wiseman, 1997).

**Suggestions for Future Studies**

The importance of our findings is corroborated by Lindemann-Matthies and Bose (2008), who argued that people only care about what they know. Conservation initiatives will fail if the public understands neither how we affect biodiversity nor how biodiversity affects us. Overall, our results suggest that there is a need to examine the variety of ways and degree to which the public understands that humans and the natural world are far more interconnected than they might appear (Cardinale et al., 2012). Future studies ought to examine these understandings and their origins on a broader scale than we have been able to do here. We suggest that additional research aim for an increased sample population, in order to make more generalizable conclusions through the use of statistics.

These studies ought to work towards understanding an efficient and meaningful way in which to educate the public on biodiversity. Our results suggest that outdoor experiences are the most meaningful in this regard. Again, we recommend that additional research take a closer look at the potential influence of this variable, attempt to understand the variety of ways in which people may experience the outdoors, and explore how these various experiences may hold different meaning and potential for continued action on conservation activities.

Specifically, as urban residency increases it is important to observe how outdoor experiences influence the perceptions of people in urban and suburban spaces. Our results indicate that amongst rural, suburban, and urban hometown classifications, there are no clear trends when it comes to biodiversity perception. This may simply be a result of our small sample size. However, there is already conflicting literature on the different ways in which rural and urban dwellers think about the environment. Therefore, we suggest that future studies look specifically at the experiences and perceptions of different groups (urban dwellers, rural dwellers, etc.) with a more detailed account of life experiences and demographics that may have influenced these perceptions. How do similar experiences affect these groups differently? As global urbanization continues to increase, this knowledge will be key to understanding the most efficient ways in which to instigate public participation in biodiversity conservation.

We anticipate that this study and its methodology will provide an interdisciplinary basis for future studies. Specifically, our methodology combines descriptive and statistical analyses, which have not been utilized in previous perceptions studies and which allowed for a more comprehensive understanding of our data.

**Limitations**

Many of the results of this study are consistent with past research; however, we acknowledge that they cannot be applied in a broader context. For one, the focus of previous studies related to hometown classification has been on childhood hometown experience specifically. In our study, we did not inquire into whether or not the provided hometown and zip code were representative of where each participant spent his or her childhood. Thus, we cannot make the same assumptions specific to childhood. However, there is some evidence that a person’s relationship and familiarity with a particular landscape can affect his or her perceptions (Swanwick, 2009). Therefore, having our participants list their hometown connotes at least a sense of familiarity with a certain classification of landscape, which can be said to possibly influence their perception of other environments.
Similarly, research conducted on the role of outdoor experience and education focuses solely on childhood and adolescent experiences. Given that the participants in our study range in age from 18-23, which is relatively young, our inquiry into outdoor experience could result in information about childhood experiences in nature. However, because we were not specific about asking when exactly these experiences took place, we cannot assume that our results will speak to the importance of childhood or adolescent outdoor experience. Also, the apparent lack of research on the role of undergraduate academic domain in relation to biodiversity perception results in the uncorroborated nature of our findings associated with that variable.

Lastly, there were some limitations regarding the structure of our study. As we based this study off of other VEP studies, which typically have 10-40 participants, our study only had 30 participants (Garrod, 2008). While consistent with descriptive VEP studies, this was not ideal for statistical analyses. Additionally, we chose to conduct this study in the fall, when most of the vegetation had begun to senesce and there might not have been the visual diversity present in the summer or spring. Another potential limitation is the format of the survey. It is possible that if we formatted this survey differently there would have been other statistical approaches that we were unable to explore.

VI. Conclusion

Today, more land in the United States is dedicated to urban and suburban areas than to national and state parks (McKinney, 2002). Social scientists interested in conservation have long recognized the challenge of engaging people in conservation solutions, and previous studies have emphasized the importance of educating a highly urbanized human population to improve biodiversity conservation in all ecosystems (McKinney, 2002; Peterson, 1982). It is necessary to find ways to merge conservation efforts and initiatives with people’s interests and the values embedded in their day-to-day lives. This study explored people’s perceptions of biodiversity, and where those perceptions originate.

Participant responses revealed a range of perceptions that our study suggests were influenced by hometown classification, level of outdoor experience, and undergraduate academic domain. As demonstrated by the language used by participants of different academic domains, these data indicate that there are differences between scientific and popular understandings of, and engagement with, the concept of biodiversity. Additionally, our data suggest that there is a fundamental difference in how individuals with higher levels of previous outdoor experience conceptualize human impacts on the landscape, generally demonstrating a more comprehensive environmental literacy. Overall, these inter-variable differences serve to illustrate the broader significance of our data; where the intricacies of biodiversity perceptions lie are within notions of how humans fit into the conversation.

Additionally, our data suggest that outdoor education and experience, and academic domain are the most important variables that contribute to this type of understanding. Having a sense of familiarity with the complexities of the human-environment relationship is understood to play a role in public appreciation of, and involvement with, biodiversity and its conservation. Therefore, while our results are not applicable to the public at large given our sample size and other study limitations, they suggest that the role of outdoor experiences and education in fostering environmental literacy must be reconciled with our increasingly urban existence.

Utilizing binomial logistic regression analysis, this study offers a new method through which to interpret perceptions, as statistics were not present in the analyses of previous studies. This methodology can inform future studies that seek to explore perceptions from a statistical
basis, and to combine descriptive and statistical analyses. Additionally, the findings of this study reinforce the conclusions of other studies. The conservation of biodiversity is dependent on the social values attached to it. It is necessary to develop a knowledge base among the public pertaining to biodiversity and other environmental issues in order to foster a more consistent, responsible stewardship of the natural world and to enable the success of conservation efforts dependent on citizen engagement (Hunter and Brehm, 2003; Turner-Erfort, 1997; Yore and Boyer, 1997).

VII. Bibliography


Nerstrand Big Woods State Park.
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NSB. (2010). *Preparing the next generation of STEM innovators: Identifying and developing our nation's human capital*: National Science Foundation.


VIII. Appendix A: Participant Photos

Participant 13, Stop 4
Participant 30, Stop 4
Participant 14, Stop 6
IX. Appendix B: Word clouds

Word cloud of combined participants (total of 30 participants)
Word cloud subset by hometown classification (A: Rural; B: Urban Cluster; C: Urban Area)
Word cloud subset by major domain (A: Fine Arts; B: Humanities; C: Natural Sciences; D: Social Science; E: Undecided)
World cloud subset by outdoor experience (A: low; B: intermediate; C: high)
Word cloud subset by class year (A: first year; B: third year; C: fourth year)
X. Appendix C: Survey

Survey and Instructions

Hello and thank you so much for volunteering to help with our ENTS comps! We would appreciate it if you would walk along the Hidden Falls loop, taking photos at every stop. Stops are marked by an orange flag on the right side of the trail, also with a number. There are a total of 10 stops along the 0.8 mile loop. You may take a total of 10 photographs, 5 of something you believe is biodiversity and 5 of something you believe is not biodiversity. Thus, you must allocate images as you see fit.

Additionally, please use the following sheet to write down descriptions of your photos on the back of this page. This will help us understand why you chose to photograph the image you did.

Make sure to explain why you believe this image represents biodiversity to YOU, or why it doesn’t.

*The numbered stops on the next page correspond to the number on the flag. Make sure you are writing your description in the correct space as some of you might be starting the loop backwards!*

After you finish the loop please take the time to fill out the survey below.

Please email your images with the stop number as the subject to ENTScomps2014@gmail.com.

Thank you again and feel free to ask us any questions!
Jamie, Ingrid, and Cassie

Survey

Name:

Gender:

Age:

Have you spent any time in Nerstrand State Park? If so, doing what?
Is your hometown (where you have lived the majority of your life) rural, urban, or suburban?

What is the name of your hometown?

What is your prior outdoor experience? (ie. living in farmhouse, NOLS trips, etc.)

How many terms have you completed at Carleton?

What is/are your major(s)?

How would you define biodiversity?

E. Photo Description Worksheet

Observations *remember that these numbers correspond to the number on the flag*

Stop 1:

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

Stop 2:

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

Stop 3:
This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

**Stop 4:**

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

**Stop 5:**

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

**Stop 6:**

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

**Stop 7:**

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

**Stop 8:**

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...
Stop 9:

This is a picture of...

This picture represents (biodiversity / not biodiversity) because...

Stop 10:

This is a picture of...

This picture represents (biodiversity / not biodiversity) because…