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Environmental Studies 651

Conservation Biology

Service-learning project with the

Lakeshore Nature Preserve

Attitudes Survey of Lakeshore Nature Preserve Users 2012

Conservation Biology 651

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Introduction

History of Usage

Over its history, the Lakeshore Nature Preserve has been home to various types of human use, ranging from early Native American burial mounds to original land surveys in the 19th century and private residences to the current 300-acre Preserve. The Preserve now includes 4.5 miles of shoreline along Lake Mendota owned by the University of Wisconsin-Madison.

When glaciers retreated during the end of the Pleistocene around 18,000 years ago, pollen records show that vegetation in the Preserve began shifting from a tundra-like community to boreal elements with dominant plant communities of spruce, fir, and pines, into a mixed deciduous forest and prairie eco-tone, including oaks, elms, hickories, and maples (Sytsma, 2012). According to Einstein (2006), "the story of human occupation along the southern shores of Lake Mendota begins more than 12,000 years ago," with changing climate and vegetation that provided a habitable landscape. Einstein continues to describe the "most visible legacies of past native peoples at UW-Madison are the earthen burial mounds," which can still be viewed today as a cultural resource, including the five mounds along Picnic Point (Figure 1).

As European settlers moved into the area during the 19th century, the Preserve's vegetation was fully indexed through a survey (Cronon, 2006). According to Cronon

(2006), “the original field survey notes for the lands now encompassing the UW-Madison Lakeshore Nature Preserve… by Orson Lyon, Original Land Survey, December 1834, is one of the earliest systematic historic records we have for the vegetation of UW-Madison's Lakeshore Nature Preserve.” The survey, includes original notes and landscape sketches, notes large trees, elevations, waterways, and other unique features to the area (Figure 2). The Preserve, located in the Township 7 North, Range 9 East, has both a plat map of the entire section and a smaller-scale view of Picnic Point (Cronon 2006, Figure 3).

As Madison became increasingly settled, the Preserve offered a host of uses designated within specific locations. “In 1866, soon after the university was designated a recipient of a Morrill Act land grant, funds were allocated to purchase the 198-acre farm situated just to the west of the original campus on Bascom Hill, becoming a “new ‘experimental farm’” and allowing for “the construction of a network of farm roads and pleasure drives in the late 1860s,” (Lakeshore Nature Preserve 2006).

The Picnic Point area also had a farm and cultivated fields extending into Bill’s Woods in the early 1900’s, which later turned into a family residence in 1924, (Einstein 2006). The farmhouse remained until a 1935 fire and the land was then sold to the University (Einstein, 2006). After the University’s acquisition, the property became an area for education, research, and recreation. According to Einstein (2006), “all that remains from the house today is the brick path that once led up to the house-now barely visible beneath the leaves and undergrowth” and the “distinctive stone entrance gateway.”

Frautschi Point was home to another private residence but later became a "gift… to the University by the Frautschi family in the late 1980s [that] provided the crucial link that tied together the western and eastern ends of the university's Lake Mendota shoreline, making possible the eventual creation of the Lakeshore Nature Preserve," (Einstein and Denniston 2006). Prior to the University's acquisition, most of the buildings were removed; however, some structures remain, including the entrance gate and stone fireplace (Einstein and Denniston, 2006; Figure 4).

The Wally Bauman Woods was originally a private residence until "A series of land trades… as the University first acquired the parcel in 1911," (Einstein and Welsh 2006). However, in 1941 "it became private property again as part of an unusual trade… to acquire Picnic Point," (Einstein and Welsh 2006) but was later traded back to the University again for Eagle Heights. According to Einstein and Welsh (2006), the "Lower Eagle Heights Woods [Wally Bauman Woods] remained undeveloped until the early 1980s, when its owner decided to build several duplex condominiums there. Opposition to the proposal produced an immediate public outcry—demanding that one of the last remaining privately held parcels of wild shoreline on Lake Mendota be saved from residential development!"

Project description

We relied upon the Conservation Measures Partnership's Open Standards for the Practice of Conservation version 2.0 to promote communication and improve the effectiveness of our conservation actions.

Our project team included four different categories: initial team, core team, advisors, and stakeholders. Six graduate students formed the initial team. Twelve

undergraduates collaborated with the graduates to make the core team. UW-Madison Professor of Conservation Biology (Environmental Studies 651) Adrian Treves and Conservation Biology Teaching Assistant Erik Olson formed the advisory committee. Finally, we identified the stakeholders as Preserve managers, users of the Preserve, inhabitants of the Preserve's neighborhoods, future students of A. Treves' Conservation Biology class, and the University of Wisconsin-Madison.

We identified the scope of our conservation project as the entire Lakeshore Preserve, including study areas A through D (Figure 7). To define our vision, we used the Preserve's mission statement in order to match our work with their conservation goals and management practices. The project vision consists of adaptive management of undeveloped areas to promote the beauty and integrity of land and contribute to foster an ethic of stewardship that promotes mutually beneficial relationships between humans and nature.

Our project's conservation targets are identified as the "Preserve's ecosystems" and "shared multiple use areas in the Preserve". The Preserve is an attractive site for people from different backgrounds practicing different activities and having different expectations and ideals concerning the management and the use of the Preserve. These differences in attitudes can lead to tensions amongst the different groups of users, and so it is useful to identify these tensions in order to improve the long-term management of the Preserve.

Our strategy linking to this target is conducting applied research over four weeks using surveys of human attitudes and human uses so as to contribute information in support of policy development and management decisions. We then identified the threats

and opportunities to design the conceptual model (Figure 5) in Miradi (https://miradi.org/), a software program "that allows nature conservation practitioners to design, manage, monitor, and learn from their projects to more effectively meet their conservation goals," (Conservation Measures Partnership, 2010). Finally, we converted our conceptual model into a results chain to represent how our strategy potentially affects our target (Figure 6). The results chain acts as a heuristic model for Preserve managers to track changes of user attitudes, opinion of hypothetical management interventions, and compliance within the Preserve.

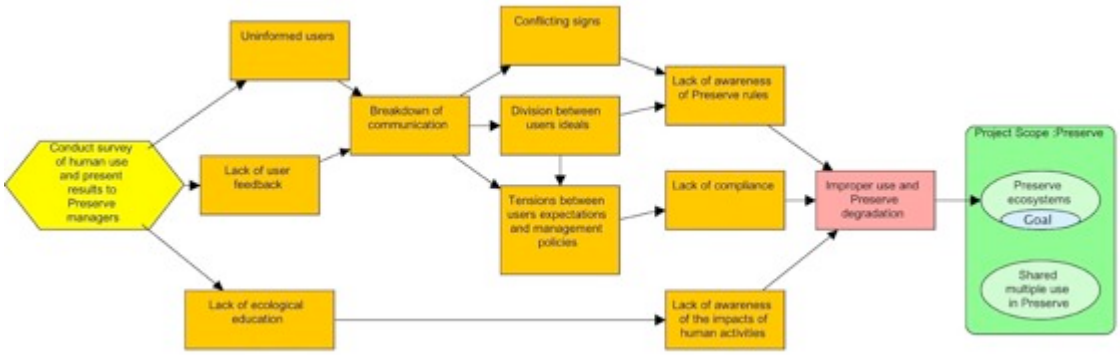

Figure 5. Conceptual Model

Figure 6. Results Chain

We designed the project to reduce several threats. The survey's raw data collection provides information on users that may not be accessible directly through our analyses. In order to analyze the survey data, we organized the project around three themes that helped tie in the data and guide the statistical analyses.

First, we investigated the different tensions that may exist amongst users, especially concerning the negative attitudes between usage types such as walkers and

bikers. This topic stood out from last year's survey, which noted tensions, especially between walkers and bikers (Anhalt et al. 2011). Negative attitudes exist towards users not following proper rules, especially when the pathway directs walkers and bikers to use separate lanes. When discussing the tensions and potential problems among users with E. Olson, who uses the Lakeshore Nature Preserve for commuting, we noted a continuation of these issues.

Then, we analyzed the impact of signs as communication tools from managers to users. We hoped to determine if the signs within the Preserve were well understood by users and provided relevant information. We were also interested in understanding if the different user groups understood signs in the same way, or if there are some groups that feel improvements in signage are needed.

Finally, we focused on highlighting the highest-priority management concerns that the Preserve staff should address in the users' opinions. This was intended to help users communicate with Preserve staff and foster the involvement of users in conservation interventions. In addition, users may be aware of specific threats and indirect threats affecting the Preserve that are unknown to Preserve managers.

Methods

Survey procedures

We used oral interviews to capture the attitudes of a range of users in the Lakeshore Nature Preserve. Attitudinal surveys are valuable in conservation planning since they help managers create informed decisions that account for the range of perspectives taken by those who use a resource (Manfredo 2008).

Similar to the design used in the 2011 survey, we again asked teams of two undergraduates to interview users starting April 1st and finishing on April 25th. One undergraduate administered the survey and one recorded user information at each of four locations including: A) the bike rack / wood platform along the Lakeshore Bike Trail B) the entrance to Picnic Point C) the bus stop / entrance to the Eagle Heights Community Garden and finally D) at the intersection of Lake Mendota Dr. and Eagle Heights Drive near Wally Bauman Woods (Figure 7). The placement of these sites allowed for walking, biking, and running, so as to not exclude a use category. We also administered our surveys at the same designated times of 7:00 to 9:00 am, 11:00 am to 1:00 pm and 2:00 to 4:00 pm. Yet, we chose to survey in the evenings from 5:00 to 7:00 pm, rather than 6:00 to 8:00 pm, to increase response rate, and increase safety of the undergraduates at night.

Undergraduate teams were tasked with surveying for a total of 12 hours, or six shifts, split as evenly as possible between weekdays and weekends and across sites. To help our survey teams with consistency in interviews the graduate design team drafted a standard set of definitions for survey teams to use when speaking with respondents (Appendix 1). Undergraduates attempted to interview every third Preserve user to randomize the sample.

To determine whether there were user tensions resulting from different activities of different user types, we broke down interview respondents in different categories based on their mode of locomotion. The first category (A) is composed of runners and/or walkers. The second category (B) includes “multi-activities users,” or those who bike, run, and/or walk. The third one (C) is formed by users who only bike within the Preserve.

Our survey instrument contained both structured questions (ranked, categorical, and forced-choice) and a space for comments at the end of the survey. Rearranging the survey like this also helped us shorten it down to two pages, which fit our goal of reducing the time required for participants to complete the interview. Our close ended questions require survey participants to choose one from a set of choices while the ranked questions rely on a bipolar scale with five options from strongly agree to strongly disagree (Appendix 2). Undergraduate survey teams also recorded group size, gender, user activity, presence / absence of a dog, and whether or not the dog was on a leash. We tallied individuals and groups going in both directions of the survey site, even though we recognize it is possible that we double counted individuals or groups by doing so.

Using an online schedule, graduate students kept records of undergraduate survey times and data entry to convert raw information to digital files. Undergraduates entered data from each timeslot and were responsible for inputting the raw data into an excel spreadsheet. Undergraduate students entered the data he or she personally collected either with survey or tally sheets; however, as certain students reached a maximum of fifteen hours of work, undergraduates with less "field time" (or time spent in the survey/tally slots) inputted the raw data.

Once we completed the survey portion of our study, a team of three graduates controlled data quality as follows: We standardized coding in our dataset, filtered out incorrect entries, and when inconsistencies in data entry were found in our dataset we worked back to the actual hard copy survey to check where the error occurred. An example of standardization arose in age, because observers might record 50's or 60's. We assigned this as 55 or 65 (n=8). However, if the respondent answered 50+, the respondent

could not be assigned to an average of 55 because there was no clear age range presented and this respondent was not included in the calculation for average respondent age. In addition, we randomly selected 26 hard copies of interviews conducted by each undergraduate and checked every answer against the digital database to ensure reliable data entry. The error rate was <3%.

Quality control for the overall user tally information consisted of comparing the total group size to both the gender breakdown (i.e., total number of males and females must equal total group size) and the activity breakdown (i.e., sum of all activities must equal total group size). For these entries where the numbers did not add up, we went back to our data sheets and corrected erroneous entries. In the end there were a total of 58 entries where the total group size did not match the gender or activity breakdown and looking back at the survey sheets for inconsistencies in data entry did not resolve the discrepancies. Most of these cases included missing data where activities or gender were not noted in the user tally. In a handful of cases, babies were variously included or not included in total group count, gender breakdown, or activity breakdown as well. Since these 58 entries only accounted for <2% of our total user tallies, we decided it would be acceptable to remove them since there was no clear way to resolve the problems.

On the user tally form, undergraduates recorded group size, gender composition of each group, and the activities of group members of all users passing by. The goal was to quantify and characterize overall usage/users at the different sites. Given this goal, group size, gender and activity are all critical variables. To be accurate, we needed the recorded group size to equal the sum of total males + females, as well as the sum of all individual activities. Otherwise the gender/activity percentages would not add up. Thus,

when the recorded numbers did not match up, we discarded the data. An example would be when the group size was recorded as 2, but 1 male and 0 females were recorded. Another example would be if group size was 2, 2 females recorded, but activity was left blank. Since such entries do not let us to calculate M/F breakdown, activity breakdown, or both, (which was our goal with the user tally data) we discarded them. Since these entries only accounted for about 60 out of over 5000 groups, we felt as though it was an acceptable loss.

Statistical analysis procedures:

We conducted statistical analyses using R software, and we used Microsoft Excel to create tables and figures. To determine whether there were user tensions resulting from different activities of different user types, we broke down users in different categories. These categories divide users regarding their mode of locomotion. The first category (A) is composed of runners and/or walkers. The second category (B) comprises people who bike and run and/or walk, which we can call "multi-activities users", and the third one (C) is formed by users who only bike within the Preserve. We also divided users regarding the activity they were performing when they were interviewed by the undergraduates' team (Walk=W; Bike=B; Run=R).

We asked each respondent to score the impact of the others activities (walking, dog walking, running, path biking, trail biking) on its own experience within the Preserve. We compared the opinion of the users' categories regarding each competing activity through a Pearson test.

The same procedure has been used to determine to users' perception towards signs. The perception has been tested through three aspects: the understanding of the

users, the usefulness of the signs, and the reliability of the signs concerning rules. We compared the opinion of the users' categories through a Pearson Chi-squared test.

Results

The survey teams of undergraduate and graduate students conducted interviews from April 1-25, 2012 over 19 different days (Appendix 4). Interview teams conducted 36 separate two-hour survey periods, for a total survey effort of 72 hours (Table 1). Survey effort was fairly evenly distributed across sites (range: 16-20 hours), time of day (range: 16-22 hours), and weekend/weekday (Table 1).

User Tally Results

Interview teams collected basic user information for 5103 passing user groups, totaling 7186 users. Group size ranged from 1 to 16 with an average of 1.4 people, 45% being female (Table A1). There was no significant difference in average group size across the four survey sites (Figure 8, ANOVA $F_{3,5099} = 2.47$, $p=0.06$); however, there were significant differences across survey time period with 7am-9am and 2pm-4pm experiencing a higher percentage of users than 11am-1pm and 5pm-7pm (Table A1; $F_{3,5099} = 46.0$, $p<0.05$). Weekend groups were significantly larger than weekday groups (Table A1; $F_{1,5101} = 102.7$, $p<0.05$).

Overall, interview teams recorded 99.8 users per hour, with Site A seeing the highest use (198.5 users/hour) and Site D being the least frequently used site (19.95 users/hour) (Figure 9). Weekend use was greater than weekday use (Table 1). The time period from 2 pm-4 pm saw the greatest use (159.4 users/hr), while the 7am-9am time period saw the least use (49.4 users /hr) (Table A1).

At all sites, the most frequently observed activity was walking, followed by biking, then running (Figure 10). This pattern was the same on both weekend and weekday (Table A1) and all time periods except for the 7am-9am time period, where biking was the most frequent activity, followed by walking and running (Table A1).

Interview Results

In total, interviews included 321 individuals over the course of the project, and resulted in a 54% response rate, meaning 46% of the people approached to take a survey refused. Since no demographic information was collected during the survey on refusals, anecdotal information suggest that bikers, runners, and younger people were more likely to refuse the survey. There was no detectable bias regarding gender, and though some users mentioned time constraints for not taking the survey some users either avoided the surveyor or ignored the interview request. Locations and times of interviews are shown in Table 2. Respondent age averaged 40 years (range: 18-78), and 51% of respondents were female (Figure 11), similar to user tallies (Pearson's Chi Square; $\chi^2 = 2.3$, df =1, p=0.13). Over three quarters of respondents had some current or past connection to the University of Wisconsin (Figure 12).

Three quarters of respondents were aware that they were in the Preserve. Of those unaware, 39, 32, 20, and 9 percent were at sites A, B,C, and D, respectively. Over 80% of respondents reported using Areas A and B (Fig 7 showing map of areas), 67% used Area C and 39% used Area D (Figure 13). Most respondents reported using the Preserve at least once a week, with 22% using it daily (Figure 14). The three most frequent forms of use reported by respondents were walking, biking, and running, as in the user tally (Figure 15). Of the respondents, 82% were walking at the time approached, 10.3% were

biking, and 7.5% were running (Figure 16). Compared to the use tally, runners and bikers were under-sampled (Pearson's Chi Square; $\chi^2 = 77.8$, df =2, $p<0.001$).

User Tensions: Activities on paths

According to the Pearson exact test, there is no statistically significant difference among user types and activities (p-value>0.05 for each activity) except for the impact of walking on other users' experience within the Preserve (p-value<0.01).

User Tensions: Dogs

Users seemed to feel tension about dogs in the Preserve. Of the general comments provided by respondents at the end of survey, 16% (27/173) were concerned with dog use. The majority of these comments (21/27) regarded dogs being off leash or leashed dogs not being controlled by their owners, people not cleaning up after their dogs, and/or rules about dogs not being clearly conveyed.

Of all respondents, 35 (11%) reported dog walking as a more negatively impacting activity on their experience within the Preserve. In comparison to dog walkers, other respondents reported a more negative impact of dog walking on their experience in the Preserve (Pearson's Chi Square; $\chi^2 = 12.5$, df=4, p=0.01) (Figure 17). However, there was no significant difference between dog walkers and non-dog walkers with respect to where leashed dogs should be allowed in the Preserve (Pearson's Chi Square; $\chi^2= 6.7$, df = 3, p=0.08) (Figure 18).

User Perceptions of Signs

The majority (74%) of respondents reported using Preserve signs for information (Figure 19). Signs were used most often for location/map information, education, and rules (Figure 19). A majority (56%) of respondents also reported that signs are helpful in

conveying rules of the Preserve, while only 11% thought they are not helpful (Figure 20). Furthermore, 69% of respondents said that they clearly understand the rules, 8% reported not understanding, and 24% were unsure.

There were 21 general user comments regarding signage and users' knowledge of rules. Of these, 16 commented signs were not prominent enough, not numerous enough, or not effective. By contrast, three respondents commented that there were too many signs. The statistical results are not significant and show no difference between the respondents' categories of activities or the present use of these respondents concerning the perception of the signs within the Preserve.

Top Management Concerns According to Users

For highest priority management issue, 22% of respondents chose "Shoreline Erosion", 21% chose "Pressure for Development Use", and 20% chose "Invasive/Exotic Species" (Figure 21). There was no significant difference in ranking of management issue from this year to last year (Pearson's Chi Square Test; χ^2=4.5592, df=6, p-value = 0.6015). In regards to specific users, 43% of Shorewood Hills users and 22% of UW Students chose "Pressure for Development" as their top management concern. Respondents from Eagle Heights had a different opinion than the majority of users with 21% choosing "Poorly Managed Human Use" as their top management concern.

Breakdown of Users from Eagle Heights and Shorewood Hills

Respondents from Eagle Heights and Shorewood Hills totaled 17% (n=53) and 7% (n=21) respectively of interview respondents. The majority of respondents from Eagle Heights used the Preserve daily (45%) and the majority of respondents from Shorewood Hills used the Preserve more than once a week (57%) (Table 3). Both Eagle

Heights and Shorewood Hills respondents frequented location C the most (98% and 90% respectively) (Table 4). In regards to the time of day respondents were interviewed the most, from 11am-1pm and 2pm-4pm both had 28% of respondents. Shorewood Hills respondents were interviewed most frequently at 11am-1pm (38%) (Table 4). Walking was the highest performed activity by both types of respondents with over 90% for each. 49% of Eagle Heights respondents also run and 38% use the Preserve for "other" activities such as gardening. 38% of Shorewood Hills respondents use the Preserve for dog walking, as well as birding. (Table 5).

Discussion and Conclusions

User Tally

Whereas our survey effort matched or slightly exceeded that of last year, the number of users varied greatly from 2,642 passersby and 191 interviews in 2011 (response rate: 69%) to this year totaling over 7000 passersby and 321 interviews (response rate: 54%). Although we tried to survey the same general area as last year we were not able to determine the exact site location used last year for each area. It is possible that the site locations we chose were in higher traffic areas than those used last year. To avoid this problem in the future we marked on the map precisely where we conducted surveys, how many hours we surveyed, and the number of surveys completed per area per hour by various users (Figure 9.). In addition, one weekend day there was a race along the Lakeshore Nature Preserve accounting for over 700 passersby in one time period and no such race was reported last year. Another possible reason for the significant difference in user numbers could reflect the early mild weather we experienced in 2012. Although April was cooler than normal, March was the warmest on

record, melting snow and perhaps attracting people outdoors earlier than usual. One of the survey weeks was also Spring Break, so more people (i.e., those affiliated with UW) may have had more time to be out in the Preserve.

Interview

While this year we were able to obtain 130 more surveys than last year it appears that our response rate decreased from 68.7% in 2011 to 54%. It is difficult to determine why this occurred as there are many factors that could be affecting this outcome. Comparisons to last year are difficult as it is unclear exactly how many undergraduate students made up an interview team and what gender composition they used. We do know that the overall user survey team was much larger last year than this year (estimating about 30 individuals versus 17). In regards to the undergraduate interview teams this year, two individuals would work together, most often two females as they composed the majority of the students making up the larger user survey team. The use of one male and one female made up the next frequent pairing of interviewers and the use of two male interviewers was very rare. This type of pairing did not occur at the latest shift as we wanted to avoid any risk perception by potential respondents, especially at remote locations such as site C and D. Undergraduate interview teams were not asked to record the gender or activity of the refusers and in hindsight this is something we would recommend for next year. Ad libitum comments regarding individuals that refused to take a survey included users not wanting to stop their run or bike, individuals with time constraints such as work or classes that prevented them from stopping, and one individual who commented that he had no money to donate to our cause.

One quarter of respondents were unaware they were within the Preserve. This may have been due to the lack of frequency they used the Preserve or lack of signage at those sites. In particular, site A may be considered strictly UW campus by many users adding to this lack of awareness as it does not resemble the forested, more remote locations.

Our teams oversampled walkers relative to bikers and runners. While undergraduate interviewers were asked to attempt an even number of surveys from all types of users it is understandable that users participating in a high level of activity would not be as willing to stop. However, without noting the type of activity non-respondents were performing it is difficult to confirm that activity was the main reason for this difference in numbers. Furthermore, most respondents reported using the Preserve for multiple activities and so, although they may have been walking at the time they were approached by the survey team, their response does not necessarily mean it is a response from a non-biker or non-runner. For example, only 38% of respondents report using the Preserve exclusively for running, walking, or biking while all other report engaging in at least two of those activities (with 20% participating in all three activities).

User Tensions: Activities on paths

Our data reveal no statistically significant difference among user types and their activities on paths within the Preserve. These results lead us to believe that although tensions exist among users, the impacts of walking on users' experience within the Preserve is minimal, yet it is difficult to conclude the meaning of this and whether we classified users correctly. More than half of our respondents reported something other than a positive experience, with biking (compared to 25% and 32% for walking and

running, respectively). This seems to suggest some tension. Many comments from respondents concerned bikers not following rules or being inconsiderate but bikers felt the same towards walkers or runners. It is unclear whether future questions should be more accurately targeted at identifying precise points of tension (e.g., do you think bikers on the paths follow Preserve rules?). In addition, many users practice two or more different activities within the Preserve that could raise their tolerance towards other groups of users, which might tend to decrease reported "tension."

User Tensions: Dogs

We found that dog walkers viewed dog walking as a significantly more positive activity than non dog walkers did when it came to the impact it had on their experience within the Preserve. However, we found little difference in attitudes concerning where dogs should be allowed within the Preserve, leading us to suggest that future work should focus on behavior that creates tension rather than locations that reveal tension. Generally, users appeared to accept dogs within the Preserve, yet we still received many complaints about rule-breaking. Strong majorities of both dog and non-dog users felt that dogs should be allowed in certain areas of the Preserve, yet again comments suggested that dogs should be on leashes - for instance one comment reflected that "big dogs have scared my kids when they come up and are out of control, even if the dog is friendly and just wants to play." Additional comments focused on a desire for increased communication and enforcement of Preserve rules regarding dogs and the need to be leashed.

The data collected through this years field surveys may serve as a good baseline for better understanding the tensions between dog and non-dog users in the Preserve. For

instance if future surveys were to continue using our question #8, while keeping track of responses from both dog and non-dog users it would be possible to see if future interventions are having an effect on bringing both user groups to a greater consensus on dog use.

User Perceptions of Signs

Our results suggest that Preserve users are using the location and sign maps, but are less attentive to the signs concerning rules. Our results also suggest that many users do feel that that the signs conveying rules are helpful . This specific thread of analysis is challenging to evaluate because if one ignores or cannot understand signs that convey rules, one may in fact be less likely to follow the rules. Therefore our data cannot distinguish ignoring from not understanding or remembering rules. In addition, a user can think that he or she is in compliance with the rules although he or she may not understand them clearly. Indeed, only 69% of the users say that they clearly understand the signs while others are unsure or do not understand them. It may be useful if future survey questions try to tease out if individual users perceive other types of users (i.e. bikers, walkers, dog walkers) as being compliant or aware of the Preserve rules, because this may better establish sources of tensions between user groups associated with rules in the Preserve.

One source of potential tension concerns where signs should be placed, how many signs should be allowed in the Preserve and whether or not signs detract from the natural beauty of the Preserve. Our surveys produced many individual comments on this topic and so in the future it will be important for Preserve managers to consider how many signs are used in the Preserve, and in particular the locations of these signs so as to not

face public backlash over lost natural beauty. Of our survey comments pertaining to signage 9 individuals felt that signs need to be more visible while more clearly stating the rules for Preserve use while 3 individuals felt that signs within the Preserve are visually unattractive and take away from the natural beauty in the Preserve. These differing perceptions of signs in the Preserve show tensions amongst users and reinforce the need for Preserve managers to carefully choose site locations for signs that still convey Preserve rules while maintaining the natural beauty of the Preserve.

According to the statistical results (Table 4A and 4B), there is no difference between the different user groups using the Preserve concerning the signs. Thus, if the Preserve managers think about improving the signs, they will not have to adapt for each community because signs are seen the same way amongst the different groups.

Top Management Concerns According to Users

Similar to last year's results the top two issues of concern for Preserve management were "Pressure from Development" and "Shoreline Erosion". However, our respondents identified the third priority as management of "Non-native invasives" rather than "Runoff" identified in 2011. This could reflect a difference in the way the question and management goals were defined between the two surveys. Even though this year we did develop a standard set of definitions for use in the survey, we suggest that the course as a whole should develop a consistent set of definitions that stays the same from year to year. By doing so we feel this will help eliminate many inconsistencies from year to year, thereby providing Preserve managers a better understanding of how concerns are changing over time.

In addition the change in priority from runoff to invasives may reflect outreach by Preserve staff. In future surveys it may be helpful if the interview teams try to be more specific about the types of invasives species that users feel are most detrimental, or if there are specific sections of the Preserve where invasives need to be removed with more urgency than others. Questions focusing on specific management goals in certain areas of the Preserve would also help to give management a better idea of whether their goals are in line with user opinions.

The majority of respondents from Eagle Heights chose "Poorly Managed Human Use" as their top management concern. This concern may highlight specific issues these users incur. Future investigation into what these problems of human use include could help management assuage their concerns.

Breakdown of Users from Eagle Heights and Shorewood Hills

We decided to take a closer look at Eagle Heights and Shorewood Hills respondents as a result of the interest by managers to understand the usage of these respondents due to their proximity to the Preserve. Usage of the Preserve appears high for Eagle Heights respondents with 45% using the Preserve daily versus 22% for overall users. Site D was the least visited site of all locations for both Eagle Heights and Shorewood Hills respondents as well as overall respondents. This is a little surprising considering site D is the closest location to Shorewood Hills respondents, but their usage there remains high at 81%.

Suggestions on survey for future students

After completion of all surveys the undergraduates were asked their opinion of the survey questions and for other feedback in hopes of providing the graduates and future

Conservation Biology classes with helpful suggestions for improvements. Suggestions included:

Question 1: Rephrasing of the question or creating age categories as some undergraduates felt the questions was awkward to ask.

Question 5: Include gardening as an activity

Question 7: Include background information with each of the Master Plan goals such as examples of where these things might be occurring. This issue was addressed because some undergraduates felt that responses may have been biased to what the responder was familiar with, therefore not choosing things they did not fully understand. Perhaps questions focusing on specific management goals in certain areas of the Preserve would also help to give management a better idea of whether their goals are in line with user opinions.

Question 8: How to rank this question was unclear and as a result some allowed 1-5 only once for the whole question while others allowed 1-5 for each of the activities.

Question 12: This question should have been phrased in a way to include the definition of prescribed burning as there was concern over responses being biased toward neutral answers from respondents that may not have understood the definition and didn't ask for clarification.

Question 13: Information should be provided to undergraduates about the audio tour offered by the Lakeshore Nature Preserve because respondents frequently asked about this. In general, if time permits it would be a good idea for graduate mentors to go over the survey with their undergrads to make sure they have enough background information on all concepts brought up in the survey.

Data entry for tally sheets took more time for those with weekend, popular sites (A and B), and peak hours (2-4) shifts. Acknowledging this when undergraduates are selecting their schedule might help with evening out the amount of work required in the end for each undergraduate. In general, the undergraduates did not complain about this and were prompt on finishing data when requested by the graduates.

Suggestions for the Lakeshore Nature Preserve

While the majority of comments from users expressed great satisfaction with the Preserve, comments also revealed that enforcement of rules within the Preserve, in particular those related to dog use were a concern users wished to be addressed. Dog use ranks high in our survey as an aspect that creates tension amongst different user groups in the Preserve. Thus, increased clear signage detailing the rules surrounding dog use in the Preserve is recommended. In addition, signage as a whole, was consulted more for distances and locations than for understanding the rules. Signs are at times confusing to users, and even our survey group found signs up within the Preserve that were outdated, e.g., one sign indicated biking was allowed at Picnic Point and some are so faded they indicate that bikers should use walking paths. If possible it may have value for the Preserve to engage with user groups in the development of signs that convey appropriate messages applicable to their specific activities.

"Pressure for Development" and "Shoreline Erosion" remain the top two concerns for users and these issues should continue to be addressed by the Preserve.

Using the results chain (Figure 6), the Preserve managers can monitor changes in user responses or compliance over time. We hope this survey of human use and presenting the results to Preserve managers will increase communication between

managers and Preserve users. This could improve communication and increase user awareness of the Preserve rules and compliance. Overall, this would impact the direct threat to the Preserve ecosystems of improper use and Preserve degradation by users.

The Lakeshore Nature Preserve is a highly used, and highly popular spot for multiple forms of human recreation, and so management decisions must reflect the attitudes of Preserve users about this diversity of use. We hope our survey contributes to effective management at the Lakeshore Nature Preserve.

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Figures

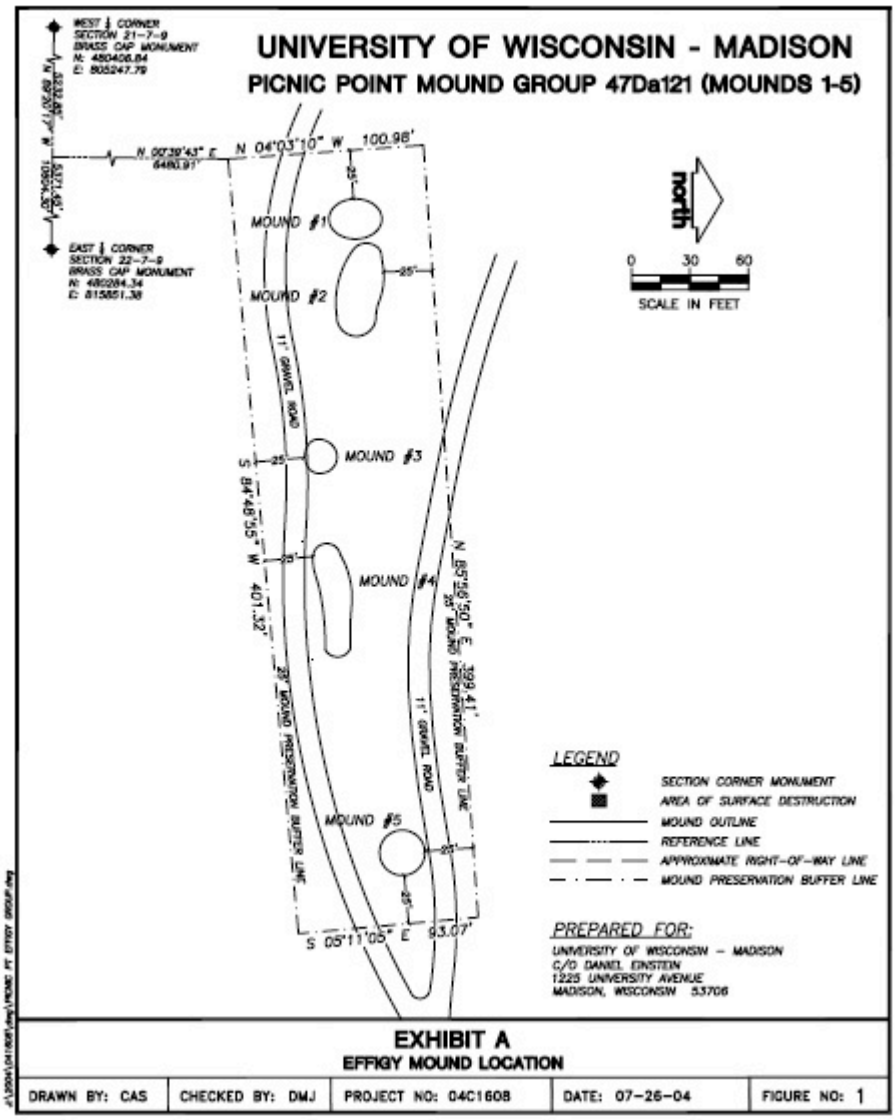

Figure 1. Native American Effigy Mounds at Picnic Point, Accessed 7 May 2012. <http://lakeshorepreserve.wisc.edu/preserve-library/bib-general/nativeamericans/DA121,PicnicPoint,Jenkins,_1-5.pdf>.

Figure 2. Survey Map of Madison, including the Lakeshore Nature Preserve, Accessed 7 May 2012. <http://images.library.wisc.edu/awareImageServer/SurveyNotesImageNav.jsp?collection=SurveyNotes&resource=PlatMaps/TN07/reference/000709EA.jp2>.

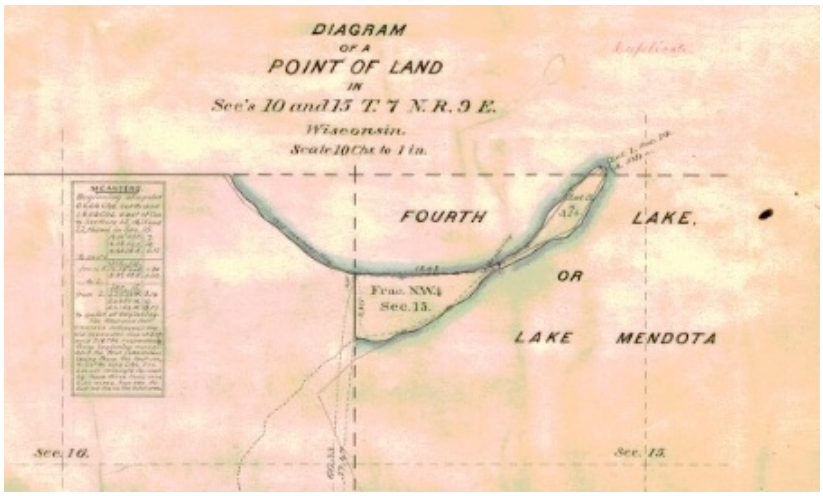

Figure 3. Survey map of Picnic Point. Accessed 7 May 2012 from

<http://images.library.wisc.edu/awareImageServer/SurveyNotesImageNav.jsp?collection=SurveyNotes&resource=PlatMaps/TN07/reference/000709EB.jp2>.

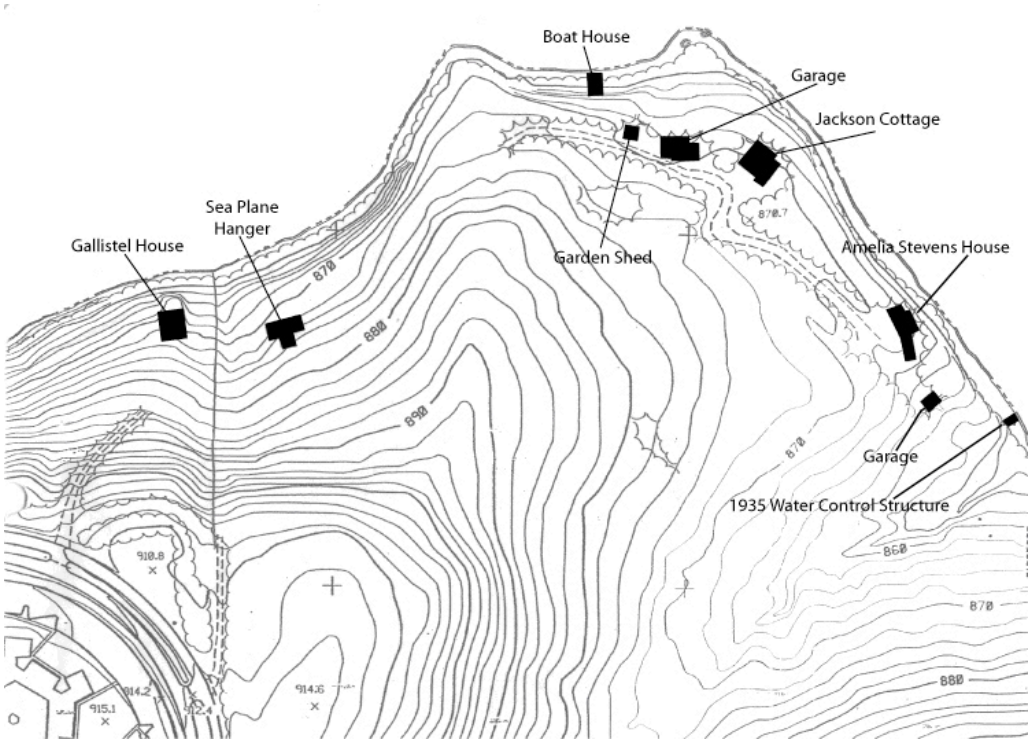

Figure 4. Frautschi Point buildings prior to the 1980 gift to the University. (Einstein and Denniston 2006).

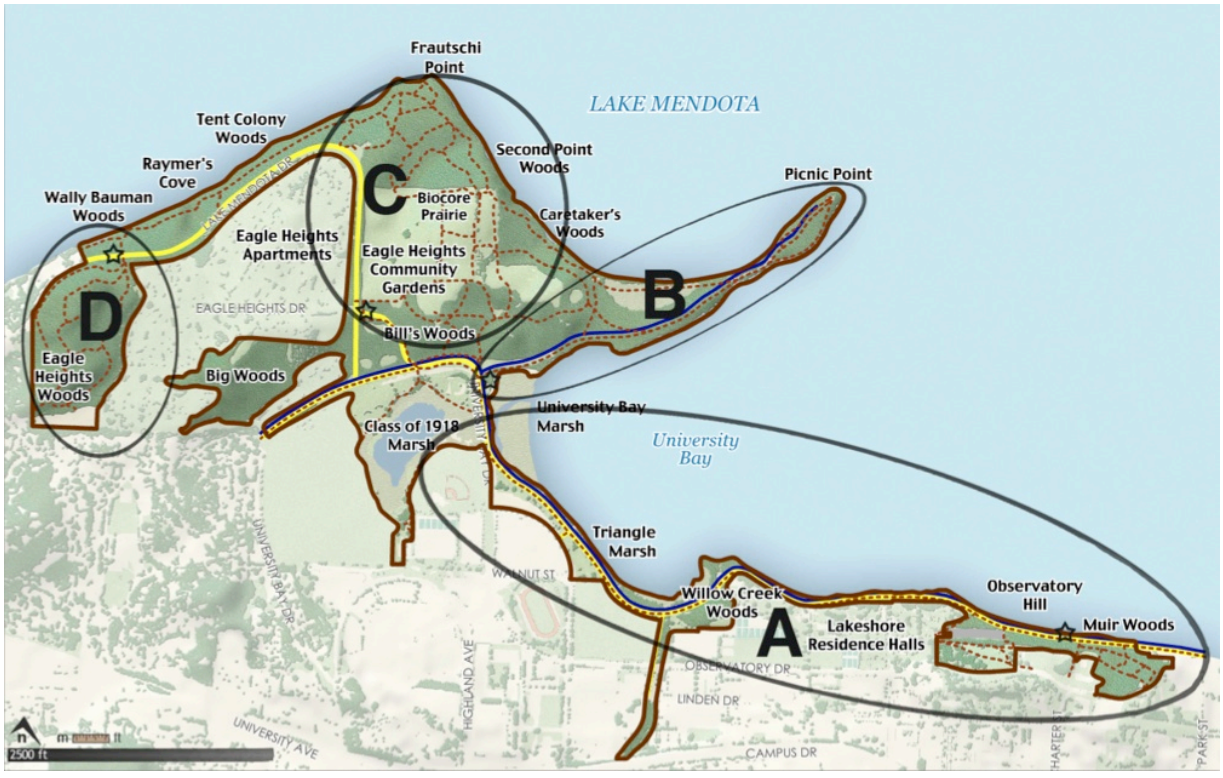

Figure 7. Lakeshore Nature Preserve Map with Locations A: Howard Temin Lakeshore Path, B: Picnic Point, C: Community Gardens, Biocore Prairie, and Frautschi Point, and D: Eagle Heights Woods.

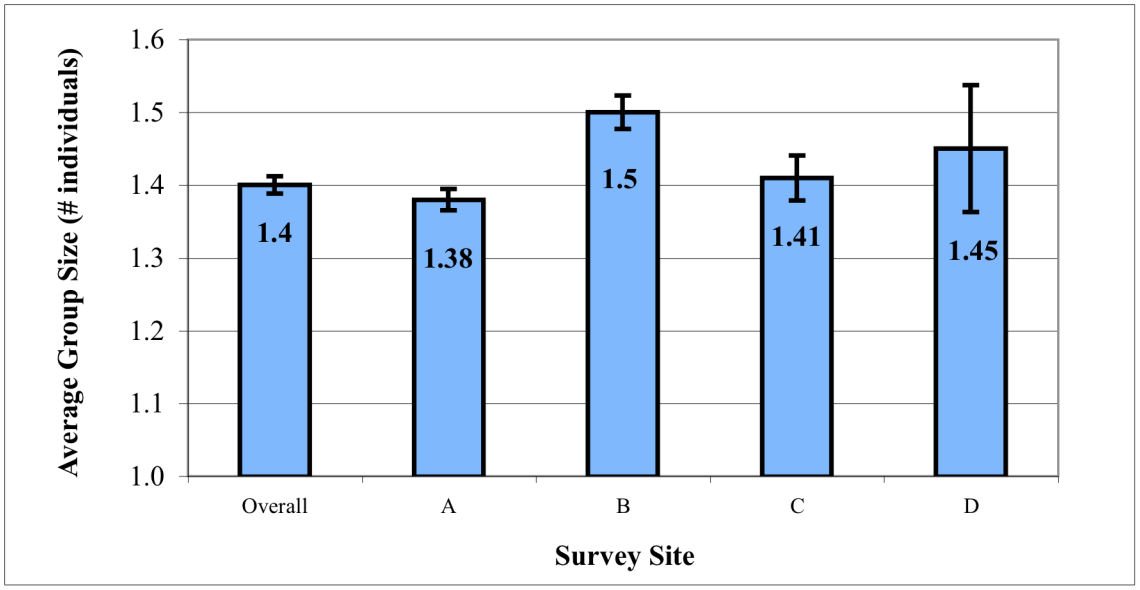

Figure 8. Average user group size (± SE) recorded by interview teams at the different survey sites in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

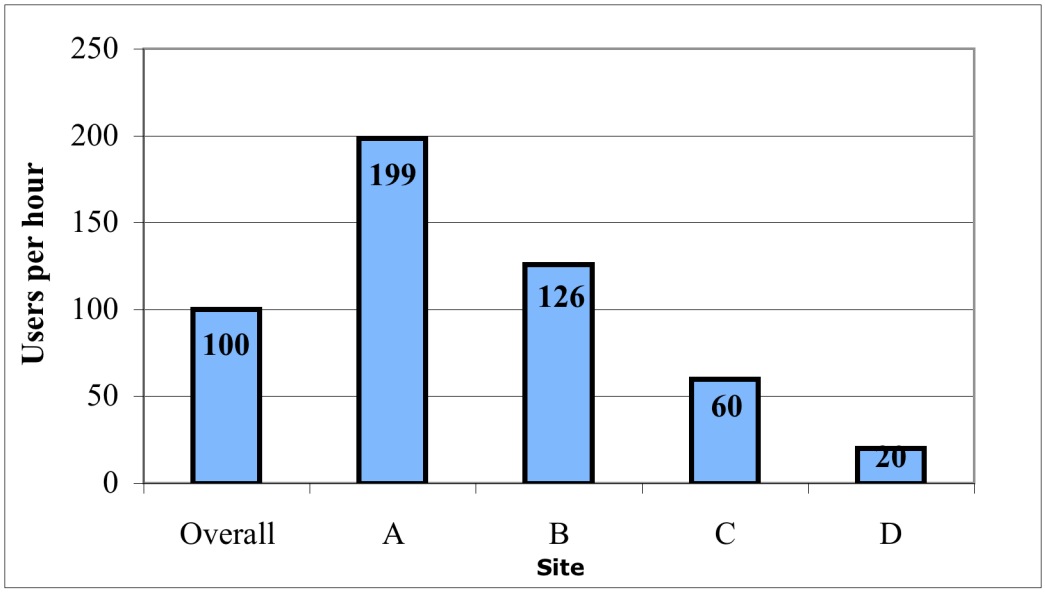

Figure 9. Users per hour (overall n= 7186; Site A n= 3573 ; Site B n= 2260; Site C n = 954 ; Site D n= 399) recorded by interview teams at different survey sites in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

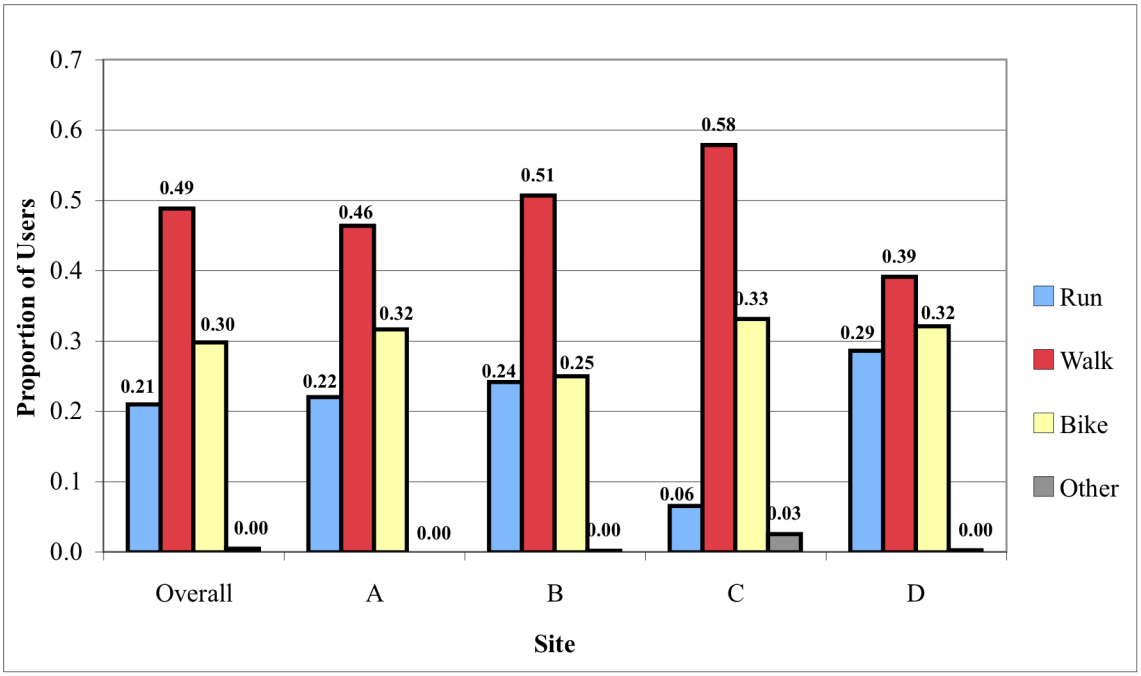

Figure 10. User activity at different sites (Overall n= 7186; Site A n= 3573 ; Site B n= 2260; Site C n = 954 ; Site D n= 399) recorded by interview teams at different survey sites in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

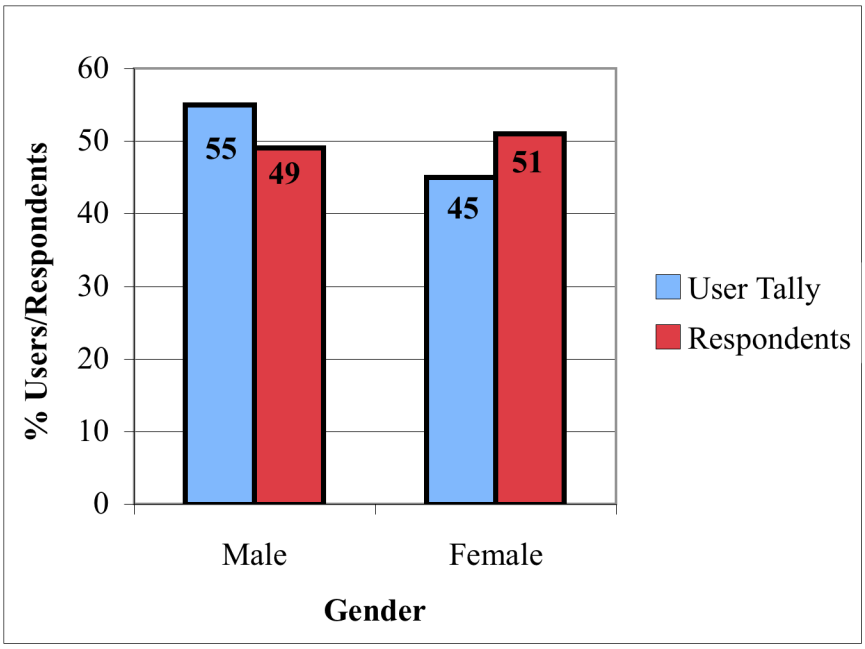

Figure 11. Gender of survey respondents (n=320) and users from user tallies (n=7186) in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

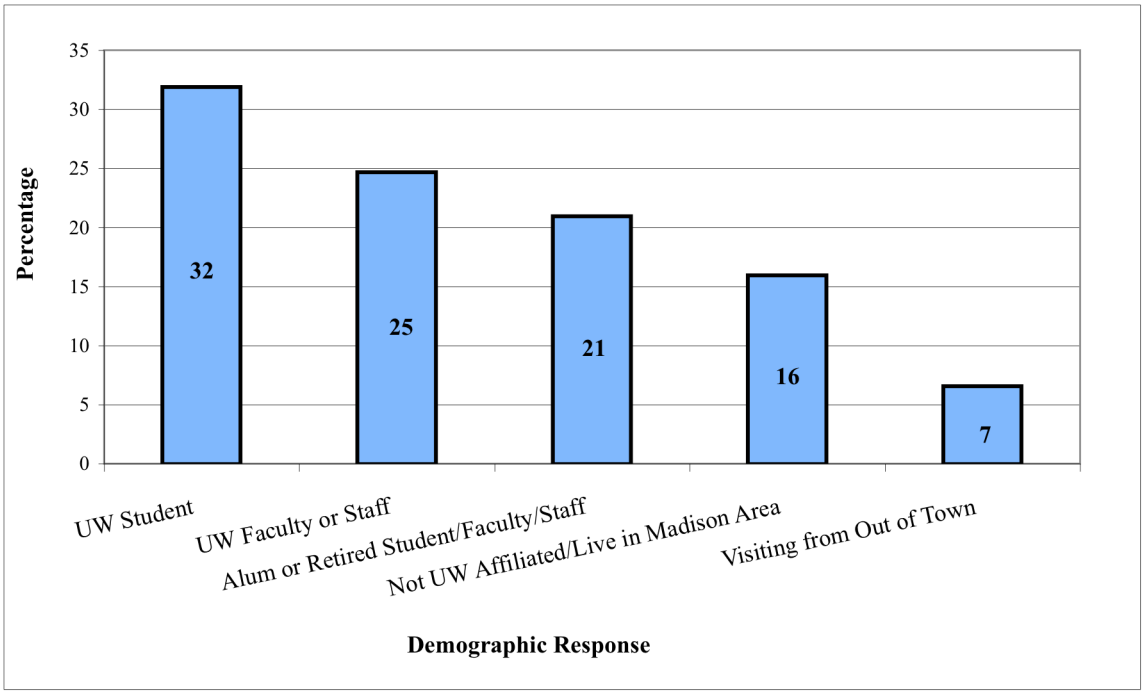

Figure 12. UW affiliations of survey respondents (n =320) in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

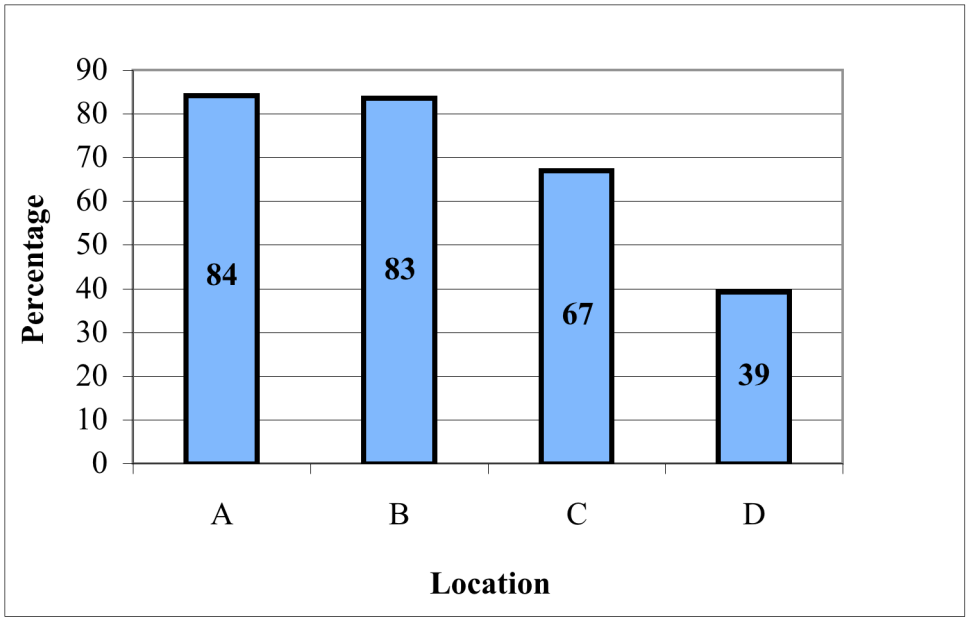

Figure 13. Areas of Preserve used by survey respondents (n = 321) in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

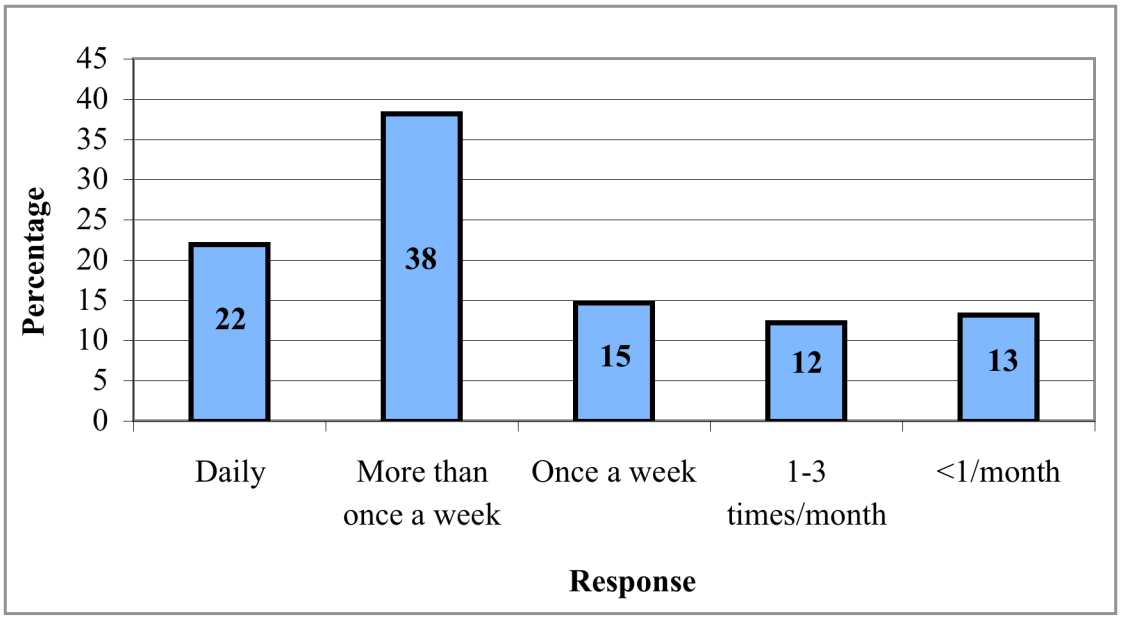

Figure 14. Frequency of Preserve use reported by survey respondents (n = 320) in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

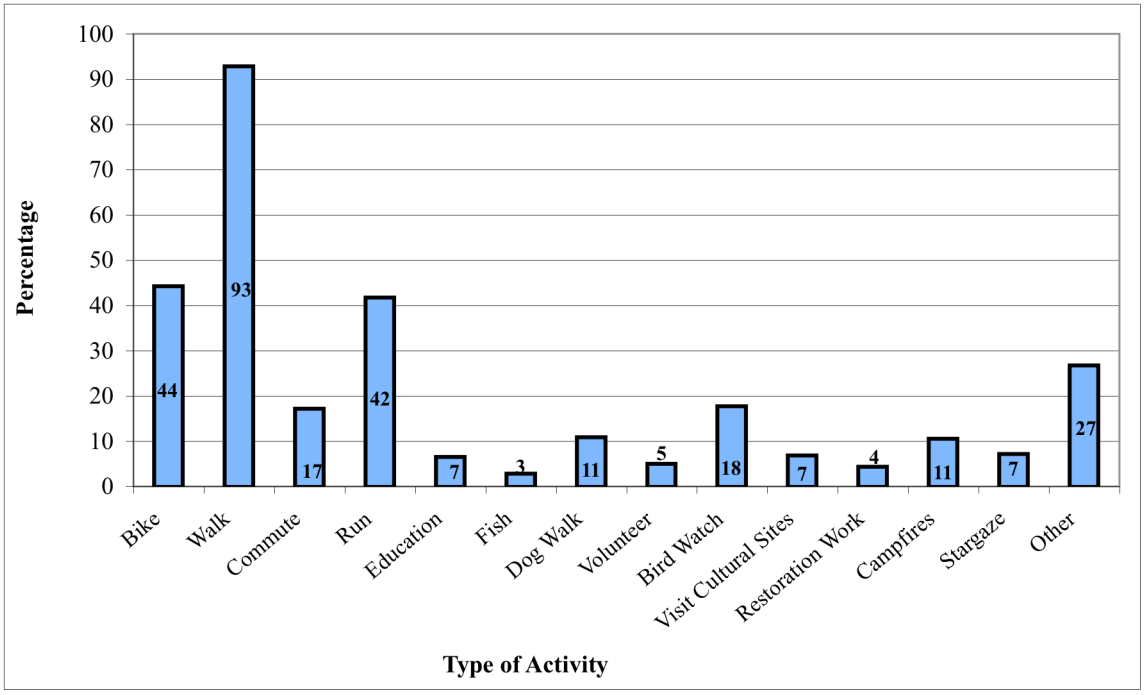

Figure 15. Activities survey respondents (n = 321) report performing in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

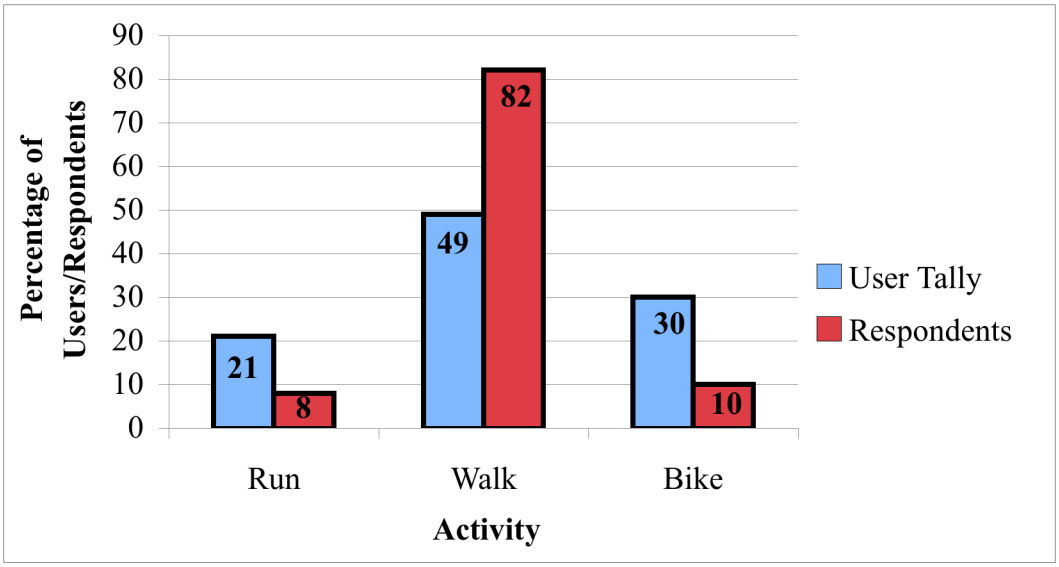

Figure 16. Current activity of survey respondents (n=321) compared to activities recorded in user tallies (n=7186) in the Lakeshore Nature Preserve from 1 April – 25 April, 2012.

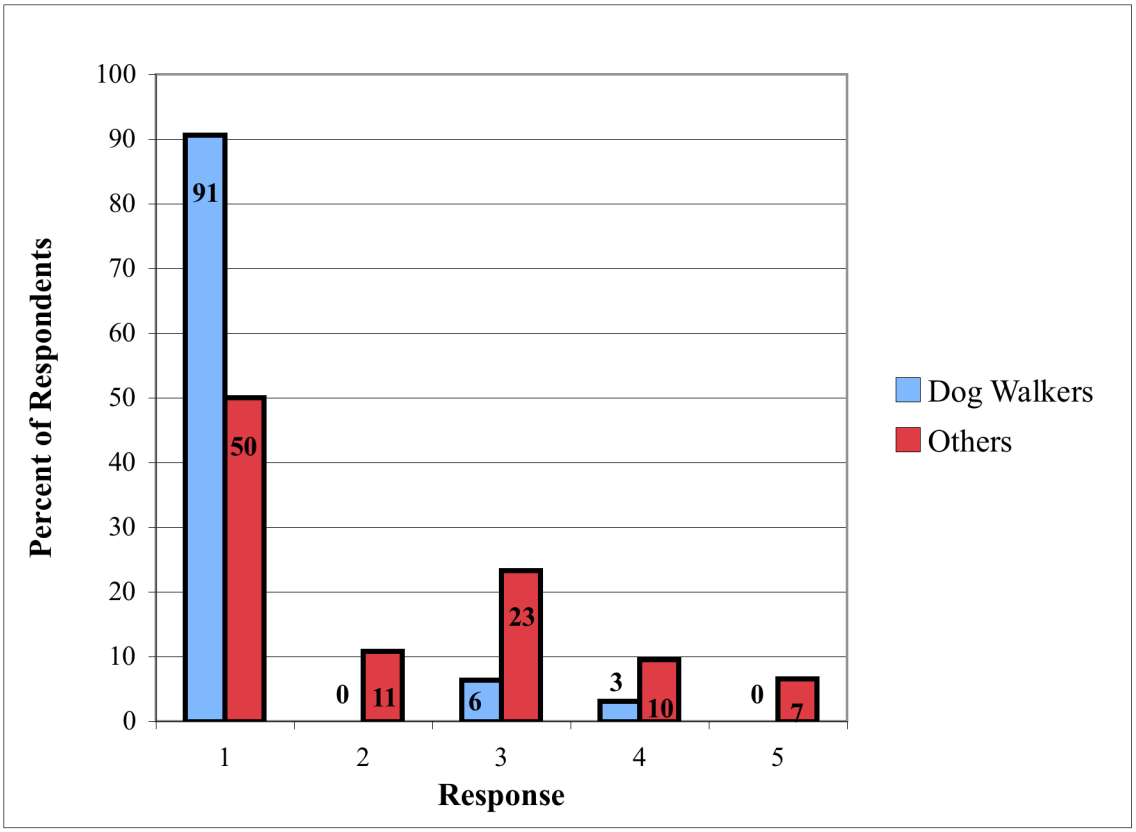

Figure 17. Responses by dog walkers (n=32) and others (n = 231) when asked to rank the activity from 1 (positive) - 5 (negative) according to how it impacts their experience with in the Lakeshore Nature Preserve. Surveys were conducted from 1 April – 25 April 2012.

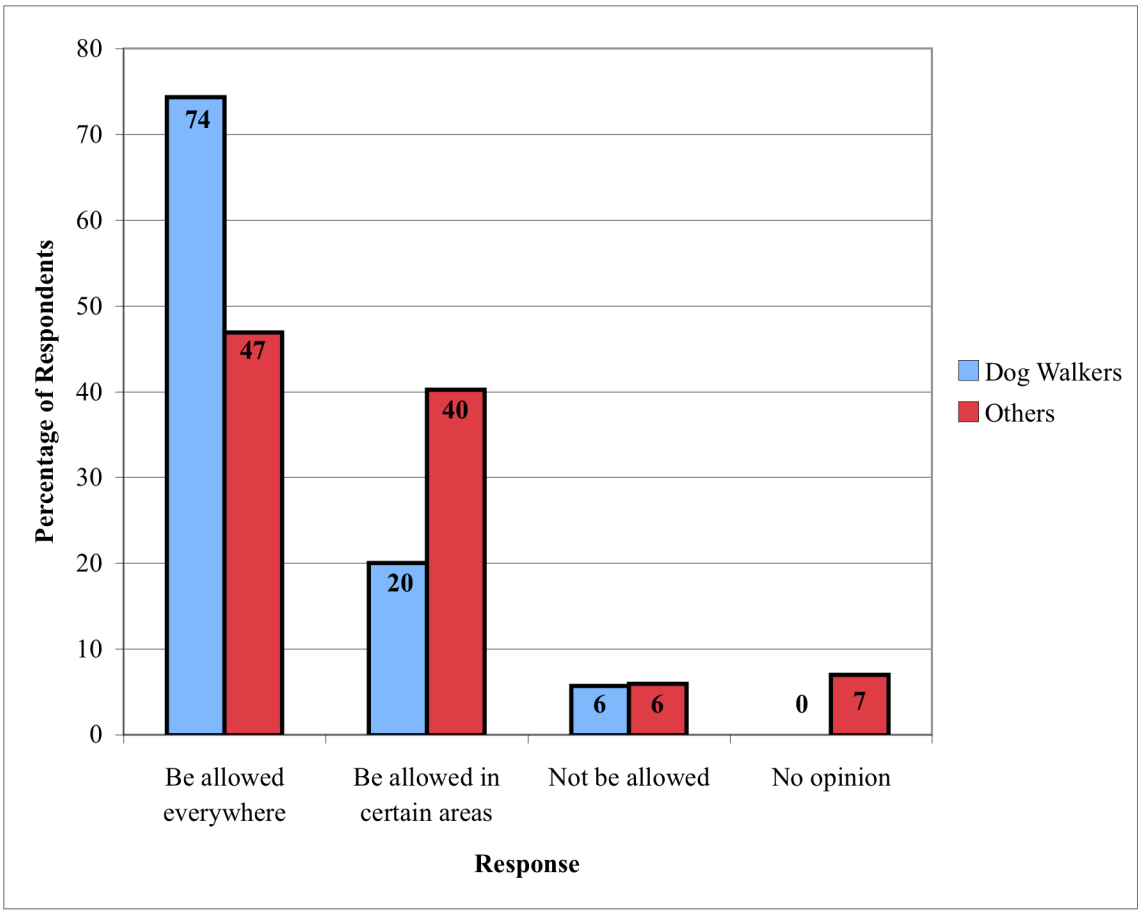

Figure 18. Responses of dog walkers (n = 35) and non-dog walkers (n = 286) in the Lakeshore Nature Preserve when asked to complete the phrase "Leashed dogs should - _____ within the Preserve with the following 4 choices: "Be allowed everywhere"; "Be allowed in certain areas"; "Not be allowed"; or "No opinion". Surveys were conducted from 1 April – 25 April 2012.

Figure 19. Types of Preserve signs respondents (n = 313) report relying on for information in surveys conducted in the Lakeshore Nature Preserve from 1 April – 25 April 2012.

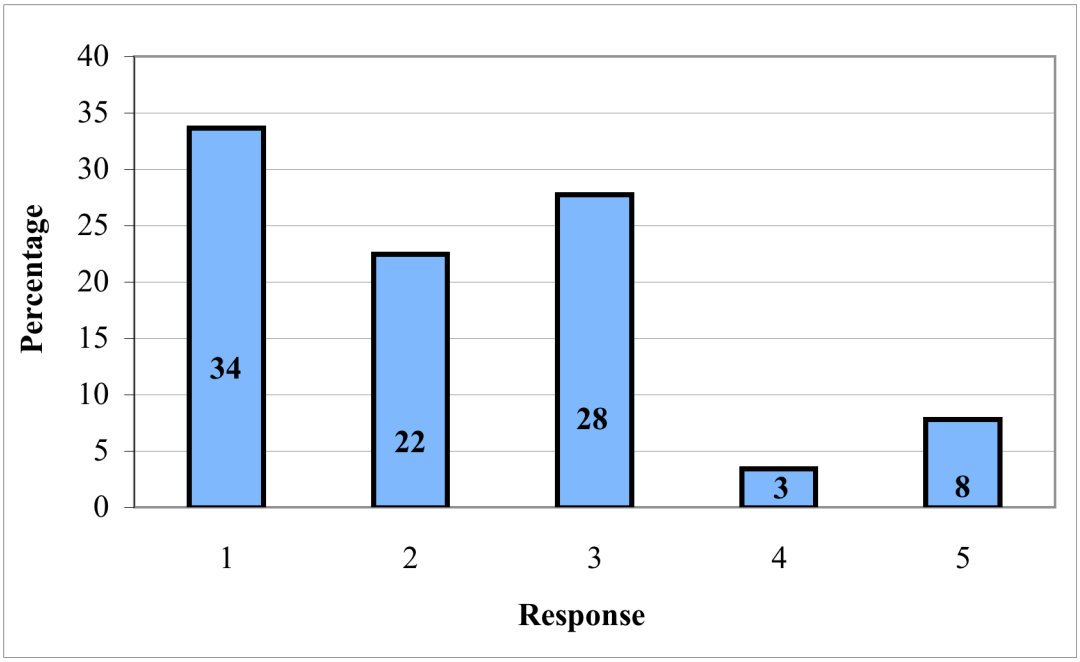

Figure 20. How helpful survey respondents (n = 307) think Preserve signs are for conveying Preserve rules on a scale of 1 (most helpful) to 5 (least helpful) as reported in surveys conducted in the Lakeshore Nature Preserve from 1 April – 25 April 2012.

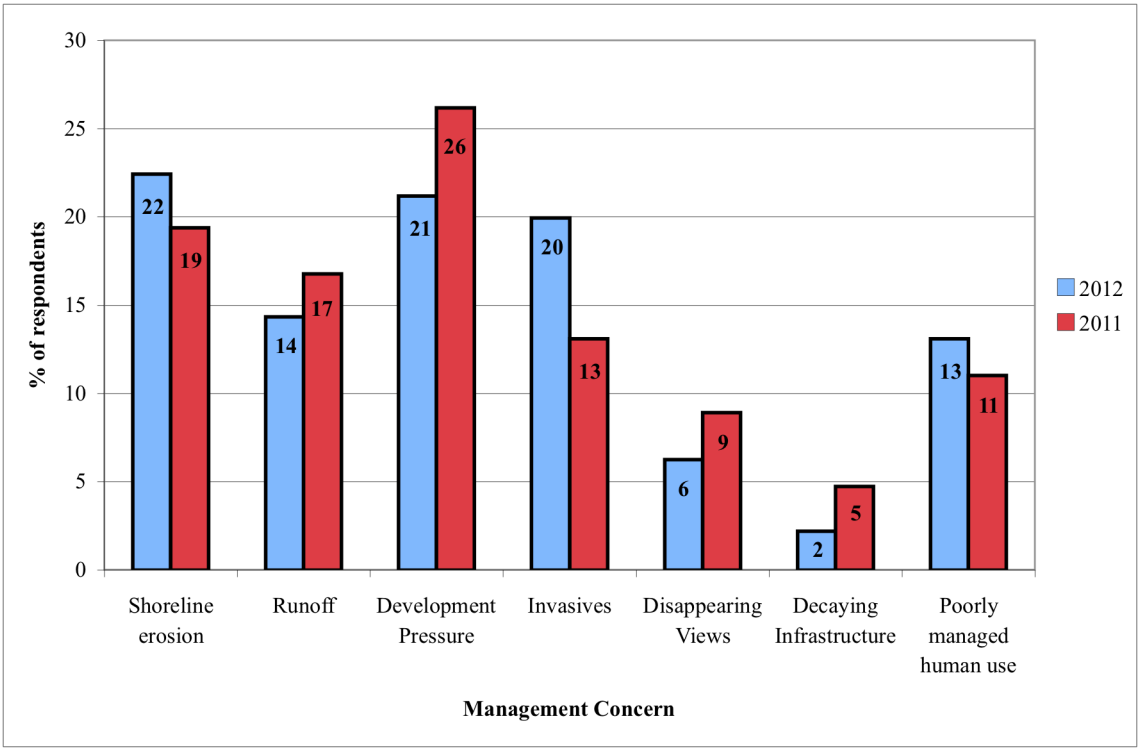

Figure 21. Top Preserve management issues for survey respondents in 2011 (n = 190) and 2012 (n=319) as reported in surveys conducted in the Lakeshore Nature Preserve from 1 April – 25 April 2012.**Table 1.** Survey effort (hours) for the service learning project from 1 April – 25 April, 2012. Total weekend (WE) survey effort was 34 hours. Total weekday (WD) effort was 38 hours.

	Site A		Site B		Site C		Site D		
Survey Time	WE	WD	WE	WD	WE	WD	WE	WD	**Total**
7h00-9h00	2	2	2	2	2	2	2	2	**16**
11h00-13h00	4	2	2	4	2	2	2	4	**22**
14h00-16h00	2	2	2	2	2	2	2	2	**16**
17h00-19h00	2	2	2	2	2	2	2	4	**18**
Total	**10**	**8**	**8**	**10**	**8**	**8**	**8**	**12**	**72**

Table 2. Interviews conducted for the service learning project from 1 April – 25 April, 2012. Total weekend (WE) interviews = 155. Total weekday (WD) interviews = 166.

	Site A		Site B		Site C		Site D		
Survey Time	WE	WD	WE	WD	WE	WD	WE	WD	**Total**
7h00-9h00	8	6	9	13	2	2	3	0	**43**
11h00-13h00	19	10	14	27	16	13	5	6	**110**
14h00-16h00	16	18	11	14	8	11	10	6	**94**
17h00-19h00	15	13	8	13	6	11	5	3	**74**
Total	**58**	**47**	**42**	**67**	**32**	**37**	**23**	**15**	**321**

Table 3. Comparing frequency of Preserve use by different user groups as reported in surveys conducted in the Lakeshore Nature Preserve from 1 April - 25 April 2012.

	Total # of Respondents	Daily	>1/ week	Once a week	1-3 times/month	<1/month
Eagle Heights	53	45%	38%	13%	2%	0%
Shorewood Hills	21	29%	57%	10%	5%	0%
Overall	320	22%	38%	15%	`12%	13%

Table 4. Comparing areas of the Preserve used by different user groups as reported in surveys conducted in the Lakeshore Nature Preserve from 1 April - 25 April 2012.

		Locations of Use				Time of Use			
	Total # of Respondents	A	B	C	D	07h00-09h00	11h00-13h00	14h00-16h00	17h00-19h00
Eagle Heights	53	75%	81%	98%	51%	13%	28%	28%	30%
Shorewood Hills	21	86%	86%	90%	81%	29%	38%	14%	19%
Overall	321	84%	83%	67%	39%	13%	34%	29%	23%

Appendix 1: Definitions Sheet

Intro Example

Greeting- Hi how are you doing?

Who you are and what you are doing- I'm a student working on a survey for class regarding usage of the Lakeshore Nature Preserve.

What you are asking from them- Would you mind stopping for a few minutes to answer some questions about your usage of the preserve?

Thank them for participating or not

****Remember to have fun and not take things too personally if someone's rude****

Definitions

Decaying infrastructure- dirt trails and parking lots eroding etc.

Disappearing views- the loss of vistas due to growth of trees

Invasive exotic species- non-native plant species that out-compete native vegetation for nutrients, sunlight and space, ex. honeysuckle, buckthorn

Native vegetation- vegetation that grows naturally in the region

Poorly managed or inappropriate human use- such as people not following the rules of the preserve

Prescribed burning- fire applied in a skillful manner under certain weather conditions in a designated place to achieve specific results, typically used to control undesired vegetation, improve wildlife forage and habitat, reduce potential wildfire hazard, and improve access and natural beauty

Pressure for development- perhaps more housing needed for students? Etc. nothing in particular known.

Runoff from buildings and houses- water flow that occurs when the soil is infiltrated with excess water. Runoff often includes soil contaminants such as petroleum, pesticides, fertilizers, etc.

Shoreline erosion- loss of material such as sand from the shore. Some erosion is healthy and natural, excessive erosion can cause serious problems such as ecosystem damage and loss of soil.

Rules of the Preserve

Bicycle paths that remain open in the Lakeshore Nature Preserve include the Howard Temin Lakeshore Path from the Limnology Building on the east to Oxford Drive on the west in Shorewood Hills, and the paved path that passes through the woods

from the Temin Lakeshore Path to the intersection of Lake Mendota Drive and

Eagle Heights Drive.

No unleashed dogs are allowed within the Lakeshore Nature Preserve

Appendix 2

UW-Madison Conservation Biology 651 Questionnaire

Surveyor Name:_____ Date:_____ Time:_____ Location: A B C D

[Sex] F M Current Activity:_____ [Dog] Y N [Leash] Y N

1.) What is your age:_____

2.) Which best describes you? *If from Madison area, Resident of…:*

A. UW Student [Eagle Heights] Y N

B. UW Faculty or Staff [Shorewood Hills] Y N

C. Alum or Retired Student/Faculty/Staff

D. Not UW Affiliated/Live in Madison Area

E. Visiting from Out of Town

3.) Are you aware you are currently within the Lakeshore Nature Preserve? Y N Unsure

4.) What sections of the Preserve do you use? *(Show respondent a map of the Preserve and mark all that apply)*

A B C D

5.) What activities do you do within the Preserve? *(mark all that apply)*

Bike Run Dog Walk Visit Cultural Sites Stargaze

Walk Education Volunteer Restoration Work Other:

Commute Fish Bird Watch Campfires _____

6.) How often do you use the Preserve?

A. Daily B. More than once a week C. Once a week D. 1-3 times/month E. <1/month

7.) The Preserve has identified the following management issues to be addressed within their Master Plan. Please rank the top three issues of greatest importance to you with 1 being the most important:

_____Shoreline Erosion _____Disappearing Views

_____Runoff from buildings and houses _____Decaying Infrastructure

_____Pressure for Development Use _____Poorly Managed Human Use

_____Invasive/Exotic Species

8. Please rank **each** the following activities from 1-5 according to how they impact your experience within the Preserve: *1 positive-5 negative*

____ Walking ____ Trail Biking (mountain) ____ Running

____ Dog Walking ____ Bike Path Biking (leisure/commuting)

9.) Leashed Dogs should _____ within the Preserve. *(Choose one of the following)*

A. Be allowed everywhere B. Be allowed in certain areas C. Not be allowed D. No Opinion

10.) Bikes should _____ within the Preserve. *(Choose one of the following)*

A. Be allowed everywhere B. Be allowed in certain areas C. Not be allowed D. No Opinion

11.) Having native vegetation within the Preserve is important.

A. Strongly Agree B. Agree C. No Opinion D. Disagree E. Strongly Disagree

12.) Increased use of prescribed burning within the Preserve is acceptable.

A. Strongly Agree B. Agree C. No Opinion D. Disagree E. Strongly Disagree

13.) Do you rely on signs for information within the Preserve? Y N *If yes, indicate types below:*

Rules Cultural Education Restoration Location/Maps Distances Audio Tour

14.) Please rank if the signage is helpful in conveying the rules of the Preserve on a scale of 1-5. *(1 being the most helpful and 5 being the least helpful):* 1 2 3 4 5

15.) How clearly do you understand the rules set forth by the Preserve? *(Includes leashed dogs, no biking zones)*

A. Understand B. Do Not Understand C. Unsure

16.) Do you have any comments for the Lakeshore Nature Preserve management staff to know or consider?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix 3

Table A1. Summary descriptive statistics for overall user tally data, as well as sorted by site, day of week and survey time period. Because survey effort was not even (see Table 1), total users could not be directly compared, so total users was divided by survey effort (in hours) to give users per hour

		Site				Day of Week		Survey Time Period			
	Overall	A	B	C	D	WD	WE	7a-9a	11a-1p	2p-4p	5p-7p
Group Size (SE)	1.4 (0.01)	1.38 (0.02)	1.5 (0.02)	1.41 (0.03)	1.45 (0.09)	1.27 (0.02)	1.51 (0.02)	1.14 (0.02)	1.42 (0.03)	1.57 (0.02)	1.35 (0.02)
Users/hour	99.81	198.50	125.56	59.63	19.95	73.08	129.68	49.44	86.23	159.38	108.22
Male (%)	55	54	55	56	58	57	53	56	57	52	56
Run (%)	21%	22%	24%	6%	29%	20%	22%	28%	22%	16%	23%
Walk (%)	49%	46%	51%	58%	39%	42%	53%	30%	51%	55%	46%
Bike (%)	30%	32%	25%	33%	32%	37%	25%	42%	26%	27%	31%
Other %	0%	0%	0%	3%	0%	1%	0%	0%	0%	1%	0%
Dogs on Leash (%)	90%	96%	96%	100%	47%	93%	89%	95%	79%	98%	86%

Appendix 4 User Schedule

April User Survey Schedule

***Please read notes below before filling out your schedule.

APRIL SCHEDULE

Each of the 4 sites will be surveyed once each time period for each a weekday and a weekend day.

Every undergrad should survey at least a total of six time periods. When selecting sites please vary time, day, and location.

After filling out your choice of survey group, please highlight the corresponding grouping from the top so that no one chooses the same grouping.

For example A-WD-7-9 means surveying in site A (lakeshore path) on a weekday (WD) from 7-9am.

Time Intervals are:
7-9am
11am-1pm
2-4pm
5-7pm

Sites:
A= Lakeshore Path
B= Picnic Point
C= Near Community Gardens
D= Eagle Heights Woods

Survey Groups:

A-WD-7-9	B-WD-7-9	C-WD-7-9	D-WD-7-9
A-WD-11-1	B-WD-11-1	C-WD-11-1	D-WD-11-1
A-WD-2-4	B-WD-2-4	C-WD-2-4	D-WD-2-4
A-WD-5-7	B-WD-5-7	C-WD-5-7	D-WD-5-7
A-WEND-7-9	B-WEND-7-9	C-WEND-7-9	D-WEND-7-9
A-WEND-11-1	B-WEND-11-1	C-WEND-11-1	D-WEND-11-1
A-WEND-2-4	B-WEND-2-4	C-WEND-2-4	D-WEND-2-4
A-WEND-5-7	B-WEND-5-7	C-WEND-5-7	D-WEND-5-7
A-WEND-11-1-duplicate	B-WEND-11-1-duplicate		D-WD-11-1-extra
			D-WD-5-7-extra

WD= weekday
WEND= weekend

Data Entry and Collection
Both User Tally and Interview Data entered/collected
Only Interview Data entered/collected
Neither User Tally or Interview Data received
Only User Tally data entered/collected

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 Site:B Time: 7-9 Name1: Erika Cardenas Name2: Emily Hunt	2 Site: Time: Name1: Name2:	3 Site: Time: Name1: Name2:	4 Site: Time: Name1: Name2:	5 Site:D Time:11-1 Name1:Erika Cardenas Name2: Andrea Smetana	6 Site: B Time:7-9 Name1: Erika Cardenas Name2: Jong Lee	7 Site: Time: Name1: Name2:
Site: A Time: 11-1 Name1: Andrea Smetana Name2:Emily Hunt	Site: B Time: 11-1 Name1:Andrea Smetana Name2:Christine Thomson	Site: A Time: 5-7 Name1: Eric Wilson Name2:Christine Thomson	Site:C Time:11-1 Name1: Eric Wilson Name 2: Kristine Marks	Site: C Time: 2-4 Name 1: Kristine Marks Name2: Erika Cardenas	Site:B Time:11-1 Name1:Andrea Smetana Name2:Emily Hunt	Site:A Time:11-1 Name1:Andrea Smetana Name2:Emily Hunt
Site:C Time:2-4 Name1:Andrea Smetana Name2:Emily Hunt	Site: Time: Name1: Name2:	Site:B Time: 2-4 Name1: Eric Wilson Name2: Lili Caruso	Site:D Time:2-4 Name1:Eric Wilson Name2: Erika Cardenas	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: B Time: 5-7 Name1: Kristine Marks Name2: Erika Cardenas	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
8 Site: B Time: 11-1 Name1: Kristine Marks Name2: Lili Caruso	9 Site: Time: Name1: Name2:	10 Site: Time: Name1: Name2:	11 Site: D Time:11-1pm Name1:Taylor Gendel Name2: Ben Wurl-Koth	12 Site: Time: Name1: Name2:	13 Site: Time: Name1: Name2:	14 Site: D Time: 2-4 Name1:Ben Wurl-Koth Name2:Elyse Kleifgen
Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name 2:	Site: C Time: 5-7 Name1: Ashley Hannah Name2: Lili Caruso	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: D Time: 5-7 Name1:Ashley Hannah Name2:Jong Lee	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: D Time: 5-7 Name1: Kristine Marks Name2: Lili Caruso	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: A Time: 2-4 Name1: Michael Laird Name2: Eric Wilson
15 Site: Time: Name1: Name2:	16 Site:A Time:11-1 Name1:Taylor Gendel Name2: Ben Wurl-Koth	17 Site: Time: Name1: Name2:	18 Site:C Time:7-9 Name1:Ashley Hannah Name2: Ben Wurl-Koth	19 Site: Time: Name1: Name2:	20 Site:A Time: 2-4 Name1: Ashley Hannah Name2:Jong Lee	21 Site:C Time:11-1 Name1:Taylor Gendel Name2:Elyse Kleifgen
Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site:B Time: 2-4 Name1: Michael Laird Name2:Elyse Kleifgen
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22 Site:A	23 Site: A	24 Site:	25 Site:D	26 Site:	27 Site:	28 Site:

April User Survey Schedule

Time:5-7 Name1:Taylor Gendel Name2: Lili Caruso	Time: 7-9 Name1: Taylor Gendel Name2:Ashley Hannah	Time: Name1: Name2:	Time:7-9 Name1:Ashley Hannah Name2:Eric Wilson	Time: Name1: Name2:	Time: Name1: Name2:	Time: Name1: Name2:
Site: D Time: 11-1 Name1: Michael Laird Name2:Taylor Gendel	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site: D Time: 5-7 Name 1: Kristine Marks Name 2: Michael Laird	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site:C Time: 7-9 Name1:Michael Laird Name2: Jong Lee	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site: B Time:5-7 Name1:Ben Wurl-Koth Name2: Elyse Kleifgen	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:
Site:D Time:7-9 Name1:Rebecca Name2:Emily	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:	Site: Time: Name1: Name2:

Appendix 5

General respondent comments from user surveys conducted in the Lakeshore Nature Preserve April 1 -25, 2012.

1. Preserve is a Great Thing
2. It's beautiful, we should keep it that way
3. Should be sign at Picnic Point saying the total distance to the end
4. Appreciate separated walk/bike area
5. Wishes to be able to stay on preserve later (picnic point), says 10pm is too early for campfires at picnic point
6. Strongly thinks 10pm is too early, likes the new development on picnic point
7. Wish dog walkers held the leash and controlled their dog
8. Appreciates the preserve
9. Is a long time user, dislikes all of the memorial benches, feels there is a lack of privacy and too manicured, buckthorn/honeysuckle is habitat for birds
10. Enjoys using, nice place to run/walk
11. No dogs!, back to nature preserve, not park
12. Bikes should be allowed on trails again
13. Maintain running. Support slow biking, kids biking on large path, recent rules have no been detrimental
14. Appreciate invasives removal, think they should increase the removal, willing to volunteer. Do not expand garden area
15. Supportive of prairie/invasive removal
16. Great!
17. Clean up the shoreline, cleaner water
18. Hopes it is preserved forever
19. ALLOW BIKES TO PICNIC POINT

20. MORE ADVERTISING

21. Doing a nice job with the preserve & surveying.

22. Like the fact they are being more aggressive w/ invasives & they fixed the end of Picnic Pt.

23. Did courses here & at Arboretum and thinks the signs are great.

24. Green space is extremely important for mental/physical/conservation. More than just preserve, must be managed w/ a love & respect for nature including the Nelson Institute. Need a more sustainable restoration between native veg. & invasives. I.e. Find a balance. Paid parking pushes people away.

25. It's an incredible resource.

26. Rules need to be posted more clearly. Too many biker/pedestrian conflicts. Make the leashes for all dogs rule clearer.

27. The preserve is great. Keep it pretty.

28. Put safety lights on lakeshore path for night runners, bikers, commuters ~40 yards apart to give some low illumination.

29. Take care of the erosion.

30. Good job.

31. I like this place.

32. Absolutely love it- feeling of being alone in nature

33. Very enjoyable, will return

34. Improvement to picnic point and views are better

35. Thoroughly enjoy the changes

36. Thrilled, don't let it disappear!

37. I think the Preserve should consider the gardens as an integral part of the preserve because they are very important to a lot of people.

38. It is a beautiful place and should be maintained.

39. I am super grateful for the preserve. Make sure dogs are kept on a leash. Big dogs have scared my kids when they come up and are out of control, even if the dog is friendly and just wants to play.

40. Integrate the gardens as a more important aspect of the preserve. It is very important to some of us.

41. Control dogs on leashes and no bikers in certain areas.

42. Enforcement of leashed dogs

43. Bikes should slow down/ keep their distance when near others. Dogs should be controlled better, even when they are on leashes.

44. I saw the improvements at picnic point!

45. More Edu Ops for nearby schools w/Preserve.

46. Picnic point has been overcleared and overdeveloped. The development of picnic point was sneaky and forced upon the locals after a secret meeting, following a public meeting wherein the local people disapproved.

47. Love the bathrooms at picnic point and that they are open all year. Please keep them open year round.

48. Some areas of lake should have weeds cleared--it gets too smelly.

49. Please don't allow more building development. Also, please make meetings more public--for example posting them in the Union.

50. It is pretty; accessibility of the lake is good.

51. The rules signs are not noticeable.

52. (Not a comment) He uses the signs for volunteer opportunities.

53. Please keep it here.

54. It's beautiful. Enjoys the fire pits and public bathrooms.

55. Keep the reserve natural.

56. "Well maintained, thank you."

57. The "No Bikes" signs are no prominent/strong enough

58. Thank you.

59. Keep up the good work.

60. Thanks for keeping it preserved.

61. Most areas for bikes are OK.

62. Some signs are not noticeable. She also noted that she is very busy chasing her child, and doesn't have time to stop and read them.

63. Dogs should not be allowed on beach, even leashed. People violating the leash rules should be enforced.

64. He liked that they've opened the vista; you can now see the capitol and the lake. Also liked how they've been attacking invasive species. He feels that they should also clean up downed wood and not leave it to rot.

65. Whoever is in control knows how much to burn, so that is how much should be done. She would like to see more lake-facing benches and picnic tables.

66. Charging for parking is not acceptable. Seniors/those with a fixed income will be adversely affected.

67. "Keep up the great work! This is a pleasant place. Free motorcycle parking would be nice!"

68. Repeated disclaimer: She filled it out herself! "Keep it as natural as possible. The parking meters disappoint me as then I'm on a schedule Can't stop & enjoy--everything. It's been unpaid spots for many for so long--why change a good thing :) preserve it."

69. Continue improving picnic point

70. There are repeating distance signs leading to picnic point (0.5 & 0.5). Also, more information on cultural aspect of sites would be nice: what native groups created then, what makes them sacred. The signs at the entrance to Picnic Point don't list dog rules--please make those and others more clear.

71. "The Wood Fairy says 'hello'"

72. Leashed dogs need to be picked up after.

73. They've done a good job of maintaining views. She also likes that they're trying to make better bird habitat.

74. Noise control: music blaring from softball field is annoying--possibly a neighborhood reminder. Otherwise, they're doing a fantastic job--like the benches, paths, and clearing.

75. "Really love the area."

76. He is concerned about runoff into lakes affecting lake water quality. "Protect lakes; prevent runoff causing algal blooms"

77. Wouldn't be sad if preserve were non-smoking area.

78. The way bike paths are marked now is good. The preserve is his favorite part of Madison and he hopes they can preserve it.

79. It's beautiful, thank you for the work you do.

80. Doesn't like dogs in the preserve because they're not pickedup after. Additionally, leave it undeveloped, don't develop it further.

81. It's fine.

82. Audio tours and signage detract from preserve. Development on Picnic Point negative. More natural management preferred.

83. Improve/grow preserve. Very glad to have it.

84. Fix signs

85. Pedestrian trails should be clearly marked

86. Very glad to have the reserve.

87. Satisfied, more natural and undeveloped areas.

88. Picnic Point should have special events e.g. Music, education, community events, sleigh rides

89. Like changes to Picnic Point

90. Overall improvement over the years

91. Map of hiking trails would be useful.

92. People walk on bike path. Rules are unclear to most users regarding dogs, etc. Good overall management.

93. Segregate run/walk/bike paths

94. Worth protecting and putting money into.

95. Bird and habitat protection in wetlands & info on native birds within preserve.

96. Gravel margins for runners off hard surface. Thoughtful use of many substrates to prevent erosion. Ice fisherman force trails through woods - brush barriers seem to be effective.

97. Signs not obvious or easy to read.

98. Things are over manipulated, have gotten worse over the years. Less like woods more like tourist attraction. Dogs and their feces are a problem. Picnic Point is too developed, not natural. Too much management/ paths.

99. Thinning for mature trees to grow. Nice view for students.

100. Dogs are not always on a leash. Unclear rules for right of way in bike/ped relations. Trail maintenance and erosion control improved.

101. Trails are clean - looks good.

102. Pedestrian path along road. Conserve woodlands.

103. Dogs need to be on paths with responsible owners. Improve signs. No development. Very glad to have the preserve.

104. Narrow trails to shore path between walkers/bikers. Not sure about Picnic Point renovation but would like mostly natural area.

105. Bikes just on Lakeshore path. More signs. Enforce parking. Overall good job.

106. Bike designated path separate from walkers. Signs sometimes unclear.

107. Paper maps for take along. Nice to have reserve, well cared for.

108. Designated dog area.

109. Dogs off leashes are a problem. Bike speed/proximity is worrisome. Too many signs/benches.

110. Signs are not necessary - visual pollution. Need less development - not necessary or desirable. Less park-like.

111. Some trails are confusing, signs might help.

112. Online surveys would be good way to collect opinion.

113. End of picnic point is good. Keep everything semi-wild.

114. I would like to see lakeshore path opened up to bikers again.

115. There has been good maintenance of the trails. Animal care is important and could be a little better (i.e. Dog cleanup).

116. Prescribed burning needs to be done discreetly. I really like having the LNP available; it's a good place.

117. Bikes should not be allowed when space is an issue and natural restoration is important.

118. I have used the area for 40 years, and the last decade has experienced more development (i.e. Picnic point) than ever before. The rules are not enforced and not obeyed. This is for dog walkers especially. The general population allows loose dogs and do not follow the rule to keep them on a leash. Dogs should not be allowed anywhere in the preserve because they are invasives. The signs are too small to read and often oriented in the wrong direction. I avoid the preserve now due to the dog infestation. There has been a loss of wildlife; I used to be able to see deer almost everywhere, and now you never see one.

119. Rules are known and well stated but not enforced. Likes new rule about no bikes on picnic point trail

120. Happy about renaturazation, and happy no mustard garlic. Dogs should only be allowed on A

121. Hope to see more wildlife, preserve the path.

122. Nice path, keep the condition

123. The survey takes too long

124. Dogs are great as long as they are kept clean (no poop)

125. Extra ordinary views and environment condition should not be gone away

126. Preserve the condition

127. Biopreserve not well attended. Should be gardens if not being used as prairie.

128. Stupid that you can't ride bikes down picnic point trail, it is a manufactured problem. Gardens are heaven on Earth

129. Appreciate the open spaces

130. Need a off-leash dog area please! Dog park, fenced in area for off leash dogs

131. Invasive species is most pressing problem

132. Like the path!

133. Really nice place!

134. Nature preserve board does a great job

135. People need to know the need to leash their dogs. Garlic mustard species is needed. Biking should be controlled

136. Invasive species control adolescent areas, focus on berry bearing buskthorns

137. Issues with unleashed dogs near picnic point and area c

138. Enjoy preserve, do what you can to keep it.

139. Spectacular place

140. Asset to university, should be preserved

141. No development, expand green space

142. Be inclusive, complete restoration and remove invasives

143. Natural as possible

144. Dogs should be allowed to be unleashed.

145. It is important to keep the preserve as natural as possible.

146. The preserve is great!

147. More signs about information, rules, locations, and what is in the preserve.

148. I like it. Keep bikes and runners on separate sections of the path.

149. Avoid future development. It would be nice to have separate trails for bikers and for everyone else.

150. I just really love this place.

151. Separate bike and walking paths.

152. Bikers come up to fast and don't give any warnings. They can be pretty scary and rude.

153. More signs with rules so people are more aware of the current situations in the preserve.

154. Preserve the preserve or Preserve²

155. I am annoyed that there are still bikers on picnic point when they are not supposed to be.

156. Native vegetation is important but exotic eradication with herbicides is negatively viewed and should not be used.

157. GREAT JOB

158. The stone structure at Picinic Point is ugly and unnatural looking. The fire pit is also too far away from where people sit.

159. Tent Colony and Raymer's Cove erosion on path. "Slag" glassy metal area out of place and not natural, and uncomfortable on feet when walking, natural stuff erodes and this is left in Tent Colony Woods path area.

160. There is increased use of the bike path by runners and dog walkers. Many dogs are unleashed. Bikers do not have enough rules and need to be controlled, specifically they need to slow their speed and heed stop signs. Coyotes should be preserved.

161. Glad that the Lakeshore Nature Preserve exists!

162. Gardens are awesome!

163. Pleasant place

164. Pick up garbage more often. On saturday morning garbage overfills and blows out.

165. Algae in water, really bad

166. Rules are generally fair. Important to bring her visitors from out of town here everytime they visit.

167. Keep it goin!

168. Great source.

169. More lighting – bikers slow down

170. Burning is a health hazard

171. Like it

172. Map signs suck

173. Major component of the quality of life

174. Dogs should be allowed off leash

Camera trap study in the Lakeshore Nature Preserve

Omar Ohrens, Ian Plummer, Emmanuel Urey, and Zachary Voyles

Introduction

As part of the Service Learning Project, we conducted a study on animals in the Lakeshore Nature Preserve to contribute to wildlife and habitat conservation efforts. For this purpose we used camera traps to detect animals within the Lakeshore Nature Preserve. Understanding ecological relationships and population dynamics of wild animals has benefitted recently from the use of camera traps; so much so, that the use of camera traps has become a preferred non-invasive tool for sampling animal populations (O´Connel et al. 2011). There is a global trend for studies of cryptic species that are difficult to investigate (Maffei et al. 2002; Mackenzie & Royle 2005; Olson et al. 2012). This increasingly used and popular method has been employed in the detection of species and determination of their frequencies in a wide range of habitats (Karanth 1995; Moreno 2001; Heilbrun et al. 2003; Trolle & Kery 2003; Wallace et al. 2003; Maffei et al. 2004; Silver et al. 2004; Rovero et al. 2010; Treves et al. 2010). Camera traps are photographic devices connected to motion sensors, which photographically capture an animal once it enters the sensor's detection zone. Camera trapping is a non-invasive method that generally causes a minimum of disturbance to the habitat and behavior of the target species (MacKay et al 2008). Camera traps can be left unattended in the field for an extended duration, and thus, are ideally suited for studying rare, elusive, and nocturnal/crepuscular animals that avoid humans (Tobler et al. 2008; Rovero et al. 2010; Treves et al. 2010; O´Brien et al. 2011). In taxa such as canids (dogs, coyotes, and foxes), and procyonids (raccoons) this avoidance behavior is especially pronounced, possibly leading to low detection rates by other sampling methods. A picture is strong evidence for the presence of a species. Complementing species

inventory studies with camera traps can enrich existing information and be a fundamental contribution to biodiversity conservation strategies (Gálvez et al. 2007). In addition, this method can be a useful tool to estimate human disturbance in wildlife habitats (Treves et al. 2010; Araguillin et al. 2011). In the case of the Lakeshore Nature Preserve, an area which has rules regarding dog leash use and experiences high rates of use by humans with dogs, using camera traps can give an idea of the levels of compliance. This method allowed us to represent the relationship between wildlife and human activity in each camera station, which has conservation implications. The aims of this survey were to determine species diversity, species richness, and relative abundance within species by comparing camera stations, habitat types, and stations with lure or without lure.

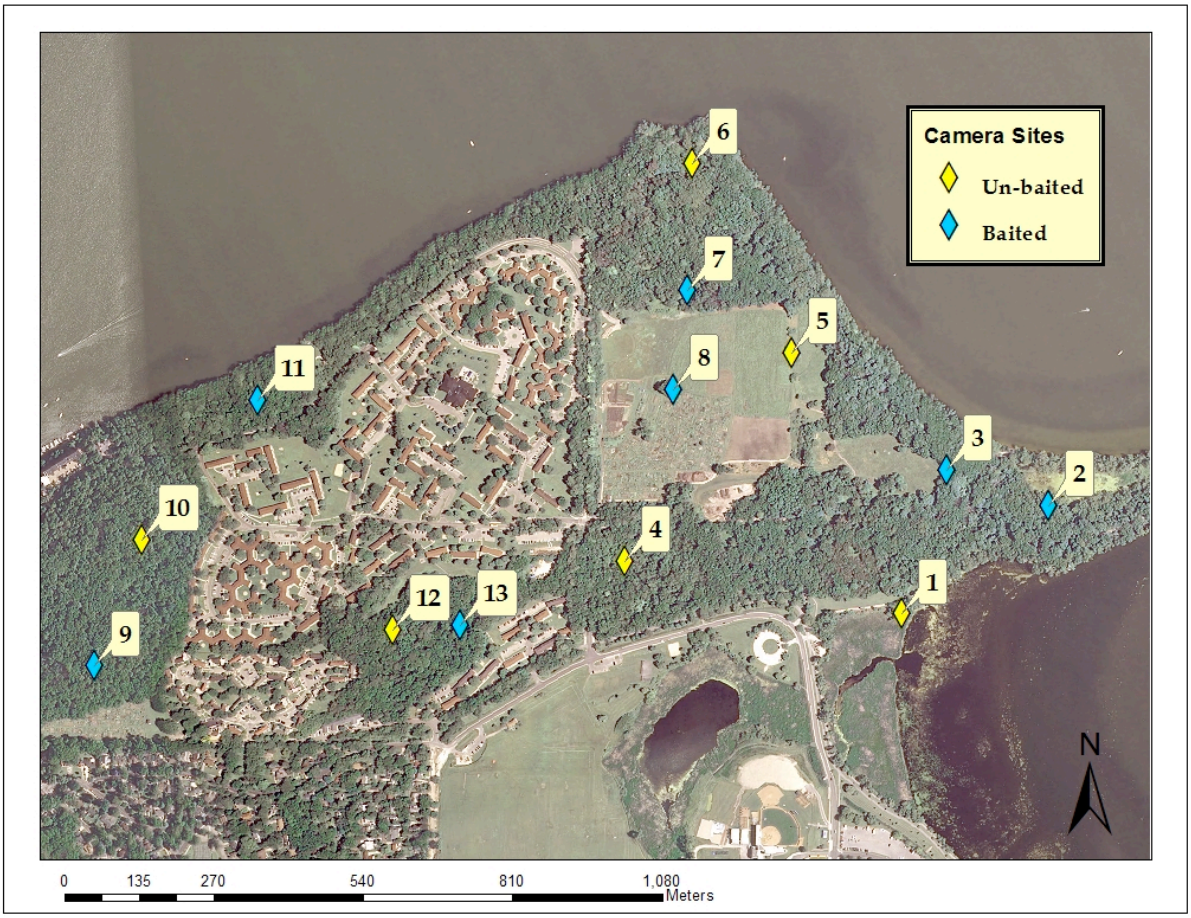
Methods

Camera trapping

All camera trapping took place within the Lakeshore Nature Preserve located on the southern shores of Lake Mendota in Madison, Wisconsin, USA. We selected approximate locations for camera traps by using a combination of satellite photographs, habitat descriptions from the previous Service Learning Project (Anhalt et al. 2011), firsthand knowledge of the Lakeshore Nature Preserve, and the Lakeshore Nature Preserve website (http://lakeshorepreserve.wisc.edu/imap/LakeshoreNaturePreserve.html). In the field we determined the exact camera locations on March 23, 2012 after examining the selected areas. Locally, we chose to place cameras to target what appeared to be active wildlife trails. By choosing trap locations based upon evidence of animal passage and sign, such as scat and footprints, we were able to maximize the probability of detecting and photographing animals (Rovera et al. 2010).

We used a total of 13 camera units (11 Reconyx PC900 and 2 Reconyx PC85) at 13 different stations (Figure 1). The chosen camera trap stations were, on average, 100-200 meters apart. At 7 of the stations, we concealed two fatty acid scent lure discs (USDA Pocatello Supply Depot) in an effort to entice animals into the range of the cameras. Lure has proven to be a successful method of wildlife attraction, especially for carnivores (Rovera et al. 2010; MacKay et al. 2008). At the baited stations, we concealed (i.e. hidden or protected to prevent consumption) one disc at ground level and the second disc above breast height. We replaced baits after two weeks. The camera stations we chose to be baited at the outset of the trapping period remained as baited stations for the duration of the trapping period and vice versa. We attached cameras to tree trunks with each camera placed approximately 70-90 cm above ground level and pointing towards the area with the highest visual evidence of previous animal activity. We recorded the camera station locations with a Garmin Rhino 120 global positioning unit and used these coordinates to create maps with ArcMAP 10 and ArcGIS Explorer.

Figure 1: A satellite photo of the Lakeshore Nature Preserve displaying the locations of 13 camera trap stations. Numbers attached to each site are for labeling purposes only



We set the camera on normal mode (photos taken in series of three, separated by a one-second interval). We installed cameras on March 24 & 25, 2012 and they remained active for 28 days. The undergraduate students on the team visited the stations once per week to ensure adequate security, battery power, and memory capacity. The combination of 13 cameras active for 28 days resulted in 364 total trap days in the study period.

At the completion of the trapping period, we removed the cameras and examined the photographs. The undergraduate students identified the species of animals in the photographs and recorded the date, time, temperature, and moon phase of each photo in which an animal was detected. Photographs containing no detectable animal were not included in data analysis. We classified unidentifiable small mammals as *Peromyscus* spp. While the primary targets of our

camera trapping activities were mammals, we did capture photographs of avian species. With the exception of ground birds, we did not include avian species in our overall data set but we did analyze them separately. We did not feel our methods provided an accurate index of species that primarily inhabit the study area above our camera capture zones.

Upon detecting an animal in a photograph series, we determined if the visit was independent of the other photos captured by the camera. We defined an independent event as (1) consecutive photographs of individuals of different species, (2) consecutive photographs of noticeably different individuals of the same species (3) consecutive photographs of individuals of the same species taken more than 30 minutes apart and (4) nonconsecutive photos of individuals of the same species (O´Brien et al. 2003; Araguillin et al. 2011).

Habitat Complexity

At each camera station, two people used a 10.3 cm long 4.2 cm diameter tube to look directly upwards at the sky and estimate the amount of coverage obscuring the sky. We estimated canopy cover from 10, 30, and 50 m (32.8, 98.4, 164 feet, respectively) from the camera tree in each of the four cardinal directions (N, E, S, W). We recorded both independent estimates and averaged the two to represent canopy coverage. We used, for each station, an overall average of canopy coverage combining all the measurements for one station and averages of each distance combining measurements from the four directions when analyzing the data.

We placed a 0.5 m^2 board, painted bright pink and divided into 16 equal squares in a 4 x 4 pattern, in the center of the field of view of each camera because this was the approximate location where an animal would be standing when captured photographically. The board was displayed at two heights, 1.3 m (the high measurement) and 0.65 m (the low measurement), measured from the top of the board to the ground. When displaying the board, we had one

member of the group view from a height of roughly 1 m and estimate percent cover. They did this from a distance of 10, 30, and 50 m in each of the four cardinal directions (N, E, S, W) for each height at which the board was displayed. The board was held perpendicular to the line of sight of the viewer. Both the low and high measurements were recorded for each distance and direction. The average of the two height measurements was used to calculate a measure of habitat complexity for the three distances. Additionally, we computed an overall average for each station incorporating all the measurements for that station.

Analysis

We entered data in a Microsoft Excel spreadsheet and used R statistical software version 2.14.0 with the Harrell Miscellaneous package loaded for statistical analysis. We used Microsoft Excel to create graphics. To test differences among camera stations, we chose to measure the correlations between our species count data as measured by 1) the number of independent species/events, and 2) the number of photos per species event. After examining the distributions of our species counts, we determined the counts were not normally distributed. Thus, we opted to use the non-parametric Spearman rank correlation as our statistical measure of correlation among our stations. Species diversity was calculated across stations using the Gini-Simpson Diversity Index (Equation 1).

$$D = 1 - \sum_{i=0}^{S} \left(\frac{n_i}{N}\right)^2 \qquad \text{Eq. 1}$$

Where **N** is the total number of species events, $\mathbf{n_i}$ is the number of events per species I, S is the total number of species.

A measure of capture frequency was calculated and standardized using the method outlined by Tobler et al. (2008), providing our rate of species capture per 100 trap-days

(Equation 2). This provided us with a measure of relative abundance of the species across our camera stations.

$$Capture\ Frequency = 100\left(\frac{Events}{Effort}\right) \quad \text{Eq. 2}$$

Where Effort = No. Traps X Days

When comparing baited and unbaited sites, using carnivore events per station as the response variable, the distribution was once again not normal. We used a Wilcoxon signed rank test as a means of handling this abnormality. P-value cutoff was 0.05 to be considered significant for all tests.

Results

Species Summaries

Species recorded over the 28 day period included eastern cottontail (*Sylvilagus floridanus*), wild turkey (*Meleagris gallopavo*), eastern gray squirrel (*Sciurus carolinensis*), northern raccoon (*Procyon lotor*), *Peromyscus* spp., eastern chipmunk (*Tamias striatus*), passerines (*Corvus brachyrhynchos & Turdus migratorius*), coyote (*Canis latrans*), and opossum (*Didelphis virginiana).*

Squirrels were by far the most common species captured, followed by cottontail rabbits and raccoons. Smaller mammals (i.e. mice, voles, etc.) were either rare at our camera stations, our cameras were not adequately set to photograph these smaller mammals, or the camera failed to detect them.

Habitat and Species Correlations

We found significant positive correlations between the number of rabbit events and understory coverage measured at 10, 30, and 50 m distances (Spearman's rho = 0.48, 0.60, 0.60;

p-value = 0.09, .03, .03 respectively at 10, 30, and 50m) (Figure 2 A-C). Additionally, when we averaged the understory coverage over all three distances, this positive correlation held (rho = 0.54, p-value = 0.06) (Figure 2 D). Similarly, the relative abundance of rabbits was positively correlated with understory coverage. However, because our trap days were equal across all stations and for each species, the correlations are identical to those found using the number of species events.

The number of photographs per rabbit event was also positively correlated with understory coverage measured at the furthest distance, 50 meters (Spearman's rho = 0.62, p-value = 0.02). We also found significant positive correlations between the number of photos per squirrel event and overstory coverage (Spearman's rho = 0.51, p-value = 0.07) (Figure 3).

Aside from wild turkeys, our cameras captured two other species of birds, American robins and American crows. Both the number of events and the number of photos per event of American robins and American crows were found to correlate negatively with overstory coverage. That is, our counts increased as overstory decreased (Figure 4).

Table 1. The species captured, the number of independent photographic events, and the frequency of those events over 28 days with 13 camera trap stations.

Species	**Common Name**	**Events**	**Capture Frequency**
Sciurus carolinensis	eastern gray squirrel	283	77.75
Sylvilagus floridanus	eastern cottontail	78	21.43
Procyon lotor	raccoon	54	14.84
Meleagris gallopavo	wild turkey	25	6.87
Canis latrans	coyote	20	5.49
Passerine spp.	American crow & American robin	9	2.47
Peromyscus spp.	deer mouse / white-footed mouse	3	0.82

Didelphis virginiana	opossum	1	0.27
Tamias striatus	eastern chipmunk	1	0.27
TOTAL		474	130.22

Table 2. A station-by-station breakdown of species captured, the presence or absence of bait, and the calculated diversity at that station.

Camera station	Species richness	Squirrel Events	Rabbit Events	Raccoon Events	Turkey Events	Coyote Events	Opossum Events	Small Mammal Events	Bird Events	Baited	Simpson's Diversity Index
1	5	1	5	3	2	7	-	-	-	No	0.73
2	5	22	1	5	-	-	1	-	2	Yes	0.46
3	5	24	10	7	-	3	-	1	-	Yes	0.65
4	4	20	11	10	-	-	-	2	-	No	0.66
5	3	-	-	-	2	2	-	-	1	No	0.64
6	5	6	9	3	1	-	-	-	2	No	0.70
7	4	57	10	1	-	5	-	-	-	Yes	0.37
8	4	4	-	1	-	-	-	1	4	Yes	0.66
9	2	1	-	-	2	-	-	-	-	Yes	0.44
10	3	12	4	2	-	-	-	-	-	No	0.49
11	3	46	-	14	-	1	-	-	-	Yes	0.38
12	5	35	5	6	1	1	-	-	-	No	0.44
13	5	55	23	2	17	1	-	-	-	Yes	0.60

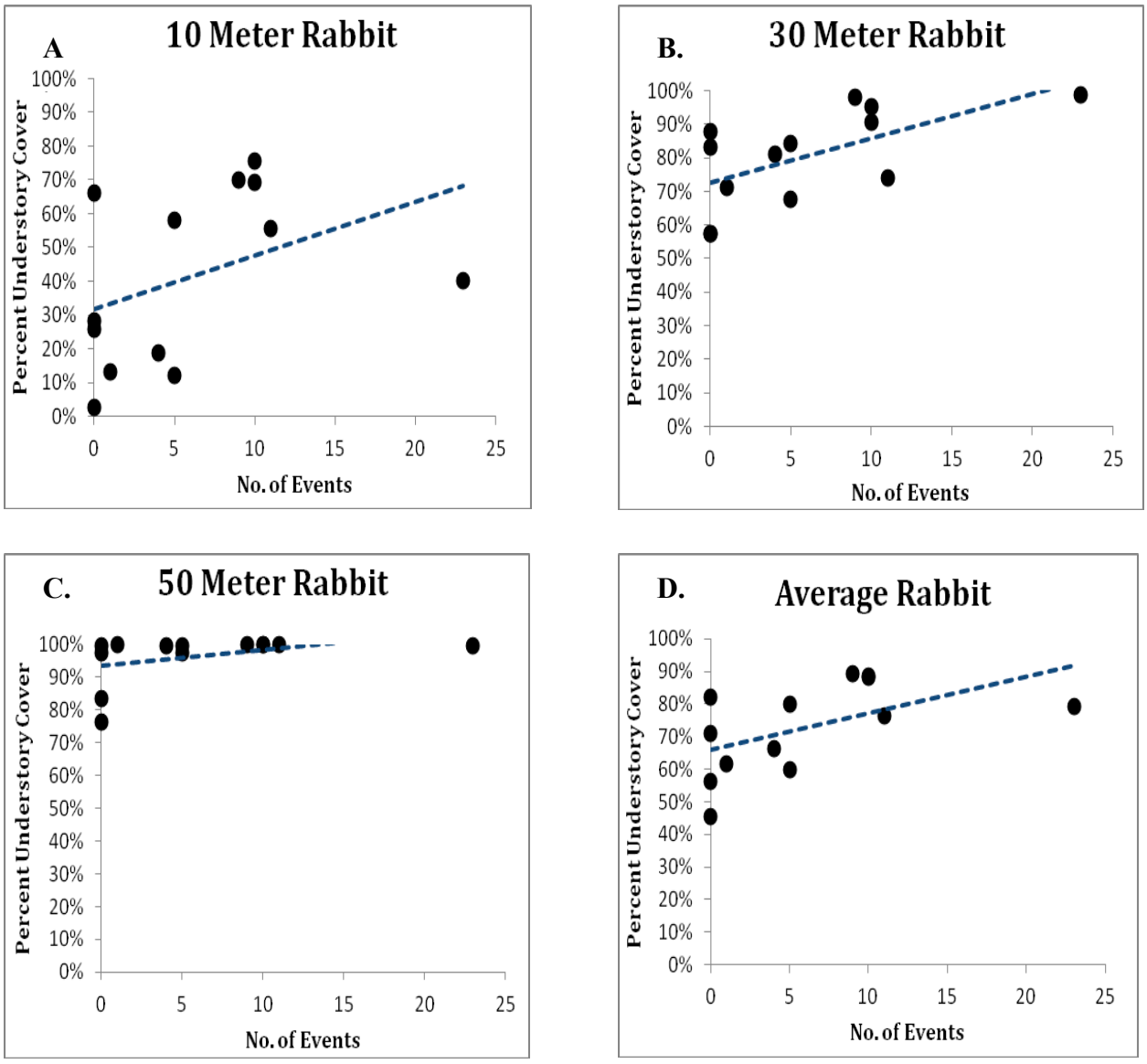


Figure 2: The number of photographic events of eastern cottontail rabbits compared to the understory coverage for the 13 camera trap stations. Understory cover is an average of 2 measurements made from four directions (N, E, S, W) at either (A.) 10 m, (B.) 30 m, or (C.) 50 m. Graph (D.) represents an overall average of all 24 understory cover measurements.

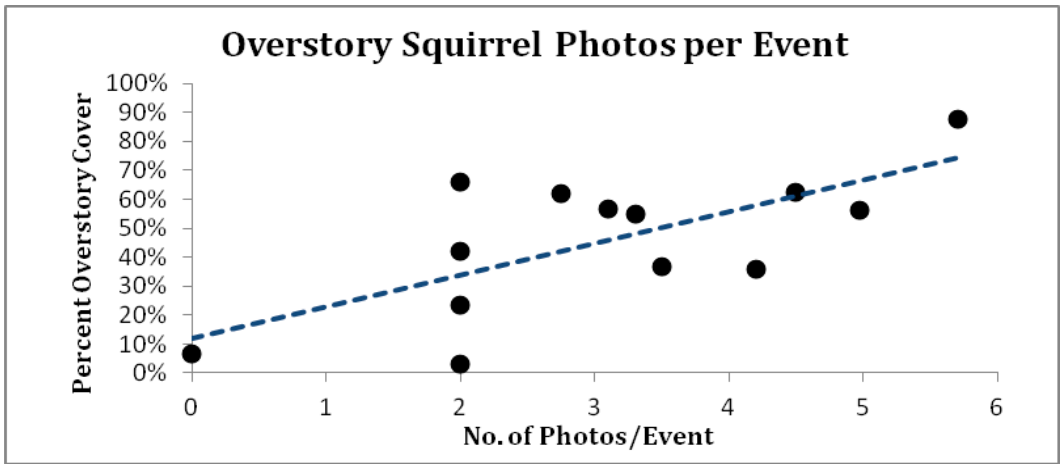


Figure 3: The number of photographic events compared to the overstory coverage for 13 camera trap stations. Overstory was estimated directly at the camera location and 10 m, 30 m, and 50 m distant in four directions (N, E, S, W). Two measurements were taken at each estimation point for a total of 26 measurements and the average was used above.

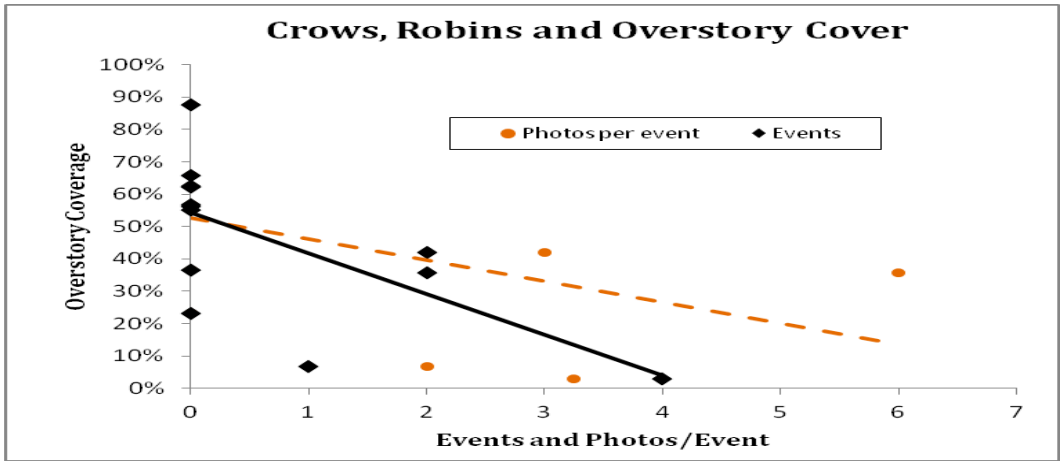


Figure 4: The number of photographic events of American crows and American robins, combined, compared to overstory coverage along with the number of photos per event compared to overstory coverage as captured by 13 camera trap stations. Overstory was estimated directly at the camera location and 10 m, 30 m, and 50 m distant in four directions (N, E, S, W). Two measurements were taken at each estimation point for a total of 26 measurements and the average was used above.

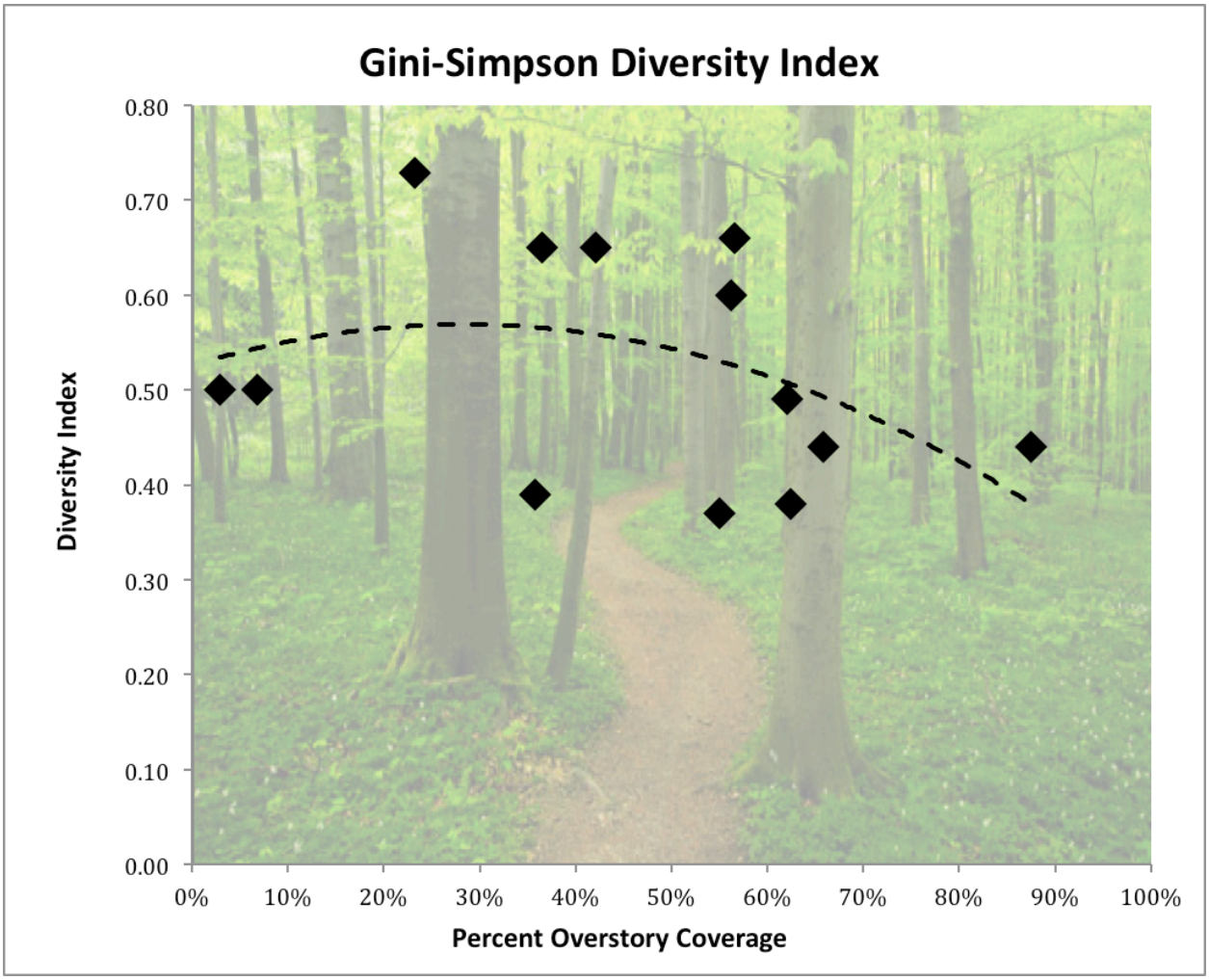


Figure 5: The average overstory coverage of 13 camera trap stations compared to the Gini-Simpson Diversity Index. Each point represents one camera trap station. Overstory was estimated directly at the camera location and 10 m, 30 m, and 50 m distant in four directions (N, E, S, W). Two measurements were taken at each estimation point for a total of 26 measurements and the average was used above.

The final significant correlation we uncovered was between our measure of diversity calculated using Gini-Simpson's Diversity Index (Equation 1) and the percentage of overstory coverage. This correlation was negative, indicating a decrease in species diversity as overstory increased (Figure 5).

Activity Patterns

We found different activity patterns between the most common species captured in the camera traps (Figure 6). Diurnal activities were recorded in wild turkeys and squirrels. Eastern cottontail rabbits were also active during the day, but most of their activity was concentrated in the night. Carnivores, represented by coyotes and raccoons, were active at night only.

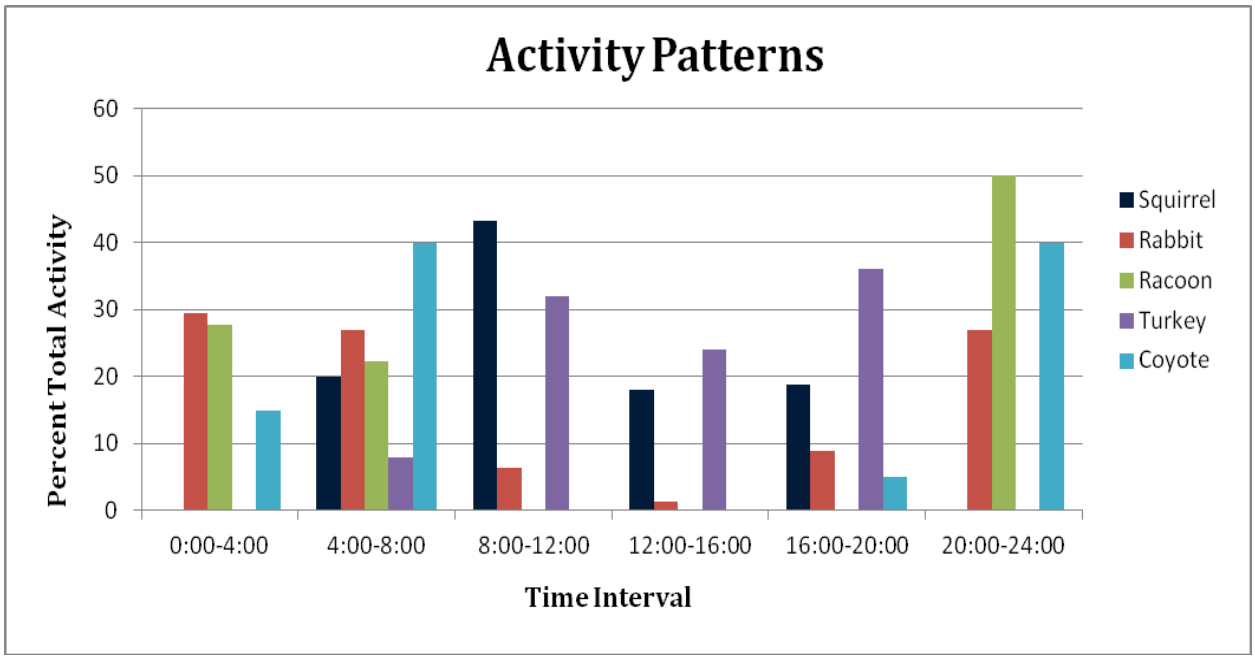


Figure 6: The temporal activity patterns of all the identifiable species photographed in the 13 camera trap stations save American crows and American robins. Activity for a species was the ratio of all of the photographs of that species over the total number of photographs of all species

Baited vs. Un-baited Stations

Lastly, we compared camera locations with and without lure. Our response variable was the number of independent carnivore events per station (summed events of coyotes and raccoons). The Wilcoxon signed rank test indicated no significant difference in the number of carnivore events at stations with scent lure compared to those without lure ($W = 20$, p-value = 0.94).

Human Use

Cameras captured humans at 12 of the 13 camera stations, with station 11 being the only location with no humans captured. The number of photographic events of humans per station varied from 0 to 6 with the exception of station 5, which captured photographs of 247 individuals. This was the only camera that was focused directly on a human footpath. Further investigation showed that at camera station 5, 56 of the 247 individuals photo-captured were with domestic dogs. Of these 56 individuals, 30 (54%) had their dog(s) on a leash while 26 (46%) did not. In addition, 6 dogs were captured without humans in the photo. Across all 13 stations and combining humans with and without dogs, we estimated human group size as an average of 1.38 individuals per event.

Discussion

Habitat and Species Correlations

We found the relative abundance of rabbits was positively correlated with understory cover. This means the denser the understory cover, the more rabbits captured by the cameras. This correlation may be a result of two things: (1) rabbits are prey to larger carnivores and raptors, so denser understory cover provides refuge and protection against predators (Cox et al. 1997); and (2) as herbivores, rabbits feed mainly on understory vegetation and the barks, buds, and twigs of woody vegetation (Allen 1984). These diets are found in areas where there are understory cover, defined as early-successional habitat types (Fuller & DeStefano 2003).

Squirrels had a strong positive correlation with canopy cover, which is indicative of dependence on forest habitat for nest sites and mast, a major component of their diet (Rosenblatt et al. 1999; Shifley et al. 2006). Another possible reason for the correlation between squirrels and heavier canopy cover is the avoidance strategy squirrels employ when encountering a possible predator. The behavior typically involves running to the nearest tree to escape. Therefore, to

reduce the risk of capture, they prefer habitats where less distance exists between trees (Dill & Houtman 1989). The abundance of squirrels in the Preserve demonstrates the resilience of these mammals in habitats that have heavy human influence and a past history of disturbance. Furthermore, the gregarious nature of squirrels combined with the temporal component we used to determine an independent event creates the possibility squirrel abundance was underestimated in this study.

The Gini-Simpson index incorporates the presence of a species while factoring in its relative abundance, giving a higher diversity index rating to locations with higher species variety and uniform relative abundances or "evenness" (DeJong 1975). In examining the diversity index among stations in the Lakeshore Nature Preserve, we found a negative correlation with canopy cover. In actuality, areas with lesser canopy cover (i.e., open spaces) showed higher diversity as measured by the Gini-Simpson diversity index. Due to the relatively small size of the Lakeshore Nature Preserve, it is possible this negative correlation is due to open spaces being coincidental to animal paths and/or funneling locations for wildlife. It is also possible the cameras were better at detecting wildlife in less complex habitats. While measures of diversity are widely used in ecological studies, we caution against using the index of diversity as a diagnostic for any specific site in the Lakeshore Nature Preserve, but suggest a composite average index value (0.56) as more representative of the diversity of medium to large size mammals in the forested areas of the Lakeshore Nature Preserve as a whole (McIntosh 1967; Whitaker 1972; Peet 1974).

Activity Patterns

In the case of the raccoons, we expected a nocturnal activity pattern, which is what we found in our data. Raccoons are described in the literature as mainly active during the night, from

dusk to dawn (Foster & Humphrey 1995; Norris & Sells 2004; Timm et al. 2008). Although principally nocturnal, raccoons come out at times during the day to feed and sun themselves (Stuewer 1943).

Squirrel activity was more frequent during daylight hours, which is also confirmed by the literature, with a peak in activity between 6 and 9 am in our data (Ables 1969). Especially during the spring season, the activity starts earlier, around 6am, increasing rapidly until a peak in activity during the period between 8 and 9 am (Thompson 1977). It is also important to consider variations between seasons. Thus, the length of day sets the period available for feeding and, therefore, affects the activity pattern. As the day length decreases, squirrels have less feeding time available and are forced to concentrate their activity during one period of the day (Thompson 1977).

The wild turkey has a diurnal activity pattern, possibly due to their poor night vision. The inability to successfully scan for predators in low light situations makes them vulnerable to night-feeding predators. Because of this, they seek an elevated night roost where they remain until the morning light (Clancy 1996). Activity restricted to daylight hours in turkey is what we recorded.

The high nocturnal activity of coyotes in our study was very similar to that found by other studies where anthropogenic effects dominate the environment (Grinder & Krausmann 2001; McClennen et al. 2001; Way et al. 2004). Commonly, coyotes are most active in the hours surrounding sunset and sunrise. But in urban areas, activity peaks also have occurred around midnight. Because humans are more active during the early hours of the evening than at other times of the night, urban coyotes, compared to coyotes in more rural areas, may remain inactive longer to avoid contact with humans (Grinder & Krausmann 2001). We also suggest the areas

where coyotes spend most of their time during the night may be areas where prey items (e.g. rabbits) are more abundant.

Human Use

While the possibility of capturing persons with our camera traps was acknowledged from the onset of the study, we did not anticipate the number of events. We also did not design our choice of camera stations to properly measure human use of the Lakeshore Nature Preserve. Still, our documentation of human use is informative. Remarkably, 46% of persons with dogs at camera station 5 along a well-used footpath did not have their dogs on a leash despite the user survey report indicating 90% of users with dogs had their animals on a leash. We feel the disparity between the amounts of dogs leashed between the two areas has to do with spatial sampling procedures. The majority of the user surveys were taken in entrance areas while camera station 5 was located over 300 m from the closest entrance which is indicative of a willingness on the part of dog owners to unleash dogs when away from higher human use areas. Additionally, it is important to note two species of wildlife we observed in the Lakeshore Nature Preserve, coyote and wild turkey, actively used the footpath by station 5 and that humans used this path daily. We noted coyote scat along many of the footpaths in and around the Eagle Heights Community Garden and the Biocore Prairie.

Management Implications and Suggestions

The most common wildlife we photographed in the Lakeshore Nature Preserve were species commonly seen in human dominated landscapes: squirrels, cottontail rabbits, wild turkeys, and coyotes (Tokar 2001; Chapman et al. 2003; Hamilton 2003; Gese et al. 2008; Hamilton 2010; Feinstein 2011; Bateman et al. 2012). The implications of this work are not to show these species are present in the Lakeshore Nature Preserve. That is known. Rather, we set

forth (along with previous camera trap studies in the Lakeshore Nature Preserve) a method to monitor these species' status and the relationship with habitats. The continued use of camera trapping in the Lakeshore Nature Preserve would prove a valuable tool to ensure human impacts do not over-extend themselves and lead to any one species decline. The continued use of this technique could also provide a measure of conservation success if, for example, less common wildlife (e.g., red fox and mink) begin to use the Preserve more frequently. A long term monitoring plan with camera traps would increase information and knowledge about the dynamics of mammals and their habitats within the Lakeshore Nature Preserve.

Some interesting possible avenues for sampling in the future could include increased camera trap stations located in the Eagle Heights Woods. We detected low abundances and diversity of species in this area, which we found surprising because the user survey group found this area to have the lowest number of human users, which we thought would make the area more attractive to wildlife. Additionally, when deploying the cameras, we noticed the higher abundance of succulent plants in comparison to the other portions of the reserve. It should be noted this was based on the observations of two participants and no measures of plant diversity or forest composition were made. In discussion of our results with managers, it was also pointed out Eagle Heights Woods has different forest types based on the aspects of the geography with all directions represented leaving open the possibility to compare different forest types in the future.

There were some species not captured in our photos that we found surprising. White-tailed deer (*Odocoileus virginianus*) thrive in large portions of human dominated landscapes in North America. Wisconsin is known for fairly large populations of white-tailed deer. There have even been reports of does with fawns in the Lakeshore Nature Preserve, yet we failed to

photograph any. This could be due to deer existing at low densities within the boundaries and not crossing in front of a camera, failure of the cameras to capture the deer when they do cross in front of the camera, or poor placement of the cameras. There were reports from some team members of deer scat encountered while checking cameras. It was also surprising the low numbers of small mammals (i.e. mice, voles, shrews) detected at the camera trapping stations. The numbers we report are probably an under sample and other means of collecting data on this group should be explored if a more accurate picture is desired.

We encourage the Lakeshore Nature Preserve to consider enhancing its natural interpretive program by providing information about some of these common species along the many footpaths and trails. The potential rewards are many, and an information campaign could provide an incentive for visitors to remain on marked trails for species and habitat preservation and lead to increased compliance with bicycle use and dog-leash rules in restricted areas. For a list of references discussing wildlife living in urban and near-urban environments, see http://www.urbanwildlifeguide.com/2.html.

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Appendix 1

Camera Trap Survey: *Species Events I*

Camera station	Species richness	Baited	Squirrel Events	Photos per Squirrel Event	Rabbit Events	Photos per Rabbit Event	Raccoon Events	Photos per Raccoon Event	Turkey Events	Photos per Turkey Event
1	5	No	1	2.00	5	11.60	3	4.33	2	8.50
2	5	Yes	22	4.20	1	8.00	5	3.60	0	0.00
3	5	Yes	24	3.50	10	3.90	7	4.71	0	0.00
4	4	No	20	3.10	11	3.27	10	4.10	0	0.00
5	3	No	0	0.00	0	0.00	0	0.00	2	4.00
6	5	No	6	2.00	9	5.00	3	6.00	1	9.00
7	4	Yes	57	3.31	10	2.80	1	6.00	0	0.00
8	4	Yes	4	2.00	0	0.00	1	5.00	0	0.00
9	2	Yes	1	2.00	0	0.00	0	0.00	2	2.00
10	3	No	12	2.75	4	2.50	2	5.50	0	0.00
11	3	Yes	46	4.50	0	0.00	14	4.29	0	0.00
12	5	No	35	5.71	5	3.60	6	9.33	1	6.00
13	5	Yes	55	4.98	23	3.86	2	3.00	17	13.29

Species Events II

Camera station	Coyote Events	Photos per Coyote Event	Opossum Events	Photos per Opossum Event	Small Mammal Events	Photos per Sm. Mammal Event	Robin and Crow Events	Photos per Robin and Crow Event
1	7	2.70	0	0.00	0	0.00	0	0.00
2	0	0.00	1	3.00	0	0.00	2	6.00
3	3	4.33	0	0.00	1	3.00	0	0.00
4	0	0.00	0	0.00	2	3.00	0	0.00
5	2	2.00	0	0.00	0	0.00	1	2.00
6	0	0.00	0	0.00	0	0.00	2	3.00
7	5	11.40	0	0.00	0	0.00	0	0.00
8	0	0.00	0	0.00	1	3.00	4	3.25
9	0	0.00	0	0.00	0	0.00	0	0.00
10	0	0.00	0	0.00	0	0.00	0	0.00
11	1	5.00	0	0.00	0	0.00	0	0.00
12	1	9.00	0	0.00	0	0.00	0	0.00
13	1	3.00	0	0.00	0	0.00	0	0.00

Site Characteristics

Camera station	Average Understory Complexity (% coverage)	Understory Complexity 10m	Understory Complexity 30m	Understory Complexity 50m	Overstory (% coverage)	Simpson's Index	Gini-Simpson Diversity Index	Simpson's Reciprocal Index	Distance to Lake (meters)
1	59.75	12.25	67.50	99.50	23.27	0.27	0.73	3.68	15
2	61.53	13.33	71.25	100.00	35.81	0.54	0.39	1.64	90
3	88.08	69.38	95.13	99.75	36.54	0.35	0.65	2.86	87
4	76.54	55.62	74.00	100.00	56.66	0.34	0.66	2.94	597
5	56.25	28.13	57.25	83.38	6.81	0.36	0.50	2.00	123
6	89.37	70.00	98.12	100.00	42.08	0.30	0.65	2.86	67
7	88.75	75.62	90.62	100.00	55.00	0.63	0.37	1.59	220
8	82.29	66.25	83.12	97.50	2.91	0.34	0.50	2.00	338
9	70.96	25.63	87.88	99.38	65.83	0.56	0.44	1.79	358
10	66.50	18.75	81.25	99.50	62.08	0.51	0.49	1.96	218
11	45.42	2.50	57.50	76.25	62.50	0.62	0.38	1.61	60
12	80.00	58.13	84.38	97.50	87.50	0.56	0.44	1.79	533
13	79.38	40.00	98.75	99.38	56.25	0.40	0.60	2.50	587

Relative Abundances

Camera station	**Squirrel**	**Rabbit**	**Raccoon**	**Turkey**	**Coyote**	**Opossum**	**Small Mammals**	**Birds**
1	3.57	17.86	10.71	7.14	21.43	0.00	0.00	0.00
2	78.57	3.57	17.86	0.00	0.00	3.57	0.00	7.14
3	85.71	35.71	25.00	0.00	10.71	0.00	3.57	0.00
4	71.43	39.29	35.71	0.00	0.00	0.00	7.14	0.00
5	0.00	0.00	0.00	7.14	7.14	0.00	0.00	3.57
6	21.43	32.14	10.71	3.57	0.00	0.00	0.00	7.14
7	203.57	35.71	3.57	0.00	17.86	0.00	0.00	0.00
8	14.29	0.00	3.57	0.00	0.00	0.00	3.57	14.29
9	3.57	0.00	0.00	7.14	0.00	0.00	0.00	0.00
10	42.86	14.29	7.14	0.00	0.00	0.00	0.00	0.00
11	164.29	0.00	50.00	0.00	3.57	0.00	0.00	0.00

12	125.00	17.86	21.43	3.57	3.57	0.00	0.00	0.00
S	196.43	82.14	7.14	60.71	3.57	0.00	0.00	0.00

Common Name	Scientific Name	Range	Conservation Status	Description
Coyote	*Canis latrans*	Widespread throughout North and Central America	**IUCN:** Least concern, **WI:** Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	The average adult coyote weighs 7-21 kg and have a body length of 75-100 cm with a tail length of about 40 cm. Coyote fur ranges from grayish brown to yellow-gray with a white throat and belly. Coyotes eat small mammals like rabbits and squirrels, as well as birds and snakes. They eat both fresh meat and carrion. They are most active late at night and early in the morning. Coyotes have a home range of as much as 19 km and often travel along fixed trails or routes (Tokar 2001; Gese et al 2008).
Opossum	*Didelphis virginiana*	Widespread from Costa Rica in the South, Southern Canada in the North, and Coast to coast across North America	**IUCN:** Least concern, **WI:** Not included in the Wisconsin Natural Heritage Working list as endangered or threatened	The north American opossum, or just commonly coined 'opossum', is the only marsupial found in North America. It is characterized by being about the size of a large house cat, having gray fur, triangular-white face, and round beady eyes. With its prehensile tail, the opossum is able hang from tree limbs and gutters. Having an omnivorous diet, it will forage for plants, small animals, and insects at night. They are adaptable creatures that live in forests and in the urban environments, though often preferring areas wet areas. When confronted by humans, they often exhibit death-like behavior by becoming stiff and breathing slowly. (Cuáron et al. 2008)
North American deermouse	*Peromyscus maniculatus*	Found throughout southern Canada, the United States, and north and central Mexico, including Baja California. Absent from the Atlantic and Gulf of Mexico coastal plains of the United States, but its range does extend to the coast in east Texas.	**IUCN:** Least Concern, **WI:** Not included in the Wisconsin Natural Heritage List as endangered or threatened	The deer mouse is the most widespread North American rodent. It ranges from about 120-225 millimeters in length and weighs between 10-30 grams. They rarely leave their shelter during the day, and instead feed opportunistically at night on a variety of food such as seeds, nuts, fruits, berries, insects, and other animal matter. They are found in almost every type of habitat within its range and find shelter in a variety of areas such as tree trunk cavities and burrows in the ground. Deer mouse populations are known to fluctuate in cycles of three to five years, with some correlation with food availability. They are known to play a role in the spread of diseases such as hantavirus and lyme disease (Linzey 2008).

Eastern chipmunk	*Tamias striatus*	Widely distributed throughout the eastern United States and adjoining Canada, from southeast Saskatchewan to Nova Scotia, south to western Oklahoma and eastern Louisiana (in the west) and to coastal Virginia (in the east).	**IUCN:** Least Concern, **WI:** Not included in the Wisconsin Natural Heritage List as endangered or threatened	The eastern chipmunk has a 14-16.5 centimeter long body, with a tail of about 11.4 centimeters. It has rusty brown fur with a white underbelly and necklace. It also has five black stripes that run down the back and sides and end at the rump. The eastern chipmunk is primarily a ground dweller, but will climb trees as well. It is found most commonly in open hardwood forests, brushy or rocky areas, and in yards. It prefers a diet of seeds, fruits, and nuts, but will also eat insects like grasshoppers, bird eggs, snails, small snakes, and garden bulbs. The eastern chipmunk is active during the day, and becomes torpid in winter, with frequent arousals (Linzey & Hammerson; 2008).
American crow	*Corvus brachyrhync-hos*	Very large range spanning continental US and extends far north into Canada. In US, absent only from southern edges of southwestern states.	**IUCN :** Least Concern, **WI :** Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	American crows are medium sized birds growing to 43 to 53 cm in length and 315-575 grams in weight. They are completely black in color with glossy feathers, a glossy beak, and bristle-covered napes. The sexes are the same in appearance with males growing slightly larger than females. Crows are very widespread and can be found in many different types of landscapes, from wooded areas to urban areas, but avoiding large areas of forest. Diet includes amphibians, reptiles, small mammals, small birds, bird eggs, grains, fruits, carrion and human food. Nests are constructed in crotches or on horizontal limbs near the trunk, with clutch sizes ranging from 3 to 7 (Birdlife International 2009).
White-footed mouse	*Peromyscus leucopus*	Two-thirds of US except for small patches in Southeast. Extends into southern Canada adjacent to US range and into southern Mexico	**IUCN :** Least Concern, **WI :** Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	The white-footed mouse grows to 145 to 205 mm in length and 16 to 29 grams in weight. Juveniles are gray and shift to reddish brown as they mature, with a white belly and feet. White-footed mice are omnivorous and their diets include a wide variety of foods such as fruits, nuts, seeds, and insects. Breeding occurs throughout the year, and these mice can be found in semi-arboreal habitats (Linzey 2008).
Wild turkey	*Meleagris gallopavo*	Widespread throughout South Canada, Central and South America except some desert regions in the American West and Southwest	**IUCN:** Least Concern, **WI:** Not included in the Wisconsin Natural Heritage List as endangered or threatened	The wild turkey is native to Canada, Mexico and the United States. It has been introduced to Australia and New Zealand. They are agile fliers with their ideal habitat being an open woodland or savannah. Males use many different vocalizations, the most common being gobbles to notify females of their presence during mating season. Females respond by “yelping” to notify the males of their location. Both males and females have a black body with long reddish-yellow to grayish green legs. Males have red on their featherless head on their throat and neck. Males are much larger and brighter than females (Clancy 1996).

Northern raccoon	*Procyon lotor*	Common throughout most of the United States and Mexico, especially the Eastern US. Less frequent in non-forested areas of the Western US and Mexico.	**IUCN :** Least Concern, **WI :** Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	The raccoon is a medium-sized mammal, usually just less than 3 feet long (tail included) and weighing between 12 and 48 pounds. A black mask across the eyes characterizes the black and grey body, surrounded by white, and a black and grey ringed tail. Nocturnally foraging for fruits, nuts, insects, small mammals, bird and reptile eggs, frogs, fishes, aquatic invertebrates, worms and garbage, the raccoon is a true omnivore. The raccoon is very adaptable, also to city life. Being fairly common across the United States and also found in several European countries, the raccoon is listed as least concern on the IUCN Red List (Norris & Sells 2004; Timm et al. 2011).
Eastern gray squirrel	*Sciurus carolinensis*	Eastern US to a line just west of the Mississippi River and adjacent Southern Canada	**IUCN**: Least Concern **WI**: Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	The eastern gray squirrel is a omnivorous, diurnal mammal found anywhere in the Eastern US where there are deciduous trees. They grow up to around 20 inches in length and are grey in color with a lighter belly color. Gray squirrels feed on a variety of things including nuts, fruit, and caterpillars. Their wide variety of predators includes snakes, skunks, foxes, and birds of prey. They mate twice a year and have a high mortality rate their first 2 years, but can live up to 10 years if they survive past that (Hamilton 2003).
Eastern cottontail rabbit	*Sylvilagus floridanus*	Eastern US to the Rocky Mountains, much of Central America especially throughout Mexico and parts of Northern South America.	**IUCN**: Least Concern **WI**: Not included in the Wisconsin Natural Heritage Working List as endangered or threatened	The eastern cottontail rabbit is one of the most common mammals in North America. They grow up to 18 inches and range in color from light brown to darker grey. The color often depends on the habitat characteristics. Cottontail rabbits feed on a variety of plants including grasses, garden, and woody plant parts depending on the seasonal availability. They also will consume their own fecal pellets due to inefficiency of their digestive system. Predators include foxes, hawks, and owls. They are solitary animals which habitat ranges up to 100 acres and they mate once a year. Young must fend for themselves after 2 weeks and the cottontail's lifespan is usually less than 3 years in the wild (Chapman et al. 2003).

Avian Community: Richness and Diversity across Habitats in the Lakeshore Nature Preserve

Emily Houtler, Teresa Olson and Isabel Rojas

Introduction

Humans have fundamentally altered global patterns of biodiversity and ecosystem services. In a recent work, Elis and Ramankutty (2008) suggested a new way to describe Earth's biomes based on a gradient of human population density, starting with low population, in one extreme, to densely urbanized areas. Highly concentrated human population drives many changes in land cover, which might affect communities of birds and other wildlife (Donnelly and Marzluff 2004). Remnant patches of the original ecosystem within the urbanized area may provide an opportunity for some birds to survive and persist.

Madison, Wisconsin was developed amid lakes, wetlands, prairies, and forests. Much of the original landcover has been converted to agriculture or urban areas. However, some remnants of the original vegetation have become protected areas and have been restored to similar conditions prior large-scale urban development, to serve as a refuge to the local biodiversity and provide recreational opportunity for citizen enjoyment. Because of its size and location, the Lakeshore Nature Preserve is one of the most important preserves among the urban area in Madison. Located along the shore of Lake Mendota, this preserve is composed of a wide variety of habitats from woodlands to wetlands to prairies which provide habitats for many species of plants, birds, mammals, reptiles, and amphibians, among others (Lakeshore Nature Preserve 2012).

The diversity in the avian community of the preserve is particularly impressive. According to the Lakeshore Nature Preserve (2012), more than 255 different bird species have been seen throughout the preserve. An additional survey found that 81 of these species are confirmed or probable nesters in the preserve. The diversity of bird species draws both community and university birders to the Preserve. The Friends of the Lakeshore Nature Preserve even provide a bird checklist for those interested. Additionally, since 1907, courses and instructors at UW-Madison have used the preserve for educational purposes (Lakeshore Nature Preserve 2012).

Thus, the Lakeshore Nature Preserve presents an opportunity to understand the diversity of the bird community in the urban landscape and also provide relevant ecological information for the preserve managers in land use and land management decisions. We focused this study on four main questions: a) Which habitat type has greater bird species richness and diversity?; b) What is the pattern of habitat use of the most abundant species (i.e. are they specialists or generalists)?; c) Have species richness and diversity changed between spring 2011 and spring 2012?; and d) Which owl species inhabit the preserve and what are their abundance?

Methods

Study Area

The Lakeshore Nature Preserve, covering approximately 121 ha (300 acres), is located in northern Madison, Wisconsin along the shore of Lake Mendota (43°4'32"N, 89°25'20"W). The principal natural communities that have remained substantially intact after 160 years of post-European human actions are small patches of forest dominated by species of *Acer spp*, *Prunus spp*, *Quercus spp*, among other (Saiki et al. 2006). Wetlands habitats are highly dominated by Typha spp., as in the case of the University Bay Marsh and Class of 1918 Marsh, and some of the most important and abundant prairie vegetation types are Indian grass (*Sorghastrum nutans*) and big bluestem (*Andropogon gerardii*) in the Biocore prairie. The degradation of many habitats within the Lakeshore Nature Preserve, in the past, can be attributed to a variety of sources, including historic land use and management, runoff from surrounding urban developments, and the proliferation of invasive, non-native species. This last factor is a major driver of the recent ecological restoration activities (Mertz 2012).

Site selection

We reused eight sites from the 2011 survey (Anhalt *et al.* 2011) and chose another four sites within the Preserve for performing bird counts (Table 1, Fig. 1). We chose to include the additional sites to account for an urban habitat type and to expand the coverage of monitoring across the Preserve area by selecting new points across the bike path and Muir Wood's that were not accounted for in the 2011 study. All sites were at least 250 meters apart to avoid double counting species between sites.

Bird data collection methods

Morning Survey

We conducted morning bird surveys on April 16, 23, and 30, 2012 between 6:30 am and 9 am. With the assistance of seven undergraduate field assistants, we surveyed all twelve sites on each date resulting in a total of 36 point counts. Point counts are a commonly used technique for monitoring bird species in an area because counts are efficient and inexpensive (Vergara *et al.* 2010). We conducted each survey simultaneously by three separate groups composed of two to four members (graduate and undergraduate students in ENVIRST 651). At least one member of every group had experience with bird identification, all members used binoculars, and every group used a bird identification guide. We surveyed sites in a different order on each date to address any time-of-day bias at a given site. Prior to surveying, we determined the primary habitat type for each site based on the dominant vegetation community or structure (e.g. open water habitat). We defined five habitat categories: open water, prairie, urban, wetland, and wooded. We only noted birds seen within or flying over the primary habitat at the site; birds seen or heard outside of the primary habitat at the site were not recorded. For example, during the prairie point counts, we did not record species utilizing the neighboring Eagle Heights Community Garden despite the close proximity.

We recorded general weather conditions prior to the start of the survey. Once the group reached the designated site location, the members remained quiet for five minutes to allow birds to adjust to the surveyors' presence. After the adjustment period, we conducted a point count for ten minutes. Group members noted the species of all birds seen or heard as well as the number of each species. We recorded additional bird species seen after the point count concluded or while walking between sites on a separate "walking list". We did not include these data in our quantitative analyses.

Owl survey

We conducted evening owl surveys on April 26 and May 3, 2012 between 7:45 pm and 9:30 pm. One survey was postponed due to heavy rain and poor visibility. We chose three sites spaced approximately 0.8 km apart: Eagle Heights Woods, Bill's Woods, and a location near Picnic Point (Table

1, Fig. 1) following Duncan et al. (2009). We used broadcast calls to survey Eastern Screech Owl (*Otus asio*), Barred Owl (*Strix varia*), Northern Saw-whet Owl (*Aeolus acadicus*) and Great Horned Owl (*Bubo virginianus*). We used broadcasting recordings of calls available from Stokes et al. (1997). We noted individual presence or call response (i.e. return of a call from an owl species in response to the audio-recording) of the four owl species as a proxy for relative abundance (Duncan et al. 2009). We conducted one survey at each site on each date. The survey consisted of one minute of audio play-back followed by one minute of listening for call responses for each species. We waited one minute before starting the play-back to allow owls to adjust to our presence. We use Philips Fidelio SBD7500 Portable Speaker Dock for iPod to play the callings. We randomized the order in which we played calls of the four species at every site.

Data Analysis

a) Which habitat type has greater bird species richness and diversity?

We calculated richness by habitat as the average of the total number of species at each point count within the particular habitat. The Shapiro-Wilk normality test and Bartlett's test for homogeneity of variances determined that parametric tests would be appropriate for these data. We analyzed the differences in richness between habitat types by conducting Welch's t-tests for each pairing of habitat types. For these and all following analyses, we considered P-values less than 0.05 significant.

We calculated diversity for each point count using the Gini-Simpson Diversity Index equation: $D= 1- [(p_i^2)]$, where p_i is the proportional abundance of species *i* relative to the total abundance of all species at that site and date. A larger value indicates higher diversity. We chose this diversity index because it allows for comparisons between sites that have different species richness. We calculated the diversity value for each habitat as the average of diversity values among point counts within that habitat. The Shapiro-Wilk normality test determined that non-parametric tests would be necessary for these data. To compare differences in diversity we conducted a Kruskal-Wallis test over all habitats followed by Kruskal-Wallis tests for each pairing of habitat types.

b) What is the pattern of habitat use of the most abundant species (i.e. are they specialists or generalists)?

A general way to quantify specialization is to count the number of habitat types in which a given species is known to be present (we termed it as the Habitat Use Index). This measure allows the ordering of species from specialists (occurring in few habitat classes) to generalists (occurring in many habitat classes) (Julliard et al. 2006). Therefore, because some species can use a wide variety of habitat but may be particularly more abundant in certain ones, it is important to take in to account the variation of abundance across habitats (Julliard et al. 2006). Thus we quantified the degree of habitat specialization as the variance of relative abundance among the five habitat classes. We used both index, Habitat Use Index and relative abundances by habitat, to characterize the degree of specialization for the five most abundant species (species with highest average for abundance across all point counts) that we identified in the Lakeshore Nature Preserve (Ring-necked Duck, Red-winged Blackbird, American Coot, Canada Goose and Mallard). We focus on the most abundant bird because we have more data available for these species to test the two different approaches. Furthermore, to conduct more robust statistical analyses we included abundance data of the same species from last year's survey. The Shapiro-Wilk normality test determined that non-parametric tests would be necessary for these data. We conducted a Kruskal-Wallis test to look for differences in Habitat Use Index among species. Then for each species, we compared the relative abundance for each habitat to identify if they were using habitats evenly using the Kruskal-Wallis test.

c) Has species richness and diversity changed between Spring 2011 and Spring 2012?

For each site replicated between 2011 and 2012, we calculated median species richness for that year. Additionally, we calculated Gini-Simpson's Diversity Index for each point count and then calculated the median Diversity Index for each site by year. Last year's data (Anhalt *et al.* 2011) were recalculated with this index in order to make comparisons between years. We used the Mann-Whitney-U test to compare median species richness and median diversity at each site between the 2011 and 2012 data. We chose this test due to the small sample size and non-normality of the data.

Results

We observed 57 species including five species observed while walking between sites and two owl species. The most abundant species were Ring-necked Ducks, Red-winged Blackbirds and American

Coots, with average abundances of 10.5, 9.2 and 5.9 respectively. When we compared mean richness per point count we found that the urban site presented higher richness than the other habitats (Fig. 2, Table 3, Welch t-test $p < 0.05$). Comparison among habitat diversity indices showed that the highest diversity value was reached by urban habitat and differed from all the other types (Fig. 3, Table 4, Kruskal-Wallis $p < 0.05$).

Habitat Use Index achieved its highest value for Red-winged Blackbirds and the lowest value for Ring-necked Ducks (Fig. 4, Table 5, Kruskal-Wallis $p < 0.05$). The first species is able to use four of the five defined types of habitat. By contrast, Ring-necked Ducks were found only in one habitat (Fig. 4). When we analyzed individual pattern of habitat use based on relative abundance by habitat, we found variation in the degree of use of habitat by each species (Fig. 5, Table 6).

The median species richness ranged from 10 to 19 in 2011 and from 3 to 9 in 2012. We found all sites to have higher median species richness in 2011 than in 2012 (Fig. 6). However, none of the values were significantly different between years (Table 7). In 2011, the sites with the highest species richness were Picnic Point, Eagle Heights Woods and Picnic Point Marsh while Old Field, Class of 1918 Marsh, and University Bay had the lowest values for species richness. In 2012, Frautschi Point, Picnic Point Marsh, and Old Field had the highest values for species richness while Picnic Point, Class of 1918 Marsh, and Biocore Prairie had the lowest values for species richness.

The median diversity ranged from 0.717 to 0.898 per point count in 2011 and from 0.503 to 0.787 in 2012. As with species richness, all sites had a higher diversity in 2011 than in 2012 (Fig. 7). However, none of these differences were significant either (Table 7). Some p-values were 1 indicating that the medians were identical. University Bay, Picnic Point and Picnic Point Marsh had the highest diversity values in 2011 while Eagle Heights Woods, Biocore Prairie and Point had the lowest.

During the first owl survey, we observed one Barred Owl in Eagle Height Woods that flew in close to the survey team. During the second survey, we heard the call response for one Northern Saw-whet Owl at Picnic Point.

Discussion

Urban habitat presented the highest average richness and diversity despite being a highly modified area with high degrees of habitat conversion. Perhaps by providing structural features that are necessary for birds to find food, nesting sites, and shelter (such as tree canopy, shrubs, bird feeders, and open spaces), the urban habitat type can support many species, including top predators. It is interesting to note that during our survey in Eagle Heights Housing, we observed a predator-prey interaction between a Cooper's Hawk and a House Sparrow. Both species are synanthropic birds (species associated with human activity). This observation led us to think that the House Sparrow may perceive a lower risk of predation in an urban setting and the Cooper's Hawk may perceive the urban setting as an easier hunting ground. Moreover, Donnelly and Marzluff (2004) have shown that the number of synanthropic birds increases when a preserve is surrounded by more than 40% of urban cover. The Preserve is located in the middle of one of the biggest cities in the state of Wisconsin. Despite the undeveloped portion of the Preserve and other protected areas nearby (e.g. UW Arboretum) and the presence of Mendota Lake, another habitat feature for birds, the Preserve is in an urban landscape. Because of this it is possible that the bird community in the Preserve is mostly composed of synanthropic birds. We suggest that future studies could analyze the proportion of synanthropics versus restricted native species (species that only occur in large patches of native forest or wetlands with lower human impacts) in the Preserve.

Moreover, we found that the highest average abundances were reached in prairie, open water and wetland habitat types (Table 2). The only area with prairie habitat among the preserve is the Biocore Prairie. This site is an ongoing project for prairies restoration. The most abundant bird there was the Red-winged Blackbird. We suspect that because the prairie was not growing during our survey, there was a lower diversity of microhabitats and food resources to support a more diverse bird community. An interesting question for future studies could be to analyze how the community at the Biocore Prairie varies during the year in relation to plant growth and phenology. These types of questions can lead to the identification of key plant species that provide nest, food and/or shelter to birds, and so can be included in future restoration efforts to enhance bird diversity. Two sites were considered as open water types of habitat, Picnic Point and Willow Creek. Interestingly, the Willow Creek site presented higher abundance

than Picnic Point. Possibly, the inputs of nutrients coming from the runoff water that flows to the lake at this site is increasing the abundance of food resources for the bird community. We surveyed three wetland sites: Class of 1918 Marsh, University Bay and Picnic Point Marsh. Particularly, wetlands appear to be very vulnerable to the formation of invasive monotypes, because they tend to collect water, sediment and nutrients, and many invasive plants can take advantage of those conditions (Zedler and Kercher 2004). We have evidence that at Picnic Point Marsh and Class of 1918 Marsh invasive species already have colonized and are displacing native plants species (personal observation). Extreme changes in native plant community can lead to a reduction in local biodiversity and change ecosystem functions (D'Antonio and Chambers 2006). Because of this, we recommend to the Preserve managers to consider restoration strategies on these wetland areas to enhance and recover native plant species. We suspect that the recovery of plant species richness can provide a wide variety of sources for the bird community and potentially increase bird species richness and abundance.

The Red-winged Blackbird appears to be the most generalist among the abundant species based on the Habitat Use Index (Fig. 4). However, it was not evenly distributed among habitats, rather it was most abundant in prairies and wetlands, compared to wooded and open water. Interestingly, species such as the Mallard and Canada Goose present a more even distribution of abundance across types of habitat, based on our statistical results, suggesting that those species were more generalist than the Red-winged Blackbird (Fig. 5). This contradictory finding among both methods suggest that it is important to use the relative abundance as a proxy of the specialization level of bird species, because this method will provide the number of types of habitat and also the distribution of the abundances across them. Future studies using these indices can focus on other groups of species such as forest specialists or prairie species. We also suggest using year-round and year-to-year data to increase the accuracy of analyses.

There are several possible reasons why species richness and diversity were higher for all sites in 2011 in comparison to 2012. First, the 2011 survey teams recorded all birds within a 150 meter radius of each site. In 2012 we only recorded birds in a single designated habitat at each site. By surveying a wider area and variety of habitats at each site, the 2011 survey likely recorded more species and larger total

number of individuals. Second, variation in weather conditions among years could affect bird abundance (Cotgreave 1995). General climatic conditions were especially different during the winter of 2011-2012 compared to the typical winter in Madison. Winter presented above normal average temperatures, and precipitation and snowfall were below normal (ALMANAC 2012). As a result spring started earlier, which also accelerated the arrival for some migrant birds around Madison (Korducki 2012). However, during our survey, weather conditions were not optimal. The first day was cool with slight rain and wind, the second day was clear, but chilly, and the third day was foggy. These conditions may have reduced our visibility and may have reduced bird activities even when migrant species were already known to have arrived in the area.

Two questions drove us to conduct the owl survey: 1) Which owl species inhabit the Preserve ? and 2) What is their abundance? We referred to the checklist of birds in the Lakeshore Nature Preserve and focused on four owl species: Eastern Screech Owl, Barred Owl, Northern Saw-whet Owl and Great Horned Owl. We only noted the presence of two of these species: the Barred Owl and the Northern Saw-whet Owl. We used one minute of audio playback of the call of each species, and stayed at the point for approximately 9 minutes total. Other studies use longer periods for playback surveys (e.g., 20 minutes, Singleton et al. 2010). We suspect that a larger period for surveying might increase the likelihood of hearing a response call, thus we suggest that future studies increase the number of playbacks for each species and stay longer at each site. In addition, the small number of these encounters does not allow us to calculate relative abundances or densities for the species, however we expect that more replicates would allow this type of survey to provide the data set to make such estimations. Despite this, it is important to discuss possible explanations for the owl community structure that can lead to future works. Owls are essentially territorial species that need large patches of forest (Mazur and James 2000). The Barred Owl, for example, has a home-range size that varies from 300 to 1000 ha, depending on breeding or non-breeding behavior (Singleton et al. 2010, Mazur et al. 1998). Winton and Leslie (2004) estimate density for the Barred Owl is one pair per 105-165 ha. Because the Preserve has an area of 121 ha, total, these existing data suggest that the Barred Owl found during this survey might be using other patches of forest

in the surrounding urban area. Furthermore, is possible to suspect that no more than one pair of owl of this species could be supported by the Preserve.

It is important also to take into account some limitations in our data. First, different groups of students vary in their ability to identify birds in the field and this may have led to the discrepancy in our results. To some degree, this limitation will repeat every year because it is not possible to assure that all the students in the class will have long-term experience identifying Wisconsin birds. We believe the 2011 group had more experience identifying birds both by sight and call than did the 2012 team. This difference may have affected our counts of rare bird species more so than that of common species. Second, the small size of our database limits our ability to estimate change through time. Thus it is important to continue to support this student initiative in order to provide repeated samples across time. We suggest a record of at least five years of data for a more reliable trend analysis. Third, there is also the issue of sample size. Only three replications provide little confidence in averages and demand mostly non-parametric statistical tests. A larger sample would have opened opportunities for multivariate tests.

Ultimately, for long-term monitoring it is important to identify the differences between the methods used by last year's study and this year's study. Because the point count method used in 2011 does not exclude any birds observed at a site, it likely produced more accurate abundance, richness, and diversity data within the Preserve as a whole. This approach, however, does not allow a by-habitat-type analysis because more than one type of habitat may exist at any given site. Another important issue to consider in the future if this method is used is that the selection of the point count sites should be random across the Preserve. This strategy may reduce any bias toward particular types of vegetation. On the other hand, to do a by-habitat-type analysis, as was the aim in this study, sites must be chosen within target habitat types and the point count must be focused on birds only *within* that habitat. The Lakeshore Nature Preserve has identified clear management units based on vegetation community types and its spatial distribution (e.g., Biocore Prairie, Class of 1918 Marsh) (Saiki et al. 2006). Due to this, we suspect that a methodology that allows characterizations and comparisons of bird communities by habitat types will provide better information for management decisions.

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TABLE 1. Point counts names, habitat types and UTM coordinates (Datum WGS84, HUSO 16).

		UTM Coordinates	
Point Location Name	*Habitat Type*	X	Y
University Bay Marsh	Wetland	302428	4773093
Class of 1918 Marsh	Wetland	302031	4772960
Picnic Point	Open Water	303424	4773618
Picnic Point Marsh	Wetland	302833	4773351
Bill's Woods	Wooded	302549	4773392
Biocore Prairie	Prairie	302205	4773191
Forest near Old Field	Wooded	302443	4773440
Frautschi Point	Wooded	302026	4773849
E.H Housing	Urban	301746	4773494
Eagle Heights Woods	Wooded	301118	4773357
Willow Creek	Open Water	302902	4772341
Muir Woods	Wooded	304327	4772147
Bill's Woods (Owl survey)	Wooded	302233	4773210
Picnic Point (Owl survey)	Wooded	303006	4773295
Eagle Heights Woods (Owl survey)	Wooded	301113	4773352

			Average abundance by habitat type				
Family	**Species**	**Common Name**	Open Water	Prairie	Urban	Wetland	Wooded
Columbidae							
	Columba livia	Rock Pigeon			x		
	Zenaida macroura	Mourning Dove		x	x	x	x
Corvidae							
	Corvus brachyrhynchos	American Crow	x	x		x	x
	Cyanocitta cristata	Blue Jay		x	x		x
Emberizidae							
	Junco hyemalis	Dark-eyed Junco			x		
	Melospiza georgiana	Swamp Sparrow			x		
	Melospiza melodia	Song Sparrow		x		x	
	Spizella passerina	Chipping Sparrow			x		
	Spizella pusilla	Field Sparrow		x			
	Zonotrichia albicollis	White-throated Sparrow*					
Fringillidae							
	Carduelis tritis	American Goldfinch		x	x	x	x
	Carpodacus mexicanus	House Finch			x		
Gaviidae							
	Gavia immer	Common Loon	x				
Gruidae							
	Grus canadensis	Sandhill Crane			x	x	x

			Average abundance by habitat type				
Family	**Species**	**Common Name**	Open Water	Prairie	Urban	Wetland	Wooded
Hirundinidae							
	Hirundo rustica	Barn Swallow	x				
	Tachycineta bicolor	Tree Swallow	x	x	x	x	
Icteridae							
	Agelaius phoeniceus	Red-winged Blackbird	x	x	x	x	x
	Euphagus carolinus	Rusty Blackbird				x	
	Molothrus ater	Brown-headed Cowbird		x	x		x
	Quiscalus quiscula	Common Grackle				x	x
Laridae							
	Larus delawarensis	Ring-billed Gull	x			x	x
	Larus smithsonianus	Herring Gull	x	x			
Mimidae							
	Toxostoma rufum	Brown Thrasher*					
Paridae							
	Poecile atricapillus	Black-capped Chickadee	x		x	x	x
Parulidae							
	Dendroica pinus	Pine Warbler					x
	Setophaga coronata	Yellow-rumped Warbler				x	x

TABLE 2 continued.

			Average abundance by habitat type				
Family	**Species**	**Common Name**	Open Water	Prairie	Urban	Wetland	Wooded
Passeridae							
	Passer domesticus	House Sparrow			x		
Picidae							
	Colaptes auratus	Northern Flicker					x
	Melanerpes carolinus	Red-belleid Woodpecker		x	x		x
	Picoides pubescens	Downy Woodpecker					x
	Picoides villosus	Hairy Woodpecker					x
	Sphyrapicus varius	Yellow-bellied Sapsucker				x	
Podicipedidae							
	Podiceps auritus	Horned Grebe	x				
Rallidae							
	Fulica Americana	American Coot	x			x	
	Porzana carolina	Sora				x	
Scolopacidae							
	Actitis macularius	Spotted Sandpiper	x				
	Calidris minutilla	Least Sandpiper				x	
Sittidae							
	Sitta carolinensis	White-				x	

			Average abundance by habitat type				
Family	**Species**	**Common Name**	Open Water	Prairie	Urban	Wetland	Wooded
		breasted Nuthatch					
Sturnidae							
	Sturnus vulgari	European Starling*					
Turdidae							
	Sialia sialis	Eastern Bluebird					x
	Turdus migratorius	American Robin		x	x	x	x
Tytonidae							
	Strix varia	Barred Owl**					
	Aegolius acadius	Northern Saw-whet Owl**					
Vireonidae							
	Vireo gilvus	Warbling Vireo*					
Total number of species			19	14	18	23	23
Average of species/point count			8	8	10	7	6
Average of abundance/point count			32.8	43.3	19.3	28.1	11.0

* Species observed during walking between point counts.

** Species observed during owl survey.

TABLE 3. T-values and p-values for Welch two sample t-test used to compare richness by habitat type. We considered p-values less than 0.05 to be significant.

Habitat	Prairie		Urban		Wetland		Wooded	
	t-value	p-value	t-value	p-value	t-value	p-value	t-value	p-value
Open water	-0.3503	0.0752	-3.3806	0.0128	0.8116	0.4317	1.573	0.1331
Prairie			-1.1142	0.3745	0.798	0.4841	1.2654	0.2881
Urban					3.9768	0.0027	4.5147	0.0004
Wetland							0.7765	0.4459

TABLE 4. Chi-square values and p-values for Kruskal-Wallis test used to compare diversity by habitat type. We considered p-values less than 0.05 to be significant.

Habitat	Prairie		Urban		Wetland		Wooded	
	chi^2	p-value	chi^2	p-value	chi^2	p-value	chi^2	p-value
Open water	5.4	0.0201	4.2667	0.0389	8.6806	0.0032	1.9636	0.1611
Prairie			3.8571	0.0495	3.0855	0.0790	3.3719	0.0663
Urban					6.2308	0.0126	4.2982	0.0382
Wetland							0.2569	0.6123

TABLE 5. Chi-square values and p-values for Kruskal-Wallis test used to compare Habitat Use Index between species. We considered p-values less than 0.05 to be significant.

	Canada Goose		*Mallard*		*Red-winged Blackbird*		*Ring-necked Duck*	
	chi^2	p-value	chi^2	p-value	chi^2	p-value	chi^2	p-value
American Coot	0.6111	0.4344	0.3352	0.5626	8.5161	0.0035	7.7631	0.0053
Canada			0.0277	0.8679	8.5161	0.0035	8.1667	0.0043

Goose								
Mallard					4.7394	0.0295	6.044	0.0140
Red-winged Blackbird							8.5161	0.0035

TABLE 6. Chi-square values and p-values Kruskal-Wallis test used to compare relative abundance between habitats for each species. We considered p-values less than 0.05 to be significant.

	Prairie		Urban		Wetland		Wooded	
	chi^2	p-value	chi^2	p-value	chi^2	p-value	chi^2	p-value
American Coot								
Open water	5.2277	0.0222	2.88	0.0897	0.2316	0.6304	5.2277	0.0222
Prairie			-	-	9.4661	0.0021	-	-
Urban					5.5862	0.0181	-	-
Wetland							9.4661	0.0020
Canada Goose								
Open water	5.2277	0.0222	2.88	0.0897	2.0842	0.1488	3.858	0.0495
Prairie			-	-	9.4661	0.0021	1	0.3173
Urban					5.5862	0.0181	0.5	0.4795
Wetland							8.9323	0.0028
Mallard								

Open water	1.1478	0.284	1.9059	0.1674	0.24	0.6242	0.5916	0.4418
Prairie			1.125	0.2888	5.4035	0.0201	0.2001	0.6546
Urban					4.0909	0.0431	1.9059	0.1674
Wetland							4.8424	0.0278
Red-winged Blackbird								
Open water	7.5154	0.0061	1.9059	0.1674	8.4255	0.0037	0.0066	0.935
Prairie			5.5862	0.0181	0.641	0.4233	7.4103	0.0065
Urban					5.5862	0.0181	4.0909	0.0431
Wetland							8.3077	0.0040
Ring-necked Duck								
Open water	-	-	-	-	5.5	0.0190	-	-
Prairie			-	-	5.5	0.0190	-	-
Urban					-	-	-	-
Wetland							5.5	0.0190

TABLE 7. P-values and statistic for point wise comparison between 2011 and 2012 for species richness and diversity. We calculated values using a Mann-Whitney-U test. We considered any p-values less than 0.05 to be significant.

	Richness		Diversity	
	p-value	U-value	p-value	U-value
University Bay	0.0722	0	1	4
Picnic Point	0.7	3	1	5
Picnic Point Marsh	0.0722	0	0.1	0
Forest near Old Field	0.0765	0	0.1	0
1918 Marsh	0.1	0	0.1	0
Biocore	0.1	0	0.1	0
Frautschi Point	0.1	0	0.1	0
Eagle Heights Woods	0.6531	3	0.4	2

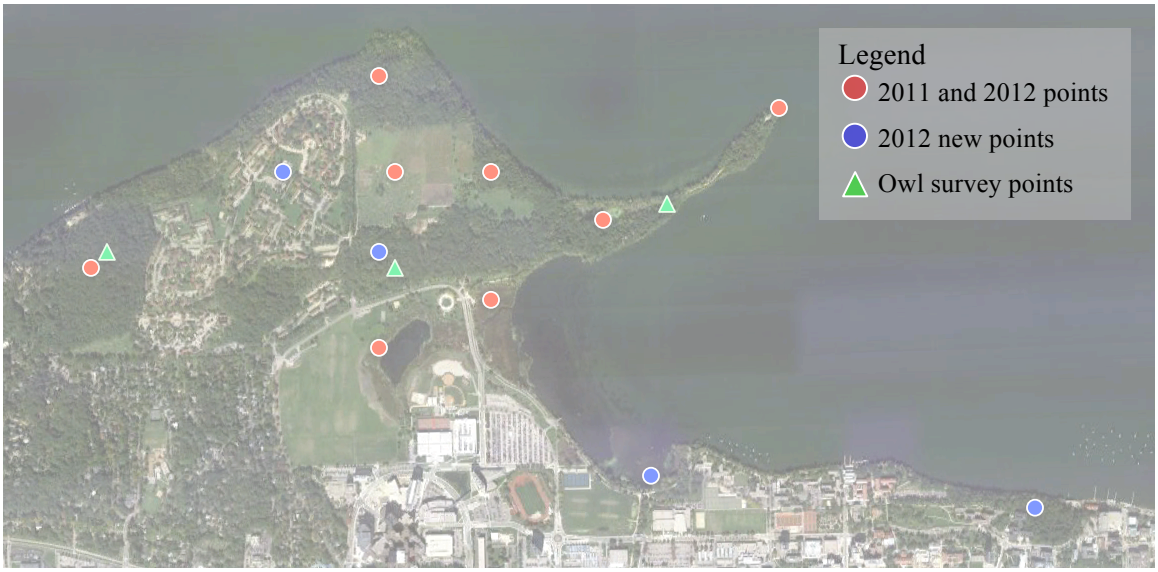

Figure 1. Point counts locations in the study area.

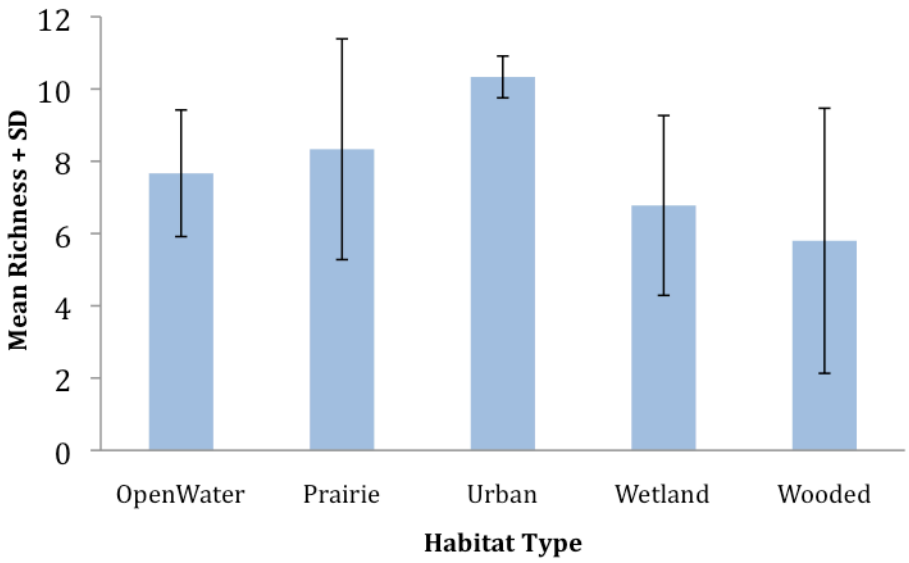

Figure 2. Mean richness comparison among habitats. See Table 3 for t-values and p-values.

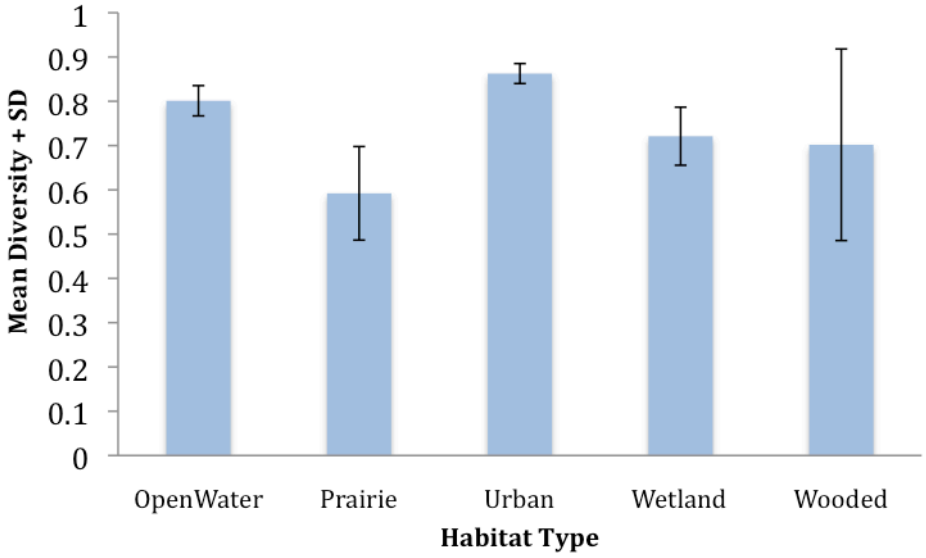

Figure 3. Gini-Simpson Diversity index comparison among habitat. See Table 4 for chi-square and p-values.

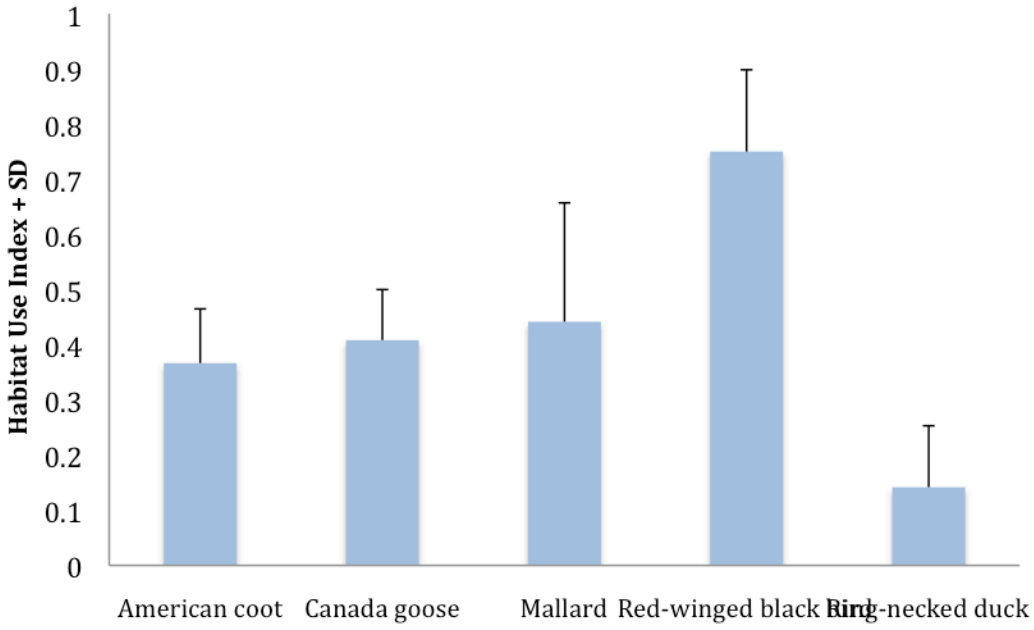

Figure 4. Comparison of Habitat Use Index among the five most abundant species. See Table 5 for chi-square and p-values.

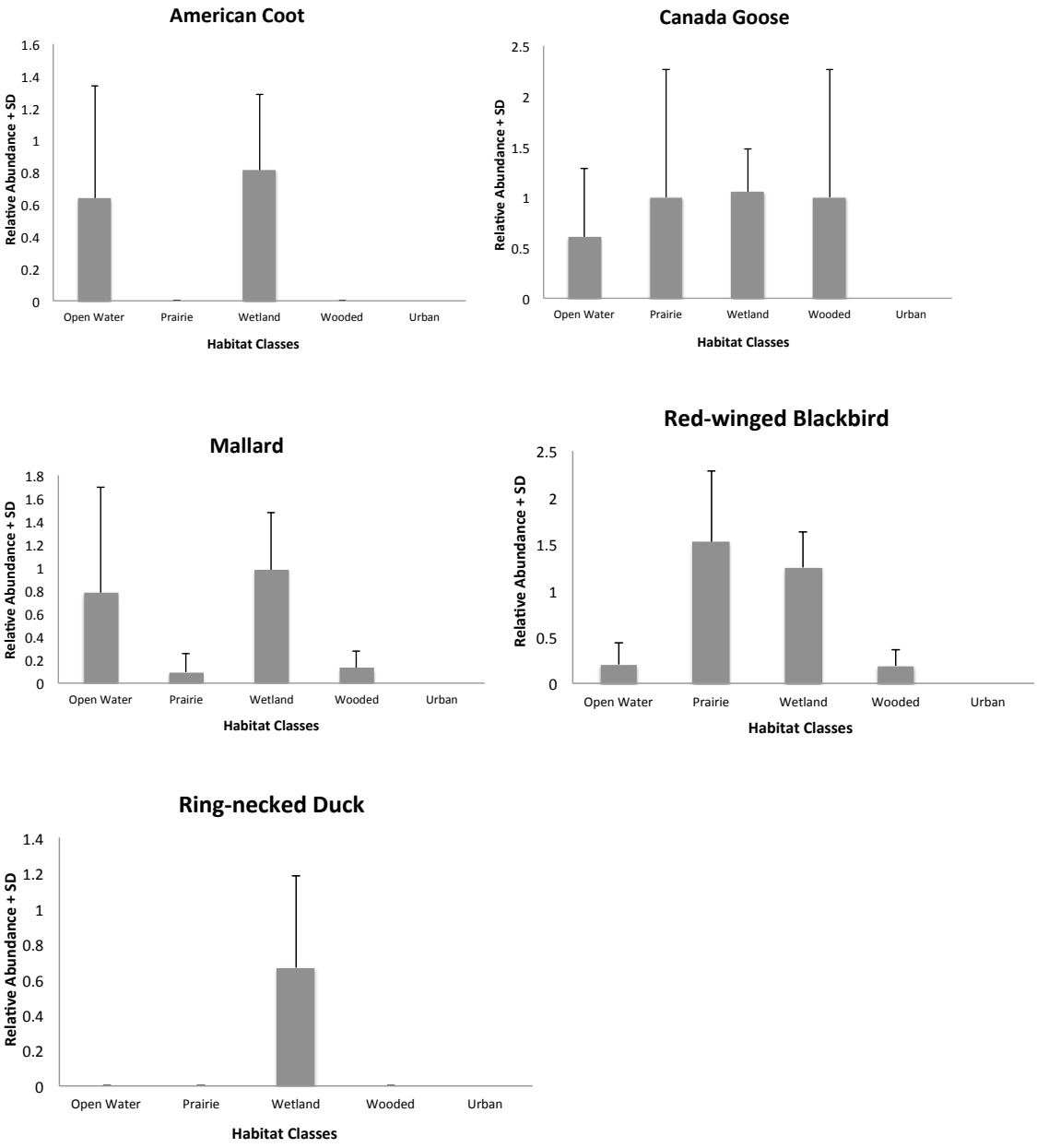

Figure 5. Relative abundance across habitat for the five most abundant species.

See Table 6 for Chi-square and p-values.

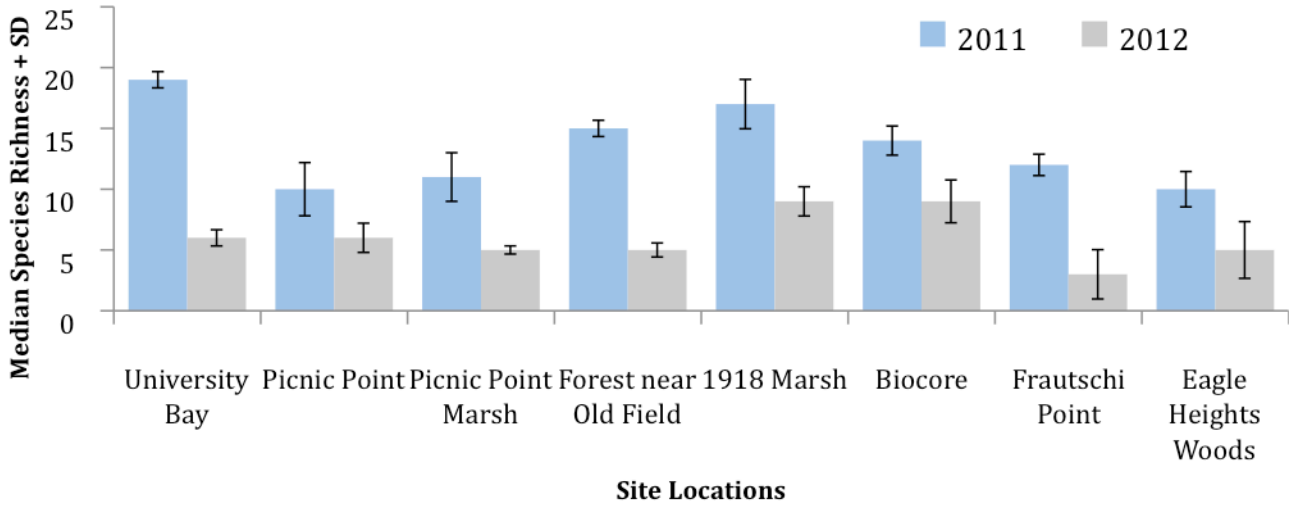

Figure 6. Median avian species richness compared between 2011 and 2012 across 8 different locations on the Lakeshore Nature Preserve.

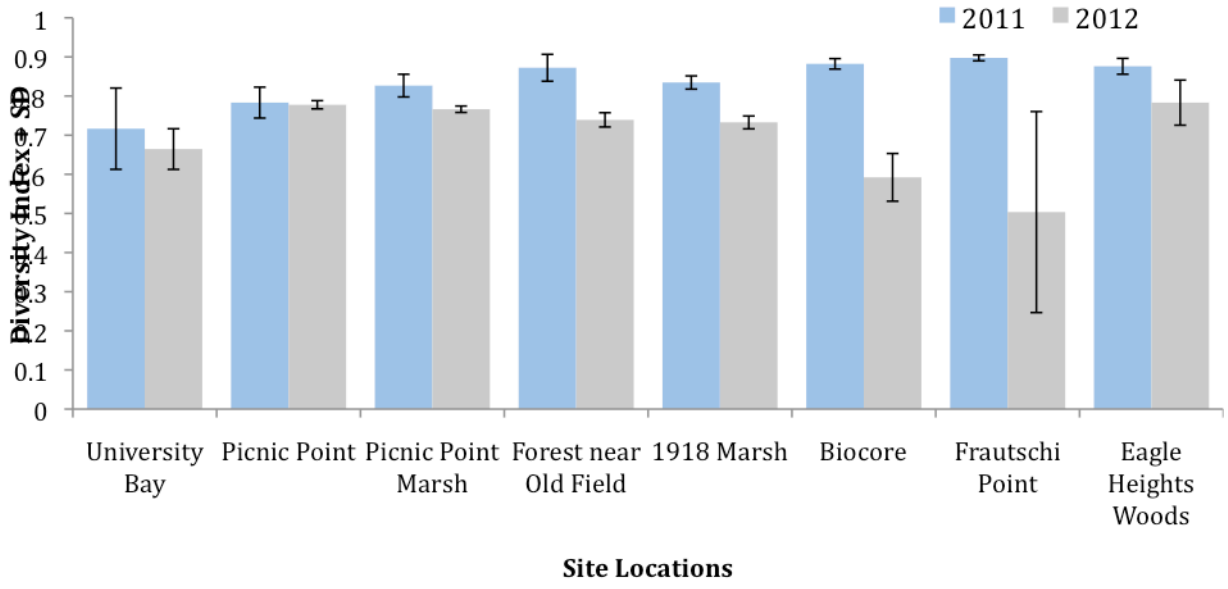

Figure 7. Median avian species diversity compared between 2011 and 2012 across 8 different locations on the Lakeshore Nature Preserve.