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Wildlife Habitat Management on College and University Campuses

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With the increasing involvement of higher education institutions in sustainability movements, it remains unclear to what extent college and university campuses address wildlife habitat. Many campuses encompass significant areas of green space with potential to support diverse wildlife taxa. However, sustainability rating systems generally emphasize efforts like recycling and energy conservation over green landscaping and grounds maintenance. We sought to examine the types of wildlife habitat projects occurring at schools across the United States and whether or not factors like school type (public or private), size (number of students), urban vs. rural setting, and funding played roles in the implementation of such initiatives. Using case studies compiled by the National Wildlife Federation's Campus Ecology program, we documented wildlife habitat-related projects at 60 campuses. Ten management actions derived from nationwide guidelines were used to describe the projects carried out by these institutions, and we recorded data about cost, funding, and outreach and education methods. We explored potential relationships among management actions and with school characteristics. We extracted themes in project types, along with challenges and responses to those challenges. Native plant species selection and sustainable lawn maintenance and landscaping were the most common management actions among the 60 campuses. According to the case studies we examined, we found that factors like school type, size, and location did not affect the engagement of a campus in wildlife habitat initiatives, nor did they influence the project expenditures or funding received by a campus. Our results suggest that many wildlife habitat initiatives are feasible for higher education institutions and may be successfully implemented at relatively low costs through simple, but deliberate management actions.

Keywords

Acknowledgements

INTRODUCTION

During the last 25 years, sustainability in higher education has received increased attention on college campuses. The first large-scale movement ignited in 1990 with the signing of the Talloires Declaration by over 300 university administrators (Alshuwaikhat and Abubakar 2008). In 2000, the U.S. Environmental Protection Agency issued an enforcement alert announcing that it would hold colleges and universities to the same standards as industry to help ensure human and environmental health (Savely et al. 2007). Since then, campus participation in voluntary sustainability programs has increased substantially, and its prominence is reflected in the literature (see Emanuel and Adams 2011, Horhota et al. 2014, Kurland 2011, Lang 2015, Lozano et al. 2013, Velazquez et al. 2005, and Velazquez et al. 2006 for some examples). A 2008 survey conducted by the National Wildlife Federation (NWF), the second in a nationwide series, demonstrated that leaders at most colleges and universities believe environmental or sustainability programs align with the cultures and values of their campuses (McIntosh et al. 2008). Completed by 1,068 campuses across 50 states, the 2008 survey indicated that schools were more committed to environmental sustainability and stewardship than they were in 2001. A comparison of the results of the 2001 and 2008 NWF surveys detailed that approximately 65% of schools have a written commitment to promote these ideals or have plans to develop one, compared to 43% in 2001. The 2008 survey stated that environmental and sustainability programs were no longer secondary to competing priorities, as they were in 2001, although money was still cited as the greatest obstacle to expanding such programs (McIntosh et al. 2008). Similarly, the Association for the Advancement of Sustainability in Higher Education (AASHE) has reported growth in the number of positions and offices within the field of campus sustainability since 2008 (AASHE 2015). Increased university engagement in sustainable development has also been documented (Lozano et al. 2013 and references therein).

While sustainability in higher education (for both academia and operations) is trending upward, consideration for wildlife and wildlife habitat continues to remain a low priority. Many campuses direct their efforts and limited resources towards recycling and energy conservation, leaving other operations like green landscaping and grounds maintenance behind. The Sustainability Tracking, Assessment and Rating System (STARS), developed by AASHE, is a transparent, self-reporting framework for colleges and universities to measure their sustainability performance. The average scores for all STARS rated institutions under STARS 1.0-1.2[1] were 71% in Grounds and 80% in Wildlife Habitat. Although these scores indicated relatively high performance, an understanding of how they are weighted within the larger framework reveals their ranked importance (STARS Dashboard 2015). Of all the subcategories in campus Operations, Grounds yields the least amount of possible points (3.25 total points possible for Grounds, compared to 16.5 points for Climate), and the Wildlife Habitat credit is worth only 0.25 points (STARS Quarterly Review 2012; STARS Technical Manual 2012). Thus, STARS provides little incentive for campuses to build on or improve their wildlife habitat management efforts.

The high Wildlife Habitat ratings in STARS contrast with the results of the NWF survey from 2008, which reported that four in 10 colleges and universities have programs in place aimed at restoring natural habitats, and approximately 39% provide food and shelter to attract wildlife

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[1] An updated version of STARS is currently in use, but the average scores provided on the interactive website are from versions 1.0-1.2.

(McIntosh et al. 2008). While this is a substantial number of campuses, it is far from the majority, and the actual impacts of these programs have not been evaluated. The NWF did note that landscaping with native plants or low-maintenance vegetation was commonplace among campuses, with 72% of schools reporting that they have such a program in place. This was an improvement from 51% in 2001. Integrated Pest Management (IPM), an approach likely to benefit wildlife through reduced use of pesticides, was also a regular component of campus grounds programs and remained consistent at 60% of schools from 2001 to 2008 (McIntosh et al. 2008).

Given the record of developments in sustainability at higher education institutions but limited comprehensive assessments directed at wildlife habitat management, this study sought to determine some of the factors that may be influencing engagement in wildlife-based initiatives. We made use of a nationwide database of self-reported projects from colleges and universities, hosted by the NWF, to examine what kinds of wildlife projects were occurring on campuses relative to available funding and type of school (e.g., public vs. private or large vs. small). Additionally, we explored the challenges campuses described in implementing wildlife-based initiatives and how they were addressed.

METHODS

Campus Case Studies and General Information

The National Wildlife Federation's Campus Ecology program is designed to support sustainability initiatives on college and university campuses. There is no cost to join the network, which is open to students, faculty, staff, and other higher education professionals. Benefits of the Campus Ecology program include access to resources, support, and opportunities to submit a case study to the NWF database. Campuses may apply for funding from the NWF through fellowships offered by the program.

Using the online search tool available through the Campus Ecology program's case study database, we searched for all case studies in the U.S. pertaining to the topic "habitat," which was one of 18 specified case study topics (NWF 2015); none of the other 18 topics were related to wildlife or wildlife habitat. This generated a list of 72 case studies across 60 different schools. We recorded basic data about each campus using information provided by the case studies and on school websites. These included school type (public, private, or community college) and size (i.e., number of students). In some case studies, the total number of students reported was undergraduates only. When the number of students on campus was not provided by the case study, an internet search on the school's website provided the information. We also ascribed a census classification to each campus using terminology derived from the U.S. Census Bureau's urban-rural classification system: urban area (50,000 or more people), urban cluster (at least 2,500 and less than 50,000 people), or rural (not included within an urban area) (U.S. Census Bureau 2015). For each campus, this census designation was determined by the population size of the city in which the campus was located. These values were established using a simple internet search.

Habitat Management Criteria

Ten criteria were used to create a list of management actions that could be completed by each campus. Campus projects were coded for analysis using binary data (one for yes and zero for no) to identify which management actions were completed (or not). We chose the following criteria based on requirements outlined by the organization's Certified Wildlife Habitat program, with additional details in *The Campus Wild* (Jones et al. 2015). The following four criteria summarize the basic necessities for wildlife habitat, as outlined by the certification program: food sources, water sources, cover, and places to raise young. The fifth component needed for certification through the program pertains to sustainable gardening practices.

The NWF's sustainable gardening category includes multiple facets of wildlife habitat: "soil and water conservation, controlling invasive exotic species and eliminating or reducing chemical use" (Jones et al. 2015). Thus, we replaced it with a finer level of categorization, using five criteria derived from the Indiana Wildlife Federation's *Landscaping the Sustainable Campus* program: sustainable lawn maintenance and landscaping; pesticide/herbicide use reduction; invasive species eradication; native plant species selection; and water conservation, retention, and recycling. Sustainable lawn maintenance and landscaping is important for wildlife species, as turf-grass lawns are often void of essential resources. Conversion of natural spaces to conventional landscapes also creates disturbance, providing opportunities for nonnative, invasive species that may compete with native wildlife and further alter surrounding natural habitats (Mooney and Cleland 2011; Shochat et al. 2010; Vitousek et al. 1997). Sustainable lawn maintenance and landscaping efforts include proper fertilization plans, as well as re-landscaping and the use of turf-grass alternatives. Pesticide and herbicides are typically used to control undesirable species, like those that are invasive, but these too pose problems; contamination from pesticide and herbicide use can adversely affect wildlife health (Taylor et al. 2006; Stark et al. 2012; Köhler and Triebskorn 2013; Mahmood et al. 2016). Native plant species play a key role in maintaining biodiversity, providing food, shelter, and habitat for prey and specialist wildlife species (Burghardt et al. 2008; Tallamy and Shropshire 2009). Conscientious choices in areas like plant selection and habitat structure can help mitigate issues with stormwater runoff and erosion, enhancing the conservation, retention, and recycling of water in a landscape (Indiana Wildlife Federation 2015).

Finally, since many case studies reported efforts to mitigate climate change in their projects, we included whether a campus directly addressed the topic. For example, some case studies mentioned creating carbon sinks (where more carbon is absorbed rather than released) as part of campus projects. While this database does not provide a comprehensive examination of campus climate change initiatives, we included climate change in our analysis because it is a major component of the NWF's sustainability efforts, and its inclusion facilitates an exploration of potential synergies between projects oriented towards wildlife habitat and climate change.

Cost, Funding, Outreach and Education

We extracted information on costs, grant or other funding support, and outreach and education activities directly from the case studies. Cost was divided into two types: (1) materials and supplies and (2) labor or other. We recorded whether any funding as financial aid or donations was provided outside of the NWF program. Cost and funding amounts were based solely on

numbers provided by each campus case study; hence, if a campus spent money or received funding but did not detail how much, the cost or funding amount was treated as missing data.

We recorded whether the recipients of outreach and education included the campus, the off-campus community, or both. Two types of education and outreach were also recorded. The "press" type encompassed outreach and education methods achieved through published or posted information, such as flyers or email. The "meet" type referred to any interpersonal outreach and education, including presentations, demonstrations, and workshops.

Statistical Analyses

We aggregated data on management actions across case studies for schools with multiple submissions to the Campus Ecology case study database (eight campuses). We conducted Spearman's correlations to examine which management actions were most commonly performed together. We used linear regressions and Analysis of Variance (ANOVA) to explore potential for factors such as school size and urban context to predict the level of engagement in wildlife-oriented management actions. All statistical analyses were performed in JMP 12 (JMP®, Version 12).

To extract common themes from the qualitative component of our research, author notes used to describe the challenges, responses, and summary of each case study were compiled and processed using word counts. We then counted the number of campuses that mentioned each of the most common themes, as determined by the word counts. This helped us to quantitatively assess the text and establish which projects, challenges, and responses were most common among the campuses.

RESULTS

A total of 72 case studies across 60 different schools were submitted between 1997 and 2012. The most case studies were submitted in 2009 ($n = 10$), followed by 2010 ($n = 9$), and none were submitted during 2007. Of the 60 schools, 28 were private, 24 were public, and 8 were community colleges. Thirty-three of the campuses were located in urban areas, while 25 were located in urban clusters. Only two were found in rural settings.

Based on the defined criteria, 51 campuses completed at least one out of 10 management actions, and nine campuses did not complete any. For some of those nine campuses, projects remained unfinished at the time the case study was submitted, while other projects simply did not meet any of the criteria. Central Piedmont Community College completed the most management actions in 2009, with eight out of 10. The two management actions left uncompleted by the college were pesticide/herbicide use reduction and invasive species eradication. Native plant species selection was the individual management action most strongly correlated with completion of management actions (Spearman rho = 0.56, $P < 0.0001$). Hence, if a campus completed this management action, it was more likely to complete others, as well.

We found that only 3% (two out of 60) of schools completed all four of the basic requirements for NWF wildlife habitat certification (i.e., food sources, water sources, cover, and places to raise young). Five percent (three out of 60 schools) completed three of the four requirements, and 13% (eight out of 60) completed one requirement. Of the 13 schools that completed at least one of these requirements, eight provided water sources and places to raise

young. Water sources were typically associated with water conservation, retention, and recycling and most often corresponded with pond/wetland restoration. Places to raise young were most commonly provided by nest boxes. Four campuses provided food sources, and five provided cover (**Table 1**).

We found a significant correlation between campuses that completed one or more of the four basic requirements of NWF wildlife habitat and the total number of management actions completed by each campus (Spearman rho = 0.59, $P < 0.0001$). In other words, completion of the four basic requirements increased the probability of adopting the other management actions. When we excluded the three campuses that completed the most management actions, the relationships among the four NWF requirements were less significant, and there was a slightly weaker correlation between the four NWF requirements and the total number of management actions completed (Spearman rho = 0.49, $P = 0.0001$).

Native plant species selection was the most common management action across all 60 campuses. Over half of the schools (32 out of 60) reported doing some sort of native species planting, while one third (20 out of 60 schools) implemented sustainable lawn maintenance and landscaping. Sustainable lawn maintenance and landscaping was often tied into native plant species selection. Many campuses sought to incorporate native plants as a chief component of sustainable landscaping practices; this occurred at a variety of scales, with some campuses converting to native species landscaping across their grounds, while others installed one or two native species gardens. Water conservation, retention, and recycling (15 out of 60 schools) along with climate change (14 out of 60 schools) followed closely behind (**Table 1**). The most common projects described in the case studies focused on native species gardens/plantings and habitat restoration: 27 mentioned *native species*, 17 mentioned *garden*, and 9 mentioned *restoration*.

Table 1. Number of campuses that completed each management action.

Management Action	Number of Campuses ($N = 60$)
Food sources	4
Water sources	8
Cover	5
Places to raise young	8
Sustainable lawn maintenance & landscaping	20
Pesticide/herbicide use reduction	3
Invasive species eradication	11
Native plant species selection	32
Water conservation, retention, and recycling	15
Climate change	14

A total of 34 campuses provided cost information for their projects, although three did not spend any money. Excluding these three schools, the minimum total cost spent by a campus was $450 ($n = 31$). Total cost includes both cost types: materials and supplies and labor or other. Maximum total cost, spent by Harvard University, was $85,000. The campus put this money towards developing a 25-acre organic landscaping program. A little over half the total cost (approximately $45,000) was spent on an initial investment for equipment. Labor and other costs, including consulting, staff training, and lab analysis, comprised the remaining $40,000. Along with Harvard University, two other campuses were noticeable outliers for total expenditures. Stonehill College spent about $67,000 to install a 5,000 ft^2 green roof atop their new Science Center, while George Mason University invested just over $49,000 for the transplanting of 13 mature trees on campus, which were retained for wildlife habitat. For the average school that provided cost information, excluding all zeros and outliers (i.e., the top three spenders), total cost was approximately $4,500 ($n = 28$). In our analysis, we used cost information from the most recent case study submitted by a campus, rather than costs accrued over multiple years. Unfortunately, the case studies did not consistently or explicitly differentiate between ongoing costs and one-time costs.

Of the 34 campuses that provided cost information, 23 detailed how much they spent on materials and supplies, and 16 described how much they paid for labor or other expenditures. Again, excluding outliers (i.e., the three campuses with the greatest total costs) and zeros, the average cost for materials and supplies for a campus was under $3,300 ($n = 16$), while the average cost for labor or other expenditures was barely $4,900 ($n = 10$). Most schools spent under $2,000 on materials and supplies, compared to a range of $3,000 to $7,000 for the cost of labor or other expenses (**Figure 1**). These two cost categories represent approximately 60% and 72% of total costs, respectively. The different cost types were analyzed separately, since not all campuses spent money or provided information for both types of expenditures. We found no significant difference in expenditures among public, private, and community colleges (ANOVA, $F_{(2,31)} = 0.47$, $P = 0.63$). There was also no significant correlation between school size and total cost (linear regression, $r^2 = 0.0031$, $F_{(1,32)} = 0.098$, $P = 0.76$).
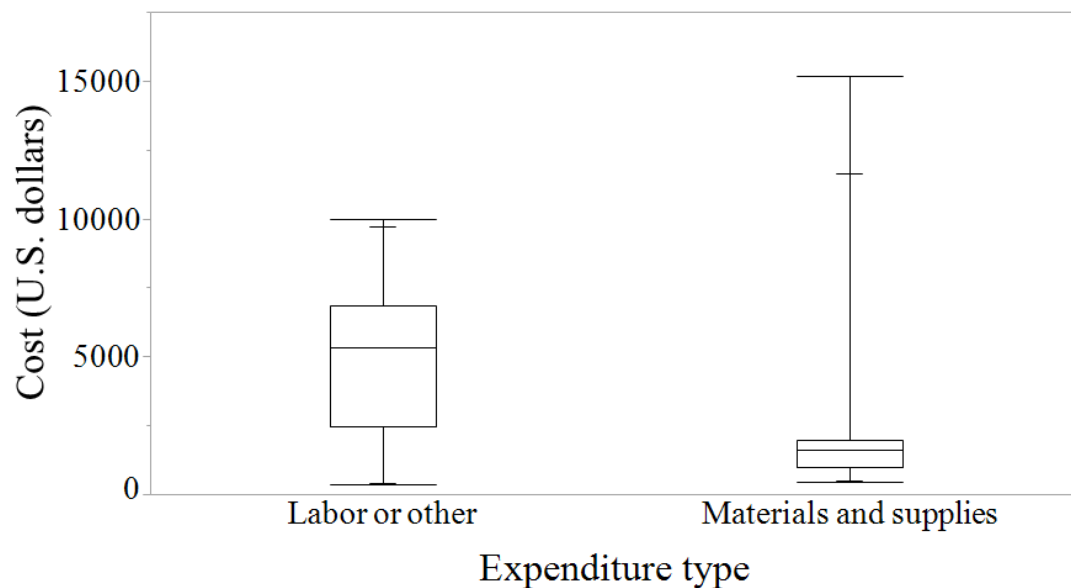
Figure 1. Boxplot representing expenditures (in U.S. dollars) for wildlife habitat projects by 19 different college and university campuses between 1999 and 2012. Costs are separated into two categories, labor or other expenditures ($n = 10$) and materials and supplies ($n = 16$), with some campuses reporting data for only one cost type.

Fifty of the 60 campuses reported receiving or using funding outside of the NWF. Of those, 22 were private schools, 20 were public, and 8 were community colleges. Twenty-seven of the campuses detailed the amounts of non-NWF funds used. The minimum amount of non-NWF funding used by a campus was $100, while the maximum amount, used by George Mason University, was around $49,000. The tree transplanting project at George Mason University, which was the third biggest spender, was funded by money from the school's maintenance reserve budget; the other two outliers for expenditures did not describe how much non-NWF funds they used. The mean amount of non-NWF funding spent by all schools was approximately $6,300. Excluding George Mason University, the average campus spent around $4,600 in non-NWF funds. There was no significant difference in non-NWF funding provided for projects at public, private, and community colleges (ANOVA, $F_{(2,24)} = 0.44$, $P = 0.65$). There was also no significant correlation between school size and the amount of non-NWF funding spent (linear regression, $r^2 = 0.06$, $F_{(1,25)} = 1.60$, $P = 0.22$).

We analyzed each of the 72 case studies, including all years for schools with multiple submissions to the database, to examine the types of outreach and education that were employed. Sixty-one of the case studies involved campus outreach and education, and 50 engaged the off-campus community, illustrating that efforts directed towards campus members, rather than off-campus parties, were more common. Thirty-three schools utilized the press or other media outlets, and 54 connected more actively through meetings or presentations, revealing that interpersonal outreach and education was more common for a school than passive methods.

DISCUSSION

Our results suggest that wildlife habitat management on college and university campuses can be approached with simple, relatively inexpensive management actions that focus primarily on sustainable landscaping practices through native plant species selection. Contrary to our preconceptions, there appears to be little to no bias towards larger, private schools and capacities to implement wildlife habitat initiatives. Differences in school type and size did not affect how much money a campus spent or received, and opportunities for outside (or non-NWF) funding were prevalent among all schools, regardless of campus size or type. It is noteworthy that, while the schools examined here intended to make positive impacts on wildlife habitat, the effectiveness of these management actions for wildlife are not known. Since many efforts focused on demonstration projects and education, there was little to no attempt to measure or monitor wildlife response to management activities.

As anticipated, campuses were faced with a variety of challenges and most discussed their responses to those challenges. Time and funding were the most commonly cited difficulties that inhibited habitat management projects. Some common struggles revolved around semester timelines and student changeover. Frequently, campuses that appeared to complete none of the management actions were restricted by the school year, unable to achieve project goals because they could not finish before the semester's end. Many campuses resolved to adjust future plans by incorporating more research, education, and involvement in the greater community. It is important to mention that the average project (i.e., average in expenditure) was student-run or facilitated by faculty members overseeing academic departments or student groups. The projects backed by school administration spent more compared to the smaller-scale projects reported by students and faculty. For example, the top three outliers for spending were supported by operations and facilities management.

Similar to our observations, previous NWF surveys reported that inadequate funding and staff time were among the most common challenges to expanding environmental and sustainability programs (McIntosh et al. 2008). Concerns about cost-effectiveness, inadequate faculty or staff interest, and inadequate student interest were also cited. The survey suggested that both smaller schools and public schools are more likely to be challenged, which differs from our findings. It is important to recognize, however, that the campuses participating in the NWF Campus Ecology program specifically sought to carry out and document environmental projects, while the 2008 NWF survey analyzed a representative sample of all schools to assess the extent of their involvement in sustainability. The NWF survey also found that schools in the West and Midwest had higher participation rates in sustainable landscaping and grounds programs, differing with the distribution of our case studies, the majority of which were in the eastern U.S. The 2008 NWF survey, by its design, is likely the better gauge of factors influencing the initiation of these projects. However, we argue that the dataset generated by the Campus Ecology program provides evidence that, once initiated, factors like campus size do not necessarily present impediments to successful implementation.

The NWF Campus Ecology program is one of a few similar certification programs that targets colleges and universities, among other organizations. Closest in comparison is Audubon International's Audubon Cooperative Sanctuary Program (ACSP), which provides guidance and information to help businesses and organizations, including higher education institutions, to implement environmental management plans. These plans address outreach and education,

resource management, and water quality and conservation, as well as wildlife and habitat management. While ACSP does feature members' success stories on its website, other facets like project challenges are not readily available. An examination of the available stories indicate that wildlife habitat management efforts inspired by involvement with ACSP align with those demonstrated by campuses participating in the NWF Campus Ecology program. Similar projects include native species plantings and nest box construction, as well as garden design and creation (Audubon International 2015). Other programs include Tree Campus USA and the IPM Star Certification Program. While these do not directly address approaches to wildlife and wildlife habitat management, they touch upon components employed by the NWF and Audubon International, which are more holistic in scope.

Notable Campuses

Three schools stood out above the others in our examination of college campuses, having completed the most management actions. While the majority of campuses achieved one or two of the predetermined criteria, Central Piedmont Community College (CPCC) in Charlotte, North Carolina completed eight of 10 management actions. The remaining uncompleted management actions included pesticide/herbicide use reduction and invasive species eradication. CPCC is a public two-year community college, located in an urban area with over 790,000 people, and features approximately 70,000 students across 6 campuses. The school, which submitted only one case study to Campus Ecology, spent $12,000. This total cost was covered in full by six internal grants (one for every campus), each worth $2,000. The money was used to design and develop wildlife habitat on each of the school's campuses and provide educational opportunities for implementation at home or the workplace. The CPCC campuses directed their efforts towards providing each of the four basic elements of wildlife habitat: food, water, cover, and places to raise young. This was achieved primarily through the use of native plants for low maintenance landscaping. Like other schools, CPCC faced challenges working with multiple entities, budgeting for expenses, recruiting volunteers, and managing time. In response, the campuses focused on "selling" concepts by explaining benefits and being persistent.

Warren Wilson College (WWC) in Asheville, North Carolina followed closely behind, having completed seven of 10 management actions aggregated across three case studies. The three criteria WWC did not meet were food sources, climate change, and water conservation, retention, and recycling. WWC is a private four-year college with only 900 students. Like CPCC, the school is located in an urban area, but the population is much smaller, about 87,000. WWC did receive non-NWF funding but provided no other details about cost or how much funding it received. The college's projects are quite extensive, spanning from sustainable landscaping practices to habitat restoration goals that aim to minimize the school's impacts on the surrounding ecosystem. This objective requires the collective cooperation of the farm, garden, forest and all other wildlife and conservation initiatives on the WWC campus. Challenges faced by the school were reported in only one of the three case studies, which detailed a native grasses project. Lack of knowledge and personnel resources, as well as deficiencies in enthusiasm and involvement, were cited as difficulties encountered at WWC.

The University of South Carolina (USC) in Columbia, South Carolina completed six of 10 management actions, excluding sustainable lawn maintenance and landscaping, pesticide/herbicide use reduction, invasive species eradication, and water conservation, retention, and recycling. USC is a public research university, with both two-year and four-year campuses.

There are more than 26,000 students on the main campus, which is located in an urban area of approximately 130,000 people. Like WWC, USC received non-NWF funding but did not detail how much it received or spent. However, the case study did mention that the school's project was relatively cost-free. This project centered on the restoration of a campus garden intended to promote wildlife habitat and native species. Thus, the scope of the project is less extensive than the other two campuses we examined and might be considered more of a demonstration project. USC still faced some challenges in the implementation of its garden, having to resolve conflicts with the University's master plan about the project site and establish a maintenance regime that would satisfy all of the stakeholders involved.

Although we found no correlation between the total number of actions completed by a campus and its urban-rural classification, it is worth mentioning that all three of the most extensive case studies were from urban areas, albeit in small- to medium-sized cities. It is also important to note that each school type (private, public, and community college) is represented here. Furthermore, both CPCC and USC sought to receive NWF wildlife habitat certification on their campuses. Consequently, the four NWF habitat requirements were met in their case studies, which was uncommon for most schools.

Other Challenges and Missed Opportunities

Aside from funding and time, many of the other challenges reported in the campus case studies involved a general lack of awareness, knowledge, and support. Many schools found it difficult to maintain the interest and involvement of students, faculty, and volunteers. Conflict with administration also arose in some instances. Deficiencies in these aspects of project planning and implementation are typical, and they illustrate the importance of articulating the relevance and significance of such initiatives to garner interest and support.

This concept of "selling" ideas to the general public, particularly university administration, proved to be a hurdle in wildlife habitat efforts and might have caused campuses to miss out on some project opportunities. Ideas that deviated from conventional or traditional practices faced the most resistance. Specifically, we noticed that few, if any, of the case studies directly mentioned a reduction in mowing (and the affiliated reduction in carbon outputs, among other benefits) as a sustainable landscape practice. A proposal such as this could be pitched to university officials as a means of saving money, but in turn, it may sacrifice pay for facilities employees. Similarly, the aesthetics of native plants on campus grounds was cited by a few case studies. Landscape designs with native species can be more cost-effective, since they may require less maintenance and external inputs than lawn areas, but there is a chance they will be considered unattractive (Helfand et al. 2006). In a study that investigated how residents responded to several different suburban landscape treatments, the conventional landscape was most often perceived as attractive and neat, but not natural and requiring high maintenance. While the treatment with the most ecologically complete plant community was generally viewed as natural, it was also perceived as messy and unattractive (Nassauer et al. 2009). Nassauer and her colleagues have developed approaches for making natural landscapes more acceptable, a so-called 'cues to care' approach. Some of the cues she recommends include visible, crisp edges or fences to define patch types within a landscape, trimmed trees and hedges, and sections of mown turf in areas that are most publicly visible (Nassauer 2011). Organizers interested in addressing concerns about native landscaping may benefit from partnering with landscape architecture or urban design programs, either on or off campus.

Outreach and Education

We noticed a considerable breadth in the variation of both campus and community outreach and education. Some projects were known only to the students and faculty members working to complete them, while others involved local elementary schools and in one instance, a church. Many schools sought to recruit volunteers to help with the hands-on aspects of their projects, and most relied on demonstrations and public accessibility to educate their campus and surrounding community.

These types of outreach and education efforts serve as starting points for making considerable changes at higher education institutions, where tradition and administrative regulation may inhibit the reform of conventional practices. Nassauer (1993) found that ecological knowledge makes a difference in peoples' perceptions of the landscape. An understanding of the importance of native species in the environment, combined with the incentive to save money, may inform decision-makers at a college or university, and encourage them to implement ecologically healthy, sustainable landscape designs. After joining Audubon International's ACSP, a golf course in Las Vegas, Nevada converted a 7,500 ft^2 area populated with sheep's fescue into a native plant garden. This low-maintenance garden requires only 10% of the hours that were once needed to maintain the fescue and saves the course approximately half a million gallons of water annually (Audubon International 2015). Likewise, appealing to the public can be achieved through educational signage explaining the benefits of native species landscaping. These may include increased abundance and diversity of bird and butterfly species, along with reduced chemical input (e.g., fertilizers) to name just a few (Burghardt et al. 2008; Hostetler and Main 2010).

Next Steps, Recommendations, and Conclusions

Given that some of the schools in our database were unable to complete projects but had plans to continue with their initiatives, it would be helpful to have a systematic approach to monitor follow-through. Additionally, the information provided by the case studies alone did not lend itself to comprehensively gauging the success of projects. The utility of the Campus Ecology program database could be greatly extended if it incorporated a mechanism for status reports and project assessments for the participating campuses. Another next step could include analyzing how much money may be saved by converting to more sustainable practices, especially in areas such as landscape maintenance and water conservation. Interestingly, none of the schools addressed nuisance wildlife or health and safety concerns in attracting wildlife to their campuses. It would be valuable to know if these potential issues were included in discussions alongside the benefits of promoting wildlife. Target wildlife included primarily pollinators and songbirds; butterfly gardens were quite common among the case studies, while nest boxes were provided for native bird species. Additional information about the success of these efforts to attract wildlife would also be helpful.

To ensure that initiatives directly benefit wildlife, efforts to create and improve habitat should provide elements based on functionality and species of interest. This is particularly important given that so few of the campuses from the NWF database specifically outlined goals to provide basic habitat necessities (i.e., food, water, cover, and places to raise young). To overcome the most commonly cited obstacles, time and money, faculty and students should appeal to campus administration for support. Partnerships with other departments, both academic

(e.g., landscape architecture, environmental conservation, etc.) and operational (e.g., facilities, grounds maintenance, etc.), could foster sound ecological decisions, financial backing, and assistance with implementation and maintenance. Many campuses reported receiving donations of seeds, plant material, planting tools, etc. Outreach to local businesses for supplies (e.g., native plant material from local nurseries) could result in mutually beneficial relationships, whereby campuses reduce costs through donations, while their projects promote local products.

Overall, our findings indicate that a variety of wildlife habitat-related initiatives are occurring across higher education institutions in the U.S. The common themes we found among the case studies suggest opportunities for widespread implementation of accessible, cost-effective projects. Anecdotal accounts such as those provided by the NWF's Campus Ecology program offer invaluable information for colleges and universities interested in launching similar initiatives.

LITERATURE CITED

AASHE. 2015. Latest AASHE Publication highlights Continued Growth in Campus Sustainability Staff Positions [Press release]. Retrieved Nov 15, 2015 from http://www.aashe.org/highlights/press-releases/latest-aashe-publication-highlights-continued-growth-campus-sustainability.

Audubon International. 2015. Audubon Cooperative Sanctuary Program. Retrieved Aug 12, 2015 from http://auduboninternational.org/acsp.

Alshuwaikhat, H. M., and I. Abubakar. 2008. An integrated approach to achieving campus sustainability: assessment of the current campus environmental management practices. Journal of Cleaner Production 16:1777–1785.

Burghardt, K. T., D. W. Tallamy, and W. G. Shriver. 2008. Impact of native plants on bird and butterfly biodiversity in suburban landscapes. Conservation Biology 23:219–224.

Emanuel, R., and J. N. Adams. 2011. College students' perceptions of campus sustainability. International Journal of Sustainability in Higher Education 12:79–92.

Helfand, G. E., J. S. Park, J. I. Nassauer, and S. Kosek. 2006. The economics of native plants in residential landscape designs. Landscape and Urban Planning 78:229–240.

Horhota M., J. Asman, J. P. Stratton, A. C. Halfacre. 2014. Identifying behavioral barriers to campus sustainability: A multi-method approach. International Journal of Sustainability in Higher Education 15:343–358.

Hostetler, M. E., and M. B. Main. 2010. Native landscaping vs. exotic landscaping: What should we recommend? Journal of Extension 48(5):5COM1.

Indiana Wildlife Federation. 2015. Landscaping the Sustainable Campus: A guide for adopting a sustainable approach to landscape management on Indiana's universities and colleges. Retrieved May 19, 2015 from http://www.indianawildlife.org/lib/uploads/files/pdfs/Landscaping%20the%20Sustainable%20Campus%20Guide.pdf.

Jones, K., C. Cochran, D. J. Eagan, and J. Goodlaw-Morris. 2015. The campus wild: How college and university green landscapes provide havens for wildlife and "lands-on" experiences for students. Retrieved Nov 22, 2015 from http://www.nwf.org/Campus-Ecology/Resources/Reports/The-Campus-Wild.aspx.

JMP®, Version 12. SAS Institute Inc., Cary, NC, 1989–2007.

Köhler, H. R., and R. Triebskorn. 2013. Wildlife ecotoxicology of pesticides: Can we track effects to the population level and beyond? Science 341:759–765.

Kurland, N. B. 2011. Evolution of a campus sustainability network: a case study in organizational change. International Journal of Sustainability in Higher Education 12:395–429.

Lang, T. 2015. Campus sustainability initiatives and performance: do they correlate? International Journal of Sustainability in Higher Education 16:474–490.

Lozano, R., R. Lukman, F. J. Lozano, D. Huisingh, and W. Lambrechts. 2013. Declarations for sustainability in higher education: becoming better leaders through addressing the university system. Journal of Cleaner Production 48:10–19.

Mahmood, I., S. R. Imadi, K. Shazadi, A. Gul, and K. R. Hakeem. 2016. Effects of pesticides on environment. In Plant, Soil and Microbes: Volume 1: Implications in Crop Science (pp. 253–269). Springer International Publishing. https://doi.org/10.1007/978-3-319-27455-3_13.

McIntosh, M., K. Gaalswyk, J. Keniry, and D. Eagan. 2008. Campus environment 2008: A national report card on sustainability in higher education. National Wildlife Federation. Retrieved May 19, 2015 from https://www.nwf.org/CampusEcology/Resources/Reports/Campus-Report-Card.aspx.

Mooney, H. A., and E. E. Cleland. 2001. The evolutionary impact of invasive species. Proceedings of the National Academy of Sciences 98:5446–5451.

Nassauer, J.I., 1993. Ecological function and the perception of suburban residential landscapes, in: Gobster, P.H. (Ed.), Managing Urban and High-Use Recreation Settings, General Technical Report, USDA Forest Service, North Central Forest Experimental Station, St. Paul, MN, pp. 55–60.

Nassauer, J. I. 2011. Care and stewardship: From home to planet. Landscape and Urban Planning 100:321–323.

Nassauer, J. I., Z. Wang, and E. Dayrell. 2009. What will the neighbors think? Cultural norms and ecological design. Landscape and Urban Planning 92:282–292.

National Wildlife Federation (NWF). 2015. Campus Ecology: NWF Campus Search. Retrieved Feb 11, 2015 from http://www.nwf.org/Campus-Ecology/Campus-Search.aspx.

Savely, S.M., A. I. Carson, and G. L. Delclos. 2007. An environmental management system implementation model for U.S. colleges and universities. Journal of Cleaner Production 15:660–670.

Shochat, E., S. B. Lerman, J. M. Anderies, P. S. Warren, S. H. Faeth, and C. H. Nilon. 2010. Invasion, Competition, and Biodiversity Loss in Urban Ecosystems. Bioscience 60:199–208.

Stark, J. D., X. D. Cheng, and C. S. Johnson. 2012. Effects of herbicides on Behr's metalmark butterfly, a surrogate species for the endangered butterfly, Lange's metalmark. Environmental Pollution 164:24–27.

STARS Dashboard. 2015. STARS Institutions: Average Scores. Retrieved May 19, 2015 from https://stars.aashe.org/institutions/data-displays/pie-chart-visualization/.

STARS Quarterly Review. 2012, Spring. Framing campus sustainability. Retrieved May 19, 2015 from http://www.aashe.org/files/documents/STARS/sqr_spring_2012_final.pdf.

STARS Technical Manual. 2012. STARS Version 1.2 Technical Manual. Retrieved May 19, 2015 from http://www.aashe.org/files/documents/STARS/sqr_spring_2012_final.pdf.

Tallamy, D. W., and K. J. Shropshire. 2009. Ranking Lepidopteran use of native versus introduced plants. Conservation Biology 23:941–947.

Taylor, R. L., B. D. Maxwell, and R. J. Boik. 2006. Indirect effects of herbicides on bird food resources and beneficial arthropods. Agriculture, Ecosystems and Environment 116:157–164.

U.S. Census Bureau. 2015. Urban and Rural Classification. Retrieved Feb 11, 2015 from https://www.census.gov/geo/reference/urban-rural.html.

Velazquez, L., N. Munguia, and M. Sanchez. 2005. Deterring sustainability in higher education institutions: An appraisal of the factors which influence sustainability in higher education institutions. International Journal of Sustainability in Higher Education 6:383–391.

Velazquez, L., N. Munguia, A. Platt, and J. Taddei. 2006. Sustainable university: what can be the matter? Journal of Cleaner Production 14:810–819.

Vitousek, P. M., H. A. Mooney, J. Lubchenco, and J. M. Melillo. 1997. Human Domination of Earth's Ecosystems. Science 277:494–499.