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Perceptions of Insects

A Visual Analysis

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Abstract

A Personal Meaning of Insects Map (PMIM) was administered to participants from eastern Canada and northeastern United States. In the four-phase inductive study, participant responses to insects were coded and analyzed. Responses were elicited prior to and after viewing an insect video. Responses regarding the most cited insects, negative and positive associations with insects, and suggested management and education strategies were examined. Participants also discussed how information was acquired from various sources. The findings suggest that perceptions of insects are contextualized and sometimes inaccurate relative to scientific taxonomy. Research and the development of education strategies that take into account how the general public understands (or misunderstands) insects and where it acquires its information would be better served if we were to develop management and educational tools that address human-insect encounters from various socio-cultural perspectives.

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Keywords

insects – encounters – interactions – perceptions – visual maps

Introduction

Nonhuman animal studies have a long history of exploring encounters between humans and nonhuman animals and other-than-humans (Franklin, 2005; Hall, & Brown, 2006: Haraway, 2007; Holden, 2003; Hughes, 2001). Attitudes towards nonhuman animals, as these studies reveal, arise from a complex interplay of factors involving social, cultural, biological, morphological, and physiological attributes (aposematic attributes such as bright colors, large sizes) (Barua, Gurdak, Ahmed, & Tamuly, 2012; Wagler, & Wagler, 2012; Lemelin, 2013b).

A number of studies suggest that early childhood experiences are central in fostering pro-active support of environmental causes (see Bixler, Floyd, & Hammitt, 2002; Bögeholz, 2006; Chawla, 1999; Ewert, Place, & Sibthorp, 2005; Kals, Schumacher, & Montada, 1999; Tunnicliffe, & Reiss, 1999). According to other studies, environmental and wildlife preferences are strongly correlated with the way the natural world is represented in modern popular culture, education, and scientific literature (see Barua, Gurdak, Ahmed, & Tamuly, 2012; Lemelin, 2009; Rule, & Zhbanova, 2012; Zoldosova, & Prokop, 2006). Whether it is early childhood experiences or experiential education or a combination thereof, researchers agree that awareness and knowledge are crucial for the recruitment of the next generation of naturalists and conservationists (Balmford, Clegg, Coulson, & Taylor, 2002; Kawahara, & Pyle, 2013; Sodhi, Koh, Brook, & Ng, 2004; Snaddon, Turner, & Foster, 2008), for people rarely protect that which they do not know. Predominant in nearly all these analyses is the examination of human interactions with companion animals, domestic animals, game species, and charismatic mega-fauna (Manfredo, Vaske, Brown, Decker, & Duke, 2008; Vaske, Wittmann, & Williams, 2001; Woodroffe, Simon, Thirgood, & Rabinowitz, 2005).

Although less-documented, human-insect encounters have been examined in ethnography (Laugrand, & Oosten, 2010; Lemelin, 2009; Lorimer, 2007; Raffles, 2010; Rennesson, Grimaud, & Césard, 2011), feminism (Braidotti, 2002; Plant, 1997; Zylinkska, 2001), and in children/insect interaction studies (Cardak, 2009; Lindemann-Matthies, 2002; Prokop, Prokop, Tunnicliffe, & Diran, 2007; Shepardson, 2002; Snaddon et al., 2008; Wagler, & Wagler, 2011, 2012, 2014).

Other researchers (see Keller, 1993; Kim, 1993; Russell, 2009) have tended to focus on the negative aspects of human encounters with insects, often defined under the rubrics of anthropomorphism (human predisposition for nonhuman animals most "like-us") and entomophobia (the fear of insects). While such approaches may confirm pre-conceived notions that human-insect encounters are largely negative, other authors (Lorimer, 2007; Motte-Florac & Thomas, 2003; Raffles, 2010; Sleigh, 2004, 2006, 2007; Wagler & Wagler, 2014) acknowledge that these interactions are complex, unsettling, and rewarding. Furthermore, entomophobia and anthropomorphism fail to consider the popularity (past and present) of certain insects like beetles (Evans, & Bellamy, 2000; Pearson, 2013), butterflies (Barrua et al., 2012; Leach, 2013), dragonflies (Laurent, 2000; Lemelin, 2007, 2009), and bees (Moore & Kosut, 2014; Spevak, 2013), and how the popularity of these nonhuman animals varies according to socio-cultural and environmental influences (Lemelin, 2013b; Raffles, 2010; Wagler, & Wagler, 2011, 2012).

In this exploratory study, we asked participants from various backgrounds to define insects. Since we expected that participants would differ from each other in their understanding and awareness of insects, we developed a hybrid visual-mapping method formulated from concept maps (Novak, 1980, 1998; Novak, & Gowin, 1984), cognitive maps (Kitchin, 1994; Knopf, 1981), mind maps (Buzan, 1974, 1995; Buzan, & Buzan, 2000), and personal meaning maps (PMM) (Falk, & Dierking, 1992, 1998, 2000; Kalof, Zammit-Lucia, & Kelly, 2011), which are described next. Following this, we provide an explanation of the patterns and trends in the participant responses, and then compare them to other similar works. By providing participants from various backgrounds in Canada and the US with an opportunity to provide their comments on insects as well as discuss how their knowledge of insects is acquired, we can reveal both the strengths and limitations of these educational and outreach tools, while suggesting how they can modified (if needed) or adapted to a rural or semi-rural context.

Materials and Methods

Extensively used in education where standard evaluative rubrics are required (Eppler, 2006; Wheeldon & Faubert, 2009), a concept map is "a top-down diagram showing the relationships between concepts, including cross connections among concepts, and their manifestations (examples)" (Eppler, 2006, p. 203). Somewhat less rigid than the structured concept map, a PMM documents in-situ experiences occurring during an educational visit to a museum or zoo (Falk, Reinhard, Vernon, Bronnenkant, Heimlich, & Deans, 2007; Kalof et al., 2011). A mind map is a collection of unstructured words or ideas provided by research participants, in a multi-colored, image-centered, organic radial diagram (Davies, 2011), representing "semantic or other connections between portions of learned material hierarchically" (Eppler, 2006, p. 203). A drawback of mind maps is the idiosyncratic and sometimes haphazard approach to mapping that participants may take when mapping their ideas.

For the PMMs, the pre-defined approach to coding using the four semi-independent dimensions of extent, breadth, depth, and mastery could be considered the antithesis of emergent coding approaches often used in qualitative research (Creswell & Plano-Clark, 2007; Patton, 2002; Rubin & Rubin, 1995; Wheeldon & Faubert, 2009). In addition, the absence of any natural museum, zoo, or butterfly pavilions in our research locations further complicated the in-situ analysis derived from the PMM approach. Davies (2011) and Eppler (2006) suggest that by combining different visualization methods, researchers can compensate for the limitations of different visual mapping approaches. Using a hybrid visual-mapping approach consisting of mind maps and PMMs, we developed Personal Meaning Insect Maps (PMIM), aimed at providing a better understanding of people's perceptions of insects. Considering some of the challenges highlighted in previous insect studies (i.e., where the negative aspects of these nonhuman animals were sought out), the research team believed that an inductive research approach minimizing the data collector's influence on the study would provide the best opportunity for participants to freely express their opinions of insects without fear of being corrected or judged.

In addition to downplaying the cognitive aspects of past studies, this approach is important because there is very little understanding of the effectiveness of current educational approaches beyond the urban centers where many of these strategies are developed by museums and zoos. Implemented and conducted in semi-urban and rural areas of the US and Canada, the approach that we developed provides a greater understanding of these potential geographical constraints, and may ameliorate some of these limitations, through improved educational and outreach strategies.

Designing PMIMs

During the fall of 2011, the PMIMs were pre-tested using small focus groups comprising undergraduate and graduate students (n = 48) who were attending a postsecondary institution in Canada. Since this was the first time that the principal investigator had used PMIMs, evaluative feedback provided by the participants was incorporated into the pre-test, which included showing slides of the various insect orders. Most participants agreed that the PMIM was useful; however, many suggested that the slide show, although interesting, was much too long (the average length of completion for the PMIMs was 40 minutes). A few participants suggested that a video depicting insects in their natural environment and lasting no more than 10 minutes would work much better. We thus replaced the slide show with a six-minute video and re-tested the instrument.

Conducting PMIMs

The research team comprised seven people all working under the supervision of the PI. Because we were seeking a wide representation, participants were recruited through a number of approaches. First, a convenience-sampling strategy was used to recruit undergraduate and graduate students at a Canadian university. Second, a purposeful-sampling strategy was used to recruit gardeners, horticulturalists, recreationists, and fishers. A third sampling strategy was used to recruit individuals interested in participating in the study. Recruitment of these different groups included presenting at a university campus, contacting members of community and/or leisure groups and requesting their cooperation, writing articles in local newspapers, and placing posters throughout various communities.

From 2011 to 2013, 280 PMIMs were administered to university students (graduate and undergraduate), gardeners, fishers, recreationists, and other targeted individuals located throughout eastern Canada and the northeastern United States. Respondents were made aware that the research had received approval from the university's research and ethics board, and that the data collected could be used in future publications, presentations, and assignments. All respondents were informed that they would remain anonymous. The role of the data collectors was to administer the PMIMs and seek additional information on key points. However, to remain true to the inductive process, the data collectors did not provide any explanation of the insects featured on the video, nor did they correct mistakes (i.e., the misidentification of spiders or ticks as insects) that were made by participants completing the PMIMs in Phases 1 and 2 (see Figure 1). Figure 1 illustrates a particularly creative PMIM. In Phase 3, the data collectors encouraged participants to provide socio-demographic data and include management and/or educational strategies that participants deemed relevant to increasing insect awareness and/or the conservation of these nonhuman animals.

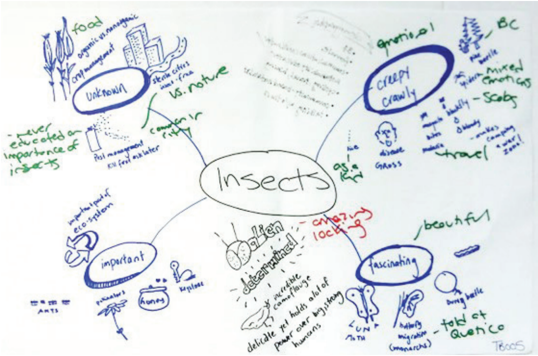

FIGURE 1 *The PMIM.*

The first phase of the study (Phase 1, Stage I, or P1-SI) began with participants being given a blank sheet of paper with the word insects written on it (see Table 1). They were then asked to draw images or write (in blue ink) as many words and phrases as needed to reflect their thoughts and ideas about insects. The participants were given as much time as they needed to write down what came to mind. Once finished, the research team member encouraged the participants to participate in Phase 1, Stage II (P1-SII), where they were asked to elaborate on certain thoughts or ideas drafted in P1-SI. The discussion in this phase allowed individuals to articulate their perceptions of insects and provide fuller explanations of their answers. In order to distinguish between unprompted and prompted responses, these data were recorded in green ink.

Phase 2, Stage 0 (P2-S0), consisted of participants viewing 28 video clips of stock footage set to music, containing a wide array of insects representing various orders. While we attempted to broadly represent insect orders in their natural settings, we were limited by available footage, funding, and time. An effort was made, however, to present popular or recognizable insects including ants, beetles, butterflies, damselflies, dragonflies, flies, ladybugs, grasshoppers, katydids, mantises, mosquitoes, moths, cockroaches, stick insects, and wasps in natural settings. Clip lengths varied from 10 to 15 seconds. All clips that were included in the video were randomly assigned a number from 1 to 28. We used the =RANDBETWEEN (1, 28) function in Excel 2010 to assign random order to the 28 clips. Clips were placed in a randomized order in Adobe Premier Elements 11, with a one-second dip-to-black transition between clips. The original audio from the clips was deleted and replaced with continuous

TABLE 1 *The PMIM process*

P1-SI	Participant-initiated responses
P1-SII	Elaboration of key elements and particular concepts
P2-S0	Video viewing and participant-initiated response
P2-SI	Initial responses post-video
P2-SII	Elaboration of key elements and particular concepts
P3-SII	Socio-demographic data and suggested management strategies
P4	Coding

ambient music licensed under a Creative Commons license. The final video was 6.01 minutes long.

Participants were asked to write down their reactions and responses to the video during Phase 2, Stage I (P2-SI), in red ink in order to compare and distinguish between their pre-viewing perceptions (P1-SI & P2-S1) and their post-viewing perceptions. Participants were encouraged to reflect on and make adjustments to their original responses to insects (P1-SI & P2-SI). Upon completion, the data collector once again prompted the participants to add to and expand on their responses, asking them to write down why they thought they responded to the video the way that they did. These responses were noted in black ink. In Phase 3, participants were asked to provide their demographic data on the back of the PMIM sheets. In addition, respondents were encouraged to provide and suggest educational strategies that would foster a better understanding of insects. Since Phase 3 was prompted, it was kept separate from the findings provided in Phases 1 and 2. The color of ink used during this phase was left up to the participants.

Analysis

Following the completion of the PMIMs, each page was digitally scanned (for back-up purposes), transcribed into Excel 2010, and then imported into NVivo 10 (QSR, 2012). The coding of the PMIMs (P4) included coding keywords based on frequencies using the Word Frequency Query in NVivo 10. Pre- and post-video phases were coded in order to run a Matrix Coding Query based on organisms that participants volunteered versus the pre-determined organisms provided during Phase 2.

Furthermore, the Matrix Coding Query also incorporated negative and positive associations from both the pre- and post-video phases. By using a set list of common pre- and post-video words, it was possible to track the effect the video had on the attitudinal shifts of participants. Selections of positive and negative word associations were based on clearly defined meanings. For example, "amazing" could be exclusively considered a positive word in virtually any context, while "fear" would obviously be a negative word. Words such as "bite," or "nature," or "different" were ignored since without further consideration of their contexts, the value and meaning of such terms would be subject to broad interpretation.

Following this, the concept-counting approach or content analysis was used to identify which participants identified which concepts and their frequencies of occurrence (Turns, Atman, & Adams, 2000). We then examined which connections between and among different levels of concepts were deemed relevant by respondents. In order to provide greater insight into how participants made sense of, and defined, their interactions with insects, we used the participants' terms for these nonhuman animals and not the scientific labels. The results (basic frequencies and occurrences) derived from the general analysis are presented next. These results are subsequently integrated with and compared to previous research examining human encounters with insects.

Results

There were 67 Americans from the states of New York and Massachusetts, and 213 Canadians from the province of Ontario who completed the PMIMs (see Table 2). The time it took to complete the PMIMs ranged from 30 minutes to 1.5 hours.

As expected, the top twenty cited insect species in Phases 1 and 2 included aesthetically pleasing nonhuman animals such as butterflies (P1: n = 162; P2: n = 117), dragonflies (P1: n = 52; P2: n = 25), and ladybugs (P1: n = 44; P2: n = 43), and insects providing ecological or utilitarian functions like bees (P1: n = 254; P2: n = 139) and ants (P1: n = 200; P2: n = 96). Species often associated with negative attributes like flies (P1: n = 289; P2: n = 84), mosquitoes (P1: n = 200; P2: n = 65), and wasps (P1: n = 78; P2: n = 14) were also cited frequently. These findings help to confirm the popularity of butterflies and bees in North America and to a lesser extent, support the importance of certain well-known utilitarian species like bees (Barua et al., 2012; Guiney & Oberhauser, 2008; Small, 2011, 2012). Although the ranking of flies and ants in Phases 1 and 2 ahead of all other insect species was somewhat unexpected, perhaps these findings should not be surprising when one considers how prevalent these nonhuman animals are in human societies and how present they are in our recreational activities (Lemelin, 2013b; Schutze & Jacobs, 2009).

TABLE 2 *Overview of participants*

Participant group	Numbers
General Population	119
Master Gardeners	59
Undergraduate and Grads.	72
Horticulturalists	10
Rotarians	9
Community Tree Stewards	7
Fishers	4
Total	**280**

Although focused on insects, participants mostly defined these nonhuman animals under the rubric of bugs (see Table 3). When unprompted, they felt more comfortable using the common term bugs in both P1 (n = 345) and P2 (n = 177), and the common names associated with these nonhuman animals. Not one participant used Latin terminology or any of the taxonomic classifications (apart from insect) to define these nonhuman animals. Furthermore, although this was a study of insects, non-insects were mentioned frequently in both Phases 1 and 2 by participants: spiders (P1: n = 150; P2: n = 26), ticks (P1: n = 50; P2: n = 8), worms (P1: n = 30; P2: n = 3), and centipedes (P1: n = 24; P2: n = 10). Millipedes (P1: n = 5; P2: n = 1) were also mentioned, though less frequently. Bugs were defined by some respondents as “bad” (P1: n = 71; P2: n = 33), “creepy” (P1: n = 73; P2: n = 22), and “gross” (P1: n = 52; P2: n = 21). Others suggested that insects were “scary” (P1: n = 49; P2: n = 25), “fearsome” (P1: n = 48; P2: n = 13), and “hated” (P1: n = 41; P2: n = 13). Some individuals described insects as “fascinating” and/or “interesting” (P1: n = 122; P2: n = 89), “cool” (P1: n = 51; P2: n = 43), “beneficial” (P1: n = 40; P2: n = 12), and “amazing” (P1: n = 29; P2: n = 39). Others noted the “beauty” of insects (P1: n = 143; P2: n = 141) and their “love” (P1: n = 55; P2: n = 25) for these nonhuman animals.

While not empirically significant, the percent change in word occurrence following the viewing of the video indicates a decline in every negative association (see Table 4). Similar to the observations of Wagler and Wagler (2012), these findings suggest that negative perceptions may be somewhat malleable and can be affected positively by images. However, it is also important to note that the number of positive associations with insects only increased on one occasion (amazement); generally, they decreased. These trends may have

TABLE 3 *Most cited insects*

Insects & other invertebrates	Phase 1 (P1SI & P1SII) Number of times cited	Phase 2 (P2SI & P2SII) Number of times cited
bugs	345	177
flies	289	84
bees	254	139
mosquitoes	200	65
ants	187	96
butterflies	162	117
spiders	150	26
wasps	78	14
beetles	76	45
caterpillars	53	11
dragonflies	52	25
moths	50	18
ticks	50	8
ladybugs	44	34
bedbugs	34	5
worms	30	3
centipedes	24	10
praying mantises	18	31
millipedes	5	1
damselflies	2	1

been due to participants providing most of their information in Phase 1 (Stages I and II) and perhaps indicative of participant fatigue in the latter phases. Although the video did not provide the same experiential learning opportunities that would be available in museums or zoos, our analysis of the responses to the video suggest that it did reduce certain negative inclinations toward insects. However, it should be noted that positive dimensions associated with insects did not necessarily increase as a result of the video.

When participants were asked to cite or describe educational and interpretation strategies that they had used to learn more about insects, they noted

TABLE 4 *Negative and positive associations of insects*

Descriptor	**Phase 1 (P1SI & P1SII) Number of times cited**	**Phase 2 (P2SI & P2SII) Number of times cited**
amazing	29	39
bad	71	33
beautiful/pretty	143	141
beneficial	40	12
Cool	51	43
creepy	73	22
fascinating/interesting	122	89
fear	48	13
good	89	46
gross	52	21
hate	41	13
love	55	25
scary	49	25
Total	**863**	**522**

experiential education ($n = 35$), the Internet ($n = 30$), videos ($n = 25$), education ($n = 25$), and childhood experiences ($n = 21$) (see Table 5). Other important sources of information included reading materials ($n = 14$), TV ($n = 11$), and libraries ($n = 11$).

The modified PMIM demonstrates how visual mappings can be conducted in locations such as smaller cities, villages, or rural areas where permanent or semi-permanent displays of insects are not available. Because the study was conducted in locations without butterfly pavilions, insectariums, and museums, our visual-mapping approach was modified and a video was incorporated into this research. We sought to minimize the interactions between the participants and data collectors during the video by only using images and a generic soundtrack that some respondents found distracting. One of the benefits of the music is that it kept audible comments by participants to a minimum and it also minimized external noises. These benefits were thought to exceed the potential distractions.

TABLE 5 *Suggested management and education strategies*

Item	Number of times cited
Education (includes experiential education, hands-on activities, & workshops)	35
Internet & online information	30
Videos	25
Schools (schoolyards)	19
TV & documentaries	16
Reading materials	14
Natural settings	11
Library	11

Discussion and Conclusions

The findings from this inductive study largely confirm the findings from other studies that have noted the conflicting (Kellert, 1993), ambivalent (Lorimer, 2007), and positive (Lemelin, 2009; Moore, & Kosut, 2014; Raffles, 2013) aspects of human encounters with insects. Similar to the conclusions reached by Lemelin (2009, 2013b) and Moore and Kosut (2013) in their discussions of inter- and intra-species/order disparity, participants tended to note butterflies (P1: $n = 162$; P2: $n = 117$), bees (P1: $n = 254$; P2: $n = 139$), and dragonflies (P1: $n = 52$; P2: $n = 25$) while overlooking moths (P1: $n = 50$; P2: $n = 18$), wasps (P1: $n = 78$; P2: $n = 14$), and damselflies (P1: $n = 2$; P2: $n = 1$). Each of these nonhuman animals was featured in the video, so this apparent disparity within some of the most popular insect orders like Hymenoptera (bees, wasps, ants), Lepidoptera (butterflies and moths), and Odonata (dragonflies and damselflies) cannot be explained by a lack of images in the video. These findings could perhaps be associated with negative emotions directed towards moths and wasps when compared to butterflies and bees (inter-order apathy), the diminutive size of some of these nonhuman animals (e.g., damselflies) (Lemelin, 2009, 2013b), a tendency to lump certain insects (e.g., dragonflies, damselflies) into one general category known as dragonflies, and/or a general lack of knowledge about insects. Other findings (e.g., the ranking of flies, ants, and mosquitoes above dragonflies and ladybugs) were surprising; however, perhaps the significance of flies, ants, and mosquitoes should not be that surprising, after all humans encounter them in many aspects of life. Concerns were expressed that some of these nonhuman animals can transmit disease, while the bite and sting of mosquitoes, blackflies, and horseflies are particularly disruptive to outdoor recreational activities, whether they occur in urban, rural, or wilderness areas (Schutze, & Jacobs, 2009). In other situations, respondents were more ambivalent, suggesting that human-insect encounters were largely contextual. Thus, in certain situations (i.e., during certain outdoor activities), human encounters with insects may be tolerated and even welcomed. In other instances (i.e., in one's home), these interactions would not be welcomed.

Human-insect encounters and how they are recalled appear to trigger emotional reactions rather than scientific, intellectual responses (Zylstra, 2014), thereby supporting the discussions of Bell and Baker (1982) and Woods (2000) who noted that some respondents in their studies were often confused by how insects were defined, and opted to use more common terms or generic terms like bugs to define these nonhuman animals. For example, in this study not one participant used a Latin name to define these nonhuman animals. Perhaps this is indicative of a general lack of knowledge, or possibly, of how the general public makes sense of these nonhuman animals. When comparing these findings with the manner in which other recreationists like birders and fishers refer to them, they are not unexpected, for many birders and fishers use common names to define and describe highly prized nonhuman animals.

These findings appear to challenge the approaches taken in some citizen science projects and at insect symposiums where science and taxonomy hold sway and new initiates are often corrected and expected to use the proper scientific labels when describing insects (Yen, Yao, & Mintzes, 2007; Prokop, Prokop, & Tunnicliffe, 2008; Lemelin, 2009). Although responses by participants to what actually is an insect may perhaps be disappointing to taxonomists and entomologists, the role of insects and the general nomenclature of these nonhuman animals illustrate how our interactions with them are conceived, defined, and interpreted. As Cardoso, Erwin, Borges, and New (2011) explain, while there is certainly a time and place for taxonomic rigor, the expert-driven model in education and interpretation may be of limited value for general audiences. Indeed, using common names for species during public outreach strategies "may radically change the public perception regarding invertebrates" (Cardoso, Erwin, Borges, & New, 2011, pp. 2649-2650). Given this, it is crucial to understand and respect how the general public perceives or views these nonhuman animals.

Educational strategies emphasizing the ecological roles that many insects play in pollination, decomposition, and bio-control could be developed to engage, challenge, and encourage participants to learn more about insects through various media including experiential dimensions offered through bug camps, symposia, citizen science (Johansen & Auger, 2013; Kawahara & Pyle, 2013; Rykken & Farrell, 2013), education (Blackawton, Airzee, Allen, Baker, Berrow, Blair, & Lotto, 2011; Ernst, Vinke, Giberson, & Buddle, 2013), technology, and new media (Mitchell, 2013). Certainly, more research on the benefits of accurate bug identification and knowledge might have the positive outcome of clarifying the general population's misconceptions about individual species and decelerate the perpetuation of stereotyping certain nonhuman animal species. This would have the effect of reducing a generalized declaration such as "I hate bugs" to specifying "I hate spiders" and may perhaps allow for an acceptance of certain benign species.

The limited references to conservation programs and nature clubs (which were active in the regions where the PMIMs were administered) suggest the relative ineffectiveness of these programs in reaching the general public in certain semi-urban and rural areas of Canada and the US. Thus, it would seem that despite some of the participants' interest in learning more about these nonhuman animals, these organizations and current management strategies are largely ineffective at mobilizing public support for the conservation of insects. These findings might have been somewhat different had we conducted the study near centers with zoos, nature museums, and/or butterfly pavilions, but despite these geographic disparities, if interpretation and conservation strategies are to be implemented, then presenting facts about insects and/or bugs in an accessible, engaging, or emotionally compelling way (e.g., experiential education and through social media) is critical.

Findings from Phase 3 were consistent with Kathy et al. (2012) Operation Spider study in Australia where they noted that some respondents sought information pertaining to insects in traditional sources (books, libraries, radio) while others relied on the Internet and social media. These findings support earlier discussions that highlight the role and importance of early childhood exposure to nature and nonhuman animals as well as the importance of education, and traditional and new media. Some of the movies featuring cartoon insects like *A Bug's Life* (1998), *Antz* (1998), and *Bee Movie* (2007) were cited by some participants as being part of their earliest exposures to the world of insects. The research on whether animated fauna depicted in movies actually promotes conservation behavior is pretty clear: the exposure received from these movies without any ongoing support is insufficient (Goldman, 2014). What these films can do, however, as Goldman (2014) explains, is engage and challenge participants.

As our study illustrates, the visuals engaged respondents and helped to remind participants of the popularity of certain species like bees and butterflies, and the aesthetic appeal of dragonflies, praying mantises, and ladybugs. In some cases, the visual was enough to remind certain participants that they did indeed like certain types of insects. Although we sought to standardize the research approach and limit interactions between the data recorder and the participants, a collaborative and engaging visual approach could also be fostered. Consisting of PIMMs, documentaries, photography, exhibitions, and perhaps experiential education, this visual approach could also display the logos of certain environmental groups and have participants describe which one they deem most effective in creating awareness.

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References

Adams, M., Falk, J. H., & Dierking, L. (2003). Things change: Museums, learning, and research. In M. Xanthoudaki, L. Tickle, & V. Sekules (Eds.), *Researching visual arts education in museums and galleries: An international reader* (pp. 15-32). Dordrecht, Netherlands: Kluwer Academic.

Ballantyne, R., Packer, J., & Sutherland, L. A. (2011). Visitors' memories of wildlife tourism: Implications for the design of powerful interpretive experiences. *Tourism Management, 32*(4), 770-779.

Balmford, A., Clegg, L., Coulson, T., & Taylor, J. (2002). Why conservationists should heed Pokémon. *Science, 295*(5564), 2367-2367.

Barua, M., Gurdak, D. J., Ahmed, R. A., & Tamuly, J. (2012). Selecting flagships for invertebrate conservation. *Biodiversity and Conservation, 21*(6), 1457-1476.

Bell, B., & Baker, M. (1982). Toward a scientific conception of 'animal'. *Journal of Biological Education, 16*(3), 197-200.

Bixler, R. D., M. F. Floyd., & Hammitt, W. E. (2002). Environmental socialization: Quantitative tests of the childhood play hypothesis. *Environment and Behavior, 34*(6), 795-818.

Blackawton, P. S., Airzee, S., Allen, A., Baker, S., Berrow, A., Blair, C., & Lotto, R. B. (2011). Blackawton bees. *Biology Letters, 7*(2), 168-172.

Bögeholz, S. (2006). Nature experience and its importance for environmental knowledge, values and action: Recent German empirical contributions. *Environmental Education Research, 12*(1), 65-84.

Buzan, T. (1974). *Using both sides of the brain*. New York, NY: Dutton.

Buzan, T. (1995). *The mind map book*. London, England: BBC Books.

Buzan, T., & Buzan, B. (2000). *The mind map book*. London, England: BBC Books.

Cardak, O. (2009). Students' ideas about dangerous animals. *Asia-Pacific Forum on Science Learning and Teaching, 10*. Retrieved from http://www.ied.edu.hk/apfslt/download/v10_issue2_files/cardak.pdf.

Cardoso, P., Erwin, T. L., Borges, P. A. V., & New, T. R. (2011). The seven impediments in invertebrate conservation and how to overcome them. *Biological Conservation, 144*(11), 2647-2655.

Chawla, L. (1999). Life paths into effective environmental action. *Journal of Environmental Education, 31*(1), 15-26.

Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

Davies, M. (2011). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Higher Education, 62*(3), 279-301.

Eppler, M. J. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization, 5*(3), 202-210.

Ernst, C., Vinke, K., Giberson, D., & Buddle, C. M. (2013). Insects in education: Creating tolerance for some of the world's smallest citizens. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 252-273). Cambridge, United Kindgom: Cambridge University Press.

Evans, A. V., & Bellamy, C. L. (2000). *An inordinate fondness for beetles*. Berkeley, CA: University of California Press.

Ewert, A., Place. G., & Sibthorp, J. (2005). Early-life outdoor experiences and an individual's environmental attitudes. *Leisure Sciences, 27*(3), 225-239.

Falk, J., & Dierking, L. (1992). *The museum experience*. Washington, DC: Whalesback.

Falk, J., & Dierking, L. (2000). *Learning from museums: Visitor experiences and the making of meaning*. Walnut Creek, CA: Alta Mira Press.

Falk, J., Reinhard, E., Vernon, C., Bronnenkant, K., Heimlich, J., & Deans, N. (2007). *Why zoos & aquariums matter: Assessing the impact of a visit*. Silver Spring, MD: Association of Zoos & Aquariums.

Goldman, J. G. (2014). Do animated animals on the big screen promote conservation on the ground? *Conservation*. Spring issue. Retrieved from http://conservationmagazine.org/2014/03/do-animated-animals-promote-conservation/?utm _source=Conservation+Magazine&utm_campaign=56223a6e58-spring_new_issue_newsletter3_14_2014&utm_medium=email&utm_term=0_d0cc46f2ab-56223a6e58-235214913.

Guiney, M. S., & Oberhauser, K. S. (2008). Insects as flagship conservation species. *Terrestrial Arthropod Reviews, 1*(2), 111-123.

Huntly, P. M., Van Noort, S., & Hamer, M. (2005). Giving increased value to invertebrates through ecotourism. *South African Journal of Wildlife Research, 35*(1), 53-62.

Johansen, K., & Auger, A. (2013). Citizen science and insect conservation. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 252-273). Cambridge, UK: Cambridge University Press.

Kalof, L., Zammit-Lucia J., & Kelly, J. R. (2011). The meaning of animal portraiture in a museum setting: Implications for conservation. *Organization & Environment, 24*(2), 150-174.

Kals, E., Schumacher, D., & Montada, L. (1999). Emotional affinity toward nature as a motivational basis to protect nature. *Environment and Behavior, 31*(2), 178-202.

Kathy, P., Lloyd, D., Zeegers, Y., Roetman, P., Daniels, C., Hoekman, B., Linnell, L., George, A. L., & Szilassy, D. (2012). Connecting teachers and students to the natural world through Operation Spider: An aspirations citizen science project. *Teaching Science: The Journal of the Australian Science Teachers Association, 58*(1), 13-20.

Kawahara, A. Y., & Pyle, R. M. (2013). An appreciation for the natural world through collecting, owning and observing insects. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 138-152). Cambridge, UK: Cambridge University Press.

Kellert, S. R. (1993). Values and perceptions of invertebrates. *Conservation Biology, 7*(4), 845-855.

Kim, K. C. (1993). Biodiversity, conservation and inventory: Why insects matter. *Biodiversity and Conservation, 2*(3), 191-214.

Kitchin, R. M. (1994). Cognitive maps: What are they and why study them. *Journal of Environmental Psychology, 14*(1), 1-19.

Knopf, R. C. (1981). Cognitive maps formation as a tool for facilitating information transfer in interpretive programming. *Journal of Leisure Research, 13*(3), 232-242.

Laurent, E. L. (2000). Children, 'insects' and play in Japan. In A. L. Podberscek, E. S. Paul, & J. A. Serpell (Eds.), *Companion animals and us* (pp. 61-89). New York, NY: Cambridge University Press.

Leach, W. R. (2013). *Butterfly people: An American encounter with the beauty of the world.* New York, NY: Pantheon.

Lemelin, R. H. (2007). Finding beauty in the dragon: The role of dragonflies in recreation, tourism, and conservation. *Journal of Ecotourism, 6*(2), 139-145.

Lemelin, R. H. (2009). Goodwill hunting? Dragon hunters, dragonflies & leisure. *Current Issues in Tourism, 12*(5-6), 235-253.

Lemelin, R. H. (Ed). (2013a). *The role of insects in recreation and tourism*. Cambridge, UK: Cambridge University Press.

Lemelin, R. H. (2013b). To bee or not to bee: Whether 'tis nobler to revere or to revile those six-legged creatures during one's leisure. *Leisure Studies, 32*(2), 153-172.

Lindemann-Matthies, P. (2002). The influence of an educational program on children's perception of biodiversity. *The Journal of Environmental Education, 33*(2), 22-31.

Lorimer, J. (2007). Nonhuman charisma. *Environment and Planning Development: Society and Space, 25*(5), 911-932.

Mitchell, F. L. (2013). May you live in interesting times: Technology and entomology. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 235-251). Cambridge, UK: Cambridge University Press.

Moore, L. J., & Kosut, M. (2013). *Buzz urban beekeeping and the power of the bee*. New York, NY: New York University Press.

Moore, L. J., & Kosut, M. (2014). Among the colony: Ethnographic fieldwork, urban bees and intra-species mindfulness. *Ethnography, 15*(4), 516-539.

Norton, B. G. (2000). Biodiversity and environmental values: In search of a universal earth ethic. *Biodiversity and Conservation, 9*(8), 1029-1044.

Novak, J. D. (1980). Learning theory applied to the biology classroom. *The American Biology Teacher, 42*(5), 280-285.

Novak, J. D. (1998). *Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations*. Mahway, NJ: Lawrence Erlbaum Associates.

Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. Cambridge, UK: Cambridge University Press.

Patton, M. Q. (2002). *Qualitative research and evaluation methods.* Thousand Oaks, CA: Sage.

Pearson, D. L. (2013). Tiger beetles: Lessons in natural history, conservation and the rise of amateur involvement. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 56-75). Cambridge, UK: Cambridge University Press.

Prokop, P., Prokop, M., & Tunnicliffe, S. D. (2008). Effects of keeping animals as pets on children's concepts of vertebrates and invertebrates. *International Journal of Science Education, 30*(4), 431-449.

Prokop, P., Prokop, M., Tunnicliffe, S. D., & Diran, C. (2007). Children's ideas of animals' internal structures. *Journal of Biological Education, 41*(2), 62-67.

Raffles, H. (2010). *Insectopedia*. New York, NY: Pantheon Books.

Rubin, H. J., & Rubin, I. S. (1995). *Qualitative interviewing: The art of hearing data*. Thousand Oaks, CA: Sage.

Rule, A., & Zhbanova, K. Z. (2012). Changing perceptions of unpopular animals through facts, poetry, crafts and puppet plays. *Early Childhood Education, 40*(4), 223-230.

Rykken, J. J., & Farrell, B. D. (2013). Discovering the microwilderness in parks and protected areas. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 306-323). Cambridge, UK: Cambridge University Press.

Schutze, G. E., & Jacobs, R. F. (2009). The camper's uninvited guest. In D. Schlossberg (Ed.), *Infections of leisure* (4th ed., pp. 97-110). Washington, DC: ASM Press.

Shepardson, D. P. (2002). Bugs, butterflies, and spiders: Children's understandings about insects. *International Journal of Science Education, 24*(6), 627-643.

Sleigh, C. (2004). *Ants*. London, United Kingdom: Reaktion Books.

Sleigh, C. (2006). Inside out: The unsettling nature of insects. In E. Brown (Ed.), *Insect poetics: Literary and cultural entomologies* (pp. 281-297). Minneapolis, MN: University of Minnesota Press.

Sleigh, C. (2007). *Six legs better: A cultural history of myrmecology.* Baltimore, MA: Johns Hopkins University Press.

Small, E. (2011). The new Noah's ark: Beautiful and useful species only. Part 1. Biodiversity conservation issues and priorities. *Biodiversity, 12*(4), 232-247.

Small, E. (2012). The new Noah's ark: Beautiful and useful species only. Part 2. The chosen species. *Biodiversity, 13*(1), 37-53.

Snaddon, J. L., Turner, E. C., & Foster W. A. (2008). Children's perceptions of rainforest biodiversity: Which animals have the lion's share of environmental awareness? *PLoS ONE, 3*(7), e2579. doi:10.1371/journal.pone.0002579.

Sodhi, N. S., Koh, L. P., Brook, B. W., & Ng, P. K. L. (2004) Southeast Asian biodiversity: An impending disaster. *Trends in Ecology & Evolution, 19*(12), 654-660.

Spevak, E. M. (2013). A is for agriculture, B is for bee, C is for colony-collapse disorder, P is for pollinator parks: An A to Z overview of what insect conservationists can learn from the bees. In R. H. Lemelin (Ed.), *The management of insects in recreation and tourism* (pp. 76-94). Cambridge, UK: Cambridge University Press.

Suh, W. J. (2010). Personal meaning mapping (PMM): A qualitative research method for museum education. *Journal of Museum Education, 4*, 61-82.

Tunnicliffe, S. D., & Reiss, M. J. (1999). Building a model of the environment: How do children see animals? *Journal of Biological Education, 33*(3), 142-148

Turns, J., Atman, C., & Adams, R. (2000). Concept maps for engineering education: A cognitively motivated tool supporting varied assessment functions. *IEEE Transactions on Education, 43*(2), 164-173.

Vetter, R. S. (2013). Arachnophobic entomologists. *American Entomologist, 59*, 169-175.

Wagler, A., & Wagler, R. (2014). Arthropods and the current great mass extinction: Effective themes to decrease arthropod fear and disgust and increase positive environmental beliefs in children? *International Journal of Environmental and Science Education, 9*(2), 197-214.

Wagler, R., & Wagler, A. (2011). Arthropods: Attitude and incorporation in preservice elementary teachers. *International Journal of Environmental & Science Education, 6*(3), 229-250.

Wagler, R., & Wagler, A. (2012). External insect morphology: A negative factor in attitudes toward insects and likelihood of incorporation in future science education settings. *The International Journal of Environmental and Science Education, 7*(2), 313-325.

Wheeldon, J., & Faubert, J. (2009). Framing experience: Concept maps, mind maps, and data collection in qualitative research. *International Journal of Qualitative Methods, 8*(3), 68-98.

Woods, B. (2000). Beauty and the beast: Preferences for animals in Australia. *Journal of Tourism Studies, 11*(2), 25-35.

Xanthoudaki, M., Tickle, L., & Sekules, V. (Eds.). (2003). *Researching visual arts education in museums and galleries: An international reader.* Dordrecht, Netherlands: Kluwer Academic Publishers.

Yen, C. F., Yao, T. W. & Mintzes, J. J. (2007). Taiwanese students' alternative conceptions of animal biodiversity. *International Journal of Science Education, 29*(4), 535-553.

Zoldosova, K., & Prokop, P. (2006). Education in the field influences children's ideas and interest toward science. *Journal of Science Education and Technology, 15*(3), 304-313.

Zylstra, M. J. (2014). *Exploring meaningful nature experience, connectedness with nature and the revitalization of transformative education for sustainability*. (Unpublished doctoral dissertation). Stellenbosch University, South Africa.