IN THE ZOOLOGICAL GARDEN-
UNDERSTANDING BOTANY IN ZOO EDUCATION

by

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A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Science in Public Horticulture

Summer 2009

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ACKNOWLEDGMENTS

It takes a village to raise a child, according to an African proverb. In this instance, it has taken several communities to raise a master's student. I am indebted to the many that have steered my development over the years. I owe a debt of gratitude to the Longwood Foundation, Inc. and to the Longwood Graduate Program for welcoming me into the ranks of the Longwood Graduate Fellows. The opportunity has encouraged my growth professionally and personally and altered the direction of my life.

I extend a heartfelt thank you to my patient and dedicated committee, Robert Lyons and, James Swasey, for freely offering guidance and support; I also thank Marty Kromer for his assistance. Thank you sincerely to Gerry Zuka for steering me along the way.

I thank the Education staff of the Philadelphia Zoo, especially Lynn Parrucci and Kym Matala, for opening their minds and classroom doors to me. Also, thank you to the individuals that completed the survey for providing insight into what was happening in their respective zoo education programs.

Lastly, thank you to my friends and family, who never lost hope or good humor. I dedicate this to Doug, who always maintained the right balance between prodding and praising.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Botany, which is the study of plants and associated knowledge, forms one of the foundations of life, yet it has lagged behind other academic disciplines in prominence. In fact, it is unfamiliar to the average citizen (Bozniak, 1994) and has lagged behind in venues of education in mainstream culture. This research sought to uncover if a bias existed in zoo education programs. Anecdotal evidence from botanists suggested a paucity of botany included in biology classes. Evidence to suggest the bias has been documented at all levels of education. Even the term ‘botany’ is unfamiliar and used to convey a scientific approach to the topic. The term ‘horticulture’, however, has a more common and approachable usage, and has a broader appeal to people outside of the scientific community.

This research also sought to document the level that horticultural topics were integrated into zoo educational programs via an original survey instrument administered to educators within zoos. Of the survey respondents, eighty-seven percent indicated that it was present in some form in their respective zoo education programs, which is encouragingly high. A conclusion that arose from the survey was that education staff is primarily responsible for the creation of education classes. An additional conclusion was that lack of interest in plants, lack of time and expertise were the largest obstacles to inclusion for those that took the survey.

Lastly, this research sought to suggest and present a lesson plan that highlights plant adaptations in a manner similar to animal adaptations in an engaging

and educational manner at the Philadelphia Zoo. An existing lesson plan was adapted to highlight adaptations of plants, as well as animals. The class was well received by two classes and their teachers, implying that horticulture need not be static and boring and, in zoo education programs, nor serve only as a support for animals.

CHAPTER ONE

INTRODUCTION

Zoological gardens in the United States date back to the early twentieth century and were formed, in part, upon the principle of education (Hanson, 2002). The educational component has fluctuated in significance throughout the history of American zoos, gaining importance again in recent years. Collection-based institutions that exhibit wildlife, such as zoos, have a special connection with nature and typically emphasize a mission of conservation within their education programs. An increase in interest in conservation issues, and the accompanying educational component, has occurred in wildlife-based collection institutions throughout the last four decades (Miller et al., 2004). Zoological parks, as well as public gardens, nature centers, natural history museums, and other related institutions, are valuable resources for environmental education, especially in urban settings (de White and Jacobson, 1994). These institutions, including zoos, present an opportunity to contribute to environmental education and should be encouraged to develop a comprehensive approach to the mission they declare (Miller et al., 2004).

At the time that zoos defined themselves as showcases for animals, messages that centered fully or primarily upon animals fit with the mission statement. Zoos have evolved a mission of conservation and environmental education in the last decade and now include objectives that should recognize that animals are only a component of the environment. Education about the plants that make up and share the environment of animals is a crucial component of an environmental education message. Zoo education programs center on not only the animals, but also on how animals survive in their environments. Classes on animal adaptations, such as mimicry, or imitation of other animals, or camouflage highlight those adaptations. Plants, like animals, have an amazing array of adaptations that allow them to thrive in the same environments and exhibit many of the same survival strategies as animals-such as mimicry or camouflage. These similar adaptations should be presented concurrently in order to present a more complete picture of the environment.

In informal discussions with members of the Association for Zoological Horticulture (AZH), a group of zoological professionals that direct the horticultural development and maintenance at zoos, the topic of ensuring botanical representation in public education programs was not a priority. While an internal education committee exists within the AZH to provide guidance on practices that directly affect the health of animals and human visitors, education for the public on botanical issues was largely excluded from consideration. No publication or presentation in the previous four years occurred on the topic of public education of plants within the AZH.

The idea to study the inclusion of horticulture in zoo education arose from a discussion with a zoo educator at the Toledo Zoo in Toledo, Ohio. When asked why information about plants was not included in the education programs, Linda Calcamuggio, the Zoo's Education Specialist, responded that zoo educators understand the importance of horticulture, they just do not know enough about it to teach it. Horticulture staff knows the importance of horticulture, but they do not know enough about education to teach it. This comment resonated with the author and shaped the idea for a thesis that would bridge the gap between educators and horticulture staff. Information about plants is largely lacking from biological curricula at all levels.

Educational messages center on how animal adaptations allow them to survive, however, similar information about plant adaptation and survival is not widespread. Several example of how plants and animals use the same methods of survival, but only the animal one is commonly known. Many zoo education programs teach how camouflage, or having physical structures that enable an organism to hide in its surroundings, helps an animal disguise itself in its environment, yet have little idea that a grass-like weed hiding amongst a bed of daylilies would be a botanical example of the same concept. Similarly, many can recite that a Viceroy butterfly benefits from mimicking a Monarch butterfly, the Monarch is unpleasant for predators to eat and is avoided, the Viceroy would be similarly avoided. Zoo education programs likely have not applied that concept to plants that look like poison ivy thriving in a garden setting, as people who have had a bad experience with poison ivy are likely to avoid any plant that has leaves of three.

The terms “botany” and “horticulture” are used throughout this document. Botany - the science or study of plants or plant life - is a scientific term that may conjure images of microscopes, growth chambers, and complicated diagrams. Horticulture - the science and art of cultivating plants - is often a more approachable term with connotations of hands-on applicability to daily life. The author found that the term botany was a deterrent to zoo educators, teachers, and students, whereas the term horticulture was acceptable. Zoo education staff was willing to talk about horticulture inclusion, but botany was not readily discussed. In this thesis, the author uses both terms, relying on botany when a scientific concept is being discussed and horticulture when interacting with zoo staff. The term “habitat” is defined as the environment in which a plant or animal lives. The term “adaptation” is used to describe a behavior or a physical characteristic that allows a plant or animal to survive in its environment.

This thesis has two objectives. First, it aims to assess the current level of horticultural inclusion in zoo education programs, the hypothesis of the researcher was that inclusion would be low. Second, it suggests a lesson plan, created with the input of both horticulturists and educators, which presents horticultural concepts in an engaging manner within the zoo setting. It is the intention of the researcher that this will serve as an incremental step toward presenting a more complete picture of environmental education, as well as inspiring students that the study of plants can be as appealing as the study of animals.

This thesis includes four parts. Chapter two reviews the literature that pertains to the role botany occupies in biological and zoo education. Chapter three discusses a survey created to assess the level of botany that currently exists in zoo education programs. Chapter four presents an education lesson plan that addresses the gap in presentation of botanical and zoological programs and provides an example of how botanical concepts can be successfully integrated into an animal-based education program. Chapter five presents conclusions for this research in light of the survey and pilot class.

CHAPTER TWO

Literature Review

Botany in Biology Education

Zoo education is a reflection of education both in and outside of the classroom. Therefore, an understanding of how botany is integrated into biological curricula in classroom education and mainstream culture must precede understanding of how botany is presented in zoo education programming. In 1992, the National Research Council, responding to an academic request, published its findings on the state of plant science research in the United States. The report, entitled *Plant Biology Research and Training for the 21st Century*, profiles why and how plant science research should be enhanced. The executive summary states, “research in and teaching of the biology of plants have been insufficiently emphasized and that plant biology has become isolated from the mainstream of biology” (Commission on Life Sciences, 1992). Eugene Bozniak of Weber State University states, “It is fair to say that botany is unfamiliar to the average citizen” (1994, 42).

In recent years, biology has become the curricular umbrella for botany, zoology, and the natural sciences in schools. However, botanists assert that biology curriculum is biased against plants, favoring animals instead. David Hershey (1996), a biology education consultant, citing five decades of research, concluded that plant neglect is widespread in biology curricula at all levels (Greenfield, 1955; Kurtz, 1958;

Taylor, 1965; Walch, 1975; Honey, 1987; Flannery, 1991; Stern, 1991; and Uno, 1994).

The lack of botanical inclusion in curriculum begins early in the educational process. In a review of textbooks, field guides, and children's books for discussions of ecosystems, Patrick Kangas of Eastern Michigan University used animals as a representation of one of the many facets of an ecosystem. Kangas concluded that of the books he studied, university textbooks contained an average of four percent devoted to animals, whereas children's books had an average of sixty-one percent devoted to animals, a clear difference in the presentation of ecosystems to varying levels of instruction. Children's books place far more emphasis on animals, even when presenting complex systems like ecosystems (Kangas, 1990).

The imbalance of ecosystem component coverage also has been noted for high school level resources. In 1994, Gordon Uno of the University of Oklahoma studied six of the best selling high school biology textbooks. He determined that only fourteen percent of the chapters was devoted mostly or completely to the study of plants, including algae, biomes, and photosynthesis, whereas forty-two percent of the chapters was centered on animals. Thirty-seven percent of the textbooks concentrated on general biological principles that could pertain to both plants and animals; however, plants were not discussed in these sections (Uno, 1994). High school and introductory college biology textbooks lack botanical content, although botanical topics and concepts are present in four of five classified kingdoms of life (Bozniak, 1994). As reported in the *Journal of Biological Education*, John Honey conducted similar research, and concluded, "It is not difficult to demonstrate the limited place that plants occupy in the school curriculum today or the relative lack of interest that is shown in plants. At present, plants do not occupy as great a proportion of teaching time as animals" (1987, 185). Lack of information in textbooks leads to fewer students exposed and therefore interested in the subject of botany (Eshbaugh, 1989).

Based on the incomplete high school biology resources, it is no surprise that criticism exists at college-level textbooks or the number of teachers. The report from the National Research Council, *Plant Biology Research and Training for the 21st Century*, criticized the teaching materials, but also the paucity of plant biology teachers, and even offered a warning for the future of plant biology. "Unless the number of plant scientists in college and university biology departments is raised, many undergraduate and graduate students will never be exposed to plant biology" (1992, 39).

The previously cited studies addressed a passionately debated subject about biology curricula - whether or not ecosystems are fairly and accurately addressed at all levels. Botanists have cited these studies as an indication that botany is overlooked and replaced by a disproportionate emphasis on animals. Zoochauvinism, a term credited to Bozniak (1994), places disproportionate emphasis on animals and their role in the environment at the expense of plants, distorting the balance of biology. Other authors have documented that students prefer to study animals to plants (Greenfield, 1955; Dawson, 1983; Wandersee, 1986; and Inagaki and Hatano, 1996) Scientists debate if this preference is learned or inherent in humans. Marshall Darley, of the University of Georgia, argues, "If we feel that animals are superior, it is only because we are animal chauvinists" (1990, 356).

The role of botany within and separate from biology has been debated for the last century. David Hershey, Dorothy Rosenthal, and Rodger Bybee compiled a comprehensive timeline on the role of botany in biological sciences (Rosenthal and Bybee, 1988; Hershey, 1996). In the 19th century, scientists preferred the natural sciences, an encompassing umbrella that oversaw multiple disciplines. Zoology was introduced in 1849 (Downing, 1925), while botany was a required subject for secondary education students in the 1850s (Rosen, 1959). The British zoologist, Thomas Henry Huxley, is credited with the introduction of an integrated biology course that included zoology and botany in Britain in 1870 (Nichols, 1919). His student, H. Newall Martin, brought the changed curriculum to the United States, although the combined biology course did not endure, and many universities reverted to separate classes in botany and zoology. Interestingly, Nichols cites the inability of teachers to proportionately present both disciplines, as they relied more upon their training in zoology or botany and skewed teaching accordingly. At the turn of the century, botany was often taught as its own year or half-year course (Coulter and Caldwell, 1911). While botany enjoyed prominence as an independent discipline, complaints arose that too many botany textbooks existed (Beal, 1907). In the early 1900's, a passionate debate occurred in academic circles via a popular journal, *School Science and Mathematics*, about merging the disciplines. Despite the warnings from botanists, most universities blended botany into biology (Oliver and Nichols, 1998). Toward the end of the decade, educators were warned to avoid bias, indicating that the combined biology course was no longer theory, but practice. In 1919, Nichols documented the decline in the importance of botany, noting a "delusion" that biology is the study of animals. By 1920, botany had been firmly established as only a portion of biology, with biology being part of a four-year curriculum including physics and chemistry (Oliver and Nichols, 1998). Botany continues today as a segment of biology.

Discussion of the development of the biology curriculum is important, for it sets the basis for current educational standards and patterns at all levels of schooling.

In an article in the *Journal of Biological Education,* Honey advocates for higher levels of inclusion of botany in biology with careful consideration: “As science syllabi continue to change, the choice of criteria which are used to decide upon the inclusion or exclusion of different topics may be very significant” (1987, 188).

Federal and state guidelines now direct curriculum development in primary and secondary schools. Currently the National Science Education Standards address biological needs for growth and reproduction, heredity, and adaptation - all characteristics and traits applicable to both animals and plants (National Research Council, 1995). The language used includes ambiguous terms such as “living things” and “organisms” to describe both plants and animals. Although not directly excluded, the inclusion of botany is at the discretion of the individual schools and teachers, a situation that concerns individuals who believe biology is biased toward animals and presented by teachers who have been trained thusly.

Botany in Mainstream Culture

The trend to favor zoology over botany is also prevalent in mainstream culture. Several theories have been suggested as to why there is less emphasis placed upon plants than animals in general culture, even outside educational systems. In an attempt to explain the deficiency in both biology and popular culture, James Wandersee and Elizabeth Schussler founded the 15-Degree Laboratory in Louisiana to attend to “the current state of inattention to and under-representation of plants - not just in biology instruction, but also in U.S. society in general” (2001, 3). They coined the term *plant blindness* as “the inability to see or notice plants in one’s own environment… leading to the erroneous conclusion that they are unworthy of human consideration” (1999, 82), citing visual and perceptual evidence to support their claims. According to the two authors, the inability to perceive plants is an inherent characteristic of humans, although they have done much work to suggest ways to overcome the bias.

According to David Hershey, however, the physical limitations of human perception do not explain the lack of attention given to plants in science and popular culture. In his opinion, the belief that humans are genetically programmed to ignore plants is erroneous; he believes the disregard is learned, not inherent. Hershey states, “Much of the evidence could be used to support zoochauvinism and plant neglect as important reasons for plant blindness” (2002, 78), building upon a previous statement, “Zoochauvinism seems to be a major cause for plant neglect… Plants are absolutely essential to animal life so to consider plant study less important has no scientific basis” (1996, 343). Uno supports the idea that conscientious choice directs the inclusion or exclusion of botany:

> In fact, most of the process skills and conceptual knowledge are generic in nature; that is, they could be taught using either plants or animals as examples…. None of these necessarily includes or excludes the study of plants, but if an instructor is unfamiliar with botanical examples, human or other animal example will be used when addressing knowledge problems (1994, 263).

Regardless of whether botanical exclusion is learned or inherent, the situation merits concern. Authors cited additional limitations to inclusion such as lack of awareness of the importance, poorly referenced literature, existing biases and preferences in the teachers, lack of support in the National Science Foundation for research and publication, lack of application of biological concepts to plants, and uninspiring botanical activities and experiments (Hershey, 1992; Uno, 1994). Many authors have suggested methods of reinvigorating botany, placing primary responsibility on teachers of biology and botanists.

In general, the consensus amongst the critics of the level of botanical inclusion is that educators should present the important role and interesting traits of plants. As stated by Gordon Uno, "The need for understanding fundamental botanical concepts remains as important as ever because of the role plants play in the biosphere and in the lives of humans" (1994, 263). A more complete understanding for educators should include a variety of settings, both in and outside the classroom. In a guest editorial in *The American Biology Teacher*, Hoekstra wrote, "In our culture, animals outrank plants because of the way we present them" (2000, 82).

Education in Zoos

Environmental education programs effectively increase the amount of knowledge of environmental issues (Bright and Tarrant, 2002; Swanagan, 2000; Vaske and Kobrin, 2001; Reade and Waran, 1996). According to Volke and Cheak (2003), the effects of an environmental education program transfer through students to their parents and their community. Zoos serve as a natural venue for applied environmental lessons, as people can observe the related biological processes and relationships in an engaging manner. The message that is conveyed to the public from a zoo educational program needs to be conscientious and complete, as it may be transferred to the community (Miller et al., 2004). Eddie Mole, of the Bristol Zoological Gardens in the

United Kingdom, elaborates that zoos should “encourage a holistic view of nature that emphasizes the interactions between plants and animals and habitat conservation” (2000, 37). In *Nature*, O.J. Ollerton summarizes the necessity of comprehensive ecology education: “Studies of biodiversity often focus on species rather than on the interactions between them, interactions that are often essential to the maintenance of the species in a system” (1998, 726). In other words, messages about the environment or conservation are incomplete if only animals are represented.

Zoos continue to draw large crowds; their popularity allows a zoological message of conservation to reach wide audiences. According to Mole, the prevalence of younger audiences and families presents a “fresh and enthusiastic group of people to target with nature conservation messages” (2000, 37). In fact, in order to qualify for accreditation within the Association of Zoos and Aquarium, a zoo must have an active education program (AZA, 2006). The goals for educational programs in zoos include increasing awareness of environmental issues, building the connection between people and the environment, and creating a sense of responsibility transferable to the global environment.

Botany in Zoo Education Programs

The role that plants play within zoos is apparent in both natural and built areas, especially in settings that rely upon the plants as a starting point for design or identification. The plants growing in them identify biomes (e.g. deserts, grasslands, tropical rain forests) (Darley, 1990). Although clearly a driving force in zoos, where focus on biomes, or habitats, extends beyond education by forming the basis for enclosures, as well as landscape and architectural design, little research exists about the role of plants in zoos or in conservation therein.

Including botany in studies of habitat, environment, and conservation is important at every level and every venue of education. The messages need to be complete and connected to the larger systems of which plants play a major role. Paul Kangas concluded, “as in zoos, animals presented without their ecosystem context are anachronisms” (1990, 50). Zoos serve as a forum for introducing students and teachers to more comprehensive habitat curricula that include multi-facetted biological concepts, and ways to present plants in a manner that inspires consideration of connections and importance. As zoo educators continue to strive to make educational programs relevant to school groups, they must adapt the programs to reflect the accepted curriculum in those schools; however, zoo educational programs offer an opportunity to present connections between seemingly disparate concepts in an engaging manner. This can include linking botany and zoology in meaningful ways. Maura Flannery, department editor of *The American Biology Teacher*, concurred. Using Wandersee and Schussler’s theory of plant blindness as a basis, Flannery stated the historical context of using analogies with animals to study plants and wrote, “recent work is revealing a whole new set of similarities between plants and animals… plant/animal analogies may indeed be valid” (1999, 305). Presenting plants in a similar manner as animals opens new avenues for connections and interest.

Divisions between plants and animals need not be as distinct as they currently are. Multiple educators have created lessons that bridge the gap between plants and animals in biology. Teresa DeGrolier, professor in the Department of Biological Sciences at Bethel University stated:

> "Because several introductory biology curricula traditionally approach plants and animal biology as separate units or courses, it is quite likely that many students may not realize that plants generally have essentially the same physiological needs as animals and need to solve similar problems in coping with their environment" (2002, 45).

Zoo educators may find DeGrolier's conclusion inspiring, as well, "I am impressed by how much I have learned about animals when I better understand plants" (2002, 51). In a study of young children's recognition of commonalities between animals and plants, Kayoko Inagaki and Giyoo Hatano deduced that young children can classify characteristics that plants and animals share (Inagaki and Hatano, 1996). They cite cultural influences, and specifically list zoos, as a primary source of acquisition of the recognition of animal-plant commonalities. Tom Cottrell, of Central Washington University, affirmed that the connections may facilitate understanding, "relating the way a plant experiences the environment to how animals interact with the world seems to appeal to those students who are less interested in plants" (2004, 444). Ian Kinchin, of the School of Education Studies at the University of Surry, UK, stated "The study of plant relationships…may help reinforce a positive view of plant interactions and counteract students' perceptions of plants in the school laboratory as organisms that 'don't do anything' " (1999, 91).

Integrating horticulture in zoo education curriculum achieves more than equal biological representation, it presents a more complete picture of what must be done in order to save habitats. In other words, advocating or teaching of the conservation of any animal in its natural habitat is ineffective if the importance of the habitat is not taught concurrently. As Mole stated, "There is no point in planning a reintroduction of golden lion tamarins, for example, if the appropriate habitat is no longer there to support them" (2000, 37). Additionally, using a format and setting that is engaging can connect ideas of how both plants and animals survive in their environments, thus raising the level of awareness of basic biological knowledge.

The research indicated that there is room for improvement in the way that botany is incorporated in biology education. The responsibility need not rest entirely with biology instructors in traditional education settings, as many authors have advocated. There is potential to teach botanical concepts concurrently with animal concepts in a manner that is inspiring and engaging. Presumably, the enthusiasm that visitors display at the zoo can be harnessed and redirected to excitement about how plants survive in the same environments.

CHAPTER THREE

INTERNET SURVEY

Methodology

The level of exclusion or inclusion of botany within zoo education programs was examined in this research via an original survey instrument (Appendix A, page 634). The survey was aimed at understanding which zoo education classes included plants, if any, and to what level, and what might hinder the inclusion of plants in curriculum. Additionally, the researcher sought to discover if people working in the field of horticulture were involved in the development of biology curriculum. Zoo education departments offer classes to both adults and children; however, the researcher designed the survey to focus on classes offered to school-aged children in light of the results from the literature review. The survey consisted of twenty-eight questions. Three introductory questions opened the survey. The next thirteen questions sought to ascertain the level of inclusion of horticulture in specific classes. Four questions sought to uncover additional information about class development and presentation. Eight demographic questions concluded the survey. The graduate committee members and two additional educators reviewed the survey. It was submitted to the Human Subjects Review Board of the Office of the Vice Provost for Research at the University of Delaware, who considered it exempt from full-board review (See Appendix B, page 70).

The survey targeted education staff of AZA-accredited zoos in the United States, as they would best understand the educational programming. The desired number of respondents was not determined in advance, but the anticipated rate was a sample reflective of the 210 zoo education departments in the United States.

The survey was posted online using the service of "www.studentresearcher.com." The website was programmed to stage the survey, offering select parameters for responses to the questions. Respondents remained anonymous. The survey was password protected to ensure that the data remained available to a specific population and only reflected the answers of the participating group of individuals.

The researcher sent a request to a listserv designated for educators within AZA to fill out the survey. On December 16, 2005, the AZA Education listserv had 689 members representing 210 accredited zoos and each member institution had at least one person on the listserv (personal communication Eric Reinhard). A reminder was sent to the listserv three weeks later, and two weeks after that, a final request was sent to the listserv. In addition, the researcher emailed members of the AZH to request that the link for the survey be sent to staff in the education department. The survey was closed after eight weeks of activity.

Results

One hundred responses were collected. The University of Delaware StatLab was enlisted for assistance in data analysis. and the StatLab staff agreed that given the survey context, items left blank for questions five through sixteen (Appendix A, page 64) could be filled in with zeros, indicating either "no horticulture included" or “class not offered”. This occurred in one hundred and eighteen of the possible answers for questions five through sixteen. Additionally, of the one hundred survey responses, four answered only the first three questions. Based upon the answer to the second question, the incomplete surveys reflected that the respondents did not report a horticulture presence in their programs and therefore the remaining answers would reflect no horticulture. Because these were considered reflective of the actual responses, the surveys were considered in the totals.

A significant methodological error was discovered for questions five through sixteen after the survey responses were compiled. Respondents were asked to rank the inclusion of horticulture in twelve different classes, yet two different sets of instructions were given. The program did not provide an option for responders to indicate that their institution did not offer the specific class listed. The response set offered by the computer program only offered a Likert scale option with a value of one indicating low inclusion of horticulture. The directions entered by the researcher asked the respondent to select a value of one to indicate the class was not offered. Continuing the discordance, a value of two in the web-based setup would, by inference, equal slightly more horticulture than a value of one. The researcher instructed respondents to use a value of “2” to indicate “no horticulture” in a class that was offered. One hundred and eighteen responses were left blank, and no direction was given to indicate what that might signify. Because of the discrepancy in directions given, not all the numerical values can be equally interpreted. The confidential method of data collecting meant the respondents could not be contacted to ask for clarification.

However, the answers fell into two categories, as opposed to the original six. The lower data points (no answer, 1, and 2) were combined to score a “no or low” inclusion of horticulture in curriculum. The higher data points (three, four, and five) were used to indicate a “medium-to-high” level of horticultural inclusion. Although this method of reporting did not yield as detailed information as the six-point scale would have, there is still merit in the groups of values. The data set was retained and no further inferences were made beyond the responses collected.

After the error was discovered, consultation with a University of Delaware statistician determined that in-depth statistical analysis would not be helpful in this application, and that simple reporting of the findings was the most appropriate analytical method for the data. This limited the usefulness of the demographic information, as categories could not be statistically compared, nor could general pronouncements be made for the inclusion of horticulture in zoo education programs. However, the survey was valuable in that it reflected the responses of one hundred individuals in the zoo education community on this topic. Following are the results and the discussion for the responses received. Demographical information on the responders is provided in Appendix C, page 72.

Table 1. Responses to Questions 1 – 3.

(Question Number) Descriptive Characteristics of Respondents	Percentage of Respondents
(1) For which department of the zoo do you work?	
Education	83
Horticulture	13
Administration	2
Animal Care	1
No Response	1
(2) Is horticulture (plant information) taught in your educational classes?	
Yes	87
No	13
(3) If yes, please choose the following:	
Stand-Alone Class	46
Component of Animal Class	14
Both	24
No Answer	16

Question 1: For which department of the zoo do you work?

The intent of the question was to distinguish the survey respondents' perspectives on the answers to the subsequent survey questions. No position descriptions were given and the categories were left vague with the hopes that the respondents would select the category that best fit their role in the organization (Table 1). The questions on eighty-three percent of the surveys were answered from the perspective of someone who works in the education department. The remaining sixteen percent (the combination of horticulture, administration, and animal care) may have access to the desired information; however, it is questionable if the respondents have a full understanding of what the education department offers. One respondent did not answer.

Question 2: Is horticulture (plant information) taught in your educational classes?

The question aimed to allow the respondent to state whether or not horticulture was included. (See Table 1.) This provided a baseline that could be compared to later answers. Eighty-seven percent answered in the affirmative. The intent of this question was to encompass a broad definition of horticulture; however, it may have been confusing. The parenthetical explanation of plant information may not have been adequate, as some respondents may have used an "art and garden" definition of horticulture, as opposed to considering horticulture as botany and part of biology. Additionally, the high percentage of affirmative responses (eighty-seven percent) may reflect the survey's bias. Individuals who already recognize horticulture's role in biology, and therefore integrate it into their education curriculum, may have taken the survey. Finally, the thirteen percent who answered "no" still took the survey, and answered some of the subsequent questions in the affirmative, perhaps indicating that the initial reaction to whether or not horticulture was included was incorrect. The same question at the end of the survey may have been an effective way to measure change in opinion or to more accurately reflect the role of horticulture in educational classes. The number of respondents indicating that horticulture was taught in educational programs strongly suggests the presence of horticulture in zoo education programs at the respondent's respective zoos.

Question 3: If yes, please choose the following: Stand-alone classes, Components of an animal class, or Both

The intent of this question was to ascertain how respondents integrated horticulture into their educational programming. (See Table 1.) Forty-six percent of the respondents indicated that horticulture is taught as a stand-alone class. Fourteen percent indicated that their institutions offer classes that specifically focus on horticulture. Twenty-four percent selected both, indicating that horticulture is taught both as stand-alone classes and as a component of animal-based classes. Sixteen percent gave no answer.

A strong presence of horticulture was indicated by the eighty-four percent who answered in the affirmative (all answers other than no answer). This percentage is just slightly smaller than the percentage for the previous question, reiterating the role of horticulture in educational programming. Overall, this high response rate indicates an important role of botanical content in zoo education programming.

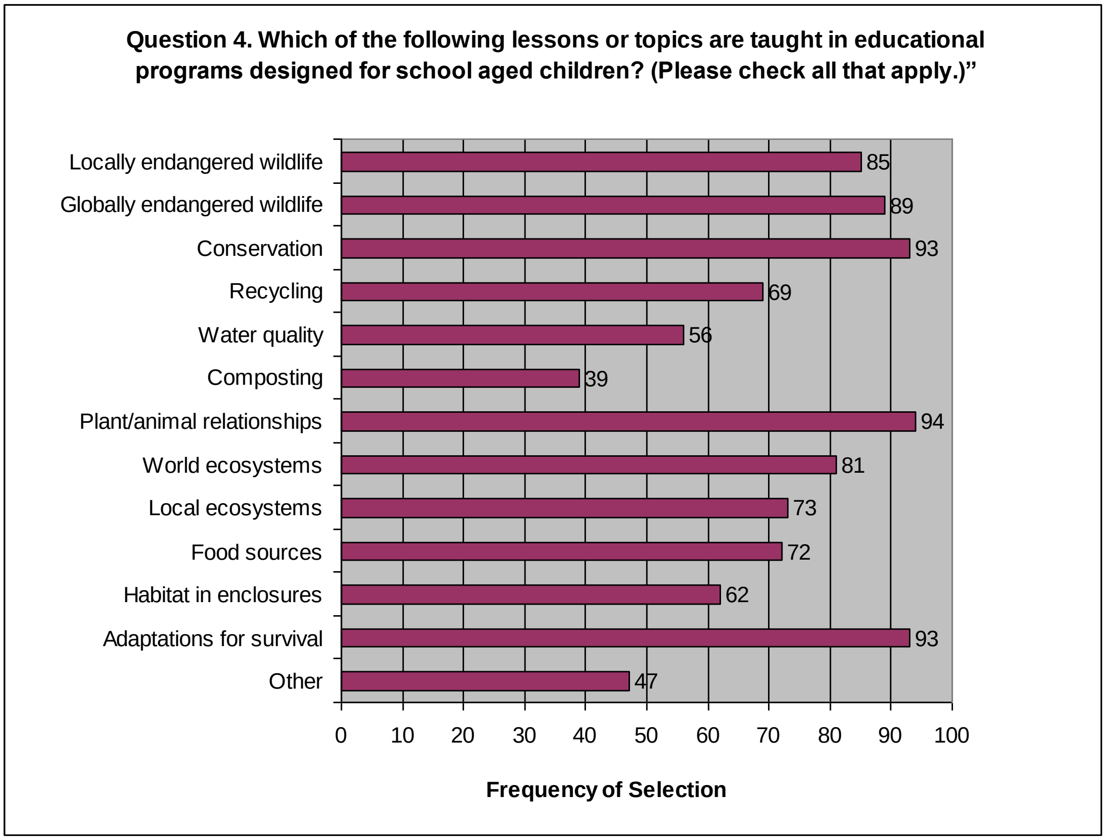

Figure 1- The frequencies of responses to Question 4.

Question 4. Which of the following lessons or topics are taught in educational programs designed for school-aged children? (Please check all that apply.)

This question served as a baseline to determine what types of classes were taught in zoo education programs, see Figure 1. The classes with the highest number of respondents were 'Plant/animal relationships' (ninety-four percent) and 'Adaptations for survival' and 'Conservation' (ninety-three percent). Eighty-nine percent of the respondents chose 'Globally endangered wildlife', closely followed by 'Locally endangered wildlife' at eighty-five percent. Eighty-one percent of respondents indicated that they taught lessons on ‘Global ecosystems’, with seventy-three percent indicating that they focused on ‘Local ecosystems’. Seventy-two percent offered classes that focus on ‘Food sources’. Sixty-nine percent offer classes on ‘Recycling’ and sixty-two offer classes on ‘Habitat in enclosures’. Fifty-six percent included lessons on ‘Water quality’. Forty-seven stated that they offer classes that were not on the list. Thirty-nine percent of respondents indicated that classes on ‘Composting’ were offered.

The researcher created the list, with the assistance of the committee guiding the research. The intent was to capture an overview of what was occurring in zoo educational programs and to set the stage for the subsequent questions. Therefore, the goal was not to create a comprehensive list of all classes occurring in zoos, and no mention was made of horticulture. The majority of the class types do hint at the overlap in the plant and animal kingdoms; for example, it is difficult to talk about endangered wildlife or ecosystems without addressing plants and animals. Several of the classes, however, leave little room to discuss plant-centric topics, such as ‘Recycling’. The question affirmed what was occurring in zoo education programs and steered the researcher toward what might be a possible basis for a class containing horticulture. The high response rate of ‘Adaptations for survival’ and ‘Plant/Animal relationships’ steered the creation of the class developed for the Philadelphia Zoo.

The popularity of some of the class types reflected current trends in education. Endangered wildlife and conservation were anticipated to be high, as those are popular themes in educational programming. The popularity of adaptation-based classes were expected, as well. Areas for future study could include using the same list to test what is popular in botanic gardens or nature based collection institutions.

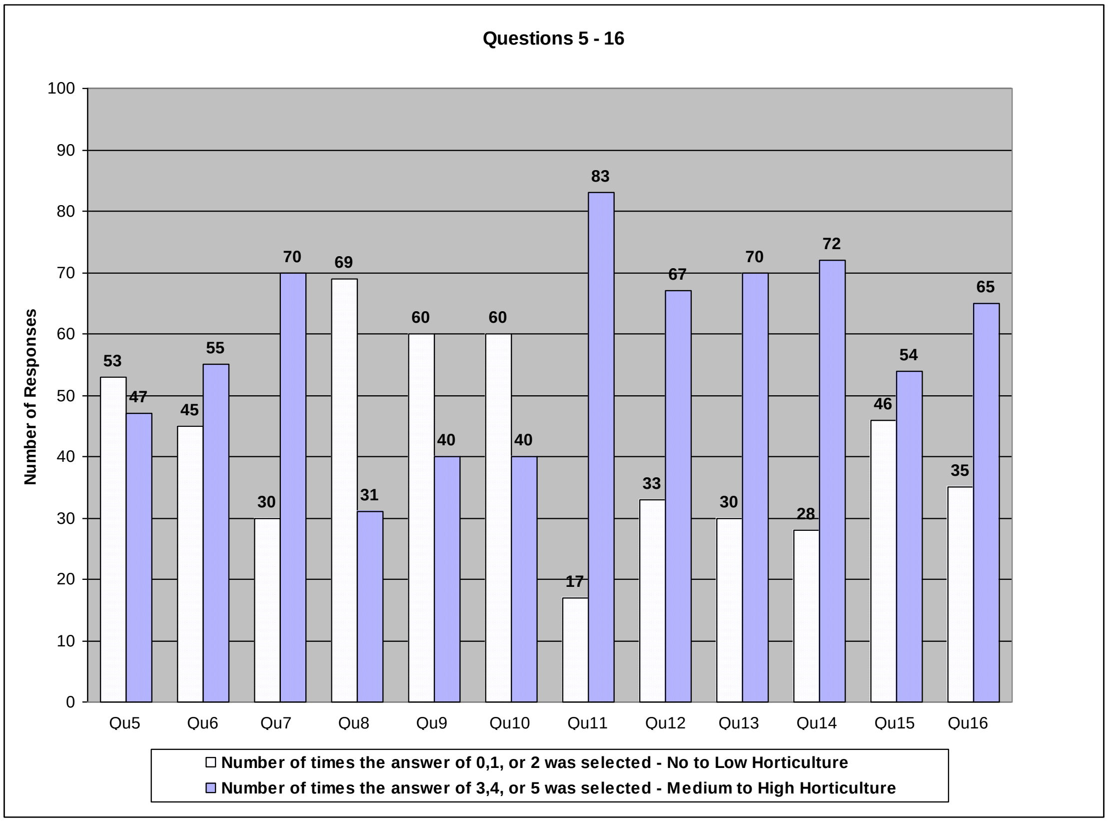

Figure 2- Responses to Questions 5 – 16.

Question 5 - Locally endangered wildlife
Question 6 - Globally endangered wildlife
Question 7 - Conservation
Question 8 - Recycling
Question 9 - Water quality
Question 10 - Composting
Question 11 - Plant and animal relationships
Question 12 - World ecosystems
Question 13 - Local ecosystems
Question 14 - Food sources
Question 15 - Habitat in enclosures
Question 16- Adaptations for survival

Questions 5 – 16. "For questions 5 – 16, please indicate the level of horticulture information included in the following lesson topics."

This question was the focus of the research; the intent was to gauge the level of inclusion of horticulture in educational programming. Due to a conflicting set of instructions, the numbers could not be interpreted on a six-point scale, as was originally intended. Instead, the answers were combined into two categories. Scores of zero, one, and two were combined to create a "no- low" inclusion category and scores of three, four, and five were combined to form a "medium- high" inclusion category for horticulture content in zoo curriculum, as is shown in Figure 2. Horticulture was expected be a major component in classes that address a complete approach to understanding animals or preserving the environment, and not occupy a major portion in classes that pertain only to animals.

Overall, fifty-eight percent of respondents indicated a medium-to-high level of inclusion of horticulture in their programs, which is the average of medium-to-high responses across all questions. The no- low horticulture category yielded an average score of forty-two percent when averaged across all questions. Eighty-three respondents indicated that 'Plant and animal relationships' contained a medium-to-high level of horticulture. Seventy-two respondents indicated that classes on 'Food sources' contained a medium-to-high level of horticulture. Seventy respondents ranked both 'Local ecosystems; and 'Conservation' classes as containing medium-to-high levels of horticulture. Sixty-seven and sixty-five respondents placed 'World ecosystems' and 'Adaptations for survival', respectively, in the medium-to-high category.

The six courses listed above all received a high percentage of respondents indicating that horticulture was included in a medium-to-high level. These are classes that would be expected to include horticulture, especially the ‘Plant and animal relationships’ course. Plants fill significant roles in the classes that pertain to animal survival, and would be expected in a discussion on food sources. Plants also occupy a significant niche in the ecosystem. Horticulture was not expected to be included to a medium-to-high level in the class on adaptations, as the researcher anticipated a bias against pants or lack of knowledge about plant adaptation. However, the inclusion is encouraging for the state of biological discussions in zoo education programs.

‘Habitat in enclosures’ and ‘Globally endangered wildlife’ had respondents almost equally divided. In the previous question, sixty-two respondents indicated that they offered courses on enclosure habitats, of these, slightly more than half (fifty-four percent) noted that the courses contained medium-to-high levels of horticulture. Of the eighty-nine percent offering ‘Globally endangered wildlife’, a similar percentage (fifty-five percent) had a horticulture focus. Both of these courses have a strong horticultural component and are difficult to imagine without a discussion of the role that plants play.

For the topics ‘Locally endangered wildlife’, ‘Recycling’, ‘Water quality’, and ‘Composting’, respondents choose no- low levels of horticulture inclusion more frequently than medium-to-high levels of inclusion. In the previous question, eighty-five, sixty-nine, fifty-six, and thirty-nine respondents, respectively, indicated that the classes are presented in zoo curricula. Therefore the possibility of the class not be offered does not explain the low scores. The exclusion of horticulture was anticipated in the ‘Recycling’ category, but is surprising in the others. Plants play a major role in composting and water quality. More information is emerging from scientists about the critical function plants play in the biological processes of composting and water purification. A no- low score in the category of “locally endangered wildlife’ is an opportunity for discussion of the indigenous plants in the students’ own surroundings that are threatened with extinction.

Overall, the results are more encouraging than was originally anticipated. Upon visual analysis, the graph indicates a medium-to-high level of horticulture. Ideally, horticulture would be included in a high level in more classes, especially in categories such as local and world ecosystems (questions 5 and 6) and locally and globally endangered wildlife (questions 12 and 13). Based on the answers of the survey respondents, horticulture or botany is included in zoo education curricula; however, there is room for increased inclusion in many courses.

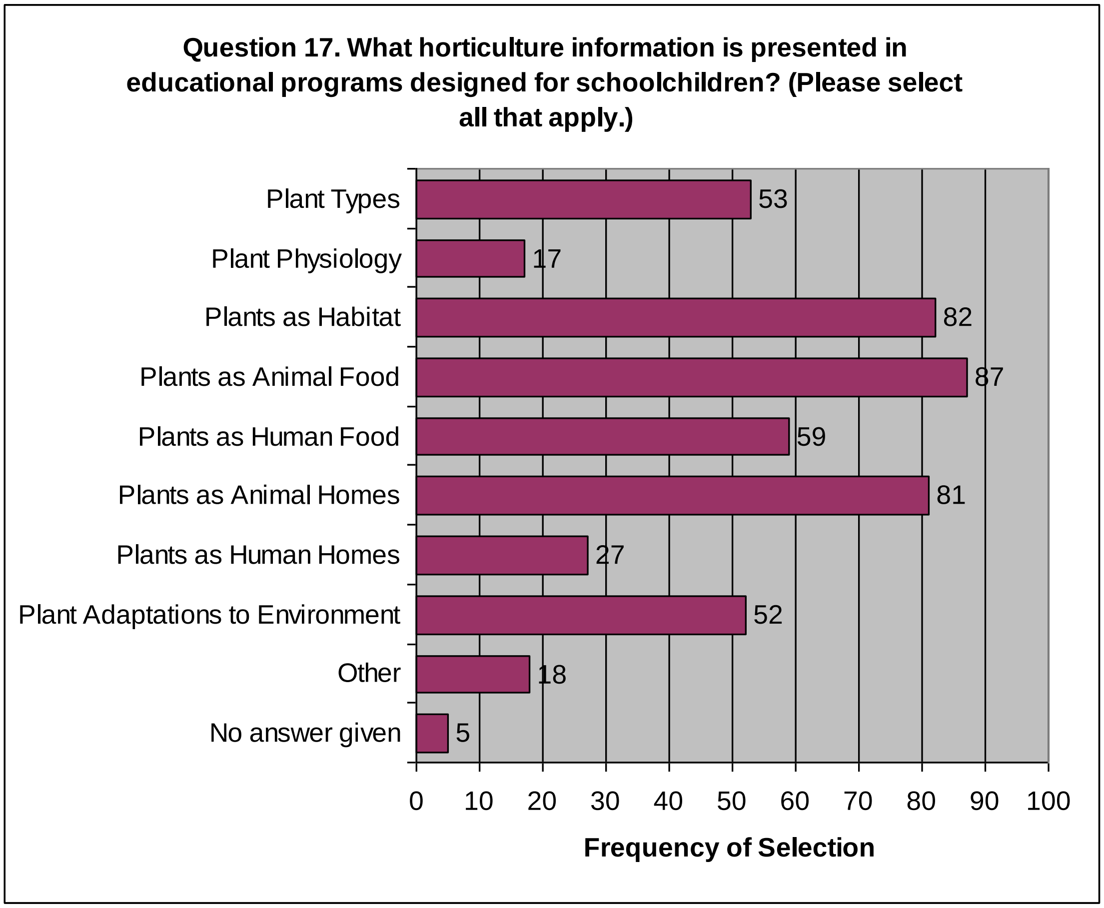

Figure 3- Responses to Question 17.

Question 17. What horticulture is presented in educational programs designed for schoolchildren? (Please select all that apply.)

This question sought to understand what aspects of horticulture were included in the educational classes. Respondents were able to choose more than one response. The categories presented a range of what could be taught in a zoo setting, offering an array of topics that would be used to portray plants as independent entities or provisions for animals, see Figure 3 above. ‘Plants as Animal Food’, ‘Plants as

Habitat', and 'Plants as Animal Homes' received the most responses, eighty-seven, eighty-two, and eighty-one percent, respectively. 'Plants as Human Homes', 'Plants Types' and 'Plant Adaptations to Environment received fifty-nine, fifty-three, and fifty-two percent, in that order. Twenty-seven percent of respondents indicated that 'Plants as Human Homes' were offered in their educational programming. Seventeen percent of respondents selected 'Plant Physiology' and eighteen percent of respondents choose 'Other'. Five percent of participants opted not to answer.

The highest categories selected, 'Plants as Animal Food', 'Plants as Animal Homes', and 'Plants as Animal Habitat', confirm that plants are presented as supporting roles for animals. This is consistent with the findings from the literature review. In many settings that have a biological emphasis, and especially in zoos, plants are perceived and presented as a means to sustain animals. The categories that pertained to the botanical aspects of horticulture ('Plant Adaptations', 'Plant Physiology', and 'Plant Types') were added to ascertain how many zoos were presenting the botanical aspects of plants, rather than the solely the supportive role implied by inclusion in the animal-based classes.

Fifty-two percent of respondents chose 'Plant Adaptations to the Environment'. However, this is confusing because only seventeen respondents indicated that they teach 'Plant Physiology', which would include plant structure, or manifestations of various adaptations to environmental conditions. Further research could ascertain what is being taught in these classes and clarify discrepancies.

Fifty-nine respondents indicated that they discuss 'Plants as Human Food' and twenty-seven respondents indicated they teach 'Plants as Human Homes'. This topic could merit future research to further understand biology in the zoo setting and whether or not humans are presented as animals.

The categories that respondents choose the most frequently indicate the current focus of zoo education programs. The data set the stage for a class that can be developed that uses the existing paradigm to present plants.

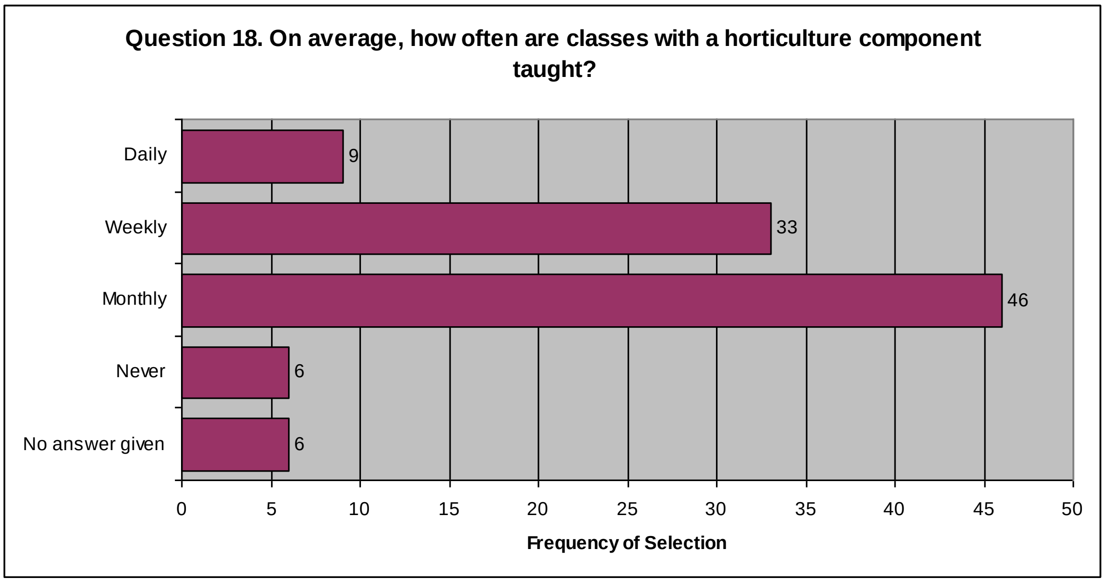

Figure 4- Responses to Question 18.

Question 18. On average, how often are classes with a horticulture component taught?

The intent of this question was to determine how often classes were taught, see Figure 4. Zoo education classes occur several times a day, as active education programs are a requirement for accreditation within AZA, as stated on the AZA Web site. Forty-six percent of respondents indicated that their institutions present classes with a horticulture component monthly. Thirty-three percent indicated that horticulture is included on a weekly basis. Nine percent responded that on a daily basis, classes with a horticultural component are presented. Six percent chose never and six opted not to answer. These results are in line with what was anticipated.

Due to slightly confusing descriptions and too many choices, the researcher reduced and reassigned the categories after the responses were submitted. (See Appendix A for original categories, page 64.) A better way to ascertain the frequency of horticultural presentation would be to assess the content of the classes, such as surveying percentage of inclusion. Additionally, more clarity could have been obtained by asking how often animal-based classes are offered as a comparison. The responses to question eighteen are in line with the findings of the previous questions and the hypothesis that horticulture does not play a prominent role in zoo education. More information on a more frequent basis about the crucial role that plants play in the environment and as support for animals should be integrated into zoo education classes.

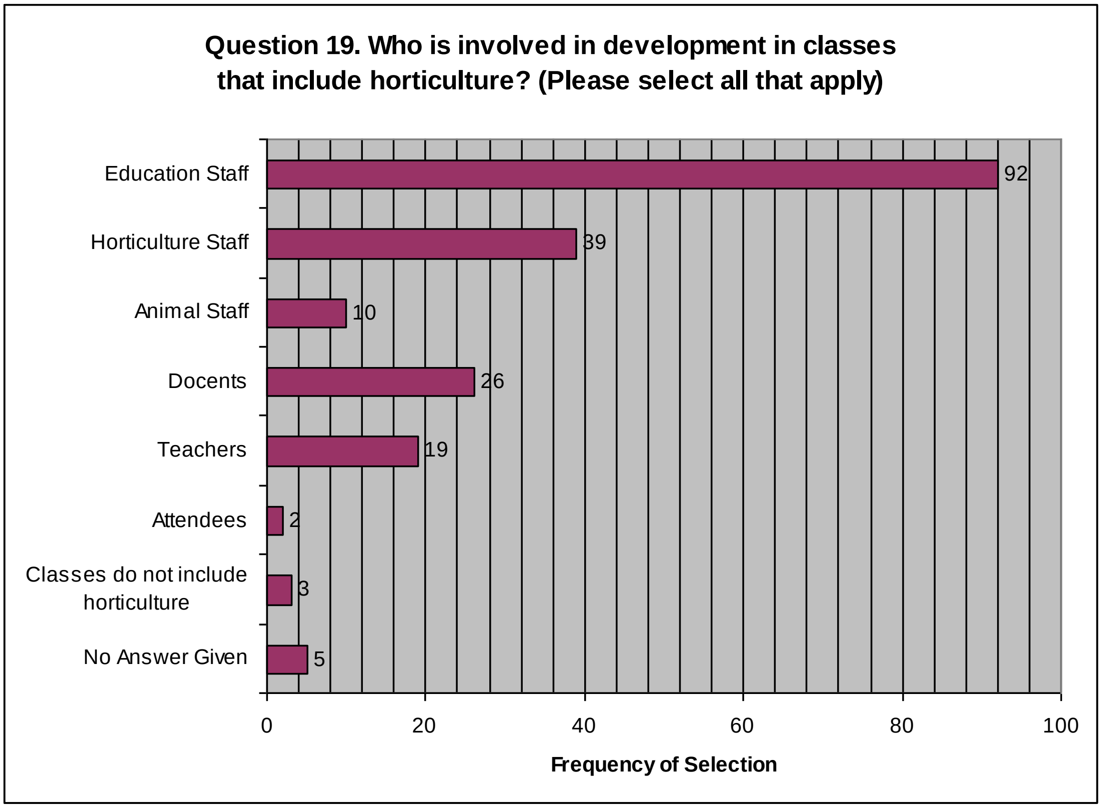

Figure 5- Responses to Question 19.

Question 19. Who is involved in the development in classes that include horticulture? (Please select all that apply.)

This question was one of the key components of the survey; it sought to test the hypothesis that education staff were primarily responsible for designing educational programs that included horticulture. As indicated in Figure 5, respondents could choose more than one answer. Not surprisingly, ninety-two percent of the respondents indicated that classes are created by education staff. Thirty-nine percent selected 'Horticulture staff'. Twenty-six percent of respondents indicated 'Docents'. Nineteen percent indicated that 'Teachers' are involved in the development of classes that include horticulture. Ten percent indicated that 'Animal Staff' assisted with the development. Three percent selected that their institutions offer classes that do not include horticulture, and five opted not to answer.

As anticipated, education staff members are primarily responsible for the content of classes containing horticulture within the institutions represented in the survey. It is presumed that education staff would primarily have a basic training in biology, which was shown to be biased against botany or horticulture. Ten percent indicated that staff working primarily with animals play a role in developing classes. An interesting follow-up would be to ask the same questions of animal-based programs in order to determine the role of animal staff members. .

The researcher hypothesized that the role of horticulture staff would be higher. Do the education staff and the teachers have a learned bias against botany? If a learned bias against botany in biology curricula exists, the classes created would reflect that. As in previous questions, the number of respondents who answered is higher than the initial thirteen percent who indicated no horticulture in education programs.

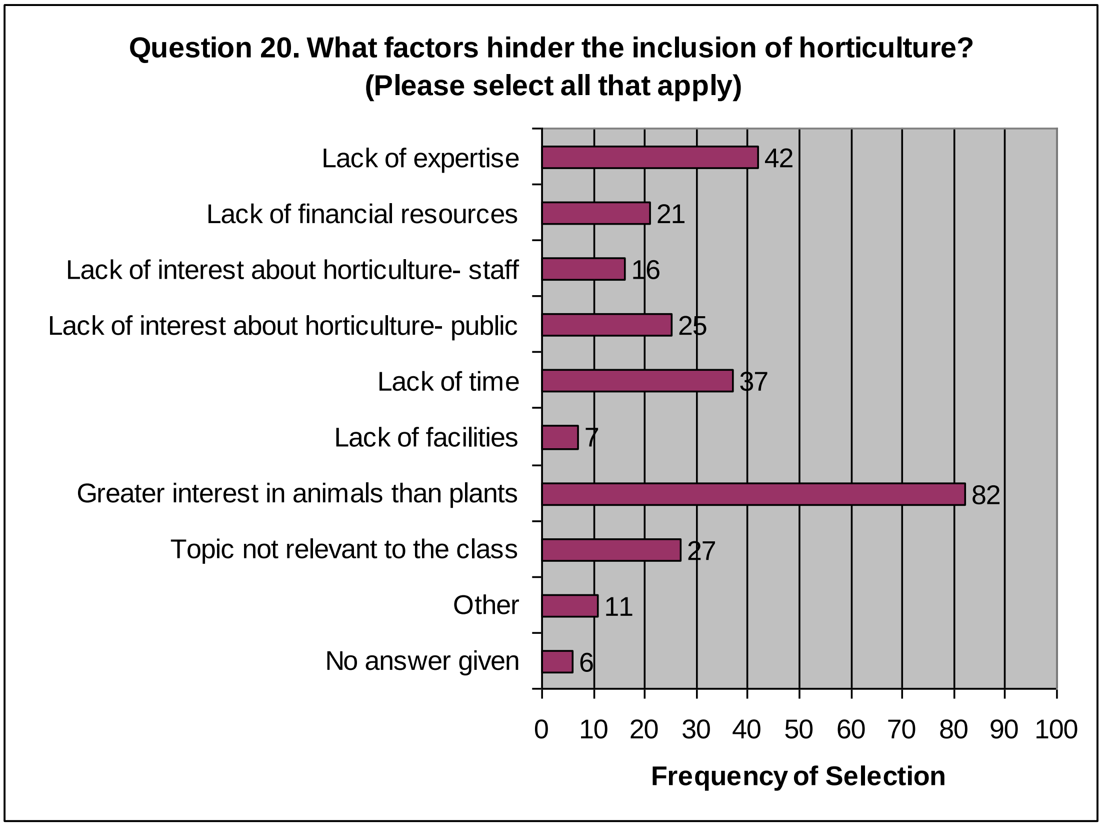

Figure 6- Responses to Question 20.

Question 20. What factors hinder the inclusion of horticulture? (Please select all that apply.)

The intent of this question was to test directly the hypothesis of the researcher; that a bias against horticulture existed and staff did not understand why or how to incorporate botany into the classes. See Figure 6 for results. Not surprisingly, 'Greater interest in animals than plants' is cited as the leading cause of exclusion, eighty-two percent chose it. This perception was anticipated, given that zoos are expected to focus on animals, although the shift is being made to having zoos present animals in a larger context (Miller et al., 2004). When broken into components, the respondents did not indicate who had a greater interest in animals than plants, the two 'Lack of interest' categories, public and staff, were selected twenty-five and sixteen times, respectively. These two categories combined to only forty-one percent, less than the eighty-two percent that indicated a greater in animals than animals. This did not fully answer the question of who was less interested in plants than animals.

The answer 'Topic not relevant to class' did not figure prominently, receiving only twenty-seven responses. The researcher anticipated that more people would not link the horticulture topics to the animal topics, and suggests horticulture was considered to be relevant to classes for seventy-three of the respondents. Likewise, neither 'Lack of financial resources' nor 'Lack of facilities' figured prominently, having been selected twenty-one and seven times, respectively.

'Lack of expertise' is cited as the second leading obstacle to inclusion of horticulture, with forty-two responses, and 'Lack of time' is the third, with thirty-seven responses. This matches the hypothesis of the researcher that education staff lacks the training and the time to learn about horticulture in order to include it in education classes.

Responses to questions 21-28 can be found in Table 4 (Appendix C, page 72). The questions provided information about the size of the zoos, number of staff and education program participants, and budgetary data. While providing an interesting insight into education programs in zoos, these provide little relevance to the questions posted without the ability to statistically analyze and compare the results. Future research should probe the connections between the demographic factors and the responses to the first twenty questions.

Survey Discussion

Original survey design was guided by standards from the committee steering this research. Upon survey completion, methods suggested by Schonlau, et. al. (2002) and Dillman (2007) shed light on interpretation of results.

Throughout the survey, the definition of “horticulture” was only clarified as ‘plant information’. While this was intended to allow a broad and inclusive definition that encompassed many factors, not providing a more complete definition provided a broad base of interpretation. In some cases, it appeared that the respondents were relying upon the definition of horticulture that pertained to gardening, at other times the botanical interpretation seemed more likely.

The respondents were recruited through convenience sampling within a closed population. Respondents could self-select into the survey, although only by being recruited to do so. Password protection on the survey allowed the researcher to restrict the number of responses, but posting the request to two listserves allowed anyone on the listserve to respond (Schonlau, 2002). The researcher sought to target zoos in the United States primarily, but did not clarify that in the survey or the requests for participation; therefore, the survey may include information from outside of the United States. While scientific significance of convenience sampling response rates is debated (Schonlau, 2002), there is value in gathering this information. Trends and observations may be drawn from the responses, but those conclusions cannot be extrapolated to include the entire zoo education population. To increase response rates, a dual-mode strategy for contact for notification was implemented via listserve and personal email (Dillman, 2007; Schonlau, 2002).

Measurement errors occur when answers to a question are inaccurate, imprecise, or cannot be compared in any useful way to other answers (Dillman, 2007).

Within the measurement error in this survey, there were two areas of concern. The respondents who completed the survey may have been more likely to have horticulture programs or consider horticulture as an important component of zoo education programs. Conversely, it was also possible that respondents who did not consider horticulture to be an important component of zoo education programs may not have completed the survey. Thus, the scores might be skewed higher than what is actually occurring in the zoo education community.

Schonlau concurred as to the importance of reduction of measurement error and outlined the second, and most significant, area of concern within the survey. He asserted that most people do not read the entire content of questionnaires in a thoughtful way; respondents take clues and skip words (2002). Pertaining to questions 5- 16, it is unknown how many respondents read the instructions given by the researcher versus those offered by the Internet site. However, pooling the data from those questions into two essential categories, from the original six-point scale, offers simplified assessment of trends and clarifies the extremes in response. For instance, a respondent's choice between medium-to-high versus high is not as meaningful as the distinction between low versus high.

Through the lack of assistance on how to provide answers, higher levels of frustration may lead respondents to provide less thoughtful or no answers, thus reducing the quality of data (Schonlau, 2002; Dillman, 2007). With the assistance and guidance of the StatLab at the University of Delaware, the researcher changed the answers left blank into "zeros," assuming that the blank entries could be interpreted as no-low horticulture included for that data point. This occurred in one hundred and eighteen of the one thousand and six hundred items that were left blank. The surveys were intended to be anonymous unless participants chose to list contact information. Therefore, follow up on incomplete surveys was not entirely possible. The incomplete surveys remained in the study, with the answers left blank recorded as zero in questions five through sixteen or ‘no response’ for the remaining questions.

According to both Dillman (2007) and Schonlau (2002), Internet surveys have the potential to be faster, cheaper, better, and easier. It was faster to use the online format emailed to a listserv; the researcher did not have to find contact information for every individual, and information was returned in a database, minimizing time and sources for transcription error. The Internet survey had minimal costs by avoiding mailing costs and data entry time. Unanticipated technical problems in assigning directions led to unusable data, creating the need to devise a new way to interpret the data (Dillman, 2007). Initially, using an online format made the survey easier; however, it was not easier to decipher the answers after the error was discovered. Overall, using an online format was better, however the limitations proved greater than anticipated and modified interpretation of the survey.

Conclusions

Horticulture is more prevalent in zoo education programs than the researcher anticipated. Eighty-seven percent indicated in the response to the second question that horticulture is included, although the number of affirmative responses is higher throughout the survey. Fourteen percent of the respondents offered it as separate classes, forty-six offer it as components of an animal class, and twenty-four both teach horticulture-only classes and integrate it into animal classes.

It was apparent throughout the survey that plants are primarily considered as supports for animals. This supports conclusions drawn from the literature review that botany is secondary to zoology in biology, at least in the zoo setting. When asked if horticulture was included, some respondents indicated that it was not, however when broken into separate components (animal food, animal homes) respondents indicated that botany was represented in education programs. More specific questions throughout the survey may have helped people realize how pervasive botany was and, ideally, the respondents became more conscious of the significance of botany beyond a support role for the animals.

A future recommendation is to create correlations between the data in the survey and the demographic information and ascertain if there is a connection between likelihood of inclusion and budget, staff, visitation, or size of zoo. Additionally, follow-up questions, such as the inclusion of horticulture, could yield more conclusive insight to the definition of horticulture used by the respondent. Future studies should address how horticulture is included in classes. A follow up study could address how the role of animals is addressed in light of the findings of horticulture presentation.

Thirty-nine percent of the respondents reported using horticulture staff to assist in the development of curriculum. This is encouraging, but a recommendation from this project is to create a stronger role for horticulture staff in creating classes. Horticulture staff could offer input on why plants matter, some of the fascinating ways plants survive, or how animals and plants interact. Groups such as AZH and horticulture groups should be encouraged to share their knowledge with education staff. Using horticulture staff to assist would create an opportunity to overcome the second and third largest reported obstacle to the lack of inclusion of horticulture, lack of expertise and time. With thoughtful and engaging programs, the most frequently cited obstacle, lack of interest, can be overcome, as well.

CHAPTER FOUR

Application of Botanical Concepts in Curriculum

Spurred by the editorial comment, "We are all more interested in animals (than plants)" (Flannery, 1991), the researcher created a program highlighting botany in a zoo setting that could increase the focus on interesting features that plants embody. The lesson plan resembled nothing the researcher found in the course of preparing the literature review or the survey; the author was unable to find any references that highlighted similarities in adaptations between animals and plants. The researcher chose the Philadelphia Zoo based upon its solid reputation in the zoo education community, the opportunity to work with head of the Education Department and the chair of the Education Committee within AZA, and proximity to the University of Delaware. Additionally, staff and the board of directors were reconsidering the role of horticulture within the zoo and in the process of including horticulture in their mission statement. The zoo recently hired a horticulture consultant to work as a liaison with the education and horticulture departments, as well.

Methodology

Before developing a pilot class that integrated horticulture into existing animal-based curriculum, the education staff at the Philadelphia Zoo invited the researcher to review existing classes offered to grade school-aged children. Minimal horticulture was found to be included in the classes reviewed, even in broadly based classes that taught habitats and adaptations. From the researcher's review of existing offerings and discussions with staff, the class entitled "Habitat Hotel' was chosen for expansion (See Appendix D, page 75). The original lesson, written for grade levels two through five, highlighted adaptations that animals possess in order to survive in various habitats. The existing premise and structure of the class allowed the researcher to integrate botanical facts with the information about the animal adaptations. Additionally, the format of the class, profiling multiple habits as opposed to specific animals, allowed for a broad inclusion of varied plants and their means of survival.

The researcher concluded that highlighting similar adaptations in the behavior of plants and animals would frame the information about plants in a manner familiar to children, thus making plant adaptations more memorable. In accordance with the structure of other zoo education programs, the researcher reviewed the online state curriculum standards for the states of Pennsylvania and New Jersey in order to integrate the information at the appropriate grade level (See Appendix E, page 80). The researcher then reviewed children's literature to find references to plants or horticulture concepts. Multiple children's books and online websites provided information about plants (See Appendix F, page 83), but none directly addressed the similarity in adaptations between plants and animals.

Using children's literature, as well as federal and state curriculum standards, the researcher compiled a list of adaptations that plants utilize for survival, organized by habitat **(See** Appendix G, page 85**)**. Then, the researcher presented the topics to the education department staff at the Philadelphia Zoo. Zoo staff and the researcher reviewed the existing lesson for "Habitat Hotel" and developed a revised lesson plan, entitled "Habits and Habitats", using the list of adaptations as a basis. The revised lesson plan integrated information about how plants use similar adaptations in the same habitats profiled, following an identical format to typical classes presented at the Zoo (See Appendix H, page 90**).** Typical classes were forty minutes in length, with one or more presenters. In general, four to five different topics were presented per class, often using a single animal to illustrate each point. The researcher chose to present the components of the class that pertained to botany, while the Zoo educator presented the components that dealt with zoology. One educator was chosen to be the representative from the Zoo to ensure consistency between presentations. The researcher and the Zoo educator rehearsed the lesson multiple times in front of Zoo staff, who offered suggestions for enhancing the presentation. The educators chose animals that were reliably available from the animal staff to ensure that the class could be presented as planned. The researcher provided both living and artificial plants to coincide with the animals that were selected.

Classes were chosen in which to present the modified version of “Habits and Habitats” by convenience. The Zoo’s procedure allowed teachers to choose classes from a catalog listing that best met the needs of their students and coordinated with their class’s visit to the Zoo. The requested classes were matched with the availability of the Zoo educator and the researcher; second and fourth grade classes were chosen as the sample. Two presentations, to different grade levels, provided a better understanding of how the information would be received by the teachers and the students. The committee guiding this research determined that two presentations would be enough to convey the idea that horticulture could be accepted into a zoo education program, accepting the limitations of generalization the data would offer to the community at large. The effectiveness of the class was assessed via a Teacher

Satisfaction Survey given to the teachers at the conclusion of the class. (See Appendix I, page 97) The Philadelphia Zoo staff developed the survey to assess classes and the individual presentations; the survey was administered for every class presented at the Zoo. Answer options were on a modified Likert scale, allowing respondents to rate the amount that they agreed or disagreed with the statement. For the pilot course, a letter accompanied the standardized survey introducing the researcher and the purpose of the modified class. (See Appendix J, page 99) The teachers were asked to answer three additional open-ended questions:

1. Has your definition of the word ‘habitat’ changed? If so, how?

2. Please describe whether or not this class was helpful for your curriculum.

3. Are you likely to include horticulture or botany information in future teachings concerning habitat?

The additional questions served two purposes. The researcher wanted to assess the inclusion of horticulture in future classes and the understanding of the word ‘habitat’. The Zoo staff wanted to ensure that the class fit the educational needs of the teacher.

The Human Subjects Review Board of the Office of the Vice Provost for Research at the University of Delaware examined the survey and the accompanying letter and considered it exempt from full board review (See Appendix K, page 101**)**.

Results

As an incentive for competed Teacher Satisfaction Surveys, respondents received two complimentary tickets to Longwood Gardens. The results for questions that pertained to the lesson developed are shown in Table 2. Additional questions that did not apply to analysis of this particular lesson can be found in Appendix L, page 103.

Table 2. Select responses to the Teacher Satisfaction Survey

Survey Questions	Responses from Teachers	
	4th Grade	2nd Grade
The zoo program provided an exciting experience for my students	Agree	Strongly Agree
My students actively participated in the zoo program	Agree	Strongly Agree
My students were captivated by the zoo program	Agree	Strongly Agree
The zoo educator was informative	Strongly Agree	Strongly Agree
The zoo educator was entertaining	Strongly Agree	Strongly Agree
The zoo educator involved my students in the lesson	Strongly Agree	Strongly Agree
The zoo program was appropriate for my students' grade level	Strongly Agree	Strongly Agree
The zoo program provided a valuable learning experience for my students	Neither Agree nor Disagree	Strongly Agree

The fourth grade teacher selected wide-ranging answers, whereas the second grade teacher circled answers in a consistent manner. The fourth grade teacher chose "Neither Agree or Disagree" to the questions that pertained to the class as an integral part of the curriculum, meeting state standards, returning to the zoo for future programs, and providing a valuable learning experience for the students. However, the fourth grade teacher selected "Agree" when asked if the program provided an exciting experience for the students, if the students actively participated, and if the students were captivated by the program. The same teacher selected "Strongly Agree" for the questions that asked if the educator was informative, entertaining, involved the students in the lesson, and if the program was appropriate for the students' grade level. A final question pertaining to the zoo program being used as a reward for students' hard work was left blank. The second grade teacher rated fifteen of sixteen questions "Strongly Agree", a question pertaining to the program meeting expectations for meeting state education standards was left blank.

In summary, of the thirty-two questions, twenty-two of the thirty-two questions were answered in the affirmative. Nineteen were marked very positively with "Strongly Agree" and three were marked positively with "Agree". The teacher's opinion is not known for the question pertaining to state standards that was left unanswered. The eight questions that received answers below "Agree" and one left unanswered did not apply directly to the "Habits and Habitats" program.

Table 3. Response from teachers to open-ended questions.

Question	Response	
	4th Grade Teacher	2nd Grade Teacher
Has your definition of habitat changed? If so, how?	"My definition of habitat has not changed but has been reinforced."	"Yes – I have talked to my students about animal habitats, but never connected the concept to the habitats of plants."
Please describe whether or not this class was helpful for your curriculum.	"The class was very helpful because botany plays a considerable part in our grade four curriculum."	"This was an excellent class! I wish I knew more about the plant adaptations before the trip, but my students learned a great deal!"

Are you likely to include horticulture or botany information in future teachings concerning habitat?	"Horticulture information will be stressed to a greater extent in the grade four study of habitats. The class also was helpful since our school participates in the PA Hortic. (sic) Soc. Jr. Flower Show each year! Thank you!"	"Yes – thank you for the inspiration!"

Responses to the additional questions posed in the attached letter were also positive, as indicated in Table 3 (see also Appendix L, page 103). The first question was "Has your definition of the word 'habitat' changed? If so, how?" The fourth grade teacher responded, "My definition of habitat has not changed but has been reinforced." The second grade teacher responded, "Yes- I have talked to my students about animal habitats, but never connected this concept to the habitats of plants."

The second question was "Please describe whether or not this class was helpful for your curriculum." The fourth grade teacher responded, "The class was very helpful because botany plays a considerable part in our grade four curriculum." The second grade teacher wrote, "This was an excellent class! I wish I knew some more about the plant adaptations before the trip, but my students learned a great deal!"

The third question was "Are you likely to include horticulture or botany information in future teachings concerning habitat?" The fourth grade teacher responded, "Horticulture information will be stressed to a greater extent in the grade four study of habitats. The class also was helpful since our school participates in the PA Horticulture Society Junior Flower Show each year. Thank you!" The second grade teacher wrote, "Yes – thank you for the inspiration!" (See Appendix L, page 103 for full text of the questions and answers.)

Discussion

The answers given to the survey indicate that the elementary school teachers were pleased with the pilot lesson plan, which integrated botany and zoology in an engaging manner; and each stated that the class made an impact on how they will teach in the future. This indicates that the modified education program was well received, confirming in this small sample that botany can be accepted as interesting, informative, and fit well within a zoo education program. As an indication of approval from the Zoo educators, the class was added to the course offerings of the Philadelphia Zoo.

This lesson plan was developed as an example for presenting botanical information in an engaging manner within a zoo education curriculum. Limitations to extrapolating the research exist. By choosing a small sample size to which to present the botanically enhanced class, broad generalizations that botanical concepts can be integrated into zoo education programs must be made with caution. Methods to overcome this research limitation could include teaching the class more times and to a broader range of grades. Another evaluation method would be to evaluate the students directly. This method was not selected for this project due to constraints in the amount of time spent with the students, but could potentially yield more information concerning what was learned about botany during the class. An assessment of the perceptions of educators representing the Zoo would also yield more conclusive results. An additional evaluation method would be to test the lesson plan, or variants of, at additional zoos or venues that display and teach both animals and plants - such as nature centers. More evaluation will continue to enhance the lesson plan and the ideas for presenting botany in a manner designed for school-aged children. An additional suggestion would be to pose the three additional questions to teachers that received the lesson plan that was not modified.

Through this pilot class, it became apparent that plants need not be perceived or taught as merely supporting objects for animals. As indicated by the favorable responses from the elementary school teachers, the Zoo education staff, and the children in the classes, botanical concepts tucked into an animal class can be entertaining and engaging, as well as informative. Neither the teachers of the class nor the educators indicated that animal information was being underrepresented. Conversely, the information about the plants helped solidify and reinforce the lessons taught to the students about biological adaptations, as reported by the teachers. This lesson plan served to undermine the broad statement made by Flannery (1991), zoology need not be more interesting than botany. Understanding the interaction and adaptations of plants and animals leads to a deeper understanding of both. Botany has the potential to be engaging and stimulating, and can highlight biological concepts when taught concurrently with zoological curricula.

CHAPTER FIVE

CONCLUSIONS

From the review of academic literature, survey of zoo professionals, and pilot lesson plan, several clear conclusions arose.

First, botany deserves a place in complete biology education. According to botanists and some biology educators, there is a paucity of botanical involvement in educational programming, including within zoo education. Lessons of species survival and environmental conservation are incomplete if the critical role that plants play is omitted. Zoos provide an ideal setting in which botany can be presented within the existing educational programs.

More botany was included in zoo horticulture programs than the researcher hypothesized; however, there is still potential for greater inclusion and understanding. Lack of interest, the main reported hindrance to horticultural inclusion in curriculum, might be mitigated with the development of engaging and balanced educational programs. Using horticulture staff at zoos to assist in program development would create an opportunity to overcome the second and third largest reported obstacles to the lack of inclusion of horticulture, lack of expertise and lack of time.

Further research can be done in conjunction with the Internet survey that was completed. The existing study can be utilized to further understand the connections between the demographical information and the answers reported. A follow-up study could provide more insight into the multiple interpretations of the word “horticulture” by zoo education staff and school teachers.

Another conclusion that arose from the pilot course component of this research is that botany education need not be static and uninteresting. Plants need not be presented, or considered, as merely a support for animals. Classes can present botanical topics and facts in an engaging manner that meets the needs of zoo and school educators.

Biology educators from all venues of education should play a more active role in ensuring botany is represented in biological curriculum. Furthermore, botany educators can do a better job of finding creative ways to present botanical concepts. The pilot lesson created through this research only focused on one way to incorporate botany. Further research should be done on alternative and new ways to include botany in curriculum. Zoo educators should expand the concepts presented to fit horticulture into more classes, presenting more complex subjects appropriate to the age group. Additionally, this research focused on inclusion in only one facet of biology - adaptation. Botanical inclusion could be expanded into different areas of biology such as inter-species relationships, population studies, or conservation of habitat.

The list compiled by the author at the onset of the creation of the pilot lesson plan could be presented to zoo education staff in a format that educators can easily use. This will facilitate introducing more botany to class creation and presentation, and overcome the obstacles cited in the survey - lack of time and expertise. The study of adaptations could be expanded and made accessible to zoo educators.

Written and oral presentations of this thesis could be made at the American Zoo and Aquarium Association and Association for Zoological Horticulture (AZH). These groups have direct influence over the content of education programs at zoos across the nation. The researcher encourages members of AZH to consider their role in education and to build partnerships that will ensure botanical concepts will be included in zoo curriculum. Horticulture staff at zoos can assist by working with zoo educators to share their knowledge about botanical concepts.

Stronger alliances can be built between organizations with an educational biological focus. Increased involvement with botanic gardens and other organizations that promote horticulture could provide the support and expertise that zoo education programs need. Additionally, assistance from a zoo would invigorate and enliven programs at botanical gardens and nature centers.

Linda Calcamuggio of the Toledo Zoo succinctly stated the problem in citing the disparity between horticulturists that possess knowledge of botany and educators that know ways to present it. Great potential lies in finding bridges between these two groups to continue sharing the exciting world of plants!

Table of Appendices

Appendix

Appendix A

Internet Survey Questions

1. For which department in the zoo do you work?

Education

Horticulture

Administration

Animal

Other

2. Is horticulture (plant information) taught in your educational classes?

Yes

No

3. If Yes, Please choose the following

Stand-alone classes

Components of an animal class

4. Which of the following classes are taught in educational programs designed for school aged children? (Please check all that apply)

- Locally endangered wildlife

- Globally endangered wildlife

- Conservation

- Recycling

- Water quality

- Composting

- Plant and animal relationships

- World ecosystems

- Local ecosystems

- Food sources

- Habitat in enclosures

- Adaptations for survival

For questions 5 – 16, please indicate the level of horticulture inclusion included in the following lesson topics. (1= class not offered, 2 = no horticulture, 5 = almost all the information pertains to horticulture)

5. Locally endangered wildlife (plant and animal)

 1 = Little inclusion, 5 = Strong inclusion

6. Globally endangered wildlife

 1 = Little inclusion, 5 = Strong inclusion

7. Conservation

 1 = Little inclusion, 5 = Strong inclusion

8. Recycling

 1 = Little inclusion, 5 = Strong inclusion

9. Water quality

1 = Little inclusion, 5 = Strong inclusion

10. Composting

1 = Little inclusion, 5 = Strong inclusion

11. Plant/animal relationships

1 = Little inclusion, 5 = Strong inclusion

12. Global ecosystems

1 = Little inclusion, 5 = Strong inclusion

13. Local ecosystems

1 = Little inclusion, 5 = Strong inclusion

14. Food sources

1 = Little inclusion, 5 = Strong inclusion

15. Habitat in enclosures

1 = Little inclusion, 5 = Strong inclusion

16. Adaptations for survival

1 = Little inclusion, 5 = Strong inclusion

17. What horticulture information is presented in educational programs designed for school aged children? (Please check all that apply)

- Plant types

- Plant physiology

- Interconnectedness of plants and animals

- Interconnectedness of plants and humans

- Plants as habitat

- Plants as animal food

- Plants as human food

- Plant adaptations to environment

- Other

18. On average, how often are classes with a horticulture component taught?

Several times a day

Once a day

Several times a week

Weekly

Several times a month

Monthly

19. Who is involved in the development of classes that include horticulture? (Please check all that apply)

Education staff

Horticulture staff

Animal staff

Docents

Teachers

Attendees

Classes do not include horticulture

20. What factors hinder the inclusion of horticulture? (Check all that apply)

Lack of expertise

Lack of financial resources

Lack of interest about horticulture- staff

Lack of interest about horticulture- public

Lack of time

Lack of facilities

Greater interest in animals than plants

Topic not relevant to the class

Other- please explain

For questions 21 – 28, please give approximate numbers for data comparison.

21. Size of zoo (in acreage)

22. Number of staff in Education department (part time)

23. Number of staff in Education department (full time)

24. Overall operating budget

25. Annual Education operating budget

26. Annual visitation to the zoo

27. Annual visitation to education programs

28. Annual visitation to education programs – school-aged children

29. May I contact you for more information? Please include name and address where you can be reached.

Thank you for your time and participation.

If you would like a copy of the information, the data will be available from:

Julie Paul

Longwood Graduate Program

University of Delaware

126 Townsend Hall

Newark, DE 19717

(302) 831-2517

jpaul@longwoodgardens.org

Appendix B

Human Subjects Review Board Approval for Survey

UNIVERSITY OF DELAWARE

OFFICE OF THE VICE PROVOST FOR RESEARCH

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

September 12, 2005

Ms. Julie Paul
Longwood Graduate Program

Dear Ms. Paul;

Subject: Human Subjects Review Board approval for a research study entitled "How Horticulture is Integrated into Zoo Education Programs"

The above-referenced proposal, which you submitted for Human Subjects Review Board approval, will qualify as research exempt from full Human Subjects Review Board review under the following category:

> Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless (1) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects, and (2) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Please note that under university and federal policy, all research, even if exempt, must be conducted in accordance with the Belmont Report, copies of which are available from this office or on our website under history and background of human subjects policy. Changes in this project must be approved in advance by the Human Subjects Review Board.

Sincerely,

Richard D. Holsten
Associate Provost for Research
Chair, Human Subjects Review Board

/tc

cc: Robert Lyons

Appendix C

Responses to Internet Survey Questions 21 - 28

Table 4. Responses to Questions 21 – 28.

(Question) Descriptive Characteristics of Respondents	Percentage of Respondents
(Q21) Size of Zoo (in acres)	
Less than 26	26
26-50	17
51-75	14
76-100	11
101-200	11
More than 201	13
No Answer	8
(Q22) Number of staff in Education department (part time)	
None	11
Less than 5 people	43
5 – 10 people	14
11 - 15 people	16
More than 16 people	10
No Answer	6
(Q23) Number of staff in Education department (full time)	
Less than 5 people	44
5 - 10 people	28
11 - 15 people	9
More than 15 people	13
No Answer	6
(Q24) Overall Operating Budget (in Dollars)	
Less than .5 Million	4
.6 – 1.0 Million	7
1.1 – 2.5 Million	9
2.6 – 5.0 Million	12
5.1 – 10 Million	7
More than 10 Million	21
No Answer	40
(Q25) Education Operating Budget (in Dollars)	
Less than 10,000	3
11,000 – 100,000	14
101,000 – 250,000	14
251,000 – 500,000	11
501,000 – 1 Million	10
More than 1 Million	7
No Answer	41

(Q26) Annual visitation to the zoo	
Less than 100,000 people	10
101,000 – 250,000 people	11
250,000 – 500,000 people	24
501,000 – 750,000 people	12
750,000 – 1 Million people	17
More than 1 Million people	13
No Answer	13
(Q27) Annual visitation to educational programs	
Less than 5,000 people	6
5,000 – 10,000 people	7
11,000 – 25,000 people	12
26,000 – 50,000 people	22
51,000 – 100,000 people	11
101,000 – 250,000 people	11
Over 250,000 people	9
No Answer	22
(Q28) Annual visitation to educational programs - Student visitation	7
Less than 5,000	15
5,000 – 10,000 people	17
11,000 – 25,000 people	17
26,000 – 50,000 people	9
51,000 – 100,000 people	8
Over 100,000 people	27
No Answer	

Appendix D

Original Lesson Plan from Philadelphia Zoo - Habitat Hotel

Original lesson plan from Philadelphia Zoo

Habitat Hotel
Grades 2-5

Main Points/Rationale
"Deserts, rainforests, wetlands and more…discover a variety of habitats and the unique animals that live in them."

Objectives
1. Students will be able to identify four different habitats.
2. Students will be able to identify the four basic needs of animals and how they find them in four different habitats.
3. Students will be able to compare and contrast four different habitats.
4. Students will be able to observe an animal's adaptations and predict what habitat it would survive best in, in the wild.

Standards
PA Standards
3.3 Biological Sciences; 4.1 Watersheds and Wetlands; 4.2 Renewable and Nonrenewable Resources; 4.3 Environmental Health; 4.6 Ecosystems; 7.1 Basic Geography Literacy; 11.1 Financial and Resource Management; 11.2 Balancing Family, Work, Community

NJCCCS
2.1 Wellness; 3.1 Reading; 5.5 Life Science; 5.8 Earth Science; 6.7, 6.8 Geographical Understanding

Prior Knowledge
- Students should know different types of habitats and be familiar with what an animal needs to survive.

Materials & Equipment
- Props
    - owl 'eyes'
    - Habitat pictures
    - Classroom map
    - Corn
    - Chinchilla Poster (if using chinchilla)
- Artifacts
    - Take whatever is appropriate for the animals you are presenting.
    - Snowy owl mount
    - Snake skin # 154 or # snake skin 112
    - Feathers: Great horned owl, red tail hawk, vulture, Macaw (if using macaw)
    - Opossum pelt & skull
- Animals
    - 1 cold weather animal: chinchilla, silky chicken
    - 1 desert/prairie/savannah animal: burrowing owl, Harris hawk, ferret, cornsnake, jirds, bullsnake
    - 1 rainforest animal: rainforest snake, ornate horned frogs, tree frogs, parrot, iguana, roach, armadillo
    - 1 wetland/marsh animal: alligator, water snake
    - optional or 5th habitat (urban): 1 urban: opossum, rabbit, rat, box turtle, great horned owl

Habitats can be taught in any order but remember: Use Reptiles Last!

Habitat Hotel
Grades 2-5

Introduction – 1-2 minutes - <u>Introduce yourself</u> (Outside and Inside Classroom)

- Rules
  - One person speaks at a time
  - Please raise your hand
  - Use quiet voices
  - stay in your seats
  - Please limit cell phone use
  - Have fun

Warm-Up – 3-5 minutes

- Define Habitat (a place where an animal lives; supplies food, water, shelter, & living space)
- There is hardly a place on the earth that is not a habitat for someone or something.
- What do all animals need to survive? (As you take answers, you can put the cards up on the board – food, water, shelter, space.)
- Can an animal live in the wrong habitat? (i.e. a polar bear in the desert) How can a zoo exhibit these animals? (They can build the appropriate homes and habitats for them.)

Transition

- "We're going to look at four different habitats and animals that might live in them. For each habitat, I want you to think about how animals find food, water and shelter in their habitat."

Activity One – Mountain/Tundra/ Steppes - 5-8 minutes

- What is it like in the mountains? What is the temperature? What do you see on the ground during the winter?
- Chinchilla
  - What is the most obvious adaptation to the cold weather? (Discuss fur: 60 hairs coming out of each follicle, dust baths, etc.)
  - Discuss other adaptations and its diet (vegetation, seeds, etc.)
- See Animal Habitat Sheet for other animals and artifacts that fit into this category.

Transition

- "Let's move onto another habitat. Why don't we see an animal that lives in the opposite habitat?"

Activity Two – Prairie/Desert/Savanna – 5-8 minutes

- When I say, prairie (or desert or savanna), what do you think of? Can you describe what that area of the world looks like? (Take descriptions and then bring out your animal.)
- Burrowing Owl
  - This owl breaks other owl rules – its supposed to be awake during the day.
  - Where does a burrowing owl live? (in burrows, under the ground)
  - Who else lives in the same habitat? (black-footed ferrets, rattlesnakes) One burrowing owl will act as a sentry or lookout and stand up high on a rock or mound. When they spot danger, the owl will give a warning call to let the others know its time to hide. They also make a sound like a rattlesnake to scare off predators (like the black-footed ferret).
  - Silent Flight
    - <u>Interactive</u>: Owl feather vs. vulture feather (Choose two volunteers – one to flap the vulture feather and one to flap the owl feather. Discuss what each bird eats and why one is quiet and the other is not.)Discuss adaptations: eyes, camouflage, hearing, etc.

Habitats can be taught in any order but remember: Use Reptiles Last!

Habitat Hotel
Grades 2-5

- See Animal Habitat Sheet for other animals and artifacts that fit into this category.

Transition
- "Now let's move from a very dry, hot climate to a humid, wet climate."

Activity Three – Rainforest – 5-8 minutes
- What are the two things that you think of first when I say rainforest? (It rains and there are lots of trees.) Describe rainforest habitat – amount of rain, humidity, noise level, types of animals that live there.
- Ornate Horned Frog – or – Rainbow Boa (if you don't have a snake)
  - What does a rainforest look like? (trees, rains, green, etc.)
  - Camouflage (discuss how your rainforest animal hides – in the trees or on the forest floor).
  - What do you think this animal eats? Discuss diet.
  - Specific animal facts (see fact sheets). (either basic frog facts or snake facts)
- Rainbow Boa
  - <u>Interactive</u>: How does a snake hear?
    - Have children place their hand on their throat and repeat after you: I love snakes. They should feel their throat vibrating. Discuss vibration (define your word) and the way a snake listens.
  - <u>Interactive</u>: Snake skin
    - Choose 10 to 12 volunteers to help you hold the snake skin for the class to see. Then allow students to touch it.
- See Animal Habitat Sheet for other animals and artifacts that fit into this category.

Transition
- "One final habitat to look at today. What do you think it might be?"

Activity Four – Marsh/Wetlands – 5-8 minutes
- Alligator – or – watersnake
- Discuss adaptations for life in a wetland habitat.
- Look at placement of eyes, nostrils, etc.
- Discuss counter shading (some animals are darkest on the surfaces where the most light hits and lightest on the surface where the least light strikes).
- Specific animal facts (see fact sheet).
- Touch crocodile pelt or snake skin.
- See Animal Habitat Sheet for other animals and artifacts that fit into this category.

Transition
- "Let's review what we learned today."

Closing - 2-3 minutes
- Review
  - What animals did we see? What animal lived in a mountainous habitat?
- As you walk around the Zoo today, see how we are trying to design exhibits to meet the needs of the animals. An exhibit may not look like a rainforest but see if it has the elements of one: things to climb on, hide under, etc. Just because it doesn't look like an animals natural home, doesn't mean it does not meet its needs.

Habitats can be taught in any order but remember: Use Reptiles Last!

Habitat Hotel
Grades 2-5

Additional Habitats

- Urban
  - Screech Owl
  - See Animal Habitat Sheet for other animals and artifacts that fit into this category.
- Deciduous Forest
  - Box Turtle
  - See Animal Habitat Sheet for other animals and artifacts that fit into this category.
- Rainforest
  - Parrot
  - See Animal Habitat Sheet for other animals and artifacts that fit into this category.

Habitats can be taught in any order but remember: Use Reptiles Last!

Appendix E

Pennsylvania and New Jersey State Standards

Pennsylvania State Standards
22 Pa. Code, Ch. 4, Final Form
January 5, 2002

Academic Standards for Science and Technology

3.3. Biological Sciences

Know the similarities and differences of living things.
Identify life processes of living things (e.g., growth, digestion, react to environment).
Know that some organisms have similar external characteristics
(e.g., anatomical characteristics; appendages, type of covering, body segments) and that similarities and differences are related to environmental habitat.
Describe basic needs of plants and animals.

Know that living things are made up of parts that have specific functions.
Identify examples of unicellular and multicellular organisms.
Determine how different parts of a living thing work together to make the organism function.

Know that characteristics are inherited and, thus, offspring closely resemble their parents.
Identify characteristics for animal and plant survival in different climates.
Identify physical characteristics that appear in both parents and offspring and differ between families, strains or species.

Academic Standards for Environment and Ecology

4.1. Watersheds and Wetlands

Identify living things found in water environments.
Identify fish, insects and amphibians that are found in fresh water.

Identify plants found in fresh water.

D. Identify a wetland and the plants and animals found there.
Identify different kinds of wetlands.
Identify plants and animals found in wetlands.
Explain wetlands as habitats for plants and animals.

E. Recognize the impact of watersheds and wetlands on animals and plants.
Explain the role of watersheds in everyday life.
Identify the role of watersheds and wetlands for plants and animals.

4.3. Environmental Health

Know that plants, animals and humans are dependent on air and water.
Know that all living things need air and water to survive.
Describe potentially dangerous pest controls used in the home.
Identify things that cause sickness when put into the air, water or soil.
Identify different areas where health can be affected by air, water or land pollution.
Identify actions that can prevent or reduce waste pollution.

C. Understand that the elements of natural systems are interdependent.
Identify some of the organisms that live together in an ecosystem.
Understand that the components of a system all play a part in a healthy natural system.
Identify the effects of a healthy environment on the ecosystem.

4.6. Ecosystems and their Interactions

Understand that living things are dependent on nonliving things in the environment for survival.
Identify and categorize living and nonliving things.
Describe the basic needs of an organism.
Identify basic needs of a plant and an animal and explain how their needs are met.
Identify plants and animals with their habitat and food sources.
Identify environmental variables that affect plant growth.
Describe how animals interact with plants to meet their needs for shelter.
Understand the components of a food chain.
Identify a local ecosystem and its living and nonliving components.
Identify a simple ecosystem and its living and nonliving components.

4.7. Threatened, Endangered and Extinct Species

Identify differences in living things.
Explain why plants and animals are different colors, shapes and sizes and how these differences relate to their survival.
Identify characteristics that living things inherit from their parents.
Explain why each of the four elements in a habitat is essential for survival.
Identify local plants or animals and describe their habitat.

Know that adaptations are important for survival.
Explain how specific adaptations can help a living organism to survive.
Explain what happens to a living thing when its food, water, shelter or space is changed.

New Jersey State Standards
2004 New Jersey Core Curriculum Content Standards

5.5 Characteristics of Life

2. A. Matter, Energy and Organization in Living Systems
Investigate the basic needs of humans and other organisms.
Compare and contrast essential characteristics that distinguish living things from nonliving things.

2. B. Diversity and Biological Evolution
1. Recognize that different types of plants and animals live in different parts of the world.
2. Recognize that some kinds of organisms that once lived on Earth have completely disappeared.

4. A. Matter, Energy and Organization in Living Systems
1. Identify the roles that organisms may serve in a food chain.
2. Differentiate between the needs of plants and those of animals.
3. Recognize that plants and animals are composed of different parts performing different functions and working together for the well being of the organism.

5.10 Environmental Studies

2. A. Natural Systems and Interactions
1. Associate organisms’ basic needs with how they meet those needs within their surroundings.

Appendix F

Lesson Plan Resources

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Ballance, A. (2000). *Habitats of the World: Tropical Rainforests*. Dominie Press, Inc. Carlsbad, CA.

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(1999). *Rainforest Animals.* New York, NY: DK Publishing, Inc.

(1997). *Desert Animals.* New York, NY: DK Publishing, Inc.

Appendix G

List of Plant Adaptations

This list was compiled by the author for the Education staff at the Philadelphia Zoo to facilitate the creation of a class that highlighted plant adaptations concurrently with animal adaptations. The adaptations are arranged by function.

Surviving in the cold

Hairy leaves- reflect sunlight that could damage plant

Dark leaves- absorb light and warmth

Clump close together - huddle for warmth

Small, thin leaves- shake off snow

Heated buds- push flowers through the snow

Dormancy/ Hibernation

Showy flowers- attract sparse insects in the area

Antifreeze-like substance- produced in woody stems

Surviving in the heat

Waxy coating- protects leaves from transpiration

Hairy leaves- reflect the sunlight

Small or non-existent leaves

Shade from plant- leaves and stems

Spines/ Thorns- protect from predation

Surviving dry conditions

Water storage-absorb quickly and store for dry times

Spines/ Thorns- protect from predation

Dormancy/ Hibernation

Short, intense flowering season

White coloring- acts like sunscreen

Fleshy, waxy leaf coating- discourages water lose and predation

Surviving wet conditions

Trapping- roots and leaves trap nutrients in water

Carnivorous- poor soil nutrients, consume small animals/insects

Elongated roots and stems- rooted yet reach the surface of the water

Elongated leaves- minimal tearing in moving water and maximized surface area

Floatation- specialized parts to float

Waxy leaves- coated with mucilage to shed excess water

Drainage channels- prevent water from collecting

Avoiding predation

Toxic parts- leaves, stems, flowers

Mimicry- structure similar to undesirable plants

Camouflage

Spines/ Thorns

Reproducing

Nectar guides- direct pollinators to correct location

Diversification- reliance upon on one or many different species

Mimicry- resembling species to attract others for pollination

Coloration- different for varying pollinators, light and dark

Scent- attract pollinators

Structure- attract and use pollinators

Timing- flowers open at same time to facilitate cross-pollination

Mobility / Stability

Tracking sunlight- angle towards areas of ideal sunlight

Seed dispersal- vectors include wind, water, animals

Travel by seed- offspring move away from adverse conditions

Asexual reproduction- floats to new location

Growth- grow to locations of correct amount of water or light

Climbing parts- thorns, suckers, tendrils,

Supporting parts- buttressed tree roots

Getting food

Photosynthesis- produce own food

Roots- absorb nutrients

Predation- trap and absorb small species

Carnivorous plants

Trapping- spring action, slippery or sticky parts, suction

Absorption- acids dissolve prey

Avoiding competition

Toxins- prevent or inhibit competition

Allelopathy

Pollination- structures encourage cross-pollination or self-pollination

Partnerships with other species of plants and animals

Parasites- rely entirely upon other organisms for survival

Epiphytes- produce own food, but rely on other organisms for survival

Symbiosis- mutually beneficial

Strange facts and adaptations

Leaves of raffia palm can be 65 feet (20 m) long

Oak tree holds the record for most inhabitants- 30 species of birds, 200 species of moth, thousands of insects

One oak tree can produce 90,000 acorns a year

Wheat- most widely grown plant. Found on every continent, except Antarctica

Largest flower is a parasite- Rafflesia 3 ft- feed on vines

Pitcher plant is largest carnivorous plant- can catch frogs

Amazon water lily can support weight of a child

Century plant takes 100-150 years to flower

Most malodorous lily is in the Amazon- smell of rotting meat detectable half a mile away

Woody plant in Namibian desert produces 2 twisting leaves that can be

Giant bamboo grows 3 feet a day – you can hear it creaking

Coco-de-mer seed weighs 45 lbs

Oldest tree alive is bristlecone pine- thought to be 5000 yrs old

Giant sequoias in California are so big enough to drive a car through them

Bamboo- most useful plant of all- food, furniture, clothing, water pipes

Smoke tree and Ironwood need torrents of rushing water to scarify seed

Appendix H

Habits and Habitats - Lesson Plan for Philadelphia Zoo

Habits and Habitats
Grades 2-5

Main Points/ Rationale
"Animals and plants are uniquely adapted to fit a broad range of habitats; many of the adaptations are similar. A habitat meets all the needs of the plants and animals, including humans, which occupy it."

Objectives
1. Students will be able to identify the four elements of a habitat.
2. Students will be able to identify characteristics of 3 different habitats.
3. Students will be able to describe differences between 3 habitats.
4. Students will be able to identify how habitats meet needs of plants and animals living in specific habitats.
5. Students will be able to identify adaptations on plants and animals that allow survival in the specific habitat.

Standards
Pennsylvania Department of Education
3.3 Biological Science:

4. A. Know the similarities and differences of living things (Identify life processes, Describe basic needs of plants and animals)

4. B. Know that living things are made up of parts that have specific functions

4. C. Know that characteristics are inherited and, thus, offspring closely resemble their parents (Identify characteristics for animal and plant survival in different climates)

4.1 Watersheds and Wetlands:

4. A. Identify living things found in water environments

4. D. Identify a wetland and the plants and animals found there

4. E. Recognize the impact of watersheds and wetlands on animals and plants

4.3 Environmental Health:

4. A. Know that plants, animals and humans are dependent on air and water.

4. C. Understand that the elements of natural systems are interdependent

4.6 Ecosystems and their Interactions:

4. A. Understand that living things are dependent on nonliving things in the environment for survival

4.7 Threatened, Endangered, and Extinct Species:

4. A. Identify differences in living things (explain how these differences relate to their survival, explain why each of the four elements in a habitat is essential for survival)

4. B. Know that adaptations are important for survival

New Jersey Department of Education- Core Curriculum Content Standards

5.5 Characteristics of Life

2. A. Matter, Energy, and Organization in Living Systems

1. Investigate the basic needs of humans and other organisms

B. Diversity and Biological Evolution

1. Recognize that different types of plants and animals live in different parts of the world

4. A. Matter, Energy, and Organization in Living Systems

1. Identify the roles that organisms may serve in the food chain

2. Differentiate between the needs of plants and those of animals

3. Recognize that plants and animals are composed of different parts performing different functions and working together for the well being of the organism.

Materials & Equipment

· Plants:
- · Papyrus plant (replica with roots)
- · Cactus (touchable spines)
- · Lithop or Living Stone
- · Enormous leaves from rainforest plants (Philodendron, Banana, or Palm- replica or live)
- · Ivy with tendrils (live or replica)
- · Bromeliad

· Animals:
- · Armadillo

· Tree Frog

· Rattlesnake (mounted or model)

· Hognose Snake

· Duck (Indian Runner Duck)

· Touchable snake skin

· Props:
- · Poster of wetland, desert, and rainforest environment.

· Mist bottle

Introduction – 1 -2 minutes – <u>Introduce yourself</u>

·Rules

- · One person speaks at a time
- · Please raise your hand
- · Use quiet voices
- · Stay in your seats
- · Please limit cell phone use
- · Have fun

Warm Up – 3-5 minutes

Ask for definition of Habitat *"Natural home of a plant or an animal"* and Adaptation *"Physical characteristics or behaviors that helps living things survive in their environment"*

Review four needs of animals/components of habitat (Food, Water, Shelter, and Space) by asking, *"What do living things need to survive?" "Animals and plants need each other to survive and have developed really interesting adaptations to survive in the area they call home."*

<u>Habitat One</u>- Wetland – 7-10 minutes

(Show poster)

Assessment question:

"What would a living thing need to survive here?"

For each answer given, cite an animal that has that adaptation.

<u>Transition to animal adaptation</u>: *"Now let's meet an animal that spends most of the time in the water."* (Bring out duck.)

"What do you notice about this animal that would help it survive in water?"

·Discussion of duck's adaptations to living in water:

- · Beak – Allows the duck to filter small amount of plants out of water.
- · Webbed feet – The shape allows the animal to move in water.
- · Feathers – Trapped air helps keep the duck warm. Shape allows water to flow off the feather. If water was absorbed, the duck would sink. A special gland at the base of the tail produces oil that the duck can spread on its feathers to keep them oiled, and more able to repel water.

Activity: Mist the duck so kids can watch the water roll off.

<u>Transition to plant adaptation</u>: *"Can you think of any plants that live in water?"*

(Show fake Papyrus plant.)

"What do you notice about this plant that would help it survive in water?"

·Discussion of plant adaptations to living in water:

- · Leaves – Can be thick and float -like water lily- in still water or thin and strap-like, necessary to live in a moving current. Thin leaves allow the water to flow like the feathers on the duck. A strong current could tear the leaf apart. The leaf needs to be flexible in order to avoid being torn apart.
- · Stems – Flexible, allows the plant to sway in the water.
- · Roots – Most plants get their nutrients from the soil. Plants that live in water need to get nutrients from the water. The root mass can trap bits of vegetation floating in the water, just like the duck's bill.

Activity: Invite children to stand up and be the current, moving their hands over the duck and the Papyrus as the water would.
·Discuss how smooth both surfaces are.
·Discuss how the leaves bend, but do not tear. *"Why do you think that would be an important adaptation for the plant? ... The current can rush by without tearing the leaf."*

<u>Transition to animal adaptation</u>: *"Besides water, what was something else living things need to survive?"* When students say, "food", respond with *"Right! Let's look at how the duck and the Papyrus get food."*
Activity: Duck demonstration of straining food from water dish with its beak.
·Discuss how the duck traps food in its beak, but the water strains out.
<u>Transition to plant adaptation:</u>
"Most plants take up nutrients from the ground. However, plants need to be adaptable in water or waterlogged soil that does not hold nutrients. For some water plants, roots can trap nutrients in their root mass in the water."
(Show root mass on Papyrus plant.)

- · Carnivorous plants live in wet or boggy areas and get nutrients from insects. They have specialized parts that trap insects and small animals inside the plant.
- · Digestion allows the plant to extract the nutrients from the insects instead of the soil.

Transition
"Let's get as far away from the water as we can, what habitat would have the least amount of water?"

<u>Habitat Two-</u> Desert – 7-10 minutes
(Show poster of desert)
Discussion of what is important in that habitat.

<u>Transition to plant adaptation:</u> *"What plants would live in this environment?"*

Activity: Show cactus. Have kids touch spines carefully. *"Would you want to eat this plant? What if you were really thirsty and this was the only source of water?"*

· Stems on cactus swell to store water during times of drought.
· Stems also shade the cactus throughout the day.
· Spines are modified leaves that protect the water saved in the stem. Discussion of why that type of protection is necessary for survival.

·Define and discuss camouflage. (Show Living Stone- Lithop- or cactus that looks like stone)
·Define and discuss mimicry, another form of protection.
·Discuss mimicry and camouflage from the point of view of the predator, not as a choice the living thing makes to look or act a certain way.

<u>Transition to animal adaptation</u>: *"Let's look at an animal that uses mimicry to avoid being eaten."*
(Show mounted Rattlesnake and live snake)
-Bull or Hognose Snake that has similar behavior and coloration to Rattlesnake.
·Discuss how mimicry -beating the tail on the ground - and camouflage -blending in with the environment- assists the hognose in survival.
·Discuss the snake's adaptations to desert:

· Scales offer protection from environmental conditions, like weather, and predators.
· Scales also offer protection and ease movement across rough surfaces, like tree bark or sand.
· Scales are made of keratin, the same material in our fingernails.

Activity: Encourage kids to touch preserved snake skin.

Transition
"Let's look at an area that is really different from the desert. What is a rainforest? What adaptations do you think living things would need to survive there?"

<u>Habitat Three</u>- Rainforest – 7-10 minutes
<u>Transition to plant adaptation</u>: *"How do you think plants survive in a rainforest?"*
Activity:
Have children hold enormous leaves of rainforest plants – philodendron, banana, or palm. Encourage them to be a rainstorm and mist the leaves with water. Have them describe what happens.
·Explain why living things need to shed excess water.

· Wet surfaces lead to fungal growth, on plants and animals. Plants have a network of drainage channels that direct excessive water off leaf, just like gutters on your house.

Transition to animal adaptation: *"The rain that runs off the leaves falls to the ground, sometimes it lands on animals. How do animals shed water from their skin?"*

- · Ground-dwelling armadillo has hard shell that sheds water like an umbrella and offers protection. (Show armadillo.)

·Discuss armadillo adaptations:

- · Hard shell offers protection. Animal curls up in ball when threatened.
- · Pointy nose allows the armadillo to pick insects/ spiders out of crevices in the ground.
- · Clawed feet allow the animal to dig for food in the dirt and in debris on the ground.

Transition to animal adaptation:
"Other animals live in the rainforest, how else could they use their feet? If we look way up high in the rainforest, how do animals we find get there?"

·Discuss benefits of living high in the tree canopy.
·Discuss ability of animals to climb. (Show tree frog)
·Discuss adaptations of tree frog:

- · Suction cups on its feet, can control the suction in order to be able to move.
- · Thick skin offers protection to the animal. Skin is very porous and absorbent, can absorb moisture from environment. This makes it susceptible to chemicals in the water and air.

Transition to plant adaptation: *"Let's talk about climbing again. Do plants climb? Have you ever seen a building or a tree trunk covered in leaves?"*
(Show root structure of ivy and other climbing plants)
·Discuss how roots can either penetrate the surface, tendrils can wrap around an object, etc.
"Even plants that do not climb are still important to animals like the tree frog."
(Show Bromeliad) *"Bromeliads have modified roots that do not need to be rooted in the soil. They cling to the sides of trees and other objects."*
·Discuss ability of plant to hold water in the central portion of the plant.
·Discuss relationship between bromeliad and small animals, like the frog, that live in or depend upon Bromeliads for water, shelter, and a place to raise young.
·Discuss ability of Bromeliad to attract insects that animals can eat.

Transition
"We talked a lot about the similarities in adaptations between plants and animals, and even how they depend upon each other for survival. Let's review what we learned."

Closing – 3-5 minutes
·Review of four necessary components of life: Water, Food, Shelter, Space
·Review plant and animal similarities and relationships.

·Review of definitions: Habitat, Adaptation, Mimicry, Camouflage
"As you walk around the zoo today, see how we are designing exhibits to meet the needs of the plants and animals. An exhibit may not look like a rainforest but see if it has the elements of one: things to climb on, hide under, etc. Notice how the animals and plants have unique adaptations that allow them to survive in their environments."

Appendix I

Blank Survey from Philadelphia Zoo- Teacher Satisfaction Survey

Philadelphia Zoo Program - Teacher Satisfaction Survey

Please take a few minutes to complete this survey. We value your feedback and we rely on your insights, comments and suggestions to improve our education programs. Thank you for your support of the Philadelphia Zoo!

Program title:		School:
Zoo educator:	Date:	Grade level(s): Zip Code:
Before today, had you ever attended a Philadelphia Zoo education program? YES NO		

Please rate your level of agreement with the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I believe the zoo program should be an integral part of instruction for my class	1	2	3	4	5
It is essential for the zoo program to meet state education standards	1	2	3	4	5
I plan a trip to the zoo as a fun reward for my students' hard work	1	2	3	4	5
The zoo program provided an exciting experience for my students	1	2	3	4	5
My students actively participated in the zoo program	1	2	3	4	5
My students were captivated by the zoo program	1	2	3	4	5
The zoo educator was informative	1	2	3	4	5
The zoo educator was entertaining	1	2	3	4	5
The zoo educator involved my students in the lesson	1	2	3	4	5
The zoo program's printed materials are effective learning tools	1	2	3	4	5
The zoo program is appropriate for my students' grade level	1	2	3	4	5
The zoo program provided a valuable learning experience for my students	1	2	3	4	5
I am interested in returning to the Philadelphia Zoo for future programs	1	2	3	4	5
How well did the zoo program meet your expectations...	Fell below		Met		Exceeded
...for integration into your curriculum?	1	2	3	4	5
...for meeting state education standards?	1	2	3	4	5
...as a fun reward for your students' hard work?	1	2	3	4	5

What did you like most about this program?

What do you recommend that we change in the program (e.g.; content, format, timing, logistics, etc.)?

May we contact you to further discuss your reactions to today's program?		YES NO
Teacher:	Phone #:	E-mail:

THANK YOU FOR YOUR FEEDBACK!!!

Please return to: Lynn Parrucci, Director of Group Programs

FAX #: (215) 243-5385 **ADDRESS:** Philadelphia Zoo, 3400 West Girard Avenue, Philadelphia, PA 19104

Appendix J

Letter to Teachers in Classes Receiving Habits and Habitats

November 17, 2005

Dear Teacher,

Thank you for participating in an enhanced version of the "Habits and Habitats" class. The modified class includes horticulture information, important to a comprehensive understanding of habitat.

I am a student at the University of Delaware and Longwood Gardens, pursuing a Master's Degree in Public Horticulture. For my thesis, I am studying zoo education programs to understand how horticulture (or botany) fits into the teaching of biology. Research by James Wandersee, Elizabeth Schussler, and David Hershey indicates that biology curriculum minimizes or neglects the importance of botany. The Philadelphia Zoo recognizes the importance of a more comprehensive curriculum and has allowed me to enhance the class today.

Please fill out the enclosed survey for the Philadelphia Zoo. In addition, I would appreciate you taking a few moments to answer the following questions. Please use the back of the survey form to write your answers and return it to the zoo at the address below or at the bottom of the survey form. In exchange for the completed survey, I would be delighted to mail you two tickets to Longwood Gardens.

1. Has your definition of the word "habitat" changed? If so, how?
2. Please describe whether or not this class was helpful for your curriculum.
3. Are you likely to include horticulture or botany information in future teachings concerning habitat?

Thank you. Please return the survey in the enclosed envelope to:
Lynn Parrucci, Director of Group Programs
Philadelphia Zoo
3400 West Girard Avenue
Philadelphia, PA 19104

If you have additional questions about the class or the research, please contact me.

Julie Paul
126 Townsend Hall
University of Delaware
Newark, DE 19716
jpaul@longwoodgardens.org

Thank you again, good luck in your teaching endeavors!
Sincerely,

Julie Paul
Longwood Graduate Fellow

Appendix K

Human Subjects Review Board Approval for Class

University of Delaware

OFFICE OF THE VICE PROVOST FOR RESEARCH

210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

November 17, 2005

Ms. Julie Paul
Longwood Graduate Program

Dear Ms. Paul,

Subject: Human Subjects Review Board approval for a survey study "How Horticulture is Integrated into Zoo Education Programs"

The above proposal, which you submitted for Human Subjects Review Board approval, will qualify as research exempt from full Human Subjects Review Board review under the following category:

> Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (1) research on regular and special education instructional strategies, or (2) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Please note that under University and federal policy, all research, even if exempt, must be conducted in accordance with the Belmont Report, copies of which are available from this office or on our website under history and background of human subjects policy. Changes in this project must be approved in advance by the Human Subjects Review Board.

Sincerely,

Richard D. Holsten
Associate Provost for Research
Chair, Human Subjects Review Board

/tc
cc: Robert Lyons

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Appendix L

Responses from Teachers to Lesson Plan Survey

Philadelphia Zoo Program - Teacher Satisfaction Survey

Please take a few minutes to complete this survey. We value your feedback and we rely on your insights, comments and suggestions to improve our education programs. Thank you for your support of the Philadelphia Zoo!

Program title: Habitats & Habitats	School: ST FRANCIS XAVIER
Zoo educator: Kym & Julie Date: 11/17/05	Grade level(s): 4 Zip Code: 19130
Before today, had you ever attended a Philadelphia Zoo education program?	YES NO

Please rate your level of agreement with the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I believe the zoo program should be an integral part of instruction for my class	1	2	3	4	5
It is essential for the zoo program to meet state education standards	1	2	3	4	5
I plan a trip to the zoo as a fun reward for my students' hard work	1	2	3	4	5
The zoo program provided an exciting experience for my students	1	2	3	4	5
My students actively participated in the zoo program	1	2	3	4	5
My students were captivated by the zoo program	1	2	3	4	5
The zoo educator was informative	1	2	3	4	5
The zoo educator was entertaining	1	2	3	4	5
The zoo educator involved my students in the lesson	1	2	3	4	5
The zoo program's printed materials are effective learning tools	1	2	3	4	5
The zoo program is appropriate for my students' grade level	1	2	3	4	5
The zoo program provided a valuable learning experience for my students	1	2	3	4	5
I am interested in returning to the Philadelphia Zoo for future programs	1	2	3	4	5
How well did the zoo program meet your expectations...	Fell below		Met		Exceeded
...for integration into your curriculum?	1	2	3	4	5
...for meeting state education standards?	1	2	3	4	5
...as a fun reward for your students' hard work? N/A	1	2	3	4	5

What did you like most about this program?

KEPT THE STUDENTS ATTENTION FOR ENTIRE PROGRAM

What do you recommend that we change in the program (e.g.; content, format, timing, logistics, etc.)?

NO LIVE ANIMALS

May we contact you to further discuss your reactions to today's program?	YES NO UNLESS NECESSARY
Teacher: KATHERINE RICHARDS Phone #: 215-763-6564	E-mail:

THANK YOU FOR YOUR FEEDBACK!!!

Please return to: Lynn Parrucci, Director of Group Programs
FAX #: (215) 243-5385 **ADDRESS:** Philadelphia Zoo, 3400 West Girard Avenue, Philadelphia, PA 19104

1- My definition of habitat has not changed but has been reinforced.

2- The class was very helpful because botany plays a considerable part in our grade four curriculum.

3- Horticulture information will be stressed to a greater extent in the grade four study of habitats. The class also was helpful since our school participates in the PA. Hortic. Soc. Jr. Flower Show each year.

Thank you!

Katherine Richards
Saint Francis Xavier School

Philadelphia Zoo Program - Teacher Satisfaction Survey

Please take a few minutes to complete this survey. We value your feedback and we rely on your insights, comments and suggestions to improve our education programs. Thank you for your support of the Philadelphia Zoo!

Program title: Habits & Habitats	School: Kulp Elementary
Zoo educator: Kim & Julie Date: 11/17/05	Grade level(s): 2 Zip Code: 19440
Before today, had you ever attended a Philadelphia Zoo education program? YES NO	

Please rate your level of agreement with the following statements:	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I believe the zoo program should be an integral part of instruction for my class	1	2	3	4	5
It is essential for the zoo program to meet state education standards	1	2	3	4	5
I plan a trip to the zoo as a fun reward for my students' hard work	1	2	3	4	5
The zoo program provided an exciting experience for my students	1	2	3	4	5
My students actively participated in the zoo program	1	2	3	4	5
My students were captivated by the zoo program	1	2	3	4	5
The zoo educator was informative	1	2	3	4	5
The zoo educator was entertaining	1	2	3	4	5
The zoo educator involved my students in the lesson	1	2	3	4	5
The zoo program's printed materials are effective learning tools	1	2	3	4	5
The zoo program is appropriate for my students' grade level	1	2	3	4	5
The zoo program provided a valuable learning experience for my students	1	2	3	4	5
I am interested in returning to the Philadelphia Zoo for future programs	1	2	3	4	5
How well did the zoo program meet your expectations...	Fell below		Met		Exceeded
...for integration into your curriculum?	1	2	3	4	5
...for meeting state education standards?	1	2	3	4	5
...as a fun reward for your students' hard work?	1	2	3	4	5

What did you like most about this program?

The material/concepts presented were interesting, students had a chance to interact, and everything was appropriate for our grade level.

What do you recommend that we change in the program (e.g.; content, format, timing, logistics, etc.)?

May we contact you to further discuss your reactions to today's program?	YES NO
Teacher: Cindi Hilferty Phone #:	E-mail: lightbe@aol.com

Kulp Elementary
801 Cowpath Road
Hatfield, PA 19440

THANK YOU FOR YOUR FEEDBACK!!!

Please return to: Lynn Parrucci, Director of Group Programs

FAX #: (215) 243-5385 **ADDRESS:** Philadelphia Zoo, 3400 West Girard Avenue, Philadelphia, PA 19104

(1) Yes - I have talked to my students about animal habitats, but never connected this concept to the habitats of plants.

(2) This was an excellent class! I wish I knew some more about the plant adaptations before the trip, but my students learned a great deal!

(3) Yes - thank you for the inspiration!

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