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Do You Know the Pangolin?: Analyzing Biodiversity Awareness and Attitudes

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Departmental Honors Thesis

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### Abstract

Understanding the impact education has on environmental knowledge and values is critical for knowing how we can promote pro-environmental awareness and attitudes. Thus, this study investigated how environmental education level influences awareness and attitudes on environmental issues, specifically the Biodiversity Crisis. Through a survey primarily utilizing Likert scale statements, the researcher evaluated the differences in knowledge and care levels between classes taking an introductory environmental science course, one class of environmental science majors and one for non-majors. One focus point of the course is the world's most trafficked mammal, the pangolin, so this species was used as a focus species to evaluate people's awareness of the role of overexploitation in the Biodiversity Crisis. Conducting the survey on the first day of class and again on the last day allowed the researcher to perform a one-way t-test to test for changes in people's knowledge and care after taking the course. The study found that education plays a significant role in affecting people's biodiversity knowledge and how much they care about biodiversity. The classes were significantly different in both awareness level and their attitudes at the beginning of the semester, with the class of ESC majors having more positive responses than the non-majors. Both classes had a significant increase in awareness and attitudes about the Biodiversity Crisis after taking the course. By the end of the semester, both classes were equally knowledgeable about the Biodiversity Crisis, though the ESC majors still had a higher care score overall.

## Introduction

### Do You Know the Pangolin?: Analyzing University Students' Awareness and Attitudes of the Biodiversity Crisis

Environmental issues heavily rely on the involvement of the general public to create and implement solutions as well as prevent new problems from developing or worsening. Political and social concern for environmental health depends on public awareness and environmental understanding. Thus, it is important from both an environmental and social standpoint for people to be educated on environmental problems. This project set out to determine if environmental science education influences university students' awareness and attitudes on environmental issues, specifically the Biodiversity Crisis.

### Biodiversity, Its Importance, and Threats to It

Of the various environmental issues plaguing the modern world, the loss of biological diversity is among the most serious. The Biodiversity Crisis describes the loss of the variability of living organisms, including the number of different species, the genetic diversity within and between species, and the habitats and ecosystems species live in (Lachman 2007, Tsioumani 2020). A lack of diversity weakens the resiliency of organisms (from populations to species to entire communities) to withstand sudden change and hardship. This loss of biodiversity directly impacts humanity as well: aside from the loss of ecological resilience, biodiversity provides us with many biological resources and services such as food production, agricultural resiliency, climate adaptability, water and air purification, organic waste disposal, and new pharmaceuticals

(Lachman 2007, Roe 2019, Tsioumani 2020). Low-income countries and communities are particularly affected by the Biodiversity Crisis as the people that inhabit these countries and communities tend to be more dependent on the natural resources provided by biodiversity and many regions of high biodiversity exist in low-income countries (Biller 2018). The Biodiversity Crisis is an economic and social issue as much as an environmental one.

Nearly all of the causes of biodiversity loss are man-made, including habitat destruction, pollution, introduction of invasive species, climate change and natural disasters, and overexploitation of species. Habitat destruction or degradation is by far the largest threat to biodiversity, being “the main factor pushing [species] toward extinction” for over 70 percent of species (Hogue 2022). Natural areas are destroyed or severely damaged to allow for agricultural development or urbanization, and in the process render the habitat incapable of supporting native species, if not eliminating them initially (Carrete 2009, Singh 2021). Pollution can be multifaceted, affecting air, water, soil, even light and noise, all of which can inhibit organisms’ physical, ecological, and reproductive health as well as their natural behaviors and the quality of their habitat. Invasive species are problematic non-native species that have been introduced to an area by human beings, either intentionally or accidentally. Though not all introduced species survive successfully, those that do can potentially disrupt the native ecosystem by out competing the native life or by preying on the natives or through the introduction of new pathogens (Doherty 2016). Natural disasters can eliminate large portions of populations which reduces biodiversity as those individual variations are lost. Additionally, with climate change increasing the frequency and intensity of natural disasters and the accelerated rate at which it is occurring,

ecosystems and their inhabiting species are unable to recover and acclimate fast enough (Singh 2021). Overexploitation of biological resources and preferred species involves the taking or use of a resource or species at a higher rate than they can naturally recover, such as through excessive hunting, fishing, or gathering (Rawat 2015, Singh 2021). The illegal trade of wildlife, poaching species for collections, fashion, bushmeat, exotic pets, trophies, and ethnomedicine generates an estimated 7 to 23 billion US dollars annually, making it the fourth largest form of illegal global trade (United Nations Environment Programme 2016).

### Pangolins as a Focus Species

This survey utilized the pangolin as a focal point to characterize how species are impacted by overexploitation and as a specific example of how improving people's awareness and attitudes generates support for such environmental concerns. Pangolins were chosen as this project's focus because: they are the most endangered and trafficked mammal in the world; much of the general public has never heard of them or if they have they do not realize the extent to which they are being trafficked; a misreport during the COVID-19 pandemic attributing the source of the virus to pangolins has negatively affected public perception, so creating positive interest in the species is necessary to counteract this; they are a flagship species whose protection can be positively correlated with the conservation of other species or communities; and their unique trait of having mammalian scales makes them a unusual example of biodiversity as well as a charismatic species (Cardinal 2019 p. 409, Heighton 2021, Choo 2022).

The different species of pangolins are split between Africa and southern Asia, with four species in Africa and now five in Asia, with the 5th being a recently discovered species, *Manis mysteria*, discovered in 2023 (Anderson 2023). All species are listed under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which bans the international commercial trade of pangolins, and they are considered Vulnerable, Endangered, or Critically Endangered by the International Union for Conservation of Nature, appearing on the Red List of Threatened Species (Aditya 2021, Heighton 2021). Pangolin populations in Asia (particularly China) are more at risk due to the high demand for pangolin products like meat, mammalian scales, claws, and skins, despite receiving some of the highest levels of protection both within countries and internationally (Challender 2015, Aditya 2021). There are declining populations in Asia, yet consistent, even increasing demands have led to an uptick of African pangolins being trafficked to Asia where use of their byproducts is more common. Pangolins are killed and traded for their scales and claws to be used in traditional remedies due to belief that they provide some “medicinal, magical or mystical properties;” they may also be desired for ornamentation and for meat in traditional dishes, though the consumption of such “bushmeat” sometimes increases the risk of spreading zoonotic diseases (Challender 2015, Soewu 2015, Aditya 2021).

Pangolins are paradoxically understudied despite being a flagship species for conservation purposes, although interest in pangolin research has been increasing (Heighton 2021, Choo 2022). In order to create adequate laws to protect wildlife, it is necessary to understand the ecological features of a species or community if they are to be preserved



(Challenger 2020, Choo 2022). Improving research allows us to better understand how pangolins live in the wild so they can be better protected through habitat designation, knowledge of potential disease and outbreaks, levels of genetic diversity, and techniques to improve reintroduction methods/breeding programs. It also allows for development of technology and methods for tracking and identifying illegal trade routes and farming methods (Choo 2022). Public support is necessary to bring attention, and thus funding for additional research, to threatened species like the pangolin.

Similarly, stronger laws and better enforcement occur when the public advocates for said regulations and is invested in maintaining them. Given the international nature of both pangolin populations and illegal trade, active cooperation between countries is needed to ensure proper protection (Choo 2022); it is not enough for just one country to have strict regulations since pangolins and the demand for them exist across countries. Finally, it is public demand for wildlife goods like pangolin scales and meat that drives this illegal industry, so educating people on wildlife and encouraging them to avoid these unethical products reduces demand (Choo 2022).

### What Can Help Resolve the Biodiversity Crisis?

Public influence and wildlife regulation are key to protecting all wildlife, not just pangolins. Populations do not exist in a vacuum; all species are part of a complex community heavily interconnected with other organisms, from the local level all the way up to the global scale. Increasing protection for one species often benefits entire ecosystems. For instance, if a

protected area is designated for a population of pangolins there, then the populations/species of plants, insects, fungi, and other animals that share that habitat also benefit from the protection (Cardinal 2019 Chapter 13 & 14). Similarly, development of environmental policies and solutions to ecological issues, like the Biodiversity Crisis, requires an active general public that is educated about the environment (GEM Report, 2021). Conservation biology as a discipline has been growing since the 1980s and has expanded to include a variety of disciplines like social sciences and humanities, which have been key to the implementation of conservation efforts into “human social systems and decision making” (Cardinale 2019, pp. 41–42). People need to be more educated so they can be aware of the choices they make as consumers, as voters, and as individuals with an environmental impact.

### The Role of Education on Pro-Environmental Attitudes

Environmental education is the main driving factor behind people’s engagement in “pro-environmental behaviors” (Varela-Candamio 2018). This means individuals that are academically informed about the environment will take actions to mitigate environmental harm and restore natural environments: actions like avoiding goods and services that exploit nature, advocating for protection of wildlife and preservation of nature, and supporting policies that promote sustainable practices and environmental stewardship (Ramos 2022). Furthermore, environmental education strengthens the relationships between pro-environmental awareness, attitudes, social norms, and motivation (Varela-Candamio 2018). Learning environmental science, especially from a young age, encourages experimental and hands-on learning to develop critical thinking skills and to recognize cause-and-effect relationships, thus improving people’s

ability to solve problems and contribute to future societal improvement (National Environmental Education Foundation). Environmental sciences also create connections between students and the outdoors through exposure to natural landscapes, which benefits those ecosystems as well as people because exposure to nature promotes both adoption of sustainable practices and improvements in mental health and happiness (National Environmental Education Foundation, Ramos 2022).

### Corresponding Research

The correlation between the amount of environmentally-focused education one receives and their level of awareness and concern for the environment has been investigated through a variety of research studies. Understanding this connection allows us to progress towards global improvement and sustainable development goals, solutions to environmental issues such as climate change and biodiversity loss, and ecological sustainability and harmony by positively influencing public knowledge, behaviors, and attitudes concerning nature through environmental education. Numerous studies exemplify this connection and its many facets.

One such study by Wang et al. (2022) considers whether education attainment influences pro-environmental attitudes and behaviors in China. Through Chinese General Social Survey microdata analysis, it was found that high levels of both positive environmental attitudes and behaviors are associated with education attainment, environmental education particularly driving this association (Wang 2022). The researchers offer their study as evidence that improving education would “set [China] on a path to more sustainable development” as the government has been aiming to do (Wang 2022). A similar study by Varela-Candamio et al. (2018) investigated

how environmental education affects “determinants of green behavior” by using a meta-analysis framework to examine the “behavioral and psychological factors” behind pro-environmental behaviors. This comprehensive paper examined intrapersonal, motivational, interpersonal, and educational factors influencing green behavior and found that environmental education along with intrapersonal factors like morals and perceived social norms were the “main drivers to predict green behavior (Varela-Candamio 2018). Studies contradicting the education-behavior correlation exist as well. The relationship between environmental knowledge, attitudes, and behaviors was also examined by Paço and Lavrador (2017), whose online survey indicated a lack of significant differences “between the attitudes and behaviors towards energy conservation” based on environmental knowledge, though the authors acknowledge this perhaps resulted from flaws in the survey distribution.

There has also been research into the broader implications of an environmentally aware and conscious public. For example, El Ouadghiri et al. (2021) found that increased public attention, both continuous and unexpected, to environmental issues significantly impacts the stock market, with investors favoring sustainable stocks when aware of environmental issues. Another study in China by Feng and He (2020) noted how environmental information disclosure (EID) to the public (i.e. public awareness) led to improvements in environmental quality and lower pollution levels. Another study found that strong public environmental concern encourages more sustainable industrial practices and reduces effects of environmental inequality, particularly in areas where official policies are weaker or not enforced (Long, 2022).

Although research on this topic is already extensive, continuous and new research is still warranted for a number of reasons. First, the existence of contradicting literature necessitates

further investigation into the role of education on environmental awareness and attitudes in order to scientifically justify this supposed connection. Second, a large body of specific research is needed to sufficiently determine the specific interrelations that may exist between education and environmental awareness and attitudes, as well as the relationship between societal improvement and environmental preservation as a whole. Finally, the ever-changing and dynamic nature of humanity requires scientific literature to be continually updated and equally diverse in order to accurately define the interconnections within and between human society and the environment.

### Methodology

The data analyzed within this paper were collected via a survey that primarily utilized a Likert scale (along with a ranking question, a best-fit question, and a one-word response question) to evaluate participants' level of awareness of environmental issues and concepts and their attitudes about the environment. The proposed survey was submitted to the Institutional Review Board for approval, then it was distributed on paper to the students of two classes at the University of Tennessee at Chattanooga. The survey was voluntary and anonymous. Both courses covered introductory environmental science, with the ESC 1510 course (Introduction to Environmental Science II) designed for and consisting of mostly Environmental Science majors and the BIOL 1100 course (Conservation of Biodiversity), designed for non-Environmental Science students and consisting of a variety of majors. Participants were given the survey on the first day of the class, prior to any lecture material; then, the same survey was given again on the last day of class after the final examination.

For the first question, participants were asked to give an open response to the question “What do you think is the most widely trafficked mammal in the world?” in order to determine people’s perception of the wildlife trade and their knowledge of its demands.

The next section consisted of Likert statements related to awareness of biodiversity regulations and issues. Participants would rank on a scale of 1 to 7 how much they disagree or agree with the statement, with lower numbers indicating stronger disagreement, higher numbers indicating stronger agreement, and 4 suggesting neither agree nor disagree. The following 11 statements were given:

1. I have heard about the trade in wildlife.
2. I am aware of the extent to which illegal/legal trade harms wildlife.
3. I know that overexploitation is the second biggest threat to biodiversity.
4. I know the worldwide trade in wildlife is valued at over 10 billion a year.
5. I know about CITES.
6. I know about the overharvesting of butterflies and also tropical fish.
7. I know about ESA, including the basics of how it works.
8. I am familiar with the Red List.
9. I know that seahorses and frog legs are in high demand.
10. I have heard of the pangolin.
11. I know that the pangolin is in high demand for its scales and claws.

All 11 statements were worded so higher numbers (i.e. stronger levels of agreement) correlated with higher levels of awareness and general knowledge of the Biodiversity Crisis. The scores for the Awareness statements were added to get a total Knowledge score for each participant, so

each participant's awareness level could be easily quantified and compared. Then, the Knowledge values for each class and for both classes were graphed on a histogram. The histograms show the distribution frequencies of the Knowledge scores within ranges of 11 intervals (since 11 is the lowest possible score and there are 11 statements).

Next, participants were asked to rank four categories of illegally trafficked goods (drugs, humans, wildlife, and guns) from Most Trafficked (with a 1) to Least Trafficked (with a 4) in terms of estimated annual value. This response would reveal which of these categories people believed generated the most money as well as how they felt the value of wildlife compared to that of guns, drugs, and humans on the black market. Another open response question asked the students' major. This question was more important for the BIOL 1100 course, since there was a greater variety of majors in that course while the ESC 1510 course (as expected) consisted of mostly Environmental Science majors.

The other Likert scale section had the same layout as the Awareness statements with participants selecting a score from 1 to 7, now in response to statements concerning attitudes about the environment and the Biodiversity Crisis. The 11 Attitude statements were as follows:

1. Biodiversity is important to me.
2. When I hear about a species going extinct, I feel sorrow.
3. I feel guilty when a species goes extinct due to human activity.
4. The potential loss of medicines due to the loss of biodiversity concerns me.
5. I would prefer to live in an area where I can see lots of green space and wildlife.
6. I am upset when a species goes extinct.
7. I feel as though all species are valuable.

8. I enjoy biodiversity.
9. Unique species like pangolins should be protected.
10. The illegal/legal trade of wildlife concerns me.
11. I wish I knew of more ways I could help preserve/conservate biodiversity.

As with the Awareness statements, higher responses indicated a stronger positive attitude about the environment, and the scores of each statement were added together to create a quantitative total Care score for each participant.

A between-subjects design was used to compare the classes both before and after completing the course, while a within-subjects design was used to measure change within each class from the beginning of the semester to the end.

For the final question, participants were asked to identify which of three statements most accurately matched their personal conservation ethic, or in other words, the statement for which they would be most willing to advocate. The three statements were:

1. I believe nature should be preserved for nature's sake (in other words, for no other reason than because nature is beautiful). Nature should therefore be left alone.
2. I believe nature should be respected, but also that we should be able to smartly and carefully use the resources provided by nature for the good of humankind.
3. I do not have a conservation ethic, because I really do not care about, nor am I interested in, nature, biodiversity, or resource conservation.

It was the intention of the researcher to select students from the classes for face-to-face interviews, as a means of more fully exploring emerging themes. Participants would have been chosen based on availability and willingness to be interviewed. Unfortunately no students



indicated a willingness to be interviewed, even though they were given the opportunity and the appropriate contact information. Prior to attempting to publish a version of this research project, it may be necessary to try again, as far as extending this contact information, in a manner consistent with that which is allowed by the approved IRB.

### Results

The survey at the beginning of the semester had 26 participants from the 1510 class for an 86% completion rate and 56 participants from the 1100 class for a 93% completion rate. At the end of the semester, the 1510 class had 27 survey respondents for a 96% completion rate and the 1100 class had 52 respondents for a 93% completion rate.

### Most Trafficked Mammal

The initial question “What do you think is the most widely trafficked mammal in the world?” was most commonly left unanswered with 28.0% of pre-semester responses and 38.8% of post-semester responses leaving it blank. At the beginning of the semester, the most frequent answer across classes was “elephants” for 15.9% of the responses, closely followed by “humans” for 14.6% of the responses; the true answer, pangolins, was the third most frequent given response at 9.8%. In the 1510 class, 5 out of the 26 participants (19.2% of the class) wrote “pangolins” while in the 1100 class, 4 out of the 56 participants (7.1% of the class) wrote “pangolins.” At the end of the semester, the number of responses accurately answering “pangolins” increased to 37.5%, making it the most frequently given answer by far. The 1510 class had 6 people answer “pangolins” (22.2% of the class) while the 1100 had 24 people answer “pangolins” (46.2% of the class).

Table 1. Frequencies of the most common answers to the question “What do you think is the most widely trafficked mammal in the world?” from participants before and after taking the course.

	Beginning of Semester Answer Frequency (Combined Classes)	End of Semester Answer Frequency (Combined Classes)
Blank/No Answer	28%	38.8%
Pangolins	9.8%	37.5%
Elephants	15.9%	3.8%
Other	46.3%	19.9%

### Awareness

The statements pertaining to awareness of environmental issues received primarily neutral or negative responses from both classes at the beginning of the semester, with the average response to each statement ranging from 5 (slightly agree) to 1 (strongly disagree). The 1510 class had higher, more positive responses to each question than the 1100 class; the 1510 average responses were around one point higher than the 1100. The final two statements relating to pangolins received neutral responses from the 1510 class and disagreement responses from the 1100 class. Overall, the second statement--“I am aware of the extent to which illegal/legal trade harms wildlife”--had the highest average response of the statements while the fifth statement--“I know about CITES”--had the lowest average response.

The scores for the Awareness statements were added to get a total Knowledge score for each participant. In the 1510 class, the majority of the total Knowledge scores were between 55

and 66, with 38.5% of scores falling in that range (Figure 2.1). The median score was 45.5 with a standard deviation of 11.3. The 1100 class had the majority of their total Knowledge scores in the range 22 to 33, though the scores were more broadly distributed than the 1510 class with that range fitting 14.3% of the scores (Figure 2.2). The median score was a much lower 29.5 with a standard deviation of 12.4. When the Knowledge scores from both classes were analyzed together, the scores most frequently fell between 33 and 44 with 24.4% of the scores within that range, and the distribution was higher than both classes individually (Figure 2.3). The median score was 35 with a standard deviation of 13.7.

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Fig. 2.1 Distribution of total knowledge scores of individuals from ESC 1510 at the start of the semester.

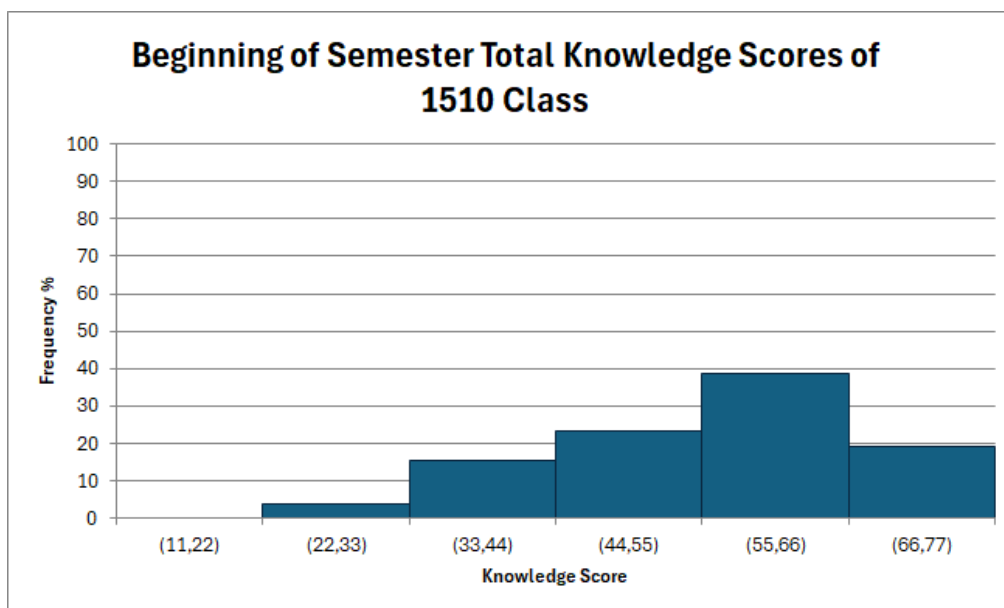


Fig. 2.2 Distribution of total knowledge scores of individuals from BIOL 1100 at the start of the semester.

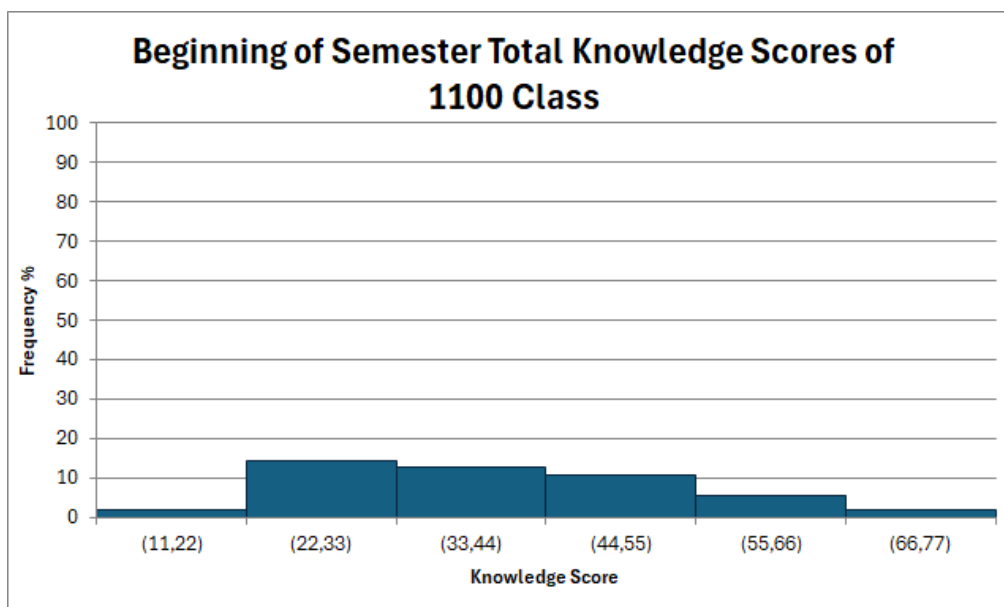
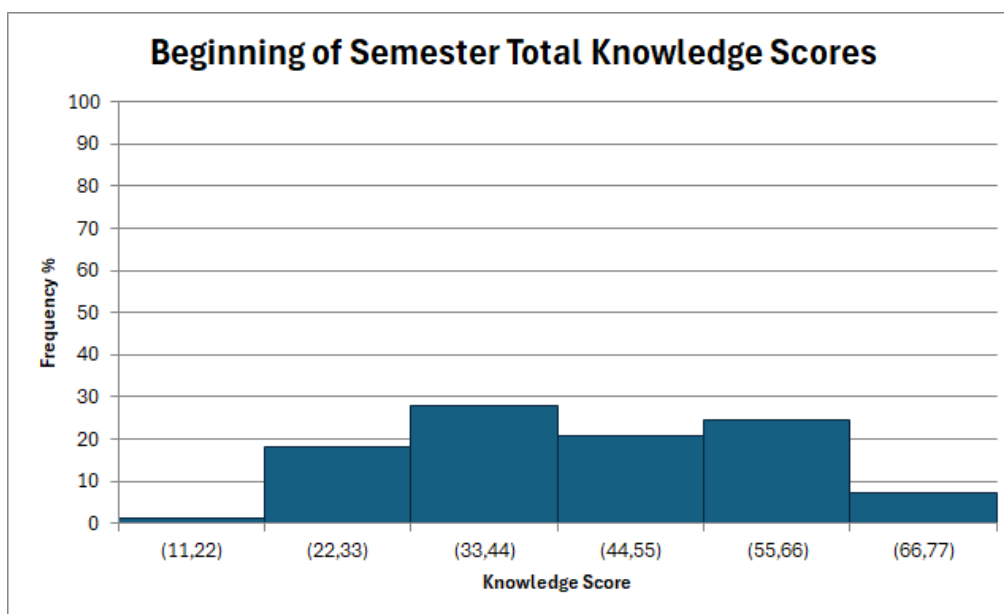


Fig. 2.3 Distribution of total knowledge scores of individuals from both classes at the start of the semester.



At the end of the semester, the classes took the survey again. Over all surveys, the Awareness scores for each statement had increased notably, with all statements now having a positive median response (i.e. ranging from 5 to 7). The third statement—"I know that overexploitation is the second biggest threat to biodiversity"--was now the statement with the highest average response of 6.39, and multiple statements had a maximum median response of 7. Two statements were tied for lowest average response—"I know the worldwide trade in wildlife is valued at over 10 billion a year" and "I know that seahorses and frog legs are in high demand"--but these statements were still correlated with agreement with an average of 5.11. The statement about seahorse and frog leg demand had a slightly higher median of 6 compared to the wildlife trade value statement's median of 5. The average responses between classes were much closer, most being within less than one point of each other. The 1100 class had a higher average for statements 4, 6, 7, 9, 10, and 11 while the 1510 class was higher on statements 1, 2, 3, 5, and 8.

The total Knowledge scores were calculated again for the end of the semester and charted on a histogram. The 1510 class now had the vast majority of its Knowledge scores (74.1%) in the 66 to 77 range, and its median increased to from 45.5 to 66 with a standard deviation of 12.9 (Figure 2.4). The 1100 class also had the vast majority of their Knowledge scores (88.5%) fall in the 66 to 77 range, and at an even higher frequency percentage than the 1510 class (Figure 2.5). The median had increased substantially from 29.5 to 67 with a standard deviation of 14.0. Analyzing the Knowledge scores from both classes together resulted in the vast majority of scores (83.5%) being between 66 and 77 (Figure 2.6). The median response increased from 35 to 67 with a standard deviation of 13.6.

Fig. 2.4 Distribution of total knowledge scores of individuals from ESC 1510 at the end of the semester.

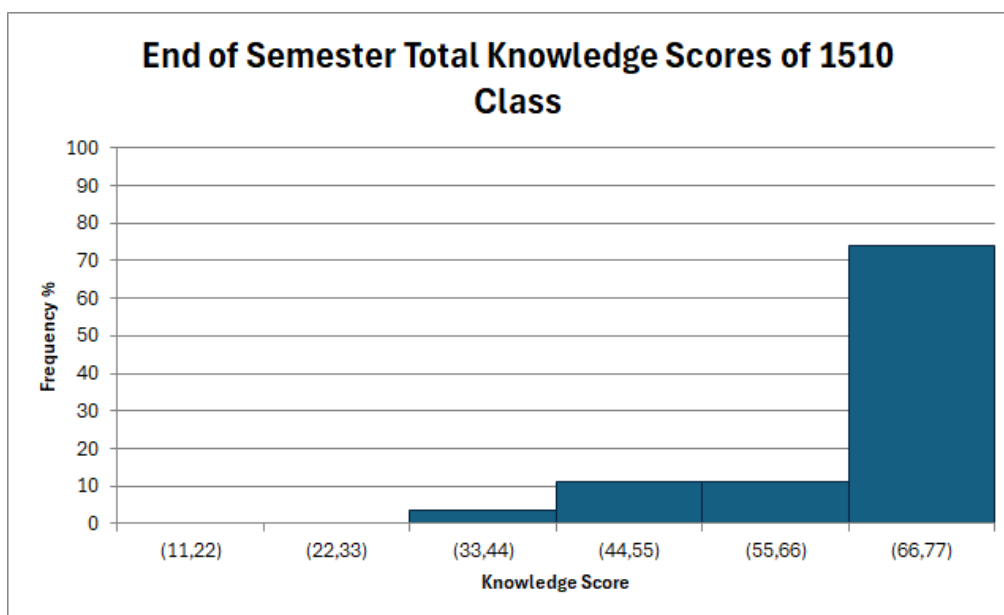


Fig. 2.5 Distribution of total knowledge scores of individuals from BIOL 1100 at the end of the semester.

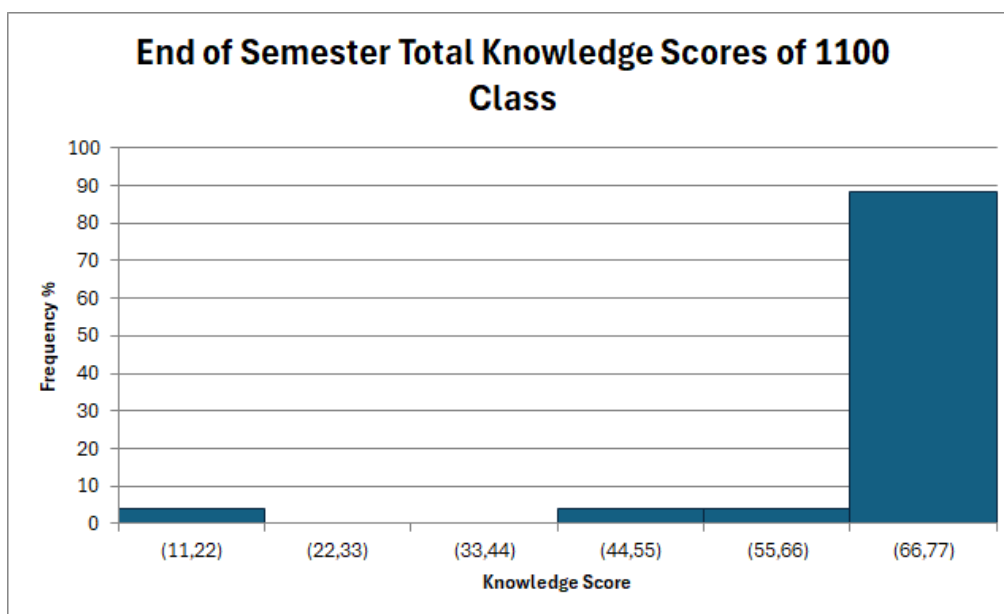
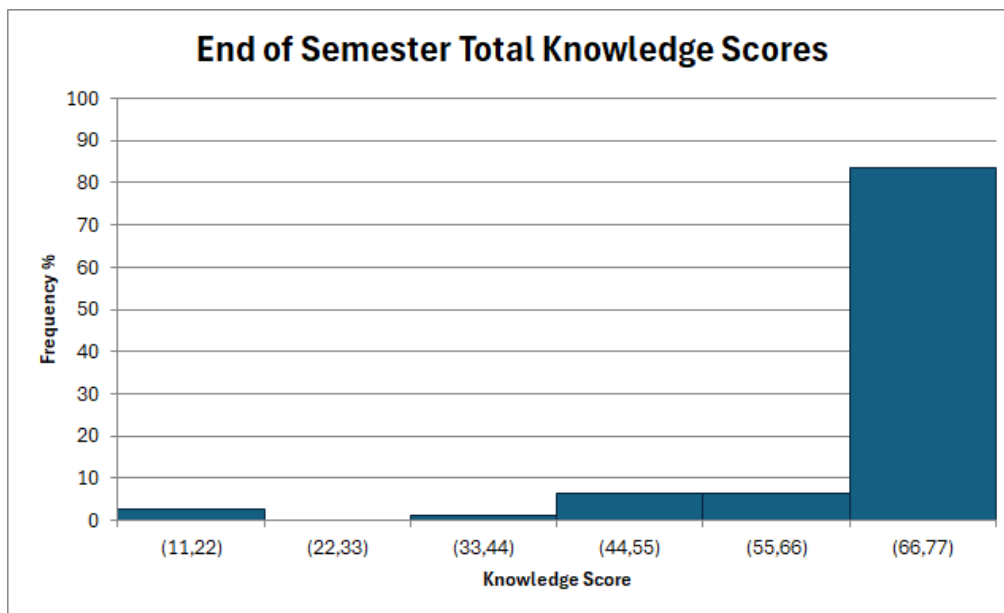


Fig. 2.6 Distribution of total knowledge scores of individuals from both classes at the end of the semester.



### Attitudes

For the statements pertaining to environmental Attitudes, the average responses across surveys were positive and higher than those for the Awareness statements. The spread of mean and median answers was far less for attitude statements than the awareness statements. Nine out of the eleven statements had a median response of 6 (Agree). Statement 9–“Unique species like pangolins should be protected”--had the highest mean at 6.15 for the combined classes, while statements 1 and 4–“Biodiversity is important to me” and “The potential loss of medicines due to the loss of biodiversity concerns me” respectively–tied for the lowest mean at 5.45.

The means for the 1510 class were slightly higher than the means for the 1100 class, but not as much as they were for the Awareness means at the beginning of the semester. The 1100

class responded with Slightly Agree to Agree for most answers, while the 1510 class responded slightly higher with means closer to Agree and Strongly Agree. The questions with the greatest difference in class means were statements like 1, 8, 10, and 11 that mentioned direct concern for or enjoyment of biodiversity. The distribution of responses to the Attitude statements was slightly lower than that for the Awareness statements, and the 1510 class had a lower distribution for the Attitude statements than the 1100 class.

As with the Awareness scores, the Attitude scores for each participant were combined for a total Care score, and those scores were graphed on a histogram. The 1510 class had the vast majority of their total Care scores at the beginning of the semester fit into the 66 to 77 range, with 92.3% of scores within that range (Figure 3.1). The median Care score was 74 with a standard deviation of 9.6. The 1100 class also had the majority of its scores in the 66 to 77 range, which consisted of 73.2% of the scores (Figure 3.2). The median Care score was 62 with a standard deviation of 12.4. The classes combined at the beginning of the semester had 79.3% of the Care scores between 66 and 77. The median was 66 with a standard deviation of 12.3.



Fig. 3.1 Distribution of total care scores of individuals from ESC 1510 at the start of the semester.

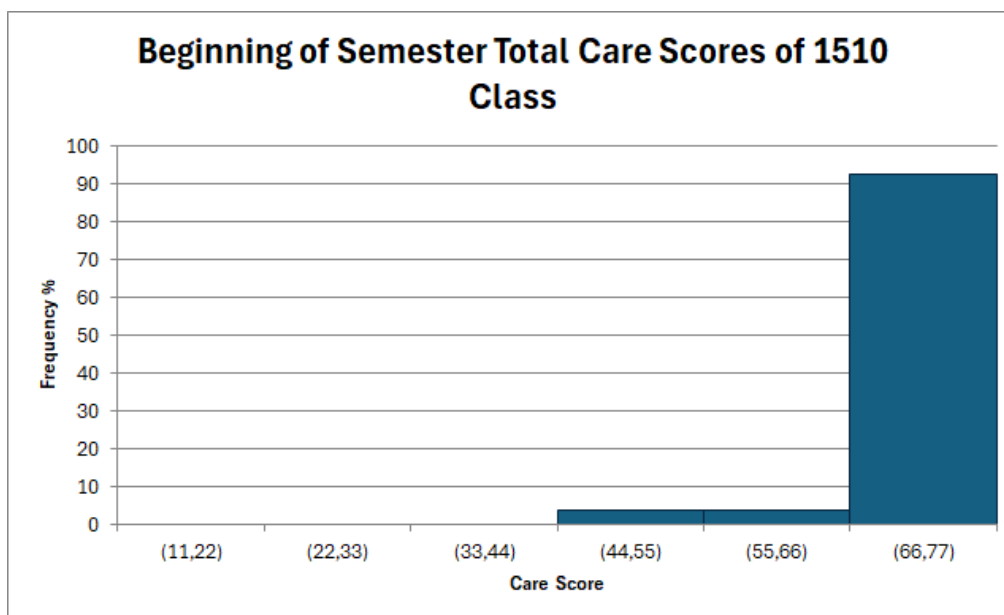


Fig. 3.2 Distribution of total care scores of individuals from BIOL 1100 at the start of the semester.

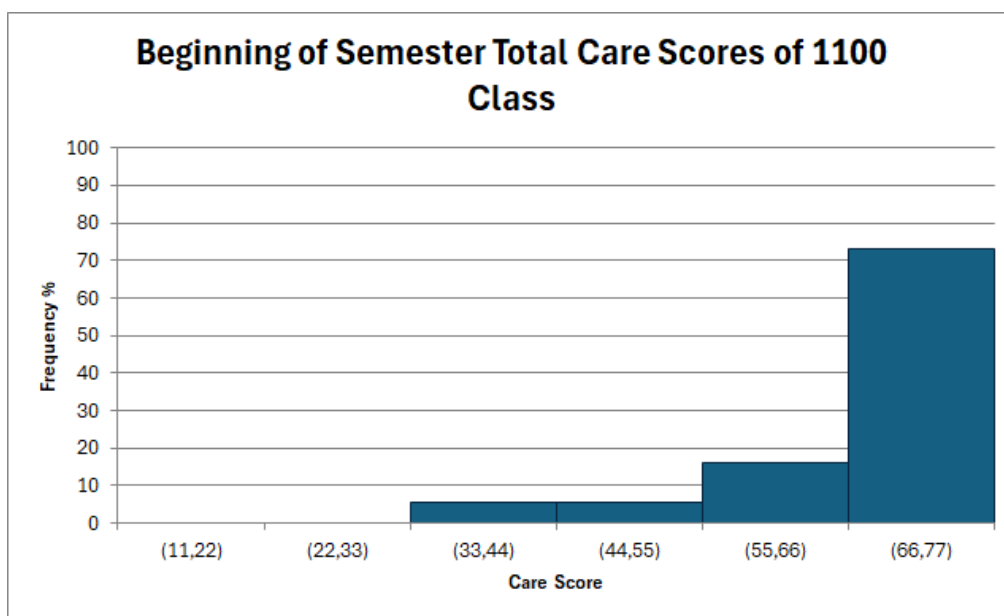
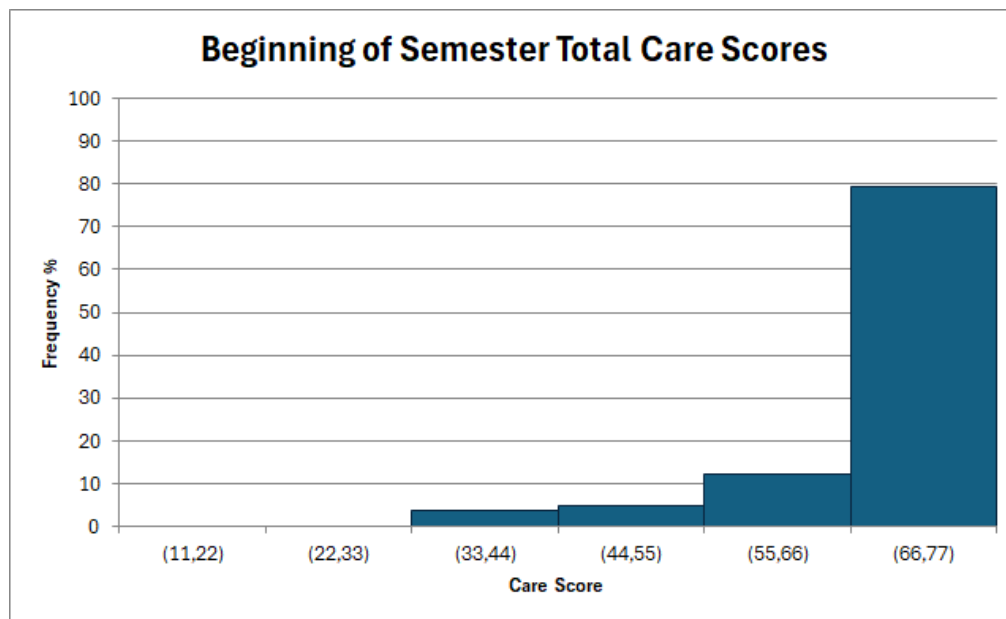


Fig. 3.3 Distribution of total care scores of individuals from both classes at the start of the semester.



By the end of the semester, the overall Attitude statements had an increase in the average response by around one point for each statement. All the statements now had a median response of 7 or Strongly Agree, except for the 4th statement which had a median of 6. The 9th statement still had the highest average at 6.51, but the 1st statement (which was previously tied for lowest at the start of the semester) now had the second highest average score at 6.38. The lowest average was 5.97 for the 3rd statement—"I feel guilty when a species goes extinct due to human activity." The averages from the 1510 class were still higher than those from the 1100 class, but the differences were all less than one point.

The histogram for the 1510 class now only had scores within the two highest ranges, with 92.6% of Care scores being between 66 and 77 and the rest being between 55 and 66 (Figure

3.4). The median remained at 74 but the standard deviation decreased to 7.0. For the 1100 class, the vast majority of scores were again within the 66 to 77 range, with 84.6% of the scores within that range (Figure 3.5). The median had increased from 62 to 70 with a standard deviation of 13.5. The two scores in the 11 to 22 and 22 to 33 ranges could be possible outliers, resulting from a participant mistakenly thinking lower numbers correlated with agreement rather than disagreement. The combined classes had the majority of the Care scores in the range of 66 to 77, with 87.3% of scores in that range (Figure 3.6). The median Care score had increased from 66 to 72 with a standard deviation of 12.0.

Fig. 3.4 Distribution of total care scores of individuals from ESC 1510 at the end of the semester.

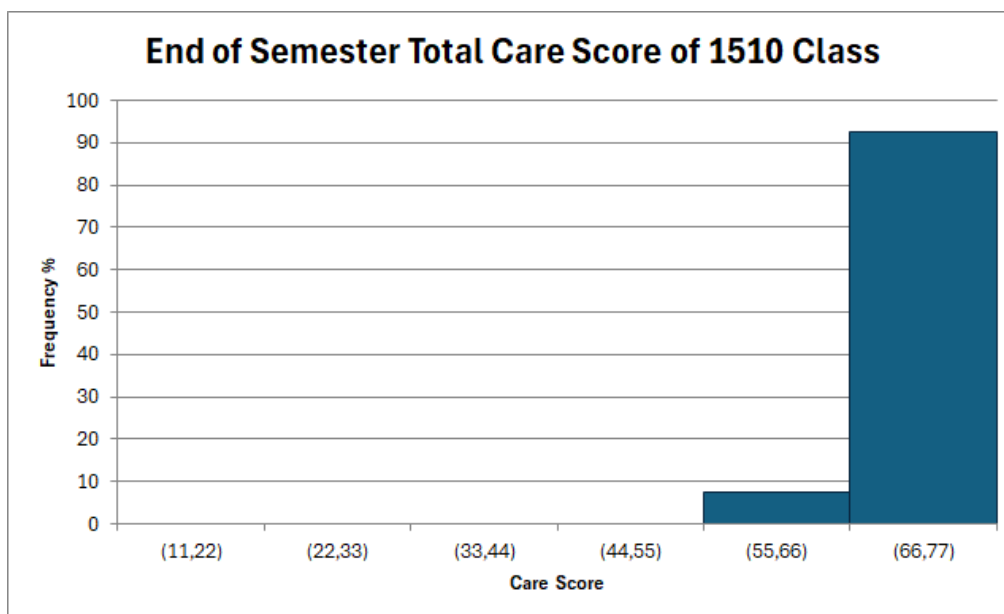


Fig. 3.5 Distribution of total care scores of individuals from BIOL 1100 at the end of the semester.

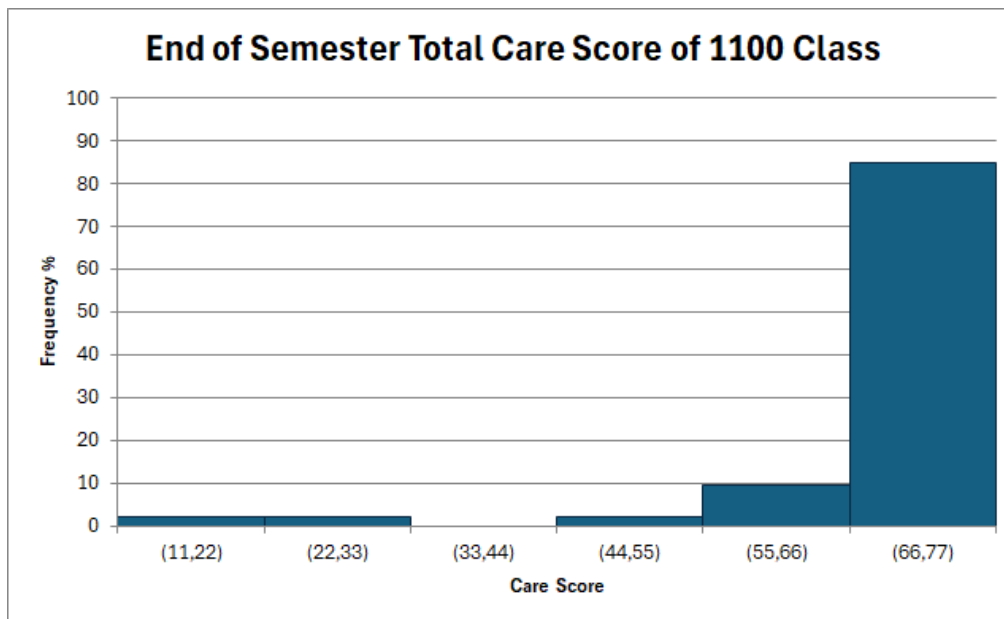
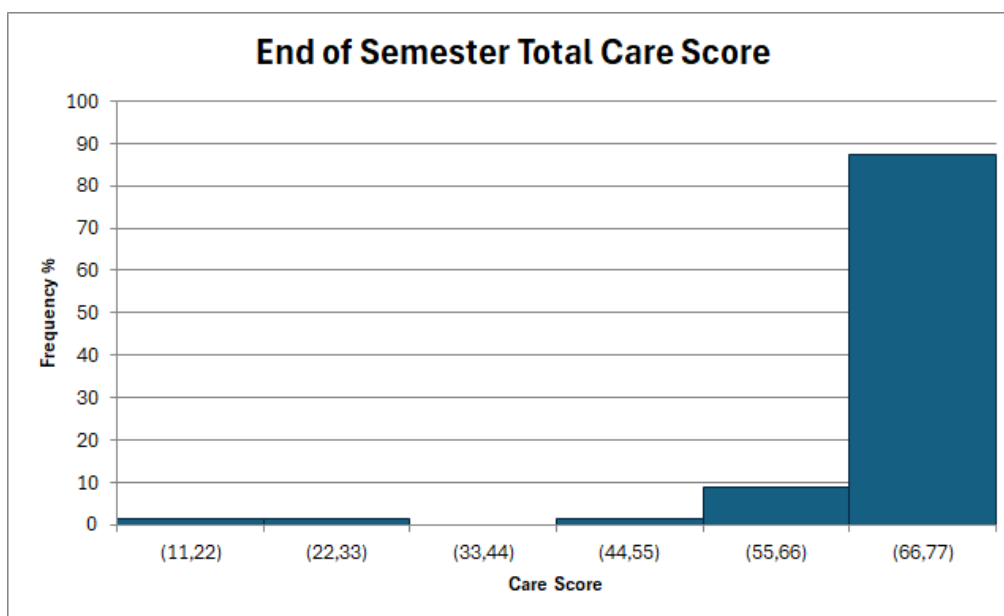


Fig. 3.6 Distribution of total care scores of individuals from both classes at the end of the semester.



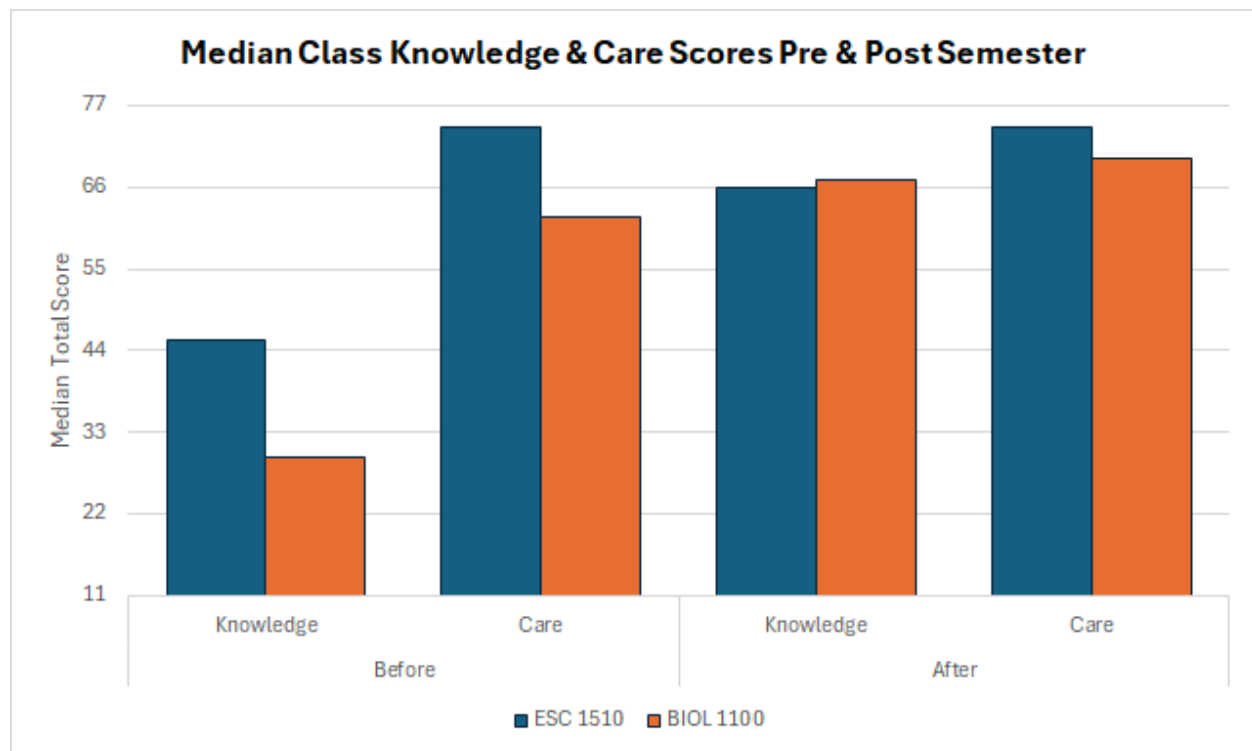
### t-Tests Before and After the Semester and Between Classes

A two-way student's t-test was run to compare the Knowledge and Care scores of the 1510 class to those of the 1100 class and to determine if there was a significant difference in the classes' scores, both at the start and at the end of the semester. The test revealed that there is a significant difference between the classes' Knowledge scores at the beginning of the semester,  $t(80) = 4.962$ ,  $p = <0.001$  at 95% confidence interval. The same was true of the classes Care scores,  $t(80) = 3.454$ ,  $p = <0.001$  at 95% confidence interval. For the end of the semester, there was no significant difference between the classes' Knowledge scores at the end of the semester,  $t(77) = -1.022$ ,  $p = .155$  at a 95% confidence interval. However, there was still a significant difference in the classes' Care scores at the end of the semester,  $t(77) = 2.186$ ,  $p = .016$  at a 95% confidence interval.

A one-way t-test was also conducted to determine if there was significant change in each classes' Knowledge and Care scores from the beginning of the semester to the end. The 1510 class had a significant increase in its Knowledge scores from a median of 45.5 to 66, with a p-value of  $<0.001$  at a 95% confidence level,  $t(25) = -4.965$ . The 1510 class's Care score increased after taking the course but not at a significant level,  $t(25) = -0.936$ ,  $p = 0.175$  at a 95% confidence level; though there was a small increase in the average Care score from 69.7 to 72, the median Care score remained the same at 74.

The 1100 class had an increase in its Knowledge score median from 29.5 to 67, which was statistically significant,  $t(51) = -11.755$ ,  $p = <0.001$  at a 95% confidence interval. The Care score also increased from a median of 62 to 70 and was statistically significant,  $t(51) = -2.292$ ,  $p = 0.013$  at a 95% confidence interval.

Fig. 4 Comparison of median total knowledge and care scores between classes before and after the semester.



### Ranking

At the start of the semester, the average ranking of trafficked goods from most to least trafficked for all surveys was Drugs, Humans, Wildlife, then Guns (Figure 5.1). Wildlife was most widely distributed, with its highest frequency as Most Trafficked at 32.9% but with 3rd Trafficked as a close second most frequent at 30.5%. The amount selecting Wildlife as most trafficked was still lower than the one for Drugs, which was at 42.0%. No one selected Guns as

the Most Trafficked. By the end of the semester, the average ranking shifted to Wildlife, Drugs, Humans, then Guns, with Wildlife heavily skewed to Most Trafficked at 60.8% (Figure 5.2).

Fig. 5.1 Distribution of individuals' ranking of illicitly trafficked goods at the start of the semester from most to least trafficked.

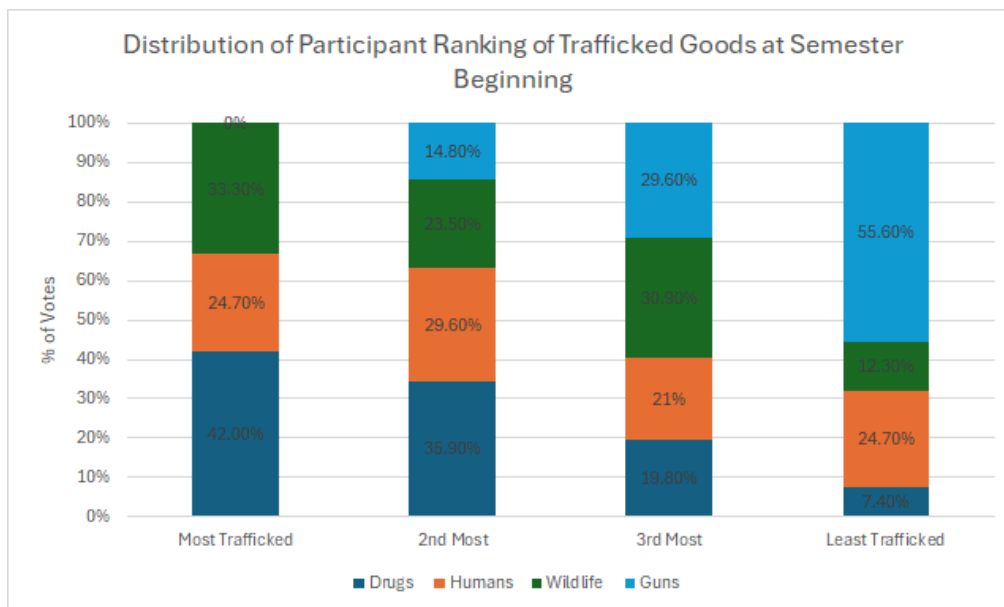
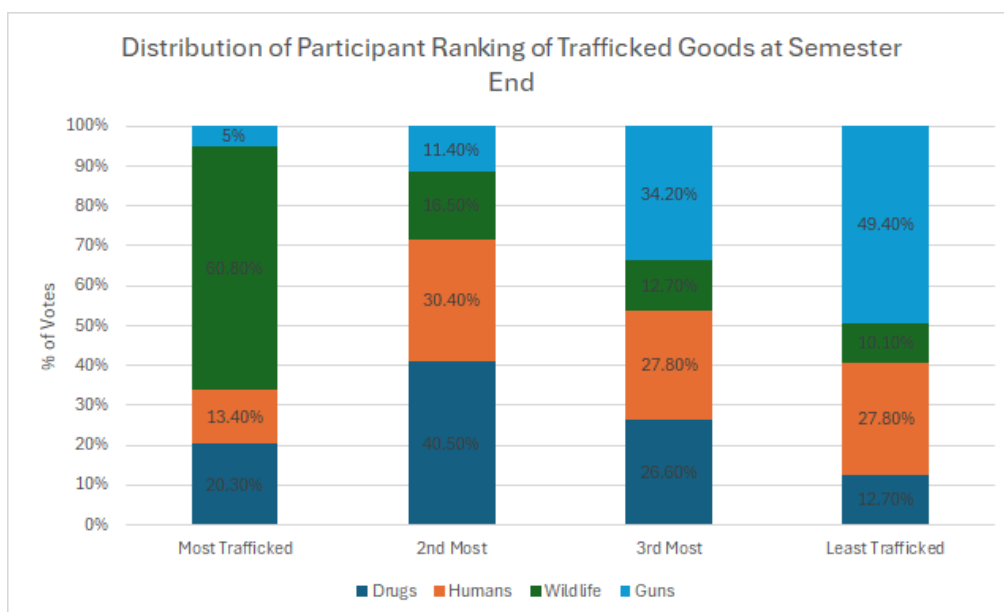


Fig. 5.2 Distribution of individuals' ranking of illicitly trafficked goods at the end of the semester from most to least trafficked.



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### Conservation Ethic

The second conservation ethic option—"I believe nature should be respected, but also that we should be able to smartly and carefully use the resources provided by nature for the good of humankind"—was the most selected response by far for both classes at 89.9% at the beginning of the semester and 87.5% at the end (the number of votes for this option actually increased by 1 but the total amount of responses decreased, resulting in a lower percentage). The 1510 class only selected between the first and second ethic options at both the beginning and end of the semester (Figure 6.1). The 1510 class had no change in the distribution of ethic selections, with the first statement getting 12% of the selection and the second statement getting 88% both before and after the semester (Figure 6.2). The 1100 class had one vote at the beginning of the semester for the third option—"I do not have a conservation ethic, because I really do not care about, nor am I interested in, nature, biodiversity, or resource conservation"—but only had votes for the first two options by the end. The 1100 class had 17% select the first statement, 79% select the second, and 4% select the third at the beginning of the semester (Figure 6.3); by the end of the semester, 13% selected the first statement and 87% selected the second, with no selections for the third statement (Figure 6.4).



Fig. 6.1 Distribution of conservation ethic statements selected by individuals from ESC 1510 at the start of the semester.

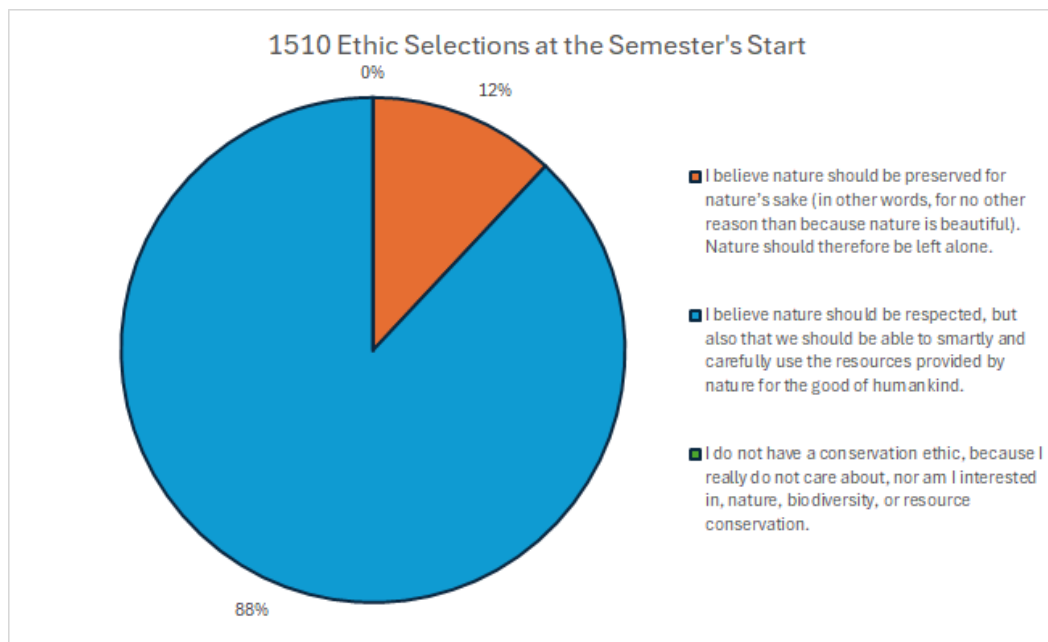


Fig. 6.2 Distribution of conservation ethic statements selected by individuals from ESC 1510 at the end of the semester.

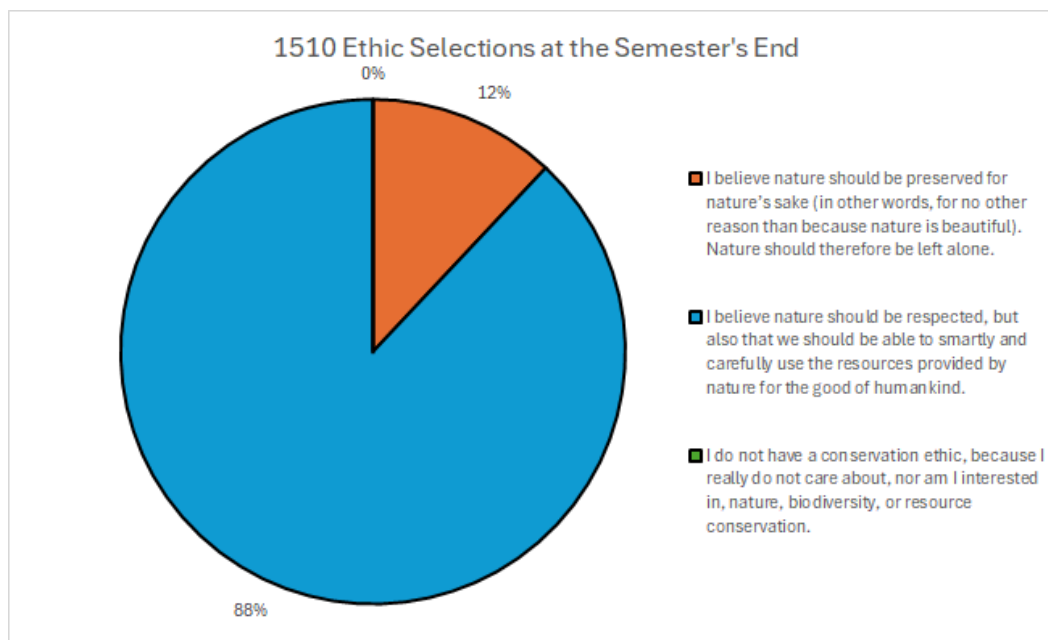


Fig. 6.3 Distribution of conservation ethic statements selected by individuals from BIOL 1100 at the start of the semester.

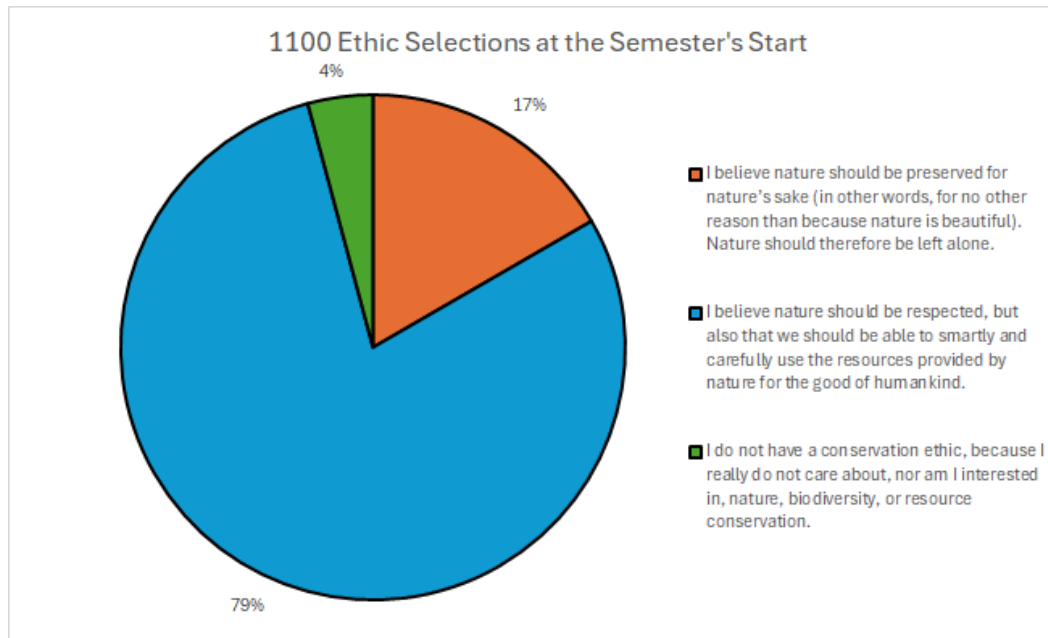
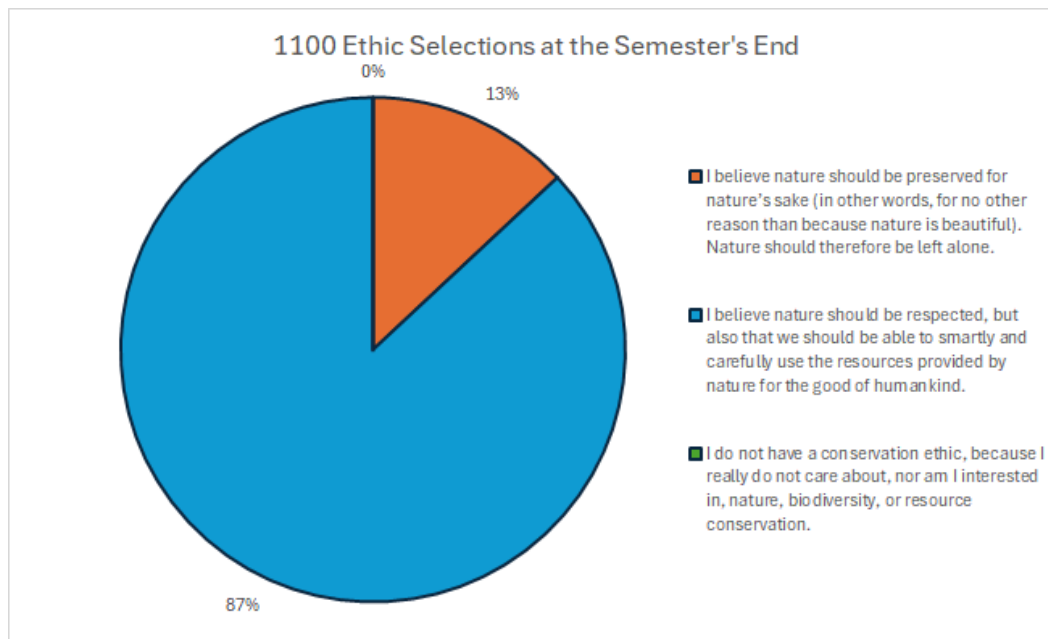


Fig. 6.4 Distribution of conservation ethic statements selected by individuals from BIOL 1100 at the end of the semester.



## Discussion

This study investigated the awareness of and attitudes about the Biodiversity Crisis among students and how the awareness and attitudes compared between a class of environmental science majors and a class of non-environmental science majors. The study also evaluated whether students' within a class had changes in their awareness and attitudes from the start of the semester versus after completing the course. Using pangolins as a focus species on a survey, the researcher determined the impact education had on people's knowledge about the Biodiversity Crisis and their care for the environment from a biodiversity perspective.

The results for the first survey question revealed that people initially assumed that the most trafficked mammal was the elephant, a charismatic megafauna, and many of the other responses included other charismatic species, such as rhinos and big cats. Few people (<10%) knew the pangolin is the most trafficked mammal, but those that did made up a greater percentage in the 1510 course versus the 1100 course. At the end of the semester, far more people were informed about pangolins and the extent to which they were trafficked as the most frequent response to the first question became pangolins. This indicates the courses were successful in improving students' awareness of the pangolin and their knowledge of wildlife demand. Unfortunately a large portion of participants left the first question unanswered, possibly because they did not want to give a wrong answer or simply skipped over the question when reading. The amount of blank responses was higher at the end of the semester possibly because the survey was included at the end of the courses' final exams, and students were likely tired and not reading closely by that point.

Results from the Likert statements about awareness showed that people in both courses at the semester's start were more aware of broader, more general concepts related to the Biodiversity Crisis yet less aware of specific concepts. They were most aware of general threats to biodiversity (i.e. the wildlife trade, overexploitation, and the harm they cause) but least aware of specific organizations and regulations dealing with biodiversity conservation and restoration. While the same was still true by the end of the semester, there was less of a difference in the mean response for each question, so people were made more aware of the specific concepts, like knowledge of CITES, while their knowledge of broader concepts also increased. The last two statements related to pangolins also saw an increase in mean response, bringing the median response up from 3 and 2 to 7, and further indicating the courses' success in bringing awareness to the pangolin.

At the beginning of the semester, ESC 1510 students were significantly more aware and knowledgeable about the Biodiversity Crisis than BIOL 1100. This makes sense as they have likely had an established interest and previous education in environmental sciences since they are majoring in the subject. As BIOL 1100 is an introductory class for non majors, this is likely their first environmentally focused course and their first time hearing about some of the subjects in the statements, so their knowledge of environmental concepts was lower. The 1510 class's neutrality about the pangolin statements suggests they may have heard of the animal before but knew little beyond its name, while the 1100 class's disagreement suggests they had never heard of the pangolin before. By the end of the semester, both classes had significantly improved their knowledge of the Biodiversity Crisis. The lack of significant difference between classes at the end of the semester indicates that the 1100 students were brought up to the same level as the

1510 class. The 1100 class even ended with a slightly higher Knowledge score than the 1510 class; while this is likely only their perceived knowledge, it nonetheless shows that the 1100 students feel that they have become substantially more aware and knowledgeable about the Biodiversity Crisis.

Results from the attitude statements at the beginning of the semester revealed that people only slightly cared about biodiversity as a whole, but they felt strongly about the protection of unique species and their desire for greenspaces and wildlife in their community. Almost inverse of the awareness results, people were more likely to care about specific topics (especially if they directly related to them) but less likely for broader topics. It is likely easier to feel sympathy or concern for a specific topic that can be easily envisioned or related to than a broad topic that is more general. However, by the end of the semester people placed more value on biodiversity as a whole as evidenced by the statement “Biodiversity is important to me” going from the lowest to the second highest median response. While they still greatly cared about more narrow biodiversity topics, students had a greater value of biodiversity after taking the course.

The Care scores for both classes were decently high at the beginning of the semester, showing some level of agreement for all the statements. The 1510 class had significantly higher Care scores than 1100 at the semester’s beginning, which was expected given that their choice in the environmental science major suggests an interest in the environment. Their median score was nearly at the maximum and with a lower standard deviation (i.e. less variation in answers among participants) than the awareness statements. There was not a significant difference in 1510’s attitudes at beginning versus end of the semester, because their attitudes were already nearly maxed out; in other words, they already cared a lot. Their standard deviation did decrease

slightly though, indicating that the range of total Care scores decreased as the lower range of scores increased. The 1100 students had a relatively high median Care score, showing that they had at least a slightly positive attitude towards the environment and biodiversity, just not as passionately as the 1510 students. Completing the course did increase the 1100 students' attitudes significantly, creating more care about biodiversity. There were a couple of outliers that had very low Care scores, though it is suspected that these participants misread the instructions (again possibly due to fatigue and impatience from finishing the final exam) and thought lower numbers correlated with agreement. Comparing between classes, there was still a significant difference in their attitudes by the end of the semester; however, this difference was just barely significant at a 95% confidence level since the p-value was 0.016, which would not be significant at a 99% confidence level and is much closer than the p-value of  $<0.001$  for comparing classes at the beginning of the semester.

The results from the ranking section revealed people's perception of the monetary value of trafficked wildlife. On average, they believe at the start that the profit from the illegal wildlife trade was similar to that of human trafficking, less than that from drug trade, and more than that from gun trade. However, by the end of the semester, the majority placed wildlife as the most profitable trafficked goods. It is possible people incorrectly assumed wildlife would be the most trafficked, since the survey focused on biodiversity and environmental science. While wildlife is not the most trafficked of the four categories, the results do reveal that taking the course makes people place more value on the wildlife in the black market, though it may have made them expect the demand and value for illicit wildlife trade to be higher than it actually is.

People mostly selected the second ethic option at both the beginning and end of the semester and for both classes, indicating that most people favored conservation over preservation. Since no one selected the third option by the end of the semester, the one that did at the beginning of the semester was possibly impacted by the course enough to change their ethic. Some people's selections were not able to be properly analyzed because they selected ethics one and two; though these two statements are slightly contradictory, people were probably trying to indicate they felt nature should be preserved for nature's sake while also being used wisely for the good of mankind.

#### Limitations and Considerations for Future Study

Given the size of the classes surveyed, the study was limited to a lower number of participants, and an equal number of respondents in each class would have been preferred. Outlier responses and lack of answers suggest there is an issue with the layout or formatting of the survey. The survey could be improved by being given in a digital format so that each section can be more clearly separated, questions not as easily skipped, and answers not changed later or influenced by proceeding sections. An error occurred in the initial version of the survey where the first question read "Before moving on with this survey, what do you think is the widely trafficked mammal in the world?" which accidentally left out the word "most" before "widely trafficked." Participants appeared to understand what the question intended to ask given the number of reasonable responses, and this error was amended for later distribution.

The study data are limited to lowerclassmen students of the University of Tennessee at Chattanooga, so further study could include: surveying students from a variety of colleges to

determine knowledge and care variations by region or college; investigating the impact of education over a longer term by surveying students over a four-year program; and surveying high school students to see how levels of secondary education affect environmental awareness and attitudes compared to college education.

### Conclusion

The researcher found that education has a significant impact on people's awareness of the Biodiversity Crisis, their attitudes towards biodiversity and the environment, and their value of biodiversity and the environment. At the beginning of the Fall 2023, awareness of aspects of the Biodiversity Crisis was neutral to slightly low for students majoring in environmental science and poor for students in other majors; at the same time, environmental science students had strong positive attitudes biodiversity, but the non-major students had slightly positive to mostly neutral attitudes. Over the course of the semester, students were educated about environmental science and the Biodiversity Crisis with focus topics like the heavily trafficked pangolin exemplifying the impact of human disturbance and overexploitation as well as the importance of environmental research and regulations. By the semester's end, both majors and non-majors were positively informed about pangolins and the Biodiversity Crisis as a whole, and the non-majors had developed stronger pro-environmental attitudes, similar to the majors.

It is obviously important for our future environmentalists to be well informed about biodiversity and to care about its preservation and well-being as they will be the primary researchers, educators, and advocates of biodiversity and the environment as a whole. Furthermore, it is equally crucial for people outside the environmental science fields to be



knowledgeable and empathetic about the environment so that they will make informed decisions for the betterment of the environment and thus humanity as they become our lawmakers, humanitarians, artists, engineers, medical professionals, and fellow citizens.

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## Appendix: Awareness & Attitudes Survey

This survey is totally anonymous and does not in any way affect your grade negatively. It's purely voluntary as well, and you are not required to fill it out. Even so, if you do fill it out, please answer honestly and thoughtfully. And THANK YOU!!

- Before moving on with this survey, what do you think is the most widely trafficked mammal in the world?

ANSWER HERE →

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Slightly Disagree
- 4 = Neither Agree or Disagree
- 5 = Slightly Agree
- 6 = Agree
- 7 = Strongly Agree

01) I have heard about the trade in wildlife.	1	2	3	4	5	6	7
02) I am aware of the extent to which illegal/legal trade harms wildlife.	1	2	3	4	5	6	7
03) I know that overexploitation is the second biggest threat to biodiversity.	1	2	3	4	5	6	7
04) I know the worldwide trade in wildlife is valued at over 10 billion a year.	1	2	3	4	5	6	7
05) I know about CITES.	1	2	3	4	5	6	7
06) I know about the overharvesting of butterflies and also tropical fish.	1	2	3	4	5	6	7
07) I know about ESA, including the basics of how it works.	1	2	3	4	5	6	7
08) I am familiar with the Red List.	1	2	3	4	5	6	7
09) I know that seahorses and frog legs are in high demand.	1	2	3	4	5	6	7
10) I have heard of the pangolin.	1	2	3	4	5	6	7
11) I know that the pangolin is in high demand for its scales and claws.	1	2	3	4	5	6	7

- RANK THE FOLLOWING (1, 2, 3, 4) from the MOST TRAFFICKED (with a 1) to the LEAST TRAFFICKED (with a 4) in terms of estimated annual value.

\_\_\_\_\_ Drugs

\_\_\_\_\_ Humans

\_\_\_\_\_ Wildlife

\_\_\_\_\_ Guns

WHAT IS YOUR MAJOR? ANSWER HERE. →

See the next page (on the back).

This survey is totally anonymous and does not in any way affect your grade negatively. It's purely voluntary as well, and you are not required to fill it out. Even so, if you do fill it out, please answer honestly and thoughtfully. And THANK YOU!!

- 1 = Strongly Disagree
- 2 = Disagree
- 3 = Slightly Disagree
- 4 = Neither Agree or Disagree
- 5 = Slightly Agree
- 6 = Agree
- 7 = Strongly Agree

12) Biodiversity is important to me.	1	2	3	4	5	6	7
13) When I hear about a species going extinct, I feel sorrow.	1	2	3	4	5	6	7
14) I feel guilty when a species goes extinct due to human activity.	1	2	3	4	5	6	7
15) The potential loss of medicines due to the loss of biodiversity concerns me.	1	2	3	4	5	6	7
16) I would prefer to live in an area where I can see lots of green space and wildlife.	1	2	3	4	5	6	7
17) I am upset when a species goes extinct.	1	2	3	4	5	6	7
18) I feel as though all species are valuable.	1	2	3	4	5	6	7
19) I enjoy biodiversity.	1	2	3	4	5	6	7
20) Unique species like pangolins should be protected.	1	2	3	4	5	6	7
21) The illegal/legal trade of wildlife concerns me.	1	2	3	4	5	6	7
22) I wish I knew of more ways I could help preserve/conservate biodiversity.	1	2	3	4	5	6	7

- How would you characterize your own personal conservation ethic? In other words, which of the following would you be most willing to campaign and advocate for? Select only one of the following with an 'X.'

\_\_\_\_\_ I believe nature should be preserved for nature's sake (in other words, for no other reason than because nature is beautiful). Nature should therefore be left alone.

\_\_\_\_\_ I believe nature should be respected, but also that we should be able to smartly and carefully use the resources provided by nature for the good of humankind.

\_\_\_\_\_ I do not have a conservation ethic, because I really do not care about, nor am I interested in, nature, biodiversity, or resource conservation.

Would you be willing to talk to Jazz Holcomb about all of this in greater detail? If so, email Jazz at [npb652@mocs.utc.edu](mailto:npb652@mocs.utc.edu) ...