INQUIRY & INVESTIGATION

“Real-World” Experience: Consequences of Anthropocene Extinctions & Biodiversity Declines

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ABSTRACT
NGSS guidance indicates that a life science curriculum’s unit on evolution must include the concepts of geologic ages, endangered species, Anthropocene extinction, and biodiversity. Enrichment lessons and labs deepen student understanding of key standards. This lesson enriches students by presenting a real-world opportunity for species conservation. First, instructors ensure a common understanding of background knowledge among students. Second, levels of species endangerment are introduced and students participate in a “willingness to pay” lab involving a philatelic-based fund to protect endangered species. Third, predicted student donation amounts are compared to actual costs needed to conserve and manage species in the wild. Finally, summative reports communicate actual conservation needs by comparing and contrasting two endangered species.

Key Words: Anthropocene extinctions; biodiversity; conservation fund; endangered species; Next Generation Science Standards; real-world experience; willingness to pay.

Learning Objectives
Much introductory information on biodiversity loss and protection is provided in standard curricular units themselves. Therefore, as an opportunity for student enrichment, the goal of this lesson and its activities is to provide students experience with actual, real-world cases of conservation in which they choose their own contribution level for protecting a given species. The lesson’s learning objectives are organized to advance from description to analysis to evaluation, as proposed by Wilkinson and Dubrow (1991) to stimulate discussion leadership. By the end of this lesson, students will be able to

1. demonstrate common understanding of probable causes of extinctions past and present and how they have affected biodiversity;
2. explain by citing three specific examples of the human role in Anthropocene extinctions;
3. use the IUCN (International Union for the Conservation of Nature) Red List to determine endangerment categories for five species (description);
4. assess the potential for student contributions to aid endangered species through a “willingness to pay” exercise (analysis) and discuss funding implications for conservation at the school level (debate/discussion); and
5. compare/contrast two species for conservation management and funding options using the IUCN Red List (evaluation).
Alignment with NGSS

The following “enrichment” lesson is closely tied to relevant Next Generation Science Standards (NGSS Lead States, 2013), and most directly to Dimension 3: Disciplinary Core Ideas – Life Sciences, for example:

Core Idea LS4: Biological Evolution: Unity and Diversity

1. LS4.D: Biodiversity and Humans. “Changes in biodiversity can influence humans” – resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on – for example, water purification and recycling.

2. NGSS-HS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

3. ETS1.B: Developing possible solutions: (i) When evaluating solutions it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics and to consider social, cultural, and environmental impacts. (ii) Both physical models and computers can be used in various ways to aid in the engineering design process.

Methodology & Implementation

Lesson Sequence & Materials

Teachers introduce biodiversity to a greater or lesser extent depending on learning objectives and available time. To support instructor choices for implementing this lesson, Table 1 presents steps, activities, objectives, and materials such that instructors have freedom to adjust to differing class and curricular needs. Step 1 is advised for all teachers in order to ensure common understanding of extinctions and their relation to biodiversity.

To provide student enrichment and “real-world” exposure, the lesson often relies on materials and discussion outside the scope of the Investigations in Science Seventh Grade (IS-7) curriculum while focusing on two key themes: endangered species and Anthropocene extinctions (Cohen, 2016). Table 1 brings together all of the information presented in support of the learning objectives established above, and the table’s five rows represent five steps matching each of the learning objectives.

The enrichment lessons involve student decisions on whether to contribute toward conservation, specifically a conservation fund associated with philatelic purchases that funds targeted activities to promote conservation and habitat retention. These actions are meant to counter extinction and habitat fragmentation (Pimm & Jenkins, 2019). The decisions students make in considering funding levels reflect experience gained in real-world wildlife conservation programs.

Items used in the activities are shown in Table 1 (column 5), as are variations for more advanced or university classes (column 8). Rubrics are still in development, but suggested steps in what would constitute full understanding, comprehension, or performance are also given in Table 1 (column 7).

Lesson Highlight for Real-World Experience

(A) Participate in an Actual Philatelic Conservation Fund

For this lesson, the real-world linkage comes from a conservation fund supported through the purchase of a semipostal stamp – that is, postage including both mailing fees and an additional amount specifically designated to benefit a defined organization or cause (Juell et al., 2016).

Table 1. Classroom lessons and activities for confirming understanding and encouraging extension of thinking on biodiversity and Anthropocene extinctions.

| 1. Step no. | 2. Instruction | 3. Objective(s) | 4. Activity or Learning Purpose | 5. Item Used for Activity | 6. Classroom Learning | 7. Rubric and Grading* | 8. Advanced Learning* |
|-------------|----------------|----------------|-------------------------------|--------------------------|-----------------------|-----------------------|-----------------------|
| 1 | Pre-lesson: Primarily directed to 7th-grade biology students | Confirm understanding of causes of extinction | Reading and quiz | 7th grade: Fossils and Extinctions | Review and do chapter quiz | 4 = all questions answered and presented in class | Extinction, geologic age, and speciation |
| 2 | Lesson Introduction | Able to explain Anthropocene extinctions and what is unique about them | Compare/contrast | Activity no.193, Extinction | Complete activity no. 193; classroom discussion and debate | 4 = answers consistent with key for pages assigned | Complete activity; paired student discussion on main points; pp. 104–105 in Evolution |
| 3 | Lesson: Biodiversity and Endangered Species | Use the Red List to explain levels of species endangerment | Demonstrate listing of five species and able to explain their current level of danger | 7th grade: Biodiversity and Red List website | Read and discuss pp. 792–801; answer two questions | 4 = questions answered fully, plus evidence shown of Red List queries | Facts on biodiversity, Millennium Assessment |
The practice of applying “art for conservation” has had a long history, and the funds generated have saved many species and their habitats (Brown, 2016; Cohen & Altman, 2021; Cohen & Altman, 2020a). The use of semipostal stamps provided by the U.S. Postal Service gives the American public an easy way to contribute to global conservation efforts, while recognizing that such funding comes from a variety of sources (IUCN, 2020).

The only conservation-directed U.S. semipostal stamp, first released in 2011, features the face of an Amur tiger cub (Figure 1). Between 1988 and 2004, various species conservation acts were authorized as part of the MSCF. By 2009, public interest in supporting these programs was recognized. In addition to a 44-cent first-class mailing fee, the Amur tiger stamp bears an 11-cent surcharge added as a contribution to the MSCF.

In this study, stamp-based resource generation was selected as the funding mechanism for conserving biodiversity. It was selected among other, more traditional, collection options for the following reasons:

1. Students’ purchases of the Amur tiger semipostal stamp require minimal time and effort on the part of collection organizers, in that donation is made automatically.
2. The level of contribution per student is easily adjusted, as they can buy as few or as many stamps as affordable.
3. Funds are delivered through the Postal Service immediately after the stamps are purchased, with no further transactions needed.
4. The funding mechanism and the endangered species of priority importance have been chosen and managed through the MSCF, which is audited annually and reported on through Congress.

Presently, the MSCF supports the following conservation organizations: the African Elephant Conservation Fund, the Asian Elephant Conservation Fund, the Great Ape Conservation Fund, the Rhinoceros and Tiger Conservation Fund, and the Marine Turtle Conservation Fund (Figure 2). A recent impact statement reported that 50,784,806 stamps had been purchased to date and that Americans had thereby raised $5,740,478 for conservation efforts to preserve some of the most iconic and charismatic animals on Earth (Congressional Research Service, 2017).

The semipostal stamp in question is sold individually or in sheets, as shown in Figure 1. At its recent authorized pricing, the stamp’s...
Figure 1. The Amur tiger stamp, a semipostal stamp from which 11 cents per stamp is automatically contributed to fund conservation for six species internationally.
over-the-counter price was 65 cents, of which 54 cents covered regular first-class postage and 11 cents was reserved for conservation. As noted above, species contributions are deducted automatically from the full purchase price of a semipostal stamp (Cohen & Altman, 2020b), so there are no further requirements of students, parents, teachers, or club sponsors in dealing with the contributions.

(B) Make Use of the IUCN Red List for Selected Species

The web-based IUCN Red List (Figure 1) categorizes species by endangerment status (https://www.iucnredlist.org/). Students use the site to abstract data and information from IUCN for the six species supported through the Amur tiger stamp. The data collected by students are used to complete Table 2 (the first row is completed as an example).

This activity determines the percentage of students who might support conservation by purchasing a particular semipostal stamp. Once the stamps are purchased, no further action is required by parents, students, or teachers; the government does the rest, sending the added cost of the stamp (i.e., minus the amount required for postage) directly to MSCF. Materials handed out/used on the web for completion of Table 2 include the following, all of which are available from the authors:

1. “Art for Conservation” is a condensed, age-appropriate reading that examines various philatelic measures whereby art is applied to the direct needs of conservation (derived from Cohen & Altman, 2020a, b).
2. Handout on the HIPPO acronym and its meaning, including Habitat destruction, Invasive species, Pollution, human over-Population, and Overharvesting. This provides students another source of informational input for Table 2.
3. To ensure that students use print resources as well as internet, relevant species “cards” from the Wildlife Fact File were made available (Figure 3).
4. “Willingness to pay” activity conducted by having students individually complete an Excel spreadsheet recording their “predictions” of the percentage of the student body that may wish to contribute to conservation and the degree to which they might participate. Details and data review from a trial assessment are presented below. The Excel file used is available from the second author (haileymark123@gmail.com).

(C) Participate in a “Willingness to Pay” Lab, Collecting and Analyzing Data

Our student sample was taken from five periods of a seventh-grade class in one middle school in Maryland. The questions and rationale were explained during Zoom-facilitated classes to participating students, with each one answering the following two main questions of the study: (1) What is your opinion about the percentage of seventh-grade students willing to contribute to help conserve endangered species? (2) From that percentage, how many stamps would you think each person might purchase?

Preparation of Excel data collection spreadsheet. An Excel spreadsheet was created to collect answers to two questions based on the principles of a “willingness to pay” study. They were gathered from sample groups of seventh-grade students attending one public middle school. However, data collection need not be limited, in that the study can be repeated at all grade levels as a way to teach the

Figure 2. IUCN Red List showing the Southern white rhino, one of the targeted species.
Table 2. Data collection organizer for students to use in gaining information on extinction or endangerment status of the six target species.

| 1. Target Species Fund                        | 2. Species Name and Endangered Category | 3. Specific Conservation Needs from IUCN Red List | 4. Additional Species and Conservation Information from Wildlife Fact File | 5. Funding Levels for Species as of 2012 (Source: IEF 2012) |
|-----------------------------------------------|----------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------|
| African Elephant Conservation Fund            | Vulnerable – Loxodonta africana        | • Site/area protection                           | • Largest land mammal, but also most gentle, in peaceful family units    | $2.0 million                                               |
|                                               |                                        | • Resource and habitat protection                | Animal of open grasslands                                                |                                                             |
|                                               |                                        | • Site/area management                           | Always found close to water                                              |                                                             |
|                                               |                                        | • Species management                             |                                                                         |                                                             |
|                                               |                                        | • Species recovery                               |                                                                         |                                                             |
|                                               |                                        | • Formal education                               |                                                                         |                                                             |
| Great Ape Conservation Fund                   |                                        |                                                  |                                                                         |                                                             |
| Rhinoceros Conservation                      |                                        |                                                  |                                                                         | $2.5 million                                               |
| Tiger Conservation                            |                                        |                                                  |                                                                         | $2.0 million                                               |
| Asian Elephant Conservation Fund              |                                        |                                                  |                                                                         | $2.0 million                                               |
| Marine Turtle Conservation Fund               |                                        |                                                  |                                                                         | $2.0 million                                               |

![Figure 3](https://example.com/figure3.png)

Figure 3. Sample “card” from the seven-volume set on wildlife, showing key facts and conservation concern for the Siberian tiger. Further facts are found on the reverse side (Conservation Society of America, 1992).
important of protecting endangered species that are on the cusp of extinction, and demonstrate the values of working together as a community.

Analysis of student response. The two main questions of the study must be addressed when creating the spreadsheet. For the first question, regarding the percentage of students who would be willing to contribute, the spreadsheet was edited to allow multiple points of data to be gathered from one answer. It converted the percentages of students in the sample survey who were “willing to participate” to the total number of students per school. This was done by taking the number of students from each school and multiplying by the given input of percentages of students participating. This simplified the data and related participants to school size.

Analysis of data from five periods of one school. The second question addressed the number of stamps each person would purchase. Five periods were sampled from one school, with a total of 88 students who would contribute by buying stamps. (Note: The seventh-grade student population substituted for the multi-school population that would have taken the survey at the annual “FIST” – Females in Science and Technology – hands-on conference for seventh-graders. Due to COVID-19, the sample group was changed from FIST groups to five periods of life science instruction.) From this question, there were two findings: the total cost spent for postage and the total amount of semipostal funds available for conservation. The students were prompted to estimate the average amount of stamps that each person in their period would buy. This was done in order to determine the total cost spent for postage by each school. It was found that each student who contributed would purchase an average of 10 stamps.

The total cost going to postage was determined from the data collected earlier by multiplying the following: the total number of students from the five periods (88), the average number of stamps per student (10), and the price of postage (54 cents per student). After multiplying, it was determined that $475.20 was going to be spent on postage from all five periods sampled.

The total estimated to be made available for conservation by the students’ purchases was determined by replacing the 54 cents in the above calculation to 11 cents (representing the money going to conservation). It was found that $96.80 was going to be donated by this one school for conservation.

Based on the 2012 authorization for this semipostal stamp program, if one school is able to set an amount of $96.80 for contribution as a minimum, and this could be replicated by other schools, then significant contributions from public schools could support the MSCF, as noted in Table 1. Lessons learned from preparation of the spreadsheet and by collecting student data include the following:

1. When determining the price of the stamps, make sure to have up-to-date information. Be careful when looking at pricing, as some information may be out-of-date.
2. Questions and answers need to be specific and understandable to the students. If they are not, it could lead to faulty data.
3. The most difficult thing is creating the formulas for the Excel sheet. Make sure you are clear on what the goals are and what needs to be entered into the formula. For example, make sure that the spreadsheet’s dropdown menu is set up properly so that the input data are converted to percentages as described above.

Conclusion

Through this lesson, students are able to work with and learn from an actual funding and management entity for the conservation and protection of endangered species. They gain hands-on experience in conducting a “willingness to pay” survey based on the opportunity for students to contribute, through purchase of the semipostal Amur tiger stamp, to the MSCF.

From this foundational work, students and their teachers can go on to actually implement a contribution program for their class or school, with all money collected from selling stamps going immediately to both first-class postage and conservation.

Unfortunately, only one year of data was able to be collected, and this had to be done using virtual classroom technologies. However, we found that a study on willingness to pay can be carried out successfully even when not in the classroom. Of course, actual contributions toward conservation, collected via stamp sales, would be extremely difficult, although not impossible, to carry out in a virtual manner.

In addition, students have gained experience with the classification of endangered species using the IUCN Red List, and with how such listings per given species are calculated. This knowledge and how to access it represents another management tool for assessing the status of species and levels of biodiversity, including examples of possible Anthropocene extinctions, as well as a chance to learn from actual wider review by colleagues, during which further information and insight into the combined approach would have been both useful and possible.

By focusing on six endangered species supported through the MSCF; students learn not only about the dangers of imminent extinction, but also how funding targets specific management needs for protecting each species. This gives students real-world experience and hands-on appreciation of actions that give these animals a chance to survive.

References

Brown, G. (2016). 100 years of protecting birds in U.S., Canada. Share America, September 19. https://share.americagov/buy-stamp-save-bird/.
Cohen, J.I. (2016). Biodiversity education and the anthropocene: an indicator of extinction or recovery. American Biology Teacher, 78, 293–299.
Cohen, J.I. & S. Altman, S. (2020a). America’s conservation saga: from the philatelic and narrative art of Kalmbach, Darling, Hines, Carson to considerations of biodiversity – part 1. United States Specialist, 91, 116–129.
Cohen, J.I. & Altman, S. (2020b). America’s conservation saga: from the philatelic and narrative art of Kalmbach, Darling, Hines, Carson to considerations of biodiversity – part 3. United States Specialist, 91, 303–325.
Cohen, J.I. & Altman, S. (2021). An historical analysis of united states experiences using stamp-based revenues for wildlife conservation and habitat protection. Discover Sustainability 2, 24. https://doi.org/10.1007/s43621-021-00031-0.
Cohen, J.I. & Mark, H. (2020). NABT Biodiversity Proposal: Adverse impacts on biodiversity: a student-centered approach to conservation and education. https://www.researchgate.net/publication/342926714_NABT_2020_Professional_Conference_Biodiversity_proposal.
Congressional Research Service (2017). Multinational Species Conservation Fund semipostal stamp. CRS no. R44809.
Conservation Society of America (1992). *Wildlife Fact File [7-vol. set].* London: IMP.

FIST (2013). *Females in Science and Technology: teaching future magnet students.* https://sites.google.com/a/mbhsmagnet.org/www/news/spring13/fist.

IEF (International Elephant Foundation) (2012). *Multinational Species Conservation Fund.* https://elephantconservation.org/multinational-species-conservation-fund/

IUCN (International Union for the Conservation of Nature) (2020). *Donors and partners report.* https://www.iucn.org/about/donors-and-partners.

Juell, R.A., Batdorf, L.R. & Rod, S.J. (Eds.). (2016). *Encyclopedia of United States Stamps and Stamp Collecting, 2nd ed.* Youngstown, OH: Minuteman Press.

Moyer-Horner, L., Kirby, R. & Vaughan, C. (2010). Education as a tool for addressing the extinction crisis: moving students from understanding to action. *International Journal of Tropical Biology, 58,* 1115 – 1126.

NGSS Lead States (2013). *Next Generation Science Standards: For States, by States.* Washington, DC: National Academies Press.

Pimm, S.L. & Jenkins, C.N. (2019). Connecting habitats to prevent species extinctions. *American Scientist, 107*(10), 162. https://www.americanscientist.org/article/connecting-habitats-to-prevent-species-extinctions.

Taimur (2018). How much is a species worth? Conservationists don’t often consider economics. Here’s why they should. *Medium,* September 11. https://medium.com/s/story/how-much-is-a-species-worth-conservation-economics-e64123221bfd.

Tollefson, J. (2019). One million species face extinction. *Nature,* 569, 171. https://www.researchgate.net/publication/269637614_Ethical_Values_and_Biological_Diversity_A_Preliminary_Assessment_Approach.

Wilkinson, J. & Dubrow, H. (1991). Encouraging independent thinking. In C.R. Christensen (Ed.), *Education for Judgement* (pp. 249–261). Cambridge, MA: Harvard Business School.

WWF (World Wildlife Federation) (2011). *US Postal Service’s new save vanishing species stamp on sale today.* Press release, September 20, 2011. https://www.worldwildlife.org/press-releases/us-postal-service-s-new-save-vanishing-species-stamp-on-sale-today.

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