High School Unit of Study:

Human Impacts on Biodiversity*

Unit Title It's More than Okay to be Different: It's Essential!

Teacher _____

Grade Level 11

Approximate Length of Unit 2-3 weeks depending on schedule (2 weeks in a block schedule)

Context

This unit of study is written to be used for students in 9th-12th grade Biology or a comparable course of study. It is written to be used as a whole unit or in parts if time is an issue. Students should have already studied basic ecological principles and relationships in ecosystems. This unit can be modified to target all ability levels of students.

The teacher might introduce this unit by integrating or co-teaching it within a larger ecology unit. The introduction may include a whole-class discussion or field experience of ecosystems and the organisms that are included in those ecosystems. Ecological concepts such as commensalism, parasitism, mutualism, predation, prey, etc. are reviewed and examples are discussed. The unit study on Biodiversity incorporates all of these and the learning experiences will allow students to be actively involved in the learning process.

* This unit of study was written by the Kentucky Environmental Literacy Plan Implementation Advisory Team with Jane VanHook, Science Teacher at Garrard County High School in Garrard County, Kentucky, as the lead. The unit will be field tested during the 2014-15 academic school year and revised as needed following field testing. The template for the unit was developed by the Kentucky Department of Education, who also collaborated with KEEC on unit development. Development of this unit of study was funded by the Southeastern Environmental Education Alliance and the Kentucky Association for Environmental Education.

Unit Organizer

It's more than OK to be different, it's essential!

The natural system functions only when every important niche is occupied with a sufficient population to accomplish the "job" that niche requires. Loss of biodiversity threatens this delicate balance, including jeopardizing those relationships essential for sustaining the human population and maintaining stability of ecosystems.

Introduction

Biodiversity refers to the variety of species that are interdependent on each other in an ecosystem. Our students need to understand the importance of the human impact on biodiversity, both on the local and global level. This unit was inspired by the following statement taken from the mission statement of the E.O. Wilson Biodiversity Foundation. Professor Emeritus at Harvard, E.O. Wilson is the greatest living scientist of our time. As a Pulitzer Prize-winning author and winner of over 100 awards, Wilson speaks about the urgent need for broader research and understanding of our biodiverse planet in order to protect key species and avoid unintended destruction of the ecosystems that sustain our lives. Wilson warns, "The loss of a keystone species is like a drill accidentally striking a power line. It causes lights to go out all over." The inadvertent degradation of the natural world can be slowed, or even halted, however, through biodiversity research that expands our understanding of our 'little known planet' and that innovates in helping us to learn how to best care for it. Additional information about the foundation can be found at eowilsonfoundation.org.

Standards Bundle

KCAS

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

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

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Supporting Standards

ACT Quality Core Biology

F.1.l Read and describe current journal articles relating to environmental concerns (e.g., loss of biodiversity, habitat loss, pollution)

F.1.m Discuss and evaluate the significance of human interference with major ecosystems (e.g., the loss of genetic diversity in cloned crops or animals)

KCAS mathematics

HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph by hand in simple cases and using technology for more complicated cases.

KCAS reading

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question to solve a problem.

Practices Emphasized in this Unit

LS2-2 Using mathematical and computational thinking

LS2-7 Constructing Explanations and Designing Solutions

LS4-6 Using Mathematical and Computational Thinking

ESS3-3 Using Mathematical and Computational Thinking

ETS1-3 Constructing Explanations and Designing Solutions

Essential/Guiding Questions

How can students understand and explain the value of biodiversity?

How can students use mathematical representations to calculate and/or predict current and future human impacts on biodiversity?

How can students identify threats to biodiversity, and design and evaluate solutions to protect it?

Students will know:	**Students will be able to:**
1. Have an operational understanding of biodiversity	1. Represent complex relationships and dependencies within an ecosystem
2. Identify basic systematic threats to biodiversity	2. Explain the economic, biological, and aesthetic value of biodiversity
3. Know the importance of various niches within common ecosystems	3. Represent data related to biodiversity using appropriate mathematical representations
4. List various human impacts on biodiversity in a number of common ecosystems	4. Describe similarities between roles in ecosystems of different scales
5. Describe varied strategies for mitigating human ecosystem impacts	5. Use constraints to evaluate and select the most appropriate strategies for potentially mitigating specific impacts
6. Understand that potential solutions are limited by a range of constraints	6. Set priorities and evaluate trade-offs for proposed solutions, then use these priorities to evaluate them
	7. Explain with data how biodiversity is necessary to sustain human populations.

Success Criteria

In collaboration with students, develop an outline of success criteria for the summative/end of unit assessment.

A student who has a working understanding of biodiversity is one who can:

- Articulate the complex relationships in an ecosystem and explain why the role of each species is important for the functioning of the whole
- Describe the inherent values of biodiversity, including why biodiversity is essential to sustain the human population
- Explain the human-induced threats to biodiversity
- Design solutions/strategies for mitigating adverse impacts, including describing the constraints and trade-offs that potentially limit those solutions
- Create explanations of biodiversity impacts and representations of relationships within ecosystems that are supported by data and mathematical representations

To determine what the students know, administer five formative questions including the examples provided below:

- Definition and example of biodiversity
- Role of keystone species
- Threats to biodiversity
- Value of biodiversity
- Manipulation of supplied data to be analyzed and interpreted

Analyze results in class discussion, possibly using formative assessment techniques from Keeley's Formative Assessment book to address gaps in understanding and common misconceptions to include:

- Losing a species doesn't affect the ecosystem or humans
- The rate of extinction is stable
- Evolution will replace missing species
- All species have been discovered
- There's nothing that can be done to protect biodiversity

Performance Task/Assessment (PBA)

A Performance-Based Task/Assessment can be delivered at the end of the unit or during the sequence of instruction. It should be unrehearsed, require application, and not be only recalled information.

Use (circle one) Formative (Summative)

Example 1: Students will research a local/global ecosystem approved by the teacher and do a class presentation using a display board or multimedia. The presentation will include the following:

Choose a local/global ecosystem and within that ecosystem:

1. List 2 keystone species
2. Evaluate the impact of the removal of one of those species
3. Identify one real world threat and describe the human role in that threat to biodiversity within that ecosystem
4. Identify an economic, ecological, and aesthetic value of biodiversity within the ecosystem
5. Design a solution to mitigate the identified threat, including identifying appropriate real world constraints of that solution
6. Develop a model to demonstrate the threat and a possible solution to solve the problem
7. Evaluate the pros and cons to identified solution, using data and evidence to support your assertions

Example 2: Students will choose a role to research/play in a Town Meeting to discuss an impact on the biodiversity, such as a major highway on the local level. Students could represent engineers, landowners, local government leaders, etc.

Unit Learning Experiences

Critical reading

Students read multiple archived and current news articles related to the threats to or loss of biodiversity, then complete a Venn diagram to compare similarities and differences of the three different circumstances. One possible site to locate articles differentiated by Lexile level is http://www.newsela.com

Manipulation of food webs

Students examine food webs and then make inferences and predictions of how the food web would be altered if a keystone species was removed, or if a non-native species was introduced.

Examination/processing of biodiversity data

(1) Students are given data related to populations within ecosystems and asked to use that data to make predictions of population changes in response to patterns identified in the data. One source for data might be http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&cad=rja&uact=8&ved=0CGsQFjAG&url=http%3A%2F%2Fwww.rewardinglearning.org.uk%2Fcommon%2Fincludes%2Fmicrosite_doc_link.aspx%3Fdocid%3D5925-2&ei=-Vx_U4PoC_Ct8gHx4oH4Dw&usg=AFQjCNGA-ulCjCPN6AqjDdMECWXUIeWjxQ&sig2=elEs3Hphx46T862-D_UuqA&bvm=bv.67720277,d.b2U

(2) Students will generate their own biodiversity data through some form of active investigation, such as a schoolyard biodiversity search, neighborhood diversity count, etc. Some possible learning experiences that may be used or modified as appropriate include:

- http://education.nationalgeographic.com/media/file/RingofDarhad_Lesson7-7.pdf
- http://www.fairchildgarden.org/uploads/docs/Education/Downloadable_teaching_modules/Environmental_Action/Parking_Lot_Diversity_Activity.pdf
- http://www.fishwildlife.org/files/ConEd-Schoolyard-Biodiversity-Guide.pdf
- Quantifying biodiversity experience (pp.12-21) from *Biodiversity* (NSTA Global Environmental Change Series)

Interview

Students interview community partners and/or local experts about the aesthetic, economic, or ecological aspects of their home, business, or other. Interview wildlife biologists or utilize them as guest speakers to discuss biodiversity issues/threats in the local environment.

Conduct research

Student (guided or individual as appropriate) research major challenges to biodiversity in order to identify possible solutions to those problems. Research should include biodiversity case studies in order to develop an understanding of real-world constraints and limitations. Student teams produce a solutions roundtable where each team discusses one possible solution to a real-world problem of biodiversity. Include in that discussion a description of the limitations or constraints of that solution. Students may present these solutions in the form of display boards, infographics, or audiovisual presentations.

Simulations

To promote understanding of biodiversity, students will work with virtual simulations to discover the relationships between factors in an ecosystem and their interdependent relationships. Some simulations to consider might include:

- http://ngm.nationalgeographic.com/2011/01/seven-billion/biodiversity-game
- http://www.virtualbiologylab.org/Biodiversity.htm
- http://www.gameforscience.com/forestia/
- http://www.accessexcellence.org/AE/ATG/data/released/0534-KathyParis/ (low tech game with index cards, no internet access or device required)

Resources/Technology/Tools

List resources/materials that are needed to support student learning.

- Students will need internet access to research websites: linked in Unit Learning Experiences listed above
- Technology to run simulations or do research
- *Biodiversity* (NSTA Global Environmental Change Series, 1997)
- Basic equipment for science field/lab experiences
- Set of articles focusing on examples of human impacts on biodiversity

Reflection

- After teaching the unit, reflect on the strengths and weaknesses of the lessons, activities and assessments. Consider the modifications/revisions that can be made to the unit so that it is more effective.

Suggested Extensions

- Extensions to this unit may include research of careers of scientists such as biologists who collect this information and use bioinformatics to sort and analyze the data so it can be understood by all involved.
- Integrate a local example of how humans have impacted the biodiversity at the local level in your area such as building a major highway, pipeline, development, lake, etc.
- Class discussion on authors/books about actual threatened biodiversity examples and consequences.