**Bioprospecting – Whose footprint should be the largest?**

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**AP Environmental Science Lesson Plan**

Academic Year Time Frame: This 1 week (3 blocks) unit will be used in early May. Its purpose is to serve as a means of examining the methods of applying the scientific principles explored during the course to policy within the frame work of our political and economic systems.

Introduction/Rationale:

The advances that have given the opportunity to millions to experience the splendor that is our common heritage have come at a price. Though not always easy to define in monetary terms, the price of use is a toll on the very environment that was chosen to protect. In making use of the Yellowstone’s resources, the citizens/owners have assumed a greater and greater role in shaping the ecosystems’ environment. We have also come to recognize that the continued expansion of human activity and involvement has spawned a new set of problems that extends beyond the boundaries of the park. The policy “options”

That follow are designed to frame the ideas of common ownership as they pertain to policy creation. They are designed to stimulate thinking about a wide range of choices and the consequences of each one. In turn these will illustrate the complications that are part of the decisions based on a wide variety of beliefs and backgrounds. Each alternative should develop a set of potential policies that could be pursued, as well as, their effect on the system. The lesson also needs to highlight some arguments in support of the position, and some criticisms of it. The lesson should cause the students to think about and clarify their concerns and values and the effect that they have on policy decisions. It will also cause the students to deliberate the strengths and challenges of each of the options presented.

**The options should be explored through the lens of the following questions:**

* How important is the issue in question compared to other problems facing the Yellowstone ecosystem?
* Which parts of the issue pose the greatest potential source of conflict? Why?
* What responsibility does the National Park Service have?
* What role do the citizens of the United States outside the Yellowstone Ecosystem have?
* What is the likelihood of consensus on the issue?
* What should our long-term goals be? (preservation versus conservation versus recreation)
* What values are important to you in determining a solution to the issue?
* What are the pros and cons of each option?

**Instructional Goals**

Students will understand the impact of human activities and choices on the physical environment as well as the implications to the regional inhabitants and the role of policy in addressing these environmental policy issues.

**Learning Objectives**

* Students will describe the role of policymakers, companies, and individuals in impacting the environment
* Students will analyze issues and problems using the Yellowstone ecosystem and its unique physical and historical characteristics as a backdrop for policy creation
* Students will resolve controversies or differences of opinion concerning environmental issues and how they can be addressed in a economically and culturally diverse setting
* Students will understand the concept and role of economic development of a common property

**Indiana Standards (Science, Government, and Economics)**

**Science: B.1.5, B.1.7, B.1.13, B.1.18, B.1.19, B.1.30, B.1.32, B.1.43, B.1.45, B.1.46**

**Government: USG 5.7, USG 5.9, USG 5.12, USG 1.2, USG 1.11**

**Economics: E.1.3, E.1.4, E.1.6 – E.1.8, E.1.10, E.3.3, E.4.1, E.4.2, E.4.8**

**Concepts**

The concepts that will be presented and/or reviewed include:

Tragedy of the Commons, “Cost”, Externalities, Cost-Benefit Analysis, Intellectual Property, Benefits Sharing, Endangered Species Protection, Life Systems, Biochemistry, and Classification

# **Materials**

* Bio prospecting Issue EIS - (**http://parkplanning.nps.gov/document.cfm?parkId=442&projectId=12515&documentID=16763**)
* Student handouts (attached)
* Tragedy of the Commons activity (attached)
* Economics and the Environment Lesson 16, Activity 15, and Activity 8, Lesson 7

# **Time Required**

2 classes (excluding time allowed for preparation of mock negotiations)

# **Procedure**

# Preparation before Class

Have students read the Environment issue EIS summary (**http://parkplanning.nps.gov/document.cfm?parkId=442&projectId=12515&documentID=16763**) in its entirety prior to class. This will set the background for class discussion.

Read Chapter 27 in *Living in the Environment* (14th Edition)

Answer Critical Thinking Questions 1, 2, 8, and 9 on pages 628-9.

# Introductory Discussion (Session 1-2)

1) Begin by presenting the power point regarding bio prospecting

***A. Demonstrate the concept of common property using the Tragedy of the Commons Activity.***

2) Start a discussion to introduce students to the interrelationship between human activity, economic growth, entrepreneurship, and the environment.

***A. Carry out the Activity 8 (lesson 7) from Economics and the Environment***

3) Next, discuss what an environmental issue is. Ask students to give examples of similar environmental issues and their likely causes. Students should be able to explain if and how common ownership has increased or reduced the severity of these problems.

* 1. Note how students from differing perspectives interpret environmental problems. Discuss why this is the case.
  2. If there is not as much diversity in the classroom, ask students to analyze the environmental problem they identified from varying viewpoints such as the NPS or the private researchers. What if a basic research project yields a much more lucrative outcome without the researcher being a prospector?
  3. Introduce the concept of sustainable development. Explain how protection of the environment and economic growth could be complementary issues.

***A. Carry out the Lesson 16 and Activity 15 from Economics and the Environment***

1. Lead a discussion on the differing viewpoints on what causes an environmental economic problem. Ask students what they think are the defining characteristics of the different viewpoints. Use the following to prompt discussion:

* Economic growth and development versus preservation
* Societal impacts
* Governmental responsibilities
* Intellectual Property

Mock Hearing (Session 3)

Follow the instructions on the handout for a mock Senate hearing. Evaluate student performance on use of cohesive argumentation, preparation and use of supporting evidence.

Observe how the groups behave during the discussion and whether they are able to reach a mutually agreeable solution. Note the reasons why the groups have or have not reached consensus.

Hearing Assessment

The Hearing will be evaluated based on observation of the groups and their presentation. Preparation and information will be evaluated for the hearing itself.

Socratic Seminar Assessment

The Socratic Seminar assessment will consist of two parts. A 12 point self evaluation and a 40 point analytical assessment by the instructor.

# **Tim Curts**

# **Tragedy of the Commons - Student Activity**

**Tragedy of the Commons Simulation**

**Abstract**This activity allows students to explore the "Tragedy of the Commons" in which common usage of a limited, potentially renewable resource invariably leads to its exploitation. In this simulation, students imagine that they are fishermen sharing access to a common fishing pond. The fish are Hershey's kisses. Two different stages of the simulation are performed. In the first, students are not allowed to communicate, and each fisher has no knowledge of how many fish have been taken before them. In the second, students are allowed to strategize, plan, and learn from their experiences. In this way, the ability (or not) to communicate is the independent variable, and the size of the resource over time is the dependent variable. At the end of this simulation, students should have an understanding of what leads to the "tragedy of the commons", and what can be done to prevent it.

**Objectives**

* Understand the conditions that lead to a "tragedy of the commons".
* Learn strategies that prevent the destruction of a common resource.
* Apply these strategies to global environmental issues and suggest solutions.

**Introduction**The purpose of this simulation is to explore how resources are used and exploited when they are available to multiple parties. When Garrett Hardin (1968) first proposed this concept, he used the example of the traditional "commons" in New England towns to signify a public resource available for private gain. In this case, the commons was used for grazing the townspeople's livestock. He demonstrated the idea that a small increase in use of the resource (e.g., one extra cow) provides a great benefit to an individual, while the cost of that additional use (decreased grass supply) is shared by all. Therefore, each user has an incentive to use (and exploit) the resource to the greatest of his or her ability. Ultimately, there is a decrease in yield for both the group and the individual.

This idea has been adapted to explain the pattern of overuse of many common, limited resources. For example, the exploitation of wild populations (ex. over-fishing), the abuse of public lands (ex. overgrazing on federal lands) and population growth can all be evaluated using this principle. Even a clean school campus (and the treatment of it by trash-leaving students) can be explained by the tragedy of the commons.

Fortunately, there are strategies that can be employed to ensure the long-term survival of a resource in spite of the natural tendency toward exploitation. Several are explored in this activity. These are incentives, privatization, communication, and education. With these solutions in hand, strategies can be devised to help protect common resources in the environment and work toward sustainable resource use.

**Background Resource**Hardin, Garrett. 1968. The Tragedy of the Commons. *Science*, 162:1243-1248.

**Materials**For each group of four

* Hershey's kisses
* Plastic spoon
* 400 ml beakers
* Fabric sleeve

**Procedure**Part 1:

Divide yourselves into groups of four. Imagine this scenario. Each person represents the head of a starving family, which requires food. The only food source for these four families is a small fishing hole, which can accommodate 16 fish. Fortunately, after each round of fishing by the four family heads, each remaining fish is able to spontaneously reproduce and make one new fish (i.e. 4 fish become 8, to a maximum of 16). Each person is allowed to take as many or few fish as you want, but if you take only one fish, your family will starve.

In this simulation, our pond is a beaker, and our fish are Hershey's kisses. Fish are caught using plastic spoons. Each fishing round will last for 1 minute. You should rotate your fishing order every round so that everyone has a chance to go first. At the end of every round, the number of remaining kisses will be doubled to simulate reproduction. The simulation will continue for three rounds. The pond will be covered with a fabric sleeve, so that it is not possible to tell how many fish have been taken before you fish. No talking is allowed in this part.

Part 2:

In this part, you will have access to two ponds, one common and one private. The rules for the common pond are the same as before. However, talking and strategizing is allowed in this part. The cloth sleeve will be removed so that you will know exactly how many fish are in the ponds at all times, and how quickly the fish will reproduce. The carrying capacity for the common ponds is 16 and for the private ponds is 4. You must remove at least one fish from each pond each round. As before, you may catch as many fish as you would like from both ponds during each round.

**Data**

1) All data should be recorded in the following tables.

Part I: Commons pond

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Round # | # of fish  at beg. of round | # of fish taken by 1st fisher | # of fish taken by 2nd fisher | # of fish taken by 3rd fisher | # of fish taken by 4th | fisher Total fish left at end of round |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| Total | XXXX |  |  |  |  | XXXXXX |

Part II: Commons pond

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Round # | # of fish  at beg. of round | # of fish taken by 1st fisher | # of fish taken by 2nd fisher | # of fish taken by 3rd fisher | # of fish taken by 4th | fisher Total fish left at end of round |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| Total | XXXX |  |  |  |  | XXXXXX |

Part II: Private pond

|  |  |  |  |
| --- | --- | --- | --- |
| Round # | # of fish at beg. of round | # fish taken this round | # of fish at the end of round |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| Total | XXXXX |  | XXXXX |

2) Calculate: the total number of fish caught by each person

**Analysis**In your analysis, you should evaluate the results and answer the following questions.

* What happened to the common resource in the in Part 1? Why?
* Did you get different results for the pond in Part 2? Why?
* Explain the rationale for your fishing technique in each part.
* If you cooperated with other fishers, what was the result of that cooperation?
* Did you use different fishing strategies in the common pond and the private pond?
* Why does common usage lead to exploitation?
* What would be the ideal way to manage the common pond?
* How would this simulation have been different if you didn't know the students in your group?
* What are the strategies that help to prevent the "tragedy of the commons"?
* If a new student had joined your group in the middle of Part 2, how would that affect your strategy and the use of the resource?
* Why is the private pond easier to manage for long-term success?

**Conclusion**Briefly summarize the results of this simulation, and discuss the implications of this simulation on the management of common resources in the environment. What other resource management examples can you think of where this topic is relevant? What would you suggest in these situations?

# **Role-Playing Exercise**

The class will participate in a mock Senate Committee hearing on the issue of bio-prospecting regulations. The purpose of this exercise is to provide students with practical experience and understanding of the legislative processes discussed in Chapter 27 of Living in the Environment and to apply knowledge of these concepts to a current situation.

The students will be divided into a maximum of seven groups. There will be a group of Senators (3 to 5 students) and up to six interest groups (2-3 students each) representing various positions in the debate concerning ways to determine fair regulations and associated costs for scientific exploration on public lands.

The six interest groups:

1. The Food and Drug Administration
2. American Medical Association
3. National Park Service
4. Pharmaceutical Industry
5. Entrepreneurial Scientific Research Representative
6. Visitor Advocacy Group

The six interest groups will present an oral argument concerning the best course of action in determining regulation standards for research projects using publically held property. Each group will have 2-5 minutes to give their presentation to the Senators.

The group of Senators will consist of (2 Democrats and 1 Republican or 3 Democrats and 2 Republicans). One of the Democrat Senators will be the Chairman of the Senate Commerce Committee and be responsible for the actual conduct of the hearing.

After all the interest groups have presented their arguments, the Senators will ask questions to each group. These questions will direct the group representatives to elaborate on or defend their stated positions in the oral argument.

# Conclusion

1. After the hearing and question session, the class will be involved in a Socratic Seminar to discuss and evaluate the various points of view and questions raised during the mock hearing.

Socratic Seminar Analytic Rubric

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Excellent | Good | Fair | Unsatisfactory |
| Conduct | Demonstrates respect for the learning process; has patience with different opinions and complexity; shows initiative by asking others for clarification: brings others into the conversation, moves the conversation forward; speaks to all of the participants; avoids talking too much. | Generally shows composure but may display impatience with contradictory or confusing ideas; comments, but does not necessarily encourage others to participate; may tend to address only the teacher or get into debates. | Participates and expresses a belief that his/her ideas are important in understanding the text; may make insightful comments but is either too forceful or too shy and does not contribute to the progress of the conversation; tends to debate, not dialogue. | Displays little respect for the learning process; argumentative; takes advantage of minor distractions; uses inappropriate language; speaks to individuals rather than ideas; arrives unprepared without notes, pencil/pen or perhaps even without the text. |
| **Speaking**  **&**  **Reasoning** | Understands question before answering; cites evidence from text; expresses thoughts in complete sentences; move conversation forward; makes connections between ideas; resolves apparent contradictory ideas; considers others’ viewpoints, not only his/her own; avoids bad logic. | Responds to questions voluntarily; comments show an appreciation for the text but not an appreciation for the subtler points within it; comments are logical but not connected to other speakers; ideas interesting enough that others respond to them. | Responds to questions but may have to be called upon by others; has read the text but not put much effort into preparing questions and ideas for the seminar; comments take details into account but may not flow logically in conversation. | Extremely reluctant to participate even when called upon; comments illogical and meaningless; may mumble or express incomplete ideas; little or no account taken of previous comments or important ideas in the text. |
| **Listening** | Pays attention to details; writes down questions; responses take into account all participants; demonstrates that he/she has kept up; points out faulty logic respectfully; overcomes distractions. | Generally pays attention and responds thoughtfully to ideas and questions of other participants and the leader; absorption in own ideas may distract the participant from the ideas of others. | Appears to find some ideas unimportant while responding to others; may have to have questions or confusions repeated due to inattention; takes few notes during the seminar in response to ideas and comments. | Appears uninvolved in the seminar; comments display complete misinterpretation of questions or comments of other participants. |
| **Reading** | Thoroughly familiar with the text; has notations and questions in the margins; key words, phrases, and ideas are highlighted; possible contradictions identified; pronounces words correctly. | Has read the text and comes with some ideas from it but these may not be written out in advance; good understanding of the vocabulary but may mispronounce some new or foreign words. | Appears to have read or skimmed the text but has not marked the text or made meaningful notes or questions; shows difficulty with vocabulary; mispronounces important words; key concepts misunderstood; little evidence of serious reflection prior to the seminar. | Student is unprepared for the seminar; important words, phrases, ideas in the text are unfamiliar; no notes or questions marked in the text; no attempt made to get help with difficult material. |

(Adapted with permission from Paul Raider)