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One Fish, Two Fish, Red Fish, Whose Fish? Subjects: Life Science, Environmental Science, Marine / Ocean Science

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Grade Level
Middle School, High School

Subject area
Civics, Economics, Environmental Science

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Title One Fish, Two Fish, Red Fish, Whose Fish? – The Interdisciplinary Approach of Management

Focus The interdisciplinary role of fisheries management and the influence of economics, ecology and human interactions in decision-making.

Grade Levels/Subject:

Middle School (6^{th} – 8^{th} grade)
High School (9^{th}- 12^{th} grade)

VA Standards

Civics and Economics

a. CE.10 – The student will apply social science skills to understand how public policy is made at the local, state and national levels of government by
a) examining the impact of the media on public opinion and public policy;
b) describing how individuals and interest groups influence public policy; and
c) describing the impact of international issues and events on local decision making.

b. CE.11 - The student will apply social science skills to understand how economic decisions are made in the marketplace by
a) explaining that because of scarcity, consumers, producers, and governments must make choices, understanding that everyone's choice has an opportunity cost; and
b) comparing and contrasting how traditional, free market, command, and mixed economies decide how to allocate their limited resources.

SOL – Grade 6 Science

a. 6.9 - The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment. Key ideas include
a) natural resources are important to protect and maintain;
b) renewable and nonrenewable resources can be managed;
c) major health and safety issues are associated with air and water quality;
d) major health and safety issues are related to different forms of energy;
e) preventive measures can protect land-use and reduce environmental hazards; and
f) there are cost/benefit tradeoffs in conservation policies.

Earth Science

a. ES.6 - The student will investigate and understand that resource use is complex. Key ideas include
a) global resource use has environmental liabilities and benefits;
b) availability, renewal rates, and economic effects are considerations when using resources;
c) use of Virginia resources has an effect on the environment and the economy; and
d) all energy sources have environmental and economic effects.

b. ES.10 - The student will investigate and understand that oceans are complex, dynamic systems and are subject to long- and short-term variations. Key ideas include
a) chemical, biological, and physical changes affect the oceans;
b) environmental and geologic occurrences affect ocean dynamics;
c) unevenly distributed heat in the oceans drives much of Earth's weather;
d) features of the sea floor reflect tectonic and other geological processes; and
e) human actions, including economic and public policy issues, affect oceans and the coastal zone including the Chesapeake Bay.

Life Sciences

a. LS.6 - The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include
a) the carbon, water and nitrogen cycles;
b) interactions resulting in a flow of energy and matter throughout the system;
c) complex relationships within terrestrial, freshwater, and marine ecosystems; and
d) energy flow in food webs and energy pyramids.

b. LS.8 - The student will investigate and understand interactions among populations in a biological community. Key concepts include
a) the relationships among producers, consumers, and decomposers in food webs;
b) the relationship between predators and prey;
c) competition and cooperation;
d) symbiotic relationships; and
e) niches.

c. LS.11 - The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include
a) food production and harvest;
b) change in habitat size, quality, or structure;
c) change in species competition;
d) population disturbances and factors that threaten or enhance species survival; and
e) environmental issues.

Learning Objectives

1) Students will re-enact a fisheries management meeting by adopting the roles of various stakeholders in Virginia (commercial fishers, recreational fishers, environmental groups, citizens, scientists, etc.) and advocate for a certain policy based on their role as a stakeholder.

a. Students will relate the role of various stakeholders to certain policy options and infer the impact of different policy options;
b. Students will compare and contrast the values of various stakeholders and how they can influence management decisions; and

c. Students will draw conclusions on the interdisciplinary role of science in policy.

2) Students will determine the role of economics for various stakeholder groups and how economics assumes a role in policy.

a. Students will apply social science skills to explain how scarce resources are managed (i.e. fishery resources); and
b. Students will apply social science skills to infer how economics influence individual behavior.

3) Students will assess the potential impacts of various stakeholder on the environment.

a. Students will compare and contrast the impacts of various stakeholders on the environment;
b. Students will define sustainability and how it is valuable to stakeholders; and
c. Students will draw conclusions on "broad picture" impacts of various stakeholders, including relationships between various organisms and environmental conditions (i.e. food webs, loss of habitat, resource depletion).

Total Length: 1 hour – 1.5 hours

Key Words/Vocabulary:

The following were adapted from www.dictionary.com

1) Stakeholder – an individual with an interest or concern in something
2) Commercial fishing – fishing for profit
3) Recreational fishing – fishing for leisure
4) Sustainability – maintaining the availability of resources for present and future use
5) Gill net – commercial fishing gear
6) Bottom trawls – commercial fishing gear

Background Information:

This re-enactment of a fishery management meeting demonstrates the interdisciplinary approach to the management of natural resources. This activity can be adapted to focus on numerous scientific concepts, including predator-prey interactions, food web dynamics, natural resource management, habitat and water quality, economics, and public policy.

In this lesson plan, students will assume the role of a stakeholder in the Chesapeake Bay to advocate for/against a hypothetical proposed policy. Stakeholders include commercial fishers, recreational fishers, scientists/researchers, environmental groups, management agencies, and citizens. In general, the overarching goal of fisheries management is to ensure the sustainability of a resource for present and future use. Each stakeholder tends to advocate based on their individual needs, often making it difficult for proposed policies to satisfy the needs of *all* stakeholders *and* achieve sustainability goals. For example, a commercial fisher may dislike the proposed policy because it will negatively affect their income, while a recreational fisher may

support the policy because it will allow them to catch more fish. It is also important to think about broader impacts associated with the policy. For example, if commercial and recreational fishers continue to remove a species from the ecosystem, what will happen to the food web? If a commercial gear is potentially damaging to the environment, what effects will this have on habitat and the species that live there?

Before the activity, it is useful to address the concept of sustainability and how it applies to fishery resources and fisheries management. Fisheries resources are scarce and management agencies strive to ensure sustainability as a means of maintaining fishery populations for present and future use. Students should acknowledge the potential impacts associated with unsustainability (i.e. think about what happens when a species is removed from the environment – loss of fishing industries, economic loss, changes in the food web, less available seafood on market, etc.). It is useful to explain what a stakeholder is and how their role will affect the sustainability of natural resources. Students should be able to identify various stakeholders in a given situation and evaluate how the viewpoints of different stakeholders vary. This can be demonstrated with a scientific or non-scientific example. For relevancy of this lesson plan to Virginia, teachers should become familiar with the summer flounder (see References). Summer flounder is a popular commercial and recreational fishing species that contributes to the economy of Virginia. In this lesson plan, students will re-enact a fishery management meeting to discuss the effects of a proposed policy that will affect summer flounder fisheries. The objective of this simulation is to emphasize that management and policy often require an interdisciplinary approach that considers social, economic, and ecological factors to achieve sustainability.

Handouts/Worksheets: Once divided into stakeholder groups, students will receive the "Stakeholder Information" handout associated with their position, as well as the "Summer Flounder Fact Sheet." As a follow-up to the re-enactment, students will complete the "Discussion" worksheet. To guide students throughout the discussion, teachers may opt to use the "Classroom Debate Rubric" sheet from the Northern Illinois University College of Education (https://www.niu.edu/facdev/_pdf/guide/strategies/classroom_debate_rubric.pdf).

Materials/Supplies: There are no additional materials or supplies needed for this lesson plan, other than the associated handouts/worksheets. Teachers may wish to use computers before discussion, so that students can find any additional material they plan to use in preparing their argument. Teachers may also wish to have a stopwatch for timing the discussions. If stakeholder roles are identified beforehand, teachers can ask students to dress for their role as a means of encouraging participation and involvement.

Classroom Setup: Students will need to divide into groups (4-6 students) throughout the classroom. There is no additional setup needed.

Procedure

***Advanced Preparation of Lab Materials* – 20 minutes**

Teachers should have copies of the "Stakeholder Information" handout and be prepared to divide students into groups (4-6 students) throughout the classroom. Ideally, one group of students (i.e. the management agency) will be able to sit at the front of the classroom. Teachers can choose to divide students into groups based on rankings beforehand or at the beginning of the lesson. If the teacher elects to have students rank their interest, this can be done with a Google Doc or the attached handout.

Teachers may plan to create and use a PowerPoint to introduce the topic to students. Depending on the classroom level, the following video may be appropriate for students and teachers - https://www.youtube.com/watch?v=zQYLVFlnAEI

***Lab Set-Up* – 5 minutes**

Teachers should divide students into multiple groups (4-6 students) and present each group with a unique "Stakeholder Information" handout.

***Introduction* – 30 minutes**

At the beginning of the activity, teachers should engage students by asking if they have ever been fishing (i.e. recreational, commercial, charter, etc.). This will give the teacher an idea about the background knowledge of students and their prior involvement with fisheries, while inviting students to think about the topic. Teachers should discuss the concept of sustainability and how it applies to fishery resources and fisheries management. Fisheries resources are scarce and must be managed to ensure sustainability. Teachers should encourage students to acknowledge the potential impacts associated with unsustainability. Questions to consider are: 1) the importance of sustainability; 2) the impacts of removing a species from the environment; and 3) the impact of unregulated fisheries and resources. Teachers may consider using a video to supplement this discussion (see References).

The next step is to explain what a stakeholder is and how their role will affect the sustainability of natural resources. Students should be able to identify various stakeholders in a given situation and evaluate how the viewpoints of different stakeholders vary. This can be demonstrated with a scientific or non-scientific example. The discussion should then focus on the summer flounder fishery in Virginia by providing a summary of the species (see References). As an introduction to the activity, teachers should ask students who the relevant stakeholders are in this fishery and demonstrate why they are relevant. It is important to make sure students understand that management agencies play a large role in fisheries resources, even though they are not using them in the same way that a commercial or recreational fisher would. Teachers should review answers from students and guide them to connect social, economic, and ecological factors for each group. For example, it may not be as intuitive to students to understand that the recreational fishing industry also has large economic impacts due to tourism, bait and tackle purchases, food and drink purchases, etc.

Activity – **40 minutes**

In this lesson plan, students will re-enact a fishery management meeting to discuss the effects of a proposed policy that will affect summer flounder fisheries.

After the initial material is presented, the teacher will divide students into groups (4-6 students). Prior to the lesson, teachers may opt to group students by sending a Google Doc or distributing a handout for students to rank stakeholders based on their personal interest (i.e. "1" being the most interested and "5" being the least interested). Teachers will distribute a unique "Stakeholder Information" handout to each group. Ideally, the "management agency" group will sit at the front of the classroom, as they will be listening to recommendations from the various stakeholders and making the final policy decision. The "management agency" will initially present the proposed policy to the class. Once the proposed policy is presented, students will review the "Stakeholder Information" handout and discuss within their groups how the proposed policy will affect them (i.e. commercial fishers may argue that the proposed policy negatively affects their income because they won't be able to catch as many fish).

Fisheries management meetings often operate under time restrictions. After discussion within groups, each group will be given 3 minutes to present their argument to the "management agency." Students are encouraged to consider economic, social, and ecological aspects in their argument. For example, recreational fishers may argue that the proposed policy will reduce tourism to Virginia and result in an economic loss (economics). Commercial fishers may argue that fishing is their livelihood and reducing their ability to catch summer flounder will force them to have to find other jobs (social). If another stakeholder group wishes to respond to the stakeholder group presenting, they will have 1.5 minutes to do so. This time does not affect their 3 minute group presentation. The teacher should encourage questions and further discussion after each group has presented. After all groups have presented and there is no further discussion, the "management agency" should discuss within their group how to proceed. Teachers should explain that the "management agency" group may propose to move forward with the current policy, alter the policy, or develop a new policy. The "management agency" group should explain their reasoning for their actions.

Discussion **– 20 minutes**

The objective of this simulation is to emphasize that management and policy often require an interdisciplinary approach that considers social, economic, and ecological factors to achieve sustainability. Once the "management agency" has reached the final decision, the teacher should invite students to think about how social, economic, and ecological aspects played a role in the decision and how the decision may impact various stakeholders in the future.

Clean-Up **– 0 minutes**

There is minimal clean-up for this lesson plan.

Assessment

The organization and discussion between various stakeholder groups will be used as an assessment in this lesson plan. Students will relate the roles of various stakeholders to certain policy options and assess the impact of the proposed policy. In doing so, students will compare and contrast the values of various stakeholders and be able to draw conclusions on the interdisciplinary role of science and policy. Additional objectives will also be met in this way. Through discussion and presentation, students will be able to identify the role of economics and how scarcity results in the need for fisheries management. Students will also be able to define sustainability and draw conclusions on the "broader impacts" of stakeholder groups. To guide students throughout the discussion, teachers may opt to use the "Classroom Debate Rubric" sheet from the Northern Illinois University College of Education (https://www.niu.edu/facdev/_pdf/guide/strategies/classroom_debate_rubric.pdf).

Students will also receive a follow-up worksheet (see "Discussion"). The worksheet will encourage students to think individually about the interdisciplinary role of science, economics, and ecology in policy. Students will assess how they would have reacted in the role of the management agency (keep policy, alter policy, develop a new policy). This worksheet will aid teachers in evaluating the ability of students to connect concepts presented in the re-enactment to the learning objectives. This assignment can also be completed as a homework activity.

References

ASMFC – Summer Flounder
http://www.asmfc.org/species/summer-flounder

NOAA – Summer Flounder
https://www.fisheries.noaa.gov/species/summer-flounder

NOAA – Greater Atlantic Region - Summer Flounder
https://www.greateratlantic.fisheries.noaa.gov/sustainable/species/fluke/
Fisheries Management in the US
https://www.youtube.com/watch?v=zQYLVFlnAEI

Fisheries Economics & Policy: Intro to Fisheries Management
https://www.youtube.com/watch?v=Z4AXnZOsrK8&t=201s

Summer Flounder Fact Sheet

Biology

- Also known as fluke, flounder, northern fluke, hirame.
- Summer flounder have a flat, rounded body that usually grows 15 - 22 inches in length.
- Females are larger than males and tend to live longer.
- Summer flounder are brownish on top and whitish on the bottom, with various large spots on the top side of their body.
- Both eyes are located on the top side of its head.
- Summer flounder are found from Canada to South Carolina and more recently, Florida.
- Summer flounder are bottom feeders.
- Prey items include shrimp, worms, crustaceans, and other fishes (including menhaden).
- Spawning occurs in autumn and mid-winter in coastal ocean waters.
- Summer flounder live in shallow eelgrass beds in the Chesapeake Bay. These beds serve as protective nursery areas.
- Lifespan can be up to 20 years, but most commonly between 12-14 years.
- Depending on their size, females can have 460,000 to over 4 million eggs.

Fishery

- The summer flounder is one of the most popular commercial and recreational species on the Atlantic coast.
- In 2014, total landings of summer flounder were approximately 17.4 million pounds.
- The current summer flounder quota allows the commercial fishing industry to harvest 60 % and the recreational fishing industry to harvest 40 % of the annual catch limit.
- Recreational fishing is primarily by hook and line.
- Commercial fishing gears include trawls, pound nets, and gill nets.
- The use of bottom trawls in the commercial fishery can impact bottom habitats, but the sandy ocean bottom habitat of summer flounder is more resilient to impacts of fishing gear.
- Summer flounder are currently subject to overfishing.

References

ASMFC – Summer Flounder
http://www.asmfc.org/species/summer-flounder

NOAA – Summer Flounder
https://www.fisheries.noaa.gov/species/summer-flounder

NOAA – Greater Atlantic Region - Summer Flounder
https://www.greateratlantic.fisheries.noaa.gov/sustainable/species/fluke/

Stakeholder Information

Stakeholder Information – Commercial Fisher

You are a commercial fisher in the Chesapeake Bay and enjoy making a livelihood on the water. Many generations of your family have also been commercial fishers and have taught you the proper techniques needed to catch fish. You often target summer flounder using gill nets and bottom trawls. Each year, most of your profit is from harvesting this species. You like to sell this species to local processors, which in return sell to local restaurants. Throughout the years, you have noticed a decline in the number of summer flounder caught. You are unsure if this is due to increasing regulations or because there are less summer flounder in the area.

Stakeholder Information – Recreational Fisher

You are a recreational fisher in the Chesapeake Bay and have been fishing in the area for years. Your favorite species to fish for is summer flounder. On occasion, your friends and family from out of town will travel to the area to fish for summer flounder with you in hopes of catching a large fish. Each weekend, you like to stop at a local gas station to get snacks and drinks before you go fishing. You are concerned that a decline in the number of summer flounder will force you to start targeting another species that is less enjoyable for you.

Stakeholder Information – Scientist/Researcher

You are a scientist at a local university. You have been researching the predator-prey dynamics of summer flounder and found that they are bottom feeders. The species typically consumes shrimp, worms, crustaceans, and other fishes. One of the prey items is the commercially valuable menhaden species. Predators of the summer flounder include spiny dogfish, large sharks, rays, and larger fishes. Due to recent declines in the numbers of summer flounder, you are concerned that predators of the summer flounder will not be able to find food, which will result in changes to the food web. You believe that without summer flounder as a prey item, it is possible for the predators of summer flounder to decline.

Stakeholder Information – Management Agency

You work for a state management agency that regulates summer flounder. Based on a recent stock assessment, the agency has determined that overfishing of the fishery is occurring. This means that summer flounder are being harvested at a rate that is unsustainable. The agency understands that there are many stakeholders involved in the summer flounder fishery and wants to hold a public comment meeting to hear the viewpoints of various stakeholders on a newly proposed policy. After hearing the comments on the proposed policy, you must decide whether to go forward with the new policy, alter the policy, or develop a new policy.

The proposed policy will reduce the annual catch limit of summer flounder to 1,000,000 pounds. The recreational fishery will be able to harvest 65 % of the annual catch limit and the

commercial fishery will be able to harvest 35 %. The minimum size limit for both industries will be 17 inches. The commercial fishery will only be able to use bottom trawls in specific areas of the Chesapeake Bay.

Stakeholder Information – Local Citizen

You are a local citizen of eastern Virginia. You are not involved in the commercial or recreational fishing industry. You enjoy visiting restaurants that offer local seafood on the menu. You feel that it is important to support the commercial fishing industry because they supply local seafood to restaurants. You believe that your community values having local seafood on the menu and that the availability of local seafood encourages people to visit the town.

Discussion

1) How do economics, ecology, and social values affect decision-making in fisheries management? Provide at least two examples.

2) Based on your role in the re-enactment, do you feel that economics, ecology, or social values most influenced your position towards the proposed policy?

3) What effects do you think the commercial and recreational fishing industry have on the ecology of the summer flounder?

4) If you were the management agency, how would you decide what to do after hearing the views of other stakeholders? Would you go forward with the proposed policy, alter the policy, or development a new policy? Why?

5) What is the overall common goal for all stakeholders?

Discussion – Answer Key

1) How do economics, ecology, and social values affect decision-making in fisheries management? Provide at least two examples.

There are a wide variety of answers and will likely reflect those discussed in the activity. Examples include:

It is important to consider the economics of fisheries because of the contribution to the state. Commercial and recreational fishing generates indirect and direct economic impacts. For example, both create numerous jobs. In the commercial industry, individuals are fishing for profit and in the recreational industry, individuals purchase items such as bait and tackle, which contributes to the economy.

It is important to understand the ecology of the species because declines in the number of a certain species can have effects on the food web. It is also possible that bycatch can cause another species to decline. If commercial gear destroys habitat, it can reduce the ability of a species to live in a certain area.

It is important to understand the social values that influence fishery management decisions. Commercial fishers make a livelihood on the water and want to continue to do so. Recreational fishers want to enjoy fishing for leisure. Citizens want to continue to enjoy local seafood in restaurants. Is it fair to give one stakeholder access to the fishery and not the other?

2) Based on your role in the re-enactment, do you feel that economics, ecology, or social values most influenced your position towards the proposed policy?

There are a wide variety of answers and will likely reflect those discussed in the activity.

3) What effects do you think the commercial and recreational fishing industry have on the ecology of the summer flounder?

This can be similar to Question 1.

It is important to understand the ecology of the species because declines in the number of a certain species can have effects on the food web. It is also possible that bycatch from the commercial and recreational industry can cause another species to decline. If commercial gear destroys habitat, it can reduce the ability of a species to live in a certain area.

4) If you were the management agency, how would you decide what to do after hearing the views of other stakeholders? Would you go forward with the proposed policy, alter the policy, or development a new policy? Why?

This question is opinion-based and there will likely be a variety of answers.

5) What is the overall common goal for all of the stakeholders?

Sustainability

Students should be able to relate this to the introduction and understand that while stakeholders have various ideas of how to achieve this, the overall objective is to ensure sustainability for current and future use.

Classroom Debate Rubric						
Criteria	**5 points**	**4 points**	**3 points**	**2 points**	**1 point**	**Total Points**
Respect for Other Team	All statements, body language, and responses were respectful and were inappropriate language	Statements and responses were respectful and used appropriate language, but once or twice body language was not	Most statements and responses were respectful and in appropriate language, but there was one sarcastic remark	Statements, responses and/or body language were borderline appropriate. Some sarcastic remarks	Statements, responses and/or body language were consistently not respectful	
Information	All information presented in this debate was clear, accurate and thorough	Most information presented in this debate was clear, accurate and thorough	Most information presented in the debate was clear and accurate, but was not usually thorough	Some information was accurate, but there were some minor inaccuracies	Information had some major inaccuracies OR was usually not clear	
Rebuttal	All counter-arguments were accurate, relevant and strong	Most counter-arguments were accurate, relevant, and strong	Most counter-arguments were accurate and relevant, but several were weak	Some counter arguments were weak and irrelevant	Counter-arguments were not accurate and/or relevant	
Use of Facts/Statistics	Every major point was well supported with several relevant facts, statistics and/or examples	Every major point was adequately supported with relevant facts, statistics and/or examples	Every major point was supported with facts, statistics and/or examples, but the relevance of some was questionable	Some points were supported well, others were not	All points were not supported	
Organization	All arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion	Most arguments were clearly tied to an idea (premise) and organized in a tight, logical fashion	
Understanding of Topic	The team clearly understood the topic in depth and presented their information forcefully and convincingly	The team clearly understood the topic in depth and presented their information with ease	The team seemed to understand the main points of the topic and presented those with ease	The team seemed to understand the main points of the topic, but didn't present with ease	The team did not show an adequate understanding of the topic	
					Total Points:	
Comments:						

Source: http://course1.winona.edu/shatfield/air/classdebate.pdf