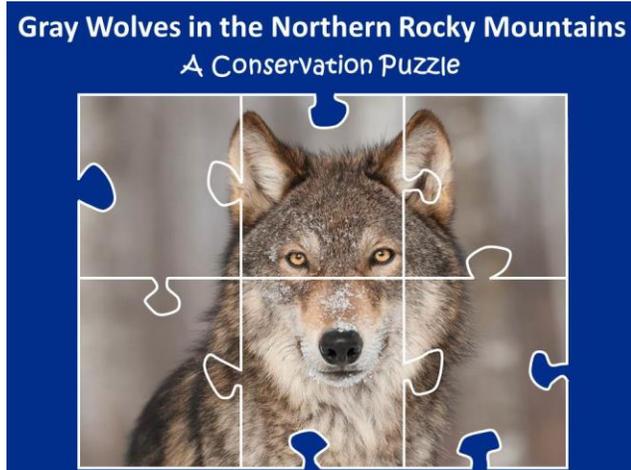


Gray Wolves in the Northern Rocky Mountains: A Conservation Puzzle

Teacher's Guide

STEM Lesson: Real-World Data and GIS



To use this lesson plan, teachers do not need to know anything about gray wolves, the delisting process, or GIS. Simply start the Introductory Video and begin! The GIS Tutorial is designed for beginner GIS students.

This STEM lesson has been aligned with Next Generation Science Standards, Common Core State Standards, NSES National Science Standards, and NCTM National Math Standards.

Lesson Synopsis

This lesson plan uses a “flipped learning model” where teachers don't stand before the class and lecture. Instead, students use real-world data to “discover” answers to timely conservation questions through scientific inquiry. In addition, students share group findings and information with the class through structured “peer-to-peer” learning activities.

Students first watch the Introductory Video, during which they learn about the Recovery Criteria that gray wolves in the Northern Rockies must meet before they can be considered for delisting. Then, students use real-world data to evaluate whether gray wolves in Montana, Idaho and Wyoming have met Recovery Criteria. Using GPS data, free GIS software, and our GIS Tutorial, students map the locations of gray wolf packs throughout the Northern Rocky Mountains to evaluate the degree to which gray wolves have expanded geographically. Importantly, students also learn about the different stakeholders involved in wolf conservation. As a capstone activity, student groups share findings with their peers and participate in a mock stakeholder meeting.

Grade Level: 9-12

Next Generation Science Standards: HS-LS2-1, HS-LS2-2, HS-LS2-6; HS-LS2-7; 9 Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts

Common Core State Standards:
MATH: CCSS.Math.Content.HSS-ID.B.5; ID.B.6, Q.A.1, Q.A.2; IF.B.4; IF.C.9

LITERACY: CCSS.ELA Literacy.RST.9-10.1; 9-10.2; .9-10.3;.9-10.4; .9-10.5, .9-10.6, .9-10.7, 9-10.8,.9-10.9

NSES National Science Standards: A 1-6, C, and G

NCTM National Math Standards: Standard 5 (Data Analyses) & Standard 6 (Process)

A complete list of standards are available at the end of this Teacher's Guide

Subjects: Science, Math, Technology, Wildlife Biology, and Literacy

Duration: Approximately 3 class periods

All lesson materials are available for free download at: www.beartrust.org

Materials for lesson:

- Introductory Video
- Teacher Guide
- Student Pages: Individual Activities
- Real-world data sets
- 6 Sets of Stakeholder Activity Pages
- 6 Stakeholder Folders
- Answer Keys
- ESRI ArcMap software (it's free!)
- Excel software or graphing paper

Lesson authors: Dr. Melissa Reynolds-Hogland and Laurie Wolf

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Gray Wolves in the Northern Rocky Mountains: A Conservation Puzzle

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Lesson Objectives

1. Students will actively participate in the process of scientific discovery, using real-world data from research done on wild gray wolves in the Northern Rocky Mountains.
2. Students will learn about wolf conservation in the Northern Rocky Mountains, including what happens when a listed species is delisted.
3. Students will learn about six different stakeholder groups in wolf conservation: Hunters, Wilderness Advocates, Wolf Watching Ecotourism, Ranchers, Native Americans, and Wildlife Managers/Scientists. Students will learn that effective, long-term wolf conservation requires cooperation among stakeholders.
4. Students will learn that there are two general philosophies about how different stakeholders view natural resources: Preservation and Conservation. Generally speaking, **Preservation = “no use” of natural resources** and **Conservation = “wise use” of natural resources**. Most people who subscribe to a preservation philosophy view the wolf from a co-existence perspective and do not use hunting. Most people who subscribe to a conservation philosophy value hunting as an important conservation tool used by wildlife managers to help keep habitat and wildlife populations in balance. There are more comprehensive definitions of these two philosophies that your students will learn.
5. Students will analyze and interpret data, using models and digital tools.
6. Students will create line and bar graphs and critically evaluate/interpret graphs and tables to determine whether gray wolves in the Northern Rocky Mountains have met Recovery Criteria.
7. Students will learn introductory GIS technology skills and use computational thinking to evaluate the degree to which gray wolves in the Northern Rocky Mountains have expanded geographically.
8. Students will use mathematical representations of phenomena to support explanations.
9. Students will work individually and cooperatively as they solve problems, construct explanations, hone critical thinking skills, and design solutions.
10. Students will hone skills in communication as they engage in a range of collaborative discussions (in groups and as a class).
11. Students will present findings to their peers, and participate in a mock stakeholder meeting.
12. Students will work collaboratively to find solutions to current issues surrounding wolf conservation by constructing explanations supported by multiple student-generated sources of evidence.

Acknowledgements

To help ensure that our lesson content is balanced and reflects each stakeholder, we reached out to numerous individuals from the following stakeholder groups: Hunters, Ranchers, Wilderness Advocates, Wolf Watching Ecotourism, Native Americans, and Wildlife Managers. We are indebted to all of the individuals who generously shared their time and expertise with us. We thank Abby Nelson, Nathan Lance, John Vore, Bob Inman, and Kevin Podusky with Montana Fish Wildlife and Parks (MFWP) for their assistance in obtaining data, their thoughtful and thorough explanations of research results and management strategies, and for helpful comments on earlier drafts of this lesson plan. We thank Nathan Varley, Barbara Ulrich, Ilona Popper, Rick Lamplugh, James Halfpenny, and Linda Thurston with Bear Creek Council who worked with us on several iterations of the Teacher Guide and the student pages pertinent to the Wolf Watching Ecotourism and Wilderness Advocate stakeholder groups; their thoughtful, expert input greatly improved the quality of this lesson plan. Thank you Tom Toman with the Rocky Mountain Elk Foundation for sharing your expertise and insights about elk hunting and elk populations, and for tracking down research results and articles that are included in this lesson plan. Thank you Todd Roggenkamp with Safari Club International Foundation for your review and comments on an earlier version of this lesson plan. We thank Adam Messer with MFWP for helping us obtain the GIS data used in this lesson plan. We also thank Jay Newell, Liz Bradley, and Bruce Sterling with MFWP for helping us obtain the elk data used in this lesson plan and for their invaluable insights into elk ecology. We thank Dr. Doug Smith with Yellowstone National Park for his time, scientific expertise, and for providing insights into wilderness advocacy. Thank you Dr. Mike Mitchell with the University of Montana for your insights into wolf research and management. Thank you Casey McDonald with the Montana Cattlemen’s Association for your time and for providing documentation about ranching that are included in this lesson plan. Thank you Aaron Carapella for sharing your amazing maps of Native American tribes and for sharing your time and knowledge about Native Americans with us. We also want to thank Jarod Raithel who provided ideas and language about possible solutions to funding wolf conservation and Diana Guerguieva who helped gather some of the information used in this lesson plan.

This lesson plan includes real-world data on the wolf Recovery Criteria that were provided by the US Fish and Wildlife Service and Montana Fish Wildlife and Parks.

Finally, we want to recognize and thank **GIS 4 Montana**, which provides ArcMap GIS software for free to all students throughout Montana. Through this generous program, our kids can access GIS software that would otherwise be prohibitively costly for many of our school districts.

GIS 4 Montana is a State-wide K-12 license for ArcGIS, made available free of charge to Montana’s public schools through an agreement between the **SpatialSci Project, The University of Montana, GeoEssentials, and ESRI**. Every K-12 public school in the state of Montana has the option to capitalize on this program that includes the latest ESRI GIS software.

Learn more: <http://www.spatialsci.com/index.php/sID/aa017b03/fuseaction/programs.cms.htm>

Lesson Materials

All lesson materials are available for free download on Bear Trust International's website:

<http://beartrust.org/gray-wolves-in-the-northern-rockies>

- Introductory Video: “Gray Wolves in the Northern Rocky Mountains: A Conservation Puzzle”
- Teacher Guide (i.e., the guide you are reading)
- Student Pages for Individual Activity
 - Student Pages: Definitions
 - Student Pages: Instructions for Analyzing Data in Excel File
 - Student Pages: Questions about Excel Data
 - Student Pages: Instructions for Analyzing GIS Data
 - Student Pages: Questions about GIS Data
- 6 Different Sets of “Stakeholder Activity Instructions”, one for each Stakeholder Group
- 6 Different “Stakeholder Folders”, one for each Stakeholder Group
- Real-World Datasets
 - Excel Data File: “Excel Datasets_Wolves”
 - GIS Data File: “GIS Data_Wolves”
- Answer Keys
 - ANSWER KEY: Questions about Excel Data
 - ANSWER KEY: Excel Data with Graphs
 - ANSWER KEY: Questions about GIS Data
- Excel software, or graphing paper and calculators for each student
- ESRI ArcMap software. It’s free!
 - SPECIAL INSTRUCTIONS:
 - **If you are a Montana school** you already have permission to use ArcMap GIS software at no cost, thanks to the generosity of GIS 4 MT Initiative.

To download ArcMap GIS software, contact Jeff Crews at jeff@spatialsci.com.

- If your school has a SCHOOL CAMPUS LICENSE for ESRI products, then you already have the necessary software to use this lesson plan. Contact your School IT Department.
- If your school does not have a SCHOOL CAMPUS LICENSE for ESRI products, then you can download the software “ArcGIS for desktop” for a free 60-day trial. <http://www.esri.com/software/arcgis/arcgis-for-desktop/free-trial>

Background Information for Teachers

Lesson Structure

By design, this lesson plan uses a “flipped learning model”. Rather than asking teachers to lecture, we ask students to actively participate in the process of discovery through scientific inquiry. Using real-world datasets, your students will address a timely conservation issue. In addition, this lesson plan promotes peer-to-peer learning by tasking student groups to share their findings and information with their peers. As such, most of the informational content (including definitions, explanations, etc.) are located in the Student Pages, Stakeholder Activity Instructions, and in the Datasets.

There are several components of this lesson plan and all of them are linked and build successively upon each other. For example, one component of this lesson plan asks students to independently analyze real-world data, create graphs, and interpret graphs. During the next lesson component, students are instructed to reference the graphs they created as evidence to support statements.

The capstone activity is a mock stakeholder meeting. The goals of this stakeholder meeting include:

1. Understand the different perspectives of each stakeholder
2. Determine “common ground” among the stakeholders
3. Work together to identify issues and possible solutions to those issues, and provide input on how stakeholders can collaboratively move forward to ensure successful wolf conservation

Background about Wolf Conservation

Gray wolves in the Northern Rocky Mountains were listed as Endangered under the Endangered Species Act (ESA) in 1973. At that point, gray wolves were placed under federal protection with the US Fish and Wildlife Service. The goal of the ESA is to recover listed species to the point that federal protection is no longer needed and management of the listed species can be returned to state wildlife agencies.

After the gray wolf was listed as Endangered, the US Fish and Wildlife Service worked to reintroduce gray wolves into the Rocky Mountains. During 1995-1997, they relocated 41 wolves from western Canada and northwestern Montana into the Greater Yellowstone Recovery Area and they relocated 35 wolves from Canada into central Idaho. These wolf reintroduction efforts worked! Many relocated wolves survived, many alpha pairs reproduced, and the number of wolves in the Northern Rocky Mountains started to increase.

Shortly after wolves were re-introduced into the Northern Rockies, the states of Idaho, Montana, and Wyoming began developing their Wolf Conservation Plans. The purpose of these State Wolf Conservation Plans is to serve as Wolf Management Plans when and if wolves are delisted.

Wolf Delisting: Politically Complex

In March, 2008, the US Fish and Wildlife Service **delisted** the Northern Rocky Mountain gray wolf in Montana, Idaho and portions of Oregon and Washington. In July, 2008, 12 parties joined together and filed a lawsuit regarding the delisting of the Northern Rocky Mountain gray wolf. Shortly thereafter, the Northern Rocky Mountain gray wolf was **relisted** as an Endangered Species because there was no evidence of connectivity between wolf populations and it was determined that the state of Wyoming didn't have a sufficient Wolf Management Plan at that time. In 2009, there was another brief **delisting** followed by another **relisting**, followed by a **delisting** in 2011 of the wolf populations in Montana, Idaho

and parts of Washington and Oregon. In 2012, the wolf population in Wyoming was **delisted** and then **relisted** again in 2014. As of August, 2016 the gray wolf population in Wyoming is listed as an endangered species while the wolf populations in Montana, Idaho, and parts of Washington and Oregon remain delisted.

Whew! Understanding the policies underlying the delisting process is beyond the scope of this lesson plan, but we provide the brief delisting history as context and we ask students in the introductory video this question: “How do we KNOW when a listed species is ready for delisting, anyway?”

Answer: look in the Gray Wolf Recovery Plan. When it was created, it provided a road map to recovery with science-based recovery criteria that must be met before a listed species can be considered for delisting.

Recovery Criteria for Gray Wolves in the Northern Rocky Mountains:

This wolf population must contain at least 300 wolves and 30 breeding pairs and must be equitably distributed in the 3 recovery areas within Montana, Idaho, and Wyoming for at least 3 consecutive years.

As part of this wolf conservation lesson plan, your students will receive the real-world data pertinent to the Recovery Criteria for gray wolves in the Northern Rocky Mountains. They will learn how to graph the data and interpret their graphs to determine whether or not wolves in the Northern Rockies have met Recovery Criteria.

Wolf Conservation Stakeholder Groups

Successful wolf conservation is grounded in sound science. In addition, there must be collaboration among wolf conservation stakeholders to ensure long term wolf conservation. As part of this wolf lesson plan, your students will learn about the different wolf conservation stakeholders including: Hunters, Wilderness Advocates, Wolf Watching Ecotourism, Ranchers, Native Americans, and Wildlife Managers/Scientists.

Stakeholders view natural resources differently, but broadly speaking there are two general philosophies: 1) Preservation, and, 2) Conservation.

Generally, **Preservation** means “no use” of natural resources and **Conservation** means “wise use” of natural resources. Most people who subscribe to a preservation philosophy view the wolf from a co-existence perspective and do not use hunting. Most people who subscribe to a conservation philosophy value hunting as an important conservation tool used by wildlife managers to help keep habitat and wildlife populations in balance. Your students will be learning more comprehensive definitions of these two philosophies and will be sharing this information through peer-to-peer learning.

Finally, this lesson plan focuses on wolf conservation in the Northern Rocky Mountains. However, other states outside of the Rockies (like Minnesota, Michigan, Wisconsin, and Alaska) also have viable wolf populations and some of these states face the same issues regarding wolf conservation that are addressed in this lesson plan.

Lesson Procedure

1. INTRODUCTORY VIDEO

- Show your students the Introductory Video called *“Gray Wolves in the Northern Rocky Mountains: A Conservation Puzzle”*

You can either present the short video to the entire class, or assign it as homework.

- At the conclusion of the video, tell your students that they are now gray wolf scientists who will be using real-world data to determine whether gray wolves in the Northern Rocky Mountains have met Recovery Criteria. They will also be using the data to answer other questions that have implications for wolf conservation.

2. INDIVIDUAL ACTIVITY 1: Evaluating Data on Wolf Recovery Criteria (Excel Data File)

Summary: This individual activity asks students to work through six Excel datasets on gray wolves, and to answer questions about their data analyses. Each dataset is presented in a table format. For some tables, students will be asked to do simple calculations. For all tables, students will be asked to graph and interpret data. Many of the graphs your students create will be referenced by different student groups during the Stakeholder Meeting.

- Provide each student access to **Excel software** (or provide graph paper and calculators)
- Provide each student the excel dataset called *“Excel Datasets_Wolves”*
- Hand out (or provide digital access to) the following pages to each student:
 - **Student Pages: Definitions**
 - **Student Pages: Instructions for Analyzing Data in Excel File**
 - **Student Pages: Questions about Excel Datasets**

** In the document called “Student Pages: Questions about Excel Datasets”, students will be asked to cut and paste graphs that they created using the Excel data. If you provide digital access to the page “Student Pages: Questions about Excel Datasets” then students can cut and paste graphs directly into this document. If you hand out hard copies of the page “Student Pages: Questions about Excel Datasets” then students will need to cut and paste each of their graphs onto a separate page.

- Ask students to read “Student Pages: Definitions” and to follow the instructions provided in “Student Pages: Instructions for Analyzing Data in Excel File”. This can be assigned as homework.
- If your students do not have experience working with Excel software, they can find instructions for using Excel to produce graphs here: <http://www.excel-easy.com/data-analysis/charts.html>

- All the correct graphs are located in your answer key called: **ANSWER KEY: Excel Data with Graphs.**
- All the answers to questions are located in the answer key called: **ANSWER KEY: Questions about Excel Datasets.**
- If you want your students to turn in their answers to the questions from “Student Pages: Questions about Excel Datasets” ask them to first make a copy that they will keep for themselves. They will need their answers during the Stakeholder Meeting.

3. INDIVIDUAL ACTIVITY 2: GIS Data

Summary: This individual activity asks students to follow a simple GIS tutorial as they learn about the spatial distribution of gray wolf packs in the Northern Rocky Mountains. The GIS Tutorial was designed for beginning GIS users.

- Provide each student access to **ESRI’s ArcMap software** (i.e., GIS software).

For instructions on how to download the ESRI ArcMap GIS software for free, please refer to the “Lesson Materials” section.

- Provide each student the zipped dataset called “**GIS Data_Wolves**”
- Hand out (or provide digital access to)the following pages to each student:
 - **Student Pages: Instructions for Analyzing GIS Data**
 - **Student Pages: Questions about GIS Dataset**

**In the document called “Student Pages: Questions about GIS Dataset”, students will be asked to cut and paste the map layout they created using the GIS data. If you provide digital access to the page “Student Pages: Questions about GIS Dataset” then students can cut and paste their map layout into this document. If you hand out hard copies of the page “Student Pages: Questions about GIS Dataset” then students will need to cut and paste their map layout onto a separate page.

- Tell your students to follow the instructions provided in the “Student Pages: Instructions for Analyzing GIS Data”. The GIS instructions are designed for beginner GIS users. Your students should have a lot of fun!
- Go around to each student and make sure they are on the right track. You have all the answers to the GIS questions, and the final map layout, in your answer key: **ANSWER KEY: Questions About GIS Data.**
- If you want your students to turn in their answers to the questions from “Student Pages: Questions about GIS Data” ask them to first make a copy that they will keep for themselves. They will need their answers during the stakeholder meeting.

4. DISCUSSION: Findings from Individual Activities

Hold a short class discussion about major findings from the Individual Activities. The main goal of this discussion is to ensure that all students are on the same page about the FACTS before they begin the stakeholder meeting.

Suggested Discussion Questions:

- ❖ Based on your analyses of Excel data, have gray wolves in the Northern Rocky Mountains met Recovery Criteria? Substantiate your answer.
- ❖ When a wildlife species is listed as endangered or threatened, the management of this species falls under the jurisdiction of the US Fish and Wildlife Service. If a species is delisted, who is responsible for managing the delisted species?
- ❖ Since the gray wolf was delisted in Montana and Idaho in 2011, have wolf populations in these two states fallen below criteria set forth by the US Fish and Wildlife Service?
- ❖ If wolf populations ever do go below criteria set forth by the US Fish and Wildlife Service, what will happen to the management of wolves?
- ❖ In 1995-1997, 76 gray wolves were relocated to Central Idaho and Yellowstone National Park. Based on your GIS work, do you think gray wolves successfully expanded their geographical range?
- ❖ Are wolves inside Yellowstone National Park managed differently than wolves that live outside Yellowstone National Park? If yes, describe the differences.
- ❖ There's a lot a media attention on wolves inside Yellowstone National Park. Based on your GIS analyses that included data from 2014, what percentage of all Northern Rocky Mountain wolf packs lived INSIDE Yellowstone National Park during 2014?
- ❖ How quickly did the wolf population grow in Northern Rocky Mountains after 76 wolves were reintroduced into this area? What does that tell you about the gray wolf's reproductive potential?
- ❖ Why are some wolves lethally removed by wildlife professionals?
- ❖ For the management of any wildlife species (including wolves), what do wildlife agencies use to help guide decision-making?
- ❖ **FINAL QUESTION:** In addition to the role that science plays in the conservation of gray wolves, what else is important to ensure successful wolf conservation?

After you have discussed the final question, tell your students something like this:

“In the next activity, you will be working in groups and participating in a stakeholder meeting about gray wolf conservation in Montana. Stakeholder meetings provide all those who have a stake in the issue a chance to be a part of the process and stay involved”

5. GROUP ACTIVITY: STAKEHOLDER MEETING

Preparation for the Stakeholder Meeting

Step 1: Assign each student to one of six stakeholder groups: Hunters, Ranchers, Wolf Watching Ecotourism, Wilderness Advocates, Native Americans, and Wildlife Managers/Scientists.

Step 2: Hand out the appropriate “Stakeholder Activity Instructions” to each group. For example, the students in the **Hunter Stakeholder** group will get the student pages called “Stakeholder Activity Instructions: Hunters”.

Step 3: Ask each group to follow instructions in their “Stakeholder Activity Instructions”. The “Stakeholder Activity Instructions” are different for each group. In their “Stakeholder Activity Instructions”, each group will be provided some information about their stakeholder group, and students will also be asked to do additional research. Each group will be instructed to put together a 3-5 minute presentation (Powerpoint or Prezi work best) about their stakeholder group, which they will present to the class at the beginning of the Stakeholder Meeting. Information about specific details that must be included in each presentation are provided in “Stakeholder Activity Instructions” for each of the six student groups.

In addition to “Stakeholder Activity Instructions”, each student group has a different Stakeholder Folder, which includes articles and other documents pertinent to each stakeholder. For example, the **Hunter Stakeholder** group has a Stakeholder Folder called “Hunter Stakeholder Folder”, which includes five articles and one document. The “Stakeholder Activity Instructions: Hunters” includes instructions about what students should do with materials in the “Hunter Stakeholder Folder”.

Step 4: Give your students time to work in their groups on this activity. Group work can be assigned as homework.

The Day of the Stakeholder Meeting

Step 5: On the day of the Stakeholder Meeting, you will be the Stakeholder Meeting Facilitator. Welcome the six Stakeholder Groups by saying something like this:

“Welcome to the First Annual Gray Wolf Conservation Stakeholder Meeting, held on this ___ day of ___. I will be your Meeting Facilitator today and I’m pleased to welcome the following Stakeholder Groups: Ranchers, Wilderness Advocates, Hunters, Native Americans, Wolf Watching Ecotourism, and Wildlife Managers/Scientists.

It’s important to remember that individual people can belong to several stakeholder groups, for example a Hunter might also be a Wilderness Advocate. A Wilderness Advocate might also be a Rancher, etc. For our stakeholder meeting, however, each person will represent only their stakeholder group.

During our Stakeholder Meeting, we have three goals:

- 1. We need to understand the different perspectives of each stakeholder**
- 2. We need to determine “common ground” among stakeholders**
- 3. We need to identify issues and work collaboratively to find possible solutions to these issues. We need to figure out how we can move forward to ensure successful wolf conservation that considers all stakeholder perspectives/goals are considered.**

Let’s get started with Goal #1 by hearing from each Stakeholder Group. Each group will have 3-5 minutes to present their perspectives regarding gray wolf conservation in the Northern Rocky Mountains”.

Step 6: Ask each group to take turns giving their 3-5 minute presentation. Follow this presentation order: Ranchers, Wilderness Advocates, Hunters, Native Americans, Wolf Watching Ecotourism, and Wildlife Managers/Scientists.

PLEASE NOTE: the Wildlife Managers/Scientists group has been instructed to put together a 5-10 minute presentation. This group has been allotted a longer presentation time because their job is relatively more complex because they need to consider and address the values of ALL stakeholders. In addition, the Wildlife Managers/Scientists group has been instructed to present several videos as part of their presentation.

Step 7: After all groups have given their presentations, begin a facilitated discussion to address Goal #2, “Finding Common Ground”.

Suggested Questions and Topics for Discussion about “Finding Common Ground”:

- ❖ What are some things that all or some stakeholders can agree on? For example, do we all agree that gray wolves in the Northern Rocky Mountains have met Recovery Criteria defined by the US Fish and Wildlife Service?
- ❖ Do most of us agree that at least SOME wolves should be on the landscape? We know that some stakeholder groups might want fewer wolves and some stakeholder groups might want more wolves, but can we at least agree that some wolves should be part of the natural system?
- ❖ Do we all agree that wolves are wild animals, and as such, should be managed by the government in trust FOR the public?
- ❖ Do we all agree that science should help guide decisions regarding the conservation of wild wolf populations?
- ❖ Do we all agree that the wolves that live inside Yellowstone National Park are, and should continue to be, managed differently than wolves that live outside Yellowstone National Park?

Step 8: After the stakeholder groups have identified some common ground, move on to Goal #3.

At this point, your job as Stakeholder Meeting Facilitator becomes critically important. You don’t want this portion of the meeting to turn into an argument. We are trying to reduce conflict, not increase it. One goal of this part of the meeting is to have the stakeholders voice their issues. Another goal is to provide a platform for students to collaboratively work to identify possible solutions to these issues.

Start this portion of the Stakeholder Meeting by saying something like this:

“Great! We’ve found some common ground. Now, we are going to address Goal #3. Here’s how it’s going to work: I’ll provide each stakeholder group a turn to voice one or more issues you believe are important to your stakeholder group. Let’s go around the room and let each stakeholder group voice their issue/s. We’ll listen to all the issues first, and then we’ll tackle some of the issues together to see if we can come up with some solutions. Remember that it’s important to respect everyone’s values, and to give everyone an opportunity to state their opinions. Let’s start with Ranchers. What is one issue you’d like to bring to the attention of the rest of the stakeholders?”

Go around to each stakeholder group and ask them to voice an issue. Make a list of the issues on your smart board or chalk board. After all issues have been voiced, ask your students which issue they want to tackle first. Help your students discuss possible solutions. Below, you will find a list of major ISSUES and some POSSIBLE SOLUTIONS. Try to steer your students’ discussion so that they collaboratively “discover” some possible solutions.

EXAMPLES OF MAJOR WOLF CONSERVATION ISSUES

ISSUE for HUNTERS: The biggest issue for many hunters is their belief that wolves have made it difficult to successfully hunt elk and deer. Wolves compete with hunters for elk and deer and in some areas, the number of elk or deer has decreased as wolf numbers have increased. In some areas, wolves may also affect elk and deer behavior by making them more wary.

POSSIBLE SOLUTIONS:

1. Increase Hunter Access on Public and Private Lands

For many elk and deer hunters, having access to the lands where elk and deer are distributed is key to successful hunting. The Wildlife Management/Science Stakeholder Group and the Hunter Stakeholder Group read about ways to increase hunter access in the article called “Finding a Way In”. Ask these two groups to discuss this possible solution.

2. Restore and increase elk habitat

In some areas, a decrease in elk numbers can be attributed, in part, to loss of elk habitat. Especially in places where fire suppression has occurred, one solution may be to restore elk habitat. Ask the Hunter Stakeholder Group about this, they read about how the Rocky Mountain Elk Foundation has worked to restore elk habitat.

3. Continue to provide hunting opportunities for hunters so that they can actively participate in the management of elk and deer to help keep these populations in balance.

4. One of the biggest reasons elk are difficult to hunt is due to the recent unequal distribution of elk on private, irrigated lands during elk hunting season. Historically, elk herds in the West shared the landscape with working ranchers, most of these working ranchers did not provide opportunities for elk herds to graze on their irrigated lands year-round. Therefore, most elk herds did not spend hunting season on private,

irrigated lands where hunting may or may not be allowed. With the recent change in land ownership moving away from working ranches and towards hobby farms, more elk are permitted to distribute themselves year-round on private land that is irrigated, where hunters often have no access. This means that many elk are not accessible to elk hunters during elk hunting season because the elk are staying on private hobby farms. Can your class think of any solutions to this dilemma?

ISSUE for RANCHERS: The biggest issue for Ranchers is that wolves kill their livestock, pets and working dogs. This wolf depredation can seriously affect a Rancher's ability to make a living.

POSSIBLE SOLUTIONS:

1. Use non-lethal measures to reduce wolf-livestock conflict. The Wilderness Advocates Stakeholder group and the Wildlife Management/Science Stakeholder group learned about several non-lethal measures, ask these two groups to describe them.

1B. A specific non-lethal strategy to reduce wolf-livestock conflict is to allocate some of the public land as "off limits" to livestock. The Wilderness Advocates Stakeholder group read about this strategy, ask them to explain this possible solution.

2. Increase the number of wolves that can be hunted and trapped in areas where livestock is depredated by wolves. The Wildlife Manager/Science Stakeholder learned that wolf hunting can be an important conservation tool to help keep wolf numbers in balance with the system. Ask the Wildlife Manager/Science Stakeholder group to explain this.

The Wolf Watching Ecotourism Stakeholder read an article that showed the number of livestock mortality may actually INCREASE instead of decrease when wolves are lethally removed from livestock areas. Ask the Wolf Watching Ecotourism Stakeholder group to explain why.

3. Reimburse ranchers for livestock losses. The Wilderness Advocate stakeholder will tell you that groups like Defenders of Wildlife helped pay for reimbursements to ranchers for livestock losses up until year 2009. At that time, each state wildlife agency started their own reimbursement programs. Ask the Wildlife Manager/Science Stakeholder to provide information about this.

ISSUE FOR WOLF WATCHING ECOTOURISM and WILDERNESS ADVOCATES: For Wolf Watching Ecotourism and Wilderness Advocates Stakeholder groups, an important issue is protecting wolves that live in Yellowstone, or in other wilderness and tourism areas. Some of these wolves periodically travel outside Yellowstone Park and when they do, they might get hunted. The Wolf Watching Ecotourism industry has stated that when Yellowstone wolves are hunted, it negatively affects their business. Some Wolf Watching Ecotourism people, along with Wilderness Advocates, state that when alpha wolves are killed, it can cause a pack to splinter and cease to exist. Many Wilderness Advocates want to see continued wolf research in places like Yellowstone, and believe that the data may help states learn how to better manage social predators like wolves.

POSSIBLE SOLUTIONS:

1. Provide a buffer zone around Yellowstone National Park, where wolves cannot be hunted.

It is worth reminding your students that wolves living inside Yellowstone are protected because they live inside a National Park, which is federally managed for the purpose of **preservation = no use**. Wolves that live outside Yellowstone in the state of Montana are not protected from hunting because these wolves are managed by the state of Montana for the purpose of **conservation = wise use**.

Possible solution #1 is not currently feasible in the state of Montana because the Montana legislature passed a law a few years ago that specifically states Montana cannot establish buffers around national parks. Why? There has to be an administrative boundary somewhere and that administrative boundary is the national park boundary. The state of Montana manages wolves throughout the state for ALL people in Montana. As a wildlife agency that uses science as the basis for management decisions, Montana Fish Wildlife and Parks doesn't make management decisions based on individual wolves. They make management decisions based on the wolf population. Montana Fish Wildlife and Parks states that even when a Yellowstone wolf is hunted near the Yellowstone border, it does not affect the overall wolf population. The number of wolves in Montana is still well above the federally mandated criteria.

2. Reduce the number of wolves that can be hunted in management units that border Yellowstone National Park. Ask the Wolf Watching Ecotourism Stakeholder group to describe this possible solution.

ISSUE FOR ALL STAKEHOLDERS: who pays for wolf conservation?

The Hunter Stakeholder group learned that Hunters directly fund wildlife conservation. Money from hunting licenses and tags, and money from the Pittman-Robertson Act (a levy on firearms and ammunitions sales) directly funds wildlife conservation, including wolf conservation.

Does anyone else pay for wildlife conservation? Yes, many non-profit organizations (Bear Trust International, Rocky Mountain Elk Foundation, Wild Sheep Foundation, Wildlife Mississippi, World Wildlife Fund, Vital Ground, Safari Club International Foundation "First For Wildlife", Dallas Safari Club, Nature Conservancy, etc.) contribute to wildlife conservation through the purchase of habitat conservation easements and protecting wildlife habitat, by conducting research on wildlife and doing conservation education, and through land stewardship. Federal agencies like the US Fish and Wildlife Service and the National Park Systems also contribute to wildlife conservation, which is paid for by US citizens who pay taxes.

Ask your students if they can think of any other ways we (all stakeholders) could collaborate to help pay for wolf conservation?

POSSIBLE SOLUTION:

1. What if we expanded the Pittman-Robertson Act? The Pittman Robertson Act began in 1937. It's also called the "Federal Aid in Wildlife Restoration Act". Here's how it works. Every time someone purchases a firearm or ammunition, there is an 11% tax placed on this purchase. The money generated from this tax is apportioned to state wildlife agencies for wildlife conservation work, including wolf conservation.

What if we expanded this idea and taxed items related to non-consumptive uses associated with wolves? In this way, people who value wolf watching and people who value products from free-ranging livestock can contribute financially to wolf conservation.

For example, we could levy a tax on all outdoor hiking items and on mass-produced artistic and creative products which make use of wolf imagery (calendars, t-shirts, television documentaries). We could levy a tax on the sale of beef, goat, and sheep products that are produced on land shared with wolf packs.

As a consumer, would you pay an additional 10 cents a pound for ground beef, or an extra 50 cents for your annual wildlife calendar, to help ensure viable wolf populations?

What does your class think about this possible solution? Do they have any other possible solutions?

Note: The Conservation and Reinvestment Act (CARA) addresses some of these ideas. Does it make sense to create additional Acts along the lines of CARA for the purpose of helping to distribute the costs of wolf conservation among both consumptive and non-consumptive users?

ISSUE FOR SOME STAKEHOLDERS: An issue that affects some stakeholders is wolf hunting and trapping. Some stakeholders, like Wilderness Advocates and some Wolf Watching Ecotourism, do not agree that wolves should be hunted or trapped.

DISCUSSION:

The Wildlife Manager/Science group learned that wolf hunting and trapping are important conservation tools that help keep wolf numbers in balance with the natural system, help minimize livestock losses, and help maintain hunting opportunities for ungulate hunters. Most Wolf Watchers and Wilderness Advocates share a **preservation = no use** philosophy, which differs from the philosophy held by state wildlife agencies, who are mandated to manage wildlife resources per the **conservation = wise use** philosophy. Although it can be difficult to get these two philosophical camps to agree completely on a single solution, it is useful to hold a discussion to see if any partial solutions emerge.

Step 9: After all issues have been presented and possible solutions have been discussed, make a class list of possible solutions and close the Stakeholder Meeting. As an optional activity, send the class list of possible solutions to the executive director of Bear Trust International who will share the list with the wildlife managers at Montana Fish Wildlife and Parks.

Send your list of possible solutions to Dr. Melissa Reynolds-Hogland : melissa@beartrust.org.

Step 10: Optional Extension: This wolf conservation lesson plan will likely spark new questions. For example, this lesson plan does not go into detail about the political process underlying the complex delisting of the gray wolf in the Northern Rocky Mountains. Your students might wish to know why wolves were delisted, then relisted over and over again. They might want to know more details about why gray wolves in Wyoming are still listed. As an optional extension exercise, you could ask students to research this topic.

Next Generation Science Standards: High School

Performance Expectations:

HS-LS2-1: Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales

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-LS2-6 : Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem

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

Science and Engineering Practices:

Asking questions and Defining Problems

Developing and Using Models

Using Mathematics and Computational Thinking

Constructing Explanations and Designing Solutions

Engaging in Argument from Evidence

Disciplinary Core Ideas:

Interdependent Relationships in Ecosystems

Developing Possible Solutions

Crosscutting Concepts:

Cause and Effect

Stability and Change

Common Core State Standards: Math

CCSS.Math.Content.HSS-ID.B.5: Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

CCSS.Math.Content.HSS-IC.B.6: Evaluate reports based on data.

CCSS.Math.Content.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.

CCSS.Math.Content.HSN-Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

CCSS.Math.Content.HSF-IF.B.4: For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship

CCSS.Math.Content.HSF-IF.C.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Common Core State Standard Connections: Literacy

CCSS.ELA-Literacy.RST.9-10.1: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-Literacy.RST.9-10.2: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CCSS.ELA-Literacy.RST.9-10.3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text

CCSS.ELA-Literacy.RST.9-10.4: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context

CCSS.ELA-Literacy.RST.9-10.5: Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force*, *friction*, *reaction force*, *energy*).

CCSS.ELA-Literacy.RST.9-10.6: Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

CCSS.ELA-Literacy.RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-Literacy.RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

CCSS.ELA-Literacy.RST.9-10.9: Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

NSES National Science Standards

Standard A: Science as Inquiry 1-6

1. Identify questions and concepts that guide scientific investigations (STEM)
2. Design and conduct scientific investigations (STEM)
3. Use technology and mathematics to improve investigations and communications (STEM)
4. Formulate and revise scientific explanations and models using logic and evidence (STEM)
5. Recognize and analyze alternative explanations and models (STEM)
6. Communicate and defend a scientific argument (STEM)

Standard C: Life Science 6; Students will understand the behavior of organisms (STEM)

Standard G: History and Nature of Science 3; Students will understand connection to historical perspectives (STEM)

National Math Standards NCTM

Standard 5: Data Analysis and Probability

- a. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
- b. Select and use appropriate statistical methods to analyze data
- c. Develop and evaluate inferences and predictions that are based on data

Standard 6: Process

- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems
- Monitor and reflect on the process of mathematical problem solving

Reasoning and Proof

- Make and investigate mathematical conjectures
- Develop and evaluate mathematical arguments and proofs
- Select and use various types of reasoning and methods of proof

Communication

- Organize and consolidate their mathematical thinking through communication
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others
- Analyze and evaluate the mathematical thinking and strategies of others;

Connections

- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in contexts outside of mathematics

Representation

- Create and use representations to organize, record, and communicate mathematical ideas
- Select, apply, and translate among mathematical representations to solve problems
- Use representations to model and interpret physical, social, and mathematical phenomena