

Grizzly Bears: Ready for Delisting?

Teacher's Guide

STEM Lesson Based on Wild Grizzly Bears in the Lower 48 States



Photo: Shawn Stewart

By design, this lesson does not require teachers to know anything about grizzly bears. Simply load Part I of the slideshow and begin!

This lesson has been aligned with Next Generation Science Standards, Common Core State Standards, NSES National Science Standards, and NCTM National Math Standards. For a complete description of standards, please see the end of this Teacher's Guide.

Lesson Synopsis

This lesson uses the flipped learning model where teachers don't stand before the class and lecture. Instead, students become grizzly bear scientists and "discover" the answers to real-world research questions through scientific inquiry.

Using six real-world data sets, students work individually, in three Science Teams, and as a class to determine whether or not the grizzly bear population in the Greater Yellowstone Ecosystem is biologically ready for delisting.

Grade Level: 9-12

Next Generation Science

Standards: HS-LS2-1, HS-LS2-2, HS-LS2-6; HS-LS2-7; **Common**

Core State Standards:

MATH: CCSS.Math.Content.HSS-ID.A.1; HSS-ID.B.5; HSS-ID.B.6; HSS-IC.B.6; HSN-Q.A.1 ; HSN-Q.A.2; HSF-IF.B.4 ; HSF-IF.C.9
LITERACY: CCSS.ELA

Literacy.RST.9-10.1, RST.9-10.2, RST.9-10.3, RST.9-10.4, RST.9-10.5, RST.9-10.6, RST.9-10.7, RST.9-10.8, RST.9-10.9, **NSES**

National Science Standards: A 1-6, C, and G; **NCTM National Math Standards:** 4, 5 & 6

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

Subjects: Science and Math

Duration: Approximately 3 class periods

Materials for lesson:

- Introductory Video
- Part II Slide Show (RESULTS)
- Student Pages: Individual Activity
- Student Pages: Group Activity
- GYE Grizzly Bear Datasets
- Excel software OR calculators and graph paper
- Figure 1
- Answer Key
- Published paper: "Response of Yellowstone grizzly bears to changes in food resources: a synthesis"

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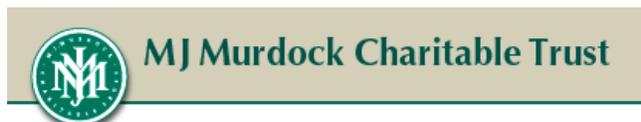
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Grizzly Bears: Ready for Delisting?

Written by Dr. Melissa-Reynolds Hogland/Bear Trust International

Printed by Bear Trust International

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Lesson Objectives

1. Students will actively participate in the process of scientific discovery, using 6 real-world data sets collected from wild grizzly bears in the Greater Yellowstone Ecosystem (GYE).
2. Students will develop hypotheses, develop predictions, analyze predictions using real data, interpret analyses, draw conclusions, and share findings with their peers.
3. Students will learn what happens when a listed species is delisted, including the transfer of management from the federal agency back to the state wildlife agencies.
4. Students will "discover" which factors are critical to grizzly bear recovery and critically evaluate whether the grizzly bear population in the GYE is biologically ready for delisting, based on the scientific definition of a healthy grizzly bear population.
5. Students will calculate lambda (per capita geometric rate of increase of the population) for 2-year time periods, 6-year running averages for mortality limits for population segments, human-caused mortality for population segments, and NChao2 (all equations are provided). Students will create line and bar graphs and critically evaluate/interpret graphs and tables.
6. Students will understand that effective conservation of wild grizzly bears requires cooperation among a wide variety of stakeholders; an engaged citizenry (the public) has been and continues to be essential to the stewardship of fish and wildlife.
7. Students will use equations (all equations are provided) and real-world data to calculate missing information in tables, graph the data, and analyze/interpret results.
8. Students will hone skills in communication as they engage in a range of collaborative discussions (in groups and as a classroom).
9. Students will present findings to their peers, emphasizing important facts with relevant evidence.
10. Students will work individually and cooperatively as they solve problems, construct explanations, hone critical thinking skills, and design solutions.

Acknowledgements

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Lesson Materials

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

www.beartrust.org

- Introductory Video: *Grizzly Bears: Ready for Delisting?*
- PART II Slideshow with RESULTS
- Teacher Guide (i.e., the guide you are reading)
- Student Pages: Individual Activity (2 versions)
 - Version A: Relatively more challenging for students (see "Procedure" below for details)
 - Version B: Relatively less challenging for students (see "Procedure" below for details)
- Excel Data File with 6 Datasets included; there are 2 versions that correspond with the 2 versions of "Student Pages: Individual Activity"
 - Version A_GYE Grizzly Bear Data Sets (relatively more challenging)
 - Version B_GYE Grizzly Bear Data Sets (all cell values in the spreadsheets are filled in)
- Figure 1
- Student Pages: Group Activity_Team 1
- Student Pages: Group Activity_Team 2
- Student Pages: Group Activity_Team 3
- Answer Key, which provides all graphs and cell values in datasets
- Excel graphing software, or graph paper and calculators for each student
- For optional extension lesson: published paper entitled "Response of Yellowstone grizzly bears to changes in food resources: a synthesis", by the Interagency Grizzly Bear Study Team

Lesson Procedure

1. Show your students the Introductory Video: "Grizzly Bears: Ready for Delisting?"

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

2. At the conclusion of the video, hand out "Student Pages: Individual Activity" to each student and provide each student the Excel File "GYE Grizzly Bear Data Sets".

For this part of the lesson, you may choose to use Version A or Version B.

Version A: This version is designed to provide a more challenging experience for students. "Version A GYE Grizzly Bear Data Sets" is an excel file that includes 6 data sets. In the "Version A Student Pages: Individual Activity", students are provided instructions on how to calculate missing values in the datasets (all equations are provided) and create graphs using the data.

Version B: The "Version B GYE Grizzly Bear Data Sets" is an excel file that includes 6 data sets (datasets can be provided as pdfs if requested). **There are no missing values in these data sets so students are NOT expected to do calculations.** In the "Version B Student Pages: Individual Activity", students are provided instructions on how to graph data in each of the 6 datasets.

The **answer key** for teachers includes missing cell values and graphs for both Version A and Version B.

Note: this lesson is specifically designed using the flipped learning model. Rather than asking teachers to lecture, we ask students to discover the answers and to teach each other through group presentations. As such, most of the informational content (including definitions and explanations for why grizzly bear scientists use one method) are included in the STUDENT PAGES: GROUP ACTIVITY and in the Datasets. In each of the 6 Datasets, definitions are provided for column headings and for other terms. As part of the group activity, each group is instructed to prepare a presentation about their Recovery Criteria, **to include definitions and explanations** that the other Science Teams might not already know.

Please note that the Student Pages: Individual Activity is specifically designed to be an individual activity so that each student has equal opportunity to work through **all** of the real-world datasets. Each student should work through his/her Individual Student Pages alone. You may wish to assign this portion as homework. Let your students know that during the next class period they need to come prepared with their datasets filled in and/or created graphs. They will likely have questions about parts of the data and why they were instructed to create some graphs. That's okay. The answers will be revealed during the Student Group activity.

3. When all students have individually completed their "Student Pages: Individual Activity" and worked through their Datasets, place your students into 3 groups. Each group will be one of three Grizzly Bear Science Teams. Group 1 will be Grizzly Bear Science Team #1, responsible for Demographic Recovery Criterion #1. Group 2 will be Grizzly Bear Science Team #2, responsible for Demographic Recovery Criterion #2, and Group 3 will be Grizzly Bear Science Team #3, responsible for Demographic Recovery Criterion #3.

4. Hand out the appropriate "Student Pages: Group Activity" to every member in each group (Team 1, Team 2, Team 3). Tell your students that each group is now a Science Team in charge of one of the Demographic Recovery Criteria for the GYE grizzly bears. For example, Group 1 is the Science Team in charge of Demographic Recovery Criterion #1. Tell students that they need to work in their groups to work through their Student Pages: Group Activity. Tell each Science Team that they will be preparing a presentation about their Demographic Recovery Criterion, which they will present to the class (all instructions for this step are included in the "Student Pages: Group Activity").

Go around to each group and make sure they have created the correct graphs (look in the excel file "Answer Key", which provides graphs for all 6 Datasets). If their graphs are not correct, help them complete the graphs to ensure they have the correct results from which to draw conclusions and present findings.

In their "Student Pages: Group Activity", each Science Team is provided instructions about what information they should include in their presentation.

5. Ask each Team to give their presentation. Have Science Team 1 go first, then Science Team 2, then Science Team 3.

6. After all three Science Teams have given their presentations, ask your students to work as a class to determine whether or not the grizzly bear population in the Greater Yellowstone Ecosystem is biologically ready for delisting based on the combined scientific results from all 3 Science Teams.

7. Next, show the class “Part II Slideshow with RESULTS”. In this slideshow, students will see some of the graphs they were asked to create so that they can compare their findings with those of the Interagency Grizzly Bear Study Team. They will also learn more about grizzly bear habitat, including important foods that are monitored as part of the Habitat Recovery Criteria.

8. As an optional extension lesson, you can ask your students to participate in a mock stakeholder meeting. For this extension lesson, the teacher will evenly divide students into stakeholder groups. Each stakeholder group will be responsible for understanding its position on grizzly bear conservation in Montana, and what they think will happen when the grizzly bear is delisted.

During the mock stakeholder meeting, the teacher serves as the meeting coordinator and the first thing you should say at the beginning of the stakeholder meeting is, "Since this is our first stakeholder meeting, we will spend most of the time talking about stakeholder issues. Each stakeholder will have 3 minutes to present his/her case. Then we will open the floor to discussion".

9. As an optional extension lesson, you can ask your students to read the published paper, "Response of Yellowstone grizzly bears to changes in food resources: a synthesis". This paper provides detailed information about the study that was done to evaluate whether or not GYE grizzly bears have been effected by the decline of whitebark pine seeds. Part II of the slideshow introduces this topic, which is directly related to the reason the 9th District Court re-listed the GYE grizzly bear population in 2009.

Background Information for Teachers

Prior to the 1800's, grizzly bears ranged from Alaska to Mexico and as far east as the western shores of Hudson Bay. In the Lower 48 states alone, there was an estimated 50,000 grizzly bears. By 1975, less than 1,000 grizzly bears remained in the lower 48 states, occupying less than 2% of their former range. In 1975, the US Fish and Wildlife Service listed the grizzly bear in the lower 48 states as Threatened under the Endangered Species Act (ESA). At that point, grizzly bears in the lower 48 states were placed under federal protection.

The goal of the ESA is to recover species back to the point where they no longer need federal protection.

When a species is listed as Threatened or Endangered, management is moved from the state wildlife agencies to the federal US Fish and Wildlife Service. Before any listed species or population can be delisted, the US Fish and Wildlife Service evaluates the following 5 factors:

1. Is there a present or threatened destruction, modification, or curtailment of its habitat or range?
2. Is there overutilization for commercial, recreational, scientific or educational purposes?
3. Is there disease or predation?
4. Is there inadequacy of existing regulatory mechanisms?
5. Are there other natural or human-caused factors affecting the population's continued existence?

Regarding the grizzly bears in the Lower 48 states, the US Fish and Wildlife Service hired Dr. Chris Servheen in 1981 to serve as the grizzly bear recovery coordinator. In 1982, the first grizzly bear Recovery Plan was completed, which identified 6 Grizzly Bear Recovery Zones in the lower 48 states:

- 1) North Cascades Recovery Zone
- 2) Selkirks Recovery Zone
- 3) Cabinet-Yaak Recovery Zone
- 4) Northern Continental Divide Ecosystem Recovery Zone
- 5) Bitterroot Recovery Zone
- 6) Greater Yellowstone Ecosystem Recovery Zone

In 1983, the **Interagency Grizzly Bear Committee (IGBC)** was formed to help ensure the recovery of viable grizzly bear populations and their habitats in the lower 48 states through interagency cooperation. The **IGBC** includes top level federal, state, and Canadian representatives from the following agencies: US Forest Service, National Park Service, Bureau of Land Management, US Fish and Wildlife Service, US Geological Service, Park Canada, Montana Fish Wildlife and Parks, Idaho Fish and Game, Wyoming Game and Fish Department, Washington Department of Fish and Wildlife, and, Provinces of Alberta and British Columbia.

The group responsible for collecting, managing, analyzing, and distributing information about grizzly bears in the GYE is the **Interagency Grizzly Bear Study Team (IGBST)**.

The responsibilities of the **IGBST** are:

- 1) conduct short and long term research projects addressing needs for bear management
- 2) monitor the bear population, including status and trend, numbers, reproduction, and mortality
- 3) monitor grizzly bear habitats, foods, and impacts on humans
- 4) provide technical support to agencies and other groups responsible for immediate and long term management of grizzly bears in the GYE

The distinction between the IGBC and the IGBST: the **IGBC** is the group of high level managers charged with implementing the recovery plan for grizzly bears in all 6 Grizzly Bear Recovery Zones. They meet twice annually. The Interagency Grizzly Bear Study Team (**IGBST**) does the hands-on research, monitoring, and analyses of data for the grizzly bear population in the GYE Recovery Zone. Members of the **IGBST** include scientists with USGS and USFS and bear managers from Montana Fish Wildlife and Parks, Idaho Fish and Game, and Wyoming Game and Fish Department.

Before the grizzly population in the GYE can be considered for delisting, it must meet the following **3 Demographic Recovery Criteria:**

Demographic Recovery Criterion 1

"Because 48 adult females with cubs of the year is equivalent to a population of approximately 500 total individuals (IGBC, p. 43), we are establishing a target number of 48 adult females of the year. This target number shall not go below 48 for any two consecutive years. For genetic reasons (Miller and Waits 2003, p. 4338) it is desirable that the total population of grizzly bears in the GYA be maintained above 400 bears. To assure that this goal is met and in order to adopt a conservative approach, the total population will be maintained at or above 500 grizzly bears. The estimate of 48 adult females with cubs of the year will be calculated by the **IGBST** based on model averaging described in the Supplement to the Reassessing Methods Document (**IGBST** 2006, pp.2-10)."

Demographic Recovery Criterion 2

"Sixteen of 18 bear management units within the Recovery Zone must be occupied by females with young, with no two adjacent bear management units unoccupied, during a 6-year sum of observations. This criterion is important as it ensures that reproductive females occupy the majority of the Recovery Zone and are not concentrated in one portion of the ecosystem."

Demographic Recovery Criterion 3

"For independent females (at least 2 years old), the current annual mortality limit, not to be exceeded in 2 consecutive years and including all sources of mortality, is 9 percent of the total number of independent females. For independent males (at least 2 years old), the current annual mortality limit not to be exceeded in 3 consecutive years and including all sources of mortality, is 15 percent of the total number of independent males. For dependent young (less than 2 years old), the current annual mortality limit, not to be exceeded in 3 consecutive years and including only known and probable human caused mortalities, is 9 percent of the total number of dependent young."

In 2007, the Recovery Plan for the GYE grizzly bear population was amended to also include 3 Habitat Recovery Criteria:

Habitat Recovery Criterion 1

"Secure habitat standard: The percentage of secure habitat within each bear management subunit must be maintained at or above levels that existed in 1998. Temporary and permanent changes are allowed under specific conditions..".

Specific conditions are listed in the "Supplement to the Grizzly Bear Recovery Plan" signed in 2007.

Habitat Recovery Criterion 2

"Developed site standard: The number and capacity of developed sites within the Recovery Zone will be maintained at or below the 1998 level with the following exceptions: any proposed increase, expansion, or change of use of developed sites from the 1998 baseline in the Recovery Zone will be analyzed, and potential detrimental and positive impacts documented through biological evaluation or assessment by action agency.

A developed site includes but is not limited to sites on public land developed or improved for human use or resource development such as campgrounds, trailheads, lodges, administrative sites, service stations, summer homes, restaurants, visitor centers, and permitted resource development sites such as oil and gas exploratory wells, production wells, plans of operation for mining activities, work camps, etc."

Habitat Recovery Criterion 3

"Livestock allotment standard: Inside the Recovery Zone, no new active commercial livestock grazing allotments will be created and there will be no increases in permitted sheep Animal Months (AMs) from the identified 1998 baseline. Existing sheep allotments will be monitored, evaluated, and phased out as the opportunity arises with willing permittees."

Please note that the data-rich component of this lesson focuses on the DEMOGRAPHIC RECOVERY CRITERIA. The HABITAT RECOVERY CRITERIA are presented in this lesson, and specific habitat studies are discussed in Part II of the slideshow, but data about grizzly bear habitat are not provided in this lesson.

Grizzly Bear Listing Status (as of April 2016)

Thanks to ESA protection and hard work by the Interagency Grizzly Bear Committee and others, in **2007** the US Fish and Wildlife Service **DELISTED** the population of grizzly bears in the Greater Yellowstone Ecosystem. In **2009**, a federal court overturned the 2007 delisting and the grizzly bear population in the Greater Yellowstone Ecosystem was **RELISTED** as a Threatened species. In 2011, the US Court of Appeals upheld the 2009 decision. In March, **2016**, the US Fish and Wildlife Service **PROPOSED DELISTING** the grizzly bear population in the GYE.

Students as Scientists

Your students will be using real-world demographic data collected by the IGBST to determine whether the grizzly bear population in the GYE is biologically ready for delisting, based on science. All data and results used in this lesson were extracted from real data provided in 22 different annual reports published by the Interagency Grizzly Bear Study Team for years 1991-2014.

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.A.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).

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-ID.B.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

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 4: Measurement (STEM)

- a. Understand measurable attributes of objects and the units, systems and the processes of measurement (STEM)

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
- d. Understand and apply basic concepts of probability

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