THE RING OF DARHAD

MONGOLIA WOLVERINE EXPEDITION

ADVENTURERS & SCIENTISTS FOR CONSERVATION
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Mountains & Minds

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

TEACHER RESOURCES

Explore the Ring of Darhad in northern Mongolia alongside the Adventurers and Scientists for Conservation team and enhance your students' understanding of science, technology, engineering and math (STEM). This unit follows the Ring of Darhad Mongolia Wolverine Expedition and includes seven standards-based lessons that align with both the traditional National Standards and Common Core Standards Initiative. Filled with hands-on and inquiry-based activities, these lessons will guide you and your students through the biodiversity of the mountainous northern Mongolian ecosystem while applying wildlife ecology research techniques to your own local schoolyard. Lessons on ecosystems, biodiversity, wildlife ecology, and climate change were provided by the Montana Institute on Ecosystems (IoE) (http://montanaioe.org) via its CLimate In My Backyard (CLIMB) curriculum series (http://eu.montana.edu/CLIMB)

The lessons can be completed in any order and can be taught independently and outside of the unit. For those following the Ring of Darhad Mongolia Wolverine Expedition in live time during Spring 2013, it is recommended that lessons are completed in sequential order. Lesson seven can be completed at the end of the unit, or completed in portions after each of the other lessons to complement lessons one through six. Each lesson is approximately one hour long and has options for adapting the lessons to different age groups and extending the learning.

Lesson 1: Meet the Team

Discover the mission of the Ring of Darhad Mongolia Wolverine Expedition and the planning that was required to make this journey a success. "Meet" the members of the team through short videos and start to uncover and appreciate how exciting adventures like this can support science.

Lesson 2: Discover the Darhad

Explore northern Mongolia and the Darhad region, including its location, topography, and people. Trace the expedition's route on a map, learn about resupply points and compare American culture with the Mongolian culture through research.

Lesson 3: Explore the Ecosystem of Northern Mongolia

Learn more about the Darhad region's ecosystem and how its species are interconnected through games and diagrams. Students will explore how the wolverine's survival depends on the health of the entire Darhad ecosystem through research.

Lesson 4: Become a Wildlife Ecologist

Explore how scientists gather data on wildlife and the techniques they use in the field. Investigate signs of life and search for evidence of life in your own schoolyard.

Lesson 5: Biodiversity of the Ring of Darhad

Discover how biodiversity is calculated by using candy, then calculate biodiversity of a model of northern Mongolia. Research species that live in the Ring of Darhad and play a whole-class game to explore the biodiversity of the region.

Lesson 6: Climate Change and the Wolverine

Study various climates around the world by exploring global data and comparing different cities. Identify how your actions contribute to climate change and how the wolverine is affected by warming temperatures. Take action to help protect the wolverine.

Lesson 7: Schoolyard Biodiversity Study

Become an adventure scientist by examining the biodiversity of your schoolyard. Use a field journal to plan and prepare for your adventure, collect data in the field, and draw conclusions from your findings. NOTE: This lesson's activities can be completed after each corresponding lesson or as a whole project at the end of the unit.

ALIGNMENT WITH NATIONAL CONTENT STANDARDS

National Science Education Content Standards Addressed	A: Science as Inquiry	B: Physical Science	C: Life Science	D: Earth & Space Science	E: Science & Technology	F: Science in Personal & Social Perspectives	G: History & Nature of Science
Lesson 1: Meet the Team						X	X
Lesson 2: Discovering the Darhad			X	X	X	X	
Lesson 3: Explore the Ecosystem			X		X		
Lesson 4: Wildlife Ecologist	X		X				X
Lesson 5: Biodiversity	X		X				X
Lesson 6: Climate Change		X	X	X			
Lesson 7: Schoolyard Biodiversity Study	X		X			X	X

Common Core Math Domains Addressed	Counting and Cardinality	Operations and Algebraic Thinking	Number and Operations in Base Ten	Number and Operations – Fractions	Measurement and Data	Geometry	Ratio and Proportional Relations	The Number System	Expressions and Equations	Statistics and Probability	Functions
Lesson 1: Meet the Team	X	X	X	X	X						
Lesson 2: Discovering the Darhad			X		X	X					
Lesson 3: Explore the Ecosystem											
Lesson 4: Wildlife Ecologist	X		X		X	X					
Lesson 5: Biodiversity	X	X	X	X	X	X	X	X	X		X
Lesson 6: Climate Change					X				X	X	
Lesson 7: Schoolyard Biodiversity Study	X	X	X	X	X	X	X	X	X		X

National English Language Arts Education Content Standards Addressed	1: Read a wide range of print and non-print texts	4: Adjust their use of spoken, written, and visual language	5: Employ a wide range of strategies as they write and use different writing process elements appropriately	7: Conduct research on issues and interests	8: Use a variety of technological and information resources to gather and synthesize information and to create and communicate knowledge
Lesson 1: Meet the Team					
Lesson 2: Discovering the Darhad				X	
Lesson 3: Explore the Ecosystem	X			X	X
Lesson 4: Wildlife Ecologist		X		X	
Lesson 5: Biodiversity	X	X	X	X	X
Lesson 6: Climate Change	X				
Lesson 7: Schoolyard Biodiversity Study		X	X	X	

National Math Education Content Standards Addressed	1: Numbers & operations	2: Algebra	3: Geometry	4: Measurement	5: Data analysis & probability
Lesson 1: Meet the Team	X	X		X	
Lesson 2: Discovering the Darhad	X		X	X	
Lesson 3: Explore the Ecosystem					
Lesson 4: Wildlife Ecologist	X		X	X	
Lesson 5: Biodiversity	X	X	X	X	X
Lesson 6: Climate Change				X	X
Lesson 7: Schoolyard Biodiversity Study	X	X	X	X	X

National Social Studies Content Standards Addressed	1: Culture	2: Time, continuity, and change	3: People, places & environments	4: Individual Development & Identity	5: Individuals, groups, & institutions	6: Power, authority & governance	7: Production, distribution & consumption	8: Science, technology, & society	9: Global connections	10: Civic ideals & practices
Lesson 1: Meet the Team		X	X	X	X	X	X	X	X	
Lesson 2: Discovering the Darhad	X	X	X			X	X		X	
Lesson 3: Explore the Ecosystem			X						X	
Lesson 4: Wildlife Ecologist			X							
Lesson 5: Biodiversity			X						X	
Lesson 6: Climate Change	X	X	X		X	X	X		X	
Lesson 7: Schoolyard Biodiversity Study			X			X				

National Geography Content Standards Essential Elements Addressed	1: The World in Spatial Terms	2: Places and Regions	3: Physical Systems	4: Human Systems	5: Environment & Society	6: The Uses of Geography
Lesson 1: Meet the Team		X		X	X	
Lesson 2: Discovering the Darhad	X	X	X	X		
Lesson 3: Explore the Ecosystem			X			
Lesson 4: Wildlife Ecologist	X					
Lesson 5: Biodiversity			X			X
Lesson 6: Climate Change	X	X	X		X	X
Lesson 7: Schoolyard Biodiversity Study	X	X	X			

Common Core English Language Arts CCR Anchors Addressed	Reading	Writing	Speaking and Listening	Language
Lesson 1: Meet the Team			X	X
Lesson 2: Discovering the Darhad	X	X	X	X
Lesson 3: Explore the Ecosystem	X		X	X
Lesson 4: Wildlife Ecologist		X	X	X
Lesson 5: Biodiversity	X	X	X	X
Lesson 6: Climate Change	X		X	X
Lesson 7: Schoolyard Biodiversity Study		X	X	

Extending your learning with ASC

The Adventurers and Scientists for Conservation (ASC) organization works with educators to expand learning beyond the four walls of the classroom. Through ASC's outdoor programs, students interact directly with professional scientists and have the opportunity to collect data for ongoing scientific research projects. ASC offers students the skills to design and implement their own research projects while serving as mentors for younger students. ASC believes that experiences with Adventurers and Scientists for Conservation will provide the spark for future interest in the scientific field.

ASC offers learning opportunities both during the school year and over the summer. The organization works with educators to ensure that students have safe, fun, and rewarding experiences that complement standard curriculum and support STEM learning. ASC's student outings are generally between two and 10 days and can be designed for students of all levels, kindergarten through university.

Visit http://www.adventureandscience.org/schools-univerisites.html or contact ASC for more details.

Curriculum Developers

Angie Weikert has worked on several teacher resources projects including Montana State University's Everest Education Expedition (http://www.montana.edu/Everest) and MacGillivray Freeman Films' To the Arctic IMAX film. She has an M.S. in Science Education from Montana State University and has taught in both formal and informal settings for ten years.

Some content for this curriculum comes from the Climate In My Backyard (CLIMB) (http://eu.montana.edu/climb) curriculum series developed by the Montana Institute on Ecosystems, Montana NSF EPSCoR and MSU Extended University.

Montana NSF EPSCoR (the Experimental Program to Stimulate Competitive Research) (http://mtnepscor.org) is a federally funded program to promote the development of science and technology capacity in the United States. Funded by the National Science Foundation, Montana NSF EPSCoR supports capacity building by investing in researchers and institutions to better position them to compete for federal research funds. The project also works to broaden participation of Native American students in STEM disciplines through focused programs at the tribal colleges and recruitment of students into STEM majors. The theme of this award is climate change across multiple scales and temporal zones. The Montana University System Institute on Ecosystems (http://montanaioe.org) is the hub of research activities around this theme.

For other K-12 educational resources related to climate science, visit http://eu.montana.edu/CLIMB

LESSON 1: MEET THE TEAM

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Discover the mission of the Ring of Darhad Mongolia Wolverine Expedition and the planning that was required to make this journey a success. "Meet" the members of the team through short videos and start to uncover and appreciate how exciting adventures like this can support science.

LEARNING OBJECTIVES

Students will be able to:

1. Describe the team of adventurers on the Ring of Darhad Mongolia Wolverine Expedition and why each person was chosen for the adventure.
2. Discuss the steps in the preparation process for an expedition.
3. Determine what items are the most important for an outdoor research expedition.

DIRECTIONS:

1. Review what students know about expeditions.

a. Tell your students that over the next several weeks, they will be following an expedition to northern Mongolia to search for wolverines. This ongoing unit is an exciting way to be a part of an expedition that will attempt a circumnavigation of the Sayan Mountains in the Darhad (or Darkhad) region to conduct a systematic survey of the region's wildlife, with the specific goal of gathering DNA evidence of wolverines while sharing their experiences with students around the world. Explain to your students that before starting this study, they are going to explore what they already know about adventurers and expeditions.

b. Make a KWL chart with your students. Label the top of three different pieces of chart paper with the following titles: "What I Know About Expeditions," "What I Want To Know About Expeditions," and "What We Learned About Expeditions." (Using chart paper will allow you to refer back to this chart over the next few lessons.)

c. Have your students brainstorm as a class what they know (or 'think they know') and want to know about expeditions and adventures. Record all student responses on the first two correlating charts. Save them to refer back to throughout and at the end of the unit. At the end of the unit, complete the section "What We Learned About Expeditions."

2. Meet the adventurers

a. Tell your students that one of the adventurers they will follow is Gregg Treinish, whom they will "meet" by watching a video. This video is available at http://www.adventureandscience.org/mongolia-team.html You can read a transcript at the end of this lesson.

b. Ask your students to imagine that they are adventurer Gregg Treinish and are preparing for this expedition. Now that they know the expedition's mission (to collect scientific data and engage students around the globe through an exploration of the remote Darhad region of Mongolia), have your students brainstorm who they would need to bring with them. Have your students consider what skills their teammates would need to have. Tell your students that this trip is limited to four core team members. Allow your students to share their ideas and discuss their answers as a whole class.

c. After brainstorming possible teammates and their skills, share with your students the names of the other adventurers on the Ring of Darhad Mongolia Wolverine Expedition team. Each adventurer's biography and photograph can be found at http://www.adventureandscience.org/mongolia-team.html.

d. Watch a short video from each team member. These videos are available at http://www.adventureandscience.org/mongolia-team.html. You can read a transcript of each video at the end of this lesson. (NOTE: Two other individuals will be a part of the expedition, including a photographer and Mongolian scientist.)

Gregg Treinish – Executive director and founder of Adventurers and Scientists for Conservation, 2008 National Geographic Adventurer of the Year, Member National Geographic Adventure Advisory Council, Member National Geographic Expeditions Council Review Committee, *Christian Science Monitor* 30 under 30 list.

Forrest McCarthy – Forrest has guided, skied, and climbed in the Canadian Rockies and throughout Alaska. He possesses a strong background in search and rescue.

Jason Wilmot – Jason played a fundamental role in the Glacier National Park Wolverine Project and was lead field biologist for the Absaroka-Beartooth Wolverine Project in Yellowstone National Park.

Rebecca Watters – Rebecca has 13 years of experience working in Mongolia, and has directed the Mongolian Wildlife and Climate Change Project since 2009. She is the only person currently researching wolverines in Mongolia.

(Note: Two other individuals will be a part of the expedition, including a photographer and a Mongolian scientist.)

e. After these video introductions, record questions students may have for the team. Encourage scientific questions based on the team's mission. (Students can email questions to the adventurers. ASC will forward students' questions to the team, and, based on the team's availability, they will be answered and posted on the Ring of Darhad Mongolia Wolverine Expedition Web site (www.mongoliaexpedition.com). Send questions using the online form available at http://www.adventureandscience.org/mongolia-questions.html If you do not receive a reply, please check for an answer on the "Frequently Asked Questions" page http://www.adventureandscience.org/mongolia-faq.html)

3. Pack your bags

a. Tell your students that expeditions—like the Ring of Darhad Mongolia Wolverine Expedition—require extensive planning. Tell your students that if they were going on an expedition to a foreign country they would need to think about the trip and spend time planning their adventure long before they leave. Have students work together, or as a class, to complete the **Plan an Expedition worksheet** to learn what planning goes into an expedition. Discuss this worksheet and review your students' answers.

b. Tell your students that today they are going to be learning more about packing for an adventure like the Ring of Darhad Mongolia Wolverine Expedition.

c. Divide your students into small groups of four to six students (the size of the Ring of Darhad team). Provide each group with the **Pack Your Bags worksheet** that includes a student list of equipment (each item listed has a weight in ounces). Tell your students that each group will be working as a team and representing the Ring of Darhad team. Together, they need to decide what equipment on the Pack Your Bags worksheet they need to bring and what needs to be left behind. Each team member may only carry 640 ounces (40 lbs.) in his or her pack. Therefore, the items each team decides to bring in this activity must not weigh more than 640 ounces all together. Have students discuss and debate the importance of each item in their small groups. After all groups have completed the activity, discuss as a whole class what each group decided to bring.

d. Share with the whole class the **Ring of Darhad Equipment List.** After students review the official list, compare and contrast what the students chose to bring in the previous exercise to what the expedition will be bringing. *NOTE: This is not a comprehensive equipment list. Food, water and scientific equipment are not included.*

e. Watch a video of Gregg Treinish introducing some of the expedition's equipment. This video is available at http://www.adventureandscience.org/mongolia-team.html

Tips and modifications:

To adapt this lesson to a different age group, use the following modifications:

1.b. For older students, this can be a discussion or independent journaling activity.

3.a. Older students can complete this activity by working independently or in small groups. These students may use the internet to explore visas, permits, and other planning topics specific to Mongolia.

Assessment:

Review students' Plan an Expedition worksheets.

Review students' Pack Your Bags worksheets.

Extending the learning:

Complete Activity 1 of Lesson 7 of the unit. This activity has students plan a research "expedition" in their schoolyard.

Have your students imitate what it's like physically to be

on the Ring of Darhad team. Have students try to carry a pack that weighs one-quarter of their body weight. Have students imagine what this pack would feel like on skis in a cold climate.

Have students plan food for a one-night backpacking trip. Discuss how this would be different for a 30-day expedition like the Ring of Darhad.

Learn about other ASC projects with your students by visiting www.adventureandscience.org.

Learn about conservation projects and issues in your hometown.

Preparation:

Materials You Provide

- Chart paper/white board to record the KWL chart
- Pencils
- Scissors
- Glue/Tape

Audio and Video

- Meet Gregg Treinish (video)
- Meet Forrest McCarthy (video)
- Meet Jason Wilmot (video)
- Meet Rebecca Watters (video)
- Expedition Equipment (video)

Videos available at http://www.adventureandscience.org/

Handouts and Worksheets

- Plan An Expedition worksheet (one per student)
- Plan An Expedition answer key
- Pack Your Bags worksheets (2 pages) (one per small group)
- Ring of Darhad Equipment List

Required Technology

- Internet Access: Required
- Tech Setup: 1 computer per classroom, projector, speakers
- Plug-Ins: Flash

Other Notes

Lesson 7 of this unit, "Schoolyard Biodiversity Study," provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas, or as a distinct unit.

BACKGROUND AND VOCABULARY:

BACKGROUND INFORMATION

The Ring of Darhad: Wildlife Survey of the Darhad Region of Mongolia Project Summary

The Darhad region of Mongolia represents one of the world's most unknown regions when it comes to wildlife species. Although wolverines have been verified in the region, almost nothing is known about the status of the population. The Mongolian government has called for surveys of all of Mongolia's wildlife species, but currently lacks the ability to pursue research on elusive and difficult-to-study species such as wolverines. The Darhad Mongolia Wolverine Project will help assess locations for future, more in-depth studies of the species.

In March, 2013 a team led by Adventurers and Scientists for Conservation (ASC) will attempt a circumnavigation of the Darhad region via cross-country skis to conduct a systematic survey of the region's wildlife. The team's overarching goal is collection of wolverine DNA to contribute to the existing database of Mongolian wolverine genetic samples. The team will also locate sites for further, more in-depth study of the region's wolverine population, so that Mongolian scientists and wolverine biologists associated with the Wolverine Foundation (TWF) and the Mongolian Wildlife and Climate Change Project (MWCCP) can learn more about the species in Mongolia.

Wolverine researchers Rebecca Watters, Jason Wilmot and Jeff Copeland have conducted interview surveys, habitat assessments, and DNA sample collection from pelts during summer expeditions in wolverine habitat across Mongolia. Based on this data, scientists know that a population of wolverines exists in the Darhad region, but understanding the population dynamics, human threat levels, and the ecology of the species in this region will be critical as wolverines begin to feel the effects of climate change. To better understand how climate change affects wolverines, scientists need data on demographics - how wolverines are reproducing and dispersing. Understanding demographics requires much more intensive study, usually with radio collars, camera stations, and further genetic analysis. This expedition will help find places to put camera stations for further study. Ultimately, the scientists of the MWCCP hope that this expedition will contribute baseline information to the ongoing effort to create a monitoring and conservation plan for wolverines in Mongolia.

The research team anticipates covering a route of approximately 350 miles as they travel through what scientific modeling suggests is the most significant block of wolverine habitat in Mongolia. The route will

VOCABULARY

Term	Part of Speech	Definition
Adventurer	Noun	A person who goes on exciting trips that may involve danger.
Conservation	Noun	Preservation, protection, or restoration of the environment, ecosystems, or species.
Expedition	Noun	A journey by a group of people with a particular purpose like exploration or research.
Educational outreach	Noun	The act of sharing and connecting a community to an experience they would not normally be exposed to.
Passport	Noun	An official government document that certifies a person's identity and citizenship and permits a citizen to travel abroad.
Permit	Noun	An official document giving permission for something.
Ring of Darhad	Noun	A ring of mountains in the Sayan mountain range in northern Mongolia
Visa	Noun	Permission to enter, leave, or stay for a specified period of time in a country.

circumnavigate the Darhad valley and travel through the Sayan and Horidol Sardag mountain ranges. Their plan is to move for several days at a time and establish camps in areas where the team expects increased probabilities of detecting wolverine. The team will remain at these camps long enough to survey the surrounding areas in greater detail.

The Method

The research team's primary goal will be to document the presence of wolverines and wolverine prey species in the area. Using non-invasive survey techniques including back-tracking, and collection of hairs, scats, and urine for DNA analysis, the team will attempt to establish the distribution and relative densities of wolverines in the area. Surveying during the wolverine denning season also offers the opportunity to explore areas of high-density tracks and possibly discover den sites, which would constitute the first recorded wolverine dens in Mongolia. Locating den sites is important for detection of reproductive potential.

Anticipated Outcomes of the Research

Conducted within the mission of Adventurers and Scientists for Conservation, the team anticipates the expedition will increase the current knowledge of wildlife species in the Darhad region. The team anticipates the collection of wolverine DNA in an area of long-term interest to the global wolverine research community. The data from these surveys will complement the MWCCP's on-going and longer-term work on wolverines, pikas, and other climate- sensitive wildlife in the Darhad region. Data-analysis under the direction of the MWCCP will contribute to peer-reviewed work on Darhad wildlife in coming years. In addition, the researchers will work with various media sources to document and publish its experience with the goal of drawing public attention to sensitive high-altitude ecosystems in a context of global climate change effects on these systems worldwide.

RING OF DARHAD Equipment List*

Gear List	Quantity	Total Weight in oz.	Brand	Weight of Worn Items
Madshus cross country ski	1		Madshus	
Climbing skins 55m kicker	1	7.2	Black Diamond	
Ski poles				
Socks	4	8	Teko	2
Ski boots	1		Madshus	
Camp shoes	1	15	Oboz	
Crampons	1	18.9	Kahtoola	
Gaiters (high)*	1	12.2	Mountain Hardwear	
Long underwear tops/ bottoms	2	13.2	MH/ B	6.6
Zip T*	1	8	MH/ B	8
Ski pants*	1	19	Mountain Hardwear	19
Insulated pant layer	1	21	Mountain Hardwear	
Insulated top layer	1	22	Mountain Hardwear	
Shell layer top*	1	19	Mountain Hardwear	19
Glove liners*	1	1.4	Mountain Hardwear	
Gloves	1	9	Mountain Hardwear	
Hat (wool)	1	2.8	Mountain Hardwear	
Hat (baseball)*	1	2.5	Mountain Hardwear	2.5
Glacier glasses	1		Smith	
Sun screen	1	6		
Avalanche beacon*	1	6.4	BCA	6.4
Avalanche probe	1	9	BCA	
Shovel	1	16	Voile	
Four-season tent	1	40	Mountain Hardwear	
Zero-degree sleeping bag	1	42	Mountain Hardwear	
Sleeping pad	1	11	ThermaRest	
Head lamp	1	3	Petzl	
Journal/notebook	1	10.4	Rite in the Rain	
Book	1	12		
Satellite phone	1	10	Thurya	
Backpack	1	64	Osprey	
Ground cloth	1	8	Mountain Hardwear	
MSR XGK stove	1	13.2	MSR	
Fuel	1	38	MSR	
Cooking pot	1	7	GSI Outdoors	
Spork	1	2	GSI Outdoors	
Lighters	3	2		
Fire starter	2	5	Wet Fire	
GPS	1	5	Garmin	
Map	4	5		

NOTE: This is not a comprehensive equipment list. Food, water and scientific equipment are not included.

RING OF DARHAD Equipment List (continued)

Gear List	Quantity	Total Weight in oz.	Brand	Weight of Worn Items
Compass	1	2		
Water bottles	2	4	Nalgene	
Batteries		16		
Camp towel	1	3		
Toilet paper roll	1	4		
Trawl	1	6		
Camp soap	1	4	Dr. Bronner's	
Toothpaste	1	4		
Toothbrush	1	2		
Leatherman/knife	1	4.4	Leatherman	

Weight of items			
Total weight in ounces	**543.6 oz.**		
Weight of worn Items (*)			**63.5 oz.**
Total weight in oz. minus worn items (*)	**472.90 oz.**		
Total weight in pounds	**33.975 lbs.**		
Total weight in lbs minus worn items (*)	**29.55625 lbs.**		

Resupply items			
Pack raft	2		
Batteries			
Spare bindings			
Spare skins	2		
Dry bags for transport	6		
Food	200 lbs.		

VIDEO TRANSCRIPTS

Gregg Treinish

Video at http://www.adventureandscience.org/mongolia-team.html

Hi everyone. My name is Gregg Treinish. I'm the founder and Executive Director of Adventurers and Scientists for Conservation and I'm a National Geographic Explorer. I'm really excited that you've joined us for the Ring of Darhad Expedition. We are going to be preparing great materials for you and your classroom to follow along, or if you're not part of a classroom, that's ok too. We're really excited to have you following our progress as we move about 400 miles in what we're calling the Ring of Darhad. The Darhad Valley is a region in the far north of Mongolia. It's technically considered part of Siberia. And we're really excited to go out and explore this area and do some of the first ever wildlife surveys of the area. The Mongolian government is in need of information from this area. We're going to be working with scientists both in Mongolia and our team members, Rebecca and Jason as well as Forrest, who are all super interested in this information.

Our primary species of focus is the wolverine (*Gulo gulo*). I know that Rebecca and Jason's videos tell a ton about those species and you'll be learning more throughout the lessons that we've created for you as well. So, I hope you'll take the time not only to love the adventure of what we're doing but really learn about the science and how exciting this opportunity is to go to such a remote place and explore it.

For me personally, this is an incredible opportunity – to go over to Asia, to do something I love to do, which is be in the backcountry and then have an incredible purpose behind it – to be able to make a difference while we play. That's the whole reason I created Adventurers and Scientists for Conservation and it's the reason that I want to go out and help the conservation of this species – to provide Rebecca and other researchers with the information they'll need to be able to protect these places for years to come and these species.

I've been really fortunate in my ability to travel and explore the world. I was the first person to walk the length of the Andes Mountains from the Equator to the southern tip and received a National Geographic Adventurer of the Year award for that in 2008 when I finished. We walked for 8,000 miles on that journey covering 22 months of terrain really off-trail for quite a bit of it and it was an amazing expedition that taught me a lot and I'll bring a lot of the skills I learned there.

So I look forward to receiving your questions in the field. I really hope that you guys will not hesitate to write in.

While we won't get to every question, we're really excited to have you following along and really excited to make this an interactive experience for you and your class. So with that said, welcome and let's go have some fun!

Jason Wilmot

Video at http://www.adventureandscience.org/mongolia-team.html

My name is Jason Wilmot. I am the Executive Director of the Northern Rockies Conservation Cooperative in Jackson, Wyoming. And I'm a wolverine researcher and have been studying wolverines for about 12 years. I started my work in Glacier National Park, Montana and recently did another field project in Yellowstone National Park. Through these projects we've been trying to understand how wolverines make a living in these remote, rugged, landscapes and learn a lot more about the species, so that we can then in turn conserve them in the United States and around the world.

I am excited to be a part of the Ring of Darhad Expedition primarily due to the fact that wolverines do inhabit that area. We know this, but no formal scientific record has been compiled. I am excited to be a part of this terrific team that's assembled to go over there, cover some big ground, and try to detect wolverines to make a contribution to wolverine science around the world and to make a contribution to wildlife information needs in Mongolia.

There's a lot of things about wolverines, that no matter where you are, to me are compelling. They're an animal that's able to travel over incredible terrain and incredible distances. One thing to keep in mind is it takes a large area depending on the size of the mountain range for example. It may take half of a mountain range to support one individual male wolverine and it has to do with their ecological niche. This is a scavenger and their method for finding food involves using their nose and covering a lot of ground. So it takes a lot of ground and a lot of sniffing around to try to find scents of something that has died in an avalanche or due to natural causes, say for example in the Rockies a mountain goat in Glacier Park. They cover ground, they use their nose, and they can smell carcasses of animals like that under 8 – 10 feet of snow, no problem, and dig them out and feed on them and when they're full, they'll take off, and move again, and go up and over mountains with ease. This is a feature of wolverines that's always compelled me is their ability to inhabit those landscapes where other species can simply not make a living, particularly in the winter.

As I said before, I'm really excited about the team we have assembled for the Ring of Darhad and really excited to make a contribution to wolverine science and other wildlife that we see in Mongolia during this trip. Thanks for your interest in this trip. We certainly can answer any questions you have now or in the future so please don't hesitate to be in touch and any wolverine questions or questions about the expedition itself are always welcome. Thanks so much and we'll report back when we're done. Thanks. Bye.

Forrest McCarthy

Video at http://www.adventureandscience.org/mongolia-team.html

Hi, I'm Forrest McCarthy, geographer and adventure athlete. I've been very fortunate over the last 20 years to travel some of the wildest places left on Earth. One of the most memorable and meaningful jobs I ever had was working as a wolverine wildlife biologist near my home in the Greater Yellowstone Ecosystem.

Wolverines are one of the most fascinating creatures to me. I like to explore wild places that are really remote and often covered in snow and ice. These same wild places for wolverine are home.

These animals are biologically engineered to handle some of the most rugged and harshest terrain on Earth. They have big, thick, heavy fur that allows them to not hibernate and stay active all winter long. They have built in crampons which make them be able to climb steep snow and ice. So the opportunity to travel to the Alti Mountains in the Darhad region of Mongolia and research this illusive and fascinating animal is incredible and the only thing that makes it even better is the opportunity to share the experience with all of you.

Rebecca Watters

Video at http://www.adventureandscience.org/mongolia-team.html

Hi, my name is Rebecca Watters and I am a writer, an artist, and a scientist and I am the Director of the Mongolian Wildlife and Climate Change Project. We study a number of species that are likely to be climate sensitive but the flagship species and my personal favorite is the wolverine.

Wolverines are members of the weasel family and they remain poorly known because they are incredibly hard to study. They live in the most rugged environments on earth. They move over long distances and they are naturally rare.

Wolverines are tied to cold environments. They den in the snow and they require cool summer temperatures in order to survive. They reach the southern extent of their range in North America in the U.S. Rockies where they live at really high altitudes. And because they require deep spring snow to den, they are likely to lose habitat as the climate warms.

Because of the uncertainty about future snowpack, wolverines are considered threatened in the U.S. In Eurasia, wolverines reach the southern extent of their range in the mountains of Mongolia. No one had ever studied wolverines in Mongolia before I began this project in 2009.

I first went to Mongolia 13 years ago as a Peace Corps volunteer. I spent two years living ger or a yurt. I taught ecology to middle school students and teachers and I spent my summers working for the National Park system surveying for snow leopards.

I learned to speak Mongolian fluently and I came to really respect the country especially the Mongolia commitment to conservation and wildlife. I knew it was a place I wanted to continue working and I was most strongly drawn to their mountainous regions which are so similar in so many ways to the U.S. Rockies.

Our research project is committed to working closely with Mongolian scientists and communities so that we learn from Mongolians detailed knowledge of the environment. And, also to exchange skills so that we leave Mongolians with methods to monitor their own wildlife populations.

The work we've done in Mongolia so far consists mostly of interviewing people in all of Mongolia's mountain regions and doing basic surveys for tracks. Our surveys in Mongolia have always been in the summer or the fall and this expedition is our first opportunity to survey for wildlife while snow is on the ground. We'll be moving over the landscape in the same way that wolverine move over it – at high altitude, continuously, for a very long distance.

The survey will give us baseline knowledge about where wolverines are in the landscape, which will help my project establish sites for further camera and hair snare DNA monitoring. Mongolia is a rigorous place to work. There are not that many roads, there is not that much infrastructure, and there is very little money for wildlife research. So, the kinds of things we do in the U.S. where we have helicopters, and snowmobiles and radio collars won't work in Mongolia. We have to come up with a low-tech way to understand the wildlife population. Automatic cameras and DNA analysis from hair snares should help provide a way to do this and the track surveys that we are doing in this expedition will help us figure out where to place those cameras and hair snares. Hopefully this will help us gain an understanding of how we can conserve this species both here and in North America at the southern end of its range in both hemispheres.

Your Name _____

PLAN AN EXPEDITION

If you were to go on an expedition, or an adventure with a mission or purpose, what would you need to do to plan and prepare for your trip?

Number the tasks below to show in what order you would plan and get ready for an expedition.

_____ TRAIN FOR YOUR EXPEDITION. Practice with your equipment and get physically fit.

_____ DECIDE ON A MISSION FOR THE EXPEDITION. Carefully describe what you want to do.

_____ GET THE MEDIA INVOLVED. Determine the type of outreach you want to do or how you want to share what you learn on your expedition. Contact the media that will help you teach others.

_____ GET PERMISSION. Apply for visas and permits you will need.

_____ RESEARCH THE AREA. Learn about the people of the area and the terrain you will be travelling in, along with where water and food sources can be found.

_____ PICK YOUR TEAM. Invite other people with the skills you need to join you.

_____ MAKE AN EQUIPMENT LIST. Identify the equipment you will need to survive in the area you'll be adventuring in.

_____ PLAN YOUR ROUTE. Decide where to go, how to get there, and where to stay.

_____ DECIDE ON THE DATES OF YOUR EXPEDITION. Determine when you will be adventuring.

Answer the following question.

Can some of these tasks be done in a different order or at the same time? Why?

ANSWER KEY

PLAN AN EXPEDITION

If you were to go on an expedition, or an adventure with a mission or purpose, what would you need to do to plan and prepare for your trip?

Number the tasks below to show in what order you would plan and get ready for an expedition.

9 _____ TRAIN FOR YOUR EXPEDITION. Practice with your equipment and get physically fit.

1 _____ DECIDE ON A MISSION FOR THE EXPEDITION. Carefully describe what you want to do.

8 _____ GET THE MEDIA INVOLVED. Determine the type of outreach you want to do or how you want to share what you learn on your expedition. Contact the media that will help you teach others.

6 _____ GET PERMISSION. Apply for visas and permits you will need.

3 _____ RESEARCH THE AREA. Learn about the people of the area and the terrain you will be travelling in, along with where water and food sources can be found.

4 _____ PICK YOUR TEAM. Invite other people with the skills you need to join you.

7 _____ MAKE AN EQUIPMENT LIST. Identify the equipment you will need to survive in the area you'll be adventuring in.

2 _____ PLAN YOUR ROUTE. Decide where to go, how to get there, and where to stay.

5 _____ DECIDE ON THE DATES OF YOUR EXPEDITION. Determine when you will be adventuring.

Answer the following question.

Can some of these tasks be done in a different order or at the same time? Why?

Your Name:_____

PACK YOUR BAGS

Imagine you are going on a winter expedition and must carry everything you need for one month in a backpack while you ski. (Your skis and poles are not included in this list.)

Directions:

Cut out the possible items to bring from the Pack Your Bags Equipment List.

Glue the items you would bring onto the backpack below. The items you include cannot weigh more than 640 ounces (40 pounds) all together.

Answer the following questions.

What item was the hardest to leave behind? Why?

What items would you need to arrange to pick up at the resupply points?

PACK YOUR BAGS EQUIPMENT LIST

Cut out the following items. Glue the items you would bring on a one-month winter expedition onto the backpack on the Pack Your Bags worksheet. The items you choose cannot weigh more than 640 ounces (40 pounds) all together.

AM/FM radio (20 oz.)	**Avalanche beacon and shovel** (30 oz.)	**Book** (10 oz.)
Camera (10 oz.)	**Camp chair** (100 oz.)	**Camp soap and camp towel** (10 oz.)
Canned meals (200 oz.)	**Cot** (60 oz.)	**Field journal and pencil** (10 oz.)
First aid kit (15 oz.)	**Flashlight and extra batteries** (15 oz.)	**Freeze dried meals** (60 oz.)
GPS, map and compass (15 oz.)	**Handheld video game** (10 oz.)	**Hiking shoes** (15 oz.)
iPad (20 oz.)	**Jacket and snow pants** (40 oz.)	**Jeans** (20 oz.)
Knife (5 oz.)	**Lightweight layers of clothes** (60 oz.)	**Magazines** (10 oz.)
Matches (5 oz.)	**Mittens/gloves and hat** (15 oz.)	**Nuts and energy bars** (40 oz.)
Pillow (40 oz.)	**Portable TV** (45 oz.)	**Potato chips and yogurt** (40 oz.)
Satellite phone (10 oz.)	**Shampoo** (5 oz.)	**Ski boots** (10 oz.)
Sleeping bag (40 oz.)	**Sleeping pad** (10 oz.)	**Slippers** (15 oz.)
Socks (10 oz.)	**Stove, fuel, and cooking gear** (60 oz.)	**Sunscreen and sunglasses** (5 oz.)
Sweatshirt (25 oz.)	**Teddy bear** (20 oz.)	**Tent** (40 oz.)
Toilet paper and trowel (10 oz.)	**Toothpaste and toothbrush** (5 oz.)	**Water bottles full of water** (70 oz.)

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LESSON 2: DISCOVER THE DARHAD

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Explore northern Mongolia and the Darhad region including its location, topography, and people. Trace the expedition's route on a map, learn about resupply points and compare American culture with Mongolian culture through research.

LEARNING OBJECTIVES

Students will be able to:

1. Locate and identify the Darhad region of Mongolia.
2. Trace the route of the Ring of Darhad expedition.
3. Describe the Darhad region including its topographical features and terrain after exploring the area with pictures.
4. Compare and contrast Mongolia with the United States both physically and culturally.

DIRECTIONS:

1. Locate the Ring of Darhad.

a. Ask your students to identify the continent where Mongolia is located (Asia) and locate Asia on a map of the world in your classroom or on the **Student World Map.** (Optional: Have students label the continents on the Student World Map.)

b. After identifying Asia, show your students a map of Asia in your classroom and hand out the **Student Asia Map**. Help your students identify the countries surrounding Mongolia. Have your students mark the location of the Darhad region and label Mongolia, Russia and China on this Student Asia Map. (Optional: Have students label the countries of Asia on the Student Asia Map.)

c. Have your students look at the **Student Mongolia Map**. Locate the Darhad region of Hovsgol Province in northern Mongolia.

d. Distribute the **Darhad Region Map**. Show the class the Ring of Darhad (the ring of mountains surrounding the Darhad Valley that the expedition will be following) using the route on the **Teacher Darhad Region Map.**

e. Mark both the Ring of Darhad and your hometown on the student World Map.

f. Using the latitude and longitude from the Mongolia Map, have students estimate the latitude and longitude of the center of the Darhad Valley. Have your students study latitude to discover if the Ring of Darhad is closer or further away from the Equator than your hometown.

g. Look at the Darhad Region Map again. Tell your students that the mountains that make up the Ring of Darhad range in elevation from 5,000 to 10,000 feet. Explain that elevation measures the height of a point on the Earth's surface by how tall it is compared to sea level. Help your students understand this height by sharing the elevation of your hometown and the highest peak in your state or region.

2. Find the route and resupply points.

a. Lead your students as they individually plot the Ring of Darhad expedition route on the Darhad Region Map using a colored pencil. Use the Teacher Darhad Region Map to help you guide your students in tracing the route. The expedition will be traveling counter-clockwise around the Ring of Darhad.

b. As your students are drawing the route, discuss as a class why this route was chosen. Tell your students that wolverines live in rugged, mountainous terrain. The expedition will be following the habitat where wolverines are most likely to be found. Use the background information and videos from Lesson 1 to learn more about the expedition.

c. Tell your students that they will follow the Ring of Darhad team along this route. Provide each student with one sticky note cut into the shape of an arrow. Place the arrow at the starting location.

d. Tell your students that on long expeditions, adventurers cannot carry all the food they need at

once. Therefore, they have to have supporters of their mission meet them at designated locations on a specific day with more food. This is called a resupply. Tell your students that it is most effective to designate coordinates for resupply points. However, in this region, the supporting individuals are Mongolians that do not have access to technology including GPS units and satellite phones required for finding the team using coordinates. Instead, the team and resuppliers must find each other using geographical land features. Ask your students to look at the route they just drew. Tell the group that the Ring of Darhad expedition will need three resupplies.

e. In small groups, have your students identify where they would coordinate resupplies and how they would describe this to those helping the mission.

f. Share with your students the actual resupply points that will be used by the team and the descriptions given to those meeting them. Have students mark these points on their maps. (Resupply points are noted on the Teacher Darhad Region Map and descriptions and explanations of how the points were chosen can be found in the Background Information.)

NOTE: During this ongoing Ring of Darhad unit, help your students mark where the adventurers are by moving the arrow as the team moves around the region. Check the team's location by visiting www.mongoliaexpedition.com. If this unit is not completed during the actual time the expedition occurs (Spring 2013), you may still "follow" the expedition by using the team's blogs.

3. Travel to the Ring of Darhad through a virtual tour.

Allow students to explore the Darhad region independently, in partners or small groups, or as a class using one of the following methods:

GoogleEarth:

- Download the GoogleEarth Ring of Darhad Route (kmz file) from www.mongoliaexpedition.com.
- Instruct students to zoom in to this area in northern Mongolia using what they learned from the mapping activity.
- Once they have found the Darhad Valley, allow students to explore the topography using GoogleEarth's features and view photographs of the region that were uploaded by other users. Resupply points are marked on this file with descriptions of each point.

Pictures/Video:

- Show your students pictures of the region. (Small images are printed with this lesson; larger images are available at www.mongoliaexpedition.com or search for Mongolia at http://alpenimage.com/alpen-galleries/)
- Video images of the region are also in Rebecca Watters' introduction video in Lesson 1.

4. Compare the United States of America to Mongolia.

a. Tell your students that Mongolia's natural environment shares many similarities to the northern Rocky Mountains of the United States.

b. Using the **Discovering the Darhad** worksheet, have your students compare and contrast the Darhad region to your hometown. This can be completed:

- As a class by having students guess the answers and after correction, record the answers you found before the activity, or
- Individually by having students complete their own research on the region.

NOTE: Mongolia divides provinces into smaller districts known as "sums." These are similar to the USA's counties.

Tips and Modifications:

To adapt this lesson to a different age group, use the following modifications:

4.b. Older students can research this information independently or in pairs.

Assessment:

Review student maps for completion and accuracy of required labels.

Review the Discovering the Darhad worksheet for accuracy and completion.

Extending the Learning:

Complete Activity 2 of Lesson 7 of the unit. This activity has students describe a research "expedition" in their schoolyard.

This unit will use feet and miles for measurements. Have students convert measurements throughout the unit to meters and kilometers.

Compare and contrast how this expedition receives its resupplies compared to other expeditions.

Research the mining industry of Mongolia, including ninja miners, and its effects on the environment

(including the wolverine) and the economy.

Study the current events of the region including Mongolia's relationships with China and Russia.

The expedition's resupplies will include the use of reindeer. Research domestic reindeer and how people who live in the region use them.

Learn about the Mongolian Wildlife and Climate Change Project (MWCCP).

PREPARATION:

MATERIALS YOU PROVIDE

- Pencils/colored pencils
- Sticky notes

RESOURCES PROVIDED

Images

- Darhad Region photos (7)

Handouts and Worksheets

- World Map (Student and Teacher versions)
- Asia Map (Student and Teacher versions)
- Mongolia Map (Student and Teacher versions)
- Darhad Region Map (Student and Teacher versions)
- Discovering the Darhad Worksheet

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, projector, speakers and 1 computer per small group
- Plug-Ins: Flash
- GoogleEarth

Other Notes

Complete the Discovering the Darhad worksheet before the activity to help your students compare your hometown to the Darhad region.

Lesson 7 of this unit, Schoolyard Biodiversity Study, provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

BACKGROUND AND VOCABULARY:

BACKGROUND INFORMATION

To learn more about Mongolia, visit National Geographic's Mongolia page at http://travel.nationalgeographic.com/travel/countries/mongolia-guide/

About the Mongolian Wildlife and Climate Change Project: MWCCP was initiated in 2009 to implement the first study of Mongolian wolverines and other climate-sensitive wildlife. Working in affiliation with the Wolverine Foundation and the Montana State University Bioregions Program, the MWCCP conducts research on poorly known alpine species, works with Mongolian communities to enhance mutual learning about wildlife and conservation, and builds ties between Mongolian and American students and scientists investigating similar species in similar ecosystems in Mongolia and the Yellowstone region. Recognizing that climate change and cross-cultural understanding provide two of the biggest challenges to conservation in the coming century, the MWCCP seeks to build models for effective research, monitoring, and culturally resonant management. You can learn more about wolverines at wolverinefoundation.org , and more about Bioregions Mongolia program at http://www.montana.edu/bioregions/ To follow on-going wolverine research in Mongolia and the US Rockies, visit the Wolverine Blog at egulo.wordpress.com

About reindeer: The communities in the Darhad are primarily Mongol-speaking herders of sheep, goats, horses, yaks, camels, and cattle; the Tuvan-speaking reindeer folks are a very small minority. Reference Vitebsky, P. 2006 . The Reindeer People: Living with Animals and Spirits in Siberia. Mariner Books. An author interview and book excerpt that references Mongolia are available at: http://www.npr.org/templates/story/story.php?storyId=5199713

About the expedition: The Ring of Darhad Mongolia Wolverine Expedition will complete a route of approximately 350 miles. The expedition will travel through what scientific modeling suggests is the most significant block of wolverine habitat in Mongolia. The route will circumnavigate the Darhad Valley and travel through the Sayan and Horidol Sardag mountain ranges. The expedition plans to move for several days at a time and establish camps in areas where these scientists expect increased probabilities of detecting wolverines. The expedition will remain at these camps long enough to survey the surrounding areas in greater detail.

RESUPPLY #1

Resupply point #1 was chosen because of the easy access and location above the tiny town of Renchinlkhumbe. The reindeer herders will simply have

VOCABULARY

Term	Part of Speech	Definition
Coordinates	Noun	The latitude and longitude that define the position of a point on the Earth.
Elevation	Noun	The measurement of a point's height above the level of the sea.
Equator	Noun	An imaginary line around the Earth half way between the north and south poles.
Latitude	Noun	Distance, measured in degrees, north or south from the Equator.
Longitude	Noun	Distance, measured in degrees, east or west from the Prime Meridian .
Prime Meridian	Noun	An imaginary line around the Earth that runs directly through the north and south poles and Greenwich, England.
Resupply	Noun/Verb	The point or act of being provided with new supplies including food and fuel during an expedition or trip.
Route	Noun	A road, course, or way for travel from one place to another.

to follow the main river out of town and will intersect the expedition's route about 20 miles and a thousand feet in elevation above the town.

RESUPPLY #2

Resupply point #2 will be one of the most difficult for the reindeer herders to find. This is in a very remote location and the expedition will need several contingencies to be sure they meet their resupply. The expedition has chosen this valley because this is where the main river flows. The expedition will tell their resuppliers to go upstream from where the river turns to the east. The expedition will likely descend as well, hoping to meet the resuppliers somewhere between the elevation of their route and the river valley.

RESUPPLY #3

Resupply point #3 was chosen for several reasons. First, the expedition anticipates that they will need small rafts called "packrafts" to ferry themselves across the river. To avoid carrying the extra weight of these rafts, the expedition will have them arrive in the resupply. Also, there is a cabin here that is owned by Boojum Expeditions in Bozeman, Montana. The group has helped the expedition organize logistics in the region and the permanent structure will allow the team to have a defined meeting point.

Prior Knowledge

Basic information about the Ring of Darhad Mongolia Wolverine Expedition and team members

Recommended Prior Activities

Lesson 1 of Ring of Darhad unit: Meet the Team

Images of Mongolia

ALL PHOTOS COURTESY OF GORDON WILTSIE. SEE ORIGINAL IMAGES AT
HTTP://ALPENIMAGE.COM/ALPEN-GALLERIES/

Darhad Valley herder moves around her sheep, yaks and cattle below the Horidol Saridag Mountains.

Horidol Saridag Mts. Riders atop Utreg Pass during annual migration from Darhad Valley to Lake Hovsgol.

West shore of Lake Hovsgol, with a nomadic family's winter camp below the slopes of Horidol Saridag Mountains.

Darhad Valley. Fall-colored larch forest in front of Horidal Saridag Mountains.

Horidol Saridag Mountains.

Darhad Valley. A herder tends his flocks next to Dood Nuur lake.

Darhad Valley. Yaks cross river below Horidol Saridog Mts.

Name:_____

DISCOVERING THE DARHAD

Compare and contrast your hometown to the Darhad region of northern Mongolia by completing the following table using information about your hometown.

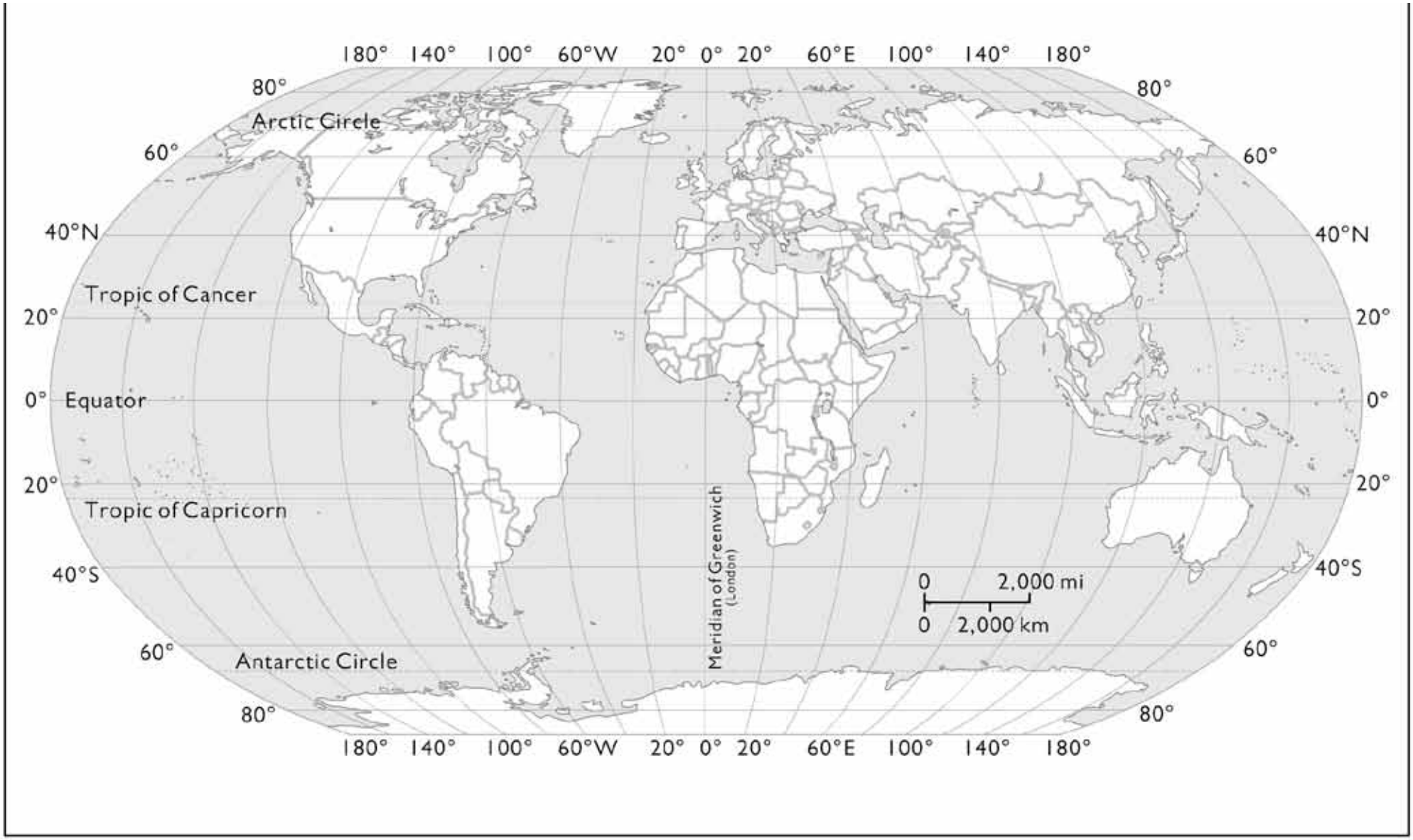
	Darhad Region, Hovsgol (Khövsgöl) Province, Mongolia	**Your Hometown: Your State: U.S.A.**
County (USA) or District/Sum (Mongolia)	Renchinlkhümbe	
Latitude	51° to 52°N	
Longitude	98° to 100°E	
Elevation	5,000 – 10,000 feet	
Topography	Part of largest mountain range in Mongolia	
Bordering countries	Russia, China	
Climate zone	Northern Hemisphere temperate zone	
Average April low temperature	11.8 F (−11.2 C)	
Average April high temperature	38.1 F (3.4 C)	
Common animal species	Elk, brown bear, wolverine, ermine, sable, moose, Siberian weasel, Siberian ibex, musk deer, roe deer, wild reindeer, wolves, red fox, Siberian mole, and red squirrel	
County/Sum population size	4,284	
Official language	Mongolian	
Time zone	UTC +7 to +8	
Currency	Togrog/Tugrik	
Traditional house	Ger (or yurt)	
Economic industry	Herding, agriculture, and mining	
Most common sports	Horse racing, archery, and Mongolian wrestling	
Years of school for children	11	
Life expectancy	65 years	

Sources:
http://travel.nationalgeographic.com/travel/countries/mongolia-guide/
http://www.discovermongolia.mn/
http://en.wikipedia.org/wiki/Mongolia
http://en.wikipedia.org/wiki/Renchinlkh%C3%BCmbe,_Kh%C3%B6vsg%C3%B6l
http://www.e-mongol.com/mongolia-environnement.htm
http://worldwildlife.org/ecoregions/pa0519

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

WORLD MAP

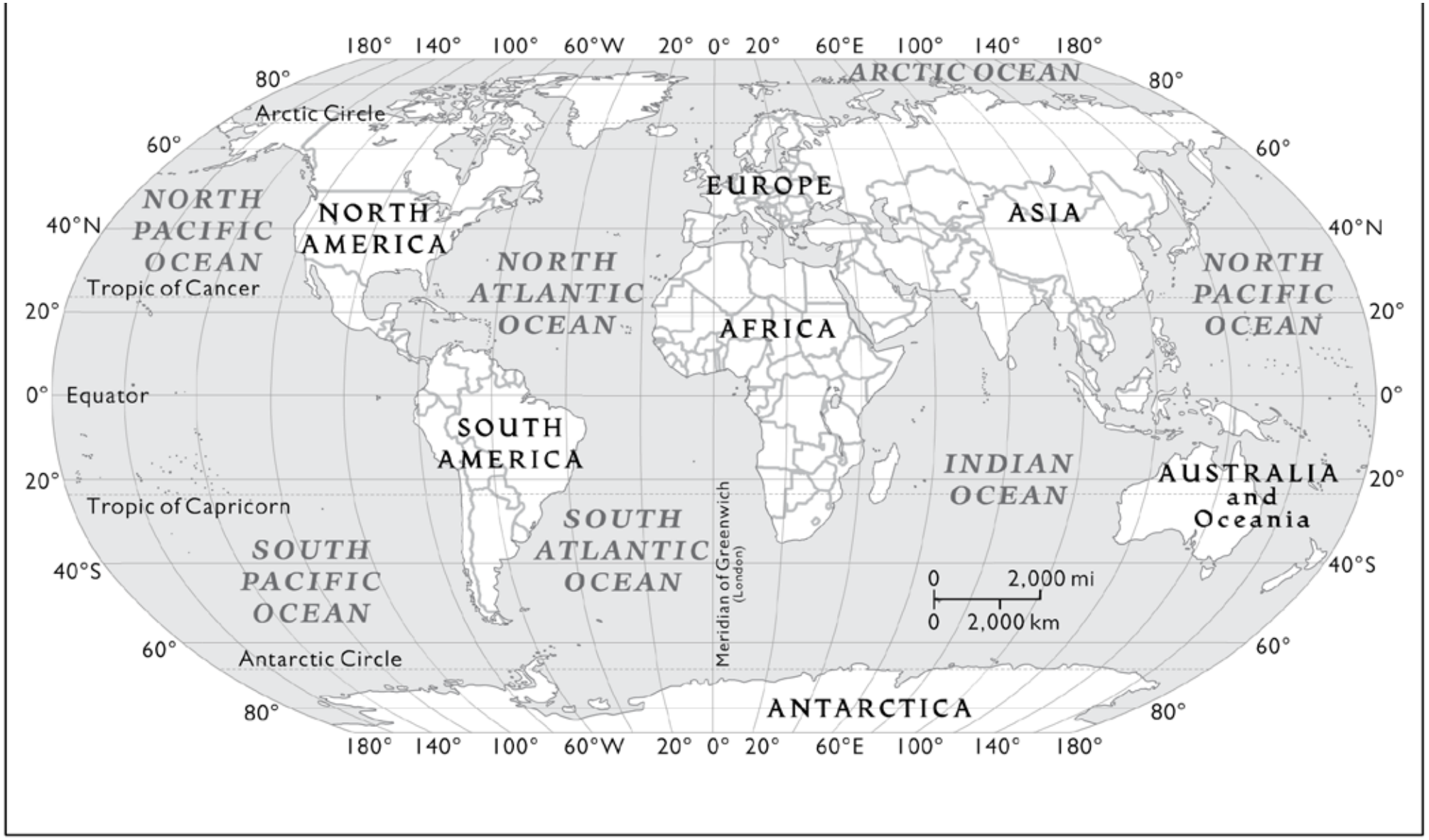
Name:_____



THE WORLD

NATIONAL GEOGRAPHIC education

TEACHER WORLD MAP

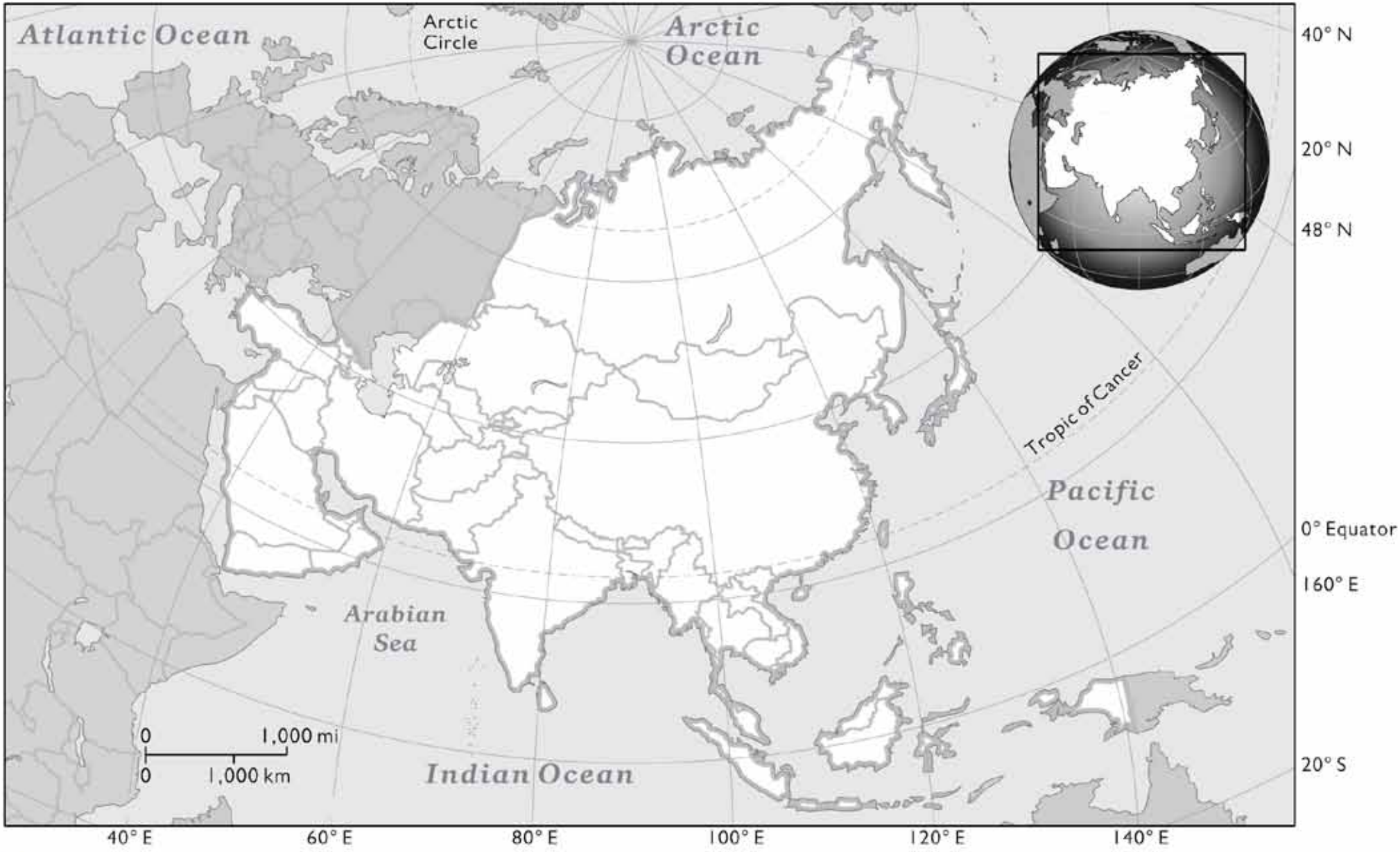


THE WORLD

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

ASIA MAP

Name:_____



ASIA

NATIONAL GEOGRAPHIC education

TEACHER ASIA MAP

ASIA

NATIONAL GEOGRAPHIC education

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

MONGOLIA MAP

Name:_____

MONGOLIA

NATIONAL GEOGRAPHIC education

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

TEACHER MONGOLIA MAP

Name:_____

MONGOLIA

NATIONAL GEOGRAPHIC education

Name:_____

RING OF DARHAD MAP

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

TEACHER RING OF DARHAD MAP

Resupply 1: This Resupply Point was chosen because of the easy access and location above the tiny town of Renchinlkhümbe. The reindeer herders will simply have to follow the main river out of town and will intersect our route about 20 miles and a thousand feet above the town.

Resupply 2: This will be one of the most difficult for the reindeer herders to find. This is in a very remote location and we will need several contingencies to be sure we meet our resupply. We have chosen this valley because this is where the main river flows. It will be possible to show this river to the coordinators with whom we are working in the Darhad Valley and they will follow the river upstream until they find us. We will likely descend as well, hoping to meet somewhere in the middle. Our directions will be to go upstream from where the river turns to the east.

Resupply 3. This Resupply Point was chosen for several reasons. First, we are anticipating that we will need small rafts called “packrafts” to ferry ourselves across the river. To avoid carrying the extra weight of these rafts, we will have them arrive in the resupply. Also, there is a cabin here that is owned by Boojum Expeditions in Bozeman, MT. The group has helped us organize logistics in the region and the permanent structure will allow us to have a defined meeting place.

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LESSON 3: EXPLORE THE ECOSYSTEM OF NORTHERN MONGOLIA

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Learn more about the Darhad region ecosystem and how its species are interconnected through games and diagrams. Explore how the wolverine's survival depends on the health of the entire Darhad ecosystem through research.

LEARNING OBJECTIVES

Students will be able to:

1. Diagram the Darhad region's ecosystem using a pyramid model.
2. Compare and contrast ecosystem structure with other organizational structures.
3. Describe important characteristics and behaviors of wolverines.
4. Explain the relationships wolverines have with other species of the Darhad region's ecosystem.
5. Assess the importance of the wolverine in the Darhad region's ecosystem.

DIRECTIONS:

1. Introduce the Darhad Region ecosystem.

a. Tell your class that the Darhad region is an ecosystem similar to the northern Rocky Mountains. The Darhad Region is filled with over 800 different types of plant species and hundreds of animal species. The wolverine is dependent upon the health of the entire ecosystem for its survival.

b. Show your class pictures of the Darhad region. Briefly compare and contrast this ecosystem to your hometown. Have students hypothesize the types of plants and animals they would expect to find in the Darhad region.

2. Diagram an ecosystem's organizational structure.

a. Tell your students that scientists have developed different methods to show how an ecosystem is organized and how different species within an ecosystem are related. Have your students use the following method to model an ecosystem. This can be done individually or as a class depending on students' familiarity with the concept.

b. Using the **Ecosystem Pyramid worksheet**, have your students complete a diagram of the levels of organization within an ecosystem using the Darhad region ecosystem as an example.
   - Review the vocabulary terms: organism, population, community, ecosystem, biome, biosphere.
   - Have students label each level of the Ecosystem Pyramid with the appropriate term based on the example provided.
   - Review student answers for understanding.

c. Have students demonstrate their understanding of ecosystem structure by applying this pyramid model to a restaurant. Have students think of all the elements of a restaurant and complete the **Restaurant Ecosystem Pyramid worksheet**.

d. Have students compare and contrast the Darhad region ecosystem and restaurant diagrams through small group discussion.

e. Ask your students the following questions and have them record their answers on their worksheet: How are ecosystems organized the same as other things? How is the organization different?

3. Review the elements of the Darhad region ecosystem by playing a card game.

a. Tell your class that they are going to explore the different levels of the Darhad region ecosystem by playing a card game.

b. Divide your class into pairs. Pre-cut and mix-up the **Ecosystem Cards** provided. (Two levels of difficulty are provided based on your students' previous knowledge of ecosystems.) Provide each pair with four to eight copies of the cards (24-48 cards total per pair).

c. Show your students each of the six cards and explain that they will be playing a card game similar to "War."
   - Each player will start with an equal number of cards.
   - The object of the game is to have all the cards in your possession.
   - Each player shuffles their cards and holds them in a stack face down.
   - Both players flip over their top card and place it face up on the playing surface.
   - The "higher" card (most general and incorporates the most organisms) wins.
   - The player that put down the "higher" card picks their card back up and the losing card and places them at the bottom of their stack of cards.
   - If players put down the same card, they will "go to war." Each player will then set down a second card face down. They will both place a third card face up. The "higher" third card wins all the cards laid down on the playing surface.

4. Research a species of interest: Wolverine

a. Tell your students that before a research team travels to the field to study one species of an ecosystem, they first research everything that is already known about that habitat and species. Explain to your students that they are going to learn more about the wolverine by researching what is known about this animal.

b. Have students use the internet (including information from National Geographic and the Wolverine Foundation) or other resources to research and describe the wolverine using the **Species of Interest: Wolverine worksheet.**

c. After completing this brief research project, as a whole class, have students identify the importance of the wolverine and its connected species in this ecosystem by answering the following questions in a group discussion.
   - What role does the wolverine play in the Darhad region's ecosystem?
   - From what you read while researching, what other animal and plant species does the wolverine depend upon for its survival?
   - Why is the wolverine important?

Tips and Modifications:

To adapt this lesson to a different age group, use the following modifications:

2.c. For older students, you can provide a blank pyramid, which can be completed using any other system including the human body or their school.

4.b. Older students can write a brief report on the wolverine instead of filling in the provided worksheet.

Assessment:

Review students' ecosystem diagrams and restaurant comparison for completion and accuracy.

Review students' wolverine research for completion and accuracy.

Have students write their answers to the discussion activity in 4.c. and review for completion and accuracy.

Extending the Learning:

Complete Activity 3 of Lesson 7 of the unit. This activity has students diagram the ecosystem in their schoolyard.

Complete Lesson 5 of the unit in which students learn more about the other species in this ecosystem.

Study more about trophic levels and energy movement throughout an ecosystem.

Do a food web activity where each student is a species. Have students stand in a circle. Give a ball of yarn to one student. Have the student hold on to one end and pass the yarn to another student who is directly connected to his or her species. Continue until all species are connected, creating a web. Discuss how all species in an ecosystem are connected.

Using the models presented in this lesson, study trophic levels by labeling the trophic level of each part of the pyramid (producers, consumers, etc.) and introduce what percentages of energy are transferred from each level to the next. (Consumers at each level generally only convert about 10% to biomass.)

PREPARATION:

MATERIALS YOU PROVIDE

Pencils

RESOURCES PROVIDED

Audio and Video

None

Images

Darhad Region photos (see Lesson 2)

Handouts and Worksheets

- Darhad Ecosystem Pyramid Worksheet (one per student)
- Restaurant "Ecosystem" Pyramid Worksheet (one per student)
- Darhad Ecosystem Playing Cards (2-4 copies per pair of students)
- Species of Interest: Wolverine worksheet (one per student)

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: Several computers for student research

Other Notes

Lesson 7 of this unit, "Schoolyard Biodiversity Study," provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

BACKGROUND AND VOCABULARY:

Background Information

An ecosystem includes all of the living and non-living components of a geographic area. All biotic (living) and abiotic (non-living) components of an ecosystem impact every other factor either directly or indirectly. Changing climate will affect the plants that are able to survive in a specific ecosystem, which will in turn affect the animals that depend on these plants as a food source or for shelter. Ecosystems can range in size from a tiny hot spring in Yellowstone National Park to the entire rainforest. Smaller ecosystems combine to form the world's biomes. Biomes are large and can be identified by the general type of biotic and abiotic factors they include. Within each biome are several smaller and varied ecosystems.

Learn more about ecosystems from National Geographic:

http://education.nationalgeographic.com/education/encyclopedia/ecosystem/?ar_a=1

As human populations grow and expand, we continue to impact the world's ecosystems – sometimes in destructive ways. Scientists from around the world

VOCABULARY

Term	Part of Speech	Definition
Abiotic	Adjective	Non-living (including water, soil, and temperature).
Biome	Noun	A large geographic area with similar ecosystems and climate.
Biosphere	Noun	All ecosystems on the Earth.
Biotic	Adjective	Living (including plants and animals).
Carnivore	Noun	A meat-eating organism
Community (ecological)	Noun	Two or more different species of organisms that interact in the same geographic area.
Ecosystem	Noun	All of the living and non-living components of a geographic area that interact.
Herbivore	Noun	An organism that feeds on plants.
Omnivore	Noun	An organism that feeds on both plants and animals.
Organism	Noun	An individual plant, animal, or other form of life.
Population	Noun	Many organisms of the same species in one geographic area.
Predator	Noun	An animal who hunts its food.
Prey	Noun	An animal who is hunted by other animals for food.
Scavenger	Noun	An animal that feeds on carcasses abandoned by other predators.
Trophic level	Noun	A position in a food chain or ecological pyramid model filled by organisms with similar feeding roles.

study individual ecosystems in order to learn how these systems work and how human actions affect nature. Montana State University and The University of Montana are working together to enhance environmental and ecosystem science research, education, and engagement across the state and beyond via the Montana University System (MUS) Institute on Ecosystems.

Learn more about ecosystem research from the Institute on Ecosystems: http://montanaioe.org/

Wolverines are the largest member of the weasel family although they more closely resemble a small bear rather than other members of the weasel family. Wolverines are scavengers and can smell carcasses of animals and dig these remains up from under 8 – 10 feet of snow . These animals are poorly known because they are incredibly hard to study. Wolverines live in the most rugged environments on earth. They move over long distances and they are naturally rare. Wolverines are tied to cold environments. They den in the snow and they require cool summer temperatures in order to survive. Wolverines require deep spring snow to den, they are likely to lose habitat as the climate warms.

Learn more about the wolverine from

- National Geographic: http://animals.nationalgeographic.com/animals/mammals/wolverine/
- The Wolverine Foundation http://wolverinefoundation.org
- The Wolverine Blog http://egulo.wordpress.com
- The PBS Nature film “Wolverine: Chasing the Phantom” http://video.pbs.org/video/1642358743/

Prior Knowledge

Ecosystems

Recommended Prior Activities

Lesson 1 of the Ring of Darhad unit: Meet the Team

Lesson 2 of the Ring of Darhad unit: Discover the Darhad

Name:_____

SPECIES OF INTEREST RESEARCH: WOLVERINE

Before a research team travels to the field to study one organism of an ecosystem, they first research everything that is already known about that habitat and species. Help the members of the ASC team by researching the wolverine for the Ring of Darhad Mongolia Wolverine Expedition.

Common name:

Scientific name:

Family:

Type of habitat:

Range:

Physical characteristics:

Looks like what other animal:

Length:

Weight:

Color:

Circle the term(s) that best describe this species:

Carnivore	Omnivore	Herbivore
Predator	Prey	Scavenger

Diet:

Draw a picture of the species:

ANSWER KEY

SPECIES OF INTEREST RESEARCH: WOLVERINE

Before a research team travels to the field to study one organism of an ecosystem, they first research everything that is already known about that habitat and species. Help the members of the ASC team by researching the wolverine for the Ring of Darhad Mongolia Wolverine Expedition.

Common name: Wolverine

Scientific name: *Gulo gulo*

Family: Weasel (largest member)

Type of habitat: boreal forests, taiga, and tundra

Range: northern latitudes of Europe, Asia, and North America.

Physical characteristics:

Looks like what other animal: small bear

Length (including tail): Head and body, 32 to 44 in (84 to 111 cm)

Weight: 24 to 40 lbs (11 to 18 kg)

Color: mostly dark with light areas along their sides and top of their face

Circle the term(s) that best describe this species:

Carnivore	**Omnivore**	**Herbivore**
Predator	**Prey**	**Scavenger**

Diet: Some plants and berries, in the summer season but mostly meat. Prey includes smaller animals, such as rabbits and rodents, but sometimes animals many times their size, such as caribou, if the prey appears to be weak or injured. Wolverines also scavenge carrion—the corpses of larger mammals, such as elk, deer, and caribou.

Draw a picture of the species:

DARHAD ECOSYSTEM CARD GAME (EASY)

Cut out the following cards for the Ecosystem Card Game. Each student will need two to four copies to play.

EARTH **(Biosphere)**	**WOLVERINE, HERD OF ELK, & TAIGA TREES** **(Community)**
ALL ALPINE ENVIRONMENTS **(Biome)**	**HERD OF ELK** **(Population)**
WOLVERINE, HERD OF ELK, TAIGA TREES, SOIL & HOVSGAL LAKE **(Ecosystem)**	**WOLVERINE** **(Organism)**

DARHAD ECOSYSTEM CARD GAME (DIFFICULT)

Cut out the following cards for the Ecosystem Card Game. Each student will need two to four copies to play.

EARTH	WOLVERINE, HERD OF ELK, & TAIGA TREES
ALL ALPINE ENVIRONMENTS	HERD OF ELK
WOLVERINE, HERD OF ELK, TAIGA TREES, SOIL & HOVSGAL LAKE	WOLVERINE

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

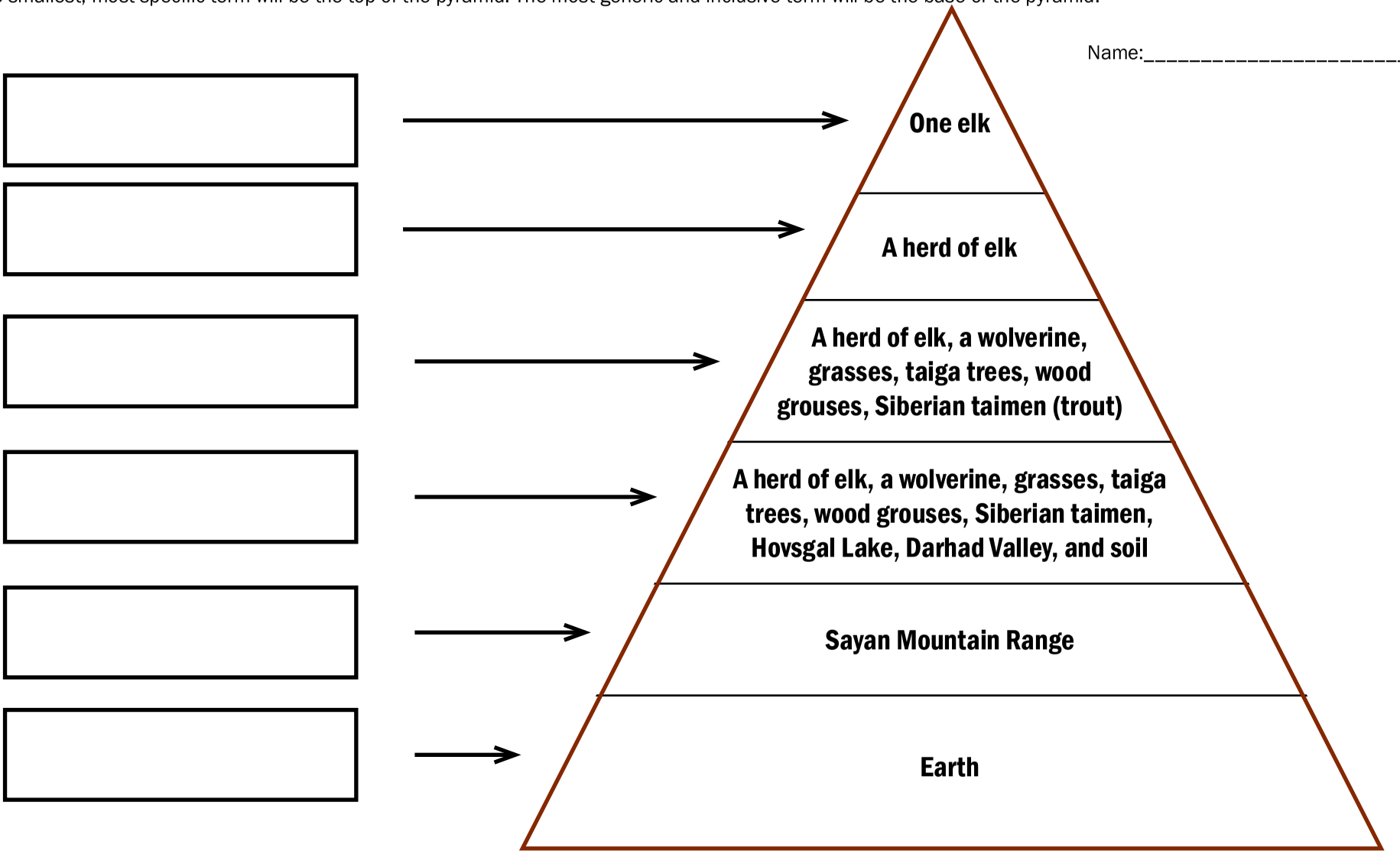
ECOSYSTEM PYRAMID MODEL

Label each of the levels of the ecosystem pyramid model for the Darhad region of Mongolia with the following terms.

Community, organism, biome, biosphere, population, ecosystem

The smallest, most specific term will be the top of the pyramid. The most generic and inclusive term will be the base of the pyramid.

Name:_____



THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

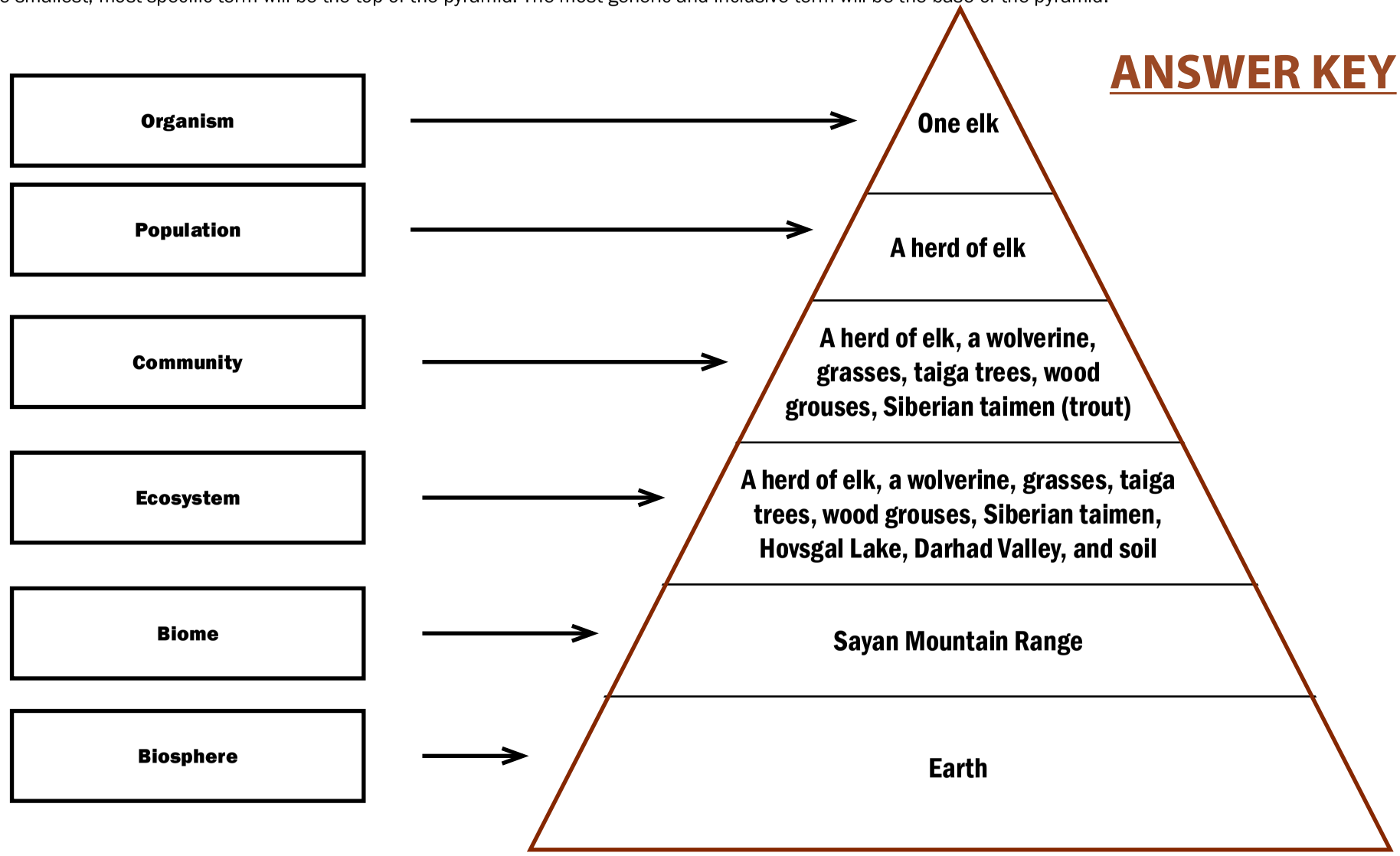
ECOSYSTEM PYRAMID MODEL

Label each of the levels of the ecosystem pyramid model for the Darhad region of Mongolia with the following terms.

Community, organism, biome, biosphere, population, ecosystem

The smallest, most specific term will be the top of the pyramid. The most generic and inclusive term will be the base of the pyramid.

ANSWER KEY



THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

RESTAURANT "ECOSYSTEM" MODEL

Use what you learned from completing the Ecosystem Pyramid Model to fill in the pyramid below using a restaurant as your biosphere instead of the Earth.

Name:_____

Organism

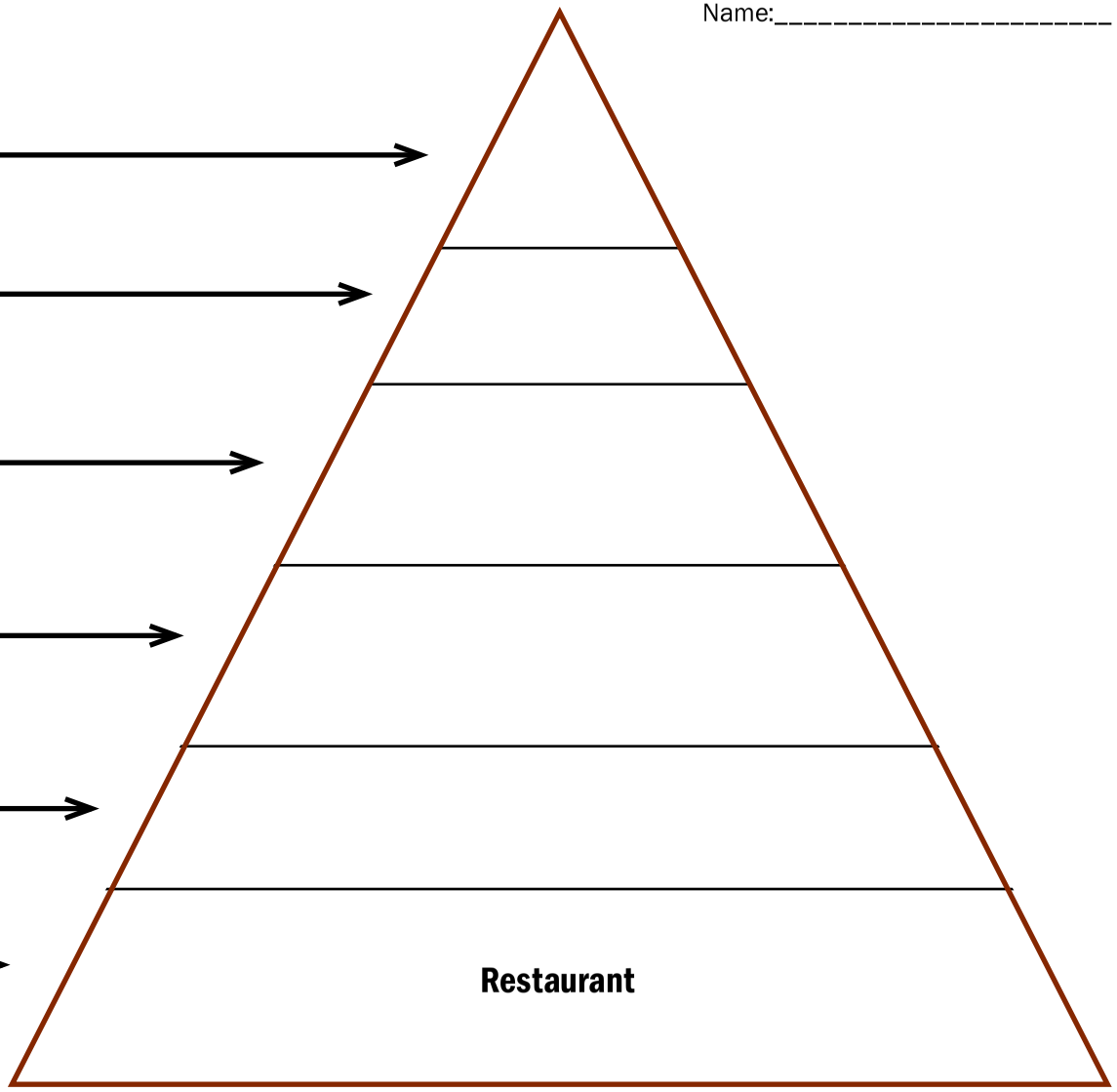
Population

Community

Ecosystem

Biome

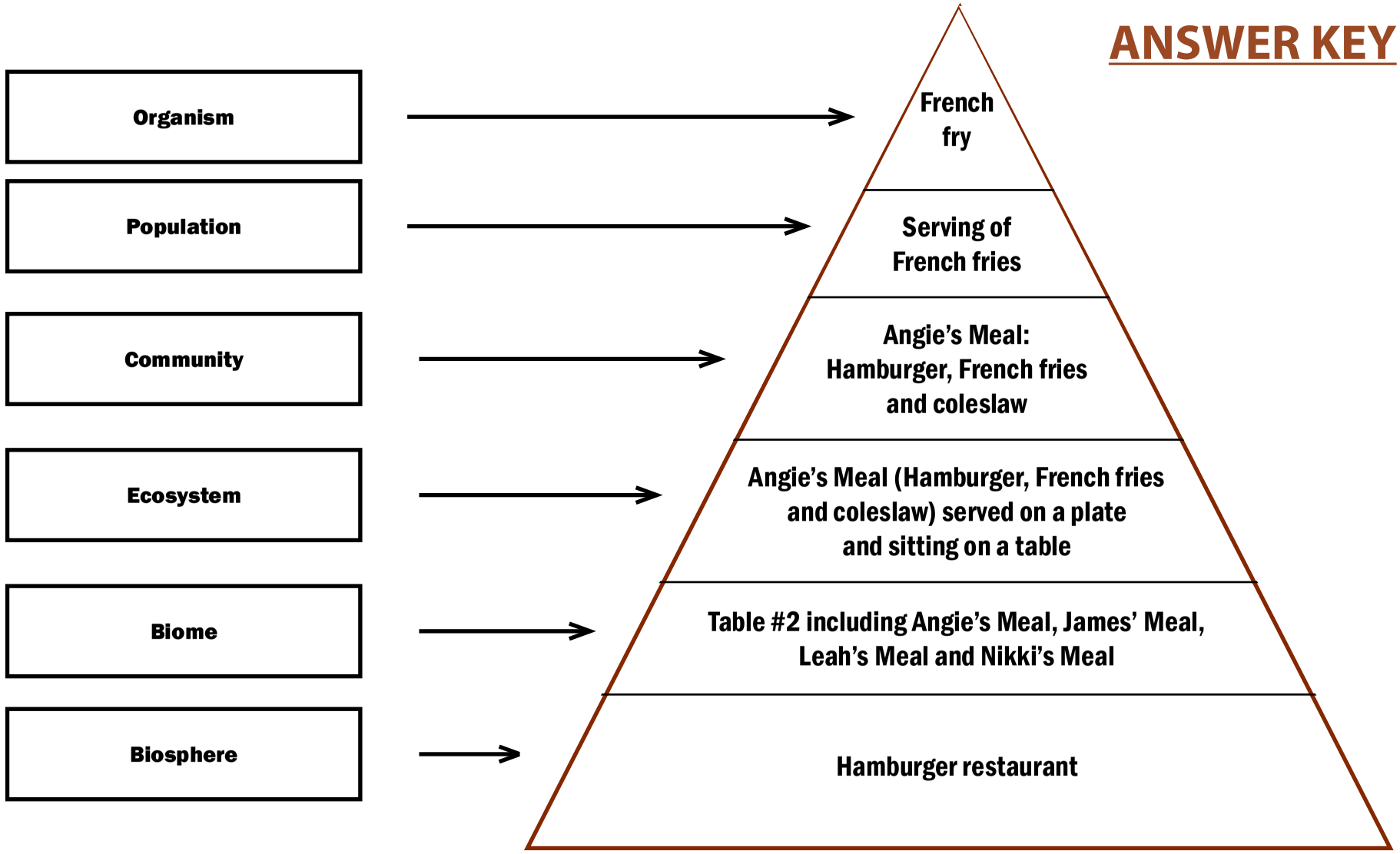
Biosphere



RESTAURANT "ECOSYSTEM" MODEL

Use what you learned from completing the Ecosystem Pyramid Model to fill in the pyramid below using a restaurant as your biosphere instead of the Earth.

ANSWER KEY



LESSON 4: BECOME A WILDLIFE ECOLOGIST

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Explore how scientists gather data on wildlife and the techniques they use in the field. Investigate signs of life and search for evidence of life in your own schoolyard.

LEARNING OBJECTIVES

Students will be able to:

1. Identify animal signs.
2. Explain the techniques scientists use to gather data about animal populations.
3. Use standard research techniques to collect data.
4. Draw conclusions about schoolyard animal populations by analyzing observations and data collected as a class.

DIRECTIONS:

1. Explore signs of life used by ecologists.

a. Brainstorm as a class how ecologists know wildlife are present even if they aren't seen live. Record these ideas and share with your students additional signs of life they did not describe. (A list of signs of life can be found in this lesson's Background Information.)

b. Distribute different signs of life to small groups. (These real examples need to be collected by the teacher prior to the activity. A list of examples can be found in the Background Information.)

c. Have the students work together to identify what each sign is, what organism it is from and what it can tell ecologists on the **Signs of Life worksheet**.

d. Have each group share their most interesting sign of life with the whole class.

2. Watch a video of ecologists collecting scientific data.

a. Watch a video from Adventurers and Scientists for Conservation of ecologists in the field who study and collect data on a species. Have students record what techniques scientists use to collect data during the video.

- ASC 2012 Grizzly Bear Tracking: http://www.adventureandscience.org/grizzly-2012-movie
- ASC 2012 Wolverine Tracking: http://www.adventureandscience.org/wolverine-movie

b. Have students share what techniques they observed. Explain why these techniques are important. Discuss what we can learn about different species through data collected using these techniques and how this data will enhance our understanding of ecosystems and wildlife management. (See the Background Information for more information on these discussions.)

3. Students collect scientific data in your schoolyard.

a. Tell students that they will be visiting their schoolyard and collecting data to understand more about what species live in their schoolyard. They will be using techniques similar to those of the Ring of Darhad Mongolia Wolverine Expedition team.

b. Before the lesson, use a map of your schoolyard and divide the whole schoolyard into smaller areas – one for each small group. If possible, before the lesson, mark these areas with stakes and flags for students.

c. If possible, distribute the schoolyard map to your students. Assign each group an area (that you have pre-determined and marked on a map) within the larger study area. Have each group circle their area on their map.

d. Ask your students what animals (including humans) they expect to find evidence of in their schoolyard. How will they know this animal species is there if they do not see it? Have your students think back to the Signs of Life activity earlier in the lesson.

e. Tell your students that when they go outside, they will be looking for these signs of life and collecting scientific data to show what evidence of animals they found.

f. Show your students the **Schoolyard Study worksheet.** Tell your students that to be a good scientist, they will need to walk slowly and listen and look carefully within their area to find signs of life. Using the examples provided on the worksheet, introduce how each group will collect their data. Go over proper collection techniques (listed in the Background Information) and school rules for the schoolyard.

g. Visit the schoolyard. Have students make observations and complete worksheets in small groups. In addition to making observations, your students may use additional optional techniques similar to the Ring of Darhad Mongolia Wolverine Expedition by:

- Using GPS units to record the locations of the evidence they find
- Collecting the evidence they find. (Use tweezers to put hair/scat in plastic bags/envelopes. Use plaster to record tracks. Use cameras to document signs you cannot bring back to your classroom.)
- Discuss with your students where good locations for wildlife cameras would be for their schoolyard. The Ring of Darhad expedition will be scouting areas for motion cameras to catch wolverine activity based on where they find the most evidence of wolverines.

h. Back in the classroom, have each group share what they found. As a whole class, discuss what species are the most common in your schoolyard and how you know. Discuss which species are rare and how you could protect these species (bird houses, natural areas, etc.)

Tips and Modifications

To adapt this lesson to a different age group, use the following modifications:

3.b. For older students, have them be a part of the process to divide the schoolyard. Have them think about where they would anticipate finding more signs of life. Have students mark the boundaries with you in the schoolyard.

3.f. Older students may record data in a field journal instead of a worksheet. This will be more similar to how data is collected during an expedition.

Assessment:

Review students' Signs of Life worksheets for accuracy and completion.

Have students record the techniques they observe in the ASC videos. Review for accuracy.

Review students' Schoolyard Study worksheets for accuracy and completion.

Extending the Learning:

Complete Activity 4 of Lesson 7 of the unit. This activity has students collect data (similar to Activity 3 in this lesson) in their schoolyard.

Leave the signs of life examples out for further independent exploration by students.

Have a biologist visit your classroom to explain the techniques he or she uses in the field and answer student questions.

Use remote cameras to collect data over a longer period of time. Visit ASC's Website to watch videos of animals recorded by remote cameras.

Discuss how DNA can be gathered from hair and scat samples. Complete an activity on extracting DNA from cheek cells or beans.

PREPARATION:

MATERIALS YOU PROVIDE

- Pencils
- Signs of life – Collected, identified, placed into bags/containers, and numbered before the lesson
- Map of your schoolyard – Divided into small areas for data collection
- Clipboards (optional for the schoolyard study)
- Rulers (for schoolyard study)

RESOURCES PROVIDED

Audio and Video

- Adventurers and Scientists for Conservation (ASC) 2012 Grizzly Bear Tracking video at http://www.adventureandscience.org/grizzly-2012-movie
- ASC 2012 Wolverine Tracking video at: http://www.adventureandscience.org/wolverine-movie

Handouts and Worksheets

- Signs of Life Worksheet (one per student)
- Schoolyard Study Worksheet (one per small group)

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom
- Projector
- Speakers
- Plug-Ins: Flash

Other Notes

Lesson 7 of this unit, "Schoolyard Biodiversity Study," provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

Background and Vocabulary

SIGNS OF LIFE EXAMPLES

- Tracks
- Hair/Fur
- Feathers
- Scat
- Nests
- Burrows
- Spider webs
- Bones
- Sounds/calls
- Digging and scratching marks on trees
- Leaves and branches with pieces missing
- Holes in dead trees and logs from insects

PROPER SIGNS OF LIFE COLLECTION TECHNIQUES

- Be careful while you are collecting, making sure not to damage any trees or plants.
- Don't touch scat, dead animals, or trash unless you are wearing gloves.
- Don't put anything you find in your mouth including plants, berries, mushrooms, and leaves.
- Don't reach into places you can't see.
- Return rocks and logs you move to where you found them.
- Wash your hands as soon as you return do your classroom. Do not touch your face without washing your hands first.

WILDLIFE ECOLOGY DATA COLLECTION METHODS

Following the scientific standards of occupancy surveys for rare, low-density species like the wolverine, the Ring of Darhad Mongolia Wolverine Expedition will survey large areas with less intensity, rather than smaller areas with more intensive surveys used for sampling common species (Mackenzie et al 2005). Like all wildlife studies, this expedition has modified data collection techniques to fit the unique needs of the location and species. The distance covered by this research expedition corresponds to how wolverine track surveys should be carried out – surveying a very large sampling area with lower search intensity. While this research is a single transect, and not replicated, the expedition is also testing whether this survey technique is effective in documenting wolverine presence in an area of presumed but unconfirmed occupancy.

Occupancy studies attempt to determine the proportion of suitable habitat that is inhabited by a species. With repeated surveys, this approach can help researchers and managers understand changes in population over time, and whether a relationship exists between

VOCABULARY

Term	Part of Speech	Definition
DNA	Noun	The material in each organism that provides the instructions for what each living thing looks like and how it will survive.
Ecologist	Noun	A person who studies living things and their environments.
Hair snare	Noun	A trap set up for collecting animal hair.
Scat	Noun	Animal droppings.
Track	Noun/verb	A mark or a series of marks left by an animal, usually footprints.
Wildlife ecologist	Noun	A person who studies animal populations and how to help them.

distribution, occupancy, and landscape processes. Many unresolved challenges exist in applying this method to naturally rare, wide-ranging species like wolverines, since researchers have to search for a single animal over a very large area. Since baselines data on wolverines in Mongolia are absent, the Mongolian wolverine expedition in the Darhad will adapt some techniques associated with occupancy studies, and some more basic, naturalist techniques associated with simply determining the presence of the species in a given area. By doing this, we gather information on presence and distribution, and also provide a baseline for future, more statistically intense research and monitoring.

When expedition team members discover a wolverine track, the team will backtrack to seek a DNA sample from fur or scat. "Collecting noninvasive genetic samples from putative wolverine (*Gulo gulo*) snow tracks is an effective method for providing definitive species identification for use in Presence-Absence surveys" (Ulizio, et. al, 2006). DNA will be analyzed to determine species identity, minimum number of wolverines detected, and genetic relationship to other wolverine populations, both in Mongolia's other mountain ranges, and globally.

Mackenzie, D. and Royle, J. 2005. Designing occupancy studies: general advice and allocating survey effort. Journal of Applied Ecology. 442: 1105-1114.

Ulizio, T, Squires, J, Pletscher, D., Schwartz, M., Claar, J., and Ruggiero, L.

2006. The Efficacy of Obtaining Genetic-Based Identifications from Putative Wolverine Snow Tracks. Wildlife Society Bulletin. 34(5):1326-1332.

BENEFITS OF MONGOLIA WOLVERINE EXPEDITION'S DATA COLLECTION

This baseline study will enhance our understanding of the Darhad region's ecosystem and contribute to wildlife management for this area by:

- Adding to the knowledge of wolverines in Mongolia and highlighting a species at risk due to climate change.
- Providing naturalists a baseline index of all wildlife species observed. This will be presented as a report from this expedition team to the Mongolian government and Mongolian Academy of Sciences who have previously expressed interest in this information.
- Identifying those areas where more intensive wolverine surveys and monitoring could be done using cameras and DNA collection grids in the future.
- Contributing to a growing global DNA database of this circumboreal species. This may add to much-needed understanding of this species' genetic diversity and possible resilience in the face of climate change.

Prior Knowledge

None

Recommended Prior Activities

Lesson 1 of the Ring of Darhad unit: Meet the Team

Lesson 2 of the Ring of Darhad unit: Discover the Darhad

Lesson 3 of the Ring of Darhad unit: Explore the Ecosystem of Northern Mongolia

SCHOOLYARD STUDY (EXAMPLE SHEET)

Name: _____ Date: _____

Name of study area: _____

_____

Brief description of study area: _____

_____

Record the signs of life you find in your section of your schoolyard using the data table below.

WHAT IS IT?	WHAT IS IT FROM?	SIZE		HABITAT TYPE	LOCATION
		LENGTH	WIDTH		
Animal Track	Dog	2”	1.5”	Open playground	By swingset in mud
Big dark feather	Bird (magpie?)	8”	1”	Under trees in grassy area	By fence under trees at the far end of the playground
Pink mitten	Child (maybe a girl?)	5”	3”	Open playground area	On the pavement by where we line up
Boot track	An adult	13”	4”	Open playground area	On the pavement by where we line up

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

SCHOOLYARD STUDY

Name: _____ Date: _____

Name of study area: _____

_____

Brief description of study area: _____

_____

Record the signs of life you find in your section of your schoolyard using the data table below.

WHAT IS IT?	WHAT IS IT FROM?	SIZE		HABITAT TYPE	LOCATION
		LENGTH	WIDTH		

Name: _____

SIGNS OF LIFE

For each sign of life, write down what you think it is, what animal it is from and what scientists can learn from this specimen.

SPECIMEN #	WHAT IS IT?	WHAT ANIMAL IS IT FROM?	WHAT CAN IT TELL US?
EXAMPLE	A track	Deer	How fast the deer was walking/running, where it was going, how big it is

LESSON 5: BIODIVERSITY OF THE RING OF DARHAD

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Discover how biodiversity is calculated by using candy, then calculate biodiversity of a model of northern Mongolia. Research species that live in the Ring of Darhad and play a whole-class game to explore the biodiversity of the region.

LEARNING OBJECTIVES

Students will be able to:

1. Explain how biodiversity is calculated.
2. Demonstrate how biodiversity is calculated using simulated ecosystems.
3. Identify the importance of a diverse biological world.

DIRECTIONS:

1. Research species of the Darhad region.

a. Assign each student a different species from the **Darhad Region Species List**. Tell your students that the species on this list are only a small representation of the biodiversity of the region. There are more than 800 species of just plants in this ecosystem.

b. Have your students use the internet to complete the **Darhad Region Species Research worksheet** on the species they were assigned. It is important that each student learns how their species is connected to other plant and animal species in this ecosystem.

Optional: Have students transcribe their research onto the smaller species research cards. These can then be turned into nametags for a food web activity.

2. Play a species "Who Am I?" game and explore biodiversity.

a. Provide each student with the Darhad Region Species List.

b. Have one student at a time present their research to the class. Have each student share three things they learned about their species. Have the other students guess what species on the list they have. (If students already know who was assigned each species, collect the Species Research worksheets and redistribute them randomly. Each student would then present another classmate's research.)

c. Discuss as a whole group how all of these species are connected.

d. Define biodiversity or biological diversity (how diverse and healthy an ecosystem is) in a large group discussion. Guide students towards defining the term and provide the definition if needed. Have students conclude the importance of biodiversity in an ecosystem.

3. Calculate a biodiversity index by counting candy.

a. Explain to students that a biodiversity index is measured by counting the number of species in an area as well as the number of individuals in each population. Explain that there are different formulas or ways to calculate biodiversity.

b. Individually or in pairs, have students calculate the biodiversity of a package of colorful candy using the **Candy Biodiversity Worksheet.** (Two different difficulty levels are available. Directions are on the worksheets.)

c. Have students share their final calculations with the rest of the class.

d. Discuss the biodiversity of the entire classroom's candy. If each bag of candy was a small sample area within the classroom candy ecosystem, was each bag of candy a good representation of the entire classroom? Which bag of candy has the most biodiversity? Which had the least?

4. Measure biodiversity of a model of the Ring of Darhad.

a. Have your students use the same methods from the candy biodiversity activity to calculate the biodiversity index of a representation of the Darhad Region.

b. Before this activity: Cut small squares of paper and place these squares in four different envelopes using the Biodiversity Model Table as a key. NOTE:

BIODIVERSITY MODEL TABLE

	Red	Orange	Yellow	Green	Blue	Purple	Pink	Brown	Black	White
	Wolverine	Brown Bear	Reindeer	Musk Deer	Sable	Fox	Pika	Ermine	Pipit	Sparrowhawk
A	2	1	12	4	7	4	25	6	14	5
B	0	0	0	3	5	7	3	4	22	8
C	0	2	0	5	6	4	21	8	12	3
D	1	0	4	7	4	5	18	5	10	3

Each envelope represents a different sample area of study. Different colors indicate different species. Each square in each envelope is one organism.

c. Explain to your class that in this activity, they will be imagining that they are analyzing data collected from the Ring of Darhad Mongolia Wolverine Expedition. During the expedition, the adventurers collected data from four sample areas (A, B, C, and D).

d. Individually or in pairs, have students calculate the biodiversity of one of the four study areas using the **Darhad Biodiversity Worksheet.** (Two different difficulty levels are available. Directions are on the worksheets).

e. Have students share their final results with the class.

f. Discuss the biodiversity of the entire Ring of Darhad model. If each envelope represents a small sample area within the Ring of Darhad ecosystem, was each area a good representation of the entire ecosystem? Which area has the most biodiversity? Which had the least? Why do scientists collect data from multiple sample areas?

Tips and Modifications

To adapt this lesson to a different age group, use the following modifications:

2. Older students can complete this guessing game individually by numbering a piece of lined paper and writing down their answers.

3 and 4. Use the appropriate worksheet to adapt these two activities to your students' abilities.

Assessment:

Review Darhad Region Species Research Worksheets for accuracy and completion.

Review Candy Biodiversity worksheets for accuracy and completion.

Review Darhad Biodiversity worksheets for accuracy and completion.

Have students write a one-sentence summary of why biodiversity is important to ensure a healthy ecosystem.

Extending the Learning:

Complete Activity 5 of Lesson 7 of the unit. This activity has students analyze the biodiversity of their schoolyard based on data collected in earlier activities.

Conduct or participate in a BioBlitz.

Research, read about, and discuss the biodiversity of local ecosystems. Have your students learn about threatened species, how their decline impacts other species, and what conservation projects are planned to ensure your local biodiversity.

Have students look at the numbers and composition of species in their Mongolia biodiversity samples. Can they infer which samples come from which elevations based on which animals they see in the sample? What methods might be used to determine whether their inferences are correct?

PREPARATION:

MATERIALS YOU PROVIDE

- Pencils
- Small pieces of colored paper divided into four envelopes

RESOURCES PROVIDED

Audio and Video

- None

Handouts and Worksheets

- Darhad Region Species Research Worksheet (one per student) and Species Research Cards
- Darhad Region Species List (one per student)
- Candy Biodiversity Worksheet (one per student)
- Darhad Biodiversity Worksheet (one per student)

REQUIRED TECHNOLOGY

- Internet Access: required
- Tech Setup: several computers for student research

Other Notes

Lesson 7 of this unit, Schoolyard Biodiversity Study, provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

BACKGROUND AND VOCABULARY:

BACKGROUND INFORMATION

In Mongolia, as in the Yellowstone region, different species are found at different elevations. This means that biodiversity levels may change within a small area, depending on the altitude at which a researcher takes measurements. Wolverines, pikas, and reindeer are restricted to high elevation regions because they are adapted to cold conditions. Other species, such as pipits and fox, thrive in lower, grassland conditions. Some animals avoid humans, which may also influence wildlife distribution. Most human habitation occurs in lower elevation valleys between high mountains, which means that wildlife may select higher regions to have greater security. The Darhad expedition will take measurements primarily in the mountains, which have low levels of human use.

Biodiversity measures all the different kinds of living organisms in an ecosystem or area. Biodiversity includes all life, even microscopic organisms. Biodiversity is measured using different biodiversity indexes. These calculations vary from simple to complex, but all include the number of different species and the number of individuals in the area of study. Biodiversity can also include genetic diversity among a species.

Ecosystems with greater biodiversity are generally stronger and more resistant to disaster than those with fewer species. When disease, fire, or climate change affects an ecosystem, those communities with greater numbers of different species have a higher likelihood of having species that are able to survive under the new conditions. Biodiversity is important because all living things are connected. When one species is removed from an ecosystem, those areas with greater biodiversity are more likely to succeed. Cold northern ecosystems tend to be naturally less diverse than tropical ecosystems. Some scientists suspect that northern ecosystems will be less resilient in the face of climate change because the loss of even a single species will have a greater effect on the system.

Humans affect biodiversity by destroying natural habitats and adding to climate change. As habitat size decreases, ecosystems can hold fewer individuals and genetic diversity decreases. A greater variety in genes among a population can help species survive disease and changes in habitat. Around the world, people are helping to protect biodiversity by protecting threatened species and habitats.

For more information from National Geographic on biodiversity visit: http://education.nationalgeographic.com/education/encyclopedia/biodiversity/?ar_a=1

Prior Knowledge

Ecosystems

Recommended Prior Activities

Lesson 1 of the Ring of Darhad unit: Meet the Team

Lesson 2 of the Ring of Darhad unit: Discover the Darhad

Lesson 3 of the Ring of Darhad unit: Explore the Ecosystem of Northern Mongolia

Lesson 4 of the Ring of Darhad unit: Become a Wildlife Ecologist

VOCABULARY

Term	Part of Speech	Definition
Basic Biodiversity Index	noun	The number of species in the area divided by the total number of individuals in the area.
Biodiversity	Noun	A measurement of how diverse and healthy an ecosystem is by measuring all the different kinds of living organisms in an ecosystem or area.
Biodiversity index	Noun	A formula that describes the amount of species diversity in a given area.
Genetic diversity	Noun	The variation in genes and combination of genes within a population.
Individual	Noun	A single organism.
Organism	Noun	An individual plant, animal, or other form of life.
Population	Noun	Many organisms of the same species in one geographic area.
Simpson Index of Diversity	Noun	$D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N-1)}$
Species richness	Noun	The number of different species in an ecosystem

Name:_____

CANDY • BASIC BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of a bag of candy. Each different colored candy is a different species in your candy ecosystem. The number of each colored candy is the number of organisms of that species in the candy ecosystem.

Directions:

Count how many different colors of candy you have. Record the name of each color in the first column. Record the total number of colors in the last box of the first column.

Count how many of each color candy you have. Record that number in the second column.

Count the total number of candies. Record that number in the last box of the second column.

CANDY COLOR (Species)	**# OF THAT COLOR CANDY (Population)**
TOTAL # OF COLORS:	**TOTAL NUMBER OF CANDIES:**

How many different colors of candy do you have?

How many candies total do you have?

Calculate the biodiversity index for your candy:

TOTAL # OF COLORS ÷ TOTAL NUMBER OF CANDIES = BIODIVERSITY INDEX

_____ ÷ _____ = _____

Compare your biodiversity index to your classmates. Is your bag of candy rich in diversity? Why or why not?

Name:_____

CANDY • SIMPSON BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of a bag of candy. Each different colored candy is a different species in your candy ecosystem. The number of each colored candy is the number of organisms of that species in the candy ecosystem.

Directions:

Count how many different colors of candy you have. Record the name of each color in the first column. Record the total number of colors in the box A of the first column.

Count how many of each color candy you have. Record that number in the second column.

Count the total number of candies. Record that number in box B of the second column.

Calculate n(n-1) for each number in the second column. (Subtract each number in the second column by 1, then multiply it by the original number.) Record each answer in the third column.

CANDY COLOR (Species)	# OF THAT COLOR CANDY (Population)	n(n-1)
(A) TOTAL: (Richness)	**(B) TOTAL:**	**(C) TOTAL**

Calculate the Simpson Index of Diversity for your bag of candy.

The equation for this method is: $D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N-1)}$

Where:

D is the index you are calculating

n is the number of individuals of a given species

N is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

Subtract the total number of species/colors (number in box A) by 1.

_____

Multiple this number by the total number of species/ colors (number in box A).

_____

Divide the sum of n(n-1) (number in box C) by this answer.

_____

The answer is D value which ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. Describe the diversity of your bag of candy and how you came to your conclusion.

_____

_____

_____

Name:_____

DARHAD • BASIC BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of the Ring of Darhad. Each square in each envelope is one organism.

The different colors of squares are different species in the ecosystem.

The population is the total number of each colored square.

The total number of squares is the total number of organisms (of all species) in the ecosystem.

Directions:

Pick one of the four envelopes. This is one sampling area of the Ring of Darhad ecosystem.

Count how many different types species are in the envelope. Record the name of each species in the first column. Record the total number of species in the last box of the first column.

Count how many of organisms of each species are in the envelope. This is number is the population. Record that number in the second column.

Count the total number of organisms. Record that number in the last box of the second column.

SPECIES (Colors)	POPULATION (# of squares of each color)
TOTAL # OF SPECIES:	**TOTAL NUMBER OF ORGANISMS:**

How many different species are in your sampling area?

What species has the largest population?

How many organisms total are in your sampling area?

Calculate the biodiversity index for your sampling area:

TOTAL # OF SPECIES ÷ TOTAL NUMBER OF ORGANISMS = BIODIVERSITY INDEX

_____ ÷ _____ =

_____

Compare your biodiversity index to your classmates and answer the following questions.

Is your sampling area rich in diversity? Why or why not?

Do all sampling areas have the same biodiversity index?

Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?

What can scientists use this biodiversity index for?

Name:_____

DARHAD • SIMPSON BIODIVERSITY INDEX

Calculate the Simpson Biodiversity Index (or how diverse and healthy an ecosystem is) of the Ring of Darhad. Each square in each envelope is one organism.

The different colors of squares are different species in the ecosystem.

The population is the total number of each colored square.

The total number of squares is the total number of organisms (of all species) in the ecosystem.

Directions:

Pick one of the four envelopes. This is one sampling area of the Ring of Darhad ecosystem.

Count how many different types species are in the envelope. Record the name of each species in the first column. Record the total number of species in box A of the first column.

Count how many of organisms of each species are in the envelope. This is number is the population. Record that number in the second column.

Count the total number of organisms. Record that number in box B of the second column.

Calculate n(n-1) for each number in the second column. (Subtract each number in the second column by 1, then multiply it by the original number.) Record each answer in the third column.

COLOR (Species)	**# OF THAT COLOR (Population)**	**n(n-1)**
(A) TOTAL: (Richness)	**(B) TOTAL:**	**(C) TOTAL**

Calculate the Simpson Index of Diversity for your sampling area.

The equation for this method is: $D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N-1)}$

Where:

D is the index you are calculating

n is the number of individuals of a given species

N is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

Subtract the total number of species (number in box A) by 1.

_____

Multiple this number by the total number of species (number in box A).

_____

Divide the sum of n(n-1) (number in box C) by this answer.

_____

The answer is D value which ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity. Describe the diversity of your sampling area and how you came to your conclusion.

_____

RING OF DARHAD SPECIES LIST

Mammals

Wolverine (*Gulo gulo)*

Elk (*Cervus elaphus*)

Moose (*Alces alces*)

Wild Reindeer (*Rangifer tarandus*)

Brown Bear (*Ursus arctos*)

Siberian Musk Deer (*Moschus moschiferus*)

Ibex (*Capra sibirica*)

Wolf (*Canis lupus*)

Sable (*Martes zibellina*)

Eurasian lynx (*Lynx lynx*)

Siberian Weasel (*Mustela sibirica*)

Fox (*Vulpes vulpes*)

Eurasian otters (*Lutra lutra*)

Altai mole (*Talpa altaica*)

Ermine (*Mustela ermine*)

Red Squirrel (*Sciurus vulgaris*)

Pika *(Ochotona alpina)*

Fish

Stone Loach (*Naemacheilus barbatulus*)

Siberian taimen/salmon (*Hucho taimen*)

Birds

Altai snowcock (*Tetraogallus altaicus*)

Capercallie (*Tetrao urogallus*)

Northern Goshawk (*Accipiter gentilis*)

Eurasian Three-toed woodpecker (*Picoides tridactylus*)

Eurasian Sparrowhawk (*Accipiter nisus*)

Tree Pipit (*Anthus trivialis*)

Reptiles

Viviparous lizard (*Zootoca vivipara*)

Common European Viper (*Vipera berus*)

Plants

Siberian Larch (*Larix sibirica*)

European aspen (*Populus tremula*)

Rhododendron (*Rhododendron parvifolium*)

Reed Grass (*Calamagrostis epigeios*)

Name:_____

DARHAD REGION SPECIES RESEARCH

Find the following information about the species you were assigned that calls the Ring of Darhad home.

Common name:

Scientific name:

Plant/Animal Family:

Type of habitat:

Physical characteristics:

Animals only:

Circle the term(s) that best describe this species:

Herbivore / Carnivore / Omnivore

Predator / Scavenger / Prey

Diet:

Plants only:

Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

Common name:

Scientific name:

Plant/Animal Family:

Type of habitat:

Physical characteristics:

Animals only:	Plants only:
Circle the term(s) that best describe this species: Herbivore Carnivore Omnivore Predator Scavenger Prey Diet:	Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:

MONTANA NSF EPSCoR MONTANA STATE UNIVERSITY Extended University

Mountains & Minds

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

Common name:

Scientific name:

Plant/Animal Family:

Type of habitat:

Physical characteristics:

Animals only:	Plants only:
Circle the term(s) that best describe this species: Herbivore Carnivore Omnivore Predator Scavenger Prey Diet:	Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:

MONTANA NSF EPSCoR MONTANA STATE UNIVERSITY Extended University

Mountains & Minds

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

Common name:

Scientific name:

Plant/Animal Family:

Type of habitat:

Physical characteristics:

Animals only:	Plants only:
Circle the term(s) that best describe this species: Herbivore Carnivore Omnivore Predator Scavenger Prey Diet:	Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:

MONTANA NSF EPSCoR MONTANA STATE UNIVERSITY Extended University

Mountains & Minds

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

Common name:

Scientific name:

Plant/Animal Family:

Type of habitat:

Physical characteristics:

Animals only:	Plants only:
Circle the term(s) that best describe this species: Herbivore Carnivore Omnivore Predator Scavenger Prey Diet:	Animals that feed on this plant:

One interesting fact about this species:

Draw a picture of the species:

MONTANA NSF EPSCoR MONTANA STATE UNIVERSITY Extended University

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THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LESSON 6: CLIMATE CHANGE AND THE WOLVERINE

Length: 60 minutes

Grades/Ages: Grades 3-7

Lesson Overview:

Study various climates around the world by exploring global data and comparing different cities. Identify how your actions contribute to climate change and how the wolverine is affected by warming temperatures. Take action to help protect the wolverine.

LEARNING OBJECTIVES

Students will be able to:

1. Compare and contrast climates around the world.
2. Describe the climate wolverines inhabit.
3. Explain how the wolverine is impacted by global climate change.
4. Make a pledge to help reduce climate change.

DIRECTIONS:

1. Define and identify weather and climate around the world.

a. Review the difference between weather and climate as a large group.

b. Use National Geographic's Map Maker Interactive to explore global winter and summer temperatures.
   - Have students navigate to the Map Maker Interactive by visiting: http://education.nationalgeographic.com/education/mapping/interactive-map/?ar_a=1
   - On the left toolbar, click on "Physical Systems – Climate."
   - Have students explore climate zones, as well as rainfall and seasonal temperatures both around the world and in their hometown and northern Mongolia.
   - Students can place a "marker" on northern Mongolia and their hometown during this exploration so they can compare the climates easier.
   - As a whole class, compare and contrast northern Mongolia with hometown and other cities of interest using the Map Maker Interactive.

2. Students study the impacts of climate change on wolverines.

a. Tell students that many animals around the world are being affected by climate change including the wolverine. Briefly review with students the causes of climate change and how it is affecting ecosystems worldwide.

b. Color in the climate where wolverines live on the **Student World Map.** (Note: Students may use the map from Lesson 2 if this lesson is being completed as part of the Ring of Darhad unit.)

c. Based on student explorations of the Map Maker Interactive from the previous activity, have students discuss the climates of the regions where the wolverine is found. What do these regions have in common?

d. Have students read the **Climate Change and the Wolverine article.**

e. After reading the article, have students use what they read to identify adaptations of the wolverine and effects of climate change from each adaptation on the **Climate Change and the Wolverine worksheet.**

f. Review student answers and discuss the impacts climate has on the wolverine as a class.

3. Take action to protect the wolverine.

a. Brainstorm with your students what daily activities of theirs contribute to climate change.

b. Discuss how their actions can affect species and ecosystems worldwide including the wolverines in Mongolia.

c. Ask each student to make a pledge to change just one behavior to reduce climate change. Have each student fill out the **Climate Change Pledge form** and post them the classroom.

Tips and Modifications

To adapt this lesson to an older age group, use the following modification:

2.d.. Have students read one of the following scientific articles on how climate is affecting biodiversity instead of the article on Climate Change and the Wolverine. Have these students write a summary of what they read instead of completing the Impacts on the Wolverine worksheet.

> *Kerr, J. and Packer, L. The Impact of Climate Change on Mammal Diversity in Canada. Environmental Monitoring and Assessment, February 1998, Volume 49, Issue 2-3, pp 263-270.* http://link.springer.com/article/10.1023%2FA%3A1005846910199#page-1
>
> *McKelvey, Kevin S., Jeffrey P. Copeland, Michael K. Schwartz, Jeremy S. Littell, Keith B. Aubry, John R. Squires, Sean A. Parks, Marketa M. Elsner, and Guillaume S. Mauger. 2011. Climate change predicted to shift wolverine distributions, connectivity, and dispersal corridors. Ecological Applications 21:2882–2897.* http://www.fs.fed.us/rm/pubs_other/rmrs_2011_mckelvey_k001.pdf

Assessment:

Have students compare and contrast the climate of their hometown with northern Mongolia in a short paragraph.

Review students' coloring on the Student World Maps of wolverine habitats for accuracy and completion.

Review students' Climate and the Wolverine worksheets for accuracy and completion.

Extending the Learning:

1. Complete Activity 6 of Lesson 7 of the unit. This activity has students analyze the impacts of climate change on a chosen species that lives in their schoolyard.
2. Complete the National Geographic Activity: Latitude, Longitude, and Temperature to learn how latitude and longitude affect climate. (http://education.nationalgeographic.com/education/activity/latitude-longitude-temperature/?ar_a=1)
3. Have students convert temperatures from Fahrenheit to Celsius.
4. Revisit student Climate Change Pledges after a designated period of time. Discuss the challenges students faced and if they were successful. Have students expand upon, modify, or continue their pledges.
5. Have students measure their carbon footprint.

PREPARATION:

MATERIALS YOU PROVIDE

- Pencils / colored pencils

RESOURCES PROVIDED

Audio and Video

- None

Images

- None

Handouts and Worksheets

- Student World Map (one per student)
- Climate Change and the Wolverine article (one per student)
- Climate Change and the Wolverine Worksheet (one per student)
- Friend of the Wolverine Climate Challenge Pledge (one per student)

REQUIRED TECHNOLOGY

- Internet access: required
- Tech Setup: Several computers for Map Maker Interactive activity

Other Notes

Lesson 7 of this unit, "Schoolyard Biodiversity Study," provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

BACKGROUND AND VOCABULARY:

BACKGROUND INFORMATION

The climate in northern Mongolia is similar to that of the northern Rocky Mountains in North America – cold and dry. This continental climate is characterized by annual variation in temperature due to the lack of significant bodies of water nearby. Instead of being influenced by a body of water, temperatures are affected by a high barometric pressure center which often sits over northern Mongolia. Winters are very cold and long, while summers are warm and short. January averages can be as low as −22 °F. In the winter, extreme cold fronts from neighboring Siberia collect in river valleys and low basins in northern Mongolia causing very cold temperatures. At the same time, slopes of mountains are much warmer due to temperature inversions (temperature increases

VOCABULARY

Term	Part of Speech	Definition
Carbon dioxide	Noun	A colorless, odorless greenhouse gas.
Carbon footprint	Noun	The amount of carbon dioxide emitted into the atmosphere by a person, group of people, or event.
Climate	Noun	The average weather for a particular area.
Climate change	Noun	Major changes in temperature, precipitation and weather patterns measured over a long period of time.
Fossil fuels	Noun	Coal, oil and natural gas.
Emissions	Noun	A discharge of something into the air or atmosphere.
Pledge	Noun/verb	A promise to do something.
Weather	Noun	The specific state of the atmosphere at a particular time in a specific location including temperature, wind, and precipitation.

with altitude). Most precipitation falls in the summer. The mountain relief gives rise to a high diversity of microclimate conditions and temperature inversions.

Climate is the long-term weather patterns for a particular geographic region. Climate varies for different parts of the world. Climate can be influenced by latitude, bodies of water, land masses, elevation, and local topography. Climate determines the types of plants and animals that are able to survive in a particular region.

For more information from National Geographic on climate visit:

http://education.nationalgeographic.com/education/encyclopedia/climate/?ar_a=1

For more information from National Geographic on climate change visit:

http://education.nationalgeographic.com/education/encyclopedia/climate-change/?ar_a=1

Prior Knowledge

Weather and Climate

Climate change

Recommended Prior Activities

Lesson 1 of the Ring of Darhad unit: Meet the Team

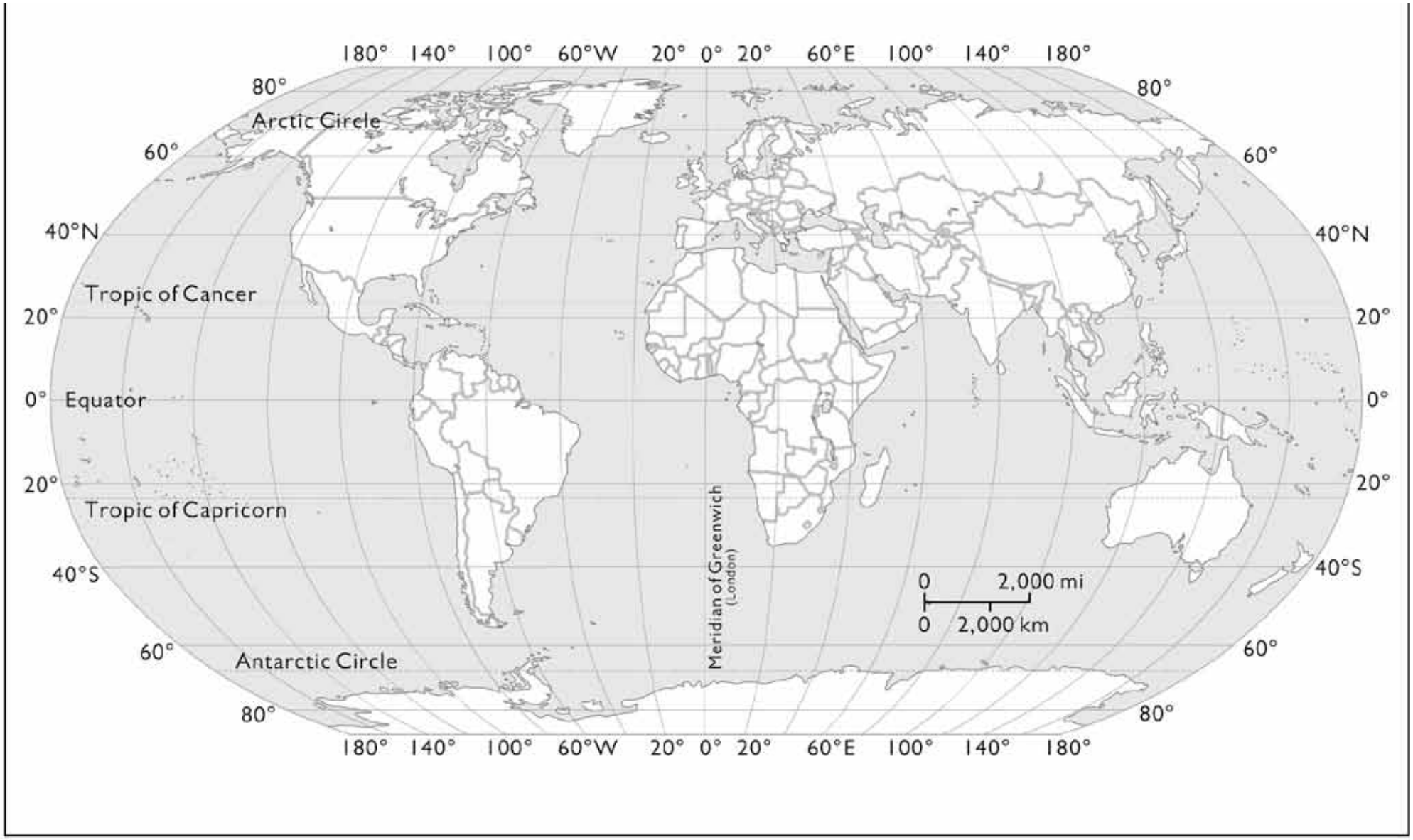
Lesson 2 of the Ring of Darhad unit: Discover the Darhad

Lesson 3 of the Ring of Darhad unit: Explore the Ecosystem of Northern Mongolia

Lesson 4 of the Ring of Darhad unit: Become a Wildlife Ecologist

Lesson 5 of the Ring of Darhad unit: Biodiversity of the Ring of Darhad

WORLD MAP



THE WORLD

NATIONAL GEOGRAPHIC education

CLIMATE CHANGE AND THE WOLVERINE

BY REBECCA WATTERS

Species that are adapted to the cold and live in alpine or arctic environments are at risk of being affected by global climate change. The wolverine (*Gulo gulo*) may be especially sensitive to warming trends in the global temperature.

Wolverines possess many adaptations for survival in cold climates. This member of the weasel family has thick, oily, frost-resistant fur to help keep it warm in frigid temperatures. Large, snowshoe-like feet help the wolverine travel across snow in some of the world's harshest environments. During winter, wolverines find food in these stark habitats by sniffing out animals that have died in avalanches or by other causes. Scientists hypothesize that wolverines have an incredible sense of smell in order to be effective at finding these food sources.

During the summer, wolverines stash carrion in cool areas under boulders, which helps keep the meat fresh for later meals. Since the cold climate regions they occupy are relatively unproductive, wolverines must defend a large home range in order to secure enough food, and they therefore exist at a very low population density. Wolverines must travel farther to find a mate and do not reproduce as often as other carnivores such as bears and wolves. This makes wolverines especially vulnerable to habitat fragmentation, climate change and, in the context of these other threats, trapping and disturbance.

Female wolverines give birth and raise their young in snow dens. Snow dens help wolverine kits survive by providing insulation from cold temperatures and protection from predators. Wolverine kits are usually born in February and do not leave the den until the middle of May, so wolverines are only found in areas with deep snow that lasts through late spring.

At higher latitudes closer to the Arctic, wolverines are evenly distributed across the landscape because deep spring snow exists everywhere. Moving south, deep spring snow and wolverines are found only at higher elevations, in mountain ranges that are separated by large areas of unsuitable lowland. Even during the summer, wolverines stay in cold regions where snow lingers. This could be to avoid summer heat, to be close to avalanche chutes where prey is more abundant, or a combination of both. Wolverines reach the southern extent of their range in the Rocky Mountains of North America and the mountains of Mongolia in Eurasia, the southernmost regions where mountains hold late spring snow. In these areas, wolverines are likely to be especially vulnerable to climate change.

Scientists use models and historical data to predict how climate change will affect spring snow cover and wolverine habitat. Climate models generate examples of what spring snow conditions could look like by using a variety of data and predictions about the future. The models incorporate snowpack data, historical precipitation patterns, future patterns of fossil fuel use, and topography. Using these models, scientists infer that spring snow in the Rockies is likely to decline and snow-covered areas will become fragmented and isolated.

Current wolverine populations are already small. Without connections among subpopulations of wolverines, the genetic diversity of the overall population will suffer. However, snowpack modeling also suggests that some areas may be less affected by climate change and maintain spring snow cover. These areas include northern Washington, the Montana-Idaho border, the Greater Yellowstone Ecosystem, and the high peaks of Colorado.

While no model can predict the exact effects of climate change on the wolverine, its connected species, and its ecosystem, this research suggests that wolverines are susceptible to climate change because of their adaptations to cold environments. As these cold environments warm and disappear, the wolverine will be endangered by the very traits that once helped it survive.

Name:_____

CLIMATE CHANGE AND THE WOLVERINE

Read the article on climate change and the wolverine.

Identify adaptations the wolverine has to help it survive in a cold environment in the first column.

Explain how climate change will impact the wolverine as a result of each adaptation.

WOLVERINE'S ADAPTATION	HOW CLIMATE CHANGE WILL IMPACT WOLVERINE'S SURVIVAL
thick, oily fur	*Wolverines' fur will prevent them from keeping cool as the average temperatures increase.*

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

Friend of the Wolverine Climate Change Pledge

Date: _____

By: _____

Teacher's Name: _____

School: _____

To reduce my greenhouse gas emissions at home and school, I pledge to:

_____

_____

_____

_____

Adventurers & Scientists for Conservation

Montana NSF EPSCoR

Montana State University Extended University

Mountains & Minds

LESSON 7: SCHOOLYARD BIODIVERSITY STUDY

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:

Become an adventure scientist by exploring the biodiversity of your schoolyard. Use a field journal to plan and prepare for your adventure, collect data in the field, and draw conclusions from your findings. NOTE: This lesson's activities can be completed after each corresponding lesson or as a whole project at the end of the unit.

LEARNING OBJECTIVES

Students will be able to:

1. Select, describe and map an area for study.
2. Use field skills to record observations about an ecosystem.
3. Calculate the biodiversity of an area of study.
4. Explore the effects of climate change on a local species.

DIRECTIONS:

1. Choose your own adventure.

a. Tell your students that they will be planning and "going on" an "adventure" just like the Ring of Darhad Mongolia Wolverine Expedition.

b. As a class help your students choose an appropriate place for their adventure. (This adventure will be used as an area of study for the entire lesson.) Begin by giving your students a boundary that will limit their travel. For example, tell your students that the location they choose for their adventure must be within walking distance.

c. Once the natural area has been selected, ask your students if they need to get permission or permits. Students may need permission to collect data on the species that live in this area from a principal or superintendent, maybe even the property owner. Students may need to get permission to travel from parents or school administrators. If appropriate, include students in the process to get permission, by writing a letter to the appropriate authority figure.

d. Distribute a **Field Journal** to each student. Explain that these field journals will be used throughout the study.

e. With your class, establish a research question for their study. This question should be focused on one species you know is present in the area. For example, the Ring of Darhad Expedition focused on wolverines. Your schoolyard study can focus on a tree species, bird, or small animal that you and your class want to learn more about. The species you chose must be abundant enough that students will be able to find signs of life from this species in your chosen area.

f. Tell your students that part of the mission of the Ring of Darhad Mongolia Wolverine Expedition is outreach or sharing what they learn with people. With your students, determine what outreach your adventure will have. Students may share what they have learned by writing letters home to family, publishing their adventure in a school newspaper or newsletter, posting information on a school bulletin board, or including what they have learned on a class or school blog.

g. Have students document the planning and approval process for their adventure using the Project Proposal in the field journal.

2. Describe own adventure.

a. Tell your students that part of the planning process for an expedition is mapping the route before leaving. Have your students make map of the study area chosen. (If needed, or if time allows, do this activity at your adventure site.)

b. Ask each student to use the blank map template in their field journal to lead them through the map making process by drawing your own version on a white board or chart paper.

c. Like the Ring of Darhad Mongolia Wolverine Expedition, have your students describe the area they are visiting as part of the preparation process. Have your students use the Study Area Description page of their Field Journal to describe the area's natural characteristics.

3. Diagram the study area ecosystem and learn more about the species of study.

a. Brainstorm plant and animal species that students expect to find in the study area. Have students record these anticipated species on the Ecosystem page of their field journal.

b. Ask each student to make an ecological structure diagram of the adventure area's ecosystem using the Ecosystem Pyramid model. (To learn more about this model, see Lesson 3: Explore the Ecosystem of Northern Mongolia of the Ring of Darhad Unit.) Have students use the species the class identified in the research question as the key species of the model (listed at the top of the pyramid at the organism level) and incorporate other identified species in the larger ecological groups including community and ecosystem.

c. Answer the following questions about what students found in the field journal:

- What are the ecosystems present in your community?
- Can the concept of ecosystem be used at the microscopic level? Why/why not? Expand on your answer using detailed examples.

d. Using the Species of Interest page of the field journal, have your students conduct research on the species identified in your research question.

4. Students collect scientific data in their schoolyard.

a. Tell students that they will be visiting the chosen area and collecting data.

b. Use the map your class created of entire study area in the previous activity and divide into smaller study areas – one for each small group. If possible, before the lesson, mark these areas for students. Have them draw the divisions onto their field journal maps.

c. Assign each small group an area (that you have pre-determined and marked on a map) within the larger study area. Have each group circle their area on their map.

d. Tell your students that when they go outside, they will be looking for signs of life and collecting scientific data to show what evidence of life they found.

e. Show your students the Data Sheet in their Field Journal. Tell your students that to be a good scientist, they will need to walk slowly and listen and look carefully within their area to find signs of life. Using the examples provided on the data sheet, introduce how each group will collect their data. Go over proper collection techniques (listed in the Background Information) and school rules for the schoolyard.

f. Visit the schoolyard and make observations and complete worksheets for each smaller area to collect data. In addition to making observations, your students may use additional optional techniques similar to the Ring of Darhad Mongolia Wolverine Expedition by:

- Using GPS units to record the locations of the evidence they find
- Collecting the evidence they find. (Use tweezers to put hair/scat in plastic bags/envelopes. Use plaster to record tracks. Use cameras to document signs you cannot bring back to your classroom.)
- Discussing with your students where good locations for wildlife cameras would be for their schoolyard. The Ring of Darhad expedition will be scouting areas for motion cameras to catch wolverine activity based on where they find the most evidence of wolverines.

g. Back in the classroom, have each group share what they found. As a whole class, discuss what species are the most common in your schoolyard and how you know. Discuss which species are rare and how you could protect these species (bird houses, natural areas, etc.)

h. Have students work together to analyze the data they have and answer questions about the population on a worksheet.

- How many different individuals can you estimate are present without DNA analysis?
- What patterns in behavior can you find for this species?
- Where are the individuals most abundant?
- Is the final number of species found by the class all there are? Why/why not?
- What other ways of collecting are there? What are the advantages/disadvantages of each?
- Are there any species we did not find a representative of? Why/Why not- explain

5. Calculate a biodiversity index of your schoolyard.

a. Explain to students that a biodiversity index is measured by counting the number of species in an

area as well as the number of individuals in each population. Explain that there are different formulas or way to calculate biodiversity.

b. Have each small group calculate the biodiversity of their study area using the Biodiversity page of the field journal. (Two different difficulty levels are available.) Although students will not know the exact number of individuals of each they found in their area because they do not have access to DNA analysis, they can make their best guess as to if each sign of life they found was from different individuals or the same individual who left multiple signs of life. (For more information on calculating a Biodiversity Index, see Lesson 5: Biodiversity of the Ring of Darhad of the Ring of Darhad unit.)

c. Discuss the biodiversity of the entire schoolyard area.

d. Which sample area of the schoolyard was the best representation of the entire classroom? Which sample area has the most biodiversity? Which had the least?

7. Students study the impacts of climate change on your species.

a. Tell students that many animals around the world are being affected by climate change. Briefly review with students the causes of climate change and how it is affecting ecosystems worldwide.

b. Have students use their knowledge from the research they conducted in a previous activity to identify adaptations that your species of study has to help it survive in its environment in the first column of the Climate Change and Your Species of Study page of the field journal. Explain how climate change will impact this species as a result of each adaptation using the second column.

c. Review student answers and discuss the impacts climate has on your species of study as a class.

d. Brainstorm with your students what daily activities of theirs contribute to climate change.

e. Discuss how their actions can affect species and ecosystems worldwide including their species of study. Brainstorm what behaviors students can to reduce climate change.

Tips and Modifications

To adapt this lesson to a different age group, use the following modifications:

1-6. Older students may record data in a notebook, creating their own tables and diagrams instead of using the provided field journal. This will be more similar to how data is collected during an expedition.

4.b. For older students, have them be a part of the process to divide the schoolyard. Have them think about where they would anticipate finding more signs of life. Have students mark the boundaries with you in the schoolyard.

5. Use the appropriate worksheet to adapt these two activities to your students' abilities.

Assessment:

Review the Field Journal for completion and accuracy.

Extending the Learning:

Complete other activities from the Ring of Darhad Mongolia Wolverine Expedition unit to learn more about each step of the adventure and science research expedition process.

Research and local conservation issues in your community and how research like your students conducted in this lesson impact decision making.

Conduct or participate in a BioBlitz.

PREPARATION:

MATERIALS YOU PROVIDE

- Pencils
- Clipboards
- Rulers

RESOURCES PROVIDED

Audio and Video

None

Images

None

Handouts and Worksheets

Field Journal (one per student)

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: Several computers for student research

Other Notes

This lesson, "Schoolyard Biodiversity Study," provides an opportunity for students to participate in all the steps of the Ring of Darhad Mongolia Wolverine Expedition. This lesson may be completed in portions at the end of the first six lessons to reinforce each lesson's major ideas.

BACKGROUND AND VOCABULARY:

SIGNS OF LIFE EXAMPLES

Tracks
Hair/Fur
Feathers
Scat
Nests
Burrows
Spider webs
Bones
Sounds/calls
Digging and scratching marks on trees
Leaves and branches with pieces missing
Holes in dead trees and logs from insects

PROPER SIGNS OF LIFE COLLECTION TECHNIQUES

- Be careful while you are collecting, making sure not to damage any trees or plants.
- Don't touch scat, dead animals, or trash without a gloved hand.
- Don't put anything you find in your mouth including plants, berries, mushrooms, and leaves.
- Don't reach into places you can't see.
- Return rocks and logs you move to where you found them.
- Wash your hands as soon as you return do you classroom. Do not touch your face without washing your hands first.

WILDLIFE ECOLOGY DATA COLLECTION METHODS

Following the scientific standards of occupancy surveys for rare, low-density species like the wolverine, the Ring of Darhad Mongolia Wolverine Expedition will survey large areas with less intensity, rather than smaller areas with more intensive surveys used for sampling common species (Mackenzie et al 2005). Like all wildlife studies, this expedition has modified data collection techniques to fit the unique needs of the location and species. The distance covered by this research expedition corresponds to how wolverine track surveys should be carried out – surveying a very large sampling area with lower search intensity. While this research is a single transect, and not replicated, the expedition is also testing whether this survey technique is effective in documenting wolverine presence in an area of presumed but unconfirmed occupancy.

Occupancy studies attempt to determine the proportion of suitable habitat that is inhabited by a species. With repeated surveys, this approach can help researchers and managers understand changes in population over time, and whether a relationship exists between distribution, occupancy, and landscape processes. Many unresolved challenges exist in applying this method to naturally rare, wide-ranging species like wolverines, since researchers have to search for a single animal over a very large area. Since baselines data on wolverines in Mongolia are absent, the Mongolian wolverine expedition in the Darhad will adapt some techniques associated with occupancy studies, and some more basic, naturalist techniques associated with simply determining the presence of the species in a given area. By doing this, we gather information on presence and distribution, and also provide a baseline for future, more statistically intense research and monitoring.

When expedition team members discover a wolverine track, the team will backtrack to seek a DNA sample from fur or scat. "Collecting noninvasive genetic samples from putative wolverine (*Gulo gulo*) snow tracks is an effective method for providing definitive species identification for use in Presence-Absence surveys" (Ulizio, et. al, 2006). DNA will be analyzed to determine species identity, minimum number of wolverines detected, and genetic relationship to other wolverine populations, both in Mongolia's other mountain ranges, and globally.

Mackenzie, D. and Royle, J. 2005. Designing occupancy studies: general advice and allocating survey effort. Journal of Applied Ecology. 442: 1105-1114.

Ulizio, T, Squires, J, Pletscher, D., Schwartz, M., Claar, J., and Ruggiero, L.

2006. The Efficacy of Obtaining Genetic-Based Identifications from Putative Wolverine Snow Tracks. Wildlife Society Bulletin. 34(5):1326-1332.

Prior Knowledge

Ecosystems

Biodiversity

Recommended Prior Activities

Lesson 1 of the Ring of Darhad unit: Meet the Team

Lesson 2 of the Ring of Darhad unit: Discover the Darhad

Lesson 3 of the Ring of Darhad unit: Explore the Ecosystem of Northern Mongolia

Lesson 4 of the Ring of Darhad unit: Become a Wildlife Ecologist

Lesson 5 of the Ring of Darhad unit: Biodiversity of the Ring of Darhad

Lesson 6 of the Ring of Darhad unit: Climate Change and the Wolverine

Vocabulary

This lesson uses vocabulary from the entire Ring of Darhad unit. Please see related lessons for vocabulary terms.

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

FIELD JOURNAL

ADVENTURE AND SCIENCE

SCHOOLYARD BIODIVERSITY STUDY

RESEARCHER'S NAME: _____

DATE OF STUDY: _____

ADVENTURE AND SCIENCE RESEARCH PROJECT PROPOSAL:

Team members: _____

Name of study area: _____

Location of study area: _____

_____

Brief description of study area: _____

_____

_____

Permission to study this area given by: _____

Dates of adventure: _____

Method of travel: _____

Permission (permit) to travel given by: _____

Research question: _____

_____

_____

_____

Method of outreach: _____

_____

_____

_____

MAP OF STUDY AREA (INCLUDING LEGEND)

STUDY AREA DESCRIPTION

Team members: _____

Name of study area: _____

Location of study area:_____

City: _____

County: _____

State: _____

Country: _____

General description of study area:

Type of habitat (select as many as applicable):

❒ Grass/meadow – maintained (mowed)

❒ Grass/meadow/shrub – not maintained ("wild")

❒ Savannah/wooded grassland – mixed trees and grass

❒ Forest – mostly coniferous (needles)

❒ Forest – mostly deciduous (leaves)

❒ Forest – even mix of both coniferous and deciduous

❒ Wetland/marsh

❒ Sand/beach

❒ Agriculture/Farms

❒ Developed – Suburban (houses, some green space)

❒ Developed – Urban (in the city, little/no green space)

❒ Water – large pond, lake or ocean

❒ Other – describe: _____

Sources:

http://www.fishwildlife.org/files/ConEd-Schoolyard-Biodiversity-Guide.pdf

ECOSYSTEM

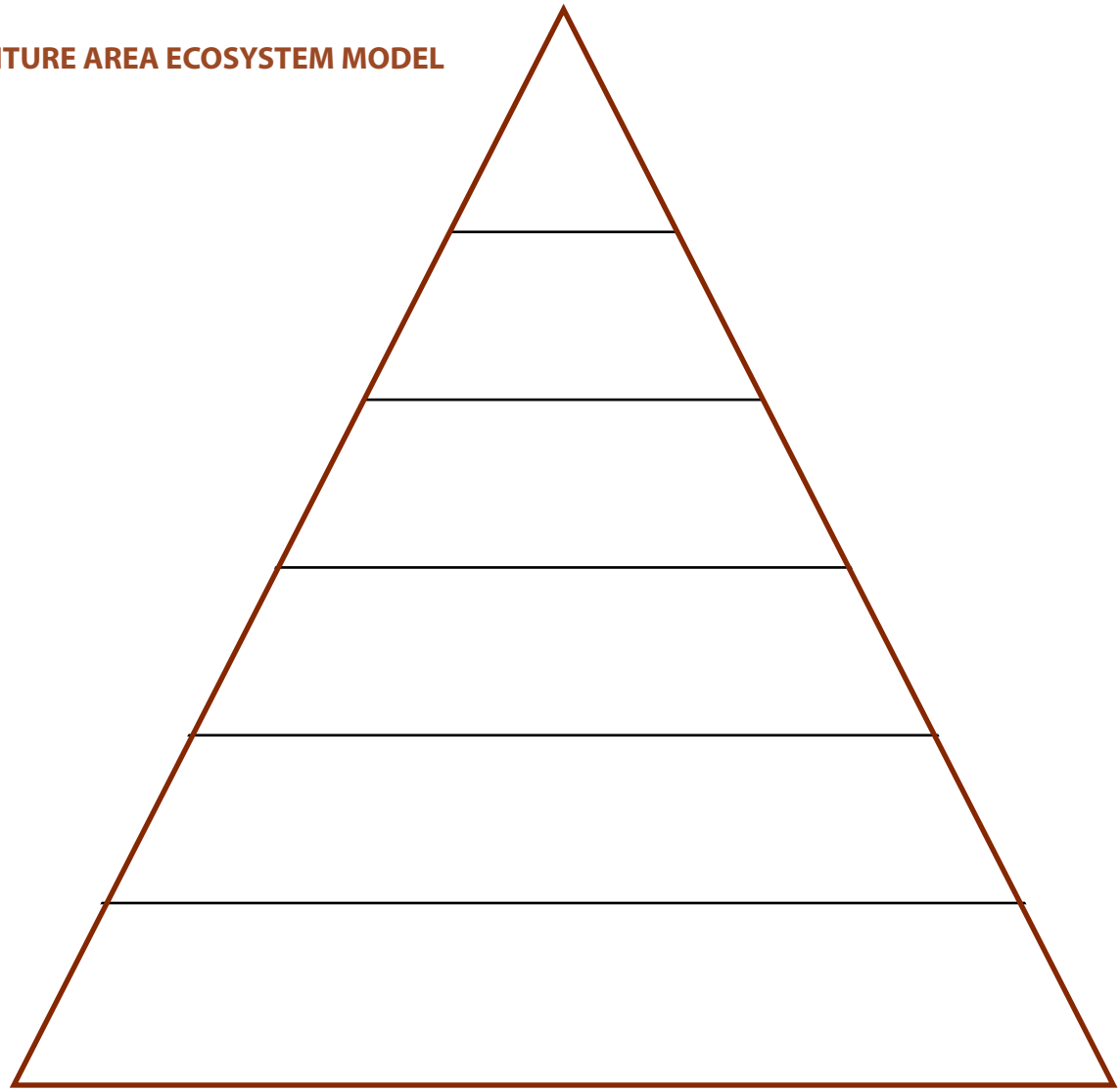
Expected animal species: _____

_____

Expected plant species: _____

_____

ADVENTURE AREA ECOSYSTEM MODEL



What are the ecosystems present in your community?

Can the concept of ecosystem be used at the microscopic level? Why/why not? Expand on your answer using detailed examples.

SPECIES OF INTEREST:

Common Name:

Scientific name:

Group: Mammal, reptile, amphibian, bird, etc.

Characteristics:

Status (native, threatened, endangered, and invasive)

Connected species:

What role does this species play in the adventure area's ecosystem?

Why is this species important?

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

SIGNS OF LIFE DATA SHEET

For each sign of life, write down what you think it is, what animal it is from and what scientists can learn from this specimen.

SPECIMEN #	WHAT IS IT?	WHAT ANIMAL IS IT FROM?	WHAT CAN IT TELL US?
EXAMPLE	A track	Deer	How fast the deer was walking/running, where it was going, how big it is

THE RING OF DARHAD
MONGOLIA WOLVERINE EXPEDITION

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EXAMPLE	A track	Deer	How fast the deer was walking/running, where it was going, how big it is

SIGNS OF LIFE DATA SHEET

How many different living things did you find?

Where did you find different things?

Were species evenly distributed across your area or did you find a greater variety in a particular location?

If there were diversity differences, what area had the greatest diversity?

Do you think as a whole group you found everything out there?

What factors may have affected the number of species you found?

What was the hardest part of the study?

Were you surprised by anything you found?

Name:_____

BASIC BIODIVERSITY INDEX

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of your study area.

SPECIES NAMES	POPULATION (# of individuals found)
TOTAL # OF SPECIES:	**TOTAL NUMBER OF ORGANISMS:**

How many different species are in your sampling area?

What species has the largest population?

How many organisms total are in your sampling area?

Calculate the biodiversity index for your sampling area:

TOTAL # OF SPECIES ÷ TOTAL NUMBER OF ORGANISMS = BIODIVERSITY INDEX

_____ ÷ _____ = _____

Compare your biodiversity index to your classmates and answer the following questions.

Is your sampling area rich in diversity? Why or why not?

Do all sampling areas have the same biodiversity index?

Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?

What can scientists use this biodiversity index for?

Name:_____

SIMPSON BIODIVERSITY INDEX

Calculate the Simpson Biodiversity Index (or how diverse and healthy an ecosystem is) of your study area.

SPECIES NAMES	POPULATION (# of individuals found)	n(n-1)
(A) Total: (Richness)	**(B) Total:**	**(C) TOTAL**

Calculate the Simpson Index of Diversity for your bag of candy.

The equation for this method is: $D = \sum_{i=1}^{S} \frac{n_i(n_i - 1)}{N(N-1)}$

Where:

D is the index we are calculating

n is the number of individuals of a given species

N is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

Subtract the total number of species (number in box A) by 1.

_____

Multiple this number by the total number of species (number in box A).

_____

Divide the sum of n(n-1) (number in box C) by this answer.

_____

The answer is D value which ranges between 0 and 1. With this index, 1 represents infinite diversity and 0, no diversity.

Describe the diversity of your sampling area and how you came to your conclusion.

_____
_____
_____

Compare your biodiversity index to your classmates and answer the following questions.

Is your sampling area rich in diversity? Why or why not?

Do all sampling areas have the same biodiversity index?

Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?

What can scientists use this biodiversity index for?