

# ZOMBIE BASED GEOGRAPHY

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# SURVIVAL



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## **Zombie-Based Geography**

Book 2

Second Edition  
David Hunter



### **About the author**

**David Hunter**, the author of the Zombie-Based Learning program, holds a master's degree in teaching. As a teacher, he designed this curriculum to allow teachers to focus on teaching and not have to track down resources—to make teaching easier. He has been a teacher of social studies and language arts at the middle school level, helping to develop Bellevue Big Picture School project-based humanities curriculum. He has served as an advisory board member of Amplify Education, Inc. and as a curriculum consultant for such companies as Valve Software, TED-Ed, and Microsoft.

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# WELCOME TO SURVIVAL!

When the zombies attack, where should we run, where regroup, and where rebuild our lives? These critical survival questions can focus student attention on a highly motivating and dangerously overlooked fact: Geography skills can save you from an impending zombie apocalypse!

Developed by David Hunter, *Zombie-Based Geography* uses students' natural desire to survive zombie assaults to motivate study of a complete curriculum based on the 2012 8th and 12th Grade National Geography Standards. Students then apply those skills in a simulation based on surviving when hordes of slaving zombies threaten to overrun their neighborhoods.



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# ● CONTENTS ●

Why Zombie-Based Geography? . . . . .	ix
General Instructions for Projects. . . . .	x

## **Project 04: Surviving the Physical Environment**

Explaining the Project: Concept . . . . .	3
Surviving the Physical Environment—Physical Characteristics:	
Outline . . . . .	4
Pre- and Post-assessment Quiz Answers . . . . .	5
National Geography Standards . . . . .	6
Summative Assessment Rubric . . . . .	7
Settlement Location Report 01: Introduction . . . . .	9
Choosing a Settlement Location: Physical Characteristics—	
Pre-assessment Quiz . . . . .	10
Choosing a Settlement Location: Physical Characteristics—	
Post-assessment Quiz . . . . .	12

<b>Lesson 1—Physical Characteristics . . . . .</b>	<b>14</b>
Physical Characteristics . . . . .	16
Physical Characteristics Exit Ticket . . . . .	17

<b>Lesson 2—Landform Patterns . . . . .</b>	<b>18</b>
The Interior of the Earth . . . . .	20
Patterns of Landforms: Chemical Weathering. . . . .	23
Patterns of Landforms: Erosion . . . . .	24
Patterns of Landforms: Folded Mountains . . . . .	25
Patterns of Landforms: Physical Weathering. . . . .	26
Patterns of Landforms: Tectonic Faults . . . . .	27
Patterns of Landforms: Volcanic Mountains . . . . .	28
Landform Patterns Exit Ticket. . . . .	29

<b>Lesson 3—Climate Patterns . . . . .</b>	<b>30</b>
Climate Patterns: Large Bodies of Water . . . . .	32
Climate Patterns: Elevation . . . . .	33
Climate Patterns: Latitude. . . . .	34
Climate Patterns: Mountain Ranges . . . . .	35
Climate Patterns: Ocean Currents . . . . .	36
Climate Patterns: Prevailing Winds . . . . .	37
Climate Patterns: Vegetation . . . . .	38

Predicting Climate Patterns . . . . .	39
Climate Patterns Exit Ticket . . . . .	40
<b>Lesson 4—Physical Processes That Change Places . . . . .</b>	<b>41</b>
Physical Change over Time . . . . .	43
Changes in Physical Characteristics Exit Ticket . . . . .	45
<b>Lesson 5—Earth-Sun Relationship . . . . .</b>	<b>46</b>
Earth-Sun Relationship . . . . .	48
Earth-Sun Relationship Exit Ticket . . . . .	50
<b>Lesson 6—Human-Environment Interaction . . . . .</b>	<b>51</b>
Human-Environment Interaction . . . . .	53
HEI Poster Directions . . . . .	54
Human-Environment Interaction Exit Ticket . . . . .	55
<b>Lesson 7—Opportunity and Constraint . . . . .</b>	<b>56</b>
Opportunity and Constraint Readings . . . . .	58
Opportunity and Constraint: Anchorage, AK . . . . .	59
Opportunity and Constraint: Detroit, MI . . . . .	60
Opportunity and Constraint: Houston, TX . . . . .	61
Opportunity and Constraint: Jacksonville, FL . . . . .	62
Opportunity and Constraint: Los Angeles, CA . . . . .	63
Opportunity and Constraint: New York, NY . . . . .	64
Opportunity and Constraint: Seattle, WA . . . . .	65
Opportunity and Constraint Exit Ticket . . . . .	66
<b>Lesson 8—Environment Modification . . . . .</b>	<b>67</b>
Modification Reading 1 . . . . .	69
Modification Reading 2 . . . . .	72
Modification Reading 3 . . . . .	74
Modification Reading 4 . . . . .	77
Modification Reading 5 . . . . .	79
Modification Reading 6 . . . . .	81
Modification Reading 7 . . . . .	84
Environment Modification Poster Directions . . . . .	86
Modifying the Environment Exit Ticket . . . . .	87
<b>Lesson 9—Natural Hazards . . . . .</b>	<b>88</b>
Natural Hazards KWL . . . . .	90
Natural Hazards . . . . .	91
Natural Hazards Research Directions . . . . .	95

<b>Lesson 10—Changing Perceptions</b> . . . . .	<b>96</b>
Changing Perceptions Exit Ticket . . . . .	98

## **Project 05: Natural Resources for Survival**

Explaining the Project: Concept . . . . .	101
Natural Resources for Survival—Natural Resources: Outline. . . . .	102
Pre- and Post-assessment Quiz Answers . . . . .	103
National Geography Standards . . . . .	103
Summative Assessment Rubric . . . . .	104
Settlement Location Report 02: Introduction . . . . .	105
Natural Resources for Survival: Pre-assessment Quiz . . . . .	106
Natural Resources for Survival: Post-assessment Quiz. . . . .	107
<b>Lesson 1—What Are Resources?</b> . . . . .	<b>108</b>
Resources . . . . .	110
Resources Poster Directions . . . . .	112
Resources Exit Ticket . . . . .	113
<b>Lesson 2—Types of Resources</b> . . . . .	<b>114</b>
Types of Resources KWL . . . . .	116
Types of Resources . . . . .	117
Examples of Types of Resources . . . . .	118
<b>Lesson 3—Cultural Use of Resources</b> . . . . .	<b>119</b>
Multiple Uses for Dung . . . . .	121
Multiple Uses for Resources . . . . .	123
Cultural Diversity in Resources Exit Ticket. . . . .	124
<b>Lesson 4—Processes That Lead to Resources</b> . . . . .	<b>125</b>
Formation of Resources . . . . .	127
Estimating Locations of Resources . . . . .	129
Physical Conditions for Resources Exit Ticket . . . . .	131
<b>Lesson 5—Where Are Resources Found?</b> . . . . .	<b>132</b>
Researching Locations of Resources . . . . .	134
Location of Resources Exit Ticket . . . . .	135
<b>Lesson 6—Resource Advantages</b> . . . . .	<b>136</b>
Best Resources For . . . . .	138
Zombie Survival Resources Poster Directions . . . . .	139
Comparing Locations Exit Ticket. . . . .	140

## **Project 06: Zombie and Human Migration Patterns**

Explaining the Project: Concept . . . . .	143
Zombie and Human Migration Patterns . . . . .	144
Pre- and Post-assessment Quiz Answers . . . . .	145
National Geography Standards . . . . .	145
Summative Assessment Rubric . . . . .	146
Settlement Location Report 03: Introduction . . . . .	147
Choosing a Settlement Location: Migration— Pre-assessment Quiz . . . . .	148
Choosing a Settlement Location: Migration— Post-assessment Quiz . . . . .	149
<b>Lesson 1—What Is Migration? . . . . .</b>	<b>150</b>
Migration . . . . .	152
Global Extents World Map . . . . .	153
Migration Exit Ticket . . . . .	154
<b>Lesson 2—What Influences Where People Settle? . . . . .</b>	<b>155</b>
Locations of Settlements Exit Ticket . . . . .	157
<b>Lesson 3—Different Types of Migration . . . . .</b>	<b>158</b>
Types of Migration . . . . .	160
Migration Poster Directions . . . . .	162
Types of Migration Exit Ticket . . . . .	163
<b>Lesson 4—Push and Pull Factors . . . . .</b>	<b>164</b>
Push and Pull Factors . . . . .	166
Push and Pull Factors Discussion Directions . . . . .	167
Push and Pull Factors Exit Ticket . . . . .	168
<b>Lesson 5—Applying Settlement Geography . . . . .</b>	<b>169</b>
Settlement Geography Poster Directions . . . . .	171
Settlement Geography Exit Ticket . . . . .	172

## **Teacher Feedback Form**

## **Release Form for Photographic Images**

## ● Why Zombie-Based Geography? ●

I love geography and I love zombies, but most of all, I love when learning happens outside of school and engagement happens in school. By building this curriculum, I wanted to show that learning could be done through far-out scenarios, or even just based on student interests. My hope is that this project will engage students, provide standards-based lessons for teachers, and support project-based learning.

This curriculum uses the 2012 National Geography Standards for the 8th grade. These standards were developed by the National Council for the Social Studies, the American Geographical Society, the American Association of Geographers, the National Council for Geographic Education, and the National Geographic Society. Students will learn to think like geographers and also learn to survive the zombie outbreak.

This curriculum also includes a companion graphic novel. *Dead Reckon* tells the story of a student struggling to survive a zombie outbreak. The challenges set up in *Dead Reckon* are the same challenges students face in this curriculum. *Dead Reckon* is meant to keep students engaged and give them reasons to tackle the geographic problems they need to solve.

My goal was to prove that rigorous academic concepts could be learned through engaging scenarios. I believe I've been successful, but this is also just the beginning. The true opportunities in education and curriculum are just being approached. I look forward to a future where engaging learning experiences are built with students in mind.

—David Hunter

## ● General Instructions for Projects ●

Zombie-Based Learning contains a total of ten interactive projects designed to engage students with geographic tools and knowledge. Each project contains an explanation of the project's goals and an outline of the unit's lessons to introduce and guide the teacher through the project. At the conclusion of each project, students will have created some form of report to help them prepare for a zombie outbreak. Instructions and a rubric are provided for each report, along with a sequence of lessons to build the necessary geographic knowledge to compile the project report.

### Teacher Guide

#### **Entry Event**

Before launching into the first project, get students excited about the prospect of a zombie apocalypse. Pick their brains about what they would do in such an event—where they would go, what they would need, and what advantages would help them survive. These are the questions you will return to again and again, but with the aid of specific geographic tools and knowledge to help students find useful answers.

#### **Explaining the Project**

Starting off each project, this element summarizes the standards-based *project goal*, describes the *main final product* of the project, and suggests *options* for expanding or simplifying project work.

#### **Outline**

The second element of each project briefly describes the unit content and its purpose, including:

- Final Project Task—a brief description of the final report to be created
- Driving Question—the question the unit is designed to answer
- Student Learning—a list of specific learning goals
- Lessons—a list of the lesson plans including in the project
- National Standards—a list of the National Geography Standards covered in the project

#### **Rubrics**

The *final product*, or report, draws on all of the knowledge acquired in the project's lessons. A rubric is provided for assessing each report, ensuring that students have grasped each of the standards covered in the project. Rubrics or answer keys may also be provided for other forms of assessments, such as quizzes.

### **Final Report Instructions**

A master is provided of the student handout that outlines the goals and requirements of each project product, usually a report. These instructions reiterate the *driving question*, describe the *final product* and what it must include, and identify what the student is expected to have learned from the unit. This handout can be given to students at the end of a project, or it can be given to students at the beginning of the project so they can track their learning and check off the items they will need to include in their final report.

### **Lessons**

Each lesson begins with an outline of what students are expected to do and what the teacher needs to do to be prepared to guide the class from introduction of the subject through the various steps to the exit ticket. A brief description of the lesson is followed by a note on what will be taught in the next lesson. Elements included are:

- Materials Needed—to help set up for the lesson. This item is accompanied in the margin by copy instructions for student handouts and supporting resources.
- National Standards—the specific standard(s) covered in the lesson.
- Learning Objectives—to help the teacher focus instruction on the learning goals necessary to meet the standard(s).
- Evidence of Learning—what the student will do to demonstrate a grasp of the geographic knowledge imparted by the lesson.
- Lesson Sequence—the order of the lesson's steps.

### **Lesson Sequence Elements**

Every lesson is designed to engage students and encourage interaction with the information and with their classmates and teacher. Lessons draw on a variety of activities and help develop a strong suite of skills that are useful far beyond the classroom. Every lesson opens with a question to be explored using the think/pair/share strategy. Every lesson ends with some presentation of evidence that the student has grasped the lesson, usually in the form of an exit ticket. In between, various methods, strategies, and activities will come into play. Here are some examples:

- Think/Pair/Share—open each lesson with a question. The prompt provided will spur discussion and a sharing of ideas and knowledge among students, who are allowed to pair off with neighbors and explore what they already know and what they wonder about the subject.

- **Define**—Define key terms.
- **Redefine**—Define key term from another angle; difficult concepts may benefit from a simplified definition that is still adequate for the purposes of the lesson and project.
- **Lecture**—Read over the lesson’s first handout with the class and offer clarification or supplemental information in response to student interest.
- **Discussion**—Discuss information or concepts interactively with students.
- **Review**—Briefly go back over concepts or information learned earlier.
- **Jigsaw**—Divide students into groups and distribute handouts; then have students divvy up responsibilities for individual tasks and assemble their combined efforts to complete a classroom exercise.
- **Group Activity**—Divide students into groups to work collectively as a discussion, research, and/or presentation team. Groups will be asked to share what they have learned with the rest of the class.
- **Presentation**—Instruct students to create some form of presentation demonstrating or sharing what they have learned. This is usually either an oral report or a poster, but some lessons allow students to select from a teacher-approved list of presentation types. Keep in mind that preparing a presentation can be time-consuming. More elaborate types of presentation may need to be completed as homework or extended to another day. Ensure that students have appropriate supplies for making maps, drawings, diagrams, and posters.
- **Gallery Walk**—Display illustrative presentations. The gallery setup may be as simple as briefly exhibiting posters on student desks, or a wall may be devoted for extended display. The walk itself is a self-guided student tour of all the presentations during which gallery strollers should take notes and absorb as much information as they can. Some lessons will require them to know what students have learned in other groups, so it is important that students take advantage of shared information.
- **Homework**—Have students complete an activity that requires more time for research or execution than is allowed for in these one-hour lessons.

## Margin Notes

The pages of the teacher guides have a wide margin to accommodate helpful notes. These contain important instructional details for conducting the lesson.

- Teaching Tips—offer suggestions to enhance learning and help orient cross-page instruction.
- Copy Instructions—list how many copies of which handouts and other materials will need to be run off in preparation for the lesson.
- Handouts—shows which handouts go with a particular lesson step.
- Ask—supplies appropriate questions to prompt discussion or exploration.

## Assessment

Each project includes two assessment handouts. The Pre-assessment Quiz gives students a chance to demonstrate what they may already know about the material and concepts to be covered in the project. The Post-assessment Quiz gives you a chance to assess how students have absorbed the materials and concepts they have learned after completing the project.

## Handouts

Masters are provided for all student handouts. Each project contains a handout describing the final product or report. Most have an exit ticket; a lesson plan will note where some other assessment serves as an exit ticket or evidence of learning. Other types of handouts include readings, worksheets, assessments, and map outlines. A note in the margin of the Lesson Sequence of the teacher guide shows where each handout is used in the course of the lesson. Worksheets and quizzes may be turned in for assessment and then returned to students. Handouts should be kept by students for reference as they work on their final reports and for review as they build on their geographic knowledge in future lessons.

## Other Materials

Most materials are supplied as handouts. Some lessons provide teachers with reference lists or other supplemental information necessary for the lesson. Students will be expected to use maps, globes, atlases, and other standard tools found in a geography classroom. Some lessons will require internet access or materials downloaded by the teacher and printed out or projected for student use.

## Zombie-Based Geography Program

The complete Zombie-Based Geography program comprises four books. The program can be purchased and implemented as a package of ten projects, or individual volumes can be purchased separately. Book 1, which comes with the graphic novel *Dead Reckon*, is essential, but Books 2 and 3 can be purchased later to complete the program.

### ***Dead Reckon***

This companion to Book 1 is a graphic novel about the zombie outbreak that gives rise to the geographic concepts explored in the first three projects.

### ***Book 1: Outbreak***

Book 1 lays a foundation for understanding geographic concepts and tools.

- Project 01—Mapping the Outbreak
- Project 02—Mapping Safe and Unsafe Regions
- Project 03—Mental Maps in the Zombie Outbreak
- Final Projects: Student Map Project, Zombie Attack Map, and Neighborhood Mental Map

### ***Book 2: Survival***

Book 2 builds on the knowledge acquired in Book 1 while exploring the physical characteristics of Earth, its natural hazards and resources, and human migration.

- Project 04—Surviving the Physical Environment
- Project 05—Natural Resources for Survival
- Project 06—Zombie and Human Migration Patterns
- Final Projects: Settlement Location Report, parts 1–3

### ***Book 3: Resettlement***

Book 3 integrates the geographic skills, information, and reasoning developed in Books 1 and 2 as students become planners and problem solvers, learning to create models and make predictions for a long-lasting, zombie-proof settlement.

- Project 07—Planning Safer Settlements
- Project 08—Human-Environment Impact
- Project 09—Predictive Geography: Ecosystems, Demographics, and Historical Models
- Project 10—Cultural Geography after the Apocalypse
- Final Projects: Settlement Design Report, parts 1–2; Future Plan Portfolio, parts 1–5

# **PROJECT 04: SURVIVING THE PHYSICAL ENVIRONMENT**



# Explaining the Project

## Concept of Project 04

### Surviving the Physical Environment: Project 04

#### Project Goal

The main goal of this project is for students to understand the *physical characteristics* of locations. Along the way they learn how these characteristics are formed or influenced as well as how they affect our perceptions. Students also learn about *human-environment interaction*.

#### Main Final Product

At the end of the project, students will complete some form of report describing the location they believe would be best to build their post-zombie outbreak settlement. The report must describe the physical characteristics of the location, including climate and landforms, and must also explain what the location's opportunities and constraints would be. This report is just one part of what will inform their decision on where to settle.

#### Project Options

There are many ways that students could present this information. You may want to manage one format for all students or allow students to choose their own formats. As long as they meet the content requirements of the rubric, they will be showing their understanding of the standards.

The following are just a few possible ways students could complete this project:

- Formal written report
- Oral presentation
- Poster
- Persuasive letter
- Video recording
- Audio recording

There are many other ways. I find that students can be very engaged when choosing their own style every now and then. I also find that when choosing a format that the whole class has to do, it is a great opportunity to teach other skills. For example, if you require a poster, take the time to teach students elements of design and require them to practice that design in their posters.

# Surviving the Physical Environment— Physical Characteristics

## Outline of Project 04

### Teaching Tip

This project helps students choose the best location based on physical characteristics.



### Handout

- Settlement Location Report 01

### Ask

Where is the best place to build our stronghold?



### Handout

- Choosing a Physical Location: Physical Characteristics: Pre-assessment Quiz

### Teaching Tip

You may choose to do all of the lessons, and then the project. You may also choose to launch the project, and then use the lessons to assist students in the completion of their goal.



## Choosing a Location: Project 04

The physical environment is the background to all human activities. Understanding the systems that make up our physical environment influences the choices we make about where to live, what to build, and what activities to take part in.

In a zombie outbreak, the physical environment would continue to influence us. We would actually be more open and susceptible to it. This is even more reason to understand it.

### Final Project Task

Students will create the first part of their Settlement Location Report on best locations to build a new settlement based on physical characteristics.

### Driving Question

How does our *physical environment* influence our lives or survival?

## Pre-assessment

### Student Learning

- How to *analyze* physical characteristics.
- Understand* how characteristics change or follow patterns.
- How to *analyze* the interaction between humans and the environment.
- Understand* natural hazards and their contributing factors.

### Lessons

- Physical Characteristics
- Landform Patterns
- Climate Patterns
- Physical Processes That Change Places
- Earth-Sun Relationship
- Human-Environment Interaction

7. Opportunity and Constraint
8. Environment Modification
9. Natural Hazards and Causes
10. Changing Perceptions

**Handout**

- Choosing a Settlement  
Location: Physical  
Characteristics: Post-  
assessment Quiz

**Pre- and Post-assessment Quiz Answers**

1. What are some *landforms* of Earth?

The natural land features of the Earth, such as mountain ranges, canyons, etc.

2. How do landforms *change over time*?

By means of weathering, erosion, and volcanic and tectonic activity.

3. What are some *patterns* in landforms on Earth?

Answers will vary but may include: Mountain ranges in the Americas typically run north to south; the Great Rift Valley of East Africa.

4. How is climate on Earth affected by the Sun?

The Sun's energy drives Earth's climate.

5. What *opportunities* come from different landforms?

Resources, transportation, climate.

6. What *constraints* come from different landforms?

Lack of resources, obstacles to movement, harsh climate.

7. What are some *natural hazards* and how are they caused?

Tectonic events from forces in Earth's interior; weather events from forces in the atmosphere.

8. How have people's *perceptions* of the environment changed over time?

Answers are numerous and will vary.

## **National Geography Standards**

### **8th Grade**

4.2.A—Explain the ways that physical processes change places.

7.1.A—Identify and describe patterns in the environment that result from the interaction of Earth's physical processes.

7.1.B —Analyze and explain patterns of physical features resulting from the interactions of Earth's physical processes.

7.2.A—Explain how Earth-Sun relationships drive physical processes and create annual patterns on Earth.

15.1.A—Explain how the characteristics of different physical environments offer opportunities for human activities.

15.1.B—Explain how the characteristics of different physical environments place constraints on human activities.

15.2.A-B—Describe and explain the types, causes, and characteristics of environmental hazards.

17.3.A—Explain how historical events were influenced by people's perceptions of people, places, regions, and environments.

### **12th Grade**

4.2.A—Explain how physical or human characteristics interact to create a place by giving it meaning and significance.

7.1.A—Explain the changing relationships among climate, vegetation, and landforms; analyze and explain the relationships between physical processes and the location of land features.

7.2.A—Explain how variability in Earth-Sun relationships affects Earth's physical processes over time.

7.3.A—Analyze and explain the results of interactions of physical processes over time.

15.1.A—Explain how people may view the physical environment as both an opportunity and a constraint depending on their choice of activities.

15.2.A—Explain and compare how people in different environments think about and respond to environmental hazards.

15.2.B—Explain how environmental hazards affect human systems and why people may have different ways of reacting to them.

17.3.A—Analyze and evaluate the role that people's past perceptions of people, places, regions, and environments played as historical events unfolded.

**Rubric for Settlement Location Report 01: Choosing a Location**

	1	2	3	4
<b>Physical Change</b> 4.2.A Explain the ways that physical processes change places.	Location's physical characteristics are not explained.	Location's physical characteristics are explained but little is described about how they may change.	Describes location's physical characteristics and the changes that may occur over time.	Many aspects of physical characteristics are deeply investigated. Integrates theories of how changes may affect settlement.
<b>Physical Patterns</b> 7.1.A Identify and describe patterns in the environment that result from the interaction of Earth's physical processes.	Patterns across physical environments are not identified.	Only a simple and general pattern is connected to landforms in this location.	Recognizes patterns in the surrounding physical environment.	Many physical characteristics of the location are explained in the context of surrounding physical characteristics.
<b>Physical Patterns</b> 7.1.B Analyze and explain patterns of physical features resulting from the interactions of Earth's physical processes.	Does not explain how physical features of this area were formed.	Explains the basic formation of only minimal physical features.	Explains what processes led to this environment.	Explains in depth what processes led to this environment in particular.
<b>Sun-Earth</b> 7.2.A Explain how Earth-Sun relationships drive physical processes and create annual patterns on Earth.	Does not accurately explain Earth-Sun relationship.	Explains very basically how the Sun affects this location. Limited to somewhat obvious examples.	Explains how the climate of this location is affected by Earth-Sun relationship.	Clearly explains how Earth-Sun relationship affects this location and provides specific examples of this relationship.

## Project 04: Surviving the Physical Environment

### Physical Characteristics

#### Rubric for Settlement Location Report 01: Choosing a Location

	1	2	3	4
<b>Opportunities</b> 15.1.A Explain how the characteristics of different physical environments offer opportunities for human activities.	Does not explain the opportunities offered by the physical characteristics of this location.	Gives some idea of the opportunities of the physical characteristics of this location.	Describes the opportunities of the physical characteristics of this location.	Provides details of the opportunities of the physical characteristics of this location. Based on research. Extensive description.
<b>Constraints</b> 15.1.B Explain how the characteristics of different physical environments place constraints on human activities.	Does not explain constraints imposed by the physical characteristics of this location.	Gives some idea of the constraints of the physical characteristics of this location.	Describes the constraints of the physical characteristics of this location.	Provides details of the constraints of the physical characteristics of this location. Based on research. Extensive description.
<b>Hazards</b> 15.2.A-B Describe and explain the types, causes, and characteristics of environmental hazards.	Does not address the issue of natural hazards.	Gives a very general description of hazards to avoid or does not explain why to avoid them.	Describes natural hazards, their causes, ways to avoid and why.	Describes natural hazards to avoid, why, their causes, and where they are often located or provides reasonable suggestions for protection from hazards.
<b>Perceptions</b> 17.3.A Explain how historical events were influenced by people's perceptions of people, places, regions, and environments.	Does not identify any possible perceptions people have of this location.	Identifies possible perceptions people have of this location.	Identifies possible perceptions people have of this location and how they would change after a zombie outbreak.	Identifies possible perceptions people have of this location, how they would change after a zombie outbreak, and how they have changed before.

# SETTLEMENT LOCATION REPORT 01

## Introduction

Just because it's the zombie apocalypse, the Earth doesn't stop affecting the survivors. We survivors need to keep dealing with *weather*, *natural hazards*, and the *constraints* of our *physical environment*. Why not find the *best* place to build a stronghold? This project will help make sure you choose a location that will provide all the opportunities you need.

### Driving Question

How does our *physical environment* influence our lives or survival? Or, where is the best place to build our stronghold?

### What You'll Produce

A *report* explaining the best location to build a settlement based on its physical characteristics. Check with your teacher to see what options you have for your report.

### Your Report Will Include the Following Information:

- *Location* you think would be best to go to build a settlement.
- *Physical characteristics* of your location and its surroundings, including how they were formed and how they might change over time.
- Description of the *climate* of your location and how it is affected by the Sun.
- *Opportunities* the physical characteristics of your location provide.
- *Constraints* imposed by the physical characteristics of your location.
- *Natural hazards* you might face in your location and how to avoid them.
- *Perceptions* people have of your location and how the zombie outbreak might change that.

It might look like a big report now, but why cut corners when it comes to survival? Once you learn what these things are, this report will be no sweat.



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CHOOSING A SETTLEMENT LOCATION: PHYSICAL CHARACTERISTICS

## *Pre-assessment Quiz*

Answer the following questions. You will soon learn all about these concepts.

1. What are some *landforms* of Earth?
2. How do landforms *change over time*?
3. What are some *patterns* in landforms on Earth?



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CHOOSING A SETTLEMENT LOCATION: PHYSICAL CHARACTERISTICS

## *Post-assessment Quiz*

Answer the following questions. You will soon learn all about these concepts.

1. What are some *landforms* of geography?
2. How do landforms *change over time*?
3. What are some *patterns* in landforms on Earth?



# Lesson 1—Physical Characteristics

## *Understanding Landforms and Climate*



One class period of instruction

This lesson introduces students to the physical characteristics of locations. Students will understand *landforms* and *climate*. They will show their learning by describing the landforms and climate of a location.

Lesson 2 will look at the patterns of landforms on Earth.

### **Copy Instructions**

Print one of each  
handout for each  
student.



### **Materials Needed**

- **Physical Characteristics**
- **Physical Characteristics Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

7.1.B—Analyze and explain patterns of physical features resulting from the interactions of Earth’s physical processes.

#### **12th Grade**

7.1.A—Explain the changing relationships among climate, vegetation, and landforms; analyze and explain the relationships between physical processes and the location of land features.

### **Learning Objectives**

1. Define what physical characteristics are.
2. Identify basic landforms and climate.

### **Evidence of Learning**

Identify and describe the landforms and climate of a location.



## Lesson Sequence

### 1. Think/Pair/Share

What are physical characteristics of Earth?

### 2. Define

**Physical characteristics:** the landforms and climate of a location.

### 3. Define

**Landforms:** the natural land features of Earth's surface.

### 4. Landform Examples

Students provide examples of landforms. Copy down a list of the examples students give.

### 5. Define

**Climate:** the prevailing weather conditions in an area in general or over a long period of time.

### 6. Parts of Climate

Students suggest what makes up climate (e.g., rainfall or precipitation, wind, temperature).

### 7. Describe Local Physical Characteristics

Students write a description of the local climate and physical characteristics.

### 8. Exit Ticket

Describe physical characteristics of the location pictured in the exit ticket.

#### Handout

- Physical Characteristics

#### Handout

- Physical Characteristics Exit Ticket

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# PHYSICAL CHARACTERISTICS

## *Understanding Physical Characteristics*

Fill in the examples as you discuss definitions with the class.

### Definitions and Examples

#### 1. Physical Characteristics

The **physical characteristics** of a location are the *landforms* and *climate* of that location.

There are many combinations of physical characteristics on Earth. The physical characteristics have a large influence on locations.

#### 2. Landforms

**Landforms** are the natural land features of Earth's surface. In other words, they are the **formations** of **land**.

List examples of *landforms* below:

How do you think landforms affect zombies? How would a zombie survive in mountains? In plains?

What kinds of landforms would you want to be surrounded by during the outbreak?

#### 3. Climate

**Climate** is the prevailing weather conditions in an area in general or over a long period of time. In other words, climate is the average weather over a long time.

List things that make up *climate* below:

How do you think climate affects zombies? How would a zombie survive in cold climates? In warm climates?

What kind of climate would you want during the outbreak?

#### To Simplify:

- **Physical characteristics:** climate and landforms
- **Landforms:** forms of land
- **Climate:** average weather of a place

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Period: \_\_\_\_\_

# PHYSICAL CHARACTERISTICS EXIT TICKET

*Show Your Understanding of Physical Characteristics*

You have learned about landforms and climate of locations. *Reflect* on what you have learned.

Look at the image below. What are the physical characteristics you would expect it to have? *Answer* the questions below.



1. Describe the landforms:
2. Describe what you think the climate would be like:

## Lesson 2—Landform Patterns

### *Understanding Patterns in the Physical Environment*



One class period of instruction

This lesson introduces students to the *formation of physical patterns* on Earth. Students will look for patterns of physical landforms and then groups will research and present on how different landforms are created.

Lesson 3 will look at the patterns of climate on Earth.

#### **Copy Instructions**

Print one copy of **The Interior of the Earth** reading for each student. Print **Landforms Patterns** jigsaw readings for each group.



#### **Materials Needed**

- Topographical map of world
- **The Interior of the Earth** reading
- **Patterns of Landforms** jigsaw readings
- **Landform Patterns Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

7.1.B—Analyze and explain patterns of physical features resulting from the interactions of Earth’s physical processes.

##### **12th Grade**

7.1.A—Explain the changing relationships among climate, vegetation, and landforms; analyze and explain the relationships between physical processes and the location of land features.

#### **Learning Objectives**

1. Identify patterns of landforms.
2. Understand how landforms are created.

#### **Evidence of Learning**

Identify and describe patterns of major global landforms on a map.

## Lesson Sequence

### 1. Think/Pair/Share

Are there any patterns of landforms on Earth?

### 2. Discuss

Ask what patterns students see and why they think the patterns are there. Make sure students notice that most mountains and high elevations are located on coasts of continents and that large mountain ranges occur along the west coasts of North and South America.

### 3. Read

As a class, read through **The Interior of the Earth**.

### 4. Jigsaw

Split students into six groups and provide each group with a reading. Groups should read, discuss, and prepare a short presentation to inform the class about what they read.

### 5. Presentation

Groups should present the important information they have learned about the formation of landforms.

### 6. Exit Ticket

Identify landform patterns and possible reasons for patterns.

**Teaching Tip**

Display topographical world map.

**Handout**

- The Interior of the Earth

**Handouts**

- Patterns of Landforms jigsaw readings

**Handout**

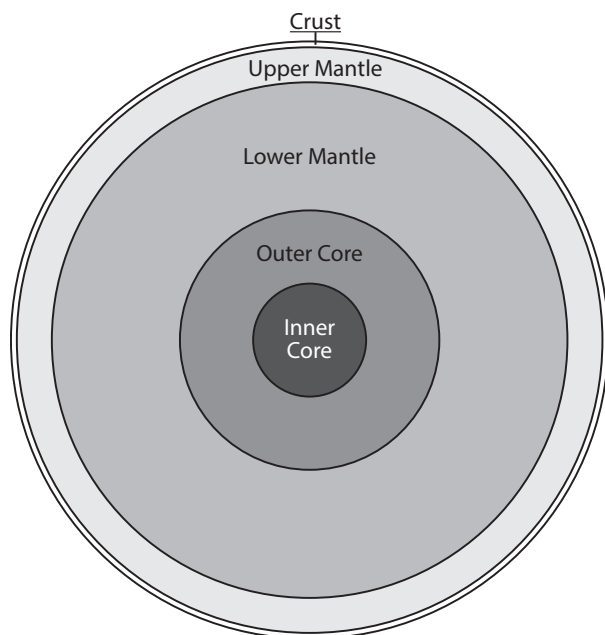
- Landform Patterns Exit Ticket



# THE INTERIOR OF THE EARTH

by Eugene C. Robertson

## Introduction



Three centuries ago, the English scientist Isaac Newton calculated, from his studies of planets and the force of gravity, that the average density of the Earth is twice that of surface rocks and therefore that the Earth's interior must be composed of much denser material. Our knowledge of what's inside the Earth has improved immensely since Newton's time, but

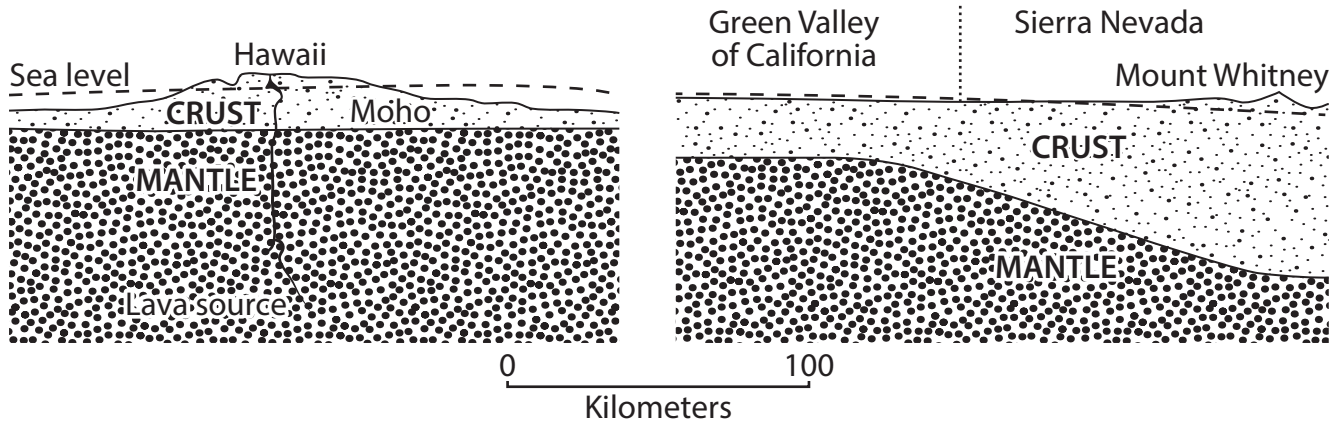
his estimate of the density remains essentially unchanged. Our current information comes from studies of the paths and characteristics of earthquake waves travelling through the Earth, as well as from laboratory experiments on surface minerals and rocks at high pressure and temperature. Other important data on the Earth's interior come from geological observation of surface rocks and studies of the Earth's motions in the Solar System, its gravity and magnetic fields, and the flow of heat from inside the Earth.

The planet Earth is made up of three main shells: the very thin, brittle crust, the mantle, and the core; the mantle and core are each divided into two parts. . . . Although the core and mantle are about equal in thickness, the core actually forms only 15 percent of the Earth's volume, whereas the mantle occupies 84 percent. The crust makes up the remaining 1 percent. Our knowledge of the layering and chemical composition of the Earth is steadily being improved by earth scientists doing laboratory experiments on rocks at high pressure and analyzing earthquake records on computers.

## The Crust

Because the crust is accessible to us, its geology has been extensively studied, and therefore much more information is known about its structure and composition than about the structure and composition of the mantle and core. Within the crust, intricate patterns are created when rocks are redistributed and deposited in layers through the geologic processes of eruption and intrusion of lava, erosion, and consolidation of rock particles, and solidification and recrystallization of porous rock.

By the large-scale process of plate tectonics, about twelve plates, which contain combinations of continents and ocean basins, have moved around on the Earth's surface through much of geologic time. The edges of the plates are marked by concentrations of earthquakes and volcanoes. Collisions of plates can produce mountains like the Himalayas, the tallest range in the world. The plates include the crust and part of the upper mantle, and they move over a hot, yielding upper mantle zone at very slow rates of a



**Figure 1.** The oceanic crust at the island of Hawaii is about 5 kilometers thick. The thickness of the continental crust under eastern California ranges from 25 kilometers under the Great Valley to 60 kilometers under the Sierra Nevada.

few centimeters per year, slower than the rate at which fingernails grow. The crust is much thinner under the oceans than under continents (see figure above).

The boundary between the crust and mantle is called the Mohorovicic discontinuity (or Moho); it is named in honor of the man who discovered it, the Croatian scientist Andrija Mohorovicic. No one has ever seen this boundary, but it can be

detected by a sharp increase downward in the speed of earthquake waves there. The explanation for the increase at the Moho is presumed to be a change in rock types. Drill holes to penetrate the Moho have been proposed, and a Soviet hole on the Kola Peninsula has been drilled to a depth of 12 kilometers, but drilling expense increases enormously with depth, and Moho penetration is not likely very soon.

## The Mantle

Our knowledge of the upper mantle, including the tectonic plates, is derived from analyses of earthquake waves; heat flow, magnetic, and gravity studies; and laboratory experiments on rocks and minerals. Between 100 and 200 kilometers below the Earth's surface, the temperature of the rock is near the melting point; molten rock erupted by some volcanoes originates in this region of the mantle. This zone of extremely yielding rock has a slightly lower velocity of earthquake waves and is presumed to be the layer on which the tectonic plates ride. Below this low-velocity zone is a transition

zone in the upper mantle; it contains two discontinuities caused by changes from less dense to more dense minerals. The chemical composition and crystal forms of these minerals have been identified by laboratory experiments at high pressure and temperature. The lower mantle, below the transition zone, is made up of relatively simple iron and magnesium silicate minerals, which change gradually with depth to very dense forms. Going from mantle to core, there is a marked decrease (about 30 percent) in earthquake wave velocity and a marked increase (about 30 percent) in density.

## The Core

The core was the first internal structural element to be identified. It was discovered in 1906 by R.D. Oldham, from his study of earthquake records,

and it helped to explain Newton's calculation of the Earth's density. The outer core is presumed to be liquid because it does not transmit shear (S)

waves and because the velocity of compressional (P) waves that pass through it is sharply reduced. The inner core is considered to be solid because of the behavior of P and S waves passing through it. Data from earthquake waves, rotations and inertia of the whole Earth, magnetic-field dynamo theory, and laboratory experiments on

melting and alloying of iron all contribute to the identification of the composition of the inner and outer core. The core is presumed to be composed principally of iron, with about 10 percent alloy of oxygen or sulfur or nickel, or perhaps some combination of these three elements.

	Thickness (km)	Density (g/cm <sup>2</sup> )		Types of rock found
		Top	Bottom	
<b>Crust</b>	30	2.2	—	Silicic rocks
		—	2.9	Andesite, basalt at base
<b>Upper mantle</b>	720	3.4	—	Peridotite, eclogite, olivine, spinel, garnet, pyroxene
		—	4.4	Perovskite, oxides
<b>Lower mantle</b>	2,171	4.4	—	Magnesium, silicon oxides
		—	5.6	
<b>Outer core</b>	2,259	9.9	—	Iron + oxygen, sulfur, nickel alloy
		—	12.2	
<b>Inner core</b>	1,221	12.8	—	Iron + oxygen, sulfur, nickel alloy
		—	13.1	
<b>Total thickness</b>	6,401			

This table of depths, densities, and composition is derived mostly from information in a textbook by Don L. Anderson (see Suggested Reading). Scientists are continuing to refine the chemical and mineral composition of the Earth's interior

by laboratory experiments, by using pressures 2 million times the pressure of the atmosphere at the surface and temperatures as high as 20,000 degrees C.

### Suggested Reading

- Anderson, D.L., 1989, *Theory of the Earth*: Boston, Blackwell Publications, 366 pages.
- Flint, R.F., and Skinner, B.J., 1977, *Physical Geology*: New York, John Wiley and Sons, 594 pages.
- Press, Frank, and Siever, Raymond, 1974, *Earth: San Francisco*, W.H. Freeman, 649 pages.
- Robertson, E.C., 1966, The interior of the Earth; an elementary description: U.S. Geological Survey Circular 532, 10 pages.
- Smith, P.J., editor, 1986, *The Earth*: New York, Macmillan, 248 pages.
- Yockstick, M.L., 1987, *Earthbook—Encyclopedia of the Earth*: Stockholm, Sweden, Esselte Map Service, 327 pages.

Source: USGS, <http://pubs.usgs.gov/gip/interior/>.

# PATTERNS OF LANDFORMS: CHEMICAL WEATHERING

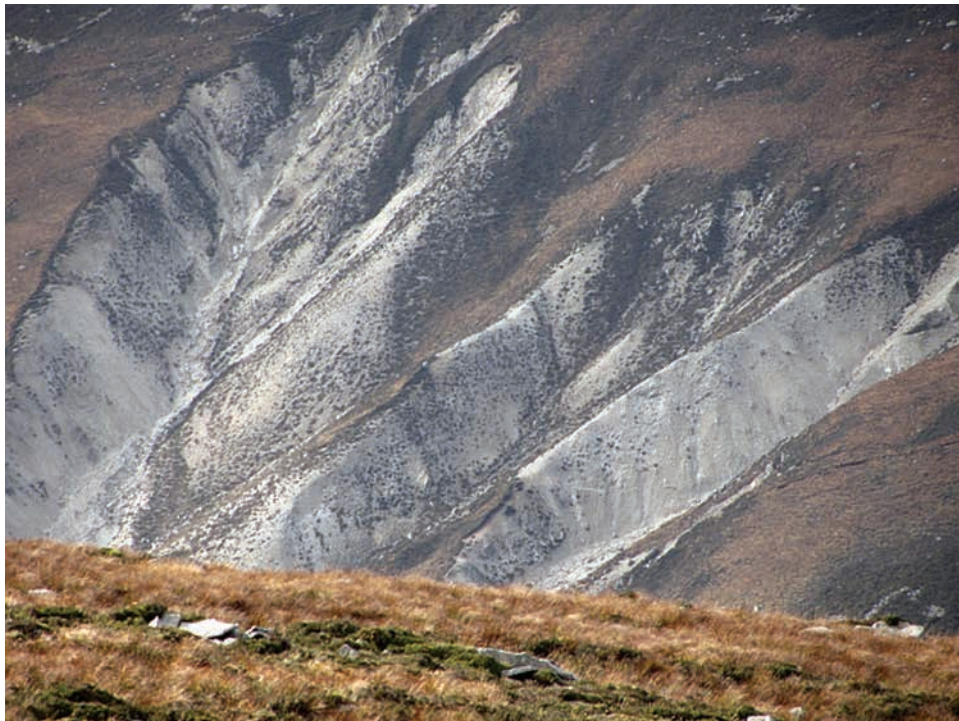
## *How Were Landforms Made?*

*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### Chemical Weathering

Chemical weathering occurs when rocks are chemically dissolved. This is different from physical weathering, which happens when rocks are broken but their physical form does not change. Chemical weathering takes place when chemical reactions break down the bonds holding rocks together. Through chemical weathering, they are broken into smaller pieces. Chemical weathering is facilitated by water, since it transports the chemicals that break down rocks. Therefore chemical weathering occurs more rapidly in warm and humid climates.

The three main types of chemical weathering are oxidation, hydrolysis, and carbonation. Oxidation is the process whereby oxygen combines with another substance to form a compound. Rust is a type of oxidation that happens to iron. Rocks containing large amounts of iron will weaken and crumble when exposed to air and water over long periods. Hydrolysis occurs when water and compounds found in water weaken rocks. There are some times of rocks that will soften and become clay when they are mixed with water. Carbonation occurs when rainwater absorbs carbon dioxide from the atmosphere. The mixture becomes carbonic acid, which is fairly weak, but since there can be a lot of it, over time it can dissolve some minerals contained in rocks. Limestone dissolves pretty easily under carbonation.



Chemical weathering—These slopes chemically changed, turning into clays that are easily eroded.  
© Richard Webb, CC BY 2.0.

# PATTERNS OF LANDFORMS: EROSION

## *How Were Landforms Made?*

*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### Erosion

#### ***What's the difference between weathering and erosion?***

Weathering involves two processes that often work in concert to decompose rocks. Both processes occur in place. No movement is involved in weathering. **Chemical weathering** involves a chemical change in at least some of the minerals within a rock. **Mechanical weathering** involves physically breaking rocks into fragments without changing the chemical make-up of the minerals within it. It's important to keep in mind that weathering is a surface or near-surface process. As you know, metamorphism also produces chemical changes in rocks, but metamorphic chemical changes occur at depth where either the temperature and/or pressure are significantly higher than conditions found on the Earth's surface.

As soon as a rock particle (loosened by one of the two weathering processes) moves, we call it **erosion** or mass wasting. Mass wasting is simply movement down slope due to gravity. Rock falls, slumps, and debris flows are all examples of mass wasting. We call it erosion if the rock particle is moved by some flowing agent such as air, water or ice.

So, here it is: if a particle is loosened, chemically or mechanically, but stays put, call it weathering. Once the particle starts moving, call it erosion.

*Source:* USGS, Geology in the Parks, <http://geomaps.wr.usgs.gov/parks/misc/gweaero.html>.



The Grand Canyon—Erosion was a major force in the creation of the Grand Canyon.

# PATTERNS OF LANDFORMS: FOLDED MOUNTAINS

## *How Were Landforms Made?*

*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### Folded Mountains

Most mountain ranges were formed when continental plates collided with each other. The plates push against each other over long periods of time. One plate's crust gets pushed under the other as the top plate's thin crust bends like clay. The bends in the crust form the mountains. The peaks of these folds are called *anticlines*. The valleys are called *synclines*. The Appalachian mountains and the Alps are examples of mountains caused by folds in tectonic plates.



Folded mountains. © Sten, CC BY-SA 3.0.

# PATTERNS OF LANDFORMS: PHYSICAL WEATHERING

## *How Were Landforms Made?*

*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### Physical Weathering

Physical weathering is the process when rocks are broken but their physical form does not change. This is different from chemical weathering, which happens when rocks are chemically dissolved. Rocks can be physically weathered by movement of water, ice, or even plants. Moving water can shift rocks, sometimes causing them to bump into each other and break them. Water can get into the cracks of rocks, freeze and expand, then cause the crack to widen. If this is repeated, rocks can eventually be broken. This is a common problem that causes breaks in roadways in colder climates. Similarly, plant roots can grow into the cracks of rocks. As the plants grow, the roots can eventually cause them to break apart.



A tree growing and splitting a rock. © Heidi Soosalu, CC BY-SA 3.0.

# PATTERNS OF LANDFORMS: TECTONIC FAULTS

## *How Were Landforms Made?*

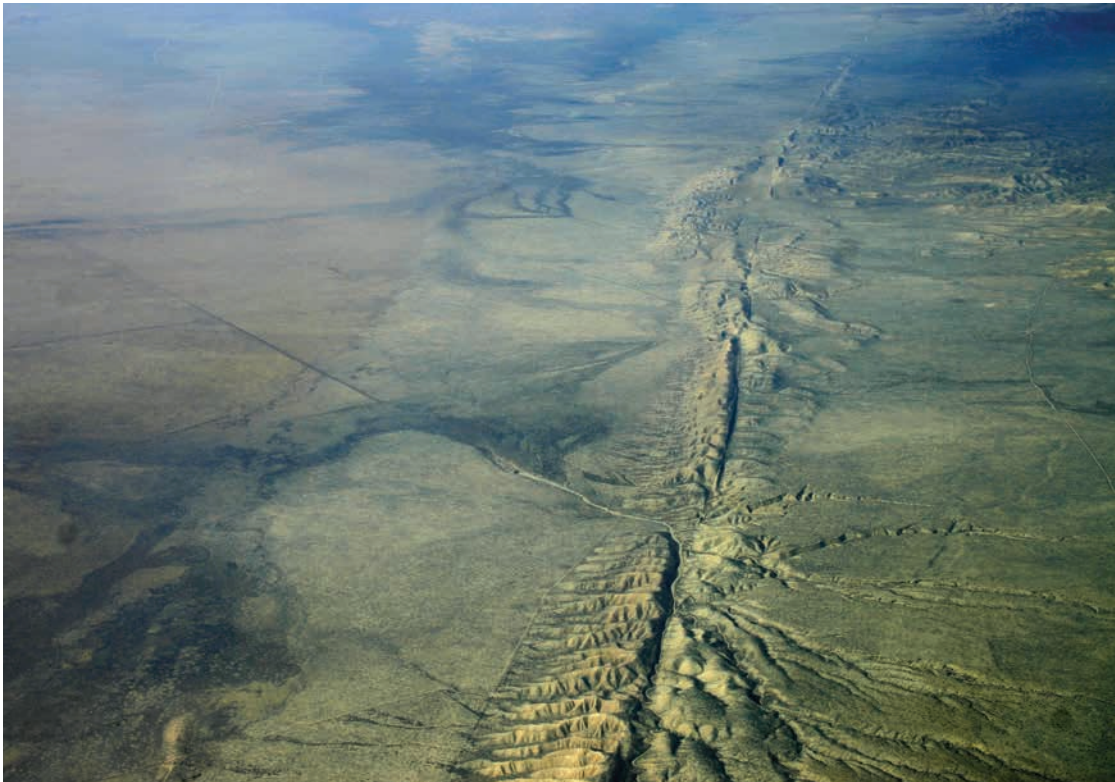
*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### **Tectonic Faults**

*Fault lines* are very large cracks in the Earth's crust. Over time, the crust moves and these fault lines may separate, slide, or become compressed. There are two main types of faults, *normal faults* and *reverse faults*.

*Normal faults* have fault lines that are stretched apart. A basin is formed within the large crack between the faults. Mountains are formed by the fault line edges on the sides of the basin.

*Reverse faults* occur when the plates at the fault line are pressed together. One plate slides under the other, pushing the top plate up. This compression can cause *folded mountains* and *overthrust mountains*. Earthquakes are frequently caused by these compressed fault lines.



The San Andreas fault. © Ian Kluft, CC BY-SA 3.0.

# PATTERNS OF LANDFORMS: VOLCANIC MOUNTAINS

## *How Were Landforms Made?*

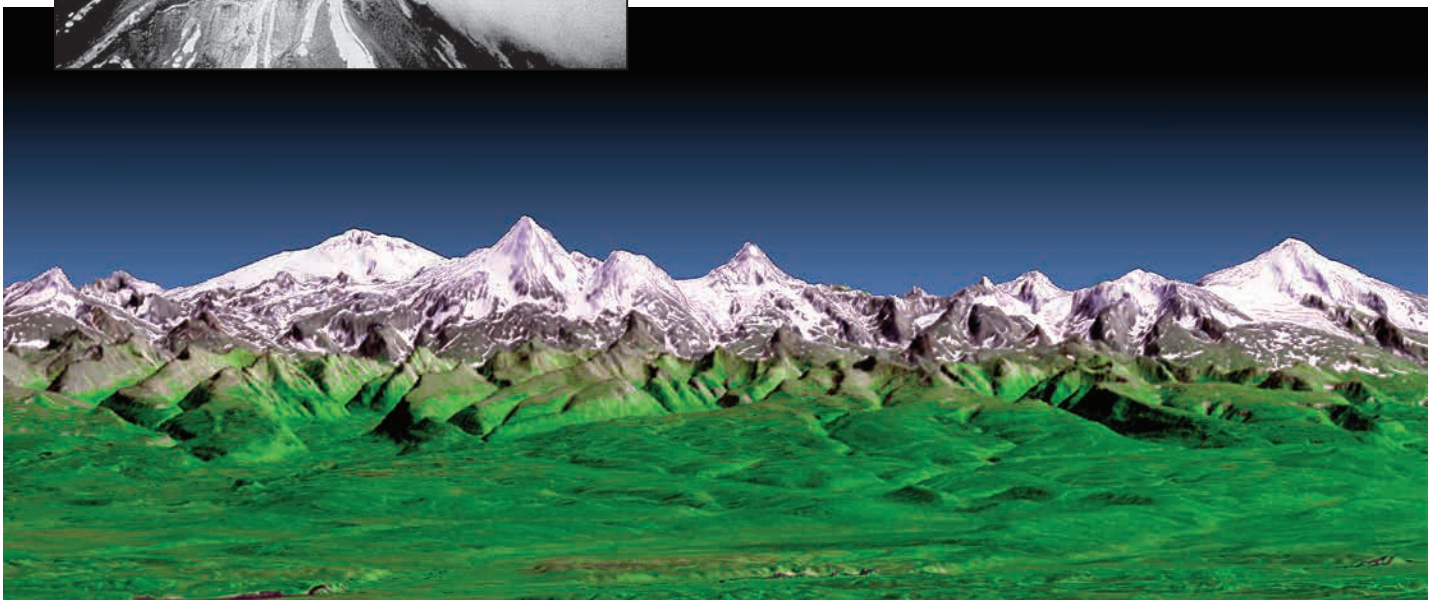
*Read* the information about how landforms were made. *Discuss* as a group and prepare to present what you learn. *Be ready* to present to the class on how these landforms are made.

### Volcanic Mountains

Volcanoes are openings in the Earth's crust where volcanic materials come out. Magma, volcanic ash, and gases rise up from below the surface. This material piles up on the Earth's surface to form a mountain. A volcano is commonly formed where tectonic plates meet or at thinner layers of the crust. There are many mountains that are actually volcanoes or were formed by volcanism. Kilimanjaro and Mount Fuji are inactive volcanoes. Mount St. Helens is an active volcano that erupted in 1980 and released magma between 2004 and 2008.



(Left) Mount St. Helens erupting in Washington State.  
(Below) Kamchatka Peninsula in Russia—volcanic mountain range.



Name: \_\_\_\_\_

Date: \_\_\_\_\_

Period: \_\_\_\_\_

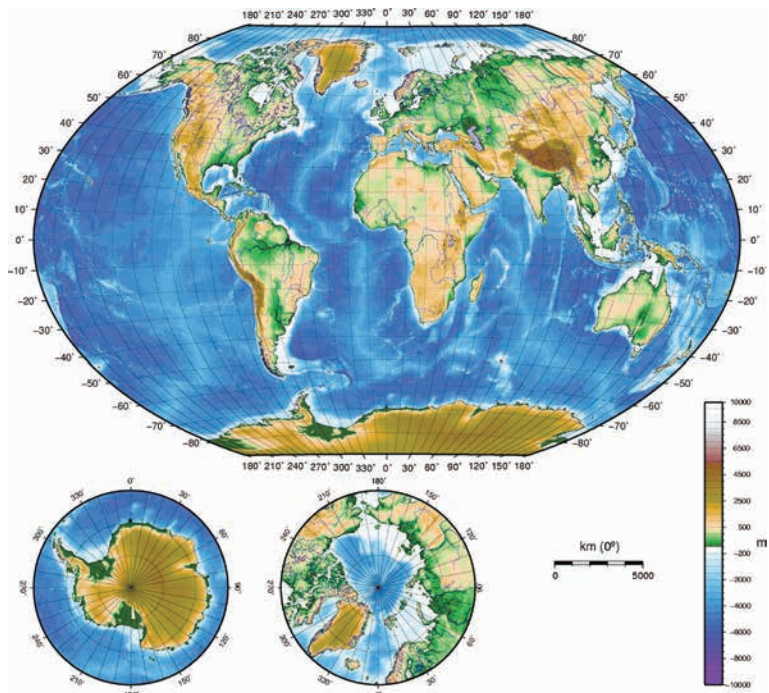
# LANDFORM PATTERNS EXIT TICKET

*Show Your Understanding of Landforms*

You have learned about landform patterns and how landforms are made.

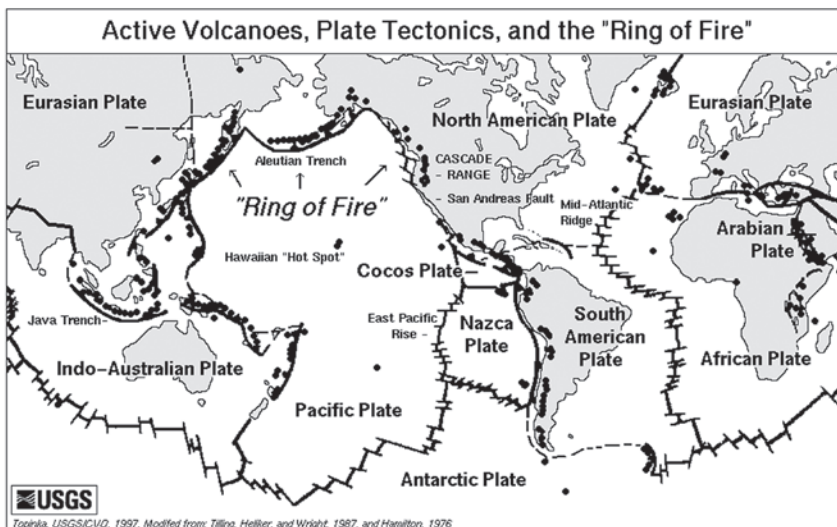
- *Reflect* on what you have learned.
- *Answer* the questions below.

Look at the images below and answer the questions to the right.



1. Describe the patterns of landforms you notice:

2. Describe why you think these patterns exist:



## Lesson 3—Climate Patterns

### *Understanding Patterns in Climate*

One class period of instruction

This lesson introduces students to the *patterns of climate* on the Earth. Students will consider how to predict the climate of locations and then groups will read and present on how to predict climate. As a class, you will try to predict the climate based on certain characteristics.

Lesson 4 will look at how physical characteristics change over time.

#### **Copy Instructions**

Print **Predicting Climate Practice**



handout for each student. Print **Climate Patterns** jigsaw readings for each group.

#### **Materials Needed**

- **Climate Patterns** jigsaw readings
- **Predicting Climate Practice**
- **Predicting Climate Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

7.1.A—Identify and describe patterns in the environment that result from the interaction of Earth's physical processes.

##### **12th Grade**

7.1.A—Explain the changing relationships among climate, vegetation, and landforms; analyze and explain the relationships between physical processes and the location of land features.

#### **Learning Objectives**

1. Identify patterns in climate.
2. Predict climate based on other geographic features.

#### **Evidence of Learning**

Students will predict climate based on given characteristic descriptions.



## Lesson Sequence

### 1. Think/Pair/Share

How could you guess the climate of a location?

### 2. Jigsaw

Split students into seven groups and provide each group with a reading. Groups should read, discuss, and prepare a short presentation to inform the class about what they read.

### 3. Present

Groups should present the important information they have learned about predicting climate.

### 4. Class Practice

As a class, look at the characteristics provided in the prompts. Students should write down their predictions and then discuss them as a class.

### 5. Exit Ticket

Students predict climates based on physical characteristics.

#### Handouts

- Climate Patterns jigsaw readings

#### Handout

- Predicting Climate Practice

#### Handout

- Predicting Climate Exit Ticket

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CLIMATE PATTERNS: LARGE BODIES OF WATER

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? Since climate is the average weather over a long period, you couldn't really wait for a long time to see what the climate was. There are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

Large bodies of water moderate the temperatures. Areas inland reach higher highs and lower lows. Water changes temperature less than land when it absorbs heat. This means that large bodies of water change temperature very little. Maritime climates are found in areas that are near large bodies of water. The temperatures of maritime climates are kept pretty moderate by the relatively steady temperatures of the bodies of water. Continental climates are climates that occur at some distance from large bodies of water. They tend to have more extreme high or low temperatures than maritime climates. Maritime climates also tend to have a fair amount of humidity because they occur close to water.

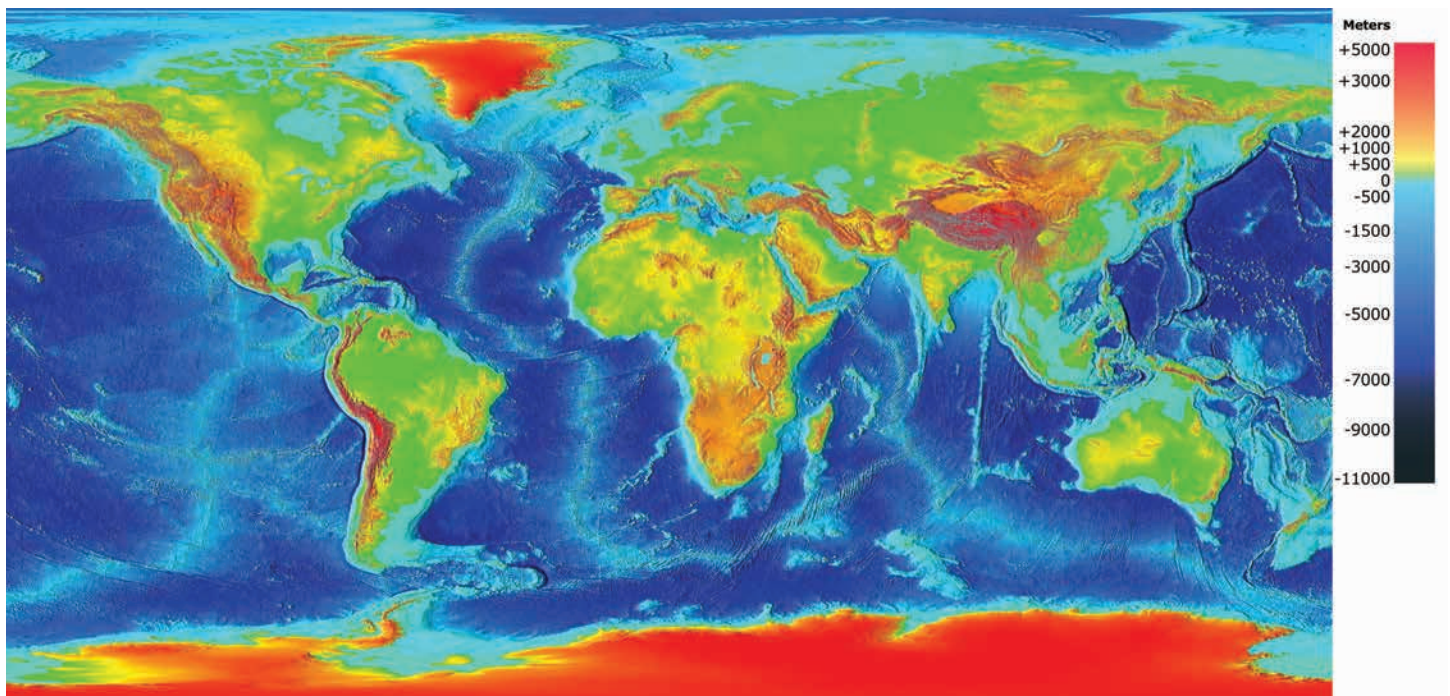


# CLIMATE PATTERNS: ELEVATION

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate is going to be? Climate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

The elevation or height from sea level has an effect on the climate. As air rises it expands and becomes cooler. On average, air cools 4 degrees Fahrenheit every 1,000 feet of elevation. It is common that mountains can be so tall that they have snow year round, even in the tropics. For example, Mt. Kilimanjaro in Africa is very near the equator and has snow at its peak year round.



# CLIMATE PATTERNS: LATITUDE

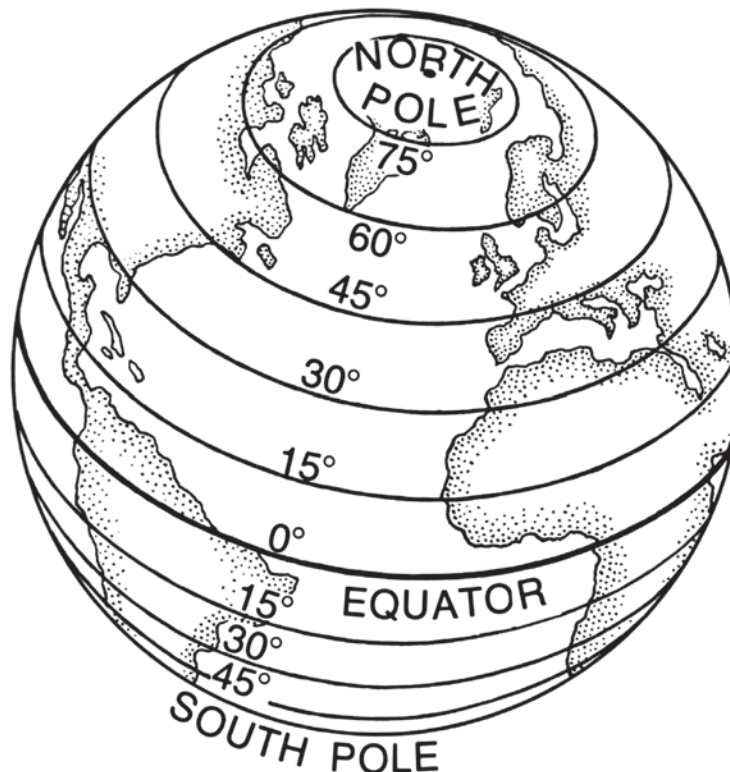
## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? Climate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

By knowing the latitude of a location, you can tell something about its climate. Latitude measures the distance north and south on the Earth surface. The equator is at 0 degrees. The North Pole is at 90 degrees north and the South Pole is at 90 degrees south. Sunlight hits the Earth most directly between 23.5 degrees north (Tropic of Cancer) and 23.5 degrees south (Tropic of Capricorn). The area in between these latitudes is called the tropics and the energy from the Sun stays pretty much the same all year. There is very little change in the seasons throughout the year. The weather is always warm in the tropics, unless you are at a higher elevation such as a mountain.

The mid-latitudes are from 23.5 degrees to 60 degrees. These areas have cooler winters and warmer summers. These areas are also called "temperate" because they are not extremely hot or cold.

The polar latitudes are the latitudes above 60 degrees. These areas get the least energy from the Sun and have cooler temperatures all year round. However, the summer is often much warmer than the very cold winters.

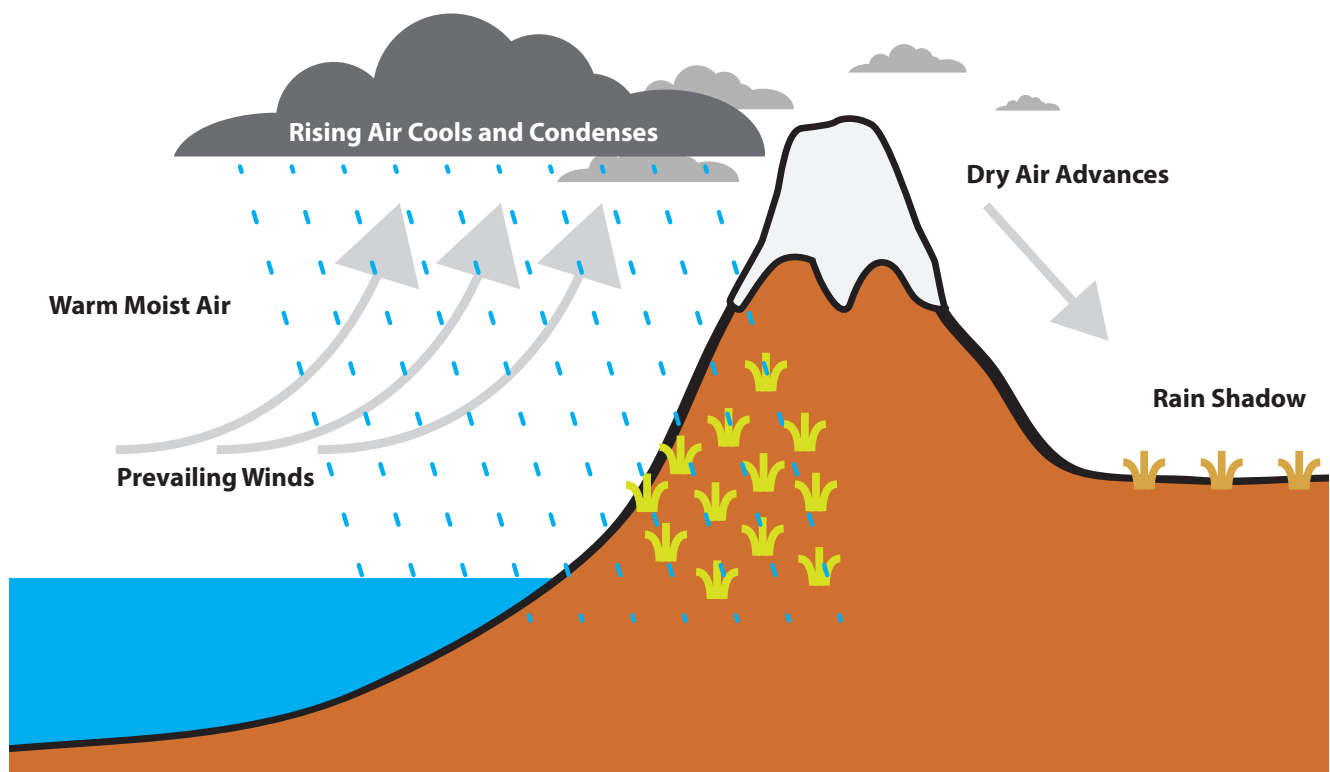


# CLIMATE PATTERNS: MOUNTAIN RANGES

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? Climate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

Nearby mountain ranges have an effect on the climate. A mountain range can act like a rain barrier and cause what is called a "rain shadow." Clouds that have been collecting precipitation reach a wall of mountains, causing the clouds to release rain. The other side of the mountain range is blocked from rain clouds and receives drier air. Washington State offers a good example of this process. Western Washington, including Seattle, is rainy, while east of the mountains, eastern Washington is much drier.

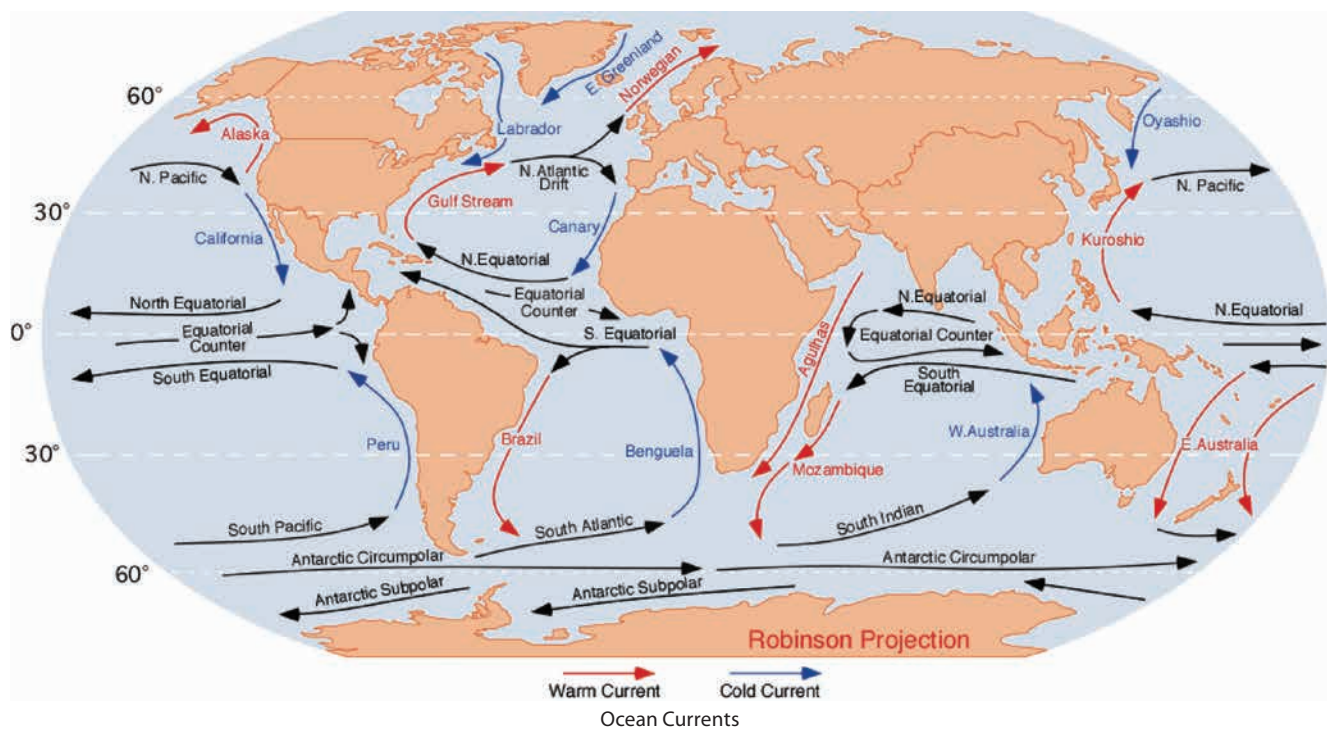


# CLIMATE PATTERNS: OCEAN CURRENTS

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? Climate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

Ocean currents are continuous movements of ocean water in a particular direction. There are many factors that contribute to the directions of the ocean currents, but the currents stay pretty consistent. The movement of this water can be over a very long distance and even act like a conveyor belt as it delivers warm or cold water. For example, the Gulf Stream circulates from West Africa to Florida and then up to northern Europe. The warm currents from the Gulf Stream make northwest Europe much warmer and livable than other locations at the same latitude. Without these ocean currents, Great Britain would be much colder.



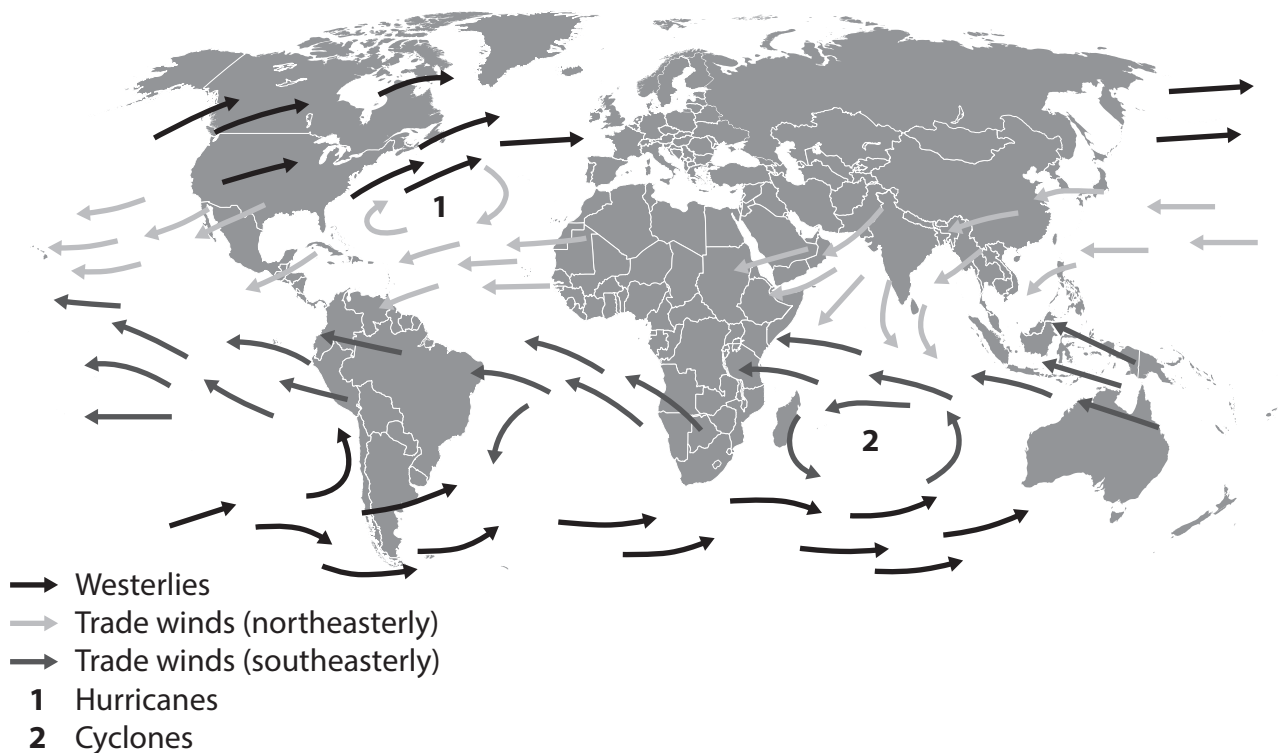
# CLIMATE PATTERNS: PREVAILING WINDS

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? Climate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

Prevailing winds are winds moving in the direction most typical for a location. Where the prevailing winds come from affects the climate of a location. For example, California receives its prevailing winds from the west, off of the Pacific Ocean. The winds off of the Pacific Ocean are at a fairly stable temperature. In New York, the prevailing winds come from inland areas in the west. These temperatures change a lot more. This causes New York's temperatures to be less consistent than California's.

**Map of prevailing wind patterns**

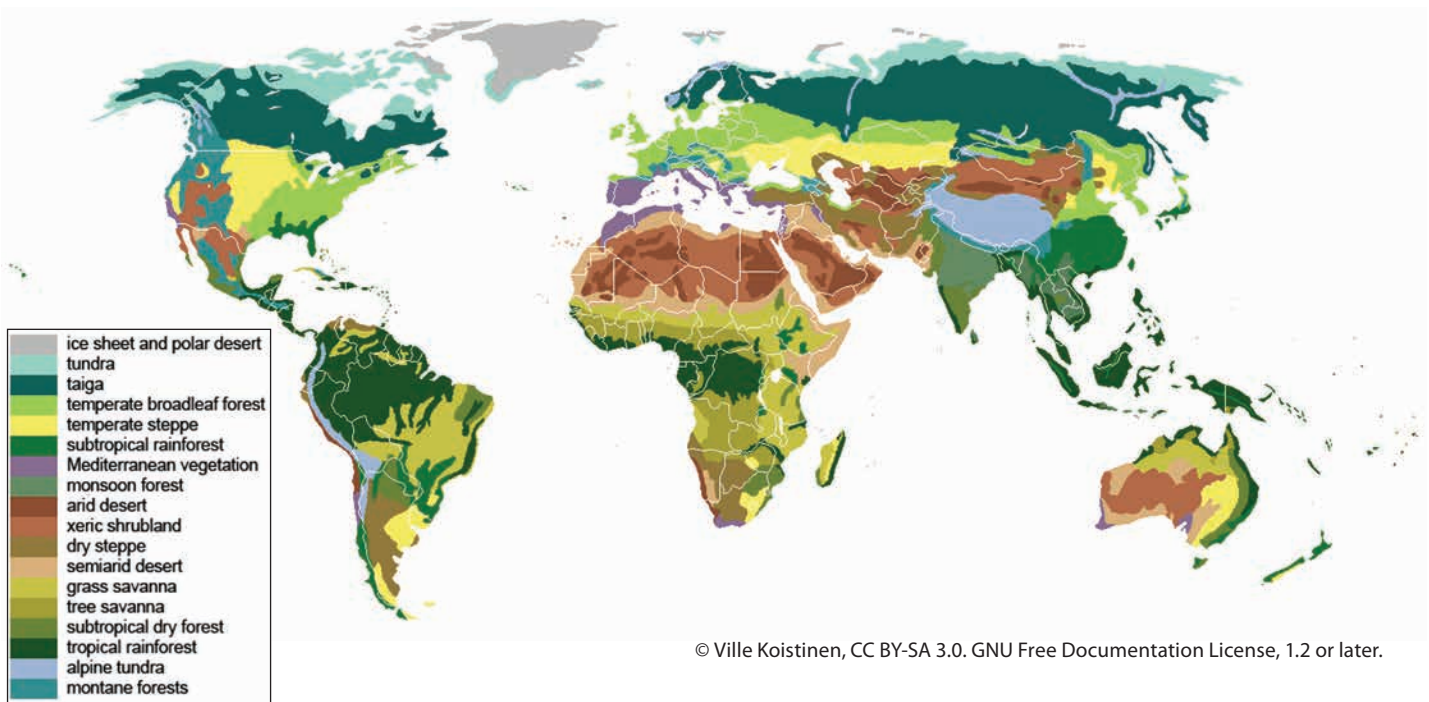


# CLIMATE PATTERNS: VEGETATION

## *Predicting Climate*

Imagine you are choosing a place to settle down and build a secure compound during the zombie apocalypse. How would you be able to tell what the climate was going to be? SClimate is the average weather over a long period, and since you are facing a zombie outbreak you couldn't really wait to learn about the location's climate before making a decision. However, there are some clues that you could use to predict what the climate of a location is, helping you to decide if it is somewhere you want to stay long term.

Climate determines what vegetation, or types of plants, there will be in a location. Soil type also makes a difference. Some plants can exist only in some climates. However, climate is also somewhat determined by the vegetation. Large forests have an effect on the climate because they can slow winds, absorb water, and absorb heat from the sunlight. Forests and plants can slow down surface winds and also help keep soils from eroding or blowing away. Plants and roots will also capture precipitation, creating a more humid climate. Thick vegetation, such as a forest, will hold in cool air during the day and slow down the release of warm air at night. Dense forests tend to be more humid and have more moderate temperatures than places without vegetation.



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# PREDICTING CLIMATE PATTERNS

Read the location descriptions and try to describe what the climate would be like and why.

1. Location at 45 degrees north latitude, on a coastline influenced by warm currents.

2. Two locations on the equator: in a continental interior and at sea level.

3. Location at 30 degrees north latitude, influenced by warm ocean currents.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CLIMATE PATTERNS EXIT TICKET

*Show Your Understanding of Factors Influencing Climate*

You have learned about factors that influence climate. *Reflect* on what you have learned. *Answer* the questions below.



Source: Photo by Auritulus Cinereus on Flickr. Image used under the Creative Commons Attribution 2.0 Generic license.

The photo above was taken at 45 degrees north latitude, 200 miles from the ocean and blocked from ocean winds by a mountain range. *Predict* the climate and *explain* your thoughts.

## Lesson 4—Physical Processes That Change Places

### *How Do Landforms Change?*

This lesson introduces students to the *the physical processes* that change physical characteristics over time. Students should be able to understand the basic ideas of how places change.

One class period of instruction

Lesson 5 will look at how the Sun affects the Earth.

#### **Materials Needed**

- **Physical Change over Time**
- **Changes in Physical Characteristics Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

4.2.A—Explain the ways that physical processes change places.

##### **12th Grade**

7.3.A—Analyze and explain the results of interactions of physical processes over time.

#### **Learning Objectives**

1. Explain how physical characteristics change over time.
2. Explain how a particular location might change over time.

#### **Evidence of Learning**

Identify changes over time and predict future changes in a local area.

#### **Lesson Sequence**

##### **1. Think/Pair/Share**

How do locations physically change over time?

##### **2. Review**

Go over the handout **Physical Change over Time**. Some physical processes will be familiar from lesson 2. This handout focuses on *wind erosion, water erosion, tectonic plates, and deposition*.



#### **Copy Instructions**

Print one of each handout for each student.

#### **Handout**

- Physical Change over Time

## Project 04: Surviving the Physical Environment

### Lesson 4—Physical Processes That Change Places

#### Handout

- Changes in Physical Characteristics Exit Ticket

#### 3. Discuss

Have a class discussion using the prompt: *How would our location change over time?* Encourage students to consider which landforms would change and how.

#### 4. Exit Ticket

Identify past physical changes from a photograph and describe possible future changes where students live.

# PHYSICAL CHANGE OVER TIME

## *How Do Locations Physically Change over Time?*

Over time places change. There are processes that slowly change the physical characteristics of locations. The following are ways places change.

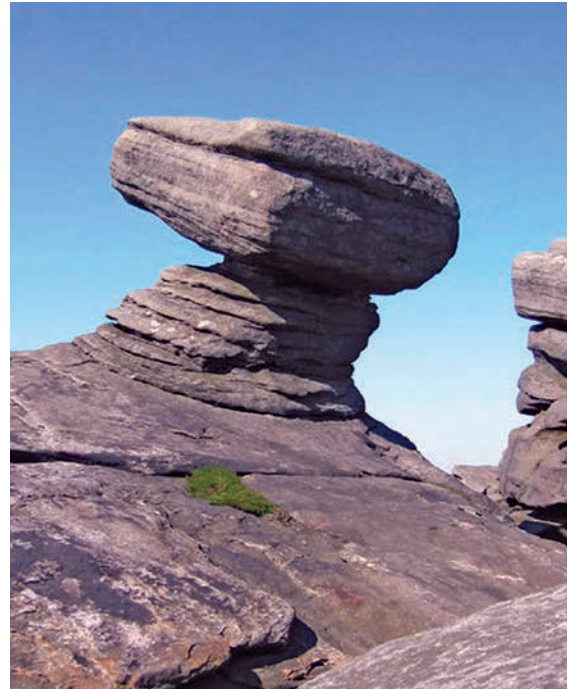
### **Wind Erosion**

Wind erosion occurs when soil, sand, or rocks are moved by the wind, usually downhill and away from their original location. Wind erosion is sometimes referred to as the *aeolian process*.

Excessive erosion leads to loss of soil, ecosystem damage, and a buildup of sediments in water sources. Building terraces and planting trees can help reduce erosion.<sup>1</sup>

<sup>1</sup> © Copyright Ohio State University, CC BY-SA 3.0.

*The image to the right shows a rock formation after centuries of being slowly eroded by wind.*



© Espresso Addict, CC BY 2.0.



### **Water Erosion**

Water erosion is similar to wind erosion except, of course, it is caused by water. There are many ways that water can erode landforms. Some ways are through rain, rivers and streams, coastal erosion, glaciers, floods, and freezing and thawing.

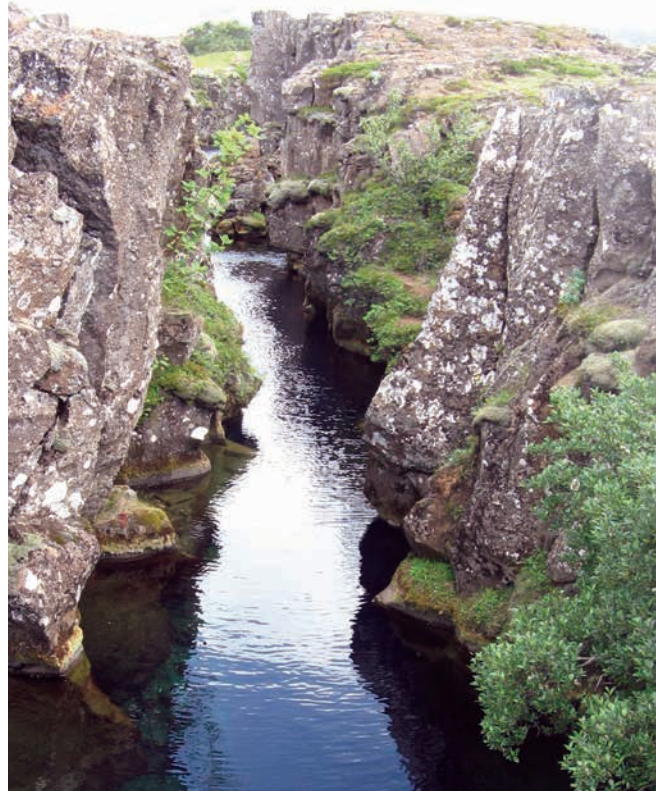
*The image on the left shows a cliff and roadway undermined by water erosion.*

### Tectonic Plates

There are seven major tectonic plates as well as several secondary and many minor plates that make up the Earth's surface. These tectonic plates have moved around on the Earth's surface through much of geologic time. The edges of the plates are marked by concentrations of earthquakes and volcanoes. Collisions of plates can produce mountains like the Himalayas, the tallest range in the world. Tectonic plates move at very slow rates of a few centimeters per year, slower than the rate at which fingernails grow.<sup>2</sup>

<sup>2</sup> From "The Interior of the Earth," by Eugene C. Robertson, USGS.

*The image to the right is from Þingvellir National Park in Iceland. It is located on the Mid-Atlantic Ridge between two tectonic plates. The faults and fissures are made by the rifting of the Earth's crust.*



© Someone35, CC BY 3.0.



### Deposition

Deposition happens when sediment is dropped or deposited in a new location. This occurs when there are changes in the speed of moving water which causes rocks, sand, mud, and other debris that was previously stirred and moved by the current to be dropped downstream.

*The image on the left shows a small river moving sediment and depositing it to build up in other locations.*

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Period: \_\_\_\_\_

# CHANGES IN PHYSICAL CHARACTERISTICS EXIT TICKET

*Show Your Understanding of Changes in Physical Characteristics*

You have learned about how landforms change over time. *Reflect* on what you have learned. *Answer* the questions below.



1. What physical changes do you think have taken place in this location?
2. Describe possible physical changes that could happen in the area where you live.

# Lesson 5—Earth-Sun Relationship

## *How Does the Sun Affect the Earth?*



One class period of instruction

This lesson introduces students to the *relationship between the Sun and the Earth*. Students should be able to understand the patterns that occur because of this relationship, mainly *seasons*, and how these patterns are manifested in different parts of the world.

Lesson 6 will look at how humans interact with the environment.

### **Copy Instructions**

Print one of each  
handout for  
each student.



### **Materials Needed**

- **Earth-Sun Relationship**
- **Earth-Sun Relationship Exit Ticket**
- World map or globe

### **National Geography Standards**

#### **8th Grade**

NGS 7.2.A—Explain how Earth-Sun relationships drive physical processes and create annual patterns on Earth.

#### **12th Grade**

7.2.A—Explain how variability in Earth-Sun relationships affects Earth's physical processes over time.

### **Learning Objectives**

1. Explain the annual patterns that are a result of Earth-Sun relationships.
2. Understand seasons on Earth.

### **Evidence of Learning**

Explain the patterns of Earth-Sun relationship and how they affect different parts of the world.

## Lesson Sequence

### 1. Think/Pair/Share

How is the Earth affected by the Sun?

### 2. Lecture

Read over the Earth-Sun handout to understand the four main factors that affect the Earth: shape, distance, tilt, and solar constant.

### 3. Relationship Examples

Choose or ask students to choose random places on a globe or world map. Call on volunteers to describe the seasons and how the Sun affects that location.

### 4. Current Relationship

Ask students to try and explain how the Sun is affecting the Earth in your current location and on this current date. Use the first image in the handout to try and identify where the Earth currently is in its orbit around the Sun.

### 5. Exit Ticket

Explain the patterns of the Earth-Sun relationship and how it affects the given location on a globe and the location where students live.

#### Handout

- Earth-Sun Relationship

#### Handout

- Earth-Sun Relationship Exit Ticket



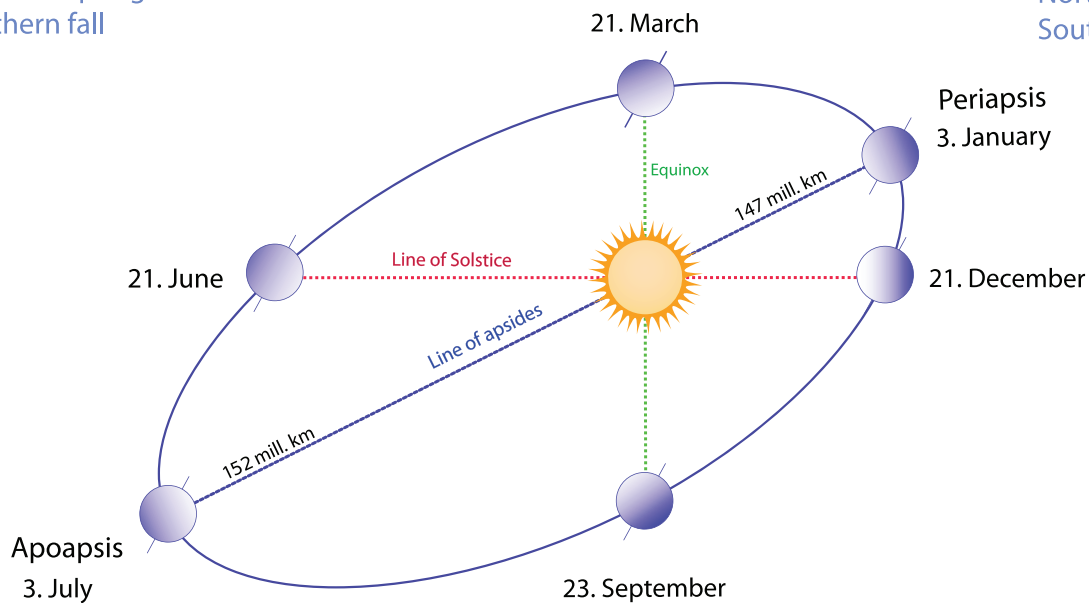
# EARTH-SUN RELATIONSHIP

## *How Does the Sun Affect the Earth?*

The relationship between the Sun and Earth relies on changes in the Earth-Sun geometry. These changes affect how much energy different locations on Earth receive from the Sun. The following principles affect this relationship.

Northern spring/  
Southern fall

Northern winter/  
Southern summer



Northern summer/  
Southern winter

Northern fall/  
Southern spring

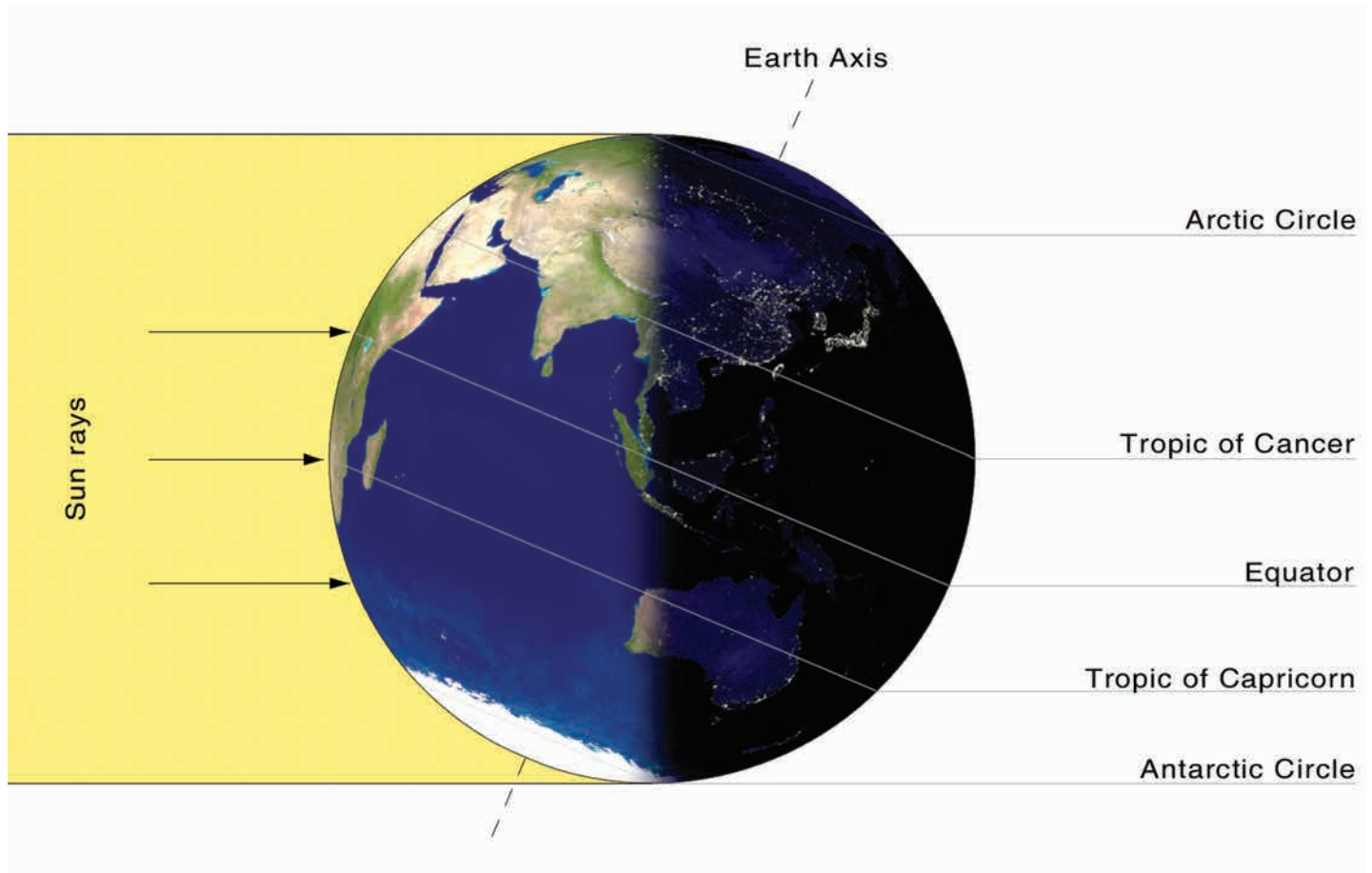
The Earth-Sun relationship. © Copyright Gothika, CC BY-SA 3.0.

### **Shape**

The Earth's orbit around the Sun is almost a perfect circle. Because it isn't exactly a perfect circle, it is technically an elliptical orbit.

### **Distance**

The average distance from the Sun is 93 million miles. However, in January it is as close as 91.5 million miles and in July it extends to about 94.5 million miles.



### ***Tilt***

Earth is tilted on its vertical axis at an angle of  $23.5^\circ$ . This is one of the major causes of the different seasons on Earth. The energy from the Sun is most powerful when it hits the Earth directly. The curve of the Earth causes some of the Sun's rays to hit parts of Earth at an angle and deflect some of the energy.

On December 21, the Southern Hemisphere has its summer solstice. This is the date when the Sun's rays are directly hitting  $23.5^\circ$  north. At this same time, the Northern Hemisphere is in winter, receiving the Sun's rays least directly.

### ***Solar Constant***

The Sun's output is constantly the same. The Sun continues to put out the same energy every day over a long time. Different points on Earth receive varying amounts of the Sun's energy depending on the seasons. In general, a point on Earth is in the same location relative to the Sun on the same day each year. This means that on the same day each year, a given location would be receiving the same amount of energy from the Sun. This makes temperatures and seasons somewhat predictable.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# EARTH-SUN RELATIONSHIP EXIT TICKET

*Show Your Understanding of the Earth-Sun Relationship*

You have learned about how the Earth's relationship with the Sun creates seasons. *Reflect* on what you have learned. *Answer* the questions below.

1. Look at the image below and answer the question.



2. How would Earth's relationship with the Sun affect this location?
3. How would Earth's relationship with the Sun affect the area where you live?

# Lesson 6—Human-Environment Interaction

## *How Do Humans and the Environment Interact?*

This lesson introduces students to the concept of human-environment interaction. Human-environment interaction is how humans affect the environment and how the environment affects humans. It is broken down as how humans *adapt to*, *depend on*, and *modify* the environment.

One class period of instruction

Lesson 7 will look at identifying the opportunities and constraints of different locations (building on *depending* and *adapting*).

### **Materials Needed**

- **Human-Environment Interaction**
- **HEI Poster Directions**
- Poster-making supplies
- **Human-Environment Interaction Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

15.1.A—Explain how the characteristics of different physical environments offer opportunities for human activities.

#### **12th Grade**

15.1.A—Explain how people may view the physical environment as both an opportunity and a constraint depending on their choice of activities.

### **Learning Objectives**

1. Understand how humans have an impact on the environment.
2. Understand how the environment influences humans.

### **Evidence of Learning**

Provide examples of how humans adapt to, depend on, and modify the places they live.



#### **Copy Instructions**

Print one **Human-Environment Interaction** handout and **Human-Environment Interaction Exit Ticket** for each student. Print one copy of the **HEI Poster Direction** for each group.

## Lesson Sequence

### 1. *Think/Pair/Share*

How do humans interact with the environment?

#### Handout

- Human-Environment Interaction

### 2. *Lecture*

Read the definition of human-environment interaction, as well as the examples of *adapting*, *depending*, and *modifying*.

#### Handout

- HEI Poster Directions

### 3. *Poster Creation*

In groups of four or fewer, students should create posters showing examples of how humans adapt to, depend on, and modify the environment.

### 4. *Gallery Walk*

Students walk around and look at each other's posters. After the gallery walk, debrief and hear about some of the examples that students saw.

#### Handout

- Human-Environment Interaction Exit Ticket

### 5. *Exit Ticket*

Provide examples of how humans adapt to, depend on, and modify the environment where they live.



# HUMAN-ENVIRONMENT INTERACTION

## *How Do Humans and Environment Affect Each Other?*

Human-environment interaction (HEI) basically means that humans affect the environment and the environment affects humans. Humans *adapt to*, *depend on*, and *modify* the environment.

### Three Parts of Human-Environment Interaction

#### 1. Adapt

In order to survive many conditions, humans must adapt or adjust to the environment. Adapting basically means changing the way you live.

An obvious example of adapting is the way people change to become more comfortable. For example, people in cold climates build warm shelters, use resources for heat, and wear warm clothing.

Another example of adapting is using irrigation to grow crops in a dry climate.

Examples of adapting to the environment.



Wearing warm clothing



Irrigation

#### 2. Depend

Humans depend on the environment when they use the environment to meet needs. For example, they use the environment to get food, clothing, shelter, and other resources.

What are resources? *Resources* are anything people can use that comes from nature.

Examples of resources people depend on.



Wind



Open space or land



Oil and mineral resources

#### 3. Modify

Humans modify the environment any time they change anything. Instead of adapting to fit the environment, many times humans will try to change the environment to fit their needs.

Anytime anyone builds anything, moves anything, or destroys anything, that human action modifies the environment.

Examples of modifying the environment.



Building dams



Plowing fields

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# HEI POSTER DIRECTIONS

## *Create a Poster Showing Examples of Human-Environment Interaction*

Human-environment interaction basically means that humans affect the environment and the environment affects humans. Humans *adapt to*, *depend on*, and *modify* the environment.

Review the **Human-Environment Interaction** handout. *Discuss* as a group to answer the following questions. *Create* a poster showing examples of human-environment interaction and be ready to share!

1. What are some ways that humans *adapt to* the environment?
2. What are some ways that humans *depend on* the environment?
3. What are some ways that humans *modify* the environment?
4. What examples would you like to display on your poster?

## Create Your Poster

Your poster must include:

- The *title* of the poster.
- *Large examples* of how humans *adapt to*, *depend on*, and *modify* the environment.
- *Descriptions* of each example.

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Period: \_\_\_\_\_

# HUMAN-ENVIRONMENT INTERACTION EXIT TICKET

*Show Your Understanding of Human-Environment Interaction*

You have learned about how humans adapt to, depend on, and modify the environment.

*Reflect* on what you have learned. *Answer* the questions below.

Provide an example for each of the following:

1. What are some ways that humans *adapt to* the environment where you live?
2. What are some ways that humans *depend on* the environment where you live?
3. What are some ways that humans *modify* the environment where you live?

## Lesson 7—Opportunity and Constraint

### *What Are the Opportunities and Constraints of Locations?*



One class period of instruction

This lesson expands on students' understanding of human-environment interaction. They will now look at the physical geography of a location and try to determine *opportunities* and *constraints* that would come from that environment.

Lesson 8 will look at specific examples of how humans modify the environment.

#### **Copy Instructions**

Print one



#### **Opportunity and Constraint Exit Ticket**

for each student. Print a different Jigsaw Reading for each group. Print one set of **Opportunity and Constraint Readings** for each group.

#### **Materials Needed**

- **Opportunity and Constraint Readings**
- **Opportunity and Constraint** jigsaw readings
- **Opportunity and Constraint Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

15.1.B—Explain how the characteristics of different physical environments place constraints on human activities.

##### **12th Grade**

15.1.A—Explain how people may view the physical environment as both an opportunity and a constraint depending on their choice of activities.

#### **Learning Objectives**

1. Identify the opportunities and constraints that come from various physical environments.
2. Consider locations to settle in a zombie apocalypse.

#### **Evidence of Learning**

Identify the opportunities and constraints of where students live, the parts of the environment humans need for settlement, and the ways people adapt to local environments.

## Lesson Sequence

### 1. Think/Pair/Share

- What opportunities do environments provide for people?
- What constraints do physical environments place on people?

### 2. Jigsaw

Divide the class into seven groups. Give each group a different jigsaw handout and the jigsaw directions. Each group will read about the climate and landforms of a location. They should follow the directions, answering the questions about opportunities and constraints. If a group finishes earlier than others, encourage them to consider if the city described in their jigsaw reading would be a good place to settle in a zombie outbreak. Why? Why not?

### 3. Discussion

Have a class-wide discussion about the best locations to settle during a zombie outbreak, based on physical characteristics. Start by having each group share information about their location and why it may or may not be a good place to settle. Continue the discussion with these prompts:  
*What kind of location would offer the best opportunities in a zombie outbreak?*  
*What constraints would a location have?*

### 4. Exit Ticket

Identify and describe the constraints and opportunities of the local physical environment, parts of the environment humans need for settlement, and the ways people adapt to local environments.

**Bonus:** Identify characteristics that would make for a good settlement location during a zombie outbreak.



#### Ideas

Travel, communication, heat/cold, food, resources.

#### Handouts

- Opportunity and Constraint Readings
- Opportunity and Constraint jigsaw readings

#### Handout

- Opportunity and Constraint Exit Ticket





# OPPORTUNITY AND CONSTRAINT: ANCHORAGE, AK

## *Discuss the Opportunities and Constraints of Anchorage, AK*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

### Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	85°F	Average Windspeed (mph)	7.1
Lowest of Record	−34°F	Highest Windspeed (mph)	75
Mean # Days Min $\leq$ 32°F	191	<b>Sunshine</b>	
Mean # Days Max $\geq$ 70°F	12	Average Percent of Possible	41
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	16.08	Number of Days Clear	61
Mean # Days $\geq$ .01 Inch	109	Number of Days Partly Cloudy	65
<b>Annual Snowfall</b>		Number of Days Cloudy	239
Average Total Inches	72.6		

### Landforms

Anchorage, Alaska, is northeast of the Alaska Peninsula. It is northwest of Prince William Sound and south of Mount McKinley. It is located on a strip of coastal lowland near the Chugach Mountains. There are many tidal inlets and the seacoast is characterized by treacherous mudflats and extreme tidal changes. People unfamiliar with the mudflats and tidal changes are warned about them. There have been at least a couple times when someone has died after getting stuck in a mudflat while the tide comes in.

Mountains	peak, in feet
Eagle Peak	6,955
Polar Bear Peak	6,614
Mount Palmer	6,585
Ptarmigan Peak	4,880
Mount POW/MIA	4,280
Flattop Mountain	3,510

Glaciers	mile length
Knik Glacier	25
Harriman Glacier	8
Portage Glacier	6

Bodies of Water	mile length
Cook Inlet	180
Ship Creek	30
Knik River	25
Eklutna River	22
Eagle River	9
Sand Lake	~0.75*
Goose Lake	0.3

\*A ~ in front of a measurement means it is approximate.



Anchorage, AK. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: DETROIT, MI

*Discuss the Opportunities and Constraints of Detroit, MI*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	104°F	Average Windspeed (mph)	10.1
Lowest of Record	-21°F	Highest Windspeed (mph)	61
Mean # Days Min $\leq$ 32°F	131	<b>Sunshine</b>	
Mean # Days Max $\geq$ 90°F	12	Average Percent of Possible	53
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	32.89	Number of Days Clear	75
Mean # Days $\geq$ .01 Inch	128	Number of Days Partly Cloudy	105
<b>Annual Snowfall</b>		Number of Days Cloudy	185
Average Total Inches	42.9		

## Landforms

Detroit, Michigan, is located in the Midwest near the Great Lakes. Detroit is in southeast Michigan on the Detroit River. Detroit's highest point is the University District at 670 feet. Its lowest point is less than 100 feet lower at the edge of the Detroit River (579 feet). Across the Detroit River is Windsor, Canada. The Detroit River connects Lake Huron and Lake Erie. It also connects to the St. Lawrence Seaway, a canal that allows ships to reach the Atlantic Ocean.

Bodies of Water	mile length
River Rouge	127
Detroit River	28
Lake St. Clair	26

Lakes	square miles
Lake Huron	23,000
Lake Erie	9,910

Islands	square miles
Grosse Ile	9.6
Belle Isle	1.53



Detroit, MI. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: HOUSTON, TX

*Discuss the Opportunities and Constraints of Houston, TX*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	109°F	Average Windspeed (mph)	7.6
Lowest of Record	3°F	Highest Windspeed (mph)	51
Mean # Days Min $\leq$ 32°F	17	<b>Sunshine</b>	
Mean # Days Max $\geq$ 90°F	100	Average Percent of Possible	59
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	47.84	Number of Days Clear	90
Mean # Days $\geq$ .01 Inch	98	Number of Days Partly Cloudy	114
<b>Annual Snowfall</b>		Number of Days Cloudy	161
Average Total Inches	0.0		

## Landforms

Houston, Texas, is located on the coast of the Gulf of Mexico in what is known as the "gulf coastal plain." The city is surrounded by forests, marshes, swamps, and prairie. Most of Houston is very flat. The highest point is 125 feet above sea level. There are many bayous that the city is well known for and were influential in the location of the city.

Bodies of Water	mile length
Buffalo Bayou	53
Greens Bayou	41
Lake Livingston	31
Brays Bayou	31
Galveston Bay	30
Sims Bayou	28
White Oak Bayou	25
Lake Conroe	21
Lake Houston	9



Houston, TX. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: JACKSONVILLE, FL

*Discuss the Opportunities and Constraints of Jacksonville, FL*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

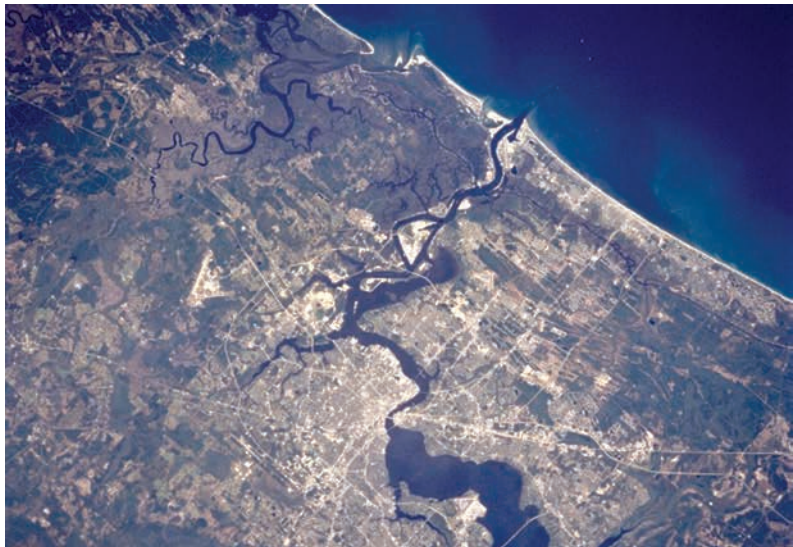
## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	105°F	Average Windspeed (mph)	7.8
Lowest of Record	7°F	Highest Windspeed (mph)	57
Mean # Days Min $\leq$ 32°F	15	<b>Sunshine</b>	
Mean # Days Max $\geq$ 90°F	80	Average Percent of Possible	63
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	52.34	Number of Days Clear	94
Mean # Days $\geq$ .01 Inch	109	Number of Days Partly Cloudy	127
<b>Annual Snowfall</b>		Number of Days Cloudy	144
Average Total Inches	0.0		

## Landforms

Jacksonville is located in northeast Florida. It is on the coast of the Atlantic Ocean. It is just 25 miles south of Georgia. The area of Jacksonville has been inhabited for thousands of years and was one of the first places in Florida colonized by Europeans. The entire state of Florida is a flat plateau. Jacksonville's highest point is just 40 feet above sea level. Mayport Naval Station is a busy and protected naval harbor capable of accommodating aircraft carrier-size vessels. There is a barrier island that is part of a suburb of Jacksonville that contains the "Beaches," a group of small communities.

Bodies of Water	mile length
St. Johns River	310
Trout River	20
Beaches	square miles
Ponte Vedra Beach	33.8
Jacksonville Beach	22
Atlantic Beach	13
Neptune Beach	6.8



Jacksonville, FL. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: LOS ANGELES, CA

*Discuss the Opportunities and Constraints of Los Angeles, CA*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	113°F	Average Windspeed (mph)	4.9
Lowest of Record	26°F	Highest Windspeed (mph)	49
Mean # Days Min $\leq$ 32°F	0	<b>Sunshine</b>	
Mean # Days Max $\geq$ 90°F	22	Average Percent of Possible	73
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	15.14	Number of Days Clear	186
Mean # Days $\geq$ .01 Inch	33	Number of Days Partly Cloudy	106
<b>Annual Snowfall</b>		Number of Days Cloudy	73
Average Total Inches	0.0		

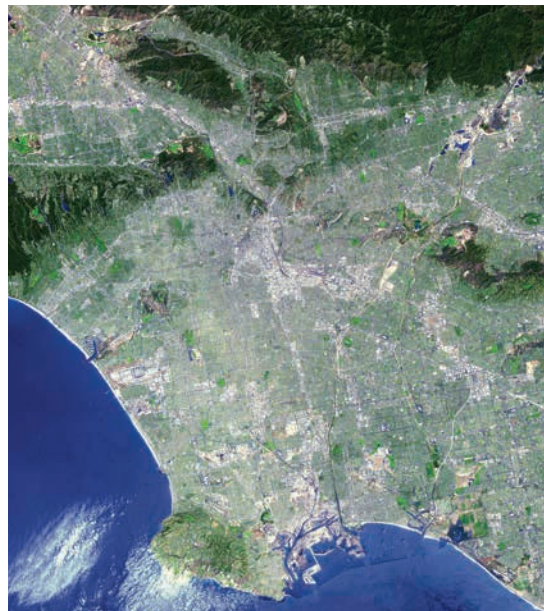
## Landforms

Los Angeles is located in Southern California on the coast of the Pacific Ocean. It is both hilly and flat. It has a combination of hills and valleys. The Los Angeles River runs through the city. It used to be a river that ran freely across flood plains but was lined in concrete by the Army Corps of Engineers, so it now runs a predictable course. Los Angeles also includes mountain, beach, and wetland habitats. Most of its vegetation is low-growing shrubs. Geologically, it is located at the border of two large plates of the Earth's crust.

Bodies of Water	mile length
Los Angeles River	97
Santa Clara River	75
San Gabriel River	59
Rio Hondo	20
Coyote Creek	13.7
Browns Canyon Wash	10.3
Bell Creek	10
Arroyo Calabasas	7

Mountains	peak, in feet
Mount Lukens	5,074
Santa Monica Mountains	3,111
Simi Hills	2,139



Los Angeles, CA. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: NEW YORK, NY

*Discuss the Opportunities and Constraints of New York, NY*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

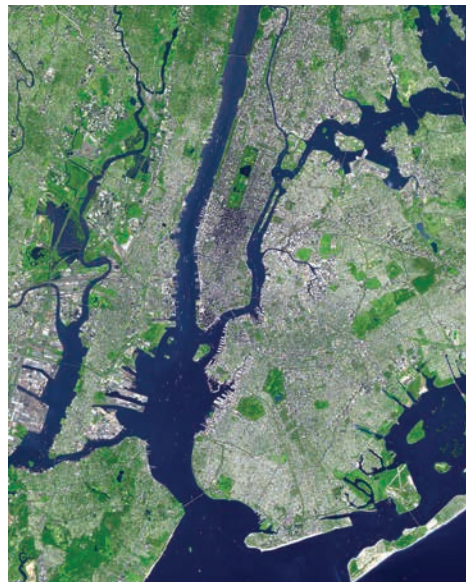
## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	104°F	Average Windspeed (mph)	9.1
Lowest of Record	-15°F	Highest Windspeed (mph)	40
Mean # Days Min $\leq$ 32°F	77	<b>Sunshine</b>	
Mean # Days Max $\geq$ 90°F	17	Average Percent of Possible	58
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	49.69	Number of Days Clear	107
Mean # Days $\geq$ .01 Inch	116	Number of Days Partly Cloudy	127
<b>Annual Snowfall</b>		Number of Days Cloudy	132
Average Total Inches	29.2		

## Landforms

New York City is located in southeast New York State. It is in the northeastern United States. New York Harbor, which is one of the world's largest natural harbors, provides access to the New York Bay and the Atlantic Ocean. Much of the geography has been altered by humans since the Dutch colonies in the 1600s. Much of Manhattan's original topography was leveled after the Commissioners' Plan of 1811 designed a street plan with streets in a grid that didn't take into account the hills. New York's highest natural point is Todt Hill with an elevation of approximately 410 feet.

Bodies of Water	mile length
Hudson River	315
Long Island Sound	118
Bronx River	24
East River	16
Harlem River	8
New York Bay	6



New York, NY. Image courtesy of NASA.

# OPPORTUNITY AND CONSTRAINT: SEATTLE, WA

*Discuss the Opportunities and Constraints of Seattle, WA*

Read the information about your location. Discuss as a group to answer the questions. Be ready to analyze opportunities and constraints as a class.

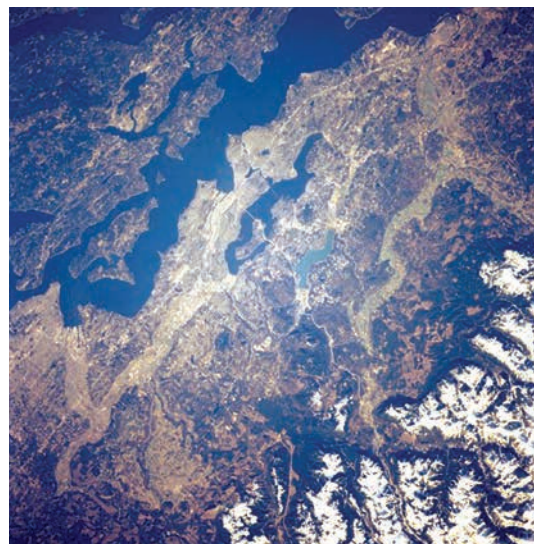
## Comparative Climate Data through 2011

Weather	Value	Weather	Value
<b>Temperature</b>		<b>Wind</b>	
Highest of Record	100°F	Average Windspeed (mph)	8.8
Lowest of Record	9°F	Highest Windspeed (mph)	63
Mean # Days Min $\leq 32^{\circ}\text{F}$	19	<b>Sunshine</b>	
Mean # Days Max $\geq 90^{\circ}\text{F}$	1	Average Percent of Possible	43
<b>Annual Precipitation</b>		<b>Sky Cover</b> (mean #)	
Average Total Inches	38.25	Number of Days Clear	71
Mean # Days $\geq .01$ Inch	150	Number of Days Partly Cloudy	93
<b>Annual Snowfall</b>		Number of Days Cloudy	201
Average Total Inches	7.3		

## Landforms

Seattle, Washington, is located in the Pacific Northwest. To the west of Seattle is the Puget Sound, Olympic Peninsula, and the Olympic Mountain Range. The Puget Sound leads to the Strait of Juan de Fuca and provides access to the Pacific Ocean. East of Seattle are Lake Washington and the Cascade Mountain Range. The city of Seattle is said to have been built upon seven hills. The highest point within the city is 520 feet above sea level. Seattle lies on the Seattle Fault, an intersection of thrust faults or breaks in the Earth's crust. Seattle's access to the sea, rivers, lakes, forests, and fields supported many early communities well before any European explorers arrived.

Bodies of Water	mile length
Puget Sound	100
Lake Washington	22
Green River	65
Cedar River	45
Sammamish River	14
Duwamish River	12
Elliott Bay	—
Lake Union	—
Green Lake	—



Seattle, WA. Image courtesy of NASA.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# OPPORTUNITY AND CONSTRAINT EXIT TICKET

*Show Your Understanding of How Environments Can  
Provide Opportunities or Constraints*

You have learned about how environments provide both opportunities and constraints. *Reflect* on what you have learned. *Answer* the questions below.

Provide an example for each of the following:

1. What are the constraints and opportunities of the physical environment where we live?

2. What parts of the environment do we depend on?

3. How do we adapt to the environment where we live?

**Bonus:** What makes a good settlement location during a zombie outbreak?

# Lesson 8—Environment Modification

## *How Do Humans Modify the Environment?*

This lesson builds upon students' understanding of human-environment interaction. In groups, they will look at specific examples of how humans *modify* the environment.

One class period of instruction

Lesson 9 will look at natural hazards.

### **Materials Needed**

- **Modification Readings** (1–7)
- **Environment Modification Poster Directions**
- Poster supplies
- **Modifying the Environment Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

15.1.B—Explain how the characteristics of different physical environments place constraints on human activities.

#### **12th Grade**

15.1.A—Explain how people may view the physical environment as both an opportunity and a constraint depending on their choice of activities.

### **Learning Objective**

Identify how people modify the environment.

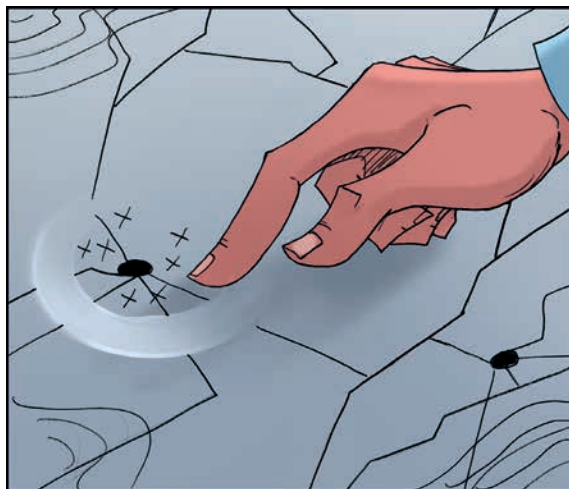
### **Evidence of Learning**

Give examples of how people modify the environment.



### **Copy Instructions**

Print one exit ticket for each student. Print a different modification reading for seven groups with enough copies for each student. Print poster directions for each group.



## Lesson Sequence

### 1. *Think/Pair/Share*

How do people modify or change the environment around them?

#### Handout

- Modification Readings

### 2. *Jigsaw*

Divide into seven groups. Provide each group with a handout about how people modify environments. Most are descriptions of how environments are modified by specific practices. **Modification Reading 5**, for example, explains the reason for a treaty in the 1970s and the concerns over how environmental modification could be used as a weapon. Some are harder to read than others. Here is the order of reading levels from low to high:

1. Coal
2. Oil
3. Deforestation
4. Dams
5. Convention Treaty
6. War
7. Fishing

#### Handout

- Environment Modification Poster Directions

### 3. *Create Posters*

Each group should create a poster after finishing their reading.

### 4. *Gallery Walk*

Students should rotate through the groups to observe the posters and examples that were made by other groups. If there is time, have the groups explain their posters and examples.

#### Handout

- Modifying the Environment Exit Ticket

### 5. *Exit Ticket*

Explain how people modify the environment, state concerns you may have, and tell how you would modify a mountainous location that is cold in the winter and hot in the summer.

# MODIFICATION READING 1

## *Coal and the Environment*

### Impacts of Coal Mining

Coal is an abundant fuel that is relatively inexpensive to produce and convert to useful energy. However, producing and using coal has many impacts on the environment.

**Surface mines**, or **strip mines**, are the source of about 70% of the coal that is mined in the United States. These mining operations remove the soil and rock above coal deposits, or “seams,” disturbing land at its surface.

One surface mining technique that has affected large areas of the Appalachian Mountains in West Virginia and Kentucky is mountaintop removal and valley fill mining, where the tops of mountains have been removed using a combination of explosives and mining equipment and deposited into nearby valleys.

As a result, the landscape is changed, and streams may be covered with a mixture of rock and dirt. The water draining from these filled valleys may contain pollutants that can harm aquatic wildlife downstream. While mountaintop mining has been around since the 1970s, its use has become more widespread and controversial since the 1990s.



A surface coal mine in the Czech Republic.

U.S. laws require that dust and water runoff from the affected area has to be controlled, and that the area has to be “reclaimed” close to its original condition. Many surface mines have been reclaimed so well that it can be hard to tell that there was a surface mine in the area. However, there are areas that have not been reclaimed as successfully.

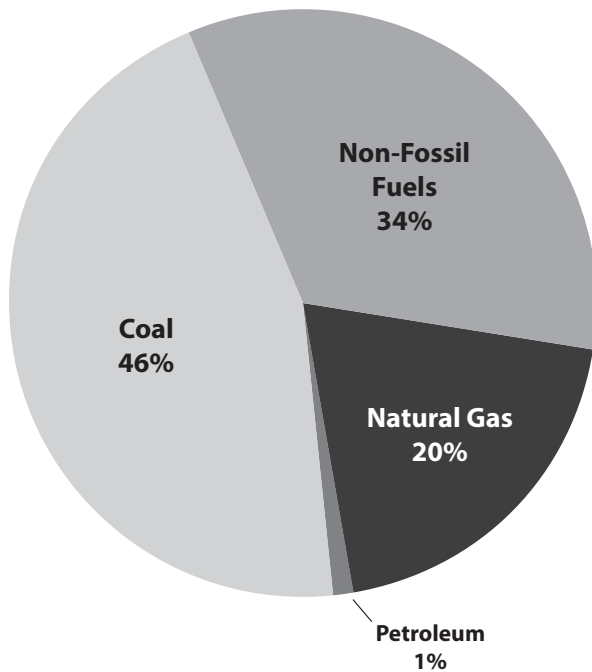
**Underground mines** have less effect on surface landforms but serious environmental impacts in other ways. The most serious impact of underground mining may be the methane gas that has to be vented out of mines to make the mines safe to work in. Methane is a strong greenhouse gas. In 2009, the most recent year for which estimates are available, methane emissions from underground mines accounted for about 10 percent of total U.S. methane emissions and 1 percent of total U.S. greenhouse gas emissions. Surface mines contributed about 2 percent of U.S. methane emissions.

The ground above mine tunnels can collapse, and acidic water can drain from abandoned underground mines. Underground coal mining is a dangerous profession, and coal miners can be injured or killed in mining accidents, especially in countries without strict safety regulations and procedures. Miners can also get black lung disease from the coal dust in the mines.

## Emissions from Burning Coal

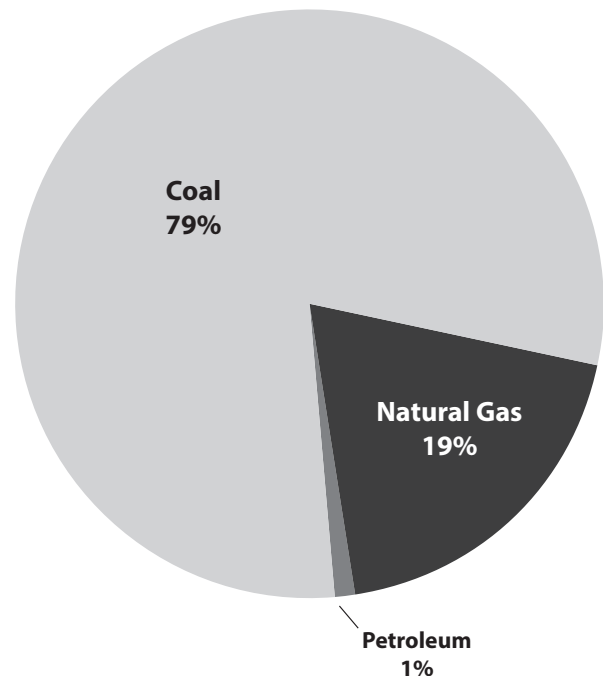
In the United States, most coal is used as a fuel to generate electricity. Burning coal produces numerous emissions that adversely affect the environment and human health.

**Major Fuel/Energy Sources for U.S. Electricity Generation, 2011**



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 2.6 (May 2012), preliminary 2011 data

**Resulting Carbon Dioxide Emissions from Electricity Generation by Fuel Type, 2011**



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1 2.6 (May 2012), preliminary 2011 data

The principal emissions resulting from coal combustion are:

1. Sulfur dioxide ( $\text{SO}_2$ ), which contributes to acid rain and respiratory illnesses
2. Nitrogen oxides ( $\text{NO}_x$ ), which contributes to smog and respiratory illnesses
3. Particulates, which contribute to smog, haze, and respiratory illnesses and lung disease
4. Carbon dioxide ( $\text{CO}_2$ ), which is the primary greenhouse gas emission from the burning of fossil fuels (coal, oil, and natural gas)
5. Mercury and other heavy metals, which have been linked with both neurological and developmental damage in humans and other animals. Mercury concentrations in the air usually are low and of little direct concern. However, when mercury enters water—either directly or through deposition from the air—biological processes transform it into methylmercury, a highly toxic chemical that accumulates in fish and the animals (including humans) that eat fish.

6. Fly ash and bottom ash are residues created when coal is burned at power plants. In the past, fly ash was released into the air through the smokestack, but by law much of it now must be captured by pollution control devices, like scrubbers. In the United States, fly ash is generally stored at coal power plants or placed in landfills. Pollution leaching from ash storage and landfills into groundwater has emerged as a new environmental concern.

## Reducing the Impacts of Coal Use

The Clean Air Act and the Clean Water Act require industries to reduce pollutants released into the air and the water.

Industry has found several ways to reduce sulfur, nitrogen oxides ( $\text{NO}_x$ ), and other impurities from coal. They have found more effective ways of cleaning coal after it is mined, and coal consumers have shifted toward greater use of low-sulfur coal.

Power plants use flue gas desulfurization equipment, also known as scrubbers, to clean sulfur from the smoke before it leaves their smokestacks. In addition, industry and government have cooperated to develop technologies that can remove impurities from coal or that make coal more energy-efficient so less needs to be burned.

Equipment intended mainly to reduce  $\text{SO}_2$  (such as scrubbers),  $\text{NO}_x$  (such as catalytic converters), and particulate matter (such as electrostatic precipitators and baghouses) is also able to reduce mercury emissions from some types of coal. Scientists are also working on new ways to reduce mercury emissions from coal-burning power plants.

Research is underway to address emissions of carbon dioxide from coal combustion. Carbon capture separates  $\text{CO}_2$  from emissions sources and recovers it in a concentrated stream. The  $\text{CO}_2$  can then be sequestered, which puts  $\text{CO}_2$  into storage, possibly underground, in such a way that it will remain there permanently.

Reuse and recycling can also reduce coal's environmental impact. Land that was previously used for coal mining can be reclaimed for uses like airports, landfills, and golf courses. Waste products captured by scrubbers can be used to produce products like cement and synthetic gypsum for wallboard.

Source: U.S. Energy Information Administration, [http://www.eia.gov/kids/energy.cfm?page=oil\\_home!](http://www.eia.gov/kids/energy.cfm?page=oil_home!)

# MODIFICATION READING 2

## *Oil and the Environment*

### How Does Oil Affect the Environment?

Products from oil (petroleum products) help us do many things. We use them to fuel our airplanes, cars, and trucks, to heat our homes, and to make products like medicines and plastics. Even though petroleum products make life easier, finding, producing, moving, and using them can harm the environment through air and water pollution.

### Emissions and Byproducts Are Produced from Burning Petroleum Products

Petroleum products give off the following emissions when they are burned as fuel:

- Carbon dioxide (CO<sub>2</sub>)
- Carbon monoxide (CO)
- Sulfur dioxide (SO<sub>2</sub>)
- Nitrogen oxides (NO<sub>x</sub>) and Volatile Organic Compounds (VOCs)
- Particulate matter (PM)
- Lead and various air toxics such as benzene, formaldehyde, acetaldehyde, and 1,3-butadiene, which may be emitted when some types of petroleum are burned

Nearly all of these byproducts have negative impacts on the environment and human health:

- Carbon dioxide is a greenhouse gas and a source of global warming.<sup>1</sup>
- SO<sub>2</sub> causes acid rain, which is harmful to plants and to animals that live in water, and it worsens or causes respiratory illnesses and heart diseases, particularly in children and the elderly.
- NO<sub>x</sub> and VOCs contribute to ground-level ozone, which irritates and damages the lungs.
- PM results in hazy conditions in both cities and scenic areas, and, along with ozone, contributes to asthma and chronic bronchitis, especially in children and the elderly. Very small, or “fine,” PM is also thought to cause emphysema and lung cancer.
- Lead can have severe health effects, especially for children, and air toxics are known or probable carcinogens.

### Laws Help Reduce Pollution from Oil

Over the years, new technologies and laws have helped to reduce problems related to petroleum products. As with any industry, the government monitors how oil is produced, refined, stored, and sent to market to reduce the impact on the environment. Since 1990, fuels like gasoline and diesel fuel have also been improved so that they produce less pollution when we use them.

#### **Reformulated Fuels**

Because a lot of air pollution comes from cars and trucks, many environmental laws have been aimed at changing the makeup of gasoline and diesel fuel so that they produce fewer emissions. These “reformulated fuels” are much cleaner-burning than gasoline and diesel fuel were in 1990.

## Technology Helps Reduce Drilling's "Footprint"

Exploring and drilling for oil may disturb land and ocean habitats. New technologies have greatly reduced the number and size of areas disturbed by drilling, sometimes called "footprints."<sup>2</sup> Satellites, global positioning systems, remote-sensing devices, and 3-D and 4-D seismic technologies make it possible to discover oil reserves while drilling fewer wells.



The use of horizontal and directional drilling makes it possible for a single well to produce oil from a much bigger area. Today's production footprints are also smaller than those thirty years ago because of the development of movable drilling rigs and smaller "slimhole" drilling rigs.

When the oil in a well becomes uneconomic to produce, the well must be plugged below ground, making it hard to tell that it was ever there. As part of the "rigs-to-reefs" program, some old offshore rigs are tipped over and left on the seafloor to become artificial reefs that attract fish and other marine life. Within six months to a year after a rig is toppled, it is covered with barnacles, coral, sponges, clams, and other sea creatures.

If oil is spilled into rivers or oceans, it can harm wildlife. When we talk about "oil spills," people usually think about oil that leaks from a ship that is involved in an accident. The amount of oil spilled from ships dropped significantly during the 1990s partly because new ships were required to have a "double-hull" lining to protect against spills.

## Natural Seeps Are a Major Source of Oil in Ocean Water

While oil spills from ships and offshore platforms are the most well-known source of oil in ocean water, a lot of oil actually gets into water from natural oil seeps coming from the ocean floor. The natural seeps may be a "major" source of oil that enters the environment globally, but they are slow, small, and spread out over large areas. In addition, the ecosystem has adapted to them, whereas a spill from a tanker or well is sudden and has a catastrophic impact on the surrounding area.

Leaks also happen when we use petroleum products on land. For example, gasoline sometimes drips onto the ground when people are filling their gas tanks, motor oil gets thrown away after an oil change, or fuel escapes from a leaky storage tank. When it rains, the spilled products get washed into the gutter and eventually flow to rivers and into the ocean. Another way that oil sometimes gets into water is when fuel is leaked from motorboats and jet skis.

When a leak in a storage tank or pipeline occurs, petroleum products can also get into the ground, and the ground must be cleaned up. To prevent leaks from underground storage tanks, all buried tanks are supposed to be replaced by tanks with a double lining.

## Endnotes

1. U.S. Environmental Protection Agency, Climate Change: State of Knowledge (1997), [https://cfpub.epa.gov/si/si\\_public\\_record\\_Report.cfm?dirEntryID=9177](https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryID=9177).
2. U.S. Department of Energy, Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology (October 1999), <https://www.osti.gov/biblio/771125>.

Source: U.S. Energy Information Administration, [http://www.eia.gov/kids/energy.cfm?page=oil\\_home-basics](http://www.eia.gov/kids/energy.cfm?page=oil_home-basics).

# MODIFICATION READING 3

## *Tropical Deforestation*

By Rebecca Lindsey  
NASA, Earth Observatory, March 30, 2007

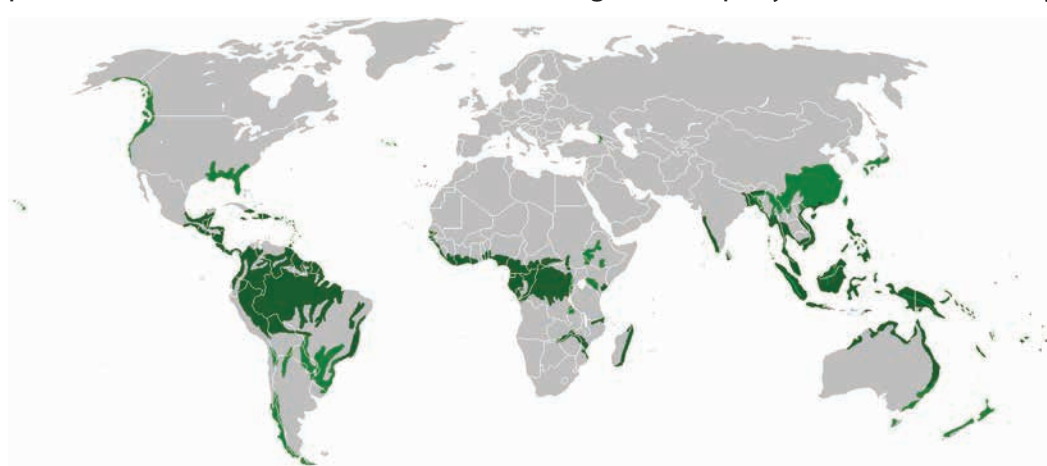
March 30, 2007

*The original version of this fact sheet, by Gerald Urquhart, Walter Chomentowski, David Skole, and Chris Barber, published in 1999, is archived as a PDF.*

Stretching out from the equator on all Earth's land surfaces is a wide belt of forests of amazing diversity and productivity. Tropical forests include dense rain forests, where rainfall is abundant year-round; seasonally moist forests, where rainfall is abundant but seasonal; and drier, more open woodlands. Tropical forests of all varieties are disappearing rapidly as humans clear the natural landscape to make room for farms and pastures, to harvest timber for construction and fuel, and to build roads and urban areas. Although deforestation meets some human needs, it also has profound, sometimes devastating, consequences, including social conflict, extinction of plants and animals, and climate change—challenges that aren't just local but global. NASA supports and conducts research on tropical forests from space-based and ground-based perspectives, helping provide the information that national and international leaders need to develop strategies for sustaining human populations and preserving tropical forest biodiversity.

### Effects of Deforestation on Biodiversity

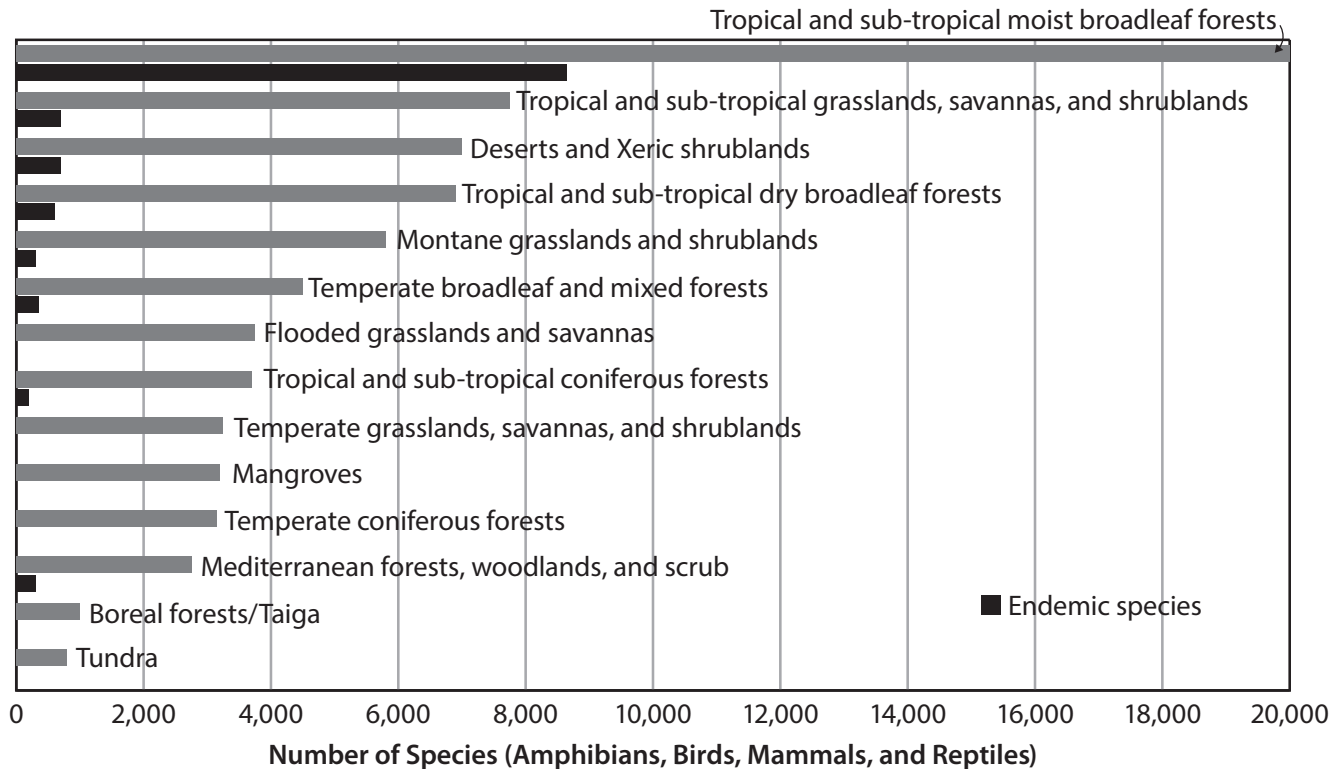
Although tropical forests cover only about 7 percent of the Earth's dry land, they probably harbor about half of all species on Earth. Many species are so uniquely adapted to microhabitats within the forest that they can be found only in those small areas. Their specialization makes them vulnerable to extinction. In addition to species becoming lost when an area is totally deforested, the plants and animals in the fragments of forest that remain become increasingly vulnerable, sometimes even committed, to extinction. The edges of the fragments dry out and are buffeted by hot winds; mature rain-forest trees often die standing at the margins. Cascading changes in the types of trees, plants, and insects that can survive in the fragments rapidly reduces biodiversity in the forest that



Tropical forests (shaded areas) on both sides of the equator thrive in the warm, usually wet climate under the Sun's most direct rays. Other rain forests exist in wet climates in temperate and continental zones. © Ville Koistinen, CC BY 2.0 and GNU Free Documentation License.

remains. People may disagree about whether the extinction of other species through human action is an ethical issue, but there is little doubt about the practical problems that extinction poses.

First, global markets consume rain-forest products



Tropical forests contain more species than any other ecosystem, as well as a higher proportion of endemic (unique) species. As people clear large areas of tropical forests, entire species are vanishing, many of them unknown. Graph adapted from the Millennium Ecosystem Assessment (<http://www.unep.org/maweb/en/index.aspx>) *Biodiversity Synthesis*.

that depend on sustainable harvesting: latex, cork, fruit, nuts, timber, fibers, spices, natural oils and resins, and medicines. In addition, the genetic diversity of tropical forests is basically the deepest end of the planetary gene pool. Hidden in the genes of plants, animals, fungi, and bacteria that have not even been discovered yet may be cures for cancer and other diseases or the key to improving the



yield and nutritional quality of foods—which the U.N. Food and Agriculture Organization says will be crucial for feeding the nearly ten billion people the Earth will likely need to support in coming decades. Finally, genetic diversity in the planetary gene pool is crucial for the ability of all life-forms to survive on Earth in response to rare but catastrophic environmental events, such as meteor impacts or massive, sustained volcanism.

### Soil Effects

With all the lushness and productivity that exist in tropical forests, it can be surprising to learn that tropical soils are actually very thin and poor in nutrients. The underlying “parent” rock weathers rapidly in the tropics’ high temperatures and heavy rains, and over time most of the minerals have washed from the soil. Nearly all the nutrient content of a tropical forest is in the living plants and the decomposing litter on the forest floor.

When an area is completely deforested for farming, the farmer typically burns the trees and vegetation to create a fertilizing layer of ash. After this slash-and-burn deforestation, the nutrient reservoir is lost, flooding and erosion rates are high, and soils often become unable to support crops in just a few years. If the area is then turned into cattle pasture, the ground may become compacted as well, slowing down or preventing forest recovery.

## Social Impacts

Tropical forests are home to millions of native (indigenous) people who make their livings through subsistence agriculture, hunting and gathering, or low-impact harvesting of forest products like rubber or nuts. Deforestation in indigenous territories by loggers, colonizers, and refugees has sometimes triggered violent conflict. Forest preservation can be socially divisive, as well. National and international governments and aid agencies struggle with questions about what level of human presence, if any, is compatible with conservation goals in tropical forests, how to balance the needs of indigenous peoples with expanding rural populations and national economic development, and whether establishing large, pristine, uninhabited protected areas—even if that means removing current residents—should be the highest priority of conservation efforts in tropical forests.

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Source: NASA, Earth Observatory, <http://earthobservatory.nasa.gov/Features/Deforestation/>.

# MODIFICATION READING 4

## *The History of Large Federal Dams: Planning, Design, and Construction*

By their very nature, dams and reservoirs changed the river ecology.<sup>1</sup> Certainly, reservoirs can improve water quality for many users, and dams of different design and operation can produce different effects downstream. “The ability of large dams to compensate for the unpredictability” of nature, one study noted, “is what makes them so attractive. . . .”<sup>2</sup> However, changes occur from a free-flowing environment to a standing or lake environment, drowning a variety of native flora and fauna, ruining forests, altering or destroying riparian vegetation and habitat, encouraging evaporation which concentrates salts, and sometimes creating mud flats. Water released from dams is likely to be low in oxygen, thus threatening river life. In deep reservoirs, the water column can stratify by temperature. Little oxygen or light can reach the lower level, and the upper level becomes warmer. This change can create a forbidding environment for cold-water fish and can allow for the habitat to be taken over by other species. Dams can alter water temperature in other ways as well. At Glen Canyon Dam, for example, water released into the Colorado River is approximately 20 degrees colder than would be natural, which destroys many native organisms. Much of the river cannot produce algae, which in turn disrupts the food chain.<sup>3</sup> On the other hand, such situations sometimes result in flourishing trophy cold water fisheries.



While having constant, predictable in-stream flows has been valuable for irrigators and other water users, artificially regulated flows produce a number of problems. Native river animals and plants have a difficult time adjusting to constant flows and constant temperatures when the natural rhythms of rivers are altered. Without high flows, silt does not get flushed from the streambed gravel, harming many species of fish and insects that depend on clean, oxygenated gravel for their eggs and larvae. Artificially and naturally low flows can cause back channels and sloughs to dry up, thus destroying primary spawning areas for trout. In 1987, a low flow from Palisades Dam on the Snake River killed approximately 600,000 cutthroat and brown trout, mostly juveniles, along with much of the aquatic food chain.<sup>4</sup> In spite of this problem the Snake River does support a blue ribbon trout fishery in the area.

Intensive irrigation has led to serious salinity problems in many agricultural regions. As Donald Worster stated, “What nature has taken geological eons to achieve, the leaching of salts from the root zone of plants, the irrigator undertakes to do in a matter of decades.” Intensive irrigation can lead to a rising water table, bringing dissolved salts to the root zone or to the surface. Growers in the Imperial Valley in Southern California faced this daunting prospect, and by the early 1970s spent more than \$66 million on tile drains and canal linings to capture saline runoff and to discharge it elsewhere. They also faced shifting to salt-tolerant crops, even though they yielded less income. An alternative was to consume more water, if possible, to flush the salt deposits.<sup>5</sup>

The salinity issue took on international proportions in the Colorado River Basin. A 1944 treaty had guaranteed Mexico 1.5 million acre-feet, but the agreement did not address water quality. Over time, Mexico was receiving heavily saline drainage from irrigated fields in the United States. In 1961,

the Wellton-Mohawk Irrigation District, along the lower Gila River in Arizona, discharged drainage water rich in salt into the Colorado River, immediately above Mexico's diversion canal, and essentially doubled the average annual salinity of the flow across the border. The United States denied that its treaty included any obligation on water quality issues, but fresher water was released from American dams, and a channel was built to divert the drainage around the Mexican intake in 1965. This proved to be a temporary solution, and finally, in 1973, both countries signed an agreement to settle the dispute. Realizing that similar disagreements could break out again, Congress passed the Colorado River Basin Salinity Control Act in 1974. All along the Colorado River, use and reuse of the water had diminished the flow and contributed to degradation of the quality of water not only as it crossed the border into Mexico, but also in the Imperial Valley and for the Metropolitan Water District of Southern California.<sup>6</sup>

The environmental repercussions of dam building are complex and not easily resolved— some have argued they are irreversible. One solution was to cease building dams on the remaining free-flowing rivers in the country. River preservation was given a boost by the Wild and Scenic Rivers Act of 1968. While not giving natural features legal standing *per se*, it provided an alternative to resource development by protecting the shorelines of designated rivers from federally permitted development. The act was an important sign that the perception of rivers as a commodity in the traditional sense was changing. Yet by the 1990s, the mileage preserved in the system was less than one percent of the nation's natural river courses.<sup>7</sup>

## Endnotes

1. Pisani, "Federal Water Policy and the Rural West," 139.
2. For additional information on water quality and dams see the Environmental Protection Agency's 1989 Report to Congress: *Dam Water Quality Study* (EPA 506/2-89/002). This report was prepared in accordance with the requirement of Section 524 of the Water Quality Act of 1987.
3. Goldsmith and Hildyard, *The Social and Environmental Effects of Large Dams*, 13.
4. Devine, "The Trouble with Dams," 72–3. Committee on Environmental Effects of the United States Committee on Large Dams, *Environmental Effects of Large Dams* (New York: American Society of Civil Engineers, 1978), 5. Echeverria, Barrow, and Roos-Collins, *Rivers at Risk*, 4. Worster, *Rivers of Empire*, 310. Palmer, *The Snake River*, 67. Palmer, *Endangered Rivers and the Conservation Movement*, 1–2. Goldsmith and Hildyard, *The Social and Environmental Effects of Large Dams*, 52, 63. Collier, Webb, and Schmidt, *Dams and Rivers*, 83–4. See also John A. Dixon, Lee M. Talbot, and Guy J. M. Le Moigne, *Dams and the Environment* (Washington, D.C.: World Bank, 1989), 2.
5. Devine, "The Trouble with Dams," 71–2. Palmer, *The Snake River*, 20–1. Echeverria, Barrow, and Roos-Collins, *Rivers at Risk*, 6.
6. Worster, *Rivers of Empire*, 153–4, 240, 319–24. See also Goldsmith and Hildyard, *The Social and Environmental Effects of Large Dams*, 134–63.
7. Hundley, "The West Against Itself," 37–9; Warne, *The Bureau of Reclamation*, 117–21. See also Berkman and Viscusi, *Damming the West*, 34–41, 46–51. Cullen, *Rivers in Harness*, 120–3. For another significant case of water degradation, see Gene Rose, *San Joaquin: A River Betrayed* (Fresno: Linrose Publishing Company, 1992), 123, 125–30. For a general description of the impact of dams and reservoirs on water quality see McCully, *Silenced Rivers*, 36–38, 40–1.

Source: U.S. Department of the Interior, Bureau of Reclamation, [http://www.cr.nps.gov/history/online\\_books/dams/federal\\_dams.pdf](http://www.cr.nps.gov/history/online_books/dams/federal_dams.pdf). Excerpt from pages 404–406.

# MODIFICATION READING 5

## *Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques*

Bureau of International Security and Nonproliferation  
Signed in Geneva May 18, 1977  
Entered into force October 5, 1978

### **Narrative**

Use of environmental modification techniques for hostile purposes does not play a major role in military planning at the present time. Such techniques might be developed in the future, however, and would pose a threat of serious damage unless action was taken to prohibit their use. In July 1972 the U.S. Government renounced the use of climate modification techniques for hostile purposes, even if their development were proved to be feasible in the future.

Both the U.S. Senate and the House of Representatives held hearings, beginning in 1972, and the Senate adopted a resolution in 1973 calling for an international agreement “prohibiting the use of any environmental or geophysical modification activity as a weapon of war...” In response to this resolution, the President ordered the Department of Defense to undertake an in-depth review of the military aspects of weather and other environmental modification techniques. The results of this study and a subsequent interagency study led to the U.S. Government’s decision to seek agreement with the Soviet Union to explore the possibilities of an international agreement.

During the summit meeting in Moscow in July 1974, President Nixon and General Secretary Brezhnev formally agreed to hold bilateral discussions on how to bring about “the most effective measures possible to overcome the dangers of the use of environmental modification techniques for military purposes.” Three sets of discussions were held in 1974 and 1975, resulting in agreement on a common approach and common language.

In August 1975, the chief representatives of the U.S. and the Soviet delegations to the Conference of the Committee on Disarmament (CCD) tabled, in parallel, identical draft texts of a “Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques.”

The Convention defines environmental modification techniques as changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere, and atmosphere, or of outer space. Changes in weather or climate patterns, in ocean currents, or in the state of the ozone layer or ionosphere, or an upset in the ecological balance of a region are some of the effects which might result from the use of environmental modification techniques.

Intensive negotiations held in the CCD during the spring and summer of 1976 resulted in a modified text and, in addition, to understandings regarding four of the Treaty articles. These were transmitted to the U.N. General Assembly for consideration during the fall session.

Article I sets forth the basic commitment: "Each State Party to this Convention undertakes not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party." An understanding defines the terms "widespread, long-lasting or severe." "Widespread" is defined as "encompassing an area on the scale of several hundred square kilometers"; "long-lasting" is defined as "lasting for a period of months, or approximately a season"; and "severe" is defined as "involving serious or significant disruption or harm to human life, natural and economic resources or other assets."

With regard to peaceful uses of environmental modification techniques, the convention provides that the parties shall have the right to participate in the fullest possible exchange of scientific and technological information.

In addition to the provision for mutual consultation regarding complaints and for resource to the Security Council, the revised draft establishes the framework for a Consultative Committee of Experts, which would meet on an ad hoc basis when so requested by a party, in order to clarify the nature of activities suspected to be in violation of the convention. Responding to the suggestion of many delegations, the revised text incorporates a provision for periodic conferences to review the Conventions operation.

During the 1976 fall session, the U.N. General Assembly held extensive debate on the draft Convention, including several resolutions relating thereto. On December 10, the General Assembly adopted a resolution by a vote of 96 to 8, with 30 abstentions, which referred the Convention to all member nations for their consideration, signature, and ratification, and requested the U.N. Secretary-General to open the Convention for signature.

The U.N. Secretary-General officiated at the signing ceremony in Geneva on May 18. The United States joined 33 other nations in signing the Convention. The Convention entered into force on October 5, 1978, when the 20th state to sign the Convention deposited its instrument of ratification. President Carter transmitted the Convention to the Senate on September 22, 1978.

The Senate gave its advice and consent to ratification on November 28, 1979, by a vote of 98–0. The President ratified the Convention December 13, 1979. The Convention entered into force for the United States on January 17, 1980, when the U.S. instrument of ratification was deposited in New York.

Find the entire Treaty at: <http://www.state.gov/t/isn/4783.htm>.

# MODIFICATION READING 6

*Excerpt from "The Environment and Military Strategy"*

By Colonel Richard W. Fisher, USAFR (*Air & Space Power Journal*, June 2003)  
*War is never an isolated act. (Clausewitz, 1831)*<sup>1</sup>

## Introduction

Bats as bombs.

It sounds like a silly gimmick but the technique was actively researched and tested during World War II.<sup>2</sup> Americans trapped whole populations of wild bats in the desert southwest during the early 1940's and attached timed incendiary devices on them. The plan was that after the bats were rigged as self-propelled weapons, they were to be metabolically cooled into a quiescent state, packed by the thousands into canisters and parachuted over enemy targets. Fortunately for the bats, the project failed in testing but it serves to illustrate a commonly found characteristic of war; that the environment and its components have little value other than as a military asset or liability.

Today, the growing worldwide awareness and sensitivity to the health and vitality of the environment compels analysis of the relationship between environmental security and national security. Are they intimately and irretrievably tied or is the anxiety about the earth's environmental perils overdrawn, thereby discounting the importance of the environment in war. To use the bat bomb as a metaphor, if a bat were a threatened mangrove ecosystem in South Vietnam, how many more bats (ecosystems) could we sacrifice without threatening the stability of the entire bat population (integrated global environment). Should any bats be sacrificed? If so, which ones? Does the genetic pool dangerously shrink as bats are destroyed? Beyond the strictly biological and physical questions is the issue of environmental ethics in war. These are provocative questions but are they pertinent to our national security?

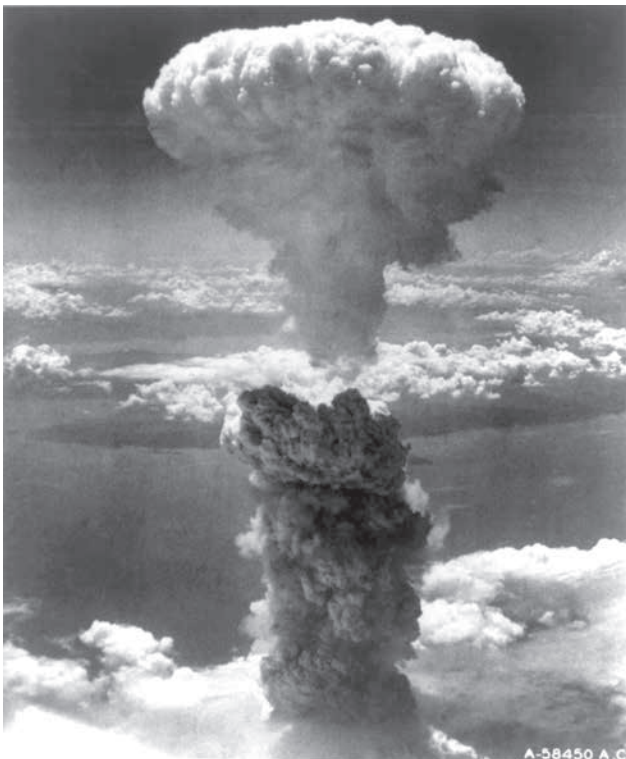
The aims of this paper are twofold. The first is to demonstrate that at least some consideration of the environmental consequences of war is necessary in the strategic planning for force employment. The second is to recommend a U.S. strategic force planning doctrine that accounts for the application of an environmentally responsible force. That is, this paper will address not the everyday peacetime problems of the Department of Defense such as the clean-up of hazardous waste sites nor the environmental resources that are likely to be fought over in the years to come. Rather, at issue is the environmental damage we are willing to accept and deliver for military gain when we wage war.

## ***A Selected Historical Perspective of the Effect of Warfare on the Environment***

Throughout history, the physical environment and ecology of the earth during wartime have only presented either logistical problems to be overcome and defeated or opportunities to be exploited. There are abundant examples from World War II. In the Pacific Theater, entire tropical islands, above and below the waterline, were denuded by both the Allies and Japanese as an incidental consequence of conflict. Populations of indigenous birds and animals on many of these islands were rendered extinct. In the west, both the German and Allied armies destroyed much soil binding

vegetation in North Africa increasing both windstorms and desertification. The Germans sunk an allied ship containing a quarter of a million pounds of mustard gas in an Adriatic port. The extremely toxic effect from the slow release of this chemical has been expected to threaten plant and animal life in this area for 400 years.<sup>3</sup>

The earth environment also has been frequently used as a weapon of war. Vegetation has been burned, soil and water supplies contaminated and the air fouled as it suited a military mission. The destruction of croplands has been commonplace. Two millennia ago, the Romans sowed salt on Carthaginian fields during the third Punic War to make them infertile. More recently, General Sheridan virtually decimated the remaining American bison herds in 1865, the staple of the plains Indian. A year earlier he had ravaged virtually all cropland in the Shenandoah Valley. In World War II, the Norwegians instigated land slides into their own fertile valleys and the Dutch broke dikes flooding a third of their own productive agricultural land in an attempt to dissuade German occupation. At the same time, the Germans were decimating the rich Czech beech forests.<sup>4</sup>



After the advent of the nuclear age when the prospect of global annihilation was a very real possibility, lower intensity warfare was still conducted with little regard for its ecological effect. A notorious example of this was the defoliation of many of the Indochinese forests in the 1960's. Here, the rich sub-tropical jungle that hid the Ho Chi Minh Trail and other areas of military interest were only so much dense foliage to be eradicated by aerial applications of toxic chemicals. In addition, much of the irrigated rice growing lands of Vietnam were drained allowing leaching of nutrients and sulfur accumulation that made the soil barren. The dry vegetation on the defoliated and drained lands was burned with permanent scarring. These were not fire dominated ecosystems such as exist in other parts of the world. Beside the loss of valuable cropland, several animal species were threatened or endangered as a result of these and other ecocidal practices.<sup>5</sup>

After World War II, strategic planning was built around the development of nuclear weapons types and arsenal sizes of such massive proportions that consideration of global human survivability was introduced into strategic thinking. Still, any concern about global or local environmental health was largely only an issue as it directly related in the short term to human survival, not the sustaining environment in which people would expect to live after war. During the 1950's, the U.S. built fallout shelters fully expecting that civilians could eventually emerge unscathed after a nuclear attack into a fully functioning and liveable environment.

Although the concept of fallout shelters was later abandoned as folly, it was not until the notion of nuclear winter was hypothesized using some general atmospheric circulation models (GCMs)

results during the late 1980's that the effect of war on global ecosystem functioning and energy budgets was seriously considered. Now, after evaluating the climatic prospects of global nuclear war, scientists are more pessimistic but not unanimous in their conclusions about the resilience of the earth to such insult.

In spite of the uncertainty in the environmental debate that grew around the potential consequence of the use of strategic nuclear weapons, still relatively little attention among force planning strategists has been directed at the environmental consequences incumbent in the conduct of either conventional warfare and especially the use of tactical nuclear weapons. Indeed, some nations continue to act without any apparent environmental ethic. Modern day examples of truly environmentally irresponsible wartime acts have not been difficult to find. The most conspicuous recent example was the loathsome destruction of Kuwaiti oil wells by Iraq in 1990 resulting in damage to Persian Gulf estuaries and the wasteful loss of an increasingly valuable finite natural resource.<sup>6</sup>

The most important thing to be said about the consequences of all these examples of assaults on the environment is that they caused either or both a physical and a biological change. In some cases, ecosystem function was permanently damaged while in others, natural processes invoked a new ecosystem paradigm. In some cases, as in the reef building around sunken ships, the change has actually benefited the environment. Of course, changes of the same magnitude have occurred and will continue to occur during peacetime. Examples are the Exxon Valdez oil spill, the huge hydroelectric generation project in the James Bay drainage of eastern Canada and our long term use of CFCs, although environmental awareness is playing a greater role in identifying damaging human activities and preventing and mitigating them. The question is, "Should the important environmental considerations in peacetime also be a concern during operations of war?" Stated another way, "Why spend enormous sums to manage, mitigate and improve the environment in everyday commerce if during wartime, all bets are off?" Such actions may soon be suicidal.

## Endnotes

1. Carl von Clausewitz, *On War*, trans. and ed. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1984), 78.
2. Conrad Crane, *The Air War in Europe* (Lecture presented to the Naval War College, October 13, 1994).
3. Susan Lanier-Graham, *The Ecology of War: Environmental Impacts of Weaponry and Warfare* (New York: Walker & Co., 1993), 52–68.
4. Lanier-Graham, 52–68.
5. SIPRI (Stockholm International Peace Research Institute), *Ecological Consequences of the Second Indochina War* (Stockholm: Almquist and Eiksell, 1976), 58–72.
6. Kattalai S. Ramachandran, *Gulf War and Environmental Problems* (New Dehli: Ashish Publishing House, 1991), xiii.

Source: Colonel Richard W. Fisher, "The Environment and Military Strategy" in *Air & Space Power Journal* (June 2003).

# MODIFICATION READING 7

## *Excerpt from "Ecological Effects of Fishing"*

By Stephen K. Brown, Peter J. Auster, Liz Lauck, and Michael Coyne  
National Oceanic and Atmospheric Administration State of the Coast Report, 1998

Historically, marine fishery resources were assumed to be almost limitless, and fishing was thought to have little impact on fish stocks and marine ecosystems. However, during recent decades, concern about the condition of fisheries has increased. Since 1989 world harvests have apparently leveled off. Many fisheries experts and commercial and recreational fishermen now recognize that fishing can have profound effects on marine fish stocks and the ecosystems they inhabit. With this change in attitude has come increased Federal responsibility to build sustainable fisheries. The recently reauthorized Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) provides many tools for the National Marine Fisheries Service (NMFS) to meet the Nation's stewardship responsibilities for fisheries. The Act now includes new requirements to reduce bycatch, halt overfishing, rebuild overfished stocks, and protect essential fish habitat.



This essay summarizes recent work on the biological and physical impacts of fishing. The information should be considered in the context that exploitation of marine fish and invertebrate resources provides many important benefits to society, including food, employment, business opportunities, and recreation. However, implementation of a sustainable-use policy requires knowledge of the impacts that exploitation can have on fishery resources and their environmental support system. Understanding the deleterious ecological effects of fishing, and reducing them where feasible, can improve ecosystem health and productivity, potentially increasing fishery yields. The biological impacts discussed here include bycatch (the unintended capture and subsequent discarding of nontarget species), ghost fishing (mortality caused by lost or abandoned gear), and alteration of populations and ecosystems. The physical impacts discussed here include effects of mobile fishing gear and small-boat propellers on bottom habitat. The information contained in this essay is primarily for the U.S. Exclusive Economic Zone, and for the continental shelf, where the water is generally less than 200 m (656 ft) deep. These issues have worldwide impacts, however, and considerable information also exists for European, Australian and Asian waters (Dayton et al., 1995).

The limited selectivity of fishing gear leads to bycatch, which is usually discarded for economic, legal or personal considerations. Bycatch discards include fish and invertebrates, as well as protected species, such as marine mammals, sea turtles and sea birds. Depending on the species, gear,

handling techniques, and the health of individuals, some or all of the discarded animals die. A recent estimate of the worldwide marine bycatch discarding is approximately 27 million metric tons (30 million tons) per year, which is about one-third of the estimated 77 million metric tons (85 million tons) of catch that is retained per year (Alverson et al., 1994).

Although comprehensive data on the magnitude and biological significance of U.S. bycatch are not currently available, considerable information now exists, and better information is being prepared. The Magnuson-Stevens Act's provisions requiring that bycatch and associated mortality be minimized have led to the development of a national bycatch plan (NMFS, on-line, 1998d). This document summarizes the available bycatch data, describes potential impacts and data gaps, and examines the causes of bycatch.

Lost fishing gear threatens marine life. Comprehensive data on ghost fishing impacts are not available, but entanglement in, and/or ingestion of, human-caused debris (including fishing gear and many other items) has been reported for over 250 marine species (Laist, 1996).

Fishing can have unintended effects on target species' populations and the ecosystems that they inhabit. Excess removal of larger, older and more fecund individuals from a population depletes spawning stocks, thus reducing a population's ability to replenish itself. Potential ecosystem impacts include changes in community structure and food chains. Removing a dominant species, for example, may allow competing or prey species to increase, or cause predator populations dependent on the harvested species to decline. Also, discarding of bycatch and processing waste may increase food availability for opportunistic scavengers, including other fish, crabs, and seabirds.

Physical impacts to the seafloor primarily come from mobile commercial fishing gear and, in shallow areas, boat propellers, anchors, and grounding. Mobile fishing gear, such as bottom trawls and dredges, which are towed along the bottom to capture groundfish, shrimp, and molluscan shellfish, can have deleterious effects on sea-floor habitat. Although mobile gear impacts have only begun to receive serious attention from U.S. scientists, some studies have already shown that a wide range in the type and degree of physical and biological damage can occur. The propellers of power boats, primarily used for recreation, can cause significant physical damage to shallow habitats, such as seagrass beds, while anchoring and grounding primarily damage coral reefs.

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Source: Stephen K. Brown, Peter J. Auster, Liz Lauck, and Michael Coyne, "Ecological Effects of Fishing," State of the Coast Report (National Oceanic and Atmospheric Administration, 1998), [https://aamboceanservice.blob.core.windows.net/oceanservice-prod/websites/retiredsites/sotc\\_pdf/IEF.PDF](https://aamboceanservice.blob.core.windows.net/oceanservice-prod/websites/retiredsites/sotc_pdf/IEF.PDF).

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# ENVIRONMENT MODIFICATION POSTER DIRECTIONS

*Create a Poster Showing Examples of How Humans Modify the Environment*

Read the information about how humans modify the environment. Discuss as a group to answer the following questions. Create a poster displaying your group's example of environment modification.

1. What do people do to modify the environment?
2. What are the reasons that people modify the environment in this way?
3. What are *positive* outcomes of modifying the environment in this way?
4. What are *negative* outcomes of modifying the environment in this way?
5. How do you feel about these modifications?

## Create Your Poster

Your poster must include:

- The title of the poster.
- *Visual examples* of how humans *modify* the environment.
- *Explanations* of the effects of these modifications.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# MODIFYING THE ENVIRONMENT EXIT TICKET

*Show Your Understanding of How Humans Modify the Environment*

You have learned about how humans modify the environment. *Reflect* on what you have learned. Answer the questions below.

1. How do people modify or change the environment where we live?
2. Do you have any concerns about how people modify the environment?
3. Imagine you live in a location that is very mountainous with cold winters and hot summers. In what ways would you want to modify your environment?

## Lesson 9—Natural Hazards

### *The Natural Hazards That Come with the Geography*



One class period of instruction

This lesson introduces students to common types of *natural hazards*. They will look at some of the *causes* or factors that contribute to natural hazards. Students will choose a location and then research the hazards that location faces.

Lesson 10 will look at how people's perceptions of locations change over time.

#### **Copy Instructions**

Print one handout  
for each student.



#### **Materials Needed**

- **Natural Hazards KWL**
- **Natural Hazards**
- **Natural Hazards Research Directions**
- Research resources (e.g., internet, encyclopedias)

#### **National Geography Standards**

##### **8th Grade**

15.2.A-B—Describe and explain the types, causes, and characteristics of environmental hazards.

##### **12th Grade**

15.2.A—Explain and compare how people in different environments think about and respond to environmental hazards.

#### **Learning Objectives**

1. Describe types, causes, and characteristics of environmental hazards.
2. Research the hazards associated with a location.

#### **Evidence of Learning**

Describe a natural hazard that the students have researched.

## Lesson Sequence

### 1. Natural Hazards KWL

Fill out the K and W sections. Ask students to share what they *know*. Ask students to share what they *want* to know. Encourage students to write down more ideas if they hear some from classmates. Encourage students' ideas and, when a hazard covered in this lesson is mentioned, let them know they will be learning something they want to know. Save the L section for later.

#### Handout

- Natural Hazards KWL

### 2. Lecture

Read over the **Natural Hazards** handout. Ask students to make connections to any examples that they can.

#### Handout

- Natural Hazards

### 3. Research

Students should follow the directions, choosing a location and researching the hazards that are relevant to that area. If possible, this may be a good time to provide internet access or have relevant books for resources.

#### Handout

- Natural Hazards Research Directions

### 4. Share (if time)

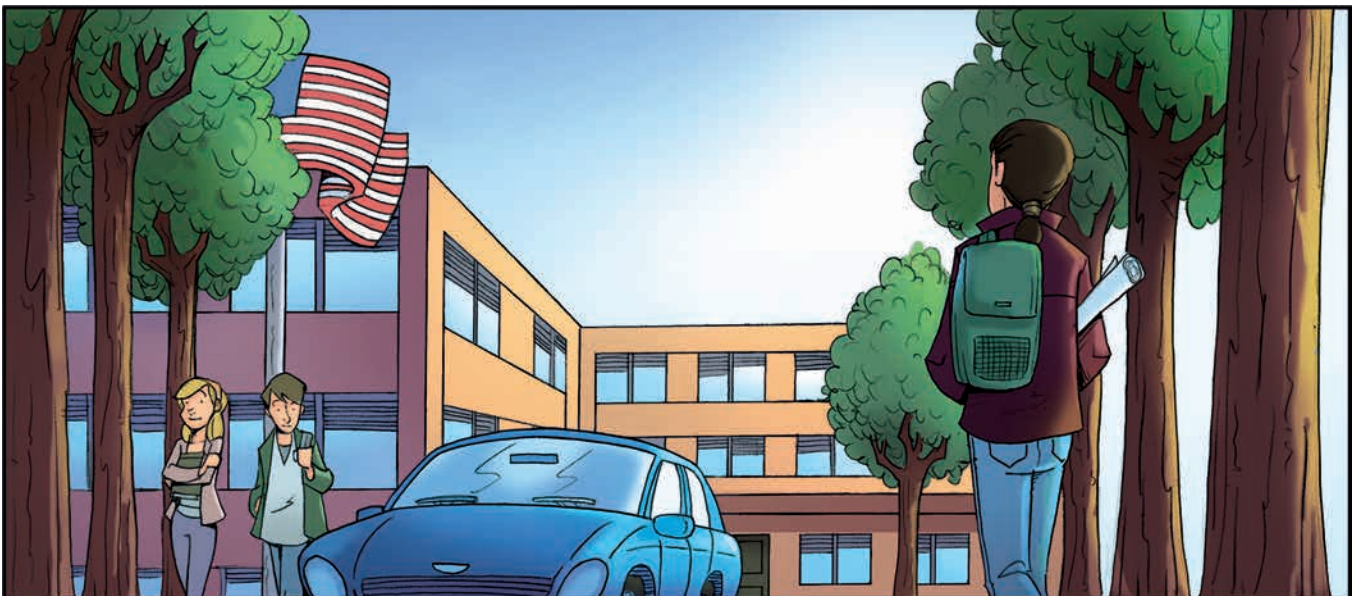
If there is time after students have finished researching, ask for volunteers to share what they found out about their locations and hazards.

### 5. Exit Ticket

Students fill in the L section of the KWL, showing what they learned about natural hazards.

#### Handout

- Natural Hazards KWL



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# NATURAL HAZARDS KWL

<b>K</b>	What do you think you <b>Know</b> about natural hazards?
<b>W</b>	What do you <b>Want</b> to know about natural hazards?
<b>L</b>	What did you <b>Learn</b> today about natural hazards?

# NATURAL HAZARDS

## *The Natural Hazards That Come with the Geography*

There are a lot of natural hazards to be aware of when choosing a place to settle. The zombie outbreak changed a lot of things, but it didn't stop natural hazards from occurring. While natural hazards are difficult or even impossible to predict, some hazards are more common in certain areas.

### Some Types of Natural Hazards to Consider



#### **Floods**

Floods are one of the most common hazards in the United States, but not all floods are alike. Some floods develop slowly, while others, such as flash floods, can develop in just a few minutes and without visible signs of rain. Additionally, floods can be local, affecting a neighborhood or community, or very large, affecting entire river basins and multiple states.

Flash floods can occur within a few minutes or hours of excessive rainfall, a dam or levee failure, or a sudden release of water held by an ice jam. Flash floods often cause a dangerous wall of roaring water carrying rocks, mud, and other debris. Overland flooding, the most common type of flooding event typically occurs when waterways such as rivers or streams overflow their banks as a result of rainwater or a possible levee breach and cause flooding in surrounding areas. Flooding can also occur when rainfall or snowmelt exceeds the capacity of underground pipes or the capacity of streets and drains designed to carry floodwater away from urban areas.

Be aware of flood hazards no matter where you live or work, but especially if you are in low-lying areas, near water, behind a levee, or downstream from a dam. Even very small streams, gullies, creeks, culverts, dry streambeds, and low-lying ground that appear harmless in dry weather can flood.

#### **Tsunamis**

Tsunamis (pronounced soo-ná-mees), also known as seismic sea waves (mistakenly called "tidal waves"), are a series of enormous waves created by an underwater disturbance such as an earthquake, landslide, volcanic eruption, or meteorite. A tsunami can move hundreds of miles per hour in the open ocean and smash into land with waves as high as 100 feet or more.

From the area where the tsunami originates, waves travel outward in all directions. Once the wave approaches the shore, it builds in height. The topography of the coastline and the ocean floor will influence the size of the wave. There may be more than one wave and the succeeding one may be larger than the one before. That is why a small tsunami at one beach can be a giant wave a few miles away.

All tsunamis are potentially dangerous, even though they may not damage every coastline they strike. A tsunami can strike anywhere along most of the U.S. coastline. The most destructive tsunamis have occurred along the coasts of California, Oregon, Washington, Alaska, and Hawaii.

Earthquake-induced movement of the ocean floor is the most common source of tsunamis. If a major earthquake or landslide occurs close to shore, the first wave in a series could reach the beach in a few minutes, even before a warning is issued. Areas are at greater risk if they are less than 25 feet above sea level and within a mile of the shoreline. Drowning is the most common cause of death associated with a tsunami. Tsunami waves and the receding water are very destructive to structures in the run-up zone. Other hazards include flooding, contamination of drinking water, and fires from ruptured gas lines or tanks.

### **Hurricanes**

A hurricane is a type of tropical cyclone or severe tropical storm that forms in the southern Atlantic Ocean, Caribbean Sea, Gulf of Mexico, and the eastern Pacific Ocean. A typical cyclone is accompanied by thunderstorms and, in the Northern Hemisphere, a counterclockwise circulation of winds near the Earth's surface.

All Atlantic and Gulf of Mexico coastal areas are subject to hurricanes. Parts of the southwestern United States and the Pacific Coast also experience heavy rains and floods each year from hurricanes spawned off Mexico. The Atlantic hurricane season lasts from June to November, with the peak season from mid-August to late October. The eastern Pacific hurricane season begins May 15 and ends November 30.

Hurricanes can cause catastrophic damage to coastlines and several hundred miles inland. Hurricanes can produce winds exceeding 155 miles per hour as well as tornadoes and microbursts. Additionally, hurricanes (such as Katrina and Wilma in 2005 and Harvey in 2017) can create storm surges along the coast and cause extensive damage from heavy rainfall. Floods and flying debris from the excessive winds are often the deadly and destructive results of these weather events. Slow-moving hurricanes traveling into mountainous regions tend to produce especially heavy rain. Excessive rain can trigger landslides or mudslides. Flash flooding can occur due to intense rainfall.

Between 1963 and 2012, eight out of ten hurricane and tropical cyclone deaths in the United States were from storm surge, surf, and freshwater rainfall flooding rather than from wind-related hazards associated with such storms.



### **Tornadoes**

Tornadoes are nature's most violent storms. Spawned from powerful thunderstorms, tornadoes can cause fatalities and devastate a neighborhood in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can exceed 1 mile wide and 50 miles long. Every state is at some

risk from this hazard. Some tornadoes are clearly visible, while rain or nearby low-hanging clouds obscure others. Occasionally, tornadoes develop so rapidly that little, if any, advance warning is possible. Before a tornado hits, the wind may die down and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

### **Earthquakes**

One of the most frightening and destructive phenomena of nature is a severe earthquake and its terrible aftereffects. An earthquake is the sudden, rapid shaking of the earth, caused by the breaking and shifting of subterranean rock as it releases strain that has accumulated over a long time.

For hundreds of millions of years, the forces of plate tectonics have shaped the earth, as the huge plates that form the earth's surface slowly move over, under and past each other. Sometimes, the movement is gradual. At other times, the plates are locked together, unable to release accumulated energy. When the accumulated energy grows strong enough, the plates break free. If the earthquake occurs in a populated area, it may cause many deaths and injuries and extensive property damage.

While earthquakes are sometimes believed to be a West Coast occurrence, there are actually forty-five states and territories throughout the United States that are at moderate to high risk for earthquakes, including the New Madrid fault line in the central United States.

The 2011 East Coast earthquake illustrated the fact that it is impossible to predict when or where an earthquake will occur, so it is important that you and your family are prepared ahead of time.

### **Volcanoes**

A volcano is a mountain that opens downward to a reservoir of molten rock below the surface of the Earth. Unlike most mountains, which are pushed up from below, volcanoes are vents through which molten rock escapes to the Earth's surface. When pressure from gases within the molten rock becomes too great, an eruption occurs. Eruptions can be quiet or explosive. There may be lava flows, flattened landscapes, poisonous gases, and flying rock and ash that can sometimes travel hundreds of miles downwind.

Because of their intense heat, lava flows are great fire hazards. Lava flows destroy everything in their path, but most move slowly enough that people can move out of the way.

Fresh volcanic ash, made of pulverized rock, can be abrasive, acidic, gritty, gassy, and odorous. While not immediately dangerous to most adults, the acidic gas and ash can cause lung damage to small infants, to older adults, and to those suffering from severe respiratory illnesses. Volcanic ash also can damage machinery, including engines and electrical equipment. Ash accumulations mixed with water become heavy and can collapse roofs. Volcanic ash can affect people hundreds of miles away from the cone of a volcano.

Sideways-directed volcanic explosions, known as "lateral blasts," can shoot large pieces of rock at very high speeds for several miles. These explosions can kill by impact, burial, or heat. They have been known to knock down entire forests.

Volcanic eruptions can be accompanied by other natural hazards, including earthquakes, mudflows and flash floods, rock falls and landslides, acid rain, fire, and (under special conditions) tsunamis.

Active volcanoes in the United States are found mainly in Hawaii, Alaska, and the Pacific Northwest. The danger area around a volcano covers approximately a 20-mile radius; however, some danger may exist 100 miles or more from a volcano.

### **Landslides**

Landslides occur in all U.S. states and territories and can be caused by a variety of factors, including earthquakes, storms, volcanic eruptions, fire, and human modification of land. Landslides can occur quickly, often with little notice, and the best way to prepare is to stay informed about changes in and around your home that could signal that a landslide is likely to occur.

In a landslide, masses of rock, earth, or debris move down a slope. Debris and mudflows are rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, during heavy rainfall or rapid snowmelt, changing the earth into a flowing river of mud or "slurry." They can flow rapidly, striking with little or no warning at avalanche speeds. They also can travel several miles from their source, growing in size as they pick up trees, boulders, cars and other materials.

Landslide problems can be caused by land mismanagement, particularly in mountain, canyon and coastal regions. In areas burned by forest and brushfires, a lower threshold of precipitation may initiate landslides. Land-use zoning, professional inspections, and proper design can minimize many landslide, mudflow, and debris flow problems.



Excerpts from "Natural Disasters," Ready.gov: <http://www.ready.gov/natural-disasters>

# NATURAL HAZARDS RESEARCH DIRECTIONS

## *Research Natural Hazards Associated with a Location*

Choose a location. *Predict* the natural hazards this place faces. *Research* to find out what natural hazards are there and how they are caused.

1. What location have you chosen?
2. What natural hazards do you predict this location encounters?

### Research

3. What natural hazards occur at this location?
4. List examples of when this location faced natural disasters.
5. What contributes to or causes these disasters?

## Lesson 10—Changing Perceptions

### *How Do People's Perceptions of Locations Change?*



One class period of instruction

This lesson engages students in the idea that *people's perceptions of locations change*. Because of many changes, our perceptions of some locations are different from the perceptions people had in the past.

This is the last lesson of this project. After completing this lesson, students will create the first part of their Settlement Location Report on the location they would choose to settle based on physical characteristics.

The next project helps students choose a location based on resources.

#### **Copy Instructions**

Print one Exit Ticket for each

student.



#### **Materials Needed**

- **Changing Perceptions Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

17.3.A—Explain how historical events were influenced by people's perceptions of people, places, regions, and environments.

##### **12th Grade**

17.3.A—Analyze and evaluate the role that people's past perceptions of places, regions, and environments played as historical events unfolded.

#### **Learning Objective**

Recognize historical events that were influenced by what people thought of environments.

#### **Evidence of Learning**

Cite an example of a historical event and identify the perceptions at play due to the specific event. Also, describe how perceptions of where students live have changed over time.

## Lesson Sequence

### 1. Think/Pair/Share

How have people's views of the environment changed over the past 100 years?

### 2. Lecture

People's perceptions of the world change. Before convenient air travel, other continents seemed far away. Before the internet ideas spread slowly and could seem more foreign.

### 3. Discussion

Conduct a class discussion using the following prompts:

- How did reports and maps of early explorers change the way people saw the world?
- How did the invention of cars, buses, and trains change the way people perceived the world?
- How have our views of natural resources changed over time?
- How would your perceptions of the environment change in a zombie outbreak?

### 4. Exit Ticket

Cite an example of a historical event that changed people's perceptions of the physical environment and describe how perceptions of students' local area have changed over time.



#### Teaching Tip

If discussion is slow to start, begin with something engaging and easy: *What was it like before the internet?*

#### Handout

- Changing Perceptions Exit Ticket





# **PROJECT 05: NATURAL RESOURCES FOR SURVIVAL**



# Explaining the Project

## Concept of Project 05

### Natural Resources for Survival: Project 05

#### **Project Goal**

The main goal of this project is for students to understand *natural resources*. Along the way they learn the different types, how they are formed, their uses, where they are located, and the advantages of locations with many resources.

#### **Main Final Product**

At the end of the project, students will create the second part of their Settlement Location Report describing the location they believe would be best to build their post-zombie outbreak settlement. The report must describe the natural resources the settlement would require, how the resources are formed, and where they are located. This report is just one part of what will inform their decision on where to settle.

#### **Project Options**

There are many ways that students could present this information. You may want to manage one format for all students or allow students to choose their own formats. As long as they meet the content requirements of the rubric, they will be showing their understanding of the standards.

The following are just a few possible ways students could complete this project:

- Formal written report
- Oral presentation
- Poster
- Persuasive letter
- Video recording
- Audio recording

There are many other ways. I find that students can be very engaged when choosing their own style every now and then. I also find that when choosing a format that the whole class has to do, it is a great opportunity to teach other skills. For example, if you require a poster, take the time to teach students elements of design and require them to practice that design in their posters.

# Natural Resources for Survival— Natural Resources

## Outline of Project 05

### Teaching Tip

This project helps students choose the best location based on natural resources.



### Handout

- Settlement Location Report 02

### Ask

Where are the resources I need for building a survivor settlement?



### Handout

- Natural Resources for Survival: Pre-assessment Quiz

### Teaching Tip

Through this project, students will be expected to learn these skills.



### Teaching Tip

You may choose to do all of the lessons, and then the project. You may also choose to launch the project, and then use the lessons to assist students in the completion of their goal.



## Natural Resources for Survival: Project 05

Maintaining access to natural resources is a matter of survival, both before and after the zombie apocalypse. It is only right that we teach our students to understand the importance of natural resources, how we define their importance, and how it is up to us to manage the use of resources. This project encourages students to consider the resources they need to survive and rebuild their settlement. This project extends their previous report to include even more details before moving to a settlement.

### Final Project Task

Students will need to create a report on best locations to build a new settlement based on natural resources.

### Driving Question

Where are resources located and why?

## Pre-assessment

### Student Learning

1. What are natural resources?
2. Understand and identify different types of resources.
3. Identify the formation process of common resources.
4. Evaluate locations based on natural resources.

### Lessons

1. What Are Resources?
2. Types of Resources
3. Cultural Use of Resources
4. Processes That Lead to Resources
5. Where Are Resources Found?
6. Resource Advantages

## Pre- and Post-assessment Quiz Answers

1. What are some different examples of resources?

Land, water, timber, fossil fuels, minerals, domesticated animals, wind and solar energy, among others.

2. What are the categories of resources?

Renewable, nonrenewable, flow.

3. What are the uses of resources?

The possible uses are virtually endless but include energy generation, farming and ranching, construction, transportation.

### Handout

- Natural Resources for Survival: Post-Assessment Quiz

## National Geography Standards

### 8th Grade

11.2.A—Compare and explain the advantages of one location over another in the access to factors of production.

16—The changes that occur in the meaning, use, distribution, and importance of resources.

16.1.A—Describe examples of how cultures differ in their definition and use of resources.

16.2.A—Describe the physical processes that influence the formation and therefore spatial distribution of renewable, nonrenewable, and flow resources.

16.2.B—Explain the location and uses of major resources in the world.

### 12th Grade

11.2.A—Identify and analyze the origins and development of and changes in patterns of economic activities.

16.1—The meaning and use of resources change over time.

16.2.A—Analyze and explain the relationships between the spatial patterns of settlement and resources.

16.3.A—Explain and compare the costs and benefits of using various types of renewable, nonrenewable, and flow resources.

## Project 05: Natural Resources for Survival

### Natural Resources for Survival—Natural Resources

#### Rubric for Project 05

	1	2	3	4
<b>Possible locations</b> 11.2.A Compare and explain the advantages of one location over another in the access to factors of production.	Struggles to compare or evaluate locations based on resources.	Compares multiple possible locations based on resources or explains the advantages of one place.	Compares the resources of multiple possible locations and chooses one, explaining its advantages.	Evaluates multiple locations based on their resources to influence final choice. (In a 3, one location is evaluated, but compared to others. In a 4, all locations are evaluated.)
<b>Possible resources</b> 16.1.A Describe examples of how cultures differ in their definition and use of resources.	Struggles to describe how resources are used in various cultures or identify helpful resources.	Describes how resources are used in various cultures or identifies resources that could be helpful.	Describes how resources are used in different ways or in various cultures. Identifies resources that could be helpful.	Describes how resources are used in different ways in various cultures. Identifies helpful resources. Evaluates resources that would no longer be available or suitable.
<b>Where do these resources come from?</b> 16.2.A Describe the physical processes that influence the formation and therefore spatial distribution of renewable, nonrenewable, and flow resources.	Struggles to describe the conditions needed to produce resources or where they are.	Describes the physical conditions needed to produce resources or the distribution of renewable, non-renewable, and flow resources.	Describes the physical conditions needed to produce one or two resources (including electricity). Describes the distribution of renewable, nonrenewable, and flow resources.	Describes the physical conditions needed to produce a variety of resources (including electricity). Describes the distribution of renewable, non-renewable, and flow resources.
<b>Where are the resources in the world?</b> 16.2.B Explain the location and uses of major resources in the world.	Struggles to explain the location of major resources in the world.	Explains the location of major resources in the world, but not how they are used.	Explains the location and uses of major resources in the world.	Explains the location and uses of major resources in the world and describes the implications or explains why the resources are there.

# SETTLEMENT LOCATION REPORT 02

## *Natural Resources for Survival: Resources Introduction*

When figuring out where to go to build your zombie-free fortress, you really need to consider resources. You do not want to choose a location and not have access to what you need to survive. In this unit you'll learn about *types of resources, different uses of resources, formation of resources, where resources are located, and how to choose a location based on its resources.*

### **Driving Question**

Where are resources located and why? Or, where are the resources I need for building a survivor settlement?

### **What You Will Produce**

You'll extend your previous *report*, explaining the best location to build a settlement based on natural resources. Check with your teacher to see what options you have for your report.

### **Your Report Will Include the Following Information:**

- *Natural resources* that your settlement needs to survive.
- *How* the resources you need are formed.
- *Where* resources tend to be located in the world.
- *Locations* with your needed resources.
- *Which* location you think is the best choice out of all of them and why.

With these skills you will not only be leading survivors to safety; you will be leading them to long-term, sustainable safety.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# NATURAL RESOURCES FOR SURVIVAL

## *Pre-assessment Quiz*

Answer the following questions. You will soon learn all about these concepts.

1. What are some different examples of resources?

2. What are the categories of resources?

3. What are the uses of resources?

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# NATURAL RESOURCES FOR SURVIVAL

## *Post-assessment Quiz*

1. What are some different examples of resources?

2. What are the categories of resources?

3. What are the uses of resources?

# Lesson 1—What Are Resources?

## *Understanding the Definition and Examples of Resources*



One class period of instruction

This lesson introduces students to *resources*. Students will learn the definition of resources and think of examples of the *benefits* of resources.

Lesson 2 will look at the different types resources

### **Copy Instructions**

Print one of each handout and **Exit**

**Ticket** for each student.  
Print one set of poster directions per group.



### **Materials Needed**

- **Resources** handout
- **Resources Poster Directions**
- Poster supplies
- **Resources Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

16—The changes that occur in the meaning, use, distribution, and importance of resources.

#### **12th Grade**

16.2.A—Analyze and explain the relationships between the spatial patterns of settlement and resources.

### **Learning Objective**

Understand the definition and examples of resources.

### **Evidence of Learning**

Define resources and give examples.

### **Lesson Sequence**

#### **1. Think/Pair/Share**

What are resources? What are some examples?

#### **2. Lecture**

Read over the **Resources** handout to see the definition and examples.

#### **3. Group Poster**

Assign each group a resource from the list on the directions. Each group should discuss the questions to consider the importance or benefits of that resource. They should then make a poster.

#### **Handout**

- Resources

#### **Handout**

- Resources Poster Directions

#### **4. Gallery Walk**

Have students walk around to observe each other's posters or have each group present on the resource they discussed and share their posters.

#### **5. Exit Ticket**

Describe the resources in the local area and how they are used.

#### **Handout**

- Resources Exit Ticket

# RESOURCES

## *What Are Resources?*

**Resource:** any part of the physical environment that people value and use to meet their needs or provides a benefit.

### Some Examples of Resources



#### ***Land or Open Space***

This includes arable land, or land that is good for farming. Open space can also be useful as a site for a building and can sometimes become very limited.

#### ***Trees and Timber***

Trees, wood, and lumber are often used for building and also burned as a source of heat or to cook with.



#### ***Oil or Petroleum***

Crude oil, also known as petroleum, is a flammable liquid. It is often burned to produce energy. Many common products are produced from crude oil, such as gasoline, asphalt, plastics, and even medicine.



### **Mineral Resources**

Mineral resources are anything that has valuable or useful minerals in it. A mineral is something that is made naturally. Oil is a mineral resource, but so are the following:

- Coal
- Gold
- Copper
- Granite
- Nickel
- Uranium
- Platinum
- Silver

There are actually over four thousand known minerals.

### **Cattle**

Cattle or other animals are actually a resource as well. They can be used to help do work, as a source of milk, and as a source of food.



### **Water**

Water is a resource used for energy production, transportation, consumption, hygiene, and irrigation.

### **Wind, Solar, and Geothermal Energy**

Wind, solar, and even geothermal energy are resources that can be turned into electricity as a power source.



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# RESOURCES POSTER DIRECTIONS

*Create a Poster Showing the Benefits of Particular Resources*

Review the handout about Resources. *Discuss* your assigned resources as a group. *Create* a poster showing the benefits of your resource and be ready to share!

Check off the resource that your group has been assigned.

- |   |   |
|---|---|
| <input type="checkbox"/> Oil or petroleum | <input type="checkbox"/> Land or open space |
| <input type="checkbox"/> Trees and timber | <input type="checkbox"/> Mineral resources  |
| <input type="checkbox"/> Cattle           | <input type="checkbox"/> Water              |
| <input type="checkbox"/> Wind and solar   |   |

1. How is this resource used?
2. What would happen if this resource were not available?
3. Sketch a draft of your poster on the other side of this paper.

## Create Your Poster

Your poster must include:

- The *title* of the poster (including your resource).
- *Large examples* of how this resource is used.
- Why this resource is *important*.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# RESOURCES EXIT TICKET

*Show Your Understanding of Resources*

You have learned about resources. *Reflect* on what you have learned. *Answer* the questions below.

1. What *resources* do we have where we live?

2. How do we *use* these resources?

## Lesson 2—Types of Resources

### *Renewable, Nonrenewable, and Flow*



One class period of instruction

This lesson explains the different types of resources: *renewable*, *nonrenewable*, and *flow*. Students are provided with some simple examples and then spend time in a group trying to come up with examples of each.

Lesson 3 will look at the different ways resources are used.

#### **Copy Instructions**

Print class set of  
**Types of Resources**  
**KWL** for each student.  
Print one set of **Examples**  
**of Types of Resources**  
per group.



#### **Materials Needed**

- **Types of Resources KWL**
- **Types of Resources**
- **Examples of Types of Resources**

#### **National Geography Standards**

##### **8th Grade**

16.2.A—Describe the physical processes that influence the formation and therefore spatial distribution of renewable, nonrenewable, and flow resources.

##### **12th Grade**

16.3A—Explain and compare the costs and benefits of using various types of renewable, nonrenewable, and flow resources.

#### **Learning Objective**

Understand different types of resources.

#### **Evidence of Learning**

Describe the types of natural resources and give an example of each type.

## Lesson Sequence

### 1. Know/Want to Know/Learned

Fill in the K and the W sections of the **Types of Resources KWL** handouts. After students have filled them out, ask for students to share with the class. Encourage students to add more to their K and W based on what their classmates share. Save the L section for later.

### 2. Lecture

Go over the handout on different types of resources.

### 3. Group Activity

Students work together to create a list of examples of different types of resources.

### 4. Share

Ask students to share the examples that their group came up with. Have a student keep a running list of the examples on the board in a T-chart.

### 5. Exit Ticket

Review what the types of resources are and then give students time to fill in the L section of their **Types of Resources KWL**. This will serve as the lesson's exit ticket.

#### Handout

- Types of Resources KWL

#### Handout

- Types of Resources

#### Handout

- Examples of Types of Resources

#### Handout

- Types of Resources KWL

# TYPES OF RESOURCES KWL

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

K	W	L
What do you <b>Know</b> about types of resources?	What do you <b>Want</b> to know about types of resources?	What did you <b>Learn</b> today about types of resources? Give examples.

# TYPES OF RESOURCES

## *What Are the Types of Resources?*

There are three specific types of resources. This includes renewable, nonrenewable, and flow resources.



### **Renewable**

*Renewable* resources are resources that can be replenished over time. However, they could still run out if overused.

For example, fish and trees can be renewable when they are not used up faster than they are produced.

### **Nonrenewable**

*Nonrenewable* resources are natural resources that can never be regrown or regenerated once consumed. When these resources are gone there will be no more to use.

Coal, petroleum, and natural gas are all examples of nonrenewable resources.



### **Flow**

*Flow* resources are resources that do not run out but do not need to be renewed or regrown.

Examples are solar energy, geothermal energy, tides, and wind.

Flow resources are often included among renewable resources.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

## EXAMPLES OF TYPES OF RESOURCES

**List as Many Examples of the Types of Resources as You Can**

Recall the types of resources. Discuss as a group to provide many examples of each. Be ready to share your ideas with the class.

Examples of <b>Renewable Resources</b>	Examples of <b>Nonrenewable Resources</b>	Examples of <b>Flow Resources</b>

## Lesson 3—Cultural Use of Resources

### *Understanding Ways Various Cultures Use Resources*

This lesson proposes the idea that not all cultures view resources in the same way. Students will read an example of different ways that dung is used. They will then try to think of as many uses for different resources as they can.

One class period of instruction



Lesson 4 will look at how resources are formed.

#### **Materials Needed**

- **Multiple Uses for Dung**
- **Multiple Uses for Resources**
- **Cultural Diversity in Resources Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

16.1.A—Describe examples of how cultures differ in their definition and use of resources.

##### **12th Grade**

11.2.A—Identify and analyze the origins and development of and changes in patterns of economic activities.

#### **Learning Objective**

Understand how different cultures use different resources.

#### **Evidence of Learning**

Describe different resources used to complete a single task in different cultures.



#### **Copy Instructions**

Print one of each  
handout for each  
student.

## Lesson Sequence

### 1. *Think/Pair/Share*

How are resources different in various cultures?

#### Handout

- Multiple Uses for Dung

### 2. *Lecture*

Read the handout on multiple uses for animal dung. Encourage the idea that the way resources are used is defined by people and cultures, not the resources themselves.

#### Handout

- Multiple Uses for Resources

### 3. *Discuss*

Students should try to come up with multiple uses for different resources.

### 4. *Share*

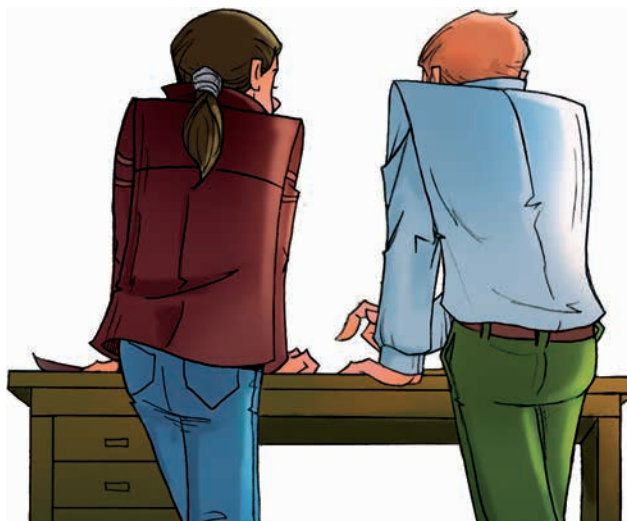
Ask students to share the resources they came up with. If there is time, allow students to share in pairs or groups so everyone gets a chance to share, and then allow students to share with the class as a whole.

#### Handout

- Cultural Diversity in Resources Exit Ticket

### 5. *Exit Ticket*

Describe how a specific task—washing clothes—can be done in multiple ways using various resources.



# MULTIPLE USES FOR DUNG

## *Not All Cultures View Resources the Same Way*

There is no specific definition for how resources are used. Over time people have found different uses for resources. The same resource can be used for something entirely different in various cultures. Think about animal poop (dung, feces, crud, etc.). Would you call that a resource? Read below to hear about just some of the ways people have turned it into a resource.

### Poo as a Resource



#### **Fertilizer**

You might be familiar with this use. There are a lot of valuable nutrients that some animals don't use up. The nutrients get left in the poop and when the manure is spread on the ground, the nutrients go back into the soil and help plants grow.

#### **Fuel**

Dried animal dung "cakes" have been used as a fuel since prehistoric times. It burns pretty well. If you have animals, it is also very cheap. In fact, approximately 2 billion people (almost one-third of the world's population) use animal dung as a fuel.



#### **Paper**

Elephants eat about 500 pounds of food a day. They produce over 100 pounds of dung a day. This dung is fibrous enough to be washed, dried, and turned into paper. One elephant produces enough waste to make about 115 pages of paper per day.

**Gunpowder**

Dried bat poop, called *guano*, contains saltpeter (potassium nitrate), an important ingredient in gunpowder. Soldiers during the Civil War got their bat guano from caves to create more ammunition.

**Getting Rid of Pollution**

Silver mines in Bolivia were leaking acid into the water. A professor used a filter that included llama droppings. The bacteria in the llama poop absorbed acid and turned acidic water into alkaline water.

**Abdominal Pain**

Flying-squirrel dung is used in some Chinese medicines. It is used like tea to treat cramps, nutritional deficiencies, and snakebites. (It's banned in the United States.)

**Jewelry**

In Alaska, tourists sometimes go out of their way to buy "moose nuggets." Really, it is moose poop dried, varnished, and hung as a decoration.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# MULTIPLE USES FOR RESOURCES

*What Are the Different Ways in Which Resources Can Be Used?*

*Recall* the reading about different uses of resources. *Consider* the different ways that resources can be used. *Be ready* to share your ideas with the class.

1. List as many different uses for *forests* as you can. Think of how different cultures could use them.
2. List as many different uses for *a large river* as you can.
3. List as many different uses for *open space* as you can.
4. List as many different uses for *cattle* as you can.



# Lesson 4—Processes That Lead to Resources

## *Understanding How Resources Are Formed*

This lesson introduces students to the way that some of the common *resources are formed*. This will help students to get an idea of what physical characteristics might be needed in order to find a resource.

One class period of instruction

Lesson 5 gives students a chance to research where resources are found in the world.

### **Materials Needed**

- **Formation of Resources**
- **Estimating Locations of Resources**
- **Physical Conditions for Resources Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

16.2.A—Describe the physical processes that influence the formation and therefore spatial distribution of renewable, nonrenewable, and flow resources.

#### **12th Grade**

11.2.A—Identify and analyze the origins and development of and changes in patterns of economic activities.

### **Learning Objective**

Understand the conditions needed for resources.

### **Evidence of Learning**

Explain physical conditions needed to produce renewable, nonrenewable, and flow resources and provide an example of each.



### **Copy Instructions**

Print one of each handout for each student.

### **Handout**

- Physical Conditions for Resources Exit Ticket

## Lesson Sequence

### 1. Think/Pair/Share

What conditions are needed to produce resources?

#### Handout

- Formation of Resources

### 2. Lecture

Read the **Formation of Resources** handout and discuss how some of the common resources are formed. Point out the physical characteristics that would be required to form these resources.

#### Handout

- Estimating Locations of Resources

### 3. Group Discussion

In groups students discuss the different resources and the conditions needed to form them, and then try to estimate some areas where these resources would be available.

### 4. Share

As a class, discuss the locations that the groups have estimated as the possible places for resources.

#### Handout

- Physical Conditions for Resources Exit Ticket

### 5. Exit Ticket

Provide an example of renewable, nonrenewable, and flow resources and explain conditions needed for that example.



# FORMATION OF RESOURCES

## *How Are Resources Formed?*

The formation of resources influences where resources are located. By understanding the conditions needed to form a resource, it is possible to predict where resources are located or available.

### Ways Some Resources Are Formed



#### **Oil**

Oil was formed from the remains of animals and plants (diatoms) that lived millions of years ago, before the dinosaurs, in a marine (water) environment. Over millions of years, the remains of these animals and plants were covered by layers of sand and silt. Heat and pressure from these layers helped the remains turn into what we today call crude oil. The word “petroleum” means “rock oil” or “oil from the earth.”

#### **Coal**

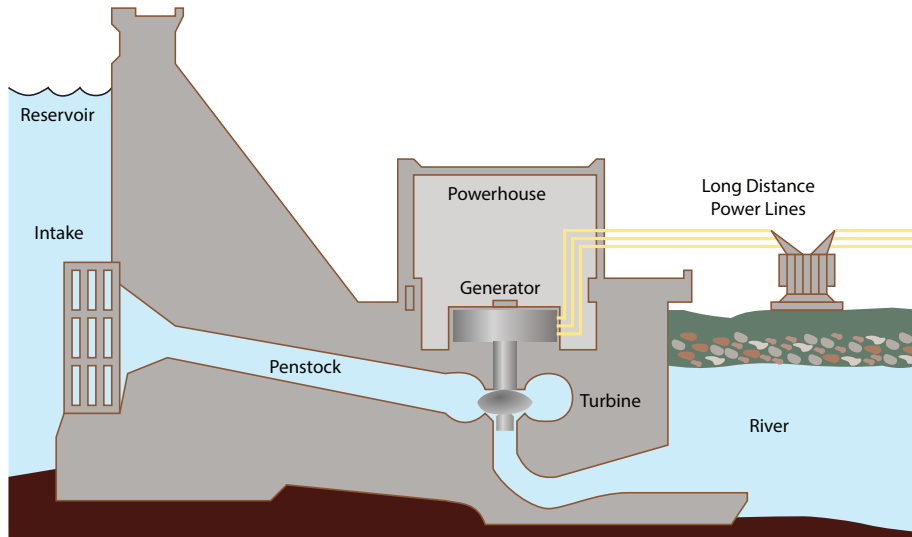
Coal is a combustible black or brownish-black sedimentary rock composed mostly of carbon and hydrocarbons. It is the most abundant fossil fuel produced in the United States.

Coal is a nonrenewable energy source because it takes millions of years to create. The energy in coal comes from the energy stored by plants that lived hundreds of millions of years ago, when the Earth was partly covered with swampy forests.



An open-pit coal mine in the Czech Republic.

For millions of years, a layer of dead plants at the bottom of the swamps was covered by layers of water and dirt, trapping the energy of the dead plants. The heat and pressure from the top layers helped the plant remains turn into what we today call coal.



Hydroelectric dam. Source: Tennessee Valley Authority.

### Hydropower

The amount of available energy in moving water is determined by its flow or fall. Swiftly flowing water in a big river, like the Columbia River that forms the border between Oregon and Washington, carries a great deal of energy in its flow. Water descending rapidly from a very high point, like Niagara Falls in New York, also has lots of energy in its flow.

In either instance, the water flows through a pipe, or *penstock*, then pushes against and turns blades in a turbine to spin a generator to produce electricity. In a run-of-the-river system, the force of the current applies the needed pressure, while in a storage system, water is accumulated in reservoirs created by dams, then released as needed to generate electricity.

### Wind

Wind is simply air in motion. It is caused by the uneven heating of the Earth's surface by the Sun. Because the Earth's surface is made of very different types of land and water, it absorbs the Sun's heat at different rates. One example of this uneven heating can be found in the daily wind cycle.

During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating wind. At night, the winds are reversed because the air cools more rapidly over land than over water.



The wind cycle. Based on an image from the National Energy Education Development Project.

In the same way, the atmospheric winds that circle the Earth are created because the land near the Earth's equator is heated more by the Sun than the land near the North and South Poles.

Names: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# ESTIMATING LOCATIONS OF RESOURCES

*Discuss as a Group Where Different Types of Resources Will Be Found*

Review the **Formation of Resources** handout. *Discuss* as a group to answer the following questions. *Be ready* to share your ideas with the class.

1. What *type of resource* is *timber*—renewable, nonrenewable, or flow?
2. What *conditions* would be needed to produce timber?
3. What *locations* can you think of that would meet these conditions?
4. What *type of resource* is *hydropower*—renewable, nonrenewable, or flow?

5. What *conditions* would be needed to produce hydropower?
  
  
  
  
  
  
  
  
  
  
6. What *locations* can you think of that would meet these conditions?
  
  
  
  
  
  
  
  
  
  
7. What *type of resource* is *coal*—renewable, nonrenewable, or flow?
  
  
  
  
  
  
  
  
  
  
8. What *conditions* would be needed to produce coal?
  
  
  
  
  
  
  
  
  
  
9. What *locations* can you think of that would meet these conditions?

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# PHYSICAL CONDITIONS FOR RESOURCES EXIT TICKET

*Show That You Understand the Physical Conditions Needed to Produce Resources*

You have learned about the physical conditions needed to produce resources. *Reflect* on what you have learned. *Answer* the questions below.

1. Provide an example of a *renewable resource*.
2. What conditions are needed to produce this resource?
3. Provide an example of a *nonrenewable resource*.
4. What conditions are needed to produce this resource?
5. Provide an example of a *flow resource*.
6. What conditions are needed to produce this resource?

# Lesson 5—Where Are Resources Found?

## *Understanding Locations of Major Resources*



One class period of instruction

This lesson provides students with an opportunity to research *where resources are found, how they are used*, and then to apply their understanding of the formation of resources to consider why the resources are there.

The next day's lesson will encourage students to compare locations based on resources.

### **Copy Instructions**

Print one **Exit Ticket** for each student. Print one set of **Researching Locations of Resources** per group.



### **Materials Needed**

- **Researching Locations of Resources**
- Internet access to the *CIA World Factbook*
- **Location of Resources Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

16.2.B—Explain the location and uses of major resources in the world.

#### **12th Grade**

16.2.A—Analyze and explain the relationships between the spatial patterns of settlement and resources.

### **Learning Objective**

Identify where major resources are.

### **Evidence of Learning**

Point out on a world map where certain resources come from.

## Lesson Sequence

### 1. Think/Pair/Share

Where are resources located?

### 2. Group Research

Divide the class into seven groups. Assign each group a resource from the checklist in the directions. Each group should research where the resources are in the world. They should then discuss why they think the resources are in that location based on what they learned about formation of resources. They must then research how these locations use the resources. Internet research is probably most effective. The *CIA World Factbook* is a great tool to find out what resources are available in each country. You can find it online at <https://www.cia.gov/library/publications/the-world-factbook/fields/2111.html>.

### 3. Share

Have groups share their findings. Students will need to hear where the different resources are found in order to do the exit ticket. You may want to consider giving the students the exit tickets before you share, so that they take notes while listening. Ask students if they were surprised by any of their research findings.

### 4. Exit Ticket

Identify on a world map where seven important resources are abundant.

#### Handout

- Researching Locations of Resources

#### Handout

- Location of Resources Exit Ticket

#### Handout

- Location of Resources Exit Ticket

Names: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# RESEARCHING LOCATIONS OF RESOURCES

*Discuss as a Group Where You Could Find These Types of Resources*

*Research* the locations of resources. *Research* and *discuss* as a group to answer the following questions. *Be ready* to share your findings with the class.

Check off the resource that your group has been assigned:

- |                                 |                                     |                                      |
|---------------------------------|-------------------------------------|--------------------------------------|
| <input type="checkbox"/> Oil    | <input type="checkbox"/> Coal       | <input type="checkbox"/> Arable land |
| <input type="checkbox"/> Timber | <input type="checkbox"/> Hydropower | <input type="checkbox"/> Iron        |

1. Where is this resource abundant? What locations have a lot of it? Use the following resource from the *CIA World Factbook* to help you: <https://www.cia.gov/library/publications/the-world-factbook/fields/2111.html>.
2. Why do you think this resource is found in these locations?
3. How do these countries use this resource?

Date: \_\_\_\_\_ Period: \_\_\_\_\_

# LOCATION OF RESOURCES EXIT TICKET

### Show That You Understand Why Resources Are Found in Certain Locations

You have learned where certain resources are in abundance. *Reflect* on what you have learned. *Complete* the activity below.



On the map, label where each of these resources is found in abundance.

- Oil
- Coal
- Arable land
- Timber
- Hydropower
- Iron

## Lesson 6—Resource Advantages

### *Comparing Advantages of Locations Based on Resources*



One class period of instruction

This lesson challenges students to compare the advantages of different locations based on the resources of each location. At the end of class, students will consider which resources would help them most in a zombie outbreak and create the second part of their Settlement Location Report.

This is the last lesson of this unit. Students should be given time to research the resources of the location they would like to settle.

#### **Copy Instructions**

Print one **Exit Ticket** for each student. Print one set of **Best Resources For ...** and **Zombie Survival Resources Poster Directions** per group.



#### **Materials Needed**

- **Best Resources For ...**
- **Zombie Survival Resources Poster Directions**
- Poster supplies
- **Comparing Locations Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

11.2.A—Compare and explain the advantages of one location over another in the access to factors of production.

##### **12th Grade**

16.2.A—Analyze and explain the relationships between the spatial patterns of settlement and resources.

#### **Learning Objective**

Evaluate locations based on resources.

#### **Evidence of Learning**

Choose the best location for certain types of production.



## Lesson Sequence

### 1. Think/Pair/Share

What would be a good location for electronics factories? Why?

### 2. Group Discussion

Provide each group with the **Best Resources For . . .** handout. Groups will explain what they think would be the best resources for four different purposes.

### 3. Think/Pair/Share

Bring the class back together to discuss the following prompt:

What resources would you want to have during the zombie apocalypse?  
Why?

### 4. Group Poster

Each group will create a poster showing the resources they would want access to in a zombie outbreak. They must also show how they would use these resources and possible places that might fit those criteria.

### 5. Gallery Walk

Have students walk around to observe the posters of different groups.

### 6. Exit Ticket

Have students compare two locations based on resources and decide which would be better to build an automobile factory and where they would rather build a zombie-proof shelter.

#### Handout

- Best Resources For . . .



*Read or say*

#### Handout

- Zombie Survival Resources Poster Directions

#### Handout

- Comparing Locations Exit Ticket

Names: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

## BEST RESOURCES FOR . . .

***Discuss the Resources Most Suitable to Do the Following***

Recall the benefits of certain resources. Discuss as a group to answer the following questions. Be ready to share your ideas with the class.

1. *List and explain* the resources that would be most useful to start a *wind farm*.
2. *List and explain* the resources that would be most useful to start an *automobile factory*.
3. *List and explain* the resources that would be most useful to start a *vacation resort*.
4. *List and explain* the resources that would be most useful to start a *cattle ranch*.

Names: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# ZOMBIE SURVIVAL RESOURCES POSTER DIRECTIONS

### Create a Poster Showing the Resources You Would Need in a Zombie Outbreak

*Review* examples of natural resources. *Discuss* the natural resources that your group would want to have during a zombie apocalypse. *Create* a poster showing the resources you would most want and how you would use them to survive.

1. List of natural resources that your group would want:
2. How would you use each of these resources?
3. What kind of location might have all of these resources?

## Create Your Poster

Your poster must include:

- The title of the poster.
- Large examples of the resources your group would want.
- Explanations of how you'd use each of the resources.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# COMPARING LOCATIONS EXIT TICKET

*Which Place Would Be Best for These Activities?*

You have discussed what the best locations for resources are. *Decide* which location you think is best for each of the following. *Explain* why you believe this.

1. Based on resources, would you rather start an *automobile factory* in *Burundi* or *Belize*? Why?

*Resources of Burundi:*

nickel, uranium, rare earth oxides, peat, cobalt, copper, platinum, vanadium, arable land, hydropower, niobium, tantalum, gold, tin, tungsten, kaolin, limestone

*Resources of Belize:*

arable land potential, timber, fish, hydropower

2. Based on resources, would you rather build a *zombie-proof shelter* in *Dominica* or *Denmark*? Why?

*Resources of Dominica:*

timber, hydropower, arable land

*Resources of Denmark:*

petroleum, natural gas, fish, salt, limestone, chalk, stone, gravel and sand

# **PROJECT 06: ZOMBIE AND HUMAN MIGRATION PATTERNS**



# Explaining the Project

## Concept of Project 06

### Zombie and Human Migration Patterns: Project 06

#### **Project Goal**

The main goal of this project is for students to understand *migration*. Along the way they learn the different types, push and pull factors, centers of population, and how to apply this thinking to a region.

#### **Main Final Product**

At the end of the project, students will create some form of report describing the location they believe would be best to build their post-zombie outbreak settlement. The report must describe the type of migration expected after a zombie outbreak, predict the kind of place where people will most likely go, and compare and evaluate possible locations for settlement based on push and pull factors, population density, and connections to other areas. This report is the final part of students' Settlement Location Report.

#### **Project Options**

There are many ways that students could present this information. You may want to manage one format for all students or allow students to choose their own formats. As long as they meet the content requirements of the rubric, they will be showing their understanding of the standards.

The following are just a few possible ways students could complete this project:

- Formal written report
- Oral presentation
- Poster
- Persuasive letter
- Video recording
- Audio recording

There are many other ways. I find that students can be very engaged when choosing their own style every now and then. I also find that when choosing a format that the whole class has to do, it is a great opportunity to teach other skills. For example, if you require a poster, take the time to teach students elements of design and require them to practice that design in their posters.

# Zombie and Human Migration Patterns

## Outline of Project 06

### Teaching Tip

This project helps students choose the best location based on human migration.



### Handout

- Settlement Location Report 03

### Ask

Before I move should I make sure it is the best decision?



### Handout

- Choosing a Settlement: Migration: Pre-assessment Quiz

### Teaching Tip

Through this project, students will be expected to learn these skills.



### Teaching Tip

You may choose to do all of the lessons, and then the project. You may also choose to launch the project, and then use the lessons to assist students in the completion of their goal.



## Zombie and Human Migration Patterns: Project 06

Humans have a history of moving and finding new places to settle. Through settlement geography, we can understand the influential factors in human migration. Before moving off to settle a new place, students learn about these influences of migration and apply these skills to once again inform their decision on where to relocate after the outbreak. This project extends their previous report to include even more details before moving to a settlement. This is the final project of this report. Students will then move on to begin designing their settlement.

### Final Project Task

Students will need to create a report on best locations to build a new settlement based on migration.

### Driving Question

Why do people *move* or *migrate*?

### Pre-assessment

#### Student Learning

- Understand and define *migration*.
- Understand and identify *different types of migration*.
- Identify the *push and pull factors* of migration.
- Evaluate locations' *settlement geography*.

#### Lessons

- What Is Migration?
- What Influences Where People Settle?
- Different Types of Migration
- Push and Pull Factors
- Applying Settlement Geography

## Pre- and Post-assessment Quiz Answers

1. What is *migration*?

The movement of human beings or animals.

2. What would make someone want to move *to* a new location?

Examples: access to resources, economic opportunities, family.

3. What would make someone want to move *away from* a location?

Examples: war, natural disaster, over-population, lack of economic opportunities.

### Handout

- Choosing a Settlement  
Location: Migration:  
Post-assessment Quiz

## National Geography Standards

### 8th Grade

3.1.A—Describe the spatial organization of people, places, and environments using spatial concepts.

3.2.A—Describe and compare the processes that influence the distribution of human and physical phenomena.

9.3.A—Identify and describe the types of migrations in terms of time, distance, and cause.

9.3.B—Identify and explain push and pull factors influencing decisions to migrate.

12.3.A—Compare and explain the location, number, and sizes of settlements in regions.

### 12th Grade

3.1.A—Analyze and explain the spatial organization of people, places, and environments (where things are in relation to other things) using spatial concepts.

3.2.A—Analyze and explain changes in spatial patterns as a result of the interactions among human and physical processes through time.

9.3.A—Compare and explain different examples of migrations in terms of the “laws of migration.”

9.3.B—Evaluate and explain the impact of international migration on physical and human systems.

12.3.A—Compare and explain the different types of settlements in the local region and the United States.

## Project 06: Zombie and Human Migration Patterns

### Zombie and Human Migration Patterns

#### Rubric for Project 06

	1	2	3	4
<b>Where do people go after the outbreak?</b> 3.2.A Describe and compare the processes that influence the distribution of human and physical phenomena.	Struggles to make any attempt to predict where people go after the outbreak.	Makes attempted predictions of where people go with limited connection to where populations are and physical geography.	Attempts to predict where people generally go after the zombie outbreak based on where populations are and physical geography.	Attempts to predict where people generally go after the zombie outbreak based on where populations are and physical geography. Includes example of one or more locations.
<b>What types of migrating do people do?</b> 9.3.A Identify and describe the types of migrations in terms of time, distance, and cause.	Struggles to identify types of migration.	Identifies types of migration based on: <ul style="list-style-type: none"> <li>• Time</li> <li>• Distance</li> <li>• Cause</li> </ul>	Identifies and describes types of migration based on: <ul style="list-style-type: none"> <li>• Time</li> <li>• Distance</li> <li>• Cause</li> </ul>	Identifies and describes types of migration based on: <ul style="list-style-type: none"> <li>• Time</li> <li>• Distance</li> <li>• Cause</li> </ul> Provides specific examples for each.
<b>Why move there?</b> 9.3.B Identify and explain push and pull factors influencing decisions to migrate.	Struggles to identify or explain push and pull factors.	Identifies limited push and pull factors.	Identifies and explains push and pull factors of a possible settlement location.	Identifies and explains push and pull factors of multiple possible settlement locations.
<b>Compare and choose locations.</b> 12.3.A Compare and explain the location, number, and sizes of settlements in regions.	Struggles to compare locations.	Compares the population of multiple locations but struggles to explain why some locations would better support a settlement.	Compares multiple locations and explains possible reasons why some locations may better support a settlement.	Compares multiple locations and evaluates the locations. Makes a decision as to which location would best support a settlement.
<b>What connections do these places have?</b> 3.1.A Describe the spatial organization of people, places, and environments using spatial concepts.	Struggles to explain surrounding connections of the location or the population density.	Describes only the population density or the surrounding connections.	Describes how a location is organized by population density and the surrounding locations it is connected to.	Evaluates a location based on how it is organized by explaining population density and the surrounding locations it is connected to.

# SETTLEMENT LOCATION REPORT 03

## *Zombie and Human Migration Patterns: Migration Introduction*

People have always moved around the world. When the zombie apocalypse happens, people will probably move even more. Zombies will move too. This movement is called *migration*. In this unit you'll learn about *where people live, migration, types of migration, reasons people move*, and how to use these ideas to help us finally decide where to put our new settlement.

### **Driving Question**

What makes an overall good location to settle? Where is the best place for us to protect ourselves from zombies?

### **What You Will Produce**

You will finalize your *report* explaining the best location to build a settlement based on patterns of human migration. Check with your teacher to see what options you have for your report.

### **Your Report Will Include the Following Information:**

- A *prediction* of where humans will go after the outbreak starts.
- *Descriptions* of the possible types of migration people will make.
- *Push and pull factors* of locations you think would make a good settlement.
- A *comparison* of multiple locations explaining which are the best choices.
- *Population* and connection description of your top-choice location.

After this report, you will be very well informed and make the best possible decision to influence your survival!

Then it will be time to start designing and building your settlement.



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CHOOSING A SETTLEMENT LOCATION: MIGRATION

## *Pre-assessment Quiz*

Answer the following questions. You will soon learn all about these concepts.

1. What is *migration*?
2. What would make someone want to move *to* a new location?
3. What would make someone want to move *away from* a location?

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# CHOOSING A SETTLEMENT LOCATION: MIGRATION

## *Post-assessment Quiz*

1. What is *migration*?
2. What would make someone want to move *to* a new location?
3. What would make someone want to move *away from* a location?

# Lesson 1—What Is Migration?

## *Identifying Centers of Population*



One class period of instruction

This lesson introduces students to migration. Students will learn the definition of migration, settlement geography, and population density. As a class, you'll discuss where people live in the world.

Lesson 2 will look at reasons why people are some places and not others.

### **Copy Instructions**

Print one handout and **Exit Ticket** for each student.



Have the **Global Extents World Map** available on the projector or for tables to view.

### **Materials Needed**

- **Migration**
- Reference resources (world populations)
- **Global Extents World Map**
- **Migration Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

3.1.A—Describe the spatial organization of people, places, and environments using spatial concepts.

#### **12th Grade**

3.1.A—Analyze and explain the spatial organization of people, places, and environments (where things are in relation to other things—using spatial concepts.

### **Learning Objective**

Understand where people are in relation to each other.

### **Evidence of Learning**

Identify areas with large populations on a world map.

## Lesson Sequence

### 1. Think/Pair/Share

What are some of the most populated places in the world?

### 2. Lecture

Read over the **Migration** handout to see the definition and examples of migration.

### 3. Research

Have students research the population, size, and densities of some locations. Ask which locations have more people.

### 4. Discussion

Go over the world map of urbanization. Point out the areas that are most populated. Ask students: Can we apply settlement geography? Why do you think they are there? Students will learn how to examine this in later lessons, so engage their questions and assumptions for now.

### 5. Exit Ticket

Identify places with a large population on a blank world map and identify regions people are migrating to.

#### Handout

- Migration

#### Handout

- Global Extents  
World Map

#### Handout

- Migration Exit Ticket

# MIGRATION

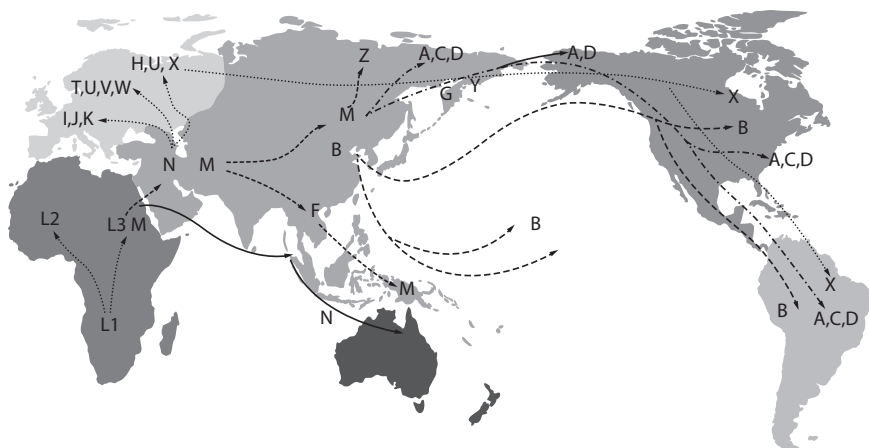
## What Is Migration?

**Migration:** the movement of people from one location or country to another.

**Settlement geography:** the study of where people live and why.

**Population density:** the number of people living in a unit of area (e.g., square miles).

### Some Examples of Migration



#### Migrations of Early Humans

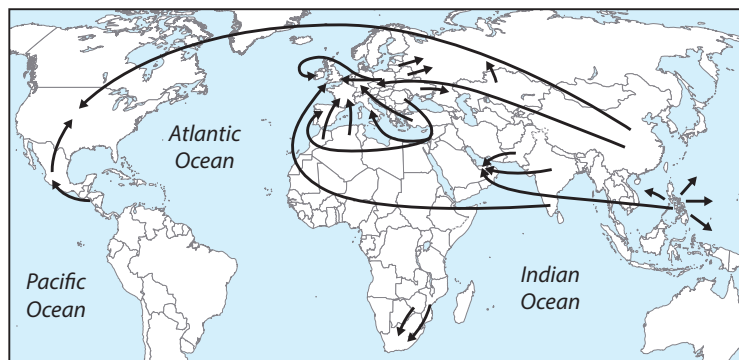
Early humans started out in Africa. Eventually, humans moved to inhabit almost all parts of the world. This movement, no matter why they moved, is an example of migration.

*The map on the left shows the spread of humans based on different DNA groups.*

#### Moving to a New Country

Migration can be as simple as a person or group of people deciding to move somewhere new. This move would either be long-term or permanent. No matter why people move, this movement is migration.

*The map on the right shows the current most popular migrations between countries.*



→ Some of the world's more important current migration routes

Sources: National Public Radio, *The Economist*. Based on map by Imma Moles, CC BY-SA 3.0.

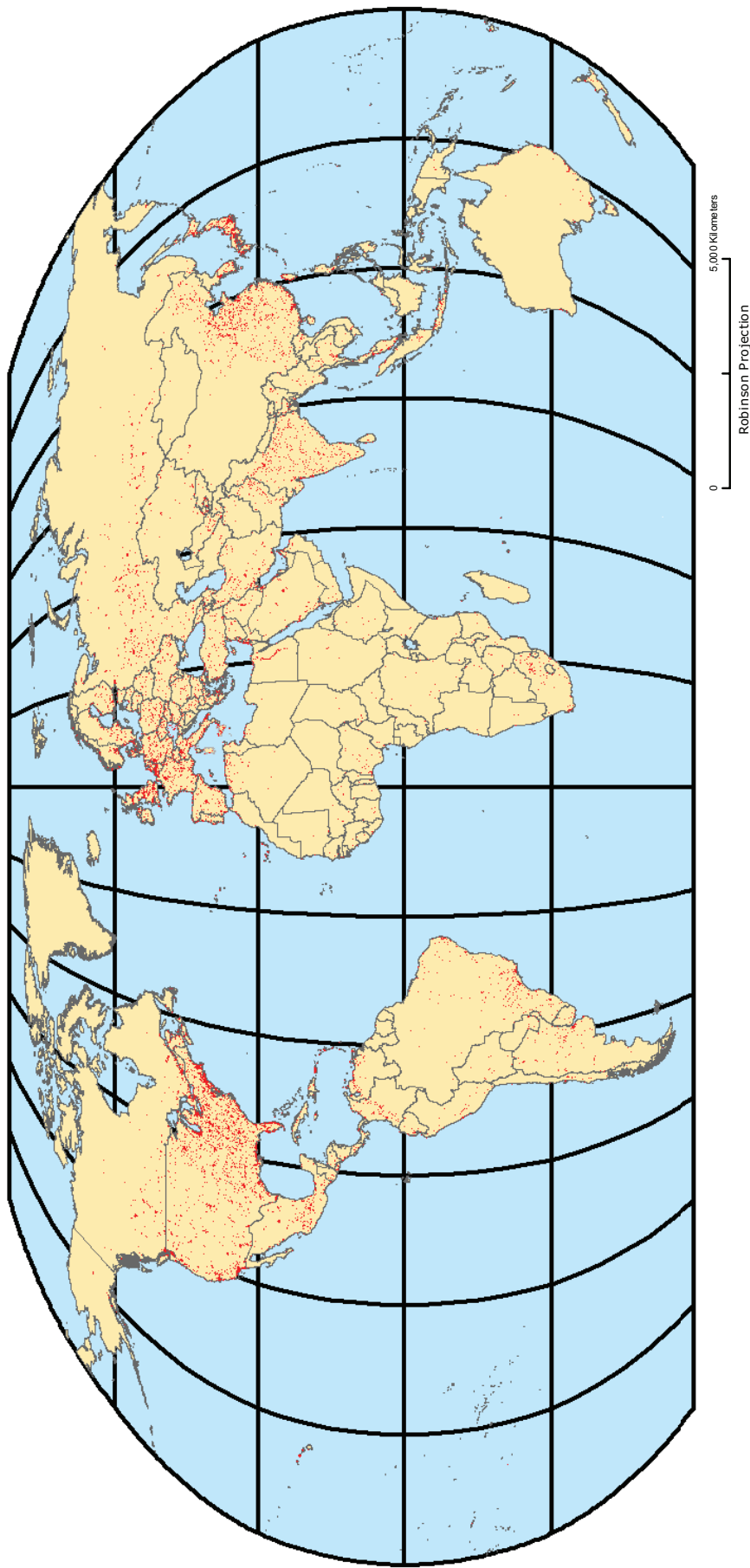
#### Forced Removal of Native Americans



Migration might not always be a choice. Sometimes the move of many people is forced by a government or other group of people. In 1830, the United States government forced members of Native American nations to relocate.

*The map on the left shows several routes that Native Americans were forced to take west. Collectively these routes are known as the Trail of Tears.*

# GLOBAL EXTENTS WORLD MAP



Copyright 2009, The Trustees of Columbia University in the City of New York, Center for International Earth Science Information (CIESIN), Columbia University, International Food Policy Research Institute (IFPRI), the World Bank, and Centro Internacional de Agricultura Tropical (CIAT). Global Rural-Urban Mapping Project (GRUMP), Population Density, Pallsades, NY: CIESIN, Columbia University. Available at: <http://sedac.ciesin.columbia.edu/gpw/>



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## Global Rural-Urban Mapping Project

- Urban Extent
- Administrative Units
- National Boundaries

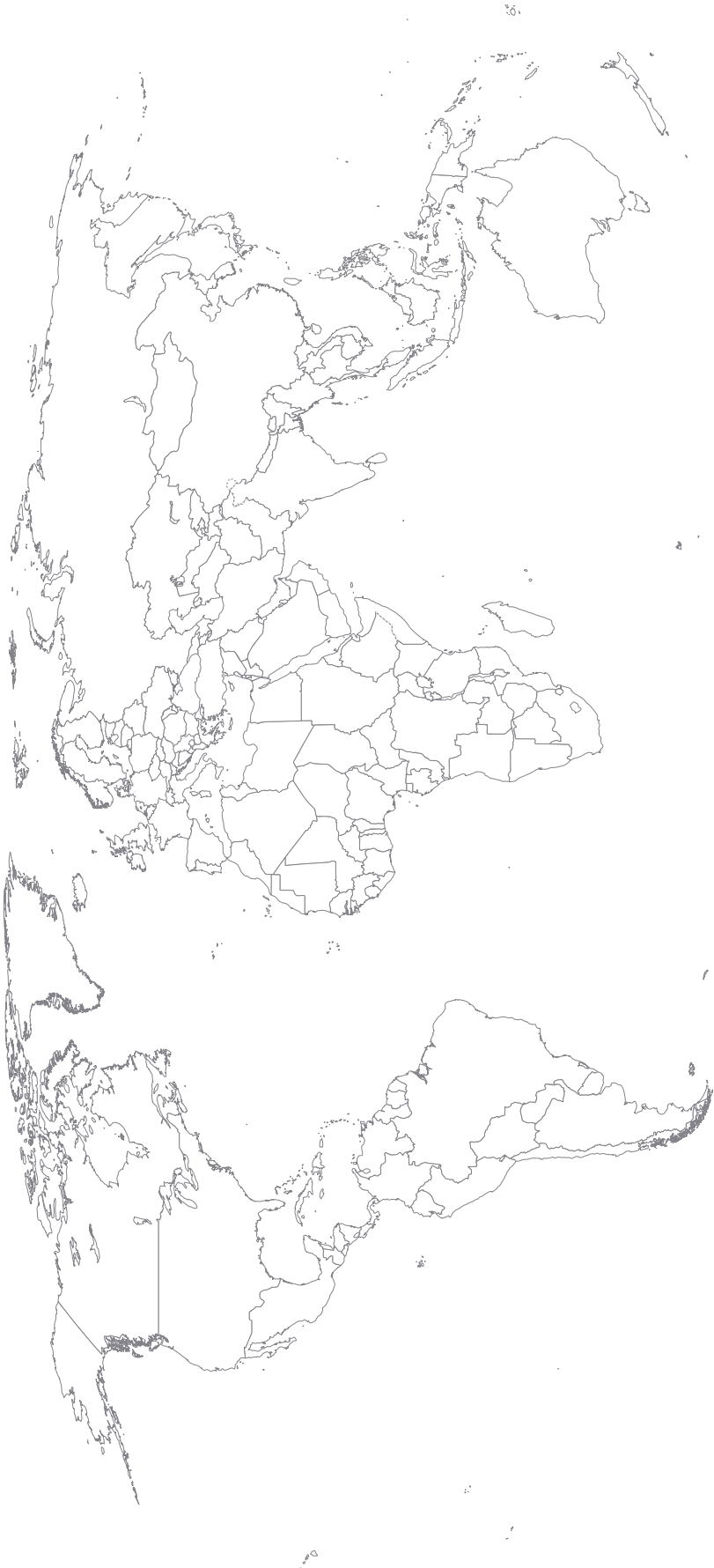
Urban extents illustrate the shape and area of urbanized places. Urbanized localities are defined as places with 5,000 or more inhabitants that are delineated by stable night-time lights. For poorly lit areas, alternate sources are used to estimate the extent of cities.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# MIGRATION EXIT TICKET

Show Your Understanding of Migration

You have learned about migration. Reflect on what you have learned. Follow the directions below.



Circle the locations in the world with a high population density. Identify regions from which people are migrating to today.

## Lesson 2—What Influences Where People Settle?

### *Identifying Influences on Population Centers*

This lesson introduces students to the *processes that influence human* distribution. They begin to think about what they personally need to live, then apply these ideas to settlements and apply those ideas to a world map.

One class period of instruction



Lesson 3 will look at different types of migration.

#### **Materials Needed**

- Abraham Maslow's Hierarchy of Needs (optional)\*
- World population density map (optional)
- **Locations of Settlements Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

3.2.A—Describe and compare the processes that influence the distribution of human and physical phenomena.

##### **12th Grade**

3.2.A—Analyze and explain changes in spatial patterns as a result of the interactions among human and physical processes through time.

#### **Learning Objective**

Understand why people are where they are.

#### **Evidence of Learning**

Explain why people live in some places and not others.

\*Available on the intern



#### **Copy Instructions**

Print one **Locations of Settlements Exit Ticket** for each student.

#### **Handout**

- Locations of Settlements Exit Ticket



**Teaching Tip**

You can provide an image of Maslow's Hierarchy of Needs if they get stuck.



## Lesson Sequence

### 1. Think/Pair/Share

List what you need to survive and rate your needs in order of importance. Examples of probable needs and desires:

- food, water, oxygen
- shelter, security, resources
- family + friends
- entertainment, beauty

### 2. Review

Review why people settle in certain places.

### 3. Discussion 1

Apply the idea of needs to a settlement. Ask students what settlements need and then want in order to survive. At what point would people stop moving? What is enough to make people stay in one place?

**Handout**

- Global Extants World Map

### 4. Discussion 2

Look at the **Global Extants World Map** from lesson 1. Ask students how much of what people need/desire do the most populated places have?

**Handout**

- Locations of Settlements Exit Ticket

### 5. Exit Ticket

Explain why large numbers of people live in some places and not others. Evaluate why there are more people living in Western Africa than Central Africa.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# LOCATIONS OF SETTLEMENTS EXIT TICKET

*Show Your Understanding of Where People Settle*

You have learned about factors that influence people to settle in certain places. *Reflect* on what you have learned. *Answer* the questions below.

1. Explain why a lot of people live in some places, while very few live in other places.

2. Why do more people live in western Africa than central Africa?

## Lesson 3—Different Types of Migration

### *What Are the Different Types of Migration?*



One class period of instruction

This lesson introduces students to *different types of migration*. Students will be introduced to examples of the different types and then work in groups to create a poster demonstrating a specific example.

Lesson 4 will look at push and pull factors of migration.

#### **Teaching Tip**

Print one **Types of Migration** handout and **Types of Migration Exit Ticket** for each student.

Print one set of directions per group.



#### **Materials Needed**

- **Types of Migration**
- **Migration Poster Directions**
- Poster supplies
- **Types of Migration Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

9.3.A—Identify and describe the types of migrations in terms of time, distance, and cause.

##### **12th Grade**

9.3.B—Evaluate and explain the impact of international migration on physical and human systems.

#### **Learning Objective**

Understand the different types of migration.

#### **Evidence of Learning**

Explain and provide examples of the different types of migration.

## Lesson Sequence

### 1. Think/Pair/Share

What is migration? What are some different types of migration?

### 2. Lecture

Read over the definition and examples in the **Types of Migration** handout.

### 3. Group Poster

Divide the class into groups and have each create a poster showing an example of a type of migration.

### 4. Gallery Walk

Have students move to different groups to view the posters. Suggestion: Provide students with stickie notes or small papers to leave feedback on the posters.

### 5. Exit Ticket

Explain migration and provide examples of different types of migration.

#### Handout

- Types of Migration

#### Handout

- Migration Poster Directions

#### Handout

- Types of Migration Exit Ticket



# TYPES OF MIGRATION

## What Are the Different Types of Migration?

Not everyone moves or migrates for the same reason. Sometimes it is a choice; sometimes it isn't. To help better analyze migration, geographers classify migrations into these different types. When people migrate, it causes diffusion or the spread of culture and ideas.

### Types of Migration

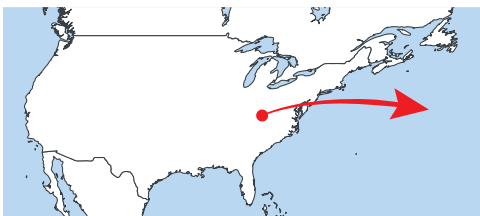


#### Internal Migration

Moving from one location to another within the *same* country or state.

#### External Migration

Moving from one location to another in a *different* country or state.



#### Emigration

Leaving a country to move somewhere else.

#### Immigration

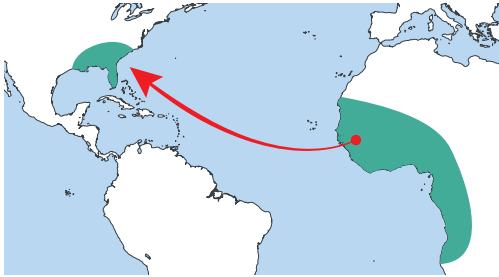
Entering a country when moving from somewhere else.



#### Population Transfer

Moving a large group of people from one place to another by government policy.

The map to the left shows the Israeli-Palestinian conflict. There has been conflict over borders and control of Jerusalem for a long time. One attempt at a solution has been to transfer the Israeli population out of the Gaza Strip and West Bank, Palestinian areas controlled by Israel since the Six-Day War but not within its internationally recognized borders. Thus far, this politically contentious solution has been applied only in Gaza.



### Forced Migration

Making people move away from their home. Also known as "displacement," this form of migration can be due to disasters, war, ethnic cleansing, slavery, human trafficking, or development projects.

### Step Migration

Moving to a new location in stages. Instead of moving from a farm to a city, someone might move from a farm to a small town in the suburbs and then to the city.

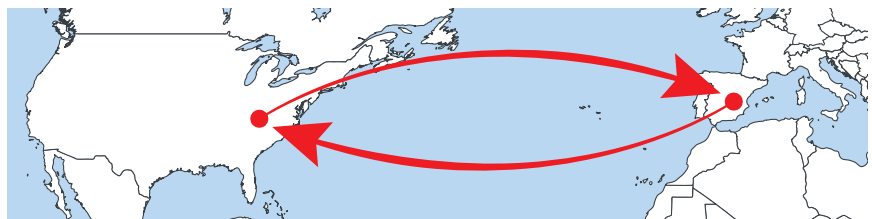


### Chain Migration

Chain migration occurs when people move from one country to another country. Then, someone else follows that person and settles in the same neighborhood and so on. For example, one family member may move to a new country; then other family members follow to the same location.

### Return Migration

Return migration occurs when people decide to move back to where they used to live.



### Seasonal Migration

Seasonal migration happens when people move to follow work or other conditions that change with the seasons. Sometimes farmworkers will move temporarily to work at different harvests. Some people in the United States will move south to avoid a cold winter and then move back after winter.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# MIGRATION POSTER DIRECTIONS

*Create a Poster Showing an Example of a Type of Migration*

Review the types of migration. Discuss the type of migration your group has been assigned. Create a poster showing examples of this type of migration.

Check off the type of migration your group is assigned:

- |  |   |
|--|---|
| <input type="checkbox"/> Internal migration  | <input type="checkbox"/> Chain migration    |
| <input type="checkbox"/> External migration  | <input type="checkbox"/> Step migration     |
| <input type="checkbox"/> Population transfer | <input type="checkbox"/> Return migration   |
| <input type="checkbox"/> Forced migration    | <input type="checkbox"/> Seasonal migration |

List possible examples of your type of migration.

## Create Your Poster

Your poster must include:

- The *title* of the poster.
- *Large examples* of the migration you are explaining.
- *Explanations* of what is happening in this type of migration.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# TYPES OF MIGRATION EXIT TICKET

*Show Your Understanding of Different Types of Migration*

You have learned about different types of migration. *Reflect* on what you have learned. *Answer* the questions below.

1. Provide an example of *internal migration*:
  
  
  
  
  
  
  
  
  
  
2. Provide an example of *immigration*:
  
  
  
  
  
  
  
  
  
  
3. Provide an example of *forced migration*:
  
  
  
  
  
  
  
  
  
  
4. Provide an example of *seasonal migration*:

## Lesson 4—Push and Pull Factors

### *Factors of Human Migration*



One class period of instruction

This lesson introduces students to *push and pull factors*. Students will learn the definitions and examples of push and pull factors. They will then practice identifying push and pull factors of different locations and assess locations based on these factors.

Lesson 5 will have students apply all that they have learned about migration to a single region.

#### **Copy Instructions**

Print one **Push and Pull Factors** handout and **Push and Pull Factors Exit Ticket** for each student.



Print one set of **Push and Pull Factors Discussion Directions** per group.

#### **Materials Needed**

- **Push and Pull Factors**
- **Push and Pull Factors Discussion Directions**
- Research resources
- **Push and Pull Factors Exit Ticket**

#### **National Geography Standards**

##### **8th Grade**

9.3.B—Identify and explain push and pull factors influencing decisions to migrate.

##### **12th Grade**

9.3.A—Compare and explain different examples of migrations in terms of the “laws of migration.”

#### **Learning Objective**

Understand push and pull factors of migration.

#### **Evidence of Learning**

Provide examples of push and pull factors of migration.

## Lesson Sequence

### 1. Think/Pair/Share

Why do people move?

### 2. Lecture

Read over the **Push and Pull Factors** handout to see the definition and examples.

### 3. Group Discussion

Divide the class into eight groups. Assign each group a number (1–8). In the table on the handout, each group circles the two locations (A and B) to which their number is assigned.

Groups identify the push and pull factors of both of their locations.

### 4. Share and Rate as a Class

Ask each group to share which location (A or B) they think would be best to settle in. Keep a list of the groups' top choices. When all the groups have shared, have the class try to agree on which of these is the best to settle in. Make sure students base their arguments on push and pull factors. If students get stuck, ask which ones are the worst to settle in and why.

### 5. Exit Ticket

Provide examples of push and pull factors.

#### Handout

- Push and Pull Factors

#### Handout

- Push and Pull Factors Discussion Directions

#### Handout

- Push and Pull Factors Exit Ticket



# PUSH AND PULL FACTORS

## *What Are Some Reasons People Move?*

In 1966, Everett S. Lee published "A Theory of Migration." In this article, Lee proposed the idea of *push* and *pull* factors. *Push factors* are reasons people move away from a location. *Pull factors* are reasons people move to a location. Locations usually have a mix of push and pull factors.

### Examples of Push and Pull Factors



#### **Push Factors**

- Not enough jobs
- Few opportunities
- Famine or drought
- Poor medical care
- Loss of wealth
- Natural disasters
- Lack of political or religious freedom
- Pollution
- Poor housing
- Discrimination
- War

#### **Pull Factors**

- Job opportunities
- Better living conditions
- Political and/or religious freedom
- Leisure activities
- Education
- Better medical care
- Attractive climates
- Security
- Family links
- Industry
- Better chances of marrying



Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# PUSH AND PULL FACTORS DISCUSSION DIRECTIONS

*Discuss the Push and Pull Factors of Different Locations*

Review push and pull factors. *Discuss* as a group and identify the push and pull factors of each location. *Be ready* to share your ideas about which location is better to settle in with the class.

Group	1	2	3	4	5	6	7	8
Location A	New York City, NY	Boston, MA	London, England	Cairo, Egypt	New Delhi, India	Rome, Italy	Amsterdam, Netherlands	Tokyo, Japan
Location B	City of Singapore, Singapore	Paris, France	Dubai, UAE	Bangkok, Thailand	Moscow, Russia	Hong Kong, China	Rio de Janeiro, Brazil	Berlin, Germany

1. *Identify the pull factors of location A.*
2. *Identify the push factors of location A.*
3. *Identify the pull factors of location B.*
4. *Identify the push factors of location B.*

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# PUSH AND PULL FACTORS EXIT TICKET

*Show Your Understanding of Push and Pull Factors*

You have learned about the different reasons people move. *Reflect* on what you have learned. *Answer* the questions below.

1. Provide examples of *pull factors*:

2. Provide examples of *push factors*:

# Lesson 5—Applying Settlement Geography

## *Apply What You've Learned to a Region*

In this lesson, students will apply their understanding of migration to a particular region.

One class period of instruction

This is the last lesson of this unit. After completing this lesson, students finish the third and final part of their Settlement Location Report. See the rubric and project for this unit.

### **Materials Needed**

- **Settlement Geography Poster Directions**
- Poster supplies
- Research resources
- **Settlement Geography Exit Ticket**

### **National Geography Standards**

#### **8th Grade**

12.3.A—Compare and explain the location, number, and sizes of settlements in regions.

#### **12th Grade**

12.3.A—Compare and explain the different types of settlements in the local region and the United States.

### **Learning Objective**

Understand how all of the previous migration factors influence a region.

### **Evidence of Learning**

Explain the makeup of a region based on size, push and pull factors, and types of migration.



#### **Copy Instructions**

Print one  
**Settlement**

**Geography Exit Ticket**  
for each student.

Print one set of  
**Settlement Geography**  
**Poster Directions**  
per group.

**Handout**

- Settlement Geography Poster Directions

**Handout**

- Settlement Geography Exit Ticket

## Lesson Sequence

### 1. Think/Pair/Share

How can you apply settlement geography to a region?

### 2. Group Poster

Divide the class into ten groups. Assign each group a number (1–10). Have groups circle their number on the directions. Groups will have to research to identify and display the centers of population, population size, and population density.

### 3. Gallery Walk

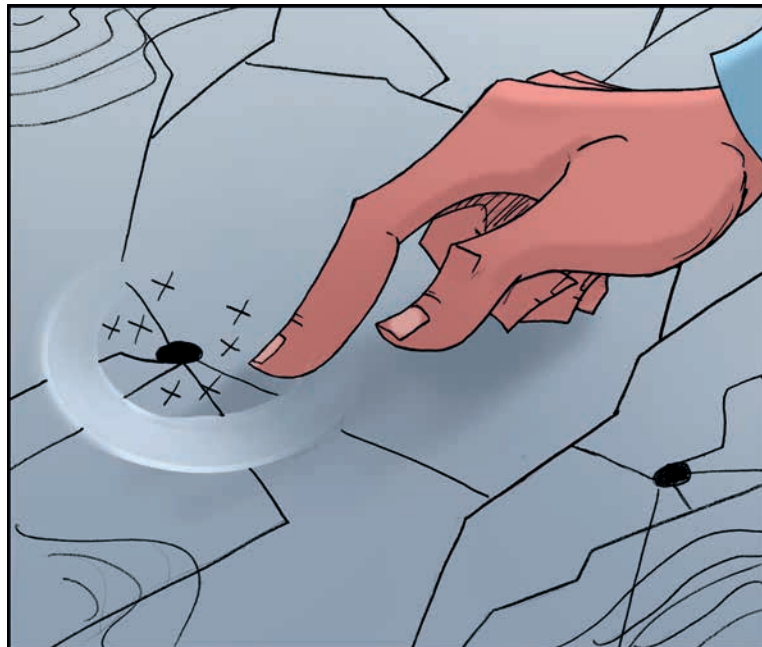
Either have the students present to the class or rotate through groups to view all of the posters.

### 4. Reflection

Ask groups to share anything they learned or found interesting. Discuss whether they believe that their location can increase in population.

### 5. Exit Ticket

Explain the makeup of a region based on size, push and pull factors, and types of migration.



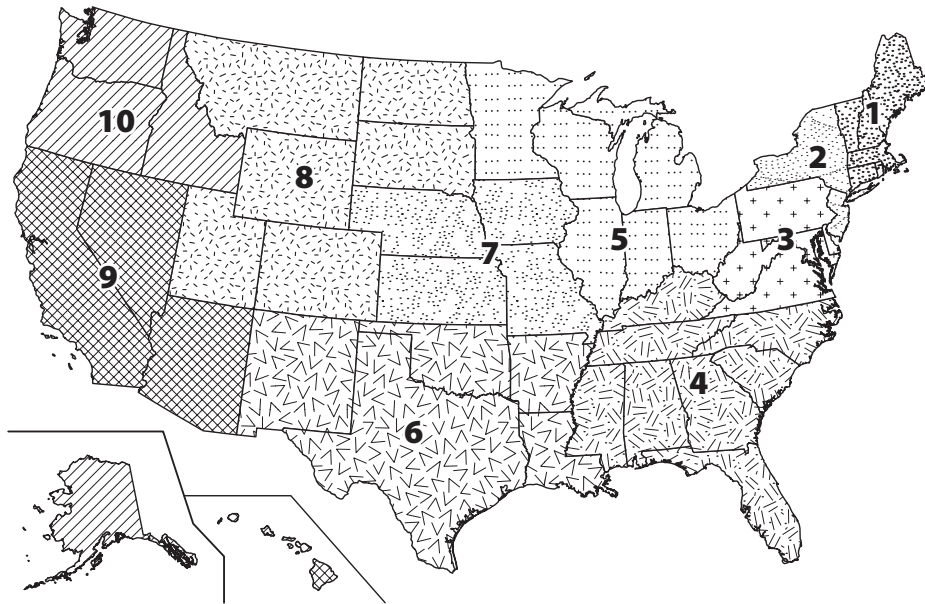
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# SETTLEMENT GEOGRAPHY POSTER DIRECTIONS

*Create a Poster Showing the Settlement Characteristics of a Region*

Review migration. Research and discuss the issues that are involved in the region you are assigned. Create a poster showing the settlement geography characteristics of your region.

Circle the region your group is assigned to settle.



1. What are the *centers of population* in that region?
2. What is the *population size* and *population density* of places in your region?
3. What are the *push* and *pull factors* of this region?
4. Do you think this region would be able to support more people?

## Create Your Poster

Your poster must include:

- The *title* of the poster.
- *Large examples* of the information you have researched.
- *Explanations* of how migration plays a role in the settlement of this region.

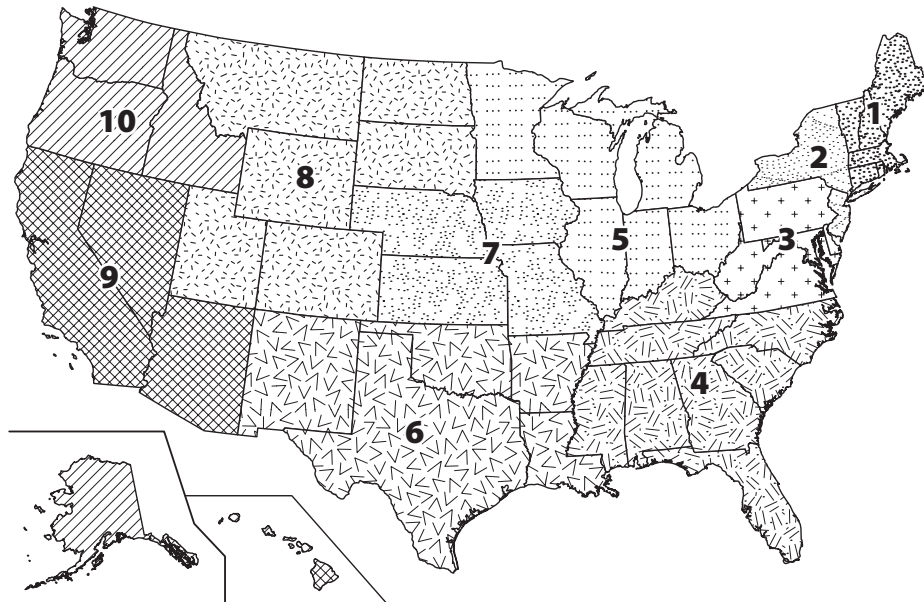
Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

# SETTLEMENT GEOGRAPHY EXIT TICKET

*Show Your Understanding of the Settlement Geography to a Region*

You have learned about population density, types of migration, and push and pull factors. *Reflect* on what you have learned. *Answer* the questions below.

Choose any region.



1. What are some of the major centers of *population* in this region?
2. What are the *push and pull factors* that affect this region?
3. What are some *types of migration* that occur in this region?

# TEACHER FEEDBACK FORM

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# RELEASE FORM FOR PHOTOGRAPHIC IMAGES

## *To Teachers:*

To help illustrate to others the experiential activities involved and to promote the use of simulations, we like to get photographs and videos of classes participating in the simulation. Please send photos of students actively engaged so we can publish them in our promotional material. Be aware that we can only use images of students for whom a release form has been submitted.

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