Exhibit created by the New Jersey State Museum

Curriculum Materials

Rising Tide Programs:

For a complete list of the Museum's exhibitions, events, and programs as well as dates and times please go to:

www.newjerseystatemuseum.org

Rising Tide: Climate Change and New Jersey

10:30 am & Noon; 60 minutes; Grades: 4-12; Auditorium; $2/person; Reservations Required

Led by one of the State Museum's Geologists/Paleontologists, this program will illustrate and describe in detail much of the overwhelming evidence for climate and sea level change in New Jersey. Ice-Age fossils, disappearing coastlines and vanishing communities are just some of the topics illustrated in this lively discussion of the effects that climate change have had in the past, and the effects they will have on the state in the future. Also, check-out the Museum's new *Rising Tide* web page – with interactive games and information at: http://www.state.nj.us/state/museum/rising-tide/

Rising Tide: New Jersey's Ice Age Beasts

10:30 am & Noon; 60 minutes; Grades: 1-9; Auditorium; $2/person; Reservations Required

Just a few thousand years ago, New Jersey was a frigid land covered by glaciers and tundra and was home to many huge and bizarre beasts, called the Pleistocene Megafauna. Many of these strange creatures, like giant ground sloths and American Mastodons, are now extinct. Others, though, are still alive, but only in the frigid North Polar Region. Learn about these animals, their environments, and their extinction, and what these things tell us about climatic changes, both past and present. Also, check-out the Museum's new *Rising Tide* web page – with interactive games and information at: http://www.state.nj.us/state/museum/rising-tide/

NEW! - School Docent Program

Tuesdays & Thursdays: October 6 - December 22; Dec 29; January 5 – 28
(Please call to schedule tours on Tuesdays and Thursdays after January 28th through April 1st – thank you.)

Rising Tide: Climate Change and New Jersey

Noon & 1:00 pm; 45 minutes; Grades: K-8; Museum Lobby; FREE; Reservations Required

This professionally trained Docent Tour of *Rising Tide: Climate Change and New Jersey* will provide students and their teachers with a guided tour of the exhibition that explains the concepts behind the exhibition, identifies key elements, and provides a personalized experience including time to explore the exhibition on their own as well as time for questions. Also, check-out the Museum's new *Rising Tide* web page – with interactive games and information at: http://www.state.nj.us/state/museum/rising-tide/

Teachers' Professional Development Program

Rising Tide Workshop

Grades: K-12;

Learn how to take the concepts explored in the Museum's exhibition, *Rising Tide: Climate Change and New Jersey* to bring your classroom conservation program to life. Learn what students can do as individuals, as groups of students, or as leaders within their communities to help make the world a greener place and to mitigate the impact of global warming. This workshop will draw directly from the *Rising Tide* exhibition as well as easily accessible on-line resources. Also, check-out the Museum's new *Rising Tide* web page – with interactive games and information at: http://www.state.nj.us/state/museum/rising-tide

For more information or to register for any of these programs, please call (609) 292-6347.

Table of Contents

Rising Tide: Climate Change and New Jersey

Curriculum Materials

Preparing for Your Visit to the New Jersey State Museum

No matter the age of the student, it is always a good idea to prepare your students for what to expect on a field trip. In addition to preparing them by completing the activities in this guide, we also recommend telling them for what to expect to happen during their trip, and how they are expected to behave while at the New Jersey State Museum. Below are just a few of the things that you might want to review with your students.

Having your students prepared for what to expect will make the trip more enjoyable for you and your students.

Potential Questions to Start the Discussion:

- Have your students visited any kind of museum? If they have, ask the students to describe their experience, what they saw, and what they did. Compare the students' experiences, the collections they saw, and what they experienced. Identify any similarities and/or differences between different types of museums.

- Ask the students if they collect anything – do they have a persona; collection? If they do, what was in it? Why did they choose to collect these materials? Where do they find information about their collection? How are they taking care of it? How is it displayed?

- Ask students to share their stories and to describe their collection (this may also work well as a "show and tell" exercise, for example: - Where did the objects come from? - What are the ages of the objects? - What do the objects have in common? - How are the objects different? - What is the function of the objects?

Explain the role and responsibilities of the New Jersey State Museum:

The New Jersey State Museum's mission is:

The New Jersey State Museum serves the life-long educational needs of residents and visitors through its collections, exhibitions, programs, publications, and scholarship in science, history, archeology, and the arts. Within a broad context, the Museum explores the natural and cultural diversity of New Jersey, past and present.

New Jersey State Museum Mission Statement Adopted December 11, 2002

How to act in a museum:

Can you touch?

- Please "touch" with your eyes, never with your hands. All of us have oils or materials on our hands that can affect the artifacts we are touching.

- When you can touch artifacts, there will be signs or a guide to tell you it is allowed.

Can you play around?

- Please only walk in the museum.

Can you talk loud, whistle or sing?

- Please talk, laugh and share your feelings, but don't disturb other visitors.

Can you eat inside?

- Please finish food and drinks before entering the museum, and do not chew gum. These items can attract unwanted visitors, such as insects and rodents that can damage the Museum's artifacts. A café is located on the first floor of the Museum complex, where you will be able to take a break, relax, and enjoy light refreshments.

Can you write or draw?

- The answer to this question is, "It depends." There are some exhibits within the Museum where students are welcome to draw and even take photographs (such as in *Rising Tide: Climate Change and New Jersey*). But in other areas, drawing is not allowed. So, please ask the guards on duty. If you are not allowed to draw, please remember your thoughts and write them down after your visit.

Can you take photographs?

- The answer to this question is, "It depends." There are some exhibits within the museum where students are welcome to take photographs (such as in *Rising Tide: Climate Change and New Jersey*). But in other areas, taking photographs is not allowed. So, please ask the guards on duty before taking photographs.

You're always welcome to:

- Take your time and enjoy the many exhibits within the New Jersey State Museum.
- Share your thoughts with others who accompanied you.
- Ask questions of the Docents and staff.
- Come back with friends and family to try these and other activities as well as to view other exciting exhibits on view at the New Jersey State Museum.
- Attend one of the many educational programs available throughout the year – check the calendar of events available on the Museum's web page:

Please visit the other museums in New Jersey and the surrounding area – compare the collections, how the objects are exhibited, and your individual and group experiences.

Please visit The New Jersey State Museum's web page frequently since information on programs, events, and exhibitions changes frequently:

www.newjerseystatemuseum.org

Additional information may also be available at the information tables on the first floor of the Museum's main building or in the lobby of the New Jersey State Museum Auditorium – but our web page will have the most accurate and up to date information.

How to Use this Curriculum Guide

Rising Tide: Climate Change and New Jersey tackles an incredibly important and often complex set of issues. The information in the exhibition is multi-disciplinary and can be included as part of your science or social science curriculum. With that in mind, we have created four units of study to accompany the exhibit, each focuses on a different aspect of the exhibit. You are welcome to select just one unit or complete all four.

Each unit has five important parts:

1. Background information specific to the unit
2. An activity to be completed before your visit
3. An activity to be completed during (or immediately after) your visit
4. An activity to be completed after your visit that will expand the students learning on the topic
5. Potential adaptations and extensions to meet the needs of your students. Activities can be done in groups, led by the teacher, or done individually.

Do I need to complete all activities?

You are in no way required to complete all, or even any, of these activities; however, we hope that you will at least look them over. We believe that by completing these activities, your students will gain a deeper understanding of the exhibit, *Rising Tide*: *Climate Change and New Jersey*, as well as the important topics explored throughout the exhibit rather than just exploring the exhibit alone.

These activities are designed to address the New Jersey Core Curriculum Content Standards for Science, the Pennsylvania Academic Standards for Science and Technology and Environment and Ecology, and to enhance your curriculum. Our goal is to provide you with tools and resources that will make your job easier and more enjoyable.

More Information:

For additional information and resources, we encourage you to check out the exhibition website at:

www.state.nj.us/state/museum/rising-tide

The site is designed specifically to engage students in these often complex topics through educational games, video clips, and more. We encourage you to give your students time to explore the site. There is also a section designed specifically for teachers.

Rising Tide: About the Exhibit

Rising Tide: Climate Change and New Jersey covers the broad spectrum of climate change issues, but specifically focuses on the impact of climate change on New Jersey, from pre-historic time, over 540 million years ago, to today. As you explore the exhibition, try to follow the footprints, which will lead you through the exhibition in sequential order. As the footprints change, the exhibit's overriding theme changes. *Rising Tide: Climate Change and New Jersey* is divided into six different sections that build upon each other to tell a linear story.

Following the Mastodon Footprints

Section #1: Earth's Ever Changing Climate

Throughout Earth's history, the planet's climate has always been in a constant state of flux, varying between greenhouse temperatures and ice house conditions. Based on fossils and other clues, we are able to accurately pinpoint what types of changes the Earth has experienced. Corals, for instance, are a great way to gauge climate. The fragility of corals enables them to be excellent indicators of ancient environments. They can only thrive in very specific conditions, therefore when we find ancient corals, we know that Earth has previously experienced climate conditions very similar to those we are experiencing presently.

The Earth is currently experiencing ice house conditions, called an ice age. This is the fourth major ice age in Earth's history, and it began approximately 52 million years ago. Each ice age includes both relatively warm interglacial periods – periods when the ice sheets shrink or recede – and markedly colder glacial periods – when the continental and polar ice sheets expand. The most recent glacial period in North America was the Wisconsinan Glaciation, which began approximately 100,000 years ago and ended nearly 12,000 years ago. During this time, the Laurentide Ice Sheet covered nearly all of Canada and much of the northern United States, including northern New Jersey. The ice sheet reached its greatest extent and thickness 18,000 years ago when the ice sheet was 3 – 4 km (up to 2.5 miles) thick. Its vast size helped to lower global sea levels by 120 meters (approximately 400 feet).

Section #2: New Jersey's Ice Age Legacy

Fossils found in and around New Jersey, tell us of a rich diversity of life that lived in New Jersey until about 10,000 years ago. Most of the fossil evidence has been found on the continental shelf, which is now covered by the Atlantic Ocean but was once open grazing lands. Many of these animals are now extinct; however, some have only left New Jersey and now can be found elsewhere. Many animals that we associate with cold temperatures, such as caribou, elk, and moose, existed in New Jersey during the Pleistocene Epoch. For example, although we do not have any proof yet, we believe that polar bears could also be found in New Jersey, because they lived during that period and had the appropriate adaptations to survive.

During the glacial periods of the Pleistocene Epoch (1.8 million years ago to 10,000 years ago), New Jersey experienced arctic and subarctic climatic conditions that are now only found near the North and South poles. Numerous large animals, collectively referred to as the Pleistocene Megafauna,

made New Jersey home. Some animals, like mammoths, mastodons, giant ground sloths, giant beavers, and elk-moose, are now extinct relatives of animals currently living in other parts of the world. Not all of the ice age animals became extinct. In New Jersey, these bizarre beasts coexisted with animals – such as caribou, musk oxen, and bison – that thrive today in the extreme conditions of the tundra or sea ice of the far north.

There are several theories on why these massive animals have become extinct. One of the theories is that over-hunting led to extinction; however we know that by this time in history, humans had diversified their diet to include plants, fish, etc., and had easier sources of food. It is unlikely that they would risk hunting enormous animals to the point of extinction when easier sources of food were available. Therefore we can be pretty sure that the extinction was a result of rapid climate change and the species' inability to adapt to quickly changing climates.

Following the Bird Footprints

Section #3: The Process Continues

Currently, climate change is having a major effect on birds all over the world. Each summer, the Arctic is home to the greatest assemblage of birds anywhere on the planet. Millions of birds from nearly every corner of the globe take advantage of long summer days to breed and feed their young. Many stop in New Jersey along the way to rest and feed. Their arrival in their Arctic breeding grounds is timed precisely to coincide with the melting of winter snow and ice and the emergence of food resources, especially insects. Arctic climate change is altering the timing of many of these events, severely affecting bird species that rely on the region.

The future is particularly grim for the Red Knot. In addition to climate change threatening their survival, humans have depleted one of their major resources. Horseshoe crab eggs provide a critical food source for migrating birds, many of which have come from as far as the tip of South America to gorge themselves on the over abundant eggs; they do this to build necessary reserves to keep them nourished through their flight to the Arctic. Unfortunately, numbers of horseshoe crabs arriving to spawn have declined over the past two decades due to over harvesting by fishermen. March 25, 2008, New Jersey Governor Jon Corzine signed legislation that put a moratorium on the harvesting of horseshoe crabs.

Following the Black Human Footprint (Carbon footprint)

Section #4: Greenhouse Gases and Fossil Fuels

What are greenhouse gases? Greenhouse gases are gases that absorb heat and trap it in the atmosphere rather than allowing it to escape into space. Without these gases the Earth would be freezing and uninhabitable. However, too much greenhouse gases create an overheating effect which causes the Earth's average temperature to rise, which will create devastating changes for the Earth and its inhabitants. Greenhouse gases include methane, water vapor, carbon dioxide and other gases.

What are Fossil Fuels? Fossil fuels are naturally occurring carbon formed by the decomposition of prehistoric organisms.

Earth has finite reserves of carbon stored in its crust in the form of fossil fuels: coal, petroleum and natural gas. We burn these fossil fuels to create energy, which in turn releases toxins and carbon dioxide, which increases the gases trapped in the atmosphere, which accelerates climate change. As we deplete these reserves of fossil fuels, the costs will continue to rise creating an economic strain in addition to the harm it's already doing to the environment. This is why it is imperative that we find renewable, sustainable resources.

Section #5: Climate Change and New Jersey

Climate change will affect, and already has begun to affect, New Jersey's economy.

Within the fishing industry, rising temperatures will force certain species to leave the region; coastal wetlands will be inundated by rising sea levels, which will destroy fish spawning grounds and the areas in which hatchlings develop. Fish may also move to cooler waters. These changes will have a dramatic negative effect on the revenue generated by the fishing industry. The decline of New Jersey's fishing industry will also have a major impact on tourism and shore revenue.

Climate change also poses a major threat to New Jersey's agriculture. Temperature increases and altered precipitation patterns will have severe effects on the Garden State's $864 million per year agricultural industry. It is likely that all crops will be affected. As a result of climate change, total production of the state's most valuable crops - hay, soybeans, and corn - are expected to decline by the year 2100. The greatest losses, however, are likely to affect fruit and dairy production, with an estimated 10% decrease in milk production expected by the end of the century.

Sea level rise is the most certain of all climate change related effects to impact New Jersey. During the last 80 years, sea level along New Jersey's coastline has risen by an average of 3.8 mm (0.149 inches) per year – about twice the global average. By 2100, that rate is expected to increase to 6 mm (0.236 inches) per year. The rising sea level will have wide-ranging and severe consequences throughout the state, from flooding, increased beach erosion, and saltwater intrusion, to loss of property, habitat, and infrastructure, all resulting in potentially irreparable harm to the state's economy. To put this into perspective, gun emplacement structures built 900 feet inland from the shoreline on Cape May in 1942 (just 67 years ago) are now at or below high tide.

Following the Green Human Footprints (Environmentally Friendly)

Section #6: What Can We Do?

What can you do to prevent climate change? Reduce, Reuse, and Recycle.

By reducing waste and recycling, we are taking major steps toward a sustainable society that won't produce harmful carbon dioxide (CO_2) or other toxins that are destroying our planet. New Jersey has emerged as an energy leader in climate change. The state is required to produce at least 20% of its energy using renewable resources by the year 2020. If we all make small changes, then we can slow global warming and help save our planet.

- Recycling aluminum saves 95% of the energy required to make cans from raw materials. Recycling one aluminum can could power a television or computer for 3 hours. Recycling 40 cans can save the same energy as 1 gallon of gasoline.

- Recycling glass uses 35% less energy than producing it from raw materials and 1 recycled glass jar is equivalent to the amount of energy used to run a 100 watt bulb for 4 hours.

- Recycling Paper: One ton of recycled paper saves 17 trees, 7000 gallons of water, 380 gallons of oil, 60 pounds of pollutants and 4100 kilowatt hours of energy (average power use of an American home for 5 months.)

We have known about alternate energy sources for quite some time. Unfortunately, it is only recently that we are really taking advantage of these Earth-friendly options such as solar power, wind power, hydro-electric, etc. However, New Jersey is taking action to become a leader in alternative energy.

- New Jersey ranks 2nd among U.S. States and is 15th in the world for its number of solar installations. More than 3,550 solar electric systems have been installed throughout the state, thanks to New Jersey's progressive incentives, tax credits and rebates.

- New Jersey was also the first state to have a coastal wind farm. This farm in Atlantic City produces enough energy to power 20,000 homes. A new farm is planned for Avalon, New Jersey and will power 110,000 homes.

Unit #1: New Jersey: Past, Present and Future

Overview of Unit:

By creating maps of New Jersey that represent past, present, and future conditions, students will gain a better understanding of how climate change can impact the land and its inhabitants.

Materials:

- Pre-visit Portion: Copies of *New Jersey: Present* worksheet (You may want to enlarge the map by copying on to 11"x17" paper), maps of New Jersey, and reference materials or access to the internet

- Exhibit Visit: Copies of *New Jersey: Past* worksheet

- Post-visit Portion: Copies of *New Jersey: Future* worksheet and reference materials or access to the internet

Standards Addressed:

New Jersey Core Curriculum Content Standards Addressed: 5.1, 5.2, 5.3, 5.4, 5.5, 5.8, and 5.10
Pennsylvania Academic Standards Addressed: 3.1, 3.3, 3.5, 4.3, 4.6, and 4.7

Background:

People often assume that the natural landscape has always and will always look the same. However, as we look at the history of the Earth, there has been tremendous change and in fact the Earth is constantly changing. Scientists called paleoclimatologists have recorded a 540-million year history of both long and short term climatic fluctuations. These scientists have discovered that Earth's climate has regularly fluctuated between warm (greenhouse) conditions, with no glaciers anywhere on Earth, and cold (ice-house) conditions known as ice ages, during which ice exists at Earth's poles and on the continents in varying amounts. The most recent ice age began approximately 52 million years ago, and continues to this day.

During ice ages, relatively low global average temperatures prevent winter snow and ice from completely melting. As ocean water evaporates into the atmosphere, precipitation freezes in the form of snow and ice and accumulates on the continents over millions of years. Earth's high-latitude regions effectively become vast storage areas for the water that was removed from ocean basins by evaporation. Because of this phenomenon, a drop in sea level is common during Earth's ice-house phases. Currently, 70% of the Earth's fresh water is stored in the polar ice caps and glaciers.

The most recent glacial period in North America was the Wisconsinan Glaciation, between 100,000 and 12,000 years ago. During this time, the Laurentide Ice Sheet covered nearly all of Canada and much of the northern United States, including northern New Jersey (as far south as Belvidere, Chester and Perth Amboy). Sea levels at that time were nearly 120 meters (400 feet) lower than today. As a result, the coastline of New Jersey extended more than 160 km (100 miles) to the east of

the modern shoreline. This area, known as the continental shelf, provided vast grazing areas for many of the Pleistocene Megafauna.

For decades, fisherman and dredgers have collected hundreds of Pleistocene age fossils from the broad, flat, shallow continental shelf off the New Jersey coast. In addition to discovering preserved remains of extinct Pleistocene Megafauna, they also find ancient remains of species that still live in Arctic regions today. These remains indicate this area was dry land – part of the coastal plain – near the end of the Pleistocene Epoch. Following that epoch, this region was inundated by rising sea levels, submerging the continental shelf under the sea.

Following the rapid warming at the end of the last Ice Age, Earth experienced relatively stable conditions. However, this abruptly changed approximately 250 years ago, when the rate of global warming suddenly accelerated. Just as rapid warming culminated in the extinction of many plants and animals at the end of the Pleistocene Epoch, climatic conditions today are changing so rapidly that many plants and animals cannot adapt quickly enough to the resulting large-scale habitat loss. As a result, many living species are endangered or have already disappeared. If climate change continues at this accelerated level, the Earth will soon look very different than it does today.

New technologies allow us to make predictions, but we still can't say exactly what will happen or how fast changes will occur. We can say that climate change will affect every living thing on Earth. Over the last century, New Jersey has already experienced rising temperatures and sea levels, increased precipitation, and more frequent storms. All of these changes are expected to intensify.

Pre-visit Portion:

We want students to have a strong understanding of the current condition of New Jersey. Depending on the age of the students and the time available, this activity can require more or less research.

To begin, give each student a copy of the *New Jersey: Present* worksheet. Have them begin to fill in the worksheet according to what New Jersey is like now. On the map include the features and places that are important, both to the student and to the state. Additional maps of New Jersey are available in the Additional Resources section at the end of the guide.

Have them include such things as:

1. Where they live.
2. The state capital.
3. Other large cities in the state.
4. Beaches they may have visited.
5. Major rivers, forest areas, or other special habitats.
6. Historic landmarks.
7. Major tourist destinations.
8. State parks and forests.

9. The type of animals that live in their region of the state.
10. The species that migrate through the state.

Please note: This list is not all inclusive. Brainstorm with your students about what else could, or should, be on your map. The map can be as complete as you have the time and interest to make it.

Exhibit Visit:

While the students are at the Museum have them focus on the Ice Age portion of the exhibit for this activity. It will allow the students to complete the *New Jersey: Past* worksheet. On their map, they should be sure to include:

1. Southern most edge of the Laurentide Ice Sheet
2. Location of the shore line at the edge of the continental shelf
3. Where the megafauna might have lived (based on where fossils have been found)

Pay special attention to the maps and images throughout the exhibit and point out the maps and images of Atlantic City and Cape May in Section #5 of the exhibit.

Post-visit Portion:

Now comes the hard part. What is New Jersey going to look like in the future? Climate change is inevitable; however the rate of climate change can be slowed by everyone doing their part to reduce greenhouse gasses. So have your students select a time period somewhere in the future, perhaps in 50 years (in their lifetimes), 100 years (in their children's lifetimes), or even 1,000 years. As they complete the *New Jersey: Future* worksheet, have them make predictions, based on the science presented in the exhibit, of what New Jersey may look like.

Some things to keep in mind, and present to your students to help them:

1. During the 20th century average temperatures in New Jersey increased 1.1° C (2° F). By 2100, average temperatures could rise as much as 4.4°C (8°F).
2. Scientists predict that sea level will rise 6mm (.236 inches) per year by 2100.
3. Due to New Jersey's flat topography, a one foot rise in sea level would result in the shorelines retreating by 120 feet.
4. It is estimated that rising sea levels will consume 1-3% of New Jersey's coastline by 2100, with occasional severe flooding inundating up to 9% of coastal areas.
5. Agricultural production will decrease by as much as 10% by 2100.
6. Rising sea levels will destroy 21% of all mid-Atlantic wetlands by 2100, reducing shorebird nesting areas and critical fish nurseries.
7. Rising ocean temperatures may force some fish species to leave the area in search of colder waters or to follow prey that have migrated to cooler waters. This will have a huge impact on New Jersey's fishing industries.

8. By 2100, the world's oceans may become more acidic than at any time in the last 20 million years, potentially leading to a total collapse of the marine food chain.
9. New Jersey's Oak-Hickory forest will be replaced by Southern Oak-Pine-Loblolly Pine forest as our current tree species migrate northward or to higher elevations. This will cause a 20% decrease in the density of New Jersey's forests.
10. On average, three major forest fires occur in the Pine Barrens each year, with increased temperatures and droughts this is likely to increase by 10-20%.
11. Increased frequency and severity of storms, large storms that happened every 20 years will likely happen every 5 years by 2050.
12. By 2100, precipitation rates will increase by 20%; however these increases will be seen most in the form of severe storms in the winter leaving spring and summer months dryer than normal.
13. If sea level does rise significantly in their time frame, how will humans and wildlife have adapted?
14. Pay special attention to the changes that have taken place in Atlantic City and Cape May in the last 50-75 years (see Section #5 of the exhibit).

Please note:

- If your students choose to do the 1,000 year option, remind them that they can extrapolate the changes predicted in 10 years and multiply that by 100 to get a possible change in 1,000 years.

- The maps and images of Atlantic City and Cape May in Section #5 of the exhibit will help illustrate actual change over time and provide ideas on how to illustrate future change.

<u>Adaptations for Younger Students</u>:

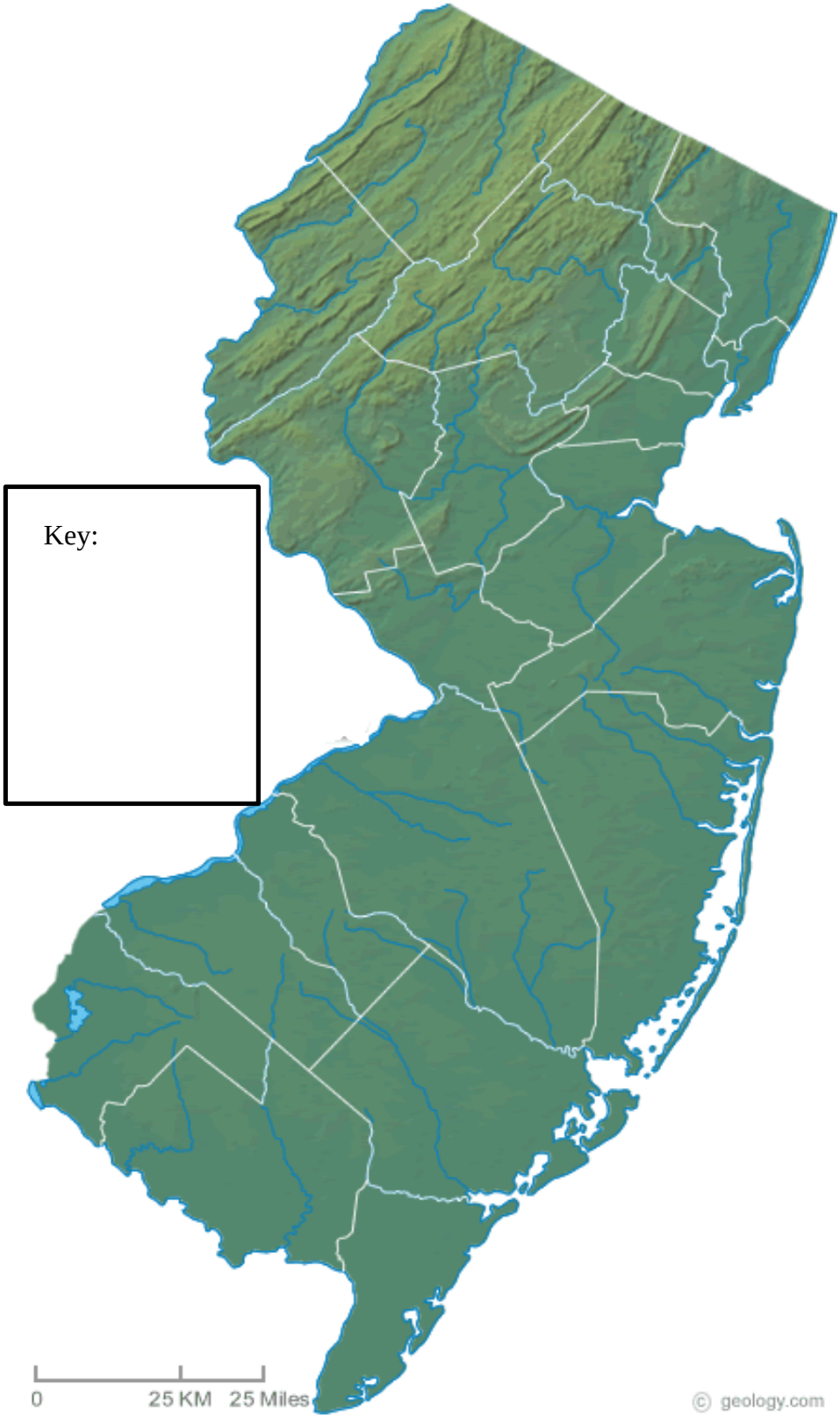
1. Instead of everyone doing a worksheet, do the worksheets in small groups or as an entire class.
2. Consider focusing on only one or two aspects from the worksheet, perhaps weather or wildlife. These are topics that are easier for younger children to understand.
3. For the *New Jersey: Future* portions, please consider the age and maturity level of your students before introducing the topics listed. Often this type of information can be very disturbing to young children. Consider choosing only one or two facts to focus on for their predications.

<u>Adaptations for Older Students</u>:

1. You may also want to have your students complete two different *New Jersey: Future* worksheets, one for the current rate of climate change and one if everyone really takes an active role and we are able to dramatically reduce our production of greenhouse gases.
2. Have the students include the topography of New Jersey on their maps. You may even want to use a more detailed map from the start that already has the topography. Topographic maps can be found online or ordered from the USGS. How will the topography impact the look of a future New Jersey?

3. For the *New Jersey: Present* worksheet, have your students complete the alternate worksheet for a more detailed look of New Jersey's recent climate.
4. Consider having your students create three dimensional models of the state to help demonstrate areas where sea level rise will cause the most problems.
5. Have your students combine the geological changes with population growth studies to see how increases in population will impact current rates of climate change.
6. Have your students look at how changes in the environment will affect large population centers as well as industry. Advanced students can extrapolate the long-term economic impact of climate change.

Unit #1: New Jersey: Present
Worksheet 1: Map



Using other maps and research materials, create a picture of what New Jersey looks like now. Don't forget to include important things like where you live!

The white lines outline New Jersey's 16 counties; the blue lines are waterways.

Unit #1: New Jersey: Present
Worksheet #2: Data Sheet

Using research materials and the internet, fill in as much information as you can about the current conditions in New Jersey.

1. Average Temperature:

2. Typical Weather:

    Winter

    Spring

    Summer

    Fall

3. Ecosystem Types:

4. Common Wildlife:

5. Common Plant Species:

Unit #1: New Jersey: Present
Worksheet #2: Alternate Data Sheet

Using research materials and the internet, fill in as much information as you can about the current conditions in New Jersey.

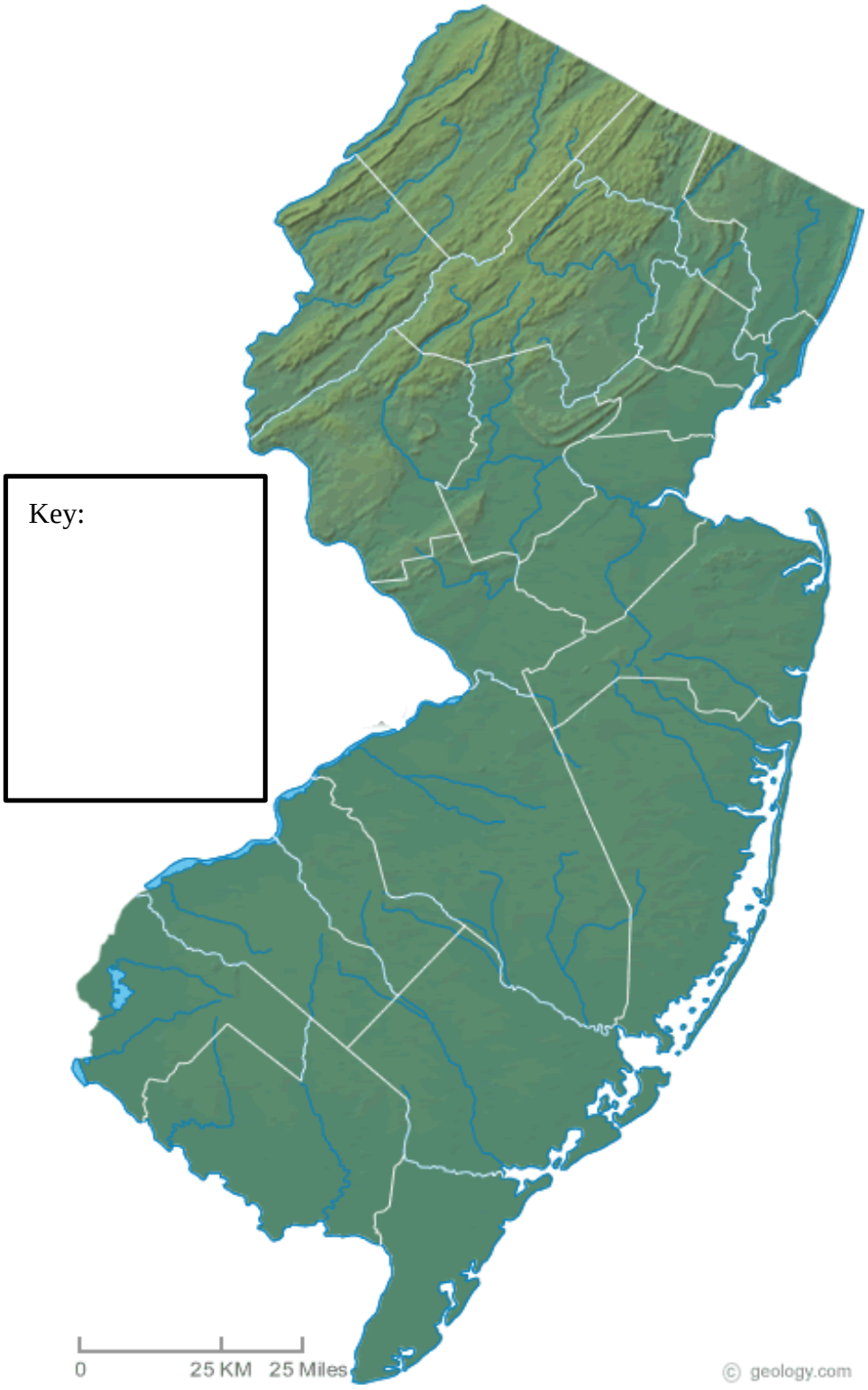
Data	*2009*	*1959*	*1909*
Average Temperatures			
Typical Weather			
• Winter			
• Spring			
• Summer			
• Fall			
# of Hurricanes			
# of Nor'easters			
# of Droughts			
# of 50 year floods			
# of 100 year floods			

1. Ecosystem Types *(note the region, area, or counties):*

2. Common Wildlife *(note any animals that have become endangered, extirpated, or extinct in the past 100 years)*:

3. Common Plant Species *(note any plants that have become endangered, extirpated or extinct in the past 100 years)*:

Unit #1: New Jersey: Past (Pleistocene Epoch)
Worksheet 1: Map



Using the information in the *Rising Tide: Climate Change and New Jersey* exhibit, create a picture of what New Jersey looked like 18,000 years ago. Don't forget to include the Laurentide Ice Sheet and the shore line at the edge of the Continental Shelf.

The white lines outline New Jersey's 16 counties; the blue lines are waterways.

Unit #1: New Jersey: Past
Worksheet 2: Data Sheet

Use the information in the *Rising Tide* exhibit; fill in information describing what New Jersey was like 18,000 years ago.

1. Average Temperature:

2. Typical Weather:

3. Ecosystem Types:

4. Common Wildlife *(indicate if extinct and if not, where they can currently be found)*:

5. Common Plants:

Unit #1: New Jersey: Future
Worksheet 1: Map

Select a time in the future, perhaps 50, 100, or 1,000 years. Using the information gained from the *Rising Tide: Climate Change and New Jersey* exhibit and additional research, make some predictions on what New Jersey will look like at your selected time. Don't forget to consider things like the location of the shoreline.

The white lines outline New Jersey's 16 counties; the blue lines are waterways.

Unit #1: New Jersey: Future
Worksheet 2: Data Sheet

In your selected future, make predictions about each of the following topics. Note how many years in the future you are describing ____.

1. Average Temperature:

2. Typical Weather:

3. Ecosystem Types:

4. Common Wildlife:

5. Common Plants:

Unit #2: Adapting to Climate Change

Overview:

By learning about what adaptations helped animals to live during the Pleistocene, students will explore what adaptations modern animals might need to gain in order to survive current and future climate change in New Jersey.

Materials:

- Pre-visit Portion: Pictures of modern animals, copies of *Local Animals* worksheet
- Exhibit Visit: Copies of *Exploring the Exhibit* worksheet (optional)
- Post-visit Portion: Research materials, materials to create their adapted animal

Standards Addressed:

New Jersey Core Curriculum Content Standards Addressed: 5.1, 5.2, 5.4, 5.5, 5.8, and 5.10
Pennsylvania Academic Standards Addressed: 3.1, 3.3, 4.3, 4.6, and 4.7

Background:

An adaptation is a physical feature or a behavior that helps an animal to survive in its environment. Adaptations do not develop during an animal's life but evolve over many generations. The shape of a bird's beak, the number of fingers, color of the fur, the thickness or thinness of the fur, the shape of the nose or ears, or migrating a long distance during the fall and spring are all examples of adaptations which help different animals to survive.

Animals during the Pleistocene Epoch were adapted to the climate in New Jersey 18,000 years ago. At that time the climate was much like the Polar Regions are today. Animals at that time would have had adaptations, such as large size, long, thick fur and a thick layer of fat for insulation.

Pre-visit Portion:

Introduce the topic of adaptations by looking at various pictures of animals that are living today. Have students identify as many adaptations as possible for each animal.

Then have each student select an animal from the list below. These are all animals that are featured in the *Rising Tide: Climate Change and New Jersey* exhibit, and will be greatly impacted by climate change. Have the students complete the *Local Animal* worksheet on the animal they have chosen. Check the Additional Resources section of this guide for information on these animals.

Animal List:

1. Brant
2. Common Eider
3. Diamondback Terrapin
4. Spring Peeper
5. Grey Tree Frog
6. American Bullfrog
7. Fowler's Toad
8. American Toad
9. Piping Plover
10. Red Knot
11. Ruddy Turnstone

Exhibit Visit:

Have the students indentify their animal and find out how they might be impacted by climate change. This is also the time to gather information on how the climate of New Jersey will change, and how changes in the past impacted different animals. An optional data collection worksheet is included to facilitate this process. Check the Additional Resources section of this guide for more information on the animals featured in the exhibit.

Post-visit Portion:

Using what students have learned about adaptations and climate change, have them "adapt" a local animal so that it will be able to survive the changes that may occur in New Jersey. They can represent the animal and their adaptations through a written description, a picture, or even a three dimensional representation (perhaps created by reusing items that would otherwise be thrown away).

Some things to think about:

1. What type of body covering does the animal have, i.e. fur, feathers, scales?
2. What does the animal eat? Will that food still be available?
3. Size of animal and how much space it needs to have in its habitat.
4. How does the animal deal with water during floods and droughts?
5. Where does the animal find shelter? Will that shelter still be available?

Students may also want to consider the changes that will occur due to climate change:

1. During the 20th century average temperatures in New Jersey increased 1.1°C (2°F). By 2100, average temperatures could rise as much as 4.4°C (8°F).
2. Scientists predict that sea level will rise 6mm (.236 inches) per year by 2100.
3. Due to New Jersey's flat topography, a one foot rise in sea level would result in the shorelines retreating by 120 feet.
4. It is estimated that rising sea levels will consume 1-3% of New Jersey's coastline by 2100, with occasional severe flooding inundating up to 9% of coastal areas.
5. Agricultural production will decrease by as much as 10% by 2100.
6. Rising sea levels will destroy 21% of all mid-Atlantic wetlands by 2100, reducing shorebird nesting areas and critical fish nurseries.
7. Rising ocean temperatures may force some fish species to leave the area in search of colder waters or to follow prey that have migrated to cooler waters. This will have a huge impact on New Jersey's fishing industries.
8. By 2100, the world's oceans may become more acidic than at any time in the last 20 million years, potentially leading to a total collapse of the marine food chain.
9. New Jersey's Oak-Hickory forest will be replaced by Southern Oak-Pine-Loblolly Pine forest as our current tree species migrate northward or to higher elevations. This will cause a 20% decrease in the density of New Jersey's forests.
10. On average, three major forest fires occur in the Pine Barrens each year, with increased temperatures and droughts this is likely to increase by 10-20%.
11. Increased frequency and severity of storms, large storms that happened every 20 years will likely happen every 5 years by 2050.
12. By 2100, precipitation rates will increase by 20%; however these increases will be seen most in the form of severe storms in the winter leaving spring and summer dryer than normal.

Adaptations for Younger Students:

1. Adaptations are a concept that almost every age group can understand. However, you may want to focus on just a few simple adaptations of just a few animals, for instance focus on the green camouflage color, longs legs and long sticky tongue of the bullfrog instead of the porous skin and nictitating membrane. You can also select from other New Jersey animals that have more obvious adaptations and that younger children may be more familiar with, such as a skunk or opossum.
2. For the post-visit portion of the unit, you might want to have the students create an imaginary animal that could survive the changes in the climate. Make sure to describe to the students what the new climate will be like and then have them use their knowledge and imagination to create a creature that could live in those conditions.

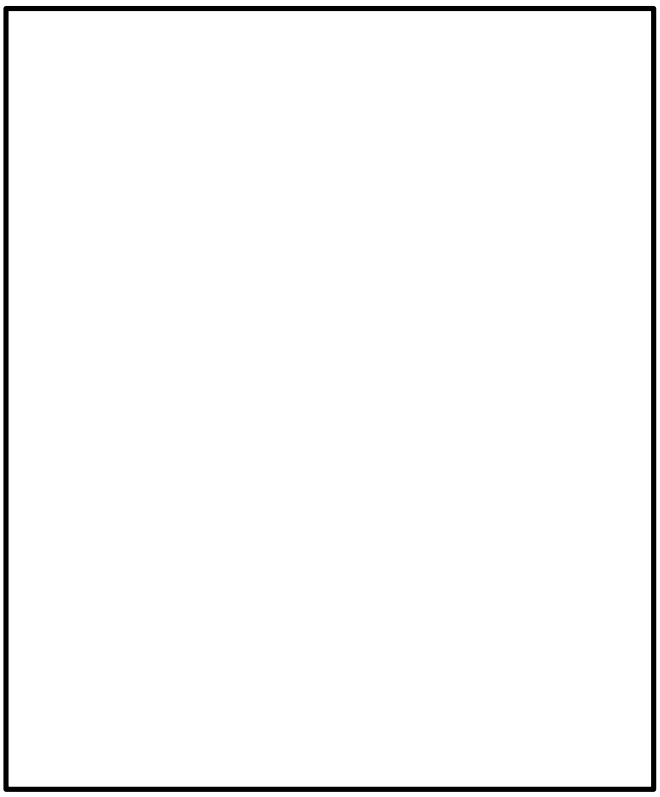
Adaptations for Older Students:

1. For older students, this can be an opportunity to explore the topic of evolution. Adaptations and natural selection are an excellent starting point. Instead of creating just the final animal, have the students create a series of animals that show the progression of the adaptation. The students can also predict what modern animals they feel are the most likely to become extinct from climate change.
2. Older students can also explore what adaptations would have to take place within human beings to survive changes in the climate. Students can also explore what the physiological limitations of human beings are and at what point are we in danger of becoming extinct if we cannot adapt quickly enough to climate change.

Unit #2: Adapting to Climate Change
Local Animal Worksheet

My Animal is a _____.

Draw or paste a picture of your animal:



1. What type of ecosystems does your animal live in?

2. Where does your animal find shelter?

3. What does your animal eat?

4. Identify at least 10 adaptations that your animal has in order to survive in its ecosystems:

1. 6.
2. 7.
3. 8.
4. 9.
5. 10.

Unit #2: Adapting to Climate Change
Exploring the Exhibit Worksheet (optional)

1. Find your animal in the exhibit

   Is the animal considered endangered?

   How is the animal reacting to climate change?

2. Find an animal that once lived in New Jersey but no longer lives here, but instead lives somewhere else: _____

   Where can this animal be found now?

   Why did it leave New Jersey?

3. Find an extinct animal in the exhibit: _____

   What adaptations did this animal have?

   What caused this animal to become extinct?

Unit #3: How Can You Slow Climate Change?

Overview:

The accelerated rate of climate change is caused by human action, so it is imperative that humans take action to slow the progression of climate change. Students will explore the reasons behind this acceleration and take action to reduce their impact on the problem.

Materials:

- Pre-visit Portion: Copies of the *Home Energy Use Survey*
- Exhibit Visit: Copies of the *How to Save Energy* Worksheet
- Post-visit Portion: Copies of the *Energy Conservation Plan* or poster making materials, additional research material may be needed

Standards Addressed:

New Jersey Core Curriculum Content Standards Addressed: 5.1, 5.3, 5.4, 5.7, 5.8, and 5.10
Pennsylvania Academic Standards Addressed: 3.1, 3.2, 3.4, 3.8, 4.2, 4.3, and 4.8

Background:

Although there are many sources of greenhouse gases, as much as 80% of the human created (anthropogenic) gases that are pumped into the atmosphere each year are produced by burning fossil fuels. What exactly are fossil fuels, and why are we so dependent on them?

The vast majority of Earth's total pool of biological carbon has been stored in the earth's crust for hundreds of millions of years in the form of fossil fuels: coal, petroleum, and natural gas. Each year we burn hundreds of trillions of tons of fossil fuels to create electricity to run our lights and appliances, gasoline to power our cars, and oil or natural gas to warm our houses. Each year the amount of fossil fuels we burn increases dramatically. Burning these energy-rich resources releases carbon dioxide, as well as other greenhouse and toxic gases. In 2005, 86% of the world's energy was produced by burning fossil fuels. Each year, more than 21 billion tons of CO_2 are produced by the burning of fossil fuels – and since only half can be absorbed by the carbon cycle, over 10.5 billion tons of CO_2 is added to the atmosphere each year.

Unfortunately, some amount of climate change and sea level rise is inevitable. There is little we can do to eliminate all of the greenhouse gases we have pumped into the atmosphere over the past few centuries. However, the increasingly catastrophic effects of future climate change will only increase if we don't take immediate steps to reduce our consumption of fossil fuels.

So, if climate change is inevitable, why should we bother?

Although climate change is a natural process, human action has accelerated the process to unnatural levels. During naturally occurring climate change, plants and animals have a long time to adapt and evolve to the changes, which is why some of the animals from the Pleistocene Epoch are still around today. Although not every animal and plant will be able to adapt, time allows them, and the other organisms that are dependent on them, a chance. By accelerating the rate of climate change, we have taken that chance away from many plants and animals. Of course, one of the most important things to remember is that we are animals! Humans will also need time to adapt to the changing climate or we could also become extinct.

The solution lies with all of us, collectively, but starts with us, individually. There are hundreds of things you can do – easy, everyday things – that will go a long way toward reducing the amount of greenhouse gases produced to create the energy you use. All of these things can be summarized by three simple words **. . . REDUCE…..REUSE….RECYCLE….**

The average home spends more than *$2000 each year* on energy bills. *Reduce* your greenhouse gas emissions and save money by . . .

- Buying Energy Star products.
- Properly insulating your home.
- Using a programmable thermostat.
- Setting your thermostat higher in summer and lower in winter.
- Unplugging your energy "vampires".
- Replacing incandescent light bulbs with compact fluorescent light bulbs (CFLs) or light emitting diodes (LEDs)
- Planting a garden and buying local.
- Planting a tree.

Americans use nearly 400 million gallons of gasoline each day, producing 8 billion pounds of CO_2. You can help reduce CO_2 emissions and save money by . . .

- Driving less.
- Slowing down.
- Buying a more fuel efficient car.
- Changing your driving habits.
- Eliminating annoying junk mail.

Reuse…each year up to 1 trillion plastic bags are consumed worldwide – that's over 1 million every minute! Reduce the number of bags you use each year by reusing them as lunch sacks, or better yet, start using reusable cloth bags instead.

Recycling most materials saves energy, raw materials, and often a whole lot more. Reduce your greenhouse gas emissions by . . .

- Recycling aluminum.
- Recycling steel and tin.
- Recycling glass.
- Recycling paper.

Energy efficiency and conservation are essential components of any plan to reduce and slow climate change, but the truth is, these efforts ***alone*** cannot significantly reduce the threat of severe climatic changes. These approaches to reducing, reusing, and recycling must be combined with new ways of thinking about new and existing technologies to create wholesale changes in the way we produce and distribute energy in this country and around the world. Alternative energy sources include:

- Energy in the Wind
- Energy from the Sun
- Energy from Atoms

Many renewable methods of producing electricity, such as bio-fuels, hydropower, geothermal, and burning waste products or methane gas released from landfills have been utilized for decades. Additionally, there are many other untapped resources of energy, such as ocean tides and currents, and we are only beginning to devise ways to exploit these energy sources.

Slowing, or even reversing, anthropogenic climate change will require ingenuity on a scale never before achieved and a willingness to implement all of these ideas and efforts as we continue to strive to discover many new ones.

Pre- visit Portion:

Using the *Home Energy Use Survey*, students should examine the energy use of their household. You may also want to send a note home to the parents explaining the project and the exhibit, so that they can take part in the project. Ideally, everyone in the family should be involved in the project.

Exhibit Visit:

While visiting the *Rising Tide: Climate Change and New Jersey* exhibit, students should complete the *How to Save Energy* worksheet. The information gathered will be used to help the students complete their post-visit activity.

Post-visit Portion:

Using their home *Energy Use Survey* and the information gained from the exhibit, students should create an *Energy Conservation Plan* for their home. The plan should include at least 10 ways that

their family can save energy and money. Students can use the optional worksheet format or create a poster for their plan.

Some facts for your students to consider (there are even more in the exhibit):

1. For each degree below 68° that your thermostat is set to in the winter, you use 3-5% less energy to heat your home. Programmable thermostats can help by reducing the temperature when you are not home and raising it again when you need it.
2. Unplugging your energy "vampires", such as televisions, DVD players, microwaves, cellular phone chargers, computers and other electronics when not needed. These "vampires" can account for up to 5% of a home's electric bills.
3. Compact fluorescent light bulbs use up to 75% less electricity than traditional incandescent light bulbs. LED bulbs can save even more.
4. The junk mail received by Americans each day could produce enough energy to heat 250,000 homes.
5. One million plastic bags are consumed every minute.
6. Recycling 40 aluminum cans saves energy equal to a gallon of gas.
7. Glass is 100% recyclable, so it can be reused indefinitely.

Adaptations for Younger Students:

1. Instead of having the students complete the survey for their home, work as a group and do a survey of the classroom or other area of the school. You can also focus on just one or two sections of the survey, perhaps the number and type of light bulbs.

Adaptations for Older Students:

1. Using electric and gas bills have the students track the success of their conservation plan for several months. Have them make changes and adapt the plan to see how much they can save.
2. In addition to their plans for home, have the students work as a group to complete the survey and create a plan for the classroom, school or work with a younger class to help them create a plan.
3. Students can also use the information they gain to extrapolate energy use in their entire family or town. Have the students repeat the *Home Energy Use Survey* for the school, three additional houses, and a municipal building (perhaps the library).
4. Have the students create an *Energy Conservation Plan* for the school or town. Have them present the plan to the School Board or City Council.

Unit #3: How Can You Slow Climate Change?
Home Energy Use Survey

1. Light bulbs: Count how many of each type are used in your home:
   - Incandescent Light bulb: _____
   - Compact Fluorescent (CFL): _____
   - Light Emitting Diodes (LED): _____
   - Flourescent: _____
   - Unknown/Other: _____

2. Temperature:
   - What temperature is your thermostat set to?
     _____
   - Do you have a programmable thermostat?
     _____
   - Do you have different thermostats for different areas/zones of your house? _____
   - How is your house heated (i.e. gas, electric, oil, wood, etc.)?
     _____
   - How is your house cooled (i.e. gas, electric, oil, fans, etc.)?
     _____

3. List all of the appliances in the house, including refrigerator, microwave, stove, oven, washing machine, etc. Put a star next to all that are Energy Star appliances.

4. List all of the electronics, including TVs, video players, game systems, computers, etc. Put a check next to those that are unplugged when not in use.

5. Does any part of your electricity come from renewable sources?

6. Circle all of the things that you can recycle in your town:

   Aluminum Steel Glass Paper Plastic

7. Circle all of the things that you recycle at your house:

   Aluminum Steel Glass Paper Plastic

8. On average, how many pieces of junk mail does your home receive each day?

9. Do you use plastic, paper or reusable cloth bags for your groceries?

10. Do you have insulation in your walls and attic?

11. Number of single pane windows: _____

12. Number of double pane windows: _____

Unit #3: How Can You Slow Climate Change?
How to Save Energy: Fact Gathering Worksheet

As you explore the exhibit, you will find facts about energy conservation, renewable energy sources, and ways that we can all reduce, reuse and recycle. Use this worksheet to help you gather information to help you in the creation of a conservation plan for your home.

List one fact for each of the issues below:

1. Compact Fluorescent Light (CFL) bulbs:

2. Programmable Thermostats:

3. "Vampire" Electronics:

4. Energy Star Appliances:

5. Junk Mail:

6. Plastic Bags:

7. Recycling Aluminum:

8. Recycling Plastic:

9. Recycling Glass:

10. Recycling Paper:

11. Planting Trees:

12. Buying Locally Grown Food:

13. Solar Energy:

14. Wind Energy:

15. Alternative Energy in New Jersey:

Unit #3: How Can You Slow Climate Change?
Energy Conservation Plan Template

We, the _____ family, in an effort to reduce our production of greenhouse gases that contribute to climate change, pledge to take the following steps.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

_____	_____	_____	_____
Parent/Guardian #1 Signature	***Date***	***Parent/Guardian #2 Signature***	***Date***
_____	_____	_____	_____
Child #1 Signature	***Date***	***Child #2 Signature***	***Date***
_____	_____	_____	_____
Child #3 Signature	***Date***	***Other Signature***	***Date***

Unit #4: Climate Change: Fun with Games and Puzzles

Overview:

Although climate change is an incredibly serious problem that students need to understand, we can still make the learning fun. By completing puzzles and creating and playing games, students will review what they have learned and share important information with others.

Materials:

- Pre-visit Portion: Internet access
- Exhibit Visit: No materials needed
- Post-visit Portion: Materials to create their own games, such as poster board, construction paper, markers, glue, recyclable materials, items that would otherwise be garbage, etc.

Standards Addressed:

New Jersey Core Curriculum Content Standards Addressed: 5.1, 5.2, 5.4, 5.5, 5.8, and 5.10
Pennsylvania Academic Standards Addressed: 3.1, 3.3, 3.4, 4.6, and 4.7

Pre-visit Portion:

The New Jersey State Museum has created an interactive website to enhance the *Rising Tide: Climate Change and New Jersey* exhibit:

www.state.nj.us/state/museum/rising-tide

On this site, students will gain introductory information and be able to play games and interactive activities on the topic of climate change.

Activities include:

- *Run for Your Life* where students must answer questions correctly in order to save the mastodon from the approaching ice sheet
- *Try Alternative Energy* where students find new ways to conserve resources.

You will want to give your students time to explore the website fully before visiting the exhibit. There is also a section for teachers with additional resources and information to help you make the most of this experience.

Exhibit Visit:

In the exhibit, students will find five interactive kiosks where they can try their hand at a number of different games and activities. Students can test their knowledge of greenhouse gases and energy conservation at the Pop Quizzes, and reinforce vocabulary with the word searches. Older students, or teams of students, can also create a newspaper story about the impact of climate change.

Be sure to encourage your students to try a number of these activities.

Post-visit Portion:

From word searches to crossword puzzles to quizzes and games, students can reinforce what they have learned by creating games and/or puzzles for others to play.

Break your class into small groups and have each group create a game or puzzle that will teach others about climate change. Then have the students rotate around the class playing the games that the other groups have created. The possibilities are endless, but here are a few potential game and puzzle formats.

1. Board games, including formats similar to Monopoly ®, Life ®, and Sorry ®
2. Trivia/quiz games, such as Trivial Pursuit ® or Jeopardy ® type games
3. Mystery games, like Clue ®
4. Puzzles, such as word searches and crosswords
5. Tag/Running Games, such as freeze tag

Enclosed are some quizzes for your students on what they learned in the exhibit. These are similar to the quizzes that the students may have completed while exploring the exhibit.

Adaptations for Younger Students:

1. Create simple games as a class and then give them to another class to play. Simple formats might be something like Chutes and Ladders ® or Candy Land ®.
2. While at the Museum, encourage your students to do the word searches on their own, but take the quizzes as a group.

Adaptations for Older Students:

1. While at the Museum, challenge the students by having a competition to see who can write the best newspaper story or score the highest on the pop quizzes.
2. Have each student create a crossword puzzle; give a prize for whomever can use the most vocabulary words. Then see who can complete the puzzle the fastest.

3. Instead of creating games for themselves, have the students create games for a younger grade to play.
4. Challenge the students to make their game completely out of materials that would otherwise be thrown away, such as cardboard boxes, bottle caps, and candy wrappers.

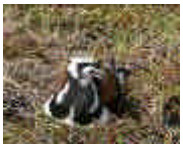
Unit #4: Climate Change: Fun with Games and Puzzles
Pick Quick Worksheet

1. Which one of these animals is a predator, meaning they eat meat?

   a. Polar Bear 

   b. Caribou 

2. Which one of these animals migrates, or flies a long way, each year?

   a. Ruddy Turnstone 

   b. Atlantic Bay Scallop 

3. Which one of these animals has tusks, or very large teeth?

   a. Grey Tree Frog 

   b. Walrus 

4. Which one of these animals can hide its head and legs within its shell?

   a. Diamondback Terrapin 

   b. American Toad 

5. Which one of these animals is an herbivore, meaning it only eats plants?

   a. American Bullfrog 

   b. Caribou 

6. Which one of these animals spends part of its life as a tadpole?

   a. Brant 

   b. Grey Tree Frog 

7. Which one of these animals lives in the ocean?

   a. Musk Ox 

   b. Harbor Seal 

8. Which one of these animals had long hair and thick skin to help them stay warm?

   a. Mastodon 

   b. Horseshoe Crab 

9. Which one of these animals eats other fish?

   a. Thresher Shark 

   b. Piping Plover 

10. Which one of these things saves energy by creating shade?

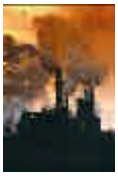
a. Power Lines

b. Tree

11. Which one of these things creates electricity from the wind?

a. Wind Turbines

b. Factory



12. Which type of light bulb saves more energy?

a. Regular Incandescent Light Bulb

b. Compact Fluorescent Light Bulb

Pick Quick Answers

1. A
2. A
3. B
4. A
5. B
6. A
7. B
8. A
9. A
10. B
11. A
12. B

Unit #4: Climate Change: Fun with Games and Puzzles
Pop Quiz: What can I do?

1) How much money does the average American household spend on energy bills each year?

   A. $500

   B. $2000

   C. $1500

2) A house with all Energy Star appliances will use how much less energy?

   A. 33%, or $600

   B. 10%

   C. 25%

3) How much of your home's energy use come from heating and cooling?

   A. 25%

   B. All of it.

   C. 50%

4) How much money can you save by using a programmable thermostat?

   A. $180

   B. $100

   C. $90

5) How much energy is saved by turning your home's thermostat down 1 degree in winter?

A. 3 – 5%

B. 0 – 1%

C. 1 – 3%

6) What are energy vampires?

A. Electronic devices that use electricity even when they are turned off.

B. Electronic devices that turn into bats and fly around the house.

C. Electronic devices that suck the blood of farm animals but only at night.

7) How much of your homes energy is wasted by energy vampires?

A. 1%

B. 5%

C. 3%

8) Which of the following is an energy vampire?

A. Unused cell phone charger

B. Hot Water Heater

C. Insulation

9) How much less energy does a compact fluorescent light (CFL) bulb use compared to an incandescent bulb?

A. 25%

B. 50%

C. 75%

10) How much money can a compact fluorescent light (CFL) bulb save you over the lifetime of that bulb?

A. $10

B. $15

C. $30

11) How many light bulbs are there in the average American home?

A. 25

B. 45

C. 75

12) How much money would be saved if every home in America changed just 1 light bulb to a CFL?

A. $600 million

B. $50,000

C. $6 million

13) How much carbon dioxide (CO_2) is absorbed each year by a healthy, mature tree?

A. 40 lbs

B. 48 lbs

C. 18 lbs

14) How much can you save on your home's cooling costs by simply having a tree shading your home?

A. 40%

B. 25%

C. 35%

15) How many gallons of gasoline do Americans use each day?

A. nearly 400 million

B. nearly 400,000

C. nearly 2 million

16) How many trees are used to make the 41 lbs of junk mail every American receives each year?

A. 100 million

B. 41 million

C. 500,000

17) How many plastic grocery bags are consumed every minute?

A. 100,000,000

B. 1 trillion

C. 250,000

Unit #4: Climate Change: Fun with Games and Puzzles
Pop Quiz: What Else Can I Do?

1) How much energy is saved by recycling aluminum cans compared to making new ones?

   A. 50%

   B. 95%

   C. 100 kilowatts

2) How long can you power your television with the power saved by recycling one aluminum can?

   A. 3 hours

   B. 15 minutes

   C. 30 minutes

3) How many times can a steel or tin can be recycled?

   A. Infinitely

   B. 20 times

   C. 1,000 times

4) How long can you power a light bulb with the power saved by recycling 1 glass bottle?

   A. 40 minutes

   B. 20 minutes

   C. 4 hours

5) How much power is saved by recycling 1 ton of paper?

A. Enough to power your home for 5 months!

B. Enough to power a light bulb for 4 hours.

C. Enough to power your television for 3 hours.

6) How many of our driving trips are actually within walking distance?

A. 20%

B. Half

C. One-quarter

7) On average, how far is food shipped before it reaches your plate?

A. 1,200 – 2,500 miles

B. 20 miles

C. 1,000 miles

8) How much energy is used to recycle paper compared to making new paper?

A. 20% less

B. 40% less

C. 10% less

9) How many pounds of junk mail does the average American receive each year?

A. 23

B. 4

C. 41

10) How much energy could be produced by the junk mail received by Americans each day?

A. Enough to power 250,000 homes

B. Enough to power 100,000 homes

C. Enough to power 10,000 homes

11) How many gallons of water are saved by recycling 1 ton of paper?

A. 700 gallons

B. 7,000 gallons

C. 70 gallons

12) How much energy is used to recycle glass compared to making it from scratch?

A. 20% less

B. 40% less

C. 35% less

13) How much energy could be produced by the junk mail received by Americans each day?

A. Enough to power 250,000 homes

B. Enough to power 100,000 homes

C. Enough to power 10,000 homes

14) How many times can glass can be recycled?

A. Infinitely

B. 20 times

C. 1,000 times

15) Recycling 40 aluminum cans saves the equivalent amount of energy as in what?

A. 1 gallon of gasoline

B. A 4-foot stack of newspapers

C. 2 light bulbs

16) How many plastic bags are consumed each year?

A. 1 trillion

B. 100,000,000

C. 250,000

Unit #4: Climate Change: Fun with Games and Puzzles
Pop Quiz: What Can We Do?

1) Where is the country's first coastal wind farm located?

   A. Atlantic City, NJ

   B. North Dakota

   C. Florida

2) What percentage of New Jersey's electricity is generated from renewable sources?

   A. 10%

   B. 2.5%

   C. 15%

3) By 2020, how much of New Jersey's energy must come from renewable sources?

   A. 2%

   B. All of it

   C. 20%

4) How much is New Jersey's demand for electricity expected to increase in the next decade?

   A. 4%

   B. 75%

   C. 14%

5) How much of our electricity needs can be reliably met by the wind and off-shore wind farms?

A. 2%

B. All of it

C. 20%

6) What kind of greenhouse gases and air pollution is released by wind energy?

A. None

B. Carbon dioxide and Methane

C. Oxygen and Nitrogen

7) What is one problem with wind energy?

A. The wind doesn't blow all of the time

B. It produces a lot of greenhouse gases

C. It isn't renewable

8) How long has wind-energy technology been used around the world?

A. Since 2000

B. Decades

C. Since 1990

9) How many homes will be powered by the new wind farm being built off the coast of Avalon, NJ?

A. 20,000

B. 110,000

C. 50,000

10) By the end of 2008, how many solar electric systems were installed in New Jersey?

A. 35

B. 350

C. 3,550

11) How much solar energy hits the Earth every hour?

A. More than the world uses each year.

B. Just enough to power all of our homes.

C. Just enough to power our cars.

12) How many states have more solar electric systems than New Jersey?

A. One – California

B. All of them

C. Five – California, Florida, Kansas, North Dakota, and Minnesota

13) How much of our electricity needs could be met by the Sun?

A. 20%

B. All of it

C. 75%

14) What is the oldest nuclear power plant in the U.S.?

A. Oyster Creek Nuclear Power Plant in New Jersey

B. Three-mile Island Nuclear Power Plant

C. Chernobyl Nuclear Power Plant

15) Name a renewable source of energy?

A. Energy in the ocean tides

B. Coal

C. Tar Sands

16) How many homes are heated with the gas produced from the Fresh Kills Landfill?

A. 5,000

B. 50,000

C. 15,000

Pop Quizzes Answer Sheet

Pop Quiz: What Can I Do*?*

1. B
2. A
3. C
4. A
5. C
6. B
7. A
8. B
9. A
10. A
11. A
12. A

Pop Quiz: What Else Can I Do?

1. B
2. A
3. A
4. C
5. A
6. C
7. A
8. B
9. C
10. A
11. C
12. A
13. A
14. A
15. A

Pop Quiz: What Can We Do?

1. A
2. B
3. C
4. C
5. C
6. A
7. A
8. B
9. B
10. C
11. A
12. A
13. B
14. A
15. A
16. B

Additional Information and Resources for Teachers

Throughout this guide there is extensive background information and resources to help you and your students complete the activities. The information and resources in this section are simply to provide you with ways to extend your lessons, with supplemental information and alternative worksheets.

Please review the entire guide and the website for additional information.

Web Resources: Global Warming and Climate Change:

http://www.koshland-science-museum.org/exhibitgcc/index.jsp
http://www.exploratorium.edu/climate/index.html
http://www.exploratorium.edu/poles/climate.php
http://www.mos.org/exhibits_shows/current_exhibits&d=2471
http://www.sciencecentercollaborative.org/nescc/programs.php
http://www.aip.org/history/exhibits/climate/index.html#contents
http://cumuseum.colorado.edu/Exhibits/InuitVoices/
http://www.virtualmuseum.ca/English/Games/explore.html
http://www.bellmuseum.org/scc2008/filmfestival.html
http://www.istl.org/01-fall/internet.html
http://www.ncdc.noaa.gov/paleo/globalwarming/home.html
http://climatechangeeducation.org/
http://www.beringia.com/
http://footprint.wwf.org.uk/
http://globalclimatechange.jpl.nasa.gov/
http://www.cotf.edu/ete/modules/modules.html
http://priweb.org/globalchange.html
http://www.41pounds.org
NJ State Museum - http://www.state.nj.us/state/museum/
Great Swamp Watershed Association - http://www.greatswamp.org/
The Nature Conservancy - http://www.nature.org/
NJ Audubon Society - http://www.njaudubon.org
Alliance for New Jersey Environmental Education - http://www.anjee.net/
Greater Newark Conservancy - http://www.citybloom.org/
Delaware Riverkeeper – http://www.delawareriverkeeper.org
Hackensack Riverkeeper - http://www.hackensackriverkeeper.org/
The Jersey City Reservoir Preservation Alliance - http://new.jcreservoir.org/
NJ Conservation Foundation - http://www.njconservation.org/
Stony Brook - Millstone Watershed Association - http://www.thewatershed.org/
The Wetlands Institute - http://www.wetlandsinstitute.org/
Delaware Nature Society - http://www.delawarenaturesociety.org/
Clean Air, Cool Planet - http://www.cleanair-coolplanet.org/
Association of New Jersey Recyclers - http://www.anjr.com/
Association of New Jersey Environmental Commissions - http://www.anjec.org/
New Jersey WasteWise Business Network -
http://www.state.nj.us/dep/dshw/recycle/brbn03.htm

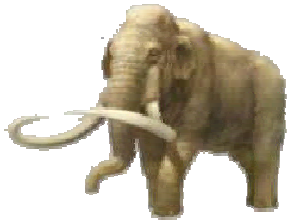
Web Resources: Maps of New Jersey:

www.geology.com
www.netstate.com
www.mapathon.com
www.nationalatlas.gov

Animal Facts and Information

This information has been compiled to help you facilitate *Unit #2: Adapting to Climate Change.* This section contains information about animals that existed during the Pleistocene Epoch and those that live today both in New Jersey and in the Arctic Regions.

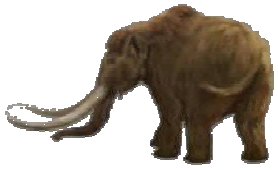
The American Mastodon



The American Mastodon (*Mammut americanum*) lived in nearly all of North and Central America, but was especially common in eastern spruce forests, lowland savannahs, and wetlands. These mastodons were very common in New Jersey and browsed on tree leaves, shrubs, and herbs. American Mastodons became extinct nearly 10,000 years ago at the end of the Wisconsinan Glaciation, most likely due to habitat loss caused by climate change.

Wooly Mammoth

While Wooly Mammoths (*Mammuthus primigenius*) were less common in New Jersey than mastodons, the animals did inhabit the region. They were widespread in northern North America, principally grazing on coarse tundra grasses. Wooly Mammoths became extinct in North America nearly 10,000 years ago at the end of the Pleistocene Epoch, most likely due to habitat loss caused by climate change. They survived for another 2,000 years in Europe, and a population of dwarf mammoths may have survived until 1,700 B.C. on Wrangell Island, Alaska.



Jefferson's Ground Sloth

Jefferson's Ground Sloth (*Megalonyx jeffersoni*) was an enormous ancient relative of the tree sloths living in Central and South American rain forests. Named after Thomas Jefferson, these huge, strange beasts were slow, gentle woodland browsers that ranged across much of the continent. This is the only species known in New Jersey, but other sloth species have been found in Pennsylvania caves. Unlike most other Pleistocene Megafauna in North America, which emigrated from Asia across the Bering Land Bridge, giant ground sloths migrated from South America.

The Elk-Moose

The Elk-Moose (*Cervalces scotti*), sometimes called the Stag-Moose, is an extinct and slightly larger relative of the living moose. Closely related to several European species, this lone North American species ranged over most of the eastern portion of the continent, inhabiting bog lands and wetlands

at least 40,000 years ago. Rapid climate change at the end of the Pleistocene Epoch is likely the main factor in this magnificent beasts' extinction. The arrival of the modern moose – which was better adapted to the new environmental conditions - at roughly the same time was also likely an important factor.

The Giant Beaver

The Giant Beaver (*Castoroides ohioensis*) truly lives up to its name, reaching 2.5 meters (over 8 feet) in length and weighing 100 kg (220 lbs) - nearly the size of a black bear. Giant Beavers were among the largest rodents ever and were common in swamps and marshes throughout much of North America, though only a few teeth have been found in New Jersey. As a likely consequence of climate change, the disappearance of their preferred habitat and increased competition with modern beavers led to the extinction of *Castoroides* at the end of the Pleistocene.

Ice Age Caribou

Caribou (*Rangifer tarandus*) live today throughout Arctic and Subarctic regions. They are superbly adapted to life on the tundra, with adaptations that include:

- two layers of thick fur to keep them warm
- broad, flat hooves that allow them to walk on snow and boggy ground

During the Late Pleistocene Epoch Arctic-like conditions extended the caribou's range as far south as Nevada and Tennessee. The remains of fossilized caribou in New Jersey usually consist only of antler fragments, and are most often under water on the continental shelf.

Woodland Musk Ox

The Woodland Musk Ox (*Bootherium bombifrons*) is a close relative of the modern musk ox (*Ovibos moschatus*), but was taller and more slender than its living cousin. The range of this animal included plains and woodlands across nearly all of North America during the Late Pleistocene Epoch, including the now-submerged continental shelf off New Jersey's coast. The Woodland Musk Ox was well adapted to its cold environment, but became extinct approximately 10,000 years ago, likely as a result of climate change.

Ice Age Walrus

The walrus (*Odobenus rosmarus*) is found today in the Arctic Ocean and in subarctic seas. These animals spend nearly their entire lives in the frigid Arctic waters or resting on ice floes, staying warm with the help of a thick layer of blubber. During the Late Pleistocene Epoch (130,000 to

10,000 years ago), walrus were common in the icy Atlantic Ocean off New Jersey, and their fossil remains have been found off the East Coast as far south as Cape Hatteras, North Carolina.

Bird Migrations through New Jersey

Each summer, the Arctic is home to the greatest assemblage of birds anywhere on the planet. Millions of birds from nearly every corner of the globe take advantage of long summer days to breed and feed their young. Many stop in New Jersey along the way to rest and feed. Their arrival at New Jersey stopover points and Arctic breeding grounds is timed precisely to coincide with the melting of winter snow and ice and the emergence of food resources, especially insects. Arctic climate change is altering the timing of many of these events, severely affecting bird species that rely on the region.

Brant

The Brant (*Branta bernicla*) spends most of the year in tidal estuaries along North America's coasts, including New Jersey, but migrates to the Arctic to breed each summer. Brants are at risk on several fronts due to climate change:

- their primary foods - eelgrass and sea lettuce - are susceptible to excess nutrients, sediment pollution, and diseases caused by excess run-off
- El Niño/La Niña weather patterns are known to reduce the population
- rising sea levels will inundate their low-lying coastal breeding grounds on the Arctic tundra

Common Eider

The Common Eider (*Somateria mollissima*), source of the celebrated eiderdown, inhabits the coasts of northern North America, Europe, and eastern Siberia throughout most of the year, but breeds in colonies that may reach 15,000 individuals on Arctic and Subarctic islands in the summer. While this large sea duck is still common, its numbers are decreasing dramatically. Climate change may be a leading factor as earlier melting of Arctic sea ice brings hungry polar bears ashore sooner each year, which may lead to increased predation on Common Eider nesting females and catastrophic egg loss.

Snow Goose

The Snow Goose (*Chen caerulescens*) is one example of a species that may be benefitting from climate change. Snow geese are common birds that form enormous flocks during its three-month, 3,000-mile migration to and from Arctic breeding grounds. Years of mild weather in the Arctic may be partly responsible for a snow goose population explosion, which is severely

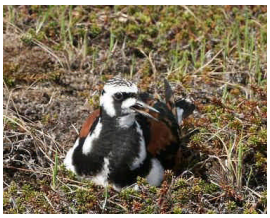
degrading both Arctic breeding grounds and the birds' summer salt marsh habitats; there are simply more birds than the salt marshes can accommodate. Unfortunately, the population explosion is also negatively impacting other species that share these habitats.

Red Knot

The Red Knot (*Calidris canutus*) migrates more than 9,300 miles from southernmost South America to its Arctic breeding grounds each spring, then makes the return trip each fall – one of the longest migrations of any species on Earth. This incredible feat is timed to coincide with the annual spawning by horseshoe crabs at the Delaware Bay and Cape May stopover points. The birds arrive each May emaciated from their long journey, and devour enough eggs in the span of two to three weeks to double their weight in preparation for the final leg of their travels. Once they arrive at their frozen breeding grounds, they rely on fat reserves built up in New Jersey for up to three more weeks while building nests, courting, mating, and laying eggs, until scores of insects finally emerge.

Unfortunately, increasing use of horseshoe crabs as bait beginning in the 1990s has resulted in a dramatic decline in the number of crabs, and their eggs. Many Red Knots are not gaining enough weight for their journey, and are starving along the way or arriving in the Arctic too depleted to successfully mate. With such a small population remaining, and with their migrations taking them through so many habitats, these birds are particularly vulnerable to climate change.

The Ruddy Turnstone



The Ruddy Turnstone (*Arenaria interpres*) earned its name from its habit of flipping stones to find invertebrate prey. These birds winter on rocky coastlines around the world, even as far south as the southern tip of South America, and migrate to breeding grounds on the Arctic tundra during the spring. Like the Red Knot, the Ruddy Turnstone relies on abundant horseshoe crab eggs at its Delaware Bay stopover. Crab overharvesting has resulted in a 65% decrease in the Ruddy Turnstone population. They are particularly vulnerable to climate change throughout their journey, but especially in their Arctic breeding grounds where they are often arriving in a weakened state.

The Piping Plover

Piping Plover (*Charadrius melodus*) is a small North American shorebird that feeds and nests on sandy and rocky shorelines of the East Coast, the Great Lakes and lakes in the Great Plains during the summer. The Plover faces numerous threats that destroy potential nesting sites, including:

- climate change
- sea level rise

- lake water level fluctuations
- severe storms

The Piping Plover population has decreased dramatically in the last half century, and the bird is now considered threatened or endangered throughout its range.

Diamondback Terrapin

Once considered a delicacy, the Diamondback Terrapin (*Malaclemys terrapin*) is found along coastlines from Massachusetts to Texas, and is the only turtle in the world adapted to live in brackish-water coastal marshes. These reptiles feed primarily on mollusks, fiddler crabs, and small fish, which share the sandy salt marsh beaches or barrier islands above the high tide line and away from vegetation. These low-lying habitats – the terrapins' breeding and feeding grounds – are put at great risk by rising sea levels and the severe coastal storms expected to accompany climate change.

Amphibians

Amphibians may be more vulnerable to climate change than any other group of plants or animals. Their permeable skin, complicated lifecycle, and unshelled eggs make amphibians highly vulnerable to even small changes in environmental conditions, like moisture and temperature. All over the world, including in pristine areas, frogs, toads, and salamanders are disappearing due to the spread of infectious diseases and other threats resulting from anthropogenic (human induced) climate change. Today, nearly one-third of the world's 6,000 amphibian species are facing extinction.

Spring Peepers

The Spring Peeper (*Pseudacris crucifer*) is a small nocturnal chorus frog that can grow to 22 mm (1 in) in length. These frogs eat small arachnids and insects and are found across eastern North America. As with nearly all amphibians, the start of the Peeper's breeding season is driven by two environmental factors that are most affected by climate change: temperature and moisture. For example, a population of Spring Peepers in New York is reproducing two weeks earlier each spring than they did in the early 1900s. This change is thought to be a direct result of climate change and the earlier arrival of spring-like temperatures.

Grey Tree Frog

The Grey Tree Frog (*Hyla versicolor*) earned its species name from its ability to change color in order to match its surroundings. These small, arboreal frogs can grow up to 5 cm (2 inches), and can be found in wooded areas near permanent water sources throughout eastern North America. Normally, breeding occurs during the spring and summer, but like the Spring Peeper, some regional populations have begun breeding earlier in the year; a change thought to be a direct result of climate change and the resulting warmer temperatures.

American Bullfrog

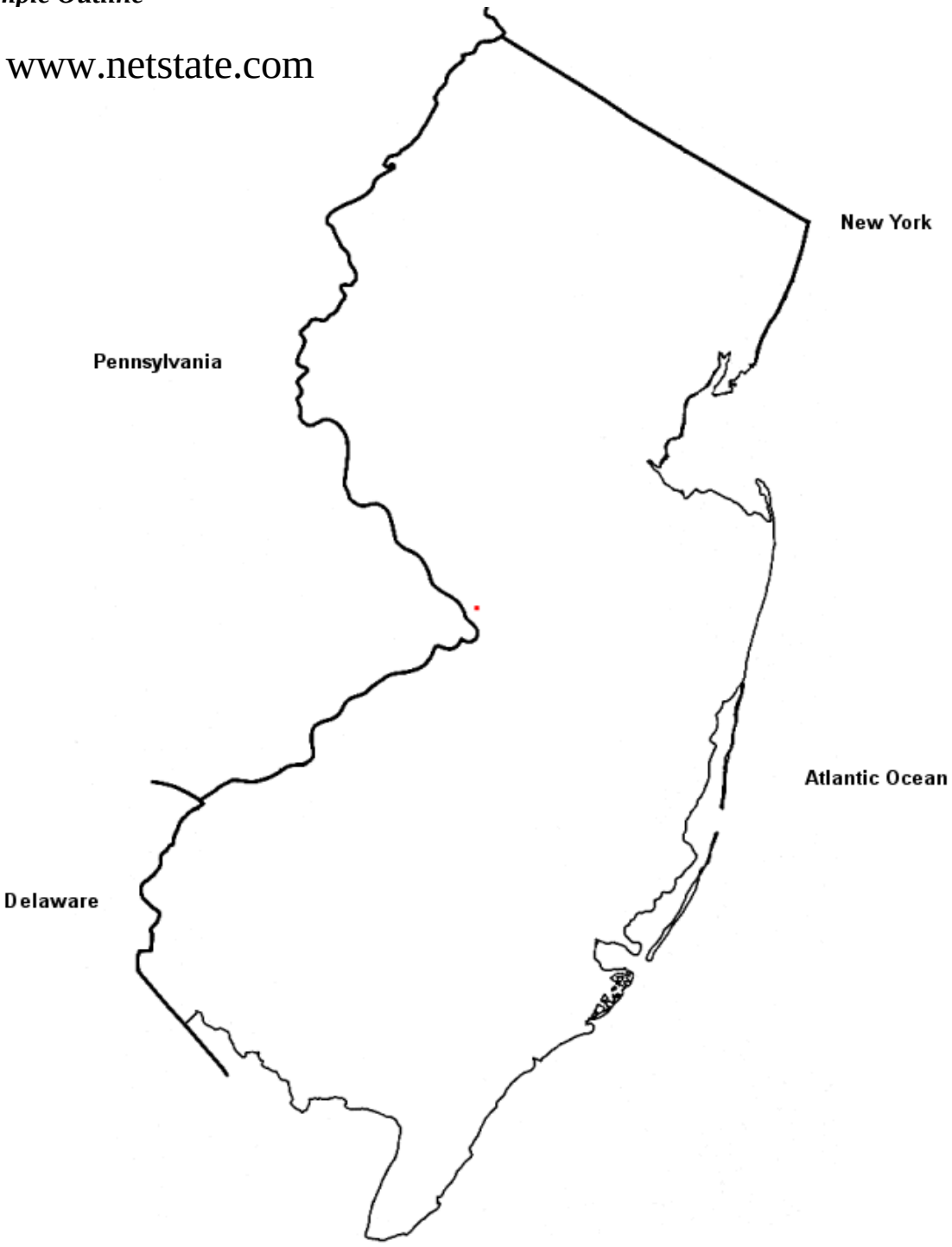
The American Bullfrog (*Rana catesbeiana*) is the largest North American frog, reaching 20 cm (7.9 inches) in length and weighing up to 0.75 kg (1.7 lbs). They are voracious predators, devouring nearly anything smaller than they are. Bullfrogs are indigenous to eastern North America, and have been introduced in western parts of the continent. As with Spring Peepers and Grey Tree Frogs, American Bullfrogs in New York are reproducing earlier each spring than they did in the early 1900s; a change thought to be a direct result of climate change and the resulting warmer temperatures.

Fowler's Toads and American Toads

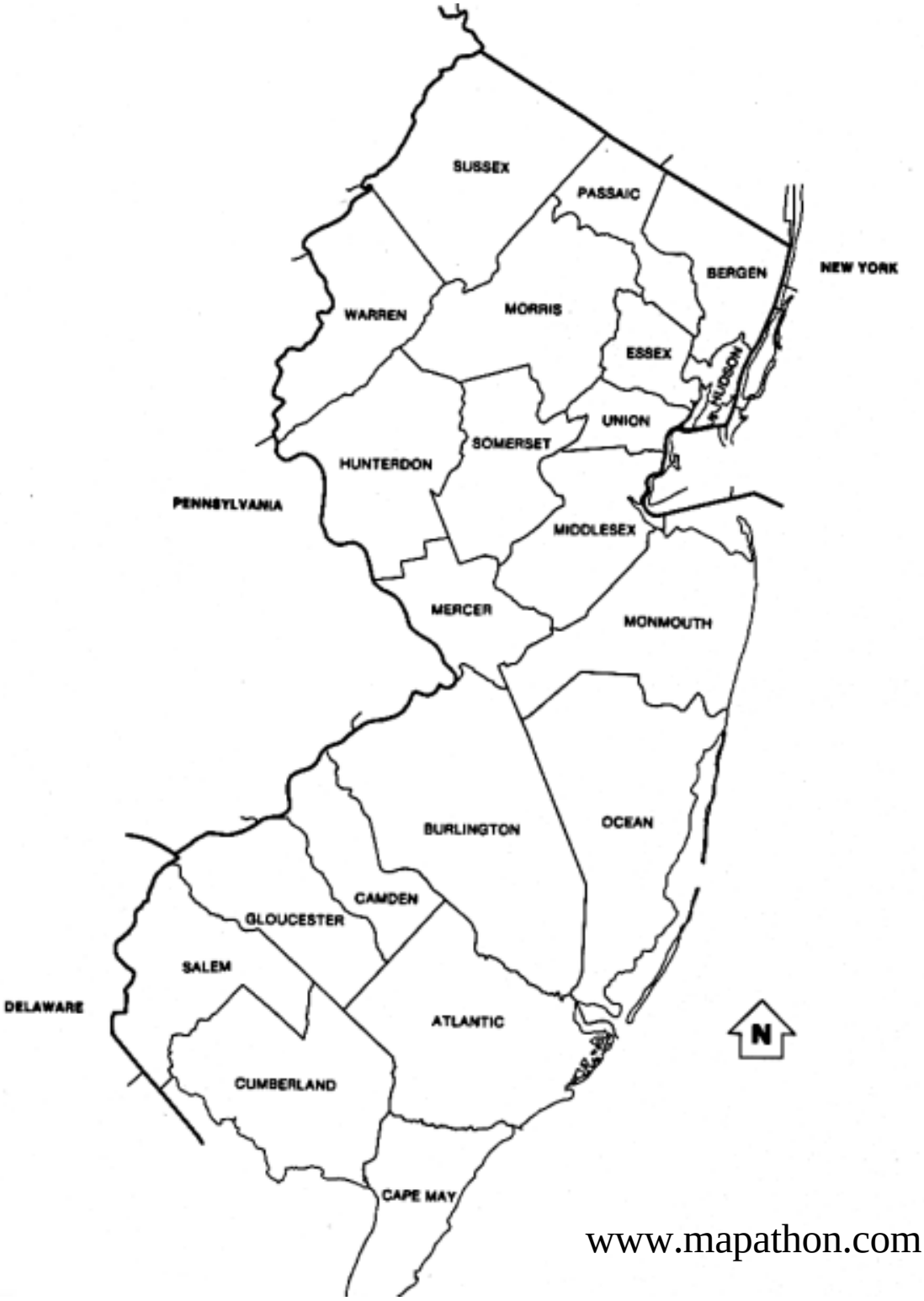
The Fowler's Toad (*Bufo fowleri*) on the left and the American Toad (*Bufo americanus*) on the right are two very common and abundant amphibians throughout most of eastern North America, including New Jersey. Both species live in open woodlands, meadows, and beaches. When threatened, they can secrete poisonous bufotoxin from the swollen paratoid gland behind each eye. To the best of our knowledge, neither of these adaptable species is presently threatened directly by climate change. However, both are hosts to a variety of internal and external parasites and fungi. Parasites afflicting amphibians across the globe are exacerbated by the rising temperatures and increased humidity associated with climate change, which has been proven to play a major role in the extinction of many amphibian species worldwide.

Alternate Maps of New Jersey:

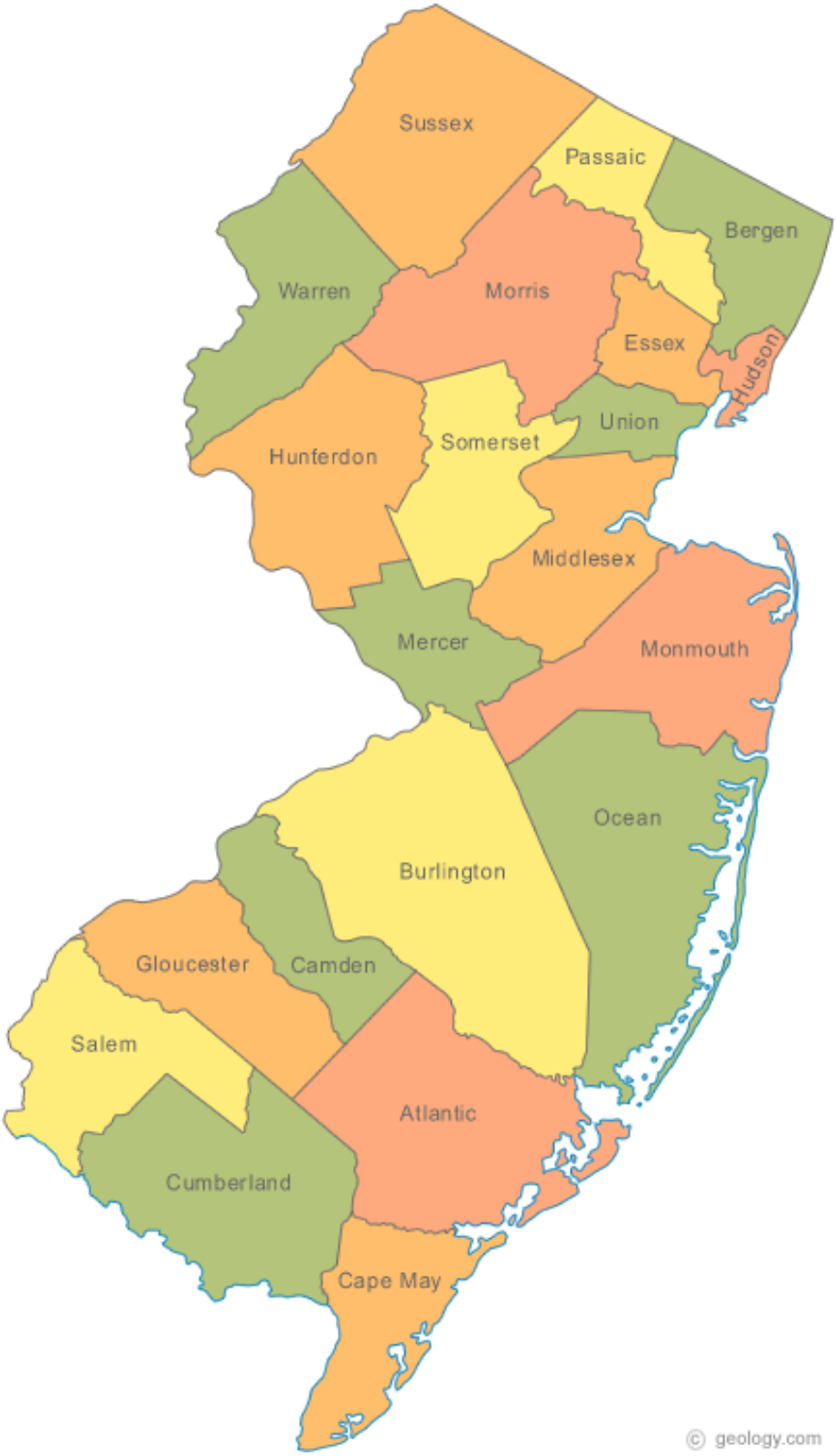
Simple Outline



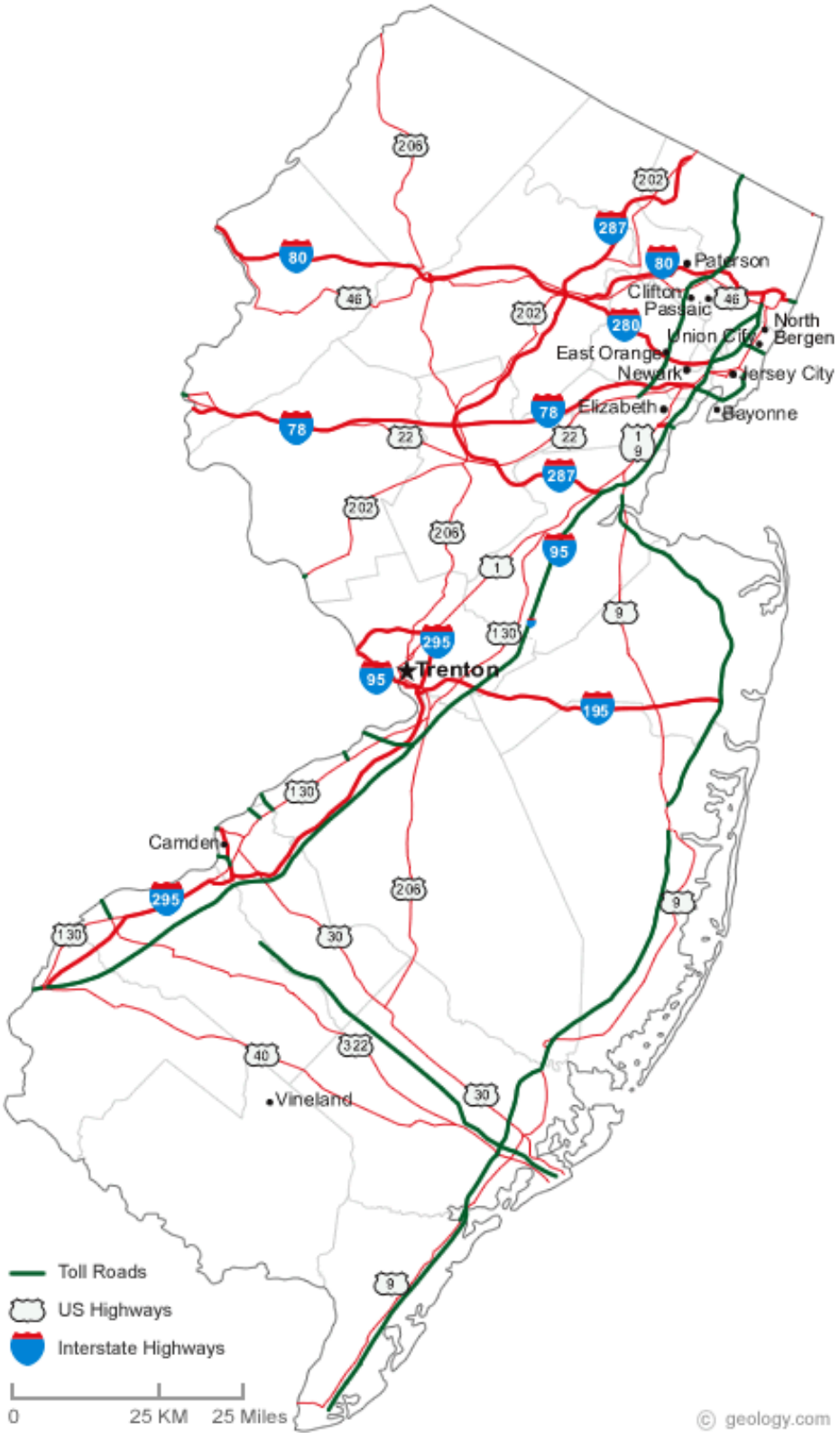
Outline of Counties



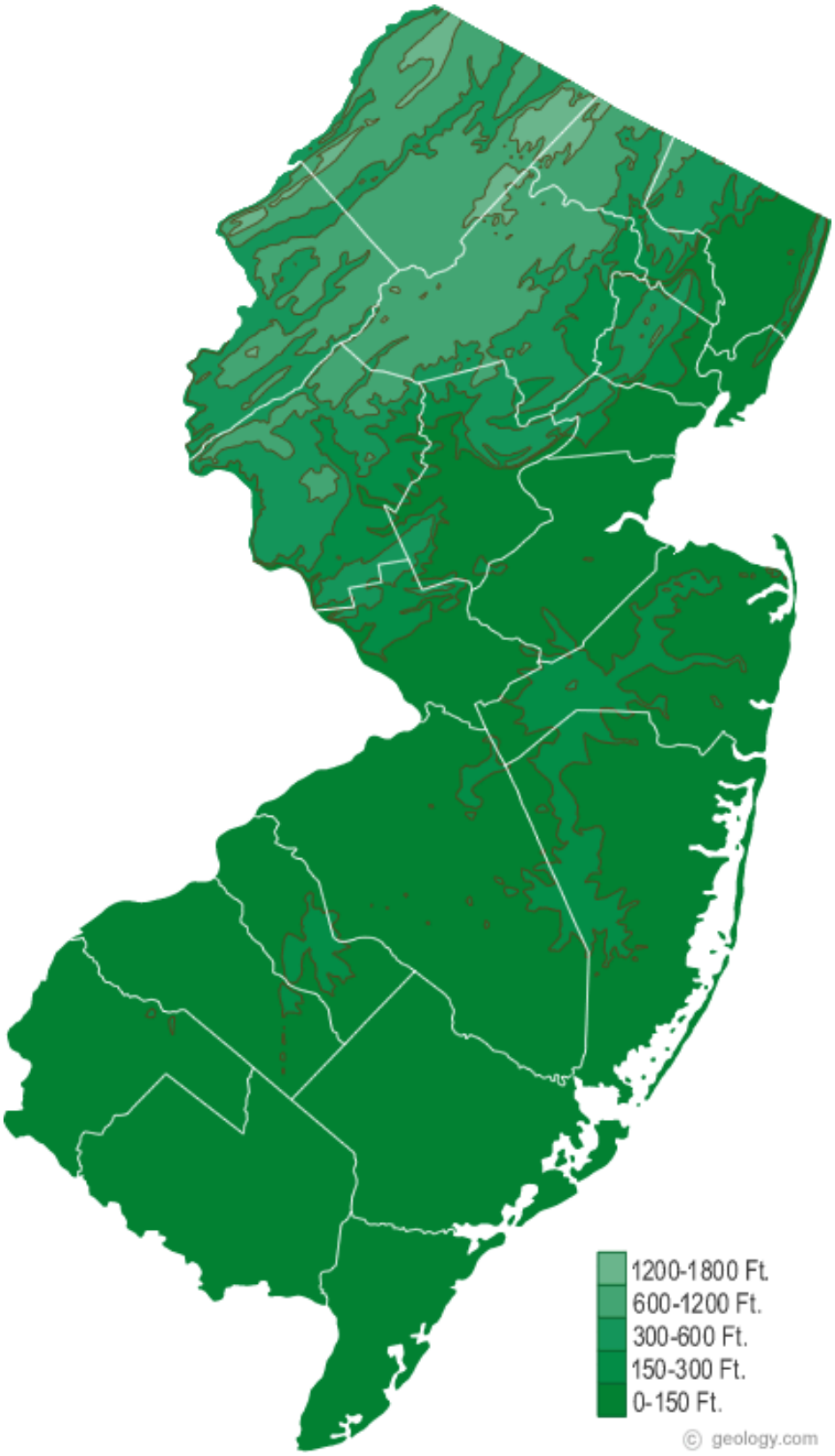
Counties in Color



Major Cities and Roads



Topography



Major Waterways

Curator Facts

How to use this document:

The amount of information available on the impact of climate change is so vast that not everything could be included in the exhibition, and some of the information, while interesting and important, is more of a side story to what we explored. So, we have provided this supplemental handout that serves as both a **scavenger hunt** within the exhibition and a resource for additional information. Find the "Curator Fact" labels and match the fact contained in this document with the section of the exhibition.

The Process Continues

1. We are presently living in an interglacial period, a slightly warmer period within the ice age that began approximately 42 million years ago. Humans have only been on Earth for approximately the last 200,000 years - that is only about 0.0048% of the time that the planet has been in the most recent ice-house conditions. That means that the entirety of the human lineage evolved during a period of relative cold, and we are adapted to live in relatively cold conditions and no humans have ever experienced the warm global average temperatures that are predicted to occur on Earth later this century.

2. The large mural of an active glacier is the Perito Moreño Glacier in southern Patagonia, Argentina. This image was chosen not just as a dramatic background but because it illustrates conditions that were common in northern New Jersey at the height of the Ice Age nearly 20,000 years ago. From this picture alone, it is difficult to grasp the true immensity of this enormous sheet of ice. For a better sense of scale, look at the image on the end of the wall facing the river - look closely - you can see tourists and a tour boat in various places in front of the glacier.

New Jersey's Ice Age Legacy

1. Jefferson's Ground Sloth – In the early 19th century, a great rivalry pitted scientists from the "Old World," mostly Europe, against those from the "New World," especially the United States. Old World scientists and socialites generally regarded many aspects of the American continent to be inferior to those of their own homelands. This attitude even extended to animals, both modern and extinct. When Thomas Jefferson described the claw of *Megalonyx jeffersoni*, he believed it to be the claw of an enormous lion and used this discovery to reject the elitist views of the Europeans.

2. In addition to being a renowned portrait painter, Charles Willson Peale was a "jack of all trades" – he was a Pennsylvania politician and served in the military during the Revolutionary War. As was often the case with educated men in the late 18th century, he was also interested in natural history. His museum in Philadelphia was the first natural history museum in the New World and

was the forerunner to the Academy of Natural Sciences of Philadelphia, which still exists today. He is most famous, though, for painting the portraits of many early American dignitaries and heroes of the Revolutionary War. There are three reproductions of his paintings in this exhibit. Can you find them?

The Process Continues

1. Between 1989 and 2002, Red Knot populations declined by more than 66% and scientists have predicted that the American subspecies could be extinct by 2010. The knots are considered an endangered species in New Jersey, but the federal government has so far refused to officially recognize this species as endangered. Governor Jon S. Corzine signed legislation that protected a vital food source for the Red Knots during their migration through New Jersey. The legislation ended New Jersey horseshoe crab harvesting in 2008, but harvesting continues in Delaware, Maryland, New York, and Virginia. No one can say for sure if these and other restrictions may save this amazing bird.

2. Snow geese are becoming so numerous in many areas that they are starting to become a nuisance, especially to farmers whose fields are damaged by large flocks of these birds. In order to try to control their populations, many states are loosening hunting laws – making it easier to harvest more of these birds during extended hunting seasons. Even New Jersey is getting into the act.

Greenhouse Gases

1. Greenhouse Gases:
    - CH4 – Methane
    - CO2 – Carbon dioxide
    - C6F14 – Perfluorohexane, or tetradecafluorohexane
    - CCl4 – Carbontetrachloride
    - C2F6 – Hexafluoroethane
    - C4F10 – Perfluorobutane
    - HFC – Haloalkanes
    - O3 – Ozone
    - CO – Carbon monoxide
    - SF6 – Sulfur hexafluoride – the most potent greenhouse gas. It has a global warming potential 22,200 times that of CO2.

2. The United States is home to less than 5% of the world's population, but we use more than 25% of the world's oil and coal, and almost 27% of the world's natural gas.

3. While the United States still uses the largest amount of fossil fuels, it no longer produces the most greenhouse gases. In 2006, China surpassed the U.S. as the world's leading producer of greenhouse gases and the rapid industrialization of India is likely to push that country past the U.S. in the near future. However, Americans still produce far more greenhouse gases per capita (meaning per person) than any other country in the world.

Climate Change and New Jersey

1. As severe storms increase in intensity and become more commonplace in the near future, the economic impact of these storms will also increase exponentially. First, storms will cause flooding, which can destroy crops, wash away top soil, and destroy homes, businesses, and infrastructure. Stronger coastal storms will have higher storm surges, which will flood larger areas, increase the severity of coastal erosion, and destroy critical habitat for wildlife, including areas depended on by many of the fish and shell fish species caught by the state's fishermen.

2. There is an unseen phenomenon happening underground near shore areas; fresh groundwater flows slowly toward the sea. This holds back salty groundwater trying to push inland from the ocean. During droughts, or when people take too much fresh water out of the ground in these areas, there is not enough fresh water to hold back the salty water, so the salt water flows farther inland and contaminates the water supply. Many people that live near the shoreline are almost completely dependent on fresh groundwater for drinking and watering their crops.

3. Rising sea levels and increased storm intensity aren't the only causes for increased beach erosion. Warming ocean temperatures are creating changes in ocean circulation patterns. Some beaches grow larger because local circulation patterns naturally deposit sediment there. Similarly, some beaches naturally erode because currents carry sediment away. Ocean temperature changes are altering local sediment deposition patterns by changing circulation patterns. If ocean temperatures continue to increase a few more degrees, large-scale global ocean currents, like the Gulf Stream, could be severely altered or eliminated altogether.

Exhibit Questions and Answers

Throughout the exhibit you will see circles with questions about what you are learning. When you move the circle, the answer is revealed. Below are the questions and answers from the exhibit.

1. How much of Earth's fresh water is stored in polar ice caps and glaciers today?

   Answer: Nearly 70%

2. How thick was the Laurentide Ice Sheet above High Point, New Jersey?

   Answer: Approximately 600 meters (2,000 feet)

3. Which country is home to 25% of the world's coal reserves?

   Answer: The United States

4. How many lbs. of CO_2 are produced by burning 1 kg (2.2 lbs) of coal?

   Answer: 1.83 kg (4 lbs)

5. Pennsylvania ranks 5th among U.S. states that refine the most crude oil. Where does New Jersey's rank?

   Answer: 6th

6. What percentage of New Jersey residents heat their homes with natural gas?

   Answer: Nearly 66%

7. How much is New Jersey's demand for electricity expected to increase in the next decade?

   Answer: At least 14%

8. How much of the electricity needs of the Mid-Atlantic States could be reliably met by off-shore wind farms?

   Answer: 20%

9. Where is the Oyster Creek Nuclear Power Plant, the nation's oldest operating nuclear power plant?

   Answer: In Lacey Township, Ocean County, New Jersey

10. How many homes are heated by landfill gas collected from the Fresh Kills Landfill in Staten Island, New York?

    Answer: 50,000