Educational Product	
Educators	Grades 5–8 & 9–12

The Potential Consequences of Climate Variability and Change

HUMAN HEALTH

Beyond The Bite: Mosquitoes & Malaria

AN ACTIVITY RESOURCE FOR TEACHERS

Responding to National Education Standards in:

- ***English Language Arts***
- ***Geography***
- ***Mathematics***
- ***Science***
- ***Social Studies***

March 2008 Update

This learning activity was developed to examine the potential impacts of climate variability and change. Each activity is part of an overall series entitled ***The Potential Consequences of Climate Variability and Change,*** which includes 1–12 teacher resources. Twelve modules (10 printed and 2 online resources) comprise the set and are presented below:

OVERVIEW

- Too Many Blankets (Grades 1–4)
- Global Balance (Grades 5–12)

AGRICULTURE

- El Niño (Grades 5–8)
  This activity is provided in an online format only and is available at *http://ois.unomaha.edu/casde/casde/lessons/Nino/teacherp.htm*.
- The Great American Desert? (Grades 9–12)
  This activity is provided in an online format only and is available at *http://ois.unomaha.edu/casde/casde/lessons/grass/teacherp.htm*.

COASTAL AREAS

- What Could a Hurricane Do to My Home? (Grades 5–8)
- What Is El Niño? (Grades 5–8, 9–12)
- Coral Reefs in Hot Water (Grades 9–12)

FORESTS

- A Sticky Situation (Grades 5–8)
- Planet Watch (Grades 9–12)

HUMAN HEALTH

- Beyond the Bite: Mosquitoes and Malaria (Grades 5–8, 9–12)
- Climate and Disease: A Critical Connection (Grades 9–12)

WATER

- Here, There, Everywhere (Grades 7–8, 9–12)

The development of the activities was sponsored by the National Aeronautics and Space Administration and the Environmental Protection Agency, in support of the US Global Change Research Program. The Institute for Global Environmental Strategies implemented the effort. For more information about IGES's educational programs, see *http://www.strategies.org*.

March 2008 Update

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Climate Variability & Change
HUMAN HEALTH

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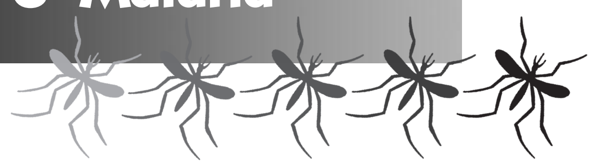
ACTIVITY
Beyond The Bite: Mosquitoes & Malaria



CONTENTS

Beyond The Bite: Mosquitoes & Malaria

This activity explores one potential impact of climate variability and change on our health by studying the increased spread of malaria. Although the following activity is designed to teach specific skills and knowledge through scientific inquiry, its broader intent is to stimulate thought about the long-term impacts of a warmer planet.

GRADE LEVELS

Grades 5–8; 9–12

TIME REQUIRED

Two to three class periods

OBJECTIVES

This activity is designed to help students:

- Determine how a warming climate may affect the distribution of malaria;
- Interpret data; and
- Predict possible changes of malaria distribution due to climate change.

DISCIPLINES ENCOMPASSED

- Biology
- Earth System Science
- Ecology
- Geography
- Language Arts
- Social Studies

PREREQUISITE KNOWLEDGE: TEACHER

- Each year, one-to-two million people die from malaria, and 42 percent of the world's population is at risk of getting the disease.
- Caused by *Plasmodiu*m protozoa spread by the bites of the female *Anopheles* mosquito, malaria affects the human liver and blood.
- Malaria may be the world's largest single cause of human disease and premature death.
- Many factors limit the spread of the disease, foremost of which may be temperature. Malaria generally spreads into regions where minimum temperatures fall no lower than 16° C (61° F).

PREREQUISITE KNOWLEDGE: STUDENTS

The following skills and knowledge will enhance students' participation in this activity:

- The ability to relate Celsius to Fahrenheit (for example, 16° C is about 61° F).
- Knowledge of malaria and the role of mosquitoes in transmitting it.
- The ability to read maps.

KEY TERMS AND CONCEPTS

The following terms and concepts will be presented in the following text and activities:

Celsius
Climate and climate change
Greenhouse gas
Malaria
Plasmodium
Protozoa
Vector
(See definitions on next page.)

SUGGESTED READING/RESOURCES

■ PUBLICATIONS

Epstein, Paul R. 1998. ***Climate Changes: An Issue Summary of Health and Climate Change.*** World Wildlife Fund. Washington, DC.

Science texts that include information on malaria.

■ WEB SITES

Center for Global Health and the Global Environment

Background materials for considering the role of climate in selected diseases prevalent in the United States:

http://chge.med.harvard.edu

World Climate

Source of the temperature data; data source for more locations in the search for answers to the effects of climate on malaria:

http://www.worldclimate.com

WHO Global Malaria Programme

WHO Division of Control of Tropical Diseases–Malaria Control:

http://www.who.int/malaria

Mapping Malaria

Feature article about a NASA study to pinpoint areas at high risk for malaria:

http://earthobservatory.nasa.gov

Epstein, Paul R. 1998. **"Is Global Warming Harmful to Health?"** in *Scientific American,* August 2000. Download the PDF at:

http://chge.med.harvard.edu/about/faculty/journals/sciam.pdf

DEFINITIONS

Celsius A scale for measuring temperature named after Anders Celsius, the Swedish astronomer who invented it. In this scale, water freezes at 0 degrees C and boils at 100 degrees C. To convert from Celsius to Fahrenheit, multiply the Celsius temperature times 1.8, then add 32 (e.g., 26 degrees C = (26 x 1.8) + 32 or 78.8 degrees F). An online temperature conversion tool is also available at: *http://eosweb.larc.nasa.gov/EDDOCS/temp_convert.html.* (Source: *MY NASA DATA Science Glossary*)

Climate The average weather in a place over more than thirty years. To describe the regional climate of a place, people often tell what the temperatures are like over the seasons, how windy it is, and how much rain or snow falls. Regional climate depends on many factors including the amount of sunlight it receives, its height above sea level, the shape of the land, and how close it is to oceans. Because Earth's equator receives more sunlight than the poles, climate varies depending on distance from the equator.

We can also think about the climate of an entire planet. Global climate is a description of the climate of a planet as a whole, with all the regional differences averaged. Overall, global climate depends on the amount of energy received by the Sun and the amount of energy that is trapped in the system. Scientists who study Earth's climate and climate change study the factors that affect the climate of our whole planet. (Source: *Windows to the Universe*)

Climate Change Systematic changes in long-term statistics of climate elements (e.g., temperature, precipitation or winds) sustained over several decades or longer. While weather can change in just a few hours, climate changes over longer timeframes. Climate events, like El Niño, happen over several years, small-scale fluctuations happen over decades, and larger climate changes happen over hundreds and thousands of years.

The term 'climate change' is sometimes used to refer to all forms of inconsistency in climate for an area. But because the Earth's climate is never static, the term is more properly used to imply a significant change, such as a change having important economic, environmental and social effects. In some cases, 'climate change' has been used synonymously with the term, 'global warming.' Scientists, however, tend to use the term in the wider sense to also include natural changes in climate. (Sources: *NASA Earth Observatory Glossary* and *Windows to the Universe*)

Malaria A parasitic disease that involves high fevers, shaking chills, flu-like symptoms, and anemia. It is caused by a parasite that is transmitted from one human to another by the bite of infected *Anopheles* mosquitoes. In humans, the parasites (called sporozoites) migrate to the liver where they mature and release another form, the merozoites. These enter the bloodstream and infect the red blood cells. The parasites multiply inside the red blood cells, which then rupture within 48 to 72 hours, infecting more red blood cells.

Malaria can also be transmitted congenitally (from a mother to her unborn baby) and by blood transfusions. Malaria can be carried by mosquitoes in temperate climates, but the parasite disappears over the winter. The disease is a major health problem in much of the tropics and subtropics. The Centers for Disease Control estimates that there are 300–500 million cases of malaria each year, and more than 1 million people die. (Source: *Medline Plus Medical Encyclopedia*)

Plasmodium The parasite that causes malaria. It is a type of protozoa. (Source: *MedTerms Medical Dictionary*)

Protozoa A single-celled organism that is only able to divide within a host cell. (Source: *MedTerms Medical Dictionary*)

Vector Latin for "bearer." In medicine a vector is the carrier of a disease. In this activity the vector is a mosquito. (Source: *MedTerms Medical Dictionary*)

<u>DEFINITION SOURCES:</u>

American Meteorological Society, ***Glossary of Meteorology,*** 2nd Edition:
http://amsglossary.allenpress.com/glossary

MedTerms Medical Dictionary:
http://www.medterms.com

NASA Langley Research Center, ***MY NASA DATA Science Glossary:***
http://mynasadata.larc.nasa.gov

NASA Earth Observatory Glossary:
http://earthobservatory.nasa.gov/Library/glossary.php3

National Library of Medicine, ***Medline Plus Medical Encyclopedia:***
http://www.nlm.nih.gov/medlineplus/encyclopedia.html

University Corporation for Atmospheric Research, ***Windows to the Universe:***
http://www.windows.ucar.edu

ACTIVITY
Beyond The Bite: Mosquitoes & Malaria

This activity will study how climate variability and change will impact the spread of malaria.

MATERIALS

- Map showing the current geographical distribution of malaria: *http://gamapserver.who.int/mapLibrary*
  Under "Search by Geographic Coverage," select "World" and under "Topics" select "Malaria. The search results will include "Malaria Cases (per 100,000) by country." If this site is down, the latest map as April 2009 (data from January 2004) can be downloaded at: *http://www.strategies.org/malaria.jpg.*
- Map of the Caribbean for plotting temperatures of an area of study (Appendix D)
- U.S. maps showing "locally" transmitted malaria (Appendix D)
- Minimum temperature data for locations near the limits of malaria range (Appendix D)
- Colored pencils
- Internet access

PROCEDURE

Step 1
Distribute the ***Student Activity Sheet*** and have them complete Parts 1–10.

Step 2
When students have completed Part 10, application of Extension 1 is possible.

Step 3
Have students complete Part 11, which provides the opportunity to apply knowledge gleaned from the preceding steps.

CONCLUSION

- Ask the students to share their predictions of the northward movement of malaria.
- Discuss with the students possible outcomes of these predictions.

EXTENSIONS

1. When students have completed Step 10, the following topics can be researched or discussed:
   - The effects of temperature and moisture on the vector mosquito;
   - The effects of climate factors on the biting frequency of the vector; and
   - The length of the period of favorable climate conditions required for transmitting the disease.
2. Group students (3–4) and have them come up with the top 5 questions from Step 10 and research answers.
3. Malaria is only one example of a tropical disease that can spread to non-infected areas if the planet warms significantly. Have the students research other tropical diseases that can spread due to temperature changes and include the following information:
   - Where the disease normally occurs;
   - How the disease can affect the human, animal, and/or plant populations;
   - How the disease spreads;
   - The effect temperature changes have on the spread of the disease;
   - How far the disease might spread due to global warming; and
   - What is/are the limiting factor(s) in the spread of this disease.

Student Activity Sheet BEYOND THE BITE: MOSQUITOES & MALARIA

Name

Answer the following questions in complete sentences, using your own words:

Part 1

Examine the world map showing the current geographical distribution of malaria. Observe the distribution of malaria in and near the United States.

Part 2

Does the map show malaria to be present in the United States? *(NOTE: Puerto Rico is part of the United States.)* Circle your response.

Yes   No   Maybe

Part 3

Where does the presence of malaria come close to the U.S. mainland?

Part 4

On the map of the Caribbean, draw a red line to show the current limits of malaria.

Part 5

Look over the temperature data sheets. Find cities that are located in the area where malaria is known to exist based on the map showing the current geographical distribution of malaria. Circle the names of those cities, in black, on the map of the Caribbean and list them below.

NOTE: It is believed that the Plasmodium *protozoa that causes malaria cannot survive where the minimum temperature falls below 16°C (61° F).*

Part 6

Does the minimum temperature for any of the cities listed in Part 5 fall below 16° C (61° F)? Circle your response.

Yes No Maybe

List any cities for which your answer is Yes.

Part 7

Are there cities located north of the distribution range of malaria that have minimum temperatures that do not fall below 16° C (61° F)? Circle the names of those cities, in purple, on the map of the Caribbean and list them below.

Given that it does not get too cold for *Plasmodium* in these cities, give reasons why these cities may not have been included in the "malaria area" of the map.

NOTE: Some scientists who study global warming suggest that average temperatures may rise 2° C (3–4° F) in the next 100 years because of increased levels of greenhouse gases that are going into our atmosphere. It is believed that average minimum temperatures will rise faster than average temperatures.

Part 8

Assuming that the average minimum temperature will rise 3° C (5–6° F) in the next 100 years, how far north might we expect to find *Plasmodium?*

Why do you think this is so?

Check the minimum temperature data for cities to the north of the malaria zone. If the temperature effect on *Plasmodium* is the limiting factor, draw a line indicating how far north we could expect to find malaria in 100 years. Use a blue pencil to mark the line on the map of the Caribbean.

Part 9

N

Assuming a 6° C (10–11° F) increase in temperature in 200 years, how far north might we expect to find *Plasmodium* in 200 years?

Why do you think this is so?

Use a green pencil to mark the line on the map of the Caribbean.

*NOTE: A recent report on locally transmitted malaria in the United States is presented on p. 18 (Appendix D), titled **Malaria;** it shows two maps that contrast locally transmitted malaria in the 1980s with that which occurred in the 1990s.*

Part 10

Examine the maps of locally transmitted malaria in the United States. Compare these maps with the others you have examined. What questions should we ask and answer so we may better understand the distribution of malaria in a potentially warming world?

Part 11

Using the Internet, identify another disease affected by climate. Which climate factors affect this disease? Include Web address(es). Use the back of the page if necessary.

Appendix A
Bibliography

Colwell, Rita R. and Jonathon A. Patz. 1998. ***Climate, Infectious Disease and Health***. The American Academy of Microbiology. Washington, DC.

Epstein, Paul T. 2000, "Is Global Warming Harmful to Health?" ***Scientific American,*** 283(2): 50–57, *http://chge.med.harvard.edu/about/faculty/journals/sciam.pdf.*

Patz, Jonathan A. et al. 1996. "Global Climate Change and Emerging Infectious Diseases." ***Journal of the American Medical Association.*** 275(3): 217–223.

Appendix B
Assessment Rubric & Answer Key

Assessment Rubric

To be used after completion of both Human Health activities:
Beyond the Bite: Mosquitoes & Malaria and ***Climate & Disease: A Critical Connection.***

SKILL	Excellent (4)	Good (3)	Satisfactory (2)	Poor (1)
Data	Able to manipulate (use) limiting factors data: temperature, genetics, and food chain population.	Able to manipulate (use) two of the proceeding sets of data.	Able to manipulate (use) one of the proceeding sets of data.	Not able to manipulate (use) the data sets.
Presentation	Able to clearly show* limiting factors of food chains, genetic factors, and geographic distribution.	Able to show* two of the limiting factors.	Able to show* one of the limiting factors.	Unable to show* limiting factors.
Concept	Able to explain* that temperature, rainfall, and genetic composition are limiting factors.	Able to explain* two of the preceding as limiting factors.	Able to explain* one of the preceding as limiting factors.	Not able to explain* the preceding as limiting factors.
Relationships	Able to clearly communicate* how the interaction of temperature, precipitation, and genetics control the spread of disease.	Able to communicate* how the interaction of two of the preceding control the spread of disease.	Able to communicate* how one of the preceding controls the spread of disease.	Not able to communicate* how the preceding factors control the spread of disease.
Applications	Able to apply the understanding of relationships of the three limiting factors to another climate related health problem.	Able to apply the understanding of relationships of two limiting factors to another climate related health problem.	Able to apply the understanding of one limiting factor to another climate related health problem.	Unable to apply the understanding of a limiting factor to another climate related health problem.

** Students may use any form of appropriate communication, language arts, mathematics, fine arts, etc.*

ANSWER KEY Student Activity Sheet–BEYOND THE BITE: MOSQUITOES & MALARIA

Students' answers should be in their own words and in complete sentences.

Part 2

Yes

Part 3

The presence of malaria comes close to the U.S. mainland at the Caribbean and Mexico.

Part 4

Use the Map of the Caribbean answer key as a guide (see p. 13).

Part 5

The cities are Kingston/Norman Manle, Jamaica; San Juan/Isle Verde International Airport.

Part 6

No

Part 7

Yes, there are cities located north of the distribution range of malaria that have minimum temperatures that do not fall below 16° C (61° F). These cities are Key West, Miami, Nassau, Veracruz, and Tampico.

Reasons why these cities may not have been included in the "malaria area" of the map will differ. Be sure a logical explanation is given.

Part 8

We expect to find *Plasmodium* as far north as Homestead, West Palm Beach, and Tampico.

Reasons why we might expect to find *Plasmodium* this far north in 100 years may differ. Be sure a logical explanation is given. Students should note that the minimum temperature is not cold enough to kill *Plasmodium.*

Part 9

Assuming a 6° C (10 –11° F) increase in temperature, in the north in 200 years we might expect to find *Plasmodium* as far north as Brownsville, Tampa and perhaps Corpus Christi.

Reasons why we might expect to find *Plasmodium* this far north in 200 years may differ. Be sure a logical explanation is given. Students should note that the minimum temperature is not cold enough to kill *Plasmodium.*

Part 10

Answers will vary; be sure they are logical and apply. Some examples of questions are:

- Can malaria be spread during the summer when temperatures do not drop below 16° C (61° F)?
- What do cool temperatures do to mosquitoes?
- What malaria control measures are used and how well do they work?

Part 11

Check addresses to make sure information is correct.

Possible answers might include:

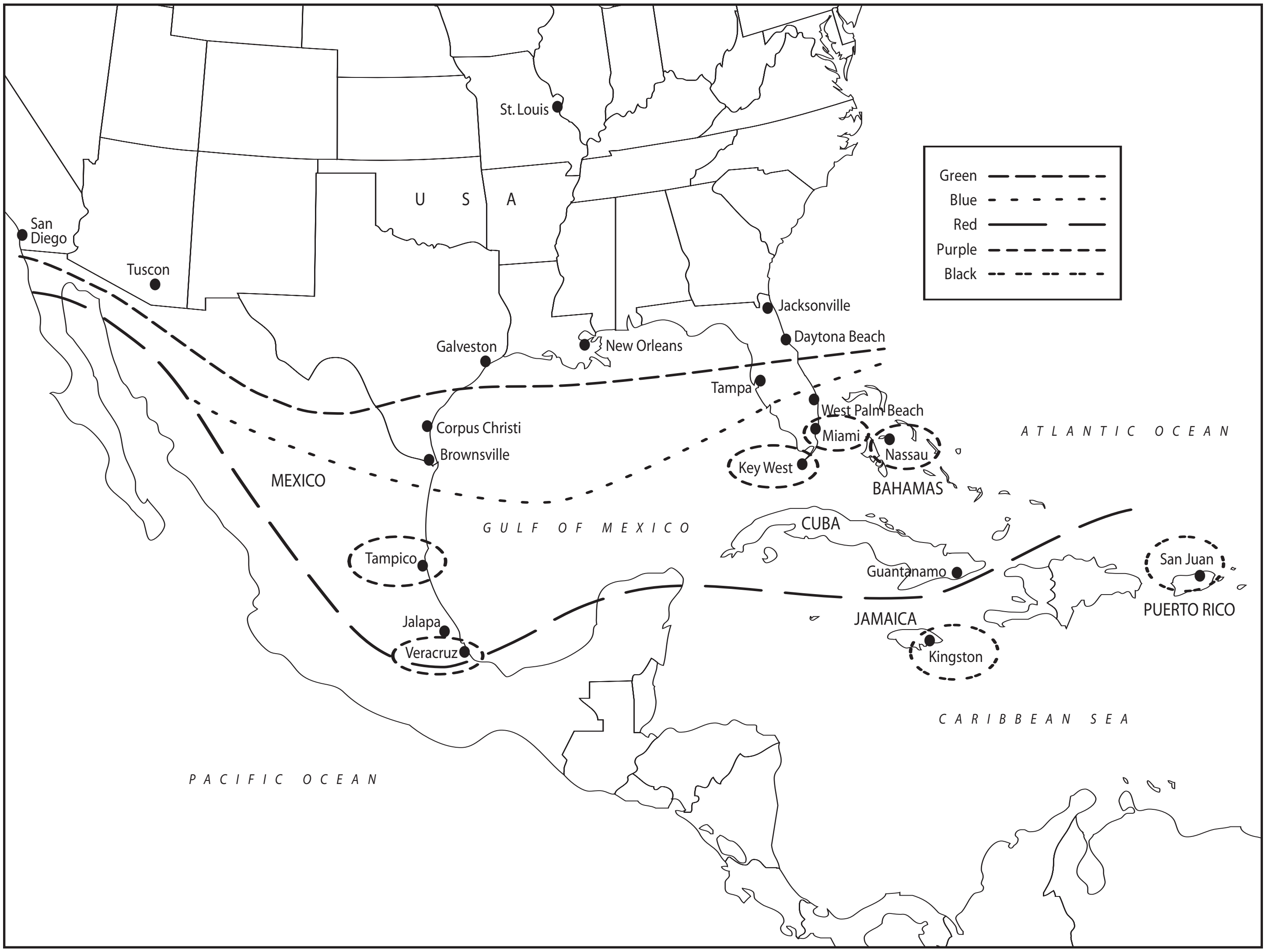
Mosquito-borne diseases: dengue fever, encephalitis, and Rift Valley fever. Rising temperatures and mild winters allow mosquitoes and mosquito-borne disease to migrate into regions formerly too cold for them.

Rodent-borne disease: hantavirus syndrome. Weather extremes in the U.S. Southwest during the early 1990s included regional drought, which helped to reduce the pool of animals that prey on rodents. The drought yielded to unusually heavy rains, which contributed to an overabundance of food for rodents, leading to a population explosion of rodents. This enabled a virus that had been dormant or isolated in a few rodents to take hold in many rodents. When drought returned in the summer, rodents sought food in human dwellings and brought the disease to people. By fall 1993, rodent numbers had fallen and the outbreak ended.

Water-borne disease: cholera. During El Niño/La Niña years, extreme weather—flooding and droughts—can lead to increases in vector-borne and water-borne diseases.

Source: "Is Global Warming Harmful to Health?" *Scientific American,* August 2000.

ANSWER KEY Map of the Caribbean



Appendix C
National Education Standards

This activity responds to the following National Education Standards:

STANDARDS FOR THE ENGLISH LANGUAGE ARTS

Standard 3: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound- letter correspondence, sentence structure, context, graphics).

Standard 4: Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

Standard 5: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

Standard 6: Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss different print and nonprint texts.

Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and nonprint texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

Standard 8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standard 12: Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

*National Council of Teachers of English and International Reading Association. 1996. **Standards for the English Language Arts** p. 24–46. Urbana, Illinois and Newark, Delaware: National Council of Teachers of English and International Reading Association.*

NATIONAL GEOGRAPHY STANDARDS GEOGRAPHY FOR LIFE

GEOGRAPHY STANDARDS: 5–8

Geography Standard 1: *The World in Spatial Terms.* How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

Geography Standard 3: *The World in Spatial Terms.* How to analyze the spatial organization of people, places, and environments on Earth's surface.

Geography Standard 4: *Places and Regions.* The physical and human characteristics of places.

Geography Standard 7: *Physical Systems.* The physical processes that shape the patterns of Earth's surface.

Geography Standard 8: *Physical Systems.* The characteristics and spatial distribution of ecosystems on Earth's surface.

Geography Standard 15: *Environment and Society.* How physical systems affect human systems.

Geography Standard 18: *The Uses of Geography.* How to apply geography to interpret the present and plan for the future.

*American Geographical Society, Association of American Geographers, National Council for Geographic Education, and National Geographic Society. 1994. **Geography for Life: National Geography Standards** p. 143–182. Washington, DC: National Geographic Research and Exploration.*

GEOGRAPHY STANDARDS: 9–12

Geography Standard 1: *The World in Spatial Terms*. How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

Geography Standard 3: *The World in Spatial Terms.* How to analyze the spatial organization of people, places, and environments on Earth's surface.

Geography Standard 4: *Places and Regions.* The physical and human characteristics of places.

Geography Standard 7: *Physical Systems.* The physical processes that shape the patterns of Earth's surface.

Geography Standard 8: *Physical Systems.* The characteristics and spatial distribution of ecosystems on Earth's surface.

Geography Standard 15: *Environment and Society*. How physical systems affect human systems.

Geography Standard 18: *The Uses of Geography*. How to apply geography to interpret the present and plan for the future.

American Geographical Society, Association of American Geographers, National Council for Geographic Education, and National Geographic Society. 1994. ***Geography for Life: National Geography Standards*** *p. 183–222. Washington, DC: National Geographic Research and Exploration.*

CURRICULUM AND EVALUATION STANDARDS FOR SCHOOL MATHEMATICS

CURRICULUM STANDARDS: 5–8

Standard 1: Mathematics as problem solving.

Standard 2: Mathematics as communication.

Standard 3: Mathematics as reasoning.

Standard 4: Mathematical connections.

Standard 10: Statistics.

Standard 11: Probability.

National Council of Teachers of Mathematics. 1989. ***Curriculum and Evaluation Standards for School Mathematics*** *p. 65–119. Reston, VA: The National Council of Teachers of Mathematics, Inc.*

CURRICULUM STANDARDS: 9–12

Standard 1: Mathematics as problem solving.

Standard 3: Mathematics as reasoning.

Standard 4: Mathematical connections.

Standard 10: Statistics.

National Council of Teachers of Mathematics. 1989. ***Curriculum and Evaluation Standards for School Mathematics*** *p. 123–186. Reston, VA: The National Council of Teachers of Mathematics, Inc.*

NATIONAL SCIENCE EDUCATION STANDARDS

CONTENT STANDARD: K–12

Unifying Concepts and Processes

Standard: As a result of activities in grades K–12, all students should develop understanding and abilities aligned with the following concepts and processes:

- Systems, orders, and organization
- Evidence, models, and explanation
- Constancy, change, and measurement

National Research Council. 1996. ***National Science Education Standards*** *p. 115–119. Washington, DC: National Academy Press.*

CONTENT STANDARDS: 5–8

Science as Inquiry

Content Standard A: As a result of activities in grades 5–8, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science

Content Standard C: As a result of activities in grades 5–8, all students should develop an understanding of:

- Structure and function in living systems
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms

Science and Technology

Content Standard E: As a result of activities in grades 5–8, all students should develop:

- Understandings about science and technology

Science in Personal and Social Perspectives

Content Standard F: As a result of activities in grades 5–8, all students should develop an understanding of:

- Personal health
- Populations, resources, and environments
- Natural hazards

National Research Council. 1996. ***National Science Education Standards*** *p. 143–171. Washington, DC: National Academy Press.*

CONTENT STANDARDS: 9–12

Science as Inquiry

Content Standard A: As a result of activities in grades 9–12, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science

Content Standard C: As a result of activities in grades 9–12, all students should develop an understanding of:

- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Earth and Space Science

Content Standard D: As a result of activities in grades 9–12, all students should develop an understanding of:

- Energy in the Earth system

Science and Technology

Content Standard E: As a result of activities in grades 9–12, all students should develop:

- Understandings about science and technology

Science in Personal and Social Perspectives

Content Standard F: As a result of activities in grades 9–12, all students should develop an understanding of:

- Personal and community health
- Population growth
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

National Research Council. 1996. ***National Science Education Standards*** *p. 173–204. Washington, DC: National Academy Press.*

CURRICULUM STANDARDS FOR SOCIAL STUDIES

Strand 3: *People, Places, & Environments.* Social studies programs should include experiences that provide for the study of people, places, and environments.

Strand 8: *Science, Technology, & Society.* Social studies programs should include experiences that provide for the study of relationships among science, technology, and society.

Strand 9: *Global Connections.* Social studies programs should include experiences that provide for the study of global connections and interdependence.

National Council for the Social Studies. 1994. ***Expectations of Excellence: Curriculum Standards for the Social Studies*** *p. 21–30. Washington, DC: National Council for the Social Studies.*

Materials

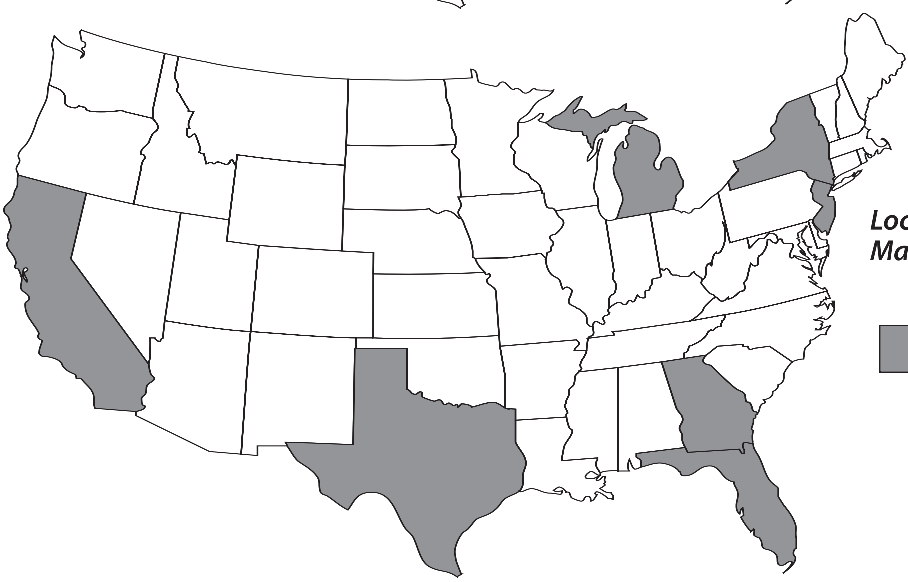
Map of the Caribbean

Malaria

Malaria is an infectious disease that occurred in the U.S. earlier in the 20th century, but became almost non-existent in this country except for imported cases. It is sometimes difficult to determine whether a case was imported or locally transmitted. Cases reported in all of the states marked in the accompanying maps, however, are believed, after extensive investigation, to have been locally transmitted.

Locally Transmitted Malaria in the 1980s

Cases reported.



Locally Transmitted Malaria in the 1990s

Cases reported.

Centers for Disease Control and Prevention. Local transmission of *Plasmodium vivax* malaria—Houston, Texas, 1994. ***Morbidity and Mortality Weekly Report*** 1995; 4 4: 295–303.

Centers for Disease Control and Prevention. Mosquito-transmitted malaria—Michigan, 1995. ***Morbidity and Mortality Weekly Report*** 1996; 4 5: 398– 400.

Centers for Disease Control and Prevention. Probable locally acquired mosquito-transmitted *Plasmodium vivax* infection— Georgia, 1996. ***Morbidity and Mortality Weekly Report*** 1997; 4 6: 264–267.

Zucker, JR. Changing patterns of autochthonous malaria transmission in the United States: a review of recent outbreaks. ***Emerging Infectious Disease*** 1996: 2 (1).

Minimum Temperature Data for Locations Near the Limits of Malaria Range

The data provided in the following tables are derived from
The Global Historical Climatology Network (GHCN), version 2 beta.

SOUTHWEST U.S.

Brownsville/Int'l Arpt

Located at *about* 25.90°N 97.43°W. Height *about* 6m/19 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	10.4	11.9	15.2	19.0	21.9	23.8	24.2	24.1	22.8	19.0	14.7	11.6	18.2
°F	50.7	53.4	59.4	66.2	71.4	74.8	75.6	75.4	73.0	66.2	58.5	52.9	64.8

Source: Derived from *GHCN 2 Beta.* 552 months between 1948 and 1993.

Corpus Christi/NAS

Located at *about* 27.68°N 97.28°W. Height *about* 6m/19 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	9.9	11.7	15.2	19.4	22.9	25.5	26.1	26.1	24.8	21.0	15.8	11.8	19.2
°F	49.8	53.1	59.4	66.9	73.2	77.9	79.2	79.0	76.6	69.8	60.4	53.2	66.6

Source: Derived from *GHCN 2 Beta.* 547 months between 1945 and 1991.

Galveston/Scholes Field

Located at *about* 29.27°N 94.87°W. Height *about* 8m/26 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	8.7	10.5	13.1	17.5	21.9	24.9	26.0	25.6	23.8	19.8	13.2	10.4	18.1
°F	47.7	50.9	55.6	63.5	71.4	76.8	78.8	78.1	74.8	67.6	55.8	50.7	64.6

Source: Derived from *GHCN 2 Beta.* 203 months between 1946 and 1963.

San Diego/Lindbergh Field

Located at *about* 32.72°N 117.17°W. Height *about* 10m/32 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	9.0	10.0	11.1	12.9	14.7	16.3	18.4	19.1	18.2	15.6	11.8	9.1	13.9
°F	48.2	50.0	52.0	55.2	58.5	61.3	65.1	66.4	64.8	60.1	53.2	48.4	57.0

Source: Derived from *GHCN 2 Beta.* 549 months between 1948 and 1993.

Tucson/Int'l Arpt

Located at *about* 32.13°N 110.93°W. Height *about* 786m/2578 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	3.6	4.8	6.8	10.3	14.4	19.7	23.0	22.2	19.6	13.7	7.2	3.9	12.4
°F	38.5	40.6	44.2	50.5	57.9	67.5	73.4	72.0	67.3	56.7	45.0	39.0	54.3

Source: Derived from *GHCN 2 Beta*. 546 months between 1946 and 1993.

SOUTHEAST U.S.

Daytona Beach/WSO AP

Located at *about* 29.18°N 81.05°W. Height *about* 8m/26 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	8.5	9.5	11.9	14.7	18.2	21.3	22.4	22.5	22.1	18.4	13.3	9.7	16.0
°F	47.3	49.1	53.4	58.5	64.8	70.3	72.3	72.5	71.8	65.1	55.9	49.5	60.8

Source: Derived from *GHCN 2 Beta*. 551 months between 1948 and 1993.

Homestead/AFB

Located at *about* 25.48°N 80.38°W. Height *about* 5m/16 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	14.8	15.2	17.1	19.9	21.8	23.6	24.5	24.5	24.2	22.0	18.4	15.3	20.1
°F	58.6	59.4	62.8	67.8	71.2	74.5	76.1	76.1	75.6	71.6	65.1	59.5	68.2

Source: Derived from *GHCN 2 Beta*. 172 months between 1956 and 1970.

Jacksonville/Cecil Fld NAS

Located at *about* 30.22°N 81.88°W. Height *about* 27m/88 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	6.0	7.3	10.4	14.0	17.7	21.0	22.3	22.2	21.0	16.0	10.7	7.2	14.8
°F	42.8	45.1	50.7	57.2	63.9	69.8	72.1	72.0	69.8	60.8	51.3	45.0	58.6

Source: Derived from *GHCN 2 Beta*. 458 months between 1947 and 1991.

Key West/NAS

Located at *about* 24.58°N 81.68°W. Height *about* 7m/22 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	20.8	21.1	22.9	25.1	26.7	28.2	28.9	28.9	28.3	26.5	24.0	21.6	25.2
°F	69.4	70.0	73.2	77.2	80.1	82.8	84.0	84.0	82.9	79.7	75.2	70.9	77.4

Source: Derived from *GHCN 2 Beta*. 471 months between 1945 and 1991.

Miami/WSO City

Located at *about* 25.72°N 80.28°W. Height *about* 4m/13 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	17.1	16.9	19.2	21.2	23.2	24.6	25.6	25.7	25.2	23.4	20.8	18.1	21.7
°F	62.8	62.4	66.6	70.2	73.8	76.3	78.1	78.3	77.4	74.1	69.4	64.6	71.1

Source: Derived from *GHCN 2 Beta*. 364 months between 1962 and 1993.

New Orleans/Int'l Arpt

Located at *about* 29.98°N 90.25°W. Height *about* 6m/19 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	6.2	7.6	11.0	14.7	18.6	21.7	23.0	22.8	21.0	15.2	10.2	7.4	14.9
°F	43.2	45.7	51.8	58.5	65.5	71.1	73.4	73.0	69.8	59.4	50.4	45.3	58.8

Source: Derived from *GHCN 2 Beta*. 552 months between 1948 and 1993.

St. Louis/Lambert Int'l Arpt

Located at *about* 38.75°N 90.37°W. Height *about* 172m/564 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	-5.9	-3.6	1.2	7.6	12.9	18.3	20.7	19.6	15.1	8.7	2.2	-3.1	7.8
°F	21.4	25.5	34.2	45.7	55.2	64.9	69.3	67.3	59.2	47.7	36.0	26.4	46.0

Source: Derived from *GHCN 2 Beta*. 577 months between 1945 and 1993.

Tampa/Int'l Arpt

Located at *about* 27.97°N 82.53°W. Height *about* 12m/39 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	10.0	10.9	13.5	16.0	19.5	22.5	23.4	23.5	22.6	18.6	14.0	10.9	17.1
°F	50.0	51.6	56.3	60.8	67.1	72.5	74.1	74.3	72.7	65.5	57.2	51.6	62.8

Source: Derived from *GHCN 2 Beta.* 550 months between 1948 and 1993.

West Palm Beach/Int'l Arpt

Located at *about* 26.68°N 80.12°W. Height *about* 7m/22 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	13.8	14.2	16.2	18.4	21.0	22.8	23.6	23.8	23.5	21.4	17.9	14.9	19.3
°F	56.8	57.6	61.2	65.1	69.8	73.0	74.5	74.8	74.3	70.5	64.2	58.8	66.7

Source: Derived from *GHCN 2 Beta.* 547 months between 1948 and 1993.

MEXICO

Jalapa, Ver. Mexico

Located at *about* 19.53°N 96.92°W. Height *about* 1427m/4681 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	14.6	15.5	17.7	20.3	20.6	20.1	19.3	19.8	19.3	18.0	16.4	15.4	18.1
°F	58.3	59.9	63.9	68.5	69.1	68.2	66.7	67.6	66.7	64.4	61.5	59.7	64.6

Source: Derived from *GHCN 2 Beta.* 241 months between 1951 and 1981.

Tampico, Tamps

Located at *about* 22.22°N 97.85°W. Height *about* 9m/29 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	21.3	21.8	23.3	25.6	27.3	27.5	27.3	28.0	27.5	26.5	24.4	22.5	25.3
°F	70.3	71.2	73.9	78.1	81.1	81.5	81.1	82.4	81.5	79.7	75.9	72.5	77.5

Source: Derived from *GHCN 2 Beta.* 430 months between 1951 and 1990.

Veracruza, Ver. Mexico

Located at *about* 19.14°N 96.10°W. Height *about* 16m/52 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	21.3	21.8	23.3	25.6	27.3	27.5	27.3	28.0	27.5	26.5	24.4	22.5	25.3
°F	70.3	71.2	73.9	78.1	81.1	81.5	81.1	82.4	81.5	79.7	75.9	72.5	77.5

Source: Derived from *GHCN 2 Beta.* 430 months between 1951 and 1990.

CARIBBEAN ISLANDS

Guantanamo Bay

Located at *about* 19.89°N 75.15°W. Height *about* 16m/52 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	20.1	20.1	21.0	22.0	23.3	24.1	24.4	24.4	24.2	23.7	22.4	20.9	22.6
°F	68.2	68.2	69.8	71.6	73.9	75.4	75.9	75.9	75.6	74.7	72.3	69.6	72.7

Source: Derived from *GHCN 2 Beta.* 527 months between 1945 and 1991.

Kingston/Norman Manle, Jamaica

Located at *about* 17.93°N 76.70°W. Height *about* 3m/9 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	25.6	25.5	25.9	26.6	27.3	28.0	28.4	28.1	27.9	27.4	26.8	26.2	27.0
°F	78.1	77.9	78.6	79.9	81.1	82.4	83.1	82.6	82.2	81.3	80.2	79.2	80.6

Source: Derived from *GHCN 2 Beta.* 1639 months between 1852 and 1990.

Nassau/Int'l Arpt

Located at *about* 25.10°N 77.50°W. Height *about* 10m/32 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	21.5	21.6	22.5	23.8	25.4	27.0	27.9	28.0	27.5	26.1	24.0	22.3	24.8
°F	70.7	70.9	72.5	74.8	77.7	80.6	82.2	82.4	81.5	79.0	75.2	72.1	76.6

Source: Derived from *GHCN 2 Beta.* 1464 months between 1855 and 1991.

San Juan/Isla Verde Int'l Arpt

Located at *about* 18.43°N 66.00°W. Height *about* 2m/6 feet above sea level.

AVERAGE MINIMUM TEMPERATURE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	21.3	21.2	21.8	22.5	23.4	24.2	24.6	24.6	24.3	23.9	23.1	22.1	23.1
°F	70.3	70.2	71.2	72.5	74.1	75.6	76.3	76.3	75.7	75.0	73.6	71.8	73.6

Source: Derived from *GHCN 2 Beta*. 462 months between 1955 and 1993.