Section 3
Mapping Earth's Surface

Key Concept Maps are tools that are used to display data about a given area of a physical body.

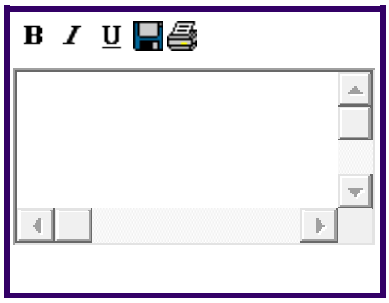
What You Will Learn
- Maps can be used to find locations on Earth and to represent information about features of Earth's surface.
- Most maps are made from data collected by a process called remote sensing.

Why It Matters
Maps help us find directions and locations on Earth.

The Greeks thought of Earth as a sphere almost 2,000 years before Ferdinand Magellan began his round-the-world voyage in 1519. The observation that a ship sinks below the horizon as it sails into the distance supported the idea of a spherical Earth. If Earth were flat, the ship would not sink below the horizon.

The way in which people have seen the world has been reflected in their maps. A **map** is a representation of the features of a physical body such as Earth. If you were to look at a world map from the second century, you might not recognize the physical features that are represented. However, if you looked at a map of Earth's surface made from a photograph taken from a satellite, you might see physical features of Earth you never knew existed.

Standards Check What is a map?



Finding Directions on Earth
Although Earth's shape is not a true sphere, it is best represented by a sphere. A sphere has no top, bottom, or sides to use as reference points

for specifying locations on its surface. However, Earth's axis of rotation can be used to establish reference points. The points at which Earth's axis of rotation intersects Earth's surface are the geographic North and South Poles, which are shown in **Figure 1.** The poles are used as reference points for finding location.

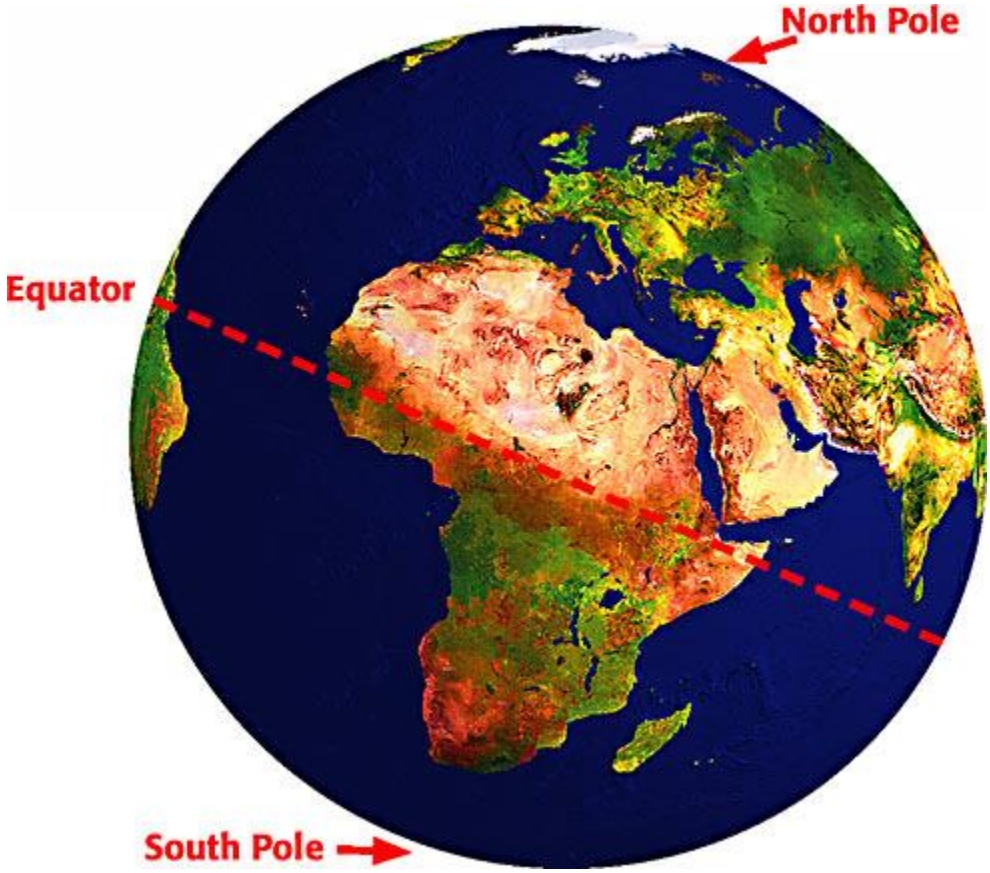


Figure 1 The geographic North Pole is a good reference point for describing locations in Earth's northern hemisphere. **What is a good reference point for describing locations in the southern hemisphere?**

Using a Compass

Earth's core generates a magnetic field that causes Earth to act as a giant magnet. Therefore, Earth has two magnetic poles that are located near the geographic poles. A *compass* is a tool that uses Earth's natural magnetism to show direction. A compass needle points to the magnetic north pole. Therefore, a compass will show you which direction is north.

Finding Locations on Earth

All of the houses and buildings in your neighborhood have addresses that give their location. But how would you find the location of something such as a city center or tip of an island? These places can be given an "address" by using *latitude* and *longitude.*

Latitude

The **equator** is a circle halfway between the North and South Poles that divides Earth into the Northern and Southern Hemispheres. Imaginary lines drawn around Earth parallel to the equator are called lines of latitude, or *parallels.* **Latitude** is the distance north or south from the equator. Latitude is expressed in degrees, as shown in **Figure 2.** The equator represents 0° latitude. The North Pole is 90° north latitude, and the South Pole is 90° south latitude. North latitudes are found between the equator and the North Pole. South latitudes are found between the equator and the South Pole.

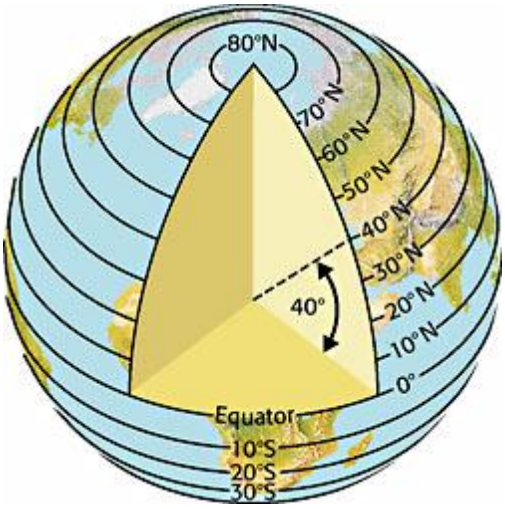


Figure 2 Degrees latitude are a measure of the angle made by the equator and the location on Earth's surface, as measured from the center of Earth.

Longitude

Lines of longitude, or *meridians,* are imaginary lines that connect both poles. **Longitude** is the distance east and west from the prime meridian. Like latitude, longitude is expressed in degrees, as shown in **Figure 3.** The **prime meridian** is the line that represents 0° longitude. Unlike lines of latitude, lines of longitude are not parallel. Lines of longitude touch at the poles and are farthest apart at the equator.

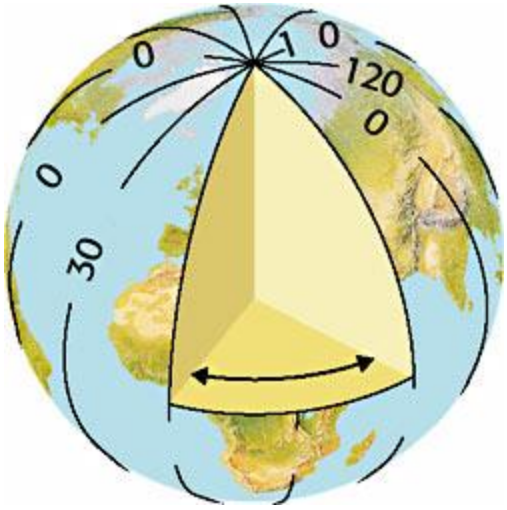


Figure 3 Degrees longitude are a measure of the angle made by the prime meridian and the location on Earth's surface, as measured from the center of Earth.

Unlike the equator, the prime meridian does not completely circle the globe. The prime meridian runs from the North Pole through Greenwich, England, to the South Pole. The 180° meridian lies on the opposite side of Earth from the prime meridian. Together, the prime meridian and the 180° meridian divide Earth into the Eastern and Western Hemispheres. East lines of longitude are found east of the prime meridian, between 0° and 180° longitude. West lines of longitude are found west of the prime

meridian, between 0° and 180° longitude.

Using Latitude and Longitude

Points on Earth's surface can be located by using latitude and longitude. Lines of latitude and lines of longitude cross. They form a grid system on globes and maps. This grid system can be used to find locations north or south of the equator and east or west of the prime meridian.

Figure 4 shows you how latitude and longitude can be used to find the location of your state capital. First, locate the star that represents your state capital on the map. Then, use the lines of latitude and longitude closest to your state capital to estimate its approximate latitude and longitude.

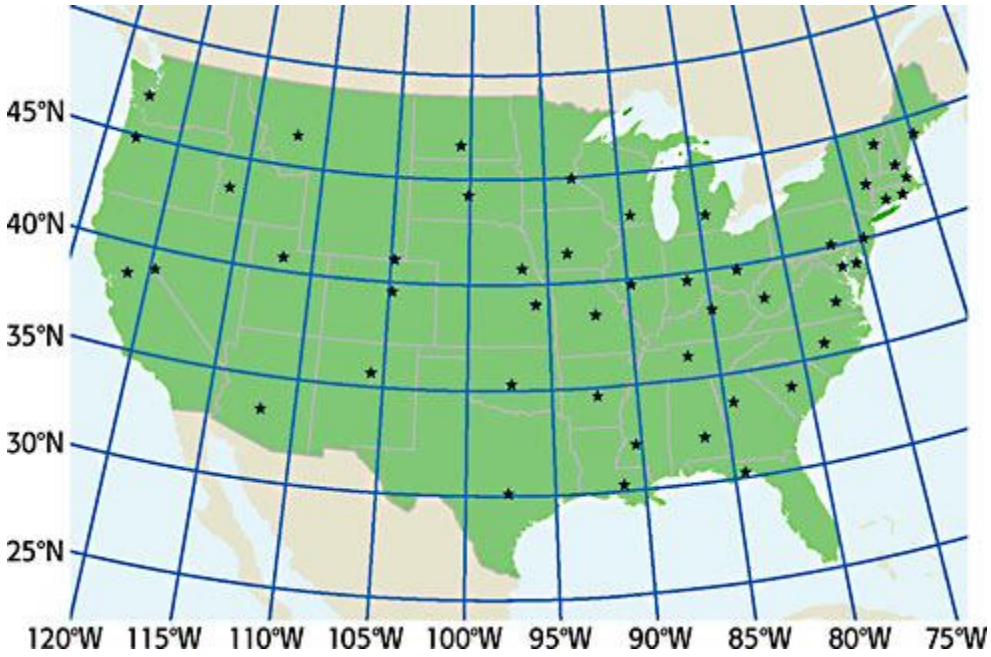


Figure 4 The grid pattern formed by lines of latitude and longitude allows you to pinpoint any location on Earth's surface. Locations are always referenced by listing latitude first, followed by longitude.

Information Shown on Maps

Maps provide information through the use of symbols. To read a map, you must understand the symbols on the map and be able to find directions and calculate distances. Regardless of the kind of map you are reading, a map typically contains the information shown in **Figure 5.** This information includes a title, an indicator of direction, a scale, a legend, and a date.


The **title** gives you information about the subject of the map.
SACRAMENTO
Roseville
Rio Linda
North Highlands
Foothill Farms
Antelope
Citrus Heights
Carmichael
Arcade
Rancho Cordova
Arden
West Sacramento
Sacramento
Rosemont
Florin
Parkway
Elverta
Sacramento International Airport
SUTTER CO.
PLACER CO.
SACRAMENTO CO.
YOLO CO.
N
An **indicator of direction** can show which way is north or give other information about the location of the map. This can be a compass rose, a north arrow, or a latitude/longitude grid.
The **date** tells you the information on map was recorded
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Figure 5 This road map of Sacramento, California, contains all of the needed information to use the map.

Standards Check What information should every map contain?

Modern Mapmaking

Data used in many of today's maps are provided by the process of *remote sensing.* **Remote sensing** is a way to gather information about an object without directly touching or seeing the object. Today, most maps are made from photographs taken by mapping cameras that are mounted on low-flying aircraft. However, mapmakers are beginning to rely on more sophisticated instruments. These instruments are carried on both aircraft and Earth-orbiting satellites. **Figure 6** shows an image taken by a satellite.

Figure 6 This image of downtown San Francisco was obtained by using remote-sensing technology.

Passive Remote Sensing

All objects on Earth's surface emit electromagnetic radiation, such as heat or X rays. In a passive remote-sensing system, sensors record the amount of different kinds of electromagnetic radiation that is emitted or reflected by objects. The data are gathered by a satellite-mounted sensor and are recorded as a series of numbers. These numbers are beamed to a ground station. There, a computer processes the data and converts the data into a satellite image of Earth's surface.

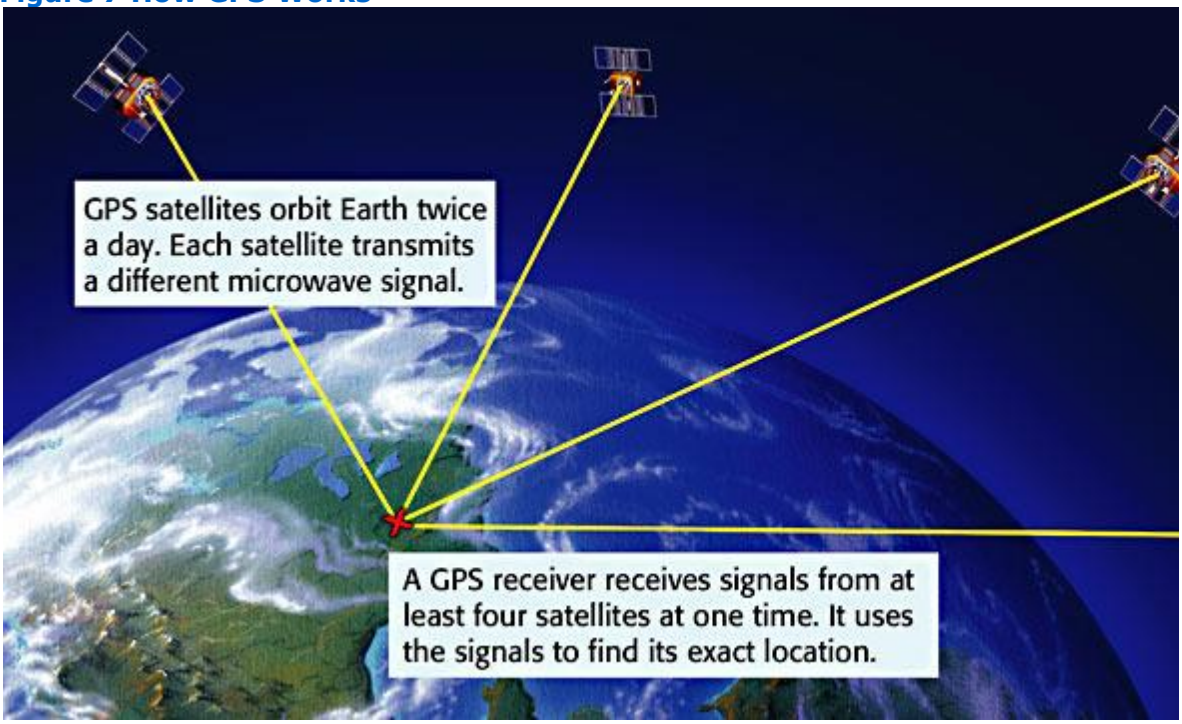
Active Remote Sensing

An active remote-sensing system produces its own electromagnetic radiation and measures the strength of the return signal. In an active remote-sensing system, radar is used to gather data. Radar gathers data by using microwaves. An advantage to using microwaves for remote sensing is that they can penetrate clouds and water. Therefore, microwaves can be used to map areas that are difficult to study.

Global Positioning System

Did you know that satellite technology can actually keep you from getting lost? The *global positioning system* (GPS) can help you find where you are on Earth. GPS is a system of orbiting satellites that send radio signals to receivers on Earth. The receivers calculate the latitude, longitude, and elevation of a given place. **Figure 7** shows how GPS works.

Figure 7 How GPS Works



GPS was invented in the 1970s by the U.S. Department of Defense for military use. However, during the last 30 years, GPS has made its way into people's daily lives. Mapmakers use GPS to check the location of boundary lines between countries and states. Airplane and boat pilots use GPS for navigation. Businesses and state agencies use GPS for mapping and environmental planning. Many new cars have GPS units that show information on a screen on the dashboard. Some GPS units are small enough to wear on your wrist, as shown in **Figure 8,** so you can know your location anywhere you go!

Figure 8 This tiny GPS unit may come in handy if you are ever lost.

Standards Check How can GPS technology be used as a tool to gather data?

Geographic Information Systems

Geographic information systems (GISs) are computerized systems that visually present information about an area. A GIS organizes information in overlapping layers. Scientists can compare the layers to answer questions. **Figure 9** shows how GISs helped scientists plan conservation areas for Florida black bears near Ocala National Forest, located northwest of Orlando.

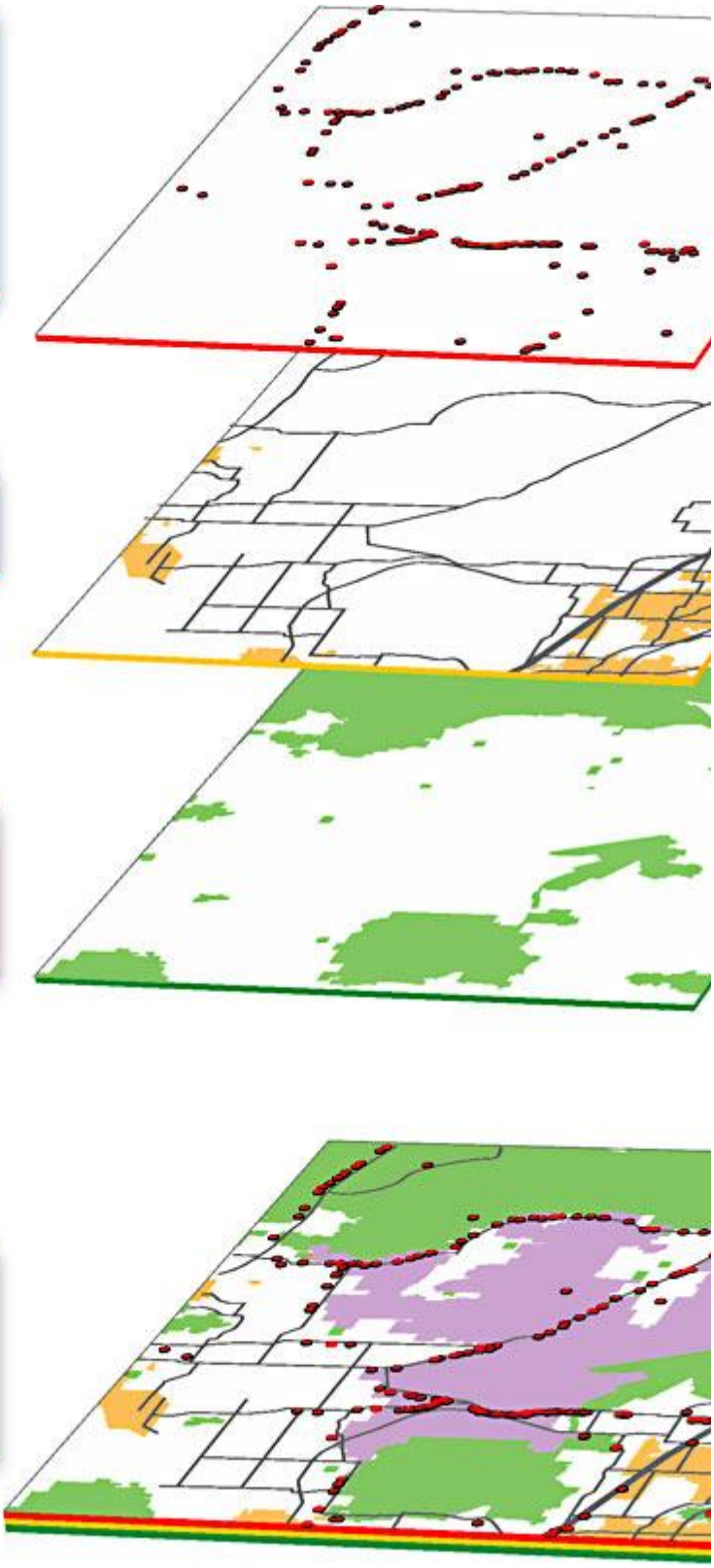
Figure 9 How GIS Works

This layer shows where bears were killed on the roads near Ocala National Forest. Each dot represents one bear. The information was collected during a 26-year period.

This layer shows roads and urban areas.

This layer shows where parkland already exists in the Ocala National Forest area.

When the layers are combined, researchers can plan where to establish bear-conservation areas (purple).



Section Summary

- A map is a representation of the features of a physical body such as Earth.
- A compass is a tool that uses the natural magnetism of Earth to show direction.
- Latitude and longitude can be used to find points on Earth's surface.
- Most maps contain a title, a scale, a legend, an indicator of direction, and a date.
- Modern mapmakers use data gathered by remote-sensing technology to make most maps.
- Remote sensing is a way to collect information about an object without being in physical contact with the object.
- The global positioning system (GPS) calculates the latitude, longitude, and elevation of locations on Earth's surface.
- Geographic information systems (GISs) are computerized systems that allow mapmakers to store and use many types of data.