medical problems, locating shopping centers, bringing relief to refugees, and warning of natural hazards, to name just a few. **Reference maps** show locations of places and geographic features. **Thematic maps** tell stories, typically showing the degree of some attribute or the movement of a geographic phenomenon.

Reference maps focus on accuracy in showing the **absolute locations** of places, using a coordinate system that allows for the precise plotting of where on Earth something is. Imagine taking an orange, drawing a dot on it with a marker, and then trying to describe the exact location of that dot to someone who is holding another orange so she can mark the same spot on her orange. If you draw and number the same coordinate system on both oranges, the task of drawing the absolute location on each orange is not only doable but simple. The coordinate system most frequently used on maps is based on latitude and longitude. For example, the absolute location of Chicago is 41 degrees, 53 minutes North Latitude and 87 degrees, 38 minutes West Longitude. Using these coordinates, you can plot Chicago on any globe or map that is marked with latitude and longitude lines.

The establishment of a satellite-based **global positioning system (GPS)** allows us to locate things on the surface of Earth with extraordinary accuracy. Researchers collect data quickly and easily in the field, and low-priced units are encouraging fishers, hunters, and hikers to use GPS in their activities. New cars are equipped with GPS units, and dashboard map displays help commuters navigate traffic and travelers find their way. **Geocaching** is an increasingly popular hobby based on the use of GPS. Geocachers use their GPS units to play a treasure hunt game all over the world. People leave the treasures ("caches") somewhere, mark the coordinates on their GPS, and post clues on the Internet. If you find the cache, you take the treasure and leave a new one. Many mobile phones and "smart" devices are also equipped with GPS units, and applications such as Google Maps have helped to spread the use of GPS even further.

Relative location describes the location of a place in relation to other human and physical features. Descriptors such as "Chicago is on Lake Michigan, south of Milwaukee" or "Chicago is located where the cross-country railroads met in the 1800s" or "Chicago is the hub of the corn and soybean markets in the Midwest" are all descriptors of Chicago relative to other features. In the southern Wisconsin, northern Illinois, and western Indiana region, all major roads lead to Chicago (Fig. 1.10).

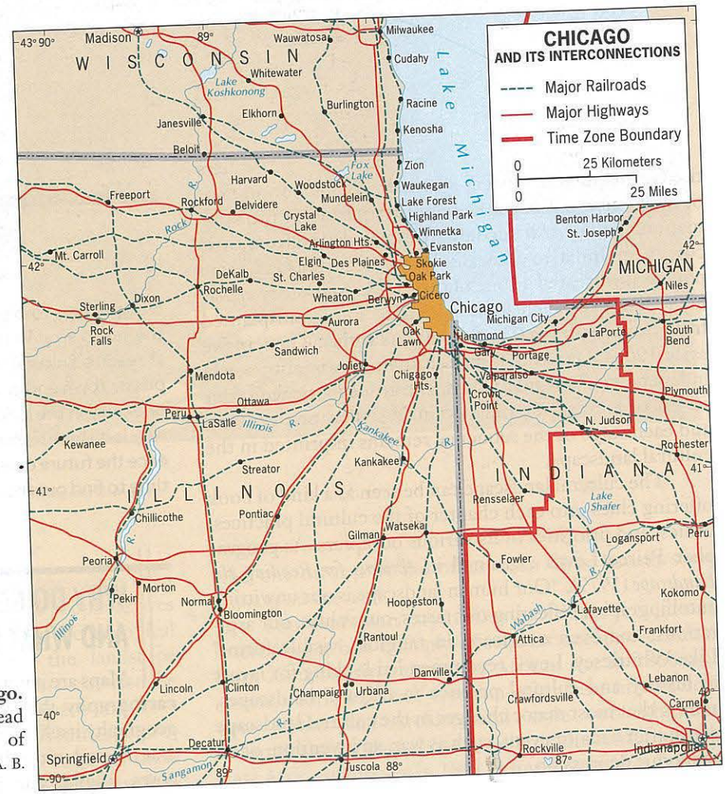

Figure 1.10
All Major Roads Lead to Chicago. Network of Midwestern roads that lead to Chicago, reflecting the dominance of Chicago in the region. © E. H. Fouberg, A. B. Murphy, H. J. de Blij, and John Wiley & Sons, Inc.

Within this region, people define much of their lives relative to Chicago because of the tight interconnectedness between Chicago and the region. Northwestern Indiana is so connected to Chicago that it has a time zone separate from the rest of Indiana, allowing people in northwestern Indiana to stay in the same time zone as Chicago.

Absolute locations do not change, but relative locations are constantly modified and change over time. Fredericksburg, Virginia, is located halfway between Washington, D.C. and Richmond, Virginia. Today, it is a suburb of Washington, D.C. with commuter trains, van pools, buses, and cars moving commuters between their homes in Fredericksburg and their workplaces in metropolitan Washington, D.C. During the Civil War, several bloody battles took place in Fredericksburg as the North and South fought over the land halfway between their wartime capitals. The absolute location of Fredericksburg has not changed, but its place in the world around it, its relative location, certainly has.

Mental Maps

We all carry maps in our minds of places we have been and places we have merely heard of; these are called **mental maps**. Even if you have never been to the Great Plains of the United States, you may have studied wall maps and atlases or come across the region in books, magazines, and newspapers frequently enough to envision the states of the region (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas) in your mind. Regardless of whether you have visited the Great Plains, you will use your mental map of the region. If you hear on the news that a tornado destroyed a town in Oklahoma, you use your mental map of the Great Plains region and Oklahoma to make sense of where the tornado occurred and who was affected by it.

Our mental maps of the places within our **activity spaces**, those places we travel to routinely in our rounds of daily activity, are more accurate and detailed than places where we have never been. If your friend calls and asks you to meet her at the movie theater you go to all the time, your mental map will engage automatically. You will envision the hallway, the front door, the walk to your car, the lane to choose in order to be prepared for the left turn you must make, where you will park your car, and your path into the theater and up to the popcorn stand.

Geographers who study human-environment behavior have made extensive studies of how people develop their mental maps. The earliest humans, who were nomadic, had incredibly accurate mental maps of where to find food and seek shelter. Today, people need mental maps to find their way through the concrete jungles of cities and suburbs.

Geographers have studied the mental map formation of children, the blind, new residents to cities, men, and women, all of whom exhibit differences in the formation of mental maps. To learn new places, women, for example, tend to use landmarks, whereas men tend to use paths. Activity spaces vary by age, and the extent of peoples' mental maps depends in part on their ages. Mental maps include *terra incognita*, unknown lands that are off-limits. If your path to the movie theater includes driving past a school that you do not go to, your map on paper will likely label the school, but no details will be shown regarding the place. However, if you have access to the school and you are instead drawing a mental map of how to get to the school's cafeteria, your mental map of the school will be quite detailed. Thus, mental maps reflect a person's activity space, what is accessible to the person in his or her rounds of daily activity and what is not.

Generalization in Maps

All maps simplify the world. A reference map of the world cannot show every place in the world, and a thematic map of hurricane tracks in the Atlantic Ocean cannot pinpoint every hurricane and its precise path for the last 50 years. When mapping data, whether human or physical, cartographers, the geographers who make maps, *generalize* the information they present on maps. Many of the maps in this book are thematic maps of the world. Shadings show how much or how little of some phenomena can be found on a part of the Earth's surface, and symbols show where specific phenomena are located.

Generalized maps help us see general trends, but we cannot see all cases of a given phenomenon. The map of world precipitation (Fig. 1.11) is a **generalized map** of mean annual precipitation received around the world. The areas shaded in burgundy, dark blue, and vibrant green are places that receive the most rain, and those shaded in orange receive the least rain on average. Take a pen and trace along the equator on the map. Notice how many of the high-precipitation areas on the map are along the equator. The consistent heating of the equator over the course of the entire year brings consistent precipitation to the equatorial region. At the scale of the world, we can see general trends in precipitation, such as this, but it is difficult to see the microscale climates of intense precipitation areas that are found throughout the world.

Remote Sensing and GIS

Geographic studies include both long- and short-term environmental change. Geographers monitor Earth from a distance, using **remote sensing** technology that gathers data at a distance from Earth's surface.