# A Sense of Place— GPS and the Biology Field Trip

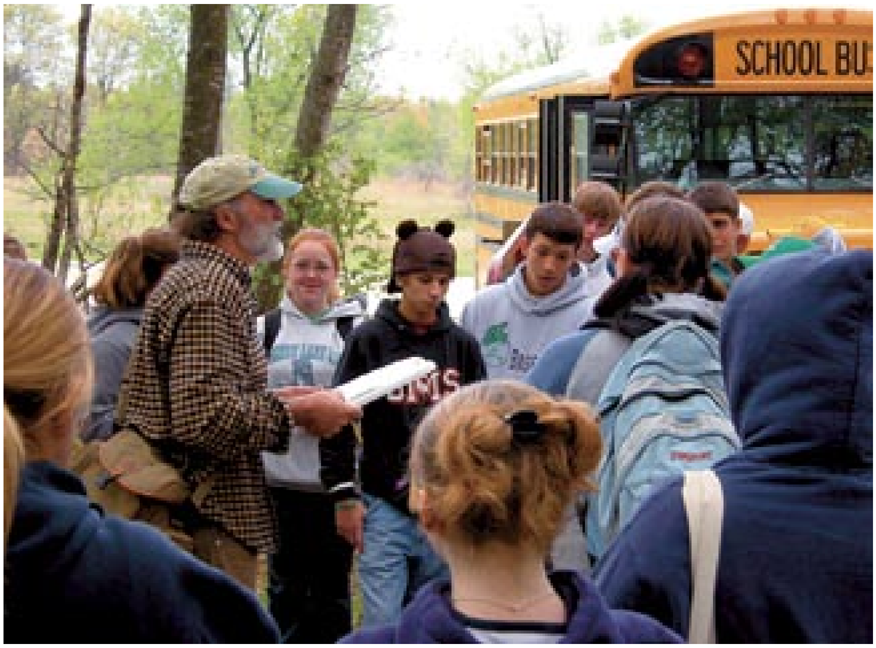
Wisps of cirrus clouds sweep across the blue sky on this spring day in the central plain of Wisconsin's oak savanna province. In between dry oak woods and openings, with sandhill cranes bugling overhead, my students and I traipse across wetlands, sidestep sedge tussocks, and remain vigilant against wood ticks and early hatched mosquitoes.

Our route passes by cowslips and skunk cabbage, fern fiddleheads, and lush verdant mats of hair-cap moss. We collect owl pellets beneath a stand of pine and discover shed snakeskin among a cluster of wood violets. Beneath a Bur oak cohort, a partial bleached out whitetail deer skeleton is discovered. The hunt goes on. And always, we share a "sense of place" by learning to navigate a route using satellites and teamwork.

My students are not on a traditional biology field trip. In this high-tech information age they are using handheld global positioning system (GPS) receivers to navigate unfamiliar terrain (within eyesight of the teacher or adult chaperone) along a three-mile route through Green Lake County's White River Wildlife Area in east central Wisconsin.

## How does GPS work?

GPS is a satellite-based radio navigation system originally developed and operated by the U.S. Department of Defense that now consists of 28 operational satellites in six circular orbits. The satellites are spaced in orbit so that at any time a minimum of six satellite transmitters broadcast position and time data continuously to users throughout the world.




**The teacher reviews the instructions for the high-tech scavenger hunt.**

GPS operation is based on satellite ranging. GPS users determine their position by measuring their distance from the group of satellites in space. The satellites are precise reference points and transmit accurate positions and time signals. Simultaneous measurements collected from four satellites are processed via a GPS receiver to determine position, velocity, and time.

GPS applications have proliferated worldwide, ranging from weapons delivery systems to hot air balloon tracking. Farmers use GPS to pinpoint field locations whose soil conditions require changes in watering, fertilization, and weed control. Recently, GPS was used to obtain a more accurate elevation measurement for Mt. Everest, which turns out to be about 2 m higher than previously thought *(http://observe.arc.nasa.gov/nasa/ootw/1999/ootw_991208/ob991208.html)*. In addition, GPS is used for synchronizing clocks, tracking wildlife and prison inmates, monitoring health emergencies, and marking, locating, and following specific reference points. GPS is also used in the sport of "geocaching."

## Scavenger hunt

Geocaching is comparable to a high-tech Easter egg or treasure hunt. Using GPS, a traditional geocache hunt involves locating waterproof containers on public lands that have been hidden by various geocache enthusiasts. The container holds a notepad log and pencil, and an array of inexpensive eclectic objects: golf balls, cheap watches, key chains, toy cars, stuffed animals, and more. Geocache etiquette requires users to record their success at locating the container in the geocache log, and permits items to be removed provided another item is returned to the container in exchange.

Latitude and longitude coordinates for the location of these hidden geocaches are downloaded from the internet (at sites such as *www.geocaching.com*) and loaded on a GPS receiver. Searchers then must rely on satellite radio signals and GPS receivers to "lock on" to the location where the geocache is hidden.

To incorporate GPS technology into the biology curriculum, I developed a hybrid form of geocaching called "BioCache." BioCache consists of student teams that navigate an unknown route using GPS, participate in a scavenger hunt, and locate personalized geocaches.

The White River Wildlife Area in Wisconsin provides an ideal setting and natural area for student exploration, outdoor learning, and GPS navigation. The area encompasses over 10,000 acres of interspersed wetlands, oak forests, openings, and prairies in the northwest portion of Green Lake County. (About 60 years ago, renowned wildlife ecologist and conservationist, Aldo Leopold, visited the same area and realized its scenic, aesthetic, and biological value. Leopold recommended a state or national wildlife area be established there. The Wisconsin Conservation Commission agreed and approved the first land acquisition on March 30, 1962.)

Preparing for BioCache is as enjoyable for the teacher as the field trip is for students. While in the field the teacher collects a series of coordinates or "waypoints" with a GPS receiver. These waypoints are then assembled in an order that establishes a "route." While collecting waypoints, attentive deliberation ensures that varied terrains and habitats are included along the route.

Next, geocaches are packaged and hidden along different sections of the route—each team locates a different cache. The geocache consists of double-bagged plastic baggies filled with candy, polished stones, miniature compasses, key rings, and certificates that authenticate a team's success at locating their geocache. To add biology content learning, we also add leaf, twig, and other plant specimens for students to identify. Plus, there is an attached note that explains what the geocache is being used for, in the event someone else visiting the area stumbles upon it.

While collecting waypoints, a list of (mostly) natural artifacts is compiled for use in the scavenger hunt. The list contains descriptions and illustrations of objects that do not deplete or despoil habitat if they are collected (e.g., acorn cap, hickory nut, wood tick, bone fragment, piece of litter).

The scavenger hunt begins as soon as the students disembark from the bus, with four-member teams staggered 10 minutes apart as they begin the route. Each person on a BioCache team has a different job, and team members are required to swap tasks during the field trip. The "navigator" carries and reads the GPS receiver; a "clerk" carries and checks off the scavenger hunt list; the "bagger" carries the scavenger hunt artifacts; and a "roamer" assists with navigation, identification, and collecting of artifacts.

Student assessment during BioCache is based on team contribution, successful navigation of a route, locating personal geocaches, and participation in the scavenger hunt. Teams must find a minimum of 10 scavenger artifacts—beyond that is extra credit! (**Safety note:** Students should be given guidelines about what is safe and appropriate to collect.) CAUTION

BioCache is not only a portal to experience Wisconsin's high-quality natural areas and learn about their ecology, but it integrates GPS technology, geography, and natural history. BioCache facilitates teamwork, provides challenging outdoor recreation, hones observation skills, and reinforces classroom learning.

What other GPS applications await students in their explorations? Students use GPS to create digital maps and locate or collect waypoints of specific landscape features and biological populations. In addition, GPS waypoints and routes can be exported as GeoTiff (georeferenced) files that are used in geographic information system (GIS) applications. Whether you are a weekend geocache enthusiast or a biology student on field trip, GPS opens a new worldview perspective of where we have been and where we are going.

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### GPS and mapping resources

Federal Aviation Administration (Satellite Navigation Product Teams): *http://gps.faa.gov/Links/links-gov-text.htm*

Geographer's Craft (Map Projections, GPS, Geodetic Datums, and Coordinate Systems): *www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html*

GPS Applications Exchange (Stennis Space Center): *http://gpshome.ssc.nasa.gov/*

Interagency GPS Executive Board: *www.igeb.gov*

International GPS Service: *igscb.jpl.nasa.gov*

Joe Mehaffey & Jack Yeazel's GPS Website: *http://joe.mehaffey.com/*

National Geographic Society (Round Earth, Flat Maps): *www.nationalgeographic.com/features/2000/exploration/projections/index.html*

Peter Bennett's GPS Site: *http://vancouver-webpages.com/peter/*

Sam Wormley's GPS Resources: *www.edu-observatory.org/gps/gps.html*

U.S. Geological Survey (National Mapping Division): *http://mac.usgs.gov/mac/isb/pubs/MapProjections/projections.html*

U.S. Naval Observatory GPS Operations: *http://tycho.usno.navy.mil/gps.html*