over the past decade, nearly all schools have added computer studies to their curricula and Internet access to their classrooms. Parents, teachers, and students routinely e-mail each other, transforming the communication patterns in schools. Websites are instructional resources, and, increasingly, students are creating their own web pages as part of their learning. It is clear that we live in a much more technologically advanced world than we did even ten years ago.

This expansion of computers into nearly every facet of our lives presents a special challenge to environmental educators, given the emphasis that we place on first-hand experience. Our most meaningful learning experiences have occurred through close investigation of nature, and we want to keep this interest in the natural environment alive in our students. We want to use technology where it is appropriate, but not at the expense of first-hand experience where that is better. Balancing the two is never easy, but when we do this well, the curriculum is transformed and the classroom comes alive as a center of inquiry.

As a relatively early adopter of the Internet in the classroom, I had the good fortune of experiencing this transformation through a project involving migratory animals. My third grade students were given the assignment of working in small groups to learn all they could about an individual species and to develop a portfolio to be shared with peers and parents. This was not intended to be a standard read-and-copy report for which elementary schools are notorious. Instead, project requirements were structured to challenge students to pursue information widely, to think deeply about their animal, and to engage thoughtfully with the world of science. Students used books, magazines, and CD-ROMs, but only as a starting point. Most of the information was gained from using the Internet to track authentic scientific research and through writing letters to organizations working with their group’s species. They were required to prepare a short report with a map of the animal’s migration pattern and a drawing of the animal in its habitat.

They were also required to include copies of electronic and paper correspondence sent and received. In this way, a wide range of science, language, and geography skills were enhanced.

Clearly, these nine-year-old students were not equipped to comprehend, let alone appreciate, all of the nuances of professional scientific research. Fortunately, mediation between the authentic data and the students’ level of comprehension was available through the on-line environmental education initiative Journey North (see sidebar). Journey North is an environmental monitoring program through which participants share data on migrating species and the northward progression of spring. Students can contribute data to the Journey North network by reporting local signs of spring, such as first sightings of monarch butterflies and the first blooming of tulips. They can also obtain data, including radio-telemetric data that allow them to track...
the migration of individual members of such species as eagles and manatees. This real-time data provides a window into the life of an animal in the wild and is supplemented by extensive information on the background of the species. Students can also pose questions on-line to an expert on each species. The use of background readings, authentic research data, and questions to experts was a uniquely valuable learning experience for my students. Each found something to be passionate about as they learned about their species, compared notes with peers, and shared the joy of receiving booklets and posters in the mail from conservation organizations they had read about and corresponded with on-line.

The three components in the students’ research — background readings, on-line data, and communication with experts — are discussed separately below, but each was inextricably linked to the others in fostering students’ growing empathy with their particular species and with wildlife in general. For a teacher, each provides an example of how computer technology can be integrated into a classroom to support effective environmental education.

Background readings
As they sought information about their species, students made good use of a range of books, magazine articles from publications such as Ranger Rick and Zoobooks, websites, and CD-ROMs. This process of searching through information from a variety of sources proved valuable for the students. Instead of being content with only one author’s presentation, they could see that their understanding deepened as they gathered new information from a variety of sources.

In a couple of cases, this led to those unique teachable moments that we treasure as teachers but can never plan for. For example, a student researching whooping cranes was puzzled by conflicting information on the number of these birds known to exist in the wild. Each source he consulted presented a different number; and while some of these population estimates were close to each other, others varied quite a bit. Most of his sources agreed that the whooping crane was making a comeback, and so we compared the numbers presented with the copyright of the source. Sources that were a decade or more old had much lower population counts, no doubt reflecting the recent successes in conservation of this endangered species. The most up-to-date data were the current counts available on-line through Journey North.

Reading on-line background information about the work of scientists helping the whooping crane made the conservation challenge very real. The provision of up-to-date information about the species’ total population — not possible in a book or CD-ROM format — further enhanced the value of the Internet in promoting understanding.

### Finding On-line Projects and Resources

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<th>On-line projects for students</th>
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<td><strong>FrogWatch:</strong> Participants gather and report data on frogs and toads at local wetlands; see <a href="http://www.nwf.org/frogwatchUSA/">www.nwf.org/frogwatchUSA/</a> in the U.S. and <a href="http://www.frogwatch.ca">www.frogwatch.ca</a> in Canada.</td>
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<td><strong>Journey North and Journey South:</strong> Participants share data on sightings of migrating species and track the progression of seasonal change; see <a href="http://www.learner.org/jnorth">http://www.learner.org/jnorth/</a>.</td>
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<td><strong>Pathfinder Science:</strong> A collection of community-based science projects that include data exchanges. Current projects include stream monitoring, phenology, and pollution studies; see <a href="http://www.pathfinderscience.net">www.pathfinderscience.net</a>.</td>
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<td><strong>Project FeederWatch:</strong> A project of the Cornell Lab of Ornithology in which students and others report on their sightings at bird feeders, data that is used to track winter bird populations and long-term trends in bird distribution and abundance; see <a href="http://www.birds.cornell.edu/pfw/">www.birds.cornell.edu/pfw/</a>.</td>
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<td><strong>RoadKill Project:</strong> An unusual project in which students monitor and report on the animal casualties of vehicular traffic in their communities; see <a href="http://edutel.musenet.org:8042/roadkill/">http://edutel.musenet.org:8042/roadkill/</a>.</td>
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<td><strong>Square of Life:</strong> A data exchange project in which students report on life in a square meter of their local community; see <a href="http://www.k12science.org/curriculum/squareproj/">www.k12science.org/curriculum/squareproj/</a>.</td>
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**On-line research tip**
To guide students in on-line research, you may wish to preview a variety of Internet sites and make “hotlists” of sites and portals that would be particularly useful in students’ research projects. Hotlists are simply word-processing documents in which URLs (Uniform Resource Locators, or website addresses) are hyperlinked to the corresponding websites, thereby enabling students to go immediately to an intended site by clicking on the URL.
Authentic data

Authentic data gathered as part of scientific research can do a great deal to illuminate animals’ behavior, habits, and population trends. Particularly dramatic migration data can be obtained through The Raptor Center’s Highway to the Tropics project,1 which follows the movements of more than a dozen ospreys as they migrate to the south and then return to their breeding grounds in several northern states. The prodigious course these birds take each year is tracked by the use of telemetric data obtained through satellite transmitters attached to the backs of the birds. The mapping of their course provides a striking display of long distance migration.

The migration of bald eagles is much more modest than that of ospreys in terms of distance traveled, but it is no less interesting. The students who were researching eagles were struck by the apparently meandering path taken by the eagle they were following. Much of the literature on migration that is written for children implies that migration routes are straightforward paths from north to south in the autumn and back north in the spring. Our eagle proved this not to be the case: it wandered from New York to the middle Atlantic region and back again, before heading up to Ontario, presumably to breed. This nuance in flight plans was particularly interesting to us since we are located near major bald eagle wintering grounds. Given what we learned about the eagles being tracked, we wondered what “our” eagles did as they migrated to and from our area.

Ask the expert

Journey North provides a two-week period during which students can submit questions to experts on migrating species. The experience of posing questions helped the students to reflect carefully on what they knew and what they still wanted to know. To make the best use of the experts’ time, I encouraged the students to be sure that what they were asking did not have a simple answer that could be found in a book. Great care was put into the phrasing and editing of each question because, as one student put it, “You don’t want to look dumb.” When this was done, students prepared and submitted their questions through Journey North’s web page. Responses, when they were posted, were read eagerly, answering such questions as: What is the record for the largest eagle? and Do manatees allow people to get close to them?

Throughout this project, students were led to think deeply about the species they were studying and to relate the real animals they were tracking to previously learned concepts, such as adaptation, ecosystem, and habitat. By applying these concepts in the broader context offered through the Internet, they considerably extended their perspectives on the natural world. Along the way, they also extended their basic reading, writing, and thinking skills.

Ultimately, the Internet presents both a danger and an opportunity. Used poorly, it can become an electronic substitute for authentic experience. Used well in the service of clear learning goals, it can provide access to many productive resources to deepen and extend students’ investigations. My students and I had a glimpse of its power in this project.

Bob Coulter is the Director of the Litzsinger Road Ecology Center, affiliated with the Missouri Botanical Garden. The project described here was undertaken with the assistance of Liz Haspiel and Nancy Mollman while he was a teacher at the Forsyth School in St. Louis, Missouri.

Editor’s note

1 The Highway to the Tropics project began in 1995 and concluded in 2002, but students can still access the data collected during that period. The project tracked the migratory movements of ospreys, Swainson’s hawks, and bald eagles. See the Migration Tracking link at <www.raptor.cvm.umn.edu>.