Habitat loss is the most significant threat to wildlife around the world and a driving force behind the extinction of species. Most of the loss is due to the expansion of human activities into natural areas, such as the conversion of wetlands into agricultural fields, or the replacement of forests or grasslands with suburban development. Yet there is reason to be optimistic about the ability of individuals and communities to restore habitat for wildlife, especially in backyards, public green spaces and riparian areas along streams and lakes. Habitat loss and fragmentation are often the result of many small and seemingly disconnected decisions that, together, lead to major changes in landscape. By considering the larger ramifications of these small decisions and restoring native vegetation in schoolyards and local green spaces, we can increase the area of habitat available to local wildlife and create valuable links among remaining patches of natural habitat.

The imaging of landscapes by remote sensing, such as by satellite and aerial photography, is an important tool by which conservationists can monitor changes in landscape over time. Such images provide a wide-angle perspective as well as local detail for use in “analyses of water quality, ecosystem health, wildlife habitat, land-cover assessments and other land management issues.” For wildlife biologists, satellite images are useful in evaluating habitat quality and identifying key areas to target for the conservation of rare species. Satellite images can be obtained from a variety of government and non-governmental organizations; but Google Earth provides free access to satellite imagery. Students can virtually explore the world with Google Earth, as images are now available for most areas of the globe.

This article presents three classroom lessons for Grades 5-6 that help students understand conservation at a landscape scale. Part of a larger 12-week curriculum, the lessons are a cohesive sequence that has students using Google Earth to analyze land cover, classify and quantify habitat types and suggest ways they might improve their schoolyard wildlife habitat. In the first lesson, students consider the habitat requirements of large cats (*Panthera*) and use a variety of Google Earth tools to explore habitats of large cats at sites around the world. Large cats are chosen because they are rare, charismatic species that excite students and stimulate imagination. In the next two lessons, students analyze and compare wildlife habitat in their schoolyard and in a nearby protected area, such as a state or provincial park. They learn the terminology of land-cover classes and determine which classes apply to their schoolyard and protected area. Each lesson is framed by a focus question and begins with prior-knowledge questions that allow students to express their ideas and begin thinking about the new material in the lesson.

These lessons are best conducted in a computer or media lab with students working in groups of two to three at one computer. Google Earth is often included in school software packages, and the program can be downloaded free. (Go to <http://earth.google.com/>, select “Download Google Earth 5” and follow the instructions.) Teachers unfamiliar with the program may wish to consult the many online resources that provide tips and lesson ideas for using Google Earth.
Lesson 1: Exploring Large Cat Habitats

In this activity, students use Google Earth to visit the habitats of jaguars, lions, and tigers in three locations in the world and to identify landscape characteristics that indicate good wildlife habitat. The exploration provides a chance for students to become comfortable using Google Earth, zooming to different scales, using the ruler to measure spatial characteristics and locating photographs embedded in maps.

Focus question: What can we learn from satellite images about the habitats of jaguars, lions, and tigers?

Time: 1 hour

Materials: One computer with Google Earth installed for each group of two or three students, LCD projector, one copy of “Student Worksheet: Exploring Big Cat Habitats” for each student, sheet of paper or journal for each student for recording responses

Prior-knowledge questions:
1. Write a short definition of habitat.
2. List 3–5 characteristics of good wildlife habitat for a native species of cat found in your geographic area.

When students have finished answering these questions individually, briefly discuss their definition of habitat and generate a list of characteristics of good wildlife habitat on the board.

Procedure:
1. Present the following introduction to students:

   Professor Dave Smith is a scientist from the University of Minnesota who uses remote cameras and radio telemetry to study tigers and their habitat in Royal Chitwan National Park in Nepal. Dave and his students spend hours trekking through the forest searching for signs of tigers, such as tracks, claw marks and scat. They use large box traps to capture the animals so that they can put radio tracking collars on them. These collars allow the researchers to follow the tigers’ movements and understand their habitat requirements. The forest habitat and the prey animals that tigers need to survive are rapidly disappearing. Many forests have already been cleared, tiger prey species are often hunted, and tigers themselves are often poached for illegal sale on the black market. Dave’s research helps scientists learn about tiger habitat and work toward their conservation.

   Today you are a biologist preparing to embark on fieldwork collecting data on large cats. You are studying three species that are said to be of “conservation concern,” which means we are concerned about how many individual animals of these species remain in their wild habitat and what we can do to improve their habitat. The cats we are studying are the jaguar (Panthera onca), the lion (Panthera leo) and the tiger (Panthera tigris). All three live in UNESCO World Heritage Natural Resource sites.

   All scientists prepare for field work before they travel to a research site. We will use Google Earth to examine those sites so that we can prepare for our field season. Watch the steps that I take to arrive at a site, then type in the same commands to arrive at the site yourself. As you arrive at a site, click on photo links to see what that area looks like. You will have five to ten minutes to explore the site on your own and answer the questions on the worksheet. Then we will depart for our next field site. Let’s go!

2. Hand out the student worksheet “Exploring Large Cat Habitats.” As students begin to work through the lesson, demonstrate each step in Google Earth with a projector so that they can watch the execution of commands and then repeat those commands until they are ready to explore independently. Regroup the class before navigating to a new location, so that groups move through the lesson together and all are able to finish.

3. Discuss students’ responses to the following worksheet questions at the end of the exercise and ask students to hand in their worksheet answers.

Site 1: Iguazu Falls, Argentina
• How wide is the river at its widest point? (Approximately 1.4 km.)
• Describe three things you can see that would make this good habitat for jaguars. (Possible answers: Large uninterrupted forest patches; access to both fast water and shallow, slow-moving pools that support different aquatic (Continued on page 12)
Set your start location in Google Earth

1. Start Google Earth, click View and select Scale Legend to add scale to your map. You will notice Eye alt on the lower right-hand corner of the screen. Eye alt is the elevation of your viewpoint as you look at the screen. The Scale Legend tells the actual distance or scale of the map as you view it and zoom in and out. The Scale Legend is the same as a scale bar on a standard print map.

2. On the left side of the screen under Search, find the Fly To box. Enter your school's address in the box and click Enter on your keyboard. The Earth will spin and zoom in on your school. Click View. At the bottom of the list, select Make this my start location. A marker will be added on the screen. You are now ready to prepare for fieldwork.

Site 1: Iguazu Falls, Argentina, habitat of jaguars

3. Enter “Iguazu Falls, Argentina” in the Fly To box and click Enter. The Earth will spin to the location. Zoom in, and you will see a large bend in the river just south of the city of Iguazu Falls. Jaguars come to the river to drink, to hunt crocodiles called caiman and to swim in pools. Use the Zoom tool to explore this jaguar habitat.

Q: Describe three things you can see that would make this good habitat for jaguars.

4. In the Layers box on the left side of the screen, make sure Places is checked. This will allow display of small blue boxes that indicate that photographs are available. To look at a photograph, click on its box. The photograph and information about the image will open in a separate box over your map. Close the photograph by clicking on the “x” in the upper-right corner, and continue exploring.

5. Click Tools and then Ruler to measure the river.

Q: How wide is the river at its widest point?

Site 2: Serengeti National Park, Tanzania, habitat of lions

6. Enter “Serengeti National Park, Tanzania” in the Fly To box, and click Enter. Use the Zoom tool and view the photographs to explore this lion habitat.

Q: Describe three things in the lion habitat that differ from the jaguar habitat.

7. Zoom in and out and notice how the image clarity changes; this will acquaint you with scale (distance) on your map. Zoom in until you can no longer make out images clearly.

Q: What does the Scale Legend say?

Site 3: Royal Chitwan National Park, Nepal, habitat of tigers

8. Enter “Royal Chitwan National Park, Nepal” in the Fly To box and click Enter. Use the Zoom tool and view the photographs to explore tiger habitat.

Q: How far is it from the Chitwan marker to the main river channel?

9. You have arrived at one of Dave Smith’s field sites. Today you are part of Dave’s research team. Where will you set up camp to start collecting data on tiger movements and habitat requirements? Record a new placemark for your site by going to the drop-down menu at the top of the screen under Add and selecting Placemark. Create a unique name for your placemark. The latitude/longitude coordinates will be visible on your Placemark screen.

Record the coordinates of your campsite.
and terrestrial organisms; very little cleared land or human development.)

Site 2: Serengeti National Park, Tanzania
• Describe three things in the lion habitat that differ from the jaguar habitat. (Possible answers: Wide open landscape with sparser tree cover, red soils instead of connected tree cover, drier landscape, less water, variety of large animals — bigger prey for lions.)

• When you zoom in enough that you can no longer make out images clearly, what does the Scale Legend say? (Approximately 1.5 km)

Site 3: Royal Chitwan National Park, Nepal
• How far is it from the Chitwan marker to the main river channel? (Approximately 6.25 km, and it is 0.17 km to the tributary nearest the Chitwan marker. There are two Chitwan markers, so the distance to the nearest tributary will depend on which marker the students use.)

4. Lead a class discussion to compare the research sites chosen by the groups. Discuss characteristics of their chosen sites that provide especially good habitat for tigers. For example: What does the vegetation cover look like? How far is it to water? What kind of tiger prey do you think would be found at your location? How much human-dominated landscape can you find (e.g., homes, villages, cities)?

Reflection: Ask students to reflect on their experience by writing a field notebook entry about the habitats of large cats around the world: What one surprising discovery did you make about another country as you explored? List three things that you found among the Google Earth sites that seemed to indicate good wildlife habitat.

Lesson 2: Analyzing Land Cover in the Schoolyard

In this lesson, students define land-cover classes for the schoolyard, quantify each type of land cover on printouts of Google Earth images of the schoolyard, measure linear distance of roads on those printouts (if time permits), and build bar and pie graphs to represent land cover in the schoolyard.

The land-cover classification systems that are used for scientific research contain many more land classes than would be suitable in an elementary classroom setting. I recommend starting with the following classes and adding others as needed to represent the landscape in your region: trees and shrubs, pavement and buildings, mowed grass, natural grassland, bare soil, water, wetland, agricultural fields and pasture.

Focus question: What can we learn from satellite images about wildlife habitat in our schoolyard?

Time: 1 hour

Materials: One computer with Google Earth installed for each student group, printed Google Earth image of your schoolyard and a 10 x 10 grid printed on an overhead for each group, dry-erase markers, tape, LCD projector for graphical analysis and discussion, clipboards, spreadsheet and graphing software such as Microsoft Excel.

Prior-knowledge questions:
1. Estimate the percentage of our schoolyard that you think is good wildlife habitat.
2. List three projects that we might be able to implement to improve wildlife habitat in our schoolyard.

Figure 1: An image of the schoolyard was selected in Google Earth and overlaid with a 10x10 grid printed on an overhead.
Preparation:
1. In Google Earth, select a view of your school that encompasses the buildings, parking area and schoolyard (see Figure 1 for an example). Make sure the Scale Legend is visible in the image. You can view a larger image by removing the Sidebar (Select View and remove the checkmark in front of Sidebar).
2. From Google Earth, save the screen image as a jpg by going to File, Save and choosing Save Image.
3. Open the image in a photo viewer and print one copy for each group of two or three students. (Note that landscape details will be more vivid if you print on photo paper.)

Helpful hints with Google Earth: To reorient the image, click on the compass in the upper right-hand corner. If you move the North portion westward, for example, you will change the orientation of the image. To return to a top-down view and remove the image perspective angle, hold Shift, left-click the mouse and move the mouse up or down.

Procedure:
1. Introduce the lesson: In Lesson One, we explored research sites in other parts of the world. Today we will work on a site we know well, our schoolyard. In our next lesson, we will use the same tools we use today to analyze a nearby protected area. We begin by defining land-cover classes that represent the variety of characteristics we observe in our schoolyard.
2. List the land-cover classes on the board so that students can refer to them as they identify characteristics of the schoolyard.
3. Have each group navigate to your school address on Google Earth and choose a view showing the schoolyard in detail and decide on which land-cover classes are represented there.
4. Specify a color for each land-cover class. Hand out to each group a printed copy of the Google Earth image of your schoolyard, a grid and other materials. Ask students to place the transparent grid over the printout, tape it into place, and use markers to color each cell to represent its land-cover class. Each square must be only one color. This means that students must decide which land cover dominates in squares that are on an edge or have mixed types. (See Figure 2.)
5. Have students count and record the squares in each class. The number of squares is equal to the percentage of land cover (the 10 x 10 grid contains 100 cells). Collect and compile student data to create Excel graphs (see Figures 3 and 4). Referring to your land-cover classes, discuss and record the percentage of the schoolyard the class would consider excellent wildlife habitat.

Reflection: Think about the land-cover graphs created at the end of today’s lesson. Write a paragraph describing how you think graphs for a protected area would be different.

Follow-up: Before the next lesson, have students spend 30 minutes in the schoolyard working in pairs to search for animal sign. Equip each pair with a clipboard and printout of the image of schoolyard. They should record on the printout each animal sign they find (including tracks, scat, fur/feathers, homes, animal sightings). Ask students to describe in one paragraph the characteristics of the places where they observed the most animal sign.

Figure 2: A land-cover analysis of their schoolyard done by a student group using the following classes: trees and shrubs, mowed grass, pavement and buildings, bare soil and water.
Lesson 3: Analyze a Protected Area

In this activity, students define land-cover classes in a protected area, quantify types of land cover on printouts of the protected area, measure linear distance of roads on printouts of the protected area (if time permits), build bar and pie graphs of protected area land cover, and compare them to graphs of the schoolyard land cover.

Focus question: What can we learn from satellite images about wildlife habitat in our protected area?

Time: 1 hour

Materials: One computer with Google Earth installed for each student group, the previous lesson’s completed grids and graphs for comparison, printed Google Earth image of the protected area (see Preparation below), a 10x10 grid printed on a transparency for each student group, tape, dry-erase markers, LCD projector for graphical analysis and discussion.

Prior-knowledge questions:
1. Estimate the percentage of our protected area that you think is good wildlife habitat.
2. List 3 to 5 things about the wildlife habitat in our protected area that you think will be different from what you noticed in our schoolyard.

Preparation:
Choose a protected area near your school, such as a state or national park, local nature center with walking trails, or another natural area that provides high-quality wildlife habitat and limited density of roads and buildings. For this lesson, I used Afton State Park, a place many students visit with their families, and a landscape and ecosystem that the current schoolyard would have resembled in pre-European times.

On Google Earth, select a view of your protected area such that the scale is as close as possible to the one you used for the schoolyard. Make sure the scale bar is visible in the image. Print a copy of the image for each group of two or three students. Project or list on the board the land-cover classes and the bar and pie graphs from the schoolyard for reference.

Procedure:
1. Introduce the lesson as follows: In our previous lesson, we determined the types of land cover in our schoolyard and reflected on how the land cover in a protected area might be different. Today we will analyze a protected area and re-examine our predictions. As we classify the land in our protected area, we may need to add land classes that are not in our schoolyard or delete some that are.
2. Hand out a copy of the Google Earth image of the protected area to each group. Have students repeat the classification steps they performed for the schoolyard. Then compile the data and develop Excel graphs for the protected area. Figure 5 shows the classification done by a student group for Afton State Park, using the categories of trees and shrubs, water, pavement and buildings, and bare soil.

3. Compare the data and graphs for the schoolyard and the protected area, discussing the quantitative differences in land cover and what these differences would mean for plants and animals. How are these species affected by our decisions, such as how much land we mow, which plant and animal species we actively remove or encourage, where we allow trees and shrubs to grow, where we place our buildings and roads, and the size of our buildings?

Especially informative contrasts may be seen by comparing the percent of land covered by pavement and buildings, and the difference in trees and shrubs or native grasses. Ask the students: Although it would be difficult to remove our buildings and roads, how might we increase the amount of land covered in native trees, shrubs and grasses that would provide food and cover for wildlife? As you compare the schoolyard to the protected area, can you identify gaps in the schoolyard where adding new plantings could connect existing patches of high-quality habitat such as native trees, shrubs and grasses? Are there places that are currently mowed in the schoolyard that could be restored so that they could provide habitat for wildlife and save money in maintenance costs? How would you research restoration projects being done in your protected area to find ideas that might be feasible in the schoolyard?

Reflection: Looking at the differences in land cover that you found between your schoolyard and protected area, which location do you think would be most similar to your home or neighborhood? Write one paragraph about similarities and differences that you would expect to see if you did this Google Earth exercise for your home.

Extensions: There are many ways to expand on these lessons. One exciting way is to look at changes in land cover over time. Historical Imagery is a new map display option in Google Earth 5.0. Click on View and select Historical Imagery. This opens a sliding bar that will allow you to view available images by date for your site. Choose an earlier date (for example 10 or 30 years prior to the current date) and repeat the analyses of your schoolyard and protected area. How has land cover changed over time? You could add even more historical perspective by using aerial photographs available from state or provincial natural resource agencies. These historical views help students understand landscape changes in recent history, and impacts on wildlife as habitat becomes fragmented and natural areas are converted to urban and agricultural areas.

Students can be encouraged to implement projects in their schoolyard to improve wildlife habitat and reduce effects of fragmentation. There are extensive resources to assist in such projects. Refer to the U.S. Fish & Wildlife Service’s Schoolyard Habitat Project Guide or Project WILD’s Wild School Sites, and consider implementing projects to work toward certification of your schoolyard for wildlife habitat through the National Wildlife Federation. As a class, you might propose a habitat-improvement project to your school board or parent organization. At Afton-Lake Elementary, the parent organization provided funds for the students to plant native fruiting trees and shrubs in the schoolyard in the spring of 2009 and allocated funds for future student-proposed habitat projects.

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Notes