Interpreting Wildlife Habitat from Satellite Images

Study Guide

Satellite images can be used to evaluate potential habitat for wildlife. This is especially helpful when evaluating property from a landscape scale. The proportion of open area to forested area, and the presence or need for riparian corridors or other travel corridors are sometimes not evident "on the ground," thus a view from above is often very helpful.

It is important to realize satellite images do not replace the need for on-site habitat evaluation. While large differences in vegetation types or successional stages (landscape composition) may be evident in satellite images, vegetation composition and structure cannot usually be discerned. Although an image containing almost all Stage 6 eastern deciduous forest could be considered better habitat for Eastern gray squirrels than an image containing almost all Stages 3 and 4, that distinction could not be made for more general species, such as white-tailed deer or wild turkey. The dominant tree species and structure of the understory in the forest would greatly influence habitat quality for deer and turkeys. Likewise, the species of grass, forbs and shrubs would influence habitat quality in Stages 3 and 4. These fine-scale habitat features must be evaluated on the ground, thus assessing satellite images as habitat for various wildlife species is often not possible without on-site verification.

Interpreting Satellite Images

When looking at satellite images, imagine how the countryside would look if you were a bird flying over or if you were in an airplane. For example, buildings look like squares or rectangles, silos appear round, woods are rough and hayfields are smooth.

Satellite images are like maps. They are full of useful and interesting information, provided you have a key. They can show us how much an area has changed, how well our crops are growing, where a fire is burning, or when a storm is coming. Wildlife scientists use satellite images to prepare habitat suitability models and identify priority areas for wildlife conservation. They help map where habitat practices can be implemented on someone's property.

To unlock the rich information in a satellite image, you need to:

1. Look for a scale
2. Look for patterns, shapes, and textures
3. Define the colors (including shadows)
4. Find north
5. Consider your prior knowledge

These tips come from the Earth Observatory's writers and visualizers at NASA, who use them to interpret images daily. They will help you get oriented enough to interpret satellite images for 4-H WHEP.

1. Look for a Scale

One of the first things people want to do when they look at a satellite image is identify the places that are familiar to them: their home, school, or place of business; a favorite park or tourist attraction; or a natural feature like a lake, river, or mountain ridge. Such satellites zoom in on small areas to collect fine details down to the scale of individual houses or cars.

You can learn different things at each scale. For example, when tracking a flood, a detailed, high-resolution view will show which homes or farms are surrounded by water. The wider landscape view shows which parts of the county are flooded and perhaps where the water is coming from. A broader view would show the entire region—the flooded river system or the mountain ranges and valleys that control the flow. A hemispheric view would show the movement of weather systems connected to the floods.

The level of detail depends on the satellite's spatial resolution. Like digital photographs, satellite images are made up of little dots called pixels. The width of each pixel is the satellite's spatial resolution. Depending on the image resolution, a city may fill an entire satellite image with grids of streets or it may be a mere dot on a landscape. Before you begin to interpret an image, it helps to know what the scale is. Does the image cover 1 mile or 100? What level of detail is shown?

Wildlife biologists who work with private landowners need to identify different map features at a small scale when writing a habitat plan. <u>For the 4-H WHEP contest, the level of detail for wildlife habitat planning from satellite imagery generally will be between 1000 to 3000 feet per inch</u>. (Note that the length of the scale on Google Earth images on screen is about one and a half inches when printed on paper.)

2. Look for patterns, shapes, and textures

If you have ever spent an afternoon identifying animals and other shapes in the clouds, you'll know that humans are very good at finding patterns. This skill is useful in interpreting satellite imagery because distinctive patterns can be matched to external maps to identify key features. Bodies of water—rivers, lakes, and oceans—are often the simplest features to identify because they tend to have unique shapes and they show up on maps.

Straight lines and geometric shapes in this image are a result of human land use. Roads cut diagonally across the squares that define farm fields. Other obvious patterns come from the way people use the land, such as from this image taken south of Clarendon, Arkansas. Farms usually have geometric shapes—circles or rectangles—that stand out against the more random patterns seen in nature. A straight line anywhere in an image is almost certainly human-made, and may be a road, a drainage ditch, a power line right-of-way, or some kind of boundary made visible by land use.

When a forest is clearcut, the clearing can be often square or run along a roadway as in the image below from Saline County. Riparian corridors have been left along streams. Planted trees appear as a series of herring-bone lines that form along roads. Various shades of green identify timber stands of different ages. Logging decks appear as rectangular-shaped patches of bare ground. These can be distinguished from the greenish cast of a pond or lake.

Geology shapes the landscape in ways that are often easier to see in a satellite image. Mountain ranges tend to run in long, sometimes wavy lines. Geologic features create visible textures. Cliffs can be squiggly or dark lines framed by shadows. Mountains look like wrinkles or bumps. The image below is taken along the Buffalo River east of Jasper, Arkansas.

Occasionally, shadows can make it hard to tell the difference between mountains and valleys. This optical illusion is called relief inversion. It happens because most of us expect an image to be lit from the top left corner. When the sunlight comes from another angle (especially from the lower edge), the shadows fall in ways we don't expect and our brains turn valleys into mountains to compensate. The problem is usually resolved by rotating the image so the light appears to come from the top of the image.

3. Define Colors

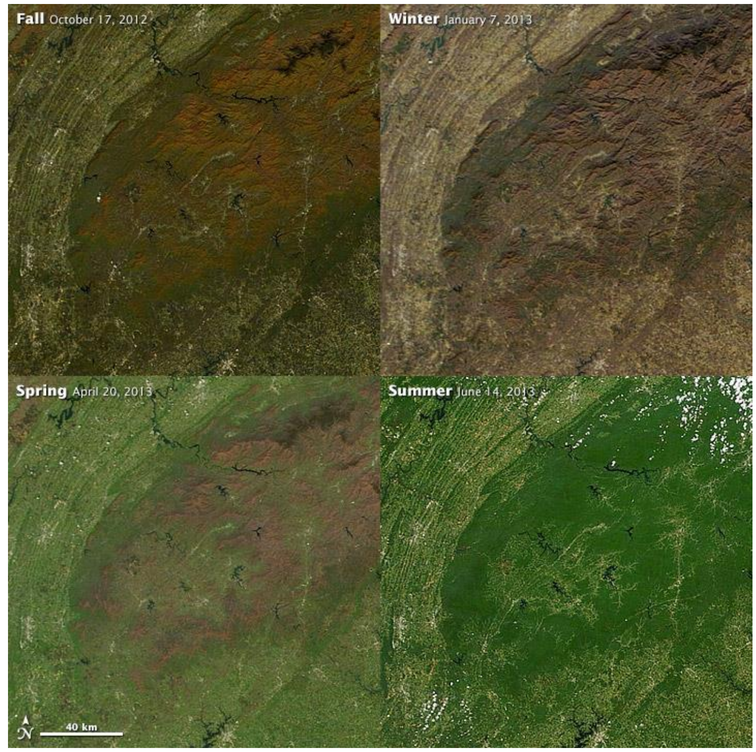
The colors in an image will depend on what kind of light the satellite instrument measured. True-color images use visible light—red, green and blue wavelengths—so the colors are similar to what a person would see from space. False-color images incorporate infrared light and may take on unexpected colors.

Water absorbs light, so it is usually black or dark blue. Sediment reflects light and colors the water. When suspended sand or mud is dense, the water looks brown. As the sediment disperses, the water's color changes to green and then blue. Shallow waters with sandy bottoms can lead to a similar effect.

Sunlight reflecting off the surface of the water makes the water look gray, silver, or white. This phenomenon, known as sunglint, can highlight wave features or oil slicks, but it also masks the presence of sediment or phytoplankton.

Frozen water—snow and ice—is white, gray, and sometimes slightly blue. Dirt can give snow and ice a tan color.

Plants come in different shades of green, and those differences show up in the true-color view from space. Grasslands tend to be pale green, while forests are very dark green. Land used for agriculture is often much brighter in tone than natural vegetation.



In some locations (high and mid latitudes), plant color depends on the season. Spring vegetation tends to be paler than dense summer vegetation. Fall vegetation can be red, orange, yellow, and tan; leafless and withered winter vegetation is brown. For these reasons, it is helpful to know when the image was collected.
The forests covering the Great Smoky Mountains of the Southeastern United States change colors from brown to green to orange to brown as the seasons progress. [National Aeronautics and Space Administration (NASA) images courtesy Jeff SchmaltzLANCE/EOSDIS MODIS Rapid Response Team, GSFC.]

Bare or very lightly vegetated ground is usually some shade of brown or tan. The color depends on the mineral content of the soil. When the ground is white or very pale tan, especially in dried lakebeds, it is because of salt-, silicon-, or calcium-based minerals. Newly burned land is also dark brown or black, but the burn scar fades to brown before disappearing over time.

Residential areas, cities, and other densely built areas are typically silver or gray from the concentration of concrete and other building materials. Some cities have a more brown or red tone depending on the materials used for rooftops.

Clouds are white and gray, and they tend to have texture just as they do when viewed from the ground. They also cast dark shadows on the ground that mirror the shape of the cloud. Some high, thin clouds are detectable only by the shadow they cast.

Smoke is often smoother than clouds and ranges in color from brown to gray. Smoke from oil fires is black. Haze is usually featureless and pale gray or a dingy white. Dense haze is opaque, but you can see through thinner haze. The color of smoke or haze usually reflects the amount of moisture and chemical pollutants, but it’s not always possible to tell the difference between haze and fog in a visual interpretation of a satellite image. White haze may be natural fog, but it may also be pollution.

Dust ranges in color, depending on its source. It is most often slightly tan, but like soil, can be white, red, dark brown, and even black due to different mineral content.

Colors in Context. Looking at a satellite image, you see everything between the satellite and the ground (clouds, dust, haze, land) in a single, flat plane. This means that a white patch might be a cloud, but it could also be snow or *sunglint.* The combination of context, shape, and texture will help you tell the difference. For example, shadows cast by clouds or mountains can be easy to mistake for other dark surface features like water, forest, or burned land. Looking at other images of the same area taken at another time can help eliminate confusion. Most of the time, context will help you see the source of the shadow—a cloud or mountain—by comparing the shape of the shadow to other features in the image.

4. Find North

When you get lost, the simplest way to figure out where you are is to find a familiar landmark and orient yourself with respect to it. The same technique applies to satellite images. If you know where north is, you can figure out if that mountain range is running north to south or east to west, or if a city is on the east side of the river or the west. These details can help you match the features to a map. Most images are oriented so that north is up. Look for a north arrow or indicator on the image to be certain.

5. Consider your Prior Knowledge

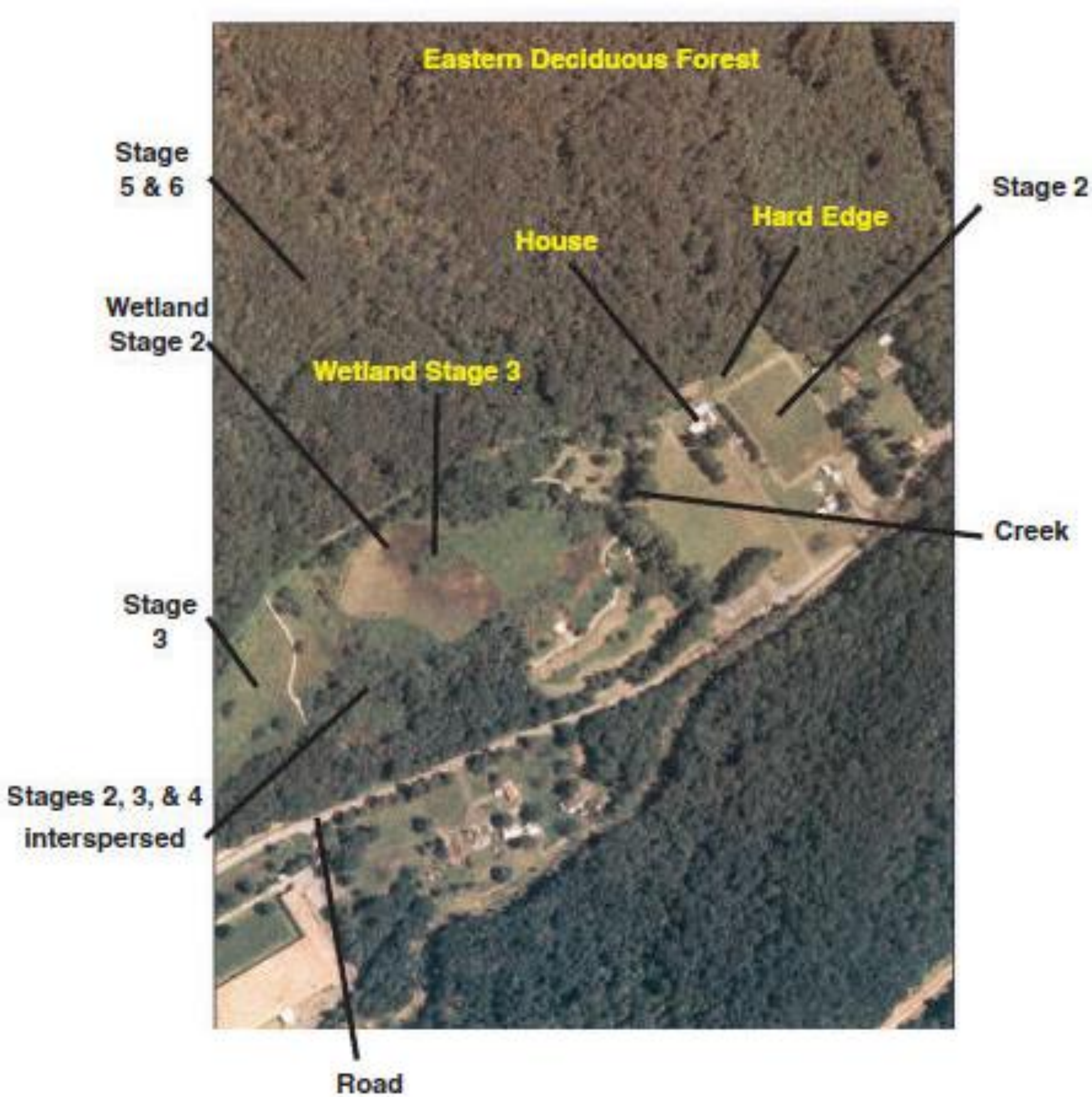
Perhaps the most powerful tool for interpreting a satellite image is knowledge of the place. If you know that a wildfire burned through a forest last year, it's easy to figure out that the dark brown patch of forest is probably a burn scar. Having local knowledge also allows you to connect satellite mapping to what's happening in everyday life, from social studies, economics, and history (for example, population growth, transport, food production); to geology (tectonics); to biology and ecology (plant growth and ecosystems); to politics and culture (land and water use); to chemistry (atmospheric pollution); and to health (pollution, habitat for disease carriers).

What's the best way to build your knowledge? Explore places you know on Google Earth (www.earth.google.com) in your quest to interpret satellite images. Look at what you see on the ground, and compare it to the satellite image.

Adapted with permission from **How to Interpret a Satellite Image: Five Tips and Strategies** by Holli Riebeek, November 18, 2013, at NASA Earth Observatory website.
URL:www.earthobservatory.nasa.gov/Features/ColorImage/

Applying Satellite Images to Wildlife Habitat Management

When using satellite images, it is important to be able to identify certain features such as rivers/streams, ponds/lakes, structures (houses, barns, commercial buildings), stages of succession, agricultural land, pasture, hard edge, soft edge, residential/urban areas, roads, power lines, etc. The most important information obtained from a satellite image is the general landscape composition and the interspersion and arrangement of vegetation types and successional stages.



Comparing Wildlife Habitat from Satellite Images

Below are sample satellite images and descriptions, followed by an analysis of their habitat suitability for selected wildlife species.

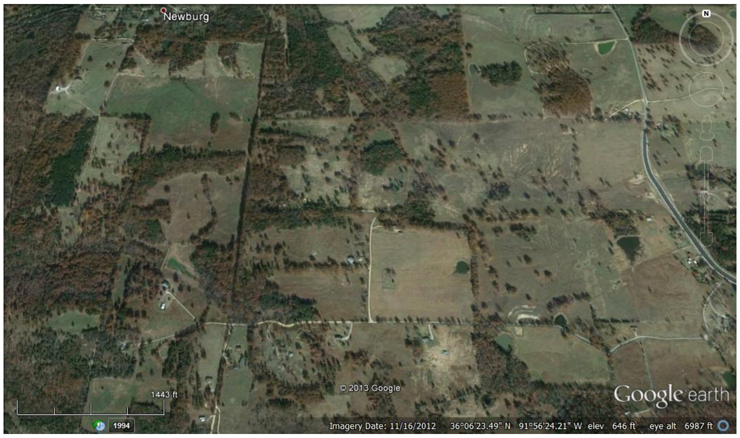


Image 1

Image 2

Image 3

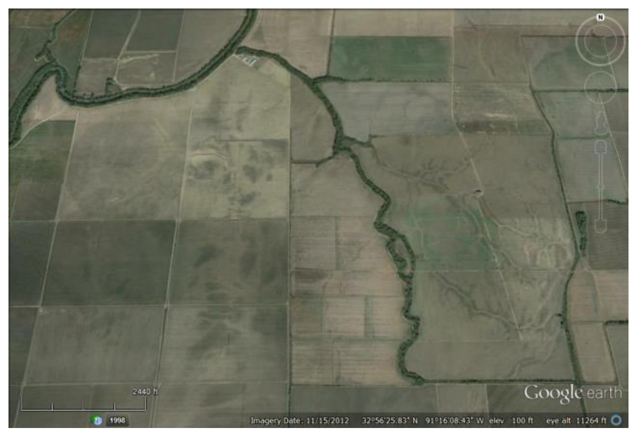


Image 4

Image 1 contains mostly Stage 3 with scattered Stage 4 and some mature deciduous trees located along drainages and field edges. There is a main road and a few secondary roads in the image. There is a pond in the upper left quadrant of the image. The area shown in this image would probably be adequate for species that require interspersion of Stages 2, 3, and 4, with some stages 5 and 6. However, habitat quality is difficult, if not impossible, to determine because the species of grass and forbs as well as the shrubs and trees cannot be identified. Because the fields have obviously been managed, they probably contain non-native species and probably do not provide adequate structure or represent optimal early successional habitat.

Image 2 is a mature deciduous and pine forest, Stage 6. Many tributaries drain into a stream or river running through the middle of the image. Tree species composition, as well as the structure and composition of the understory, is unknown. Nonetheless, this area would probably provide adequate habitat for wildlife that require mature forest for their habitat needs.

Image 3 contains approximately one-fifth mature pine forest, one-fifth Stage 5 and 6 deciduous forest, one-fifth in Stage 4, and two-fifths Stages 2 and 3. There is a secondary road leading to an area of bare ground on the left border of the image, with a portion of a pond or lake nearby. A power line right of way cuts diagonally across the upper left corner. A number of other roads can be seen running through the pine forest at the upper right quadrant of the image. The area is likely to provide suitable habitat for species that require a mixture of vegetation types and successional stages.

Image 4 is an agricultural setting, composed of cropfields and haylands. Types of crops and plant species in the hay pastures are unknown. Tree/shrub cover is completely lacking, except for along roads and streambanks. With a lack of structural cover, little water and continual disturbance, this area would provide habitat for very few wildlife species.

The habitat quality of these satellite images depends on the focal species and its habitat needs. Being able to assess habitat using satellite imagery will help prepare contestants for this portion of the contest. Determining the best habitat requires knowledge of the particular stages of plant succession preferred by the wildlife species. The summary table is a comparison of best and worst habitat using the four images for several selected wildlife species, followed by a discussion for each species.

Table: Habitat evaluation for wildlife species using four satellite images.

	Satellite Image #	
Species	**Best Habitat**	**Worst Habitat**
American Kestrel	1	2
Bluegill	1	4
Brown Thrasher	3	4
Eastern Bluebird	1	2
Eastern Cottontail	1	2
Eastern Gray Squirrel	2	4
Mourning Dove	4	2
Hairy Woodpecker	2	4
Northern Bobwhite	1	2
Ovenbird	2	4
Raccoon	3	2
White-tailed Deer	3	4
Wild Turkey	3	4
Wood Duck	3	1

- **American kestrels** prefer large open areas in Stages 2 and 3 of plant succession interspersed with areas in Stages 4, 5, and 6 of plant succession. Image 1 fits this well. Image 3 also supplies this type of habitat, but has less area in Stage 2 or 3 of plant succession and is rated lower than area 2. Image 4 has large open areas, but has little interspersion of other plant succession stages. Image 2 does not have any open areas and thus is ranked last.

- **Bluegill** would prefer habitat with ponds or permanent streams, so Image 1 is preferred with 5+ ponds. Image 3 has a portion of a lake and tree-lined stream or marsh which provides suitable habitat, but is more difficult to manage for bluegill because of its size and presumably lack of water control structures. Image 3 is preferred over Image 2 because Image 3 has a lake. Image 2 has a permanent stream which is also suitable habitat, and is preferred over Image 4 because of streambanks protected on both sides with large forested buffers. Image 4 has small possibly intermittent streams and ditches with minimal buffers or forest cover, and therefore less preferred than Image 2. Image 4 is least preferred.

- **Brown thrashers** prefer dense shrub thickets. Image 3 supplies the greatest amount of this type of habitat. Image 1 has more area in Stage 4 of plant succession than either Image 2 or 4. Images 2 and 4 are difficult to judge. In this instance, we would assume there is more shrub cover associated with the woodland area in Image 2 than what is shown in Image 4.

- **Eastern bluebirds** would most prefer Image 1 and least prefer Image 2. They like to nest in tree cavities adjacent to open fields and prefer open fields for feeding. They are found in early successional habitat (Stages 2 and 3) interspersed with shrubs and woodlands (Stages 4, 5 and 6). Image 3 would be second-best because of the woodland-field edge, but has less interspersion than Image 1. Image 4 has a few trees and we presume a few tree cavities, and therefore is third. Image 2 has no open fields and is least preferred.

- For **Eastern cottontails**, Image 1 is the best and Image 2 is the worst. Image 1 is preferred because it has nearly the proper ratios of habitat components for rabbits (one-third grassland, one-third cropland, and one-third shrub cover), and they are well interspersed (mixed together). Image 3 has less interspersion, but more habitat diversity (different kinds of habitat) than Images 2 and 4. Image 4 has plenty of grass and cropland, but little shrub cover. Image 2 has very little to none of the habitat components for rabbits.

- **Eastern gray squirrels**, **hairy woodpeckers** and **ovenbirds** prefer Stages 5 and 6 deciduous woodland, and therefore Image 2 is most preferred. Image 3 would be second and Image 1 third, because of the amount of tree cover. Image 4 is least preferable because it lacks trees.

- **Mourning doves** prefer Image 4 and least prefer Image 2. Since doves prefer open fields for feeding, habitat suitability is based on the amount of open fields available. Second would be Image 1 followed by Image 3, because of the amount of open fields.

- For **Northern bobwhites**, Image 1 is the best and Image 2 is the worst habitat. The reasons are similar to those of cottontail rabbits. However, in some judging instances, images may be rated differently for bobwhites than cottontails. For example, bobwhites do not need quite as much shrub cover as cottontails.

- **Raccoons** would prefer the areas in Image 3 the most and Image 2 the least. All images have streams or open water that attract raccoons. Image 3 is ranked ahead of others since it has riparian areas and wetlands interspersed with mature trees for denning sites, and with open fields. Image 1 is ranked ahead of Images 2 and 4 because of interspersed successional stages near open water. Because raccoons prefer agriculture habitat, and because some trees are present along riparian corridors, Image 4 barely beats Image 2, which lacks agriculture.

- For **white-tailed deer**, habitat in Image 3 would be most preferred and Image 4 least preferred. Deer prefer woodland areas interspersed with areas in various stages of succession. Image 3 fits this well; it includes three plant succession stages. Image 3 is ranked ahead of 1, since it has larger contiguous areas of Stages 5 and 6. Image 1 is selected over Image 2 because of the interspersed successional stages it offers. Image 4 is too open, so Image 2 is picked third and 4 last.

- For **wild turkey**, habitat in Image 3 is most preferred and Image 4 is least preferred. Generally turkeys need one-fourth to one-half of their range open, and one-half to three-fourths mature woodland. Image 3 is preferred because it has roughly one-half the area in mature woodlands, and nearly one-fourth the area is open. Image 1 is second, as it has both open areas and mature woodland. However, it does not meet the mature woodland requirement as well as Image 3. Image 2 is ranked third because it has more timber than Image 4 and more cover in general. Due to the absence of woodlands, it is doubtful if Image 4 could support a turkey population.

- **Wood ducks** would prefer Image 3 the most and Image 1 the least. Wood ducks prefer wetlands and flooded bottomland hardwood forests. A lack of mature woodlands surrounding water sources, plus smaller sizes of water sources, are of concern in Image 1. Both Images 3 and 4 require improvements equally to attract wood ducks. Image 3 needs flooded timber and Image 4 needs more trees in flooded areas to attract wood ducks.

Resources for Satellite Images

Google Earth (www.earth.google.com) maps are good resources for samples of satellite images. Additional articles and educational activities about interpreting satellite images are available on the NASA Earth Science Week web site, Mapping Our World (http://nasaesw.strategies.org/).