## Supporting Ideas

### Geometry and Measurement

<table>
<thead>
<tr>
<th>Benchmark Code</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA.6.G.4.1</td>
<td>Understand the concept of $\pi$, know common estimates of $\pi$ (3.14; 22/7) and use these values to estimate and calculate the circumference and the area of circles.</td>
</tr>
<tr>
<td>MA.6.G.4.2</td>
<td>Find the perimeters and areas of composite two-dimensional figures, including non-rectangular figures (such as semicircles) using various strategies.</td>
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<tr>
<td>MA.6.G.4.3</td>
<td>Determine a missing dimension of a plane figure or prism, given its area or volume and some of the dimensions, or determine the area or volume given the dimensions.</td>
</tr>
</tbody>
</table>

### Access Points for Students with Significant Cognitive Disabilities

#### Independent:
- MA.6.G.4.In.a Compare the distance around the outside of circles (circumference) using physical or visual models.
- MA.6.G.4.In.b Measure the distance around all sides (perimeter) of polygons, such as squares, triangles, rectangles, and hexagons.

#### Supported:
- MA.6.G.4.Su.a Identify the distance around the outside of circles (circumference).
- MA.6.G.4.Su.c Compare the areas of rectangular and square shapes using physical models.

#### Participatory:
- MA.6.G.4.Pa.b Follow three or more directional instructions in daily activities.
- MA.6.G.4.Pa.c Identify differences in objects with two-dimensional shapes, such as circle, square, or triangle.
**Benchmark MA.6.G.4.2**

**Reporting Category**  
Geometry and Measurement

**Standard**  
Supporting Idea  
Geometry and Measurement

**Benchmark**  
MA.6.G.4.2  
Find the perimeters and areas of composite two-dimensional figures, including non-rectangular figures (such as semicircles) using various strategies.

Also assesses MA.6.A.3.4 Solve problems given a formula.

**Item Type**  
At Grade 6, this benchmark will be assessed using MC and GR items.

**Benchmark Clarification**  
Students will find the perimeters and areas of composite two-dimensional figures made from convex and concave polygons, circles, and semicircles.

Students will find the missing dimensions of composite two-dimensional figures, given some of the dimensions, or the perimeter or area of the figure.

**Content Limits**  
Students will work with composite two-dimensional figures, which may be composed of shapes within other shapes.

Polygons used in composite two-dimensional figures may be convex or concave.

The figures used within another figure are limited to triangles, quadrilaterals, circles, and semicircles.

Composite two-dimensional figures may be created from up to three different simple polygons.

Dimensions of polygons may be whole numbers; fractions with denominators of 2, 4, or 10; or decimal values, which may include 0.25, 0.75, or tenths.

Composite shapes should not be represented on grids.

Items will not include the vocabulary of inscribed or circumscribed, but these concepts may be represented graphically.

**Stimulus Attributes**  
Items should be set in a real-world or mathematical context.

Items that are set in real-world context may use length and width as dimensions as well as base and height as dimensions.

Graphics should be used in all of these items.

**Prior Knowledge**  
Items may require the student to apply mathematical knowledge described in the Standards from lower grades. This benchmark requires prerequisite knowledge from MA.3.G.3.1, MA.3.G.3.3, and MA.5.G.5.4.
**FLORIDA GRADE 6 CONTENT MODULE  MA.6.G.4.2**

**Benchmark:**  Supporting Ideas

**MA.6.G.4.2:** Find the perimeters and areas of composite two-dimensional figures, including non-rectangular figures (such as semicircles) using various strategies

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MA.6.G.4.2 – VERTICAL ALIGNMENT

4th Grade

MA.4.A.6.6 Estimate and describe reasonableness of estimates; determine the appropriateness of an estimate versus an exact answer.

MA.4.G.3.1 Describe and determine area as the number of same-sized units that cover a region in the plane, recognizing that a unit square is the standard unit for measuring area.

MA.4.G.3.3 Select and use appropriate units, both customary and metric, strategies, and measuring tools to estimate and solve real-world area problems.

5th Grade

MA.5.G.5.3 Solve problems requiring attention to approximation, selection of appropriate measuring tools, and precision of measurement.

Benchmark: Supporting Ideas

MA.6.G.4.2: Find the perimeters and areas of composite two-dimensional figures, including non-rectangular figures (such as semicircles) using various strategies.

7th Grade Big Idea 2: Develop an understanding of and use formula to determine surface area and volumes of three-dimensional shapes.

MA.7.G.2.1 Justify and apply formulas for surface area and volume of pyramids, prisms, cylinders and cones.

MA.7.G.2.2 Use formulas to find surface areas and volume of three-dimensional composite shapes.

MA.7.A.5.1 Express rational numbers as terminating or repeating decimals.
Students will find the perimeter and area of composite two-dimensional figures made from convex and concave polygons, circles and semi-circles.

Students will find the missing dimensions of composite two-dimensional figures, given some of the dimensions or the perimeter or area of the figure.

In the real world, not every object is a shape with a geometric name! More often, the shape of an object is a composite of geometric shapes. For instance, students will be familiar with kitchen counters that are priced according to their area but are L-shaped or rounded.

Flooring is also purchased by the square unit, yet not all floors are rectangular or square in shape. Molding is purchased by the foot to fit around the perimeter of a room, and it is necessary to measure the perimeter of rooms that are not standard polygonal shapes. Students should be given lots of exposure to these real world applications of irregular perimeter and area.

Students should also become familiar with how to analyze irregular shapes drawn on grid paper. 6th graders often need direct instruction in counting the edge of the squares on the grid that represent the perimeter of the figure. Be sure that students are counting the “spaces” and not the “lines.”

Encourage students to become good mathematical communicators by drawing diagrams that are neat and clearly labeled. Emphasize the need to include a scale for the diagram. Students need to understand the difference between a linear unit of measurement and a square unit of measurement and should recognize the importance of using the correct unit label.
GLOSSARY OF RELATED MATHEMATICAL LANGUAGE

**algorithm** An explicit step-by-step procedure for performing a mathematical computation or for solving a mathematical problem.

**altitude of a triangle or quadrilateral** A line segment (or its length) drawn from a vertex perpendicular to the line containing the opposite side.

**approximation** A mathematical quantity that estimates a desired quantity.

**area** The measure of the interior surface of a closed region or figure; area is measured in square units.

**base** A particular side or face of a geometric figure.

**circle** A plane closed curve consisting of all points a fixed distance from a fixed point called its center.

**circumference** The distance around a circle, calculated by multiplying the length of the diameter of the circle by pi (i.e., \( C = \pi d \)).

**diameter** A chord of a circle which passes through the center of the circle.

**Example:** In the diagram below, \( \overline{AB} \) is the diameter of circle \( O \).

![Diameter Example](attachment:image.png)

**estimate** An answer that is an approximation.

**experiment** An action or process carried out under controlled conditions in order to discover an unknown effect or law, to test or establish a hypothesis, or to illustrate a known law.

**exponent** A number that tells how many times the base is used as a factor; in an expression of the form \( b^a \), \( a \) is called the exponent, \( b \) is the base, and \( b^a \) is a power of \( b \).

**perimeter** The distance around a closed figure.

**pi** (\( \pi \)) The ratio of the circumference of a circle to its diameter; pi is an irrational number whose approximate value is 3.141592654.

**plane figure** A figure that lies on a flat surface.

**radius** A line segment that extends from the center of a circle to any point on the circle.

**Example:** \( \overline{OA} \) is a radius of circle \( O \).
**round a number**  To approximate the value of a whole number or decimal to a specific place value.

**Example:**

Rounded to the nearest ten:  
- 125 rounds to 130  
- 122 rounds to 120

Rounded to the nearest tenth:  
- 1.25 rounds to 1.3  
- 1.22 rounds to 1.2

**verify**  To ascertain or confirm that a mathematical property, concept, or statement is true.
DESCRIPTION OF STUDENT DEVELOPMENTAL LEVEL

LITERACY STRATEGIES

A K-W-L chart could be used when working with the diagram of an irregular area. Normally, this is a three-column chart with the columns labeled “K – What do you KNOW?”, “W – What do you WANT to know?”, and “L – What did you LEARN?”

The student will fill in the “K” column with the formulas and dimensions that are given. The “W” column will list the question posed in the problem as well as the missing dimensions. After working on the solution, the student can fill in the “L” column with the solution and anything else that was learned.

NUMERACY STRATEGIES

Numeracy, or quantitative literacy, is the ability to reason with numbers and other mathematical concepts. Numeracy includes a comfort with using logic and reasoning and the ability to apply mathematical knowledge to the solution of real-world problems and everyday tasks.

There are categories of diagrams that will be studied for this benchmark. One category involves knowing two short sides of a diagram and adding them to find the opposite longer side. The other involves knowing the longer side and one opposite shorter side then using subtraction to find the missing dimension. Give enough repeated practice with both of these kinds of diagrams so that the student automatically recognizes the strategy to use.

BRAIN-COMPATIBLE LEARNING STRATEGIES

Consider Howard Gardiner’s Multiple Intelligences and plan a variety of experiences for students who will benefit from an alternate lesson format. Spatial learners should show a good ability to dissect these diagrams if a should logical-sequential learners. These students might be paired with students with strength in another learning style to facilitate learning for both of them.
<table>
<thead>
<tr>
<th>QUADRANT C (assimilation)</th>
<th>QUADRANT D (adaptation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Examines Tetris and polyomino shapes to find area and perimeter.</td>
<td>1. Judges the efficacy of the grid strategy vs the geometric simulation strategy for calculating area of farm forest.</td>
</tr>
<tr>
<td>2. Develops a method for predicting the perimeter of a tetris or polyomino shape.</td>
<td>2. Determines a strategy for filling a Tetris well.</td>
</tr>
<tr>
<td></td>
<td>3. Breaks down an irregular floor plan into its component shapes.</td>
</tr>
<tr>
<td></td>
<td>4. Validate the results of student estimates.</td>
</tr>
<tr>
<td>1. Draws a model of each polyomino piece on graph paper.</td>
<td>1. Utilizes a selected strategy to estimate area of farm forest.</td>
</tr>
<tr>
<td></td>
<td>2. Finds the perimeter and area of an irregularly-shaped floor plan.</td>
</tr>
<tr>
<td></td>
<td>3. Finds the cost of flooring or molding.</td>
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</tbody>
</table>

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<tr>
<th>QUADRANT A (acquisition)</th>
<th>QUADRANT B (application)</th>
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</table>
Subject(s) Mathematics
Grade Level 6

Instructional Focus
Geometry
Students apply geometric concepts, properties, and relationships in a problem-solving situation. Students communicate the reasoning used in solving these problems.

Tools and Technology
Students use appropriate tools and technologies to model, measure, and apply the results in a problem-solving situation. Students communicate the reasoning used in solving these problems.

Student Learning
Students will realize that irregular right-angled shapes can have the same area but different perimeters.

Performance Task
Investigating Tetris and Pentaminoes is an interesting and motivating activity that gives students practice with spatial relations and the perimeter and area of irregular right-angled shapes. The accompanying worksheet can be used as a starting point to get students thinking about how these shapes were created out of squares. Students should be encouraged to realize that since the shapes are all made out of the same number of squares, their areas must be equal. The perimeters of the shapes, however, are not always equal. Astute students can probably verbalize a method for predicting the perimeter of a tetris or a pentamino shape.

A link to an Internet version of Tetris is provided below.
http://www.freetetris.org/

A pentamino is an arrangement of 5 unit squares (or sometimes cubes) that are joined along their edges. Up to isomorphism (rotating and flipping), there are 12 possible shapes, which are illustrated below.

The problem is to fit the 12 pentamino pieces into various shapes, often rectangles. The rectangle shapes that fit all 60 squares are of sizes 3x20, 4x15, 5x12, and 6x10. The National Library of Virtual Manipulatives has a digital version of
pentamino shapes that can be manipulated on the computer. Lesson plans and ideas for activities are also available on that website.

http://nlvm.usu.edu/en/nav/frames_asid_114_g_2_t_3.html?open=activities&from=category_g_2_t_3.html

http://sue.csc.uvic.ca/inf/misc/PentInfo.html

**Scoring Guide**

Evaluate student understanding of the area/perimeter relationship by reading journal entries about their observations. Use this as a type of formative assessment to adjust teaching strategies for more complex problems with irregular figures.

**Attachments/Resources**

Tetris Pentamino worksheet

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Pentamino:
Tetris is a game that uses shapes made up of 4 congruent squares placed edge to edge. There are 7 Tetris shapes. Draw them on the grid paper.

If each grid square measures \( \frac{1}{4} \) " by \( \frac{1}{4} \) ", what is the area of each Tetris shape?

On each shape in the grid, write its perimeter.

Tetris is a puzzle with the shapes each consisting of several squares, that are falling down a well that is 10 squares wide. The player can rotate them and move them left and right. The object is to try to make a solid line from side to side.

Draw the 7 Tetris shapes in the well so that there is a line from side to side.

Pentaminoes are 12 puzzle shapes that are made up of 5 squares linked edge-to-edge. Unlike Tetris, shapes, all 12 pentamino shapes are different, even if they are rotated. Draw all 12 pentaminoes on the grid paper.
If each grid square measures $\frac{1}{4}$ " by $\frac{1}{4}$ ", what is the area of each Tetris shape?

On each shape in the grid, write its perimeter.

It’s pretty hard to figure out, but there are lots of ways that you can use all 12 pentaminoes to fill in a 6 x 10 rectangle. Give it a try!

If you don’t already have access to a Tetris game, you can play it for free on the Internet. The website is: http://www.freetetris.org/

Good Tetris players develop favorite strategies for winning the game. One player explains her strategy this way: "I try to make solid lines in the centre, leaving empty vertical lines on the boards. When a long thin shape falls down, I fill the borders, deleting several lines at once. This brings me tons of points!"

After playing Tetris a few times, write down your favorite strategy. Using geometric vocabulary will get you more points!

You can make your own set of Pentamino pieces by cutting them out of cardboard or some other stiff paper. But if you like to use the computer, you can go to the National Library of Virtual Manipulatives and use digital pentamino pieces. The link is:

http://nlvm.usu.edu/en/nav/frames_asid_114_g_2_t_3.html?open=activities&from=category_g_2_t_3.html

Try to fill in a 6 x 10 grid with all 12 pieces. After working on this for a little while, write down some of the strategies you have to use to be successful.
**Subject(s)**
Mathematics

**Grade Level**
6

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### Instructional Focus

**Number Operation and Concepts**
Students use number, number sense, and number relationships in a problem-solving situation. Students communicate the reasoning used in solving these problems.

**Geometry**
Students apply geometric concepts, properties, and relationships in a problem-solving situation. Students communicate the reasoning used in solving these problems.

**Measurement**
Students use a variety of tools and techniques of measurement in a problem-solving situation. Students communicate the reasoning used in solving these problems.

**Tools and Technology**
Students use appropriate tools and technologies to model, measure, and apply the results in a problem-solving situation. Students communicate the reasoning used in solving these problems.

**Problem-Solving and Mathematical Reasoning**
Students apply a variety of problem-solving strategies to investigate and solve problems from across the curriculum as well as from practical applications.

### Student Learning

Students will use a grid with a given scale to estimate the area of an irregular shape in a real-world situation.

Students will use common shapes to simulate the area of a real-world irregular shape and will apply area formulas to estimate its area.

### Performance Task

(Use the accompanying worksheet, “forest area measurement” for background information and for the introductory student exploration.)

Forest management requires fairly accurate measurements of ground area along with other specialized measurements of tree volume. Farmers often incorporate forested area into their land management plans. Students are asked to brainstorm reasons that farmers might want to include this forested area on a farm. They then read a passage that instructs farmers in a method of measuring their forested area by using a GPS map and a grid overlay.

Google topographical and satellite maps are an easily-accessed source of aerial photographs of pretty much any area in the country. The worksheet shows an aerial photograph with a grid overlay and a scale. Students are asked to estimate the forested area using a grid method. Rulers should be provided.
Discuss the closest geometric shape of the forested area. The worksheet provides a drawing of this composite shape, with a scale, and asks students to use geometric formulas to find an estimated area.

Students should be asked to compare the estimates using the grid method and the geometric shape method. The class can generate a list of pros and cons for each.

To extend this introductory activity, students can be asked to download an aerial map of some other area – perhaps in their town – and to use an effective method to estimate the area of one feature on the map (golf course, amusement park, pond, baseball stadium, etc.). Students can communicate the mathematics that they used by making a presentation board to show to the class.

**Scoring Guide**

Scoring Guide Attached

**Attachments/Resources**

Worksheet: Forest Area Measurement and background information about forest measurement and PDF – pond measurement

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**Scoring Guide:**

Score student learning on a scale of 4 to 0, where

4 = Shows complete understanding
3 = Understands most concepts
2 = Shows understanding with some misconceptions
1 = Demonstrates understanding of only a few concepts
0 = Shows no understanding – needs more practice

<table>
<thead>
<tr>
<th>STUDENT LEARNING</th>
<th>SCORE</th>
</tr>
</thead>
</table>
| Students will use a grid with a given scale to estimate the area of an irregular shape in a real-world situation.  
  - Farm-forest problem  
  - Student project |       |

| Students will use common shapes to simulate the area of a real-world irregular shape and will apply area formulas to estimate its area.  
  - Farm-forest problem  
  - Student project |       |
The location of a forest can be marked on a farm plan or topographic map. Making a note of the map coordinates, or even the longitude and latitude, may be a requirement for joint ventures etc. The centre of the forest, a prominent corner or other referencing point may be used.

Where the forest includes areas of different species, age classes, soil types or performance, the areas may be separated into homogenous units so as to facilitate ease of forest measurement. This stratification makes the results more useful and accurate, and may even reduce the costs of any sampling procedure.

It is often crucial to obtain an accurate assessment of each forest block area. This is because most assessments of timber volume involve the measurement of a sample of trees rather than the whole stand. The results from the sample are multiplied out on the basis of the calculated net or stocked area of each block. Errors in area assessment can result in large errors in timber volumes.

To calculate the area, an accurate map of the forest boundary is required. The boundary might be defined by the location of tree trunks, the extent of the tree canopies or by the paddock boundaries. Maps can be based on field measurements of the length and bearings of every side of the plantation but this is often very time consuming. It may be easier to identify each block on a topographic map. This can be done using GPS data collected at each corner. If aerial photographs are available that show the boundaries of the forest, these can save time, although it may be necessary to make corrections for slope or photographic distortions.

Once calibrated for scale, many computer programs can generate areas of irregular shapes very quickly. Dot matrices or fine grids copied onto clear plastic sheets are useful for manually estimating the area of irregular shapes on farm plans, aerial photographs or topographic maps. For narrow belts it may be more practical to simply measure the length of belt rather than try and determine the effective area of the planting. Results may then be presented in terms of yield per 100m of belt rather than yield per hectare.

**Designing a farm forest**

Why would you want to grow or manage a forest? The responses to this question will vary widely but will generally relate to the financial, environmental, agricultural, non-agricultural or personal goals of farmers such as:

**Financial goals**
- investment
- diversification
- deferring income
- utilising unproductive land
- enhancing property values
- providing on-farm employment

**Environmental goals**
- controlling land degradation
- enhancing natural habitats

**Agricultural goals**
- shade and shelter
- controlling vermin and noxious weeds
- recycling or fixing soil nutrients
- fodder for stock

**Non-agricultural goals**
- enhance tourism potential

**Personal and lifestyle goals**
- wishing to leave a legacy
- watch a forest grow
- learn about the natural environment
- improve the view

Farmers’ participation in forestry is driven and constrained by diverse and complex motivations and limitations. Identifying clear motivations is the first step to designing appropriate farm forestry options.
FARM FORESTS

Why would a farmer want to create a forest area on a farm?

Brainstorm at least one reason under each category:

Financial: _______________________________________

Environmental: _______________________________________

Agricultural: _______________________________________

Non-agricultural: _______________________________________

Personal reasons: _______________________________________

Farmers might read this description about how to start planning a farm forest:

The location of an existing forest can be marked on a farm plan or topographic map. Make a note of the map coordinates or the longitude and latitude of the center or a corner of the forest.

To calculate the area, you must make an accurate map of the forest boundary. Maps can be based on actual field measurements of the length and bearings of every side of the forest but this is often very time-consuming. Aerial photographs that show the boundaries of the forest may be available on the Internet. These can be combined with GPS data collected at each corner of the forest.

Once calibrated for scale, many computer programs can generate areas of irregular shapes very quickly. If you do not have access to this technology, small grids copied onto clear plastic sheets are useful for manually estimating the area of irregular shapes on farm plans, aerial photographs or topographic maps.

Work with a partner to estimate the dark forested area shown below.

Scale: ______________

(Hint! Draw grids.)
Forests are just one example of shapes that are irregular. The forest in the photo looks sort of like a right-angled trapezoid with a semi-circle cut out of its side. The diagram below could be used to estimate the area of the forest.

Estimate the area of the forest by finding the area of the trapezoid and the area of the semi-circle and subtracting. You'll need to use a ruler. Show all work!
What is Forest Fragmentation and Why is it Important?

Forest fragmentation occurs when large, continuous forests are divided into smaller blocks, either by roads, clearing for agriculture, urbanization, or other human development. Ornithologists suspect that fragmentation harms many woodland birds by increasing their susceptibility to predation and nest parasitism.

Predators such as jays, crows, raccoons, and cats, as well as the parasitic Brown-headed Cowbird, typically are not abundant in extensive forests. But when a forest is fragmented, predators and cowbirds gain more access to the woodland. The importance of large areas of continuous forest for maintaining forest-interior bird species has been demonstrated in the eastern United States during the past 15 years.

It is important to distinguish between a forest that is fragmented by agricultural or urban development and a forested landscape composed of a mosaic of mature and regenerating stands that results from timber harvesting. The first situation typically is more damaging to forest bird populations and may represent permanent habitat loss, whereas the latter situation may only cause a temporary reduction in habitat for forest-interior species that rely on mature forests. Furthermore, early successional forests do provide habitat for many bird species, including some Neotropical migrants that are declining. Nevertheless, forest-interior species that require mature forests are affected by both sources of fragmentation. In most large landscapes, the needs of early successional species can be met quickly through various sources of disturbance, including timber harvesting. Much more time, however, is required to develop suitable habitat for species that require mature forest. Effective conservation strategies must focus on maintaining adequate amounts of mature forest at any point in time.

INTO THE WOODS

By Leslie Intemann

Through the Lab's Birds in Forested landscapes program, participants learn the finer points of bird study while gathering important scientific data on woodland thrushes and raptors.
It was the kind of spring day Upstate New Yorkers dream about during the seemingly endless gray days of winter, which are short on light and long on chilling temperatures. By 10:30 on that morning in late May, the sun's rays had warmed Sapsucker Woods to a most pleasant temperature in the low 70s Fahrenheit, and the dreary brown landscape of winter had turned spring green as new leaves blossomed throughout the forest. All was quiet within the canopy of trees save for the occasional rustle of leaves beneath our feet. A che-bek call rang out every so often as a Least Flycatcher tracked our progress through the trees. A Veery lighted on a nearby branch to watch us, too. An Ovenbird's teacher-teacher-teacher song echoed from afar. How fitting for the project of the day.

Lab biologists Jim Lowe and Sara Barker had the good fortune to be out on that gorgeous morning, collecting sample data for Birds in Forested Landscapes (BFL), a volunteer-based research project recently launched by the Lab of Ornithology. They hoped to attract Veeries, Wood Thrushes, and Hermit Thrushes, using sound recordings of the birds' vocalizations. But, Lowe and Barker weren't the only ones lucky enough to be working outside. This past year, hundreds of citizen scientists across the United States and Canada went into the woods during the breeding season to see and hear birds in forested landscapes.

Simply put, BFL is a continentwide study to look at the effects of habitat, and especially forest fragmentation, on the breeding success of thrushes and hawks. BFL focuses on seven species of North American thrushes--Wood Thrush, Veery, Swainson's Thrush, Gray-cheeked Thrush, Varied Thrush, Hermit Thrush, and Bicknell's Thrush and two forest raptors: Cooper’s Hawk and Sharp-shinned Hawk. Because BFL is a breeding survey, fieldwork starts after spring migration and wraps up before migration starts again in late summer.

BFL is the natural outgrowth of Project Tanager, which was one of three National Science Experiments developed by the Cornell Lab of Ornithology. (The other two were the Seed Preference Test and Project PigeonWatch.) These
experiments were designed to involve birders and amateur scientists across the continent in scientific research. Project Tanager studied the effects of forest fragmentation on four species of North American tanagers—Scarlet, Summer, Hepatic, and Western. Between 1993 and 1996, more than 1,500 groups of volunteers combed nearly 3,000 woodlots across the United States and Canada to find breeding pairs of these species.

Forest fragmentation results when large, continuous forests are chopped into smaller blocks by roads, logging, agriculture, or development. Many researchers suspect that fragmentation of woodland habitat makes the birds that reside there more vulnerable to predators and nest parasites. They point out that open-country and edge predators such as jays, crows, and cats, as well as the parasitic Brown-headed Cowbird, can easily penetrate forests that have been dissected by roads or power-line cuts.

Results from Project Tanager suggest that Scarlet, Summer, and Western tanagers are sensitive to the size of a potential habitat patch, and that the nature of the habitat surrounding a forest fragment can have just as significant an influence on the birds as the size of the fragment itself. In some locations, tanagers will nest in a small patch of forest—as long as the landscape surrounding that patch contains extensive amounts of forest.

Ken Rosenberg, project director of BFL, discusses why Project Tanager was just the tip of the iceberg when it comes to studying forest fragmentation. "Two difficulties cropped up with Project Tanager. First, people couldn't find nests, because tanagers nest high in the forest canopy. So, although we received a lot of information about where the tanagers were, we had almost no information on how fragmentation might actually be affecting their reproductive success. And second, we weren't able to determine the actual rates of nest parasitism and predation."

Thus, the idea for using the same protocol (sending volunteers out with sound recordings to take a targeted census at particular points, then measuring the habitat) on a different set of birds was born. The Lab chose thrushes because, like tanagers, at least one or more species can be found across most of North America. But, adds Rosenberg, thrushes nest on the ground or low in trees, making it easier for participants to find nests and thus enabling them to go one step further than Project Tanager, gathering vital data about rates of parasitism and nest predation in relation to forest fragmentation.

Another issue surfaced once the Project Tanager data were analyzed. "We figured out the minimum size required for a woodlot that is likely to have tanagers, and it turned out to be very small—tanagers were found in woodlots of just a few acres. We worried that, by using tanagers, we were studying at a scale that was not large enough to capture a landscape-level problem with
fragmentation," adds Rosenberg.

To compensate, the Cooper’s Hawk and Sharp-shinned Hawk were added to the group of species being studied by BFL, because, in theory, they require much larger areas of appropriate habitat than small songbirds to breed successfully. Additionally, BFL is studying large-scale features of the landscape, such as the percentage of forest in the 2,500 acres surrounding the census points and the distance to the next closest forest. In the end, BFL scientists will see which of these factors is most important in determining where these birds will be found.

But there’s something else about BFL that’s just as important as the data. And that’s the human quotient. The people at the Lab of Ornithology make these citizen-science projects work, because they’re honestly excited and inspired by what they’re learning. And they communicate their excitement to the participants. Ask members of the BFL team what they like best about this project, and they’ll tell you two things: getting out into the field and working one-on-one with volunteers.

Stefan Hames considers his involvement with BFL a "lucky break." Hames, who is a BFL research biologist, is also a graduate student pursuing a Ph.D. in Ecology and Evolutionary Biology at Cornell. In his thesis research, he is studying how birds of prey space themselves over the landscape—research that dovetails nicely with BFL. In addition to studying the effect of fragmentation on Cooper’s and Sharp-shinned hawks across North America, Hames will compare large-scale patterns derived from BFL data with the results of his local

Although the Sharp-shinned Hawks (above) and Cooper’s Hawks are secretive predators, they both respond to broadcasts of their own and related species’ vocalizations. Using sound recordings makes it easier to detect these two raptors, providing scientists with a detailed picture of their habitat requirements and an increased understanding of the effects of habitat fragmentation on their populations.
research in Tompkins County, New York. "This combination should help us tease apart the mechanisms underneath the patterns we see," says Hames. "This type of research would not be possible without the participation of volunteers."

Hames is also enthusiastic about BFL's potential role in educating the public about woodland raptors and its potential for involving new participants in the Lab's citizen-science projects. Moreover, as a former volunteer at California's Golden Gate Raptor Observatory who "turned pro," he knows how seriously volunteers take these projects and how many good researchers are out there among the so-called amateurs. "From both a research and an educational standpoint, it's just exciting to be able to tap into that network," he says.

If it sounds like BFL is a project for advanced birders only, think again. Jim Lowe, a Lab biologist since 1983, explains why BFL is within reach for all interested birders. "Even beginning birders are welcome to take part in the project, as long as they're willing to work a bit harder," says Lowe. "This is a fairly complex project that does entail more work than most citizen-science projects, but because you're working with a limited number of species, you don't have to be an expert birder. In most places, people have one, two, or maybe three thrushes they need to identify. If they can't identify these thrushes at the start, they can take our training tape and their field guides, and they can practice and learn just those few."

As Lowe says, the birding portion of BFL is relatively simple. The habitat portion is more challenging, because it involves procuring accurate maps or aerial photographs, measuring habitat patches, measuring the distance to the next closest forest, and writing up detailed site information. Although this may seem intimidating, Sara Barker, the BFL project coordinator, assures me that help is available to all who request it. "We start by giving people a list of site coordinators, many of whom are with land management agencies and have access to accurate maps or GIS mapping systems," says Barker. "We also recommend checking the natural resources department of your local college for mapping assistance."

"We talk to participants who feel overwhelmed," explains Lowe. "We encourage them to start small—pick just one site and practice this year, and if they feel good about it, they can turn in data next year." And Lowe's success rate? "After we talk, most people are willing to try."

The time each participant spends on BFL is also manageable for most people. To monitor one or two sites, the fieldwork—not including the drive or hike to
the site--takes about 30 minutes for each visit. Only two visits are required if you don't detect any thrushes or hawks at all. If you do find birds, you're encouraged to make extra visits to search for nests, check for fledglings, and look for signs of predators. The mapping portion takes an average of two hours per site. If you choose three or four sites, which is the average number of sites for BFL participants, your time involved might add up to two full days, but keep in mind that this time is divided into small portions from early spring until the data are due in September.

After all BFL data are collected and analyzed over the next three to four years, what's next? Extending the project to include other species, perhaps, and to secure that most significant goal--developing conservation guidelines. Rosenberg shoulders the task of analyzing the field data and translating the analysis into conservation guidelines. "If an area is going to be fragmented, we'll recommend the minimum size needed for forest blocks to maintain these forest birds, how close the forest blocks need to be, and whether they need to be in a continuous block. We'll also make habitat recommendations--what kind of trees the birds require for nest sites, how tall the trees should be, and how to make smaller woodlots more suitable for these birds by maintaining a denser understory or adding fruit trees or a water source, for example.

"Eventually," adds Rosenberg, "we'll be able to make recommendations to developers of state parks who would perhaps like to have Cooper's Hawks and a couple of species of thrushes on the property. At the largest scale, we'll be able to advise state and federal agencies how much forest is needed, at a county level, for instance, to maintain whole populations of these birds."

For more information on Birds in Forested Landscapes, write to BFL, 159 Sapsucker Woods Road, Ithaca, NY 14850; call (607) 254-2465; or send e-mail to <forest_birds@cornell.edu>.

Welcome BFL Participants
Thank you for taking part in the Birds in Forested Landscapes (BFL) research project. The data you collect will help to answer important scientific questions that can only be addressed through the collective efforts of thousands of volunteer birders like you. To assure the highest level of accuracy in your data collection, please carefully review the Project Summary and all instructions on this web site before you begin the study. BFL is a relatively simple and straightforward project, so don't be intimidated by the length of these instructions. We have tried to make them as thorough as possible, and to anticipate as many questions about the methodology as we could (see FAQ).

Complete instructions for participating are only available on this web site. They are organized by chapters, which are found under tabs at the top of the page. The best way to print these chapters is by opening the pdf documents located on the Print BFL Manual page under the Quick Links section. The BFL staff will mail you a CD with study species vocalizations for field use, an acetate grid overlay, and 2 nest record cards.

To begin, you will need good maps of your study area, binoculars, and a portable CD player to broadcast the recordings of your study species. If you prefer to use a cassette player, you may copy portions of the BFL CD onto cassette.
Next read the Project Summary for an overview of BFL and then begin in the General Instructions section. Move through each tab at the top of the page from left to right after navigating through the sidebar pages, as if you were reading a book.
Once you've completed your field work, please enter your data on-line under the Data Entry tab and send your Field Forms and maps to Cornell. If you can not enter data on-line, the BFL staff will enter them for you from your hard copies. Be sure to attach the correct amount of postage, and try to return this package by September 15. For a mailing address visit the Contact Staff page.

7. BFL Grid Overlay

This transparent grid can be used to measure your percentage of forest (link) if you are using a 1:24,000- or 1:25,000-scale map or aerial photograph (7.5 minute). See Landscape level characteristics and Appendix B. You will be sent the grid overlay through the mail.

Landscape Level Characteristics

- Outline a 2,500-acre (1,000-hectare) block with the survey point at the center
- For the 2,500-acre (1,000-hectare) landscape surrounding each survey point, calculate these variables using maps and record on the back of the Field Form:
  - patch edge
  - forest patch size
  - percentage of forest
  - linear distance of edge
- If your patch is less than 1,000 acres (400 hectares), calculate two measures of isolation for each forest patch (see “Isolation measurements” in this section)
- If you need help, contact a local site coordinator
- Send us maps or photos to help us visualize your site

For BFL to be successful, we need participants to describe the 2,500-acre block of landscape surrounding their study site. In particular, knowing what percentage of the surrounding area is forested and the amount of edge present will help us to understand the relationship between forest birds and forest fragmentation on a landscape scale.

We realize that, because these measurements are best taken from aerial photographs or up-to-date topographic maps, it may be difficult for you to provide this information. For assistance, refer to “How to get help: Working with site coordinators” in this section or contact the BFL staff.

If possible, clearly mark your study sites on a copy (or photocopy) of the aerial photos or maps you used to make your landscape calculations and send this to us. If obtaining the landscape information is causing you to delay sending us your data, please do not hesitate to call a site coordinator or the BFL staff for assistance.

- **Patch Edge**—Check all habitat/land-use types that are adjacent to your patch. You may need to answer this question in the field as well as at home while looking at your topographic maps. For habitat types such as secondary growth or natural shrub, you may need to drive or walk around the area surrounding your patch to actually see what habitat types ajoin your patch. Topographic maps will probably show land uses such as residential and industrial/commercial.
- **Forest Patch size**—Record the size of the forest patch. (See Appendix B for information on how to measure patch size). Also mark whether you determined the size by measuring (using a grid, pacing, GIS, etc.) or estimating. If you ask the landowners for patch size, try to find out if they measured or estimated it. In situations where one or more forest stands are connected by corridors, try to determine the total size of contiguous (connected) forest.
Making your calculations using the BFL grid

Begin by outlining a 2,500-acre (1,000-hectare) block on the map or photo with the survey point at the center. Use the transparent grid provided or Table 2 to find the dimensions of the block. Within this block, estimate the percentage of land that is forested and the total length of forest/nonforest edge.

- **Percentage of forest**—Estimate the percentage of forested land within the 2,500-acre (1,000-hectare) block surrounding your survey point. You can do this in several ways:
  - If you are using a 1:24,000- or 1:25,000-scale map or aerial photograph (7.5 minute), you can use the transparent grid overlay provided in this kit to measure percentages.
  - If you are using other map/photo scales, you will use a similar method, but with a different grid. You can create your own grid (with 100 or 1,000 squares) using the dimensions in Table 2. If your map scale is not listed in Table 2, you will have to calculate the dimension yourself. If you need help, contact a site coordinator or the BFL staff.
  - A site coordinator or professional land manager may be able to help you measure landscape characteristics.

- **Linear distance of edge**—Estimate the total linear distance of edge (the boundary between forest and nonforest habitats) within the 2,500-acre (1,000-hectare) block. Measure along the perimeter of all isolated forest patches as well as the boundary of any continuous forest. If several forest patches are located within the same 2,500-acre (1,000-hectare) block, calculate linear distance of edge as a total for all patches within the block (see Figure 1).

  If the boundary between forest and nonforest is fairly simple (straight and not very long) you can use a ruler to measure it, and then convert the measurement to linear feet or meters using the map or photo scale (Table 2). If your scale is not listed and you need help, contact the BFL staff.

  If the edge that you are measuring is convoluted, you can use either a map wheel or the “string method” to measure inches or centimeters on your map, then convert the measurement to linear feet or meters of edge.

  - **Map wheel**—This device is available for in-office use at most land management offices and some engineering or architectural firms. Trace the edge boundary with the wheel to measure edge length, then convert the measurement to feet or meters using the scale of your map or photo (Table 2).
  - **String method**—Lay a piece of string on your map or photo along the habitat edge boundary. Mark the string to indicate the length of the edge, then straighten it and measure the distance between the marks with a ruler. Convert to feet or meters using the scale of your map or photo (Table 2). Waxed dental floss works well because it is tacky and sticks to the photo or map.

**Isolation measurements**

Patch isolation is a measure of the distance from your forest patch to other forest patches. This measurement gives us another way of describing how your forest patch fits into the landscape, and how the arrangement of patches in the landscape might affect forest bird distribution and breeding.

**If your patch is 1,000 acres (400 hectares) or more, you do not need to complete this part of the form.** If your patch is less than 1,000 acres, please measure the distance from the edge of your patch to the nearest patch of 100 acres (40 hectares) or more and to the nearest patch of 500 acres (200 hectares) or more. Depending on the type of fragmentation surrounding your patch, you may be able to use the same photo or map you used to measure the percentage of forest and linear edge, or you may need a larger map.

To measure isolation, find the edge of your patch and look for the nearest neighboring forest patch of 100 acres (40 hectares) or more. Measure the distance on the map or photo from the edge of your patch to the edge of this neighboring patch and convert the measurement to either feet,
miles, meters, or kilometers using the map scale (see Table 2). Mark this distance on your form under the category “100 acres (40 hectares) or more” (located on the right under “Isolation measurements”) and indicate whether it was measured in feet, miles, meters, or kilometers.

Now look for the nearest patch of forest that is 500 acres (200 hectares) or more. Again, measure the distance from the edge of your patch that is closest to the edge of this larger neighboring patch and convert this measurement to feet, miles, meters, or kilometers. Mark this distance on your form under the category “500 acres (200 hectares) or more” and indicate the units. Note that if the first neighboring patch of 100 acres (40 hectares) or more also happens to be 500 acres (200 hectares) or more, you should use the same distance for both measurements.

If your patch is very isolated (miles from the nearest patch of 100 or 500 acres or 40 or 200 hectares), you may estimate the distance to the neighboring patches. Be sure to mark “mi” or “km” to indicate “miles” or “kilometers.”

**Appendix B: Determining forest patch size**

Determining the sizes of the forest patches in which your study sites are located is critical to BFL. Here’s how to do it. First, identify and outline the forest patch on your aerial photo or map. You can use tracing paper or clear acetate if you don’t want to write directly on the map or photo. If the edge of your forest patch is not distinct, consider areas with less than 15 percent tree canopy cover as nonforest. For this study, a change in tree species is not considered an edge. However, any gap in the forest patch more than 300 feet (90 meters) wide is considered an edge. If your forest patch is connected to other forested areas by a forested corridor, then for the purpose of this project your patch is part of the larger, interconnected forest; measure the total area.

Once your patch is outlined, you can measure patch size in several ways:

- **Grids**—If you are using maps or aerial photographs with a 1:24,000 scale (such as 7.5-min. USGS topographic maps), you can use the transparent grid overlay provided in this binder. Lay the grid over the outline of the patch. Count the number of squares in the grid that are at least half filled by the forest patch, then multiply this number by a conversion factor of 2.5 to estimate the area in acres or 1.0 to estimate the area in hectares. (Each square in the grid provided in this binder represents 2.5 acres or 1 hectare.) If you are using a different scale, refer to Table 2 on page 2.13 of the Study Site Instructions section.

- **Pacing**—If the patch is small, you can pace its dimensions on the ground, then calculate the area from your estimates of distance. Refer to Appendix A for information on measuring your pace.

- **Assistance of land managers**—If you have teamed with professional land managers, you may be able to enlist their assistance in measuring patch size. They may have planimeters or computer mapping systems that allow easy and accurate measurements.

NOTE: If your study site is in a forest patch larger than 500 acres (200 hectares), you may estimate the size to the nearest 100 acres (40 hectares). If the patch is larger than 5,000 acres (2,000 hectares), estimate to the nearest 1,000 acres (400 hectares).
Forest Fragmentation Lab

**Problem**: How does Forest Fragmentation affect the quality of a forest?

**Background Information:**

*Forest Fragmentation*

Forests used to cover much of our area hundreds of years ago, but early European settlers cleared much of the forest for farming, especially for tobacco. By the early 1800’s there was even less forest than there is today. However, what forest we have is broken up or fragmented by farms, houses, and roads. If you’ve ever flown over our county or see a satellite photo, the areas of forest look like little islands.

It would seem that a fragmented forest is still forest and habitat for forest species. Why is it that there are fewer species in a fragmented forest, and why does the shape of the forest matter? A smaller forest means less variety in habitat, but it also make it easier for predators and the cowbird to get into forest areas. A forest over 100 hectares could have most forest species and even the most sensitive species while under 10 hectares, forest species would be rare. Between 10 and 100 hectares, sensitive species would usually not be found but area tolerant species could be found.

*Predation and Brood Parasitism*

Predators can affect the population of bird species by eating eggs and young. In a smaller fragment, predators are found in larger numbers than in a larger forest. This is because a predator can only go so far into a forest, and a smaller fragment will have less and less interior to edge as it gets smaller. If a predator can only go in 50 feet and the fragment is only 100 feet wide, the predators can go all the way to the center of the forest, and, therefore, there is no safe interior for a bird. So as the forest fragments get smaller it is harder to successfully nest. Some of these predators include raccoons, foxes, skunks, opossums, squirrels, rat snakes, crows, blue jays, grackles, feral and pet dogs and cats.

Not only do predators affect the nesting success of birds in fragmented forest, but brood parasites such as the Brown-headed Cowbird are a major factor. The Brown-headed Cowbird is a bird species that will lay its eggs in another bird’s nest. Since the cowbird’s eggs will hatch quicker than the rest and get most of the food, the other young will die, and the cowbird will grow. Many times the adult cowbird will eat or destroy the host egg so that the female does not notice a change in her nest. This brood parasite, like the predators, only enters a forest so far. It has been shown that a cowbird can only enter 100 meters into a forest. Research has shown that Brown-headed Cowbirds and many predators are common in fragmented landscapes.

The important part of a forest for forest dwelling species is the interior where predators and cowbirds do not go. We will refer to this as Quality Interior Forest. In this lab, we are first going to draw forest shapes and put buffers on them. Then we will see what happens to the amount of interior for each shape. Then we will use ArcView to put buffers on actual forests to see how much quality interior forest there is in our area.
Pre-Lab Activity:
1. Draw Shape 1: a rectangle that is 3 cm x 24 cm.
2. Draw Shape 2: a rectangle that is 6 cm x 12 cm.
3. Draw Shape 3: a rectangle that is 9 cm x 8 cm.
4. What is the area of each?
5. Put a 1-cm buffer inside of each shape, and shade the buffer areas as in the diagram above.
6. Calculate the area of the remaining interior of each.
7. Calculate the percentage that the Remaining Interior Area is of the original Beginning Area of each shape.

Pre-lab Data:

<table>
<thead>
<tr>
<th>SHAPE</th>
<th>Beginning Area</th>
<th>Remaining Interior Area</th>
<th>Percentage (%) of Beginning Area Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHAPE 1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SHAPE 2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>SHAPE 3</td>
<td></td>
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</tbody>
</table>

Using ArcView to Calculate the Area of Forests
1. Start ArcView if it is not already running.
2. Select “Opening an existing project”, and open the “Forests.prj” file from the “C://GIS/Forests” directory.
3. Make sure “Forests” Theme is active/selected.
4. In X-Tools Menu, Select “Calculate Area, Perimeter, Length, Acres, Hectares”.
5. In box that opens, select “Forests”, and hit OK.
6. Hit Table Icon (Open Theme Table), or under Theme Menu, select “Table”.
7. You will see the area of each of the forests in both acres and hectares. (1 hectare is 10,000 sq. meters.)
8. Count how many forests there are. How many are greater than 10 hectares, the area needed for even the most tolerant forest interior birds.
9. To find the total area of all the forests, highlight the “hectares” field in the table.
10. Under the Field Menu, select “Statistics”. You will see the sum of all the forest areas in the box. Record this data.
11. Close the table. If continuing, leave the project open. When done, close the project, but DO NOT save it.

**Put a 100-meter buffer inside of these forests.**
*(Here we will make a new theme, which is a 100-meter buffer inside the perimeter of each forest.)*

1. Open the “Forests.prj” file from the “C:/GIS/Forests” directory if not already done.
2. Make sure “Forests” Theme is active/selected.
3. Under X-Tools Menu, choose “Buffer Selected Feature”.
4. Make sure units are “Meters”.
5. Select “Forests” as Input Theme to Buffer.
6. You will be asked to choose where you will save the file you are building. Go to the “C:/GIS/Students” directory and name the file “Buffer.shp”.
7. For Select Buffer Input, select “Buffer Distance”.
8. For Buffer Distance, type in “-100” so that the buffer is put inside the forest perimeter.
9. For Buffer Option, select “Inside/Outside”.
10. For Output Structure, select “Contiguous”.
11. Turn on the Buffer Theme by putting a check in the theme box.
12. Save the Project.

**Make a New Theme for the Forest Interior.**
*(Here we will make a new theme, which is a 100-meter buffer inside the perimeter of each forest.)*

1. Open the “Forests.prj” file from the “C://GIS/Forests” directory if not already done.
2. From X-Tools Feature, select “Erase Features”.
3. For Select Input Theme, Select “Forests”.
4. For Select Erase Theme, select “Buffer.shp”.
5. You will then be asked to Name and save the Output Theme. This will be a Theme that subtracts the buffer from the original forests. Go to the “C://GIS/Students” directory and name the file “Interior.shp”.
6. Turn off the Forests and Buffer Themes by unchecking them. What will be left is the Quality Interior Forest, the area that predators and cowbirds cannot get into.
7. To find the area of the Quality Interior Forests, make the Interior theme active.
8. In X-Tools Menu, Select “Calculate Area, Perimeter, Length, Acres, Hectares”.
9. In box that opens, select “Interior.shp”, and hit OK.
10. Hit Table Icon (Open Theme Table), or under Theme Menu, select “Table”.
11. You will see the area of each of the Forest Interior in both acres and hectares.
12. To find the total area of all the forest interiors, highlight the “hectares” field in the table.
13. Under the Field Menu, select “Statistics”. You will see the sum of all the forest interiors in the box. Record this data.
14. Close the table. If continuing, leave the project open. When done, close the project, but DO NOT save it.

**Forest Interior Data**

**Finding How Many Local Forests are Suitable for Forest Birds**

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<table>
<thead>
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<tbody>
<tr>
<td><strong>Number of Forests Total</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Number of Forests &gt; 10 hectares</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% of Forests &gt; 10 hectares</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Number of Forests &gt; 100 hectares</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% of Forests &gt; 100 hectares</strong></td>
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</table>

**Area (hectares)**

<table>
<thead>
<tr>
<th></th>
<th>Original Forests</th>
<th>% that Interiors are of Actual Forests</th>
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</thead>
<tbody>
<tr>
<td>Quality Forest Interiors</td>
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<td></td>
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</tbody>
</table>

**Finding How Many Interior Forests are Suitable for Forest Birds**

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<tbody>
<tr>
<td><strong>Number of Forests Total</strong></td>
<td></td>
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<td><strong>Number of Forest Interiors &gt; 10 hectares</strong></td>
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<td><strong>% of Forests Interiors &gt; 10 hectares</strong></td>
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<td><strong>Number of Forest Interiors &gt; 100 hectares</strong></td>
<td></td>
</tr>
<tr>
<td><strong>% of Forests Interiors &gt; 100 hectares</strong></td>
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</tbody>
</table>

**Questions:**

1. Of the original forest area, how much is quality interior forest?
2. If these forests are representative (typical) of those in this area, how would you evaluate the quality of forests in this area as habitat?
3. Looking at the map of the original forests, what general changes would you recommend to significantly increase the amount of quality interior forest.

**Conclusion:** (Answer the problem. Support your answer both with background information and with data.)
| CMS Main Menu | George M. Radcliffe  
Centreville Middle  
School  
231 Ruthsburg Rd.  
Centreville, MD 21617  
1-410-758-0883, ext. 277  
radclifg@qacps.k12.md.us |
<table>
<thead>
<tr>
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<td>Radcliffe Menu</td>
<td></td>
</tr>
<tr>
<td>Unit Main Menu</td>
<td></td>
</tr>
</tbody>
</table>
HOME IMPROVEMENT

Subject(s)          Rigor/Relevance Framework
Mathematics         Number Operation and Concepts

Grade Level         Students use number, number sense, and number relationships in a problem-solving situation. Students communicate the reasoning used in solving these problems.
6                    Geometry

Instructional Focus Students apply geometric concepts, properties, and relationships in a problem-solving situation. Students communicate the reasoning used in solving these problems.
Focus

Rigor/Relevance Framework
Measurement
Students use a variety of tools and techniques of measurement in a problem-solving situation. Students communicate the reasoning used in solving these problems.

Tools and Technology
Students use appropriate tools and technologies to model, measure, and apply the results in a problem-solving situation. Students communicate the reasoning used in solving these problems.

Problem-Solving and Mathematical Reasoning
Students apply a variety of problem-solving strategies to investigate and solve problems from across the curriculum as well as from practical applications.

Student Learning
Students will find the area of composite two-dimensional shapes.

Performance Task
Home improvement encompasses carpeted floors, new countertops, crown molding, wallpaper borders, and tiled showers – just to name a few! Each of these projects requires accurate measurement of area or perimeter, often of irregular shapes.

Students should choose at least two home improvement projects to analyze; one that requires the calculation of area and one that requires the calculation of perimeter. The shape of each project must be irregular. Students can find floor plans or room diagrams in magazines, on the Internet or by measuring a room in their home. For instance, a student might find a floor plan of an L-shaped kitchen and determine its total area by calculating the area of the component shapes. The student should then research the cost of covering the floor with either carpet or tile. The area should be converted into either
square feet or square yards and the cost of the flooring should be estimated. Next, the student should research the cost to place molding around the edge of the floor (or ceiling) of this irregular space.

Students should submit a picture or diagram along with their calculations of area and perimeter and their cost estimate.

Ask students to exchange their area and perimeter calculations along with their cost estimate. Pairs of students or groups of four can work together to validate the results.

**Scoring Guide**

Scoring Guide Attached

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**Scoring Guide:**

Score student understanding of calculating irregular area and perimeter on a scale of 4 to 0, where

4 = surpasses expectations;
3 = high quality performance;
2 = satisfactory performance;
1 = minimum quality performance;
0 = does not meet expectations

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>Trial Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagram chosen contained an example of irregular area</td>
<td>0 1 2 3 4</td>
</tr>
<tr>
<td>Area of the irregular shape was calculated correctly</td>
<td></td>
</tr>
<tr>
<td>Perimeter of the irregular shape was calculated correctly</td>
<td></td>
</tr>
<tr>
<td>Cost of flooring/countertops, etc was correct.</td>
<td></td>
</tr>
<tr>
<td>Cost of molding, border, etc was correct</td>
<td></td>
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</tbody>
</table>
Students With Disabilities

First of all, make sure that students know how to compute areas of single geometric figures. When a student is given a composite figure, the single figures from which it is composed may not be obvious. The teacher should provide tracing paper or colored paper or plastic overlays that the student can cut or outline to show the individual geometric shapes. Students can figure the areas then add or subtract to find the area of the irregular shape.

When a diagram is partially labeled and the measure of some sides is missing, students can use colored pencils to mark the known measures, using the same color on congruent sides.

English Language Learners

ELL students may have a particularly difficult time learning geometric terms because the vocabulary is so specialized. Essentially, geometry is like a third language for them to acquire! Geometric terms are also not commonly used in everyday discussions so the opportunity for reinforcement is minimized. ELL students should be given lots of occasions where they can engage in conversations using geometric vocabulary. Writing about geometry in the form of journal entries shared between ELL students and the teacher can provide helpful feedback for students.

Teach ELL students about roots of geometric terms – often based on Latin or Greek roots. For instance poly means many, pente means five, tetra or quad means four, circum means around.

Extended Activities for Enrichment

Print out the PDF document from the Penn State School of Forest Resources entitled, “Measuring Pond Area and Volume.” This is a document that explains real-world techniques for accomplishing this. Accelerated students can read the document, learn about the method and compare it to the skills in this benchmark.

http://pubs.cas.psu.edu/FreePubs/pdfs/XH0012.pdf
Dana plans to paint the front face of her doghouse, as shown by the shaded region below. The face is rectangular in shape, with 2 congruent rectangular doorways cut out.

Dana needs to calculate the area of the shaded region to be painted so she can purchase the correct amount of paint. What is the area of the shaded region of her doghouse that needs to be painted?

A. 5 square feet
★ B. 10 square feet
C. 10.5 square feet
D. 12.5 square feet
Sample Item 15  GR

Mr. Lindbrook wants to purchase molding to place around the edges of the ceiling in his family room. The shape and dimensions of his family room are shown below.

**Dimensions of Mr. Lindbrook’s Family Room**

![Diagram of a rectangular room with dimensions labeled: 15 feet by 9 feet, with a protruding section of 5 feet by 3 feet, and a 5 feet by 5 feet section.]

Mr. Lindbrook needs to know the perimeter of the family room in order to know how much molding to purchase. What is the perimeter, in feet, of Mr. Lindbrook’s family room?

**Sample Response** 54

**Item Context** Social Studies/Consumerism
Kevin owns a minivan that has a flat, rectangular space in the back. When the rear seats of the van are folded down and moved forward, the rectangular space in the van is increased by 2 feet in length, as shown in the diagram below.

![Diagram of Kevin's Van]

By how many square feet does the area of the rectangular space increase when the van's seats are folded down and moved forward?
1.  http://illuminations.nctm.org/LessonDetail.aspx?ID=L580  This lesson leads students through an investigation of the area formula for trapezoids. It includes an Applet that illustrates the concept that the average length of the two bases is what is used to multiply with the height to calculate area.

2.  http://illuminations.nctm.org/LessonDetail.aspx?ID=L583  This is a lesson in which students develop strategies for calculating the area of irregular figures.

3.  http://illuminations.nctm.org/LessonDetail.aspx?id=L269  This lesson requires students to use patterns, perimeter, area and analysis to solve problems.

4.  http://www.shodor.org/interactivate/lessons/LengthPerimeterArea/  This lesson uses one of many digital resources that can be found on www.shodor.org. It leads students through an exploration of right-angled irregular shapes including their areas and perimeters.


6.  http://wilson.coe.uga.edu/EMT668/EMAT6680_2000/Simmons/emat6700/Chapter1/perimeterarea.htm  This lesson explains one way to use The Geometer’s Sketchpad to aid in calculating the area of irregular right-angled figures.

7.  http://nlvm.usu.edu/en/nav/frames_asid_114_g_2_t_3.html?open=activities&from=category_g_2_t_3.html  This electronic manipulative is found on the National Library of Virtual Manipulatives. Pentaminoes are a set of the 12 irregular shapes that can be made by placing 5 squares edge-to-edge. They can be used for all sorts of activities concerning the area and perimeter of irregular polygons.


10. http://www.sanctuaryasia.com/kidsfortigers/teachers/maths.pdf  This is a lesson plan about a tiger preserve in India that simulates the area needed for animals in an ecosystem and uses an estimation method to find irregular area.

11. http://www.shodor.org/interactivate/activities/PerimeterExplorer/  Irregular shapes are shown on a grid and the student compares area and perimeter.