

Timber Harvest Planning Using GIS

— by Alexandra Locher

Introduction

Problem

Where should timber harvest occur, and how will it affect wildlife?

Forest and wildlife managers must work together to ensure that forest management practices are meeting timber and wildlife goals. Harvesting timber provides an important resource for commodities such as paper, plywood, furniture, and many others. Harvesting timber also affects wildlife. Habitat for some species may be enhanced, while habitat conditions for other species may be temporarily diminished or lost. Forests are always changing in space and time due to harvesting and natural disturbances such as windthrow or fires.

Therefore, it is extremely useful for managers to understand how these changes might impact production or wildlife habitat. In this lab, students will determine the spatial location of timber harvest and predict how the proposed harvest will affect habitat conditions for ruffed grouse (*Bonasa umbellus*).

Location

The physical location is in Michigan's western Upper Peninsula, but the processes used to answer the spatial question are applicable to any area where timber harvesting occurs.

Time to complete the lab

This activity should take approximately two hours.

Keywords: forestry; habitat; land-use planning; Michigan; timber harvest; wildlife; vector; attribute queries; location queries; joining tables; field calculator; creating layouts

Prerequisites

This exercise is intended for introductory- or intermediate-level students with some background in GIS.

Data used in this lab

- Forest_stands: Forest stand boundaries for study area (vector, shapefile)
- Rivers_streams: Rivers and streams (vector, shapefile)
- Geographic coordinate system: GCS_North_American_1927
- Datum: D_North_American_1927
- Projection: Hotine_Oblique_Mercator_Azimuthal_Natural-Origin

Student activity

Forests are managed for multiple objectives. On public land, state and federal agencies manage timber, wildlife habitat, aesthetics, and human recreation. In industrial forests, timber is the primary objective, but wildlife habitat also may be incorporated into management plans. Natural resource managers and planners must carefully prepare management plans and understand how those plans might affect the spatial pattern of vegetation types in the resulting landscape, which may in turn affect the availability of wildlife habitat. For instance, aspen is an important timber resource used to produce commodities such as paper, pallets, boxboard, and plywood. It is extensively harvested and managed for production in many areas including the Great Lakes region. Aspen also provides valuable habitat for many wildlife species. One such species is the ruffed grouse, a popular game bird in northern regions and in portions of the Appalachian Mountains. In northern states, ruffed grouse are associated with early successional forest types such as aspen. Many natural resource agencies and private landowners manage their lands for grouse.

As the GIS specialist for a natural resource agency, you are charged with identifying the spatial location and consequences of timber harvests on production and ruffed grouse habitat.



Specifically, you are interested in understanding

- How much area (in acres) of aspen is there in state-owned public and industrial forests?
- How much area of aspen will be harvested?
- How much volume of timber will be harvested from state-owned public and industrial private forests?
- How much area can be considered potential ruffed grouse habitat prior to timber harvest?
- Does the amount of potential grouse habitat increase or decrease following implementation of the timber harvest plan? By how much?

You spoke with the forest manager and the wildlife manager for your agency, and they provided several pieces of information that are critical for answering the spatial question. Their information is provided below.

Timber harvest information

The forest manager stated that the agency wants to develop a harvest plan for the next 10 years for aspen. Thus, harvesting will only occur in aspen stands. Aspen can grow on a variety of soil types, and therefore, production varies. For instance, less timber can be produced on dry, sandy soils than on rich, loamy soils. Equations for calculating volume have been determined by the forest manager from previous data. All timber managers try to implement best management practices, which include protecting water bodies from erosion and sedimentation due to cutting trees too close to the water. Therefore, harvesting cannot occur within 100 feet of a river or stream.

Harvesting criteria for aspen on state-owned public lands include

- 100-foot buffer along rivers and streams
- Only stands ≥ 20 acres
- Only stands with soil types characterized by well-drained loamy sand, well-drained loam, and well-drained sandy loam
- Only stands ≥ 50 years old

Harvesting criteria for aspen in industrial lands include

- 100-foot buffer along rivers and streams
- All aspen ≥ 40 years old

Very little aspen will likely be harvested in nonindustrial private forests, so your model will not include these forests.

Volume Equations

| Soil type | Volume equation |
|--------------------------|--------------------------------|
| Excessively drained sand | $y = 14.318 * \ln(x) - 36.695$ |
| Well-drained sand | $y = 17.373 * \ln(x) - 49.959$ |
| Well-drained loamy sand | $y = 14.378 * \ln(x) - 36.808$ |
| Well-drained sandy loam | $y = 24.572 * \ln(x) - 75.969$ |
| Well-drained loam | $y = 15.319 * \ln(x) - 41.775$ |
| Moderately drained loam | $y = 17.109 * \ln(x) - 48.980$ |
| Poorly drained silt | No harvest |

Table 1. Equations for calculating volume on different soil types. Volume (y) is a function of age class (x) on various soil types. Volume is determined in cords per acre.

Wildlife habitat information

The wildlife manager would like a general idea of how ruffed grouse habitat will change after implementing the timber harvest plan. He decided that an extremely general model of habitat suitability would suffice to get an idea of what areas would likely provide habitat versus other areas that likely wouldn't. His model classifies habitat as high, medium, and low quality and nonhabitat according to the following criteria:

- High-quality habitat consists of aspen ≤ 20 years old adjacent to aspen ≥ 50 years old. The younger aspen provides cover and the old aspen provides high-quality food.
- Medium-quality habitat consists of aspen ≤ 20 years old adjacent to oak stands. Oak may provide food, but it is not as preferred by grouse as aspen.
- Low-quality habitat consists of other aspen stands ≤ 20 years that are not adjacent to old aspen or oak.
- Nonhabitat is all remaining areas.

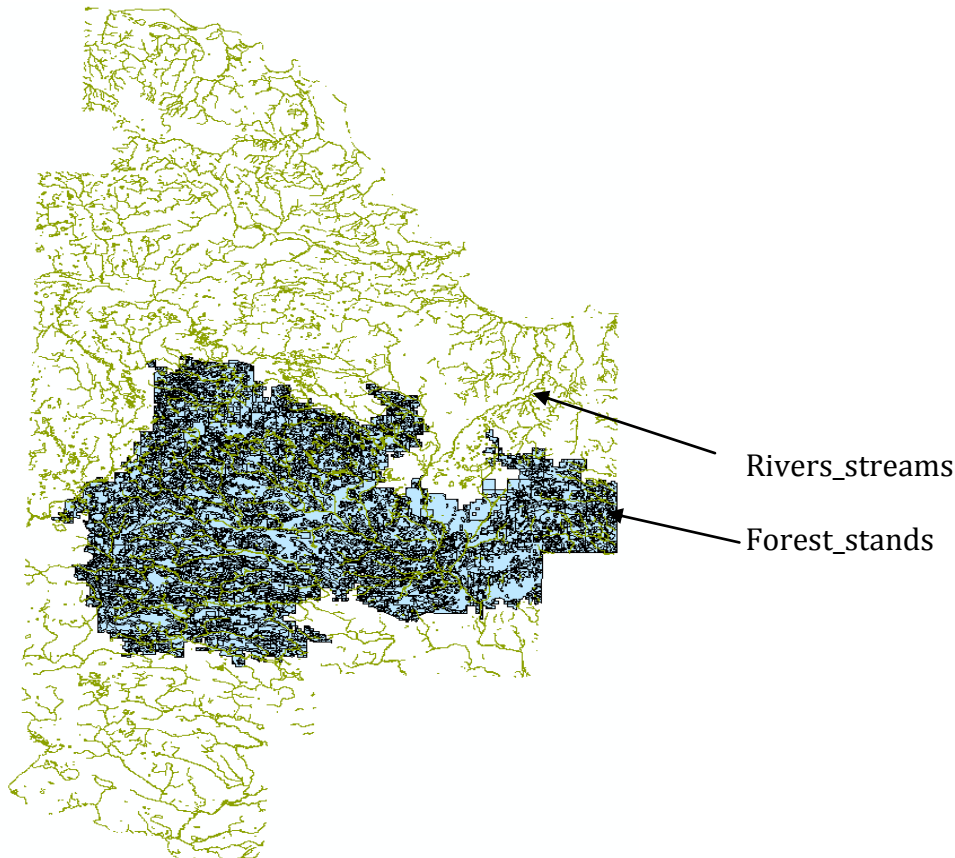
GUIDELINES FOR PLANNING TIMBER HARVESTS AND ASSESSING RUFFED GROUSE HABITAT QUALITY

ADD SPATIAL DATA TO ARCMAP

Make sure you are connected to the folder where your spatial data is stored.

- 1 Add the *forest_stands* and *rivers_streams* files to ArcMap by using the *Add Data* button or by dragging it from ArcCatalog.

The map should resemble this:




GET ALL DATA INTO A SPATIAL FORMAT

For this exercise, you have two types of datasets. One type consists of shapefiles, which are spatially explicit. The other type is a nonspatial comma-delimited file (*stand_data.csv*). Add this file into ArcMap, also.

As a GIS expert, occasionally you will receive nonspatial tabular data that you will need to incorporate into your GIS analysis. This is ordinarily not a problem, but there are certain requirements that determine whether the nonspatial tabular data is useful. You can view the data using Microsoft Excel, another spreadsheet program, or ArcCatalog. First, ask yourself if there are any *x,y* coordinates in the table. If there are, you can use them to project the data spatially. If there are not any coordinates, can the data be joined to another spatially referenced table based on a common field? If not, the data is probably not going to be useful to you. In this case, the comma-delimited file does not contain *x,y* coordinate information. Therefore, you can probably join the tabular data with a shapefile. To determine if joining is possible, the tabular data and the shapefile must share a common field. In this case, the *Stand_ID* field is common to the *forest_stands* shapefile. That is the field on which you will base the join.


- 1 Identify a field common to both tables: *Stand_ID*.

Common field



| | B | C | D | E | |
|---|----------|-------------------------|-----------|------------|-------------------|
| 1 | Stand_ID | Soil | Age_class | Ownership | Veg_type |
| 2 | 4066 | well-drained loamy sand | 999 | industrial | upland shrub |
| 3 | 4173 | well-drained loamy sand | 999 | industrial | lowland forest |
| 4 | 4280 | well-drained loamy sand | 999 | industrial | northern hardwood |
| 5 | 4387 | poorly-drained silt | 20 | industrial | aspen |
| 6 | 4494 | well-drained loamy sand | 999 | industrial | openland |
| 7 | 4601 | poorly-drained silt | 999 | industrial | lowland forest |
| 8 | 4708 | well-drained loamy sand | 70 | industrial | aspen |

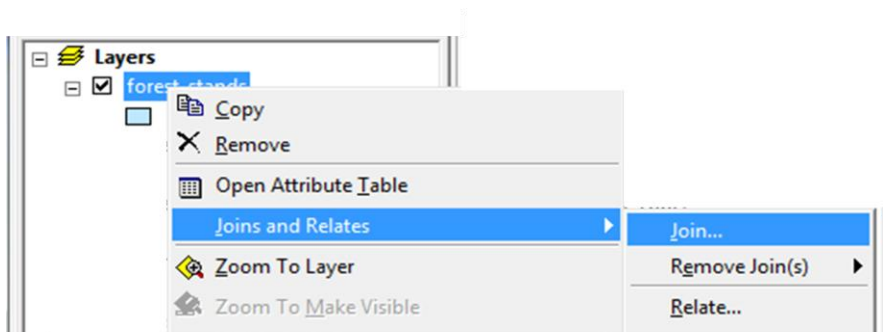
Common field



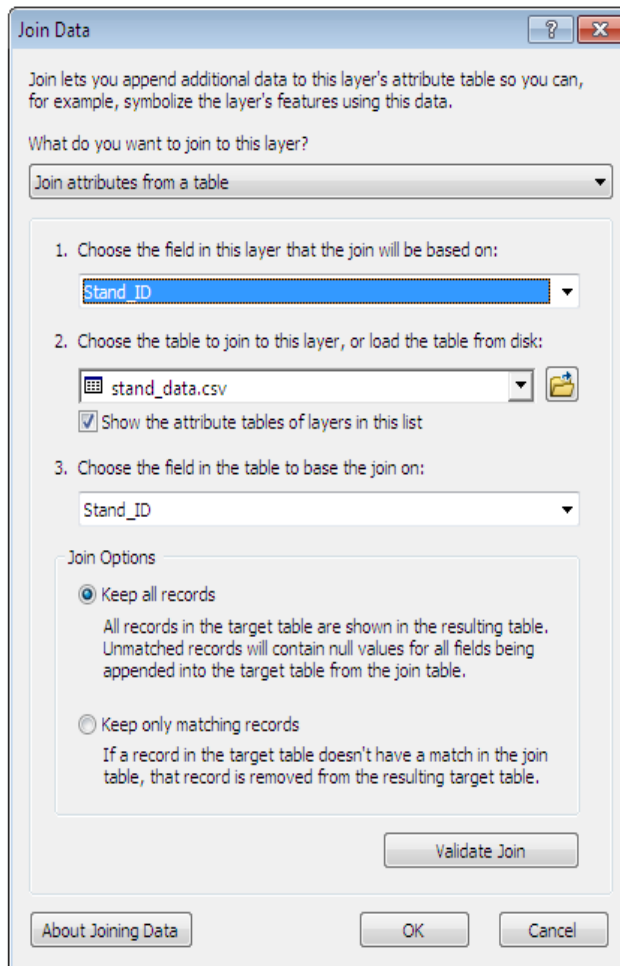
Attributes of forest_stands

| FID | Shape * | Stand_ID | Veg_type |
|-----|---------|----------|-------------------|
| 0 | Polygon | 4066 | upland shrub |
| 1 | Polygon | 4173 | lowland forest |
| 2 | Polygon | 4280 | northern hardwood |
| 3 | Polygon | 4387 | aspen |
| 4 | Polygon | 4494 | openland |
| 5 | Polygon | 4601 | lowland forest |

- To join layers, right-click the *forest_stands* shapefile, click *Joins and Relates*, and then click *Join*.



- 3 Make your dialog box look like the one below and click *OK*.



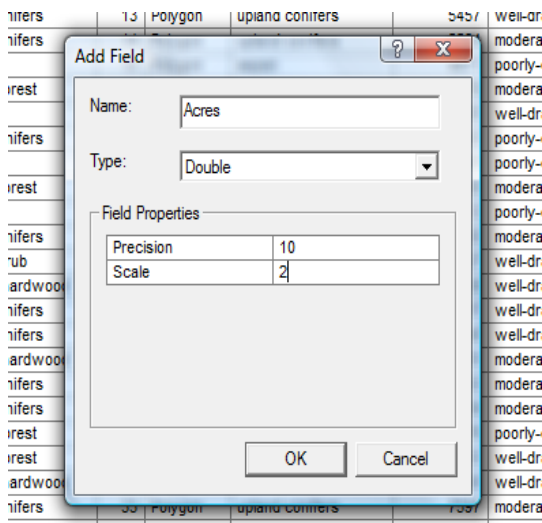
- 4 The resulting attribute table for the *forest_stands* shapefile should now contain all the information reported in the *stand_data* comma-delimited file. Because queries are much slower on joined files, export the data to a new shapefile to lock in the new joined columns. Right-click the *forest_stands* shapefile in the table of contents and select *Data » Export Data*. Name the file *joined_forest*.

DETERMINE HOW MUCH AREA OF ASPEN THERE IS ON DIFFERENT LAND OWNERSHIPS

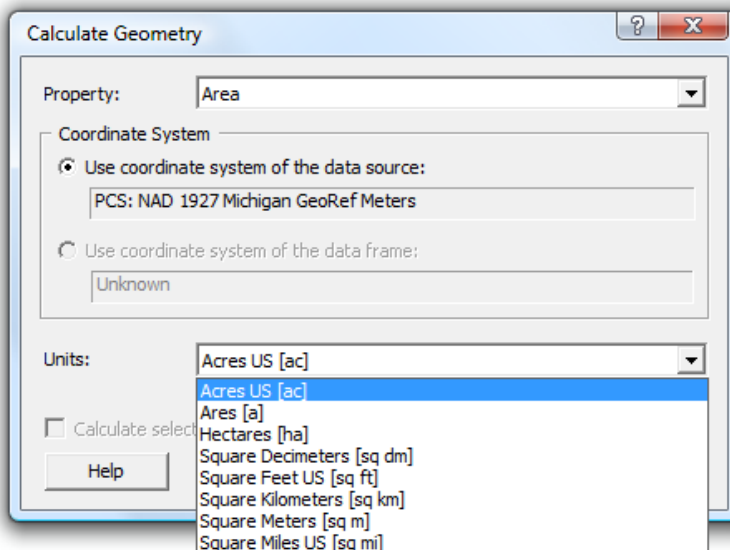
To answer the question of how much aspen area occurs on state-owned public and industrial forestland, you must first calculate area.

- 1 In the attribute table for the *joined_forest* shapefile, click the *Table Options* button at the top left and select *Add Field*. Name the new field *Acres* and specify the type as *Double*. Make the

precision 10 and the scale 2. Remember that *Precision* is the field width and *Scale* indicates the number of decimal places. Click *OK*. The new field is added to the end of the table.

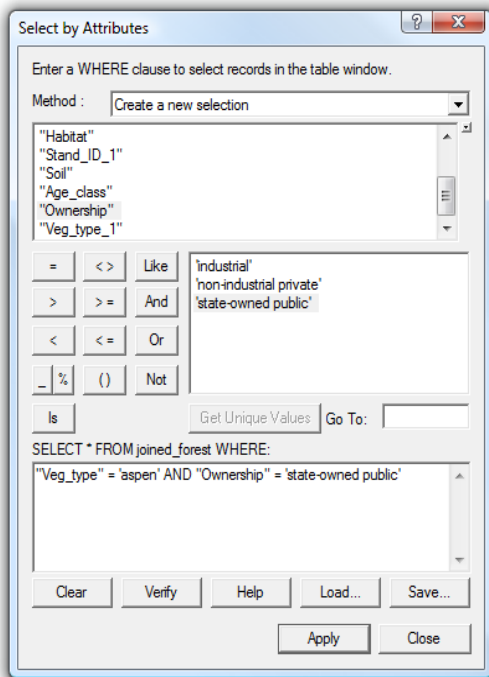


- 2 Now, you can calculate area. Right-click the new *Acres* field and select *Calculate Geometry*. A warning will appear indicating that you are outside an edit session. This is okay. You can click *OK* and proceed.
- 3 On the dialog box, specify the property as *Area* and the units as *Acres US*. Click *OK*.



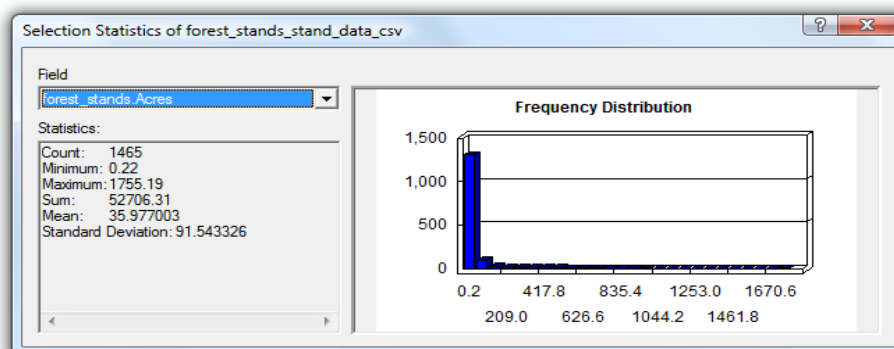
Now, you have acres for all stands, but you need to isolate aspen on state-owned public and industrial private lands.

- 4 Now would be a good time to do an attribute query. Click the *Table Options* button again, but this time, click *Select By Attribute*.
- 5 Create a new selection from the *joined_forest* shapefile, where the vegetation type is aspen and the ownership is state-owned public lands. Click *Apply*.



The query should have returned 1,465 records. You're not done yet, though. You need to add up the acres indicated in all the selected records. Don't worry, you don't need to punch the numbers in your calculator. You can use a function that's built into ArcMap.

- 6 Right-click the *Acres* field and select *Statistics*. There you have it! Approximately 52,700 acres are classified as aspen on state-owned public lands.



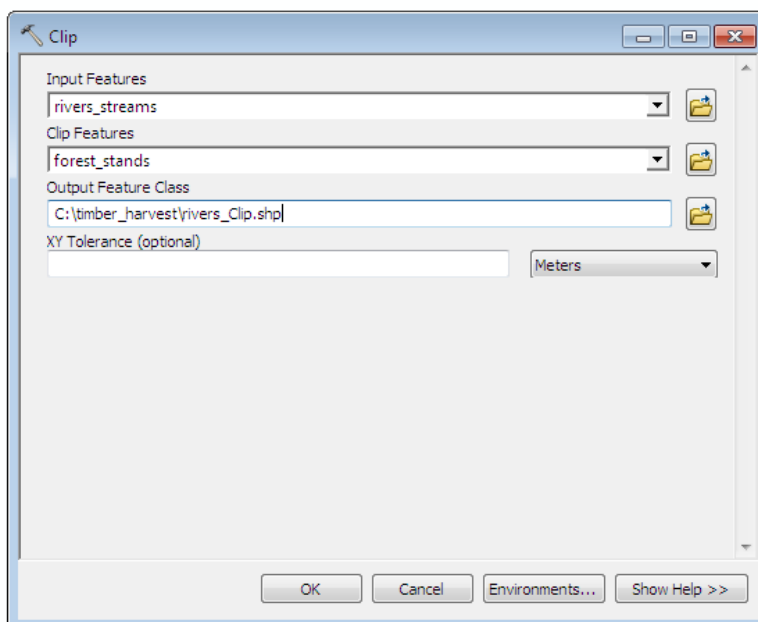
- 7 Repeat steps 4 through 6, but this time, design your query to select aspen on industrial lands. Don't forget to clear your selections after each query when they're no longer being used for a task.

You should have 123 records selected with a total acreage of 2,627 acres of aspen forest on industrial lands.

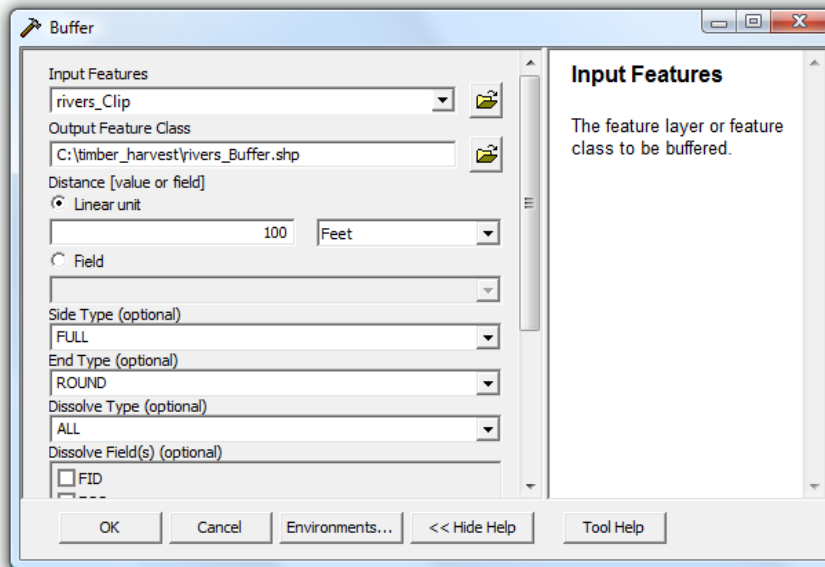
DETERMINE AREAS FOR HARVEST

Now that you have answered the first question of how much total area of aspen there is on state-owned public and industrial lands, you can determine which stands will be harvested. The forest manager has provided you with harvesting criteria: establishing 100-foot buffers along rivers, harvesting stands that are at least 20 acres, at least 50 years old, and only on soil types containing loam. So the most logical first step would probably be to establish your buffers.

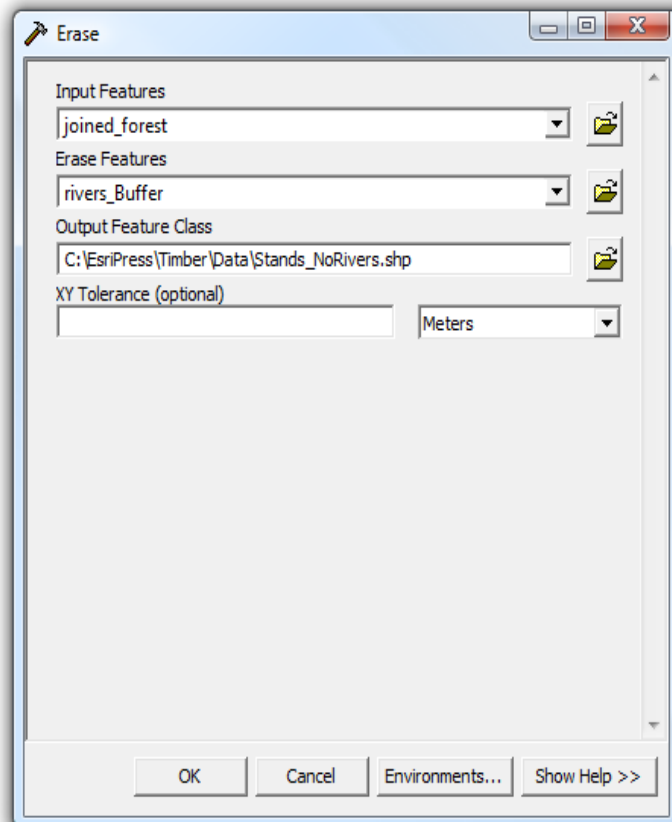
- 1 The spatial extent of the *rivers_streams* shapefile is much larger than the extent of the *joined_forest* shapefile. Therefore, it is a good idea to remove the excess information by clipping the *rivers_streams* file so that it matches the spatial extent of the *joined_forest* file. Navigate to *Analysis Tools* » *Extract* » *Clip*.
- 2 On the *Clip* dialog box, *rivers_streams* is the input feature, and the clip feature, of course, is the *joined_forest* shapefile. Name the new file something like *rivers_Clip.shp*. Once the new clipped file is added to the view, remove the old file (*rivers_streams*) and zoom to the extent of the new clipped file.



- 3 Next, because you are practicing good forestry, you need to buffer the rivers and streams. The forest manager specified that no harvesting was to occur within 100 feet of the water. Thus, your buffer will be 100 feet. Navigate to *Analysis Tools* » *Proximity* » *Buffer*. The input features are the clipped rivers. Name the output feature something like *rivers_Buffer.shp*. Specify the linear unit as *100 feet*, then specify *Dissolve Type* as *All*. This will make one buffer around all river segments rather than creating one buffer around *each* river segment.

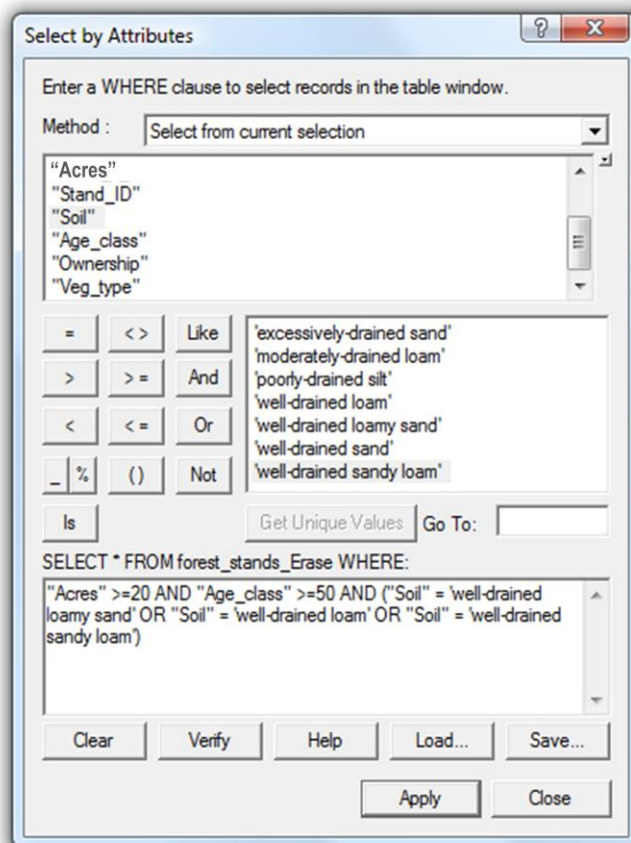


- 4 Once the buffers are created, eliminate the area within the buffer (because it is unavailable for harvesting). A good tool to eliminate area is the *Erase* tool. Navigate to *Analysis Tools* » *Overlay* » *Erase*.
- 5 Erase the buffered area within the *joined_forest* shapefile by specifying information as on the *Erase* dialog box at the right:
- 6 Now, because you removed some area, you have to adjust the acreages in the attribute table. The values in the *Acres* field are not automatically recalculated after geoprocessing, so open the attribute table of the *Stands_NoRivers* shapefile and right-



click the *Acres* field. Select *Calculate Geometry* and recalculate the acres.

- 7 Using the *Stands_NoRivers* dataset, create a new selection to identify aspen on state-owned public lands, this time with the buffer area eliminated. You should see that you still have 1,465 state-owned forest parcels, now totaling 52,000 acres of aspen and that the aspen in the 123 industrial parcels covers 2,600 acres.
- 8 Once aspen on state-owned lands is identified with the attribute query, you can identify actual stands to harvest using more attribute queries. Recall the harvesting criteria for state-owned lands: only stands ≥ 20 acres, ≥ 50 years old, and on specific soil types. With the *Select by Attributes* dialog box still open, make sure the method for selection is *Select from current selection*. Proceed to construct your query.

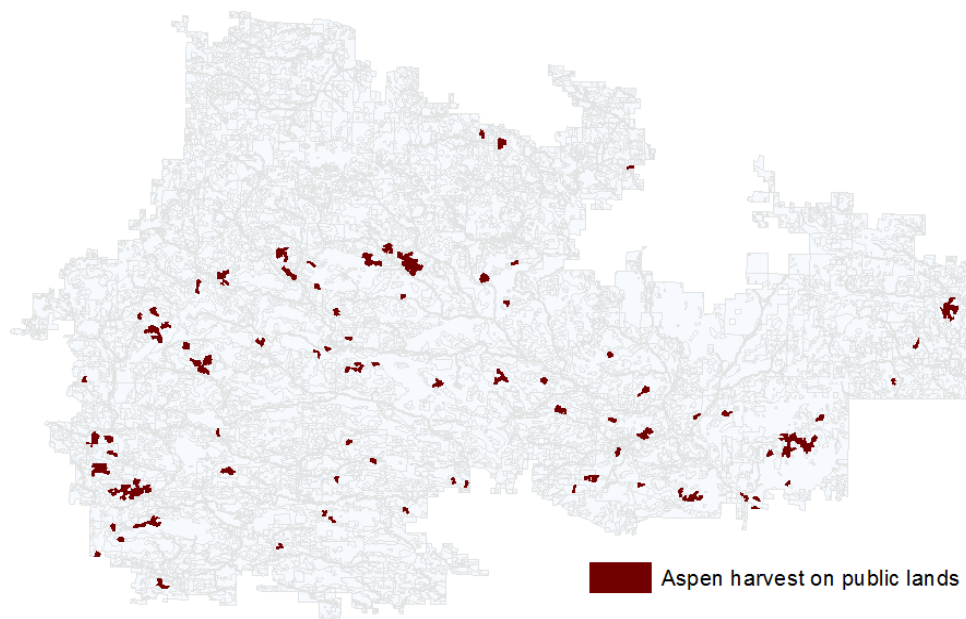


- 9 The result should be 78 records selected. The total acres proposed for harvest is approximately 5,582 (recall that to determine a sum, right-click the *Acres* field and click *Statistics*).
- 10 It might be a good idea to save the results of the query in a spatial format. Having a separate layer for the selection will be helpful if you need to make maps or work with the selected features later on. Right-click the *Stands_NoRivers* shapefile in the Table of Contents and navigate

to Selection » Create Layer From Selected Features. Rename the new layer *Aspen harvest on public lands*.

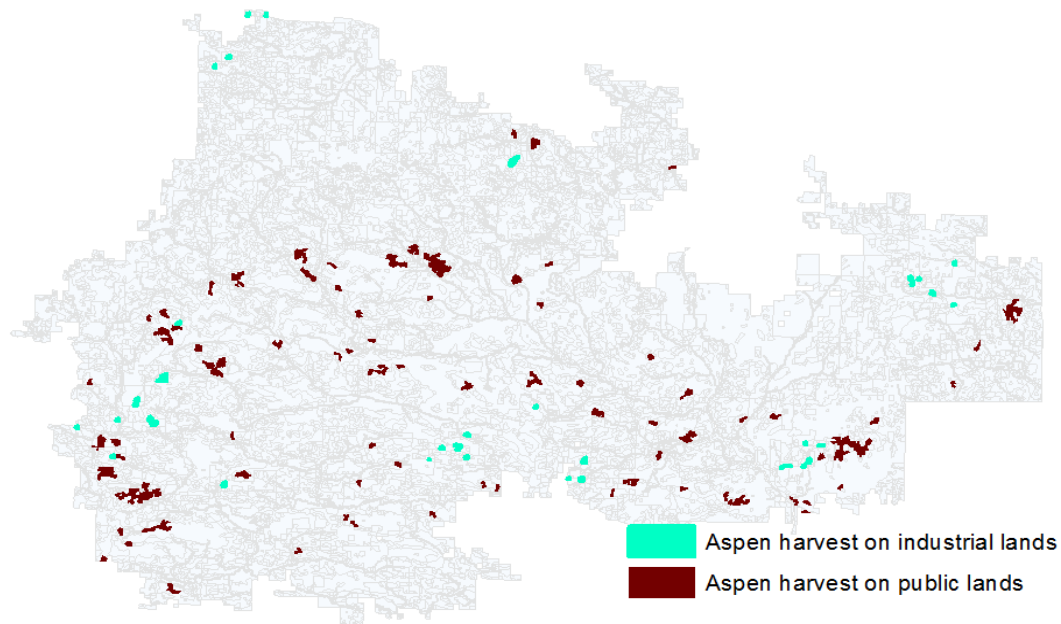
Note: Creating a new layer from a selection does not make a new shapefile. The layer essentially suppresses the information that is not selected. Many people get confused and treat these layers as if they were separate shapefiles.

The layer should resemble this:



- 11 Now that you know the procedure, you can determine the total acres proposed for harvest on industrial private forests and create a new layer identifying harvestable stands. (Refer to the lab introduction for a refresher on characteristics of landownership.) The query should return 35 records. The total acreage is 355.

The new layer should resemble this:

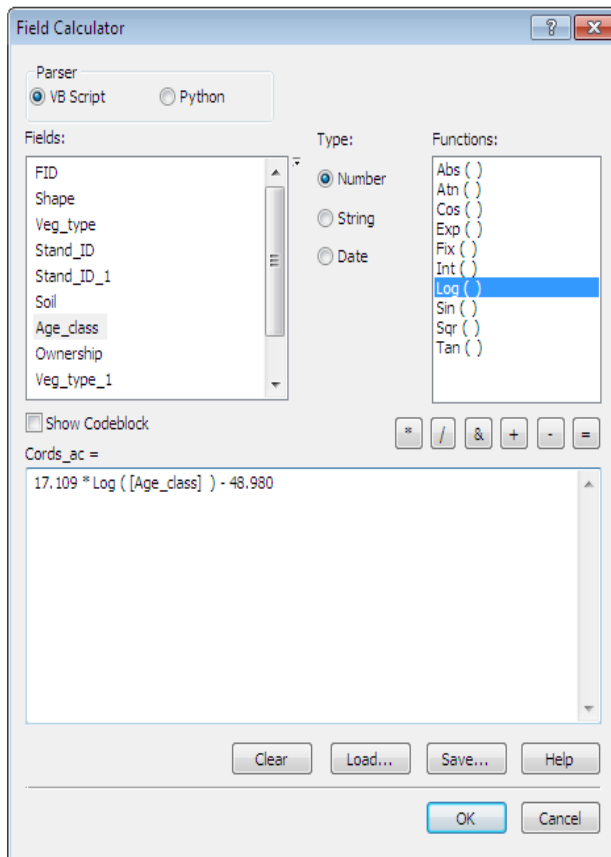


CALCULATE VOLUME

The forest manager needs to know how much timber will be harvested on state-owned public and industrial forest land. This information helps the manager document trends in production and forecast potential future production yields. Refer to table 1, which provides necessary equations for calculating timber volume.

- 1 Recall that creating new layers from a selection does not create a new shapefile. The layer is still linked to the original shapefile from which the selection was identified. If you had created a new shapefile, all the volume calculations would have to be repeated twice, which would be aggravating. So, using the *Stands_NoRivers* shapefile, create a new field and call it *Cords_ac* to stand for the number of cords produced per acre. Make it *double* with *Precision* equaling 10 and *Scale* equaling 2.
- 2 Open the attribute tables for the layers *Aspen harvest on industrial lands* and *Aspen harvest on public lands*. Observe the soil types associated with the identified records. Notice that all soil types are not represented. To be efficient, it does not make sense to calculate volume in areas that will not be harvested. Thus, you will calculate volume on moderately-drained loam, well-drained loam, well-drained loamy sand, and well-drained sandy loam.
- 3 Calculate volume on moderately-drained loam first. So, open the table for the *Stands_NoRivers* shapefile. Using the attribute query, select all records with *veg_type* equal to *aspen* and *soil type* equal to *moderately-drained loam*.

- 4 Activate the *Field Calculator* by right-clicking the *Cords_ac* field and choosing *Field Calculator*.
- 5 The equation is 17.109 multiplied by the natural log of age, minus 48.980. Using the field calculator, the equation would be written like this:



Notice that some numbers in the *Cords_ac* field are negative. The negative numbers occur in forested stands that are too young for harvesting (i.e., < 40 years old).

- 6 Repeat the volume calculations for aspen on the other soil types.
- 7 Now notice this. Open the attribute table for the layer *Aspen harvest on public lands*. Because this layer is a selection of the *Stands_NoRivers* shapefile, all the important volume calculations are visible, and the others are suppressed.
- 8 Close the attribute table for the layer *Aspen harvest on public lands*. (If the table is already open, close it and open it again so the numbers will refresh.)
- 9 You're not done yet. Remember that the calculations you just performed are in units of cords/acre. The forest manager wants to get a *total* yield. Therefore, you need to multiply the cords/acre by the number of acres in each stand to get the total yield in units of cords. This

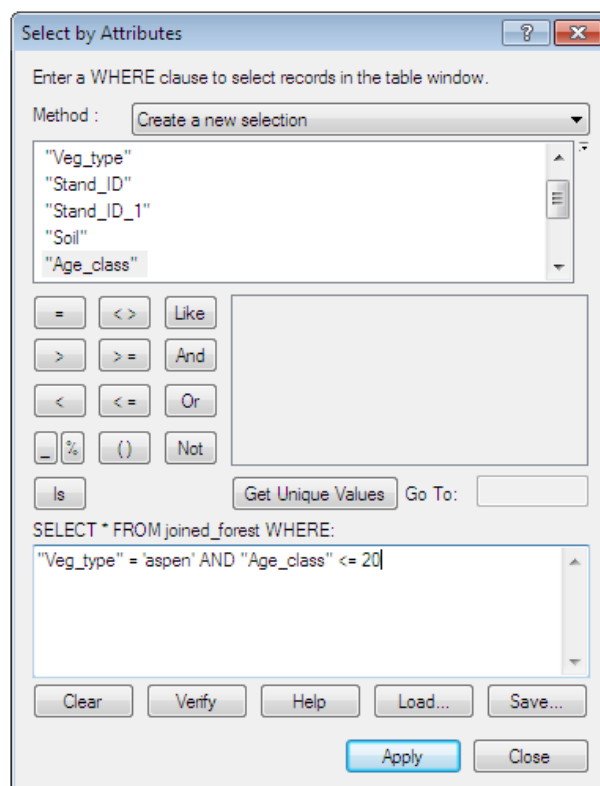
means creating another field in the *Stands_NoRivers* shapefile. By now, you should be a pro at creating new fields. Name this one *Cords*.

- 10 Using the field calculator, multiply *Cords_ac* by *Acres*.
- 11 Now you should have all the volume calculations you need. Open the attribute table for *Aspen harvest on public lands* and run *Statistics* on the *Cords* field to get a total yield. The total yield on state-owned public lands is approximately 125,000 cords.
- 12 Open the attribute table for *Aspen harvest on industrial lands* and run *Statistics* on the *Cords* field to get a total yield. The total yield is just under 6,600 cords.

ASSESS RUFFED GROUSE HABITAT QUALITY PRIOR TO HARVEST

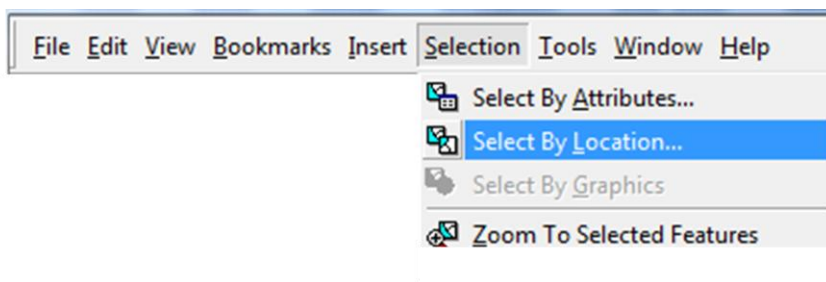
The wildlife manager provided you with a general guide to classifying ruffed grouse habitat quality as high, medium, low, and nonhabitat. Based on the criteria, you need to conduct attribute and location queries to identify different classes of habitat. You need to assess habitat quality before and after timber harvest. Start with assessment of habitat quality before timber harvest.

- 1 Activate the *joined_forest* shapefile. Create a new field in which you will indicate habitat quality. Name the new field *Habitat*, specify that it is *Text*, and make the length 20 characters.
- 2 Start with identifying areas that are necessary for assessing habitat quality. The wildlife manager tells you that high-quality habitat consists of aspen ≤ 20 years old adjacent to aspen ≥ 50 years old. The manager also tells you that medium-quality habitat consists of aspen ≤ 20 years old adjacent to oak stands. Low-quality habitat is all other aspen stands ≤ 20 years, and nonhabitat is all remaining areas. So make some queries to identify aspen stands ≤ 20 years old, aspen stands ≥ 50 years old, and oak stands. You can make each of the queries into a new layer and conduct some location queries to finalize the habitat classification. Start with the attribute query, which will identify aspen ≤ 20 years old.
- 3 Create a new layer from the selected features just so you don't accidentally clear the selection and have to redo it.

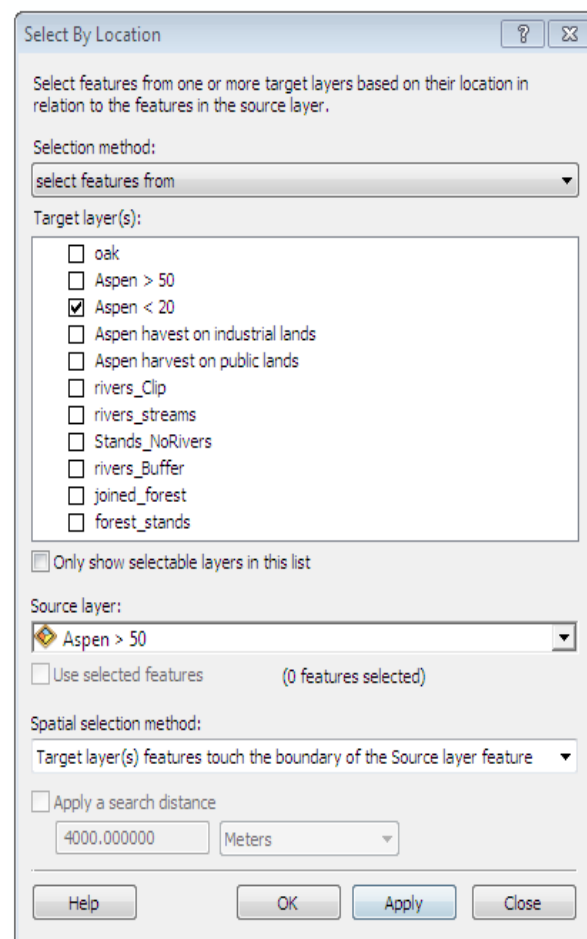


Recall the steps: Right-click the *joined_forest* shapefile, then click *Selection » Create Layer From Selected Features*. Name it *Aspen < 20*.

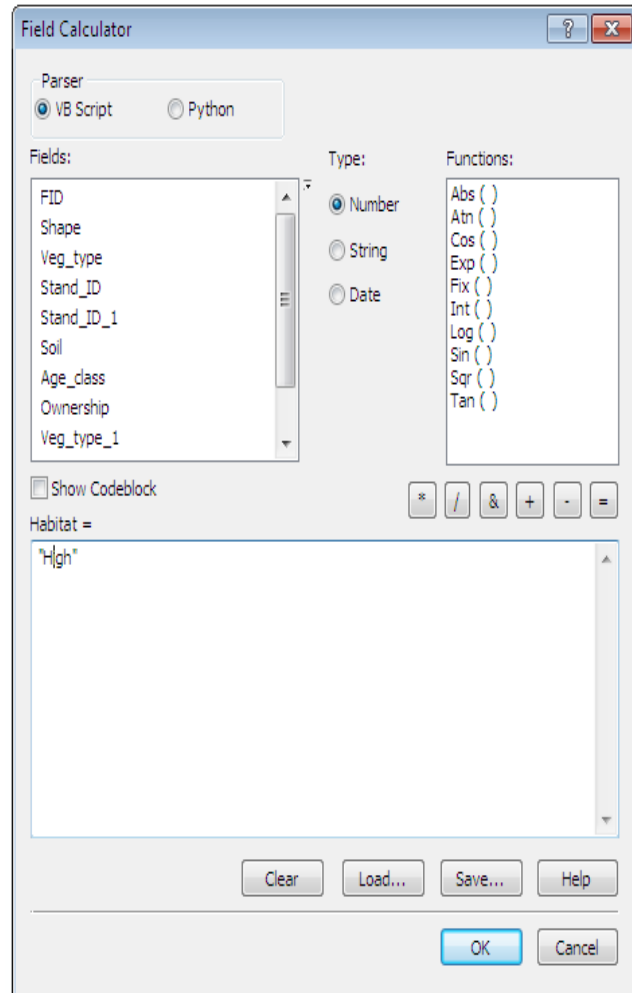
- 4 Create a layer for all aspen ≥ 50 years old by repeating steps 2 and 3, but specify “*Veg_type*” = ‘*aspen*’ AND “*Age_class*” ≥ 50 . Name the new layer *Aspen > 50*.
- 5 Do the same thing for oak stands. Conduct an attribute query for “*Veg_type*” = ‘*oak*’.
- 6 Identify high-quality habitat (i.e., aspen ≤ 20 adjacent to aspen ≥ 50). This requires a location query. Navigate to *Selection » Select By Location*.



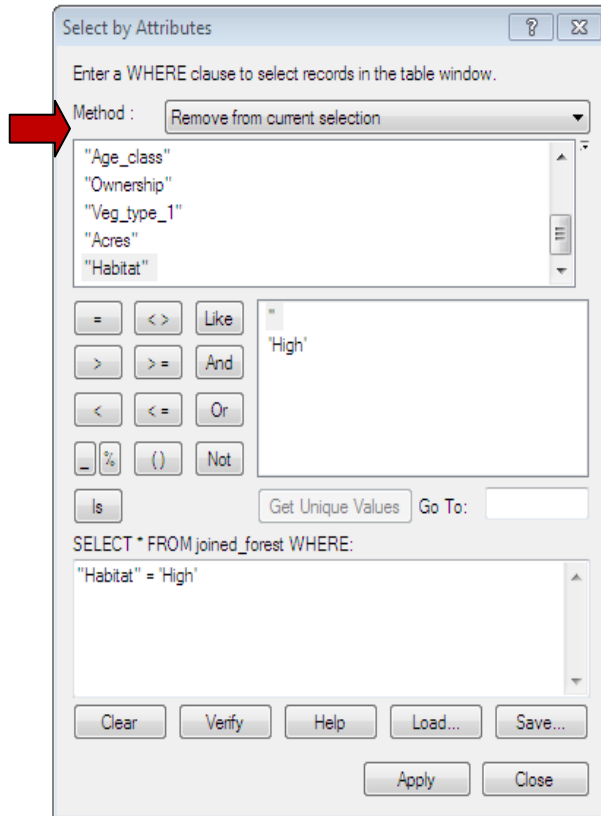
- 7 A dialog box appears that allows you to input specific criteria for selecting polygons. Essentially, you want to select features from the *Aspen < 20* layer (the target layer) that touch the boundary of the features in the *Aspen > 50* layer (the source layer). The end result should be 87 records selected.



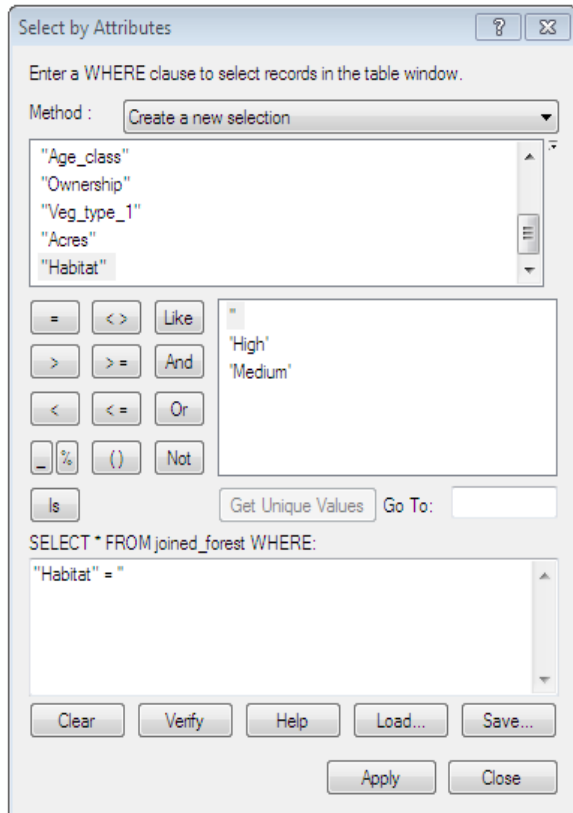
- 8 Label the selected areas as high-quality habitat in the attribute table. Open the attribute table of the *Aspen < 20* layer and use the field calculator to specify that the selected records are high quality.
- 9 Now that you've identified areas of high-quality grouse habitat, identify medium-quality grouse habitat. The wildlife manager has indicated that medium-quality habitat consists of aspen ≤ 20 years (target layer) adjacent to oak stands (source layer). To identify these areas, conduct another location query.



- 10** Step 9 should have returned 43 records, but some of the selected areas are also adjacent to aspen > 50 years, which are considered high-quality habitat. Therefore, before labeling these areas as *Medium*, remove the records labeled *High* by conducting an attribute query. Be sure *Method* says *Remove from current selection*. Use the field calculator again on the *Habitat* field and label the remaining areas as *Medium*.



- 11 To identify low-quality habitat areas, find all aspen stands ≤ 20 years that are not already labeled as high or medium quality. This calls for another attribute query using the *Aspen < 20* layer. This query should specify "*Habitat*" = "" .



- 12 Step 11 should have returned 1,009 records. Use the field calculator on the *Habitat* field and label these areas as *Low*.
- 13 Open the attribute table for the *joined_forest* shapefile. The *Habitat* column should be updated with the *High*, *Medium*, and *Low* labels. Conduct an attribute query on the *joined_forest* shapefile to identify records that are not yet labeled (Hint: The query should read "*Habitat*" = ""), then label all other areas as *Nonhabitat*.
- 14 Using queries and the *Statistics* tool, you can determine the total number of acres classified as high, medium, low, and nonhabitat prior to implementing timber harvest.
- High: 87 records, 4,771.62 ac.
 - Medium: 37 records, 1,036.41 ac.
 - Low: 1,009 records, 30,063.68 ac.
 - Nonhabitat: 8,598 records, 456,384.33 ac.

ASSESS RUFFED GROUSE HABITAT QUALITY AFTER HARVEST

Based on what you learned about ruffed grouse habitat, do you anticipate the amount of high-quality habitat to increase or decrease? What about the amount of area classified as non-habitat?

Assessing habitat quality after harvest is a bit trickier. There are several things to think about. First of all, the age of the harvested stands must be set to 0. Second, all nonharvested stands must age 10 years. Third, you created buffers in which harvest does not occur. Therefore, any aspen within the buffer will continue to age, while aspen outside the buffer may be harvested. Additionally, the boundaries of stands have changed because of the buffers.

So, it might be helpful to create a workflow to assist with problem solving. A logical sequence of steps could be

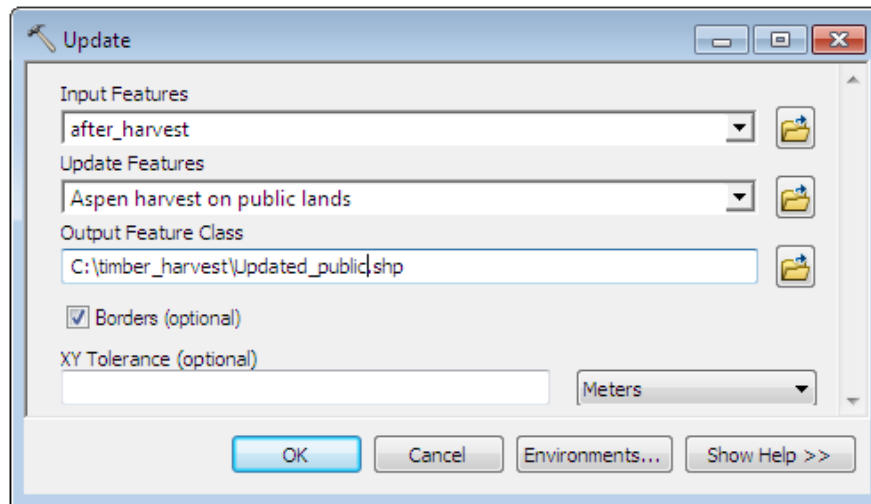
1. Copy the *joined_forest* shapefile and name it *after_harvest* so that you have a file that can be manipulated and portray the landscape following timber harvest.
2. You need a new field indicating age class after harvesting. Nonharvested stands will have to age 10 years. The age of harvested areas will have to be set to 0.
3. The boundaries of harvested areas (stand boundaries minus the buffered area) are represented in two layers: *Aspen harvested on public lands* and *Aspen harvested on industrial lands*. So, an update of stand boundaries and ages may be necessary.
4. Ruffed grouse habitat will need to be reassessed following timber harvest.

That should work. Go ahead and implement these steps:

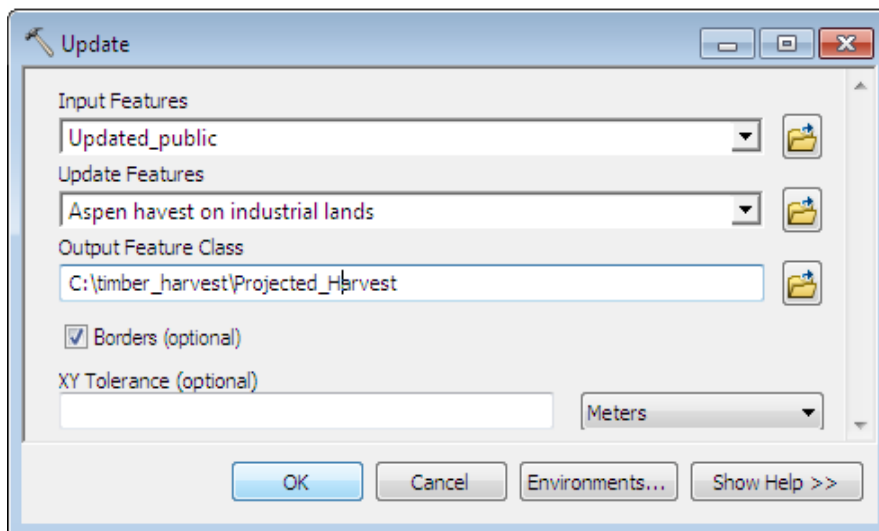
- 1 To copy the *joined_forest* shapefile, right-click the file in the table of contents and select *Data » Export Data*. Name the new file *after_harvest*. All features should be selected.
- 2 Create a new field called *Age_after* in the *after_harvest* shapefile. This field will be a short integer type and will represent ages of areas following harvest.
- 3 Using the field calculator, add 10 years to the original age class of stands (*Age_class*). The code for unevenly aged stands (i.e., age class = 999) will now be 1009, but that is irrelevant for assessing ruffed grouse habitat. You can change it later if you would like to keep the same 999 code for unevenly aged stands.
- 4 In the attribute table of the layer *Aspen harvested on public lands*, create a new field called *Age_after*. The same new field will automatically be created in *Aspen harvested on industrial lands* because they are linked to the same original shapefile. Because these layers represent stands that will be harvested, use the field calculator and assign 0 as the age of all records.

Now you are ready to replace the information in the *after_harvest* shapefile with the updated harvest information contained in the layers *Aspen harvested on public lands* and *Aspen harvested on industrial lands*.

- 5 Navigate to *Analysis Tools » Overlay » Update*. The input feature is the file that needs updating (i.e., the *after_harvest* shapefile). The update features are contained in the two layers representing harvested areas. You will have to conduct the update twice—once for aspen harvest on public lands and once for aspen harvest on industrial lands. Update with harvest information on public lands first. You'll name this new shapefile *Updated_public*.



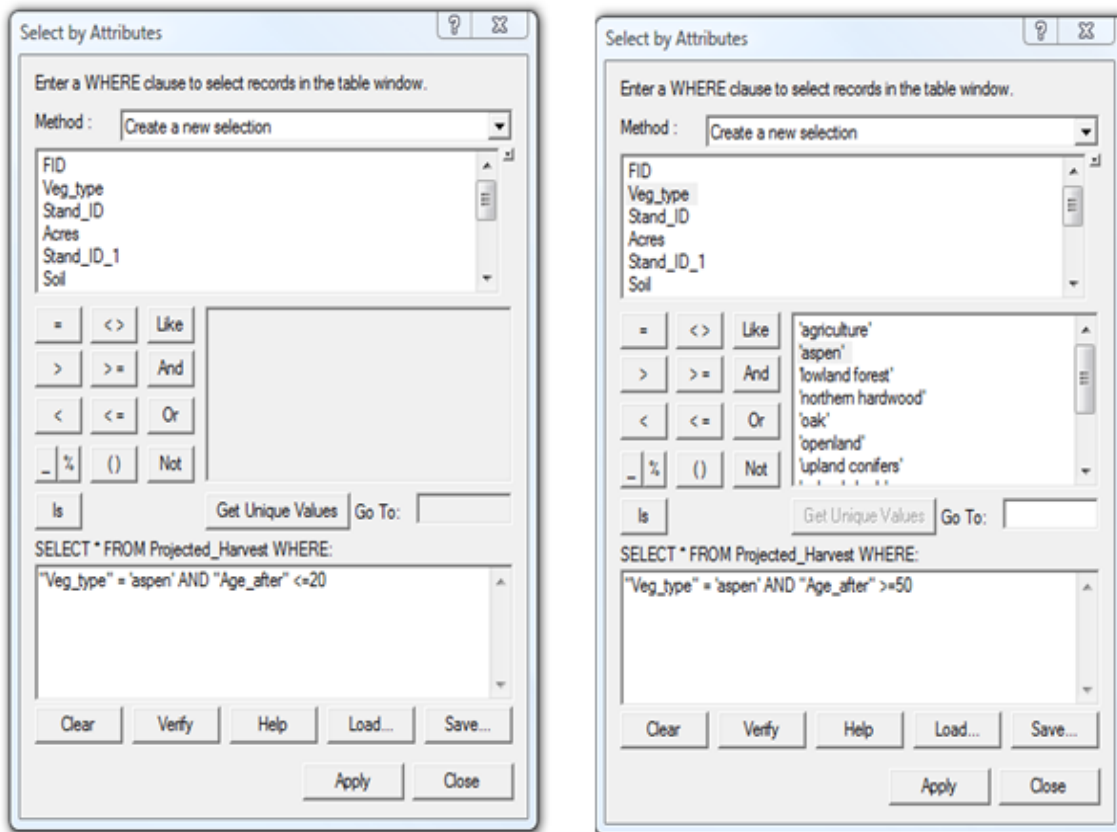
- 6 Next, conduct another update using the *Updated_public* shapefile as the input features and the *Aspen harvest on industrial lands* layer as the update features. Name the final file *Projected_Harvest* because it contains information on the harvest projected for the next 10 years.



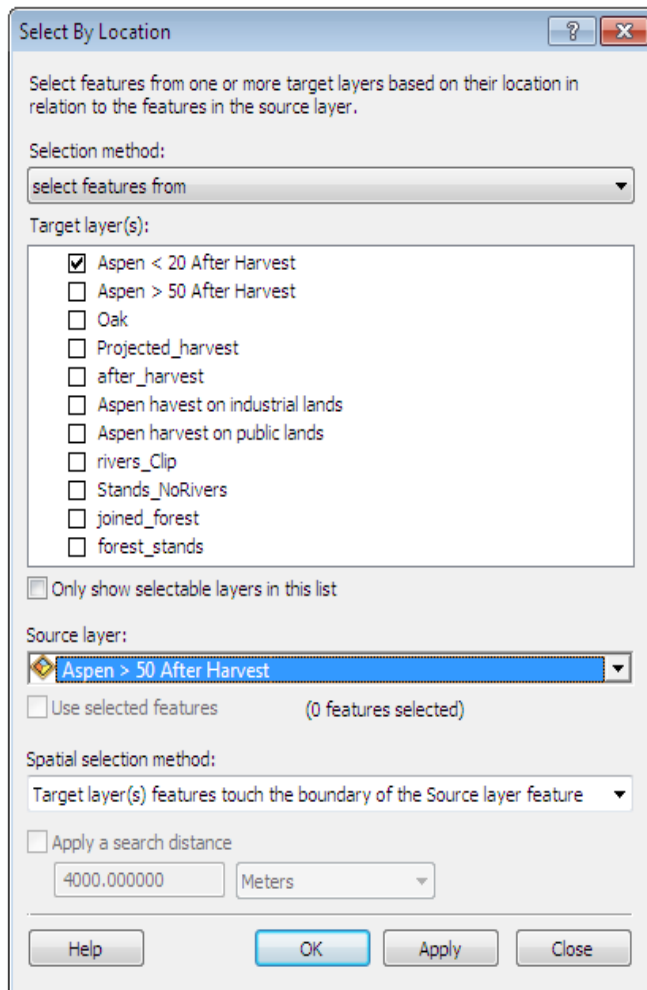
- 7 Reassess ruffed grouse habitat quality in the shapefile portraying what the landscape will look like 10 years from now. Don't forget when you conduct your queries on age class to use the *Age_after* field. Also, don't forget to recalculate acres using *Calculate Geometry*. The area of some polygons may have changed since you updated. Go through identifying areas of high-quality habitat. Begin by making a new field in the *Projected_Harvest* shapefile and name it *Hab_After*. In this field, you will label areas as high, medium, low, and nonhabitat.

- 8 Next, conduct the attribute queries. Recall that high-quality habitat is defined by aspen ≤ 20 years old that is adjacent to aspen ≥ 50 years old. Create a layer of aspen ≤ 20 years old and a layer of aspen ≥ 50 years old from attribute queries using the *Age_after* field. Rename the new layer *Aspen < 20 after harvest*.

One attribute query should read "*Age_after*" ≤ 20 . The other one should read "*Age_after*" ≥ 50 .



- 9 After making layers from the selection and renaming them, conduct the location query to identify all high-quality habitat areas. The location query should read as below:



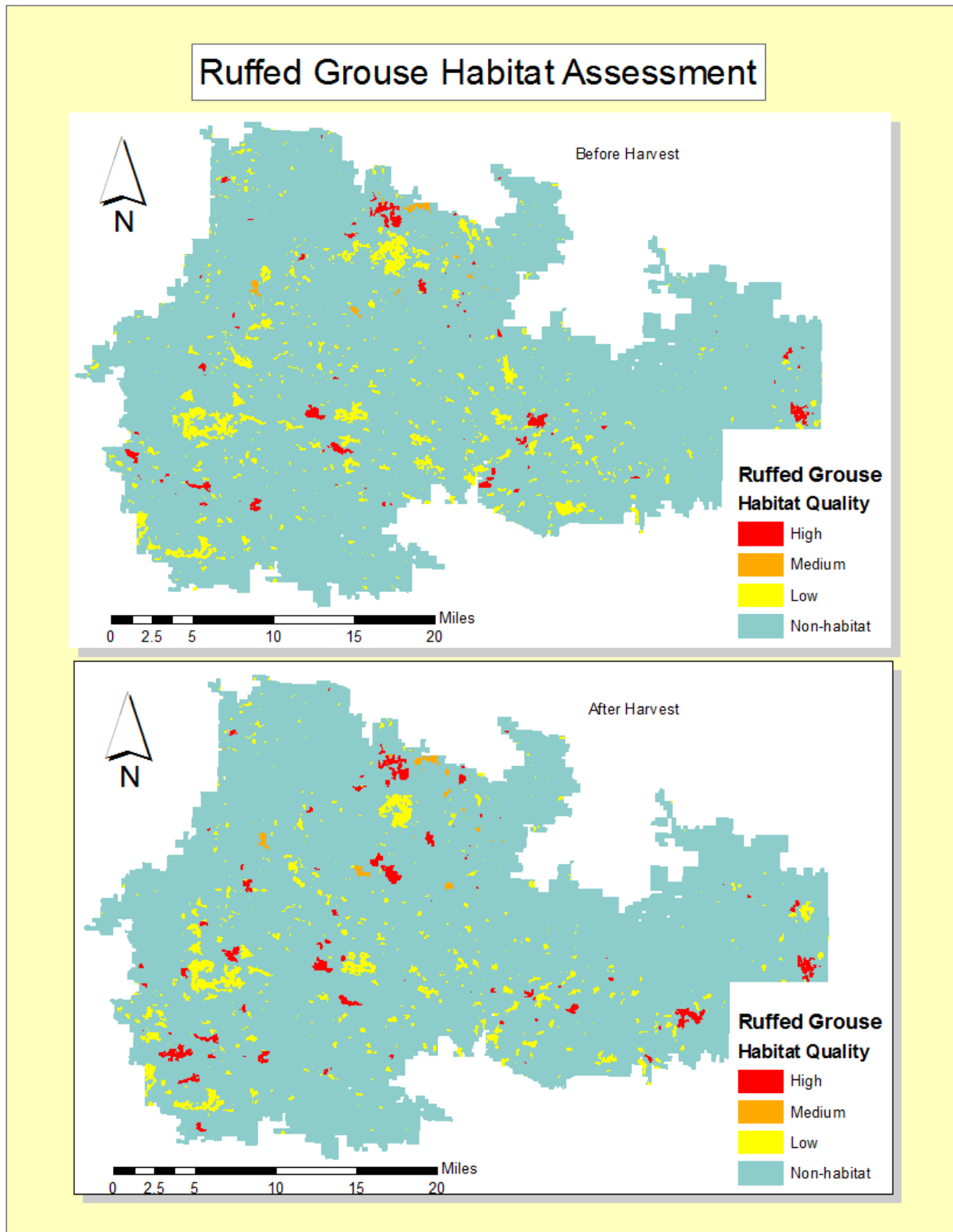
- 10 Now, you can refer back to steps 8–14 in the section “Assess ruffed grouse habitat quality prior to harvest” to identify areas of medium quality, low quality, and nonhabitat in the *after_harvest* shapefile.

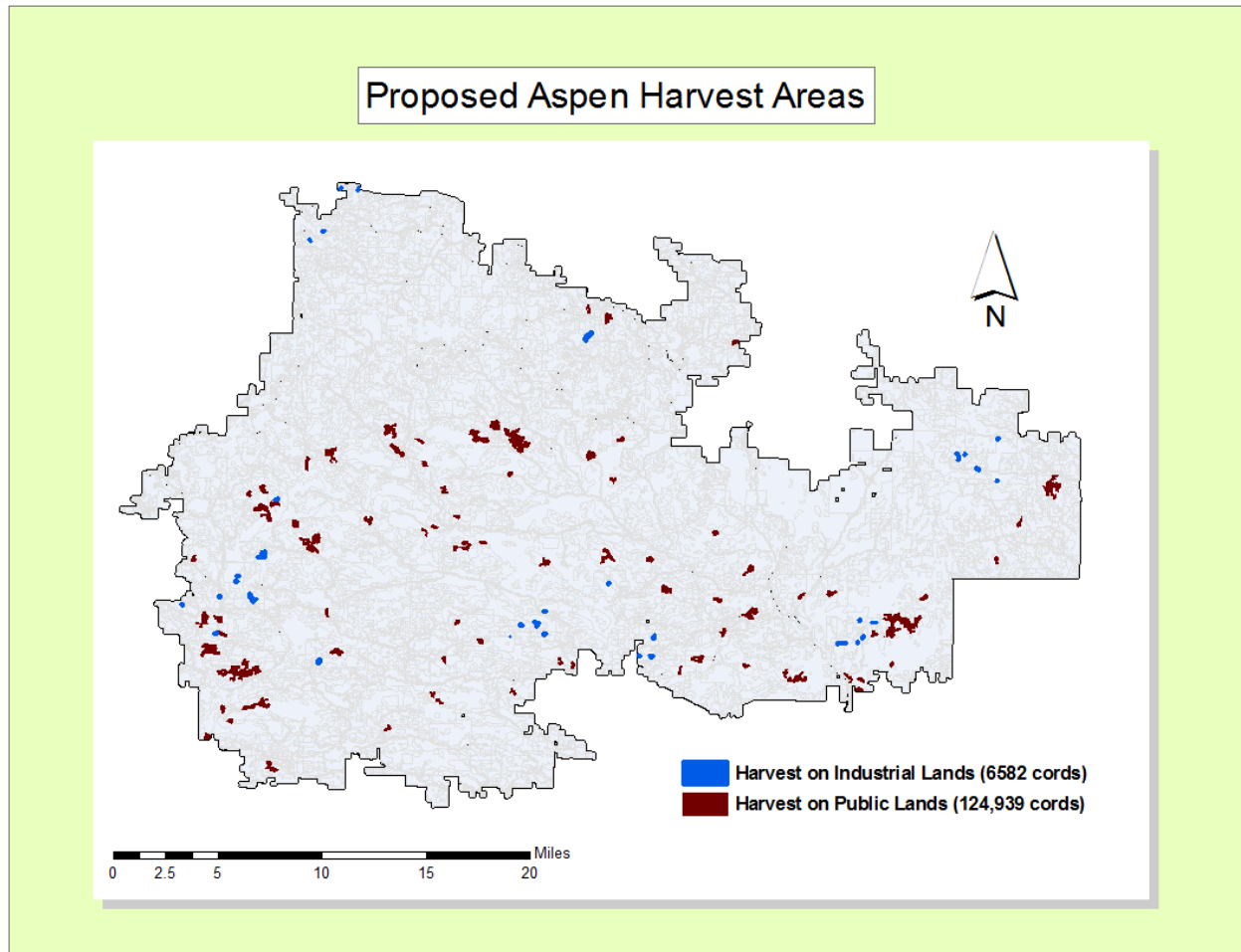
The area in ruffed grouse habitat quality categories after the timber harvest is as follows:

- High: 88 records, 6,145.48 ac.
- Medium: 25 records, 1,016.28 ac.
- Low: 671 records, 20,329.57 ac.
- Nonhabitat: 8,963 records, 466,941.82 ac.

The amount of high-quality habitat for ruffed grouse has *increased*; however, the overall amount of available habitat (low, medium, and high quality) has decreased.

DISPLAY RESULTS OF TIMBER HARVEST AND HABITAT ASSESSMENT (EXAMPLE)





CRITICAL THINKING

Question 1: *Forest management decisions must be made based on available data. For this lab exercise, you were provided with vector data defining stand boundaries. From a timber management standpoint, vector data models are essential to define boundaries of stands. From a wildlife habitat standpoint, however, can you think of any limitations of using vector data to quantify habitat quality? Is habitat quality a discrete variable or is it continuous, represented by a gradient of conditions?*

Question 2: *What other data might you include to refine the habitat model? Do you think features such as soil type, elevation, and proximity to water might enhance the model?*

Question 3: *If you could have additional data to validate your habitat classification, what data would you select? (Often, wildlife biologists and managers will collect data such as grouse nesting success or drumming surveys.)*

Question 4: *If you were a forest manager charged with creating ruffed grouse habitat, how might you design your timber harvest strategy to maximize the amount of high-quality habitat?*

Submit your work

Submit the following:

- Illustration of results in a map layout
- Written summary of results (1-2 pages)
- Responses to critical thinking questions

Glossary

Cord A unit of measure for volume of wood; refers to a 4 x 4 x 8-foot stack

Even-aged A term referring to forest stands containing trees of the same age

Land cover A classification used to describe the type of vegetation or land use that occurs in a particular geographic area (examples: deciduous forest, herbaceous open land, water, or urban)

Loam A soil type consisting of a mixture of sand, silt, and clay

Mixed-aged A term referring to forest stands containing trees of multiple ages

Ruffed grouse Scientific name: *Bonasa umbellus*; popular game bird that inhabits early successional forests in eastern North America such as aspen; known for the drumming sound males make by beating wings against their breast to attract females during the breeding season (Photo taken in northern Michigan by D. Walsh)

Silt A soil type consisting of fine sedimentary material

Succession A gradual process of vegetative change over time (example: a field changing into shrubland, which then changes into a forest)

Vegetation type A classification used to describe the composition of vegetation growing in a particular area; usually named for the dominant overstory plant species or type (e.g., trees such as pine, oak, aspen or other vegetation such as upland shrub or herbaceous open land).

Credits

Sources of supplied data

forest_stands.shp, courtesy of Michigan Department of Technology, Management & Budget,
Michigan Geographic Data Library

rivers_streams.shp, courtesy of Michigan Department of Technology, Management & Budget,
Michigan Geographic Data Library

stand_data.csv, courtesy of Michigan Department of Technology, Management & Budget, Michigan
Geographic Data Library

Instructor resources

Updates for 2013

This lab has been updated to reflect the changes in ArcGIS version 10.1. Screen-captures for tables and queries have changed. Additionally, methods have been revised to improve workflow efficiency and to reflect software version changes.

Additional information

This lab is intended for introductory or intermediate GIS students who have some background in geoprocessing. Students should have experience with map layouts.

This lab is relevant for instructors who wish to demonstrate an application of using GIS for wildlife and forest management. It presents a good example of a real-world (and common) spatial question in the forestry and wildlife profession.

Instructors who would like to demonstrate more in-depth wildlife or forestry analysis can use the data to quantify volume estimates in different cover types or assess habitat for different wildlife species.

Advanced students might develop a management plan and identify harvesting areas that will actually improve habitat for ruffed grouse or other wildlife species.

Data information

The following files are important for completing this lab exercise:

| <u>Data File</u> | <u>Description</u> |
|-------------------|---|
| Forest_stands.shp | Shapefile of forest stands and vegetation types that occur in the study area |
| | Attributes include: Stand_ID: A numerical value assigned to forest stands for identification |

Veg_type: Vegetation types

Agriculture: Crops such as corn, beans, hay.

Aspen: Dominant species is aspen

Lowland forest: Trees adapted to moist soil conditions

Northern hardwood: Maple, beech, basswood, etc.

Oak: Dominant species is oak

Open land: Open areas with grass

Upland conifers: Conifers adapted to dry soil conditions

Upland shrub: Dry, shrubby areas

Urban: Roads, parking lots, housing, other structures

Water: Open water

Wetland: Poorly drained areas or standing water with emergent vegetation

Rivers_streams.shp Contains information on location of rivers and streams in the study area

Attributes include:

Name

Length

Stand_data.csv Tabular data containing information about the forest stands

Attributes include:

Stand_ID: A numerical value assigned to forest stands for identification

Soil: Describes soil types in the study area

Age_class: Indicates age class of forest stand in 10-year increments

0 = clearcut or harvested area

10 = age 10–19

20 = age 20–29

30 = age 30–39

40 = age 40–49

50 = age 50–59

60 = age 60–69

70 = age 70–79

80 = 80+ years

999 = mixed-aged stands or areas where age is irrelevant (i.e., agriculture)

- Forest stand boundaries were created from land-cover data obtained from the Michigan Geographic Data Library (<http://www.mcgi.state.mi.us/mgdl>). The file was 2001 Land Cover (Lower Peninsula).
- Rivers and stream data was also obtained from the Michigan Geographic Data Library. The file was Michigan MI Geographic Framework Hydrography Lines (v10a).

Reference:

- Michigan Department of Natural Resources (MDNR). 2003. *IFMAP/GAP Upper Peninsula Land Cover* (map). 1997–2001. 1:64,000; created by Forest, Mineral, and Fire Management Division, MDNR, using ERDAS IMAGINE 8.5.
http://www.dnr.state.mi.us/spatialdatalibrary/sdl2/land_use_cover/2001/IFMAP_lp_landcover.htm (1 April 2003).
- Projection information for land cover data
- Geographic coordinate system: GCS_North_American_1927
- Datum: D_North_American_1927
- Projection: Hotine_Oblique_Mercator_Azimuthal_Natural-Origin