

Assessing Clearcutting Activities

Compiling harvest opening sizes

—by Glen Jordan

Introduction

Problem

How does one compile a harvest opening size distribution to gauge the effects of clearcutting?

As forest development activities increase worldwide, public reactions are frequently negative. Forest harvesting activities, in particular, draw considerable attention. Forest managers are often confronted about clearcut harvesting and its perceived negative effects.

Because clearcuts are so common and obvious, their size, which can be upward of 100 hectares (ha), can cause an immediate negative public reaction. From an aesthetic perspective, of course, small is beautiful. However, from an economic perspective, small probably isn't beautiful, as it's much more costly to operate across several small clearcuts as opposed to one large one. Likewise, from an ecological perspective, small is not necessarily good. It spells fragmentation of conditions and is not desirable; rather, a mixture of sizes from small to large is important for the ecological well-being of a forest.

A numerical distribution of harvest opening sizes, then, would be one way of measuring and assessing clearcutting in a forest from all three perspectives—*aesthetic, economic, and ecological*. It would tell us if the openings created by recent clearcuts are mostly large, mostly small, evenly distributed, or some other distribution.

Location

A small, 1,400 ha woodlot in the Acadian-New England forest region of North America

Keywords: harvest opening size; characterizing by a single number; numerical distribution; map; selecting features by attribute; using Python in the Field Calculator; dissolving features; summarizing an attribute

Time to complete the lab

Two hours

Prerequisites

A basic working knowledge of geographic information system (GIS) data, including use of a geodatabase (Familiarity with basic forest analysis techniques is important, while familiarity with forest inventory data and terminology is also helpful but not essential.)

Data used in this lab

- Feature classes and rasters for a forest woodlot (personal geodatabase)
- Geographic coordinate system: NAD 1983 CSRS New Brunswick Stereographic
- Datum: NAD83
- Projection: New Brunswick Double Stereographic Grid (unless otherwise stated)

Student activity

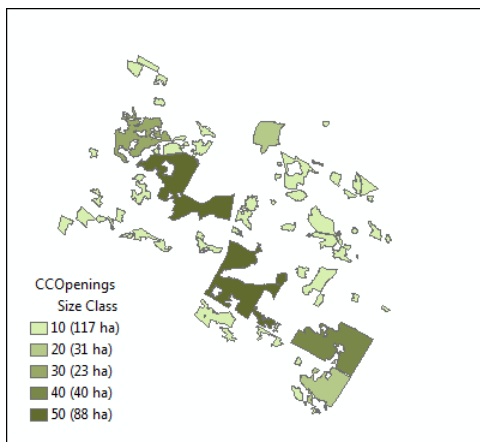
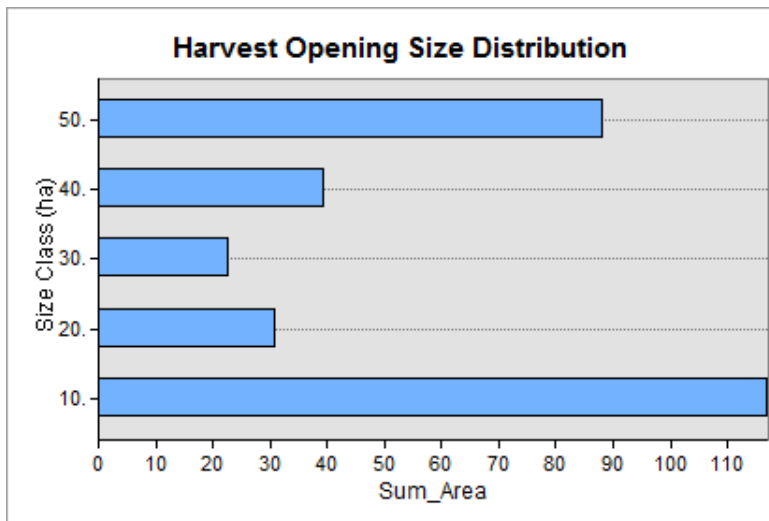
What are harvest opening sizes like in the Woodlot, where clearcut harvesting activity has been widespread and not bound by government opening-size regulations? Are the openings mostly large, mostly small, or some other distribution? What does it tell us about aesthetic, economic, or ecological effects?

In this exercise, you'll attempt to find the answer by compiling and mapping the distribution of harvest openings created in the Woodlot over the past 10 years.

Results expected

A summary table, bar chart, and map of harvest opening sizes in the Woodlot

	OBJECTID *	SizeClass	Count_SizeClass	Sum_Area
▶	1	10	58	117.145091
	2	20	2	30.93104
	3	30	1	22.954
	4	40	1	39.532776
	5	50	2	88.284008



Data available

Cover types feature class: *cover*

Solution steps

1. Identify and examine clearcuts of the last 10 years.
2. Merge adjacent clearcuts into harvest openings.
3. Reclassify harvest openings into 10 ha classes.
4. Compute a harvest opening size distribution.
5. Map harvest openings by size class.

IDENTIFY AND EXAMINE CLEARCUTS OF THE LAST 10 YEARS

Labeling Woodlot stands as clearcuts simply involves adding a new numeric attribute field to the *cover* feature class and then using those figures to flag stands accordingly.

Identifying clearcuts should be relatively easy. They'll be stands no older than 10 years ($AGE \leq 10$) that have retained and regenerated no, or very little, volume yield ($VH \leq 30$) since harvest.

RELATED CONCEPT: RECLASSIFY USING THEMATIC ATTRIBUTES FOR LABELING

- 1 Start ArcMap, and if you haven't already done so, use *Environment Settings* to establish both your *Current Workspace* and *Scratch Workspace* as your *Woodlot* geodatabase.
- 2 Add the *cover* feature class and add a short integer attribute field named *CCut*.

You can now use the *CCut* field to label stands as clearcut by assigning a value of 1. You should find recent clearcuts relatively easy to identify. They'll be Woodlot stands no older than 10 ($Age \leq 10$) that have retained and regenerated none, or very little, volume yield ($Vh \leq 30$) since harvest. But be careful: don't mistakenly select nonforested features ($AGE = -99$) or treed bogs ($TYPE = 'BG'$) as clearcuts.

It wasn't critical that *CCut* be a short integer field. It could just as easily have been a text field that you populate with a "Yes" string, for example.

- 3 Using *Select By Attributes*, select clearcut stands using this query expression:

```
[AGE] <> -99 AND [TYPE] <> 'BG' AND [AGE] <= 10 AND [VH] <= 30
```

This step should select 122 stands. You can see their attributes in the *Cover Types* attribute table, as well as the features themselves scattered across the Woodlot in *Map View*.

4 Use *Field Calculator* to calculate $CCut = 1$.

You could use a similar procedure to identify and label uncut stands with a *CCut* value of 0, but it won't be necessary; the *Null* values will serve that purpose.

At this point, it's easy to get a preliminary look at clearcut sizes in the Woodlot by sorting the currently selected clearcuts by area.

5 Sort the 122 selected clearcut stands by area, largest to smallest.

This step indicates that the largest clearcut stand is almost 18 ha (177,043 square meters [m²]). Most others are much smaller.

It would seem, then, that clearcut openings are relatively small in the Woodlot, given that typical environmental regulations set maximum clearcut opening size at 100 ha.

The clearcut sizes, though, aren't an accurate reflection of openings created over the last 10 years in the Woodlot. Here's why.

In all likelihood, some adjacent stands were clearcut over the 10-year period, and as a result, some larger clearcut openings may exist. In fact, if you zoom in and pan around the map display with the 122 clearcut stands selected, you can confirm this.

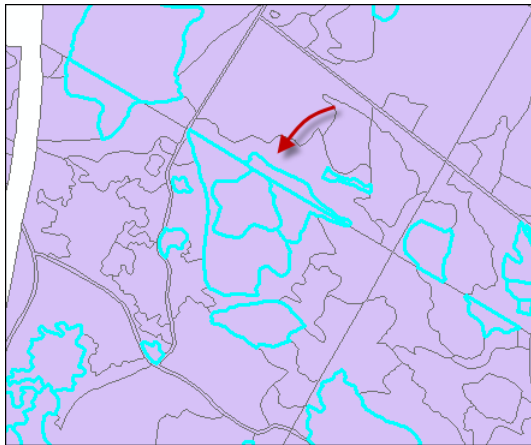


Figure 1. Zoomed in on a cluster of adjacent clearcut stands.

You'll need to calculate the size of the openings formed by adjacent clearcuts. How might you do that?

MERGE ADJACENT CLEARCUTS INTO HARVEST OPENINGS

Forming harvest openings is simply a matter of removing boundaries between any of the 122 clearcut stands where they are adjacent.

This can be done using the *Dissolve* tool in ArcToolbox™. It removes boundaries shared by adjacent features where they share a common attribute value(s). In this case, adjacent clearcut stands share a common *CCut* value of 1.

RELATED CONCEPT: RECLASSIFY SPATIALLY—DISSOLVE

- 1 With the 122 clearcuts still selected, run the *Dissolve* tool (*Data Management* » *Generalization*) using the *CCut* field as the dissolve field. Name the output *CCOpenings* and *do not* create multipart features.

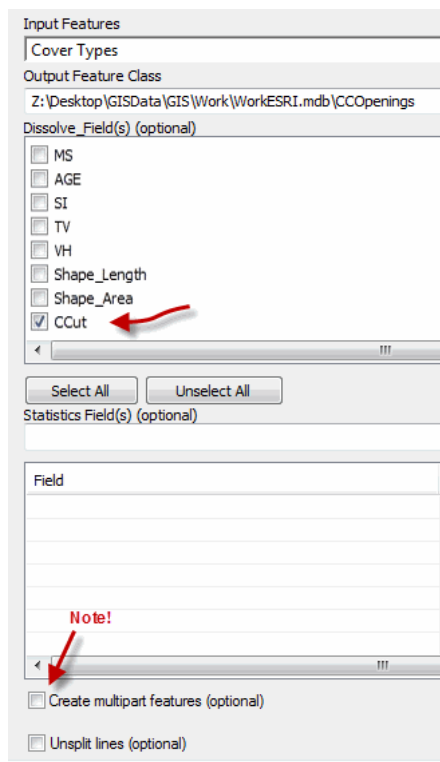


Figure 2. Dissolve tool dialog box with multipart features disabled.

Question 1: *What would happen if you didn't disable multipart features when merging?*

If you close or minimize the *Cover Types* attribute table and turn off the *Cover Types* layer, you can readily see that adjacent clearcut stands have been merged into single polygons, or patches.

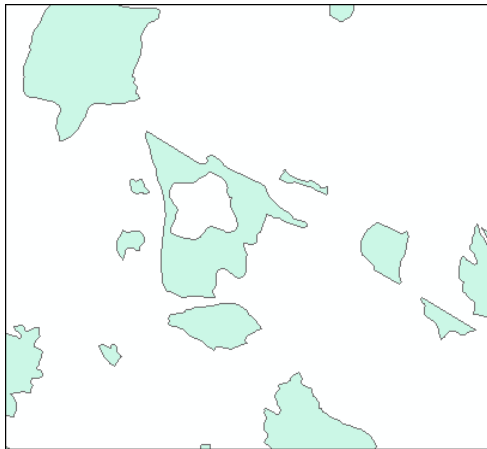


Figure 3. Zoomed in on clearcut openings in the Woodlot.

If you open the *CCOpenings* attribute table, you'll see that there are just 64 features. That means about half the 122 clearcut stands in the Woodlot are immediately adjacent.

What range of clearcut sizes do we have now?

2 Calculate statistics for the *Shape_Area* field in *CCOpenings*.

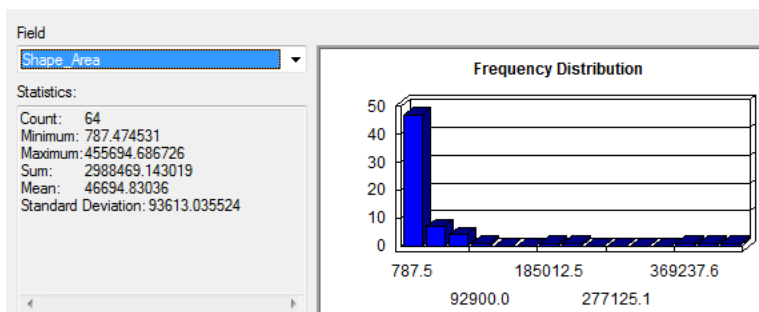


Figure 4. Statistics and frequency distribution of harvest opening sizes.

The maximum size has increased, but at 45.6 ha, it still isn't particularly large, and the frequency distribution shows that most openings are much smaller than that.

On the other hand, the almost 300 ha (sum: 2,988,469) of clearcuts that have been carried out over the past 10 years seems large. That's about 20 percent of the Woodlot's 1,400 ha. Should that harvest rate continue, all Woodlot stands would be harvested in the next 40 years.

3 Close the stats report and the *Cover Types* attribute table if it's still open.

By spatially reclassifying clearcut stands based on their adjacency, you've identified 64 harvest openings and now have an initial idea about their sizes.

The stats and frequency distribution are useful, but knowing the amount (ha) of clearcutting by harvest opening size would be more informative. To find that, though, you'll first need to reclassify opening sizes into size classes. A class interval of 10 ha is reasonable.

RECLASSIFY HARVEST OPENINGS INTO 10 HA CLASSES

This is a classic reclassify operation. You want to assign harvest openings to 10 ha size classes as follows.

Size class (ha)	Definition
10	Area > 0 and area <= 10
20	Area > 10 and area <= 20
30	Area > 20 and area <= 30
40	Area > 30 and area <= 40
50	Area > 40 and area <= 50

Table 1. Harvest opening size class definitions

That means adding a new attribute field in the *CCOpenings* attribute table and then assigning class values using *Select By Attributes* and *Field Calculator*, or a simple formula in *Field Calculator*.

RELATED CONCEPT: RECLASSIFY USING LOCATIONAL ATTRIBUTES TO QUANTIFY

First, though, since *Shape_Area* values in the *CCOpenings* attribute table are in square meters, you should convert the m² values to hectares.

- 1 In *CCOpenings*, add a new field of *float* type named *Area* and assign an alias of *Area (ha)*.

The screenshot shows a dialog box for creating a new field. The 'Name' field contains 'Area', the 'Type' dropdown is set to 'Float', and the 'Field Properties' table shows an alias of 'Area (ha)'. Red arrows highlight these three elements.

Name:	Area
Type:	Float
Field Properties	
Alias	Area (ha)
Allow NULL Values	Yes
Default Value	

Figure 5. Creating an Area field for calculating harvest opening sizes in hectares.

Question 2: Why can't you simply recalculate existing *Shape_Area* values to hectares?

- 2 Using *Field Calculator*, calculate *Area* values by dividing *Shape_Area* by 10,000.

Now that you have sizes calculated in hectares, you can proceed to assign openings to 10 ha classes, but that will require adding another new numeric field.

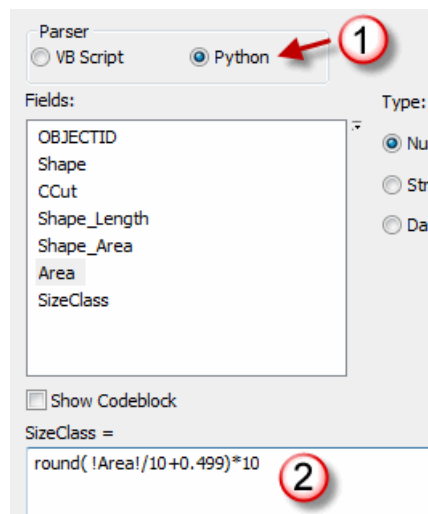
- 3 In *CCOpenings*, add a new short integer field named *SizeClass* with the alias *Size Class*.

Remember, spaces and a number of other special characters are not permitted in field names. Of course, you can always assign an alias that includes spaces or special characters.

Now on to the task of assigning clearcut openings to 10 ha size classes.

- 4 Using the following Python formula in *Field Calculator*, populate *SizeClass* with 10 ha size classes:

```
SizeClass = round(Area / 10 + 0.499) * 10
```



You could use Visual Basic (VB) here instead of Python. The problem with VB, though, is that it does not deal well with Null field values. In this case, there are none.

Figure 6. Calculating 10 ha harvest opening size classes using the Python Round function.

This step populates *SizeClass* with 10 ha classes in very short order.

Efficient calculation method

The formula is a very efficient way to calculate defined interval classes when compared to the alternative—in other words, a series of *Select By Attribute* and *Field Calculator* operations. The general form of the formula is `round(infield / class interval + 0.49) * class interval`. To correctly handle input values that lie on interval boundaries, though, you will have to change 0.49 to 0.499 or 0.4999, et cetera, depending on how many decimal places are involved in the input field. Warning: If the inputs are whole numbers, add a decimal to *interval* to avoid truncating when dividing.

- 5 Clear selected records.

Now you're ready to tally Woodlot areas in each harvest opening size class.

COMPUTE A HARVEST OPENING SIZE DISTRIBUTION

An opening size distribution, —in other words, the number of hectares in each 10 ha size class—is easily computed summarizing the *Size Class* field.

RELATED CONCEPT: CHARACTERIZE USING A NUMERICAL DISTRIBUTION

- 1 Summarize the *SizeClass* field by *Area (ha)* sum, naming the output table *Distribution*.

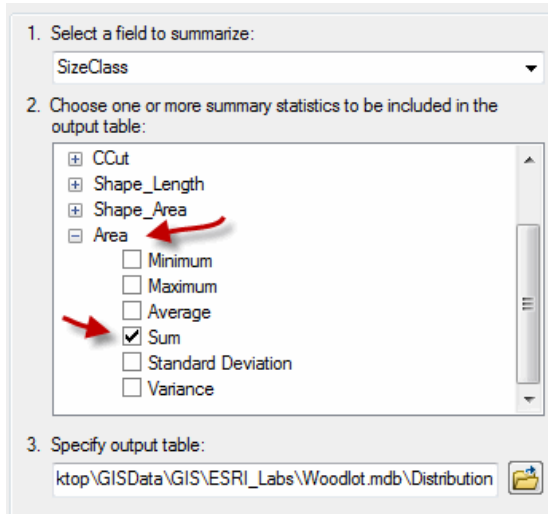


Figure 7. Calculating size (Area) totals by 10 ha harvest opening size classes (*SizeClass*).

If you open *Distribution*, it's readily apparent that a large portion of the openings, 117 ha, occurs in the 10 ha class, although the two openings in the 50 ha class occupy 88 ha.

	OBJECTID*	SizeClass	Count_SizeClass	Sum_Area
▶	1	10	58	117.145091
	2	20	2	30.93104
	3	30	1	22.954
	4	40	1	39.532776
	5	50	2	88.284008

Figure 8. Area distribution of harvest opening sizes by 10 ha size classes.

Even though the number of size classes is small, a chart of the results would make interpreting them easier.

- 2 Create a horizontal bar chart of *Sum_Area* by *SizeClass* (*Table Options* » *Create Graph*) similar to the following:

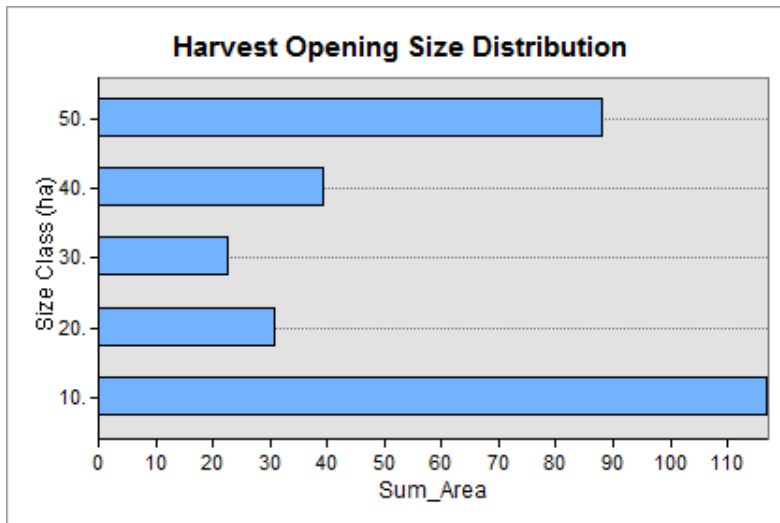


Figure 9. Amount of clearcutting by harvest opening size class.

Now, you have the clearcut opening size distribution for the Woodlot. It shows a pretty good range of sizes but with most openings concentrated in the smallest size class.

How are harvest openings distributed spatially, in other words, what's their spatial pattern? For example, are the two large openings near one another or dispersed among the smaller openings? A map of opening size classes (*Size Class*) will help you answer that.

MAP HARVEST OPENINGS BY SIZE CLASS

Values in the *SizeClass* field are continuous-ratio data. A graduated color scheme always works well with such data.

RELATED CONCEPT: CHARACTERIZE USING A GEOGRAPHIC DISTRIBUTION (MAP)

- 1 In *CCOpenings*, map *Size Class* using the *Yellow-Green Light to Dark* graduated color scheme or something similar. Change class labels to indicate class and associated area (*Sum_Area* values in the *Distribution* table).

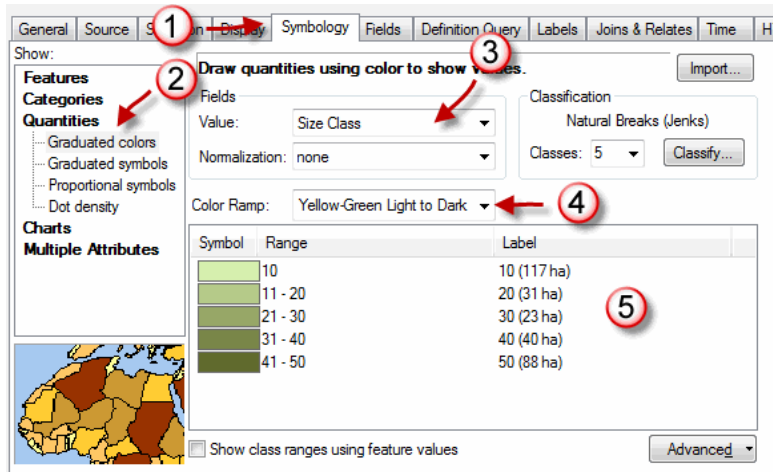


Figure 10. Symbolizing and labeling the Size Class attribute using a graduated color scheme.

You can always manually edit class ranges if you don't like the defaults. Simply enter the desired ranges in the *Range* column or use the *Classify* options.

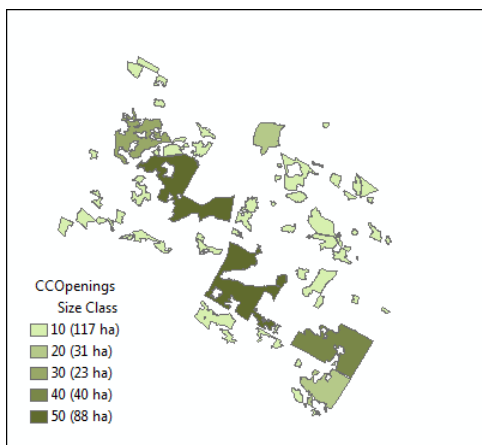


Figure 11. Map of harvest openings by 10 ha size classes with class amounts indicated.

- Zoom out and note that the two largest harvest openings are in close proximity to each other in the central part of the Woodlot.

Adding the area amounts for the size classes is a powerful way to add quantitative information to a map.

Conclusion

Your numbers, distribution, and map tell some things about clearcutting in the Woodlot. They show that clearcut openings are generally small, constitute a relatively large amount in total (300 ha),

and are distributed widely across the Woodlot. Is this good news or bad, from aesthetic, economic, and ecological perspectives?

By the way, calculating patch size distributions, like your harvest opening size distribution, finds frequent application in forestry. Can you think of other examples?

Submit your work

- Summary table, chart, and map of harvest openings by 10 ha size classes
- Answers to the questions posed in the exercise:
 1. What would happen if you didn't disable multipart features when merging?
 2. Why can't you simply recalculate existing *Shape_Area* values to hectares?
- A summary of the exercise, indicating where and how related reclassifying and characterizing concepts, as well as analysis techniques, are used (It could take the form of a table that checks off each of these elements.)
- A written assessment of clearcutting in the Woodlot, from aesthetic, economic, and ecological perspectives
- A harvest opening size distribution for a different forest, compiled using techniques similar to those encountered in the exercise

Credits

Sources of supplied data

Course Data

Data\cover, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\highway, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\newprop, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\tin, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\Woodlot.mdb, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\Codes\Woodlot_Codes.xls, courtesy of University of New Brunswick UNB Faculty of Forestry and Environmental Management

Data\Coordinate Systems\ATS 1977 New Brunswick Stereographic.prj, courtesy of ESRI
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Data\GPS\Knowledge.shp, courtesy of University of New Brunswick
Data\GPS\towers.xls, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\Layer Files\Age Classes.lyr, courtesy of Glen Jordan
Data\Layer Files\Air Photo Centre Points.lyr, courtesy of Glen Jordan
Data\Layer Files\Main Roads.lyr, courtesy of Glen Jordan
Data\Layer Files\Mgt Compartments.lyr, courtesy of Glen Jordan
Data\Layer Files\Non-forested.lyr, courtesy of Glen Jordan
Data\Layer Files\Secondary Roads.lyr, courtesy of Glen Jordan
Data\Layer Files\Streams.lyr, courtesy of Glen Jordan

Data\Mass Points\DTM.txt, courtesy of Service New Brunswick

Data\Models\Clearcutting.tbx, courtesy of Glen Jordan
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Data\Models\Forest Values.tbx, courtesy of Glen Jordan

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Data\WatershedDelineation\Watershed Delineation Tools.tbx – ESRI

Lesson 3: Clearcutting data

Data\Openings\DiagStep2a.gif, courtesy of Glen Jordan
Data\Openings\DiagStep3a.gif, courtesy of Glen Jordan
Data\Openings\DiagStep3b.gif, courtesy of Glen Jordan
Data\Openings\DiagStep4a.gif, courtesy of Glen Jordan
Data\Openings\DiagStep5a.gif, courtesy of Glen Jordan
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Data\Openings\ResStep2a.gif, courtesy of Glen Jordan
Data\Openings\ResStep2b.gif, courtesy of Glen Jordan
Data\Openings\ResStep4a.gif, courtesy of Glen Jordan
Data\Openings\ResStep4b.gif, courtesy of Glen Jordan
Data\Openings\ResStep5a.gif, courtesy of Glen Jordan

Data\Visible\DiagStep1a.gif, courtesy of Glen Jordan
Data\Visible\DiagStep1b.gif, courtesy of Glen Jordan
Data\Visible\DiagStep1c.gif, courtesy of Glen Jordan
Data\Visible\DiagStep2a1.gif, courtesy of Glen Jordan
Data\Visible\DiagStep2a2.gif, courtesy of Glen Jordan
Data\Visible\DiagStep2b.gif, courtesy of Glen Jordan
Data\Visible\DiagStep3a.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4a.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4b.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4c.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4d.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4e.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4f.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4g.gif, courtesy of Glen Jordan
Data\Visible\DiagStep4h.gif, courtesy of Glen Jordan
Data\Visible\ResStep1a.gif, courtesy of Glen Jordan
Data\Visible\ResStep2a.gif, courtesy of Glen Jordan
Data\Visible\ResStep2b.gif, courtesy of Glen Jordan
Data\Visible\ResStep2c.gif, courtesy of Glen Jordan
Data\Visible\ResStep3a.gif, courtesy of Glen Jordan
Data\Visible\ResStep3b.gif, courtesy of Glen Jordan
Data\Visible\ResStep4a.gif, courtesy of Glen Jordan
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Data\Visible\ResStep4f.gif, courtesy of Glen Jordan
Data\Visible\ResStep4g.gif, courtesy of Glen Jordan
Data\Visible\ResStep4h.gif, courtesy of Glen Jordan
Data\Visible\ResStep4i.gif, courtesy of Glen Jordan

Data\Visible\ResStep4j.gif, courtesy of Glen Jordan
Data\Visible\ResStep4k.gif, courtesy of Glen Jordan

Data\Watershed\DiagStep2a.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep2b.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep3a.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep3b.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4a.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4b.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4c1.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4c2.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4d.gif, courtesy of Glen Jordan
Data\Watershed\DiagStep4e.gif, courtesy of Glen Jordan
Data\Watershed\ResStep1a.gif, courtesy of Glen Jordan
Data\Watershed\ResStep1b.gif, courtesy of Glen Jordan
Data\Watershed\ResStep2a.gif, courtesy of Glen Jordan
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Data\Watershed\ResStep2c.gif, courtesy of Glen Jordan
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Data\Watershed\ResStep4c.gif, courtesy of Glen Jordan
Data\Watershed\ResStep4d.gif, courtesy of Glen Jordan
Data\Watershed\ResStep4e.gif, courtesy of Glen Jordan
Data\Watershed\ResStep4f.gif, courtesy of Glen Jordan
Data\Watershed\Result3D.gif, courtesy of Glen Jordan
Data\Watershed\ResultTable1.gif, courtesy of Glen Jordan
Data\Watershed\ResultTable2.gif, courtesy of Glen Jordan