

Forest Analysis Techniques

Assessing balsam fir tipping potential

—by Glen Jordan

Introduction

Problem

How might one assess a forest for its potential as a source of branch tips for wreath making?

The manufacture and sale of Christmas wreaths is a growing business in northeastern North America. The primary product used in wreath manufacturing is balsam fir (*Abies balsamea*) branch tips. While other tree species are used occasionally in wreath making, balsam fir is preferred, given its aromatic, dense, deep green foliage.

Branch tips are harvested in late fall from young, full-crowned trees once needles have set. Balsam fir stands occur commonly in northeastern forests, on most sites. Mature trees produce abundant seed most years, and seedlings establish readily and grow quickly following disturbances such as timber harvests. Ideal tipping stands will be those that are young, with nonmerchantable-size trees that are relatively open-grown with large crowns. More information can be found at the website: <http://umaine.edu/publications/7011e/>

Location

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

Time to complete the lab

Three hours

Keywords: nontimber forest product analysis; characterizing by a single number; numerical distribution; map; selecting features by attribute and location; using VB in Field Calculator; overlaying features (poly-on-poly); buffering features (fixed width); summarizing an attribute

Prerequisites

A basic working knowledge of geographic information system (GIS) data, including the geodatabase, and ArcGIS® software in particular; familiarity with forest inventory data and terminology also helpful but not essential

Data used in this lab

- Feature classes and rasters for the 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

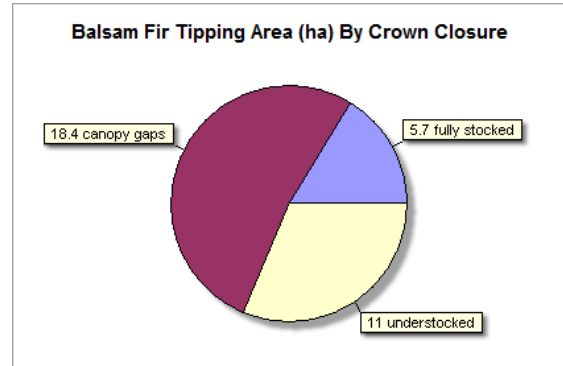
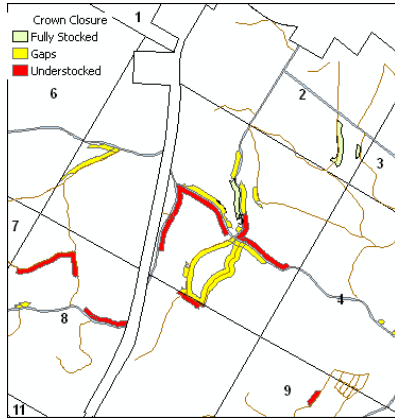
In this lab exercise, you'll assess the Woodlot for its balsam fir tipping potential. The obvious questions are: Are young balsam fir stands, with relatively open-grown trees, abundant? Are these stands accessible?

You'll attempt to find answers by compiling and mapping the distribution of areas of young balsam fir by their crown closure status and accessibility.

Results expected

A summary table, pie chart, and map of road-accessible balsam fir tipping areas in the Woodlot (see below)

Tipping_Summary				
	OBJECTID *	Crown Closure	FREQUENCY	SUM_Shape_Area
▶	1	fully stocked	15	5.7
	2	canopy gaps	28	18.4
	3	understocked	16	11



Data available

- Cover types feature class: *cover*
- Secondary roads feature class: *roads*
- Stand volumes table: *volumes*
- Management compartments layer file: *mgt compartments*

Solution steps

1. Identify balsam fir tipping stands.
2. Determine accessible amount.
3. Summarize and map tipping areas by crown closure.

IDENTIFY BALSAM FIR TIPPING STANDS

Young to immature balsam fir-dominated stands are ideal for tipping operations. Individual tree crowns will be large, and if relatively open grown, have branches extending to chest level or lower, making the removal of branch tips quick and easy.

In the Woodlot inventory, stand age and crown closure are recorded in the cover types feature class (*cover*). Balsam fir content, on the other hand, is found in the *volumes* table, where the *BF_* field indicates the percentage of balsam fir.

So, stands from 5 to 40 years old, with a minimum of 50 percent balsam fir content, would be acceptable tipping stands. Stands satisfying these conditions should be easy to identify in the Woodlot.

How much is there, though?

RELATED CONCEPT: CHARACTERIZE USING A SINGLE NUMBER

- 1 Start ArcMap™, and if you haven't already, use *Environment Settings (Geoprocessing » Environments » Workspace)* to establish both your Current Workspace and Scratch Workspace as your *Woodlot* geodatabase.
- 2 Add the *cover* feature class from the *Woodlot* geodatabase, and then join *volumes* via the common stand identifiers—*Stand#* and *Stand_ID*, respectively.

That makes the search fields, *AGE* and *BF_*, available for building a query that will isolate potential balsam fir tipping stands.

- 3 Using *Definition Query (Layer Properties » Definition Query)*, isolate the Woodlot's potential balsam fir tipping stands with the following query expression. Rename the layer *BFtipping*.

```
[cover.AGE] >= 5 AND [cover.AGE] <= 40 AND [volumes.BF_] >= 50
```



Figure 1. Potential balsam fir tipping stands in the Woodlot.

Doing this selects 46 stands. What area do these 46 potential tipping stands occupy?

- 4 Open the *BFTipping* attribute table, right-click *Shape_Area*, and select *Statistics*.

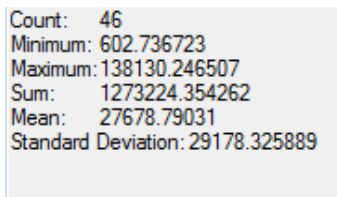


Figure 2. Summary area statistics (m²) for potential balsam fir tipping stands.

The summary reveals that the Woodlot has 127 ha (Note: 1 ha is 10,000 square meters [m²].) of stands with balsam fir tip harvesting potential, a significant area.

But how accessible are these stands? Any areas beyond about 30 m of the roadside would not be practical for tip harvesting.

DETERMINE ACCESSIBLE AMOUNT

The Woodlot has ample roads, so you wouldn't expect access to be a large issue. Bear in mind, though, that just because a road passes through a stand or within 30 m of it doesn't mean the entire stand is accessible for tip harvesting.

The question should be, what *portions* of the 46 balsam fir tipping stands are within 30 m of a road?

RELATED CONCEPT: CHARACTERIZE USING A SINGLE NUMBER

Answering that question is more complicated. You'll first need to buffer Woodlot roads to 30 m, and then overlay the buffers on the 46 stands to isolate their accessible portions.

- 1 Add secondary roads (*roads*) as a layer in ArcMap.



Figure 3. The Woodlot's secondary roads superimposed on potential balsam fir tipping stands.

You can see that many of the 46 tipping stands are either transected by a secondary road or have one passing nearby.

Some of these so-called roads are actually trails that would not support vehicle travel. You should exclude these from the analysis.

- 2 Using *Definition Query* again, exclude trails from the *Secondary Roads* layer using `CLASS <> 'C4'`.

Doing this reduces access somewhat, but don't overlook main roads in the Woodlot. There are plenty of them, and they obviously improve the odds of accessing balsam fir tipping stands.

- 3 Add the cover types feature class (*cover*) a second time, but this time limit it to main road rights-of-way using a *Definition Query* expression of `TYPE = 'RD'`. Rename the layer *ROW*.

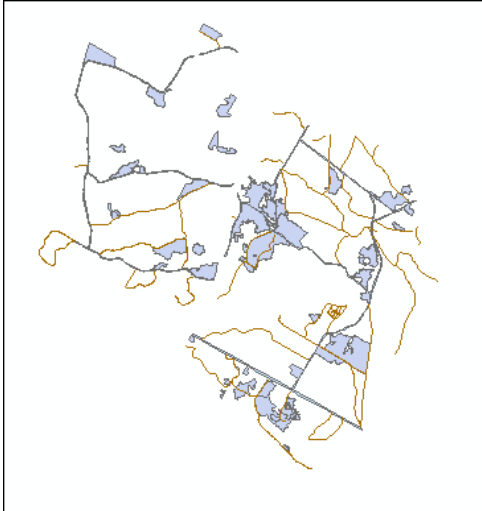


Figure 4. The Woodlot's main roads, secondary roads, and 46 potential balsam fir tipping stands.

Now, isolating accessible portions of the 46 stands should be a simple matter of merging main and secondary roads, buffering to 30 m, and then overlaying the buffers on the 46 stands.

The only problem is, *Secondary Roads* and *ROW* are different feature types. One has linear features and the other polygons. That means you can't merge the two types into one network for buffering, but rather, you'll have to buffer the two layers separately and then combine their buffers using a union overlay.

- 4 Use the *Buffer* tool in ArcToolbox™ (*Analysis Tools* » *Proximity*) to buffer *Secondary Roads* to 30 m, making sure to set *Dissolve Type* to *All*. Name the output *roads_buffer*.

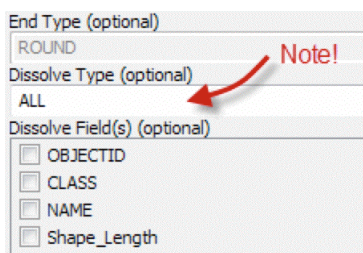


Figure 5. *Buffer* tool dialog box indicating *ALL* for the *Dissolve Type* parameter.

Question 1: *What would happen if you didn't set Dissolve Type to All when buffering?*

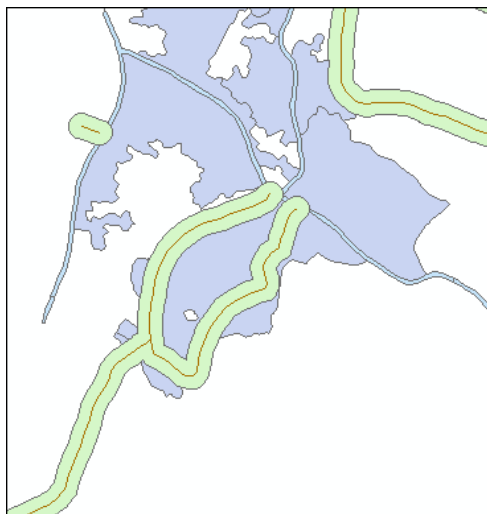


Figure 6. Zoomed in on 30 m secondary roads buffers in the central portion of the Woodlot.

Zoomed in, it's easy to see where the 30 m buffer of *Secondary Roads* overlaps balsam fir tipping stands and, thus, be able to identify portions that are accessible.

You can do a similar thing for main roads.

- 5 Buffer *ROW* to 30 m, again making sure to set *Dissolve Type* to *All*. Name the output *ROW_buffer*.

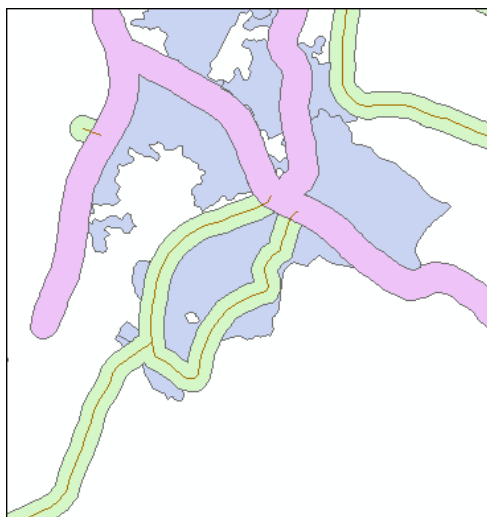


Figure 7. Zoomed in on 30 m main road rights-of-way buffers in the central portion of the Woodlot.

That, of course, identifies additional balsam fir tipping stands that are accessible, although there are also overlaps between the two buffer types.

What you want to know now is, precisely how much of the tipping stands lie within one buffer or the other, or both?

To answer that question, you'll first have to combine the two buffers, and then overlay the result on the tipping stands.

- 6 First combine the two buffers using the *Union* tool (*Analysis Tools » Overlay*). Make sure *Gaps Allowed* remains checked. Name the result *buffers*.

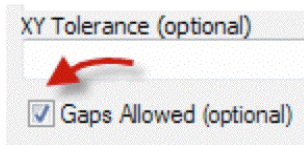


Figure 8. Union tool dialog box indicating *Gaps Allowed*.

Question 2: What would happen if the *Gaps Allowed* option wasn't selected when combining buffers?

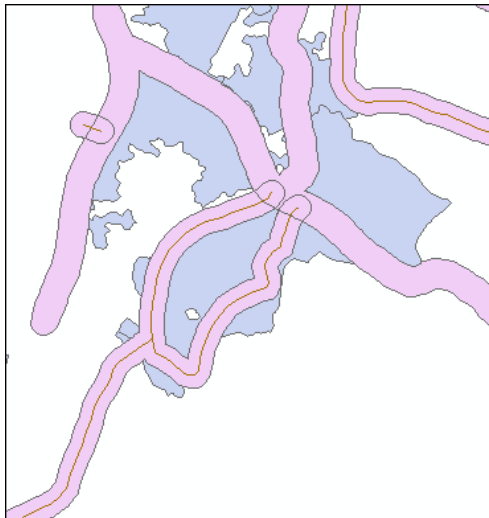


Figure 9. Union of secondary and main road buffers for the central portion of the Woodlot.

Note that where buffers have overlapped, new polygons have been formed, and as a result, no duplication of area occurs.

All you need to do now is overlay the combined buffers on the tipping stands.

- 7 Use the *Intersect* tool (*Analysis » Overlay*) to overlay buffers on *BFtipping*. Name the result *Tipping*.

If you turn all layers off, except *Tipping*, you can see that the overlay has left you with a feature class of only the accessible portions of tipping stands.

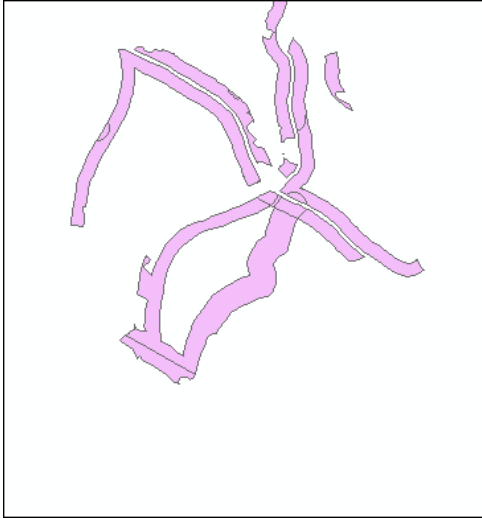


Figure 10. Accessible portions of balsam fir tipping stands in the central portion of the Woodlot.

What amount does the accessible portion represent, compared with your earlier estimate?

- 8 Open the *Tipping* attribute table and, as you did earlier, compute statistics for the *Shape_Area* field.

Count:	59
Minimum:	0.019417
Maximum:	46853.343365
Sum:	351873.961191
Mean:	5963.965444
Standard Deviation:	7933.350952

Figure 11. Summary statistics (m^2) for accessible balsam fir tipping areas.

Computing this indicates that 35 ha of tipping area, involving 59 polygons, is accessible within 30 m of the roadside, compared with the total tipping stand area of 127 ha that you calculated earlier. Even so, 35 ha is not an insignificant amount.

But that, too, is misleading.

Recall that the best tipping opportunities exist where young-to-immature balsam fir trees are growing in relatively open-grown conditions. You know that the 35 ha tipping area contains balsam fir trees from 5 to 40 years old, but how much of the 35 ha area has open-grown trees, and how many are a size that's suitable for tipping?

Answering that is next.

SUMMARIZE AND MAP TIPPING AREAS BY CROWN CLOSURE

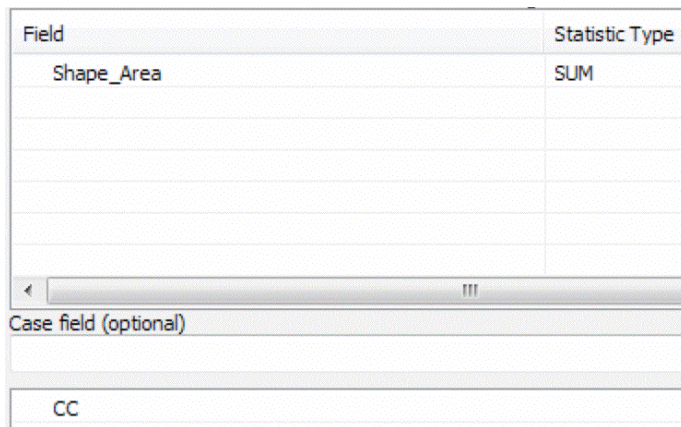
The crown closure (CC) field in the Woodlot inventory classifies stands by the extent to which tree crowns tend to fully occupy stand area or not.

Several classes are recorded—fully stocked, indicating a closed canopy across the stand; canopy gaps, indicating some openings are present; and understocked, indicating generally open-grown trees.

How are the 35 ha of accessible balsam fir tipping stands distributed across these crown closure classes? One would hope that most are in the understocked and canopy gaps categories.

RELATED CONCEPT: CHARACTERIZE USING A NUMERICAL DISTRIBUTION

- 1 Use the *Summary Statistics* tool (*Analysis Tools » Statistics*) to summarize CC in *Tipping* by *Shape_Area Sum*. Name the output table *Tipping_Summary*.



As an alternative here, you could right-click the CC field and select Summarize. However, the CC field domain and its code descriptions would not be carried forward into the summary table.

Figure 12. Summarizing crown closure classes (CC) by area totals (Shape_Area).

If you open the summary table, you can see area amounts (m²) in three crown class categories.

	OBJECTID *	Crown Closure	FREQUENCY	SUM_Shape_Area
▶	1	fully stocked	15	57224.797539
	2	canopy gaps	28	184492.931387
	3	understocked	16	110156.232265

Figure 13. Summary table of areas (m2) by crown closure classes.

Understocked and canopy gaps are the crown closure conditions most likely to produce open-grown trees suitable for tipping. You can see that there are 18 ha and 11 ha, respectively, of these conditions.

A pie chart would be an effective way to communicate this information in a report.

But first, it would make sense to recalculate area amounts (*SUM_Shape_Area*) as hectares, and then reduce decimal places to just one.

- 2 Using a Visual Basic (VB) expression in Field Calculator (right-click *SUM_Shape_Area* » *Field Calculator*), recalculate *SUM_Shape_Area* as

`Round(Sum_Shape_Area /10000,1)`

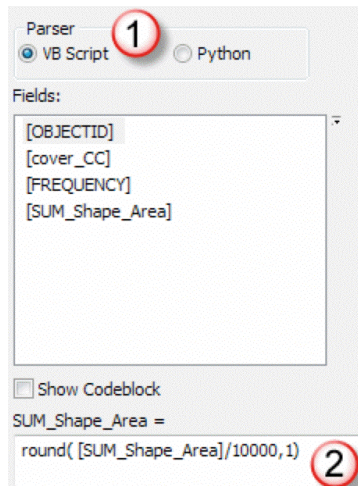


Figure 14. Computing area values in hectares to one decimal place using the *VB Round* function.

Now you're ready to build the pie chart.

- Use the chart wizard (*Table Options » Create Graph*) and your *Tipping_Summary* table to build a pie chart similar to the one in figure 15:

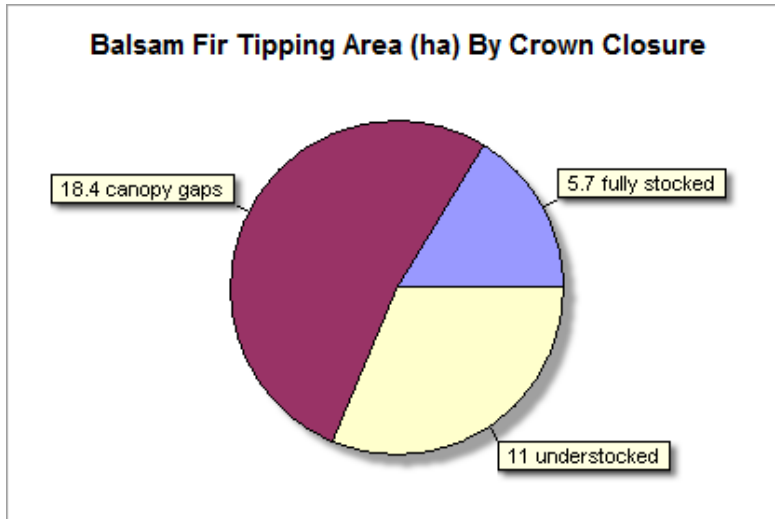


Figure 15. Chart of accessible balsam fir tipping areas by crown closure classes in the Woodlot.

The chart makes the numerical distribution of balsam fir tipping areas by crown closure very obvious.

Where are these amounts located, however? Are the desired conditions clustered or widely distributed? A map would help answer that.

- Zoom to full extent and symbolize *Tipping* based on the unique values of *A*, *B*, and *C* in the *Crown Closure* field.

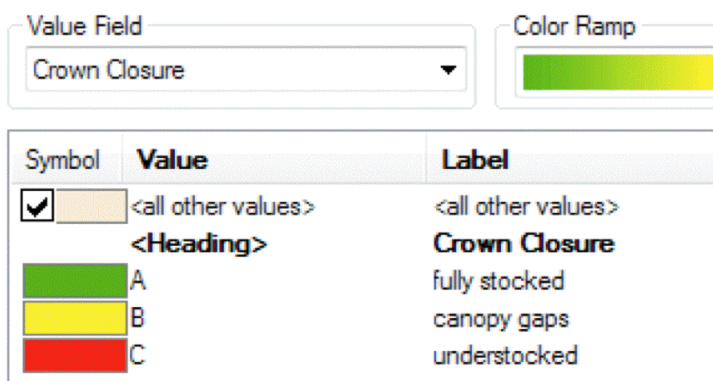


Figure 16. Crown closure classes (*Crown Closure*) are mapped using unique colors.

Fully zoomed out, it's pretty obvious there is a concentration of crown closure class B and C tipping areas in the central areas of the Woodlot.

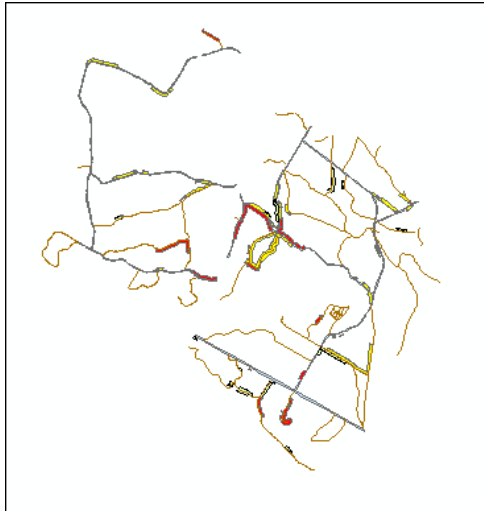


Figure 17. Map of accessible balsam fir tipping areas in the Woodlot, symbolized by crown closure class.

- 5 Zoom in on the central area of the Woodlot and add the management compartments layer file (*Mgt Compartments* in the *Layer Files* folder).



Figure 18. Map of accessible balsam fir tipping areas in and around management compartment 5 of the Woodlot, symbolized by crown closure class.

If you were looking to go tipping balsam fir trees in the Woodlot, management compartment 5 looks like your best opportunity.

Question 3: *How might you calculate balsam fir tipping amounts by Woodlot management compartment?*

Conclusion

Your numbers, distribution, and map provide insight into balsam fir tipping potential in the Woodlot. Is it worth pursuing?

You might want to explore changing some parameters, like buffer width, or the selection criteria for identifying balsam fir tipping stands. Are results sensitive to these inputs?

Submit your work

- Summary table, chart, and map of accessible balsam fir tipping areas by crown class
- Answers to the questions posed in the exercise:
 1. What would happen if you didn't set *Dissolve Type* to *All* when using the *Buffer* tool?
 2. What would happen if the *Gaps Allowed* option isn't selected when using the *Union* tool?
 3. How might you calculate balsam fir tipping amounts by Woodlot management compartment?
- A summary of the exercise, indicating where and how related reclassifying and characterizing concepts, as well as analysis techniques, are used (Your summary could take the form of a table that checks off each of these elements).
- Assessment of the Woodlot for some other nontimber forest product, using techniques similar to those encountered in assessing balsam fir tipping potential

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
Data\Coordinate Systems\NAD 1983 CSRS New Brunswick Stereographic.prj, courtesy of ESRI

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

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

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Data\Updates\l23_18u.tif, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\Updates\l24_129u.tif, courtesy of University of New Brunswick Faculty of Forestry and Environmental Management

Data\WatershedDelineation\Watershed Delineation Tools.tbx – ESRI

Lesson 2: Analysis data

Data\Budworm\DiagStep1a.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep2a.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep3a.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep4a.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep4b.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep6a.gif, courtesy of Glen Jordan
Data\Budworm\DiagStep7a.gif, courtesy of Glen Jordan
Data\Budworm\ResStep3a.gif, courtesy of Glen Jordan
Data\Budworm\ResStep6a.gif, courtesy of Glen Jordan
Data\Budworm\ResStep6b.gif, courtesy of Glen Jordan
Data\Budworm\ResStep7a.gif, courtesy of Glen Jordan

Data\Erosion\DiagStep1a1.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep1a2.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep2a.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep3a.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep3b.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep3c.gif, courtesy of Glen Jordan
Data\Erosion\DiagStep4a.gif, courtesy of Glen Jordan
Data\Erosion\ResStep1d.gif, courtesy of Glen Jordan
Data\Erosion\ResStep2a.gif, courtesy of Glen Jordan
Data\Erosion\ResStep3a.gif, courtesy of Glen Jordan
Data\Erosion\ResStep3b.gif, courtesy of Glen Jordan
Data\Erosion\ResStep4a.gif, courtesy of Glen Jordan
Data\Erosion\ResStep4b.gif, courtesy of Glen Jordan
Data\Erosion\ResStep4c.gif, courtesy of Glen Jordan

Data\Skid\DiagStep2a1.gif, courtesy of Glen Jordan
Data\Skid\DiagStep2a2.gif, courtesy of Glen Jordan
Data\Skid\DiagStep2b.gif, courtesy of Glen Jordan
Data\Skid\DiagStep3a.gif, courtesy of Glen Jordan
Data\Skid\DiagStep3b.gif, courtesy of Glen Jordan
Data\Skid\DiagStep4a.gif, courtesy of Glen Jordan
Data\Skid\DiagStep4b.gif, courtesy of Glen Jordan
Data\Skid\DiagStep4c.gif, courtesy of Glen Jordan
Data\Skid\DiagStep5a.gif, courtesy of Glen Jordan
Data\Skid\ResStep1b1.gif, courtesy of Glen Jordan

Data\Skid\ResStep1b2.gif, courtesy of Glen Jordan

Data\Skid\ResStep3a.gif, courtesy of Glen Jordan

Data\Skid\ResStep4b.gif, courtesy of Glen Jordan

Data\Skid\ResStep4c.gif, courtesy of Glen Jordan

Data\Tipping\DiagStep2a.gif, courtesy of Glen Jordan

Data\Tipping\DiagStep2b.gif, courtesy of Glen Jordan