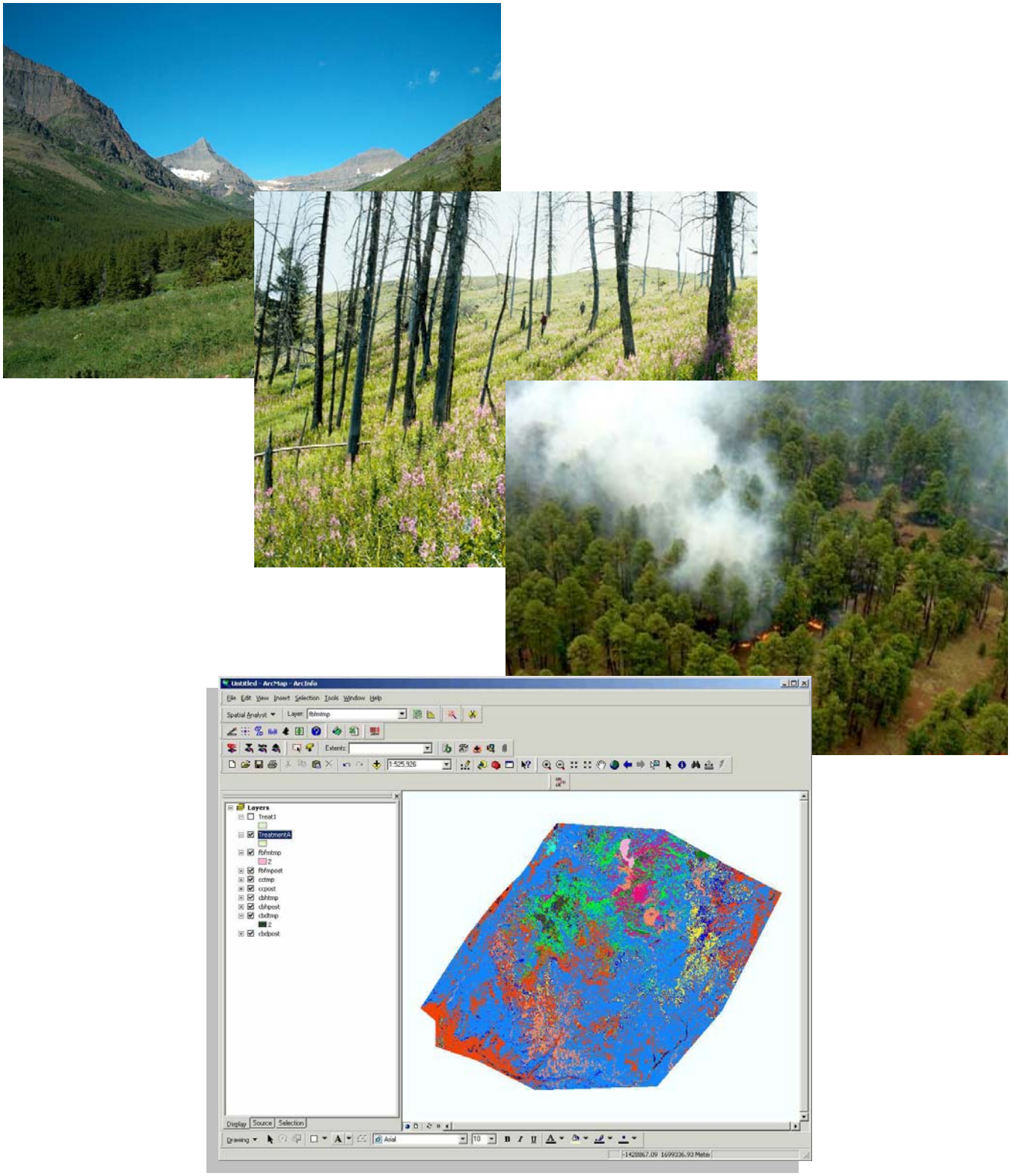

Area Change Tool User's Guide

Version 2.0.3

January 2008

National Interagency Fuels Coordination Group

Preface

The Area Change Tool (ACT) was developed in response to the need for a tool that could be used to help design and delineate fuel and vegetation prescriptions as well as edit raster layers to accurately portray treatment outcomes. These edited data can be used with fire behavior analysis systems such as FARSITE (Finney 1998) and FlamMap (Finney and others, 2006) to evaluate the effectiveness of proposed fuel or vegetation treatments. However, since ACT is simply a geographic information system (GIS) tool, its potential applications can include any GIS analysis that involves:

- Creating a new shapefile
- Editing an existing shapefile
- Converting the attributes of a shapefile into a raster
- Combining multiple rasters into a single raster
- Editing the value attribute table of a raster
- Converting edited attributes into a new raster
- Merging an edited raster layer into the original raster layer to create a new layer that incorporates the edits

This version of the Area Change Tool (version 2.0.3) was released in January 2008. Future versions will incorporate additional features, so be sure to check the NIFTT website at www.niftt.gov for tool updates and enhancements as well as associated updates to this user's guide.

What's new in version 2.0.3?

The original version of the Area Change Tool contained two user interfaces: a Wizard Interface and a Toolbar Interface. The Toolbar Interface has been removed to eliminate redundancy and to reduce complexity.

We have also changed some of the terminology used in the ACT dialog boxes for added clarity.

Prerequisites

The Area Change Tool uses ArcGIS (including ArcMap and Spatial Analyst), Microsoft Windows, Microsoft Excel, and Microsoft Access. Users need a basic understanding of these software packages in order to successfully process data using the Area Change Tool.

The specific hardware and software requirements for operating the Area Change Tool are described in Chapter 1 of this user's guide.

Obtaining copies

To obtain additional copies of this ACT User's Guide or to obtain the ACT Tutorial (available spring 2008), follow these steps:

1. Go to the NIFTT website at www.niftt.gov.
2. Click on **NIFTT Tools and User Documents** in the menu. On that page, select **NIFTT User Documents.**
3. Click on the material you wish to download.

Credits

The Area Change Tool was developed for the National Interagency Fuels Technology Team (NIFTT) by Lee Hutter of Systems for Environmental Management (SEM), Missoula, Montana. Direction was provided by Jeff Jones and Wendel Hann from the USDA Forest Service and Marc Levesque of Acadia West, Silver City, New Mexico.

Support for the development of ACT was provided by the USDA Forest Service and the U.S. Department of Interior.

This Area Change Tool User's Guide was written by Jeff Jones of the USDA Forest Service and Deb Tirmenstein of Systems for Environmental Management.

Lastly, we thank Christine Frame of Systems for Environmental Management for her editorial proficiency.

Your input

We value your input. Please forward any questions, comments, reports of bugs, or ideas to the National Interagency Fuels Technology Team (NIFTT) at helpdesk@niftt.gov.

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Chapter 1: About the Area Change Tool (ACT) User's Guide

1.1 Before you begin
1.2 How to use this guide
1.3 System requirements
    1.3.1 Computer hardware
    1.3.2 Computer software

1.1 Before you begin

As mentioned, ACT users must be familiar with Microsoft Windows and have at least a basic understanding of ArcGIS operations, including a working knowledge of ArcMap and the Spatial Analyst extension. If ACT is used for editing raster data, users must be familiar with editing data in either Microsoft Excel or Microsoft Access. For help with ArcMap or Spatial Analyst, please refer to ArcMap's help utility.

1.2 How to use this guide

You need not read the entire guide from front to back to carry out a specific task in ACT. Once you are familiar with the basic concepts associated with ACT, you can quickly locate commonly used tasks by referring to headings in the Table of Contents near the beginning of this guide. You can then go to the specific section that addresses your needs. Whenever possible, screen captures are used to illustrate the steps to complete a required task.

Note that the ACT User's Guide is intended to provide step-by-step guidance on the operation of the tool and serves as a reference guide. The ACT Tutorial, available spring of 2008 at www.niftt.gov, will provide specific examples of the use of the tool.

1.3 System requirements

1.3.1 Computer hardware

Your choice of hardware will greatly affect ACT's performance. In general, computers having faster processors, more memory, and more free hard drive space will process data faster. A computer system having the minimum requirements identified in table 1-1 will likely suffice for applications involving relatively small analysis areas, such as tens of thousands of acres. However, a computer system should have the recommended requirements (table 1-1) if users will be frequently processing relatively large analysis areas, such as hundreds of thousands of acres.

Table 1-1. Minimum and recommended computer specifications for ACT.

	Minimum	Recommended
Windows operating system	2000/XP	2000/XP
Memory	1GB	At least 1.5GB
Processor: P4 or equivalent	1.0GHz	At least 2.0GHz
Free hard drive space	5GB	At least 10GB
Display resolution	800 x 600	At least 1280 x 1024
Mouse or pointer	Required	Required

1.3.2 Computer software

ACT users need ArcMap versions 9.0 or 9.1 and the Spatial Analyst extension.

> ***Note**: ACT has not yet been tested with ArcMap 9.2 or with the Microsoft Windows Vista operating system.*

Chapter 2: ACT Function

2.1 What does ACT do?
2.2 Applications of ACT
2.3 How does ACT work?

2.1 What does ACT do?

ACT is a GIS tool that facilitates the combining and editing of raster data using ArcMap versions 9.0 and 9.1. It does nothing that cannot be accomplished using ArcView or ArcInfo Workstation. However, ACT completes these tasks from the ArcMap platform and uses Microsoft Excel or Microsoft Access to edit the attribute tables of raster layers. Moreover, ACT allows you to maintain logical relationships between raster layers by combining them first into a single layer so that multiple attributes can then be edited simultaneously.

ACT incorporates seven GIS functions that are commonly used for editing raster data. These include:

- Delineating new shapefiles (for example, identifying a project boundary)
- Editing shapefiles (for example, identifying various treatment units within a project boundary)
- Converting shapefile attributes to raster layers
- Combining multiple rasters into a single layer
- Editing the value attribute table of a combined raster
- Creating a new raster layer from an attribute of an existing raster layer
- Merging edited values back into the original raster layer

2.2 Applications of ACT

In general, ACT is useful for GIS applications that involve:

- Editing incorrect raster layers
- Updating raster layers to reflect recent disturbances such as wildland fire, insects, disease, or weather
- Changing raster layers to reflect post-treatment outcomes
- Characterizing conditions at the pixel level based on multiple attributes

- Deriving a new thematic layer based on a combination of multiple existing layers
- Prioritizing treatment areas on the basis of layers created from a combination of attributes

The following discussion illustrates several of the more common applications of ACT.

For efficiency, GIS layers representing many ecosystem components such as biophysical settings, vegetation, fuels, soils, and climate are commonly modeled across relatively large geographic extents (millions of acres). Users of these data frequently attempt to "make them better" by refining layers at a more local level. Unfortunately, the process of editing raster layers can prove complicated for GIS users. However, even less-skilled GIS users will be able to make changes to raster layers using ACT. For example, suppose a fire behavior analyst believes that an existing fuel model layer is limiting his or her ability to simulate observed fire behavior on an incident. The analyst can use ACT along with ancillary data layers such as aspect, slope, and cover type to modify the existing fuel model layer to more closely simulate actual observed fire behavior.

The simple fact that ecosystems are dynamic necessitates frequent updates to GIS data. Wildland fires, wind storms, floods, insects, disease, and anthropogenic activities are constantly modifying vegetation structure and composition as well as landscape patterns. Consequently, vegetation and fuel data layers need to be updated on a continual basis to reflect changing conditions. ACT can be used with disturbance layers (for example, burn severity data) to change vegetation and fuel data layers to reflect post-disturbance conditions.

ACT can be used to evaluate the effectiveness of proposed vegetation and fuel treatment prescriptions in meeting management objectives. ACT can be used to change the raster layers so that they reflect the outcome of the proposed treatment. The edited layers can then be fed into modeling systems that forecast potential fire behavior, wildlife habitats, ecosystem departure, or other layers of interest. That is, the post-treatment conditions can be used to evaluate the effectiveness of the treatment.

By combining multiple raster layers into a single layer, data can be integrated at the pixel level. GIS modelers commonly derive a thematic layer based upon the combination of a suite of layers. For example, some wildlife habitat layers may be derived based on the spatial coincidence of elevation, aspect, cover type, diameter class, and canopy cover. ACT can be used to combine these layers and then used to classify the habitat of interest. In other words, ACT can be used to derive or model a new thematic layer based on some combination of existing layers.

The integration of a suite of variables at the pixel level allows for a speedy diagnosis of concerns, identification of opportunities, and development of general prescriptions for treatment. As many as 20 rasters can be combined to generate a value attribute table where each record (value) represents a unique combination of the input layers. Having information on up to 20 layers represented on every given pixel can be powerful. For

instance, ACT can be used to characterize each pixel by biophysical setting, existing vegetation (cover type, size class, or canopy cover), existing fuels (fire behavior fuel model, canopy base height, canopy height, or canopy bulk density), and likely fire behavior given some environmental parameters (for example, fuel moisture and wind). The combined layer could then be used to identify treatment opportunities and help design treatment prescriptions.

Predicting fire behavior using FlamMap (Finney and others 2006) and FARSITE (Finney 1998) requires a landscape area defined by the combination of elevation, slope, aspect, fire behavior fuel model, canopy base height, canopy height, and canopy cover. Fire behavior is then predicted on the basis of these layers combined. Since several of the themes in this example are interrelated, it may be important to retain the logical relationships between them. Therefore, if a user wants to model fire behavior but believes that the fire behavior fuel model layer needs refinement, it may be necessary to modify the canopy cover, canopy base height, and canopy bulk density layers so that they are logically consistent with the fuel model layer. In other words, a change in one variable, for example fire behavior fuel model, may require changes to other related variables such as cover type, size class, canopy base height, canopy cover, and canopy bulk density. ACT can be used to edit the values of multiple layers simultaneously, thereby maintaining the logical relationships between the layers.

ACT can be used to develop spatial priorities by identifying areas where a combination of conditions occur. For example, fuel treatment polygons can be delineated around areas where passive or active crown fire would likely occur in conjunction with specific fire behavior fuel models, canopy base height values, and canopy cover values. If managers are limited to using mechanized equipment to treat fuels and vegetation, the selection criteria could be further limited using thematic layers denoting slope and distance to open roads.

2.3 How does ACT work?

ACT uses a Wizard interface to guide the user through a sequential process for delineating vegetation and fuel treatment polygons, combining raster data layers that may need to be changed to reflect treatment objectives, editing the value attribute table to reflect treatment outcomes, and creating new updated raster layers. Although the Wizard interface uses a linear process that links multiple GIS processing steps together, that process need not be followed. Any of the GIS tasks performed by the Wizard can be selected at any time.

ACT contains two options for changing raster layers: Uniform Change and Variable Change. The Uniform Change is used when all values of a given layer within a polygon are changed to a single value (fig. 2-1). The Variable Change option is used when the desired edits would result in multiple values within a polygon (fig. 2-2). For example, suppose you have an existing fire behavior fuel model layer that follows Anderson

(1982). After the fuel model layer was produced, you were provided with a detailed map of exotic annual grasses that you believe should be classified as FBFM-1 (Short Grass Model). Consequently, you want to change to FBFM-1 all of the values in the existing fuel model layer that coincide with the polygons denoting exotic annual grasses. In this example, you could easily make these edits using ACT's Uniform Change option since only one value is being assigned to the polygons (fig. 2-1). However, if you want to update a fuel model layer after a wildland fire on the basis of three classes of burn severity (for example, low, moderate, and high), then the Variable Change option could be used to assign different fuel models on the basis of pre-burn conditions and burn severity class (fig. 2-2).

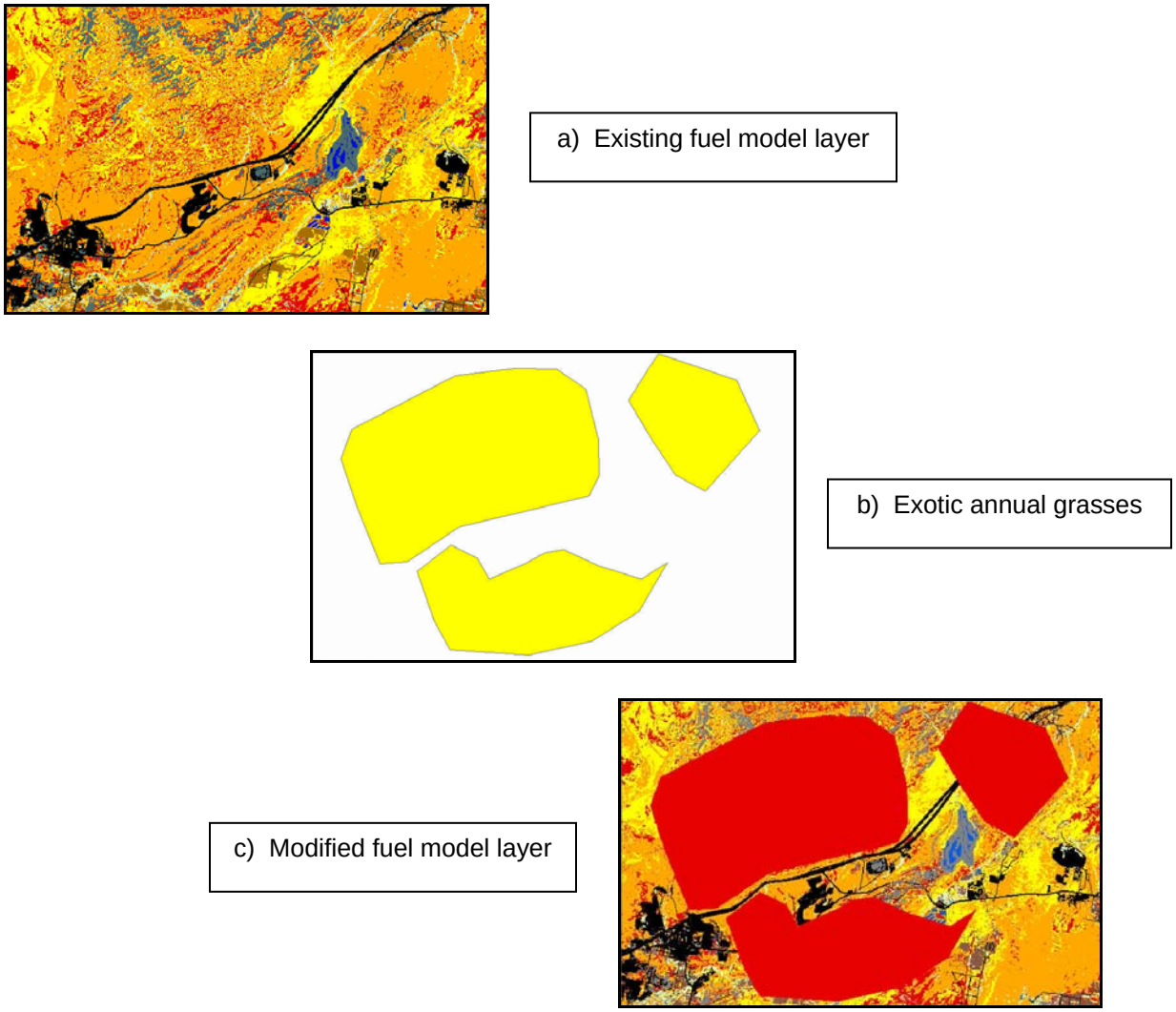


Figure 2-1. Using the Uniform Change option to change the fire behavior fuel models based on areas mapped as exotic annual grasses.

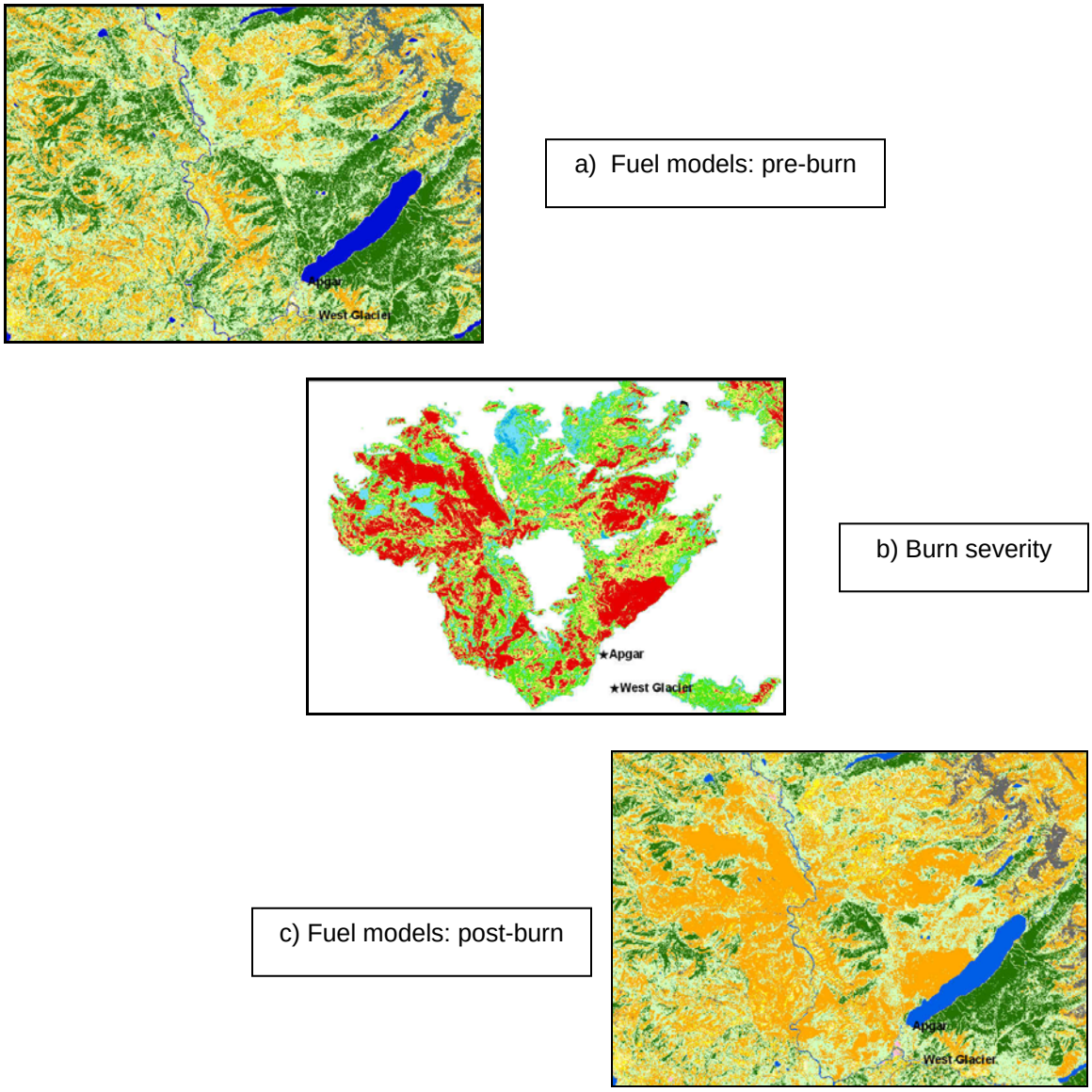


Figure 2-2. Using the Variable Change option to update a fuel model layer based on burn severity data.

ACT contains two options for editing a raster layer's attribute table when the Variable Change option is selected. Microsoft Excel can be used to edit relatively small or homogeneous areas when the number of unique values or records is low. However, combining multiple raster layers into a single layer may result in a value attribute table with several thousand unique values. Using Excel to edit a table of this size can be very tedious. For these situations, edits can be made more efficiently by using Microsoft Access, which enables you to write queries that will change hundreds of records simultaneously.

Chapter 3: Installing ACT

3.1 Installation instructions
3.1.1 Installing the complete NIFTT tool package
3.1.2 Single tool (ACT) installation
3.2 Troubleshooting ACT installation

3.1 Installation instructions

Currently, all NIFTT tools can be installed at once as a package. For some NIFTT tool users, the complete or package installation is most convenient.

> ***Note**: The following instructions apply to installation of the entire NIFTT package. Single tool installation will be addressed later in this chapter.*

Before you begin installation, it is important to note that both Microsoft .Net, Microsoft .Net Framework 1.1 with Service Pack 1, and the Hotfix are required for all of the NIFTT tools. If you have only Microsoft .Net Framework 1.1, you need to upgrade to Service Pack 1 and the Hotfix.

You can obtain Microsoft .Net Framework 1.1 by searching at http://www.microsoft.com.

The folder **dotnetfxsp1** contains three required files, and they *must be installed in the following order* (the install programs provide help in the form of warnings):

1. **dotnetfx.exe** (Microsoft .Net Framework 1.1).
2. **NDP1.1sp1-KB867460-X86.exe** – (Microsoft .Net Framework 1.1 Service Pack 1).
3. **NDP1.1sp1-KB886903-X86.exe** - (Microsoft .Net Framework 1.1 Hotfix).

You will need to reboot after installation. However, only one reboot is necessary.

> ***Note**: To confirm that these programs are installed on your computer, check Add/Remove Programs. You should see the following if the necessary programs are present:*

- Microsoft .Net Framework 1.1
- Microsoft .Net Framework 1.1 Hotfix (886903)

Note: *There is no indication given that Service Pack 1 is present except that Hotfix will not install unless Service Pack 1 has already been installed.*

3.1.1 Installing the complete NIFTT tool package

If you have earlier versions of any of the NIFTT tools (Fire Behavior Assessment Tool [FBAT], Fire Regime Condition Class Mapping Tool [FRCCmt], Multi-scale Resource Integration Tool [MRIT], or the Area Change Tool [ACT]) installed on your computer, you will first need to un-install these tools before proceeding with installation of the current versions.

To determine which version is currently installed on your computer, go to **Start > Control Panel > Add or Remove Programs**. View the version of the NIFTT tool you are interested in (fig. 3-1).

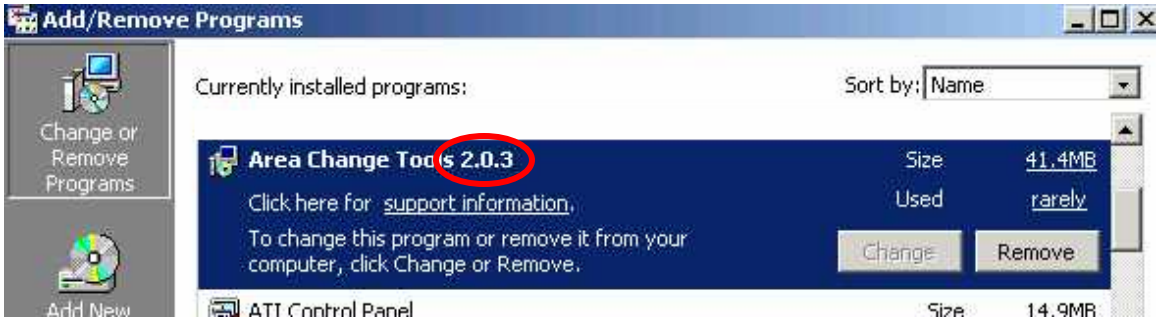


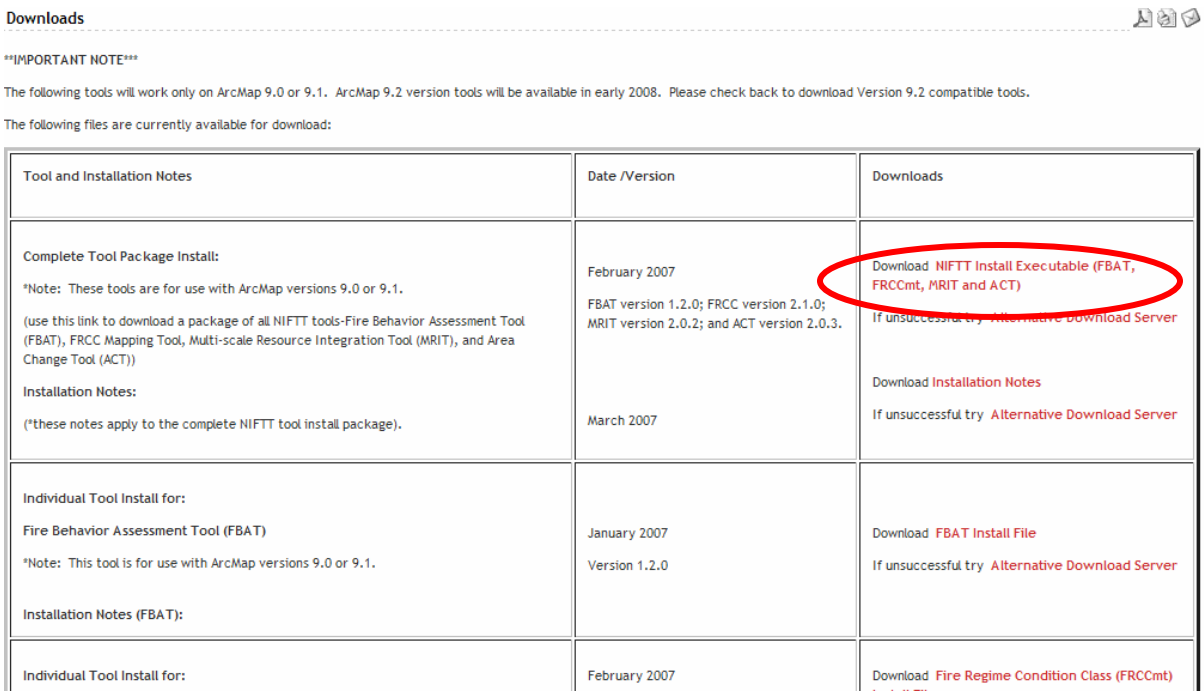
Figure 3-1. Version 2.0.3 of ACT.

> ***Note***: *NIFTT naming conventions are as follows: ACT_ 203_070215 indicates that this "install" is version 2.0.3 which was completed on 02/15/2007.*

You may need administrative privileges to install the NIFTT tool package. Contact your system administrator if you experience problems with the installation.

Follow these steps to install the complete NIFTT tool package:

1. From the NIFTT website at www.niftt.gov, click on **NIFTT Tools and User Documents** in the menu. On that page, select **NIFTT Tools**.
2. Click on the NIFTT Install Executable file (FBAT, FRCCmt, MRIT and ACT) as shown in figure 3-2.



Downloads

IMPORTANT NOTE*

The following tools will work only on ArcMap 9.0 or 9.1. ArcMap 9.2 version tools will be available in early 2008. Please check back to download Version 9.2 compatible tools.

The following files are currently available for download:

Tool and Installation Notes	Date /Version	Downloads
Complete Tool Package Install: *Note: These tools are for use with ArcMap versions 9.0 or 9.1. (use this link to download a package of all NIFTT tools-Fire Behavior Assessment Tool (FBAT), FRCC Mapping Tool, Multi-scale Resource Integration Tool (MRIT), and Area Change Tool (ACT)) Installation Notes: (*these notes apply to the complete NIFTT tool install package).	February 2007 FBAT version 1.2.0; FRCC version 2.1.0; MRIT version 2.0.2; and ACT version 2.0.3. March 2007	Download NIFTT Install Executable (FBAT, FRCCmt, MRIT and ACT) If unsuccessful try Alternative Download Server Download Installation Notes If unsuccessful try Alternative Download Server
Individual Tool Install for: Fire Behavior Assessment Tool (FBAT) *Note: This tool is for use with ArcMap versions 9.0 or 9.1. Installation Notes (FBAT):	January 2007 Version 1.2.0	Download FBAT Install File If unsuccessful try Alternative Download Server
Individual Tool Install for:	February 2007	Download Fire Regime Condition Class (FRCCmt)

Figure 3-2. Downloading the complete NIFTT tool package.

3. Next, double-click on **NIFTT_Install_070226.exe** to begin downloading the most recent tool installation package (note that the date in the file name may have changed). You will see the dialog box shown in figure 3-3:

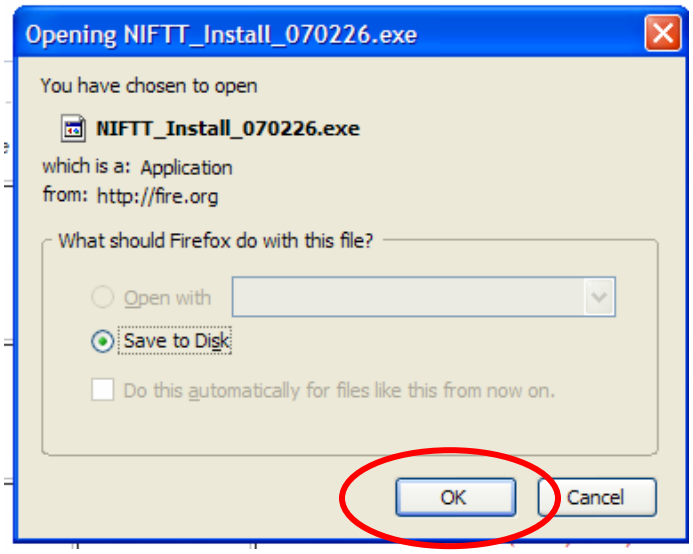


Figure 3-3 Opening and preparing to download package installation file.

4. Click **OK** to download the installation file and then save it to a convenient location on your computer.

   The following box will open as soon as the download is complete.

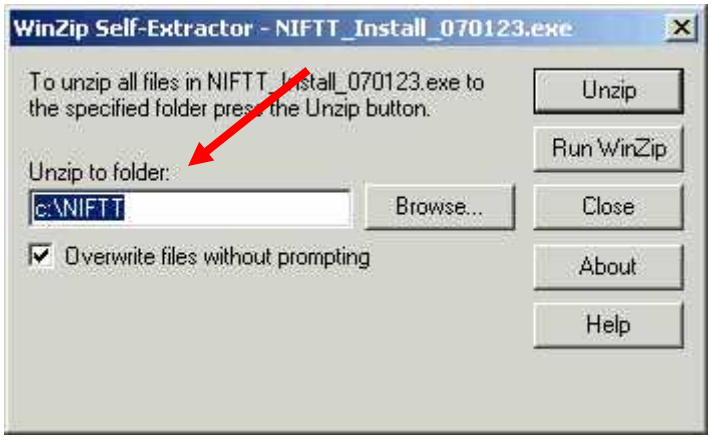


Figure 3-4. WinZip Self-Extractor NIFTT install dialog box.

5. Unzip the file to either the default location (C:\NIFTT as shown above in figure 3-4) or the location of your choice by selecting the Browse button.

   ***Note**: Do not install the tools to any pathways that may contain a space in the folder name such as My Documents or Program Files.*

6. A folder labeled NIFTT_Install_070123 will be created within the NIFTT (default) folder. Locate and then double click on the folder labeled NIFTT_Install_070123 as shown in figure 3-5 to begin the installation process. (Again, dates in folder names may have changed.)

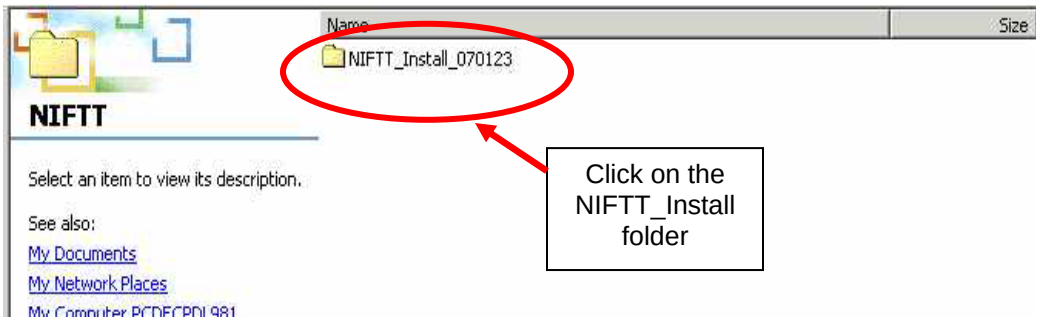


Figure 3-5. NIFTT_Install folder

7. When the NIFTT_Install folder opens, you will see the following files. Next, double-click on the installation batch file **NIFTT_setup.bat**.

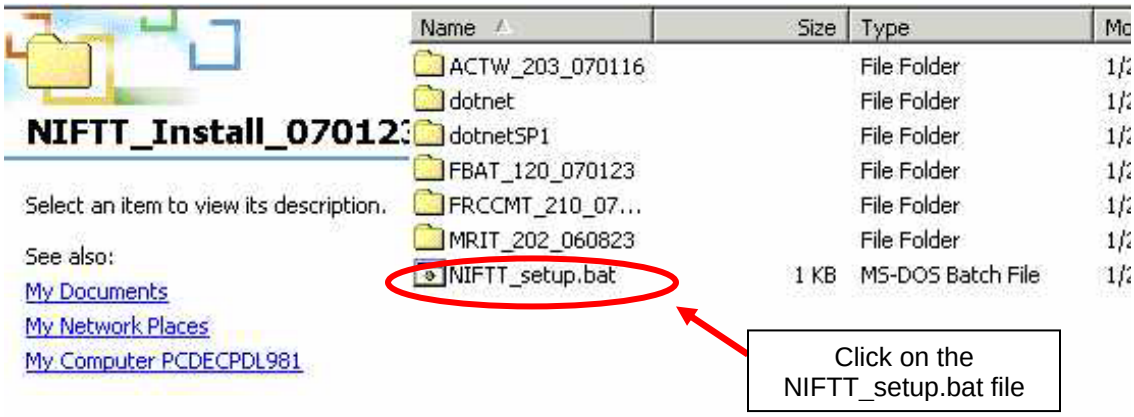


Figure 3-6. NIFTT Install folder contents.

8. You'll see a number of dialog boxes such as the one in figure 3-7. Click **Yes** to install the Microsoft.NET Framework package.

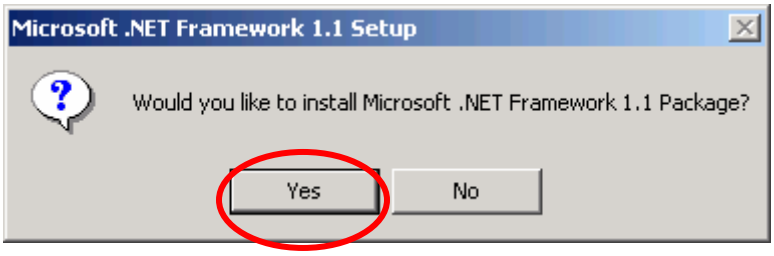


Figure 3-7. Microsoft Framework Setup dialog box.

9. Follow instructions as directed in a series of tool installation screens. Finally, you'll see the following dialog box:

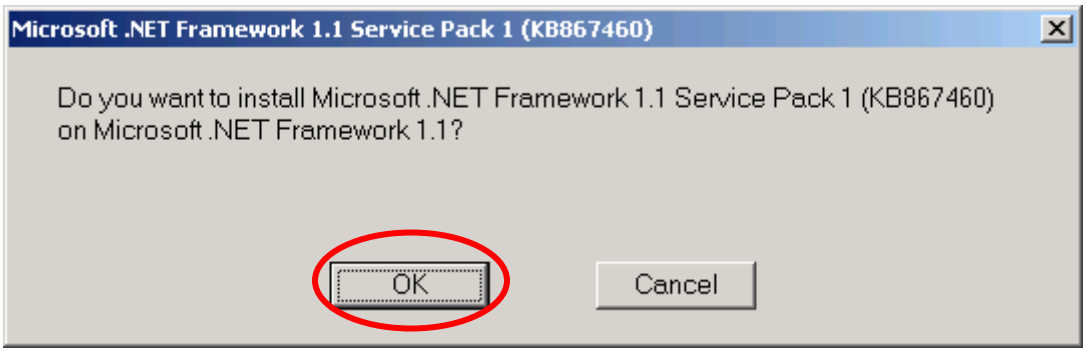


Figure 3-8. Microsoft Service Pack dialog box.

10. Click **OK** to install the Microsoft.NET Framework Service Pack 1, which is necessary for proper operation of the NIFTT tools.

11. You will be directed to reboot your computer after installation of each service pack. However, do not reboot the first time you see the following message box:

Figure 3-9. Microsoft .NET Framework dialog box.

12. When prompted a second time, click Yes to reboot.

    ***Note**: If for some reason you do not see a second message box asking if you want to reboot your computer, reboot your computer after the installation is complete.*

    In addition, during installation of the MRIT tool, you may be asked to specify whether the tool is to be installed for "Everyone" or "Just Me." Select the radio button next to the Just Me option.

Installation of the NIFTT tool package should now be complete. The following NIFTT tools should now be installed on your computer:

- Area Change Tool (ACT)
- Fire Behavior Assessment Tool (FBAT)
- FRCC Mapping Tool (FRCCmt)
- Multi-scale Resource Integration Tool (MRIT)

Two other applications, Microsoft.NET Framework and the Microsoft.NET Framework1.1Service Pack 1, should now also be installed.

> ***Note**: For NIFTT tools to function properly, ensure that the Spatial Analyst Extension is installed and activated.*

Now, open ArcMap and make sure that all of the NIFTT toolbars are visible as shown in figure 3-10:

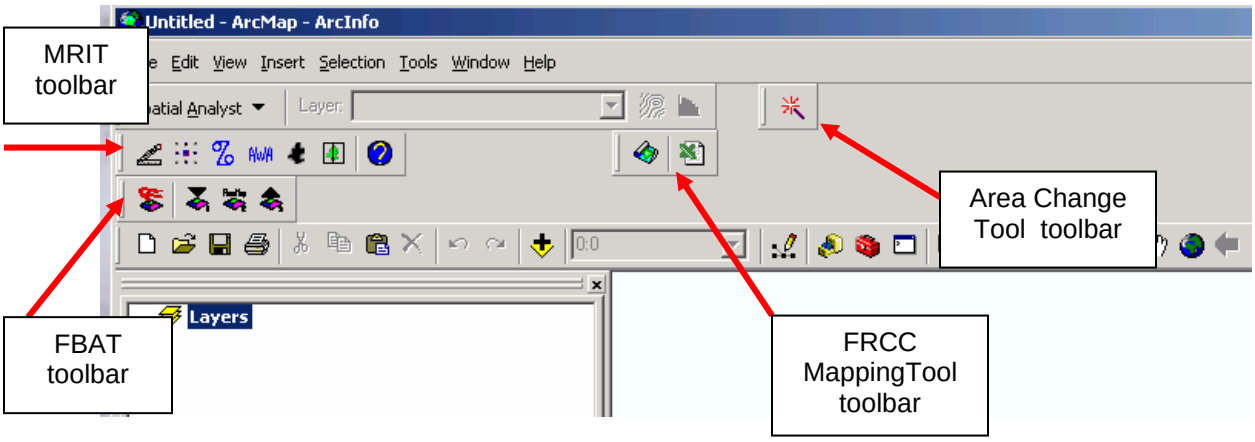


Figure 3-10. ArcMap showing NIFTT toolbars.

> ***Note**: Toolbars may be "floating," and you may need to anchor them in convenient locations by dragging them to toolbars at the top of your screen.*

3.1.2 Single tool (ACT) installation

If you wish to install or reinstall ACT as a single tool without the entire NIFTT package, follow these steps:

1. From the NIFTT website at www.niftt.gov, click on **NIFTT Tools and User Documents** in the menu. On that page, select **NIFTT Tools**.
2. Click on the ACT Install file as shown in figure 3-11.

Individual Tool Install for: Multi-scale Resource Integration (MRIT) Tool *Note: This tool is for use with ArcMap versions 9.0 or 9.1. Installation Notes (MRIT):	August 2006 Version 2.0.2	Download MRIT Install File If unsuccessful try Alternative Download Server
Individual Tool Install for: Area Change Tool (ACT) *Note: This tool is for use with ArcMap versions 9.0 or 9.1. Installation Notes (ACT):	February 2007 Version 2.0.3	Download ACT Install File If unsuccessful try Alternative Download Server
Fire Regime Condition Class Standard Landscape Worksheet Application Software Installation File	December 2007	Download Fire Regime Condition Class Standard Landscape Application
Fire Regime Condition Class Standard Landscape Application - Installation Notes	December 2007	Download Fire Regime Condition Class Standard Landscape Application Installation Notes

Figure 3-11. Downloading individual ACT tool.

3. Navigate to the directory in which you have copied NIFTT tool files and downloaded ACT (see figs.3-4 and 3-5).

4. If the installer determines a previous version of ACT is already installed, go to the **Control Panel (Start** > **Settings** > **Control Panel**) and select **Add/Remove Programs**. Uninstall **Area Change Tool** and then rerun **Setup.exe**.

5. If the installer determines that Microsoft Data Access Components (MDAC) are not up-to-date, run **mdac_type.exe** from the distribution source and rerun **Setup.exe**.

6. If the installer determines the setup needs the **.NET Framework**, double click on the **dotnetfx.exe** file and follow the prompts. When complete, double click **Setup.exe** to continue.

   ***Tip**: If the **dotnetfx.exe** file is already present on your computer, the downloaded .zip file will contain everything needed to install FBAT on your computer. If it is not already installed, you must download and install **dotnetfx.exe**.*

7. Once the installation begins, choose to install ACT for a single user ("Just Me") and then select your install location. Follow the defaults and then select **Close.**

8. Open ArcMap with your desired map document. Go to the **View** menu and select **Toolbars**. Make sure that the ACT Toolbar is checked and visible.

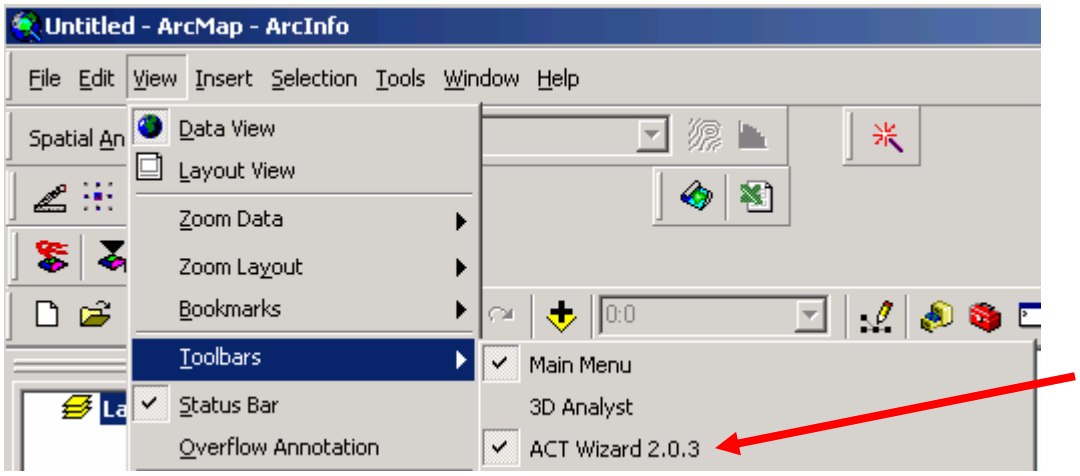


Figure 3-12. Selecting the **ACT** toolbar.

***Note**: Be sure that you do not have an earlier version of ACT installed on your computer before downloading any newer version of the product.*

3.2 Troubleshooting ACT installation

If the ACT toolbar shown at the right does not appear automatically when you open ArcMap, you will need to select **View > Toolbars** and check the box to the left of ACT Wizard 2.0.3 as shown in the figure below:

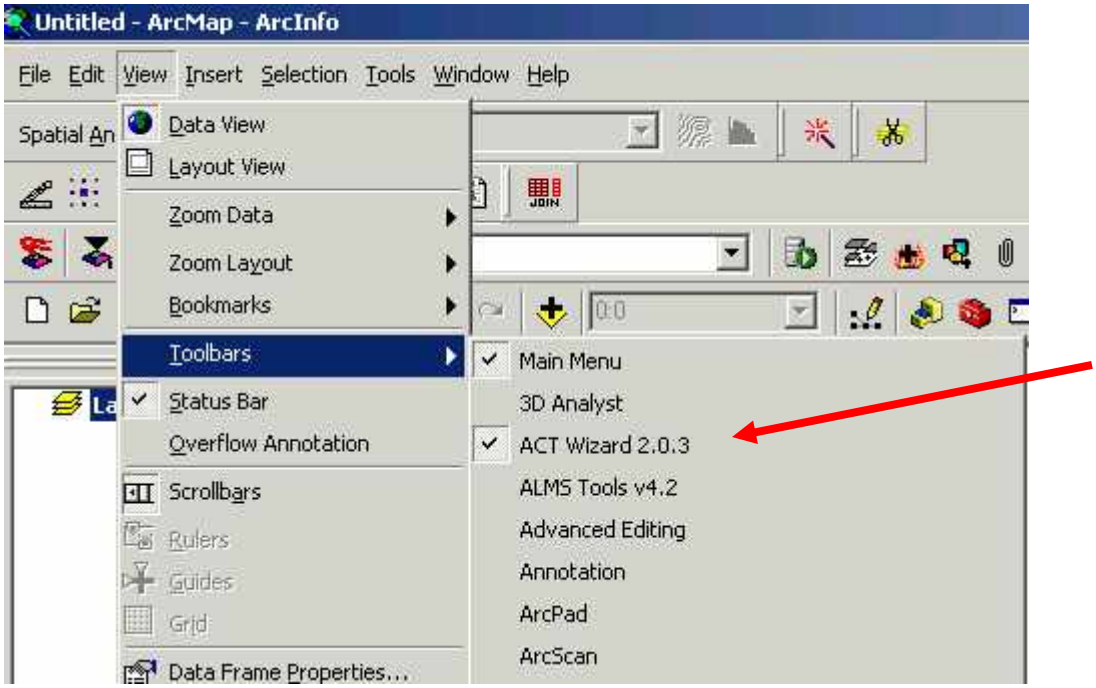


Figure 3-13. Verifying **ACT** toolbar is checked.

If you are still unable to view the ACT toolbar, follow these steps:

1. Click on the **Tools** menu and select **Customize**. Make sure the ACT 2.0.3 and Spatial Analyst boxes are checked and select **Close**. Next, click on the **View** menu and select **Toolbars**. Be sure to check the box to the left of ACT 2.0.3 if it is not already checked.

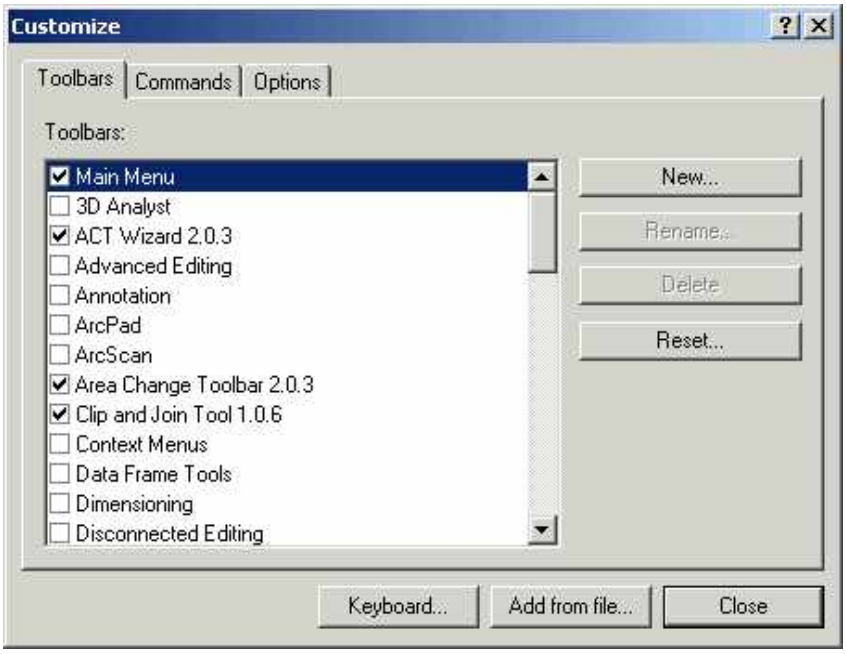


Figure 3-14. The **Customize** dialog box.

2. If you still cannot view the ACT toolbar in the ArcMap window, ACT may not be properly installed. You may need to verify that there are no earlier versions of ACT present and if so, uninstall any previous versions. Finally, reinstall the latest version and try the following:

    a. In ArcMap, again select the **Tools** menu and click on **Customize** to open the box shown above (fig. 3-14).

    ACT 2.0.3 should now be present in the Customize list as shown in the above figure. It should be checked. If it is not, check the box to the left of the file.

    b. In ArcMap, select the **View** menu and click on **Toolbars**. Make sure that the Area Change Tool Toolbar 2.0.3 box is listed and checked and make sure that the Spatial Analyst Toolbar is installed and turned on.

    Tip: *Just because you can view a Spatial Analyst toolbar in ArcMap doesn't necessarily mean that the tool is installed and operational. You can verify that it is turned on by selecting* ***Tools > Extensions.*** *If Spatial Analyst is listed but not checked, check it now; if it is not listed, then you will need to obtain it now.*

    Note: *If you have any additional questions about tool installation, please contact the helpdesk at: helpdesk@landfire.gov.*

Chapter 4: Using the ACT Interface

4.1 The ACT interface
4.2 Starting ACT
4.3 Setting the editing task
4.4 Uniform Change editing
    4.4.1 GIS functions
    4.4.2 Create a new shapefile
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    4.4.3.1 The Editor Toolbar
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4.1 The ACT interface

ACT uses a Wizard interface to guide the user through a sequential process for delineating vegetation and fuel treatment polygons, combining raster data layers that need to be changed to reflect treatment objectives, editing the value attribute table to reflect the treatment outcomes, and creating new raster layers that depict treatment outcomes. Although ACT uses a linear process to link multiple GIS processing steps together, that sequential process need not be followed or completed. Instead, any of ACT's GIS tasks can be selected in any order, or used completely independently of each other.

ACT uses a suite of various user-friendly dialog boxes to complete GIS processing. Each dialog box includes an overview as well as tool tips to help the user navigate within the box itself (fig. 4-1).

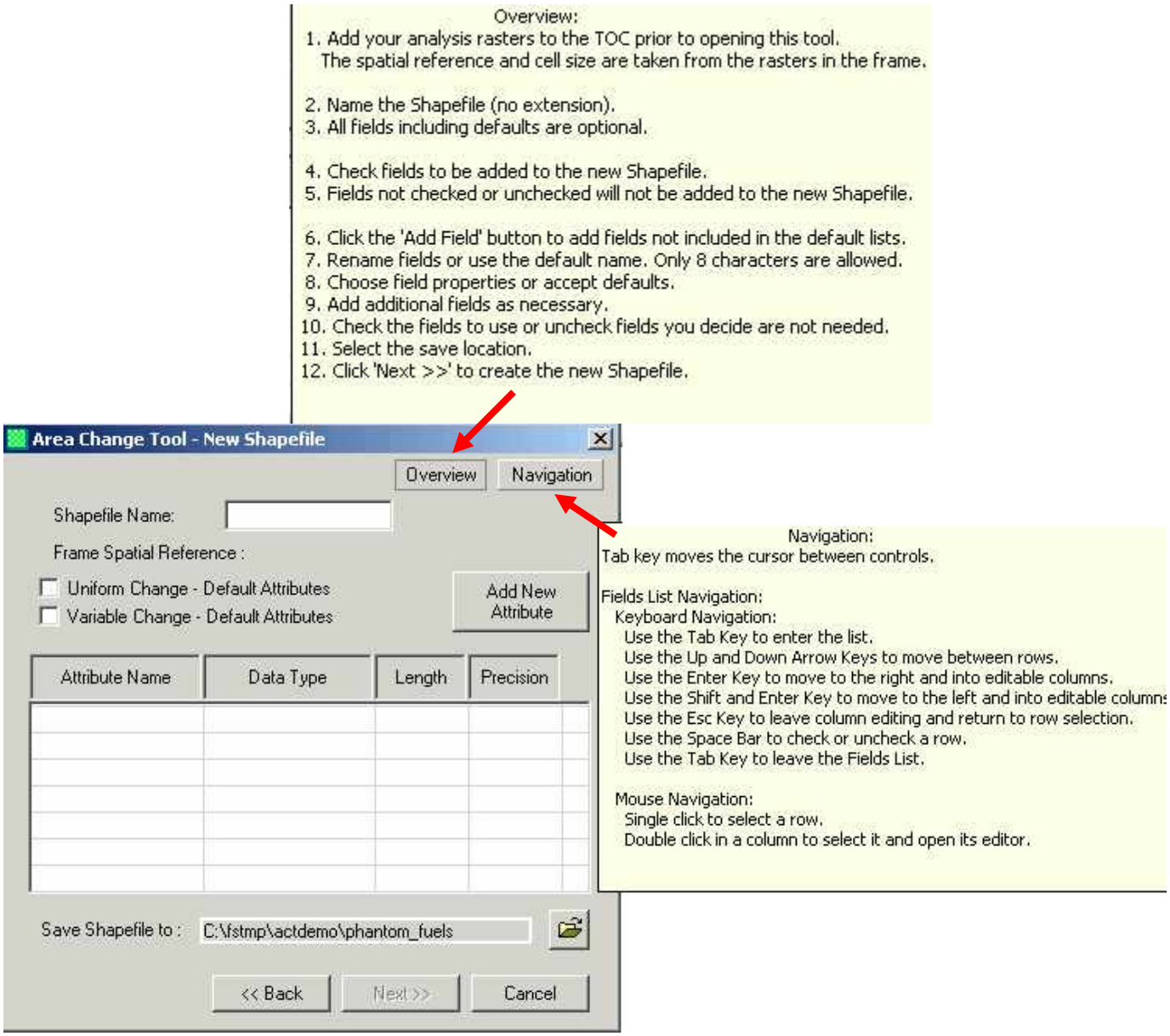


Figure 4-1. Each dialog box contains Overview and Navigation tips.

4.2 Starting ACT

Because ACT operates from an ArcMap platform, ArcMap must be opened before ACT can be initiated. A toolbar consisting of a single icon should be visible after you open an ArcMap project (fig. 4-2).

Figure 4-2. The ACT toolbar.

1. First start ArcMap and create a new project by selecting **A new empty map** as shown in figure 4-3:

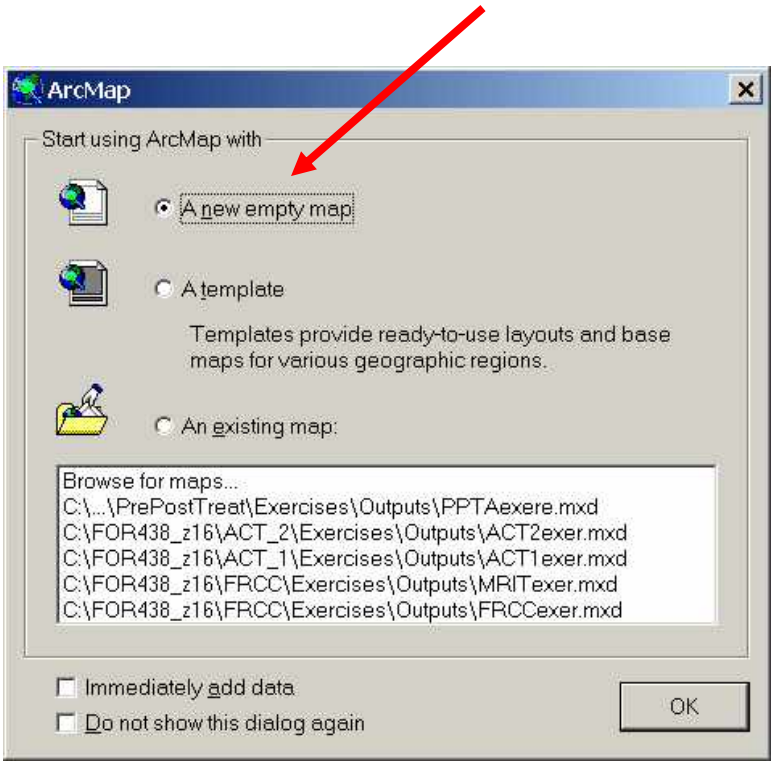


Figure 4-3. Creating a new project in ArcMap.

2. Next, load input layers into your ArcMap project by clicking on the **Add Data icon** (fig. 4.4):

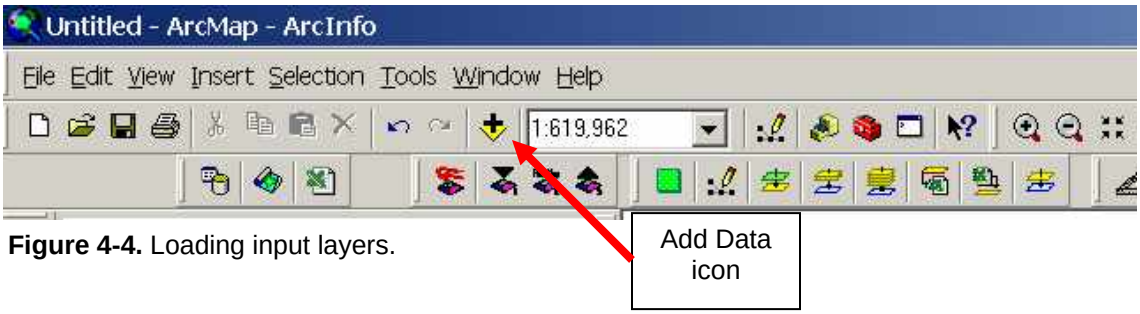


Figure 4-4. Loading input layers.

3. Navigate to the directory where your data layers are stored and add input layers.

   Tip: *At this point, you may see several Create pyramids dialog boxes similar to the box shown in figure 4-5. Click* ***No*** *to speed up processing. If you do not want to see this box again, put a check in the lower left-hand corner to disable it.*

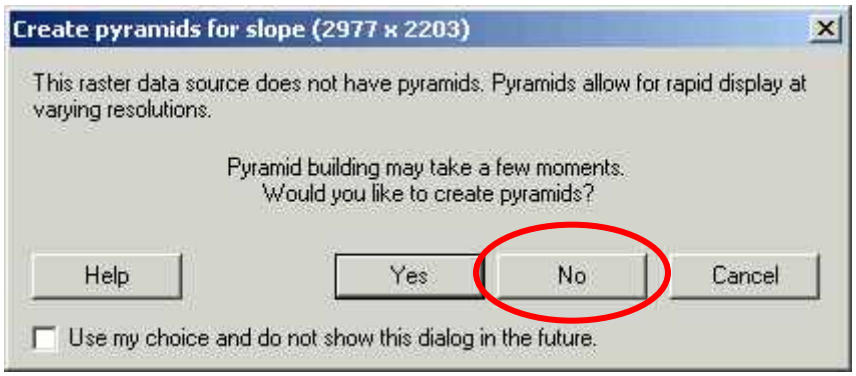


Figure 4-5. Create pyramids dialog box.

4. Click on the ACT toolbar (fig. 4-2) to open the main dialog box (fig. 4-6). All applications of ACT must begin with the Area Change Tool dialog box, which is used to specify the Editing Task, identify where to store outputs, and to select the GIS task that is to be performed.

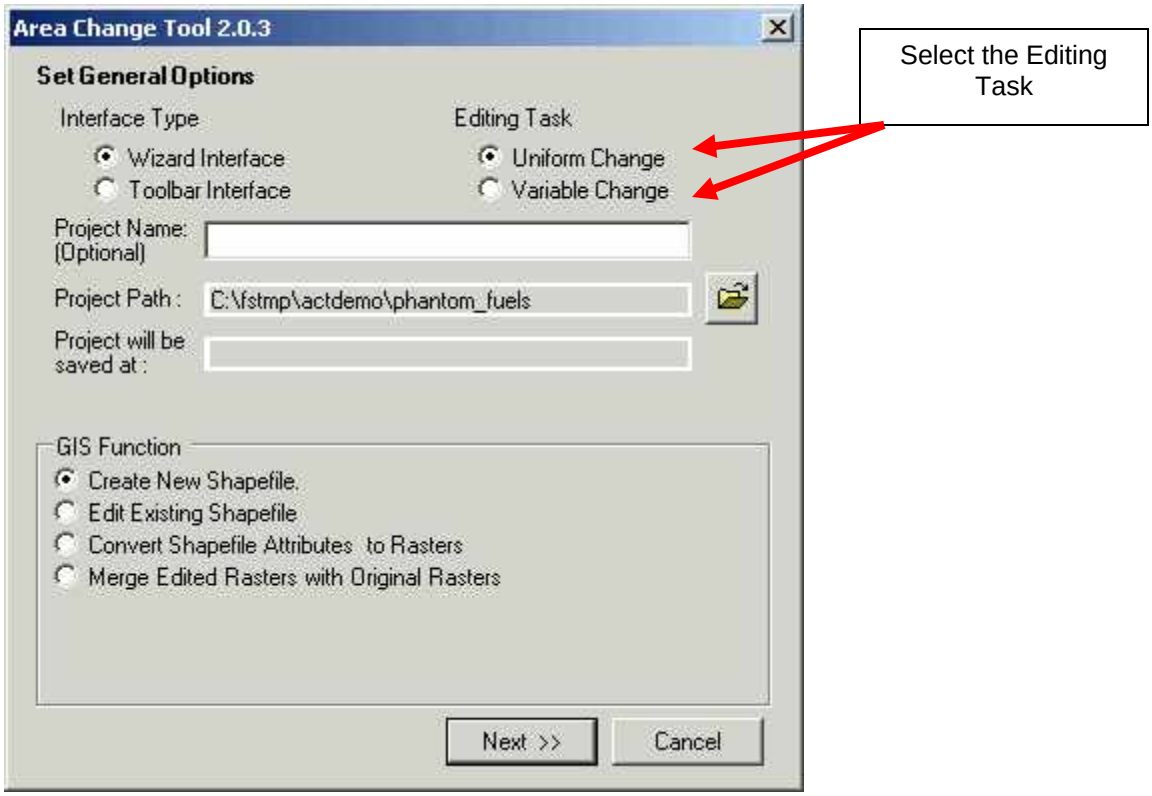


Figure 4-6. Selecting the editing task.

4.3 Setting the editing task

Two types of editing can be accomplished using ACT. The *Uniform Change* option will alter all raster values within a polygon to a single value that is specified by the user (in other words, a many-to-one change). The *Variable Change* option allows you to change raster values within a polygon to many different values. It represents a non-uniform change in which you can define rules that will include multiple changes to many attributes (or, a many-to-many change). This option can also include changes to multiple data layers

A Uniform Change might include creating a treatment area with a prescription that would change one or more grid values to a single value. For example, a prescribed fire might change the fire behavior fuel model, canopy base height, and canopy cover so that each is represented by a single value (for example, FBFM 2; 15-feet canopy base height, and 30 percent canopy cover). All other values outside of the burn perimeter would remain unchanged.

Uniform Change edits are generally useful only when dealing with very homogenous environments. Typically, vegetation and fuel prescriptions vary according to the complexity of conditions on the land (slope, aspect, biophysical setting, cover type, size

class, canopy cover, surface fuels, canopy fuels) or according to management objectives (habitat objectives, visual objectives, air quality objectives). The Variable Change editing process is more useful to real world GIS challenges.

A Variable Change involves altering many different values within a polygon to many other values. Typically, the different values are assigned on the basis of a combination of attributes denoting different conditions. For example, since fire behavior varies with weather, fuels, and topography, it is not surprising that fuel treatment prescriptions might vary according to attributes such as slope, aspect, elevation, surface fuels, and canopy fuels.

Select the radio button that corresponds to the type of editing that is desired (see fig. 4-6 above). We will first address the Uniform Change option.

A ***Uniform Change*** allows you to change all pixels in an area to the same value.

A ***Variable Change*** will allow you to change pixels within an area in a non-uniform way to multiple values.

4.4 Uniform Change editing

Remember that the objective of the Uniform Change is to change all of the current values of one or more layers that intersect a polygon to a single value. Follow the below steps to edit data using the Uniform Change option.

> ***Note***: *If you would prefer to start with Variable Change editing, click on the link in this sentence to skip to that section.*

1. Select the **Uniform Change** radio button as shown above in figure 4-6.

2. Identify a Project Name by entering the name of your choice in the window provided as shown in figure 4-7 below (this step is optional).

3. Next select the Project Path by clicking on the browse icon to navigate to a folder in which to store your output (this step is required).

   ACT will automatically fill in the "Project will be saved at" box if the user specified a name and a path for the project. If a Project Name was not identified, then no

information will appear in this space. There is no need for the user to enter any information.

***Tip**: Once a project path or location for the project to be stored is entered, it cannot be edited. Therefore, if you make an error, you will need to start over with this dialog box.*

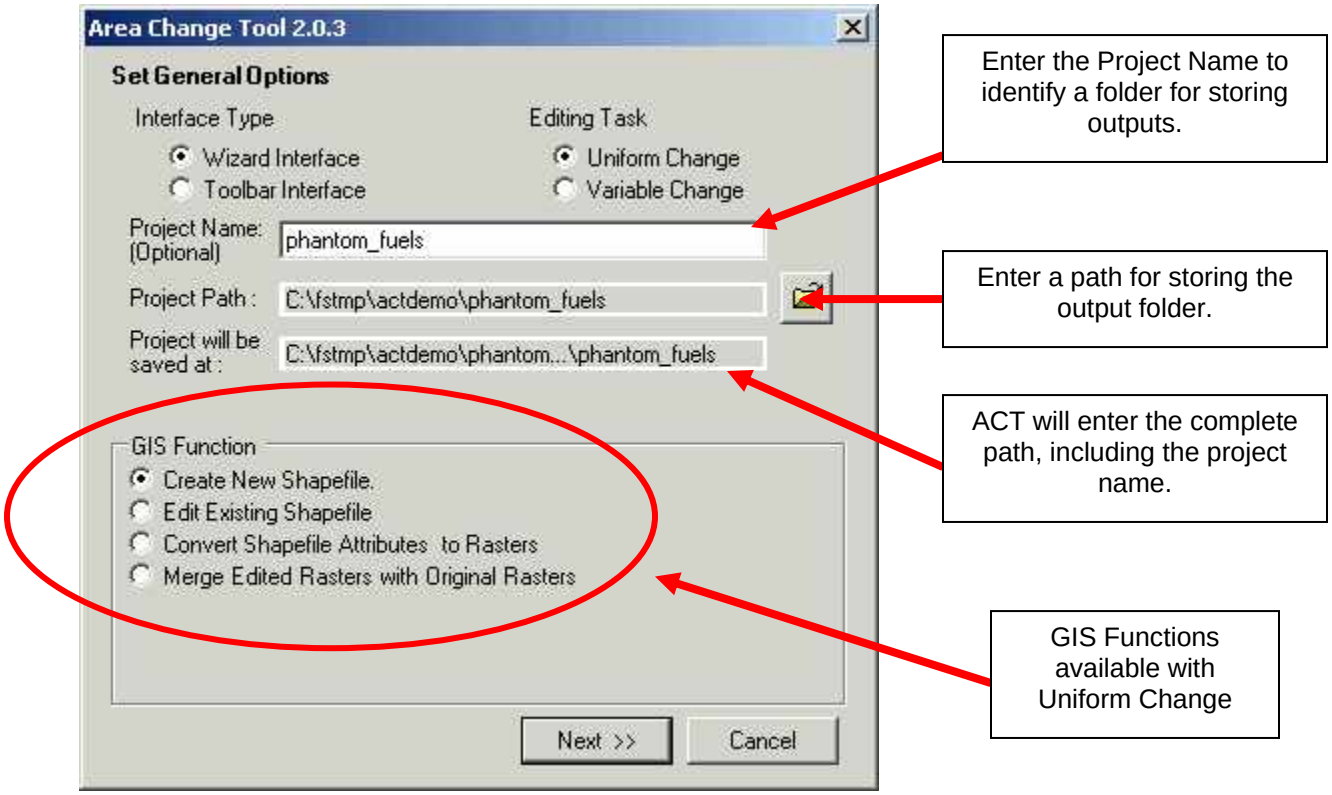


Figure 4-7. Providing inputs to the Area Change Tool dialog box.

4.4.1 GIS functions

There are four GIS functions that will be available for use when the Uniform Change option is selected. These include:

- **Create a new shapefile** – The shapefile is used to delineate polygons where edits are to occur. When this option is selected, the **Next** button will take you to the New Shapefile interface.

- **Edit an existing shapefile** – When this option is selected, the **Next** button will close ACT and bring up ESRI's Editing Toolbar. You can use the

Editor Toolbar to modify an existing shapefile. When the edits are complete, once again select the main ACT dialog box to continue.

- **Convert shapefile attributes to rasters** – When this option is selected, clicking on the **Next** button will take you to the Shapefile Attributes to New Rasters dialog box. This utility allows you to convert any numerical attribute contained within the shapefile to a new raster layer.

- **Merge edited rasters with original rasters** – When this utility is selected, the **Next** button will take you to the Merge Edited Rasters dialog box. This function is used to "burn-in" the values from an edited layer into the original layer. Thus, a new layer is created by adding the edited values to the original values.

4.4.2 Create a new shapefile

The process for creating a new shapefile occurs in essentially two steps. The first step involves delineating the polygons. The second step involves attributing the polygons drawn in the first step.

1. First, select the radio button **Create New Shapefile** under the GIS Function box shown in figure 4-8. This feature allows you to create an empty shapefile having either default or user-defined attributes that can be used during the editing session.

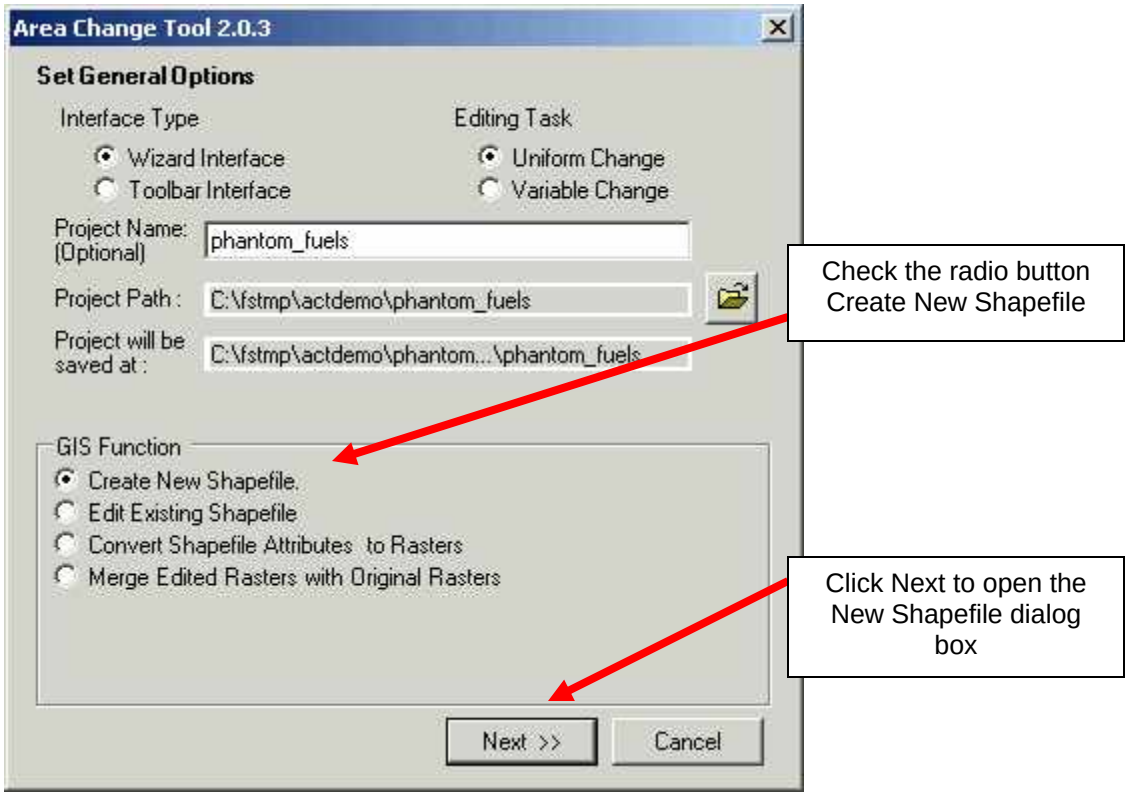


Figure 4-8. Using ACT to create a new shapefile.

2. Click **Next** to open the New Shapefile dialog box as shown below (fig. 4-9). This dialog box is used to name the shapefile and identify any attributes the user wishes to include in the shapefile. Attributes should be added to the shapefile if values in the original raster layer may be changed.

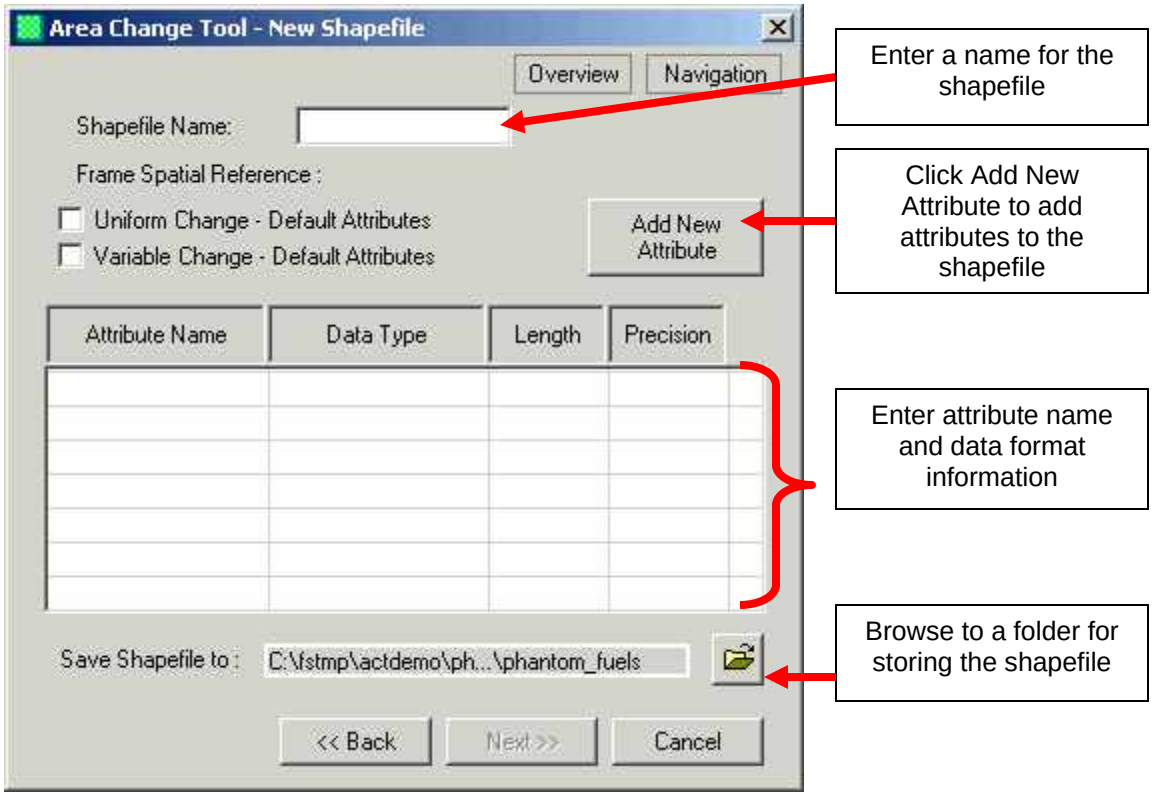


Figure 4-9. The New Shapefile dialog box.

3. Enter a name for your shapefile in the box above (fig. 4-9). Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;"'< >,.).

You can add any attribute to the shapefile by clicking **Add New Attribute** and entering a Name, Data Type, Length, and Precision (the number of decimal places). If the shapefile will contain multiple polygons, we recommend that you include an identifier as an attribute to keep track of the specific polygons. Notice that ACT can add default attributes to the shapefile, if desired. Simply check the box indicating **Uniform Change - Default Attributes**. The default attributes were established for those interested in editing surface and canopy fuel layers and succession class layers, which are used to derive fire regime condition class (fig. 4-10). The default attributes are shown in table 4-1.

Table 4-1. Default attributes available for the Uniform Change option.

Attribute Name	Attribute Description
Id	Polygon identifier
SClass	Succession class
FBFM	Fire behavior fuel model
CC	Canopy cover
CH	Canopy height
CBH	Canopy base height
CBD	Canopy bulk density

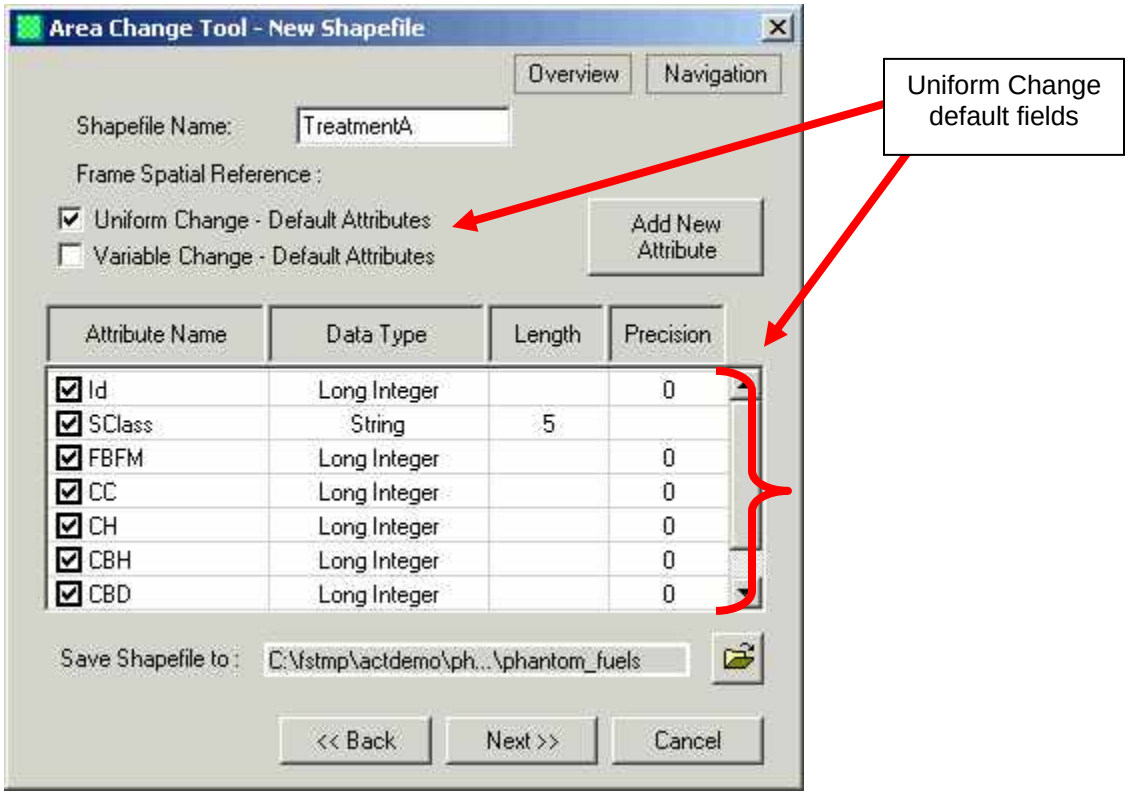


Figure 4-10. Selecting the default attributes for a Uniform Change. Only attributes that have been checked will be added to the shapefile.

4. Check the box to the left of Attribute Name after adding all attributes that you are interested in editing. Only those attributes that have been checked will be included within the shapefile. Simply check or uncheck selections to add or remove them from your new shapefile.

   ***Tip**: Using the Data Type drop-down menu allows you to choose a data type such as "Long Integer," "String," etc., or you can accept the default values. The Length field gives the expected number of characters in a string. The ACT Tool Tip defines the Precision field as "the number of digits in a number." You can modify the data*

format as needed. Refer to ArcGIS Desktop Help for further information pertaining to data type.

5. Click **Next** when the dialog box is complete to open the Editor Toolbar and close ACT.

4.4.3 Edit an existing shapefile

1. Select the Edit Existing Shapefile radio button in the GIS Function box if you want to edit an existing shapefile rather than create a new shapefile from scratch (fig. 4-11).

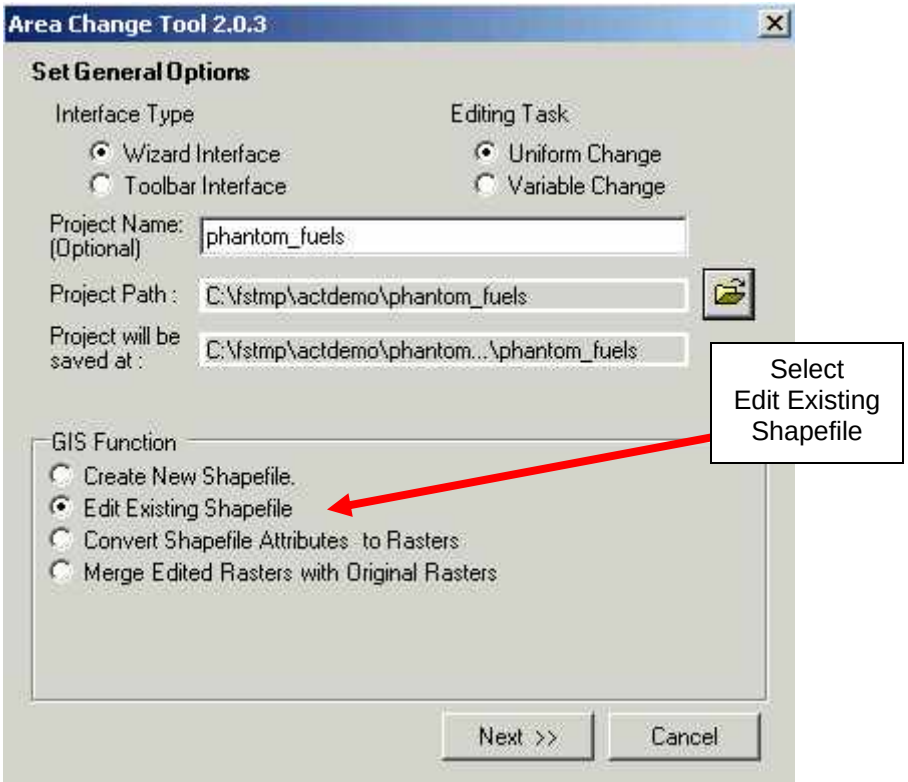


Figure 4-11. Selecting the Edit Existing Shapefile GIS function from the Area Change Tool dialog box.

2. Click **Next** to open the Editor toolbar. The Editor toolbar used by ACT (fig. 4-12) is exactly the same as the Editor toolbar available in ArcMap. The Editor Toolbar is used to create and/or edit shapefiles.

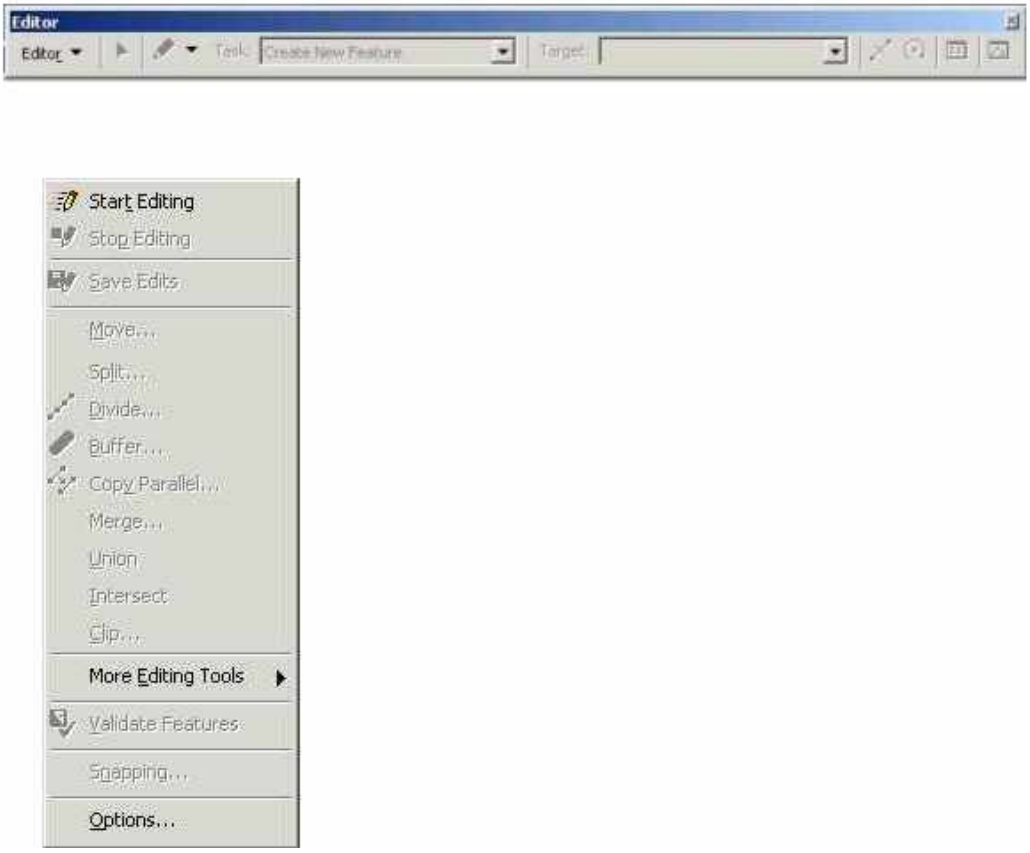


Figure 4-12. Editor toolbar and Editor drop-down menu.

***Tip**: When editing is complete, return to the ACT Wizard Interface by clicking on the ACT toolbar.*

3. Click on the **Editor** drop-down menu and click on **Start Editing** at the top of the list as shown in figure 4-12.

4. When the Start Editing dialog box appears (fig. 4-13), select the appropriate path containing the shapefile to be edited.

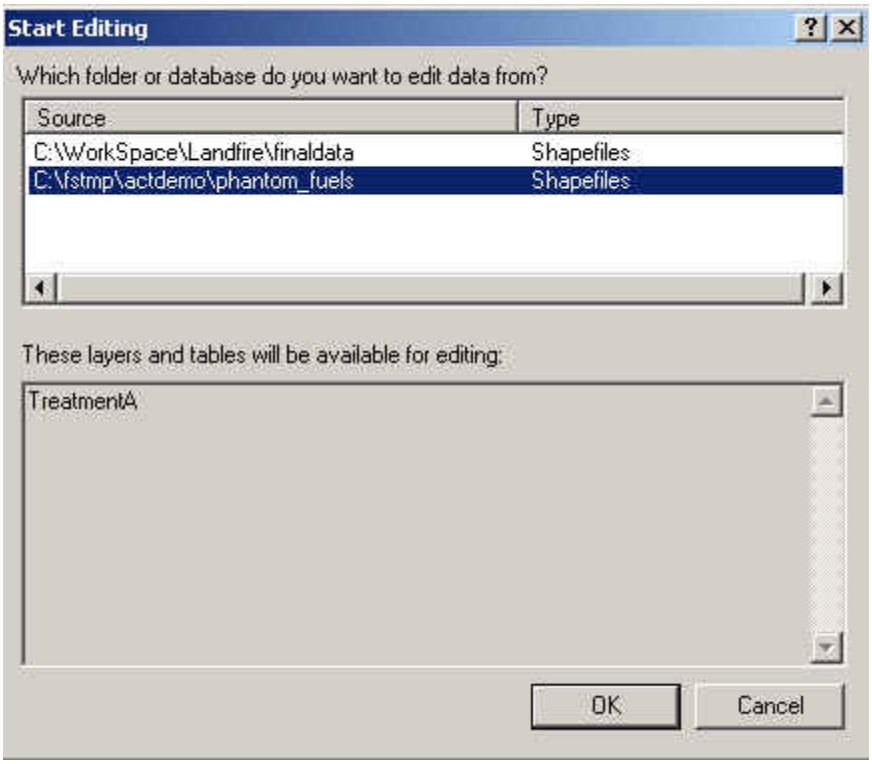


Figure 4-13. The Start Editing dialog box indicating layers available for editing within the selected path.

5. The Editor toolbar shown below will appear after you select the appropriate path. Identify the editing task on the Editor Toolbar by selecting **Create New Feature** from the Task drop-down menu and then select the appropriate shapefile from the Target drop-down menu (fig. 4-14).

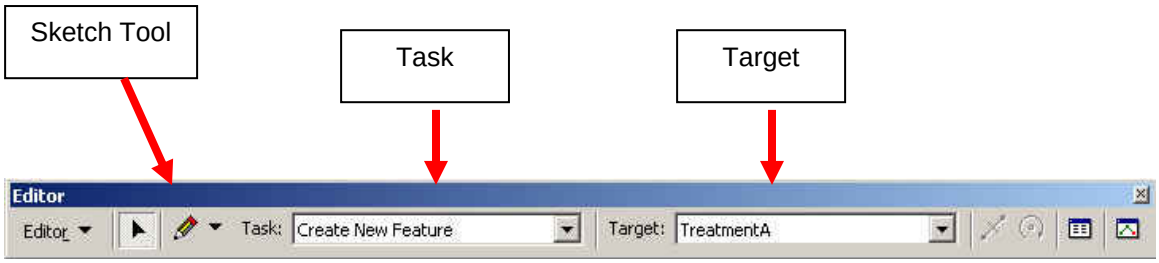


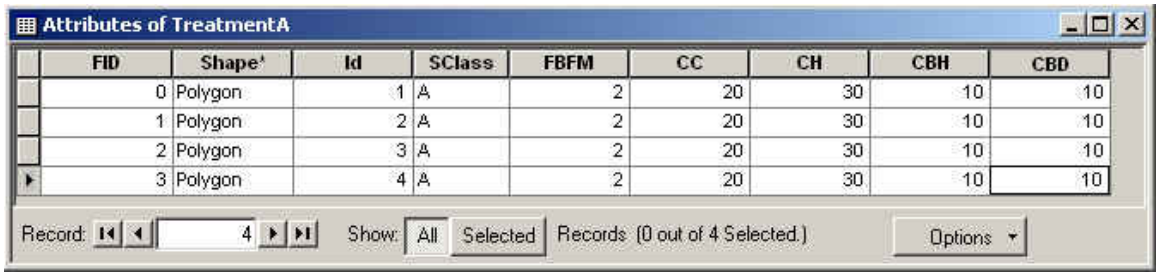
Figure 4-14. Editor toolbar showing the Sketch Tool, Task, and Target drop-down menus with the shapefile "TreatmentA" selected.

6. Click on the Sketch Tool icon to begin drawing a polygon. Consult ArcMap's Help utility for more information on creating and editing polygons. We recommend that you save your edits frequently (for example, after you have

completed each polygon). When you have finished drawing all polygons within your shapefile, be sure to select **Save Edits**.

***Tip**: If you happen to make a mistake in your drawing, it may be easier to delete the polygon and start over rather than trying to edit an existing polygon.*

7. Next, you need to provide the appropriate values for the attributes within the shapefile. Open the attribute table of the shapefile you have created by right clicking on the new shapefile in ArcMap's Table of Contents and select **Open Attribute Table** (see fig. 4-15).



Attributes of TreatmentA

FID	Shape*	Id	SClass	FBFM	CC	CH	CBH	CBD
0	Polygon	1	A	2	20	30	10	10
1	Polygon	2	A	2	20	30	10	10
2	Polygon	3	A	2	20	30	10	10
3	Polygon	4	A	2	20	30	10	10

Record: 4 Show: All Selected Records (0 out of 4 Selected.) Options

Figure 4-15. Example attribute table of a shapefile with four polygons containing the following attributes: **Id** = polygon identifier, SClass = succession class, FBFM = fire behavior fuel model, CC = canopy cover, CH = canopy height, CBH = canopy base height**,** and CBD = canopy bulk density.

8. Enter the values that you wish to use in the appropriate cells of your attribute table. When finished, save your edits by selecting **Editor > Stop Editing > Save Edits**. Close the Editor toolbar and the attribute table.

***Tip**: Be sure to press the Enter key after adding the last value and then close the attribute table before continuing.*

9. Select the appropriate Task and Target from the drop-down menus on the Editor toolbar (fig. 4-16). Select the task Create New Feature if your objective is to add polygons. Select the task Reshape Feature if your objective is to change the shape of existing polygons. On the other hand, if your objective is to modify the values in the attribute table, simply open the attribute table and change the values.

Figure 4-16. Identifying the task and target on the Editor Toolbar.

10. When finished editing, select **Editor** > **Stop Editing** > **Save Edits**.

4.4.4 Convert shapefile attributes to rasters

The next step in the Uniform Change process is to convert a shapefile's attributes of interest to new raster layers. The GIS function Convert Shapefile Attributes to Rasters enables the user to convert every attribute of a shapefile to a new raster layer.

1. Select the radio button to the left of **Convert Shapefile Attributes to Rasters** and click Next (fig. 4-17).

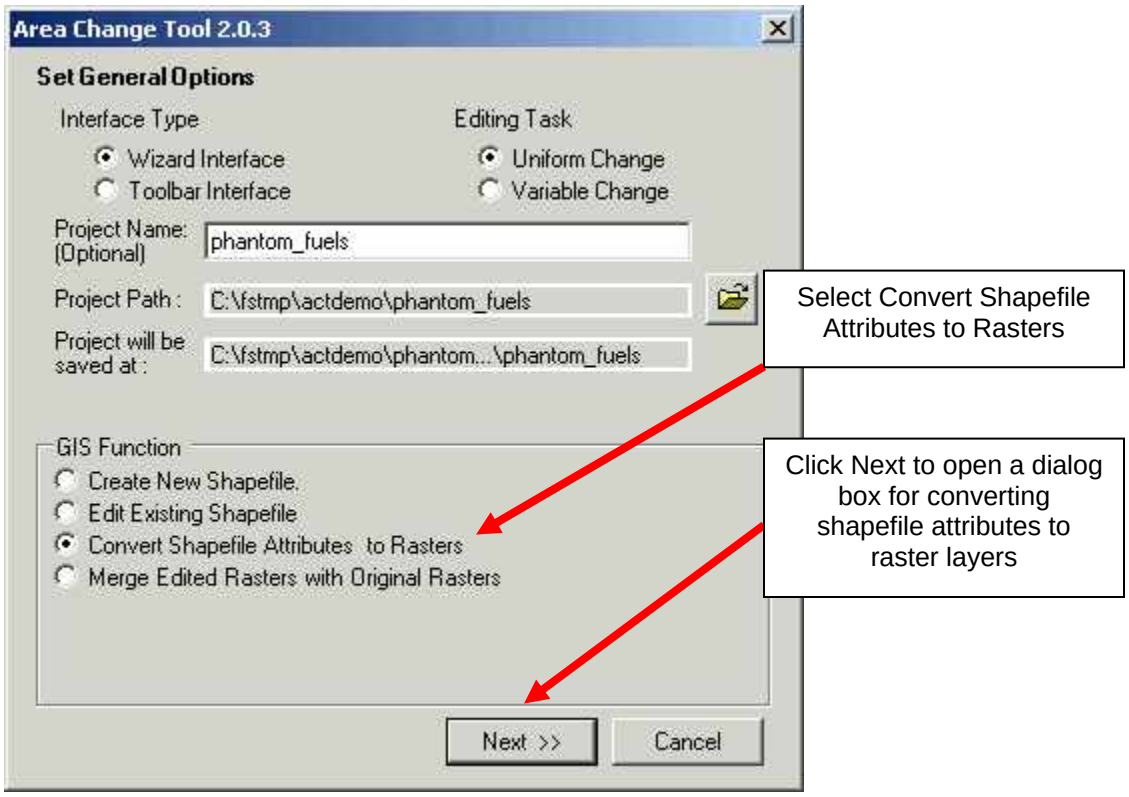


Figure 4-17. Selecting Convert Shapefile Attributes to Rasters function**.**

2. Click **Next** to open the following dialog box (fig. 4-18):

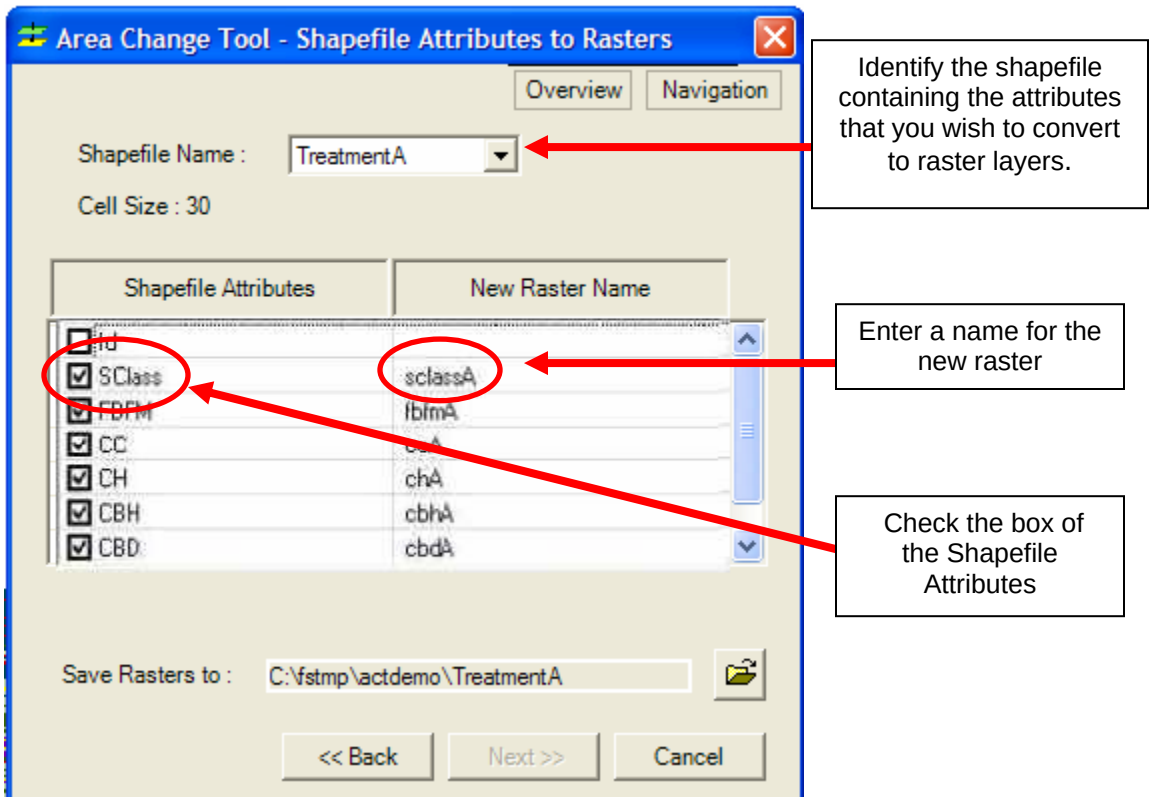


Figure 4-18. Shapefile Attributes to New Rasters dialog box. In this example, the shapefile contains seven attributes: Id = polygon identifier, SClass = succession class, FBFM = fire behavior fuel model, CC = canopy cover, CH = canopy height, CBH = canopy base height, and CBD = canopy bulk density.

***Note**: The target shapefile must exist within the ArcMap Table of Contents before you can convert its attributes to new rasters.*

3. Select the appropriate shapefile containing the attributes to be converted to rasters from the drop-down menu at the top of the dialog box (fig. 4-18). Provide a name for each new raster by double clicking the space under New Raster Name and then enter a name. Once you have entered a new raster name, the box to the left of each attribute's name will become enabled, and you can check the attributes that you would like to convert. Only attributes that are checked will be converted to a new raster.

   ***Note**: Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).*

***Tip**: You will not be able to check the boxes under the Shapefile Attributes window until you double-click in the corresponding New Raster Name cell and enter a name.*

4. When you have finished filling out the dialog box, use the browse button to select a path and folder for storing the new rasters. Click **Next** to begin the conversion process. The new raster layers will automatically be added to the ArcMapTable of Contents.

   ***Note**: A progress bar located at the bottom of the dialog box indicates that conversion is proceeding.*

4.4.5 Merge edited rasters with original rasters

The last step in the Uniform Change process is to merge the newly created rasters into the original, or target, rasters, thereby creating a new raster that covers the full extent and that reflects the edits that have been made.

1. First make sure that the Edited Rasters and Target Rasters are available in your ArcMap project. The availability of rasters that can be selected from the Merge Change Raster dialog box depends on the layers existing within the Table of Contents of your ArcMap project.

2. Next, select the radio button pertaining to **Merge Edited Rasters with Original Rasters** as shown in figure 4-19 to merge the Edited and Target rasters. Click **Next** to open the following Merge Change Rasters dialog box:

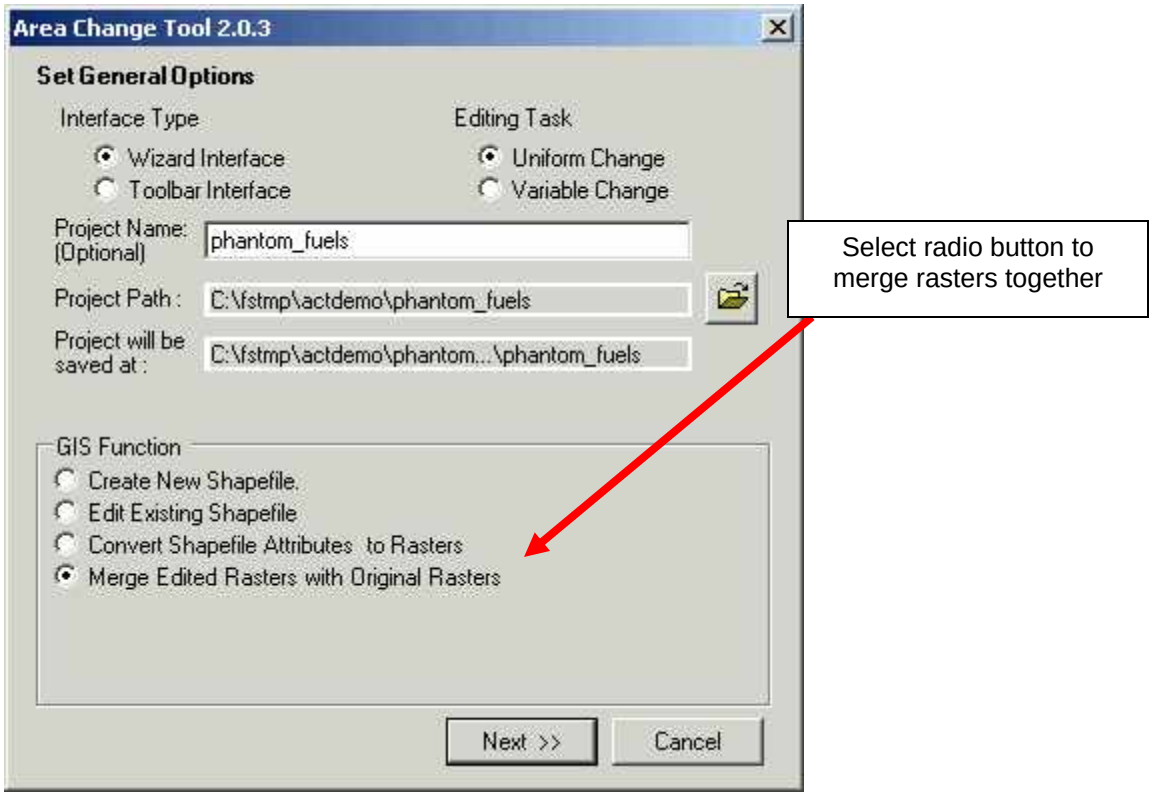


Figure 4-19. Selecting the Merge Edited Rasters with Original Rasters function from the Area Change Tool dialog box.

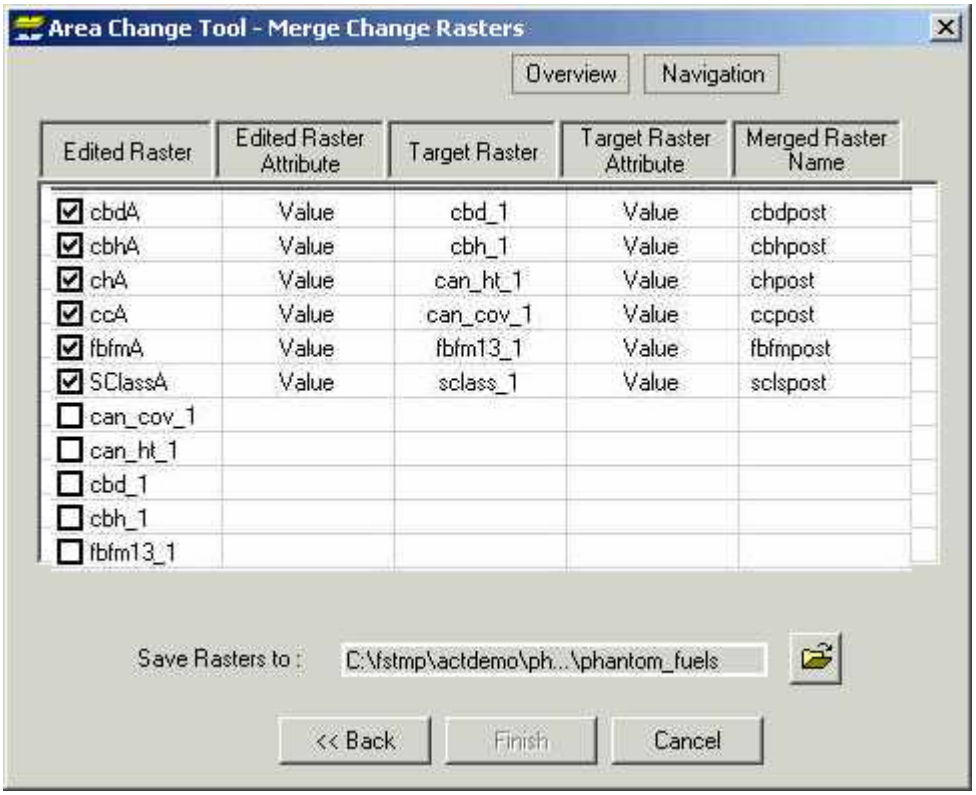


Figure 4-20. The Merge Change Rasters dialog box is used to identify the rasters and attributes that will be merged together.

The Merge Change Rasters dialog box (fig. 4-20) requires the following information.

- **Edited Raster** – The raster created from the shapefile containing the edited information. The list of available rasters includes any raster currently in the ArcMap Table of Contents. The Edited Raster will be merged into the original or target raster.
- **Edited Raster Attribute** – The attribute contained within the Edited Raster that will be used to overwrite the corresponding attribute from the original or target raster. The drop-down menu will include all attributes contained within the Edited Raster.
- **Target Raster** – The original or target raster that will be merged with the Edited Raster. The drop-down menu will include any raster that currently resides in the ArcMap Table of Contents.
- **Target Raster Attribute** – The attribute from the target raster that will be overwritten by the attribute from the Edited Raster.
- **Merged Raster Name** – The new raster created by merging the edited and original rasters together.

3. First, highlight the row containing an edited raster that you wish to use to overwrite an existing raster. Use the Enter key to advance your cursor to the next column labeled Edited Raster Attribute. Double-click in the cell to activate the drop-down menu. The drop-down menu will list all attributes contained within the Edited Raster.

4. Next select the appropriate attribute and use the Enter key to advance the cursor to the next column (Target Raster). Select the target raster from a drop-down menu that includes every raster within the ArcMap Table of Contents. Again, use the Enter key to advance your cursor to the next column (Target Raster Attribute). Select the attribute of the target raster that will be overwritten by the Edited Raster. Use the Enter key to advance your cursor to the last column (Merged Raster Name) of the dialog box.

5. Enter a name for the new raster that will result from merging the Edited Raster with the Target Raster. Lastly, place a check in the box associated with the Edited Raster in the first column.

   ***Note**: Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as* `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

   Use the Browse icon located to the right of the "Save Rasters to:" window to navigate to an appropriate folder for storing the newly created rasters.

6. Click **Finish** to initiate the processing of the new raster layers which will automatically be added to the ArcMap Table of Contents. The "Uniform Change" process is now complete.

   ***Tip**: Rest your cursor on the Navigation button located at the upper right corner of the dialog box for help in moving around the Merge Change Rasters dialog box.*

Be sure to follow the usual naming conventions used with ACT.

4.5 Variable Change editing

The Variable Change editing process involves changing pixel values in a non-uniform manner. Frequently, the edits are made within polygons that denote a target area.

However, these changes can also be made across the full extent of the data layer(s) without the use of polygons.

***Note**: the instructions in this section are very similar to those for the above section on editing using the Uniform Change option. Rather than referring the reader back, we repeat the instructions here for convenience.*

1. Start the editing process by opening ArcMap, adding all layers of interest, and then clicking on the ACT Toolbar -

2. The Area Change Tool dialog box will open (fig. 4-21). Select the radio button below Editing Task to the left of Variable Change.

3. Enter a Project Name (optional) and Project Path as demonstrated in figure 4-7. The project name will establish a unique folder for storing all outputs; leave this entry empty if a unique output folder is not desired.

4.5.1 GIS functions

There are seven GIS functions that will be available for use when the Variable Change option is selected. These include:

- **Create a new shapefile** – The shapefile is used to delineate polygons where edits are to occur. When this option is selected, the **Next** button will take you to the New Shapefile interface.

- **Edit an existing shapefile** – When this option is selected, the **Next** button will close ACT and bring up ESRI's Editing Toolbar. You can use the Editor Toolbar to modify an existing shapefile. When the edits are complete, once again select the main ACT dialog box to continue.

- **Convert shapefile attributes to rasters** – When this option is selected, clicking on the **Next** button will take you to the Shapefile Attributes to New Rasters dialog box. This utility allows you to convert any numerical attribute contained within the shapefile to a new raster layer.

- **Combine rasters** – This function is used to integrate multiple data layers by selecting attributes from rasters to join into a combine raster. Clicking on the **Next** button opens the Combine Rasters interface.

- **Edit the raster attribute table** – When this option is selected, clicking on the **Next** button opens the Edit Rasters Manager. This dialog box can be

used to transfer an attribute table to Excel, transfer edited data in Excel to an attribute table, transfer an attribute table to Access, or to transfer edited data in Access to an attribute table.

- **Convert raster attributes to rasters** – This option allows you to create individual raster layers from the attributes of a combined layer. Clicking on the **Next** button will open the Raster Attributes to Rasters dialog box.

- **Merge edited rasters with original rasters** – When this utility is selected, the **Next** button will take you to the Merge Edited Rasters dialog box. This function is used to "burn-in" the values from an edited layer into the original layer. Thus, a new layer is created by adding the edited values to the original values.

Although the ACT Wizard toolbar was designed to follow a sequence of processing steps, a user does not have to follow the sequence or complete all of the steps. In other words, each of the GIS functions can be used independently as a stand-alone process. For example, if you plan to make changes throughout the entire extent of your analysis area, there is probably no need to create a shapefile to constrain the changes to a limited area. In this instance, the editing process might actually begin with combining a suite of rasters.

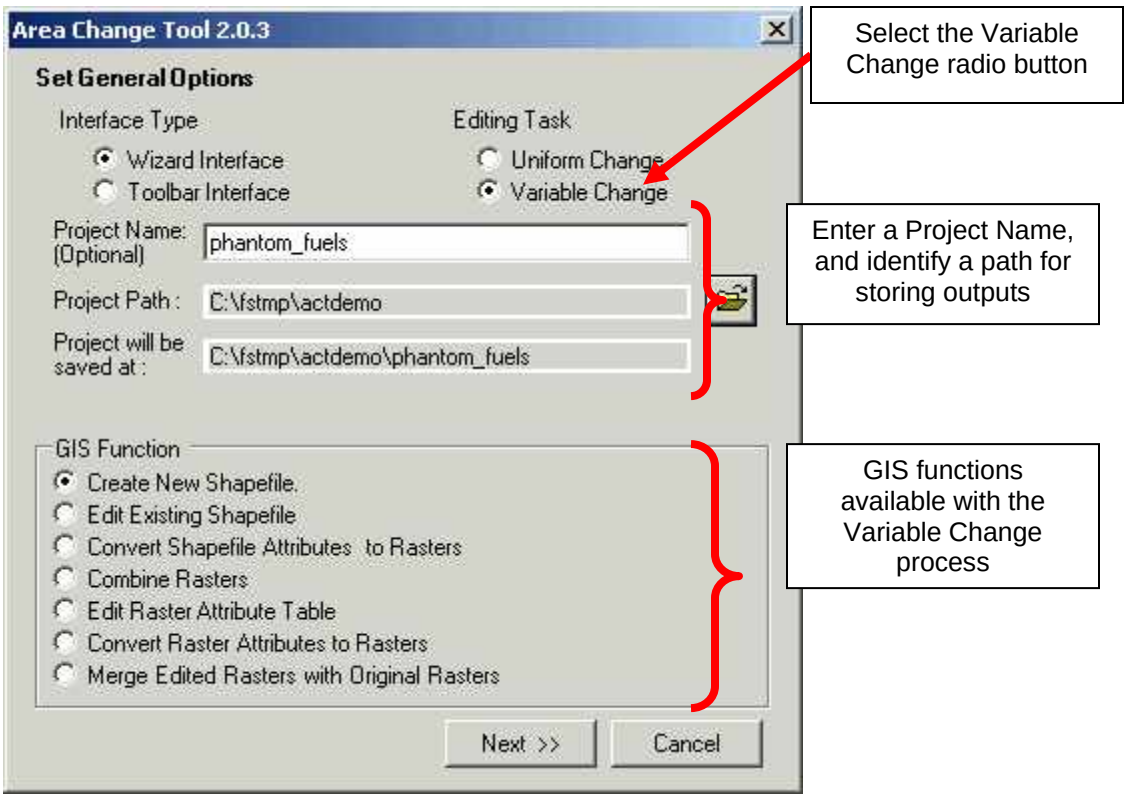


Figure 4-21. Area Change Tool dialog box showing the GIS functions available when conducting Variable Change edits.

4.5.2 Create a new shapefile

The process for creating a new shapefile occurs in essentially two parts. The first part involves delineating the polygons. The second part involves attributing the polygons drawn in the first part of the process.

1. First, select the radio button **Create New Shapefile** under the GIS Function box shown in figure 4-22. This feature allows you to create an empty shapefile having either default or user-defined attributes that can be used during the editing session.

2. Click **Next** to open the New Shapefile dialog box as shown in figure 4-23. This dialog box is used to name the shapefile and to identify any attributes you wish to include. Attributes should be added to the shapefile if you intend to change their values in the original raster layer.

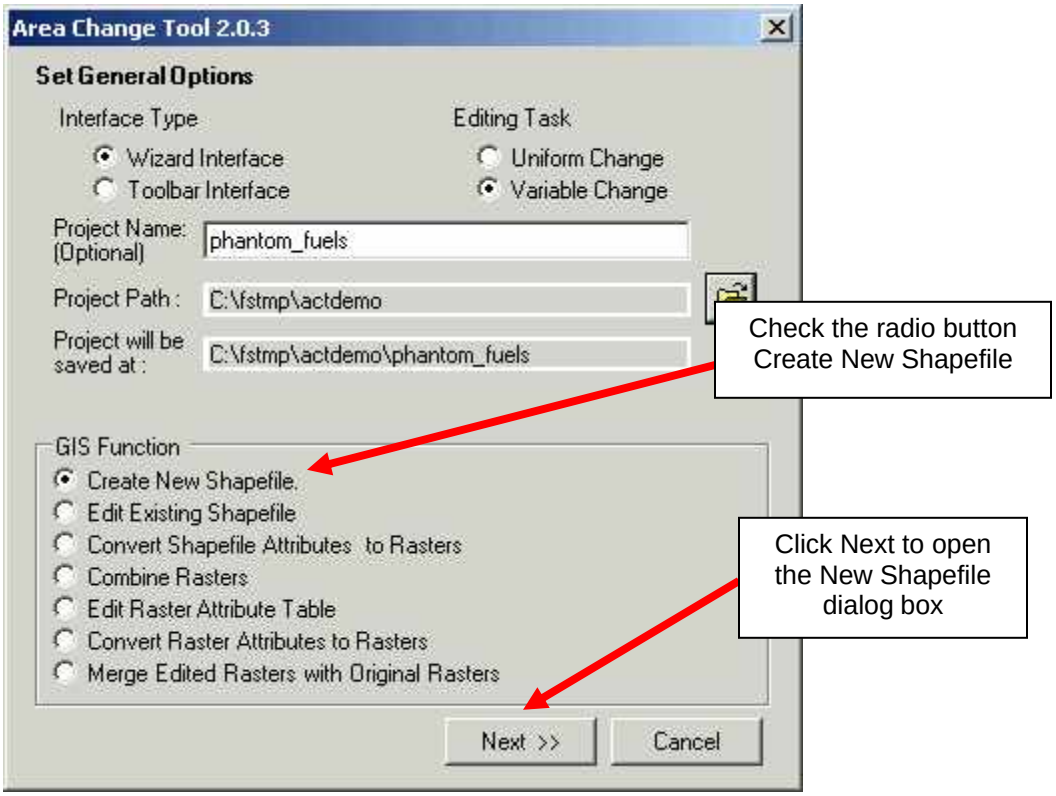


Figure 4-22. Using the ACT Wizard to create a new shapefile.

3. Enter a name for your shapefile (fig. 4-23). Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

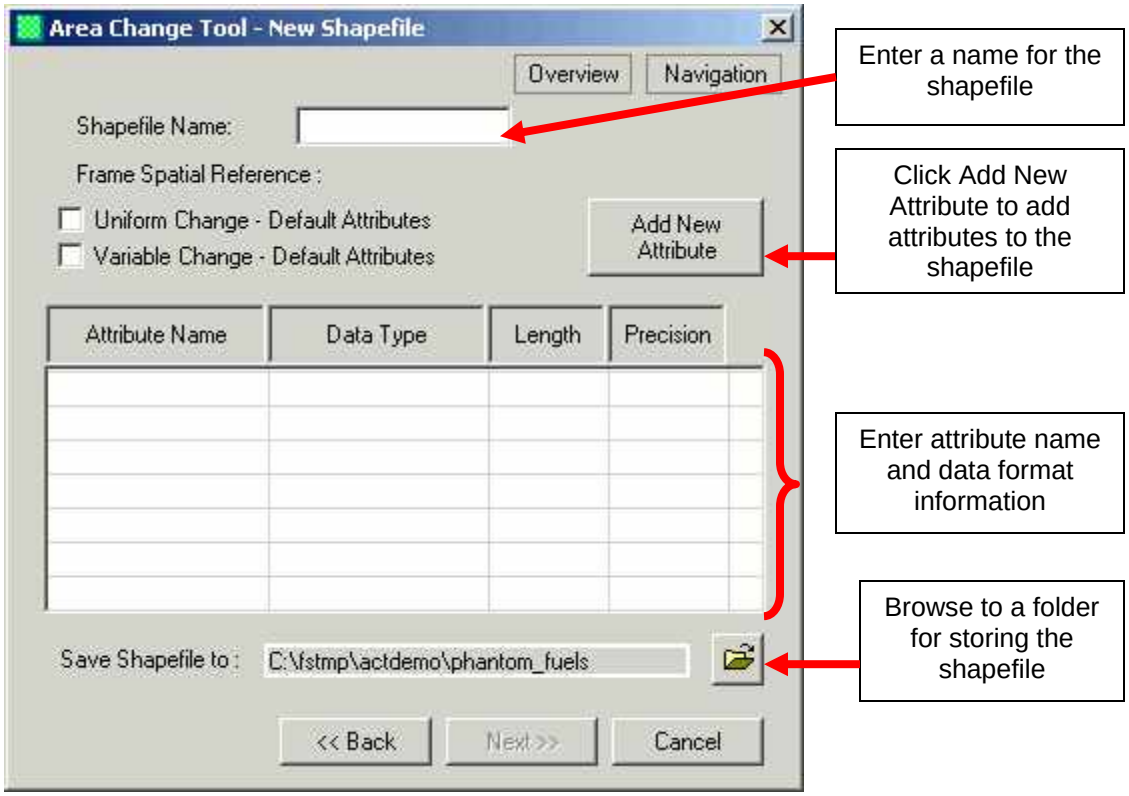


Figure 4-23. Creating a new shapefile.

You can add any attribute to the shapefile by clicking **Add New Attribute**. You will need to provide an Attribute Name, Data Type, Length, and Precision (number of decimal places). If the shapefile contains multiple polygons, we recommend that you include an identifier as an attribute to keep track of the specific polygons. Checking the box next to Variable Change - Default Attributes adds an identifier for individual polygons (fig. 4-24).

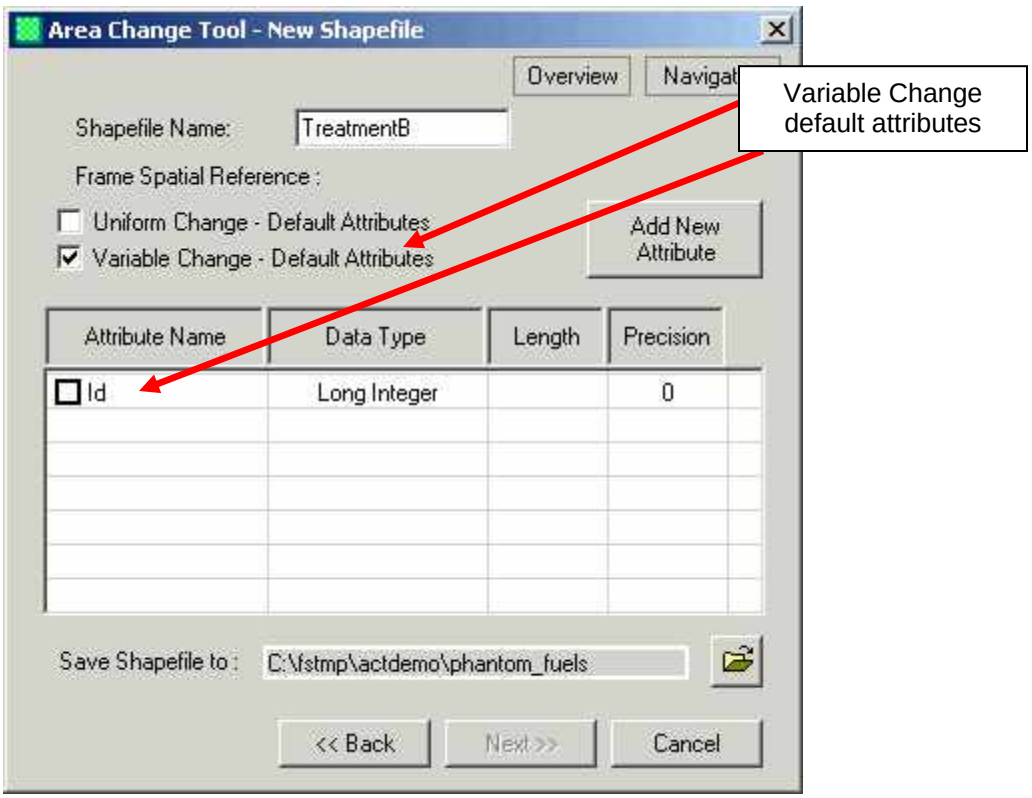


Figure 4-24. Selecting default attributes for Variable Change**.**

Be sure to check the box to the left of the "Attribute Name" after adding all attributes that you are interested in editing. Only those attributes that have been checked will be included in the shapefile. Simply check or uncheck selections to add or remove them.

Tip: *Using the Data Type drop-down menu allows you to choose a data type such as "Long Integer," "String," etc. (or you can accept the default values). The Length field gives the expected number of characters in a string. The ACT Wizard's Tool Tip defines the Precision field as "the number of digits in a number." You can modify the data format as needed. Refer to ArcGIS Desktop Help for further information pertaining to data type.*

4. Click **Next** when the dialog box is complete to open the Editor toolbar and close ACT.

4.5.3 Edit an existing shapefile

1. Select the **Edit Existing Shapefile** radio button under GIS Function (fig. 4-25) if you want to edit an existing shapefile rather than create a new shapefile from scratch.

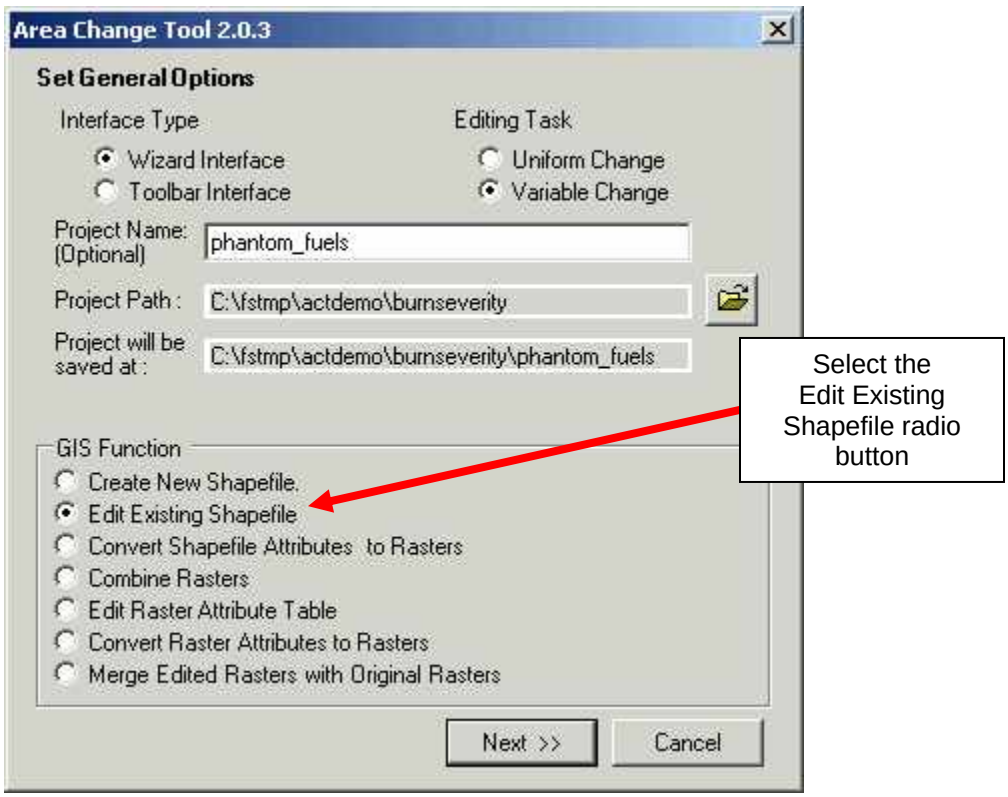


Figure 4-25. Use the Edit Existing Shapefile option to edit existing shapefiles.

2. Click on **Next** to open the Editor toolbar (fig. 4-26), which you can use to add new polygons or to modify the shape of existing polygons. In addition, select this option if you need to edit the values of an exiting shapefile's attribute table. The Editor toolbar used by ACT is exactly the same as the Editor toolbar available in ArcMap.

Figure 4-26. The Editor Toolbar.

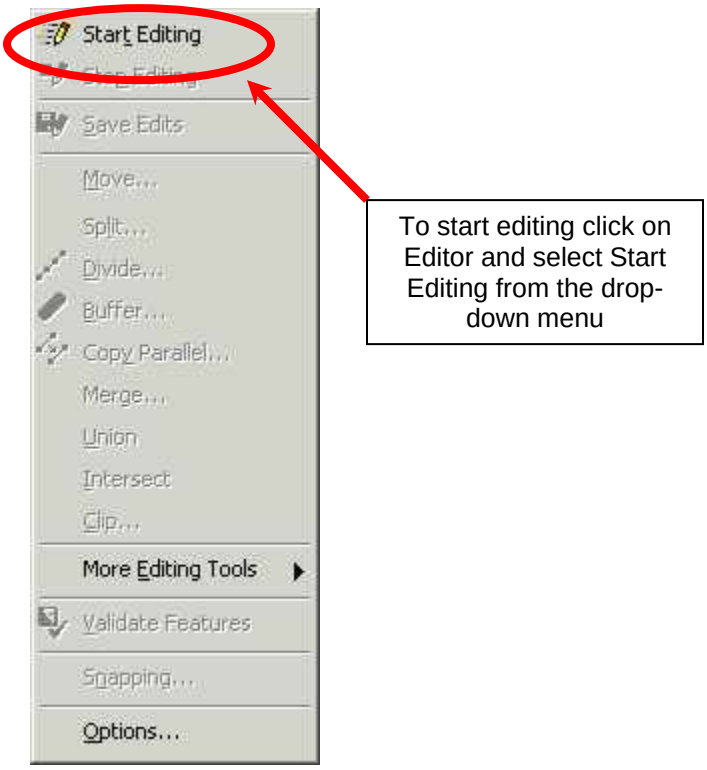


Figure 4-27. Drop-down Editor menu.

3. Click on the **Editor** drop-down list and select **Start Editing** at the top of the menu as shown above in figure 4-27. As before, you will need to identify the path that contains the target shapefile. A Start Editing dialog box, which is used to select the appropriate path containing the shapefile to be edited, will appear (fig. 4-28).

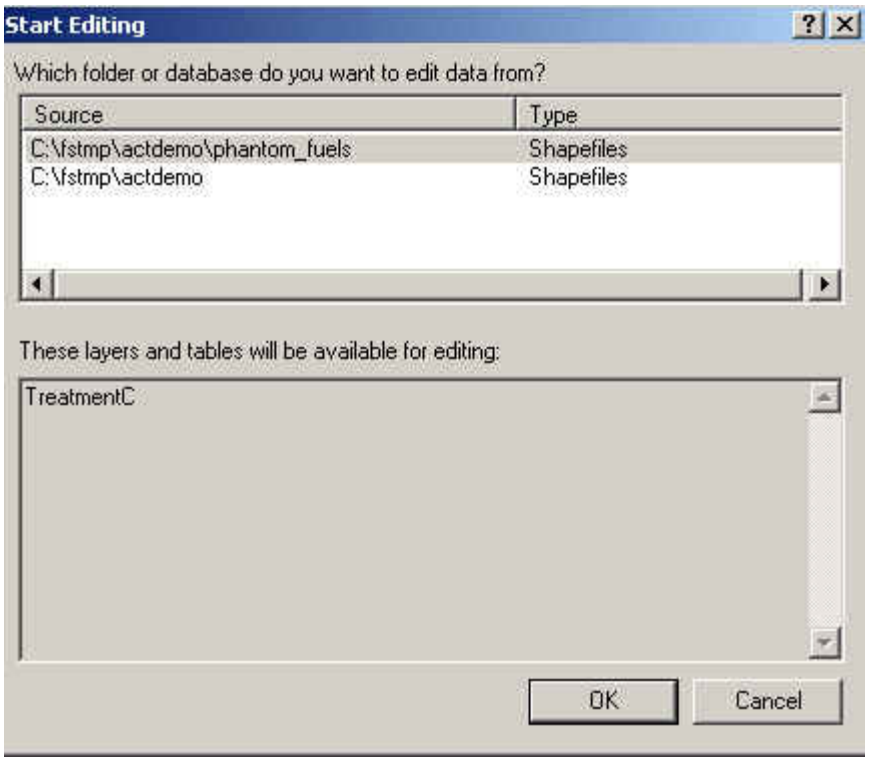


Figure 4-28. The Start Editing dialog box shows the layers available for editing within the selected path.

4. After identifying the appropriate path, select an editing task from the Task drop-down menu on the Editor toolbar (fig. 4-29).

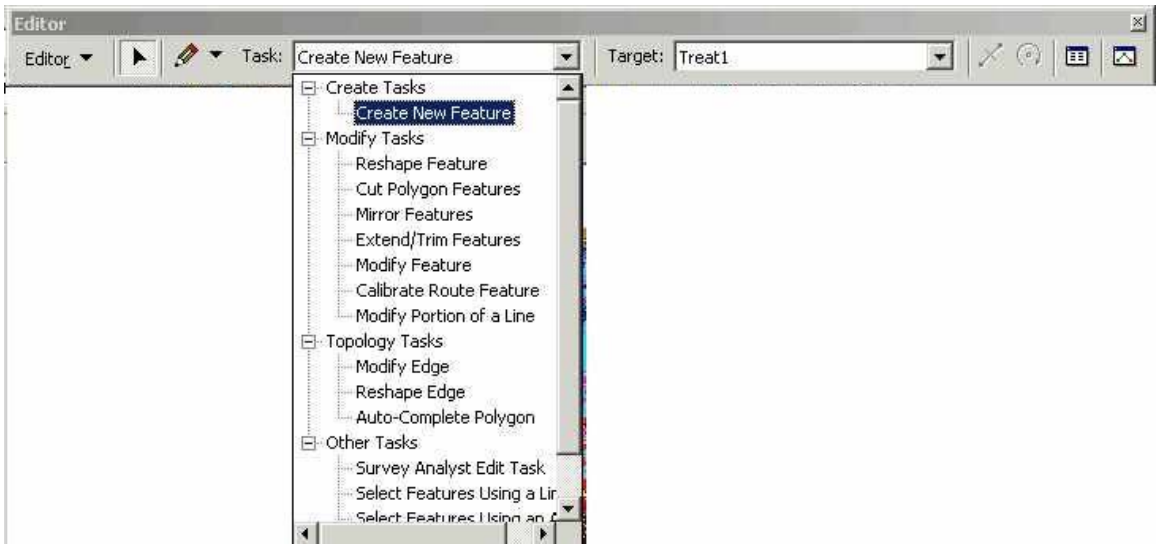


Figure 4-29. Selecting an editing Task from the Editor Toolbar.

5. Select **Create New Feature** if your objective is to add polygons. Select **Reshape Feature** if your objective is to change the shape of existing polygons. If your objective is to modify values in the attribute table, simply open the attribute table and change the values.

6. Finally, you will need to select the appropriate shapefile from the Target drop-down menu on the Editor Toolbar (fig. 4-30).

Figure 4-30. Use the Target drop-down menu on the Editor toolbar to select an appropriate shapefile.

7. Select the **Sketch Tool** icon shown below (fig. 4-31) to begin drawing a polygon. Consult ArcMap's Help utility to learn more about creating and editing polygons. We recommend that you **Save Edits** frequently (for example, after completing each polygon). When you have finished editing, select **Editor** > **Stop Editing** > **Save Edits**.

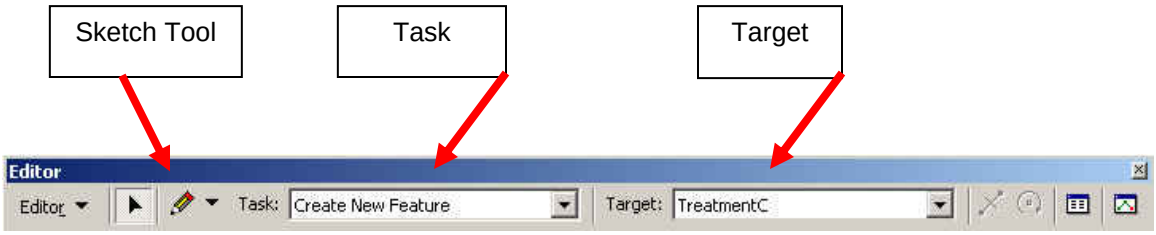
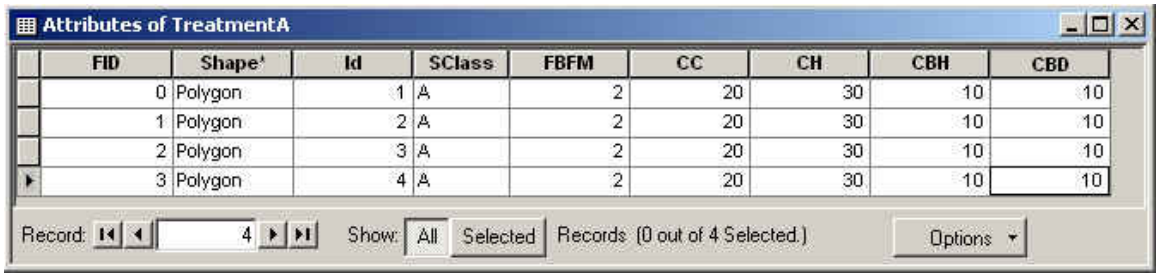


Figure 4-31. Editor toolbar showing the Sketch Tool, Task (Create New Feature), and Target shapefile ("TreatmentC").

Tip: *If you happen to make a mistake in your drawing, it may be easier to delete the polygon and start over rather than trying to edit an existing polygon.*

8. Now you will need to provide the appropriate values for the attributes within the shapefile. Open the attribute table of the shapefile you have created by right clicking on the new shapefile in the ArcMap Table of Contents (fig. 4-32) and select **Open Attribute Table**.



Attributes of TreatmentA

FID	Shape*	Id	SClass	FBFM	CC	CH	CBH	CBD
0	Polygon	1	A	2	20	30	10	10
1	Polygon	2	A	2	20	30	10	10
2	Polygon	3	A	2	20	30	10	10
3	Polygon	4	A	2	20	30	10	10

Record: 4 Show: All Selected Records (0 out of 4 Selected.) Options

Figure 4-32. Example attribute table of a shapefile with four polygons and containing the following attributes: Id = polygon identifier, SClass = succession class, FBFM = fire behavior fuel model, CC = canopy cover, CH = canopy height, CBH = canopy base height, and CBD = canopy bulk density.

9. Enter the values that you wish to use in the appropriate cells of the attribute table.

   ***Note**: Be sure to press the Enter key on your keyboard after adding the last value and then close the attribute table before continuing.*

10. When you are finished, save your edits by selecting **Editor > Stop Editing > Save Edits**. Close the Editor toolbar and the attribute table.

    Tip: When you have finished editing, return to ACT by clicking on the ACT toolbar.

4.5.4 Convert shapefile attributes to rasters

The next step in the Variable Change process is to convert the attributes of interest in a shapefile to new raster layers. The GIS function Convert Shapefile Attributes to Rasters enables the user to convert each attribute of a shapefile to a new raster layer. Select the radio button to the left of Convert Shapefile Attributes to Rasters and click **Next** (fig. 4-33).

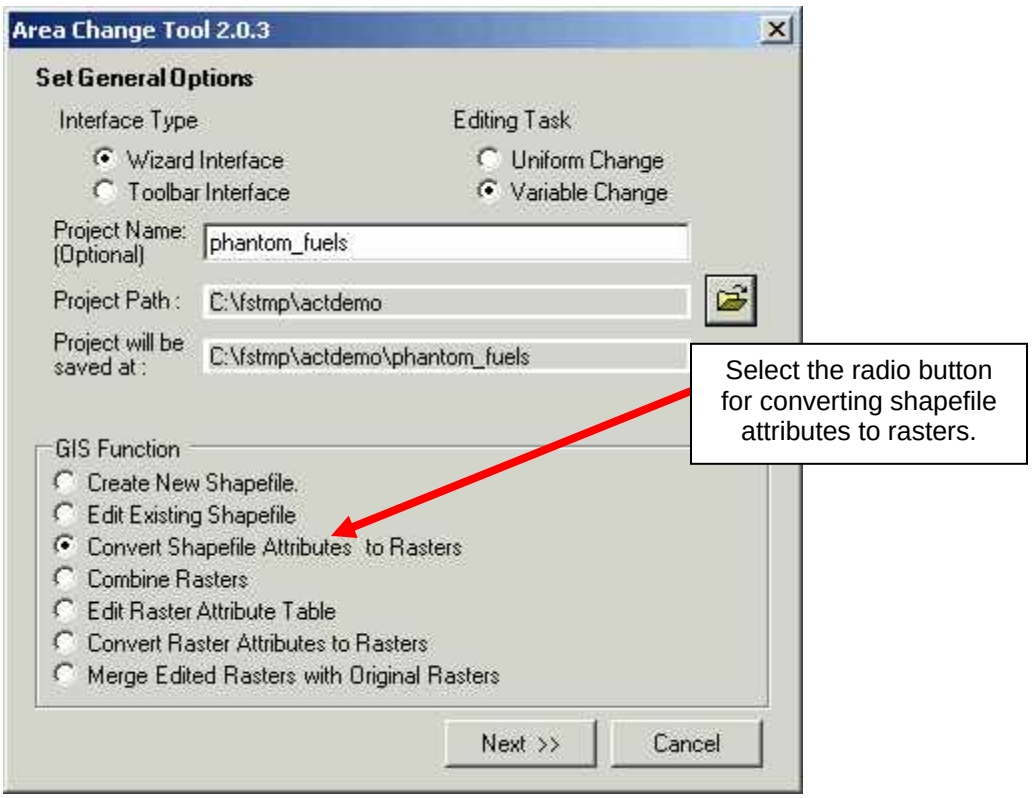


Figure 4-33. Converting shapefile attributes to rasters**.**

1. Click **Next** to open the following dialog box (fig. 4-34):

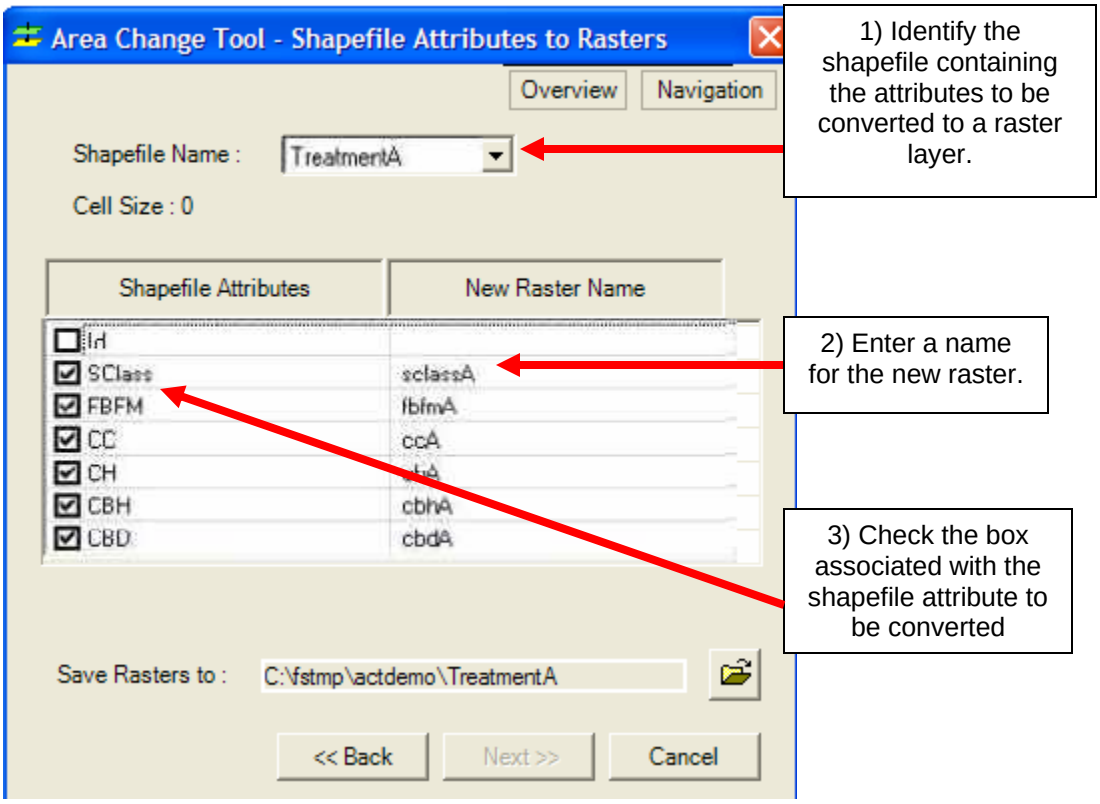


Figure 4-34. Shapefile Attributes to New Rasters dialog box. In this example, the shapefile contains seven attributes: Id = polygon identifier, SClass = succession class, FBFM = fire behavior fuel model, CC = canopy cover, and CH = canopy height, CBH = canopy base height, and CBD = canopy bulk density.

***Tip**: The target shapefile must exist within ArcMap's Table of Contents before you can convert its attributes to new rasters.*

2. Select the appropriate shapefile containing the attributes to be converted to rasters from the drop-down menu at the top of the dialog box (fig. 4-34 above). Provide a name for each new raster by double clicking the space under New Raster Name and enter a name. Once you have entered a new raster name, the box to the left of each attribute's name will be enabled. You can then check the attributes that you would like to convert. Only attributes that are checked will be converted to a new raster.

   ***Note**:* Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

***Tip**: You will not be able to check the boxes under the Shapefile Attributes window until you double-click in the New Raster Name column and enter a name.*

3. When you have finished filling out the dialog box, use the browse button to identify the path and folder for storing the new rasters. Click **Next** to begin the conversion process. The new raster layers will automatically be added to the ArcMap Table of Contents.

   ***Note**: A progress bar located at the bottom of the dialog box indicates that conversion is proceeding.*

4.5.5 Combine rasters

Combining rasters is an effective technique for integrating multiple data layers at the pixel level. When rasters are combined, each cell of the combined raster is assigned to one of the unique combination of cell values from the input layers. The cell values of the input layers become attributes of the combined layer (see the ArcGIS help utility for a more thorough explanation of combining raster layers).

The maximum number of grids that can be input into the ArcGIS "combine" function varies with different hardware platforms. The combine function is also limited by the range of grid values in each layer. No more than 10 million unique combinations are possible. However, ArcGIS currently determines the number of potential combinations based on the maximum grid values in each of the layers to be combined. For example, if a layer has two unique values with grid values of 100 and 101, then ArcGIS assumes that there are actually 101 unique values in that layer. If this layer is combined with a similar layer, ArcGIS assumes that the combine function will result in 10,201 potential values even though in reality, there could be only four potential values representing the unique combinations of both layers.

***Tip**: If you receive an error message indicating that the combine function will result in over 10 million unique combinations, you may be able to remedy the situation by:*

- *dropping one or more of the input layers,*
- *reclassifying the values of the input layers to decrease their maximum values,*
- *classifying the values of the input layers to reduce the number of potential combinations, or*

- *combining the layers in stages. For example, combine the first three layers in one step, the second three layers in another step, and then lastly combine the two combined layers.*

***Note**: The remainder of this chapter will use a single example to demonstrate the Variable Change editing process. This example involves updating five fuel layers using the burn severity layer of a recent fire. Specifically, fuel layers characterizing pre-burn conditions will be updated using the Variable Change editing process to reflect post-burn conditions.*

All input layers to be combined must be added to your ArcMap project prior to initiating the combine function. After adding all layers of interest to ArcMap, select the radio button to the left of **Combine Rasters** (fig. 4-35) to open the Combine Rasters dialog box.

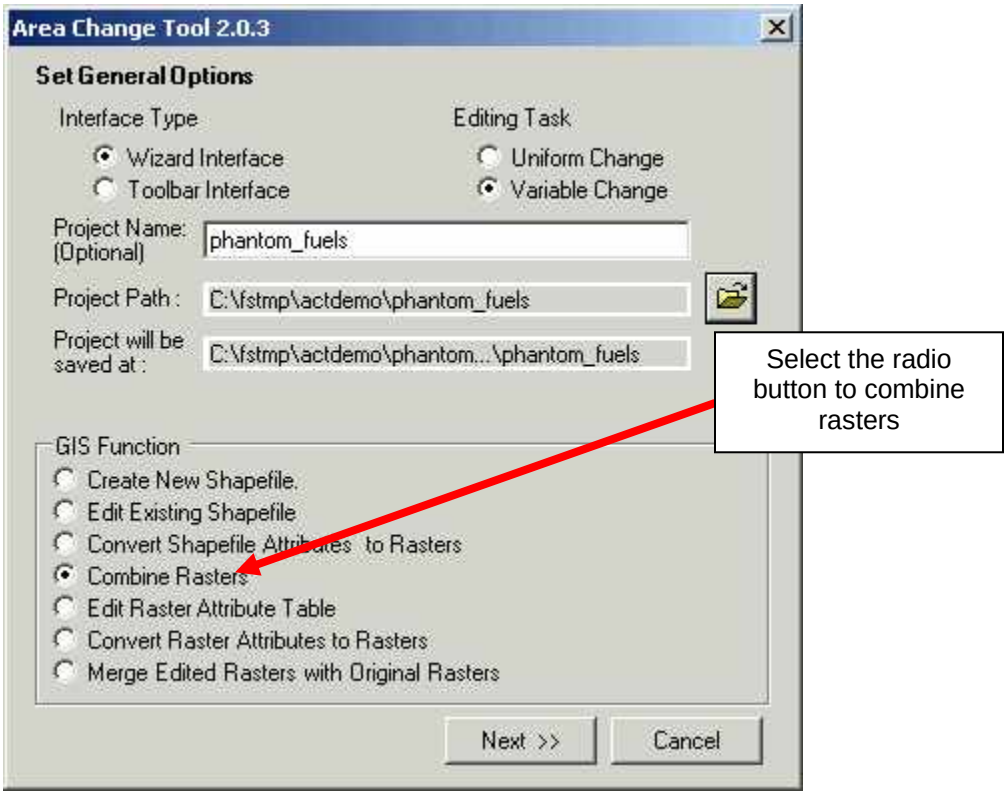


Figure 4-35. Selecting the Combine Rasters function.

The Combine Rasters dialog box (fig. 4-36) is used to name the new combined layer, order the layers as they will appear in the value attribute table, and identify additional attributes from the input layers that should be included within the value attribute table of the combined layer.

1. First, provide a name for the combine raster in the window labeled New Raster Name**.**

   ***Note**: Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~!@#$^()-+={ }[ ]|\?/:;'"< >,.).*

2. Next, identify the rasters layers that are to be combined. The Rasters to Combine column will include any rasters that have been loaded into your ArcMap project. Place a check in the box associated with any raster to be included in the combined layer. The order in which rasters are checked will determine how they are arranged in the value attribute table of the combined layer. The column labeled Attrib Order will automatically display the sequence in which layers are checked. The last column in the dialog box, Join Attributes**,** adds any ancillary attributes, such as descriptive labels of a layer, into the value attribute table of the combined layer. To include an ancillary attribute, double-click on the appropriate cell and then check the box or boxes of those attributes to be included.

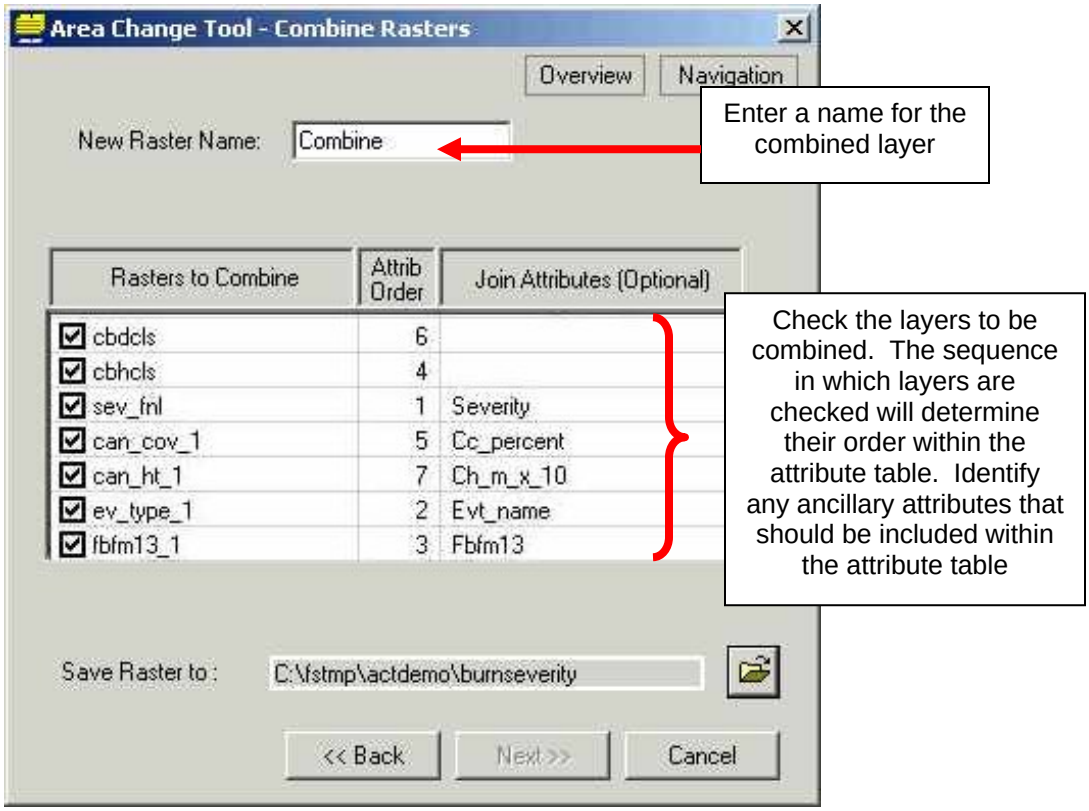


Figure 4-36. The Combine Rasters dialog box.

3. When you have completed the dialog box by identifying the rasters (Rasters to Combine), specifying their appropriate order (Attrib Order), and adding important ancillary attributes (Join Attributes), use the browse icon to navigate to the folder in which you wish to use to store the combined layer. You can accept the default path or choose a new location.

Click **Next** to create the new raster. The new raster will automatically be added to the Table of Contents in your ArcMap project. Review the value attribute table of the combined layer to ensure that the layer will meet your needs. The value attribute table for this example is displayed below (fig. 4-37).

Values of input rasters

Attributes of input rasters

Attributes of combine

Objectl	Value	Count	Sev_fml	Ev_type_1	Fbfm13_1	Cbhcls	Can_cov_1	Cbdcls	Can_ht_1	Severity	Evt_name	Fbfm13	Cc_percent	Ch_m_x_10
0	1	12	1	2045	10	25	85	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
1	2	10	1	2045	8	25	75	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM8	70 <= CC < 80	100 <= CH < 250
2	3	8	2	2045	10	25	85	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
3	4	23	1	2045	10	25	85	15	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
4	5	44	1	2227	8	15	85	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
5	6	4	1	2227	8	25	75	5	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
6	7	11	2	2045	8	25	75	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM8	70 <= CC < 80	100 <= CH < 250
7	8	14	2	2227	8	25	85	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
8	9	4	2	2227	8	25	75	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
9	10	12	1	2227	8	15	75	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
10	11	18	1	2227	8	25	85	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250

Record: 13 Show: All Selected Records (0 out of 2491 Selected.) Options

Figure 4-37. The attribute table of the combined layer showing the first 11 of 2,491 records.

4.5.6 Edit raster attribute table

ACT has two options for editing attribute tables of raster layers: Microsoft Excel or Microsoft Access. The choice of software program is largely dependent on your own experience. Excel may be easier to use, but can be more tedious than Access and can be inappropriate for large editing projects. Attribute tables of a combined layer commonly contain thousands of records which may prove problematic when using Excel since Excel has a limit of 65,560 records. Using Access is typically more efficient since update queries can change hundreds of records simultaneously.

Select the **Edit Raster Attribute Table** radio button in the Area Change Tool dialog box (fig. 4-38) and click **Next** to open up the Edit Raster Manager dialog box (fig. 4-39).

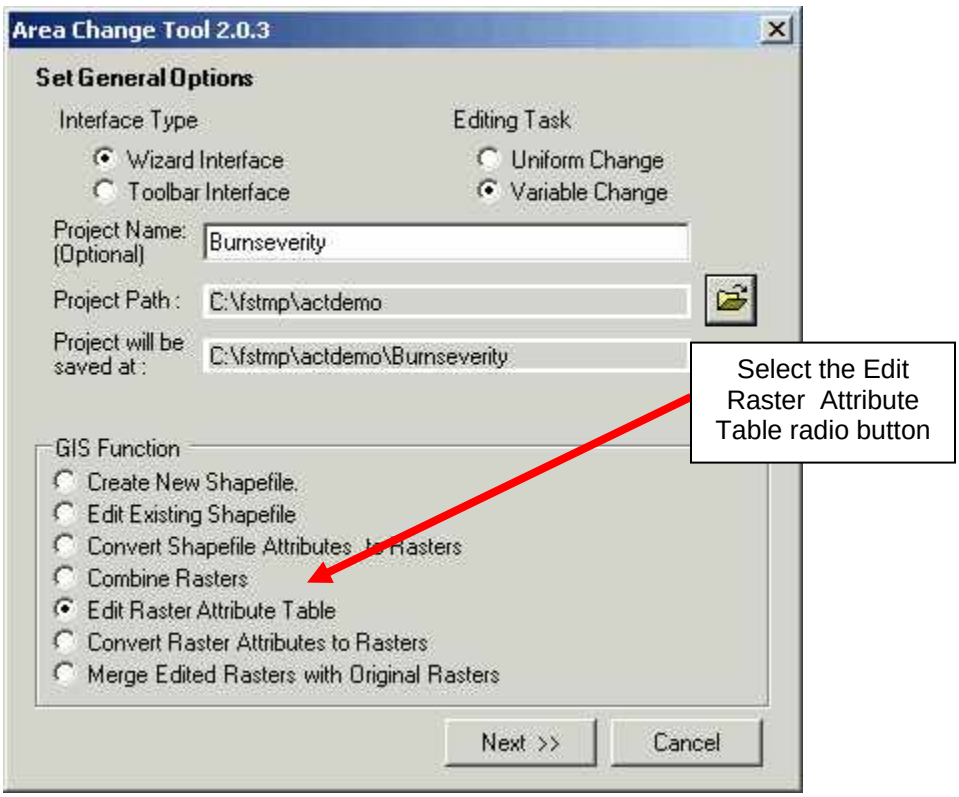


Figure 4-38. Selecting the GIS function to edit a raster attribute table.

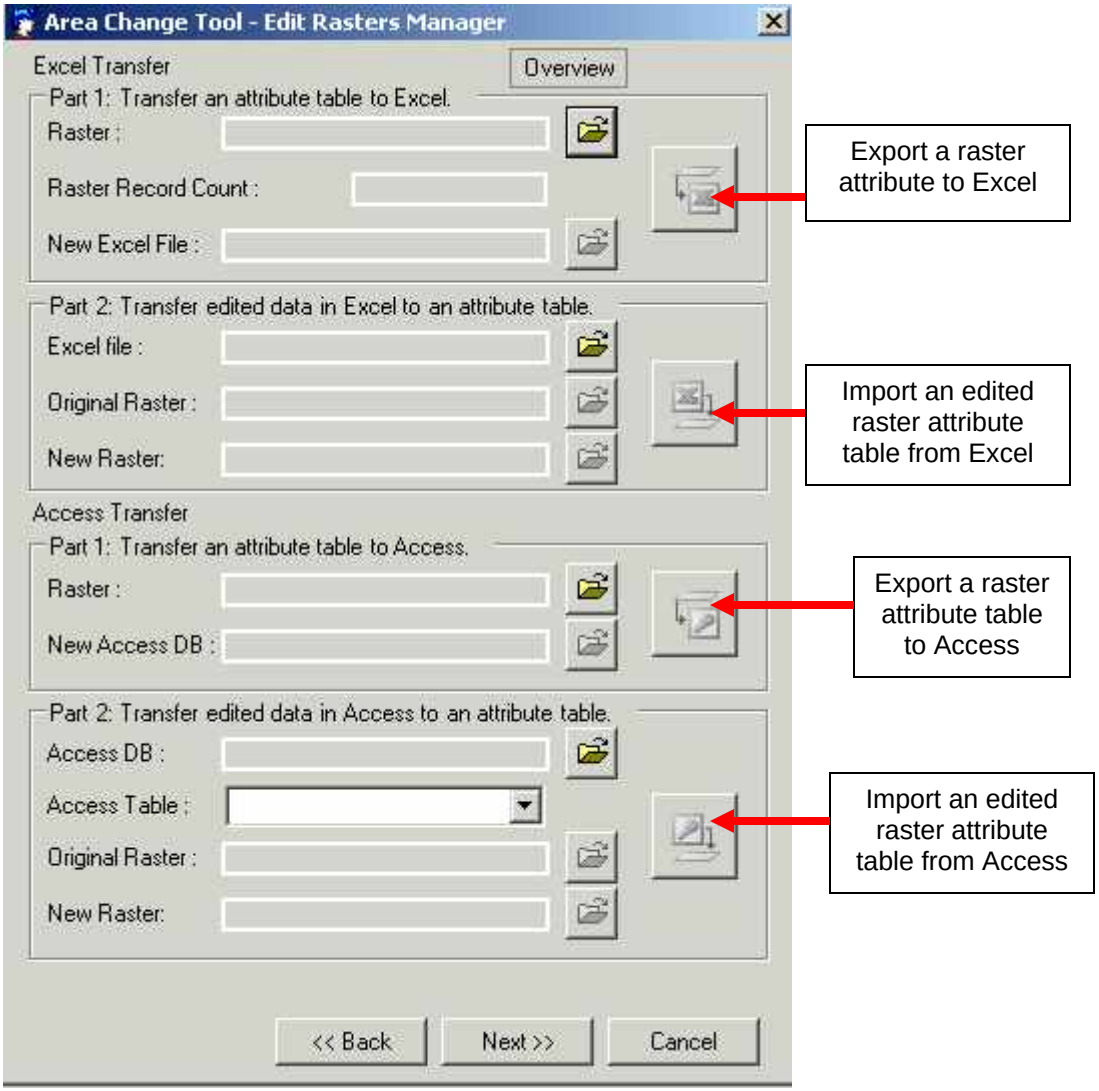


Figure 4-39. The Edit Rasters Manager dialog box.

The Edit Rasters Manager dialog box (fig. 4-39) is used to transfer value attribute tables to either Excel or Access for editing and subsequently to transfer the edited Excel/Access data to a value attribute table of a new raster layer. The upper portion of the Edit Rasters Manager dialog box pertains to Excel and the bottom half relates to Access.

Excel Transfer

Part 1: Transfer an attribute table to Excel

Three steps are required to export an attribute table to an Excel spreadsheet for editing (fig. 4-40).

1. First, identify the raster that is to be edited by clicking on the browse icon to the right of the Raster box.

2. Second, create an Excel spreadsheet by clicking on the folder icon to the right of the box labeled New Excel File.

3. Lastly, export the raster attribute table to Excel by clicking the large icon (Export a raster attribute table to Excel) to the right of the Excel Transfer Part 1 box. During the exporting process, the record count of the raster will appear in the dialog box. This feature is useful for determining if the raster has more than 65,560 records which will exceed the capacity of Excel spreadsheets. Excel will open automatically when the exporting process is complete (fig. 4-41).

   ***Tip**: If the record count exceeds the limit of Excel (65,560 records), a warning message will appear on your screen and the Excel transfer will stop.*

   ***Note**: A progress bar at the bottom of the dialog box indicates that the transfer is proceeding. Processing may take several minutes for rasters with large numbers of records and/or attributes.*

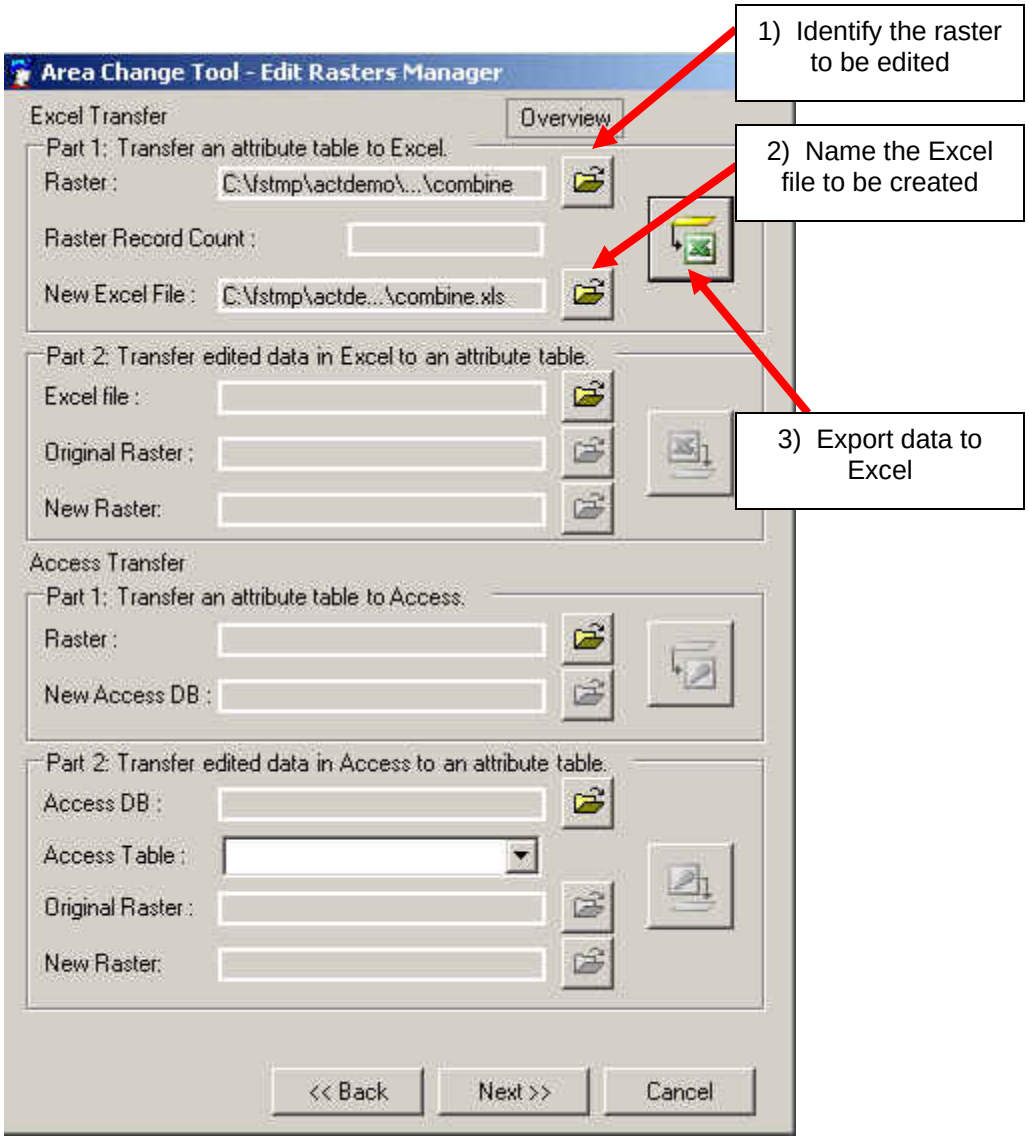
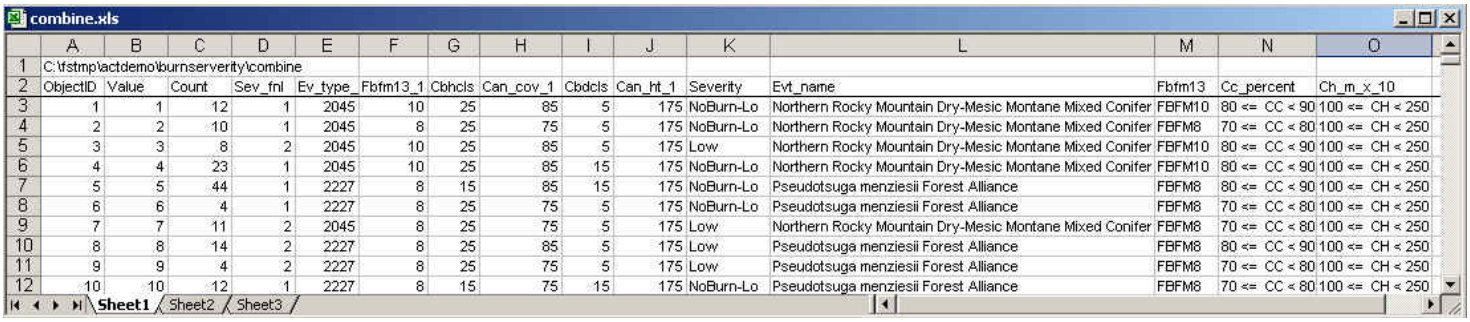


Figure 4-40. Use the Edit Rasters Manager dialog box to export a raster attribute table to Excel.



combine.xls

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	C:\fstmp\actdemo\burnserverity\combine														
2	ObjectID	Value	Count	Sev_fnl	Ev_type_	Fbfm13_1	Cbhcls	Can_cov_1	Cbdcls	Can_ht_1	Severity	Evt_name	Fbfm13	Cc_percent	Ch_m_x_10
3	1	1	12	1	2045	10	25	85	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer	FBFM10	80 <= CC < 90	100 <= CH < 250
4	2	2	10	1	2045	8	25	75	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer	FBFM8	70 <= CC < 80	100 <= CH < 250
5	3	3	8	2	2045	10	25	85	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer	FBFM10	80 <= CC < 90	100 <= CH < 250
6	4	4	23	1	2045	10	25	85	15	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer	FBFM10	80 <= CC < 90	100 <= CH < 250
7	5	5	44	1	2227	8	15	85	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
8	6	6	4	1	2227	8	25	75	5	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
9	7	7	11	2	2045	8	25	75	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer	FBFM8	70 <= CC < 80	100 <= CH < 250
10	8	8	14	2	2227	8	25	85	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
11	9	9	4	2	2227	8	25	75	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
12	10	10	12	1	2227	8	15	75	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250

Sheet1 Sheet2 Sheet3

Figure 4-41. An Excel spreadsheet derived from the value attribute table.

You can begin editing immediately after Excel opens. However, please note the following editing caveats:

- We recommend making a backup copy of the spreadsheet prior to changing any values. If mistakes are made, an original copy will be available to fall back on.
- Never change values in the ObjectID, Value, or Count fields of a combined raster. Instead, edit only the attributes of that raster.
- Never delete any records.
- Be very careful when sorting a spreadsheet – data can easily be scrambled beyond repair. Be sure to sort the entire spreadsheet and not just some subset of fields. Always return the spreadsheet to its original form before transferring data to an attribute table by sorting the entire spreadsheet using the Value field.

Use the **SaveAs** function to save your worksheet when edits are complete. Close Excel and save your ArcMap project at this point.

Part 2: Transfer edited data in Excel to an attribute table

This feature of ACT is used to create a new raster from the edited version of an Excel worksheet. Open the Area Change Tool dialog box and then select the radio button Edit Raster Attribute Table. The following steps are required to import a spreadsheet into an attribute table (see fig. 4-42 below).

1. Identify the Excel spreadsheet that contains the edited data by clicking on the browse button to the right of the Excel file box.

2. Identify the Original Raster that was used to create the Excel spreadsheet. ACT will commonly provide this information automatically, but make sure that this information is correct before you continue.

3. Enter a name and path for the New Raster by clicking on the browse button to the right of the New Raster box. Remember that the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

4. Create the new raster by clicking on the large icon (Import an edited attribute table in Excel) at the far right of the Part 2 box.

The new raster will be added automatically to the Table of Contents in your ArcMap project. Save your ArcMap project at this time.

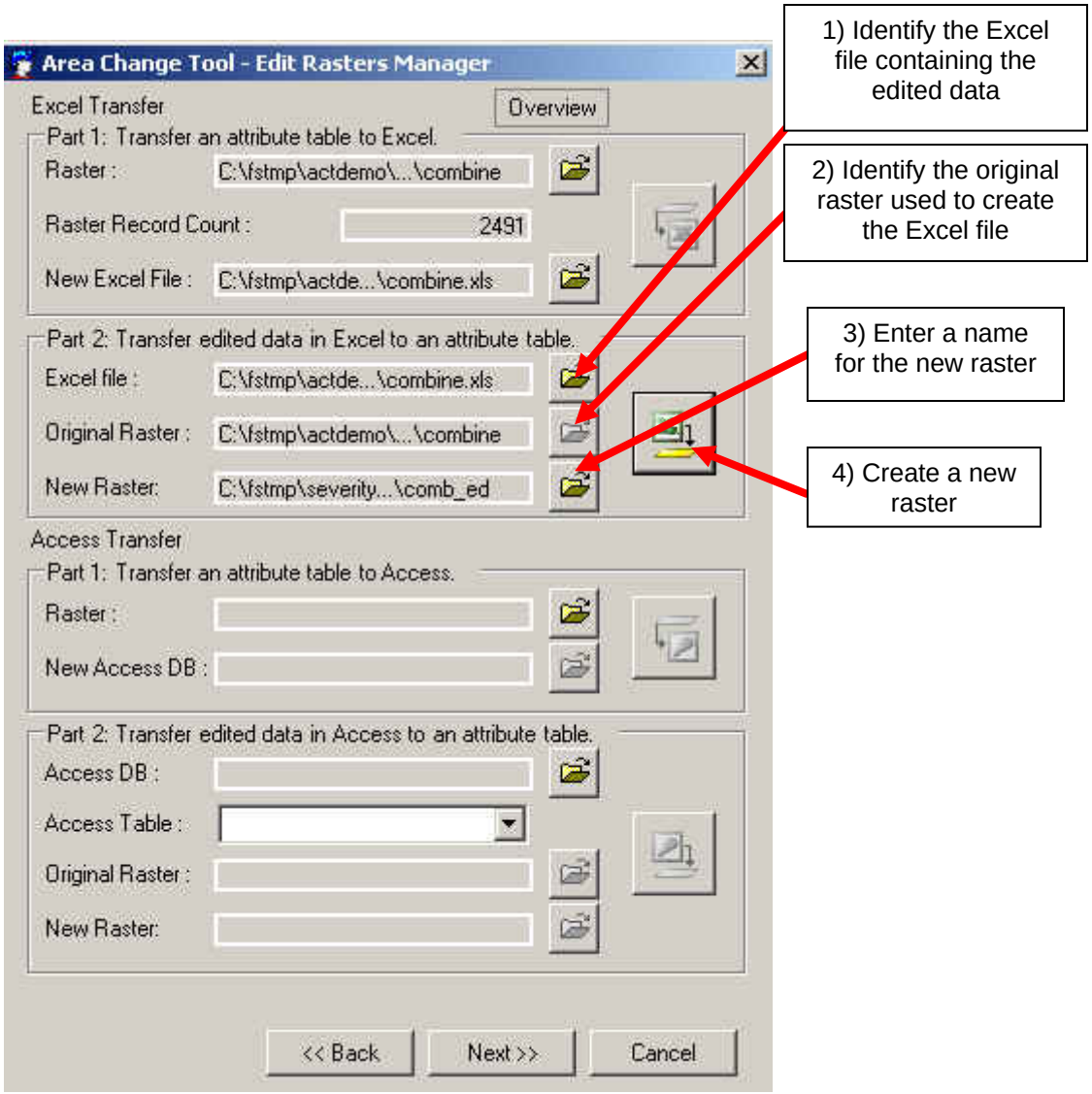


Figure 4-42. Use the Edit Rasters Manager dialog box to create a new raster from an edited Excel spreadsheet.

Access Transfer

Part 1: Transfer an attribute table to Access

Open the Edit Rasters Manager dialog box by selecting the radio button labeled **Edit Raster Attribute Table**. The bottom portion of the Edit Rasters Manager dialog box pertains to using Access to edit the attribute table of an existing raster.

Exporting a value attribute table to Access is a simple three-step process (see fig. 4-43 below).

1. Identify the raster to be edited by clicking on the browse button to the right of the Raster box.

2. Name the Access database by clicking on the browse button to the right of the New Access DB window.

3. Click on the large icon to the far right of the Access Transfer Part 1 box to export the value attribute table into an Access database. The Access database will open automatically when the transfer process is complete. The database will contain a table with the same name as the database (fig. 4-44). Open the table and begin editing.

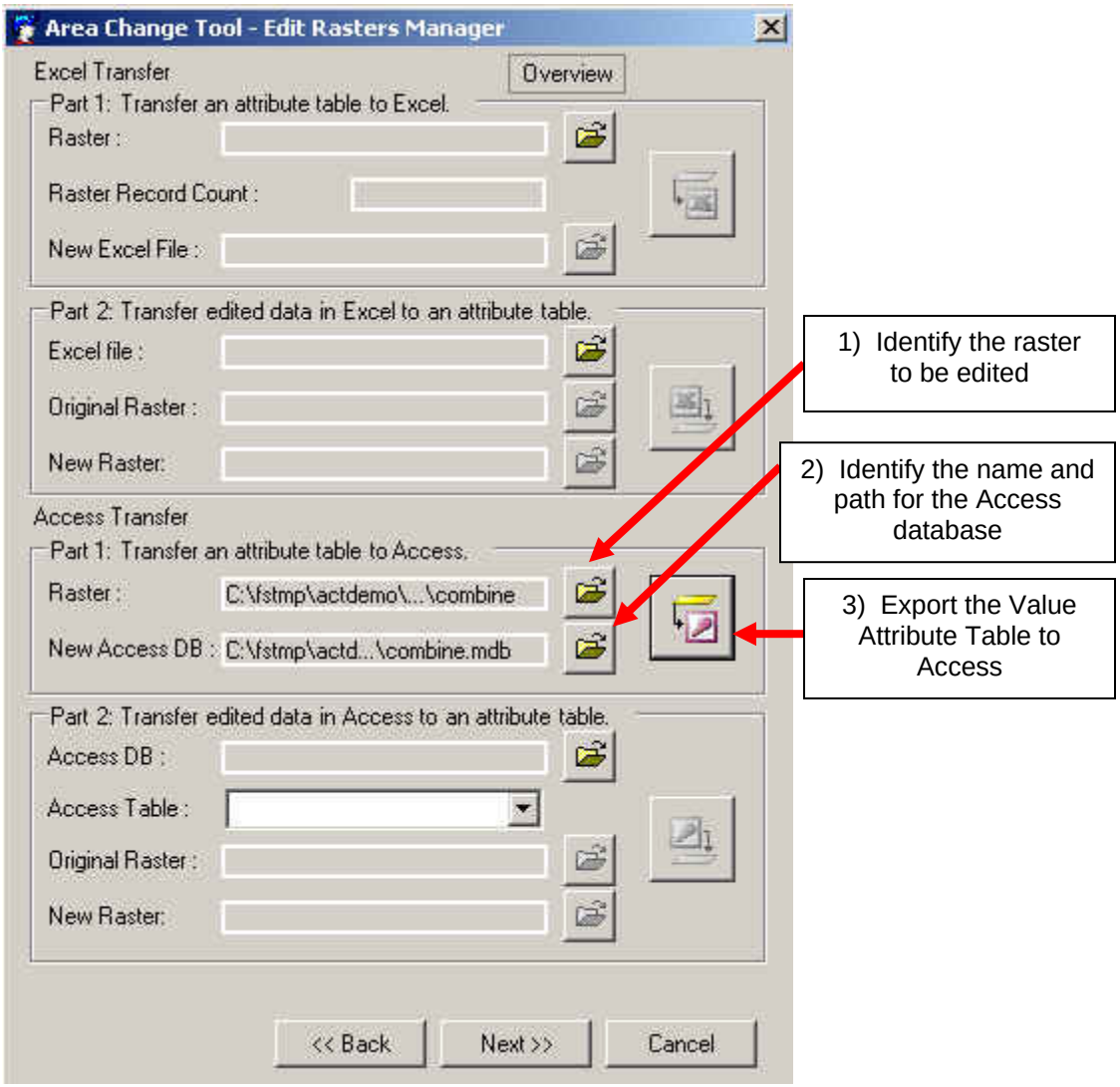


Figure 4-43. Use the Edit Rasters Manager dialog box to transfer a value attribute table to an Access database.

combine : Table

OBJECTID	Value_	Count_	Sev_fnl	Ev_type_1	Fbfm13_1	Cbhcls	Can_cov_1	Cbdcls	Can_ht_1	Severity	Evt_name	Fbfm13	Cc_percent	Ch_m_x_10
1	1	12	1	2045	10	25	85	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
2	2	10	1	2045	8	25	75	5	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM8	70 <= CC < 80	100 <= CH < 250
3	3	8	2	2045	10	25	85	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
4	4	23	1	2045	10	25	85	15	175	NoBurn-Lo	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM10	80 <= CC < 90	100 <= CH < 250
5	5	44	1	2227	8	15	85	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
6	6	4	1	2227	8	25	75	5	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
7	7	11	2	2045	8	25	75	5	175	Low	Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	FBFM8	70 <= CC < 80	100 <= CH < 250
8	8	14	2	2227	8	25	85	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	80 <= CC < 90	100 <= CH < 250
9	9	4	2	2227	8	25	75	5	175	Low	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250
10	10	12	1	2227	8	15	75	15	175	NoBurn-Lo	Pseudotsuga menziesii Forest Alliance	FBFM8	70 <= CC < 80	100 <= CH < 250

Record: 12 of 2491

Figure 4-44. An Access table derived from the value attribute table.

Tips:

- *It is always a good idea to create a backup table before any changes are made. The backup table can be quite useful if mistakes are made during editing that cannot be easily corrected.*
- *Never change values within the OBJECTID, VALUE, or COUNT attributes of a combined raster. Change data only in fields corresponding to layer attributes.*
- *Never delete any records.*
- *Save any update queries used for editing. These queries can be useful at a later date for identifying errors. In addition, queries document changes that you have made and can be used in another editing process to make consistent changes.*

Part 2: Transfer edited data from Access to a value attribute table

This feature is used to create a new raster from the edited version of an Access database table. Open the Area Change Tool dialog box and then select the radio button labeled **Edit Raster Attribute Table** to open the Edit Rasters Manager dialog box. The following steps are required to import a database into an attribute table (see fig. 4-45 below).

1. Select the Access database that contains the table to be converted to an attribute table. Click the browse button to the right of the Access DB box to navigate to your database.

2. Select the appropriate table in the database by using the drop-down menu to the right of the Access Table window.

3. If necessary, identify the original raster layer using the browse button associated with Original Raster. ACT will usually complete this step automatically once the Access table is identified. However, make sure that the Wizard has identified the correct raster layer before proceeding.

4. Identify a name and path for the new raster layer by clicking on the browse button to the right of the New Raster window. Remember that the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

5. Create the new raster by clicking on the icon Import an edited raster attribute table from Access to the right of the dialog box. The new raster containing the edited information will appear automatically in the ArcMap Table of Contents.

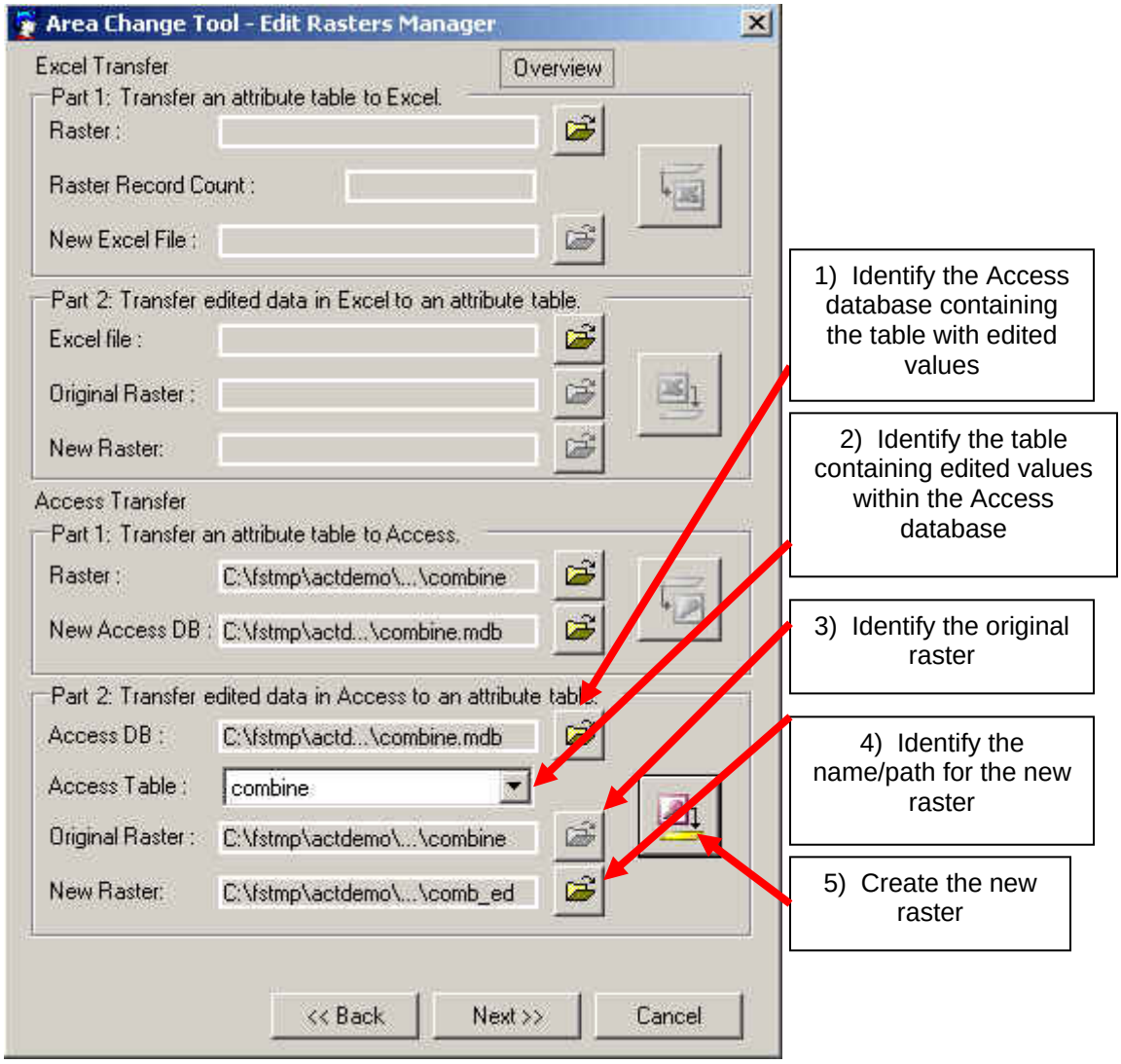


Figure 4-45. Converting Access database table to a new raster layer.

From the drop-down menu to the right of Access Table, select the table to import from Access. If the original raster is located, its path and name will be displayed in the box to the right of Original Raster. However, if it is not found, the icon to the right of the box will be enabled, and you will need to click on it to browse to the original raster. Once a valid original raster has been entered, the folder to the right of New Raster will be enabled. Click on this icon and enter a name and path for your new raster. Next, click on the icon "Import an edited raster attribute table from Access" located to the right of the box as shown above in figure 4-45. The new raster layer will be created and added to your ArcMap project's Table of Contents.

4.5.7 Convert raster attributes to new rasters

This feature of ACT is used to create individual raster layers from the attributes of a combined layer. Open the Area Change Tool dialog box and select the radio button for **Convert Raster Attributes to Rasters** (fig. 4-46).

> ***Tip***: *The raster of interest must exist within your ArcMap project before this GIS function can be implemented.*

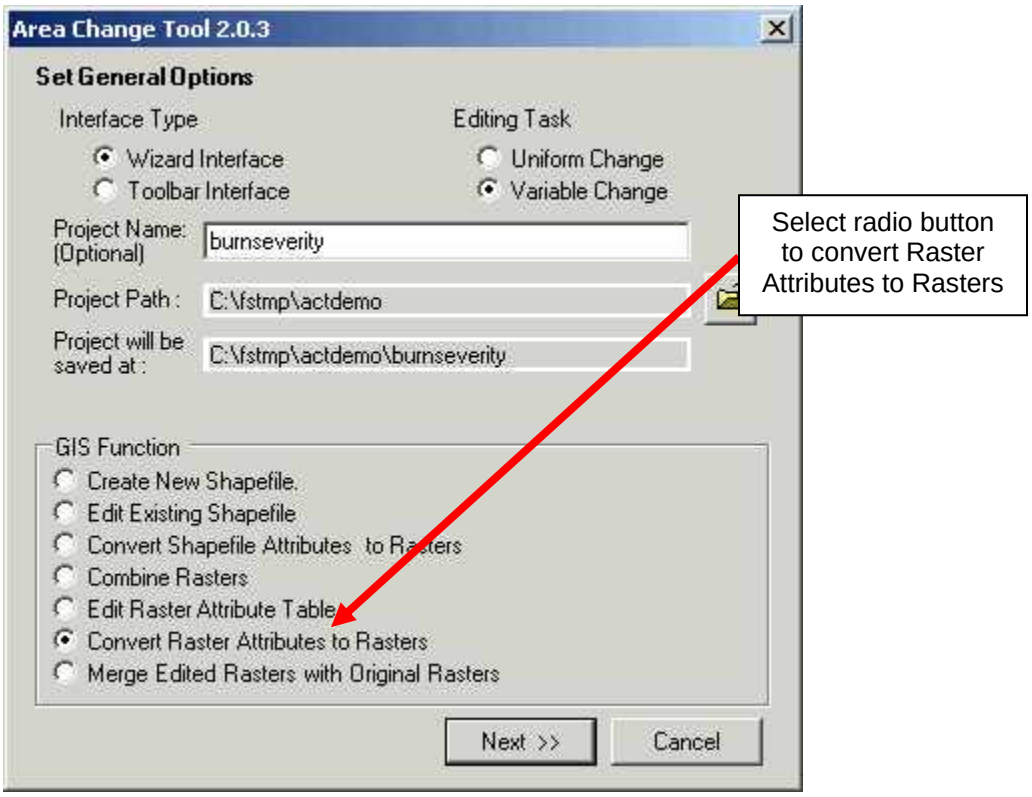


Figure 4-46. Converting raster attributes to raster layers.

A dialog box entitled Raster Attributes to Rasters will open (fig.4-47).

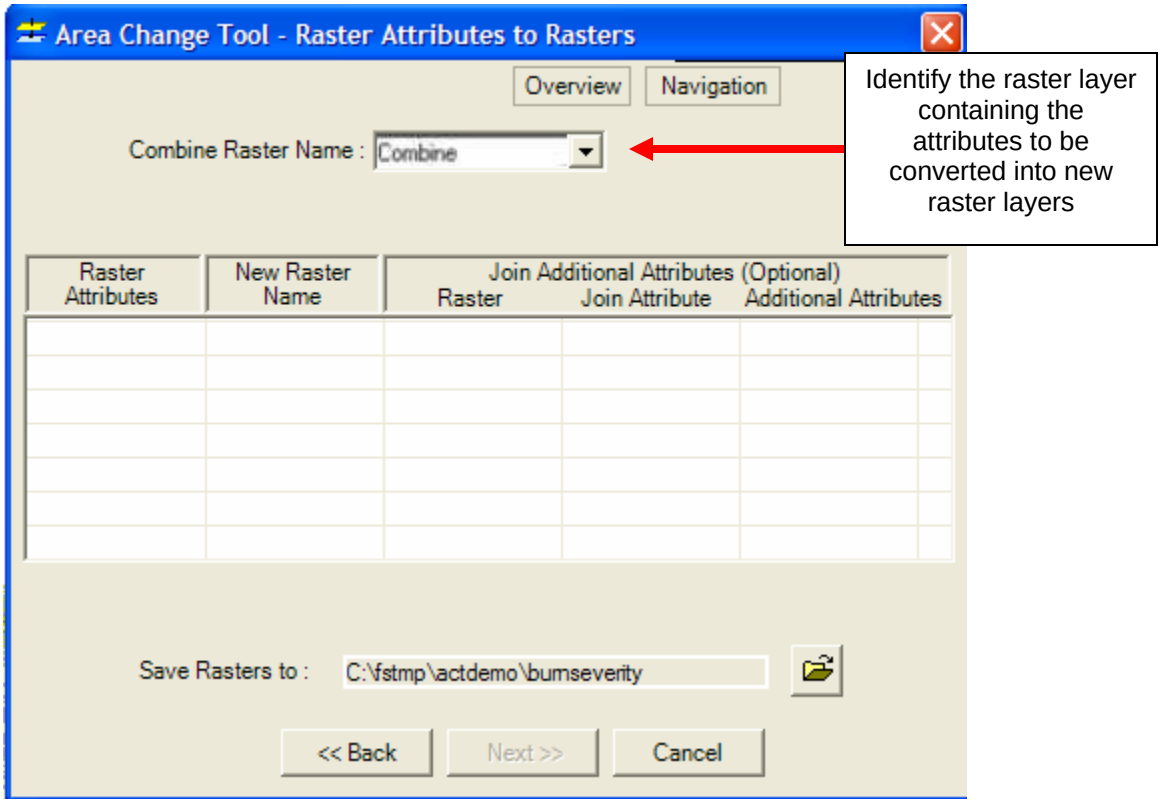


Figure 4-47. The Raster Fields to New Rasters dialog box is used to convert raster attributes to individual raster layers.

The dialog box for converting raster attributes to raster layers (fig. 4-47) is used to identify the combined raster and the attributes to be converted to individual layers. To carry out this function, follow these steps:

1. Select a raster containing the attributes that you would like to convert to new raster layers (this will generally be a combined raster). Use the drop-down menu to the right of Combine Raster Name to select the combined raster. All attributes contained within the combined raster will then appear in the lower portion of the dialog box (see fig. 4-48).

2. Enter a New Raster Name in the appropriate cell of the second column that corresponds to the attribute of interest as shown in figure 4-48.

   ***Note**: Remember that the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as* `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

3. The remaining three columns of the dialog box (Raster, Join Raster, and Join Additional Attributes) are optional and can be used to join any additional attributes to the new raster layer. Typically, these are ancillary

attributes that are used for descriptive purposes, such as a descriptive name that corresponds to a particular raster value. These additional attributes are generally included within the combined layer or in a layer that was used to create the combined layer. To join additional attributes to the new raster layer, double click in the cell under Raster. Select the raster layer containing the appropriate attributes from the drop-down menu (see fig. 4-48).

***Tip**: The raster must exist within your ArcMap project before it appears in the drop-down menu.*

4. Double click in the cell under Join Attribute and select the appropriate field from the drop-down menu that will be used to join the attributes to the new raster layer. This entry must correspond to the value of the new raster layer (see fig. 4-48).

5. Double click in the cell under Additional Attributes. Select all attributes from the drop-down menu by putting a check in the box corresponding to the appropriate attribute(s). After entering all the appropriate information for a particular row of the dialog box, return to the first column and click on the box to check it.

   ***Tip**: New raster layers will be created only for those Raster Attributes containing a check mark.*

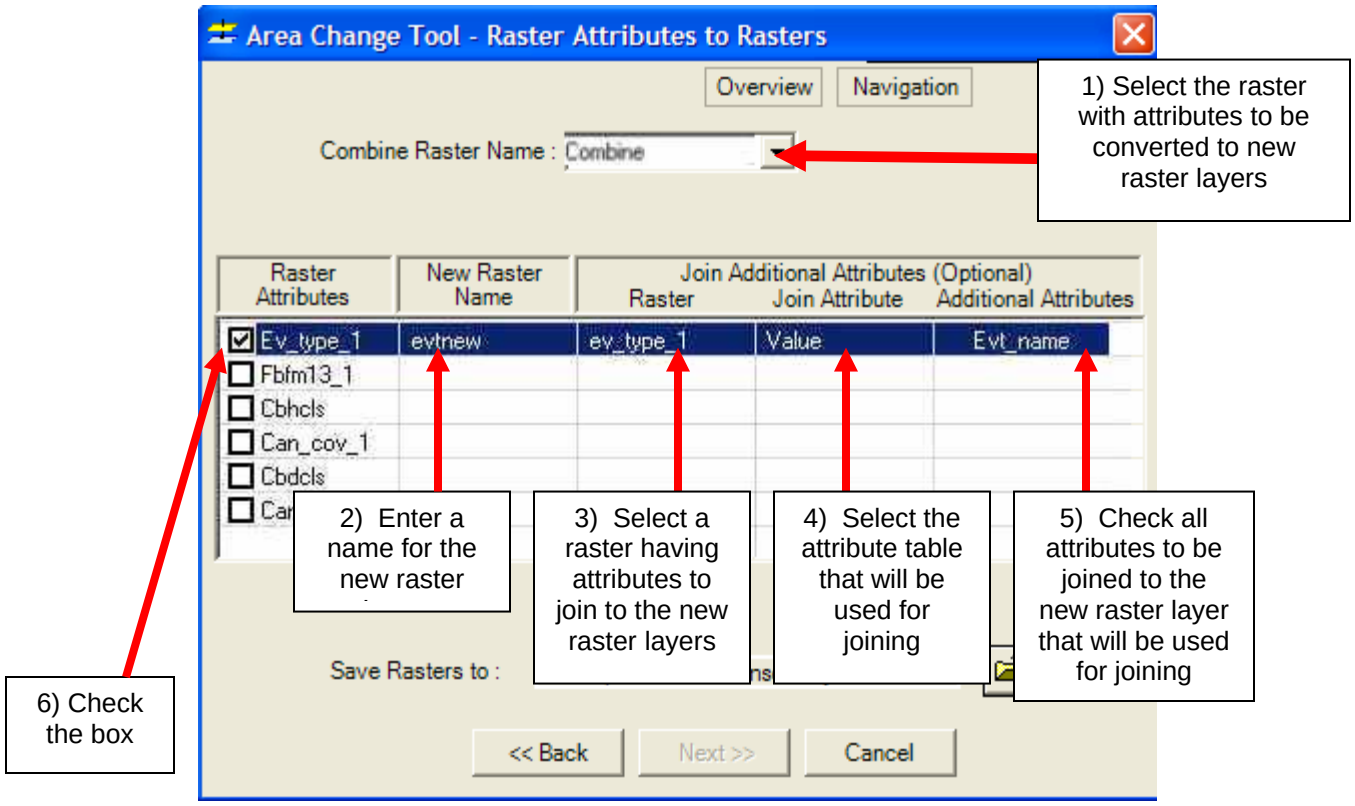


Figure 4-48. The Raster Fields to New Rasters dialog box. In this example, a new raster named "evtnew" is created from the "Ev_type_1" attribute from the combine layer. The new raster layer will include an attribute labeled "Evt_name" which originates from the raster layer denoted as "ev_type_1".

6. Next save your work to a location of your choice by clicking on the browse button to the right of the Save Rasters to box. You can select a new location or accept the default value that appears in the window. Click **Next** to create the new rasters. After processing is complete, the new raster layers will appear in ArcMap's Table of Contents.

> At this point, you may decide to merge these treatment rasters BACK into their original counterparts. This will create new input layers that you can run in FBAT or in the FRCC Mapping Tool to observe the effect of changes you have made.

4.5.8 Merge edited rasters with original rasters

The Merge Edited Rasters with Original Rasters function is used to create a new raster layer made up of edited and non-edited data. In other words, the edited data is "burned into" the non-edited data. For example, post-burn data might be used to overwrite pre-burn data.

> ***Note**: The raster layers to be merged must exist in your ArcMap project before you can use this GIS function.*

1. Open the Area Change tool dialog box and select the radio button labeled **Merge Edited Rasters with Original Rasters** (fig. 4-49).

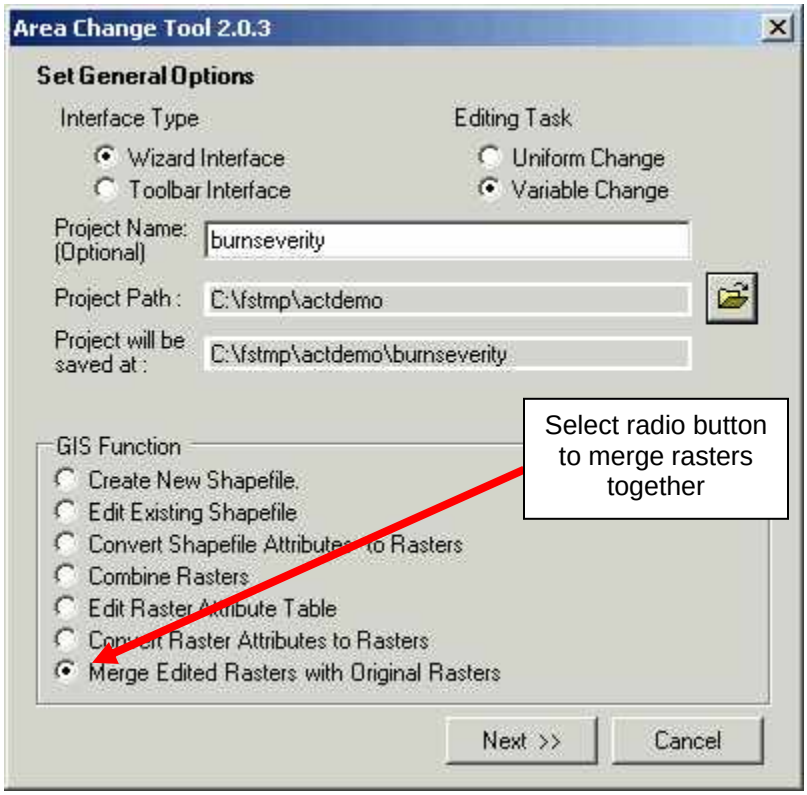


Figure 4-49. Use the Merge Edited Rasters with Original Rasters radio button to open the Merge Edited Rasters dialog box and merge rasters.

2. Click **Next** to open the Merge Edited Rasters dialog box (fig. 4-50).

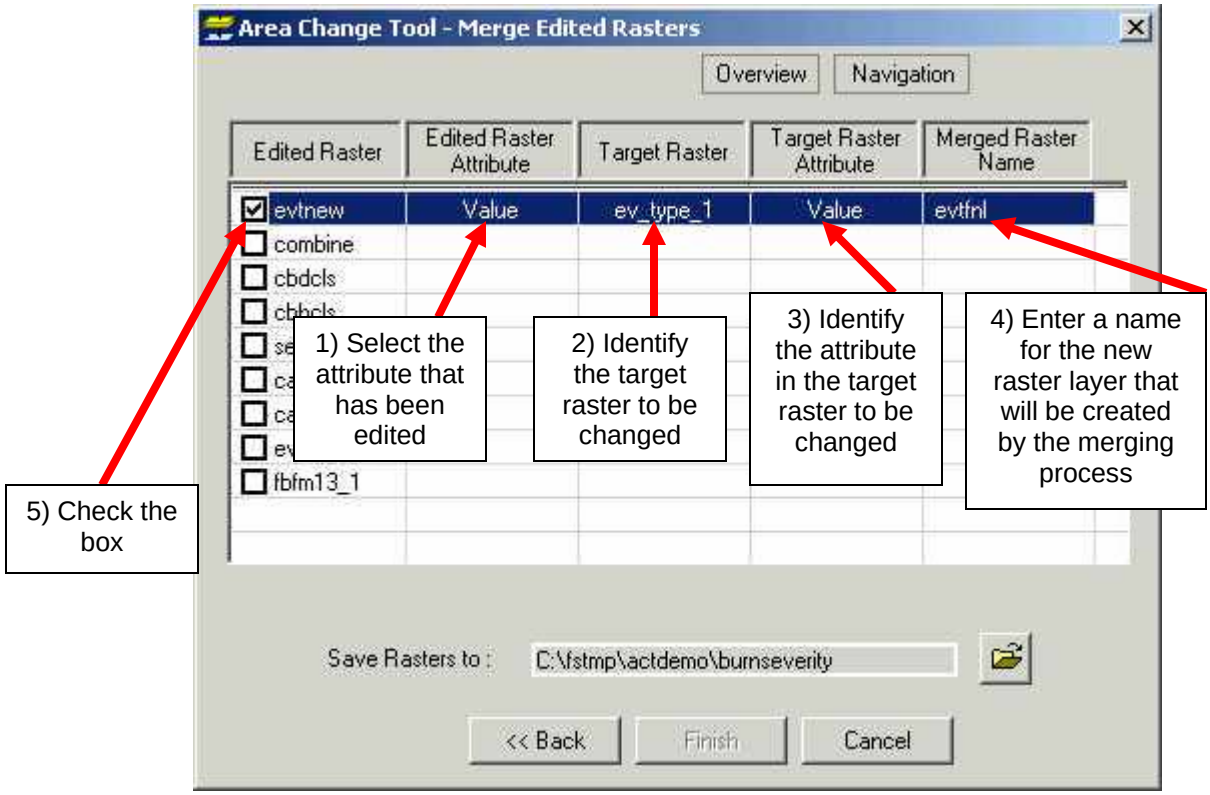


Figure 4-50. The Merge Edited Rasters dialog box. In this example, the edited raster name "evtnew" is merged with the original raster named "ev_type_1" to produce a new raster named "evtfnl."

3. Identify a raster that contains edited values from the Edited Raster column (note: no selection is made at this time). Double-click in the adjacent cell in the column labeled Edited Raster Attribute. The Edited Raster Attributes column identifies the attribute that was edited; that is, the attribute that will be used to overwrite the attribute in the Target Raster. Select the appropriate attribute contained within the Edited Raster box by using the associated drop-down menu.

4. Identify the Target Raster layer from the drop-down menu by double clicking in the cell within the Target Raster column. The target raster is the layer that will be changed by "burning" in the values from the Edited Raster.

5. Now, select the Target Raster Attribute from the target raster that will be changed by the Edited Raster. Double click in the cell within the Target Raster column and select the appropriate attribute from the drop-down menu.

   ***Tip**: Typically, Target Raster Attributes must match the Edited Raster Attributes.*

6. Enter a name for the Merged Raster Name in the last column.

***Note**: Remember that the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.). Do not include an extension.*

7. After entering a name, return to the first column and check the box associated with the Edited Raster's name. Complete the same process for each set of raster layers that you want to merge.

   ***Note**: Once again, be sure to follow the usual naming conventions for ACT.*

8. Identify an output folder for storing the new raster layers by using the browse button to the right of the "Save Rasters to" box. Navigate to a directory of your choice and create a new folder.

9. Lastly, click **Finish**. The new raster layers will automatically appear in the ArcMap Table of Contents.

We recommend that you save your ArcMap project at this time. In addition, we recommend that you zoom into those pixels with values that were changed during the editing process. Are the changes evident in each of the output layers? Toggle back and forth between the pre- and post change raster layers to compare pixel values that should have changed (note: be sure to use identical legends).

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Chapter 5: Troubleshooting ACT – Common Errors, Symptoms, and Solutions

If ACT fails to produce a new raster layer, consider the following:

Naming Conventions

Remember that you do not need to add an extension, and the name is limited to eight characters or less. In addition, the file name you select should not contain any spaces, leading numbers, or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >,.).

Output Path

The total length of the output path is limited to 80 characters. In addition, names of folders within the path cannot contain spaces or special characters (such as `~! @#$^()-+={ }[ ]|\?/:;'"< >, .).

To report a bug, please contact helpdesk@niftt.gov.

Appendix A: References

Anderson, H. E. 1982. Aids to determining fuel models for estimating fire behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 22 p.

Finney, M. A. 1998. FARSITE: fire area simulator; model development and evaluation. Res. Pap. RMRS-RP-4. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 47 p.

Finney, M. A.; Brittain, S.; Seli, R. 2006. FlamMap version 3.0. [Online]. Available: http://fire.org.