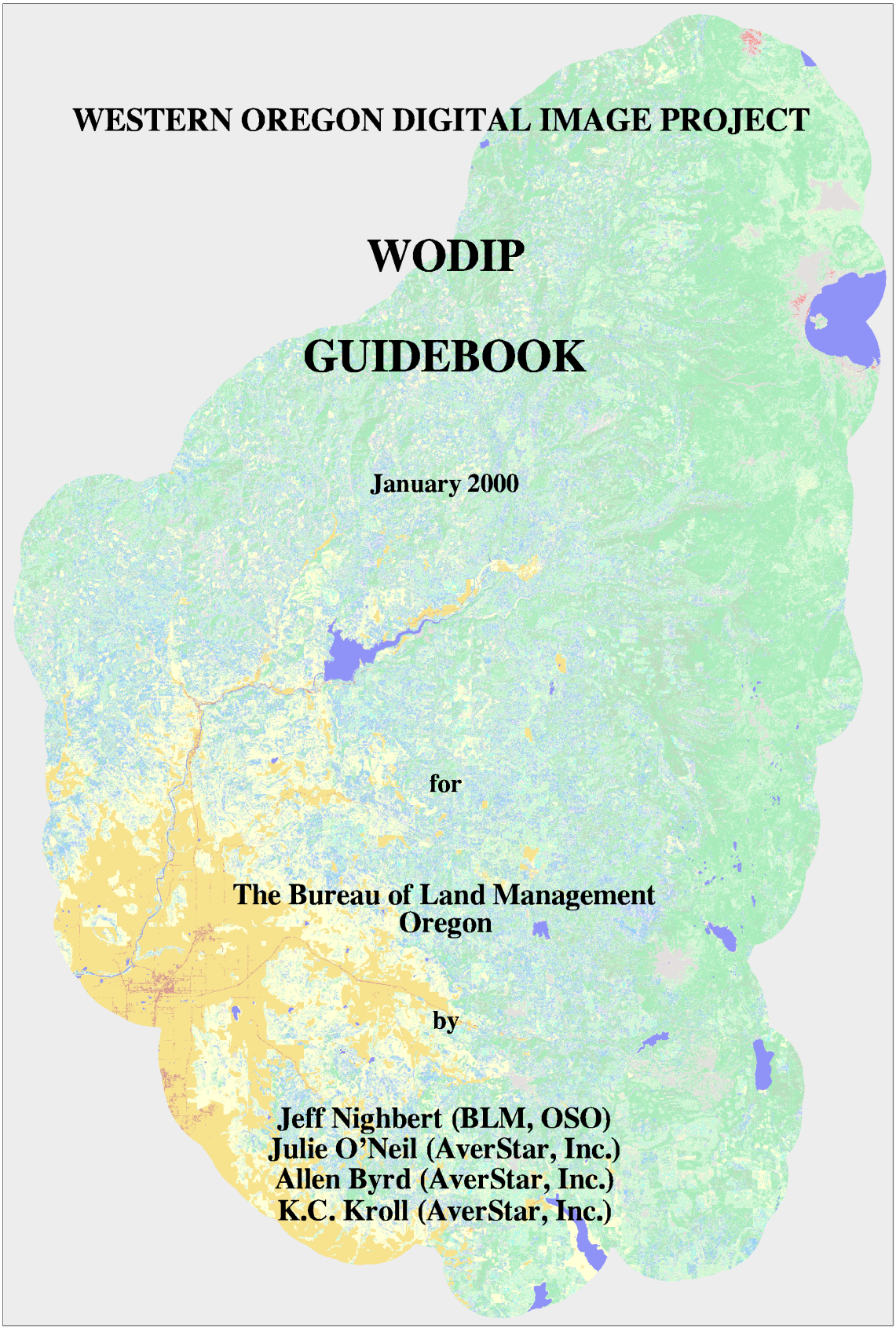
WESTERN OREGON DIGITAL IMAGE PROJECT

WODIP

GUIDEBOOK

January 2000



for

The Bureau of Land Management
Oregon

by

Jeff Nighbert (BLM, OSO)
Julie O'Neil (AverStar, Inc.)
Allen Byrd (AverStar, Inc.)
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Part One: Overview

Background

There is an absence of vegetation maps having complete coverage of Western Oregon, yet there is a demand for such maps to assist in numerous land management activities. Such activities include watershed analysis, habitat assessments, forest inventories, and ecosystem modeling. Western Oregon Digital Image Project (WODIP) provides one of the first vegetation maps covering 28,600 square miles. This project utilized remotely sensed data (Landsat Thematic mapper imagery (1993) and 1:12,000 color aerial photographs) in a two phase approach.

The image data used was acquired from Landsat 5 in 1993. Landsat 5 orbits the earth 430 miles up in space, and records energy reflected and emitted from the earth's surface in various portions of the electromagnetic spectrum. Different land covers reflect and absorb energy differently. This allows the different land covers to be distinguished on satellite imagery and as a result, vegetation maps are produced.

Data Types

1. Landsat Thematic Mapper satellite data 25 meter spatial resolution
2. SPOT Panchromatic satellite data 10 meter spatial resolution
3. BLM field inventories: 5 point, Yew Wood, Forest Operations Inventory (FOI)
4. BLM GIS data: streams
5. Atterbury data (digitized land cover types interpreted from aerial photographs)
6. Color aerial photography, 1:12,000
7. Forest Service vegetation maps derived from satellite imagery

Objectives

1. To develop procedures using digital satellite data that will identify and label forest cover types within Western Oregon.

2. To assess the effectiveness of ancillary data resources (aerial photographs and forest inventory records) in producing a forest cover type map.

3. To determine how satellite data classification can be used to estimate specific information such as crown closure, size class, age class, and structure.

4. To produce digital maps and databases.

Preprocessing

! Satellite data selection:

Landsat Thematic Mapper (TM) data was used with a summer 1993 date. Landsat records energy reflectance in 7 regions or channels of the electromagnetic spectrum called bands. For WODIP, 4 bands were selected for optimum viewing: Near Infra-red, Red, long Mid Infra-red, and short Mid Infra-red.

! Satellite data enhancement/transformations:

To optimize selected channels for vegetative study, several transformations were completed: tasseled cap bands 1, 2, and 3, and Normalized Difference Vegetative Index (NDVI). Eight band stacked image files were created to include TM bands 4, 5, 3, and 7, NDVI and tasseled cap 1, 2, and 3.

! Satellite data corrections:

Cloud/shadow, fire/smoke, and noise (bad lines) were corrected for using either averaging out or masking out techniques.

! Satellite image stratification:

For Phase I of the project, each scene was stratified into major physiographic regions; the Coast Range, Klamath Mountains, Willamette Valley, Cascades East, and Cascades West. Stratification accounts for variations in soil, vegetation, and geomorphic features. For Phase II of the project, each scene was stratified into watersheds.

Methods Phase I

The aim of Phase I was to produce a general land cover map of water, urban/agriculture, non-forest vegetation (grass and brush), barren (rock, lava, sand, etc.), other (snow, clouds, fire, smoke, noise, etc.), and forest. This was achieved using a combination of unsupervised classification and supervised classification techniques, along with cluster analysis and some aerial photo interpretation.

Methods Phase II

The goal of Phase II was to further refine the classification of forest areas by identifying tree species (conifer, hardwood, and mixed types), tree size (size 1: 0 to 10 inches diameter at Breast Height (DBH), size 2: 10 to 20 inches DBH, size 3: 20 to 30 inches DBH, and size 4: greater than 30 inches DBH), tree crown closure (from 5% to 95% in 10% increments), and tree structure (even or uneven). This was achieved using field inventory plots as training data along with aerial photograph interpreted polygons in a supervised classification on masked imagery non-forest classes removed as identified by Phase I). This reduces image variability due to soil type, geomorphology, and physiography. To further reduce variability, the imagery was stratified into watersheds. This gave the potential of 246 land cover classes. The final product is a single streamless Crest to Coast vegetation digital database for any or all four vegetation characteristics.

Applications

The vegetation maps have a wide variety of applications: wildlife habitat studies, watershed analysis, forest inventories, environmental modeling (fire hazard warning, fire prediction, tree harvesting impacts, soil erosion, slope stability), change detection, land cover/type inventories, and environmental impact assessments.

Classification Scheme

See APPENDIX A for the complete classification scheme.

NON-FOREST VEGETATION	Water
	Urban/agriculture
	Non-forest vegetation
	Barren
	Other
FOREST SPECIES	Conifer
	Hardwood
	Mixed
FOREST STRUCTURE	Even
	Uneven
FOREST SIZE	1 (less than 10 inches DBH)
	2 (10-19 inches DBH)
	3 (20-29 inches DBH)
	4 (greater than 30 inches DBH)
FOREST CROWN CLOSURE	5%
	15%
	25%
	35%
	45%
	55%
	65%
	75%
	85%
	95%

Final Products

There are several options for obtaining WODIP data.

1. You may request request a CD that contains information for individual watersheds (see Appendix B for a list of watersheds). This option is for BLM personnel only.

2. You may request a CD that contains information for mosiacked data. This option may be utilized by both the public and BLM personnel.

3. You may download the data from the web. This option is also for both the public and BLM personnel.

1. A watershed CD contains all the digital files produced by the classification process. The final classified files exist in several different formats: (ERDAS 7.5, ERDAS IMAGINE 8.2, and ARC GRID), to enable use in different software packages.

All files and directories are stored as 10 compressed tar files representing the 10 directories used to store all the WODIP files. These compressed tar files are written to CD, and are listed below:

aml.tar.Z	lan.tar.Z
gis.tar.Z	plot.tar.Z
ascii.tar.Z	report.tar.Z
grd_fnl.tar.Z	vector.tar.Z
grd_rw.tar.Z	imagine.tar.Z

The total size of all the compressed tar files can be as much as 650 MB. By taring files in their own directories, allows files to be selectively copied from the CD, a great advantage if disk space is a limiting factor.

UNIX: To copy a file from the CD to harddrive:

1) change directory to the CD rom:	cd /CDROM
2) copy file from CD to harddrive:	cp grd_fnl.tar.Z /usr3/grd_fnl.tar.Z
3) uncompress file:	uncompress /usr3/grd_fnl.tar
4) untar file:	tar -xvf /usr3/grd_fnl.tar

Windows NT: If you use a Windows OS you need WinZip. Click and drag to copy the file. Double-click on *Tarred/Compressed File* to open using WinZip.

In addition to the digital files, there are several ASCII files:

1. A READ.ME file lists all the file names, and displays the directory structure, file sizes and file descriptions.
2. DISPLAY_HINTS is an ASCII file that describes various methods of image display in ERDAS and ARC software packages.
3. LEGEND is a list of the master legend with values and attributes.
4. If any edits have been performed, a file called wshed_edits is created to

document these changes.

Tools and additional products:

1. ARCVIEW 3.0 scripts have been written to allow the display and query of WODIP data in ARCVIEW. (LAN and GIS files are provided for use in ARCVIEW 2.1) ARCVIEW 3.0 with Spatial Analyst should be available within a year.
2. AMLs have been developed that perform rule based aggregation.
3. All the aerial photograph interpretations have been stored as an ARC attributed point coverage. These are available upon request.
4. AMLs to make plots and the actual plot files are provided. Digital files are delivered on CDROM along with WODIP data.
5. The WODIP Guidebook is available at www.or.blm.gov/gis/projects/wodipbydist.htm.

2. A mosaic CD consists of the following directories or folders:

- aml: contains AMLs developed for WODIP to assist with queries, filtering, recording, and plotting.
- docs: contains metadata, guidebook, legend, readme files.
- mosaic: contains mosiacked watersheds as an ARC GRID.
- plot: contains plot files.

The mosiacked file was created by stitching together all of the individual watersheds.

3. The third way to acquire the WODIP data is to download individual files for specific watersheds. See Appendix B for a list of files that are available on our website at: **www.blm.gov/gis**. The files are in a compressed tar format for each watershed. Use WinZip or UNIX (uncompress and tar-xvf) to access the data.

Modeling/Application

FISH HABITAT ANALYSIS

The Salem BLM district is using WODIP data to analyze streamside vegetation to determine potential impacts to stream temperatures and the potential for large woody debris (LWD).

Stream Temperature Risk: The risk of higher stream temperatures is correlated to shade produced by riparian vegetation, with large conifer trees providing the most shade and non-forest vegetation, agriculture, barren etc. providing the least shade. Hardwoods and small conifers provide moderate amounts of shade.

Large Woody Debris Potential: A direct correlation based on large conifers having high potential to contribute LWD to a stream and non-forest vegetation, hardwoods, agriculture, etc. having low potential.

The results of these analyses became the basis for identifying where different landowners might want to plant conifers or develop in-stream structures to improve fish habitat.

OWL HABITAT ANALYSIS
WODIP data are being used to study owl habitat. WODIP vegetation is regrouped into habitat categories: nesting habitat (two story old growth stands), foraging habitat (mature conifer stands), roosting habitat (conifer and hardwood mixed stands) and non-habitat (pure hardwood stands, young conifer stands). Areas identified as possible suitable habitat can then be targeted for management.

WATERSHED ANALYSIS
In Roseburg, WODIP data have provided information on private land which was not covered by BLM's private inventory theme. Diameter Base Height (DBH) size categories were interpreted into three age classes, where a size between 0 to 10 inches became 0 to 30 years, 10 to 19 inches became 30 to 80 years, and greater than 19 inches became greater than 80 years. The raster vegetation data were converted to polygons for use in Arcview. Frequency tables were developed to enable analysis.

HABITAT ANALYSIS
Roseburg BLM office is using WODIP data in an overall vegetation analysis in riparian reserves for the Ollala-Lookingglass watershed, and in an analysis of dispersal habitat in several regions.

WODIP data were reclassed according to size, and dispersal habitat was considered to be anything with a size greater than 10 inches DBH. The distribution of dispersal habitat in critical areas connecting Lake-Successional Reserves and Riparian Reserves were found. This information helped in recommending management strategies, and also helped to locate where on the landscape should the focus be in terms of accelerating growth of young stands to improve 'weak' areas.

Older habitats (of size 30 inches DBH or greater) were located, and the percentage of the reserve system actually functional in each drainage was calculated. This information tells which creeks have the best chance of recovery for fish habitat (where large log structures may be expected to enter the stream, etc.) and also which areas can actually depend on the Riparian Reserves for connectivity for late seral species. The benefit of WODIP data is that it has helped visualize the condition of private lands and allowed the recommendation of a management strategy which takes into account these private lands.

Satellite Data

Satellite data exist in a raster format where the data are stored in a grid containing cells called pixels. Landsat data has a pixel size of 30 meters. This means that the Thematic Mapper sensor on board Landsat records energy reflected from an area on the ground measuring 30 meters by 30 meters. Any feature on the ground less than 30 meters will probably not be identified in the imagery. Exceptions include features that are drastically different from their surroundings. For example: small streams flowing through urban areas, or bare forest roads cutting through dense forest. During the rectification process the pixel size was resampled from 30 meters to 25 meters.

Vegetation maps derived from satellite data strive to attain an overall accuracy of 80%. Some land cover types having unique energy reflectance properties are easier to identify using image

classification techniques, and therefore are classified more accurately. Other land cover types that reflect similar amounts of energy can bring about mis-classification. Examples of such land cover types include: water and shadow, agriculture fields and recent clearcuts, dense brush and small hardwood stands.

To perform supervised classifications there is a need for training data. WODIP used two sources of data for training: the 5 point inventory data and aerial photo interpreted polygons. The resulting classification can only be as good as the training data used. The 5 point data has a number of disadvantages: it only falls onto BLM land, it was created in 1985, and is biased towards conifer stands. Using vegetation types interpreted from aerial photos can be inconsistent when numerous individuals are performing the interpretations. Aerial photo coverage, like the 5 point data, is for BLM land only, so any photo interpreted training data is for BLM land.

Contacts

For additional information about the WODIP project please contact:
Jeff Nighbert, BLM/Oregon State Office, 503-952-6399.

To order CD products, please contact:
Lisa Blackburn, BLM/Oregon State Office, 503-952-6276.

Part Two: Using WODIP Data with ARC/INFO

*Please note: Some of the system commands are UNIX commands.

Displaying WODIP Data

Imagery can be displayed in both ARCPLOT and GRID. Most of the commands used to display imagery in ARCPLOT will also work in GRID. To display raw imagery, use the **image** command in ARCPLOT.

Arcplot: display 9999
Arcplot: mape image mrog_v
Arcplot: image
Usage: IMAGE <image | image_catalog> COMPOSITE
<red_band> <green_band> <blue_band>
Arcplot: image mrog_v composite 1 2 3
Arcplot: image mrog_v composite 3 2 1
Arcplot: image mrog_v composite 1 1 1

You can display grids of WODIP classified data very easily in Arcplot using the **gridpaint** command. The Arc/Info section of this guidebook uses the Middle Rogue watershed final classified grid (mrog_cls_fnl3) as an example of how to use the commands. The first time a command is mentioned in this section, the response with the command usage will be shown just as it is in Arc, Arcplot, or Grid to show the arguments for how the command is used. The first example is a simple way to draw the watershed on the screen using the **gridpaint** command after initially setting the display and mapextent:

Arcplot: mape mrog_cls_fnl
Arcplot: gridpaint
Usage: GRIDPAINT <grid> {item}
{IDENTITY | LINEAR | EQUALAREA | remap_table}
{WRAP | NOWRAP} {NOMINAL | GRAY | colormap_file}
Arcplot: gridpaint mrog_cls_fnl

This will draw the grid on the screen using the default colormap (Figure 1).

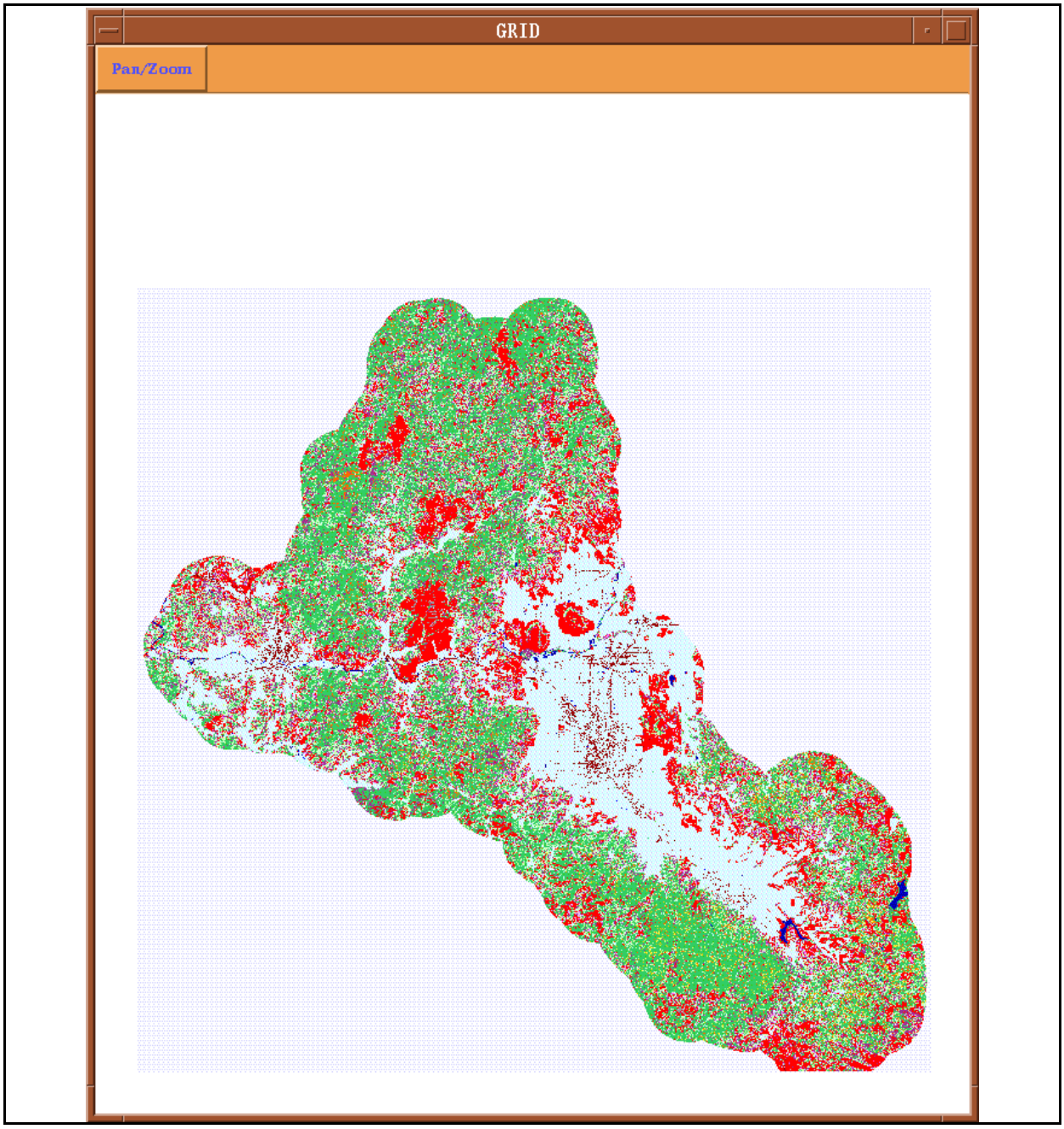

Figure 1 Middle Rogue watershed crown closure classification.

There are potentially 247 unique classes in each watershed grid and there are not enough colors to display all of them. To solve this problem, we use a colormap to regroup the data into fewer categories. A colormap is an ascii file that relates the 247 WODIP classes to red, green and blue (rgb) color values. To draw the grid on the screen to show the crown closure, species or size classified data, you can use one of the three colormaps supplied in the WODIP package that ends with a ".cmap": cover_crown.cmap, cover_species.cmap, or cover_size.cmap.

Colormap files are ascii files that specify rgb color values for each class value. To view a colormap file:

Arcplot: &sys more cover_species.cmap

```
0 235 235 235        /* no data/zero values   light gray
1 0 0 182            /* water      blue
2 219 237 255        /* urban ag  light blue
3 255 0 0            /* nonforest  red
4 169 169 169        /* barren     gray
5 0 0 0              /* other      black
6 0 255 255          /* clearcut   turquoise
7 190 255 190        /* conifer 1story size1 5%
8 190 255 190        /* conifer 1story size1 15%
9 190 255 190        /* conifer 1story size1 25%
10 190 255 190       /*conifer 1story size1 35%...
```

To obtain rgb values:

Arcplot: shadecolor
Usage: SHADECOLOR <color_spec>
Arcplot: shadecolor red
Arcplot: shadeinfo

Shadescale factor is 1.
Layer Type Pattern Angle Size Separation Offset Font Pensize Linecap Linejoin Linepattern
1 Hardware 0 0.00 0.000 0.000 0.000 0.000 0.000 0.000 0 0.000 BUTT MITER 0
1 Color: C-0.000% M-100.000% Y-100.000% K-0.000% (Red)

Arcplot: show rgb cmyk 0.000 100.000 100.000
255,0,0

To display WODIP data using a colormap file:

Arcplot: gridpaint mrog_cls_fnl
Arcplot: gridpaint mrog_cls_fnl # # nowrap cover_crown.cmap (Figure 1)
Arcplot: gridpaint mrog_cls_fnl # # nowrap cover_size.cmap
Arcplot: gridpaint mrog_cls_fnl # # nowrap cover_species.cmap
Arcplot: mape * (Define box in display window)
Arcplot: clear
Arcplot: gridpaint mrog_cls_fnl # # nowrap cover_species.cmap

Pixel Queries

You can select single pixels with the **cellvalue** command and have their attributes displayed on the screen as in the following:

Arcplot: clear
Arcplot: mape mrog_cls_fnl
Arcplot: gridpaint mrog_cls_fnl
Arcplot: cellvalue
Arcplot: Usage: CELLVALUE <grid> <xy | *> {item...item | NONE}
Usage: CELLVALUE <stack> <xy | *> {NONE | ALL}

Arcplot: cellvalue mrog_cls_fnl * (Select pixels or cells to query)

This will allow you to interactively use the crosshairs to select the pixel or pixels (also called "cells") of your choice. After you select a cell, the following information is displayed:

The cell containing point (521633.800,4664061.624) has value 35

20

VALUE	= 35
COUNT	= 241918
COVER_TYPE	= forest
SPECIES	= conifer
STRUCTURE	= one
SIZE	= 3
CROWN_CLOSURE	= 85

To end query put cursor in display window and hit 'control key/right mouse button' or with the cursor in the display window hit the number 9 key.

To view the items that can be queried:

Arcplot: items
Usage: ITEMS <info_file>
Arcplot: items mrog_cls_fnl.vat

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME
1	VALUE	4	10	B	-	-
5	COUNT	4	10	B	-	-
9	COVER_TYPE	12	12	C	-	-
21	SPECIES	12	12	C	-	-
33	STRUCTURE	6	6	C	-	-
39	SIZE	1	1	I	-	-
40	CROWN_CLOSURE	2	2	I	-	-

As with some other Arc/Info commands, you can also choose to list only the items in the .vat that interest you, as in the following:

Arcplot: cellvalue mrog_cls_fnl * crown_closure size species

The cell containing point (522467.901,4662810.468) has value 25

Record	crown_closure	size	species
17	85	2	conifer

Criteria Queries

You can display the cells that show selected WODIP classified data such as crown closure greater than 45% by using the **gridquery** and **gridnodatasymbol** commands:

Arcplot: gridnodatasymbol
Usage: GRIDNODATASYMBOL<symbol | colormap_index>
Usage: GRIDNODATASYMBOL TRANSPARENT
Usage: GRIDNODATASYMBOL <color> {SPOT <percentage>}
Usage: GRIDNODATASYMBOL <color_model> <parameters> {SPOT <percentage>}
Arcplot: gridquery
Usage: GRIDQUERY <grid> {item}
{IDENTITY | LINEAR | EQUALAREA | remap_table}
{WRAP | NOWRAP} <logical_expression>

Arcplot: gridnodatasymbol transparent
Arcplot: gridquery mrog_cls_fnl # # nowrap crown_closure gt 45

To obtain the attributes that are available to be queried, you can use the **items** command:

Arcplot: arc items
Usage: ITEMS <info_file>

Arcplot: arc items mrog_cls_fnl.vat

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME
1	VALUE	4	10	B	-	-
5	COUNT	4	10	B	-	-
9	COVER_TYPE	12	12	C	-	-
21	SPECIES	12	12	C	-	-
33	STRUCTURE	6	6	C	-	-
39	SIZE	1	1	I	-	-
40	CROWN_CLOSURE	2	2	I	-	-

Multiple criteria can be used with **gridquery** such as crown closure greater than 45% and size greater than 2:

Arcplot: gridquery mrog_cls_fnl # # nowrap crown_closure gt 45 ~
and size gt 2

(HINT: A '~' is used in ARC/INFO to continue a command onto an additional line.)

Logical expressions:

For character-defined items (cover_type, species, structure) use **cn** (contains), **eq** (equals), **nc** (does not contain), and **ne** (not equal).

Example: species cn 'conifer'

For integer defined items (size, crown_closure) use the folowing symbols to customize selections: =, > , <, etc.

Example: crown_closure = 45 and size < 3

'and' is to be used when you want both expressions to be true and **'or'** when only one expression is to be true.

These grid cells will be displayed using the current shadeset.

QUERY.AML

An easier way to do the above is to use the "query.aml". The same results are displayed as in the second example by typing only one command line at the Arc prompt as in the following:

Grid: &r query
==========
USAGE: &r query <grid> <foreground> <background> <query_expression>
==========

Grid: &r query mrog_cls_fnl red tan crown_closure gt 45 and size gt 2

The arguments for the aml are: grid, foreground, background and query_expression where:

grid = the name of the grid to be queried
foreground = the color of the data you want displayed
background = the color of the grid background
query_expression = the logical expression with which to query the INFO database

The "query.aml" draws the specified data in the color you choose along with the buffered watershed boundary using only one command line instead of several. You can select the colors and enter them by their names from the "colornames.shd" shadeset in the Arc/Info manual "Map Display and Query".

To overlay two or more data selections, you can follow this example:

Grid: &r query mrog_cls_fnl red tan species cn 'mixed'
Grid: &r query mrog_cls_fnl blue transparent species cn 'hardwood' ~
and crown_closure gt 45
Grid: &r query mrog_cls_fnl green transparent species cn 'hardwood' ~
and size = 1

The first line draws all the mixed species locations in red with a light colored background. The second line draws the conifers with crown_closure greater than 45% in blue. The "transparent" argument sets the cells with no data to transparent so you can see through them by using the **gridnodatasymbol** command in the aml. The third line draws the hardwoods that are size 1 and also uses the transparent argument. Just change the foreground color and keep the background transparent each time you make another data selection using the aml (Figure 2).

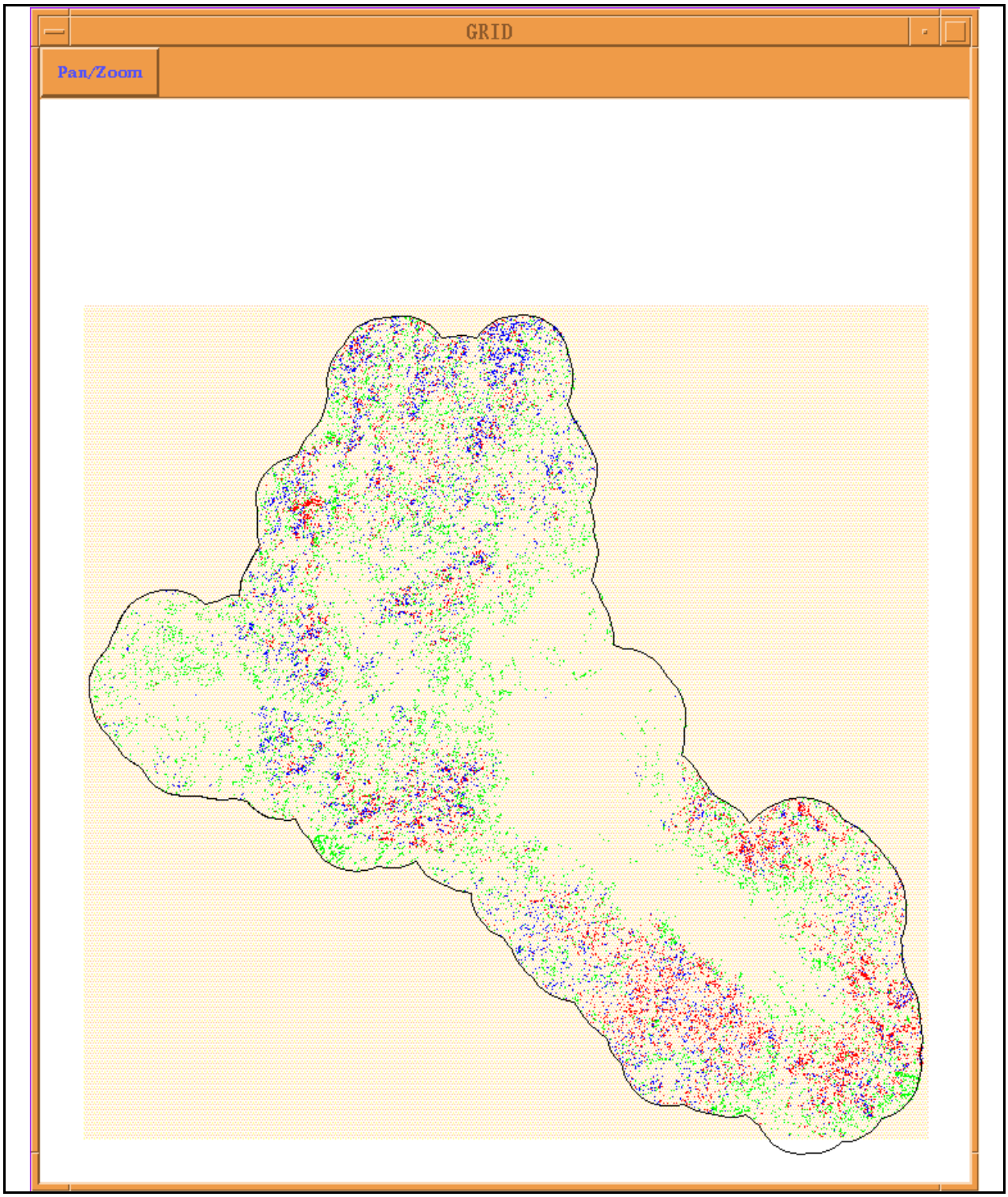

Figure 2 Result of the **gridquery** criteria example on p.16 using the "query.aml".

Separate grids can be created from the WODIP classified data based on specific criteria using the **select** command at the Grid prompt:

Grid: select
Usage: (*) SELECT (<grid>, <logical_expression>, {out_value_item})

Grid: hard_gt45 = select(mrog_cls_fnl,'species cn ''hardwood'' and~
crown_closure gt 45')
Grid: mape hard_gt45
Grid: gridpaint hard_gt45

(HINT: The logical expression in the above query requires double single quotes surrounding ‘hardwood’, rather than double quotes.)

This will create a separate grid complete with its own .vat for query (Figure 3). To properly query the database, however, you must join the INFO file "master_phase3" with the outgrid using the **joinitem** command:

Arc: joinitem
Usage: JOINITEM <in_info_file> <join_info_file> <out_info_file> <relate_item>
<start_item> {LINEAR | ORDERED | LINK}

Arc: joinitem hardwood_gt45.vat master_phase3 hard_gt45.vat value 1

The master_phase3 (to include urban) info file is provided as an export file(.e00). Make sure master_phase3.e00 has been imported as an info file

Grid: Arc import info master_phase3.e00 master_phase3
Grid: list hard_gt45.vat
Grid: Arc joinitem hard_gt45.vat master_phase3 hard_gt45.vat value 1
Grid: list hard_gt45.vat

Figure 3 Hardwoods with greater than 45% crown closure using the **select** command.

The **reselect** command can then be used to list INFO records on the screen:

Grid: reselect
Usage: RESELECT <info_file> INFO {logical_expression}

Grid: reselect hard_gt45.vat info size = 2
Grid: ap list hard_gt45.vat info # size species

Record	size	species
5	2	hardwood
6	2	hardwood

SELECT.AML
Another way of creating a separate grid of selected data is to run the "select.aml" from the Arc prompt. It is provided with the WODIP package and does all of the above steps listed regarding the **select** command:

Arc: &r select.aml

```
=========================================================
USAGE: &r select <ingrid> <outgrid> <background> <query_expression>
=========================================================
```

Arc: &r select.aml mrog_cls_fnl hard_gt45b white species cn~
'Hardwood' and crown_closure gt 45
Grid: list hard_gt45b.vat

Merging Datasets

If you want to join two or more WODIP datasets for query or display you can use the **merge** command. Before merging, however, the grids need to clipped with their buffered watershed polygon boundaries to remove the black nodata areas that surround the grids. To merge the three Rogue watersheds, (mrog, urog and lrog) follow this example which also uses the **gridclip** command:

Grid: gridclip
Usage: GRIDCLIP <in_grid> <out_grid>
{* | COVER <clip_cover> | BOX <xmin ymin xmax ymax>}

Grid: gridclip mrog_cls_fnl3 mrog_clip cover mrog_buf
Grid: gridclip urog_cls_fnl3 urog_clip cover urog_buf
Grid: gridclip lrog_cls_fnl3 lrog_clip cover lrog_buf
Grid: merge
Usage: (*) MERGE (<grid, ..., grid>)

Grid: rog3 = merge(mrog_clip,urog_clip,lrog_clip)

This will merge the middle, upper and lower Rogue watersheds together into one grid (Figure 4).

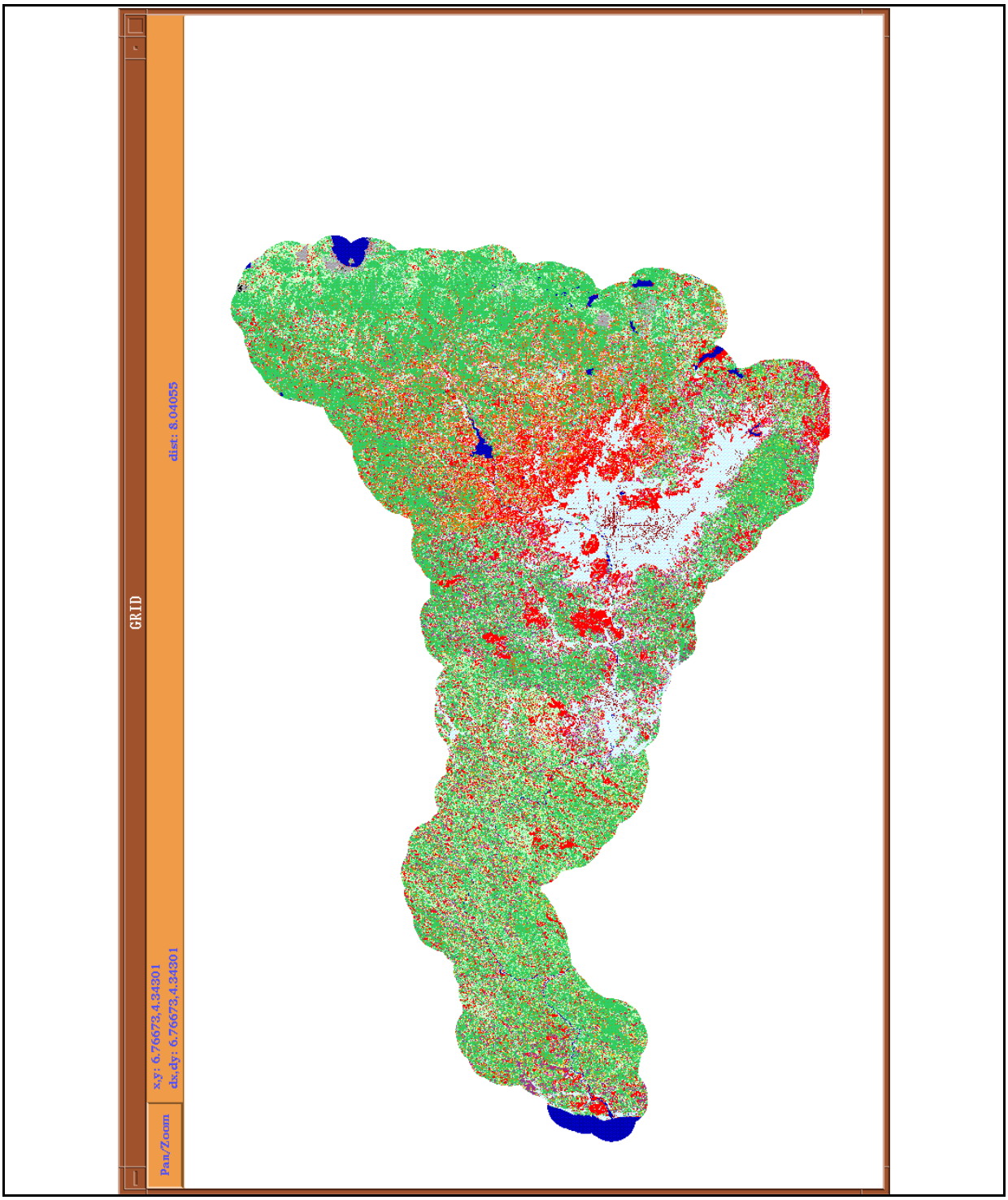

Figure 4 Merged (and rotated) grid of lower, middle and upper Rogue watersheds.

***Note:** Remember to use the **gridnodatasymbol** command (p. 13) with the "transparent" option before you use the **gridpaint** command:

Grid: clear
Grid: gridnodatasymbol transparent
Grid: mape rog3
Grid: gridpaint rog3 # # nowrap cover_crown.cmap

Remember that grids may not always edgematch with a seamless boundary because each watershed was processed independently using different training data. To obtain the best possible merge, you can list the most preferred watershed first in the order of the **merge** command and the least preferred ones after that. The first watershed will overlay on top of the rest and extend three miles into the adjacent watersheds. Merging with the stitch lines less visible was done by 'blending' the grids in ERDAS IMAGINE.

Hardcopy Plots

You can make a WODIP hardcopy plot using one of the colormaps provided to show crown_closure, species or size. Following is a description of how to make a quick plot:

Arcplot: display 1040
Enter ARC/INFO Graphics filename : mrog_cls_fnl3.gra
Arcplot: mape mrog_cls_fnl3
Acrcplot: &r start_blm_plot.aml 24000 'WODIP_TEST' doiblm_logo utm_bar2none
Arcplot: gridpaint mrog_cls_fnl3 # # nowrap cover_crown.cmap
Arcplot: q

Usage: POSTSCRIPT <in_meta_file> <out_postscript_file> {scale}
{parameter_file} {image_resolution}
{color_calibration_file} {xmin ymin xmax ymax}

Arc: **postscript mrog_cls_fnl3.gra mrog_cls_fnl3.eps 1 normal.prm**
Arc: q
Unix prompt: alchemy
usage: alchemy [-options] inputFile [outputFile] (-h for help)

Unix prompt: alchemy mrog_cls_fnl3.eps –r -Zm2 -Ze1 -ds1 mrog_cls_fnl3.rtl

This will create a graphics file (.gra) named **mrog_cls_fnl3.gra**, with the title "WODIP_TEST", at 1:24,000 scale. You may change the scale and title as desired. (HINT: the size of your paper plot will depend upon which scale you choose). Prior to running start_blm_plot.aml you may need to set your amlpaths to the directory where start_blm_plot.aml resides. At an Arc prompt type: **&amlpath /or_tools/pdtk_ap/aml /or_tools/pdtk_ap/aml_local**. The correct aml paths may carry from one BLM district to another, so if start_blm_plot.aml will not run, consult with you GIS Coordinator for the proper aml location.

For a look at the graphics file you have created:

Arc: display 9999
Arc: draw mrog_cls_fnl3.gra

Hit <return> when you are finished viewing the .gra file.
Next, convert the .gra file to a .eps file, and then convert the .eps file to a .rtl file.

Arc: postscript
Usage: POSTSCRIPT <in_meta_file><out_postscript_file> {scale}
{parameter_file} {image_resolution}
{color_calibration_file} {xmin ymin xmax ymax}

Arc: postscript mrog_cls_fnl3.gra mrog_cls_fnl3.eps
Arc: q
Unix prompt: alchemy
Usage: alchemy [-options] inputFile [outputFile] (-h for help)

Unix prompt: alchemy mrog_cls_fnl3.eps mrog_cls_fnl3.rtl –r -Zm2 -Zel -ds1

The postscript command will create an .eps file. Alchemy will translate the .eps file into a .rtl file (Raster Transfer Language), which the HP plotters can read and plot. Consult with your GIS Coordinator for the name of the plotter to send the .rtl file to, as well as your district's plotting syntax.

***Note:** To plot size or species data, substitute the appropriate .cmap. Separate grids created with the **select** command in Grid can also be plotted this way.

Reclassing of WODIP Data

The 247 classes can be combined to fit specific applications by using the **reclass** command. For example, if only three species types are important regardless of crown closure classes, size and structure, then values 1 to 6 and value 247 can be combined to reflect non-forest cover types, values 7 to 86 can be combined to reflect conifer types, 87 to 166 can be combined to reflect hardwood types and 167 to 246 can be combined to reflect mixed types.

The first step is to make a remap table which is an ascii file that you create with your text editor. The format is as follows:

```
1 6 : 1        /* non-forest classes regrouped
7 86 : 2       /* conifer classes regrouped
87 166 : 3     /* hardwood classes regrouped
167 246 : 4    /* mixed classes regrouped
247 247 :1     /* urban class
```

To view this file type:

Grid: &sys more classes4.remap

The above remap table is provided with the WODIP data package and is called "classes4.remap". The following is another remap table ("reclass_size.remap") for size reclassification:

```
1 6 : 1  /*non-forest classes regrouped
7 16 : 2 /*conifer size 1
17 26 : 3  /*conifer size 2
27 36 : 4  /*conifer size 3
37 46 : 5  /*conifer size 4
47 56 : 2  /*conifer size 1
57 66 : 3  /*conifer size 2
67 76 : 4  /*conifer size 3
77 86 : 5  /*conifer size 4
87 96 : 6  /*hardwood size 1
97 100 : 7  /*hardwood size 2
107 116 : 8  /*hardwood size 3
117 126 : 9  /*hardwood size 4
127 136 : 6  /*hardwood size 1
137 146 : 7  /*hardwood size 2
147 156 : 8  /*hardwood size 3
157 166 : 9  /*hardwood size 4
167 176 : 10  /*mixed size 1
177 186 : 11  /*mixed size 2
187 196 : 12  /*mixed size 3
197 206 : 13  /*mixed size 4
207 216 : 10  /*mixed size 1
217 226 : 11  /*mixed size 2
227 236 : 12  /*mixed size 3
237 246 : 13  /*mixed size 4
247 247 : 1  /*urban
```

Next, use the **reclass** command to create a new grid of the regrouped data:

Grid : reclass
Usage: (I) RECLASS (<grid>, <remap_table>, {DATA | NODATA},
{in_item}, {out_item})
Grid : mrog_classes4 = reclass(mrog_cls_fnl3,classes4.remap)

This will create a grid that contains four classes representing non-forest, conifer, hardwood and mixed cover types (Figure 5). Use the **joinitem** command on this grid to be able to properly query the database (p. 17), or the additem command shown on page 25.

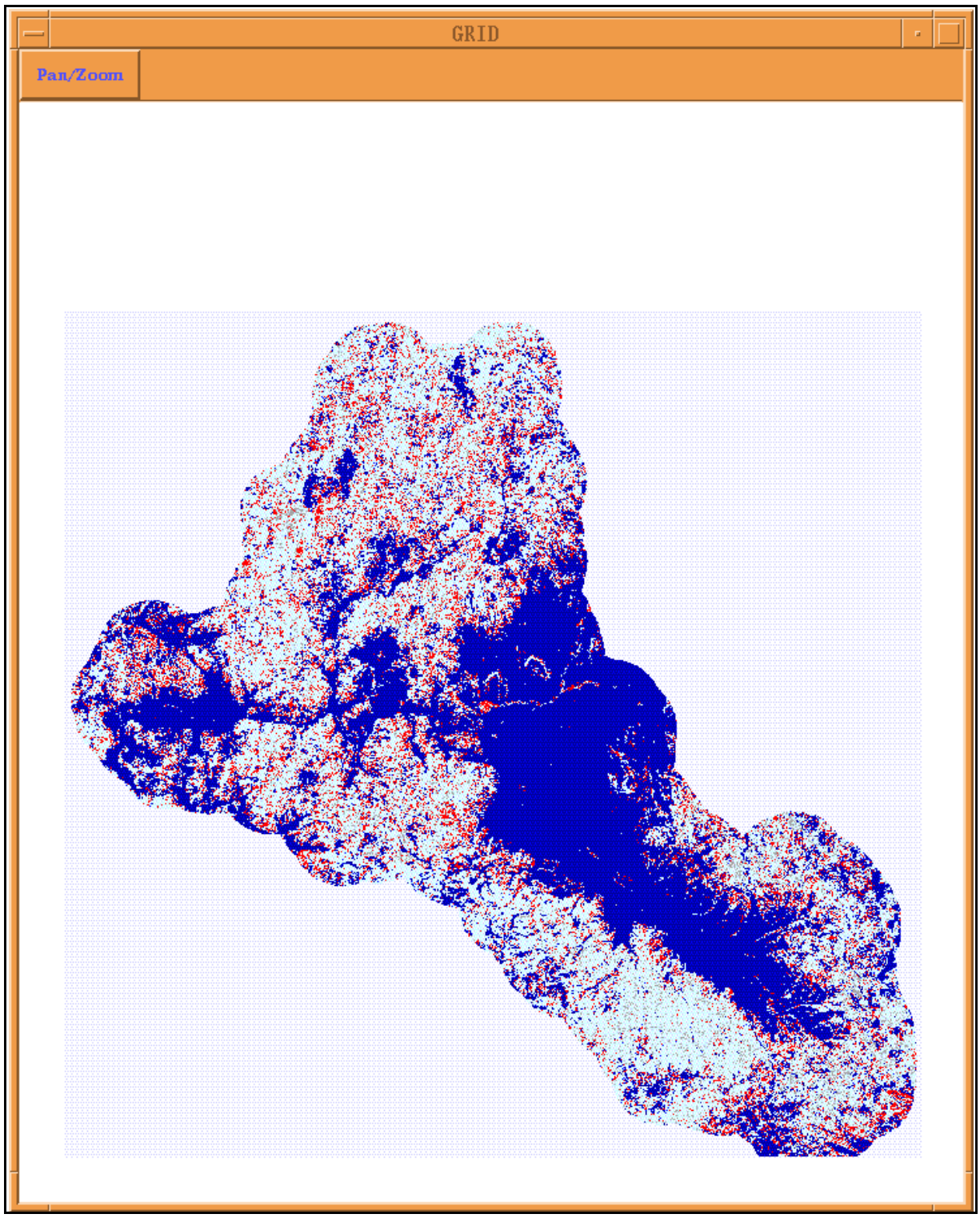

Figure 5 Non-forest, conifer, hardwood and mixed classes resulting from the **reclass** command.

How to add items to a reclassed grid.
Grid : arc additem
Usage: ADDITEM <in_info_file> <out_info_file> <item_name> <item_width>
<output_width> <item_type> {decimal_places} {start_item}
Grid: arc additem mrog_classes4.vat chet_classes4.vat species 10 10 c
Grid: list mrog_classes4.vat
Grid: q
Arc: info
ENTER USER NAME> ARC
ENTER COMMAND > SEL MROG_CLASSES4.VAT
ENTER COMMAND > UPDATE SPECIES
RECNO>1
1

>SPECIES = NON-FOR
<RETURN>
RECNO>2
2

>SPECIES = CONIFER
<RETURN>
RECNO>
3

>SPECIES = HARDWOOD
<RETURN>
RECNO>4
4

>SPECIES = MIXED
<RETURN>
<RETURN>
ENTER COMMAND >Q STOP
Arc: List mrog_classes4.vat

RECLASS.AML
Another way of doing this is to run the "reclass.aml" from the Arc prompt. It is provided with the WODIP package and does all of the above steps listed regarding the **reclass** command and the **merge** that follows:

Arc: &r reclass
==========
USAGE: &r reclass <ingrid> <outgrid> <background> <query_expression>
==========

Arc: &r reclass.aml mrog_cls_fnl3 mrog_classes4 blanchedalmond ~ classes4.remap

Filtering

Classified data often have a salt-and-pepper appearance. You can "smooth" or filter the classified data to show only the dominant classification.

***Note:** For the remaining figures in this guidebook, we will use a small area of a watershed. The classified, unfiltered file is shown in Figure 6. The remaining figures show the differences between the filtering methods.

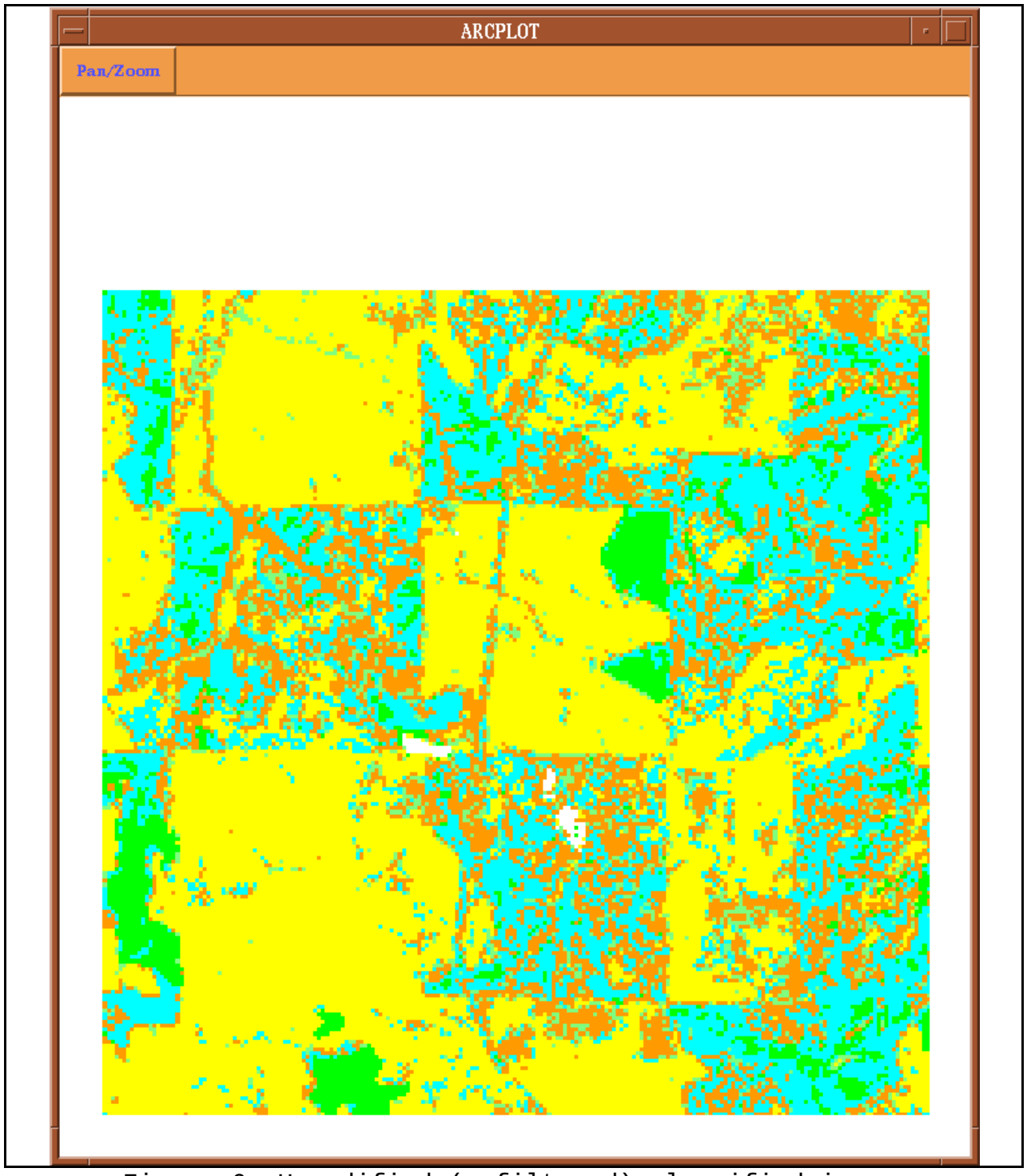

Figure 6 Unmodified (unfiltered) classified image.

Classified data can be filtered by using a majority filter which changes single pixel values to the value of the majority class of the surrounding pixels. The Grid command to do this is **focalmajority:**

Grid : focalmajority
Usage: (*) FOCALMAJORITY (<grid>, <RECTANGLE>, <width>, <height>, {DATA | NODATA})

Grid : mrog_filtered = focalmajority(mrog_cls_fnl3,rectangle,3,3)

If there is not a majority value in the surrounding cells, the center cell remains unchanged. When there is more than one majority value, the center cell becomes nodata (Figure 7). To remove the nodata value, you need to merge the focalmajority output grid with the original classified grid.

Grid : mrog_filter2 = merge(mrog_filtered,mrog_cls_fnl3)
Grid: gridpaint mrog_cls_fnl3
Grid: gridpaint mrog_filtered
Grid: gridpaint mrog_filter2

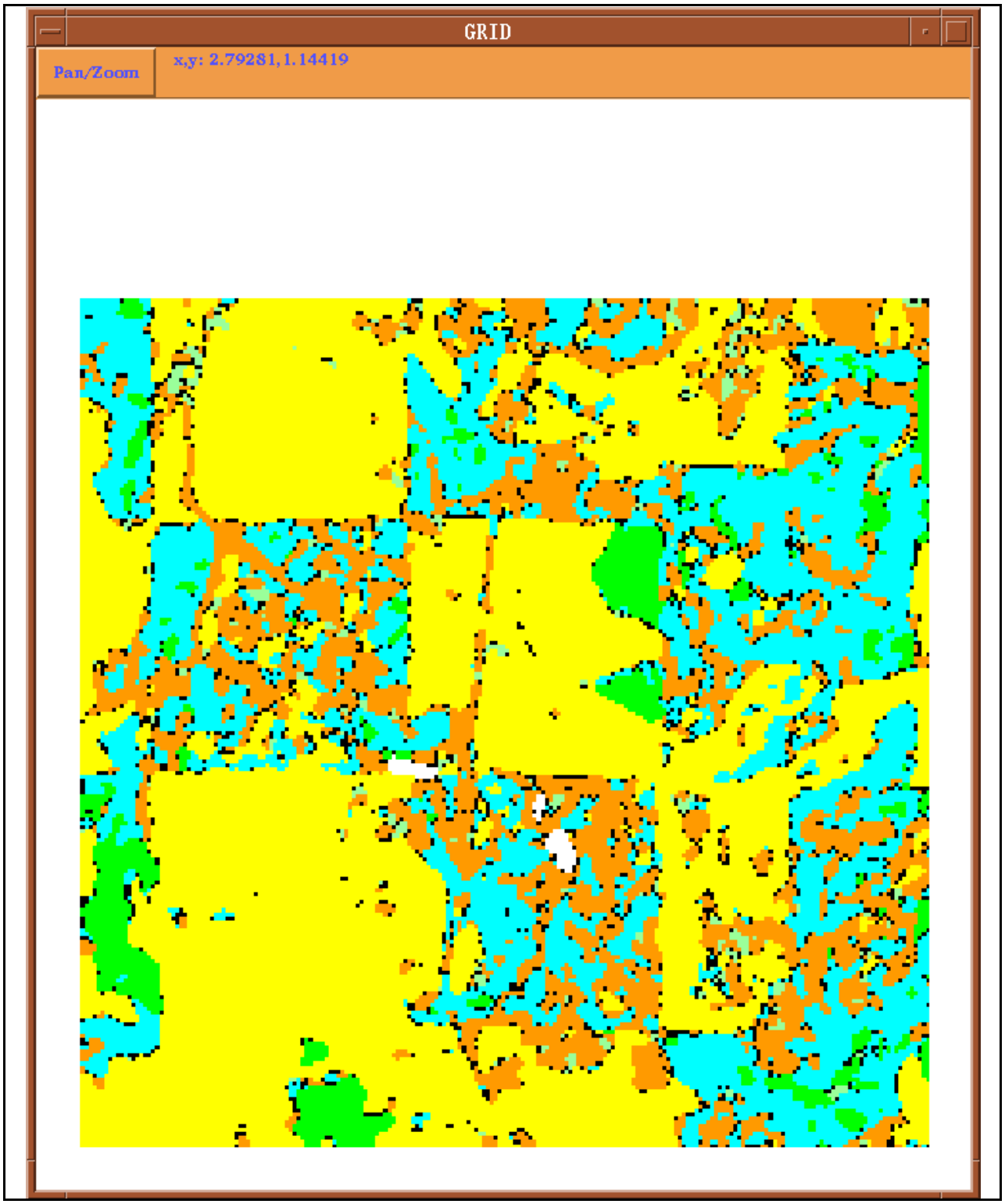

Figure 7 Result of **focalmajority** command with center cells being "nodata".

This will create a grid that has the nodata areas in the filtered grid filled with the original WODIP

values (Figure 8). Use the **joinitem** command on this grid to be able to properly query the database (p. 17), or use the additem command (p. 25).

Filtering reclassed WODIP data

Grid: mrog_f_r = focalmajority(mrog_classes4,rectangle,3,3)
Grid : mrog_filt3 = merge(mrog_f_r,mrog_classes4)
Grid: gridpaint mrog_classes4
Grid: gridpaint mrog_f_r
Grid: gridpaint mrog_filt3

***Note:** If filtering reclassed grid, merge back with the reclassed grid.

There are other ways of filtering the data such as using one of the three filtering programs provided with the WODIP package: "focmaj.aml", "nibble_filter.aml" or "island_filter.aml". The choice of which filtering program to use depends on:

1. The level of filtering:
   a) crude filtering - **focalmajority** or "focmaj.aml"
   b) moderate filtering - "nibble_filter.aml"
   c) sophisticated filtering - "island_filter.aml"

2. The size of the area or map extent - for a large area use a less intensive (crude filtering) program such as **focalmajority** or "focmaj.aml".

3. The number of classes - if there is a large number of classes, use a less intensive (crude filtering) program such as **focalmajority** or "focmaj.aml".

FOCMAJ.AML

The "focmaj.aml" does all of the steps previously mentioned above describing the **focalmajority** command, the **merge** afterwards and the **joinitem** command (Figure 8). The "focmaj.aml" is a crude filtering program and the least intensive in terms of processing. Focalmaj.aml must be run in ARC.

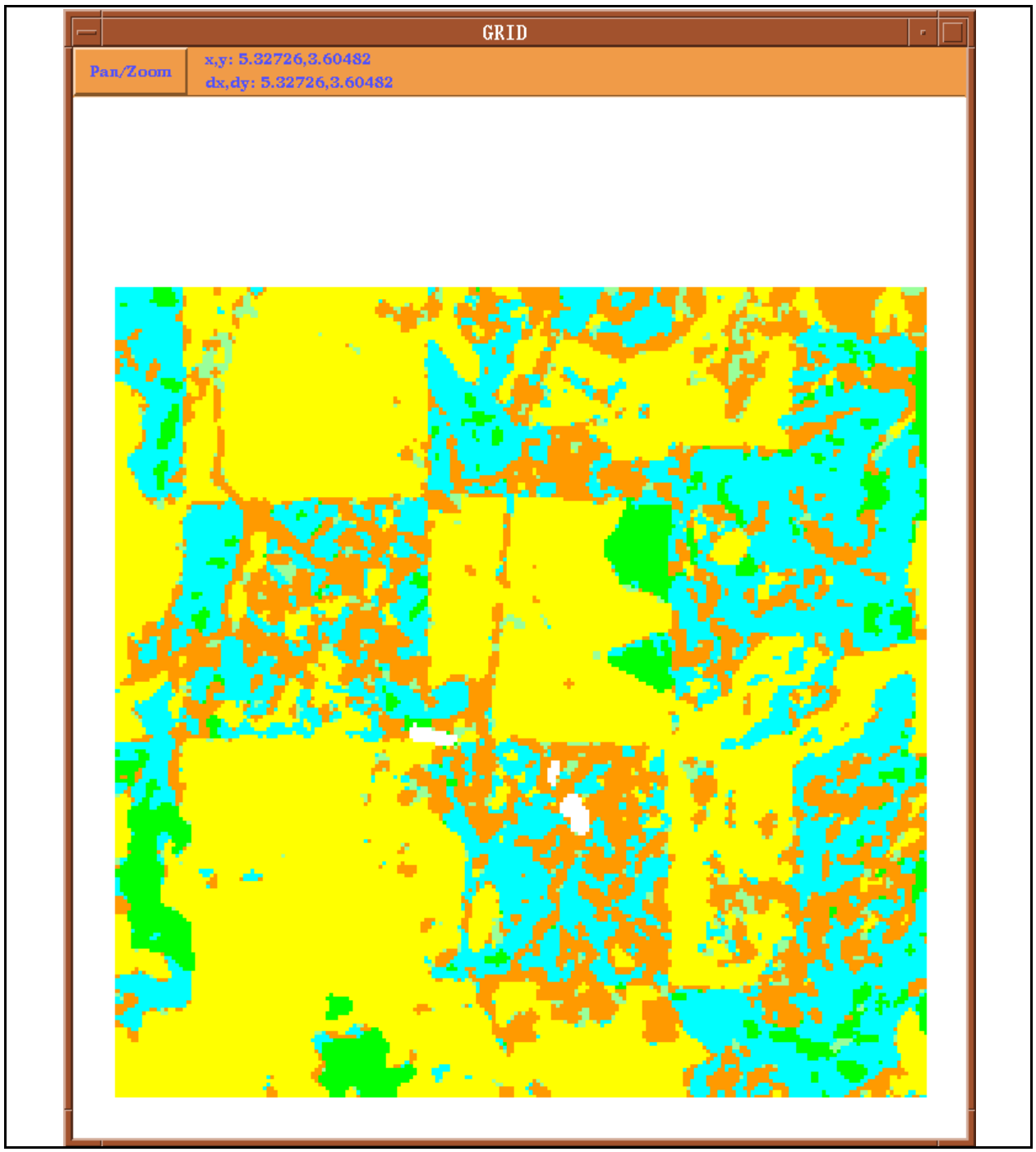

Figure 8 Result of **focalmajority** and **merge** commands or the "focmaj.aml".

Arc: &r focmaj.aml

```
==================================================
USAGE: &r focmaj <ingrid> <outgrid> <background>
==================================================
```

Arc: &r focmaj.aml mrog_cls_fnl3 mrog_filt blanchedalmond

***Note:** uses defaults: rectangle and 3,3. Includes joinitem. This will not work if filtering a reclassed grid.

Focalmajority and "focmaj.aml" may smooth the classified data too much by not recognizing that pixels might belong to a region. A region is a group of pixels with the same value (vegetation type). Focalmajority works on a pixel by pixel basis and because it does not consider regions, it tends to break up boundaries. "Nibble_filter.aml" is provided in the WODIP package to help overcome this. It is a moderate filtering program and has one main requirement: a reclassed grid with no more than 20 classes (See page 22, Reclassing of WODIP Data).

NIBBLE_FILTER.AML

This program must be run from the Grid prompt and the arguments can be entered on one command line or you will be prompted for them. The following example used the default settings for the last two arguments to create Figure 9.

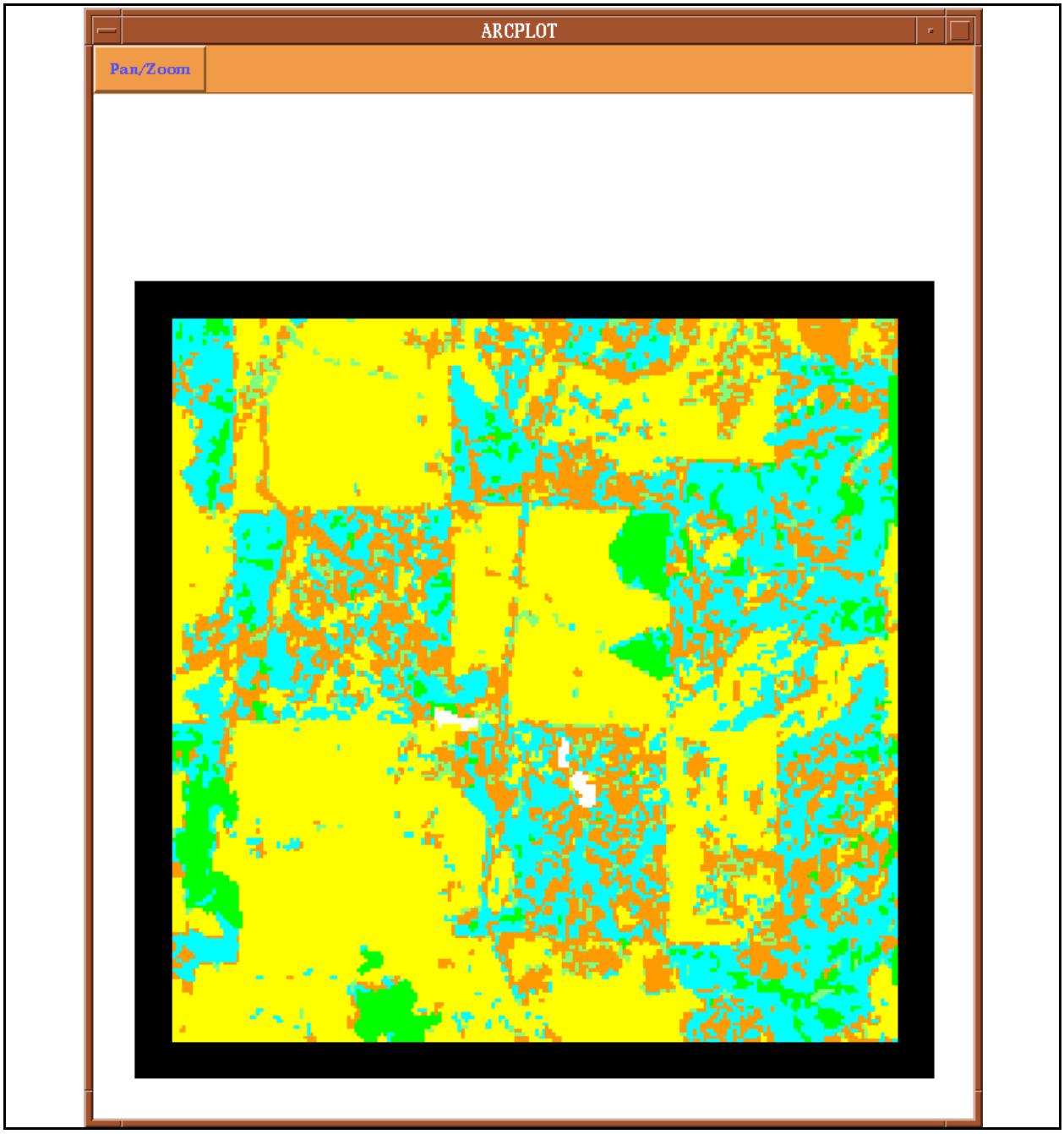

Figure 9 Result of "Nibble_filter.aml".

Grid: &r nibble_filter <reclassed_grid> <output_grid> <pixels> <connectivity>

Enter the input grid: (cr to exit) -->:input reclassed grid **mrog_classes4**
Enter the output grid: (cr to exit) -->:output filtered grid **mrog_nib**
Enter the maximum island size in pixels (5) -->:This is the maximum number of connected pixels to be filtered out and it defaults to five pixels. The higher the number of pixels, the more filtered (smoothed) the output.
Enter connectivity type <four|4|eight|8|> (four) -->:This determines how groups of pixels are defined. Four defines a simple island not accounting for diagonals, while eight defines a complex island accounting for diagonals. It defaults to four, and eight will result in larger groups of pixels being filtered out.

ISLAND_FILTER.AML The "island_filter.aml" is a sophisticated filtering program that does not destroy boundaries and has two main requirements:

1. A map extent no greater than a 5th field watershed because of the processing time
2. A reclassed grid with no more than 20 classes (See page 22, Reclassing of WODIP Data).

This program must be run from the Grid prompt and the arguments can be entered on one command line or you will be prompted for them. The following example used the default settings for the last two arguments to create Figure 10.

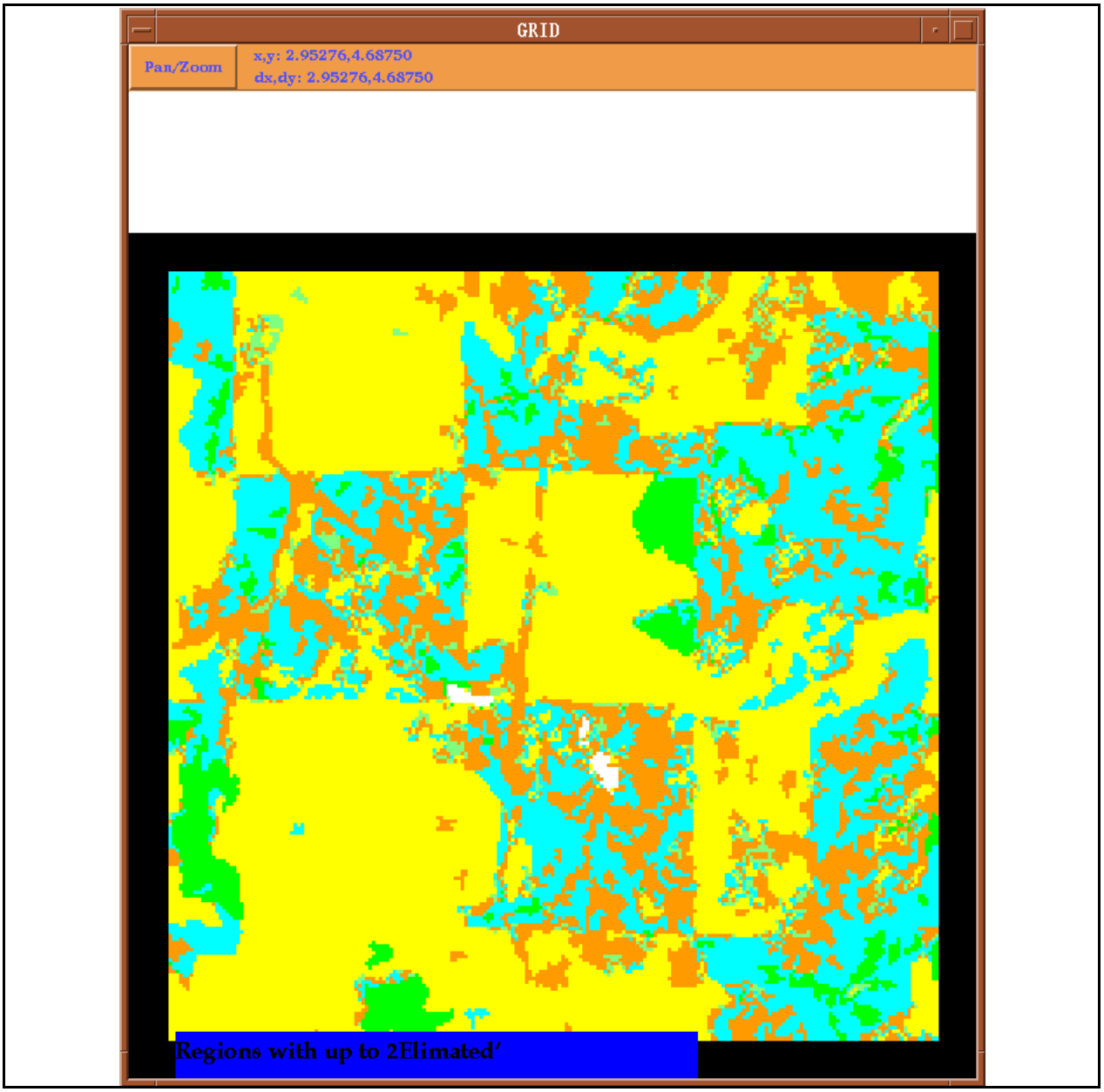

Figure 10 Result of "island_filter.aml".

Grid: &r island_filter <input grid> <output grid> <pixels> <four|4|eight|8>

<neighbors>

Enter the input grid: (cr to exit) -->:input reclassed grid **mrog_classes4**
Enter the output grid: (cr to exit) -->:output filtered grid **mrog_isl**
Enter the maximum island size in pixels (5) -->:This is the maximum number of connected pixels to be filtered out and it defaults to five pixels. The higher the number of pixels, the more filtered (smoothed) the output. It tends to clean up groups of pixels.
Enter connectivity type <four|4|eight|8|> (four) -->:This determines how groups of pixels are defined. Four defines a simple island not accounting for diagonals, while eight defines a complex island accounting for diagonals. It defaults to four, and eight will result in larger groups of pixels being filtered out.
Enter the allowable number of neighbors (2) -->:This is the number of allowable different neighbors and it defaults to two. The higher the number of neighbors, the more filtered the output. It tends to clean up single 'mixed' pixels.

The decisions that need to be made before using this program are:
1. The maximum island size in pixels.
2. The connectivity type.
3. The number of allowable neighbors.

The decision making flow chart can help by giving you some examples:

Clean up majority of single pixels ---------->>> pixels = 5
connectivity = 4
neighbors = 2 or 3

Clean up groups of pixels ---------->>> pixels = 5
connectivity = 8
neighbors = 2

Clean up larger groups of pixels ---------->>> pixels = 10, 20
connectivity = 8
neighbors = 2

Clean up even larger groups of pixels ---------->>> pixels = 10, 20
connectivity = 8
neighbors = 3

If some land cover types need to be protected or preserved, i.e., not filtered out, these cover types can be pulled out from the WODIP data. They can then be merged with the filtered grid after the filtering has taken place.

To protect or preserve a certain class use the **select** and **merge** Grid commands. First, use the **select** command on the WODIP grid or the reclassed WODIP grid to create a grid of protected values. If there are more than a couple of values that need protecting, use the **reclass** command to create a separate grid of protected values.

Using select and merge to preserve a small number of vales:

Grid: protected_grd = select(mrog_reclass,'value = 3 or value = 4')
Grid: gridpaint protect_grd

This is protecting hardwoods.

Grid: merge
Grid: Usage: (*) MERGE (<grid, ..., grid>)
Grid: filt_prot = merge(protect_grd, mrog_isl)
Grid: mape filt_prot
Grid: gridpaint mrog_isl
Grid: gridpaint filt_prot

Grid: protect_recls = reclass(wodip_filtered,protect.remap)

For more remap information, see page 22 on the Reclassing of WODIP Data. The following remap table will help create a new grid containing only protected values 1, 3, and 5. The remaining values will be null or nodata.

1 1 : 1
3 3 : 3
5 5 : 5

Next, filter the reclassed WODIP grid with either **focalmajority**, "focmaj.aml", "nibble_filter.aml" or "island_filter.aml".

The grid containing the selected/reclassed/protected values needs to be merged with the filtered grid. By putting the selected/reclassed/protected grid first in the **merge** command, the protected values will overwrite any values in the filtered grid (Figure 10). Example:

Grid: filt_protect = merge(protected_grd,wodip_filtered)

Vectorizing

If you need to convert the grids from raster to vector data, you can use the **gridpoly** command. Vectorizing works better on grids that have been reclassed and/or filtered.

Grid: gridpoly
Usage: (*) GRIDPOLY (<in_grid>,{weed_tolerance})

Grid: mrog_poly = gridpoly(mrog_species)

This will convert the reclassed species grid to a polygon coverage.

***Note:** If the original WODIP data has been reclassed, the values in the output polygon coverage item called "GRID-CODE" will relate to the reclassed values. To find out what the numbers in this item represent, refer back to the remap table you used to create the reclassed grid. If the original WODIP grid was not reclassed, you can use the **joinitem** command (p. 17) on that grid with the master_phase3 INFO file to list the attribute information on the .PAT.

Appendix A

CLASSIFICATION SCHEME

VALUE	COVER_TYPE	SPECIES	STRUCTURE	SIZE	CROWN_ CLOSURE
1	water				
2	urban/agric				
3	nonforest veg				
4	barren				
5	other				
6	forest	conifer	1 story	1 (DBH < 10 ")	5%
7	forest	conifer	1 story	1 (DBH < 10 ")	15%
8	forest	conifer	1 story	1 (DBH < 10 ")	25%
9	forest	conifer	1 story	1 (DBH < 10 ")	35%
10	forest	conifer	1 story	1 (DBH < 10 ")	45%
11	forest	conifer	1 story	1 (DBH < 10 ")	55%
12	forest	conifer	1 story	1 (DBH < 10 ")	65%
13	forest	conifer	1 story	1 (DBH < 10 ")	75%
14	forest	conifer	1 story	1 (DBH < 10 ")	85%
15	forest	conifer	1 story	1 (DBH < 10 ")	95%
16	forest	conifer	1 story	2 (DBH 10-19")	5%
17	forest	conifer	1 story	2 (DBH 10-19")	15%
18	forest	conifer	1 story	2 (DBH 10-19")	25%
19	forest	conifer	1 story	2 (DBH 10-19")	35%
20	forest	conifer	1 story	2 (DBH 10-19")	45%
21	forest	conifer	1 story	2 (DBH 10-19")	55%
22	forest	conifer	1 story	2 (DBH 10-19")	65%
23	forest	conifer	1 story	2 (DBH 10-19")	75%
24	forest	conifer	1 story	2 (DBH 10-19")	85%
25	forest	conifer	1 story	2 (DBH 10-19")	95%
26	forest	conifer	1 story	3 (DBH 20-29")	5%
27	forest	conifer	1 story	3 (DBH 20-29")	15%
28	forest	conifer	1 story	3 (DBH 20-29")	25%
29	forest	conifer	1 story	3 (DBH 20-29")	35%
30	forest	conifer	1 story	3 (DBH 20-29")	45%

31	forest	conifer	1 story	3 (DBH 20-29")	55%
32	forest	conifer	1 story	3 (DBH 20-29")	65%
33	forest	conifer	1 story	3 (DBH 20-29")	75%
34	forest	conifer	1 story	3 (DBH 20-29")	85%
35	forest	conifer	1 story	3 (DBH 20-29")	95%
36	forest	conifer	1 story	4 (DBH > 30")	5%
37	forest	conifer	1 story	4 (DBH > 30")	15%
38	forest	conifer	1 story	4 (DBH > 30")	25%
39	forest	conifer	1 story	4 (DBH > 30")	35%
40	forest	conifer	1 story	4 (DBH > 30")	45%
41	forest	conifer	1 story	4 (DBH > 30")	55%
42	forest	conifer	1 story	4 (DBH > 30")	65%
43	forest	conifer	1 story	4 (DBH > 30")	75%
44	forest	conifer	1 story	4 (DBH > 30")	85%
45	forest	conifer	1 story	4 (DBH > 30")	95%
46	forest	conifer	2 story	1 (DBH < 10 ")	5%
47	forest	conifer	2 story	1 (DBH < 10 ")	15%
48	forest	conifer	2 story	1 (DBH < 10 ")	25%
49	forest	conifer	2 story	1 (DBH < 10 ")	35%
50	forest	conifer	2 story	1 (DBH < 10 ")	45%
51	forest	conifer	2 story	1 (DBH < 10 ")	55%
52	forest	conifer	2 story	1 (DBH < 10 ")	65%
53	forest	conifer	2 story	1 (DBH < 10 ")	75%
54	forest	conifer	2 story	1 (DBH < 10 ")	85%
55	forest	conifer	2 story	1 (DBH < 10 ")	95%
56	forest	conifer	2 story	2 (DBH 10-19")	5%
57	forest	conifer	2 story	2 (DBH 10-19")	15%
58	forest	conifer	2 story	2 (DBH 10-19")	25%
59	forest	conifer	2 story	2 (DBH 10-19")	35%
60	forest	conifer	2 story	2 (DBH 10-19")	45%
61	forest	conifer	2 story	2 (DBH 10-19")	55%
62	forest	conifer	2 story	2 (DBH 10-19")	65%
63	forest	conifer	2 story	2 (DBH 10-19")	75%
64	forest	conifer	2 story	2 (DBH 10-19")	85%
65	forest	conifer	2 story	2 (DBH 10-19")	95%

66	forest	conifer	2 story	3 (DBH 20-29")	5%
67	forest	conifer	2 story	3 (DBH 20-29")	15%
68	forest	conifer	2 story	3 (DBH 20-29")	25%
69	forest	conifer	2 story	3 (DBH 20-29")	35%
70	forest	conifer	2 story	3 (DBH 20-29")	45%
71	forest	conifer	2 story	3 (DBH 20-29")	55%
72	forest	conifer	2 story	3 (DBH 20-29")	65%
73	forest	conifer	2 story	3 (DBH 20-29")	75%
74	forest	conifer	2 story	3 (DBH 20-29")	85%
75	forest	conifer	2 story	3 (DBH 20-29")	95%
76	forest	conifer	2 story	4 (DBH > 30")	5%
77	forest	conifer	2 story	4 (DBH > 30")	15%
78	forest	conifer	2 story	4 (DBH > 30")	25%
79	forest	conifer	2 story	4 (DBH > 30")	35%
80	forest	conifer	2 story	4 (DBH > 30")	45%
81	forest	conifer	2 story	4 (DBH > 30")	55%
82	forest	conifer	2 story	4 (DBH > 30")	65%
83	forest	conifer	2 story	4 (DBH > 30")	75%
84	forest	conifer	2 story	4 (DBH > 30")	85%
85	forest	conifer	2 story	4 (DBH > 30")	95%
86	forest	hardwood	1 story	1 (DBH < 10 ")	5%
87	forest	hardwood	1 story	1 (DBH < 10 ")	15%
88	forest	hardwood	1 story	1 (DBH < 10 ")	25%
89	forest	hardwood	1 story	1 (DBH < 10 ")	35%
90	forest	hardwood	1 story	1 (DBH < 10 ")	45%
91	forest	hardwood	1 story	1 (DBH < 10 ")	55%
92	forest	hardwood	1 story	1 (DBH < 10 ")	65%
93	forest	hardwood	1 story	1 (DBH < 10 ")	75%
94	forest	hardwood	1 story	1 (DBH < 10 ")	85%
95	forest	hardwood	1 story	1 (DBH < 10 ")	95%
96	forest	hardwood	1 story	2 (DBH 10-19")	5%
97	forest	hardwood	1 story	2 (DBH 10-19")	15%
98	forest	hardwood	1 story	2 (DBH 10-19")	25%
99	forest	hardwood	1 story	2 (DBH 10-19")	35%
100	forest	hardwood	1 story	2 (DBH 10-19")	45%

101	forest	hardwood	1 story	2 (DBH 10-19")	55%
102	forest	hardwood	1 story	2 (DBH 10-19")	65%
103	forest	hardwood	1 story	2 (DBH 10-19")	75%
104	forest	hardwood	1 story	2 (DBH 10-19")	85%
105	forest	hardwood	1 story	2 (DBH 10-19")	95%
106	forest	hardwood	1 story	3 (DBH 20-29")	5%
107	forest	hardwood	1 story	3 (DBH 20-29")	15%
108	forest	hardwood	1 story	3 (DBH 20-29")	25%
109	forest	hardwood	1 story	3 (DBH 20-29")	35%
110	forest	hardwood	1 story	3 (DBH 20-29")	45%
111	forest	hardwood	1 story	3 (DBH 20-29")	55%
112	forest	hardwood	1 story	3 (DBH 20-29")	65%
113	forest	hardwood	1 story	3 (DBH 20-29")	75%
114	forest	hardwood	1 story	3 (DBH 20-29")	85%
115	forest	hardwood	1 story	3 (DBH 20-29")	95%
116	forest	hardwood	1 story	4 (DBH > 30")	5%
117	forest	hardwood	1 story	4 (DBH > 30")	15%
118	forest	hardwood	1 story	4 (DBH > 30")	25%
119	forest	hardwood	1 story	4 (DBH > 30")	35%
120	forest	hardwood	1 story	4 (DBH > 30")	45%
121	forest	hardwood	1 story	4 (DBH > 30")	55%
122	forest	hardwood	1 story	4 (DBH > 30")	65%
123	forest	hardwood	1 story	4 (DBH > 30")	75%
124	forest	hardwood	1 story	4 (DBH > 30")	85%
125	forest	hardwood	1 story	4 (DBH > 30")	95%
126	forest	hardwood	2 story	1 (DBH < 10 ")	5%
127	forest	hardwood	2 story	1 (DBH < 10 ")	15%
128	forest	hardwood	2 story	1 (DBH < 10 ")	25%
129	forest	hardwood	2 story	1 (DBH < 10 ")	35%
130	forest	hardwood	2 story	1 (DBH < 10 ")	45%
131	forest	hardwood	2 story	1 (DBH < 10 ")	55%
132	forest	hardwood	2 story	1 (DBH < 10 ")	65%
133	forest	hardwood	2 story	1 (DBH < 10 ")	75%
134	forest	hardwood	2 story	1 (DBH < 10 ")	85%
135	forest	hardwood	2 story	1 (DBH < 10 ")	95%

136	forest	hardwood	2 story	2 (DBH 10-19")	5%
137	forest	hardwood	2 story	2 (DBH 10-19")	15%
138	forest	hardwood	2 story	2 (DBH 10-19")	25%
139	forest	hardwood	2 story	2 (DBH 10-19")	35%
140	forest	hardwood	2 story	2 (DBH 10-19")	45%
141	forest	hardwood	2 story	2 (DBH 10-19")	55%
142	forest	hardwood	2 story	2 (DBH 10-19")	65%
143	forest	hardwood	2 story	2 (DBH 10-19")	75%
144	forest	hardwood	2 story	2 (DBH 10-19")	85%
145	forest	hardwood	2 story	2 (DBH 10-19")	95%
146	forest	hardwood	2 story	3 (DBH 20-29")	5%
147	forest	hardwood	2 story	3 (DBH 20-29")	15%
148	forest	hardwood	2 story	3 (DBH 20-29")	25%
149	forest	hardwood	2 story	3 (DBH 20-29")	35%
150	forest	hardwood	2 story	3 (DBH 20-29")	45%
151	forest	hardwood	2 story	3 (DBH 20-29")	55%
152	forest	hardwood	2 story	3 (DBH 20-29")	65%
153	forest	hardwood	2 story	3 (DBH 20-29")	75%
154	forest	hardwood	2 story	3 (DBH 20-29")	85%
155	forest	hardwood	2 story	3 (DBH 20-29")	95%
156	forest	hardwood	2 story	4 (DBH > 30")	5%
157	forest	hardwood	2 story	4 (DBH > 30")	15%
158	forest	hardwood	2 story	4 (DBH > 30")	25%
159	forest	hardwood	2 story	4 (DBH > 30")	35%
160	forest	hardwood	2 story	4 (DBH > 30")	45%
161	forest	hardwood	2 story	4 (DBH > 30")	55%
162	forest	hardwood	2 story	4 (DBH > 30")	65%
163	forest	hardwood	2 story	4 (DBH > 30")	75%
164	forest	hardwood	2 story	4 (DBH > 30")	85%
165	forest	hardwood	2 story	4 (DBH > 30")	95%
166	forest	mixed	1 story	1 (DBH < 10 ")	5%
167	forest	mixed	1 story	1 (DBH < 10 ")	15%
168	forest	mixed	1 story	1 (DBH < 10 ")	25%
169	forest	mixed	1 story	1 (DBH < 10 ")	35%
170	forest	mixed	1 story	1 (DBH < 10 ")	45%

171	forest	mixed	1 story	1 (DBH < 10 ")	55%
172	forest	mixed	1 story	1 (DBH < 10 ")	65%
173	forest	mixed	1 story	1 (DBH < 10 ")	75%
174	forest	mixed	1 story	1 (DBH < 10 ")	85%
175	forest	mixed	1 story	1 (DBH < 10 ")	95%
176	forest	mixed	1 story	2 (DBH 10-19")	5%
177	forest	mixed	1 story	2 (DBH 10-19")	15%
178	forest	mixed	1 story	2 (DBH 10-19")	25%
179	forest	mixed	1 story	2 (DBH 10-19")	35%
180	forest	mixed	1 story	2 (DBH 10-19")	45%
181	forest	mixed	1 story	2 (DBH 10-19")	55%
182	forest	mixed	1 story	2 (DBH 10-19")	65%
183	forest	mixed	1 story	2 (DBH 10-19")	75%
184	forest	mixed	1 story	2 (DBH 10-19")	85%
185	forest	mixed	1 story	2 (DBH 10-19")	95%
186	forest	mixed	1 story	3 (DBH 20-29")	5%
187	forest	mixed	1 story	3 (DBH 20-29")	15%
188	forest	mixed	1 story	3 (DBH 20-29")	25%
189	forest	mixed	1 story	3 (DBH 20-29")	35%
190	forest	mixed	1 story	3 (DBH 20-29")	45%
191	forest	mixed	1 story	3 (DBH 20-29")	55%
192	forest	mixed	1 story	3 (DBH 20-29")	65%
193	forest	mixed	1 story	3 (DBH 20-29")	75%
194	forest	mixed	1 story	3 (DBH 20-29")	85%
195	forest	mixed	1 story	3 (DBH 20-29")	95%
196	forest	mixed	1 story	4 (DBH > 30")	5%
197	forest	mixed	1 story	4 (DBH > 30")	15%
198	forest	mixed	1 story	4 (DBH > 30")	25%
199	forest	mixed	1 story	4 (DBH > 30")	35%
200	forest	mixed	1 story	4 (DBH > 30")	45%
201	forest	mixed	1 story	4 (DBH > 30")	55%
202	forest	mixed	1 story	4 (DBH > 30")	65%
203	forest	mixed	1 story	4 (DBH > 30")	75%
204	forest	mixed	1 story	4 (DBH > 30")	85%
205	forest	mixed	1 story	4 (DBH > 30")	95%

206	forest	mixed	2 story	1 (DBH < 10 ")	5%
207	forest	mixed	2 story	1 (DBH < 10 ")	15%
208	forest	mixed	2 story	1 (DBH < 10 ")	25%
209	forest	mixed	2 story	1 (DBH < 10 ")	35%
210	forest	mixed	2 story	1 (DBH < 10 ")	45%
211	forest	mixed	2 story	1 (DBH < 10 ")	55%
212	forest	mixed	2 story	1 (DBH < 10 ")	65%
213	forest	mixed	2 story	1 (DBH < 10 ")	75%
214	forest	mixed	2 story	1 (DBH < 10 ")	85%
215	forest	mixed	2 story	1 (DBH < 10 ")	95%
216	forest	mixed	2 story	2 (DBH 10-19")	5%
217	forest	mixed	2 story	2 (DBH 10-19")	15%
218	forest	mixed	2 story	2 (DBH 10-19")	25%
219	forest	mixed	2 story	2 (DBH 10-19")	35%
220	forest	mixed	2 story	2 (DBH 10-19")	45%
221	forest	mixed	2 story	2 (DBH 10-19")	55%
222	forest	mixed	2 story	2 (DBH 10-19")	65%
223	forest	mixed	2 story	2 (DBH 10-19")	75%
224	forest	mixed	2 story	2 (DBH 10-19")	85%
225	forest	mixed	2 story	2 (DBH 10-19")	95%
226	forest	mixed	2 story	3 (DBH 20-29")	5%
227	forest	mixed	2 story	3 (DBH 20-29")	15%
228	forest	mixed	2 story	3 (DBH 20-29")	25%
229	forest	mixed	2 story	3 (DBH 20-29")	35%
230	forest	mixed	2 story	3 (DBH 20-29")	45%
231	forest	mixed	2 story	3 (DBH 20-29")	55%
232	forest	mixed	2 story	3 (DBH 20-29")	65%
233	forest	mixed	2 story	3 (DBH 20-29")	75%
234	forest	mixed	2 story	3 (DBH 20-29")	85%
235	forest	mixed	2 story	3 (DBH 20-29")	95%
236	forest	mixed	2 story	4 (DBH > 30")	5%
237	forest	mixed	2 story	4 (DBH > 30")	15%
238	forest	mixed	2 story	4 (DBH > 30")	25%
239	forest	mixed	2 story	4 (DBH > 30")	35%
240	forest	mixed	2 story	4 (DBH > 30")	45%

241	forest	mixed	2 story	4 (DBH > 30")	55%
242	forest	mixed	2 story	4 (DBH > 30")	65%
243	forest	mixed	2 story	4 (DBH > 30")	75%
244	forest	mixed	2 story	4 (DBH > 30")	85%
245	forest	mixed	2 story	4 (DBH > 30")	95%
246	urban				

Appendix B

WATERSHED ABBREVIATIONS AND AVAILABLE INFORMATION

FULL NAME	ABBREVIATION	FILE NAME	FILE SIZE
Alsea	alsea	alsea.tar.Z	2.09MB
Applegate	aple	aple.tar.Z	2.11MB
Coast Fork Willamette	cfw	cfw.tar.Z	1.57MB
Chetco	chet	chet.tar.Z	3.57MB
Clackamas	clack	clack.tar.Z	2.65MB
Coos Bay	coos	coos.tar.Z	2.32MB
Coquille	coq	coq.tar.Z	2.79MB
Illinois	illin	illin.tar.Z	3.83MB
Lower Rogue	lrog	lrog.tar.Z	3.75MB
Lower Willamette	lwil	lwil.tar.Z	1.02MB
McKenzie	mck	mck.tar.Z	3.82MB
Middle Fork Willamette	mfw	mfw.tar.Z	3.59MB
Molalla-Pudding	mlpd	mlpd.tar.Z	1.43MB
Middle Rogue	mrog	mrog.tar.Z	2.68MB
Middle Willamette	mwill	mwill.tar.Z	1.02MB
Wilson-Trusk-Nestucca	nest	nest.tar.Z	2.60MB
North Santiam	nsant	nsant.tar.Z	2.00MB
North Umpqua	nump	nump.tar.Z	4.08MB
Necanicum Nehalem Lower Columbia Lower Columbia- Clatskanie watersheds	NW	nw.tar.Z	4.05MB
Lower Columbia-Sandy	sand	sand.tar.Z	1.61MB
Siltcoos	silt		
Siletz-Yaquina	silyaq	silyaq.tar.Z	1.95MB

FULL NAME	ABBREVIATION	FILE NAME	FILE SIZE
Siuslaw and Siltcoos watersheds	siu	siu.tar.Z	3.23MB
Sixes	sixes	sixes.tar.Z	1.45MB
South Santiam	ssant	ssant.tar.Z	2.62MB
South Umpqua	sump	sump.tar.Z	4.57MB
Tualatin	tual	tual.tar.Z	1.31MB
Upper Klamath	uklam	uklam.tar.Z	1.55MB
Umpqua	ump	ump.tar.Z	3.70MB
Upper Rogue	urog	urog.tar.Z	4.36MB
Upper Willamette	uwill	uwill.tar.Z	3.19MB
Yamhill	yam	yam.tar.Z	1.52MB

Appendix C

METADATA

Identification_Information:
Citation:
Citation_Information:
Originator: BLM
Title: WODIP
Description:
Abstract: This theme contains land cover types, by watershed, for Western Oregon (west of the Cascades to the coast) with attributes for cover type, forest species, forest size, forest crown closure, and forest structure.
Purpose: Resource Management
Supplemental_Information: Grid Integer with attributes in INFO.
Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1993
Currentness_Reference: ground condition
Status:
Progress: Complete
Maintenance_and_Update_Frequency: As needed
Spatial_Domain:
Keywords:
Theme:
Theme_Keyword_Thesaurus: None
Theme_Keyword: Vegetation
Theme_Keyword: Land Cover
Theme_Keyword: Forest
Theme_Keyword: Size
Theme_Keyword: Structure
Theme_Keyword: Crown Closure
Theme_Keyword: Species
Place:
Place_Keyword_Thesaurus: None
Place_Keyword: Western Oregon
Place_Keyword: Oregon
Access_Constraints: Discretionary, contains no sensitive information - generally considered releasable.
Use_Constraints: None

Point_of_Contact:
Contact_Information:
Contact_Person_Primary:

Contact_Person: Jeff Nighbert
Contact_Organization: OR/WA State Office, Bureau of Land Management
Contact_Position: Geographer
Contact_Address:
Address_Type: mailing address
Address: P. O. Box 2965
City: Portland
State_or_Province: OR
Postal_Code: 97208
Country: USA
Contact_Voice_Telephone: (503)952-6399

Native_Data_Set_Environment: Arc/Info 7.0.4; UNIX/AIX 3.2.5.1
Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report: Attribute accuracy review planned for 2000.
Completeness_Report: This theme covers all of Western Oregon (Crest of the Cascades to the coast).
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report: Unknown
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: EOSAT Imaging Space Center
Publication_Date: 1993
Title: Landsat Thematic Mapper Satellite Imagery
Type_of_Source_Media: magnetic tape
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 199308
Source_Currentness_Reference: ground condition
Source_Citation_Abbreviation: BLM WODIP
Source_Contribution: Data source provided spectral information (25 meter pixels).
Process_Step:
Process_Description: The theme was created using satellite image supervised classification techniques.
Source_Used_Citation_Abbreviation: BLM WODIP
Process_Date: 1996-1999

Spatial_Data_Organization_Information:
Indirect_Spatial_Reference: Western Oregon

Direct_Spatial_Reference_Method: Raster

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator

Universal_Transverse_Mercator:
UTM_Zone_Number: 10
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: Coordinate Pair
Geodetic_Model:
Horizontal_Datum_Name: North American datum of 1927
Ellipsoid_Name: Clarke 1866
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98

Entity_and_Attribute_Information:
Detailed_Description:
Entity_Type:
Entity_Type_Label: Land Cover Type
Entity_Type_Definition: Land cover defined using image classification techniques.
Entity_Type_Definition_Source: BLM

Attribute:
Attribute_Label: Cover_Type
Attribute_Definition: Land cover type covering surface of ground.
Attribute_Definition_Source: BLM
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: forests
Enumerated_Domain_Value_Definition: surface covered by forest vegetation.
Enumerated_Domain_Value: barren
Enumerated_Domain_Value_Definition: barren ground (rock outcrops, etc)
Enumerated_Domain_Value: non_for_veg
Enumerated_Domain_Value_Definition: Non-forest vegetation (grass, brush, etc).
Enumerated_Domain_Value: urban_ag
Enumerated_Domain_Value_Definition: surface covered by urban or agricultural uses.
Enumerated_Domain_Value: water
Enumerated_Domain_Value_Definition: surface covered by water (streams, ocean, lakes)

Attribute:
Attribute_Label: species

Attribute_Definition: Species of forest vegetation.
Attribute_Definition_Source: BLM
Attribute_Domain_Values:

Enumerated_Domain:
Enumerated_Domain_Value: mixed
Enumerated_Domain_Value_Definition: Vegetation type of mixed conifer and hardwood vegetation.
Enumerated_Domain_Value: hardwood
Enumerated_Domain_Value_Definition: Hardwood vegetation types.
Enumerated_Domain_Value: conifer
Enumerated_Domain_Value_Definition: Conifer vegetation types.
Enumerated_Domain_Value: blank
Enumerated_Domain_Value_Definition: No species/unknown

Attribute:
Attribute_Label: structure
Attribute_Definition: Forest tree structure (number of canopy stories)
Attribute_Definition_Source: BLM
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: multi
Enumerated_Domain_Value_Definition: Multi (2 or more) storied tree structure.
Enumerated_Domain_Value: one
Enumerated_Domain_Value_Definition: Single story tree structure.

Attribute:
Attribute_Label: size
Attribute_Definition: Forest tree size (diameter at breast height-dbh).
Attribute_Definition_Source: BLM
Attribute_Domain_Values:
Enumerated_Domain:
Enumerated_Domain_Value: 4
Enumerated_Domain_Value_Definition: greater than 30 inch dbh
Enumerated_Domain_Value: 3
Enumerated_Domain_Value_Definition: 21-30 inch dbh
Enumerated_Domain_Value: 2
Enumerated_Domain_Value_Definition: 11-20 inch dbh
Enumerated_Domain_Value: 1
Enumerated_Domain_Value_Definition: 0-10 inch dbh

Attribute:
Attribute_Label: crown_closure
Attribute_Definition: Percentage of forest tree crown closure.
Attribute_Definition_Source: BLM
Attribute_Domain_Values:

Range_Domain:
Range_Domain_Minimum: 5
Range_Domain_Maximum: 95
Attribute_Units_of_Measure: Percentage, from 5-95 in 10 percent increments.

Distribution_Information:
Distributor:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Lisa Blackburn
Contact_Organization: Bureau of Land Management, OR/WA State Office
Contact_Position: State Records Administrator
Contact_Address:
Address_Type: mailing address
Address: P. O. Box 2965
City: Portland
State_or_Province: OR
Postal_Code: 97208
Country: USA
Contact_Voice_Telephone: (503)952-6276
Distribution_Liability: No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual use or aggregate use with other data.

Standard_Order_Process:
Digital_Form:
Digital_Transfer_Information:
Format_Name: ARCE
File_Decompression_Technique: No compression applied
Digital_Transfer_Option:
Offline_Option:
Offline_Media: 8 mm cartridge tape
Recording_Capacity:
Recording_Density: Low
Recording_Format: TAR
Compatibility_Information: Sun UNIX
Fees: $8 administrative fee; $18.60 per hour research time (human time spent to locate the files and make the tape); $0.13 per page copying costs (8.5x11 up to 8.5x14); $7.50 per paper plot; $16.00 per mylar plot; cost of media (diskettes, tapes, etc); cost of postage (based on actual postage, including tubes, padded envelopes, overnight/express mail, etc).
Ordering_Instructions: Contact Distributor
Custom_Order_Process: Contact Distributor

Metadata_Reference_Information:
Metadata_Date: 19980126
Metadata_Future_Review_Date: 19990126

Metadata_Contact:
Contact_Information:
Contact_Person_Primary:
Contact_Person: Stanley Frazier
Contact_Organization: Bureau of Land Management, Oregon State Office
Contact_Position: State Data Administrator
Contact_Address:
Address_Type: mailing address
Address: P.O. Box 2965
City: Portland
State_or_Province: OR
Postal_Code: 97208
Country: USA
Contact_Voice_Telephone: (503)952-6009
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: 19940608