

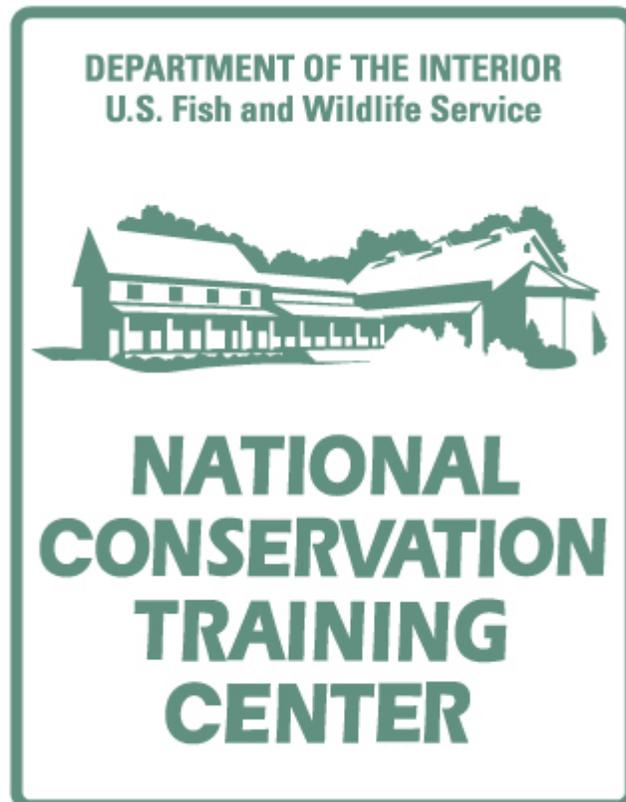
# **Vegetation Mapping**

**CSP7201**

June 17-21, 2013

Shepherdstown, West Virginia

*Offered by:*



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## Agenda (Hot Weather Version)

**June 17-21, 2013**

Times	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-8:30	Class Overview	Review			
8:30-9:30	Project Planning	Mapping with ArcPad	NPS Case Studies	Accuracy Assessment	FWS Case Studies
<b>9:30-9:45</b>	<b>Break</b>				
9:45-10:30	Vegetation Classification	Mapping with ArcPad	ENVI: Supervised Classification	Accuracy Assessment	Student Topics & Course Wrap-up
10:30-12:00	Vegetation Plot Sampling	ENVI: Unsupervised Classification		Sampling Design	
12:00-1:00	<b>Lunch</b>				
1:00-2:30	Vegetation Classification	ENVI	Editing with Topolgy	Site Assessment	
	NatureServe				
<b>2:30-2:45</b>	<b>Break</b>				
2:45-4:30	Working with Imagery	Open Lab		ENVI: Line Segmentation	
4:30-5:30	Project Consultations				



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Exercise 5 – Customizing ArcPad Toolbars (optional) .....	Tab 6



## **Exploring the US National Vegetation Classification (NVC) using NatureServe Explorer and USNVC.org to identify Ecological Systems, Groups, and Associations**

**Session Objectives** - At the conclusion of this session you will be able to:

- Explore the hierarchy of the US National Vegetation Classification
- Identify the total number of known Ecological Systems and NVC Associations by State and Ecoregion
- View comprehensive NVC Association reports
- Search for an NVC Group or Association based on a local plant name
- Search for an NVC Group or Association based on an NVC code
- Use Google to find reference material and local experts

**Materials created by:** Eric Kelchlin and Jim Vanderhorst (March 2010)

**Revision:** Elizabeth Byers (May 2013)

**Software:** IE 7, Adobe Reader

**Directory Path:**

**Notes:**

## SECTION 1 – Explore the hierarchy of the NVC

1. Open Internet Explorer and navigate to the U.S. National Vegetation Classification (NVC) <http://usnvc.org>
2. Click on **Explore the Classification** link.



3. Note the three sections listing the 8 classes, the key to hierarchical levels, and the status of the NVC documentation.
4. Name one class that occurs in your project area \_\_\_\_\_
5. Which hierarchical levels of the NVC are linked to descriptions?  
\_\_\_\_\_
6. Which hierarchical level of the NVC has the most finely divided vegetation units?  
\_\_\_\_\_
7. Expand the Class **1 Forest & Woodland** Class

Subclass **1.C Temperate Forest**

Formation **1.C.2 Cool Temperate Forest**

Division **D008 Eastern North American Cool Temperate Forest**

Keep expanding until you get to the bottom of the hierarchy (Association).

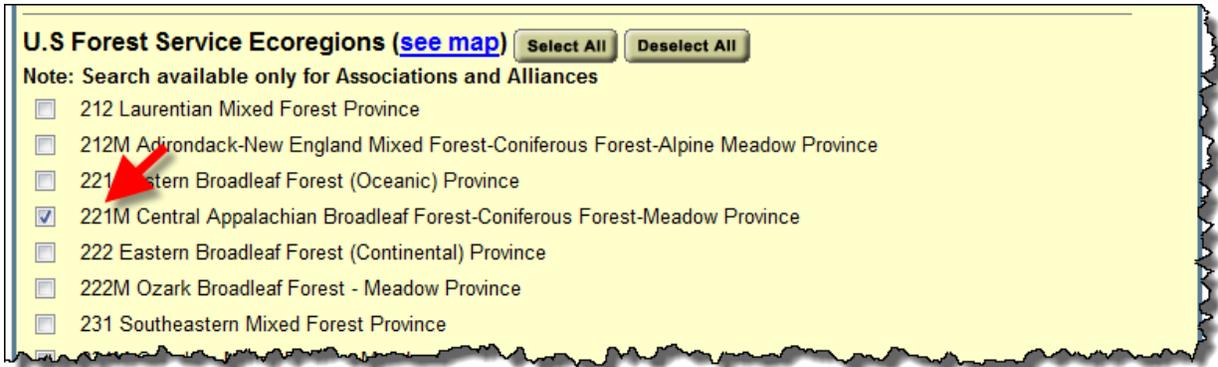
## SECTION 2 – Ecological Systems and Associations by State

In this section you will determine the number the number of known Ecological Systems and Associations in the State of West Virginia, and in a US Forest Service Ecoregion.

1. Open a new tab in Internet Explorer and navigate to NatureServe Explorer <http://www.natureserve.org/explorer/>.
2. Click on **Search > Ecological Communities & Systems**.



3. Click on the **Location** tab.
4. In the **U.S. States** section, check the box next to **West Virginia**.
5. Click the **Search Now** button in the **U.S. States** section. After a few seconds you will see the search results.
6. How many Ecological Systems are in West Virginia \_\_\_\_\_?
7. How many known Associations are in West Virginia \_\_\_\_\_?
8. Click on the **Change Criteria** button on the top right.
9. Select the **Location** tab if it is not already selected.
10. Uncheck the box next to West Virginia. Scroll down the page to the **U.S. Forest Service Ecoregions** section. NCTC falls within the 221M Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow Province. Put a check next to this Province.



11. Click the **Search Now** button. After a few seconds you will see the search results.
12. How many Ecological Systems are in province 221M \_\_\_\_\_?
13. How many known Associations are in province 221M \_\_\_\_\_?
14. **Quiz** - Determine the number of known Ecological Systems and Associations for your area of interest.

State/Province/Ecoregion: \_\_\_\_\_

Number of Ecological Systems: \_\_\_\_\_

Number of Associations: \_\_\_\_\_

### SECTION 3 – Viewing an Association Report

In this section you will learn one way to search for a comprehensive report for an Association that can be found on the NCTC campus.

During an evening walk to the Potomac River on the NCTC campus, you notice a floodplain forest that is dominated by silver maple with abundant box elder in the understory. Let's see whether we can find a description of this forest in the NVC.

1. In NatureServe Explorer, click the **New Search** button at the top of the page.
2. Click on the **Name** Tab and check Associations in the **Search by Name** section.
3. In the **Search by Name** text box, enter: *silver maple box elder*.
4. Click the **Search Now** button. After a few seconds you will see the search results.
5. What is the NVC Code for this Association (hint: it begins with the letters CEGL)?  
\_\_\_\_\_

6. What is the Global Conservation Status Rank (NatureServe Rank) for this Association? \_\_\_\_\_

Note: definitions of Conservation Status Ranks is on the NatureServe website at: <http://www.natureserve.org/explorer/ranking.htm> )

7. In which states is this Association found? \_\_\_\_\_
8. Click on the Association name to see the full report.
  - Scroll through the report and note the sections on Classification, Conservation Status, Distribution, Environmental Setting, and Dynamic Processes.

## SECTION 4 – Search for NVC Associations in NatureServe Explorer

In the last section, you used a name search to find a comprehensive report for a silver maple floodplain forest. Sometimes name searches will result in a confusing list of Associations. This section will show you how to narrow your search for Associations.

Your colleague tells you that she got to see the rare bitternut hickory forest while walking along the upper floodplain of the Potomac River at NCTC. Let's see whether we can find this forest type in the NVC.

1. In NatureServe Explorer, click the **New Search** button at the top of the page.
2. Click on the **Name** Tab and check **Associations** in the **Search by Name** section.
3. In the **Search by Name** text box, enter: *bitternut hickory*.
4. Click the **Search Now** button. After a few seconds you will see the search results. Oh dear, there are 10 different possibilities! Let's narrow our search by location.
5. Click on the **Change Criteria** button at the top right, select the **Location** tab, and select **West Virginia**. Click the **Search Now** button. Hmm, we still have 3 Associations to choose from. Since your colleague said the forest type was rare, let's narrow the search by rarity.
6. Click on the **Change Criteria** button at the top right, select the **Status** tab, and select the check boxes next to **G1**, **G2**, and **G3**. Click the **Search Now** button.
7. Now there are just two results. Only one of them is a floodplain forest. You can read through the descriptions to get further confirmation of which one is likely to occur at NCTC. What is the NVC Code of this forest type? \_\_\_\_\_

## SECTION 5 – Finding NVC Associations and Groups with USNVC.org

In this section you will learn to find Associations, Groups, or other hierarchical levels of the NVC using the new USNVC.org website, which is linked to NatureServe Explorer. This search method is especially useful if you know the NVC code for a particular vegetation category. This session also introduces how to access primary references for your vegetation types, using Google Search.

Scenario: You hire a contractor, who tells you that you have three types of bog & fen on your refuge, with NVC codes CEG006549, CEG007856, and CEG006570. You want to learn more about this vegetation.

1. Open Internet Explorer and navigate to the U.S. National Vegetation Classification at <http://usnvc.org>
2. Click on **Explore the Classification**
3. In the Search box, type: **6549**
4. You will notice that the path to the NVC Association is highlighted in pink. Expand the categories and follow the path to CEGL006549.

**Explore The Classification**



The U.S. National Vegetation Classification

Explore the National Vegetation Classification with the USNVC Hierarchy Explorer, which provides detailed descriptions of all U.S. vegetation, with ecological context and geographic ranges. (NOTE: This tool is still under development. Types and descriptions are drafts and in peer review. The browser may take a few seconds to load).

SEARCH by typing one or more keywords

BROWSE by clicking on + signs to expand categories, and click "NS" symbol for a detailed report from NatureServe Explorer

with description  with link to NatureServe

- [-] **1 Forest & Woodland**
  - + 1.A Tropical Moist Forest
  - + 1.B Tropical Dry Forest
  - + 1.C Temperate Forest
  - + 1.D Boreal Forest
- [-] **2 Shrubland & Grassland**
  - + 2.A Tropical Shrubland, Grassland & Savanna
  - + 2.B Mediterranean Scrub & Grassland
  - [-] **2.C Temperate & Boreal Shrubland & Grassland**
    - + 2.C.1 Temperate Grassland, Meadow & Shrubland
    - + 2.C.2 Boreal Grassland, Meadow & Shrubland
    - + 2.C.3 Temperate & Boreal Scrub & Herb Coastal Vegetation
    - [-] **2.C.4 Temperate & Boreal Bog & Fen**
      - [-] **D029 North American Bog & Fen**
        - + M061 Appalachian, Interior Plateau & Prairie Fen
        - + M065 Atlantic & Gulf Coastal Plain Bog & Fen
        - [-] **M062 North American Boreal Bog & Fen**
          - [-] **G386 Eastern North American Boreal Acidic Bog & Poor Fen Group**
            - CEGL002494 Betula pumila / Chamaedaphne calyculata / Carex lasiocarpa Shrubland NS
            - CEGL006524 Carex (oligosperma, exilis) - Chamaedaphne calyculata Shrub Herbaceous Vegetation NS
            - CEGL006549 Carex canescens - Eriophorum virginicum / Sphagnum spp. Herbaceous Vegetation NS

5. What is the name of the NVC group for this vegetation?

- Click on the small “NS” box at the end of the yellow-highlighted Association name. This will take you to the now-familiar full description on the NatureServe Explorer website. *Note that you cannot use NVC codes to search directly in NatureServe Explorer – you must use the usnvc.org website for code searches.*
- Scroll down to the References section of the comprehensive description. Highlight the first reference and copy it. Open a new tab in your browser, navigate to Google Search and paste the reference into the Google Search box.

References ---Jump to Section---

- Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2007. Classification and conservation assessment of high elevation wetland communities in the Allegheny Mountains of West Virginia. West Virginia Natural Heritage Program, West Virginia Division of Natural Resources, Elkins.
- Eastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boston, MA.
- Fortney, R. H. 1975. The vegetation of Canaan Valley, West Virginia: A taxonomic and ecological study. Ph.D. dissertation, University of West Virginia, Morgantown.
- Gawler, S. C., R. E. Zaremba, and B. Agius. 2005. Vegetation mapping at Minute Man National Historical Park. Draft final report. Technical Report NPS/NER/NRTR--XXXX/XXX. National Park Service. Philadelphia, PA.
- Walbridge, M. R. 1982. Vegetation patterning and community distribution in four high-elevation headwater wetlands in West Virginia. M.S. thesis, West Virginia University, Morgantown.
- Walbridge, M. R., and G. E. Lang. 1982. Major plant communities and patterns of community distribution in four wetlands of the unglaciated Appalachian region. In: R. B. MacDonald, editor. Proceedings of the Symposium on Wetlands of the Unglaciated Appalachian Region. West Virginia University, Morgantown.
- Wieder, R. K., A. M. McCormick, and G. E. Lang. 1981. Vegetational analysis of Big Run Bog, a nonglaciated sphagnum bog in West Virginia. Castanea 46:16-29.

- Click on the link to the report (pdf file).

The screenshot shows a Google search interface with the search query "Byers, E. A., J. P. Vanderhorst, and B. P. Streets. 2007. Classification and conor". The search results show "About 213 results (0.63 seconds)". The top result is a PDF link titled "Classification and Conservation Assessment of High Elevatio ..." with the URL "www.wvdnr.gov/publications/.../High%20Allegheny%20Wetlands-web". The link is circled in red. Below the link, there is a snippet of text: "by EA Byers - 2007 - Cited by 0 - Related articles Nov 29, 2007 - Wetland Communities in the Allegheny Mountains of West Virginia ..... EPA through the end of 2007, to allow the completion of data synthesis, mapping, and ..... Appendix B in Byers, E. A., J. P. Vanderhorst, and B. P. Streets. You've visited this page 4 times. Last visit: 5/17/13". Below this is another link: "Classification and Conservation Assessment of High Elevation ... aswm.org > Wetland Programs > State Wetland Programs > Jan 26, 2011 - Association of State Wetland Managers - Protecting the Nation's Wetlands. ... High Elevation Wetland Communities in the Allegheny Mountains of West Virginia ... Authors: E.A. Byers, J. P. Vanderhorst, and B. P. Streets. 2007."

9. When the pdf document is open, click <control F> to bring up the Find box and enter: 6549. Scroll down through the hits until you get to the photo and description. This is how a primary reference for the NVC might look. If you can find local primary references for NVC types in your area, you may gain important information on local conditions and also find local experts to help with questions regarding the NVC in your area.

### Silvery Sedge Fen



**Scientific Name:** *Carex canescens* / *Polytrichum* spp. - *Sphagnum* spp. Fen  
**Translated Name:** Silvery Sedge / Haircap Moss - Peatmoss Fen  
**NVC Name:** [CEGL006549](#); *Carex canescens* - *Eriophorum virginicum* / *Sphagnum* spp. Herbaceous Vegetation  
**Conservation Rank:** S2 / GNR

This herbaceous hummocky sedge fen occurs on temporarily flooded, semi-permanently flooded, and saturated peat in the Allegheny Mountains region of West Virginia, at elevations between 950 and 1210 m. It is a small-patch type that

occupies flat to very gently sloping land (0-0.5 degree) in headwater basins. It includes two subtypes, dominated by either *Sphagnum* or *Polytrichum* moss. The *Sphagnum*-dominated subtype occurs on the margins of active beaver ponds and on top of old beaver pond areas that have been abandoned long enough (often a decade or more) for open water to be replaced by a vegetative mat. The *Polytrichum*-dominated subtype has pronounced hummocky microtopography and occurs on the margins of low-gradient, first-order, meandering headwater streams. Both types form part of successional beaver-influenced wetland mosaics and often

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10. Repeat steps 1-6 for CEGL007856 and CEGL006570.

- Are all three of these peatlands in the same NVC group? \_\_\_\_\_
- Are they in the same NVC Macrogroup? \_\_\_\_\_
- How about the same NVC Division? \_\_\_\_\_

**SECTION 6 – Finding Associations, Groups, and Ecological Systems in your project area (optional)**

If you complete sections 1-5 and have additional time, try to identify some of the NVC vegetation that occurs in your area. Use name searches and location searches in NatureServe Explorer, or browse the hierarchy at <http://usnvc.org>

What did you find?

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## NOTES:

The NVC continues to evolve. There have been major improvements in the last three years with the development of Groups and Macrogroups. NatureServe Explorer currently provides descriptions of natural vegetation **Associations** and **Ecological Systems** in the NVC. **Alliances** are currently under review. NVC **Group** and **Macrogroup** descriptions are available for many areas in USNVC.org . NatureServe Explorer does not currently include “Provisional”, “Semi-natural” or “Planted” associations. Some of these cultural vegetation types are included in usnvc.org (but without links to descriptions).

Use NatureServe Explorer to **search** using scientific name, common name, location, or Conservation Status Rank. Use USNVC.org to browse the hierarchy or to search using scientific name or NVC code.

**Ecological Systems** are linked loosely to the NVC but fall outside the strict NVC hierarchy and typically represent spatially associated assemblages of Associations sharing a common set of ecological processes. An example is the High Allegheny Wetlands Ecological System, which is comprised of a mosaic of swamp, bog, fen, and marsh Associations and occurs in the broad flat-lying headwater basins of the Allegheny Mountains. Ecological Systems have been mapped wall-to-wall in several parts of the country.

If you can't find an Association or Group in NatureServe Explorer, try usnvc.org. If that does not work, you can perform Google searches to find documentation. If you still do not find information, then you may wish to contact a NatureServe ecologist or State Natural Heritage Program for information.

**Field Key to the Vegetation Associations and Other Map Classes  
of the USFWS National Conservation Training Center  
Jefferson County, West Virginia**

Prepared by Jim Vanderhorst and Elizabeth Byers  
Natural Heritage Program, WV Division of Natural Resources  
30 May 2013

**Please note:** This key includes all vegetation associations and other map classes known to be present at the USFWS National Conservation Training Center. However, it is possible that you may encounter a vegetation type not included here. Once you have made your selection of a vegetation type based on the key, read the NVC description if available. If your site appears to be a poor fit, flag the data sheet for further expert review.

1. Buildings, graveled or impervious surfaces, or active rights-of-way (dirt roads) cover at least 20% of the area, or area is covered by water without vegetation ..... **Not covered in key**  
 Not as above; vegetation covers at least 80% of the area ..... 2
2. Predominantly herbaceous, shrubby, or sparse vegetation; canopy trees over 6m tall are sparse or absent, covering less than 25% of the area; includes savanna-like areas with widely spaced, open-grown trees or standing dead trees over predominantly herbaceous vegetation ..... 3  
 Forests and woodlands; canopy trees over 6m tall cover at least 25% of the area; understory varies .. 7
3. Predominantly herbaceous; woody cover is less than 25%. ..... 4  
 Shrublands and stunted woodlands; shrubs, young saplings, stunted trees, and/or woody vines cover at least 25% of the area ..... **Successional Shrubland**
4. Mowed lawns around buildings and along rights-of-way. Vegetation is primarily turfgrass with or without occasional planted trees or shrubs ..... **Ornamental Lawn**  
 Grassland, pasture, and hayfield; may be mowed but not kept short as turfgrass lawn ..... 5
5. Field is cultivated for hay and maintained by regular mowing; heavily dominated by grasses; forbs uncommon and woody plants generally absent ..... **Agricultural Hayfield**  
 Not mowed for hay; anthropogenic grasslands and herbaceous old fields ..... 6
6. Anthropogenic grassland planted with mixed native grasses; may be maintained by brush-hogging to keep woody species from colonizing ..... **Planted Native Grassland**  
 Anthropogenic herbaceous vegetation dominated by exotic pasture grasses and forbs, often *Dactylis glomerata* (orchard grass) and *Rumex acetosella* (sheep sorrel); may be maintain by brush-hogging to keep woody species from colonizing ..... **Orchard Grass – Sheep Sorrel Meadow**

7. Riparian and floodplain forests. Site subject to flooding by the Potomac River (within the mapped flood-prone zone). ..... 8
- Not as above; forests and woodlands of upland sites (slopes, ridges, and upland flats not subject to flooding) ..... 11
8. Natural floodplain forest communities with tall canopies dominated by *Platanus occidentalis* (sycamore), *Acer saccharinum* (silver maple), or *Carya cordiformis* (bitternut hickory), often with *Acer negundo* (box-elder) abundant in the subcanopy..... 9
- Forests and thickets strongly dominated by a short canopy of *Acer negundo* (box elder). Semi-natural communities developed on abandoned farmland  
.....**Successional Box-elder Floodplain Forest (CEGL005033)**
9. Frequently flooded communities along the river’s edge with canopies dominated by *Platanus occidentalis* (sycamore) and/or *Acer saccharinum* (silver maple)..... 10
- Infrequently flooded communities on or behind a natural levee above the river’s edge with canopies dominated by *Carya cordiformis* (bitternut hickory), often with *Juglans nigra* (black walnut) and *Fraxinus* spp. (ash) .....**Bitternut Hickory Terrace Floodplain Forest (CEGL006445)**
10. Forests strongly dominated by *Acer saccharinum* (silver maple). Communities in the most frequently flooded positions .....**Silver Maple Floodplain Forest (CEGL006217)**
- Forests dominated by *Platanus occidentalis* (sycamore), sometimes growing with *Acer saccharinum* (silver maple), *Juglans nigra* (black walnut), and *Carya cordiformis* (bitternut hickory). Communities in somewhat less frequently flooded positions  
..... **Rich Floodplain Forest (CEGL004073)**
11. Semi-natural successional forests and woodlands that developed on abandoned farmland or in areas that were cleared or repeatedly logged. Canopies are often apparently even-aged and are dominated by a single species or by a mixture of light demanding, early successional species including *Liriodendron tulipifera* (tuliptree), *Platanus occidentalis* (sycamore), *Juniperus virginiana* (eastern red-cedar), *Robinia pseudoacacia* (black locust), *Fraxinus americana* (white ash), *Celtis occidentalis* (hackberry), and *Prunus serotina* (black cherry). ..... 12
- Natural forests in areas that were less affected by farming and other human activities often due to their location on steeper slopes and rocky areas. Forests and woodlands dominated by *Quercus* spp. (oaks), *Carya* spp. (hickories), *Tilia americana* (basswood), and/or *Acer* spp. (maples). ..... 15
12. Evergreen forests and woodlands dominated by *Juniperus virginiana* (eastern red-cedar).....  
..... **Old field Eastern Red-cedar Forest (CEGL006024)**
- Forests and woodlands dominated by deciduous trees. *Juniperus virginiana* (eastern red-cedar) is absent or present with lower cover..... 13
13. Forests strongly dominated by *Platanus occidentalis* (sycamore) or *Liriodendron tulipifera* (tuliptree). Sycamore or tuliptree comprise greater than 50% of total canopy cover..... 14

Forests and woodlands with a mixture of successional tree species or sometimes with dominance by a species other than *Liriodendron tulipifera* (tuliptree) or *Platanus occidentalis* (sycamore). Common trees include *Robinia pseudoacacia* (black locust), *Liriodendron tulipifera* (tuliptree), *Fraxinus americana* (white ash), *Celtis occidentalis* (hackberry), *Prunus serotina* (black cherry), and *Juniperus virginiana* (eastern red-cedar) .....  
 ..... **Successional Mixed Limestone Forest (CEGL007281)**

14. Upland forests dominated by *Platanus occidentalis* (sycamore). Sites are often depressions (e.g., sinkholes) or concave slopes. Tree species composition resembles sycamore floodplain forest (CEGL004073) but these sites are never flooded .....**Sycamore Successional Forest**

Forests dominated by *Liriodendron tulipifera* (tuliptree)  
 .....**Successional Tuliptree Forest (Rich Type) (CEGL007220)**

15. Forests dominated by species of *Quercus* (oaks) and *Carya* (Hickories) and lacking significant cover by species of *Acer* (maples). Common tree species include *Quercus muehlenbergii* (chinquapin oak), *Quercus alba* (white oak), *Quercus rubra* (red oak), *Quercus shumardii* (Shumard oak), *Carya cordiformis* (bitternut hickory), and *Carya ovalis* (oval pignut)  
 .....**Limestone Oak-Hickory Forest (CEGL004793)**

Forests with significant cover by maples, including *Acer saccharum* (sugar maple) and *Acer nigrum* (black maple)..... 16

16. Forests on colluvium and bedrock of river bluffs and ravine slopes. Canopies are mixed and include *Tilia americana* (basswood), *Quercus muehlenbergii* (chinquapin oak), *Quercus rubra* (red oak), *Fagus grandifolia* (beech), *Acer saccharum* (sugar maple), and *Acer nigrum* (black maple). Spring herb layers are usually lush with abundant nutrient demanding species including *Allium tricoccum* (ramps), *Jeffersonia diphylla* (twinleaf), and *Caulophyllum thalictroides* (blue cohosh)  
 .....**Rich Cove / Mesic Slope Forest (Twinleaf - Blue Cohosh Type) (CEGL008412)**

Forests on residual soils of knobs above the river bluffs. Canopies are dominated by *Quercus rubra* (red oak) with *Acer saccharum* (sugar maple) dominant in the subcanopy. Herb layers can be diverse but have lower cover and lack the most nutrient demanding species ..... **Rich Red Oak - Sugar Maple Forest (CEGL008517)**

USNVC references:

National Vegetation Classification System:

Development, Status, and Applications:

<http://www.natureserve.org/library/vol1.pdf>

National Vegetation Classification Standard, Version 2: FGDC-STD-005-2008

[http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS\\_V2\\_FINAL\\_2008-02.pdf](http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS_V2_FINAL_2008-02.pdf)

Contours of the Revised U.S. National Vegetation Classification Standard:

<http://www.esajournals.org/doi/pdf/10.1890/0012-9623-90.1.87>

Standards for associations and alliances of the U.S. National Vegetation Classification:

[http://www.esa.org/science\\_resources/DocumentFiles/Standards%20National%20Vegetation%20Classification.pdf](http://www.esa.org/science_resources/DocumentFiles/Standards%20National%20Vegetation%20Classification.pdf)

Ecological Systems:

<http://www.natureserve.org/library/usEcologicalsystems.pdf>

Web pages:

NatureServe Explorer:

<http://www.natureserve.org/explorer/>

U.S. National Vegetation Classification

<http://usnvc.org>

Links to Natural Heritage Programs:

<http://www.natureserve.org/visitLocal/index.jsp>

USGS/NPS Vegetation Characterization Program:

<http://biology.usgs.gov/npsveg/>

VegBank:

<http://www.vegbank.org/vegbank/index.jsp>

**Vegetation Classification for Your Project**  
(corresponds to steps 1-5 of the NPS 12-step program)  
Elizabeth Byers, WV Natural Heritage Program, WVDNR  
May 29, 2013

Nine steps to vegetation classification for great maps!

1. Compile existing data
2. Envision map purpose
3. Stratify assessment units
4. Sample plots
5. Analyze plot data
6. Crosswalk to NVC
7. Build map units
8. Write local descriptions
9. Create field key

Notes

- 1. Compile and assess existing data**
  - a. Vegetation classifications, maps, GIS layers, plot data, observation point data
- 2. Envision how your vegetation map will relate to management and conservation objectives**
  - a. Biological integrity, diversity → ranked Associations in NVC
  - b. Trust species or species of concern
    - i. Mappable, vegetation-related habitat elements: don't try to do everything, but some elements may be possible to include, or at least noted in plots. Examples might be seeps, riparian areas, boulderfields, rock outcrops, vegetation structure, snags, coarse woody debris, mast-producing trees, larval host plants, invasive species
  - c. Other management and conservation objectives
- 3. Stratify project area into preliminary assessment units**
  - a. Delineate known cultural areas and developed areas
  - b. In natural areas, what are the environmental gradients and disturbance regimes that will impact vegetation?
    - i. Flooding – be sure to sample the various parts of the floodplain (narrow, closely-packed communities can occur along this strong gradient)
    - ii. Geology and soils
    - iii. Elevation, vertical zonation
    - iv. Slope and aspect, e.g. moist coves and dry convex slopes
  - c. Known or suspected special areas
    - i. Old growth
    - ii. Rare plants (often but not always indicate special vegetation)
    - iii. Wetlands, cliffs, other special habitats if not captured in stratified units

#### **4. Sample vegetation plots**

- a. Most expensive step; plan it carefully & execute it adaptively
- b. Sample plots in all stratified units and special areas; bias toward higher quality stands and distance from ecotones.
- c. Sample with eyes wide open - build in 10% of effort for stands observed in the field but not captured on the preliminary stratification, e.g. high quality stands, unique vegetation, large stands.
- d. The FDGC vegetation classification standard does not require that vegetation map classes be equivalent to USNVC classification units, but it does require that map classes be characterized by data on structure, composition, and environment that facilitate cross-walking to standard USNVC types.
- e. Plots include:
  - i. Identifiers
  - ii. Floristics: Species abundance by stratum, Tree height and diameter
  - iii. Environment: Topographic variables (aspect, slope, slope shape, topographic position), Hydrology, Soils
  - iv. Ecological Processes: Disturbance regimes, Successional state
  - v. Size: hectares of small patch, large patch, or matrix vegetation
  - vi. Environmental Condition
  - vii. Landscape Context
- f. Plot data is stored in databases
  - i. Plots2-WV: A database for vegetation plot data facilitates archival and retrieval of plot data, and enforces standardized species taxonomy and constrained values for environmental variables. The Plots2-WV database is based on the Plots Database 2.0 which was developed for the NPS vegetation mapping program. An updated version Plots Database 3.0 and is now available at <http://biology.usgs.gov/npsveg/tools/plotsdatabase.html> .
  - ii. "The Vegetation Panel maintains VegBank (Ecological Society of America, Vegetation Classification Panel 2008) as a repository to facilitate archiving, discovering, viewing, citing, and disseminating plot data. There is, however, no requirement that classification plot data be deposited in VegBank as long as the data meet archival requirements for public accessibility." (Jennings et al. 2009)
  - iii. Natural Heritage Database. Plot data are a basis for creating natural community occurrences in state Natural Heritage Databases. Each state maintains such a database for conservation planning and land management purposes.
- g. Plot data is used for classification, monitoring, restoration, biodiversity measurements. Plots may grow in value and data richness in the future, especially as climate change impacts communities. The plot is the specimen of vegetation, like an herbarium voucher is the specimen for a plant.

#### **5. Analyze plot data using multivariate statistics**

- a. Classify local units of vegetation and their environments

- b. Data analysis can provide new insight into classification of vegetation AND provides a communication tool for peer review required by FDGC standard for proposing new classification units and revisions to existing units. Multivariate statistical analyses are performed using PC-Ord software. R-scripts are also available.
  - c. Non-parametric multivariate statistics
    - i. Summary statistics, data transformation, outliers
    - ii. Hierarchical agglomerative cluster analysis
    - iii. Indicator species analysis
    - iv. Ordination: non-metric multi-dimensional scaling
    - v. Environmental overlay on ordination
    - vi. Iterative scenario analysis
  - d. Cluster Analysis. Two-way cluster analysis simultaneously clusters plots (based on species composition) and species (based on occurrence in plots) to provide a picture of communities. Plots on left, species on top. Dominant and Diagnostic species. Constancy, Fidelity. Communities are classified based on repeated patterns of species co-occurrence.
  - e. Ordination places plots in species space based on overall similarity in species composition. Symbology represents final classification (association level) of plots. Rotation of ordination allows three-dimensional view, resolving some groups that are not easily distinguishable in a two-dimensional view.
- 6. Crosswalk local units to NVC**
- 7. Build the mapping units from the classification – essential to a good map!**
- a. May want to lump some units to Group or Ecological System
    - i. Units that occur in very small or narrow patches, below the minimum mapping unit or minimum mapping width
    - ii. Units that are not distinguishable using available mapping methods
    - iii. Units that have the same management prescriptions, where cost savings in mapping is a priority
  - b. May want to split some units
    - i. Associations that contain a wide range of vegetation structures, successional states, environmental conditions, or habitat elements, necessitating different management or conservation approaches
  - c. Add back in the cultural units of vegetation
- 8. Write local descriptions**
- a. Association, Group, and Ecological System descriptions can be downloaded from NatureServe Explorer or USNVC.org and customized for the project area.
- 9. Create a dichotomous field key to accompany the local descriptions**
- a. Accuracy assessment
  - b. Updating and correcting the map over time
  - c. Use by management and conservation staff
  - d. Public education, fact sheets

## Vegetation Classification: Concepts and Standards

Elizabeth Byers and Jim Vanderhorst, WV Natural Heritage Program, WVDNR  
May 20, 2013

What is “vegetation” and why classify and map it?

- Physiognomy (structure)
- Plant species composition
- Habitat
- “Coarse filter” for conservation of biological diversity in all kingdoms

“Consistent mapping of vegetation types requires that a classification be completed first because classification defines the entities to be mapped” (FGDC 2008)

**Vegetation = Community = Habitat.** Vegetation classification is based on plants, but is meant to represent communities composed of organisms in all taxonomic kingdoms and their environment. Vegetation represents habitat for numerous organisms at various scales. From the carnivore’s perspective: vegetation is what food eats. From a wildlife biologist’s perspective: vegetation is food and habitat for wildlife.

What is a Natural Community? An interacting assemblage of organisms, their physical environment, and the natural processes that affect them. *Natural communities repeat across the landscape.* WV Northern Flying Squirrel, Cheat Mountain Salamander, snail, Olive-sided Flycatcher

**Natural vs. Cultural.** Natural = Nonanthropogenic. Structure and composition primarily determined by site characteristics and spontaneous biotic and abiotic processes.

Cultural = Anthropogenic: Structure and composition primarily determined by human activity.

**Semi-natural.** Spontaneous vegetation established after abandonment of human activity. This wetland site used to be a balsam fir swamp forest before it was cleared and grazed. Livestock were removed and native plants, including rare species dominate the site today. Balsam fir is being replanted. Should the restored balsam swamp be considered natural vegetation?

**Existing vs. Potential Vegetation.** Examples of classifications of potential vegetation include the forest habitat type classifications commonly applied in the western USA.

**Physiognomy** is the general appearance of vegetation based on growth form, height, and spacing of the dominant plants. Physiognomy often reflects large scale climatic patterns, small scale edaphic patterns, natural disturbance

regimes, or human land uses. Physiognomy was the basis for the upper levels of the old (pre 2008) USNVC hierarchy.

**Floristics:** Complete plant species composition and abundance in all strata (herb, shrub, subcanopy, canopy). This is the basis for most quantitative vegetation classification approaches, and is a requirement for the new FGDC Vegetation Standard.

**Presence and Abundance.** Cover: Toadshade 40% Squirrelcorn 30% Bloodroot 10% Larkspur 5% Enchanters nightshade 5% Honewort 2% Wild ginger 2% Garlic mustard 2%

**U. S. National Vegetation Classification:** An established classification standard facilitates exchange of knowledge concerning land management and prioritization and coordination of conservation efforts.

- Maintained by NatureServe (and Natural Heritage Programs)
- Federal standard (FGDC) – 1997, 2008
- Peer reviewed
- Describes existing vegetation
- Hierarchical system, based on physiognomy and floristics
- Based on plot data

**U. S. National Vegetation Classification Hierarchy** (1997 vs. 2008): Revisions include 1) separating cultural vegetation in separate hierarchy 2) new Class units 3) deleting 2 upper levels 4) adding 3 middle levels. Additional guidance and standards related to vegetation mapping: “The Standard also requires that vegetation mapping and inventory units crosswalk to the NVC.” “This standard requires that when Federal efforts are conducted, they are conducted in ways that, whatever else they do, they provide the **minimum data needed to integrate plot data and crosswalk vegetation types, and map units to the content standard (the NVC)**. Individual plots should be assignable to one vegetation type at the lowest possible level of the NVC hierarchy. Local vegetation types and map units may crosswalk to one or more NVC vegetation types at a similar level of the NVC hierarchy.” (FGDC 2008)

U. S. National Vegetation Classification Hierarchy (current, with # units)

National Vegetation Classification: example

USNVC.org, with classes & hierarchy

## **8 Classes**

**Forest & Woodland**, with Formation, Group, Association examples. This class is comprised of vegetation dominated by trees, regardless of height and spacing.

**Formations** incorporate physiognomy with hydrologic and broad scale climatic modifiers. Formations can often be interpreted or inferred from aerial photos.

Groups are a new middle floristic level in the USNVC hierarchy. **Group and Macrogroup** descriptions were recently written and many are available via USNVC.org . **Associations** are the basic unit in the USNVC and are defined by a relatively small range in variation of physiognomy and floristic composition. They have detailed descriptions and are ranked for conservation status.

**Shrubland & Grassland**, with Group examples. The complete name for this class was “Mesomorphic Shrubland and Grassland,” indicating an adaptation to relatively moist, temperate climates. Other shrublands and grasslands are included in the Semi-Desert Class and the Polar and High Montane Vegetation Class.

**Semi-Desert**, with Group examples. The Semi-Desert Class includes shrublands and grasslands of arid climates. Sparse and nonvascular vegetation are not included in this class.

**Polar & High Montane**. This class represents vegetation of cold climates beyond the altitudinal or latitudinal tolerance of trees. “Montane” seems to be a misnomer because this term usually applies to high elevations below the tree line. “Alpine” is probably a better term. Sparse and nonvascular vegetation are not included in this class.

**Aquatic Vegetation**. Vegetation growing in fresh and salt water.

**Nonvascular and Sparse Vascular Rock Vegetation**. This class includes nonvascular and sparse vegetation of all climate zones, including semi-deserts and polar/alpine habitats.

**NatureServe Explorer**. For these 6 classes of natural vegetation, information on the lower levels of the USNVC (primarily associations) is available at NatureServe Explorer.

**Conservation Ranking**. Conservation status ranks are assigned at the Association level for natural vegetation types only (these are conservation targets). They are an indication of relative rarity and vulnerability of individual Associations. Global ranks are assigned based on all occurrences of an Association across its entire global range. State conservation ranks are assigned by state Natural Heritage Programs.

- **Rarity**: number of occurrences, range extent, environmental specificity, intrinsic vulnerability
- **Status**: viability and protection status of occurrences
- **Threats**: severity, scope, and immediacy
- **Trends**: short-term and long-term

G = Global S = State

- 1 = critically imperiled
- 2 = imperiled

- 3 = vulnerable
- 4 = apparently secure
- 5 = widespread, abundant, and secure
- X = Extirpated
- H = Historic
- NR = Not Ranked
- NA = Not Applicable

All natural vegetation is a declining resource, but globally rare associations (G1-G3) should be given a high priority for conservation. If you have a G1-G3 association in your management area, then its occurrence there is probably a vital component for conservation of the type across its range.

### **USNVC Hierarchy for Cultural Vegetation (2008)**

**Class: Agricultural Vegetation.** Lower levels of this class have not yet been developed. Pecans and cotton in Georgia. Irrigated rice in California. Hops in Washington.

**Class: Developed Vegetation.** Lower levels of this class have not yet been developed. The National Arboretum in DC. Longwood Gardens topiary in Delaware. Oahu golf course. Arlington Cemetery.

Review slide of classes for 2008 hierarchy revision.

**Ecological Systems.** “Ecological systems represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. They are intended to provide a classification unit that is readily mappable, often from remote imagery, and readily identifiable by conservation and resource managers in the field.”

Comer et al. 2003. Ecological systems are groups of associations that occur together on the landscape. Ecological Systems are not part of the USNVC hierarchy; individual associations can belong to multiple Ecological Systems.

**High Allegheny Wetland Ecological System**, with swamp and open wetlands.

### **Bluestone National Scenic River, WV**

Associations (17) vs. Ecological Systems (6)

Using Ecological Systems reduces the number of map classes for natural vegetation. One-to-one and many-to-one relationship between “association” map classes and Ecological System map classes. Distinctions between oak types are maintained but distinction between hemlock and deciduous mesophytic forests is lost. Cultural and disturbed areas are split into several map classes.

## Exercise 1 – Data Collection with ArcPad

**Session Objectives:** At the conclusion of this session, you will be able to:

- Check out data from a geodatabase for editing in the field using ArcPad Data Management Tools.
- Use ArcPad to map points and polygons.
- Check in field data and update a geodatabase using ArcPad Data Management Tools.

**Material Created By:** Eric Kelchlin 2008

**Revision:** April 2013

**Software:** ArcGIS 10 SP5, ArcPad 10 SP3

**Directory Path:** D:\CSP7201\Exercise1

**MXD:** Exec1.mxd

**GDB:** Exercise1.gdb

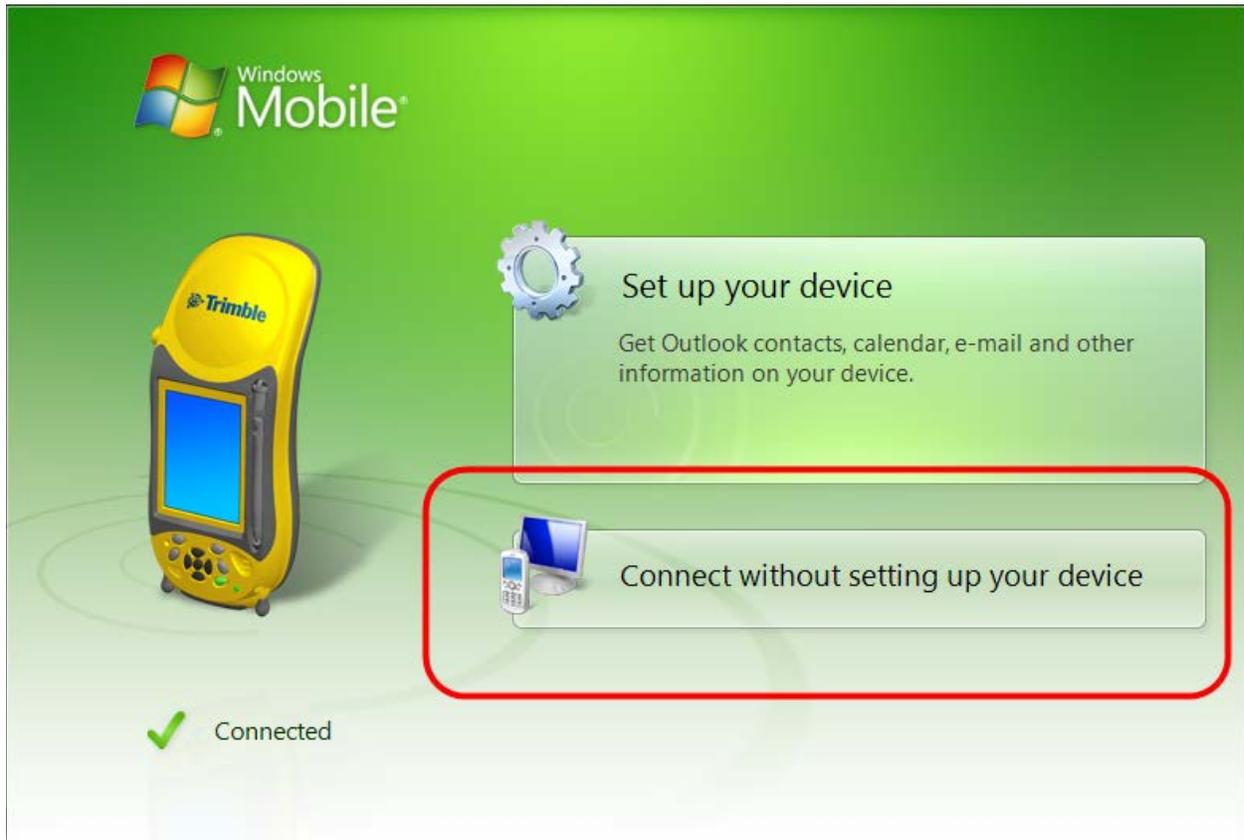
**Imagery:** GIS\_Data\Imagery\ntc\_color\_ortho\_2009.sid

## TASK 1 – Establishing a Connection with your Mobile GPS Device

ActiveSync software is used to transfer files from your mobile GPS device to your PC if you are running Windows XP. Windows Mobile Device Center is the transfer software on Windows 7 systems.

These instructions were developed using Windows Mobile Device Center version 6.1 and assume that you have not established a partnership between a mobile GPS device and your PC.

1. Connect your GPS device to a USB port on your PC. The Windows Mobile Device Center (WMDC) will appear. If not, then open the program from the Startup Start Menu.
2. Select Connect without setting up your device.



3. If you still don't have a connection, then disable the advanced network functionality on your Trimble Device (Settings>Connections>USB to PC) and reconnect.

## TASK 2 – Now Where Did I Put Those Domain's?

**All data are located in D:\CSP7201\Exercise1, unless otherwise stated.**

1. Launch ArcMap and open the **Exec1.mxd**.
2. Open **ArcToolbox** on the sidebar and find the **Exercise1.gdb** geodatabase.
3. Examine the domains inside the geodatabase (i.e., the CAN) by right-clicking on the CAN, selecting properties and clicking the Domains tab. A “domain” is simply a list of predefined attributes that you can link to fields in the layers attribute table. Domains allow us to create drop-down menus for data entry in the field.
4. Select the Technicians domain and scroll down to see if your name is in the list of coded values, if not, add your last name to both the Code and Description fields.

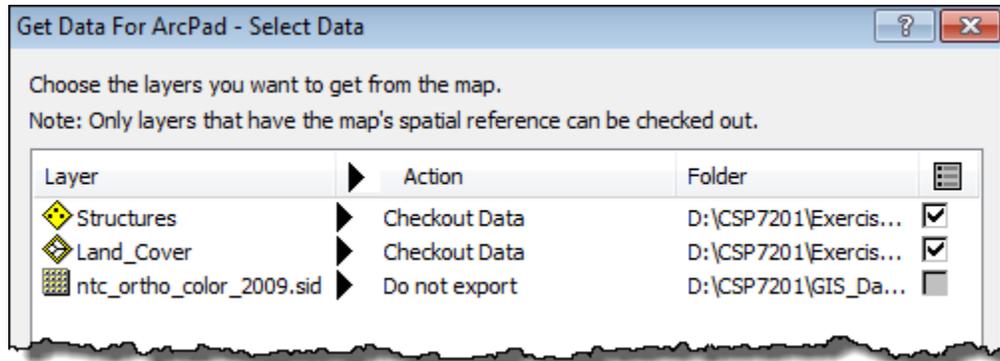
Coded Values:

Code	Description
Other	Other
Pearl	Pearl
Plascencia	Plascencia
Vilchek	Vilchek

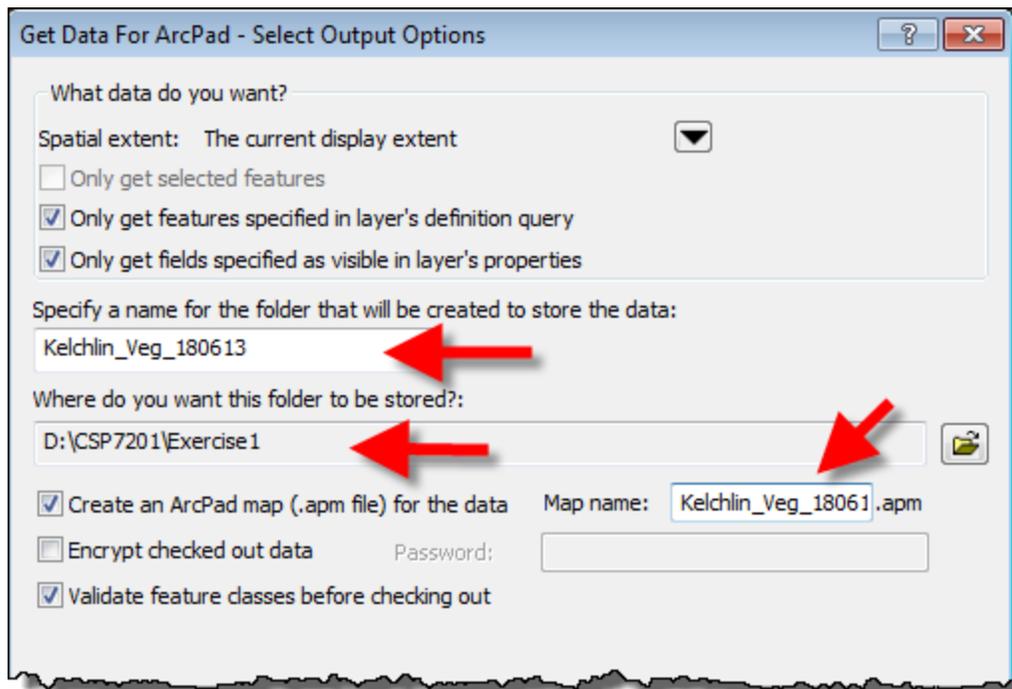
5. Next, examine the field properties in the two feature classes: **Land\_Cover** and **Structures**.
  - Right-click on the feature class and select the Fields tab.
  - What fields have domains assigned to them?  
\_\_\_\_\_
  - What fields have default values?  
\_\_\_\_\_
6. Start an editing session, open **Land\_Cover** attribute table, and double click on the empty record to see how the domains act like drop-down menus. This is a good way to test if you're domains are associated to the fields and working correctly before heading out into the field.
7. Stop editing and don't save edits.

### TASK 3 – Check Out the Data

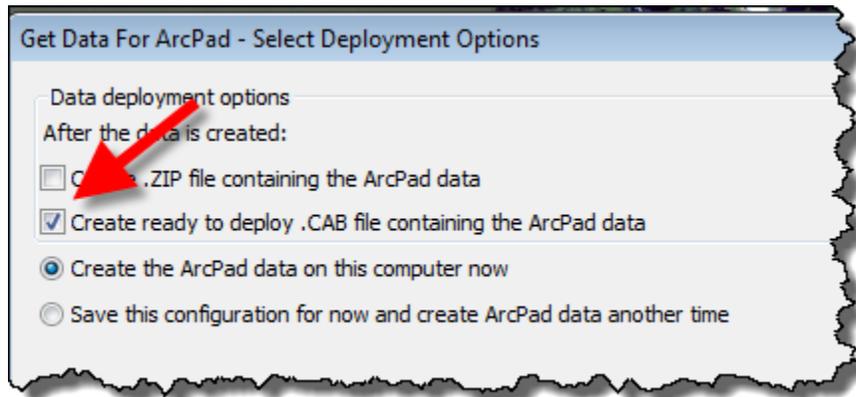
1. Ensure that you have the ArcPad Data Manager Toolbar visible. Click on the Get Data for Arcpad  button.
2. Click the **Action** column header and select **Check Out all geodatabases layers and copyout all other layers**. Do not export the imagery.



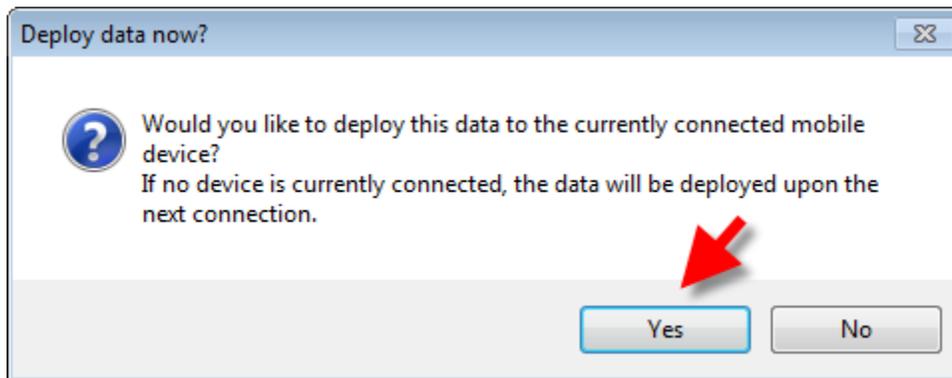
3. Click **Next** on the Select Picture Options dialog.
4. Name your project folder and ArcPad map using the following the ***last name\_project title\_ddmmy*** naming convention as shown below. Click **Next**.



5. Create a .CAB file. Click .



6. Click OK at the report dialog.
7. Click **Yes** to deploy the CAB file onto your Trimble unit. Overwrite any existing files.



8. Follow the instruction on the Trimble unit to finish installing the CAB file.

NOTE: **DataForArcPad** will be the default file name for CAB files. It would be a really good idea to change the name on the Trimble unit if you want to check out multiple projects or work on a project for longer than a day. You can quickly do this from the Windows Mobile Device Center on your PC. The file is located in the My Documents folder on the Trimble.

Tips when checking out raster images for ArcPad projects:

- ✓ The raster image, when clipped to the extent, cannot exceed 50 MB in size.
- ✓ The raster image must be in the same datum and coordinate system as the vector layers or else you won't be able to use it in the ArcPad project.
- ✓ You must change the format to JPG2000 or TIFF at check out to avoid sending the entire image to ArcPad.

**TASK 4 – Open the Project on your Mobile Device**

It's always good practice to open ArcPad on your mobile device and make sure all your data came over correctly before you head-out into the field.

1. Open ArcPad on your Trimble unit by single tapping the large ArcPad Icon on the Today Toolbar. It will take about 20 seconds to load.



2. Tap the **Choose map to open** button on the Welcome Dialog.
3. Highlight the map on the list (you should only have one right now) and tap the  button at the bottom left of your screen to open the map.

4. Tap on the Table of Contents icon  and see if your layers are present.

5. If your layers are present, then simply tap the Quick Action Toolbar  and select **Exit**.

6. Tap **No**, do not save any changes. Get ready to head-out and collect field data.

## TASK 5 – Checking In GPS Field Data

In this exercise you will update your **Exercise1.gdb** geodatabase with newly collected GPS field data using ArcPad's Data Management Toolbar.

1. Exit ArcPad on your mobile device if you haven't done so already. Connect the GPS device to your computer via Windows Mobile Device Center (WMDC).
  - Navigate to your **My Documents** folder on the Trimble unit from the File Management WMDC dialog.



- Copy the **DataForArcPad** folder (or whatever you named the CAB file folder) and paste in the **Exercise1** folder on the PC. You can replace the existing checked out folder if asked, but it's not necessary.
- Reopen the ArcMap document we saved earlier in the day and start an editing session.
- On the ArcPad Data Manager Toolbar, click the **Check In Edits From ArcPad**  button.
- Click the **Browse for ArcPad AXF files**  button and browse to the **Exercise1.gdb.axf** file in your ArcPad project folder. Click .
- Click **Select All** and **Check In**. Click **Yes** and then **OK** to accept the updates.
- Click  to close the Check in window.
- Stop editing and save your edits.
- Open the attributes table to view your new records. Mmmmm, tasty data.

**Congratulations, you just updated your file geodatabase with GPS field data!**

## Exercise 2 – Editing and Topology

**Session Objectives:** At the conclusion of this session, you will be able to:

- Delineate & attribute a simple land cover map
- Create a Topology feature class and add rules
- Validate the topology
- Fix topological errors in a feature class

**Material Created By:** Karen Klinger (Dec 2008)

**Revision:** Gabriel DeAlessio (May 2010)

**Revision:** Eric Kelchlin (May 2013)

**Software:** ArcGIS 10, SP5

**Directory Path:** D:\TEC7201\Exercise2

**GDB:** Exec2.gdb

**Imagery:**

**MXD:**

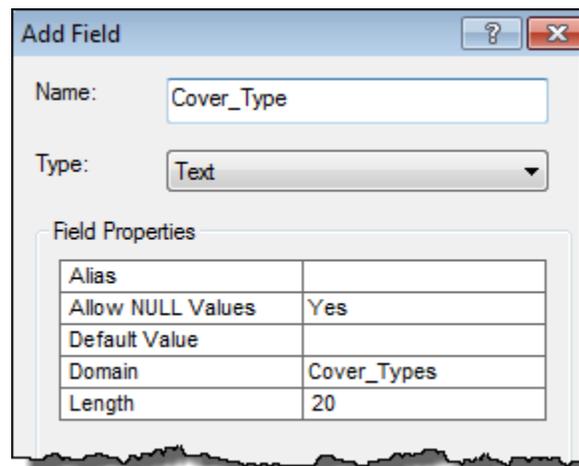
## SECTION 1 – Heads-up Digitizing in ArcMap 10

Digitizing landscape features from aerial photos or satellite imagery represents the most basic technique of mapping vegetation. Sometimes this level of detail is all you need, or in most cases, all you can afford giving time and budget constraints. This technique works best for general land cover features such as forest, grassland, agriculture and developed land. Small plant communities or species of interest that are poorly defined in the imagery can be captured with a GPS unit on the ground and added to the map later on.

**All data are located in D:\CSP7201\Exercise2, unless otherwise stated.**

### TASK 1 – Add a Domain and New Field

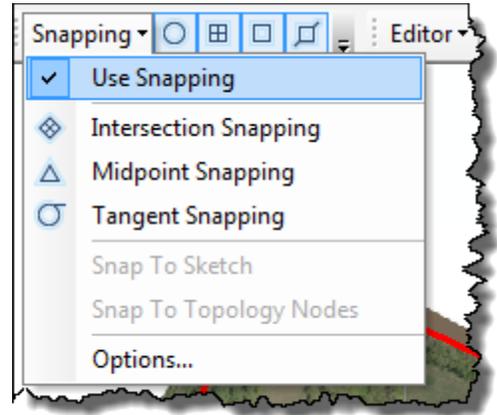
1. Launch ArcMap and open the **Exec2.mxd**.
2. To make attributing polygons easier, let's add a **Cover\_Type** field and a domain to generate a simple drop-down list.
  - First, create a new domain. Open ArcCatalog on the sidebar and right-click on the **Exercise2.gdb**. Select Properties and the Domains tab.
  - Name the new domain **Cover\_Types** and add a description.
  - Change the Field Type to Text and add the following cover types in both the Code and Description fields: Forest, Field, Developed and Water.
  - Open the **Land\_Cover** attribute table and create the new **Cover\_Type** text field. Give the field a text length of 20 and assign the domain we just created to the domain field.



## TASK 2 – Set Editing Preferences and begin Editing

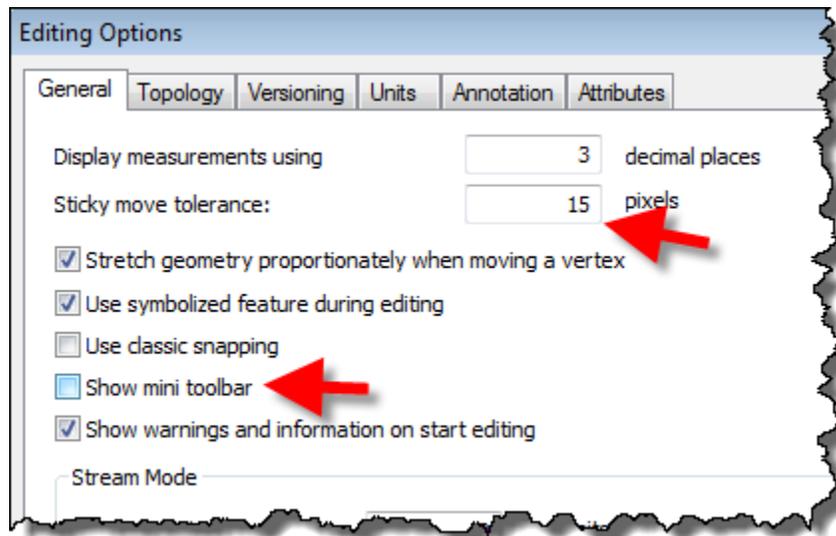
1. From the **Editor** Toolbar, select Snapping > Snapping Toolbar. Dock the new toolbar.

2. From the Snapping Toolbar select Options and ensure the Snapping Tolerance is set to 10 units. Also, make sure to enable Use Snapping by selecting it.



3. From the Editor Toolbar, select Options and ensure that the Sticky move tolerance is set to 15-20 pixels to avoid accidental polygon moves.

- Also, uncheck the Show mini toolbar box to hide a really annoying tool.

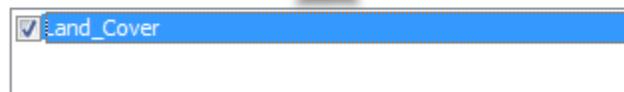


4. Click on the Attributes tab and have the attribute dialog pop-up after each polygon is created.

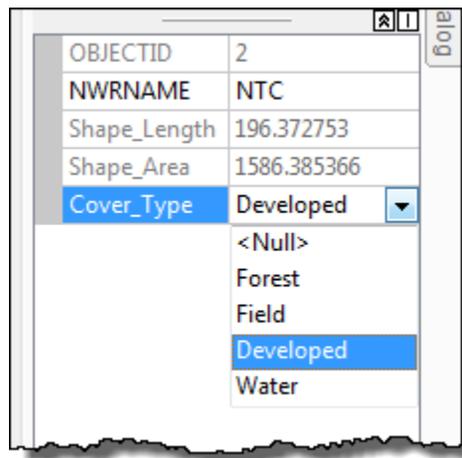
You can choose to have the attributes dialog appear for every layer or for specific layers.

- Display the attributes dialog before storing new features

- For all layers
- For the following layers



5. Start an editing session from the Editor Toolbar. The objective is to create polygons that are perfectly aligned so there are no gaps, dangles or overlaps. To do this you start from a single polygon, like we have here, and digitize new smaller polygons using the Cut Polygon Tool.
  - First select the single large polygon using the Edit Tool .
  - Zoom into the area you want to work-on using the mouse scroll wheel.
  - Select the Cut Polygon Tool  from the Editor Toolbar. In order to make a cut you use one of two strategies:
    - i. Start cutting the smaller polygon outside the boundary of the larger selected polygon and then double-clicking outside again to complete.
    - ii. Overlap the polygon on itself to finish the cut. This works great for smaller land cover features that are “islands” within the large selected polygon.
6. Assign the polygon a cover type by first selecting the polygon with the Edit Tool , then click the Attribute Tool  and select the cover type from our domain that we created earlier.



7. Repeat these processes for a few more polygons to get the idea. If you make a mistake remember that the Undo Tool  is a lifesaver!
8. Stop Editing and Save Edits.

## SECTION 3 – Heads-up Digitizing with Topology

### TASK 1 - Establish Topology Rules

The land cover layer you just built was created without topology rules and as a result, the layer has no topological integrity. In layman's terms; the polygons may or may not border each other correctly.

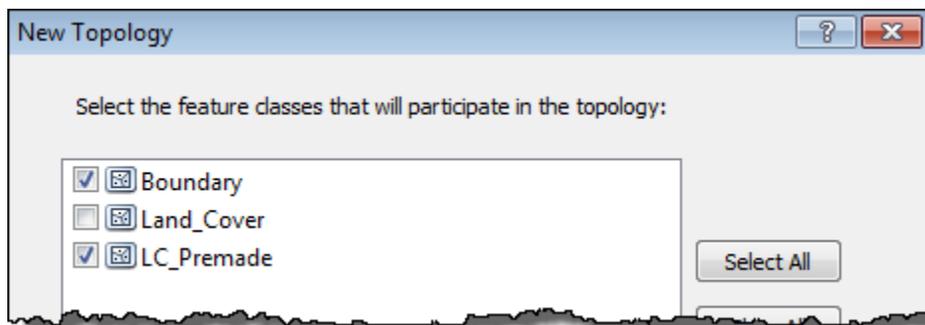
In this part of the exercise, we will use the LC\_Premade feature class, one that has common errors that sometimes occur when editing. Some polygons overlap their neighbors, while others don't come close enough and leave gaps. We're going to apply the following topological rules (i.e., relationships) in the geodatabase to clean-up the mess:

**Rule 1** A polygon cannot exist in the space as another polygon or overlap;

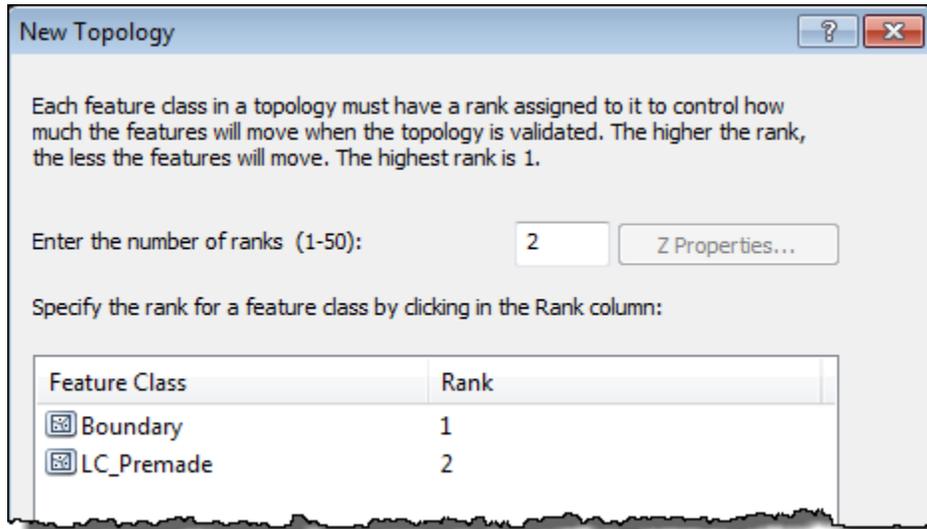
**Rule 2** All polygon boundaries are contiguous and there are no gaps between polygons; and

**Rule 3** **LC\_Premade** feature class must cover the **Boundary** feature class.

1. Close ArcMap and open ArcCatalog.
2. To make a new topology, simple browse to the **Exercise2.gdb**. Right-click on the **NCTC** feature dataset, select **New** and choose  **Topology**.
3. A **New Topology** dialog appears. Read the overview information. Click Next.
4. Name the new topology **Landcover\_Topology**. Accept the default tolerances. Click Next.
5. Select **Boundary** and **LC\_Premade** to participate in the topology. Click Next.

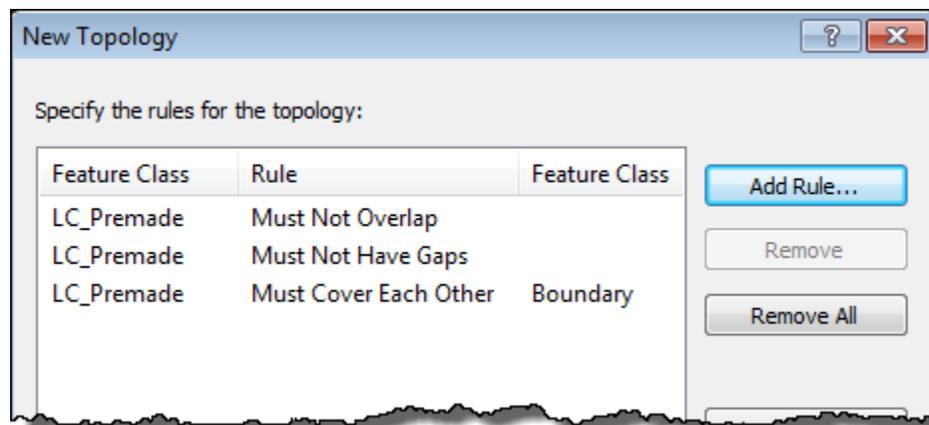


6. Enter the number of ranks to be **2**. Then, change the rank values as shown below. Click Next.



**What does this ranking mean?** Feature classes of a lower rank will be snapped to feature classes of a higher rank. So, in this example, the landcover layer will be adjusted to the boundary layer. The boundary is ranked the highest because we want to minimize any adjustment of this feature.

7. Select **Boundary** and **LC\_Premade** to participate in the topology. Click Next.
8. Use the  button to add the following 3 rules:



9. Click OK when finished adding the topology rules. A summary appears in the New Topology dialog. Click Finish.
10. Choose **NO** when asked to validate the topology. We will validate the topology and fix any errors using ArcMap in the next section.

## Why did we select these topology rules?

**Must Not Overlap** – Requires that the interior of polygons in the feature class not overlap. The polygons can share edges or vertices. This rule is used when an area cannot belong to two or more polygons. It is useful for modeling administrative boundaries, such as ZIP Codes or voting districts, and mutually exclusive area classifications, such as land cover or landform type.

**Must not have gaps** – This rule requires that there are no voids within a single polygon or between adjacent polygons. All polygons must form a continuous surface. An error will always exist on the perimeter of the surface. You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, soil polygons cannot include gaps or form voids—they must cover an entire area.

**Must Cover Each Other** – Requires that the polygons of one feature class must share all of their area with the polygons of another feature class. Polygons may share edges or vertices. Any area defined in either feature class that is not shared with the other is an error. This rule is used when two systems of classification are used for the same geographic area, and any given point defined in one system must also be defined in the other. One such case occurs with nested hierarchical datasets, such as census blocks and block groups or small watersheds and large drainage basins. The rule can also be applied to nonhierarchically related polygon feature classes, such as soil type and slope class.

For complete listing of rules and fixes, open the ArcGIS help and look up topology rules.

## TASK 2 – Validate Topology & Must Cover Each Other Errors

1. Close ArcCatalog and return to ArcMap.
2. Add the topology to the map. Click **Add Data** and browse to the topology.
  - When prompted, click **Yes** to add all associated feature classes.
3. Zoom to Full Extent  if the entire boundary is not visible. It's time to validate to see to see if and where errors exist within the feature classes.
4. Right-click in the top menu section of ArcMap and check the box next to Topology to load the toolbar.
5. Start an editing session.
6. Click the **Validate Entire Topology**  button.



7. Click **Yes** when asked if you are really sure you want to validate the full extent. Yikes, look at all that red!
8. Click the **Error Inspector**  tool. This tool allows you to manage and interact with the topology errors on your map. You can search for violations of specific topology rules or for exceptions (errors that you mark as acceptable). You can also choose whether to inspect the currently visible extent or the entire topology.



9. Click the **Search Now** button. You should find 21 errors total.

Error Inspector

Show: <Errors from all rules> 21 errors Search Now  Errors  Exceptions

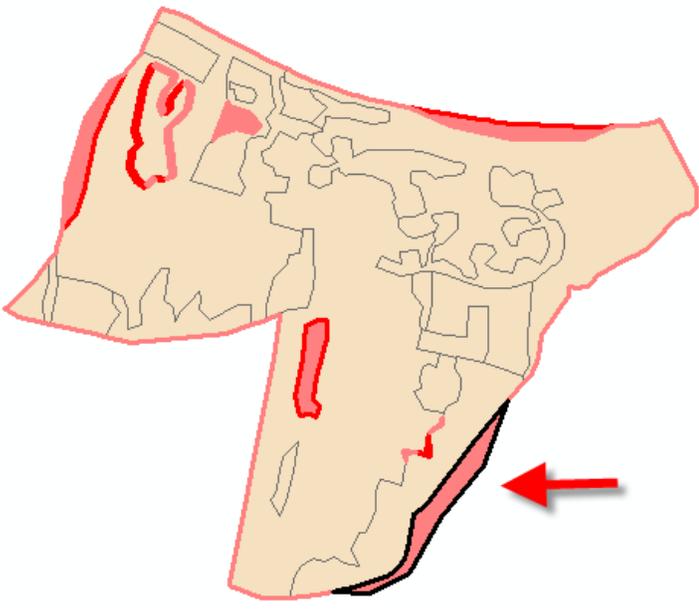
Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False
Must Not Have Gaps	LC_Premade		Polyline	0	0	False

- Click on Down Arrow and Select **Must Cover Each Other**. Click **Search Now**.
- Click on the first error in the Error Inspector. Notice how the identified error turns black on the map.

Error Inspector

Show: LC\_Premade - Must Cover Each Other - Boundary 9 errors Search Now  Errors  Exceptions

Rule Type	Class 1	Class 2	Shape	Feature 1	Feature 2	Exception
Must Cover Each Other	LC_Premade	Boundary	Polygon	4	0	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	0	1	False
Must Cover Each Other	LC_Premade	Boundary	Polygon	13	0	False



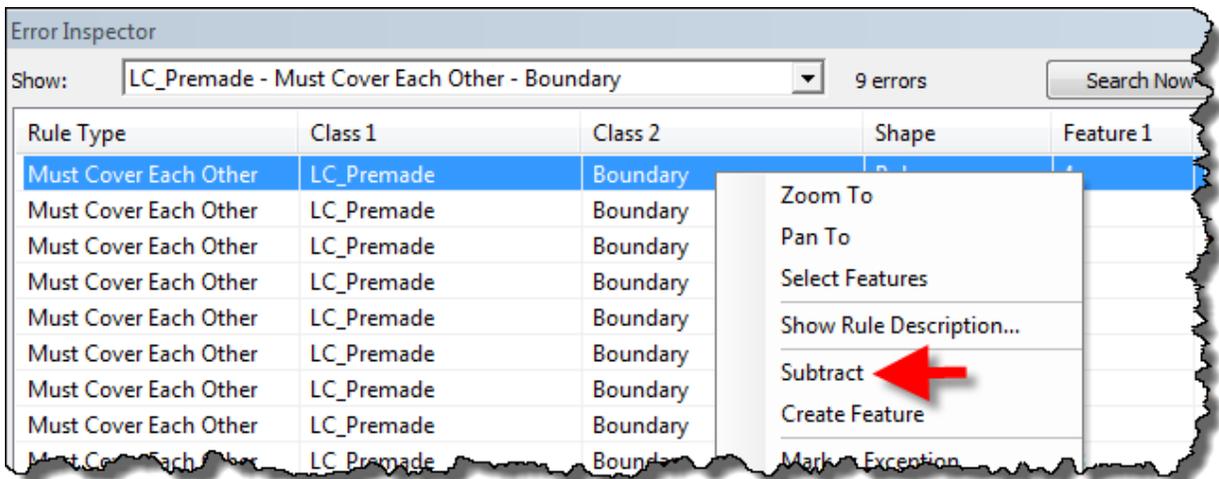
12. Close inspection reveals that the polygon lies outside the NCTC Boundary.

To fix errors identified by the **Must Be Covered By Feature Class Of** rule we have two options:

**Subtract:** removes the overlapping portion of each feature that is causing the error so the boundary of each feature from both feature classes is the same.

**Create Feature:** creates a new polygon feature out of the portion of the overlap from the existing polygon so the boundary of each feature from both feature classes is the same.

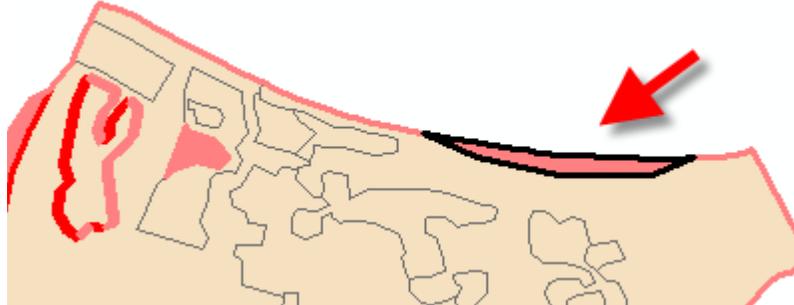
13. With this error selected, **Right click** on the selected line inside the dialog and select **Subtract**. This will remove this area completely from the **LC\_Premade** layer (reshaping the layer's boundary). **Do not use Create Feature as this fix will modify the NCTC Boundary, which we know is correct and don't want to change.**



- Now let's **Validate Entire Topology**  again to make sure we fixed the problem.

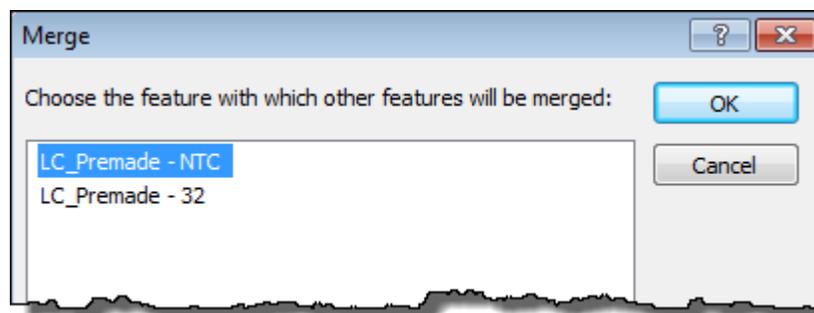
14. Another way to correct topology is to use the **Fix Topology Error Tool** . Activate the tool on the toolbar by **left clicking** on it.

- With the tool active, select the error in the northeast.



15. Looking closely will reveal that there is a gap in the landcover between the NCTC Boundary and the existing landcover polygons. To correct, we need to **right click** and select **Create Feature** to add in a polygon.

- Once the feature is added, open the **Attribute** tool. You will notice that it lacks any attribute data. You can code it individually or choose to merge it to an adjacent feature.
- **Select**  both the new polygon and the Forest polygon to the south. Then in the **Editor Menu**, select **Merge**. Be sure to select the feature with attributes to Merge to rather than the new one to retain those attributes!



- Now let's **Validate Entire Topology**  again to make sure we fixed the problem.
- Notice this error is gone now. Leave the remaining errors for now, we'll fix them later.

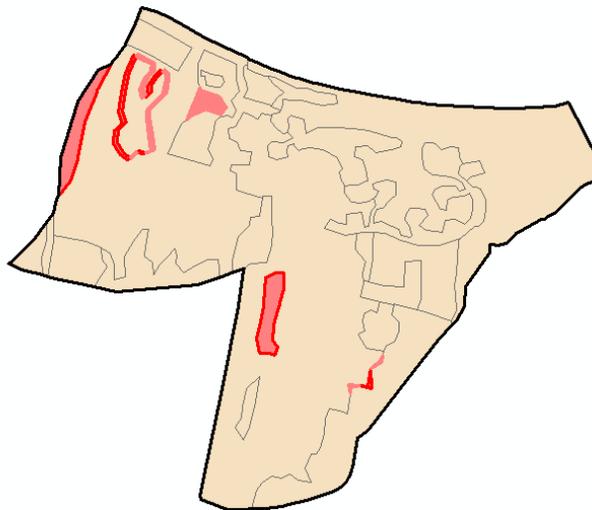
### TASK 3 – Must Not Have Gaps

In this section we'll examine the MUST NOT HAVE GAPS errors. This is one of the few rules that will ALWAYS generate an error. This is because you will always have an 'end' to your polygons extents, and therefore a 'gap' where they do not touch another. We will start by marking this error as an exception

#### Must Not Have Gaps

This rule requires that there are no voids within a single polygon or between adjacent polygons. All polygons must form a continuous surface. **An error will always exist on the perimeter of the surface.** You can either ignore this error or mark it as an exception. Use this rule on data that must completely cover an area. For example, soil polygons cannot include gaps or form voids—they must cover an entire area.

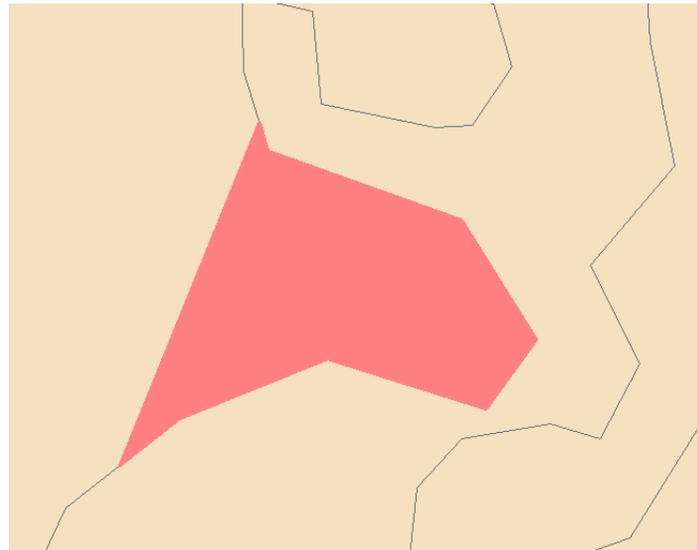
1. Click on the **Fix Topology Error Tool**  and click on the boundary so that it has a black outline.



- Click the **Error Inspector**  button. Notice there is only one error shown. Since this one error will always show up when we inspect, let's make it an exception so it won't appear again. That way, only the errors we are concerned with will be displayed.
- Right click on the error in the Error Inspector dialog and choose **Mark as Exception**.
- **Validate the Entire Topology** again to make sure we fixed the problem.
- Close the **Error Inspector** dialog.

**Tip:** If you need to go back to the error you marked as an exception, in the Error Inspector check Exceptions and click Search Now. Notice if you Right click on the Exception you can choose Mark as Error.

2. Let's look at actual errors now. Zoom into the error as shown below.



- Click the **Error Inspector**  button.
- Click the **Search Now** button to quickly find this error.
- Select the error in the Error inspector dialog. The polygon should have a black outline.
- To fix this error – Right click and select **Create Feature**, which will create a new polygon feature within **LC\_Premade** (getting rid of the gap). If you had multiple errors and use selected them all and used the Create Feature fix, the result will be one polygon feature per gap. So, be careful.

3. Open the Attribute table and Attribute the new polygon to Developed.

OBJECTID	35
NWRNAME	<Null>
Classification	Developed
Acreage	
Shape_Length	459.507047
Shape_Area	8962.922456

4. **Validate the Entire Topology** again to make sure we have fixed the problem.

TIP: After any polygon editing session; including the subtracting and creating and merging we just did, remember your Acreages are no longer accurate! ALWAYS recalculate your Acreages after editing shapes.

#### TASK 4 – Must Not Have Overlap

In this section, we will zoom-in to an area where polygons are overlapping. Since a land cover can only have 1 attribute per location, these are errors that need to be corrected. Overlapping polygons also lead to double counting of acreages.

1. Zoom to full extents .
2. Click the **Error Inspector**  button. Click **Search Now**.
3. Select the “**Must Not Have Overlap**” error to identify the error on the map.

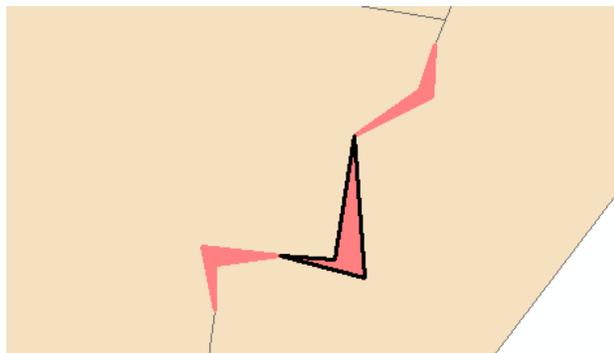
To fix errors identified by the **Must Not Have Overlap** rule we have **3** options within the error inspector:

**Subtract:** removes the overlapping portion from each feature and leaves a gap or void in its place. This fix can be applied to one or more selected Must Be Covered By Feature Class Of errors.

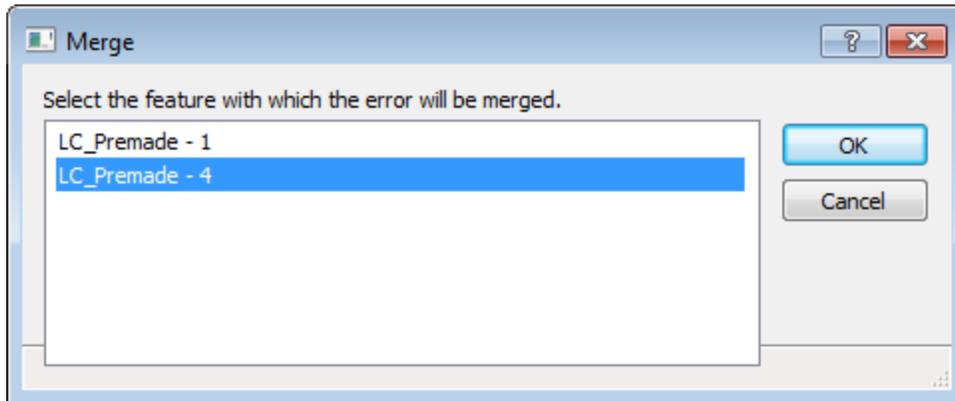
**Merge:** adds the portion of overlap from one feature and subtracts it from the others that are violating the rule. You need to pick the feature that receives the portion of overlap in the Merge dialog box that pops up. This fix can be applied to one Must Not Overlap error only.

**Create Feature:** creates a new polygon feature out of the error shape and removes the portion of overlap from each of the features. The fix can be applied to one or more selected Must Be Covered By Feature Class Of errors.

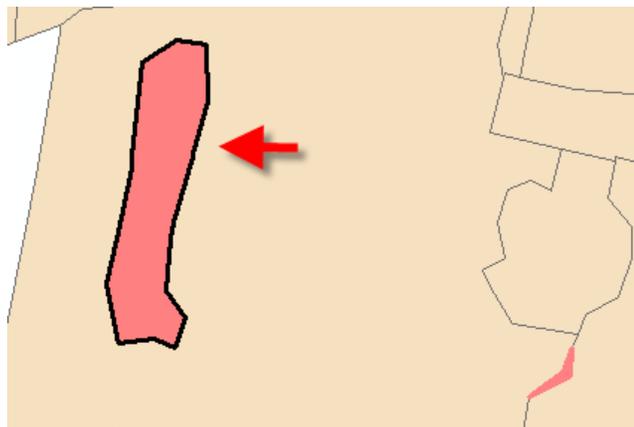
4. Select the error highlighted below using the **Fix Topology Error Tool** 



- Right click on the topology and select **Merge**. **Do Not** use Create Feature (which will make new polygons) or Subtract (which will create slivers in the LC\_Premade feature class).
- Based on the underlying land cover, select the second feature on the list and click **OK**.



- **Validate the Entire Topology** again to make sure we fixed the problem.
5. Next, select the large overlapping error as shown below. We need to make sure only 1 polygon exists.



- **Right click** and choose **Create Feature**. This forces 2 simultaneous actions: 1) it subtracts the shape from the underlying polygon and 2) it creates a new feature in the same location.
- Identify on the new feature. You will notice the attribute has been lost since the Create Feature removes the existing and replaces it with a new polygon. You can attribute the new polygon to Forest.

OBJECTID	36
NWRNAME	<Null>
Classification	Forest
Acreage	<Null>
Shape_Length	775.233606
Shape_Area	20373.875404

- **Validate the Entire Topology** again to make sure we fixed the problem.
  - Stop editing and save edits.
6. If time permits: Using the skills learned in this exercise; restart editing and continue fixing any remaining topological errors. Remember to right-click on the Acreage field and Calculate the Geometry to generate the correct acres. It's not automatic.

The screenshot shows a software window titled 'Table' containing a table named 'LC\_Premade'. The table has columns for OBJECTID, Shape, NWRNAME, Classification, Acreage, Shape Length, and Shape Area. A context menu is open over the 'Acreage' column, with 'Calculate Geometry...' selected. The status bar at the bottom indicates '(0 out of 25 Selected)'.

OBJECTID *	Shape *	NWRNAME	Classification	Acreage	Shape Length	Shape Area
1	Polygon	NTC	Field	145.8	253	
3	Polygon	NTC	Forest	107.1	718	
4	Polygon	NTC	Forest	35.6	564	
6	Polygon	NTC	Developed	5.7	108	
7	Polygon	NTC	Developed	18.6	681	
8	Polygon	NTC	Developed	13.1	392	
9	Polygon	NTC	Shrub	5.1	143	
10	Polygon	NTC	Developed	6.	158	
11	Polygon	NTC	Shrub	6.3	884	
12	Polygon	NTC	Field	11.1	152	
13	Polygon	NTC	Forest	107.2	831	
14	Polygon	NTC	Shrub	3.4	013	



## **Exercise 3 – Creating an ArcPad Project for Navigating to and Classifying Forest Polygons in the Field**

**Session Objectives:** At the conclusion of this session, you will be able to:

- Create a geodatabase with domains to standardize and simplify data collection in the field.
- Create a custom data form using ArcPad Studio.
- Use ArcPad navigate to forest polygons in the field and populate the database with the appropriate association using a dichotomous key.
- Check in field data and update a geodatabase using ArcPad Data Management Tools.

**Material Created By:** Eric Kelchlin, May 2013

**Revision:**

**Software:** ArcGIS 10 SP5, ArcPad 10 SP3

**Directory Path:** D:\CSP7201\Exercise3

**MXD:** Exec3.mxd

**GDB:** Exercise3.gdb

**Imagery:** none

**Tables:** Veg\_Domins.xlsx

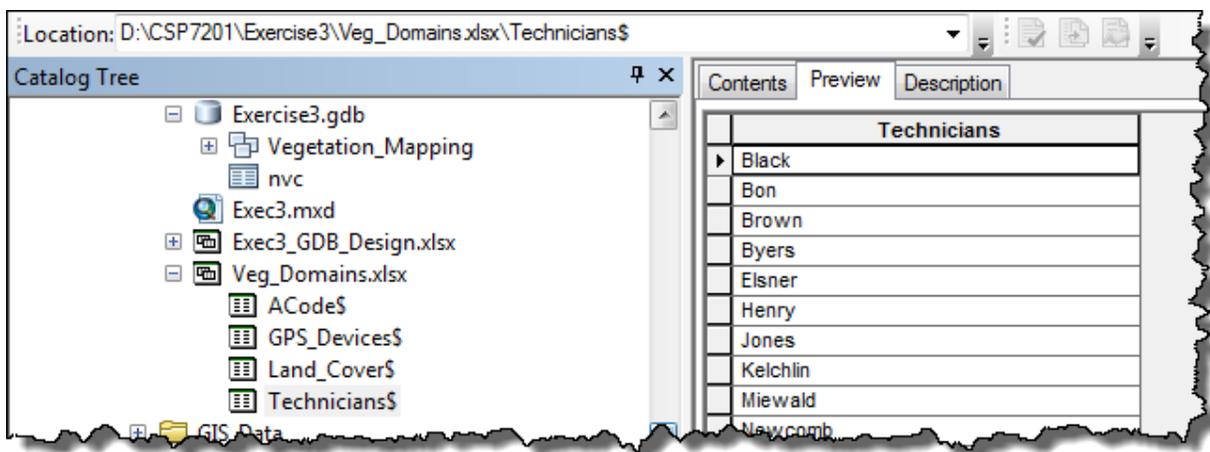
This exercise shows you how to create a relational geodatabase with drop-down menus (i.e., domains) for use with ArcPad in the field. We'll be going outside to examine forest polygons that were classified from infrared imagery using eCognition software. Our goal is to take a compact database into the field, navigate to individual polygons and update fields in the database from drop-down menus. We'll be using a paper dichotomous key of forest associations that was created by ecologists from the West Virginia Natural Heritage Program. This key was the product of 22 vegetation plot assessments done on the NCTC campus in 2011.

### TASK 1 – Add Domains to the Geodatabase to Create Drop-down Menu's

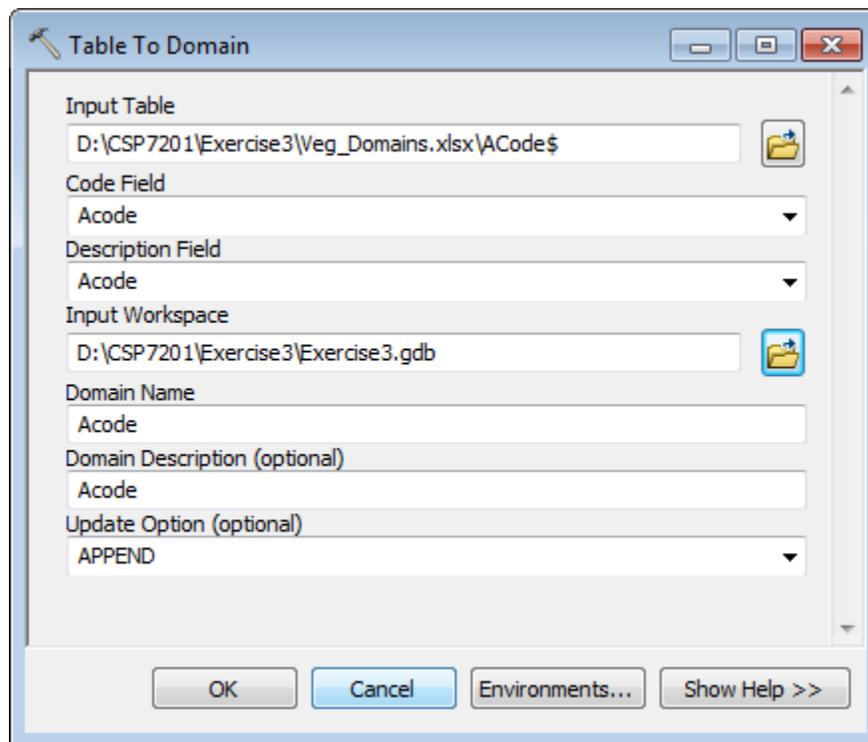
As we've already seen, domains are a great way to standardize attributes and speed-up data collection in the field. Why waste time typing when you can simply select items from a drop-down list? This section shows you how to import a list of values from Excel spreadsheets into the geodatabase and quickly create the domains.

**All data are located in D:\CSP7201\Exercise3, unless otherwise stated.**

1. We need to add 2 domains to the geodatabase. Launch ArcCatalog and familiarize yourself with the **Veg\_Domains.xlsx** worksheets.
  - Notice that each list in the worksheet starts with a header. This header should never be a reserved word, like "Percent", or "Date". Also, don't use special characters like "%". If you fail to follow these simple rules the geodatabase layers that are assigned to the domains will not show-up in ArcPad, or will just behave unusual.



2. Import the Technician and ACode worksheets into the geodatabase using the Table to Domain Tool.
  - Use the **Search** tool on the sidebar in ArcCatalog to locate and launch the **Table to Domain Tool**.
  - Get an Error? Then you're curser is still on an Excel worksheet in the file tree. ArcCatalog loves to lock files down. Best to just shut down ArcCatalog and try again.
3. Follow the following guidelines when using the Table to Domain Tool:
  - The **Code** and **Description** fields will be the same for each domain.
  - The input workspace will be the **Exercise3.gdb** geodatabase.
  - Make sure the Domain Name is the same as that listed on the data form.

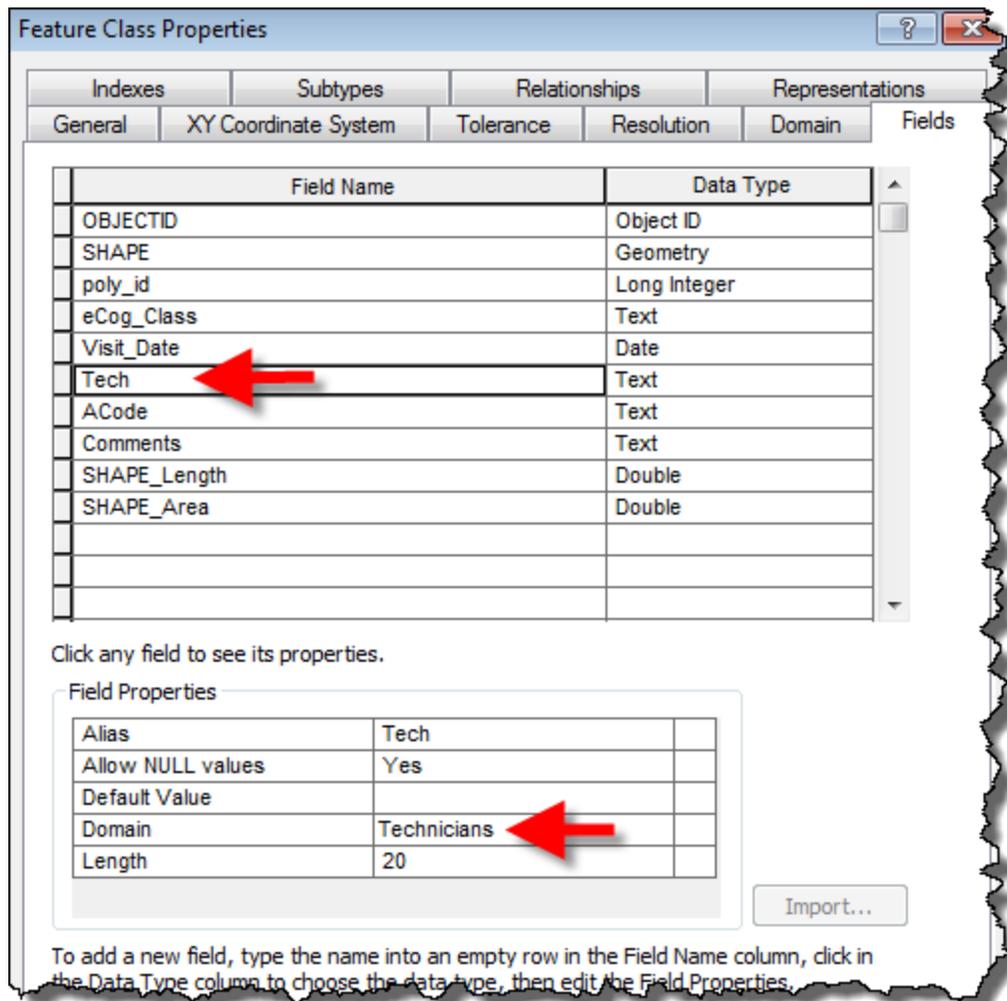


4. Right-click on the **Exercise3.gdb**, select Properties and the Domains tab to verify that the domains were successfully imported.

## TASK 2 – Assign the Domains to the Fields

Now that we have our domains in the can, our next objective is to assign (i.e., link) the domains to the appropriate fields in the feature class.

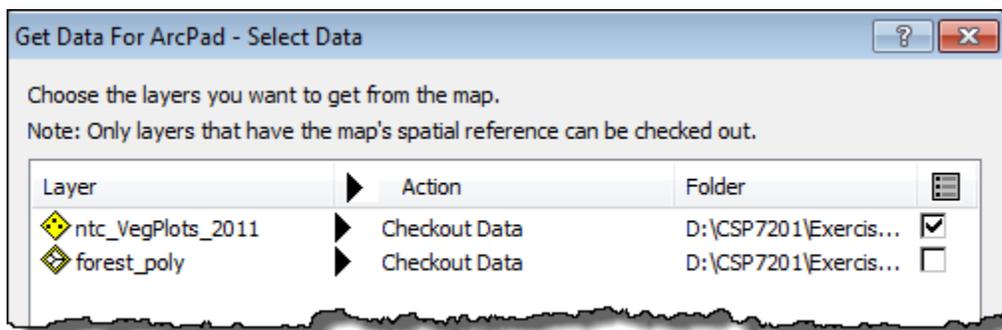
1. Right-click on the **forest\_poly** feature class and select **Properties > Fields** tab.
2. Assign the domains to the **Tech** and **ACode** fields by clicking the respective field, and then in the Field Properties section select a domain from the drop-down list in the Domain field. Click Finish when done.



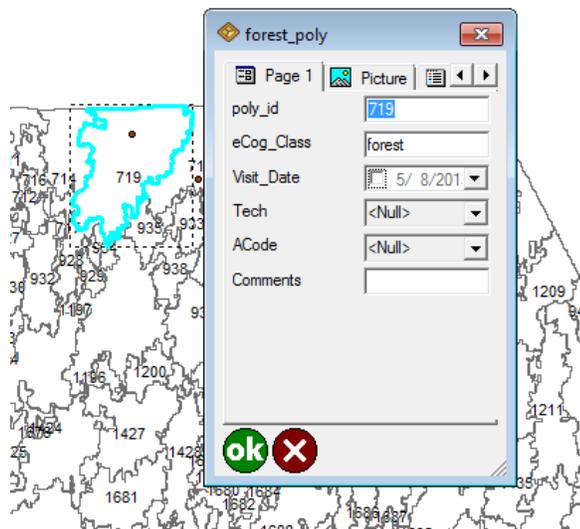
### TASK 3 – Preview the Data in ArcPad

This section shows you a quick way to test the domains and view the default data form in ArcPad on your PC before you go into the field. We're going to do this right now because I want you to see what you get straight out of the box without any customization.

1. Launch the **Exec3.mxd** from within ArcCatalog.
2. Check out the data using ArcPad Data Manager as a ready to deploy CAB file as before. However **DONOT** have it automatically sent out to your GPS unit.
3. Name the project **Forest**.



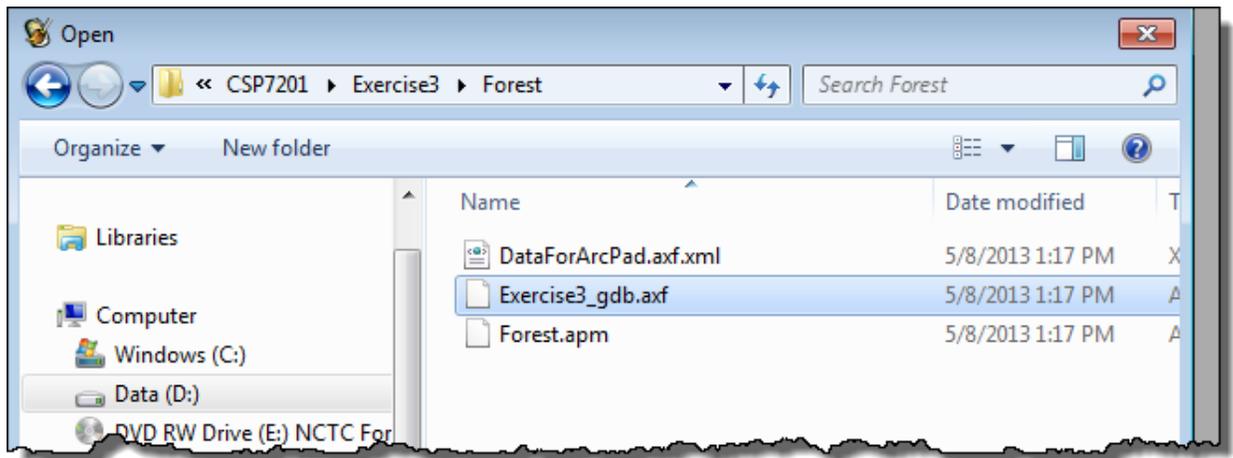
4. Launch ArcPad from your PC and open the ArcPad map document (.apm).
5. Start an editing session on the forest\_poly layer and double click on one of the polygons using the select tool (i.e., the big blue arrow) to call up the data form.
6. Check to see if you have drop-down lists for the Tech and ACode fields.



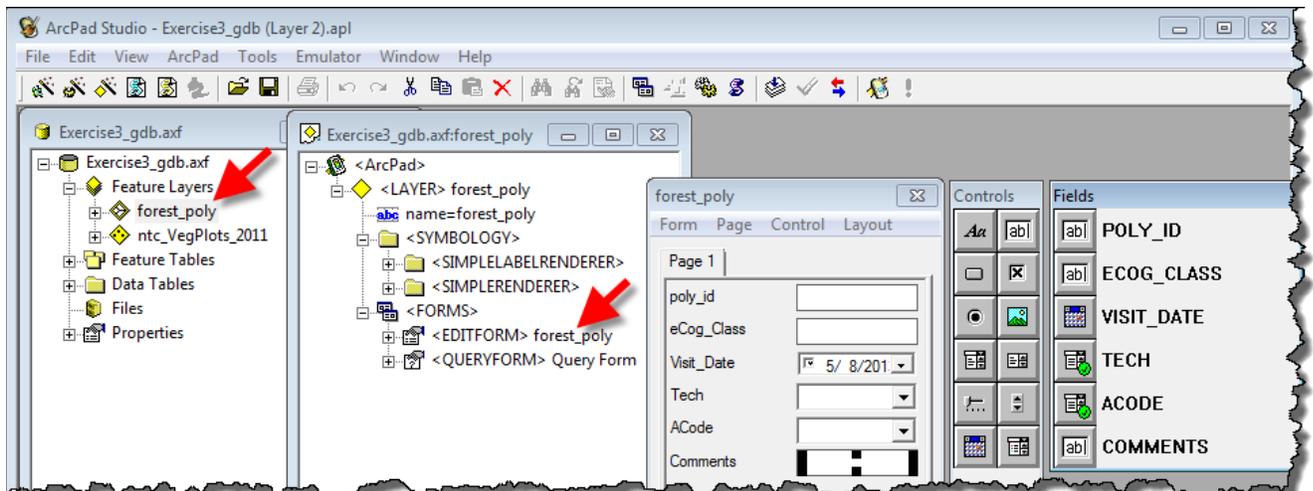
## TASK 5 – Customize the Data Form

ArcPad Studio contains many powerful toolsets to modify ArcPad's look and feel, however, the program is far from user friendly. This quick exercise is designed to ease you into modifying standard toolbars in ArcPad Studio.

1. Close ArcPad and launch ArcPad Studio.
2. Browse for files and open the **Exercise3\_gdb.axf** file located in the Forest project folder.

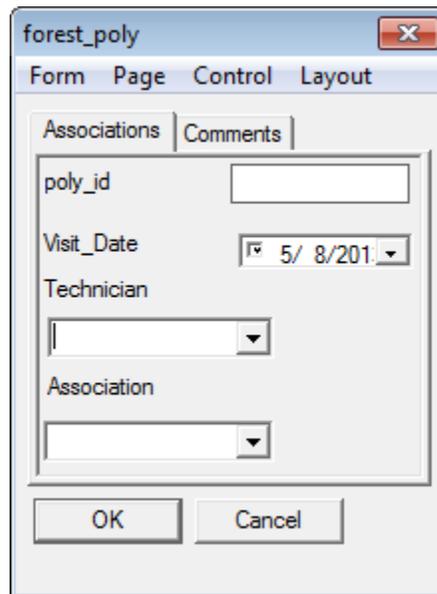


3. Double-click on the **forest\_poly** layer, then double-click on the **<EDITFORM> forest\_poly** form to start editing the default data form.



4. Let's remove and modify some of these data fields:

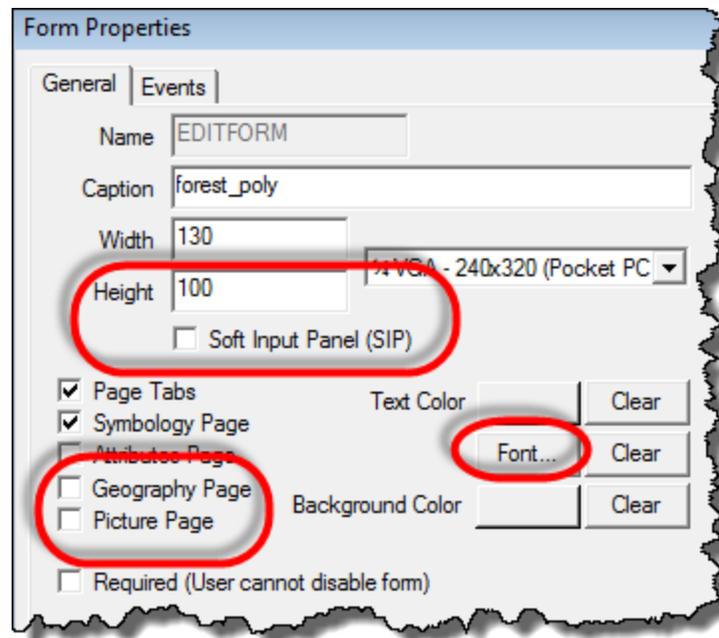
- Select the **eCog\_class** text and hit the delete key to remove it. Do the same for the eCog\_class field box.
- Delete the Comments text and field box.
- Double click on the Tech and ACode text fields and change the names to Technician and Association, respectfully.
- Move the fields into a configuration as shown below:



The screenshot shows a window titled "forest\_poly" with a close button in the top right corner. Below the title bar are tabs for "Form", "Page", "Control", and "Layout". The "Form" tab is selected, and within it, there are sub-tabs for "Associations" and "Comments". The "Comments" sub-tab is active, showing a form with the following fields: "poly\_id" (text input), "Visit\_Date" (date picker showing "5/ 8/201"), "Technician" (dropdown menu), and "Association" (dropdown menu). At the bottom of the window are "OK" and "Cancel" buttons.

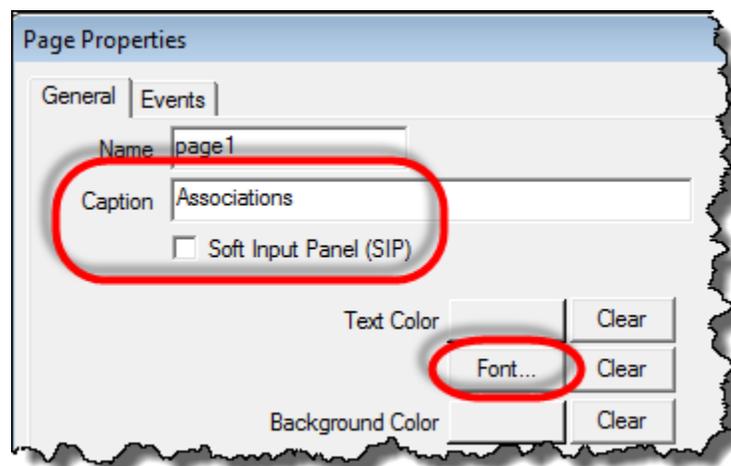
5. Click on the **Form** tab and select **Form Properties**.

- Give the form a Height of **100**.
- Uncheck the SIP box so the electronic keyboard does not pop-up automatically when the data form is loaded.
- Change the font to Aerial Bold size 9.
- Remove the Geography and Picture Tabs. Click **OK**.

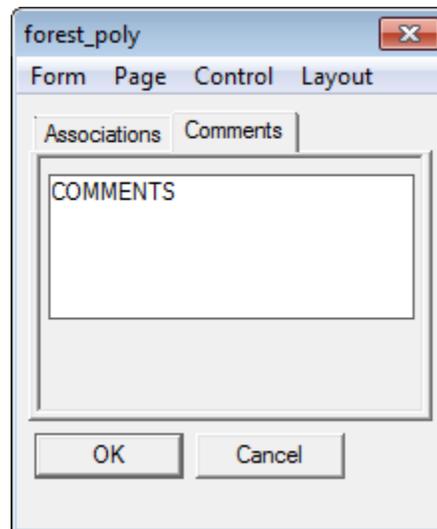


6. Click on the **Page** tab and select **Page Properties**.

- Change the caption to **Associations**.
- Uncheck the SIP box.
- Change the font to **Bold**, size **10**. Click **OK**.



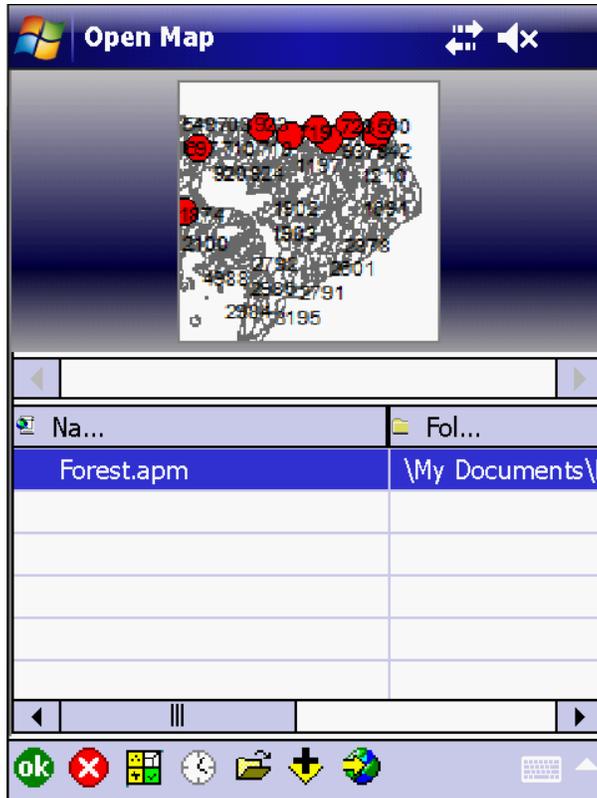
7. Click on the Page tab again, but this time select Add Page. A Page 2 tab will appear.
  - Click on the Page tab > Properties and name the new page Comments.
8. From the Fields dialog, select and drag the COMMENTS field over to the Comments form.
  - Drag the corners and side of the COMMENTS box to make the box larger.



9. Next, double-click on the Comments box and put a check next to the multiline option. This will allow the text to wrap, otherwise by default it does not.
10. Click OK when finished and click the  Save icon.
11. Close ArcPad Studio.
12. Open the Forest map again in ArcPad and see what you've created.

### TASK 4 – Send the Project to ArcPad

1. Using Windows Explorer or the Windows Mobile Device Manager, simply copy the Forest ArcPad project folder and past in My Documents on the GPS unit.
2. Open the project on your device to make sure it checked out correctly.





## **Exercise 4 - Sampling Design for a Thematic Accuracy Assessment**

**Session Objectives** - At the conclusion of this session you will be able to:

- Use ArcGIS to create sampling points, polygons and lines for a thematic accuracy assessment
  
- Check out the data to ArcPad and navigate to sampling sites in the field to conduct an accuracy assessment.

**Materials created by:** Eric Kelchlin (May 2010)

**Revision:** May 2013

**Software:** ArcGIS 10, SP5; ArcPad 10 SP3

**Directory Path:** D:\CSP7201\Exercise4

**Geodatabase:** Exercise4.gdb

**MXD:** AA.mxd

## Sampling Design for Thematic Accuracy Assessment

The objective of a thematic accuracy assessment is to verify the classification of the mapped polygons and use the data to create a confusion matrix. This matrix identifies how many times the polygon was correctly classified and how many times it was wrongly classified. In turn, users are informed of the limitations of the individual vegetation map classes and of the relationship of the errors between classes.

Sample size allocation must be taken into consideration to make reasonably precise statements about the accuracy of each map class. Table 1 by Lea and Curtis (2010) shows the sample size guidelines in relation to rarity of the map classes. A sample size of 30 samples will be allocated to more abundant map classes. Rarer map classes will have a minimum sample size of 5.

Furthermore, the sampled polygons must have a minimally sufficient size to accommodate most or all of the attributes that established the classification. This is known as the minimum thematic observation area (Table 2). The observation area should be equal to or greater than the minimum mapping unit (MMU) and the center point located far enough from the edge of the mapped polygon to avoid ecotones and GPS accuracy limitations. The default MMU (and thus the observation area) is 0.5 hectares, but this may be reduced or enlarged for map classes based on the spatial attributes of the vegetation stands represented by the classes and on cost and logistical issues (Table 3).

**Table 1. Sample size guidelines\***

Total Area of Map Class (Hectares)	Sample Size
> 50	30
8.33 - 50	Area x 0.6
< 8.33	5

**Table 2. Thematic observation area and corresponding buffer radius for GIS\***

Observation Area (Hectares)	Buffer Radius (Meters)
0.10	18
0.25	28
0.50	40
1.0	56

**Table 3. Range of minimal mapping unit (MMU) sizes for types of vegetation\***

<b>Vegetation Category</b>	<b>MMU (Hectares)</b>
Forests	0.25 – 1.0
Humid to Semi-arid Woodlands	0.5 - 1.0
Arid to Semi-arid Woodlands, Shrublands & Wooded Shrublands	0.5 – 1.0
Humid to Semi-arid Shrublands & Wooded Shrublands	0.1 – 0.5
Herbaceous and Non-vascular Vegetation	0.1 – 0.5

\* Lea, C. and A. C. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service Vegetation Inventory, version 2.0. Natural Resource Report NPS/2010/NRR—2010/204. National Park Service, Fort Collins, Colorado.

Another import issue to bring up with an accuracy assessment is observer bias. The general rule is the person who creates the vegetation map does not conduct the field work to assess the classification accuracy. The field crew should be experts in botany and be given a printed or digital map with only enough information for navigation to the site. The role of the GIS specialist during the accuracy assessment phase is to randomly sample the map classes and provide the field crew three sources of data:

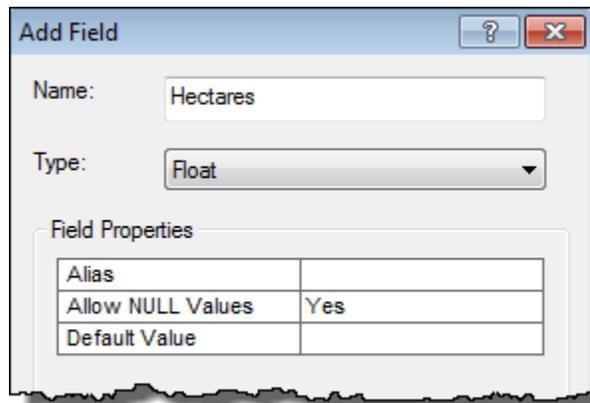
- Points that are centered or dispersed in each polygon so that they are far from the edge as possible. You can have multiple points within a single polygon if they vegetation map class covers a large area.
- Buffers that are centered on each point with an appropriate radius as shown in Table 1.
- If the buffers overlap the mapped polygon, then the GIS specialist will include the line work that intersects the buffer. This lets the field person know how far to evaluate the site while standing at the observation point without giving the whole shape of the polygon away.

This exercise shows you how to calculate the sample size, create centroid points within vegetation polygons, create buffers to delineate observation areas and clip the line segments that intersect the buffers. These data will then be checked-out to our GPS units running ArcPad for navigation into the field.

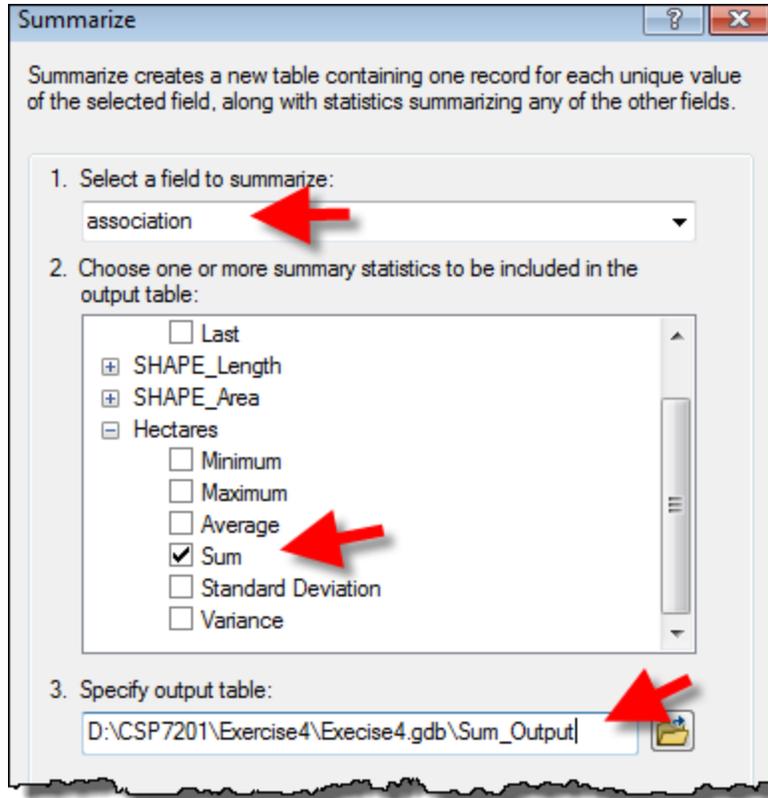
## STEP 1 – Calculate the Sample Size

**All data are located in D:\CSP7201\Exercise4, unless otherwise stated.**

1. Launch ArcMap  and open the **AA.mxd**.
2. The sample size is determined by the total number of hectares within each vegetation map class (see Table 1). The “map class” for our purposes will be the association field.
  - Open the **Forest** attribute table and add a new field . Make it a floating data type and name it **Hectares**.



- Right-click on the Hectares field and select Calculate Geometry. Click Yes to make the changes outside of an editing session.
- Change the units to Hectares and click OK.
- Next, summarize the total number of hectares by association and create a new table of the results. To do this simply right-click on the association field header and select Summarize.
- Select the fields as shown below and save the output to the **Exercise4.gdb** keeping the default file name.



- Select Yes to add the table to your Table of Contents. The list by source view will automatically be shown. It's a table thing.
  - Open the **Sum\_Output** table and view the results.
3. Next calculate the number of samples needed in the **Sum\_Output** table using Table 1 as a guide.
- Create a new integer field  and name it **Sample**.
  - Select the records that need only 5 samples. Double-click on the Hectares header to sort the records to make life easier.
  - Right-click on the Samples header and select **Field Calculator**. Type a **5** in the dialog under "Sample = " and select OK.
  - Switch the selection  and repeat the action. But this time use the following equation to calculate the sample size.

$$[\text{Sum\_Hectares}] * 0.6$$

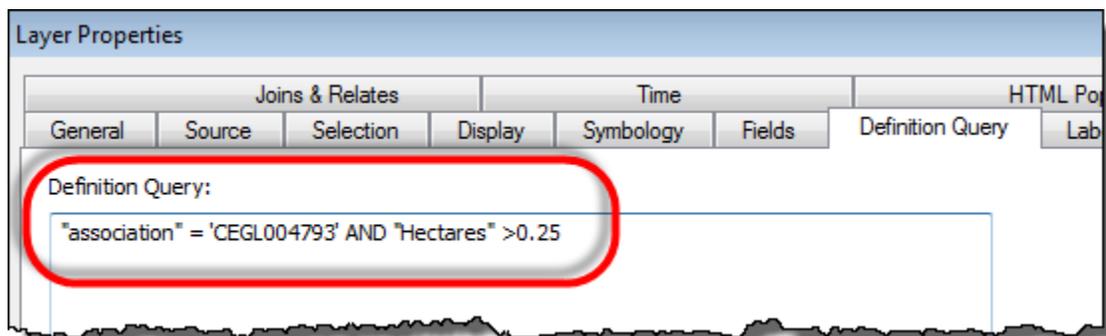
- You should see these results.

OBJECTID *	association	Count_association	Sum_Hectares	Sample
6	CEGL006217	2	0.413674	5
5	CEGL006024	25	0.636274	5
7	CEGL006445	4	3.044258	5
4	CEGL005033	4	3.781722	5
1	CEGL000000	2	4.430197	5
10	CEGL008412	13	4.482946	5
9	CEGL007281	64	7.519614	5
11	CEGL008517	20	13.863002	8
8	CEGL007220	27	21.937111	13
2	CEGL004073	93	24.976007	15
3	CEGL004793	38	39.306323	24

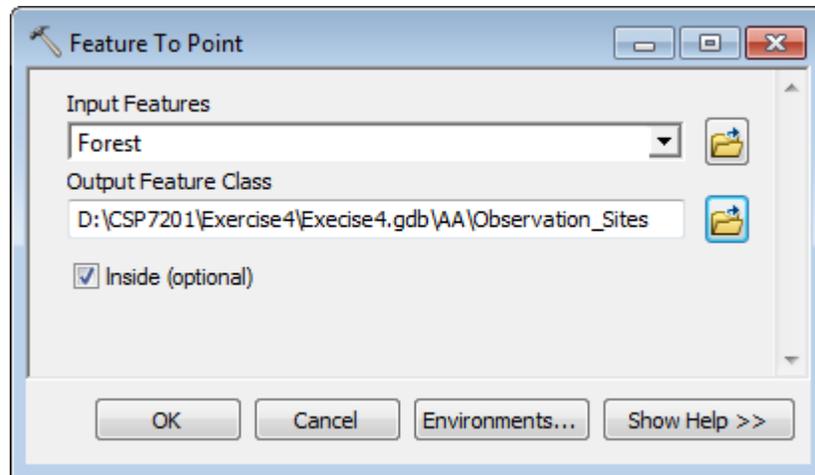
## STEP 2 – Create Points within the Polygons

For this exercise let's focus on the association with the largest area: CEGL004793. This association represents the Chinkapin Oak - (White Oak, Northern Red Oak) - Bitternut Hickory / Smooth Blackhaw Forest.

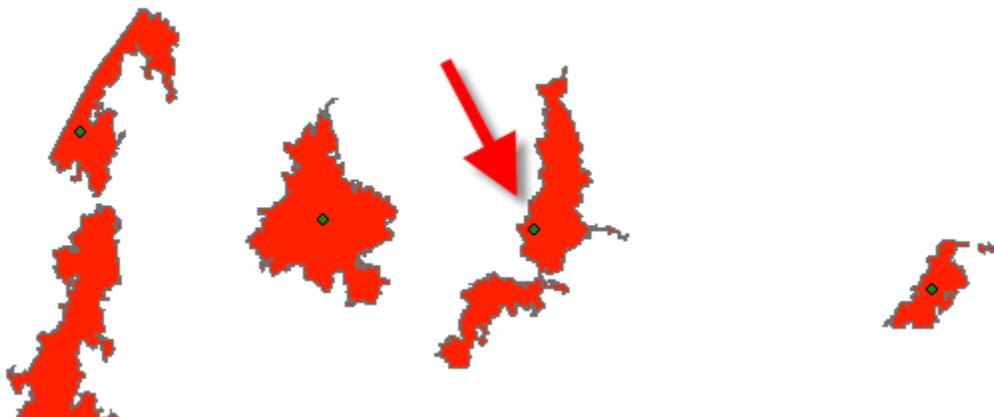
1. First eliminate any polygons that do not have the CEGL004793 association attribute and does not meet our minimum observation area. In our case use 0.25 hectares as the minimum.
  - Right-click on the Forest layer and select **Properties > Definition Query** tab.
  - Click on the Create Query button and create the following query.

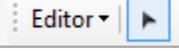


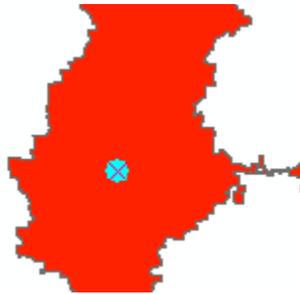
- How many records are visible\_\_\_\_\_? Note: the definition query does not delete the data it only shows what data you want to see and analyze.
2. Next, create the points in the center of each polygon.
- From ArcToolbox on the sidebar, browse to the **Feature To Point** tool (Data Management Tools → Features).
  - Double-click on the tool and input the following. Save the layer as **Observation\_Sites** in the geodatabase. Make sure to have the Inside box checked.



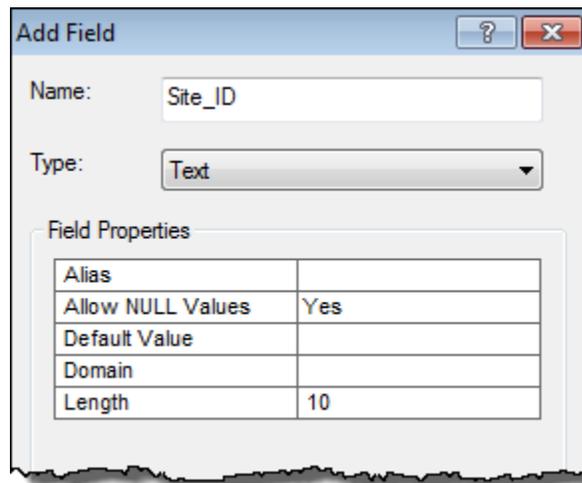
3. Some of the points may be closer to the edge of a polygon than you wanted. This depends on the shape of your polygons. Notice the point in the upper left corner of the map. Let's move it a bit more to the inside of the polygon.



- Right-click on the **Observation\_Sites** layer and select Edit Features > Start Editing.
- Zoom in closer to the point with your scroll wheel on the mouse and select the point using the select features tool  on the Standard Toolbar.
- Hold down the Shift key and select the polygon to unselect it. On the Editor Toolbar select the black edit features arrow . Left-mouse click on the selected point. While holding down the left-mouse button, move the mouse to move to point towards the center of the polygon.



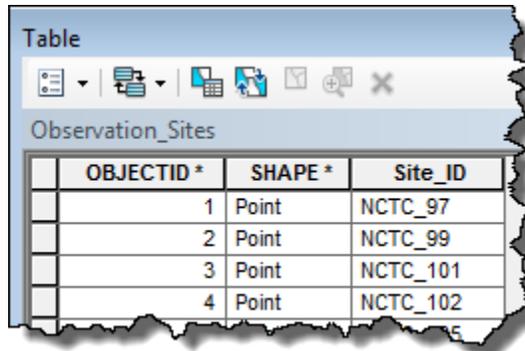
- Click on the Editor button and select Stop Editing and Yes to save edits.
4. Finally, let's add a unique ID to these points and remove any fields that would bias our field observers.
- Open the attribute table and create a new text field with a length of 10 characters. Name the field **Site\_ID**.



- Use the Field Calculator  **Field Calculator...** on the new field to create the following statement.

**“NCTC” & “\_” & [ORIG\_FID]**

- Delete the remaining fields except for the first two mandatory fields. The quickest way to do this is simply right-click on each of the field headers and select Delete Field.

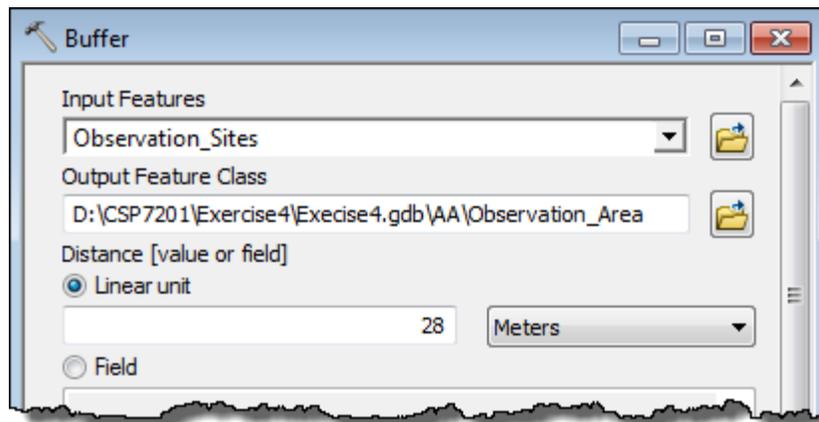


OBJECTID *	SHAPE *	Site_ID
1	Point	NCTC_97
2	Point	NCTC_99
3	Point	NCTC_101
4	Point	NCTC_102
5		

5. Label the points by changing the label field in the Properties to **Site\_ID** and then selecting the Label Features option when you right-click on the point layer.

### STEP 3 – Create the Observation Area Buffers

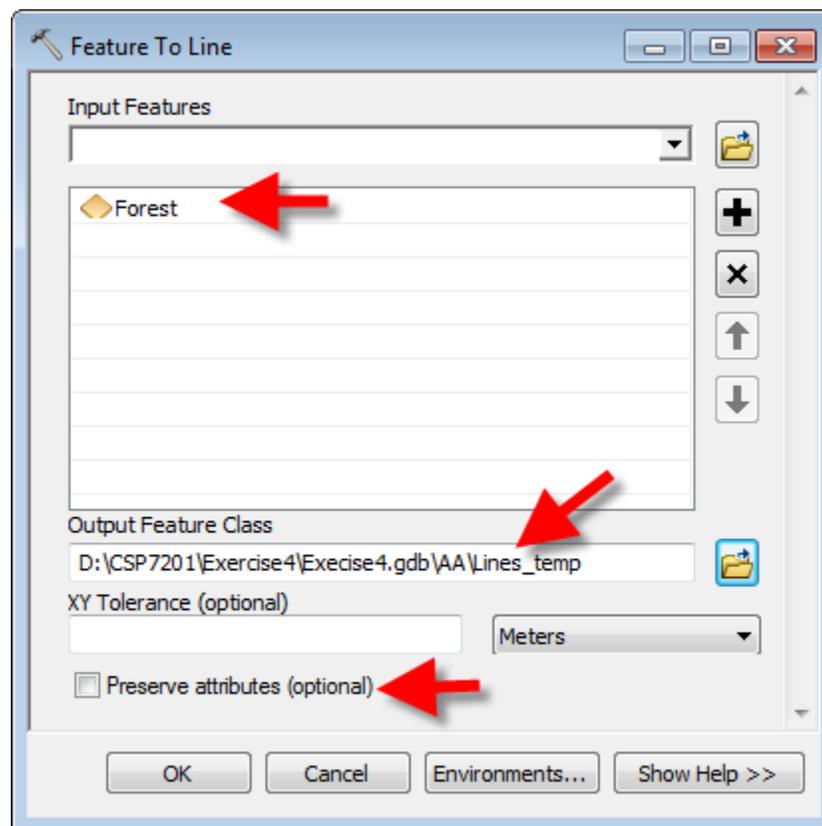
1. In ArcToolbox open the Buffer tool (Analysis Tools → Proximity) and create 28 meters buffers for the **Observation\_Sites** layer.
  - Name the new layer **Observation\_Area**.



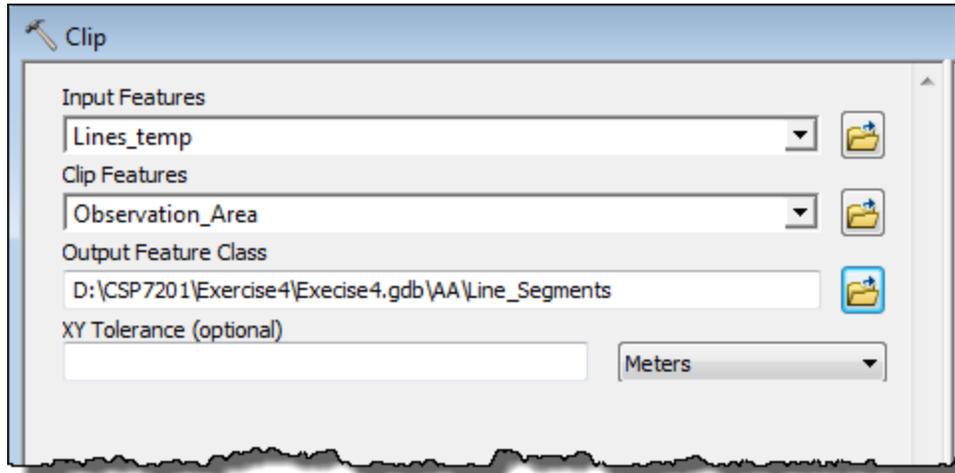
## STEP 4 – Create Line Segments

Remember that If the buffers overlap the mapped polygon, then we need to include the line work that intersects the buffer so the field person knows how far to evaluate the site while standing at the observation point.

1. Open ArcToolbox and convert the polygons to lines using the Features to Line Tool (Data Management Tools → Features).
  - Name the feature class **Lines\_temp**.
  - Uncheck the Preserve attributes option.



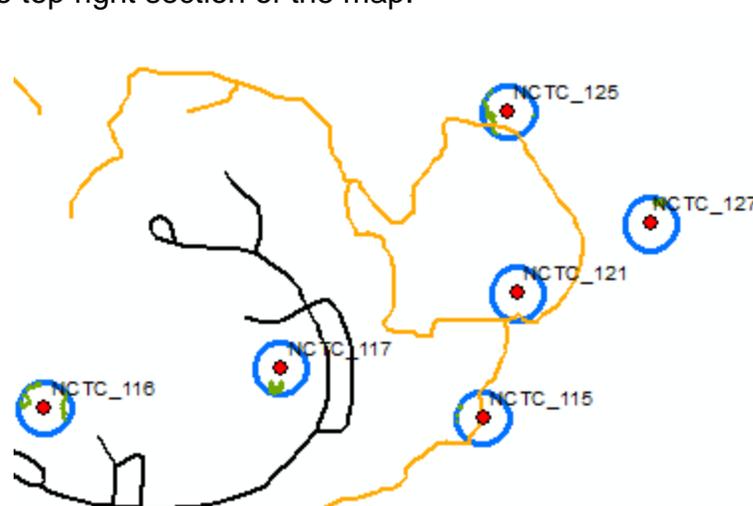
2. Open ArcToolbox and use the Clip Tool to cut the lines that intersect the 28 meter buffers (Analysis → Extract).
  - Name the new feature class **Line\_Segments** and make sure to save it in our Exercise4 geodatabase.



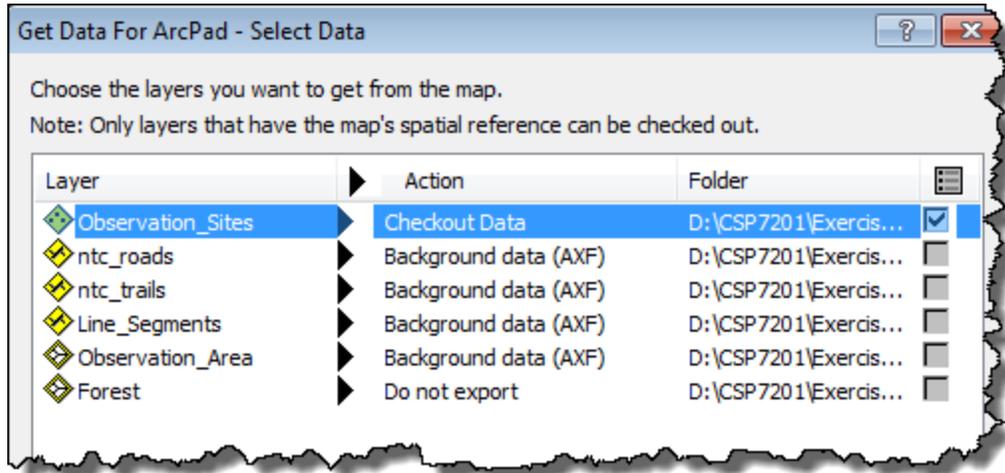
3. Remove the **Lines\_temp** layer from the Table of Contents.

### STEP 5 – Check Out the Data to ArcPad

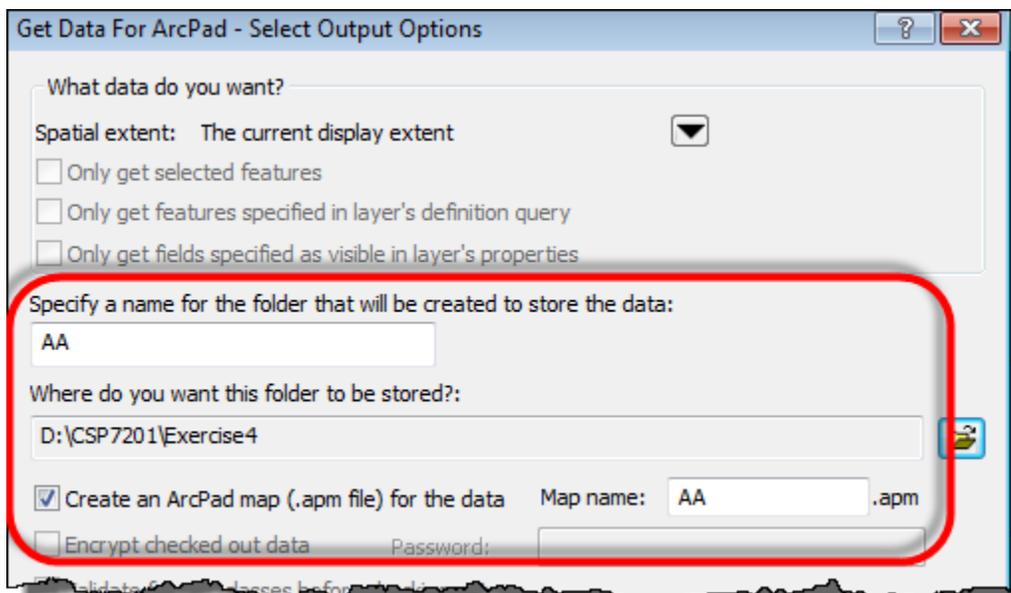
1. Add the Transportation feature dataset to the map and change the symbology of the layers if they need to be more contrasting.
2. Zoom into the top right section of the map.



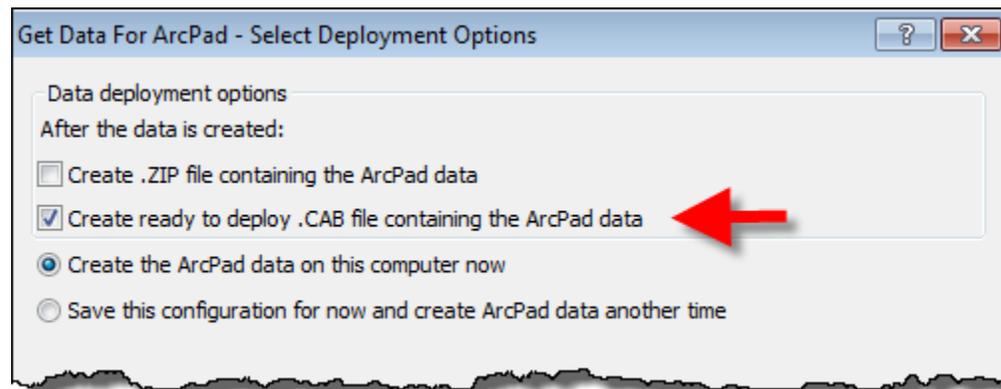
3. Check Out the data using the Arcpad Data Manager Toolbar. Make sure you have a connection via WM Device Manager before you proceed.
  - Send the data over as Background data (AXF) except for Observation\_Sites. Do not export the Forest layer.



- Name the Project and map AA. Save the project in the Exercise 4 folder.



- Create a ready to deploy cab file and send it over to your Trimble device.



- Open the ArcPad map document on the Trimble unit to make sure all is well.

4. Get ready to head out into the field.

## Exercise 5 - Customizing ArcPad Toolbars

**Session Objectives:** At the conclusion of this session, you will be able to:

- Use ArcPad in Design Mode to create a custom toolbar applet.
- Use ArcPad Studio to customize an applet.
- Add the toolbar applet to ArcPad on the Trimble unit.

**Material Created By:** Eric Kelchlin, June 2011

**Revision:** January 2012

**Software:** ArcPad 10 SP3, ArcPad Studio 10 SP3

**Directory Path:** C:\Documents and Settings\All Users\Documents\ArcPad\Applets

**Files:**

## Introduction

You have three ways to customize the default toolbars:

- Favorites – choose your favorite tools to display on a single toolbar. This is done on the fly in ArcPad (easy but limited).
- Modify Built-in Toolbars – modify existing toolbars using ArcPad in Design Mode OR create an applet in ArcPad Studio (easy and more options).
- Create User Defined Custom Toolbars – create custom commands and toolbars with VBScript or JScript in ArcPad Studio (not easy, but only limited by your creativity).

## SECTION 1 – Creating a Custom Toolbar in ArcPad Design Mode

This section walks through the process of creating an applet using the Design Mode in ArcPad on your PC. This can be done in ArcPad Studio as well, but the Design Mode method is easier. The applet will automatically load in ArcPad when the applet (.apa) file is saved in the Program Files\ArcPad\Applets folder on your Trimble GPS unit.

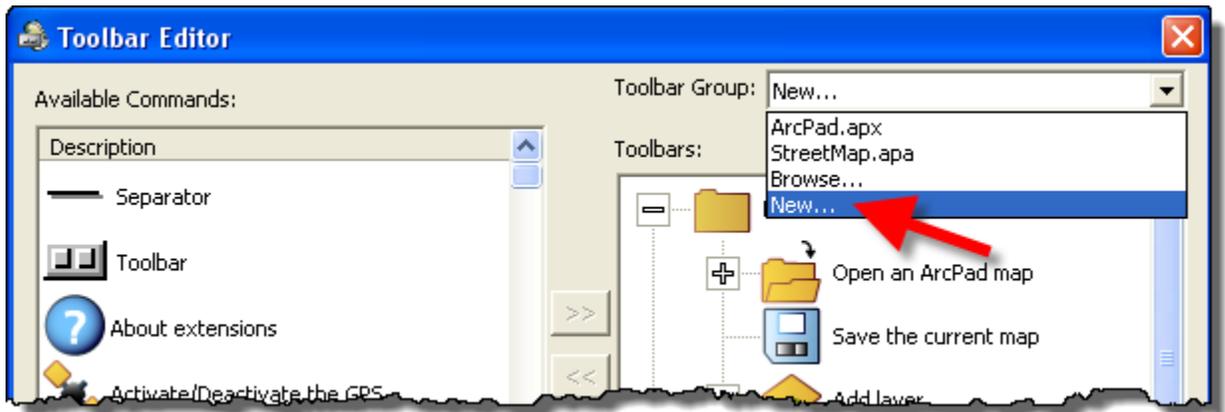
1. Open ArcPad 10 on your PC and open a New Map.
2. Click the **Toolbar Options button** and select **Design Mode** from the drop-down menu. You know when you're in design mode when the Quick Action toolbar changes color from a blue to a red.



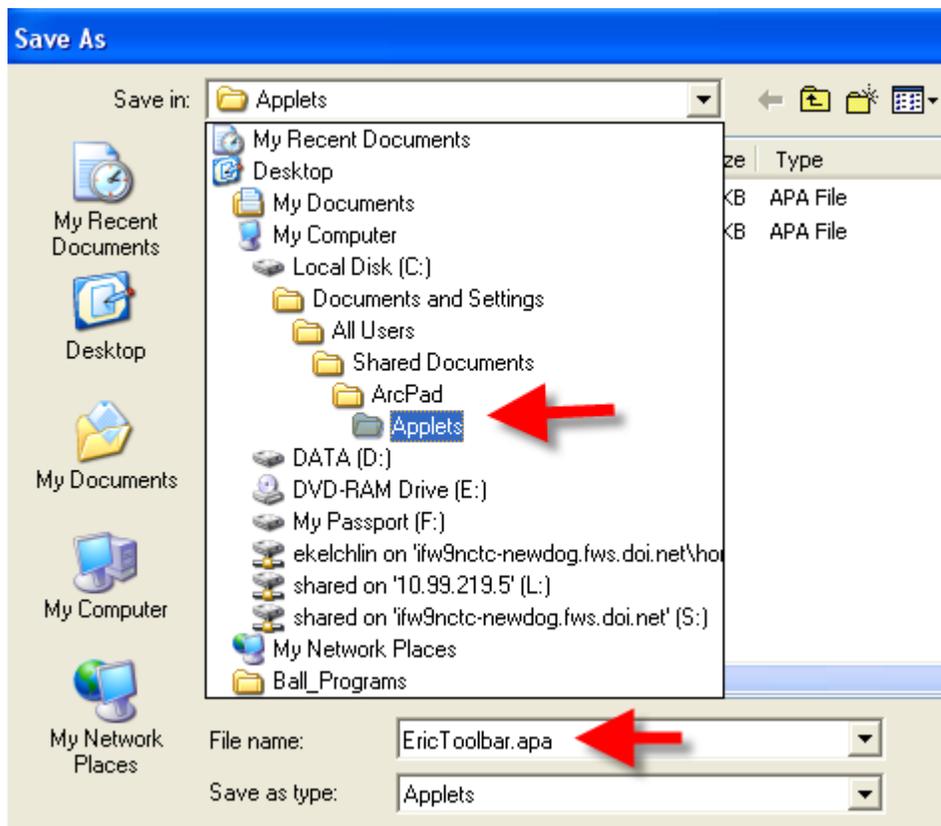
3. Select the **Toolbar Options button** again and select **Design Mode > Customize Toolbars**.



4. Select **New** from the **Toolbar Group** drop-down menu.



5. Name your applet and save it in the location shown below.

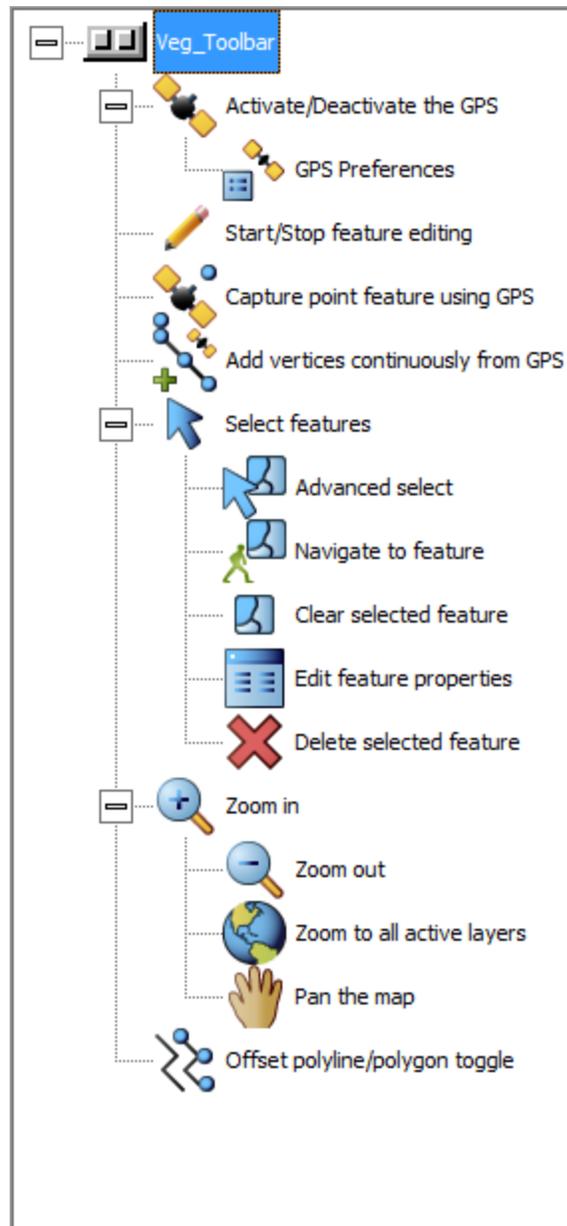


6. Create a new toolbar with the tools shown on the right.

- To create the tool bar simply drag & drop from the left side to the right side of the dialog.

OR

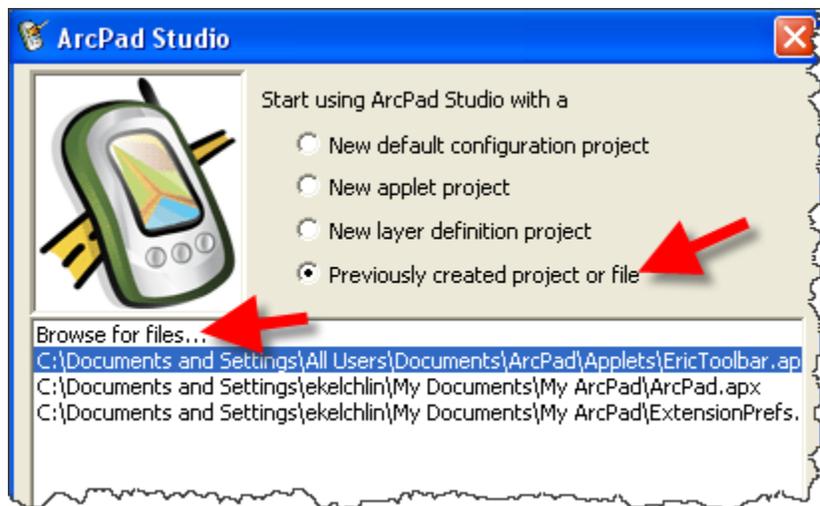
- Select the tool on the left, select the location where you want it to go on the right, and click the Arrow button  in the middle on the screen.
- To make tool groups with drop-down list of tools, simply drag and drop the tool onto another tool.



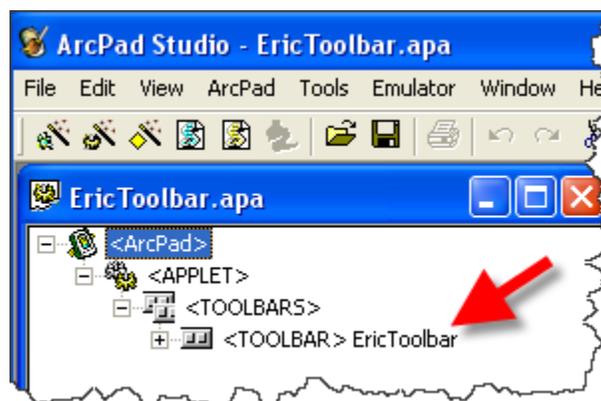
7. Click **OK** when done and **Yes** to restart ArcPad. Open a new map.
8. Click on your new toolbar to see what you created. Notice that it defaulted to a plain looking toolbar with no caption. The next section will show you how to modify the way the button looks and how to add a caption.

## SECTION 2 – Modifying a Toolbar in ArcPad Studio

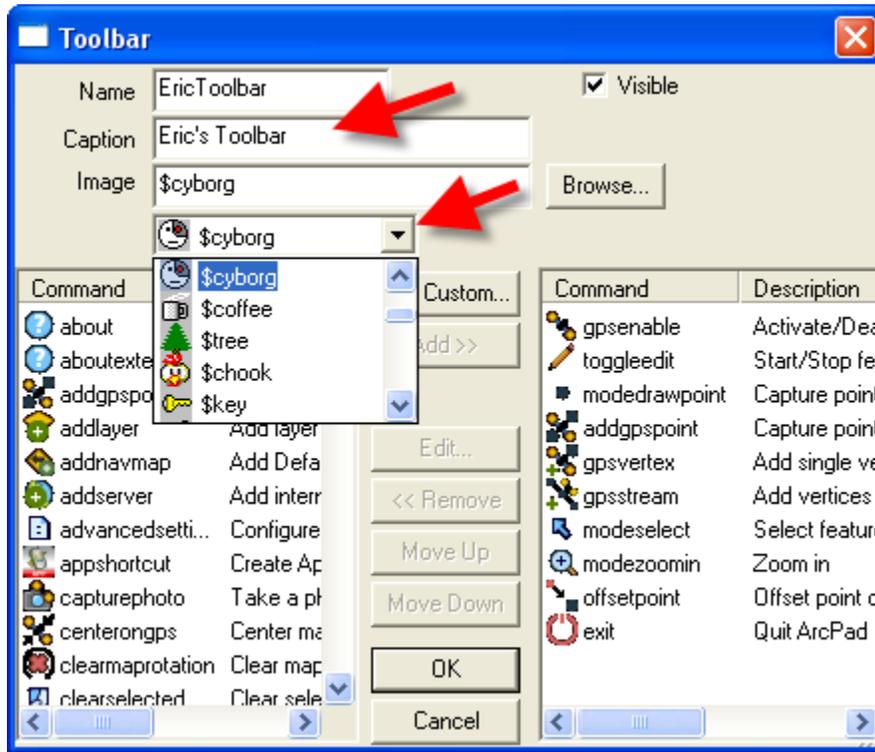
1. Close ArcPad and open ArcPad Studio.
2. Select **Previously created project or file** and browse to the location of your MyToolbar applet.



3. Double-click on the MyToolbar item in the list.



4. Give your toolbar a Caption and select a symbol from the Custom drop-down arrow. Click **OK**.



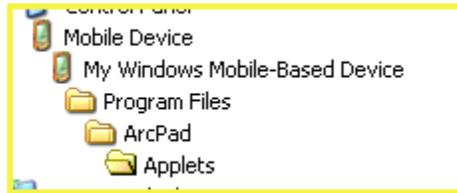
5. Save  your applet and close  ArcPad Studio.
6. Open ArcPad and check-out your cool toolbar!

### SECTION 3 – Saving the Tool Applet on the Trimble Unit

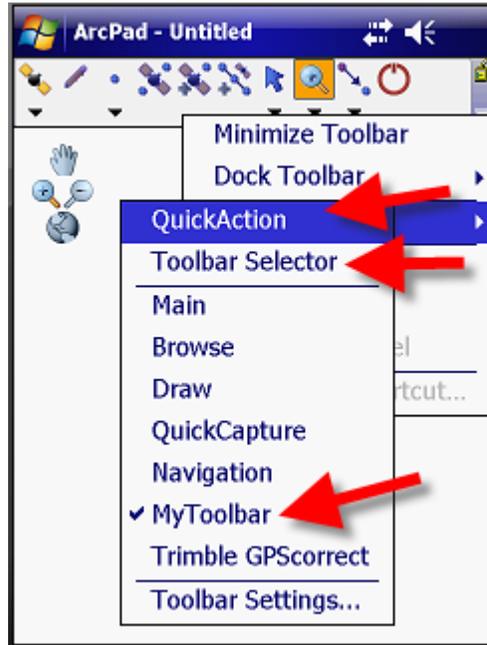
1. Close  ArcPad.
2. Make sure your Trimble unit is connected. Use ActiveSync to find and copy the **MyToolbar.apa** file on from the Applets folder on your **PC**. NOTE: the path may be different than the one shown below.



3. Past the **MyToolbar.apa** file in the Applets folder on your **Mobile Device**.



4. Open ArcPad on your Trimble unit and test your new toolbar.
5. To hide all other toolbars, except your new “fancy” one, tap the **Toolbar Options button** (i.e., the drop-down arrow just below the lock icon on the right hand side). Check the **MyToolbar** and uncheck the **QuickAction** and **Toolbar Selector** toolbars.



6. To remove the toolbar on your GPS unit, simply delete the applet file from the Applets folder.