As Many Maps as You Need: The Power of Automated Map Generation

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- Requirement
- Automation overview
- Map development process
- Quality checking procedures
- Process considerations
- Method enhancement possibilities
- Programming considerations
- Map access

## Requirement

- Endangered species risk assessment a key requirement in the agrichemical product registration process
- Four key variables:
  - Use site target for product use, typically a crop
  - Application Method Type
  - Location a county for the purpose of this example
  - Species a threatened/endangered species present in the county, according to various species location sources

May be many thousands of permutations, each of which needs a determination and, sometimes, a supporting map

### **ESRI Map Scripting Capabilities**

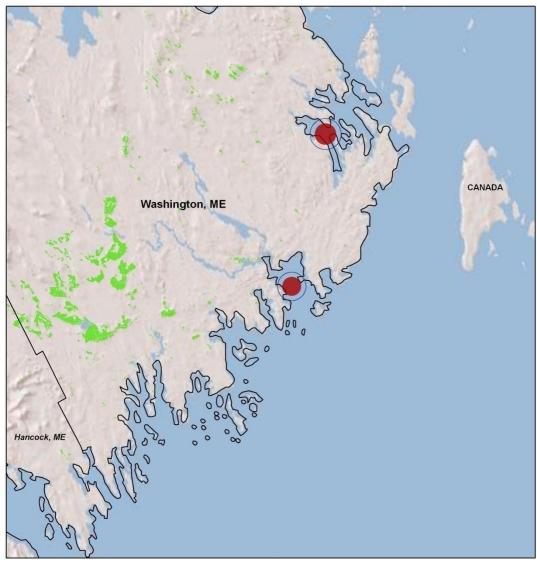
 ArcInfo – Arc Macro Language Versatile, simple, still widely used ArcView 3.x – Avenue Multiple layouts ArcMap/ArcObjects – VBA (Python at 9.4) One layout per document ArcMap/ArcObjects – Many languages Highly versatile, external development

### **Automation Concept**

- Map automation process analogous to model development
- Develop a set of procedures that use information you pass to them
- Make the input information available
- Set up the process to run efficiently
- Start the process, keep track of progress
- Restart the process as required
- Check the output carefully

## Develop Single Map

- Create document
- Add data layers
- Set up layout
- Add/customize
  - map elements
  - graphics elements
- Export map





#### Legend

- Species Occurrence Locators
- Species Occurrences (ARTIFICIAL)
- Counties
  - NLCD 2001 Cultivated Crops (Class 82)

#### **County Types**

County of interest: Large label Neighboring county: Small label Other county: Small label Note: a species occurrence may be reported by NatureServe as pertaining to the county of interest, but may be physically present in a neighboring county

Projection: North America Albers Equal Area Conic

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12 Miles

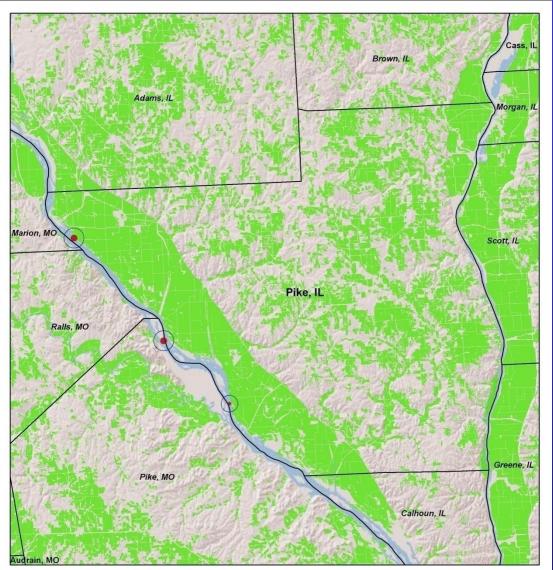
### Map Development Replication

- Develop code to replicate map creation process
- Could use C#/ArcObjects code to read document properties or just copy/paste properties into code

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	layerControl.AddCountyOfInterest(ref map);	-
	//All other counties	
	layerControl.AddAllOtherCounties(ref map);	
	//NLCD Class 82 layerControl.AddNLCDClass82(ref map);	
	TayerControl. AddNLUDCTasso2 (ref map);	
	//All counties - boundaries only	
	layerControl.AddCountyBoundaries(ref map);	
	//EOs (set number of EOs)	
	layerControl.InitializeEOList();	
	int eoCount = layerControl.EoCount;	
	layerControl.AddEOs(ref map);	
	//EO Locators	
	layerControl.AddEOLocators(ref map);	
	//Compute the map exent (uses EOWhereClause)	
	IEnvelope ctyOfIntExtent = GetMapExtent(layerControl.CtyOfIntFeatureClass, layerControl.CtyOfIntWhereClause);	
	<pre>mapExtent = null;</pre>	
	if (eoCount > 0)	
	<pre>{     IEnvelope eoExtent = GetMapExtent(layerControl.EoFeatureClass, layerControl.EoWhereClause);</pre>	
	<pre>mapExtent = GetCtyIntEOMapExtent(ctyOfIntExtent, coExtent); mapExtent = GetCtyIntEOMapExtent(ctyOfIntExtent, coExtent);</pre>	
	S S S S S S S S S S S S S S S S S S S	
	else	
	mapExtent = ctyOfIntExtent;	
	} IActiveView activeView = mapDocument.ActiveView;	
	activeView.Extent = mapSctent;	-
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## **Process Inputs**

- Species identifier
  - Species scientific name
  - Species common name
  - Occurrences
- Location identifier
  - State code
  - County name
  - Counties



Fat pocketbook (Potamilus capax) - Pike, IL (Three occurrences)

#### Legend



Species Occurrences (ARTIFICIAL)



NLCD 2001 Cultivated Crops (Class 82)

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0	3.75	5	7.5				15 Miles
	1 1	1		1	1	1	

## **Iteration Framework**

Map ID	Species ID	Location ID	Process Flag	Start Time	End Time
1	54	632	1	4/21/2008 23:35	4/21/2008 23:35
2	2341	781	1	4/21/2008 23:37	4/21/2008 23:52
3	121	63	0	NULL	NULL

- SQL Server table stores
  - Input parameters
  - Process control data
- Loop over records with process flag = 0
  - Run map process
  - Set process flag = 1 at end of process
  - Continue looping while records are remaining with process flag = 0

Allows for restarting the process in the event of failures

### **Map Generation Considerations**

### • Variables:

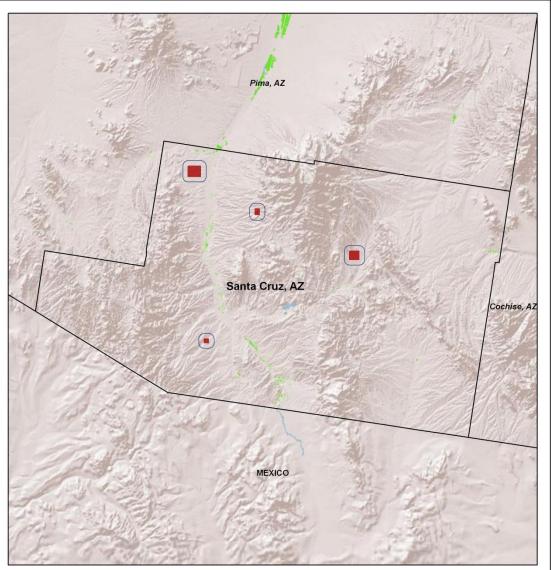
- Need to define rules for aspects of the map that vary
  - E.g., map extent = bounding rectangle of species locations and counties plus 5 km
- Scale
  - Feature visibility use locators (1 km buffers)
  - May incorporate scale dependency to hide/show locators
  - Exported image resolution must be such that features don't get distorted and/or disappear

### **Map Generation Considerations**

- Useful information
  - Map extents written to output table for use in an ArcGIS Server website showing similar information
  - May produce locator map(s) showing extents for maps
- Map checking
  - Create a bookmark for map extent

# Text Overrun

- Use ScreenDisplay-Class object to check length of string on screen
- Reduce font, test length again
- Repeat as required



Arroyo (=arroyo southwestern) toad (Bufo californicus (=microscaphus)) - Santa Cruz, AZ (Four occurrences)

#### Legend

County of interest:

Other county:

Neighboring county:

Species Occurrence Locators
Species Occurrences (ARTIFICIAL)
Counties
NLCD 2001 Cultivated Crops (Class 82)
County Types

Large label

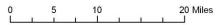
Small label

Small label

Note: a species occurrence may be reported by NatureServe as pertaining to the county of interest, but may be physically present in a neighboring county

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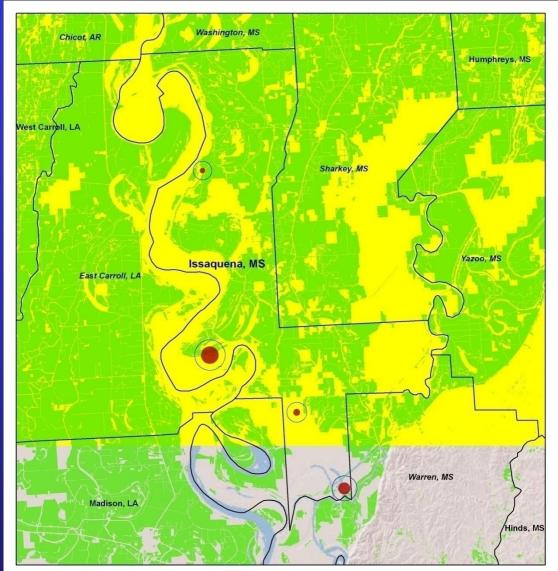
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## Map Service Failure

- Use unique color for data frame
- Run code to read image as bitmap
  - Check for data frame color
  - Set process
     flag to 0 if color
     present
  - Rerun process if required



alligator, American (Alligator mississippiensis) - Issaquena, MS (Four occurrences)

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0 1.5 3 6 Miles

### **Process Simplification**

- Minimize processing requirements
- Break process into small tasks
- Never do the same thing twice (if you can avoid it)
- Consider steps to improve map performance
- Consider ESRI advice for web maps
  - Preprocess layers, if required
  - Use standard projection for all layers

### **Process Simplification (2)**

- Develop re-usable code
- Employ object-based approach
   Using coarser objects allows you to bury
   the more fine-grained ArcObjects code
   E.g., text element much easier to
   instantiate new text element object than
   repeat/modify finer code
- Could run process to create map documents first then run separate process to export maps

Trade-off: time required to run process versus effort required to speed things up

## **.NET Code Structure**

- CreateMaps method (main loop over species-county pairs)
- Generate map:
  - Map Generator object, CreateMap method
    - Create document
    - Add layers LayerControl object (get extents)
    - Create a layout, set up data frame, set map extent, create bookmark
    - Add graphics elements
      - SimpleText object
      - NorthArrow object
      - ScaleBar object
      - Bounding rectangle object
- ExportMap

### **Method Enhancement Possibilities**

 Anything you can do in the ArcMap interface, you can do in code
 Beware of terminology differences, e.g., remove duplicate labels

Placement Properties ? 🔀	*
	AnnotateLayerProperties
Placement Conflict Detection	IAnnotateLayerProperties O IAnnotateLayerProperties : IUnknown
Polygon Settings Always horizontal C Always straight	AddUnplacedToGraphicsContainer: Boolean     AnnotationMinimumScale: Double     AnnotationMinimumScale: Double     Class: String     CreateUnplacedElements: Boolean     DisplayAnnotation: Boolean     Extent: Envelope     FeatureLinked: Boolean     GraphicsContainer: IGraphicsContainer     LabelWhichFeatures: esriLabelWhichFeatures
C Try horizontal first, then straight	UseOutput: Boolean ■ WhereClause: String
Only place label inside polygon	IAnnotateLayerTransformationProperties O
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Duplicate Labels	esriSystem.IClone O
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C Place one label per feature part	▲
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е

### Method Enhancement Possibilities (2)

- In current application, maps are independent of one another
- Can easily extend procedure to create a map series (introduce dependencies between maps)
- Use templates
- Set up annotation
- Pre-define layers, read layer files
- Cache map services

## Programming Considerations Memory Management

Clear resources

{

Use ReleaseComObject method or set object to null

```
public static void ClearResources(object o)
```

```
//http://support.microsoft.com/default.aspx?scid=kb;en-us;317109
try
{
   System Runtime InteropServices Marshal ReleaseComObject(o)
```

```
System.Runtime.InteropServices.Marshal.ReleaseComObject(o);
}
catch {}
finally
{
    o = null;
}
```

Run separate executable(s)

## Programming Considerations Why .NET?

- Versatility
- Ability to interact with other programs
   E.g., insert maps into a Word document or other report format
- Ability to incorporate sophisticated procedures
- Ability to manage memory
- Controllability
- Can develop a control interface (use a form application)

### Map Access

- Maps stored in SQL Server database table:
  - Species identifier
  - Location identifier
  - Image
- AJAX-enabled web page
- User selects species and county When map is requested, image is drawn on screen using .NET graphics capabilities (much faster than using HTML img element)
- Partial refresh of page fast using AJAX

### Conclusion

- Microsoft .NET/SQL Server/ESRI ArcObjects technology provides a powerful framework for automated development
- Concepts are applicable to other frameworks
- Let me know if you need help <u>dhowes@complianceservices.com</u>