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

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# Overview

- 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
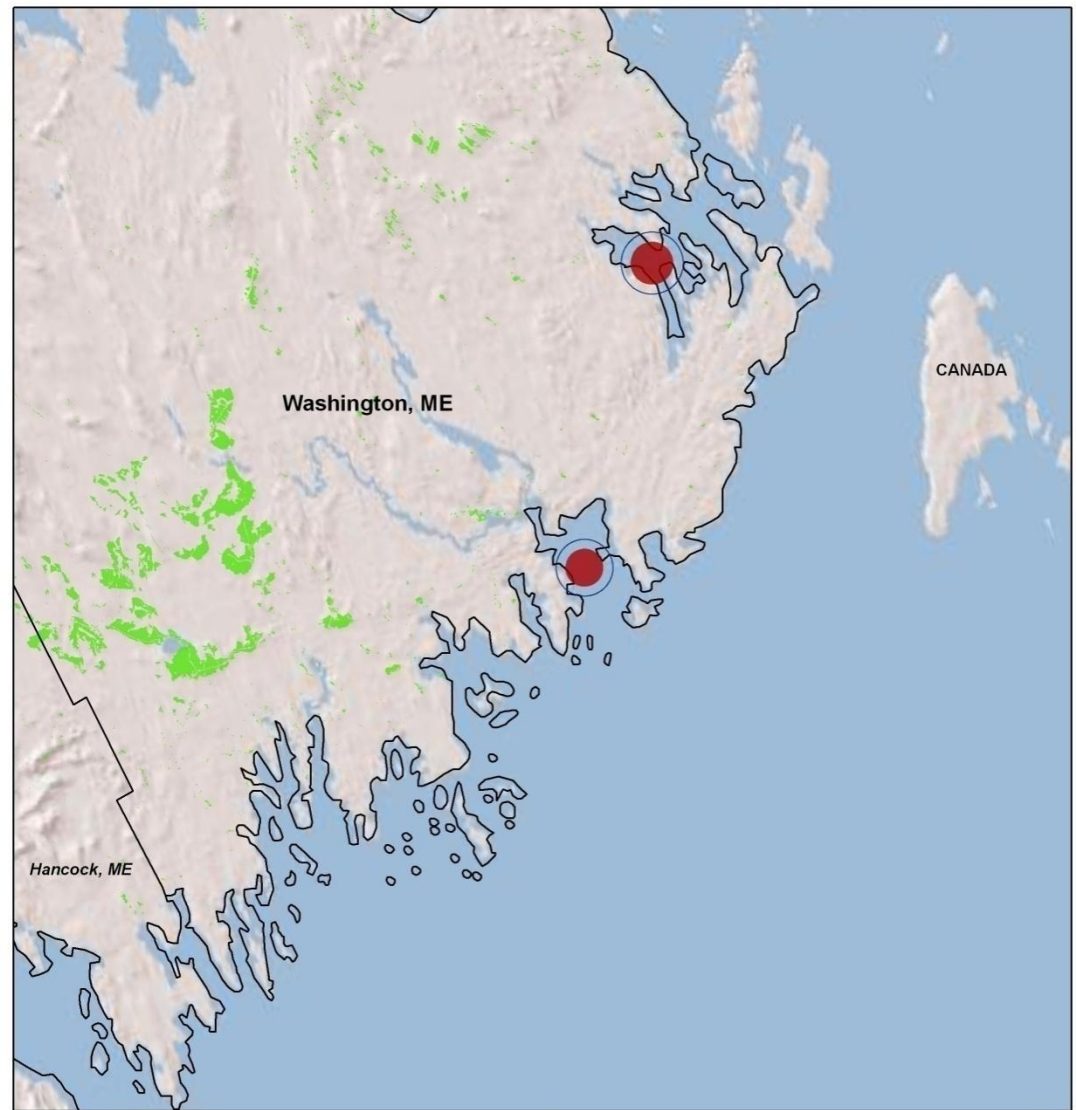


Roseate tern (*Sterna dougallii dougallii*) - Washington, ME (Two occurrences)

**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

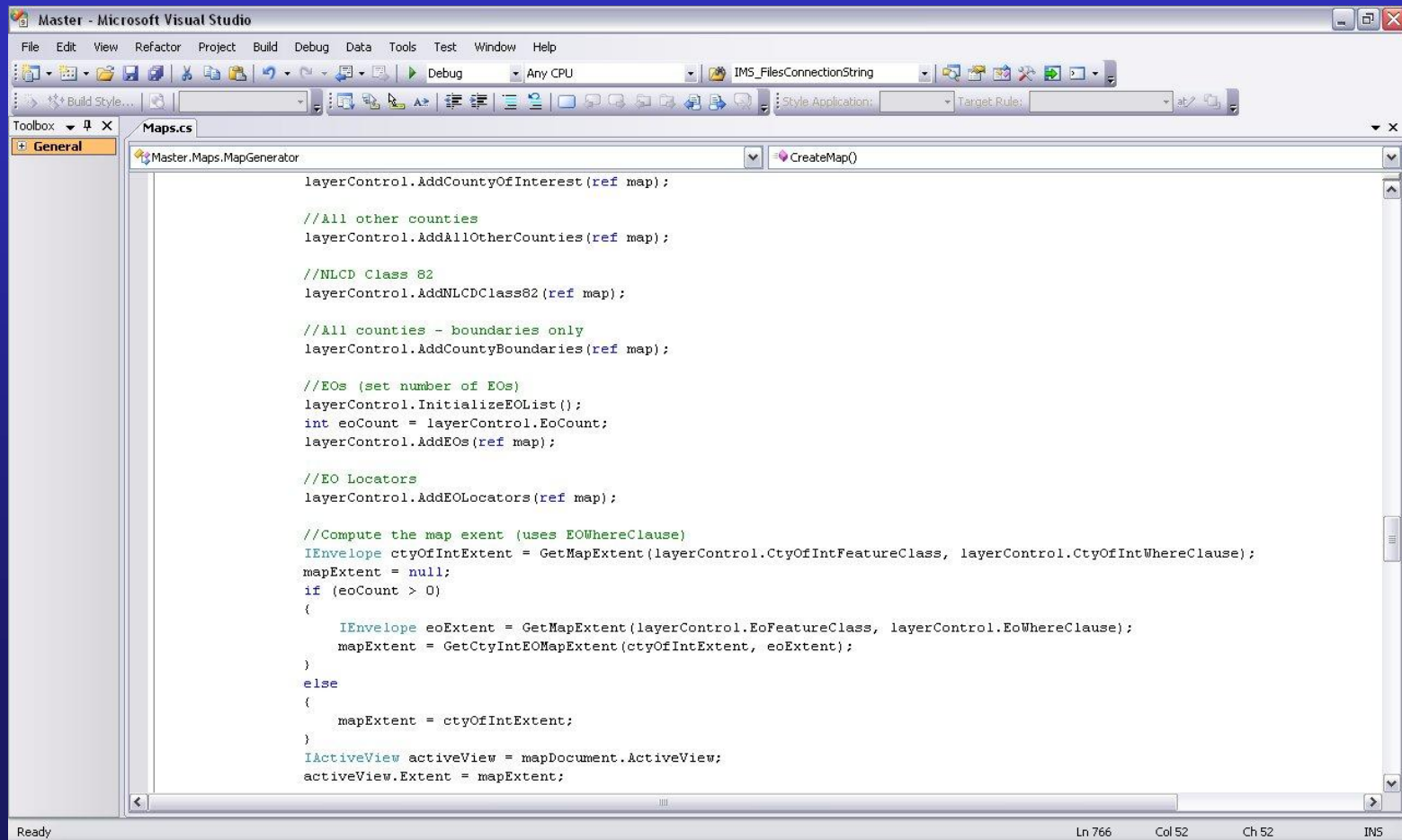Projection: North America Albers Equal Area Conic

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0    3    6         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

# Process Inputs

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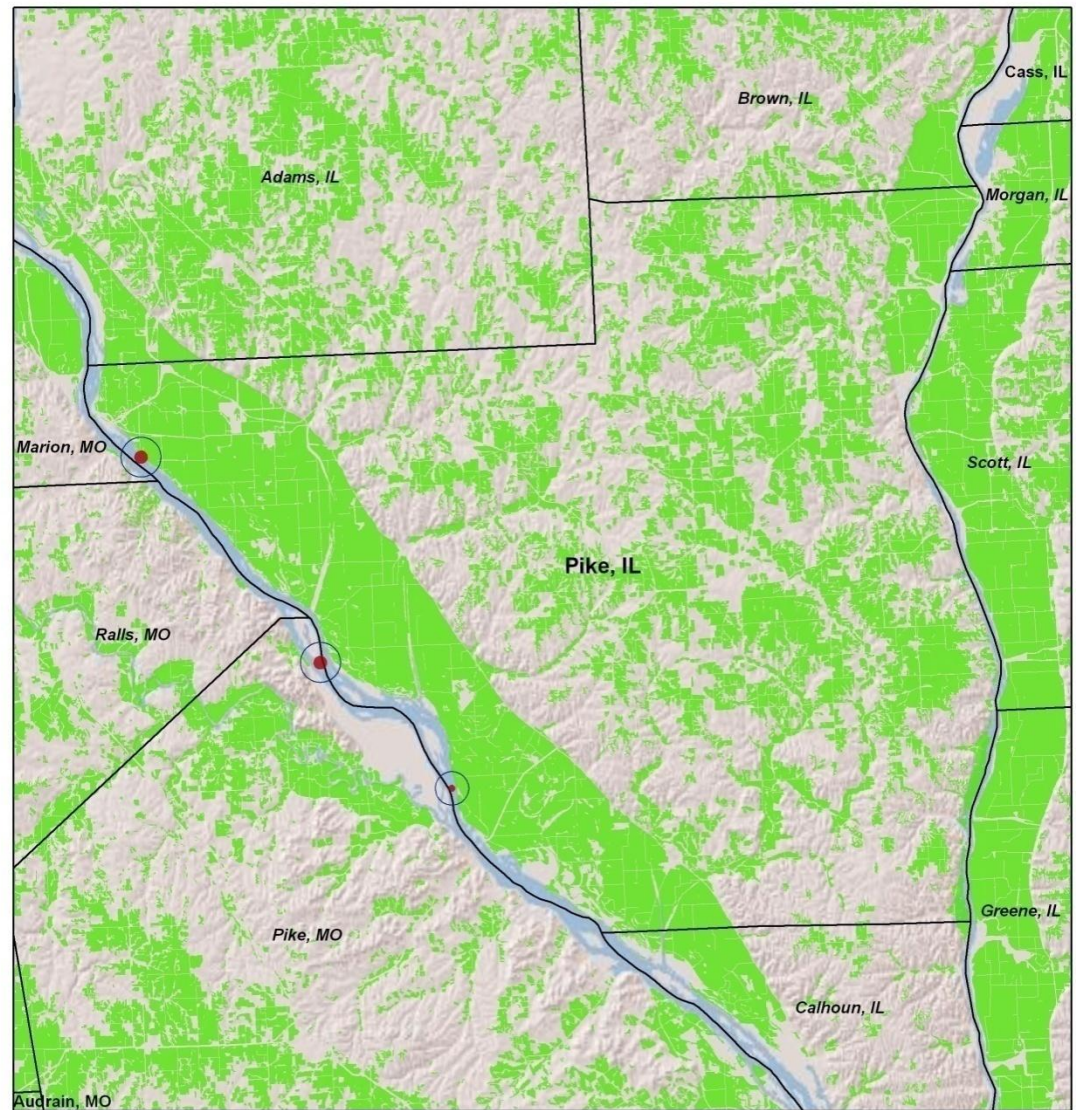


**Fat pocketbook (*Potamilus capax*) - Pike, IL (Three occurrences)**

**Legend**

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|---|---|
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0    3.75    7.5    15 Miles

N

# 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
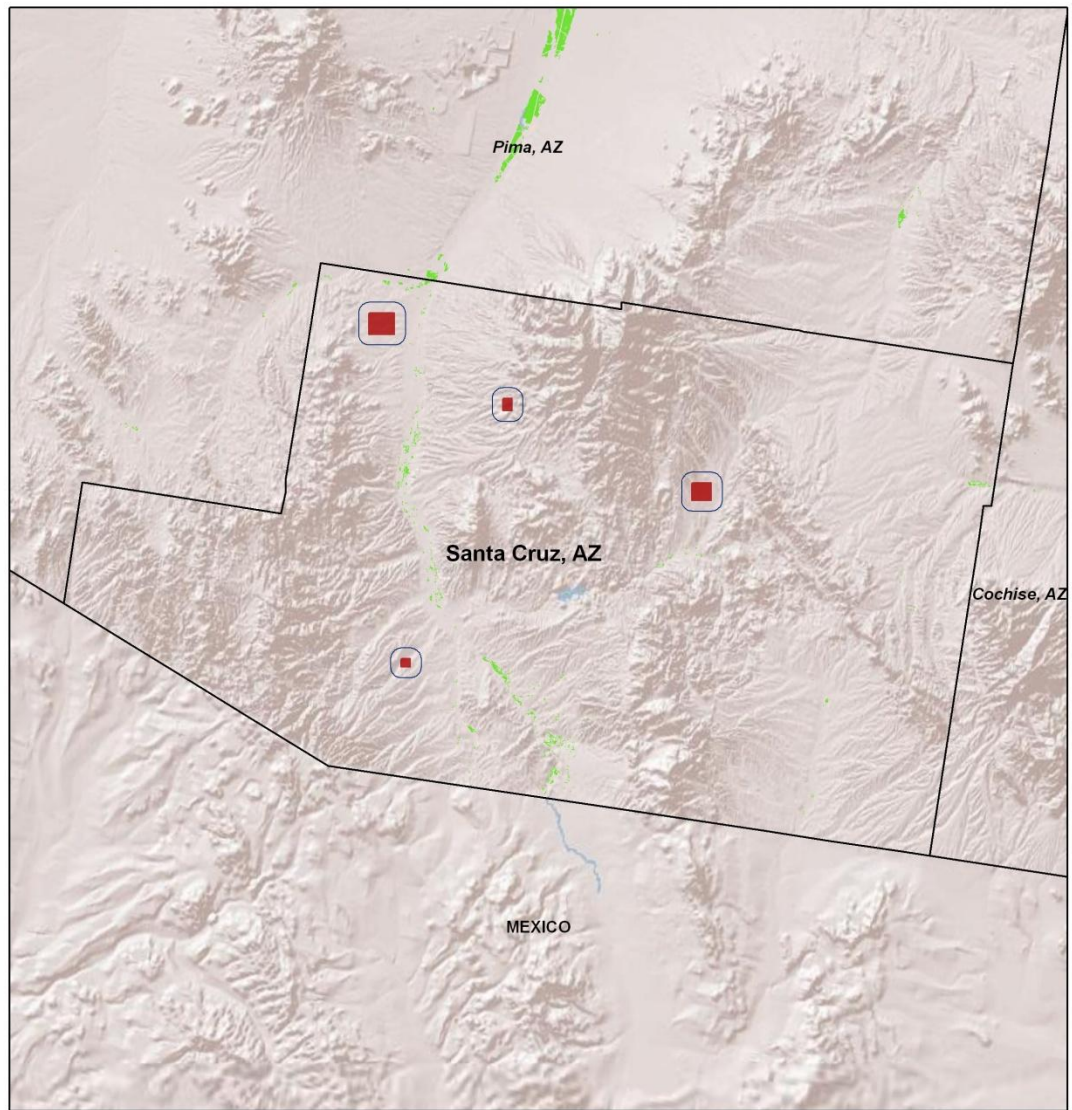


Arroyo (=arroyo southwestern) toad (*Bufo californicus (=microscaphus)*) - Santa Cruz, AZ (Four occurrences)

**Legend**

Species Occurrence Locators

Species Occurrences (ARTIFICIAL)

Counties

NLCD 2001 Cultivated Crops (Class 82)

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0    5    10    20 Miles

# 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)

**Legend**

| | |
|---|---|
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| ■ | Species Occurrences (ARTIFICIAL) |
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| ■ | NLCD 2001 Cultivated Crops (Class 82) |

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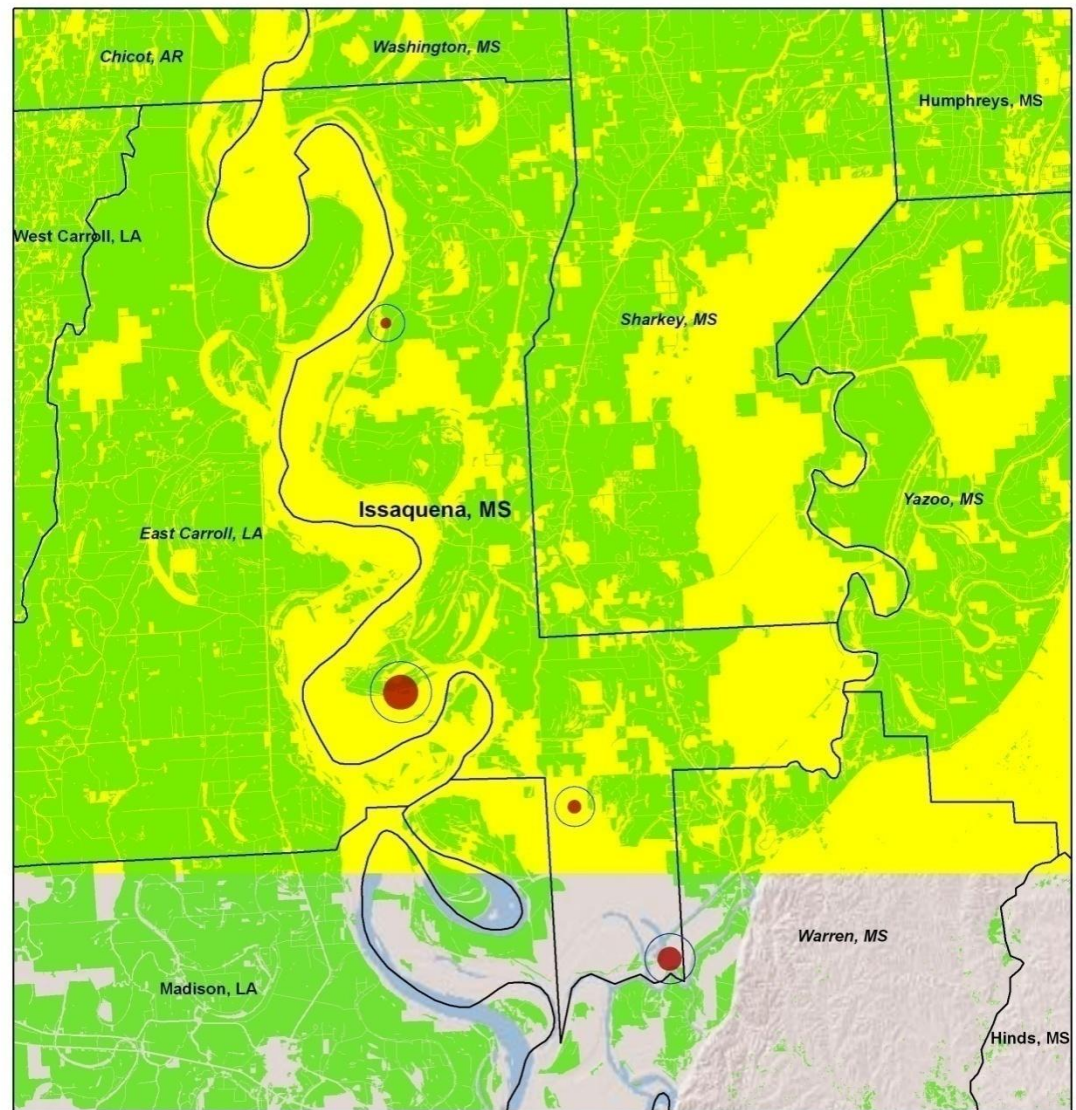
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0   1.5   3      6 Miles

# 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
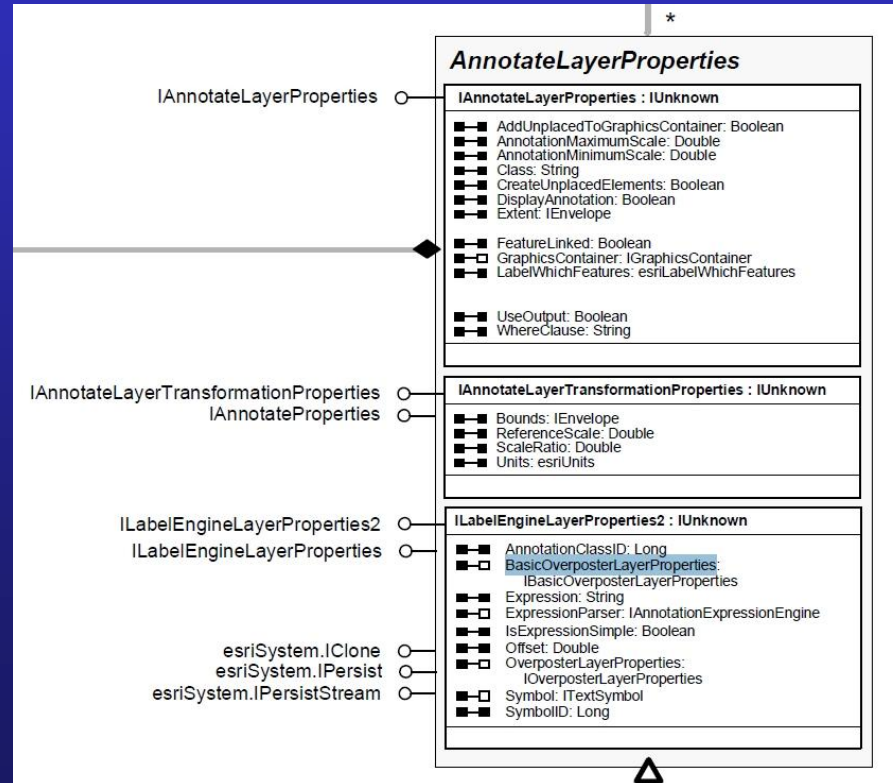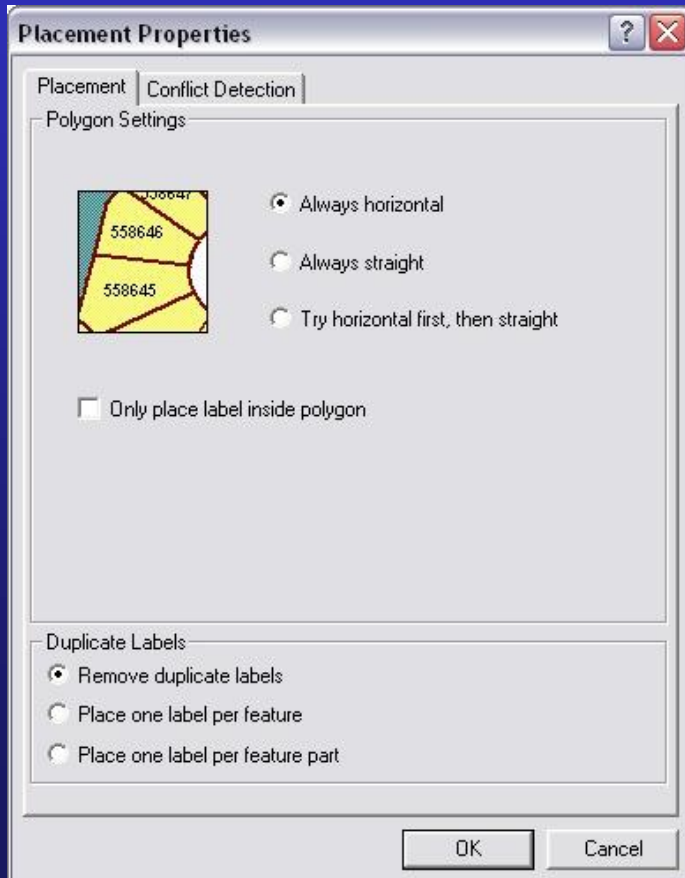


esriBasicNumLabelsOption.esriOneLabelPerName

# 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);
    }
    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

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