

Fish Habitat Modeling using ArcGIS Server

Making Complex Data Usable



Introductions

PRESENTERS

- Jeena Credico
 - Fish and Wildlife Biologist GIS/LC
 - Midwest Fisheries Center
- Fritz Boettner
 - Principal
 - Downstream Strategies
- Michael Strager
 - Associate Professor
 - West Virginia University
- Frank Orr
 - Spatial Solutions Consultant
 - Critigen



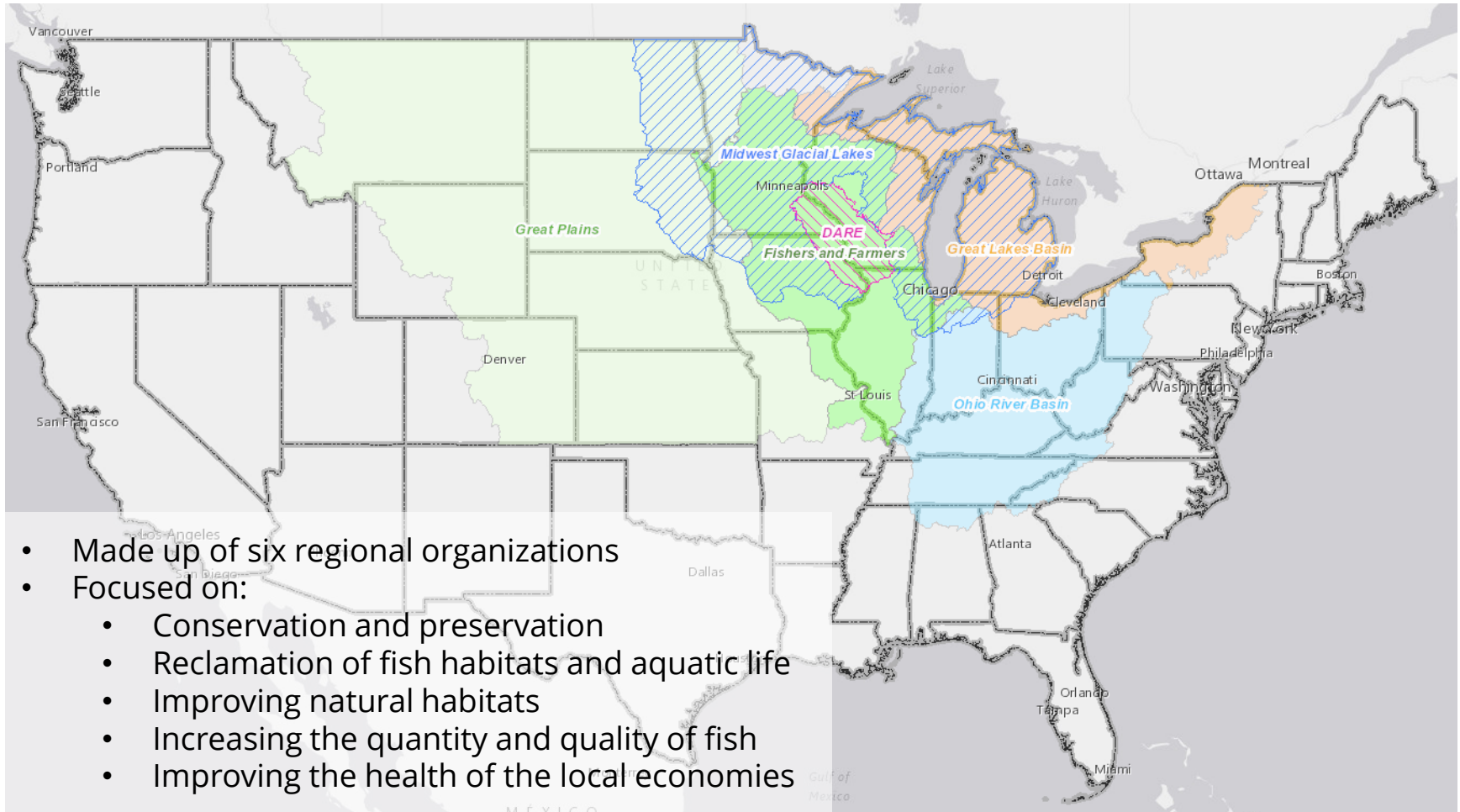
**Downstream
Strategies**
building capacity for sustainability



CRITIGEN

Introduction

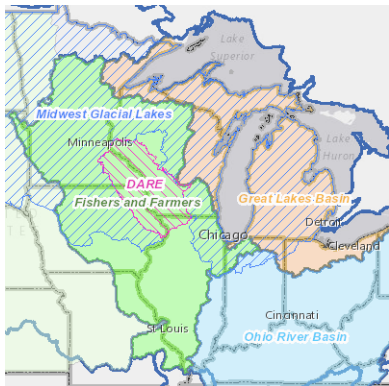
The Midwest Fish Habitat Partnership



- Made up of six regional organizations
- Focused on:
 - Conservation and preservation
 - Reclamation of fish habitats and aquatic life
 - Improving natural habitats
 - Increasing the quantity and quality of fish
 - Improving the health of the local economies

The Problem

Loads and Loads of Data



Six FHPs



800 HUC8s



33,065 HUC12s

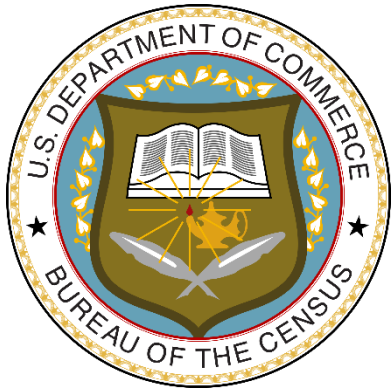


1,032,216 Catchments

- Up to 150 variables per catchment
- Species-specific variables
 - Probability of presence
 - Habitat quality
 - Stress indices
- Landscape variables
 - Land cover
 - Human impact
 - Geology/geography
- Socioeconomic

The Process

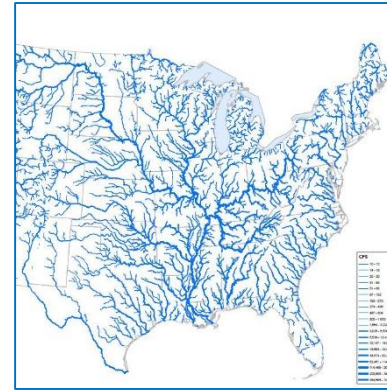
Where did this data come from?



US Census



NLCD

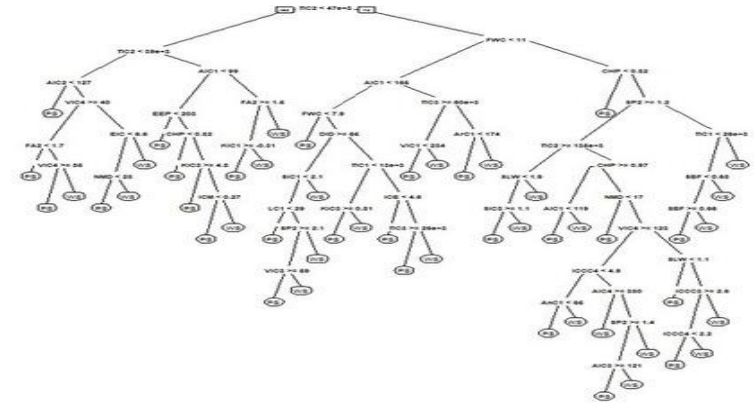


NHD PLUS



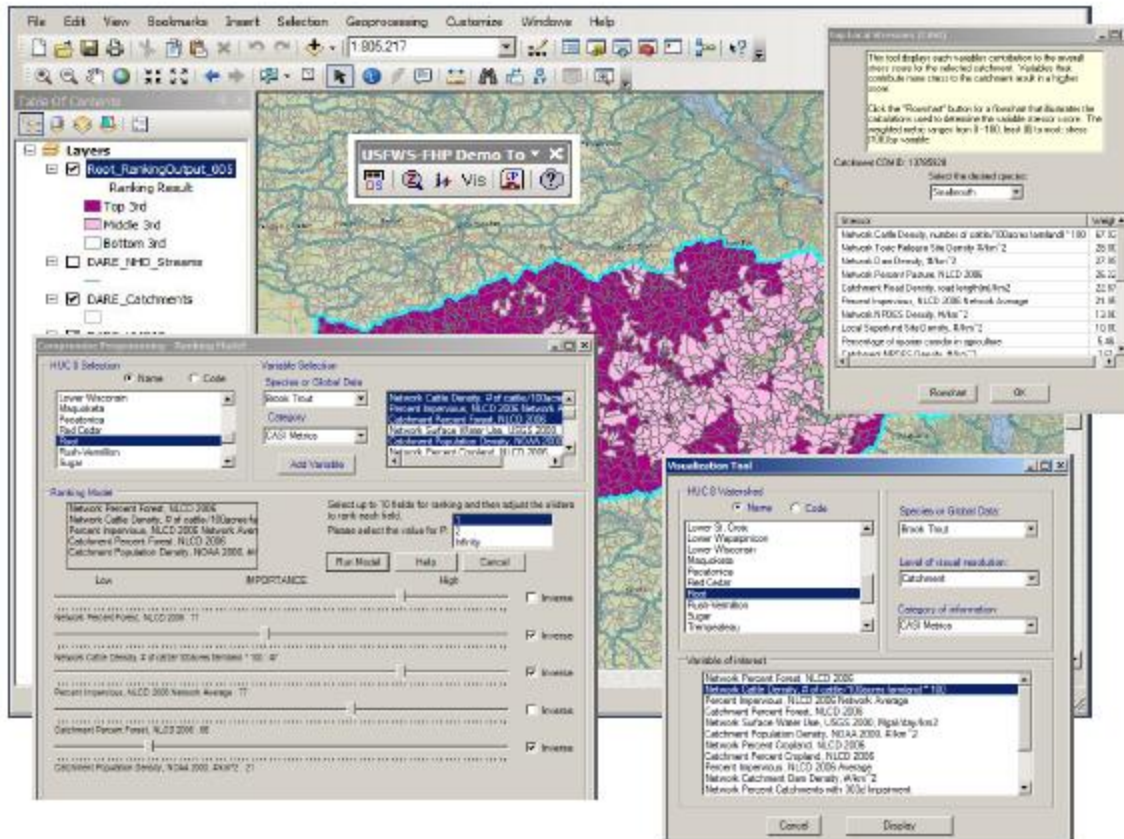
Fish Surveys

- Plus....
 - USGS
 - Department of Agriculture
 - Office of Surface Mining
 - And so on, and so on....



Boosted Regression Tree Analysis

The History Desktop Application



The Good

- Provided ability to visualize and create rankings for fish habitat data
- Very well-designed tool

The Not-so-Good

- Had to load data one FHP at a time
- Dependent on ArcGIS version

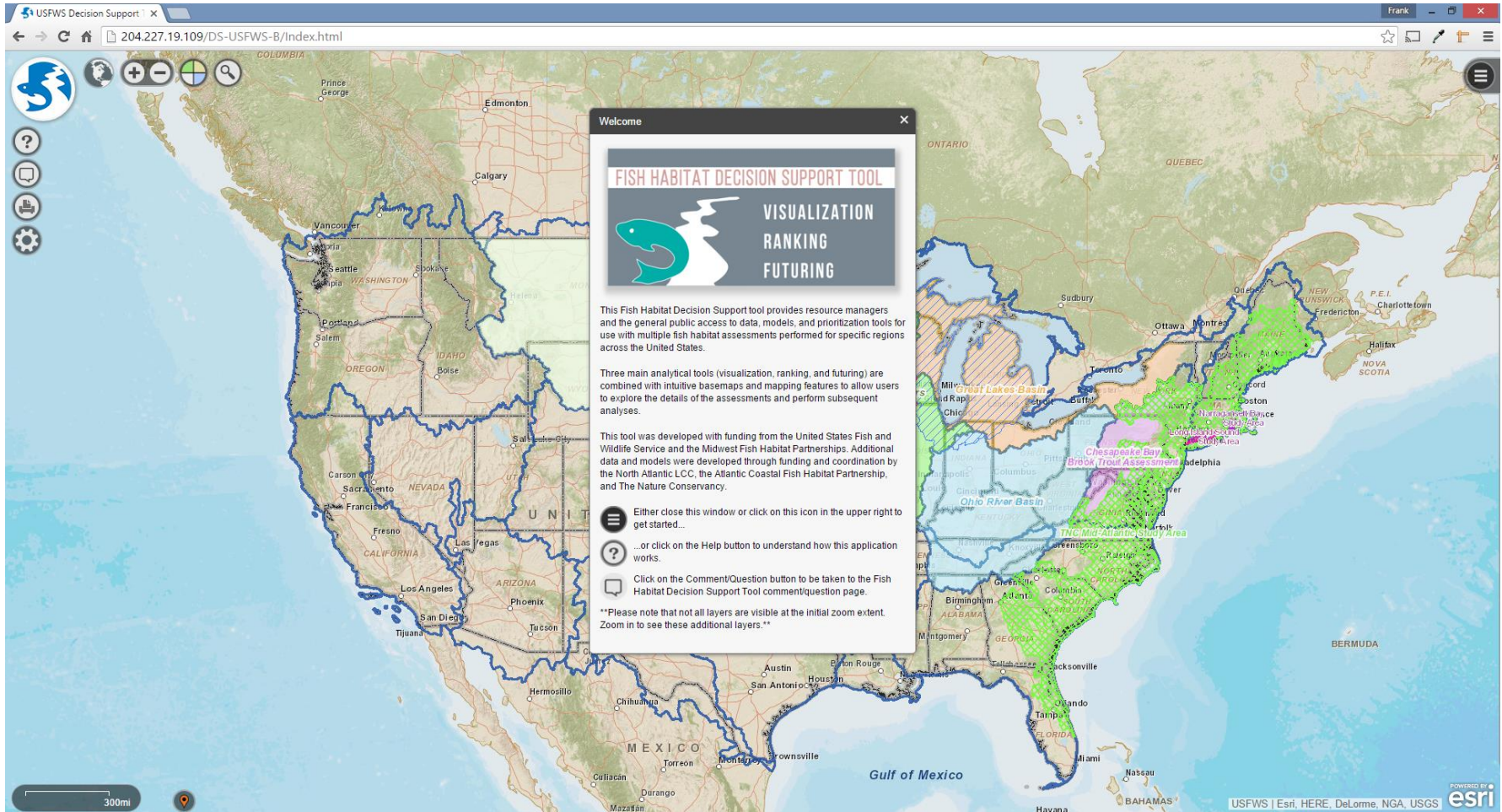
The Bad

- Limited adoption



The Solution

Custom Web-based Mapping Application



The Design

Custom Web-based Mapping Application

Simple design maximizes map space.

Slide-out tool tray only visible when needed.

Reference Layers


- Study Areas
 - Long Island Sound Study Area
 - Narragansett Bay Study Area
 - TNC Mid-Atlantic Study Area
 - DARE
 - Midwest Glacial Lakes
 - Fishers and Farmers
 - Great Lakes Basin
 - Great Plains
 - Ohio River Basin
 - Chesapeake Bay Brook Trout Assessment
- Watershed
 - HUC2
 - HUC4
 - HUC8
 - HUC12
 - Catchment
 - Waterbodies
 - NHD Flowlines
- Political
 - State
 - 113th Congressional Districts
 - County
- Socioeconomic
- Ecological Areas

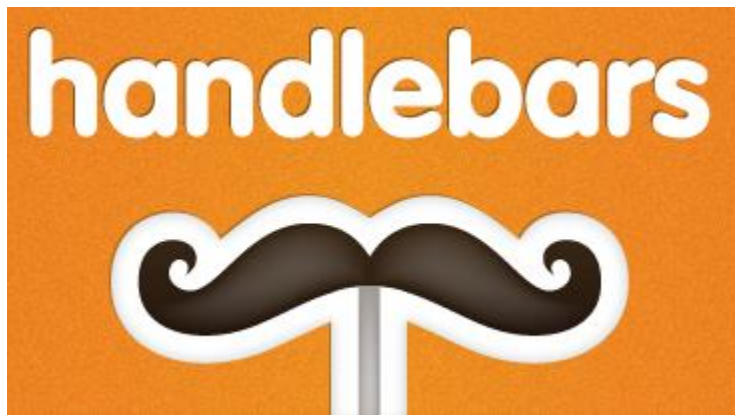
USFWS | Esri, HERE, DeLorme, NGA, USGS

POWERED BY esri

Geek Talk

Obligatory Architecture Slide

- ArcGIS For Server 10.3.1
- JavaScript API 3.14
- Server-side GP services and client-side rendering
- R Statistical Package - Version 3.1.2
- [Toastr](#) notifications 
- [Handlebars.js](#) for dynamic HTML



The Tools

Custom Web-based Mapping Application

Visualization Tool

Setup Results About Help

Visualization Name
Viz1

Scale and Geography of Visualization
Watershed (data by catchment)

Watershed Selector
Hocking - 05030204

Model or Data Category
Landscape Variables

Data of Interest
Catchment Percent Agriculture

Visualize Reset

Visualization

Ranking Tool

Setup Results About Help

Ranking Name
Rank1

Scale and Geography of Ranking
Watershed

Watershed Selector
Driftwood - 05120204

Model or Data Category
Landscape Variables

Data of Interest
Network Active Mine Density

Variable(s)

Landscape Variables: Catchment Percent Forest
Weight: 50
 Inverse Remove

Landscape Variables: Network Active Mine Density
Weight: 25
 Inverse Remove

Add Variable Remove All Variables

Rank Reset

Ranking

Futuring Tool

Setup Results About Help

Futuring Name
Future1

Model of Interest
Brook Trout

Catchment Selector
Thunder Bay - 04070006 - 12962899

Model Data of Interest
Catchment Percent Agriculture

Catchment Variable(s)

Brook Trout: Catchment Percent Agriculture
Catchment ID: 12962957
Value: 70
Flash Remove

Brook Trout: Catchment Percent Developed
Catchment ID: 12962953
Value: 80
Flash Remove

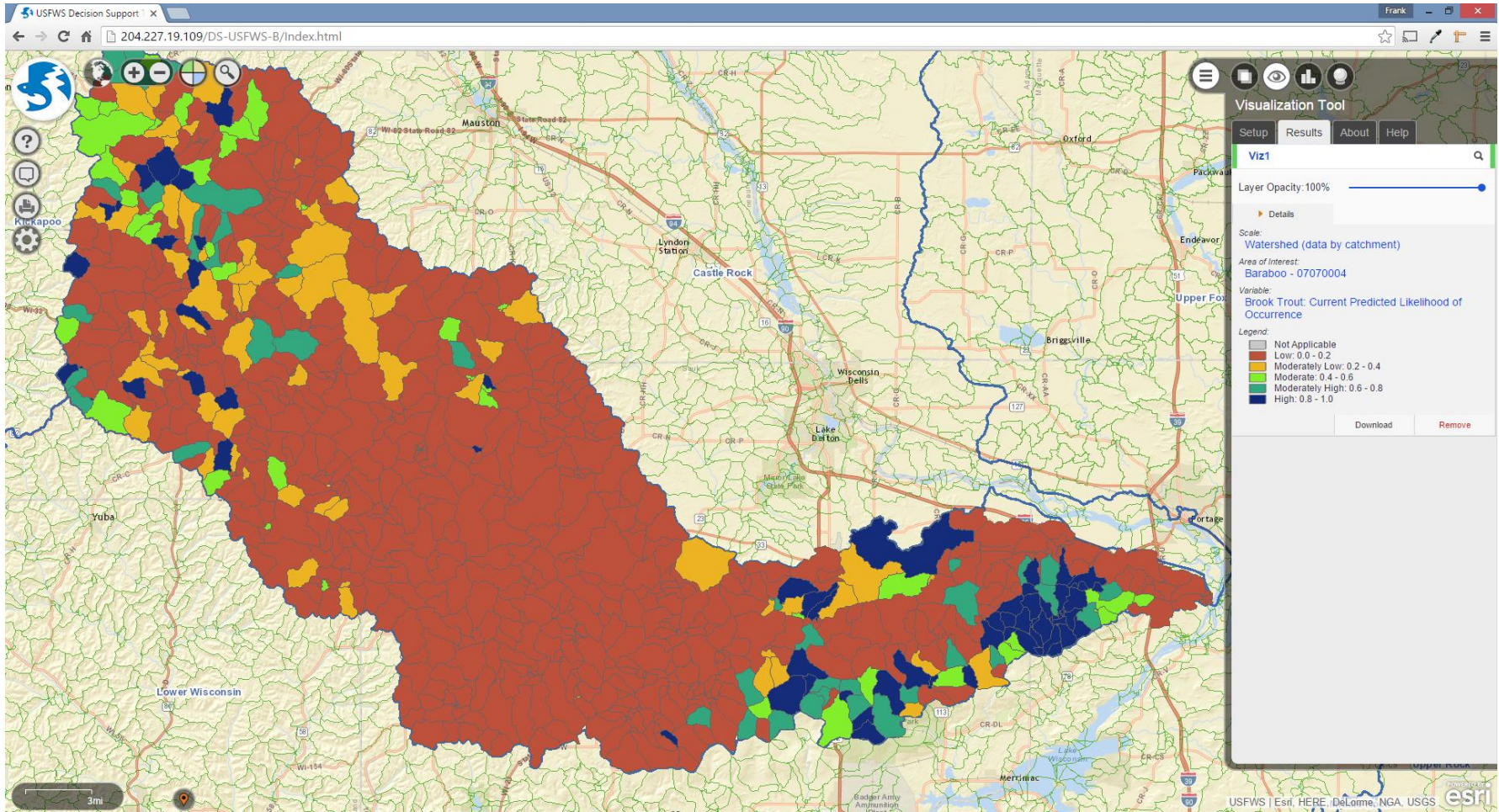
Add Catchment Remove All Catchments

Future Reset

Futuring

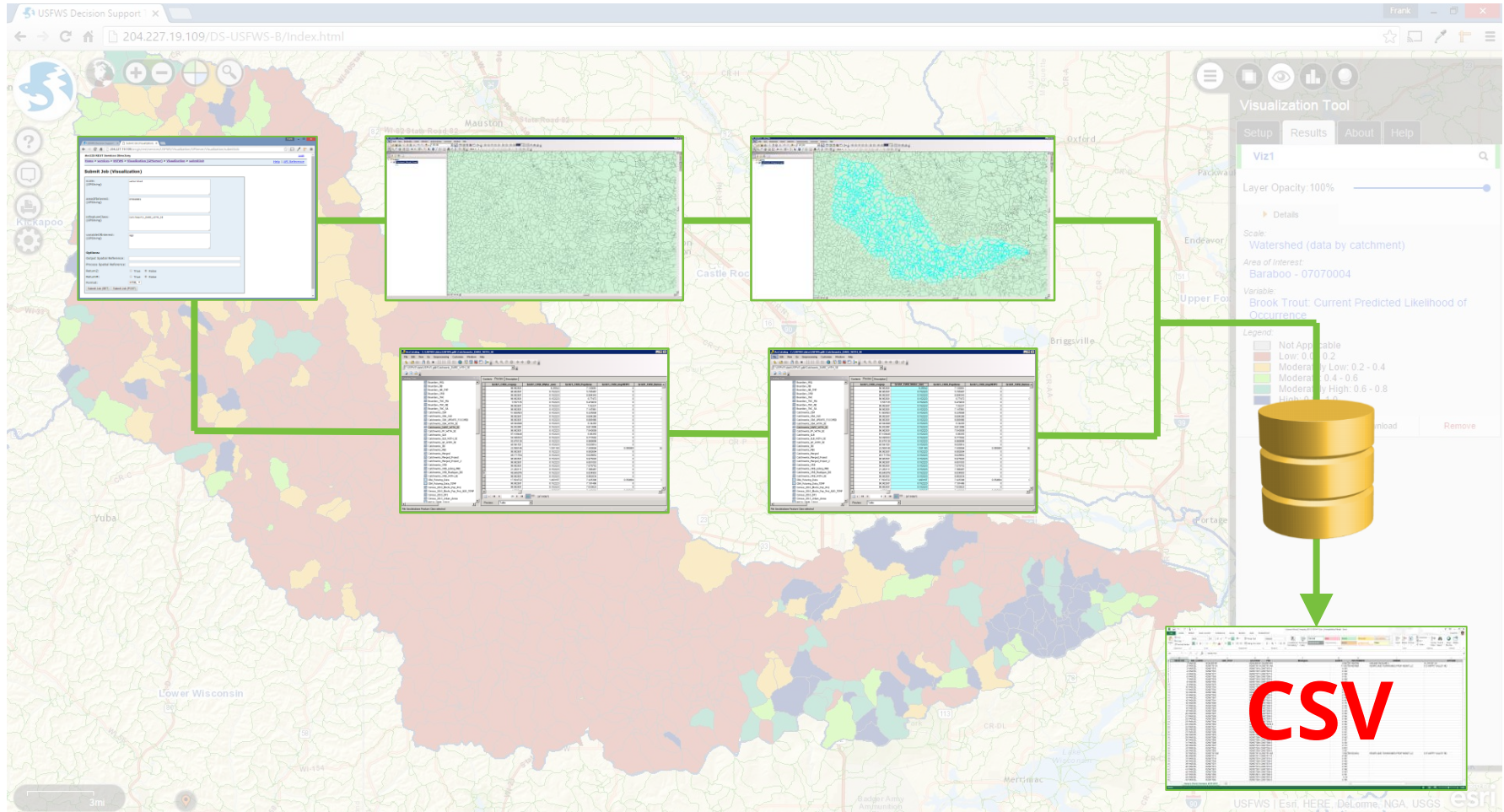
Visualization

Custom Web-based Mapping Application



Visualization – Inner Workings

Custom Web-based Mapping Application



Visualization – Inner Workings

Custom Web-based Mapping Application

```
} else if (renderType == "rendererColdBrktrtBad"){  
  
    var rendererColdBrktrtBad = new ClassBreaksRenderer(genericSymbol, "vizRender");  
    rendererColdBrktrtBad.addBreak({minValue: -0.1, maxValue: 0.03, symbol: highSymbol, label: "Low: 0.0 - 0.03"});  
    rendererColdBrktrtBad.addBreak({minValue: 0.03, maxValue: 0.10, symbol: mediumhighSymbol, label: "Moderately Low: 0.03 - 0.1"});  
    rendererColdBrktrtBad.addBreak({minValue: 0.10, maxValue: 0.20, symbol: mediumSymbol, label: "Moderate: 0.1 - 0.2"});  
    rendererColdBrktrtBad.addBreak({minValue: 0.20, maxValue: 0.40, symbol: lowmediumSymbol, label: "Moderately High: 0.2 - 0.4"});  
    rendererColdBrktrtBad.addBreak({minValue: 0.40, maxValue: 1.10, symbol: lowSymbol, label: "High: Over 0.4"});  
  
    var optionsArray = [];  
    var drawingOptions = new LayerDrawingOptions();  
    drawingOptions.renderer = rendererColdBrktrtBad;  
    optionsArray[0] = drawingOptions;  
    vizLayer.setLayerDrawingOptions(optionsArray);  
}
```

Custom, server-side rendering

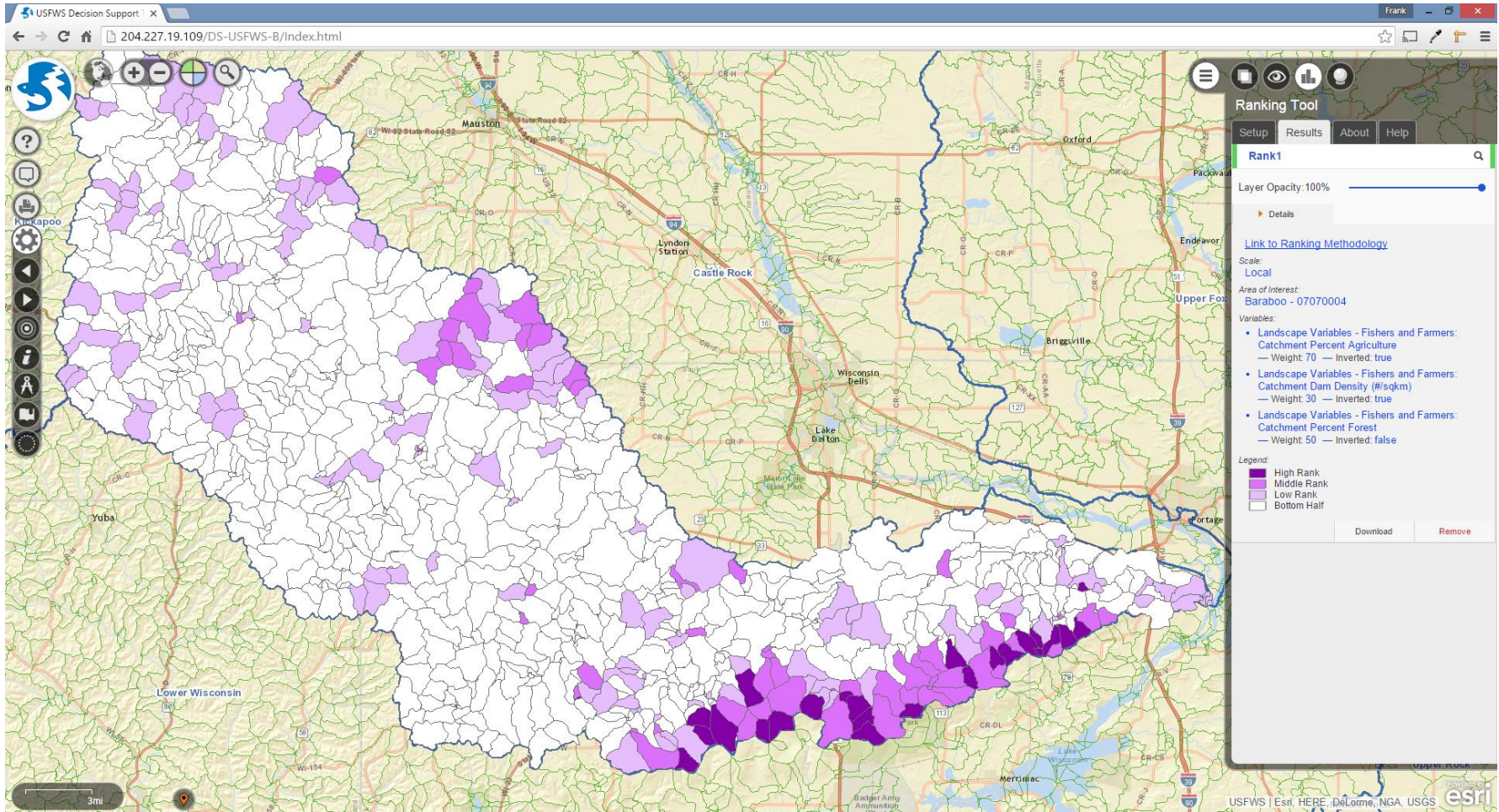
Visualization – Inner Workings

Custom Web-based Mapping Application

```
1 (function (USFWS) {
2   'use strict';
3   USFWS.dataSchema = {
4     "FishHabitatPartnerships": [
5       {
6         "name": "Narragansett Bay Winter Flounder",
7         "abbreviation": "area_HEXNB",
8         "VisualResolution": [
9           {
10            "type": "area",
11            "featureClassName": "Hex_NB",
12            "zoomToUrl": "http://204.227.19.109/arcgis/rest/services/USFWS/USFWS_Base_3/MapServer/2",
13            "data": {
14              "metrics": [
15                {
16                  "name": "Predictions",
17                  "models": [
18                    { "dbsname": "model5_preds_fish100m2", "alias": "Current Predicted YOY Density ", "renderer": "rendererNBFlounderPreds" }
19                  ]
20                },
21                {
22                  "name": "Aquatic Habitats",
23                  "models": [
24                    { "dbsname": "AREA_WATER", "alias": "Hexagon Area of Water", "renderer": "rendererHexNaturalBreaks" },
25                    { "dbsname": "DIST_SHORE", "alias": "Minimum Distance to Shoreline", "renderer": "rendererHexNaturalBreaks" },
26                    { "dbsname": "DIST_SAV12", "alias": "Minimum Distance to Submerged Aquatic Vegetation (2012 Survey)", "renderer": "rendererHexNaturalBreaks" },
27                    { "dbsname": "AREA_SAV12", "alias": "Hexagon Area of Submerged Aquatic Vegetation (2012 Survey)", "renderer": "rendererHexNaturalBreaks" },
28                    { "dbsname": "PCT_SAV12", "alias": "Hexagon Percent of Water Area As Submerged Aquatic Vegetation (2012 Survey)", "renderer": "rendererHEXNBPercentage" },
29                    { "dbsname": "DIST_SAV06", "alias": "Minimum Distance to Submerged Aquatic Vegetation (2006 Survey)", "renderer": "rendererHexNaturalBreaks" },
30                    { "dbsname": "AREA_SAV06", "alias": "Hexagon Area of Submerged Aquatic Vegetation (2006 Survey)", "renderer": "rendererHexNaturalBreaks" },
31                    { "dbsname": "PCT_SAV06", "alias": "Hexagon Percent of Water Area As Submerged Aquatic Vegetation (2006 Survey)", "renderer": "rendererHEXNBPercentage" },
32                    { "dbsname": "DIST_SAV_ALL", "alias": "Minimum Distance to Submerged Aquatic Vegetation (2006/2012 Surveys)", "renderer": "rendererHexNaturalBreaks" },
33                    { "dbsname": "AREA_SAV_ALL", "alias": "Hexagon Area of Submerged Aquatic Vegetation (2006/2012 Survey)", "renderer": "rendererHexNaturalBreaks" },
34                    { "dbsname": "PCT_SAVALL", "alias": "Hexagon Percent of Water Area As Submerged Aquatic Vegetation (2006/2012 Survey)", "renderer": "rendererHEXNBPercentage" },
35                    { "dbsname": "LENGTH_HAR", "alias": "Length of Hardened Shoreline Within Hexagon", "renderer": "rendererHexNaturalBreaks" },
36                    { "dbsname": "DIST_HARDS", "alias": "Minimum Distance to Hardened Shoreline", "renderer": "rendererHexNaturalBreaks" },
37                    { "dbsname": "OPEN_WATER", "alias": "Hexagon Area of Open Water Habitat", "renderer": "rendererHexNaturalBreaks" },
```

dataSchema.js

Ranking Custom Web-based Mapping Application



Ranking – Inner Workings

Custom Web-based Mapping Application

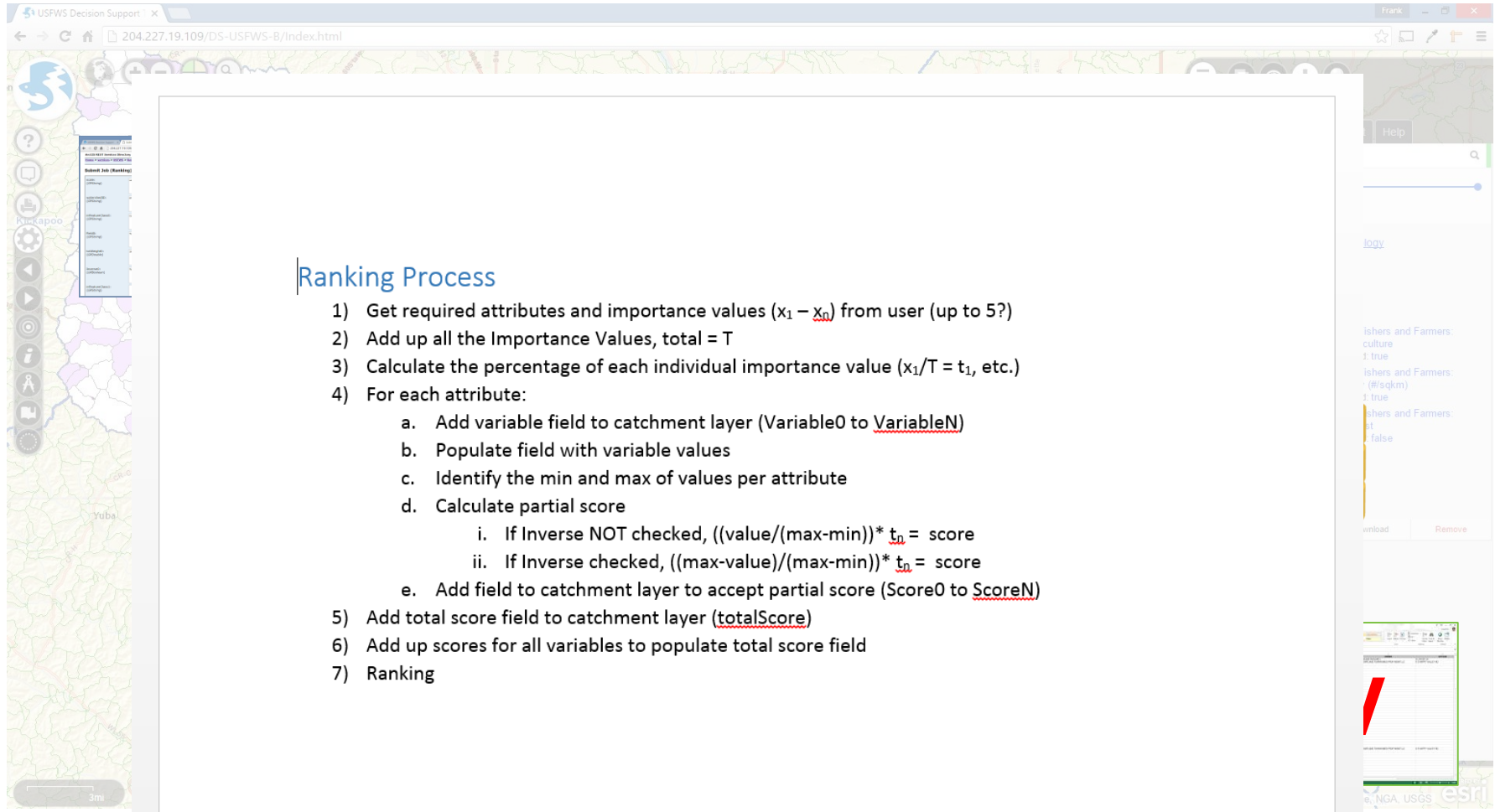
The screenshot illustrates the inner workings of the ranking process in a web-based mapping application. The interface includes a map of a region with various land use and habitat features. Overlaid on the map are several windows and panels:

- Ranking Tool:** A panel on the right side of the map, containing a search bar, a 'Rank1' dropdown, and a 'Layer Opacity: 100%' slider. It also includes a 'Details' section with a 'Link to Ranking Methodology' and a 'Scale: Local' indicator.
- Rank1 Map View:** A map window showing a specific area highlighted in cyan, representing the ranked results.
- Ranking Process:** A text box in the lower center of the map, detailing the steps of the ranking process:
 - 1) Get required attributes and importance values (i.e., -sd from user input)
 - 2) Add all the importance values (sd=1)
 - 3) Calculate the percentage of each individual importance value (i.e., $T \times i$, etc.)
 - 4) For each attribute:
 - a) Add variable rank to cumulative score (i.e., variable \times (rank/number of values))
 - b) Proceed until all variables are done
 - c) Identify the area and sum of values per attribute
 - d) Calculate final score
 - e) If inverse RPT checked, (rank/number of values) \times score
 - f) If inverse RPT checked, (rank/number of values) \times score
 - 5) Add final cumulative score to overall final score (i.e., (sd) \times (score))
 - 6) Add importance rank to cumulative score (i.e., (sd) \times (score))
 - 7) Ranking
- Database:** A yellow database icon is shown, with a green arrow pointing from it to a 'CSV' output window at the bottom right.
- CSV Output:** A window at the bottom right showing a table of data, with the text 'CSV' in large red letters overlaid on it.

Green arrows indicate the flow of data and information between these components, showing how the ranking process is visualized on the map and how the results are exported to a CSV file.

Ranking – Inner Workings

Custom Web-based Mapping Application

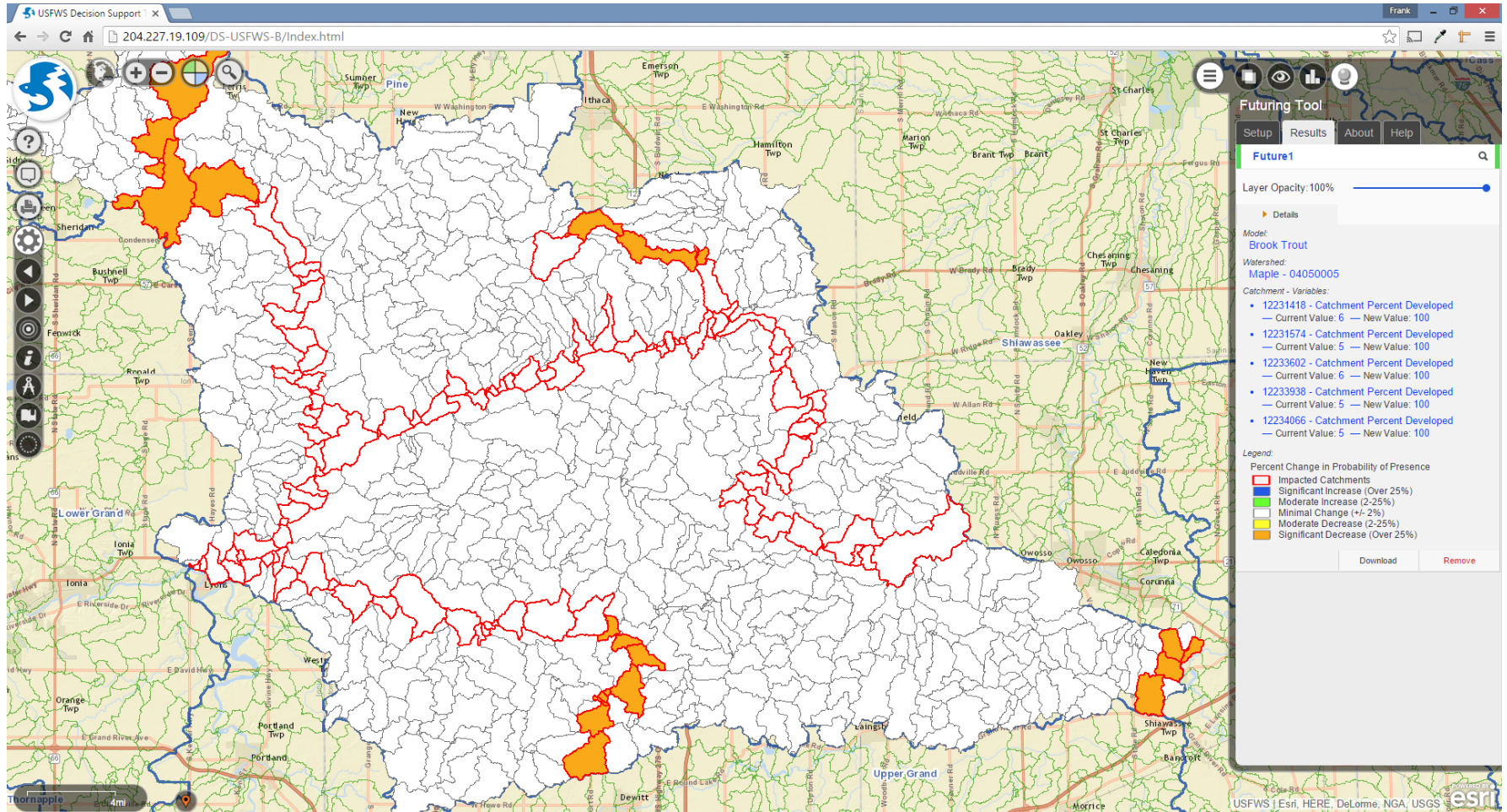


The screenshot shows a web browser window titled "USFWS Decision Support" with the URL "204.227.19.109/DS-USFWS-B/Index.html". The interface includes a map on the left with a toolbar, a central text box containing a list of steps for the ranking process, and a right-hand panel with a search bar, a legend, and a data table. The data table has columns for "fishers and Farmers: culture", "fishers and Farmers: (#sqkm)", and "fishers and Farmers: st", with values "true" and "false" respectively. The table also includes "unload" and "Remove" buttons. The bottom right corner of the interface shows logos for "NGA, USGS" and "esri".

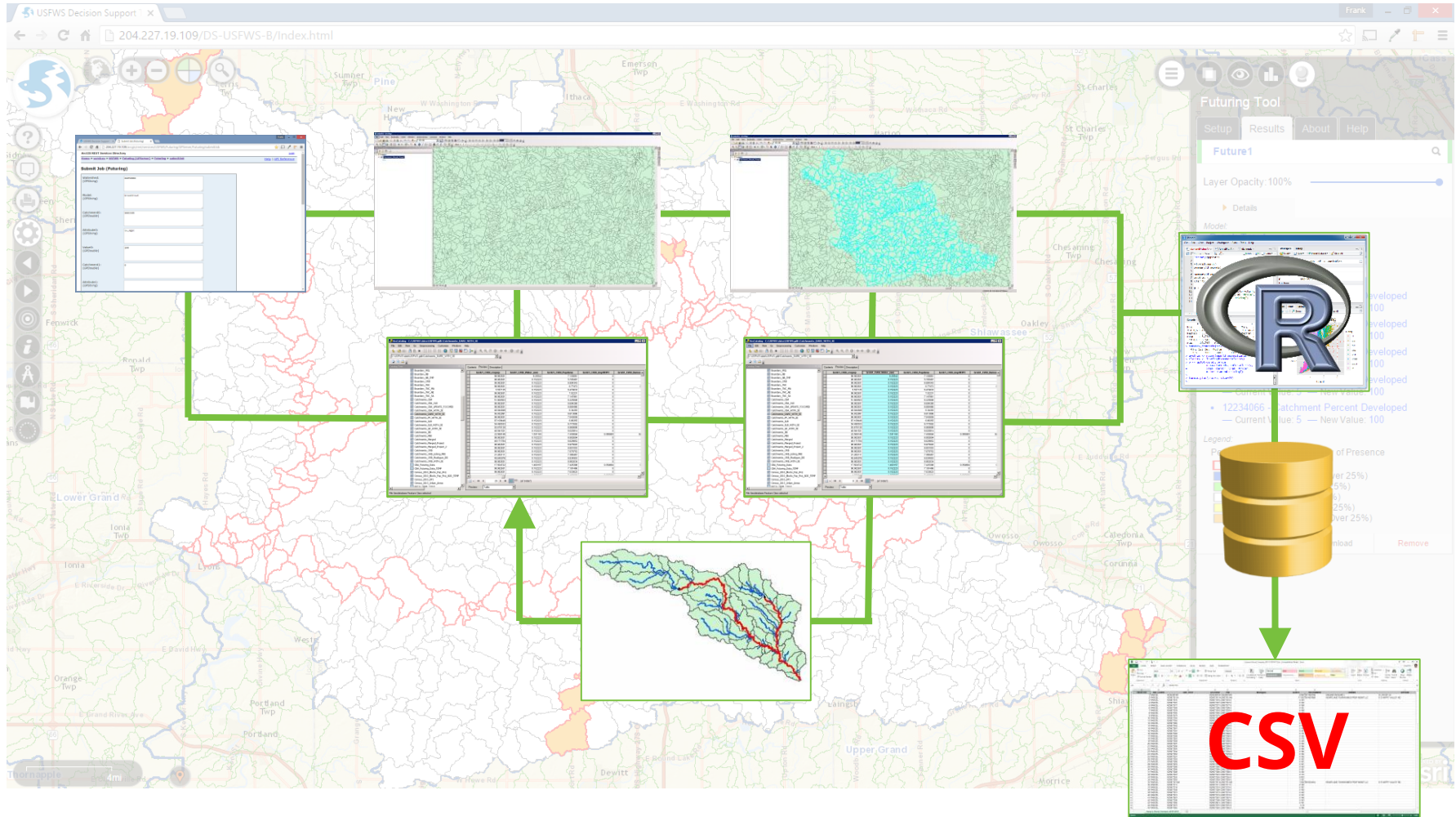
Ranking Process

- 1) Get required attributes and importance values ($x_1 - x_n$) from user (up to 5?)
- 2) Add up all the Importance Values, total = T
- 3) Calculate the percentage of each individual importance value ($x_1/T = t_1$, etc.)
- 4) For each attribute:
 - a. Add variable field to catchment layer (Variable0 to VariableN)
 - b. Populate field with variable values
 - c. Identify the min and max of values per attribute
 - d. Calculate partial score
 - i. If Inverse NOT checked, $((\text{value}/(\text{max}-\text{min})) * t_n) = \text{score}$
 - ii. If Inverse checked, $((\text{max}-\text{value})/(\text{max}-\text{min})) * t_n = \text{score}$
 - e. Add field to catchment layer to accept partial score (Score0 to ScoreN)
- 5) Add total score field to catchment layer (totalScore)
- 6) Add up scores for all variables to populate total score field
- 7) Ranking

Futuring Custom Web-based Mapping Application



Futuring Custom Web-based Mapping Application



Questions **ANSWERS**

