VASWCD Annual Meeting
December 10, 2024

Introduction to GIS and ArcGIS Pro

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Agenda

- **Geographic Information Systems – Key Concepts**
- **GIS Data Formats**
- **ESRI Platform Overview**
- **Working with CAS Data in the ESRI Platform**
- **Resources for Finding Data**
- **Help Resources**

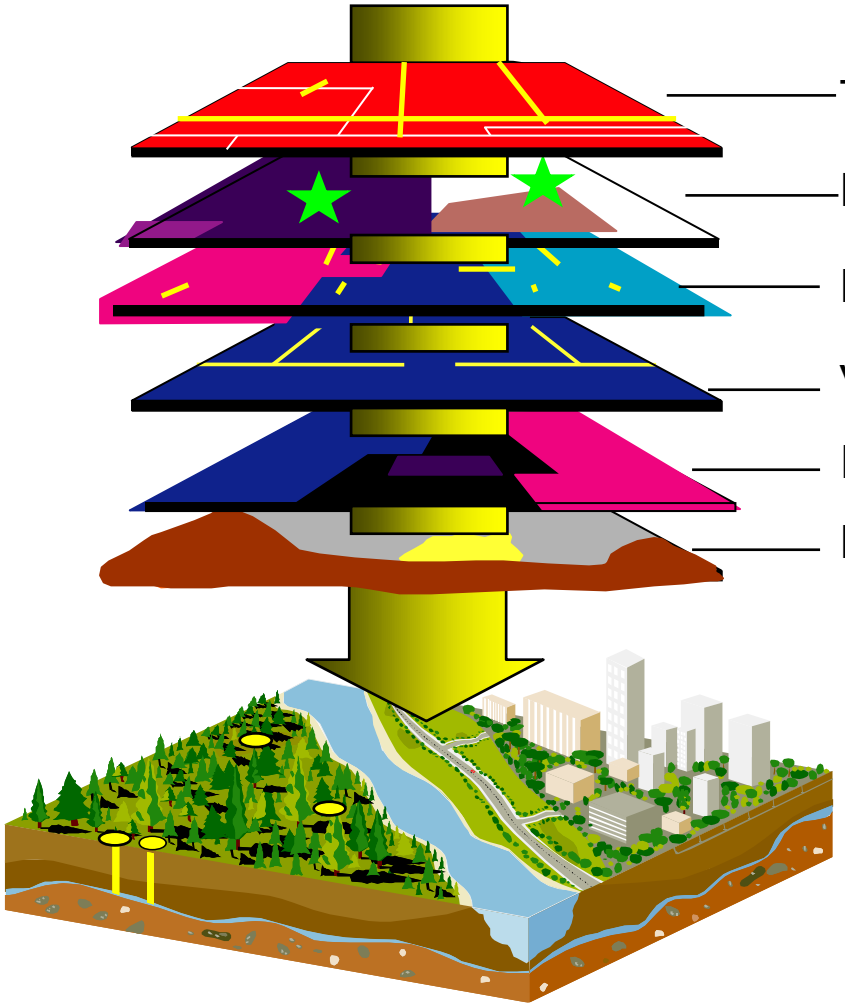
What is a Geographic Information System (GIS)?

Geographic Information System:
"an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information"

More simply put:
"A computer system capable of holding and using data describing places on the earth's surface."

(ESRI)

How Does GIS Work?



- Data are geographically referenced
- Possible to overlay multiple data layers for analysis

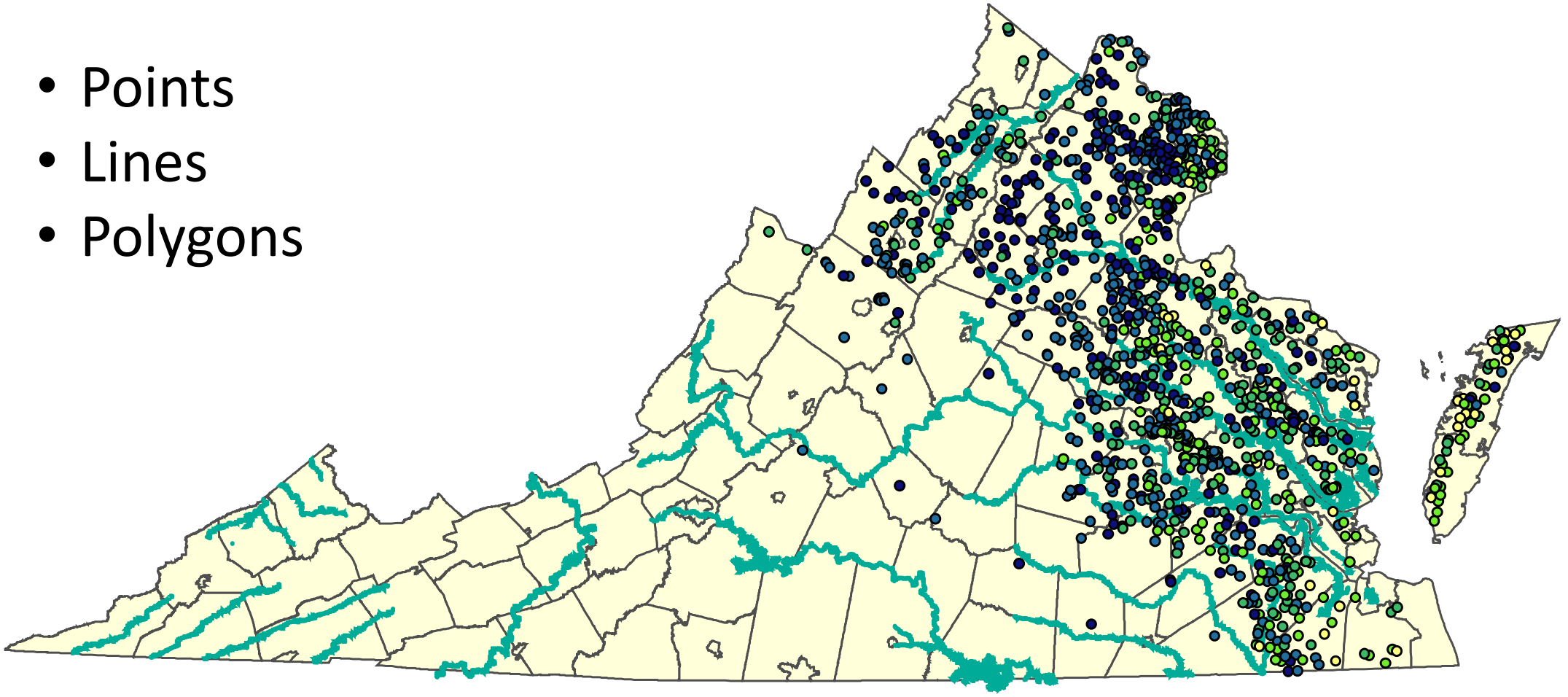
Key Concept - Vector Data Model

The vector data model represents each feature as a row in a table, and feature shapes are defined by x,y locations in space (the GIS connects the dots to draw lines and outlines). Features can be discrete locations or events, lines, or polygons.

- Points - Locations such as the representative point for a BMP or the location of a well.
- Lines – Examples include streams or roads.
- Polygons - Defined by borders and are represented by closed polygons. Examples include county boundaries or field boundaries.

Vector Data

- Points
- Lines
- Polygons



Vector Attribute Table

County Boundaries

Field: Add Delete Calculate | Selection: Zoom To Switch Clear Delete Copy

FID	Shape	AREA	PERIMETER	FIPS	COUNTY_NAM	CNTYADMIN	ACRES	HECTARES
0	Polygon	1077088050.75	225908.281015	69	Frederick	69	266148.457	107708.805
1	Polygon	1351379798.71	185010.273569	107	Loudoun	107	333925.948	135137.98
2	Polygon	461899668.593	100643.788544	43	Clarke	43	114135.408	46189.967
3	Polygon	24189490.8437	23994.358375	840	Winchester	840	5977.223	2418.949
4	Polygon	1327828655.31	201825.063633	171	Shenandoah	171	328106.461	132782.866
5	Polygon	1055163829.42	202435.713005	59	Fairfax	59	260730.982	105516.383
6	Polygon	560652462.671	121608.961924	187	Warren	187	138537.224	56065.246
7	Polygon	1689959026.57	227401.49858	61	Fauquier	61	417588.875	168995.903
8	Polygon	67446267.5781	39693.108167	13	Arlington	13	16665.973	6744.627
9	Polygon	905361383.515	210653.521447	153	Prince William	153	223714.798	90536.138
10	Polygon	5149465.34375	10548.201372	610	Falls Church	59	1272.433	514.947
11	Polygon	16180610.8437	19994.380055	600	Fairfax City	59	3998.229	1618.061
12	Polygon	39894617.9375	33015.014757	510	Alexandria	59	9857.96	3989.462
13	Polygon	691591883.625	129392.448934	157	Rappahannock	157	170892.354	69159.188
14	Polygon	2210196876.73	262371.640327	165	Rockingham	165	546139.648	221019.688
15	Polygon	813735665.078	139630.414775	139	Page	139	201074.083	81373.567
16	Polygon	4750438.40625	14996.657396	685	Manassas Park	153	1173.833	475.044
17	Polygon	26010813.0625	30608.583124	683	Manassas	153	6427.272	2601.081
18	Polygon	991032785.078	203108.362785	47	Culpeper	47	244884.201	99103.279
19	Polygon	833915395.546	149714.296576	113	Madison	113	206060.494	83391.54

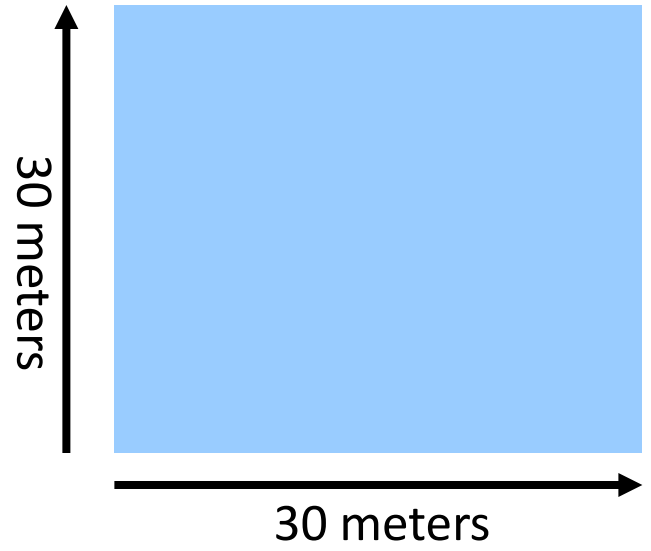
0 of 136 selected

- GIS stores descriptive information about geographically referenced features.
- Each entity has associated attribute information stored with it. This attribute information is linked to the entities along with the coordinate information.

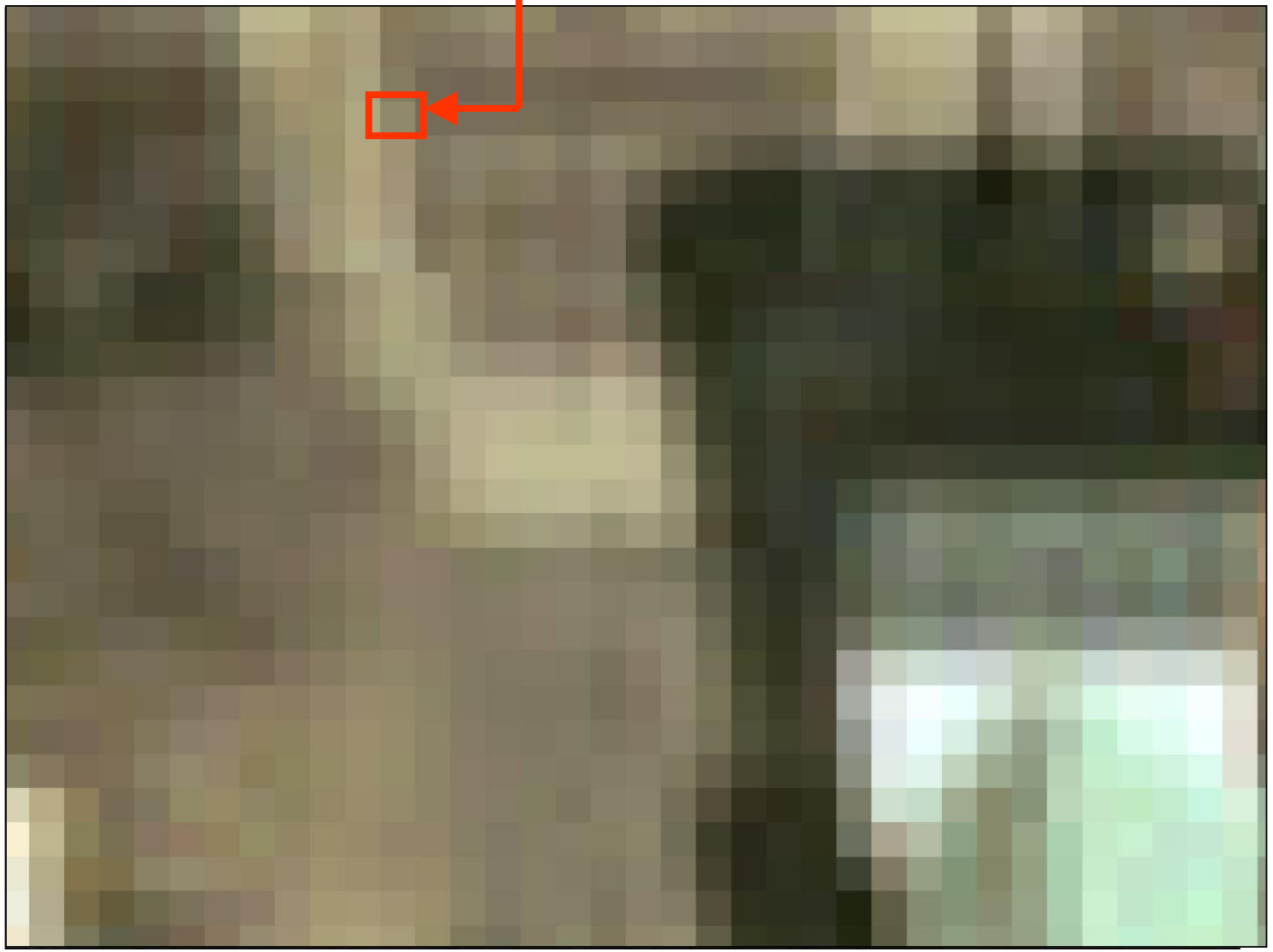
Demo – Vector Data in ArcGIS Pro

Key Concept - Raster Data Model

- Satellite imagery, aerial photography, topographic maps or land use.
- The raster data model represents features as a matrix of cells in continuous space.
- The cell size is based on scale and projection of the data. For example, a cell size can be set to 30 meters. That means 1 cell is equal to 30 meter by 30 meter cell size, or an area of 900 square meters.



Uniform grid of cells or pixels



Demo – Raster Data in ArcGIS Pro

Key Concept - Projections

- The process of flattening the earth is called *projection*.
- Projected coordinate systems are any coordinate system designed for a flat surface. It has constant lengths, angles, and areas across the two dimensions.
- Mathematical transformations are applied to translate a 3D point to a 2D surface, or, rather, to project a 3D point onto a 2D surface.

Key Concept - Projections

- When the mathematical transformations are applied to translate the 3D spatial information into 2D, distortions occur in one or more of the following properties:
  - **Shape**
  - **Area**
  - **Distance**
  - **Direction**

No projection can preserve all these properties; as a result, all flat maps are distorted to some degree. Fortunately, you can choose from many different map projections.

Projections Video

https://www.youtube.com/watch?v=kIID5FDi2JQ

Demo – Affect of Projection on Measuring in ArcGIS Pro

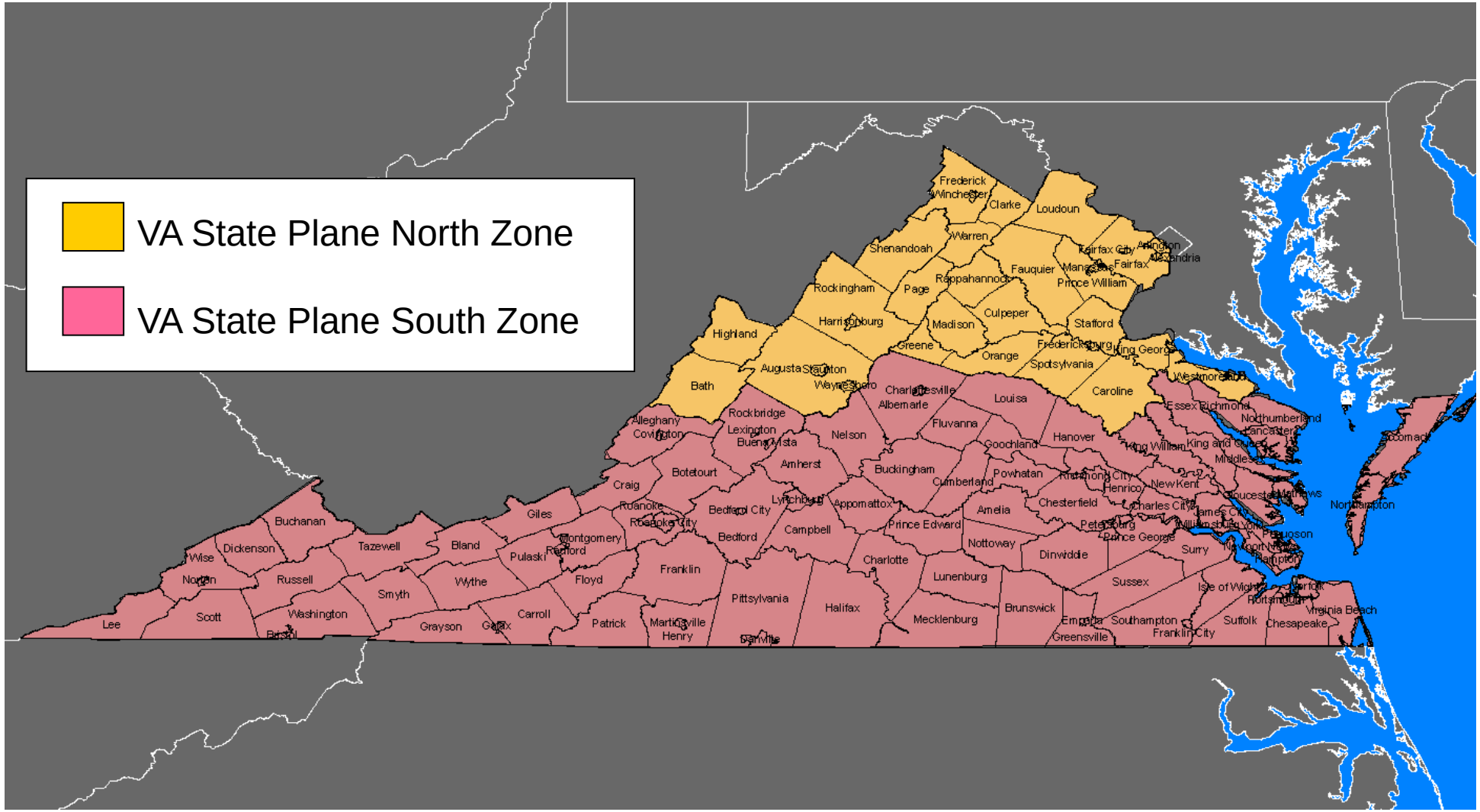
Projections - Examples

Mercator projection preserves shape but distorts area. On the map, Greenland is much larger than Brazil, but on the earth it is smaller.

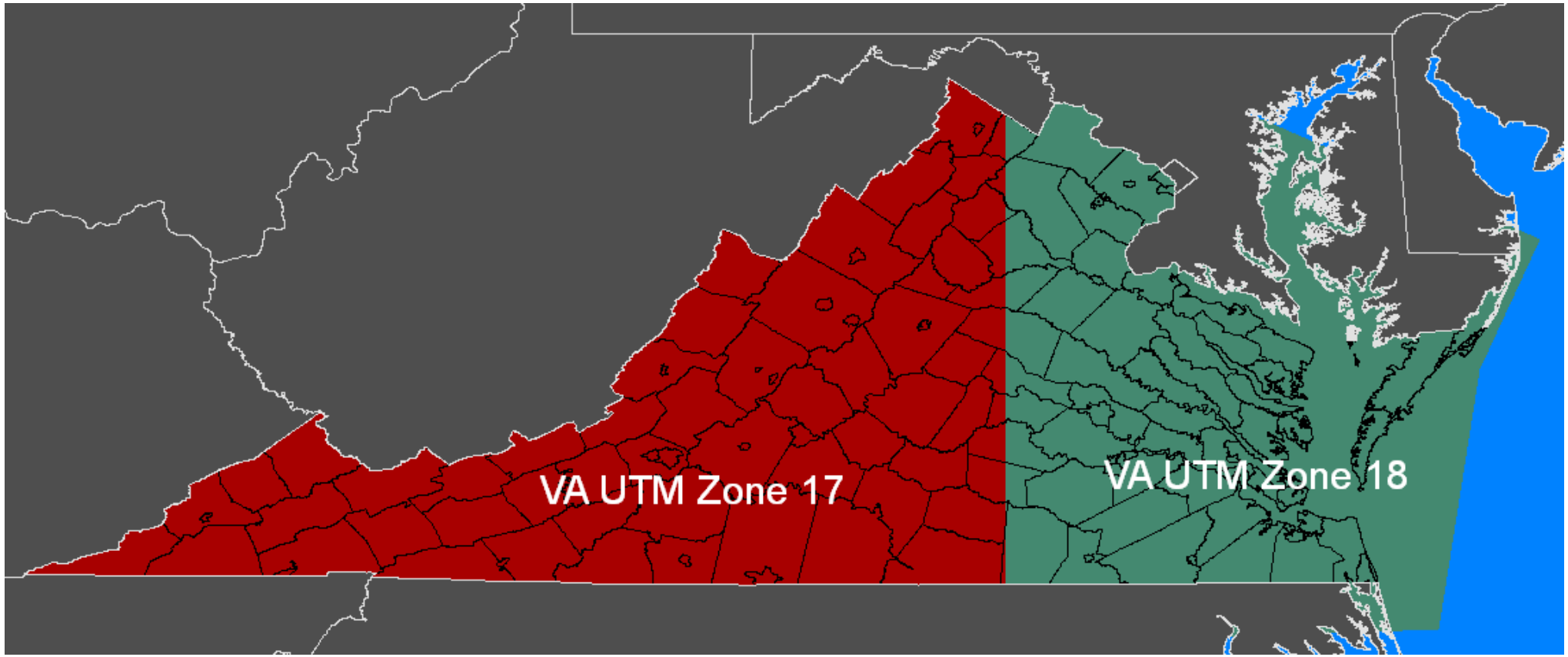
Sinusoidal projection preserves area but distorts shape. The proportional sizes of Greenland and Brazil are correct, but not their shapes.

Many map projections are designed for specific purposes. One map projection might be used for preserving shape while another might be used for preserving the area (conformal versus equal area).

Common Projections in Virginia



Common Projections in Virginia



Key Concept - Scale

- To show a portion of the Earth surface on a map, it must be reduced.
- Map scale is the extent of reduction and is expressed as a ratio:
  - 1 inch = 2,000 ft
  - 1 inch = 24,000 inches
  - 1:24,000
- A representative fraction (RF) means amounts on either side of the : are equivalent –same units (ex. 1:24000 can mean 1 inch = 24000 inches)
  - Map scale is typically expressed as a representative fraction in GIS applications.

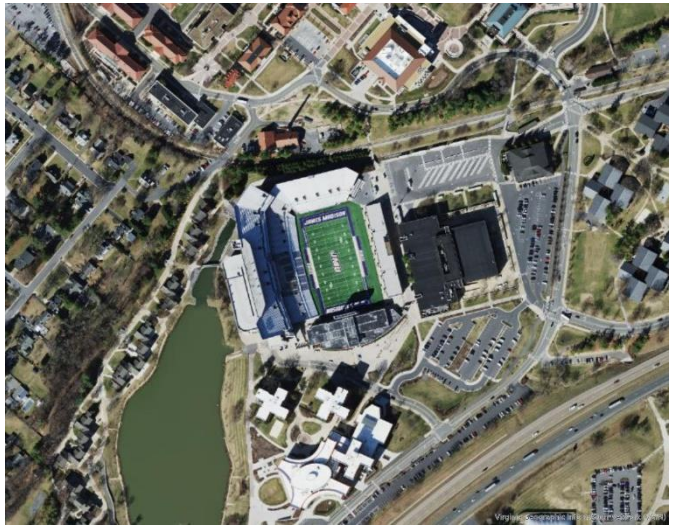
Scale Examples

1:1000

1:20,000

1:250,000

1:4000



1:100,000

1:1,000,000

GIS Data Format - Shapefile

Shapefiles: a simple format for storing the geometric location and attribute information of geographic features. Geographic features in a shapefile can be represented by points, lines, or polygons.

This is has become the standard format that can be used across various GIS applications

One shapefile is made up of multiple files, which store the geographic (x, y coordinates) and attribute (descriptive) information of the entities in the shapefile. These files must all be stored in the same project workspace so the computer can properly read the information.

GIS Data Format - Shapefile

The shapefile files are made up of:

.shp—The main file that stores the feature geometry. *Required*

.shx—The index file that stores the index of the feature geometry. *Required*

.dbf—The dBASE table that stores the attribute information of features. *Required*

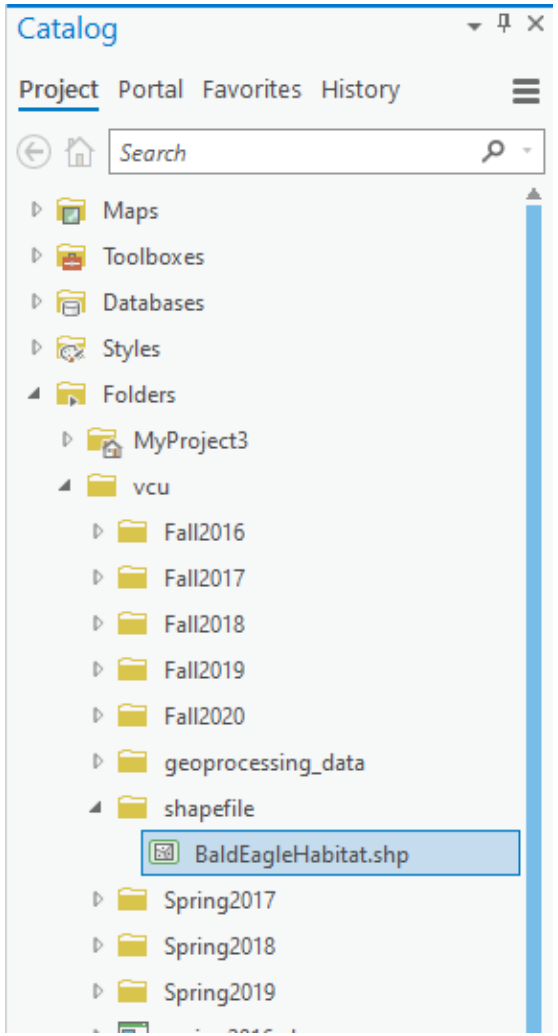
.prj—The file that stores the coordinate system information. Used by ArcGIS Pro. *Not Required but Important!*

.xml—Metadata for ArcGIS—stores information about the shapefile.

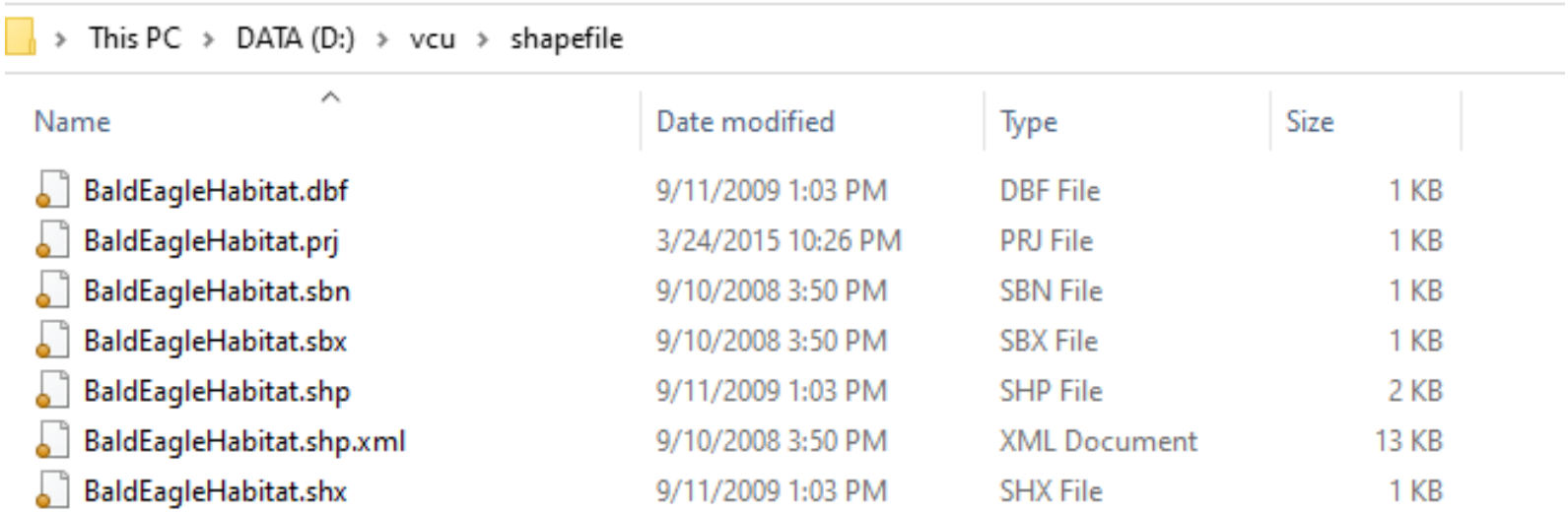
.sbn and .sbx—The files that store the spatial index of the features.

GIS Data Format - Shapefile

Shapefile in ArcGIS Pro



Shapefile in Windows Explorer



When sharing shapefiles, it is standard practice to combine the files into a “zip” file

Demo – Shapefiles in ArcGIS Pro

GIS Data Format - Geodatabase

Geodatabase: spatial data storage format that stores geographic features, non-spatial tabular data, and other information.

A geodatabase can contain multiple datasets, attachments, field domain definitions, and relationships between layers and tables.

A geodatabase is the primary data storage model for ArcGIS software products and services. It's used for editing and data management and is the native data structure for ArcGIS.

Specifically – a **file geodatabase** is the recommended data format to use with ArcGIS Pro

- Data are stored in a folder with a .gdb extension

Geodatabase Advantages

- Ability to store multiple datasets, including rasters, so it helps with organizing data
- Reduced size on disk for storing data
- Improved performance versus a shapefile
- Attribute domains can be created which establishes and enforces valid values or ranges of values for an attribute field and minimizes data entry mistakes by prohibiting invalid values
- Subtypes can be created
- Behavior rules can be stored

Demo – Geodatabases in ArcGIS Pro

GIS Data Format - Rasters

ArcGIS Pro supports MANY different raster data formats

The most common raster formats include:

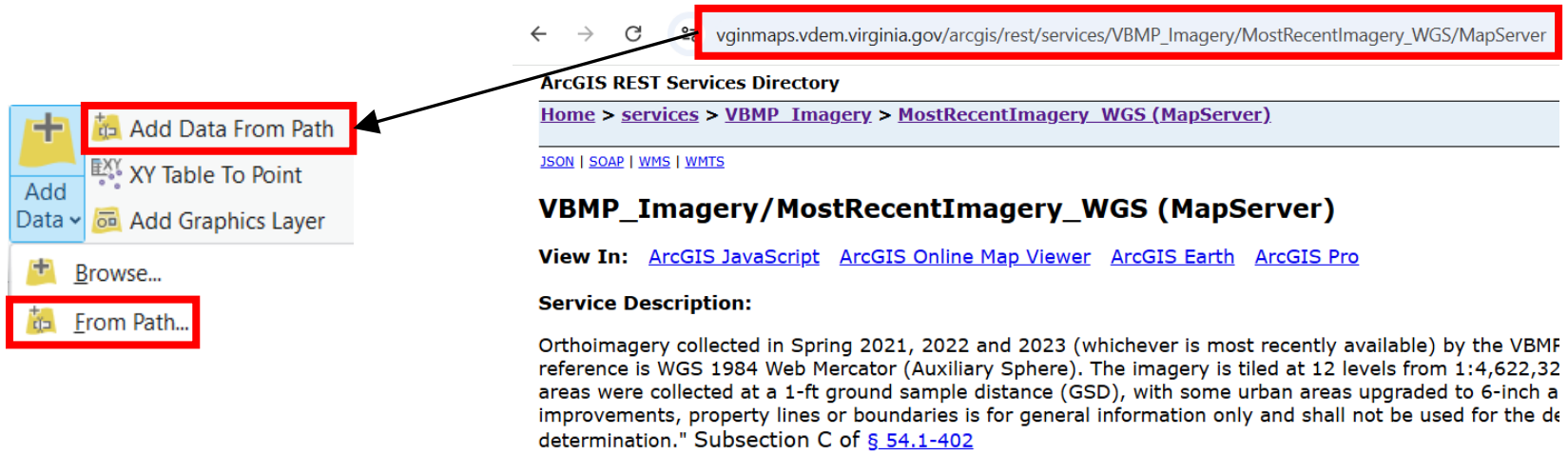
- **.jpg** - A standard compression technique for storing full-color and grayscale images. Can also have .jpeg, .jpc, .jpe, and .jgw file extensions.
- **JPEG 2000** - A compression technique especially for maintaining the quality of large imagery. Allows for a high-compression ratio and fast access to large amounts of data at any scale. Can have .jp2, .j2c, .j2k, or .jpx file extensions,
- **.tif** - Widespread use in the desktop publishing world. It serves as an interface to several scanners and graphic arts packages. TIFF supports black-and-white, grayscale, pseudo color, and true color images, all of which can be stored in a compressed or decompressed format. Can have .tif, .tiff, or .tfw file extensions.
- **Geodatabase** - The geodatabase is the native data structure for ArcGIS and is the primary data format for representing and managing geographic information, including raster datasets and mosaic datasets. Images are stored within the .gdb folder.

GIS Data Format – Map Services

The **map service** is the way GIS data can be made available over the internet.

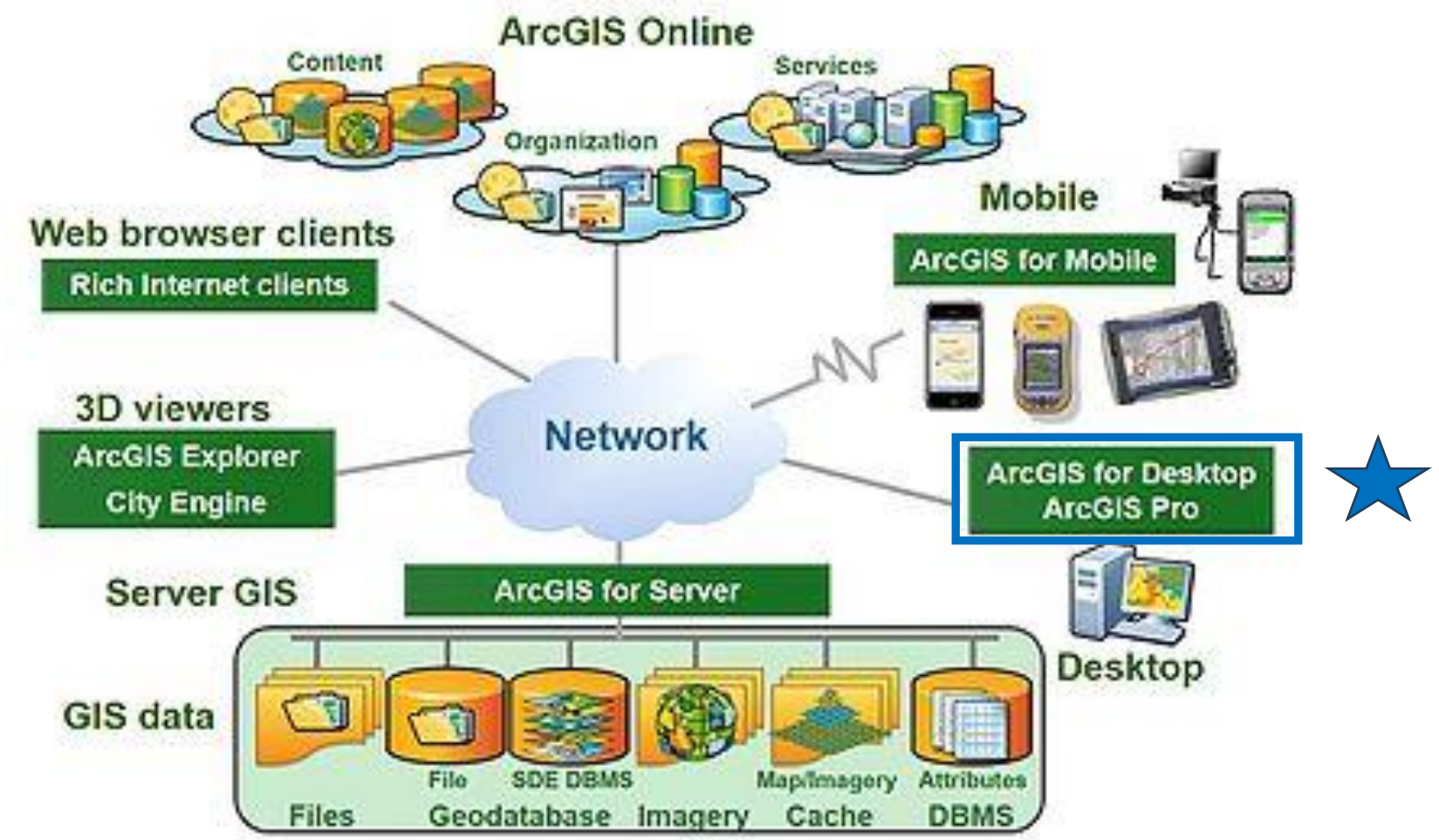
A map service makes maps, features, and attribute data available inside many types of client applications and can expose different levels of capabilities.

Map services or individual layers within map services can be added to web applications, ArcGIS Pro, ArcGIS Online, and other client applications as a map image layer or a feature layer, respectively



Demo – Map Services in ArcGIS Pro

ESRI Platform Overview



ArcGIS Pro Licensing

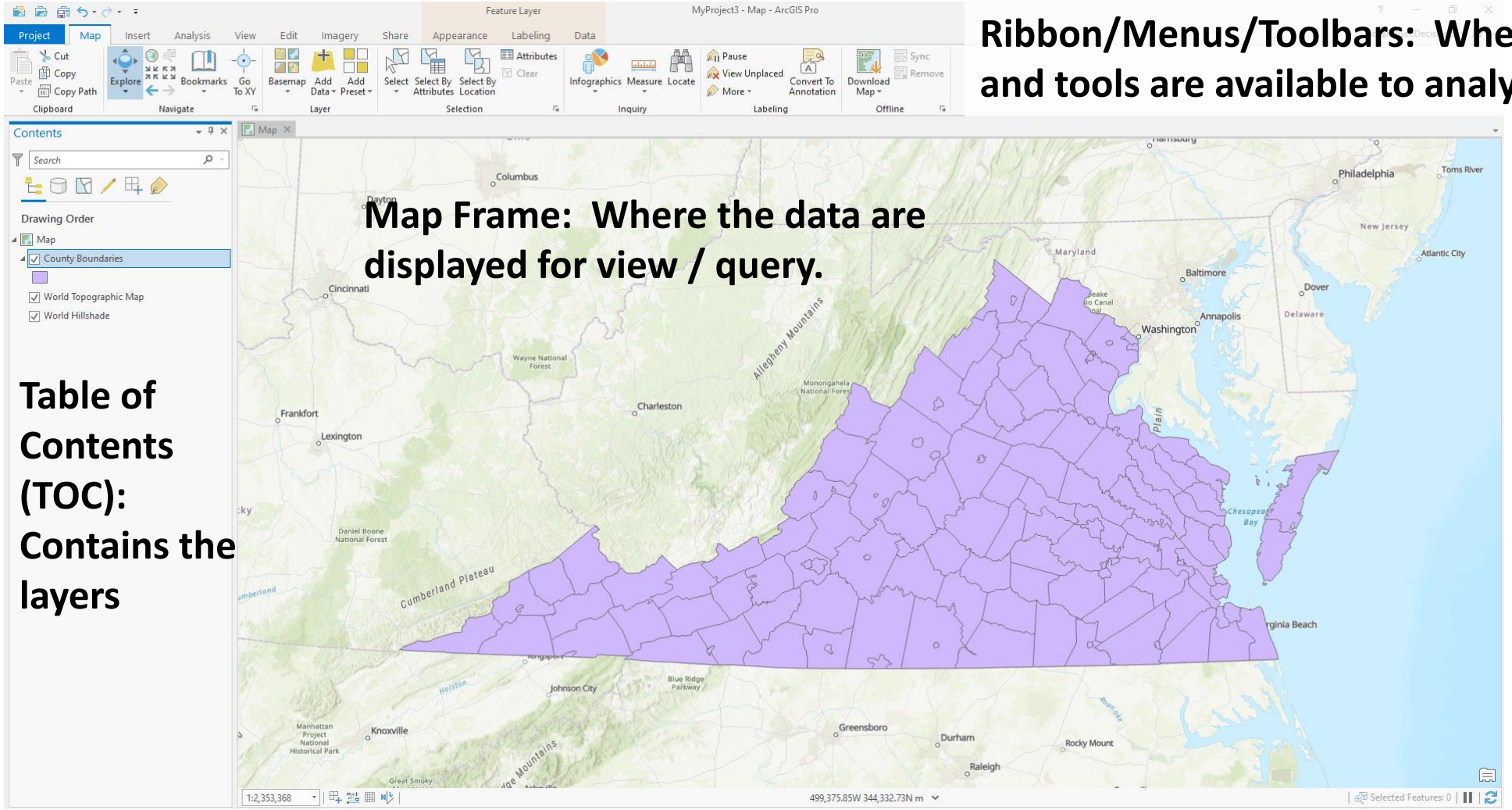
- License Levels
  - Basic – Provides core GIS capabilities.
  - Standard – Expands upon Basic with additional editing and data management capabilities.
  - Advanced - Provides the full suite of ArcGIS Pro tools and capabilities

- License Types
  - Single Use – uses a license file that only works on a single computer
  - Named User – authenticated through ArcGIS Online and can work across multiple computers
  - Concurrent User – license through server on network (in process of being deprecated)
    - Licenses are not tied to a specific version of ArcGIS Pro – you can upgrade!

ArcGIS Pro Extensions

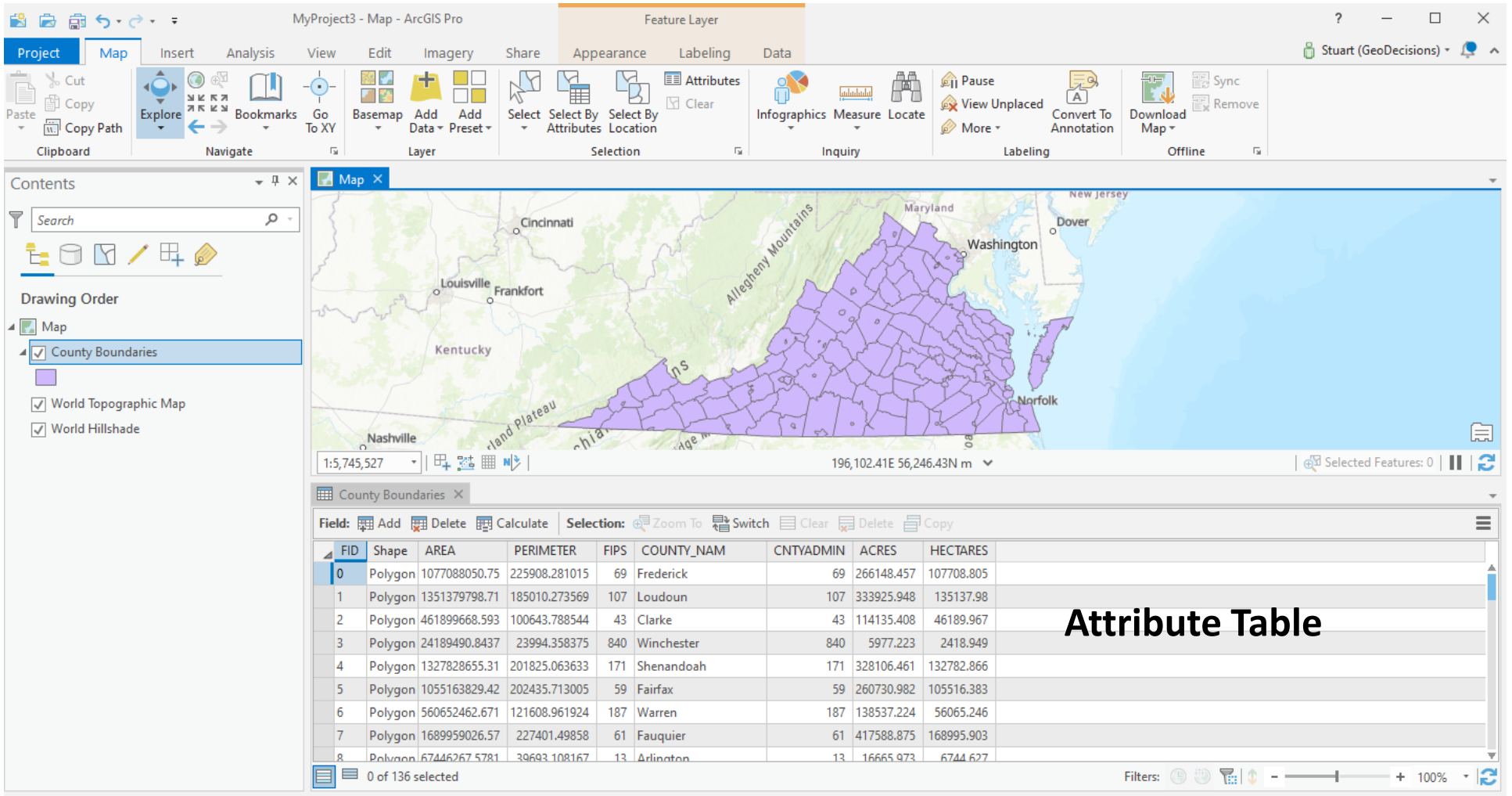
- Extensions are products that integrate seamlessly with ArcGIS Pro to enhance productivity and analysis. Extensions are purchased and licensed separately from the core product.
- Example Extensions
  - Spatial Analyst - The ArcGIS Spatial Analyst extension provides tools for creating and analyzing raster data and for performing integrated analysis of raster and vector data.
  - 3D Analyst - The ArcGIS 3D Analyst extension provides tools to create and analyze surfaces and other 3D data.
  - Network Analyst - The ArcGIS Network Analyst extension provides transportation network-based analysis tools for solving complex routing problems.

ArcGIS Pro Interface



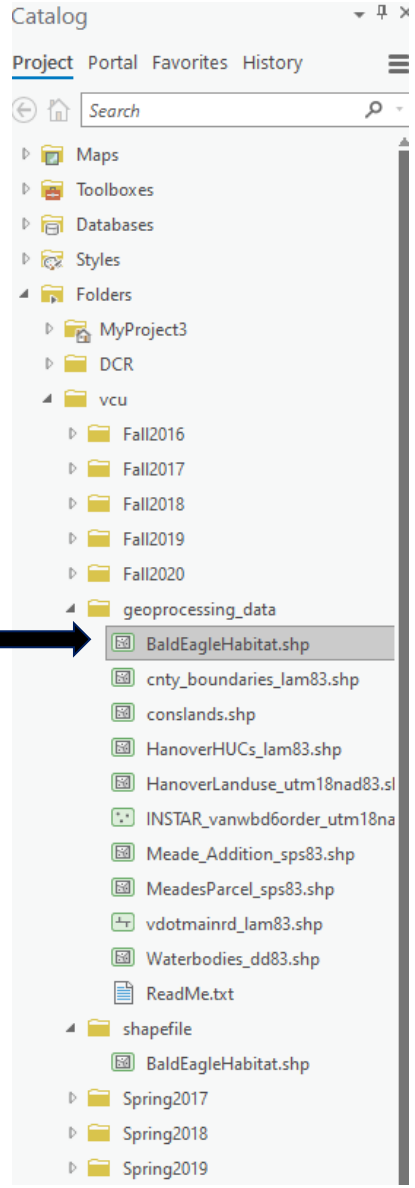
Ribbon/Menus/Toolbars: Where commands and tools are available to analyze data.

ArcGIS Pro Interface

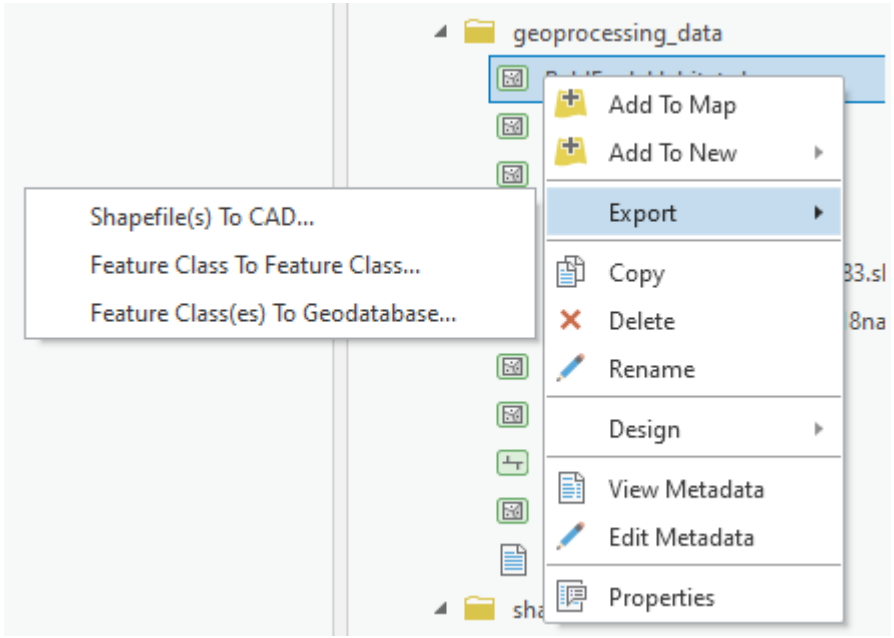


ArcGIS Pro Interface

Right-Click



Context Menus



Right-Clicking in ArcGIS Pro can lead to many shortcuts!

Demo – ArcGIS Pro Interface Basics

ArcGIS Pro – Geoprocessing Tools

Geoprocessing tools in ArcGIS Pro are a set of tools designed to perform spatial data processing and analysis tasks. They are a cornerstone of GIS workflows and are used to manipulate geographic data, analyze spatial relationships, and derive insights from spatial data.

Some of the most commonly used tools are:

Demo – Select ArcGIS Pro Tools

- Buffer - Create areas around features.
- Intersect - Determine where datasets overlap.
- Spatial Join - Combine attributes based on spatial relationships.
- Clip - Extract portions of data within a defined boundary.
- Dissolve - Combine features based on attribute values.

ArcGIS Pro – Integration with CAS

Data created and/or edited in ArcGIS Pro can be imported into CAS using the Import Shapefile tool

- Currently available for land units in plans
- Tool will be released this week (Wednesday evening) for BMP Components

Data Services is working on a new capability to allow “live” access of CAS data directly through ArcGIS Pro

- Data can be viewed/queried/analyzed
- Custom maps can be created
- Analysis can be performed

Demo – Viewing/Working With CAS Data and Exporting Data for CAS Import

Resources for Finding Data

- Google – Search for subject of interest and include the word “shapefile”
- Virginia Geographic Information Network Data Clearinghouse
  - https://vgin.vdem.virginia.gov/pages/clearinghouse
- NRCS Geospatial Data Gateway
  - https://datagateway.nrcs.usda.gov/
- ArcGIS Online
  - Living Atlas

Help Resources

- ESRI
  - Learn ArcGIS
    - https://learn.arcgis.com/en/gallery/
  - Modern GIS Website
    - https://modern-gis-learngis.hub.arcgis.com/
  - Training
    - https://www.esri.com/training/
- Chat GPT
  - Many specific questions about GIS and ArcGIS Pro can be answered with a high level of accuracy
- ArcGIS Pro
  - Online Help Documentation
    - https://pro.arcgis.com/en/pro-app/latest/help/main/welcome-to-the-arcgis-pro-app-help.htm
  - Blog
    - https://www.esri.com/arcgis-blog/products/arcgis-pro/

Questions?