**The Forest Inventory and Analysis: BIGMAP User Documentation in ESRI products**

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**Contents**

**Preface**

**Abstract**

**Keywords**

**Authors**

**Background**

In 1928, Congress enacted the McSweeny-McNary Forest Research Act which states that, *“… a comprehensive survey of the present and prospective requirements for timber and other forest products of the United States…*” Thus, began the Forest Inventory and Analysis (FIA) program, which collects Forest health parameters such as condition, volume, growth, and use of trees on the Nations Forest lands. FIA publishes yearly summary reports of the lands they survey, which benefits forest management and policies across the United States.

These reports are constructed with the same information that is publicly available and can be found on the Forest Inventory and Analysis Database (FIADB). Most inventories can be located using this database, some historical information might not be available due to the changes in inventory sampling. As a widespread reach for national consistency, all annual inventories use a common plot design and common data collection procedures. These summary reports, written by Forest Service Personal can be found on the geospatial showcase hub.

The Big Data Mapping and Analytics Platform (BIGMAP) is FIA’s could-based national scale modeling, mapping, and analysis environment for US Forests. The foundation of BIGMAP was established with the use of moderate spatial resolution imagery from MODIS to produce Continuous United States (CONUS) raster data sets on numerous forest attributes. BIGMAP intends to provide users with simple ways to estimate forest attributes (and associated uncertainties), eliminating the need to understand how FIA stores and processes information. BIGMAP allows access to data services that are derived from the integration of FIA data and ancillary predictors are based upon peer-reviewed modeling approaches, these models can be constructed to simultaneously protect plot security and provide reliable estimates of various forest attributes across a range of spatial scales. Lastly, individual forest attributes can be combined easily with other content to provide integrative assessments (developed by the Agency as well as its partners) relevant to resource managers, policymakers, and the interested publics to create associated maps. This report should be used to navigate the geospatial showcase to locate BIGMAP layers and utilize them for further analysis.

**Acknowledgements**

-Partnership with ESRI

**Chapter 1: Introduction**

* 1. **Purpose of This Guide**

This guide is user guide to the Big Data Mapping and Analytics Platform (BIGMAP) developed through a partnership between the USFS and ESRI. This guide is the first version of documentation of BIGMAP layers and will be revised and updated as more layers are being developed. Layers developed through BIGMAP are intended to be used by those outside of FIA who are interested in FIA for independent analyses. It is important for users of this data to understand how the layers were derived from the collection of the data through FIA field plots and the satellite imagery that were based on. This guide is meant to be a source of information to aid users through their personal processing of BIGMAP Aboveground Biomass layers.

* 1. **Early Stages of BIGMAP**

Early stages of BigMAP

* + CONUS ([Characterization and visualization of the accuracy of FIA's CONUS-wide tree species datasets | US Forest Service Research and Development (usda.gov)](https://www.fs.usda.gov/research/treesearch/46519)

**Chapter 2: Raster format -Layer Catalog**

Raster images are comprised of pixels each one filled with information that when combined with other pixels create an image. The information that is collected from each pixel is information regarding the color and where it falls on the visible color spectrum, which can be manipulated to and interpretated to match real-time environmental conditions. This is the framework for remote sensing analytics and combined with data collected in the field many things can be harnessed.

BIGMAP uses CONUS Landsat images from 2014-2018 and 212,978 FIA plots using harmonic regression to associate each pixel with the most similar FIA plots. This multivariate association approach is known as “k nearest neighbors,” using XXXX. Models were created for 36 CONUS ecoregions and then mosaicked together using spatial indexing from EMAP hexagons as the sampling design for FIA utilizes a standardized hexagonal grid.

Parallel processing outputs raster imagery which are packaged into a single mosaic dataset, containing 327 species at a 30m pixel resolution for the Aboveground Biomass layers in acres ton, which are then stored on an image service.

Image services exist for public access of the data. To use an image service, first connect to the GIS server and navigate to your source data. Source data for BIGMAP can be found on the [FIA Geospatial Showcase](https://fia-usfs.hub.arcgis.com/) page under FIA BIGMAP General Layer Catalog.

**Chapter 3: Mosaic Dataset**

Mosaic datasets are used to manage collections of raster images stored in the geodatabase. The translation of raster imagery to mosaic dataset allows you to store, manage, view, and query your raster imagery quickly and efficiently. Their advanced raster querying capabilities and processing functions are a result of the referencing of the raster imagery rather than manipulating the source imagery.

A mosaic dataset is created and stored in the geodatabase through the geoprocessing toolbox. At first it is created empty where then the user can add an unlimited amount of raster imagery to the dataset. The images added to a mosaic dataset do not need to be continuous and can be pieced together so long as the coordinate system is the same.

It is best to store the image service layers from the BIGMAP catalog in mosaic datasets because of the ease at which the information can be cataloged and processed. The design at which mosaic datasets can handle varying resolutions all spectrally, spatially, temporarily, and radiometrically. As the mosaic datasets only reference the raster imagery while preforming functions the source pixels are never altered or converted, and the metadata remains intact.

Just like normal spatial layers mosaic datasets have attribute tables that are related to spatial data layers. The attributes associated with mosaic datasets include:

* **ObjectID**
* **Raster**
* **Name**
* **MinPS and MaxPS**
* **LowPS and HighPS**
* **Category**
* **Tag**
* **GroupName**
* **ProductName**
* **CenterX and Century**
* **ZOrder**

The three layers that are created through a mosaic dataset include: boundary, footprint, and image layer. The boundary layer displays the full extent of all the raster imagery added to the mosaic dataset. The footprint layer reflects the extent for each individual raster image added to the mosaic dataset. Each footprint box corresponds to a unique row in the attribute table that can be used to query the data. The image layer is what controls the rendering of the data which can be manipulated through the stretch, RGB band combination, resampling, mosaic method, and other properties.

The seamline layer is another layer that can be added that acts similarly to the footprint layer in mosaicking images together. The functionality of this layer ensures that there is minimal overlap between all the raster images once added to the mosaic dataset. The use of seamlines is recommended when you do not need to view individual mosaic dataset images separately and would like to keep one feature selected throughout the mosaic dataset.

**Chapter 4: Accessing BIGMAP layers**

Graphical user interface, text, application, email

Description automatically generatedBIGMAP species layers are stored on an image service that can be located by through the [USFS geospatial showcase.](https://fia-usfs.hub.arcgis.com/) There are two ways you can process the data: 1) via ArcGIS online 2) ArcGis pro. Access for the already processed and created mosaic dataset can be found at: [FIA\_BIGMAP\_2018\_Species\_Aboveground\_Biomass - Overview (arcgis.com)](https://usfs.maps.arcgis.com/home/item.html?id=1e75650439c84a27ab9ff1f1c169f10b)

**Chapter 5: Viewing and manipulating BIGMAP data in AGOL**

**Section 5.1 Accessing**

**Map viewer classic**

1. Click on the drop down arrow in “Open in Map Viewer”, and open in the species ABG layer in, “Open in Map Viewer Classic”
2. Once open zoom into extent of the United States
3. In the layers pane, under the species layer right click in the eclipses, … for a drop down menu to appear
4. In the drop down menu click on, “ Image Display”
5. In the Image display window, change the “renderer display” to your species of interest
6. Hit apply and your species of interest will be displayed
7. If you are interested in changing the Color Ramp, change:
   1. Symbology type: Classify
   2. Field: Value
   3. Method: Natural Breaks
   4. Color Ramp: [Color of choice]
8. Hit apply and your species of interest and color will be displayed

**5.2 Creating an area of interest**

**Chapter 6: Viewing and manipulating BIGMAP data in ArcGIS Pro**

**6.1 Accessing**

1. In scrolling to the bottom of the page, copy the image service url
2. In ArcGIS Pro, open a new map window
3. Upload the species data using the URL from the image service: Navigate to Map ribbon >> Layer >> Add Data >> Data From Path >> [image service url](https://di-usfsdata.img.arcgis.com/arcgis/rest/services/FIA_BIGMAP_2018_Species_Aboveground_Biomass/ImageServer)
4. To filter layer by species:
   1. Processing Template
      1. In the Data Ribbon>> choose processing template>> species of choice>> click on species of interest
   2. Definition queries
5. To change symbology, right click on the layer in the contents page, scroll down to symbology
6. In the symbology pane change the “Color Scheme” to the desired color ramp

**6.2 Creating an area of interest**

**Chapter 7: Use Cases – Choose 2 or 3**

**Chapter 9: Raster functions**

**Input: - FIA\_BIGMAP\_2018\_Species\_Aboveground\_Biomass**

**-**

|  |  |  |  |
| --- | --- | --- | --- |
| **Function** | **Additional inputs** | **Description** | **Output** |
| **Zonal Statistics** |  |  |  |
|  |  |  |  |

1. Calculate Cell pixel statistics

Zonal statistics as a table

1. Tabulate area
2. Different graphs

**Chapter 10: Validation data**

1. FIA Plot design
   1. Hexagonal grid
2. Comparative Accuracy Assessment
   1. Metrics used
      1. Agreement coefficient
         1. What
         2. Why
      2. Systematic vs. unsystematic
      3. Use of different scales
      4. Hexes and how they were scaled up
      5. How edge of dataset boundaries were handled
3. Interpretation
   1. scatter plots for each scale
   2. legend and maps
   3. SPCD-level line plot

Packaged alongside the BIGMAP layers is an additional layer of validation data modeling an accuracy assessment

**Chapter 11: Common errors/troubleshooting**

1. [Mosaic Dataset Analyzer: Error 70100—ArcMap | Documentation (arcgis.com)](https://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/mosaic-dataset-analyzer-error-70100.htm)
2. **Error 001491** Cannot process above the size limits of the image service: 'FIA\_BIGMAP\_2018\_Species\_Aboveground\_Biomass'. The allowed maximum number of rows and columns is 4100 and 15000 respectively. Please adjust the output extent and/or cellsize to fit within the limits.

**Chapter 12: Python functionality**

**Chapter 13: Tool development**

1. Dashboard Mike made.
2. Proposed tools and future development

**Literature Cited**

**Appendix**