Outline

• Riparian in Arizona
  – Habitat Diversity
  – The Numbers
  – Impacts to Riparian

• Background on the Riparian Project
  – The First of its Kind
  – The Second of its Kind
  – Difficulty of Statewide Riparian Mapping

• Approach to Mapping Riparian Statewide
  – What is the Plan?
  – MESIC: USFS Riparian Buffer Delineation
  – XERIC: Pinal County Desert Riparian

• Next Steps
  – Collecting Training Points
  – Building a Database Repository
  – Citizen Science Opportunities

• Q & A
Riparian in Arizona
Habitat Diversity

© Hike Lemmon
Habitat Diversity
Habitat Diversity
The Numbers

• 0.4% of Arizona’s total area accounts for riparian
• Dependence of Riparian
  – 80% of all vertebrates
  – 70% of threatened and endangered vertebrates
• Over 90% of desert riparian habitat (hydro- & meso-) has been lost
Impacts to Riparian

Hydromodification

Drought

(c) USGS/Photograph Robert H. Webb

Urbanization

Recreation

(c) U.S. Library of Congress

Invasives
Background on the Riparian Project
The First of its Kind

When?
Completed 1993

Data
Two major sources of imagery:
- Landsat Thematic Mapper (TM)
  - Base map
- Multiple Resolution Aerial Videography (MRAV)
  - Finer resolution to determine vegetation classes
    - Classified using Brown and Lowe

Funding and Resources
- Eight field biologist leads, each supervised four to eight biologists
- Two to four spatial analysts and/or statisticians
- Estimated cost of over $500K

- In 1993, massive floods occurred, erasing much of what was mapped
- Any attempt at mapping riparian is a “point in time” condition
**The Problem**

AZGFD doesn’t have an updated, reliable riparian dataset for project evaluations. We don’t have a way to determine where riparian corridors are and their current condition.

**The Question**

Where are the riparian in Arizona and what is their condition?

**Defining Riparian**

Riparian areas are plant communities contiguous to and affected by surface and sub-surface hydrologic features of perennial or intermittent (lotic and lentic water bodies) as well as ephemeral.

- Riparian areas have one or both of the following characteristics:
  1. distinctively different vegetative species than adjacent areas
  2. species similar to adjacent areas but exhibiting more vigorous or robust growth forms.
Difficulty of Statewide Riparian Mapping

1. A Diverse Landscape
2. Cost
3. Computing Power and Data Capabilities
Approach to Mapping Riparian Statewide
What is the Plan?

Utilizing Two Different Models

1. MESIC: Identify riparian corridors using NHD data, 50-year flood height, and soils data (Rim country, Northern AZ, White Mountains)

2. XERIC: Identify the desert riparian using imagery and a valley bottom model (lower-lying desert regions of the state (Southwest Arizona “off the rim,” low elevation in southeastern Arizona)

Benefits

1. Low-cost way to delineate “focus areas” for future, more detailed data collection
2. Not recreating the wheel
3. Laying a framework and methods for future data collection and improvement
Establish Data Planning and Collection Framework

Models delineate focus areas from “nonriparian” zones

Focus areas are prioritized and assessed via field, web, or photo examination

Citizen Science/Feedback

AZRiparian Data Repository

Public Use of Authoritative Riparian Data

AZGFD / SMEs, Interns, Riparian Experts

AZGFD/Riparian Council

Arizona Public
Background

- Developed by Dr. Sinan Abood of the U.S. Forest Service
- Multi-scale approach to provide a national and regional report map
- National Heritage New Mexico at the University of New Mexico and New Mexico Game and Fish Department are working with USFS to create statewide coverage
Overview

• Maps riparian zones adequately and efficiently along moving watercourses by hydrologically defining a riparian ecotone to occur at the 50-year flood height and incorporating elevation data.

• Why a 50-year flood height?
  • 50-year flood recurrence interval intersects the first terrace or other upward sloping surface and supports the same microclimate and geomorphology as the stream channel.

• Optional data inputs to extend riparian mapping
  • Wetlands, riparian soil type, land cover, etc.

• Built with an ArcGIS toolbox with a simple interface.
MESIC: USFS Riparian Buffer Delineation

**Four Step Process**

1. Download Data
2. Prepare Data and Riparian File Geodatabase
3. Run “Riparian Batch” tool
4. Prepare Results

Abood, S. 2017. USFS Riparian Inventory. IGTF 2017 Presentation
Download Data

• Streams, Watersheds, Lakes
  • USGS National Hydrology Dataset

• National Wetlands Inventory

• gSSURGO Soils
  • NRCS

• Elevation
  • 1m, 2m, 3m, & 10m

• Land Cover
  • NLCD
  • Cropland
Prepare Data and Riparian File Geodatabase

1. Prepare Study Area
   - USGS HUC 12 digit watersheds

2. Prepare Streams and Lakes Feature Classes
   - Stream order
   - Calculate 50-year flood height

3. Prepare gSSURGO Layer
   - Three approaches

4. Prepare Riparian File GDB
   - Required data: DEM, streams, and watersheds
   - Optional data: soils, lakes, wetlands, and land cover
Run “Riparian Batch” Tool

- The model generates a file geodatabase for each processed watershed using the watershed names.
Prepare Results

- Run “Prepare Riparian Areas Inventory” tool to create a seamless riparian areas dataset for the study area
**Background**

- Developed by Ben Hickson
- Riparian outputs were to be applied to the Pinal County Comprehensive Plan
- Supported by Pinal County and Arizona Land and Water Trust
Overview

- Built with four vegetation classes: xerio-, meso-, hydroliriparian, and upland
  - **Xerio-**: mesic to xeric habitat-type with average annual moisture higher than surrounding uplands, but provided with surface moisture in the excess of local rainfall only on infrequent occasions
  - **Meso-**: wetlands with non-hydric soils and whose substrates is dry seasonally; usually associated with intermittent water or high elevation ephemeral wetlands
  - **Hydro-**: wetlands with hydric soils or whose substrates are never dry or are dry for only a short period; usually associate with perennial or intermittent water
- Incorporates NAIP and Landsat imagery and Valley Bottom Model (VBM) (developed by USFS)
- Ideal for the lower deserts where Sinan’s model will likely not perform well
- Currently built on a Classification and Regression Tree (CART) model, but will be updated with a Random Forest model

Seven Step Process

1. Prepare NAIP Collection Grid
   - Remove shadow effect
2. Prepare NAIP Imagery
   - Low pass filter, focal mean, focal range
   - Convert to Surface Reflectance to generate:
     - NDVI, EVI, MSAVI, SAVI, OSAVI
3. Prepare Landsat 8 Imagery
4. Create VBM Training Points and Run Model
5. Create Random Forest Training Points and Run Model
6. Perform Density Assessment
7. Clip Random Forest Model to VBM
Model Training Variables

26 Total Used in Final Iteration

3 Topographic
   Aspect, Elevation, Slope, Hillshade

16 Spectral
   4 x NAIP, 4 x NAIP (Low Pass Filter), 2 x NAIP (Focal Mean), 1x NAIP (Focal Range), 6 Landsat

5 Vegetation Indices
   NDVI, EVI, MSAVI, SAVI, OSAVI

1 Temporal
   NAIP Collection GRID
Create VBM Training Points and Run Model

• User-identified binary training points: valley bottoms (1) or upland area (0)
• Training points are used in a generalized linear model in R
  • The regression coefficients produced are used as input variables in a logic function used in ArcGIS to produce a new raster

0 – Not Valley Bottom
1 – Is Valley Bottom
Create VBM Training Points and Run Model
Create Random Forest Training Points and Run Model

- Random Forest requires training data to be identified so the model can correlate values to the classes
- Why Random Forest over CART?
  - Random Forests consist of a large number of decision trees (CART)
  - Decision trees are weak learners and prone to overfitting (high variance)
  - Ensembles (Random Forest) average out the noisy data and unbiased model to create a low variance model
- Easy to implement in R and Python
- Stable
Create Random Forest Training Points and Run Model

- Perennial Veg.
- Annual Veg.
- Herbaceous
- Open Water Structure (Bright)
- Barren (Dark)
- Shadow
- Barren (Light)
- Impervious (Dark)
- Impervious (Light)
Create Random Forest Training Points and Run Model
Perform Density Assessment

- Density coverages are generated for the annual and perennial vegetation classes using a circular window buffer with each square-meter pixel
  - Vegetation class (1)
  - Unoccupied by vegetation class (0)

<table>
<thead>
<tr>
<th>Density Value of Annual Pixel</th>
<th>Vegetation Zone ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.345</td>
<td>A_u</td>
</tr>
<tr>
<td>0.345 - 0.500</td>
<td>A_x</td>
</tr>
<tr>
<td>0.500 - 0.900</td>
<td>A_m</td>
</tr>
<tr>
<td>&gt; 0.900</td>
<td>A_h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Density Value of Perennial Pixel</th>
<th>Vegetation Zone ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.121</td>
<td>P_u</td>
</tr>
<tr>
<td>0.121 - 0.500</td>
<td>P_x</td>
</tr>
<tr>
<td>0.500 - 0.900</td>
<td>P_m</td>
</tr>
<tr>
<td>&gt; 0.900</td>
<td>P_h</td>
</tr>
</tbody>
</table>
Clip Random Forest Model to VBM
Clip Random Forest Model to VBM
Next Steps
Collecting Training Points and Focal Data

Collector for ArcGIS Application

• Develop an application for field biologist and wildlife managers to collect training points

• Some questions to ask:
  • Is riparian present?
  • Specific indicator species
  • Upland, lentic, lotic setting
    • If lotic, indicate perennial, intermittent, ephemeral
Preventing a Static Dataset

• Creating a “living and breathing” dataset for updates to riparian corridors
• The framework is just the beginning, as time goes on the database grows and always has the most up-to-date information
• Allowing for database updates to be performed in the field (e.g. Collector for ArcGIS)
• Working with partners to incorporate the small scale, fine detail riparian projects into the database
Citizen Science Opportunities

Getting that Extra Help

• In high priority critical habitat areas performing BioBlitzs
  • A great opportunity to capture not only riparian information, but wildlife utilizing the riparian as well.

• Adopt-a-HUC
  • Design a program to allow citizen scientist to adopt a HUC 12 digit watershed to collect riparian information as well as wildlife

• iNaturalist
  • A way to capture basic information such as specific indicator species