Riparian Buffer Delineation Model
RBDM v3.5

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Introduction

- Riparian areas occupy less than 10% of total landscape and provide numerous ecosystems services to wildlife, fish, water, recreation and other values.

- Riparian areas provide connectivity with different landscapes, plant and animal habitat, native plant and animal species, bank stability, water quality, aesthetic qualities and recreation, and natural filtering and trapping of sediments.

- Riparian areas are dynamic, transitional ecosystems between aquatic and terrestrial ecosystems with well defined vegetation and soil characteristics.

- Riparian areas acts as buffers to protect surface water quality.

- Riparian vegetation reduces pollutants by plant uptake also recycles entrapped nutrients providing permanent habitat for many types of fauna.

- Riparian vegetation reduces streams temperature.

- Riparian areas provides biodiversity also provides food source for plants and animals.
Develop a national context inventory of riparian areas and their condition within national forests and rangelands.

The resulting product will supplement information in the FS Terrestrial Condition Assessment and the FS Watershed Condition Classification. The product will provide a multi-scale framework to discuss land management opportunities with partners.

Freely available data will be used to inventory and delineate riparian areas base maps.
New Methodology

- A new simple practical mapping approach utilizing available open source geospatial data and the geospatial capabilities of python language under ArcGIS Desktop.

- The model utilizes multiple 50 year flood height values per stream type and stream order.

- The model accounts for river/stream watercourse and its associated floodplain.

- Optional data inputs provides extended riparian mapping and attributes such as riparian wetlands, riparian soil type, and riparian land cover classes.

- The model is independent of landform.

- The model is an ArcGIS toolbox with a simple interface that can be easily added, shared, and used by a non GIS expert.

- The model results can be easily shred and results can be replicated.
objectives

1) Where are riparian areas?
   1) How many acres/hectares of riparian areas.
   2) What is the physical extent of riparian boundaries?
   3) Area & type of wetlands/riparian wetlands within riparian areas?
   4) What is the soil profile of riparian areas?
   5) What is the general composition of riparian areas land cover?

2) Multi scale approach to provide a national and regional report map. Create a product for managers to easily understand where to apply the information at various scales.

3) Provide a framework and an end product to stakeholders and apply the information into management actions and strategies.

4) Ensure relevancy to management decisions. Effective monitoring program management are critical to accomplishing the goals of this assessment.

5) Incorporate and connect to agency and partner efforts to assess national conditions. Consider how this can inform fs WCC, TCA or fs national hierarchy. Make use of existing efforts to produce a unified product.
# Model Inputs

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<th>Input Data</th>
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| Streams, Lakes, and Watersheds | USGS National Hydrology Dataset (NHD)  
| 50 year Flood Height | Calculated utilizing Masson (2007)                                      |
| Wetlands             | National Wetlands Inventory (NWI)  
| Soil                 | Natural Resources Conservation Service (NRCS)  
| Elevation            | National elevation Dataset  
| Land Cover           | National Land Cover Database  
Corp land Data Layer  

*Also most of the data mentioned above can be downloaded at [http://datagateway.nrcs.usda.gov/](http://datagateway.nrcs.usda.gov/) or [http://viewer.nationalmap.gov/basic/?howTo=true](http://viewer.nationalmap.gov/basic/?howTo=true)*
Pilot studies
RBDMv3.5 GUI

- Watershed
- Drainage Network (i.e. Streams)
  - Drainage Type
    - FTYPE = 334 OR FTYPE = 460 OR FTYPE = 558
- Waterbodys (i.e. Lakes)
  - Lakes Buffer (Meters); 30.48m buffer distance according to Ilhardt et al (2000)
  - Sampling Distance
    - 250
- DEM
- Option-1: Specify Slope Threshold
- Option-2: Add Wetlands Data
- Option-3: Add SSURGO Data
- Option-4: Add gSSURGO Data
- Option-5: Add Land Cover Data

OK  Cancel  Environments...  Show Help >>
RBDMv3.5 GUI

Option 1: Specify Slope Threshold
Percent Rise (optional)

Option 2: Add Wetlands Data
Wetlands (optional)
Wetlands Criteria (optional)
WETLAND_TY = 'Freshwater Emergent Wetland' OR WETLAND_TY = 'Freshwater Forested/Shrub Wetland' OR WETLAND_TY = 'Riverine'

Option 3: Add SSURGO Data
Hydric Soil Rating (optional)
Hydric Soil Criteria (optional)
HydroRating >= 90
Drainage Class (optional)
Drainage Class Criteria (optional)
DrainClass = 'Somewhat poorly drained' OR DrainClass = 'Poorly drained' OR DrainClass = 'Very poorly drained'
Hydrologic Soil Group (optional)
Hydrologic Soil Group Criteria (optional)
HydrolGrp = 'D' OR HydrolGrp = 'C' OR HydrolGrp = 'C/D' OR HydrolGrp = 'B/D' OR HydrolGrp = 'A/D'
Flood Frequency (optional)
Flood Frequency Criteria (optional)
FloodCls = 'Frequent' OR FloodCls = 'Very Frequent' OR FloodCls = 'Occasional'

Option 4: Add gSSURGO Data
Use gSSURGO data (optional)
Prepared gSSURGO layer (optional)

Option 5: Add Land Cover Data
Classified Raster Dataset (optional)
The ability to utilize multiple 50 year flood height values per each stream type and stream order.

Slope threshold to eliminate steep slopes.

The ability to use SSURGO and gSSURGO data.

Highlighting riparian soil units using one parameter or four parameters approach.

Faster performance.
Updates

Verry et al. 2004 and Palik et al. 2004
The 50-year floodplain value is the optimal hydrologic descriptor of riparian ecotone along moving watercourse as determined by Ilhardt et al. (2000).

This flood recurrence was selected because in most cases the 50-year flood height intersects the first terrace or other upward sloping surface and supports the same microclimate and geomorphology as the stream channel.

There are many methods to calculate the 50 year flood height.
Calculate the 50-year floodplain using the Hydrologic Estimation.xlsm file developed according to Mason (2007) and Bedient & Huber (2002).
Hydrological Estimation
multiple gauges per stream order

y = 0.0264x³ - 0.2319x² + 0.6234x - 0.2212
R² = 0.9039
## SUPPLEMENT 1: Regression equations and standard errors of intercept (SE$_I$) and slope (SE$_S$) for the Physiographic Divisions and Provinces

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DEVELOPMENT AND EVALUATION OF BANKFULL HYDRAULIC GEOMETRY RELATIONSHIPS FOR THE PHYSIOGRAPHIC REGIONS OF THE UNITED STATES

Katrin Bieger, Hendrik Rathjens, Peter M. Allen, and Jeffrey G. Arnold
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### Hydrological Estimation

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<td>99.419516</td>
<td>0.66318</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2176.1624</td>
<td>5964.6827</td>
<td>1369.6176</td>
<td>Grayling Creek</td>
<td>0</td>
<td>0</td>
<td>4796.3</td>
<td>100.345639</td>
<td>0.66304</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Preparation

Streams positional inaccuracies and streams attributes.

Prepare soils data.

Prepare the model file geodatabase (last step).
Riparian Inventory

Western Hiawatha National Forest

- AlamosaRiver_1.gdb
- AlderCreekRioGrande_1.gdb
- BellowsCreek_1.gdb
- CarneroCreek_1.gdb
- ChavezCreekRioChama.gdb
- CityofAlamosaRioGrande_1.gdb
- ClearCreek.gdb
- ClearCreek_1.gdb
- ConejosRiverHeadwaters_1.gdb
- DeadmanCreekSanLuisCreek.gdb
- EmbargoCreek_1.gdb
- FordCreekSaguacheCreek.gdb
- GarnerCreekSanLuisCreek.gdb
- GooseCreek.gdb
- HeadwatersRioGrande_1.gdb
- HeadwatersSaguacheCreek_1.gdb
- HeadwatersSanLuisCreek.gdb
- KerberCreek.gdb
- LaGaritaCreek_1.gdb
- LaJaraCreek.gdb
- MiddleCreekSaguacheCreek.gdb
- MinersCreek_1.gdb
- NavajoRiver.gdb
- OutletConejosRiver.gdb
- PinosCreek_1.gdb
- RedMountainCreek.gdb
- RiodelLosPinos.gdb
- RioSanAntonio.gdb
- RockCreek_1.gdb
## Results

### Hiawatha National Forest

<table>
<thead>
<tr>
<th></th>
<th>% Riparian Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>43 (87,523 Ha)</td>
</tr>
<tr>
<td>Western</td>
<td>42 (139,140 Ha)</td>
</tr>
</tbody>
</table>

### Rio Grande National Forest

<table>
<thead>
<tr>
<th></th>
<th>Ha</th>
<th>% Riparian Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable width riparian areas</td>
<td>45808</td>
<td>5.85</td>
</tr>
</tbody>
</table>
Results
Wetlands

<table>
<thead>
<tr>
<th>Hiawatha NF</th>
<th>wetlands</th>
<th>Ha</th>
<th>% of riparian areas associated with wetlands</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>66,195.66</td>
<td>75.63</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>107,097.55</td>
<td>76.97</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rio Grande NF</th>
<th>Ha</th>
<th>% of riparian areas associated with wetlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable width riparian areas</td>
<td>15963.5</td>
<td>34.85</td>
</tr>
</tbody>
</table>

USDA FOREST SERVICE  WATERSHED, FISH, WILDLIFE, AIR & RARE PLANTS PROGRAM– WASHINGTON OFFICE
Results
Soils

1. Hydric Soils:
   - Bar chart showing the percentage of riparian areas with different percentages of hydric soils.

2. Drainage Class:
   - Bar chart showing the percentage of riparian areas with different drainage classes.

3. Flood Frequency:
   - Bar chart showing the percentage of riparian areas with different flood frequencies.

4. Hydrological Soil Group:
   - Bar chart showing the percentage of riparian areas with different hydrological soil groups.
<table>
<thead>
<tr>
<th>Hiawatha National Forest</th>
<th>% Riparian Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>43 (87,523 Ha)</td>
</tr>
<tr>
<td>Western</td>
<td>42 (139,140 Ha)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Map</th>
<th>Reference</th>
<th>Riparian</th>
<th>Upland</th>
</tr>
</thead>
<tbody>
<tr>
<td>HNF West</td>
<td>Riparian</td>
<td>300</td>
<td>6</td>
</tr>
<tr>
<td>Upland</td>
<td>37</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>User %</th>
<th>Commission Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>306</td>
<td>98.04</td>
<td>1.96</td>
</tr>
<tr>
<td>52</td>
<td>71.15</td>
<td>28.85</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>337</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer %</td>
<td>89.02</td>
<td>71.43</td>
</tr>
<tr>
<td>omission Error %</td>
<td>10.98</td>
<td>28.57</td>
</tr>
</tbody>
</table>

Overall accuracy: 88
## Application—Land Cover Assessment

<table>
<thead>
<tr>
<th>New land cover classes</th>
<th>Original Land cover classes</th>
<th>Value</th>
<th>Color Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops/Grains/Hay/Seeds</td>
<td>Corn, sorghum, soybeans, sunflower, barley, spring wheat, winter wheat, rye, oats, millet, spletz, alfalfa, other hay/non alfalfa, sugar beets, dry beans, potatoes, clover/wildflowers, sod/grass seed, fallow/idle cropland, cherries, apples, grass/pasture, and celery</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Developed and Roads</td>
<td>Developed/ open space, developed/low intensity, developed/med intensity, and developed/high intensity</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Barren Land</td>
<td>Barren</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Natural/Semi Natural (Forests)</td>
<td>Deciduous Forest, Evergreen Forest, and Mixed Forest</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Natural/Semi Natural (Shrubland)</td>
<td>Shrubland</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Natural/Semi Natural (Wetlands)</td>
<td>Woody wetlands and herbaceous wetlands</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>
Application - Land Cover Assessment

2014

Legend:
- Crops
- Developed
- Barren Land
- Forests
- Shrubland
- Wetlands

Distance Scale: 0 - 5 Miles
Riparian Land cover distribution 2010-2014. Source CDL-USDA. Hiawatha National Forest

- Crops/Grains/Hy/Seeds
- Developed and Roads
- Barren Land
- Natural/Semi Natural (Forests)
- Natural/Semi Natural (Shrubland)
- Natural/Semi Natural (Wetlands)

Acres

- 2010
- 2011
- 2012
- 2013
- 2014
Application
Land Cover Assessment

2010 2011 2012 2013 2014

% Natural/Semi Natural Other
Application
Land Cover Change Matrix

Change from 2010 to 2014
- forests to grass/pasture
- forests to wetlands
- grass/pasture to forests
- grass/pasture to shrubland
- grass/pasture to wetlands
- shrubland to forests
- unchanged
- wetlands to forests
- wetlands to grass/pasture
Application
Road Density
Application
Riparian areas % tree canopy
Model Parameters

- Hydrological estimation (50 year flood height).
- NHD positional inaccuracies.
- DEM spatial resolution.
Current Projects

National Riparian Inventory & Assessment.

Rangelands Riparian Inventory & Assessment.
Potential projects
Questions

sinanayadabood@fs.fed.us

saabood@mtu.edu

http://geospatial.forest.mtu.edu/
References


*2nd place recipient of the 2013 ESRI Award for Best Scientific Paper in Geographic Information Systems, American Society of Photogrammetry & Remote Sensing (ASPRS) 2013 Annual Conference.