

Building an UFDA – GIS Perspective

Necessities

1. ArcGIS (ArcInfo License and Spatial Analyst extension)
2. GIS Data and lots of it. (See Agency Data page for list of data layers and resources)
3. Internet connection
4. Phone
5. Time and patience
6. Support from your entire office and family

GIS Steps – data, GIS tools, and Model Builder

1. Community Profile
 - a. Constraints
 - b. Density
 - c. Developable Land
 - d. Agency Data
2. Scenarios
3. Suitability Analysis
4. Allocation Layer - Staff Recommended Growth Allocation
5. UFDA Yearbook geodatabase

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GIS Map Products/Brochures

UFDA Project - Outlines UFDA project, why needed and gives Community profile in numbers and maps with promise of more to come. January 16, 2008 (11x17 color brochure)

UFDA Project Update and Staff Recommendation –

Present scenarios, suitability analysis, and neighborhoods along with the staff recommendation

July 30, 2008 (11x17 color brochure)

Growth Policy Amendment – Growth allocation map

Adopted County – December 9, 2008

Adopted City – November 24, 2008

UFDA Yearbook 2008 – July 2009 (11x17 color brochure)

UFDA Yearbook 2009 – April 2010 (11x17 color brochure)

The year in numbers – building permits, annexations, new roads, new sewer, new parks, new open space, ag land developed, sensitive resources developed, open space cornerstones developed.

Scheduled

UFDA Yearbook 2010 – April 2011 (11x17 color brochure)

UFDA Key Chain – just kidding ☺

COMMUNITY PROFILE

Constraints Layer

A delineation of all land where residential dwellings are prohibited either by geography, land ownership or regulation

Shapefiles or geodatabase layers of areas constrained from residential development are imprinted into one constraints layer with the identity analysis tool in the ArcGIS toolbox.

GIS Data

- Public ownership (not school trust lands)
- Conservation easements
- Cemeteries and golf courses
- Public Parks
- 100-year regulated FEMA floodplain
- Slopes greater than 20% (raster DEM data converted to shapefile)
- Riparian resource districts (zoning layer)
- Airport restricted lands
- Zoning restricted lands: Land not explicitly zoned to permit residential uses*
 - * Outside the City Limits, the County commercial and industrial zones are restrictive of residential uses, except for an on-site manager or caretaker. Commercial and some industrial zoning designations inside the City limits allow residential housing.

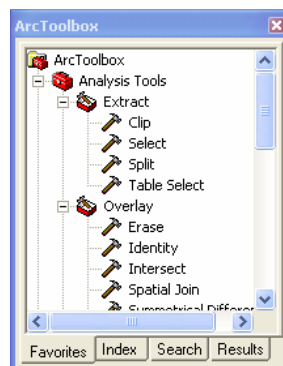
GIS Tools

Model Builder and Analysis tools - Clip, Identity, calculate
 Constraints layer model created in ArcGIS Model Builder. A model is created to be run multiple times to account for changing and emerging data. An ArcInfo license is needed to run the *Identity* process. With the *identity* process you can overlay one constraint after another over the entire county, essentially cutting up the county and attributing it in a data table at the same time.

No programming is needed to create a model. The Model Builder module is part of the ArcGIS ArcToolbox in either ArcCatalog or ArcMap. Each tool in the ArcToolbox can be grabbed and placed within a model while you create the links to the data and create the parameters. Create the space for a new model by right-clicking on a toolbox and scrolling to New Model. Within the model create an if/then statement to calculate which areas are constrained. **If** floodplain, or restrictive zoning, or conservation easements, or steep slopes is present **then** land is considered "constrained". Or just sort and calculate it manually at the end.

| Shape * | FEMADES | EaseFull | ZONE_ | ZONING | BUILT_OUT | PLAT | OWNFULL | Park | ZONE_ABR | GOLF | F_ACRES | Constrain |
|---------|------------------|-----------------|-------|--------|-----------|------|---------|------|----------|------|--------------|-------------|
| Polygon | Zone X Flood Are | City and County | | | | | | | | | 56.828967429 | constrained |
| Polygon | Floodway-Zone A | | RPZ | | | | | | | | 6.0380403934 | constrained |
| Polygon | ZONE A | | RPZ | | | | | | | | 0.1413808336 | constrained |
| Polygon | ZONE X | | RPZ | | | | | | | | 57.495789594 | constrained |
| Polygon | Zone AE | | RPZ | | | | | | | | 4.6031491641 | constrained |
| Polygon | Zone X Flood Are | | RPZ | | | | | | | | 0.3732105033 | constrained |
| Polygon | ZONE X | SOS | RPZ | | | | | | | | 0.0158764717 | constrained |
| Polygon | Floodway-Zone A | | | C-I1 | NO RES | | | | | | 40.363625306 | constrained |
| Polygon | Floodway-Zone A | | | C-P1 | NO RES | | | | | | 80.016758198 | constrained |
| Polygon | Floodway-Zone A | | | I-I | NO RES | | | | | | 0.0781136964 | constrained |
| Polygon | Floodway-Zone A | | | I-I/EC | NO RES | | | | | | 0.0620332099 | constrained |

ArcToolbox with
Analytical Tools
shown



Snapshot of records in
constraints table

Density Maps

Unit for density measurement is U.S. Census Block Group. Neighborhood unit would be ideal, but Missoula's housing data is census block group based so the block group is the easiest unit of analysis. Purpose is to show estimated actual density, density that could occur with full capacity of the zoning, and land use.

GIS Data

- U.S. Census Block Group data with full housing count. Missoula's Census block group housing unit data was updated with housing unit numbers from CAMA and Missoula's local building permits database.
- Zoning layer with dwelling units per acre
- Comp Plan Designation layer with dwelling units per acre
- Constraints layer

GIS Tools

Clip, Identity, Dissolve, Calculate

Developable Lands Layer

The purpose of this layer is to focus upon parcels which seem mostly likely to develop in the next 20 years AND to attribute these remaining parcels and pieces of parcels with zoning density data, land use density data, constraint data and the block group in which they lay. Data must be created so it can be aggregated and synthesized with the Census Block Group data, so that scenarios and density calculations can be run.

GIS Data

- Study area boundary
- Constraints layer (created with a different model)
- Census housing estimate by block group
- Zoning with dwelling units per acre data
- Comp Plan land use layer with dwelling units per acre
- Entitled Lots
- Subset of "underdeveloped" cadastral parcels from CAMA ("underdeveloped" = parcels where land is assessed more than the improvement on the land + parcels assessed as agriculture)

GIS Tools

Model Builder, Clip, Identity, Select, Dissolve, Calculate, Add field, Join, MS Access

Steps

1. Create "underdeveloped" parcel layer. "Underdeveloped" was defined by OPG. Using the Montana tax assessor's Computer Assisted Mass Appraisal (CAMA) Database, parcels were considered "underdeveloped or developable" if their assessed land value was equal to or greater than the value of the land's improvements or if they were assessed as agricultural
2. Download parcels and Access database from state. (CAMA – available at <http://giscoordination.mt.gov/cadastral/msdi.asp>)
3. Locate the PARCELVALUES table and COMMON table in the MsCAMA.mdb ACCESS database.
4. Join the parcel value and common data to the parcels via the geocode.

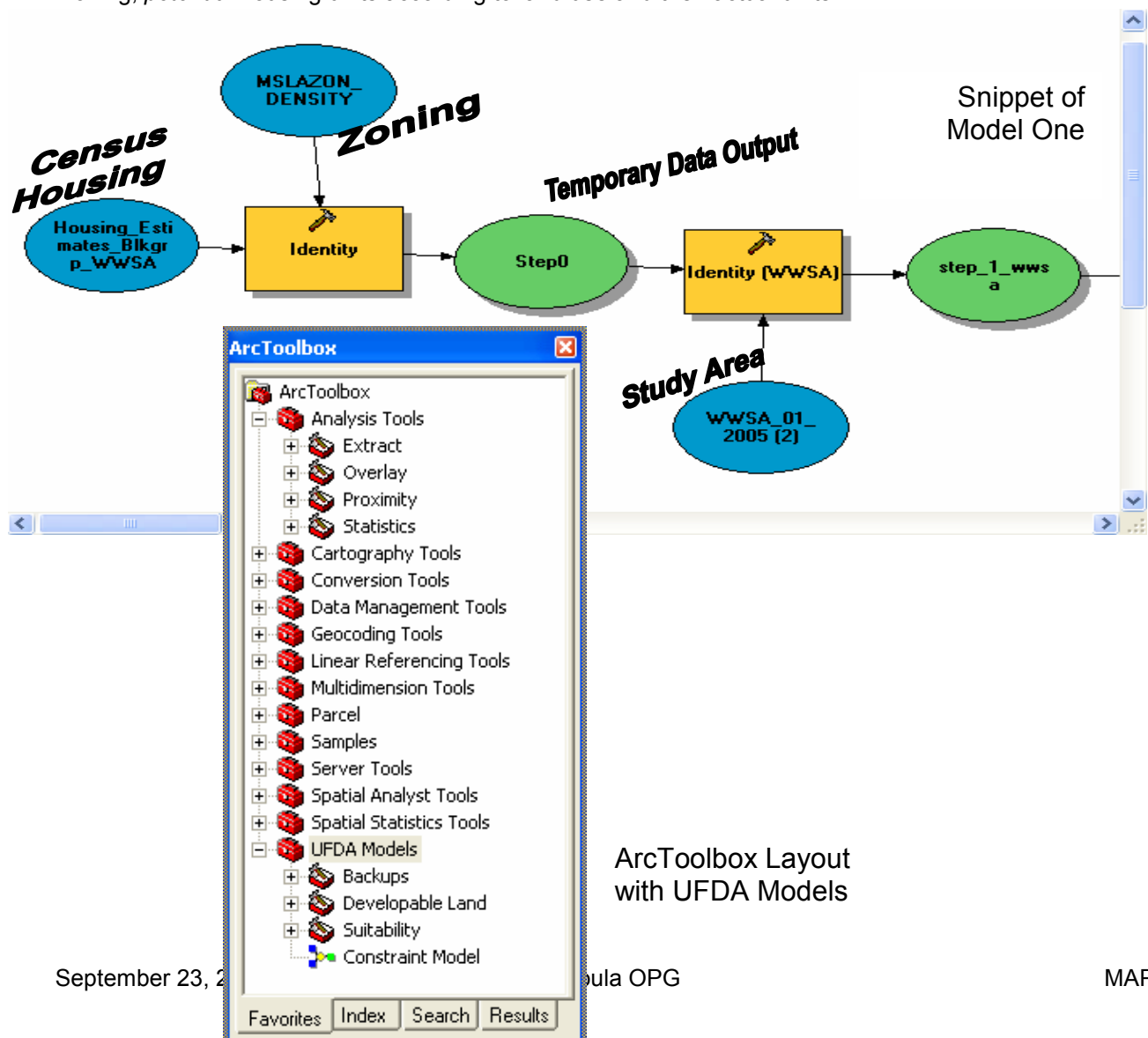
5. Sort, calculate and cull the database according to value, whether improvements are worth more than the land.
6. Additionally, land assessed as agricultural (COMMON table) was considered “developable” because of its low assessed value and because the historical development pattern in Missoula shows that agricultural land is land that is likely developed.
7. Optional: cull the parcels of properties that are Exempt (EP), Centrally Assessed (CA), non-valued (NV), and locally assessed utility (LA).
8. Create model

Developable Lands Layer Model Created in ArcGIS Model Builder

A model is created to be run multiple times accounting for changing data and to incorporate new analyses into the data. ArcInfo license needed to run the *Identity* process. No programming needed. Two models were used to create the final developable land layer.

Model 1 attribute the “developable land” with, land use designation and density info, zoning and density info, census block group number, and constraint data.

Model 2 aggregates the final output data from Model 1 to U.S. Census block group to generate density numbers for each block group as well as the number of *potential* housing units according to zoning, *potential* housing units according to land use and then actual units.



Agency Data

(Data source in parentheses)

Base Data

- Census data by blockgroup (population blockgroup data will be available when March 2011. Housing – April 2011 (U.S. Census)
- Res. New Building Permits (City PW)
- Parcel boundaries (PW)
- CAMA data- property type, assessed value land, assessed value improvement (State GIS)
- City Limits (City PW)
- Urban Services Area (City PW)
- Hydrography
- 100-year Floodplain (FEMA/DFIRM)
- Zoning (OPG)
- Comp Plan Land Use (OPG)
- Conservation Easements (MTNHP plus local research)
- Public Ownership (MTNHP plus local research)
- Digital Elevation Model 10m (USGS)
- Recently Approved Subdivisions (OPG created the data myself)

Agency Data

Transportation (OPG)

- Roads (PW)
- Road Capacity Deficiency (OPG)
- Transportation Improvement Plan (TIP) Projects (OPG)
- Bus Routes (OPG – digitized self)

Sewer (City PW)

Septic (Missoula Health Dept)

Water Lines (Mountain Water Co.)

Wells (State DEQ)

Parks and Rec (City Parks and Rec.)

- Trails
- Bike/Ped Facilities (City PW)
- Areas of Park Deficiencies
- Proposed Parks

- Planned Parks
- River Access

Fire

- MFD Fire Stations (MFD)
- MFD Response Times (MFD – created by intern)
- WUI (Frenchtown RFD - CWPP)
- RFD Stations and Boundaries (County PW)

Natural Resources

- National Wetlands Inventory (State)
- Riparian (Zoning)
- Important Bird Area (5 Valleys Audobon)
- Big Game Winter Range (FWP)
- Highway Wildlife Linkage Zones
- Important Agricultural Soils (NRCS)
- Existing Ag Parcels (CAMA)

Environmental Health (State DEQ)

- Hazardous Waste Generators
- Water Quality Remediation Sites
- DEQ CERCA Remediation Sites
- High Nitrates
- MT Pollutant Discharge Elimination sites
- Sewage Land Application Sites
- Active and Retired Landfills

Synthesized Data Layers

- Net Density by Census Block Group
- Constrained Lands
- Developable Lands
- Growth Scenarios
 - Business as Usual
 - Focus Inward
 - Neighborhood Satellites
- Suitability Analysis
 - Weighted Equally
 - Weighted towards protecting non-renewable resources
- Staff Recommendation for housing unit allocation as Growth Policy Amendment

Agency Data continued

Glossary with web source when available

OPG – Missoula Office of Planning and Grants

City PW – City Public Works

PW – County Public Works

State Data

NRIS – Natural Resources Information System - <http://nris.mt.gov/>

MTNHP - Montana Natural Heritage Program - <http://mtnhp.org/stew.asp>

MT FWP – Montana Fish, Wildlife and Parks -

<http://fwp.mt.gov/doingBusiness/reference/gisData/dataDownload.html>

MT DEQ – Montana Department of Environmental Quality – Get DEQ data through the State’s Digital Atlas of Montana Data Bundler <http://maps2.nris.mt.gov/mapper/>

NRCS – Natural Resources Conservation Service – USDA Soil Data Mart –

<http://soildatamart.nrcs.usda.gov/> or <http://nris.mt.gov/nrcs/soils/datapage.asp>

CAMA – Computer Assisted Mass Appraisal Database – Cadastral Data

<http://giscoordination.mt.gov/cadastral/msdi.asp>

Montana Flood Map Modernization Program (no GIS data) <http://www.montanadfirm.com/>

FEMA - <http://www.fema.gov/hazard/map/q3.shtm>

USGS - <http://seamless.usgs.gov/> -Digital Elevation Models (DEM) and much more

Other data sources:

Montana GIS Clearinghouse

<http://nris.mt.gov/gis/>

Montana GIS Portal <http://gisportal.msl.mt.gov/GPT9/catalog/main/home.page>

U.S. Census Bureau Geography

<http://www.census.gov/geo/www/index.html>

On-line Cartographic Resources and Geography

<http://www.census.gov/geo/www/tiger/webchart.pdf>

2010 Census Data Products

<http://www.census.gov/population/www/censusdata/c2010products.pdf>

UFDA website

<http://www.co.missoula.mt.us/opgweb/UrbanInitiative/index.htm#UFDA>

Cool fonts

<http://www.dafont.com/>

Scenarios

For the Missoula UFDA Project, scenarios were derived from the Envision Missoula process used in the 2008 long range transportation planning process. The three scenarios, Business as Usual, Focus Inward, and Suburban Satellites were uncovered through a public input process and provided a convenient method for creating UFDA scenarios. UFDA data was intersected with Envision Missoula scenarios’ development pattern and densities to come up with UFDA numbers and scenarios. No magic. No algorithms.

Link to Envision Missoula -

http://www.co.missoula.mt.us/transportation/ev_overview.htm

Suitability Layer

Suitability means suitability for residential development.

The purpose of this layer is to give a visual representation of non-regulatory data layers such as agricultural soils, open space cornerstones, proximity to existing infrastructure. Suitability for residential development can be defined in terms of 1.) physical limitations of the land 2.) as meeting the community goals as expressed in the growth policy. Results show areas within the Urban Services Area that are more or less suitable for residential development based upon eight criteria.

GIS Data:

- * Missoula City Fire Travel Response Times
- * Mountain Water Mains
- * City Sewer Lines
- * Roads
- * Road deficiencies
- * Bus Lines and Existing Bike Route Access
- * Prime Soils
- * Open Space Cornerstones
- * Wetlands, Riparian, Irrigation ditches
- * Wildlife, winter range, other critical habitats
- * Constraints

GIS Tools

The Suitability Analysis is a raster analysis performed using the Spatial Analyst extension and tools of ArcGIS: *raster calculator*, *feature conversion* and *weighted sum overlay*, and *combine* tool. Each criterion was originally a shapefile vector feature, but was converted to a raster grid and ranked in order to perform this analysis.

Number of key considerations for suitability analysis.

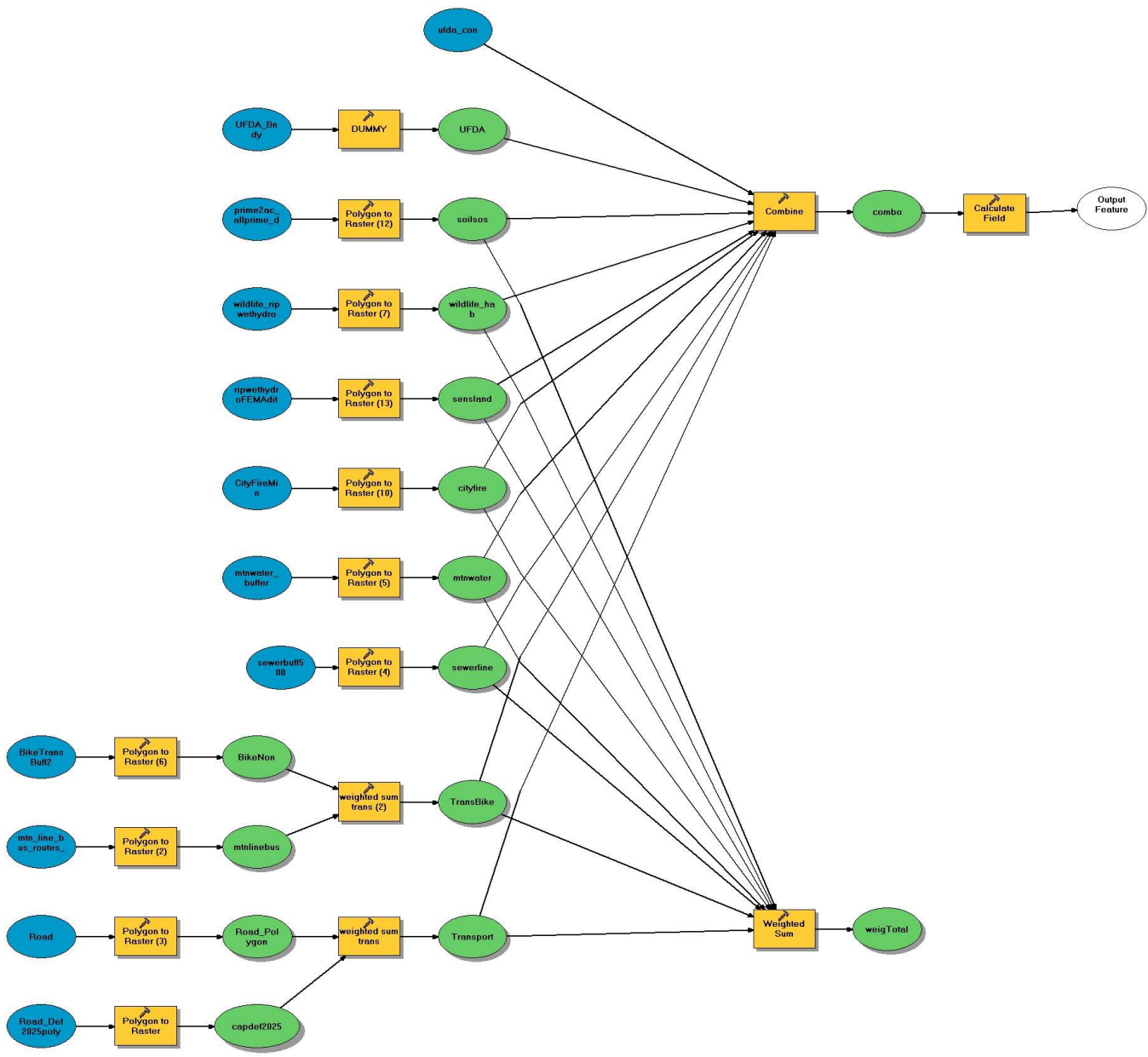
- * Establish a unit of analysis appropriate for the data and the analysis (pixel = 30ft x 30ft)
- * Create numeric rating scale for criteria data from not suitable to highly suitable. We chose (1,4,7,10,13)
- * Consensus on how to rate the data. For instance, is Big Game Winter Range highly, moderately or not suitable for residential development? Depends on your perspective
- * Decide how you want to weight the data. Is everything equal or is proximity to existing infrastructure rated more important?
- * Two resource papers to read up on Suitability Analysis:
Ravalli County
<http://www.ravallcounty.mt.gov/planning/documents/RavalliCountyLandSuitabilityAnalysisReport.pdf> and NC Division of Coastal Management
http://dcm2.enr.state.nc.us/planning/user_guide_lsa2005.pdf

Equally Weighted Suitability Analysis – creates the final weight for each pixel, but I also output a combined layer of all the inputs, so that when I try to get information about a pixel I can see which rankings made that pixel is not suitable

Suitability Model

This model both weights the data (equally) and combines it into a layer with attributes. With the combo function the data attribute remains.

| Transit | Low → | Medium | High |
|--|-----------|---------------|------------|
| Existing Bus Routes | > .5 mile | .25 - .5 mile | < .25 mile |
| Existing Bike Commuter Network and Major Bike/Ped Facilities | > .5 mile | .25 - .5 mile | < .25 mile |
| Mountain Water | Low → | High | |
| Access to Mountain Water Mains | >500 feet | <500 feet | |



Allocation Layer

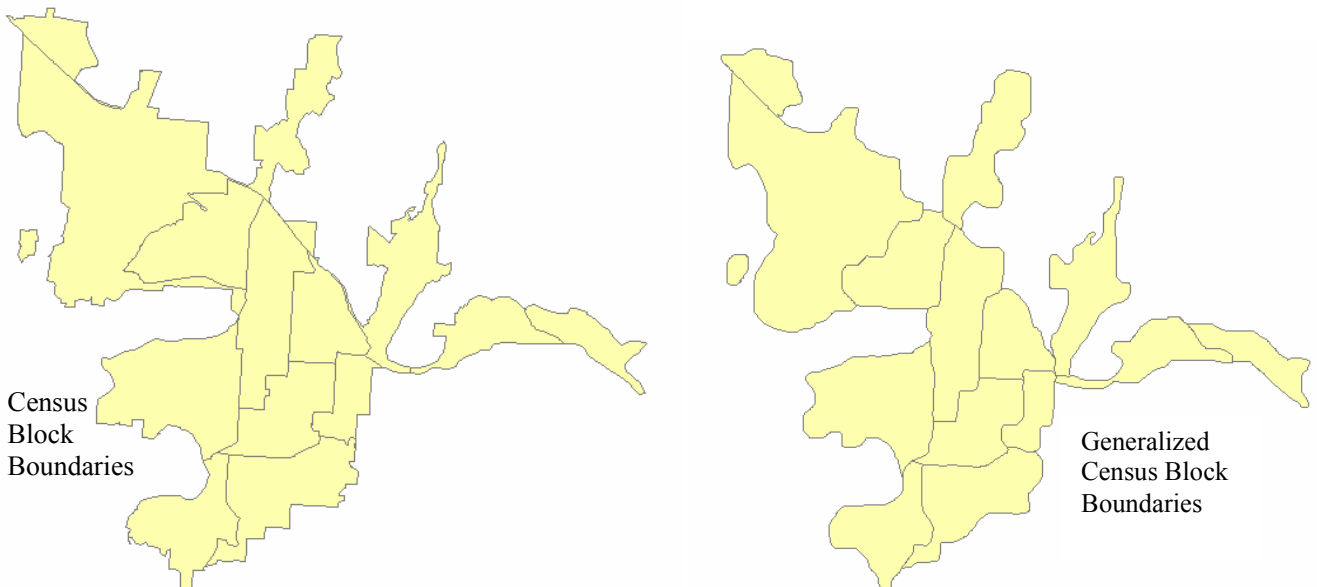
Allocation numbers used for the Growth Policy Amendment
Shows projected residential housing unit growth by area for the next 15,000 units. Also includes potential additional residential dwelling units according to zoning and **entitled lots**.

GIS Data

- * URSA Regions are aggregated block groups from the **developable lands model output**. Aggregate the block group boundaries as well as the data.
- * Best to maintain separate data table with numbers that *join* to the region layer via the name.
- * Final allocation number derived from the three scenarios, suitability analysis, public input, and development already in the works.
 - Scenario Focus Inward for seven regions
 - Scenario Status Quo for two regions
 - Something in between for five others

GIS Tools

ArcGIS Joins, Dissolve, Field Calculator, Editor. Re-digitized and generalized Region boundaries to make them more palatable aesthetically.



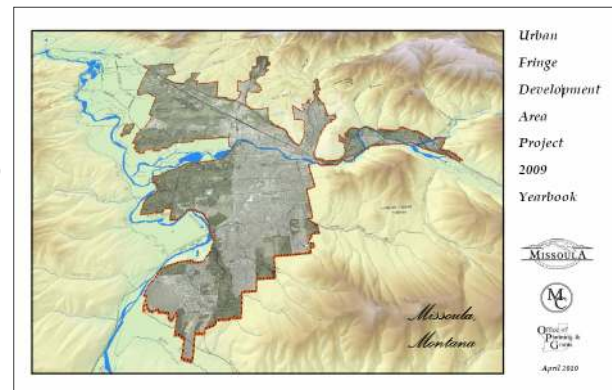
| NAME | ZON_DU | ALLOCATIO | ENTLOTS | _BP | _ALLO | _SUBS | ENTLOTS |
|---------------------|--------|-----------|---------|-----|-------|-------|---------|
| Bonner - W. Riversi | 482 | 302 | 0 | 1 | 301 | 0 | 0 |
| Brooks Corridor | 3734 | 2154 | 0 | 24 | 2130 | 0 | 0 |
| Grant Creek | 1276 | 0 | 0 | 0 | 0 | 0 | 0 |
| University | 56 | 400 | 0 | 1 | 399 | 0 | 0 |
| South Hills | 2885 | 800 | 28 | 11 | 789 | 0 | 28 |
| Reserve to Russell | 5076 | 2400 | 19 | 72 | 2328 | 16 | 35 |
| Rattlesnake | 795 | 315 | 163 | 11 | 304 | 0 | 163 |
| East Missoula | 1218 | 678 | 298 | 23 | 655 | 39 | 337 |
| Target Range - Orc | 1655 | 1000 | 301 | 14 | 986 | 50 | 351 |
| Wye | 3182 | 2281 | 443 | 0 | 2281 | 0 | 443 |
| West Mullan | 2234 | 773 | 529 | 48 | 725 | 0 | 529 |
| Central | 4031 | 2595 | 564 | 22 | 2573 | 0 | 564 |
| East Mullan | 6521 | 2500 | 970 | 104 | 2396 | 0 | 970 |
| Miller Creek | 1737 | 1366 | 1242 | 4 | 1362 | 340 | 1451 |

UFDA Yearbook Geodatabase

The yearbook displays annual changes to the data upon which the UFDA growth allocation was based. It is a gathering of mappable information on the cumulative effects of development. In another two years there will be enough data to view trends.

GIS Data (calendar year)

- * New building permits (polygon)
- * Entitled Lots, aka approved subdivisions (polygon)
- * Roads
- * Bus lines
- * Bike and Pedestrian facilities (not sidewalks)
- * Sewer
- * Water Mains
- * Resource Sensitive lands
- * Agricultural Soils
- * Critical Wildlife Habitat
- * Parks and Open Space Cornerstones
- * Conservation Easements



GIS Tools

Analysis tools - identity, clip, and calculate. MS ACCESS. Data is assembled into one ESRI file geodatabase UFDA_Update.gdb. No model was created for these data. Difficulty with this update is the coordination with other agencies in receiving and reporting data and conflicting data.

