Geoprocessing Services for the Estimation of Ecosystem Services

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Ecosystem Services Calculators

• Background
• InFOREST – web application
• MEASURES – geoprocessing services
  - Air Quality
  - Biodiversity
  - Carbon Sequestration
  - Nutrient and Sediment Runoff
  - Open Lands
• Summary
Interdisciplinary Collaboration

- State, federal, and NGO interdisciplinary leadership team led by VDoF
- Multiple organizations at Virginia Tech:
  - Biological Systems Engineering
  - CEARS
  - Conservation Management Institute
  - Enterprise GIS
  - Forest Modeling Cooperative
  - Forest Resources & Environmental Conservation
  - Geospatial & Environmental Analysis Program
Background: Vision

Web-based user Interface

Climate

Land Management

Land Cover & Use

Remote Sensing

Tract-scale Boundary or HUC/County Selection

Other Inputs

What-if?

Carbon

Air

Water

Open Lands

Biodiversity
InFOREST Interface: inforest.frec.vt.edu
InFOREST - Technical Details

- Web application built with ArcGIS Server JavaScript API
- Geoprocessing and map services are ArcGIS Server 10.x REST services
  - Uses Python wrappers for legacy DLLs
  - Models used within GP services include i-Tree Eco, GWLF, FVS and FASTLOB
- Data resides in a fGDB on ArcGIS Server
MEASURES-Geoprocessing Services
Air Quality

• Inputs
  - project area (drawn on map) or county/city (selected from map or drop-down list)
  - changes to current and/or expected forest cover (deciduous and evergreen)

• Outputs
  - amount of each air pollutant, CO, SO\textsubscript{2}, O\textsubscript{3}, NO\textsubscript{2}, and PM\textsubscript{10}, removed by the current and expected forest cover (output from i-Tree Eco)
Air Quality - Interface

**Step 1: Define the scale of analysis**
Analysis is currently limited to a single Virginia county
scale: county or city

**OR project area**

**Step 2: Locate the area of interest**
Choose a state/county combination from the list OR select a county in the map
state: Virginia, county: Giles

**OR draw a project area on the map**

**Step 3: Edit or enter expected forest cover types**
Load and modify current forest cover (acres)

<table>
<thead>
<tr>
<th>baseline</th>
<th>current</th>
<th>(+/-)</th>
<th>expected</th>
<th>(+/-)</th>
<th>forest cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>178579.5</td>
<td>178579.5</td>
<td>(0)</td>
<td>178579.5</td>
<td>(0)</td>
<td>deciduous forest</td>
</tr>
<tr>
<td>6478.4</td>
<td>6478.4</td>
<td>(0)</td>
<td>6478.4</td>
<td>(0)</td>
<td>evergreen forest</td>
</tr>
<tr>
<td>45611.7</td>
<td>45611.7</td>
<td>(0)</td>
<td>45611.7</td>
<td>(0)</td>
<td>other non-forest</td>
</tr>
<tr>
<td>230669.6</td>
<td>230669.6</td>
<td>(0)</td>
<td>230669.6</td>
<td>(0)</td>
<td>total acreage (net change)</td>
</tr>
</tbody>
</table>
A decrease in forest area results from the proposed road project thus yielding a reduction in the pounds per year of each pollutant removed. Results for project area within Sussex County.
### Forest Stand Air Pollutant Load Removals

<table>
<thead>
<tr>
<th>current (acres)</th>
<th>expected (acres)</th>
<th>net change (acres)</th>
<th>forest stand</th>
</tr>
</thead>
<tbody>
<tr>
<td>220.9</td>
<td>220.9</td>
<td>0</td>
<td>total</td>
</tr>
<tr>
<td>23.3</td>
<td>0.1</td>
<td>-23.2</td>
<td>deciduous</td>
</tr>
<tr>
<td>82.2</td>
<td>0.1</td>
<td>-82.1</td>
<td>evergreen</td>
</tr>
<tr>
<td>115.4</td>
<td>220.7</td>
<td>105.3</td>
<td>non-forest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>current (lbs/yr)</th>
<th>expected (lbs/yr)</th>
<th>net change (lbs/yr)</th>
<th>air pollutant</th>
</tr>
</thead>
<tbody>
<tr>
<td>81.3</td>
<td>0.2</td>
<td>-81.2</td>
<td>CO</td>
</tr>
<tr>
<td>653.4</td>
<td>1.1</td>
<td>-652.3</td>
<td>SO2</td>
</tr>
<tr>
<td>434.6</td>
<td>0.7</td>
<td>-433.9</td>
<td>NO2</td>
</tr>
<tr>
<td>4685.7</td>
<td>8.5</td>
<td>-4677.2</td>
<td>O3</td>
</tr>
<tr>
<td>3569.1</td>
<td>6.1</td>
<td>-3563</td>
<td>PM10</td>
</tr>
</tbody>
</table>
Biodiversity

• Inputs

- 6th level hydrologic unit (HU)/watershed or project area

- Select the wildlife database used in diversity calculations (both provided by the Virginia Dept. of Game & Inland Fisheries (VDGIF))
  
  - Geographic Points: 332,844 wildlife sightings of 1163 unique species
  
  - Biota of Virginia: includes above plus non-spatially referenced sightings of a total of 3319 unique species

- If desired, watershed for beta diversity
Biodiversity

- Expected project area vegetation type

• Outputs

- Alpha diversity (# of unique species)
- Impact on alpha diversity from veg change
- Beta diversity (between 2 HUs)
  - Whittaker’s measure
  - Sorensen’s Similarity Index (0 to 1)
- Guild Diversity (Bird Response Guilds)
- Warning if there are any species of concern within the HUs selected
Biodiversity - Interface

**Step 1: Define the scale of analysis**
Analysis is currently limited to areas within Virginia 6th-level hydrologic units.

scale: watershed

results are always for the hydrologic unit

**Step 2: Locate the area of interest**
Enter a VAHU6 code OR select a hydrologic unit in the map

VAHU6 code: enter VAHU6 code

hydrologic unit name: n/a

**Step 3: Choose database for diversity calculations**
type: Geographic Points

**Step 4: Choose a watershed for modeling beta diversity (optional)**
Enter an additional VAHU6 code OR select another hydrologic unit in the map

beta VAHU6 code (not required): enter VAHU6 code

beta hydrologic unit name: n/a
Step 3: Choose database for diversity calculations

type: Geographic Points

Step 4: Choose expected project area vegetation type

Impact on biodiversity from project area vegetation change can only be calculated using the Geographic Points database.

vegetation:
- no change
- open water
- developed, open space
- developed, low intensity
- developed, medium intensity
- developed, high intensity
- barren land
- deciduous forest
- evergreen forest
- mixed forest
- scrub/shrub
- grassland/herbaceous
- pasture/hay
- cultivated crops
- woody wetlands
- emergent herbaceous wetlands

The vegetation inside the project area may be managed as the selected landcover/landuse class in order to evaluate potential change in biodiversity.
Wildlife Biodiversity Report

Watershed: User-defined project area within CU63 (Seacock Swamp-Reddy Hole Branch)

Selection Criteria

Database: Geographic Points

Results Summary

Warnings and notifications for this scenario

Warning. Species of concern are present within the hydrologic unit. Please consult with experts at the Department of Game and Inland Fisheries to discuss the potential impact of your scenario on biodiversity within Virginia.

species of concern: 23 (CU63)
Biodiversity – Alpha Diversity

Baseline Alpha Diversity (species richness)

- Aquatic Insects: 51.3%
- Amphibians: 17.6%
- Birds: 17.6%
- Crustaceans: 4.2%
- Fish: 12.6%
- Mammals: 12.6%
- Mollusks: 1.7%
- Other Aquatic Invertebrates: 1.7%
- Other Terrestrial Invertebrates: 4.2%
- Reptiles: 12.6%
- Terrestrial Invertebrates: 17.6%

Birds: 61 unique species
Biodiversity – Alpha Diversity

### Alpha Diversity (unique species or species richness) - CU63

<table>
<thead>
<tr>
<th>species richness</th>
<th>taxonomic group</th>
</tr>
</thead>
<tbody>
<tr>
<td>119</td>
<td>all taxonomic groups</td>
</tr>
<tr>
<td>0</td>
<td>aquatic insects</td>
</tr>
<tr>
<td>15</td>
<td>amphibians</td>
</tr>
<tr>
<td>61</td>
<td>birds</td>
</tr>
<tr>
<td>0</td>
<td>crustaceans</td>
</tr>
<tr>
<td>15</td>
<td>fish</td>
</tr>
<tr>
<td>5</td>
<td>mammals</td>
</tr>
<tr>
<td>0</td>
<td>mollusks</td>
</tr>
<tr>
<td>0</td>
<td>other aquatic invertebrates</td>
</tr>
<tr>
<td>0</td>
<td>other terrestrial invertebrates</td>
</tr>
<tr>
<td>21</td>
<td>reptiles</td>
</tr>
<tr>
<td>2</td>
<td>terrestrial invertebrates</td>
</tr>
</tbody>
</table>

**Impact to alpha diversity from expected project area vegetation change**

Note: Only calculated when the Geographic Points database is selected and the project area is less than 5 percent of the majority hydrologic unit area.

Vegetation: developed, medium intensity

<table>
<thead>
<tr>
<th>majority VAHU6</th>
<th>richness before</th>
<th>richness after</th>
<th>change percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU63</td>
<td>119</td>
<td>119</td>
<td>0.00%</td>
</tr>
</tbody>
</table>
## Biodiversity – Beta Diversity

### Beta Diversity

Hydrologic units: CU63, CU57

<table>
<thead>
<tr>
<th>Taxonomic Group</th>
<th>Whittaker Species Overlap</th>
<th>Sorensen Species Overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td>All taxonomic groups</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Aquatic insects</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Amphibians</td>
<td>0.48</td>
<td>0.52</td>
</tr>
<tr>
<td>Birds</td>
<td>0.35</td>
<td>0.20</td>
</tr>
<tr>
<td>Crustaceans</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Fish</td>
<td>0.57</td>
<td>0.00</td>
</tr>
<tr>
<td>Mammals</td>
<td>0.29</td>
<td>0.00</td>
</tr>
<tr>
<td>Mollusks</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other aquatic invertebrates</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other terrestrial invertebrates</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Reptiles</td>
<td>0.55</td>
<td>0.00</td>
</tr>
<tr>
<td>Terrestrial invertebrates</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Biodiversity – Guild Diversity

Bird Guilds (percent represented)

- Canopy Nester
- Birds of Exotic Origin
- Forest Generalist
- Forest Ground Nester
- Insectivore - Bark Prober
- Insectivore Ground Cleaner
- Insectivore Lower Canopy Forager
- Insectivore Upper Canopy Forager
- Interior Forest Obligate
- Open Ground Nester
- Nest Predator/Brood Parasite
- Resident Migratory
- Single Brooded Compositional
- Shrub Nester
- Temperate Migrant
- Trophic Guild - omnivore

Resident Migratory 56.67%
Biodiversity - Guild Diversity

<table>
<thead>
<tr>
<th>represented percent</th>
<th>functional bird guild</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.00</td>
<td>canopy nester</td>
</tr>
<tr>
<td>66.67</td>
<td>birds of exotic origin</td>
</tr>
<tr>
<td>61.54</td>
<td>forest generalist</td>
</tr>
<tr>
<td>21.43</td>
<td>forest ground nester</td>
</tr>
<tr>
<td>69.23</td>
<td>insectivore - bark prober</td>
</tr>
<tr>
<td>42.86</td>
<td>interior forest obligate</td>
</tr>
<tr>
<td>36.36</td>
<td>insectivore ground cleaner</td>
</tr>
<tr>
<td>52.30</td>
<td>insectivore lower canopy forager</td>
</tr>
<tr>
<td>33.33</td>
<td>insectivore upper canopy forager</td>
</tr>
<tr>
<td>57.14</td>
<td>nest predator/brood parasite</td>
</tr>
<tr>
<td>8.33</td>
<td>open ground nester</td>
</tr>
<tr>
<td>56.67</td>
<td>resident migratory</td>
</tr>
<tr>
<td>40.30</td>
<td>single brooded compositional</td>
</tr>
<tr>
<td>54.55</td>
<td>shrub nester</td>
</tr>
<tr>
<td>53.33</td>
<td>temperate migrant</td>
</tr>
<tr>
<td>43.24</td>
<td>trophic guild - omnivore</td>
</tr>
</tbody>
</table>

Note: Guild diversity may not be measurable when the Geographic Points database is used.
Carbon Sequestration

• Inputs
  - Stand size or draw a project area
  - Stand composition (hardwood, pine or mixed) which determines the model used
  - Stand characteristics
    - Hardwood or mixed (FVS model):
      - Basal area or dominant height
    - Pine (FASTLOB model):
      - Site index or dominant height (pine)
      - Trees per acre
      - Stand age
Carbon Sequestration

- Basal area (optional)
- Growth information (optional)
  - Number of years to grow (both)
- Fertilization (pine)
  - Age at fertilization
  - Rate of nitrogen (lbs/ac)
  - Whether to apply phosphorus
- Thinning (pine)
  - Age at thinning
  - Row removal rate or thin to basal area
Carbon Sequestration

- Outputs
  - Metric tons of carbon dioxide equivalent sequestered within current and future stand (also includes removals if thin option selected, for pine only)
Carbon Sequestration - FVS

Step 1: Define the scale of analysis
Analysis is currently limited to areas within Virginia
scale  project area

Step 2: Locate the area of interest
Enter a known stand size OR draw a project area in the map
acres  enter or draw 0.25 or greater  use map

Step 3: Enter information about the stand of interest
What is the stand composition? hardwood

Carbon Model: FVS

Step 4: Enter additional information about the stand of interest
Select basal area or dominant height:
- basal area (sq ft/ac)  enter range 1-300
- dominant height (ft)  enter range 1-135

Step 5: Enter additional growth information about the stand
Grow the stand to obtain an estimate of future carbon sequestration?
- no  yes  If yes, how many years? 5
Carbon Sequestration - FASTLOB

Step 4: Enter additional information about the stand of interest
Select site index or dominant height:
- site index (base 25) [input]
- dominant height (ft) [input]

How many trees per acres are in the stand? [input]
What is the stand age (years)? [input]

Step 5: Enter OPTIONAL information about the stand of interest
What is the basal area of the stand (sq ft/ac)? [input]

Step 6: Enter additional growth information about the stand
Grow the stand to obtain an estimate of future carbon sequestration?
- no [input]
- yes [input]
  If yes, how many years? [input]

What kind of management to apply to the stand during the growth projection?
- fertilization [input]
- thinning [input]
What kind of management to apply to the stand during the growth projection?

- fertilization
- thinning

**Fertilization**

At what age to fertilize the stand (years)? enter range 5-30

What rate of nitrogen (N) in lbs/acre to apply? enter range 50-300

Apply phosphorus (P) in addition to nitrogen (N)? no yes

**Thinning**

At what age to thin the stand? enter range 6-75

Thin the stand to:

- row removal rate enter range 2-5 (range 2 - 5)
- basal area (sq ft/acre) enter range 35-130 (range 35 - 130)
Carbon Sequestration – Chart 1

Total Carbon Dioxide Equivalent (Metric Tons Per Acre)

- **Current Growth**
- **Future Growth**

- Current Growth: 120 MT/acre
- Future Growth: 150 MT/acre
Carbon Model Used:

FVS

Summary of Forest Stand Conditions

Current Stand Conditions:
Species Composition: Oak-Pine
Total Acres: 220.9
Dominant Height (feet): N/A
Basal Area (sq.ft.): 200

Forest Management Options Chosen:
Years Grown: 10

Results Summary

The carbon sequestration estimates provided below are based on the inputs above for the current stand conditions and the chosen scenario for forest management options. All units of measurement are in metric tons of carbon dioxide equivalent (MT CO₂e).

Current Stand: 26879.112 MT CO₂e
Projected Stand: 31738.912 MT CO₂e
Carbon Sequestration – Chart 2

Total Carbon Dioxide Equivalent (Metric Tons)

Current Growth: 10,000 MT
Future Growth: 20,000 MT
Removal Estimate: 6,260.6 MT
Carbon Sequestration - FASTLOB

Carbon Model Used: FASTLOB

Summary of Forest Stand Conditions

Current Stand Conditions:
Species Composition: Pine
Total Acres: 220.9
Current Age (years): 15
Trees per Acre (TPA): 250
Site Index (Base Age 25): 70
Dominant Height (feet): N/A
Basal Area (sq.ft.): N/A

Forest Management Options Chosen:
Years Grown: 10
Age Fertilized (years): 15
Nitrogen Applied (lbs/acre): 200
Phosphorus Applied: true
Age Thinned (years): 20
Row Removal Rate (every n rows): 3
Basal Area Thinned To: N/A

Results Summary

The carbon sequestration estimates provided below are based on the inputs above for the current stand conditions and the chosen scenario for forest management options. All units of measurement are in metric tons of carbon dioxide equivalent (MT CO₂e).

Current Stand at 15 years of age: 12111.6505893 MT CO₂e
Projected Stand at 25 years of age*: 17569.2685139 MT CO₂e

*This projected level of carbon sequestration reflects a removal of 6260.69083238 MT CO₂ when the stand is thinned at age 20.
Nutrient and Sediment Runoff

• Inputs
  - 6th level hydrologic unit (HU)/watershed or project area
  - changes to 13 classes of current and/or expected land use/land cover

• Outputs
  - Current and/or expected changes to watershed loads of nitrogen, phosphorus and sediment (lbs or tons/yr)
Nutrient and Sediment Runoff

Step 1: Define the scale of analysis
Analysis is currently limited to areas within Virginia 6th-level hydrologic units.

OR project area

Step 2: Locate the area of interest
Enter a known 6th-level hydrologic unit code OR select a hydrologic unit in the map.

OR draw a project area on the map

Step 3: Edit or enter expected landuse/landcover types
Load and modify current vegetation (acres)
Nutrient and Sediment Runoff

<table>
<thead>
<tr>
<th>baseline</th>
<th>current</th>
<th>(+/-)</th>
<th>expected</th>
<th>(+/-)</th>
<th>landuse/landcover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1543.9</td>
<td>1469.9</td>
<td>(-74)</td>
<td>1303.9</td>
<td>(-166)</td>
<td>conventional tillage cropland</td>
</tr>
<tr>
<td>2559.3</td>
<td>2437.3</td>
<td>(-122)</td>
<td>2162.3</td>
<td>(-275)</td>
<td>conservation tillage cropland</td>
</tr>
<tr>
<td>104.1</td>
<td>447.1</td>
<td>(343)</td>
<td>427.1</td>
<td>(-20)</td>
<td>hay</td>
</tr>
<tr>
<td>188.6</td>
<td>810.6</td>
<td>(622)</td>
<td>775.6</td>
<td>(-35)</td>
<td>grazed pasture (with applied manure or fertilizer)</td>
</tr>
<tr>
<td>22.1</td>
<td>95.1</td>
<td>(73)</td>
<td>91.1</td>
<td>(-4)</td>
<td>grazed pasture (with applied poultry litter)</td>
</tr>
<tr>
<td>13.9</td>
<td>142.9</td>
<td>(129)</td>
<td>142.9</td>
<td>(0)</td>
<td>confined livestock operation</td>
</tr>
<tr>
<td>353.9</td>
<td>59.9</td>
<td>(-294)</td>
<td>56.9</td>
<td>(-3)</td>
<td>unimproved pasture (no applied manure or fertilizer)</td>
</tr>
<tr>
<td>16744</td>
<td>16447.0</td>
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<td>13110.0</td>
<td>(-3337)</td>
<td>forest</td>
</tr>
<tr>
<td>927</td>
<td>911.0</td>
<td>(-16)</td>
<td>726.0</td>
<td>(-185)</td>
<td>harvested forest</td>
</tr>
<tr>
<td>88</td>
<td>1.0</td>
<td>(-87)</td>
<td>1.0</td>
<td>(0)</td>
<td>barren</td>
</tr>
<tr>
<td>1086.4</td>
<td>1677.4</td>
<td>(591)</td>
<td>4036.4</td>
<td>(2359)</td>
<td>urban pervious</td>
</tr>
<tr>
<td>629.7</td>
<td>425.7</td>
<td>(-204)</td>
<td>2091.7</td>
<td>(1666)</td>
<td>urban impervious</td>
</tr>
<tr>
<td>816.7</td>
<td>152.7</td>
<td>(-664)</td>
<td>152.7</td>
<td>(0)</td>
<td>water</td>
</tr>
<tr>
<td>25077.7</td>
<td>25077.7</td>
<td>(0)</td>
<td>25077.7</td>
<td>(0)</td>
<td>total acreage (net change)</td>
</tr>
</tbody>
</table>


Nutrient and Sediment Runoff

Expected Area by Landuse/Landcover (acres)

- BAR 1.0
- HFO 726.0
- urban pervious 4036.4 acres
- PER 4036.4
- IMP 2091.7
- WAT 152.7
- CVC 1303.9
- CNC 2162.3
- FOR 13110.0
- HAY 427.1
- GPM 775.6
- GPP 91.1
- CLO 142.9
- PAS 56.9

Legend:
- CVC = conventional tillage cropland
- CNC = conservation tillage cropland
- HAY = hay
- GPM = grazed pasture (with applied manure or fertilizer)
- GPP = grazed pasture (with applied poultry litter)
- CLO = confined livestock operation
- PAS = unimproved pasture (no applied manure or fertilizer)
- FOR = forest
- HPO = harvested forest
- BAR = barren
- PER = urban pervious
- IMP = urban impervious
- WAT = water
Nutrient and Sediment Runoff

Expected Nitrogen by Landuse/Landcover (lbs/yr)

- HFO 1907.2
- FOR 1415.8
- PAS 355.8
- CLO 25408.5
- GPP 2027.6
- GPM 2711.0
- HAY 4266.6
- IMP 23957.2
- BAR 2.6
- PER 12155.8

Legend:
- CVC = conventional tillage cropland
- CNC = conservation tillage cropland
- HAY = hay
- GPP = grazed pasture (with applied manure or fertilizer)
- GPM = grazed pasture (with applied poultry litter)
- CLO = confined livestock operation
- PAS = unimproved pasture (no applied manure or fertilizer)
- BAR = barren
- FOF = forest
- HFO = harvested forest
- PER = urban pervious
- IMP = urban impervious
- WAT = water

CNC 65929.5
# Nutrient and Sediment Runoff

1) **Current Watershed Loads** *(provided or modified baseline)*

<table>
<thead>
<tr>
<th>acres</th>
<th>nitrogen (lbs/yr)</th>
<th>phosphorus (lbs/yr)</th>
<th>sediment (tons/yr)</th>
<th>landuse/landcover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1469.9</td>
<td>28785.5</td>
<td>4978.3</td>
<td>1188</td>
<td>conventional tillage cropland</td>
</tr>
<tr>
<td>2437.3</td>
<td>74314.3</td>
<td>20322.4</td>
<td>1085.4</td>
<td>conservation tillage cropland</td>
</tr>
<tr>
<td>447.1</td>
<td>4466.3</td>
<td>402.6</td>
<td>13.2</td>
<td>hay</td>
</tr>
<tr>
<td>810.6</td>
<td>2833.4</td>
<td>490.1</td>
<td>51.4</td>
<td>grazed pasture (with applied manure or fertilizer)</td>
</tr>
<tr>
<td>95.1</td>
<td>2116.7</td>
<td>599.9</td>
<td>6</td>
<td>grazed pasture (with applied poultry litter)</td>
</tr>
<tr>
<td>142.9</td>
<td>25408.5</td>
<td>5081.7</td>
<td>0</td>
<td>confined livestock operation</td>
</tr>
<tr>
<td>59.9</td>
<td>374.6</td>
<td>33.1</td>
<td>10.4</td>
<td>unimproved pasture (no applied manure or fertilizer)</td>
</tr>
<tr>
<td>16447</td>
<td>1776</td>
<td>173.7</td>
<td>45.1</td>
<td>forest</td>
</tr>
<tr>
<td>911</td>
<td>2393.3</td>
<td>503.3</td>
<td>486.1</td>
<td>harvested forest</td>
</tr>
<tr>
<td>1</td>
<td>2.6</td>
<td>0.7</td>
<td>0.7</td>
<td>barren</td>
</tr>
<tr>
<td>1677.4</td>
<td>5051.7</td>
<td>545.4</td>
<td>11.6</td>
<td>urban pervious</td>
</tr>
<tr>
<td>425.7</td>
<td>4875.7</td>
<td>522.5</td>
<td>87.1</td>
<td>urban impervious</td>
</tr>
<tr>
<td>152.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>water</td>
</tr>
<tr>
<td>25077.6</td>
<td>152398.7</td>
<td>33653.6</td>
<td>2985.1</td>
<td>total</td>
</tr>
</tbody>
</table>
Nutrient and Sediment Runoff

The nitrogen load increased significantly while the phosphorus and sediment loads decreased slightly.

<table>
<thead>
<tr>
<th>acres</th>
<th>nitrogen (lbs/yr)</th>
<th>phosphorus (lbs/yr)</th>
<th>sediment (tons/yr)</th>
<th>landuse/landcover</th>
</tr>
</thead>
<tbody>
<tr>
<td>-166</td>
<td>-3250.9</td>
<td>-562.2</td>
<td>-134.2</td>
<td>conventional tillage cropland</td>
</tr>
<tr>
<td>-275</td>
<td>-8384.8</td>
<td>-2293</td>
<td>-122.5</td>
<td>conservation tillage cropland</td>
</tr>
<tr>
<td>-20</td>
<td>-199.7</td>
<td>-17.9</td>
<td>-0.6</td>
<td>hay</td>
</tr>
<tr>
<td>-35</td>
<td>-122.4</td>
<td>-21.2</td>
<td>-2.2</td>
<td>grazed pasture (with applied manure or fertilizer)</td>
</tr>
<tr>
<td>-4</td>
<td>-89.1</td>
<td>-25.1</td>
<td>-0.3</td>
<td>grazed pasture (with applied poultry litter)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>confined livestock operation</td>
</tr>
<tr>
<td>-3</td>
<td>-18.7</td>
<td>-1.5</td>
<td>-0.5</td>
<td>unimproved pasture (no applied manure or fertilizer)</td>
</tr>
<tr>
<td>-3337</td>
<td>-360.2</td>
<td>-36.3</td>
<td>-9.2</td>
<td>forest</td>
</tr>
<tr>
<td>-185</td>
<td>-486.1</td>
<td>-102.3</td>
<td>-98.7</td>
<td>harvested forest</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>barren</td>
</tr>
<tr>
<td>2359</td>
<td>7104.2</td>
<td>767</td>
<td>16.4</td>
<td>urban pervious</td>
</tr>
<tr>
<td>1666</td>
<td>19081.4</td>
<td>2044.3</td>
<td>340.7</td>
<td>urban impervious</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>water</td>
</tr>
<tr>
<td>0</td>
<td>13273.6</td>
<td>-247.1</td>
<td>-11</td>
<td>net load change</td>
</tr>
<tr>
<td>25077.6</td>
<td>165672.3</td>
<td>33406.4</td>
<td>2974.1</td>
<td>new total</td>
</tr>
</tbody>
</table>
Open Lands

• Inputs
  - Project area (drawn on map)
  - Classification system*
    - Farmland or
    - Land capability
  - Select classes of interest from above
  - Slope* cutoff value (selects any map unit > or = specified value)

* Based on SSURGO data
Open Lands

• Outputs

- Area of AOI classified as Open
- Area of AOI that meets user selected criteria (classification choices and slope)
- Area of AOI that meets user selected criteria and is classified as Open
- Area of AOI in each of 4 riparian buffers (35’, 50’, 100’, and 200’)
- Area within each riparian buffer that is open, other, selected, not selected, open selected or other selected
Open Lands - Interface

Step 1: Define the scale of analysis
Analysis is currently limited to areas within Virginia
scale: project area

Step 2: Locate the area of interest
Draw a project area in the map
acres: draw area 0.25 or larger, use map

Step 3: Select a classification system
system: farmland

Step 4: Choose open land values of interest
Classification: Farmland
- 0 - Not prime farmland
- 1 - All areas are prime farmland
- 2 - Prime farmland if drained
- 3 - Prime farmland if protected from flooding or not frequently flooded during the growing season
- 5 - Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- 30 - Farmland of statewide importance

Step 5: Specify a slope cutoff for open land of interest
minimum slope: 15%
Open Lands - Interface

Step 3: Select a classification system

system: land capability

Step 4: Choose open land values of interest

Classification: Land Capability

- [ ] Class I (1) - Slight limitations
- [ ] Class II (2) - Moderate limitations
- [ ] Class III (3) - Severe limitations
- [ ] Class IV (4) - Very severe limitations
- [ ] Class V (5) - Not erosion, but other limitations
- [ ] Class VI (6) - Severe limitations, unsuitable for cultivation
- [ ] Class VII (7) - Very severe limitations, unsuitable for cultivation
- [ ] Class VIII (8) - Recreation, wildlife, water supply

Soils have very severe limitations that restrict the choice of plants or require very careful management, or both.
Open Lands – Chart 1 Output

![Chart 1 Output](chart1.png)
Open Lands – Chart 2 Output
Open Lands – Report Output

**Area of AOI that is classified as open**
51.21 acres

**Area of AOI that meets user selected criteria**
62.69 acres

**Area of AOI that meets user selected criteria and is classified as open**
10.28 acres

**How much area in each riparian buffer is classified as open?**

<table>
<thead>
<tr>
<th>total acres</th>
<th>open land</th>
<th>other land use</th>
<th>buffer distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(acres)</td>
<td>(acres)</td>
<td>(acres)</td>
<td>(ft)</td>
</tr>
<tr>
<td>5.80</td>
<td>0.07</td>
<td>5.73</td>
<td>35</td>
</tr>
<tr>
<td>7.35</td>
<td>0.14</td>
<td>7.22</td>
<td>50</td>
</tr>
<tr>
<td>12.73</td>
<td>0.44</td>
<td>12.29</td>
<td>100</td>
</tr>
<tr>
<td>23.19</td>
<td>1.17</td>
<td>22.03</td>
<td>200</td>
</tr>
</tbody>
</table>

Total area of AOI = 220.93
### Open Lands – Report Output

#### How much area in each riparian buffer meets user selected criteria?

<table>
<thead>
<tr>
<th>total acres (acres)</th>
<th>selected land (acres)</th>
<th>not selected (acres)</th>
<th>buffer distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.09</td>
<td>0.42</td>
<td>1.67</td>
<td>35</td>
</tr>
<tr>
<td>2.99</td>
<td>0.63</td>
<td>2.36</td>
<td>50</td>
</tr>
<tr>
<td>6.00</td>
<td>1.69</td>
<td>4.31</td>
<td>100</td>
</tr>
<tr>
<td>13.00</td>
<td>4.58</td>
<td>8.42</td>
<td>200</td>
</tr>
</tbody>
</table>

#### How much area in each riparian buffer meets user selected criteria and is classified as open?

<table>
<thead>
<tr>
<th>total acres (acres)</th>
<th>open selected (acres)</th>
<th>other selected (acres)</th>
<th>buffer distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.09</td>
<td>0.42</td>
<td>1.67</td>
<td>35</td>
</tr>
<tr>
<td>2.99</td>
<td>0.63</td>
<td>2.36</td>
<td>50</td>
</tr>
<tr>
<td>6.00</td>
<td>1.69</td>
<td>4.31</td>
<td>100</td>
</tr>
<tr>
<td>13.00</td>
<td>4.58</td>
<td>8.42</td>
<td>200</td>
</tr>
</tbody>
</table>

Example report output with inaccurate numbers.
### Open Lands – Report Output

#### Area in each SSURGO map unit (soil type)

Map units that were selected based on user inputs are shown below in **bold**.

<table>
<thead>
<tr>
<th>acres</th>
<th>map unit name (decreasing order of abundance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63.444</td>
<td>Slagle fine sandy loam, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>44.459</td>
<td>Slagle fine sandy loam, 2 to 6 percent slopes</td>
</tr>
<tr>
<td>23.493</td>
<td>Craven clay loam, 6 to 10 percent slopes, severely eroded</td>
</tr>
<tr>
<td>22.854</td>
<td>Craven loam, 2 to 6 percent slopes</td>
</tr>
<tr>
<td>9.357</td>
<td>Roanoke loam, 0 to 2 percent slopes, frequently flooded</td>
</tr>
<tr>
<td>7.094</td>
<td>Myatt loam, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>7.068</td>
<td>Bibb and Chastain soils, 0 to 2 percent slopes, frequently flooded</td>
</tr>
<tr>
<td>6.752</td>
<td>Yemassee fine sandy loam, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>6.236</td>
<td>Emporia-Slagle complex, 0 to 2 percent slopes</td>
</tr>
<tr>
<td>6.065</td>
<td>Emporia-Slagle complex, 2 to 6 percent slopes</td>
</tr>
<tr>
<td>5.430</td>
<td>Emporia-Slagle complex, 6 to 10 percent slopes</td>
</tr>
<tr>
<td>4.571</td>
<td>Rumford-Uchee complex, 2 to 6 percent slopes</td>
</tr>
<tr>
<td>3.146</td>
<td>Chastain loam, 0 to 2 percent slopes, frequently flooded</td>
</tr>
<tr>
<td>2.741</td>
<td>Nevarc and Emporia soils, 10 to 15 percent slopes</td>
</tr>
<tr>
<td>2.387</td>
<td>Nansemond sandy loam, 0 to 4 percent slopes</td>
</tr>
<tr>
<td>2.056</td>
<td>Warne fine sandy loam, 0 to 2 percent slopes, rarely flooded</td>
</tr>
</tbody>
</table>
Open Lands – Display Output

AOI is in red and open, riparian (200’) and selected area is in purple.
Summary

- Web-based calculators designed for use by land owners, land managers, and planners
- Both land use and land management scenarios supported
- Focus on tract-level information
- Best-of-breed modular model approach
- Could be expanded beyond Virginia
Questions?

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