South Dakota Forest Stewardship Program
Spatial Analysis Project
Summary and Methodology Report

September 2007
South Dakota Forest Stewardship Program
Spatial Analysis Project
Summary and Methodology Report

Prepared by
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We thank all those state agencies within South Dakota, such as the Department of Game Fish & Parks, the Department of Environment and Natural Resources, and the Bureau of Information and Telecommunications.

Finally we would like to thank those states that have already completed their Spatial Analysis Project report: Massachusetts, Missouri, Colorado and Arizona. We were able to borrow ideas from those states that we could modify in order to craft our report and maps.

Cover Photos: Diversity of forest types across South Dakota
# List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>DCA</td>
<td>Damage Causal Agent</td>
</tr>
<tr>
<td>DEM</td>
<td>Digital Elevation Model</td>
</tr>
<tr>
<td>DENR</td>
<td>Department of Environment and Natural Resources</td>
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<td>ESRI</td>
<td>Environmental Systems Research Institute</td>
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<td>FS</td>
<td>Forest Service</td>
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<td>FSCC</td>
<td>Forest Stewardship Coordinating Committee</td>
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<td>FSP</td>
<td>Forest Stewardship Program</td>
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<tr>
<td>GIS</td>
<td>Geographic Information System</td>
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<tr>
<td>HUC</td>
<td>Hydrologic Unit Code</td>
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<td>LFSP</td>
<td>Landowner Forest Stewardship Plan</td>
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<td>NED</td>
<td>National Elevation Dataset</td>
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<td>National Land Cover Dataset</td>
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<td>National Resource Conservation Service</td>
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<td>NWI</td>
<td>National Wetlands Inventory</td>
</tr>
<tr>
<td>RC&amp;F</td>
<td>Resource Conservation &amp; Forestry Division</td>
</tr>
<tr>
<td>RHV</td>
<td>Risk, Hazard, Value</td>
</tr>
<tr>
<td>SAP</td>
<td>Spatial Analysis Project</td>
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<td>SMZ</td>
<td>Stream Management Zones</td>
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<td>SSURGO</td>
<td>Soil SURvey GeOgraphic Database</td>
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<td>SWAP</td>
<td>Source Water Assessment Program</td>
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<tr>
<td>T&amp;E</td>
<td>Threatened and Endangered</td>
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<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<td>USGS</td>
<td>United States Geological Survey</td>
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Executive Summary

The Forest Stewardship Program (FSP) Spatial Analysis Project (SAP) was developed to evaluate the impact over the landscape that the FSP has had over the last decade and identify areas of stewardship suitability to allow for strategic delivery of the FSP. The Spatial Analysis Project has two main components: the historic spatial database of stewardship plan tracts, and the 12 + layer suitability analysis. Both components are used together in a Geographic Information System (GIS) analysis to categorize areas within the state according to stewardship potential, and evaluate how effective a state has been at delivering the FSP in those priority areas.

Key findings that came from the spatial analysis project include:

- There are 44,580,491 acres of stewardship capable lands in South Dakota.
- Of the total capable lands there are 751,100 acres that are forested.
- There are 813,600 acres of forest and non-forest land with high forest stewardship potential.
- Active landowner forest stewardship plans (LFSPs) cover 39,994 acres, or .09% of forest stewardship capable lands.
- Of the 44.6 million acres of stewardship capable lands, 2 percent have high forest stewardship potential, 26 percent have moderate potential, and 72 percent have low potential.

Approximately 80 percent of active LFSP acres lie within high and moderate forest stewardship potential areas, suggesting Resource Conservation & Forestry Division (RC&F) has done a good understanding of where need and potential for program delivery exists in the state.
PART 1 – Summary Report

Forest Stewardship Program Background

Established through the 1990 Farm Bill, the Forest Stewardship Program (FSP) encourages private forest landowners to manage their lands using professionally prepared forest stewardship plans. These plans consider and integrate forest resources, including timber, wildlife and fish, water, aesthetics, and all associated resources to meet landowner objectives. Nationally, the FSP has been successful in meeting the intent of the program; more than 25 million acres of private forests have been placed under professional forestry management. In South Dakota, FSP is guided by the State Forest Stewardship Plan and input from the State Forest Stewardship Coordinating Committee.

Current Issues

Since its inception, the FSP has been delivered and made available to nonindustrial private forest landowners on a first-come, first-served basis. This customer-friendly approach assists landowners in improving their forest resources; however, it fails to allow assessment of the program’s full impact across the landscape. It does not take into consideration the connectivity of stewardship tracts, nor does it target landowners whose forest land has a greater need or opportunity for professional expertise and who may not have been aware of resources and programs available to them. There has been no standard or consistent way to assess the impact that stewardship plans have had on the forest resource as a whole, or in addressing regionally or nationally significant resources issues. Given limited program resources and a demand that exceeds program capacity, FSP coordinators and managers increasingly need to address accountability for results on the ground, assuring the Nation’s taxpayers that program implementation is efficient and effective, and positively affects forest resources.

After over a decade of implementation, it is timely to evaluate the impact the Forest Stewardship Program has had on the landscape and position the program to be strategically implemented to more effectively address critical resource management needs in the future, while meeting landowner objectives.

Implementation of the Spatial Analysis Project in South Dakota

The Spatial Analysis Project (SAP) for South Dakota consists of two major components. The first component is the stewardship suitability analysis. In South Dakota we used 12 basic datalayers and an “analysis mask” that were developed by four pilot states and the USDA Forest Service, and a state specific “agroforestry layer”. A weighted overlay analysis was conducted using these 14 layers. The results of this weighted overlay analysis was then broken down into low, medium, and high stewardship potential.

The second component is the historic database of stewardship plans in South Dakota. The purpose of including the historical data is to show where forest stewardship plans have been prepared, how the existing plans correlate with current priority areas, which plans have been implemented, and which plans have not been implemented.

South Dakota officially got involved with SAP in April of 2005. The 14 SAP data layers were completed by October of 2006 and the final weighted analysis layer was completed by November of 2006. Historical data was entered into the WebDET geodatabase during the summer of 2007.
Suitability Analysis

The first phase of implementing SAP in South Dakota is to create a stewardship suitability analysis for the whole state. This consists of 12 common datalayers, a state specific layer, and an analysis mask. South Dakota added an “Agroforestry layer” for mapping forestry potential on non-forested lands capable of growing trees. The layers are divided into four groupings: resource potential, resource threats, optional layer(s) of resource potential, and an analysis mask (used to mask out non-qualifying areas).

Resource Potential:
1. Riparian Corridors
2. Priority Watersheds
3. Minimum Forest Patch Size
4. Threatened and Endangered Species
5. Public Water Drinking Supply Sources
6. Private Forested Lands
7. Proximity to Public Lands
8. Forested Wetlands
9. Topographic Slope

Resource Threats:
10. Forest Health
11. Developing Areas
12. Wildfire Assessment

Optional State Specific Layer:
13. Agroforestry Suitability

Other Data:
14. Analysis Mask

The layers were created as raster data or converted from vector data sources to raster for faster geoprocessing time. These raster values were then reclassified to a common scale with values ranging from zero to one. A value of 1 indicates presence of values from that layer, and a value of 0 indicates negative presence of values from that layer. Each layer is weighted in order of priority and added together to create areas of high, medium and low stewardship suitability. This weighted overlay analysis allows for strategic stewardship program delivery as well as a spatial means of work planning and prioritizing.
Final maps depicting data layers used in the Spatial Analysis Project
**Data layer Development**

The Division created a draft of each data layer for presentation to the South Dakota Forest Stewardship Coordinating Committee (FSCC). The FSCC provided feedback to the division in the form of other possible data sources, and other ways to analyze or present the data. The final process for data layer development is described in the paragraphs below. The final data layers are shown on page 5.

**Resource Potential**

1. **Riparian Corridors** - The riparian corridors dataset was derived from the U.S. Rivers and Streams portion of the National Hydrologic Dataset (NHD). This particular dataset was provided by Environmental Systems Research Institute. The U.S. Rivers and Streams dataset provides a database of linear water features that interconnects and identifies the stream segments and reaches that comprise the surface water drainage system of the United States. The U.S. Rivers and Streams dataset was digitized from 1:24,000 scale United States Geological Survey (USGS) Topographic maps. For the purpose of SAP in South Dakota we extracted the rivers and streams data from the 1:24,000 rivers dataset that covered the state. This data was then queried to select all the major streams, all the perennial streams, and key intermittent streams that generally remain flowing during “normal” rainfall years. Next this data was buffered by a 50 foot distance on either side of the stream course to produce a buffered vector dataset. The 50 foot distance is based on the streamside management zone defined by South Dakota’s Best Management Practices for forestry applications. This buffered dataset was then converted to an ESRI Grid (raster) for the final layer.

2. **Priority Watersheds** - Priority watersheds in South Dakota were determined using the “319 Project Status” dataset produced by the South Dakota Department of Environment and Natural Resources (DENR). DENR created this dataset from a combination of Hydrologic Unit Code (HUC) 11 watershed datasets, scanned DENR project maps, and new HUC 12 watersheds. This dataset is always being updated by DENR on a regular basis. The key attribute in this dataset is “DENR Status”, in which there are four watershed categories: Assessed, Assessing, Implemented, and Implementing. For South Dakota only the “implementing” DENR Status category is considered as “Priority Watersheds”.

3. **Forest Patch Size** - The goal of the “grouped forest patches” layer is to determine a minimum patch size for the state and emphasize management of these forested areas. To create this dataset, larger contiguous patches of forests need to be isolated and patches below the size threshold need to be removed. For South Dakota the threshold patch size is set to 50 acres or 202,341 square meters (square map units). The initial forested land data was extracted from the 2001 National Land Cover Data (NLCD) raster dataset. Forested values 41 (Deciduous Forest), 42 (Evergreen Forest), 43 (Mixed Forest), and 91 (Woody Wetlands) are selected and reclassed to a value of “1”. All non-forested lands were reclassed to a value of “0” or “NoData”. Next the state roads layer (acquired from South Dakota Department of Transportation) was then buffered by 66 feet, and converted to a grid (raster layer). This buffered roads layer was subtracted from the forested land raster layer to create the initial unorganized forested patches layer. This layer is then processed in “ArcMAP Spatial Analyst” with the “Region Group” command which classifies each “forested patch”. Next the “Zonal Geometry” tool is used to add an “area” attribute to the raster dataset. Finally the “Extract by Attributes” tool is used to select all large forested patches that are larger than 50 acres. This results in the final “grouped forest patches” raster data layer.

4. **Threatened and Endangered Species** - Threatened and endangered (T&E) species data comes from the South Dakota Natural Heritage Database Program. The South Dakota Department of Game
Fish and Parks (GF&P) archives this geodataset. The raw T&E species data was obtained from the GF&P. The T&E species dataset contains point, line and polygon vector attributes. Some of these T&E species sites are active and some are not. Following consultation with the Natural Heritage Database biologist, key T&E species sites were selected by querying and selecting all state endangered and state protected areas, and by querying and selecting all federally endangered, federally threatened, and candidate species. Also active T&E species sites were selected by querying the data field “Last Observed” and selecting observation dates ranging from 1980 and later. This active T&E species vector dataset was then converted to a grid (raster dataset) for the final T&E species layer.

5. Public Water Drinking Supply Sources -
The South Dakota “Public Drinking Water Supplies” data layer was extracted from the Statewide Source Water Assessment Program (SWAP) dataset. The Statewide SWAP dataset was created and maintained by DENR, with watershed delineations in the Black Hills Region coming from the USGS. DENR utilized “Hydrologic Modeling” concepts, and HUC 11 watershed data to create this dataset. The key field in the Statewide SWAP dataset for SAP is the “Zone” field which is actually called “Priority Zones”. There are three categories: Zone A, Zone B, and Zone C.

Zone A is considered the critical zone, it is where drinking water supplied for each community originates. In the Black Hills area it includes recharge areas for wellheads, and a ¼ mile buffer zone around perennial streams that feed these watersheds. In the greater Missouri river watersheds, Zone A includes ¼ mile buffer zones around wellheads and perennial streams and up to 10 miles upstream from each communities.

Zone B is not as critical as Zone A but is important because groundwater originating in Zone B watersheds flows into Zone A watersheds. Zone B is the remaining priority watersheds in the Black Hills area. In the greater Missouri watersheds, Zone B is buffered to within 25 miles of the wellheads, within the confines of the watershed boundaries.

Zone C constitutes the remainder of the greater Missouri river watersheds.

For the purpose of this project analysis only zone “A” and “B” were used to build the “Public Drinking Water Supplies” layer.

6. Private Forested Lands - The goal of the private forest lands layer is to show where all of the states privately held forests lie. This includes timberlands, riparian areas, very small “patches” of forests, shelterbelts, and shelter-pastures. Most stewardship projects involve privately owned forests. This data was extracted from the NLCD 2001 landcover raster dataset. Forested values 41 (deciduous forests), 42 (conifer forests), 43 (mixed forests), and 91 (woody wetlands) were selected and reclassed to a “1” for forest lands, and a “0” for all other lands. Then the analysis mask (Layer 13) was used to mask out all of the publicly owned forest lands. The resulting grid includes only the privately owned forestlands.

7. Proximity to Public Lands - This dataset was created by buffering the Federal and State public lands geodataset by 800 meters (1/2 mile). The purpose of this buffer is to locate private lands that are in close proximity to public lands. Private land owners who live next to public lands can be impacted by prairie dogs, weeds, insects, wildfire, etc. that originate on public lands. An opportunity exists for cross-border cooperation to address common management concerns. The Federal and State public lands geodataset is a subset of the analysis mask layer (layer 13), minus the census water bodies and urban areas.
8. **Forested Wetlands** - The data for South Dakota’s forested wetlands came from a 30M raster version of the National Wetlands Inventory (NWI) dataset covering the entire state of South Dakota. NWI data was created by the U.S. Fish and Wildlife Service to produce information on the characteristics, locations, and extent of the nation’s wetlands and deepwater habitats. Currently digital NWI data exists for the entire state of South Dakota at 1:24,000 scale in both vector and raster form. The current NWI classification scheme takes a hierarchical approach to classifying different wetland types. This involves “systems”, “subsystems”, “classes”, “subclasses”, and “additional modifiers”. South Dakota has only three (3) wetland systems: Lacustrine, Palustrine, and Riverine. For SAP analysis we are concerned with those wetland systems that contain forested wetland “classes”. These “classes” include ‘Forested Wetlands’, and ‘Scrub Shrub Wetlands’. From the NWI Wetlands raster dataset the final “Forested Wetlands Layer” dataset was created by reclassifying those wetland classes titled ‘Forested Wetlands’, and ‘Scrub Shrub Wetlands’ as a “1” and all other wetland classes and systems as a “0”. This produced the final raster dataset titled “Forested Wetlands”.

9. **Topographic Slope** - Topographic slope criteria generally defines the range of operability for mechanized timber harvesting. In South Dakota a percent slope of 0 to 60% is the range of operability for mechanical timber harvesting. This dataset was created from USGS 30 meter Digital Elevation Model’s (DEMs) for South Dakota. A percent slope grid was initially created, and was then reclassified to a value of 1 for slopes between 0 and 60% and 0 for slopes greater than 60%. NED 30 meter DEMs data for each state can be found online at: [http://ned.usgs.gov](http://ned.usgs.gov).

**Resource Threats**

10. **Forest Health Issues** - The forest health issues layer was produced by using USFS Region 2, forest health aerial survey data. Aerial surveys from 2005, 2004, and 2003 were used to better illustrate the bark beetles extent. Damage Causal Agent (DCA) codes (Appendix C) of 11006, 11029, 11030, and 11055 were selected to show areas of bark beetle activity. DCA codes of 15005, 24022, and 25000 were selected to show areas of twolined chestnut borer activity, Dutch elm disease spread, and other defoliator issues. Other DCA codes selected are 30000 (fire), 50000 (weather), and 70000 (man caused) damages. These extracted datasets were converted to raster form (ESRI GRID) and then merged to create the final layer.

11. **Developing Areas** - Dr. David Theobald produced the housing density layer used for the South Dakota SAP analysis. This data was part of his Western US Housing Density map used for his “Forest on the Edge” study. The data is produced by subtracting state and federal lands and Census water from the 2000 Census Block database and recalculating acres per house for each census block unit. 2030 density projections are subtracted from the 2000 density to determine areas under pressure from development. Finally this “developing areas” layer was converted into a grid (raster) and reclassified so grid cells representing development return a “1” and grid cells representing other areas return a “0” (NoData).

12. **Wildfire Assessment** – The Wildfire Assessment Layer (Red Zone Layer) was extracted from the reclassified Risk, Hazard Value (RHV) dataset for South Dakota. Those areas that were classified as “High Risk” for wildfire occurrence are considered critical for SAP. The reclassified RHV layer was created by overlaying the wildfire risk grid, the wildfire hazards grid, and the social value grid.
   1. The wildfire Risk grid was extracted from ten years of past wildfire occurrences.
   2. The social Value grid was created by extracting data from the “Housing Density” field of the 2000 US Census inventory database.
   3. The wildfire Hazard grid was created from overlaying “vegetation fuels loading hazards” grid, “vegetation disturbance regimes hazards grid, and terrain hazards grids (I.E. Slope and Aspect grids).
• Vegetation fuels loading and disturbance regimes were derived from the NLCD 92 dataset.
• The slope and aspect grids were extracted from the South Dakota 30m DEM raster dataset.

Optional State Specific Layer

13. Agroforestry Suitability - The Agroforestry Suitability dataset was created from the USDA Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) & soils geospatial database. The NRCS soils geospatial database contains digitized soils mapping unit polygons for 64 of South Dakota’s 65 counties (Lawrence county is not complete).

The SSURGO soils database contains dozens of fields containing unique soil properties. The key field used for developing the Agroforestry layer was “Conservation Tree & Shrub Groups”. The soils in this field are rated ordinally for their ability to support trees and shrubs for shelterbelts and other Agroforestry purposes.

There are ten primary groups and some specialized subgroups for selected primary groups. Group one is most suitable for tree planting, and group 10 is least suitable. For South Dakota’s Agroforestry criteria primary groups one through five and associated subgroups were selected by query. This was done for all of South Dakota’s counties (except Lawrence). These top five groups were merged into one group titled “Agroforestry Suitability”. Once this was completed for each county, the data was converted to a grid (raster dataset). Then each of these county raster datasets were merged together to create the statewide Agroforestry suitability layer.

Other Data

14. Analysis Mask - The purpose of the analysis mask is to exclude those areas (cells) that are not considered eligible for FSP participation. Those areas masked out are all the public lands, all census water bodies, and urban areas (cities). Setting an analysis mask means that processing will only occur on selected locations and that all other locations are assigned a value of “NoData”.

Weighted Overlay Iteration Process

Individual data layers were combined to form a single composite map to illustrate areas in South Dakota with high, medium, and low forest stewardship potential. To accomplish this, the South Dakota Forest Stewardship Coordinating Committee (FSCC) was asked to prioritize the layers by assigning each a value from 1 to 100. It should be noted that not all SAP datalayers are equally important to forest stewardship suitability. Each FSCC member was given the opportunity to prioritize all the layers, thus creating a model for analysis. Maps of Statewide Forest Stewardship Potential were created reflecting each FSCC member’s model. High, medium, and low stewardship potential classifications were identified using the “Natural Breaks” GIS tool. Using this tool, class breaks conform to gaps in data distribution by minimizing variation within classes and maximizing variation between classes. Following review of the individual maps, a model was developed that averaged the recommendations from FSCC members. This averaged priority ranking became the FSCC recommendation to the State Forester. The final Forest Stewardship Potential map reflects the FSCC recommendation with the exception that riparian areas were assigned slightly higher priority. The final datalayer weighting is summarized in the following table.
Final Data layer Weights

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<th>Layer</th>
<th>Layer Name</th>
<th>Weight</th>
<th>Decimal Weight</th>
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<tr>
<td>6</td>
<td>Private Forested Lands</td>
<td>14.6%</td>
<td>(0.146)</td>
</tr>
<tr>
<td>1</td>
<td>Riparian Corridors</td>
<td>13.5%</td>
<td>(0.135)</td>
</tr>
<tr>
<td>3</td>
<td>Forest Patch Size</td>
<td>10.7%</td>
<td>(0.107)</td>
</tr>
<tr>
<td>10</td>
<td>Forest Health Issues</td>
<td>10.2%</td>
<td>(0.102)</td>
</tr>
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<td>13</td>
<td>Agroforestry Suitability</td>
<td>9.6%</td>
<td>(0.096)</td>
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<td>2</td>
<td>Priority Watersheds</td>
<td>8.4%</td>
<td>(0.084)</td>
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<td>12</td>
<td>Wildfire Hazards</td>
<td>7.5%</td>
<td>(0.075)</td>
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<td>11</td>
<td>Housing Density Changes</td>
<td>5.4%</td>
<td>(0.054)</td>
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<td>5</td>
<td>Public Drinking Water Supply Sources</td>
<td>5.0%</td>
<td>(0.05)</td>
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<td>8</td>
<td>Forested Wetlands</td>
<td>4.9%</td>
<td>(0.049)</td>
</tr>
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<td>7</td>
<td>Proximity to Public Lands</td>
<td>4.4%</td>
<td>(0.044)</td>
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<td>4</td>
<td>Threatened &amp; Endangered Species</td>
<td>3.8%</td>
<td>(0.038)</td>
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<tr>
<td>9</td>
<td>Slope</td>
<td>2.0%</td>
<td>(0.020)</td>
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</table>

Weighted Overlay Analysis Results and Map Products

The weighted overlay analysis process was done in an ‘ArcGIS Grid’ (raster) environment for faster computer processing time. Actual analysis values were between 0 and 0.817. The 0.817 high value indicates no cells were ‘covered’ by all of the layers. South Dakota chose to run the analysis with a 30 meter cell size for each grid. This matches the resolution of most of the datasets used in the analysis.

After the weighted analysis was run, the low, medium and high classes were determined using the Natural Breaks classification algorithm (Jenk’s Algorithm). The class values were defined as follows:

- **Low**: 0.0 – 0.129
- **Medium**: 0.129 – 0.269
- **High**: 0.269 – 0.817

Forested & Non-forested priority areas showing stewardship capable lands in South Dakota

<table>
<thead>
<tr>
<th>Stewardship Potential</th>
<th>Stewardship Capable Lands</th>
<th>Non-Forest</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Forest</td>
<td>% of total For.</td>
<td>Non-Forest</td>
</tr>
<tr>
<td>High</td>
<td>328,612</td>
<td>43.75%</td>
<td>484,988</td>
</tr>
<tr>
<td>Medium</td>
<td>203,195</td>
<td>27.05%</td>
<td>11,532,920</td>
</tr>
<tr>
<td>Low</td>
<td>219,293</td>
<td>29.20%</td>
<td>31,811,483</td>
</tr>
<tr>
<td>Total</td>
<td>751,100</td>
<td>43,829,391</td>
<td>44,580,491</td>
</tr>
</tbody>
</table>

South Dakota Spatial Analysis Project
Collecting and Digitizing Existing Historic Stewardship Plans

The other main component of SAP was the collecting and digitizing boundaries of historic stewardship plan tracts and associated tabular data. Stewardship plans over 10 acres were targeted for digitizing property boundary locations into polygonal shape files. Practice locations within those boundaries were also digitized or imported when the data was available. The historic map layer was then combined with the suitability analysis to illustrate past stewardship efforts compared to current stewardship low, medium and high stewardship potential (See Map #2). Forest stewardship plans for smaller tracts, primarily agroforestry practices, have not been loaded into the WebDET geodatabase. Point data for forest stewardship plans representing agroforestry practices reside in a separate database.

PART 2 - Final Map Results

Completion of the Spatial Analysis Project required the initial suitability analysis, mapping of existing plans, and preparation of a series of seven maps with their own analysis and statistics. There are three groups of maps, not presented in numerical order, but grouped by theme. The first series contains the results of the weighted overlay analysis, the results with existing stewardship plans, and a regional map. The second series of maps stratifies the results into forested and non-forested areas. The third and final series of maps looks at Resource Richness and Resource Threats with existing stewardship plans. These maps are numbered in accordance with USDA Forest Service requirements.

Results

Map #1: Potential for Forest Stewardship Program Benefits

This map displays the statewide suitability analysis. Accompanying the map is a table comparing each level of stewardship potential with total stewardship capable lands.

Map #2: Potential for Forest Stewardship Program Benefits and Existing Stewardship Plans

This map is similar to Map #1 with the addition of active landowner forest stewardship plans. Active plans are those that are new or updated with some type of activity record or other modification within the last ten years. Plans displayed are greater than 10 acres in size. Most agroforestry plans in the state are not reflected by this map because they are less than 10 acres in size, but have been geospatially recorded with point data.

Map #7: Stewardship Potential on Forested and Non-Forested lands and Existing Stewardship Plans for the Black Hills Region

This map focuses on the stewardship potential on the private lands adjacent to the Black Hills National Forest. It includes both Forested and Non-Forested lands.
**Forested vs. Non-Forested**

**Map #3: Forest Stewardship Potential on Private Forest Lands and Existing Stewardship Plans**

This map looks at stewardship potential only on private forested lands. It is overlain with the existing landowner forest stewardship plan locations.

**Map #4: Forest Stewardship Potential on Non-Forested lands and Existing Stewardship Plans**

This map looks at forest stewardship potential on stewardship capable lands that are not forested. It is overlain with the existing landowner forest stewardship plan locations.

**Resource Potential**

**Map #5: Forest Stewardship Potential Resource Richness**

This map displays the nine resource potential layers added together with the state added Agroforestry layer.

**Map #6: Forest Stewardship Potential Resource Threats**

This map displays the three resource threat layers added together.
Forest Stewardship Potential on Private Forest Land and Non-Forest Land and Active Stewardship Plan Locations Greater than 10 Acres for South Dakota's Black Hills Region

Stewardship Potential for:

- Non-Forested
- Private Forest
- Other Legend Items:
  - Federal Lands
  - State Lands
  - Municipal Lands
  - Active Stewardship Plan Locations > 10 Acres
  - South Dakota County Boundaries
  - Census Water

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Map Notes
Date: Mar. 2007
Updated: Sept. 2007
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GIS Analysis/Staff Forester
Appendix A:

FSP Spatial Analysis Concept Paper
Background

Established through the 1990 Farm Bill, the Forest Stewardship Program (FSP) encourages private forest landowners to manage their lands using professionally prepared forest stewardship plans. These plans consider and integrate forest resources, including timber, wildlife and fish, water, aesthetics, and all associated resources to meet landowner objectives. Nationally, the FSP has been successful in meeting the intent of the program; more than 25 million acres of private forests have been placed under professional forestry management.

Issue

Since its inception, the FSP has been delivered and made available to non-industrial private forest landowners on a first-come, first-served basis. This customer-friendly approach assists landowners in improving their forest resources; however, it fails to allow assessment of the program’s full impact across the landscape. It does not take into consideration the connectivity of stewardship tracts, nor does it target landowners whose forest land has a greater need or opportunity for professional expertise and who may not have been aware of resources and programs available to them. There has been no standard or consistent way to assess the impact that stewardship plans have had on the forest resource as a whole, or in addressing regionally or nationally significant resource issues. Given limited program resources and a demand that exceeds program capacity, FSP coordinators and managers increasingly need to address accountability for results on the ground, assuring the Nation’s taxpayers that program implementation is efficient and effective, and positively affects forest resources.

After over a decade of implementation, it is timely to evaluate the impact the Forest Stewardship Program has had on the landscape and position the program to be strategically implemented to more effectively address critical resource management needs in the future, while meeting landowner objectives.

The Project

What: The FSP Spatial Analysis Project (SAP) provides participating States a consistent methodology (while offering them the ability to customize it according to State conditions) to spatially display:
- Important forest lands (rich in natural resources, vulnerable to threat, or both);
- Existing stewardship tracts (properties under stewardship plans); and
- Areas of opportunity to focus future FSP efforts (stewardship potential).

The SAP addresses the following questions, as they relate to the FSP:
1. Where are the State’s stewardship tracts?
2. Where are the priority lands (those lands of highest potential to benefit from the FSP)?
3. How do the State’s stewardship tracts and priority lands overlap (or not)?
4. Where should greater FSP efforts be considered in the future?
5. What has been the impact of FSP efforts on priority lands and other forest lands?

Why: The SAP responds to the issues identified above by:
- Assessing program effectiveness in serving State-identified critical resource management needs;
- Creating geo-referenced, spatial data displaying stewardship tracts relative to FSP potential;
- Relating factors such as stewardship practices completed and resource condition to help determine future practices that might be most effective in addressing critical needs based on the site-specific resource condition; and
- Providing tools that help States focus future FSP efforts to effectively and efficiently address critical forest resource issues.
This portion of the SAP project is highly labor intensive, considering that FSP plans developed over the years often exist only as paper copy and must be manually entered into the electronic database, and the tract location scanned and digitized.

**Key Point:** Once a State participates in the SAP, it is imperative to continue to enter new plans into the electronic database, leading to currency and accuracy. The Forest Service is working with the initial pilot States to develop and test a Web-based tool to allow natural resource professionals preparing the plans to enter the information once electronically, including “drawing” the tract location on Web-based available maps. This step is critical to the long-term success and utility of the SAP and will facilitate future FS reporting requirements.

**Statewide Assessment of Important Forest Lands:** The statewide assessment focuses on current conditions to help identify the highest need or opportunity for future Forest Stewardship Program delivery. It is a composite of common data layers (table 1) determined by the pilot States and FS specialists to spatially map risks or vulnerabilities to existing forest resources, natural resources important to forest sustainability, current public forest land management, and existing stewardship plans (see discussion on geo-referenced, spatial database, page 2). The common data layer selection criteria are as follows:

- The attribute (data layer) represents a strong connection to the potential benefits to be derived from the development and implementation of a forest stewardship plan.
- The data source is existing and readily available at the State, regional, or national level.
- The minimum standard of map scale and resolution is consistent across States.
- The vulnerability or resource potential applies across the States (not solely a single-State concern).

<table>
<thead>
<tr>
<th>Data Layer</th>
<th>Source*</th>
<th>Scale</th>
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<tbody>
<tr>
<td>Wildfire assessment</td>
<td>Grid analysis on landcover and DEM</td>
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<td>Forest patches</td>
<td>MRLC</td>
<td>TM 30 meter</td>
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<tr>
<td>Proximity to public land</td>
<td>CT DEP—public, Federal, and municipal lands</td>
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<tr>
<td>Private forested lands</td>
<td>MRLC and DEP</td>
<td>30 meter</td>
</tr>
<tr>
<td>Threatened and endangered species</td>
<td>DEP—Heritage database</td>
<td>1:24000</td>
</tr>
<tr>
<td>Change in households</td>
<td>USFS, Census block data</td>
<td>30-meter grid</td>
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<tr>
<td>Forest pests</td>
<td>USFS</td>
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<tr>
<td>Wetlands</td>
<td>DEP/NRCS or USGS</td>
<td>1:24000</td>
</tr>
<tr>
<td>Riparian areas</td>
<td>Derived from DEP hydro streams</td>
<td>1:24000</td>
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<tr>
<td>Public water supplies</td>
<td>DEP—Aquifer protection wells and surface water quality layer</td>
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<td>Slope</td>
<td>Statewide NED DEM layer, USGS</td>
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<td>Priority watersheds</td>
<td>HUC from USGS</td>
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<td>Analysis mask (urban, open water, public lands)</td>
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<tr>
<td>Stewardship tracts (polygons)</td>
<td>Digitized or town parcel data</td>
<td>variable</td>
</tr>
<tr>
<td>Stewardship tracts (centroids)</td>
<td>Polygon script or address match</td>
<td>variable</td>
</tr>
</tbody>
</table>

*Source will vary by State. Connecticut sources shown as an example.

In addition to the common data layers, each participating State has the opportunity to add **State-specific layers** that respond to or reflect conditions or resources unique to the State. Other complementing State assessment efforts, State natural resource specialist or State Stewardship Coordinating Committee recommendations, or a combination of these may drive the need for additional data layers. The State is responsible for providing rationale and metadata for these data layers in addition to the metadata for the common data layers.
A composite map with associated tabular data of all GIS common data layers, including the stewardship plan data layer, is then developed. States may choose to include the State-specific data layers on this composite map as well. Based on State Stewardship Coordinating Committee or resource specialist recommendations, the data layers may be weighted to indicate priority. The final product is a statewide map that indicates high, medium, and low potential need for development of forest stewardship plans (figure 2).

![Composite map of Missouri with various data layers](image)

**Figure 2.** Individual common data layers, contributing to the weighted composite, Missouri

**Analysis:** The tabular data and accompanying composite map contribute to in-depth statewide analyses that consider how stewardship plans correspond to lands identified as having high, medium, or low potential for Forest Stewardship Program benefit. For those working with private landowners on a local level, the results of the analyses can spatially display the potential for stewardship benefit and guide efforts within a given watershed or service forester jurisdictional area. This will aid not only in plan preparation but also in implementation of the activity practices. The analysis and assessment will lead to informed recommendations, considering the resources and vulnerabilities beyond the boundaries of the tract the plan addresses. Based on where the tract is located and surrounding opportunities or challenges, the professional forester may recommend to the landowner that practices be implemented to complement the surrounding land base or to respond to the landscape surrounding the given tract.
Potential Applications

**Ability to show program effort in working on lands impacted by critical resource management issues in conjunction with other landowner assistance programs, not only to landowners and resource managers, but also to the lawmakers who design the programs, appropriate funds, and to whom we are ultimately accountable.**

Not only can Forest Stewardship Program results be quantified (in the form of number of acres and number of plans) within a State, those results can also be displayed. The Spatial Analysis Project enables resource managers to demonstrate connectivity in program efforts of plan development and how they complement other natural resource efforts and other State and Private Forestry programs. Through time, they will be able to track the accomplishment of plan-prescribed activities on given stewardship tracts.

The results of this project give resource managers the capability to gather and display information according to geographic area, watershed, congressional district, county, or service area (such as district forester jurisdiction) to assess the amount and type of work completed and yet to do.

**Ability to ensure that new stewardship plans consider elements deemed important by the State’s Stewardship Coordinating Committee.**

The Forest Stewardship Program emphasizes addressing the landowner’s objectives through professional forest management. Often a forest landowner is not aware of the importance of the resources on his or her land, particularly as they relate to surrounding properties. A professional forester has an obligation to help the landowner understand the full potential and extent of the resources on the tract. With that body of information, the landowner then has the capability of making informed decisions about long- and short-term objectives.

The Spatial Analysis Project provides key information concerning not only resource potential and vulnerability, but also the extent of professional management occurring around a given tract, respecting private property rights and confidential information. Landowners may find new opportunities to complement the activities already begun in a geographic area, or learn of a need to protect their tracts from a significant vulnerability such as invasive insects or fire threats.

**Ability to conserve and consolidate forest patch size in critical areas.**

In addressing a plan request backlog or as new opportunities arise to promote the Forest Stewardship Program, service and consultant foresters can build from a core base of forest land. They will be able to identify forest lands of high stewardship potential based either on richness of forest resources or on vulnerabilities, or a combination of the two. They will have enhanced information at their fingertips as they approach and work with forest landowners.

**Ability to more effectively allocate staff resources across the landscape.**

The results of this project can provide information to State forestry agency managers so they can strategically allocate staff resources throughout the State based on the greatest needs and opportunities. In a similar manner, consultant foresters have the ability to look at project results across the State, and target their professional forestry services accordingly. Further, service foresters working within their assigned areas have the ability to determine high, medium, and low needs and opportunities to help prioritize their efforts.
Appendix B:

National Land Cover Dataset (NLCD) Codes

2001 Land Cover Class Definitions
from: http://www.epa.gov/mrlc/definitions.html

10. Water - All areas of open water or permanent ice/snow cover.
   11. Open Water - All areas of open water, generally with less than 25% cover of vegetation or soil.
   12. Perennial Ice/Snow - All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

20. Developed - Areas characterized by a high percentage (30 percent or greater) of constructed materials (e.g. asphalt, concrete, buildings, etc).
   21. Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
   22. Developed, Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.
   23. Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.
   24. Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to 100 percent of the total cover.

30. Barren - Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.
   31. Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
   32. Unconsolidated Shore* - Unconsolidated material such as silt, sand, or gravel that is subject to inundation and redistribution due to the action of water. Characterized by substrates lacking vegetation except for pioneering plants that become established during brief periods when growing conditions are favorable. Erosion and deposition by waves and currents produce a number of landforms representing this class.

40. Forested Upland - Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25-100 percent of the cover.
41. **Deciduous Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

42. **Evergreen Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. **Mixed Forest** - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

50. **Shrubland** - Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall, with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. **Dwarf Scrub** - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.

52. **Shrub/Scrub** - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

59. **Non-Natural Woody** - Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25-100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

60. **Orchards/Vineyards/Other** - Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

70. **Herbaceous Upland** - Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. **Grassland/Herbaceous** - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

72. **Sedge/Herbaceous** - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.

73. **Lichens** - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.

74. **Moss** - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.

80. **Planted/Cultivated** - Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover.

81. **Pasture/Hay** - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.

82. **Cultivated Crops** - Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as
orchards and vineyards. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.

83. **Small Grains** - Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.

84. **Fallow** - Areas used for the production of crops that do not exhibit visible vegetation as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.

85. **Urban/Recreational Grasses** - Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

90. **Woody Wetlands** - Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

91. **Palustrine Forested Wetland** - Includes all tidal and non-tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent.

92. **Palustrine Scrub/Shrub Wetland** - Includes all tidal and non-tidal wetlands dominated by woody vegetation less than 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is below 0.5 percent. Total vegetation coverage is greater than 20 percent. The species present could be true shrubs, young trees and shrubs or trees that are small or stunted due to environmental conditions.

93. **Estuarine Forested Wetland** - Includes all tidal wetlands dominated by woody vegetation greater than or equal to 5 meters in height, and all such wetlands that occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.5 percent. Total vegetation coverage is greater than 20 percent.

* Coastal NLCD class only
Appendix C:

USDA FS Aerial Detection Survey Damage Causal Agent Codes – South Dakota

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<th>DCA Code</th>
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Appendix D:

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4) South Dakota, Department of Environment and Natural Resources, 319 Project Status data, 2006


6) South Dakota, Department of Game Fish and Parks, *South Dakota Heritage Program, Threatened and Endangered Species geo-database*

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