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A GIS Analysis of Probable High Recreation Use Areas in Three Sisters Wilderness
Deschutes and Willamette National Forests

Introduction

The Three Sisters Wilderness is managed by the Deschutes National Forest and the Willamette National

Forest. It is located in Central Oregon, and the Cascade Crest runs north to south through the wilderness.

There are tall mountains, streams, hiking trails, meadows, alpine lakes, and other natural features that

attract recreation use year-round. Recreation use is not a bad thing; indeed it is one of the goals of

wilderness designation. However, high recreation use can lead to resource damage, and this is a concern

for resource managers and wilderness rangers. Resources that land managers are tasked with protecting

are animal and plant habitat, as well as cultural resources. Wilderness managers from the Deschutes and

the Willamette have identified a few areas of high recreation use where resources are potentially

threatened. In those areas, there are overnight camping restrictions, dog leash restrictions, and permit

processes in place in order to manage the recreation use and associated resource damage.

There may be more areas where resource damage occurs from high recreation use that are

unknown or not identified as such. The Forest Service recreation and wilderness programs have limited

budget and resources. They need to focus their inventories, monitoring, and visitor contacts to the areas

where recreation use is highest to make the best use of their time and resources. The question that

resource mangers ask is: What areas in the Three Sisters Wilderness are likely to receive the highest

recreational use?

Areas people are likely to visit during their recreation trip to the Wilderness can be predicted.

People will tend to camp and hike and explore in the following areas:

1) Near existing trails – within 0.25 mile. People tend to access the Wilderness by existing trails, and the majority of the wilderness use is within a quarter mile of a trail.

2) Near streams – within 0.1 mile. People who are visiting the Wilderness, especially during the warm summer months will tend to be attracted to the area around streams.

3) Near lakes – within 0.5 mile. Lakes are a popular destination for visitors to the Wilderness, and the area around lakes is likely to see high recreation use.

4) Slopes that are 10° or less. People are not likely to camp on steep ground. Areas steeper than 10° are less likely to have impact from high recreation use. Areas that are 10° to 20° slope are moderately likely to have high recreation use. Areas that are greater than 20° slope are unlikely to have high recreation use.

5) Areas that meet the above requirements that are also larger than one acre in size. Areas smaller than this are less likely to attract recreational use, as people will want to camp and spend time in areas that are larger than one acre in size. Additionally, the resource managers and wilderness rangers will want to focus their time on larger areas, as resource damage over large areas is more important to them.

6) Areas outside of the buffer distances were considered to be low probability for this analysis. Any piece of land more than a half a mile from a trail, and more than 0.1 miles from a stream, and 0.5 miles from a lake were considered low probability

A GIS analysis was performed to show those areas of the highest likely recreation use. A map was produced that shows those areas that are the most likely to attract high recreation use. Resource managers can use this map to plan areas for patrolling and monitoring. In this way, Wilderness Rangers will make the best use of their time and resources by visiting areas that are most likely to attract high recreation use. This analysis could help identify areas for consideration for closure or permit process to control recreation use.
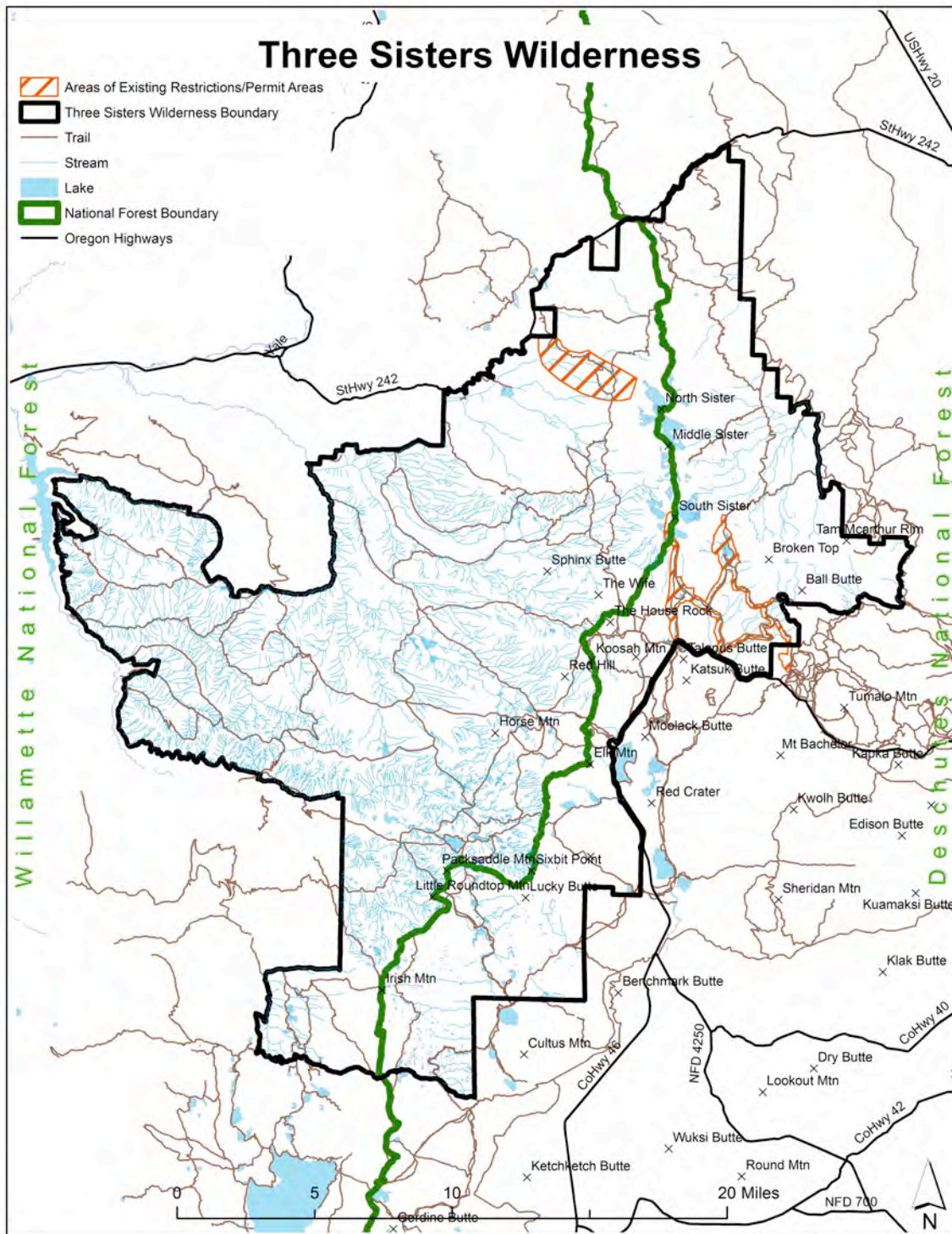
Figure 1. Map showing Three Sisters Wilderness and existing restriction areas.

Data Acquisition

Data for this analysis was acquired from the Deschutes National Forest and the Willamette National Forest. US Forest Service GIS data managers maintain separate data for each National Forest. All GIS data in Oregon and Washington at the time of this analysis was stored on a centralized server. Since the Three Sisters Wilderness is in both forests, separate data sets were acquired from each forest. The default projection for US Forest Service data in Oregon and Washington is a customized Albers projection: Oregon and Washington Albers, NAD 1983. No data projection or transformations were necessary for this analysis. US Forest Service GIS data carry a disclaimer. The Forest Service does not guarantee the accuracy of any data for location or attributes.

Vector Data for Analysis

Three Sisters Wilderness Boundary
Streams
Lakes
Trails

Vector Data for Map Display

Deschutes National Forest Boundary
Willamette National Forest Boundary
Oregon Highways
Three Sisters Wilderness Existing Restrictions/Permit Areas
Mountain Peaks

Raster Data for Analysis

Three Sisters Wilderness Digital Elevation Model (DEM). The resolution of the raster was 10m.

Analysis

ArcGIS 9.3.1, ArcInfo license was used for the analysis and map production for this project. Model Builder was used to perform the analysis.

Vector Data

The first step for this analysis was to clip all the vector data to the Wilderness boundary. The input data was clipped using ArcToolbox tool Clip. The analysis was performed using model builder. Then the ArcToolbox Buffer tool was used to buffer each vector dataset in accordance with the guidelines for most likely areas to see high recreation use. The streams were buffered 0.1 miles, the trails were buffered 0.25 miles, and the lakes were buffered 0.5 miles. The buffer polygon feature classes were then combined into one buffer feature class. The streams buffer feature class was combined with the lakes buffer feature class by using the Union tool in ArcToolbox, to create the water buffer feature class. This water buffer feature class was intersected with the trails buffer feature class, by using the Intersect tool. In this way, a buffer feature class was formed that has polygons that correspond to the water features (streams or lakes) buffer, trails, or both lakes and trails. This feature class represents the areas near enough to trails, streams, or lakes to be susceptible to high recreation use.

Raster Data

A digital elevation model (DEM) for the wilderness area was used for this analysis. First, Spatial Analyst Slope tool was used for creating a new raster that has slope in degrees for each pixel. This Slope raster was then reclassified using the Reclassify tool. The slope value that is associated with each pixel was reassigned a value of 1, 2, or 3 depending on the slope of the pixel. For the areas likely to have high recreation use, or 10° or lower, the value was 1. For areas somewhat likely to have high recreation use, or 10° to 20° slope, the new value was 2. For areas least likely to have high recreation use, the new value was 3.

Table 1: Reclassify Values and their Corresponding Slope and Recreation Use Probability.

Slope	Reclassify Value	Recreation Use Probability
0°-10°	1	High
10°-20°	2	Moderate
>20°	3	Low

The reclassified slope raster was then converted to a shapefile using the Raster to Shapefile tool in ArcToolbox. The resulting feature class has polygons with a value of 1, 2, or 3, corresponding to high likelihood of recreation use, moderate recreation use, or low recreation use respectively.

Final Analysis Steps

The buffers feature class was then intersected with the slope reclassify feature class. The tool used was the ArcToolbox tool Intersect. The result is a polygon feature class of all the areas near enough to a trail, stream, or lake to be considered likely for high recreation use, and the associated slope class (1, 2, or 3) for each polygon.   A field called Acres was added to the Final result attribute table, and acres were calculated for each polygon.

Map Products

The first map product from this analysis shows the entire wilderness, and the entire buffer feature class and the corresponding areas that have been designated high, moderate, and low probability for recreation use.

For the second map product, the areas with high likelihood for recreation use only are shown. A query of the final feature class was done for the display of this map. The query for this new feature class that only shows high probability areas of at least one acre in size used the following SQL query: "GRIDCODE" = 1 AND "Acres" >= 1 This resulting map shows the areas predicted to have high recreation use only.
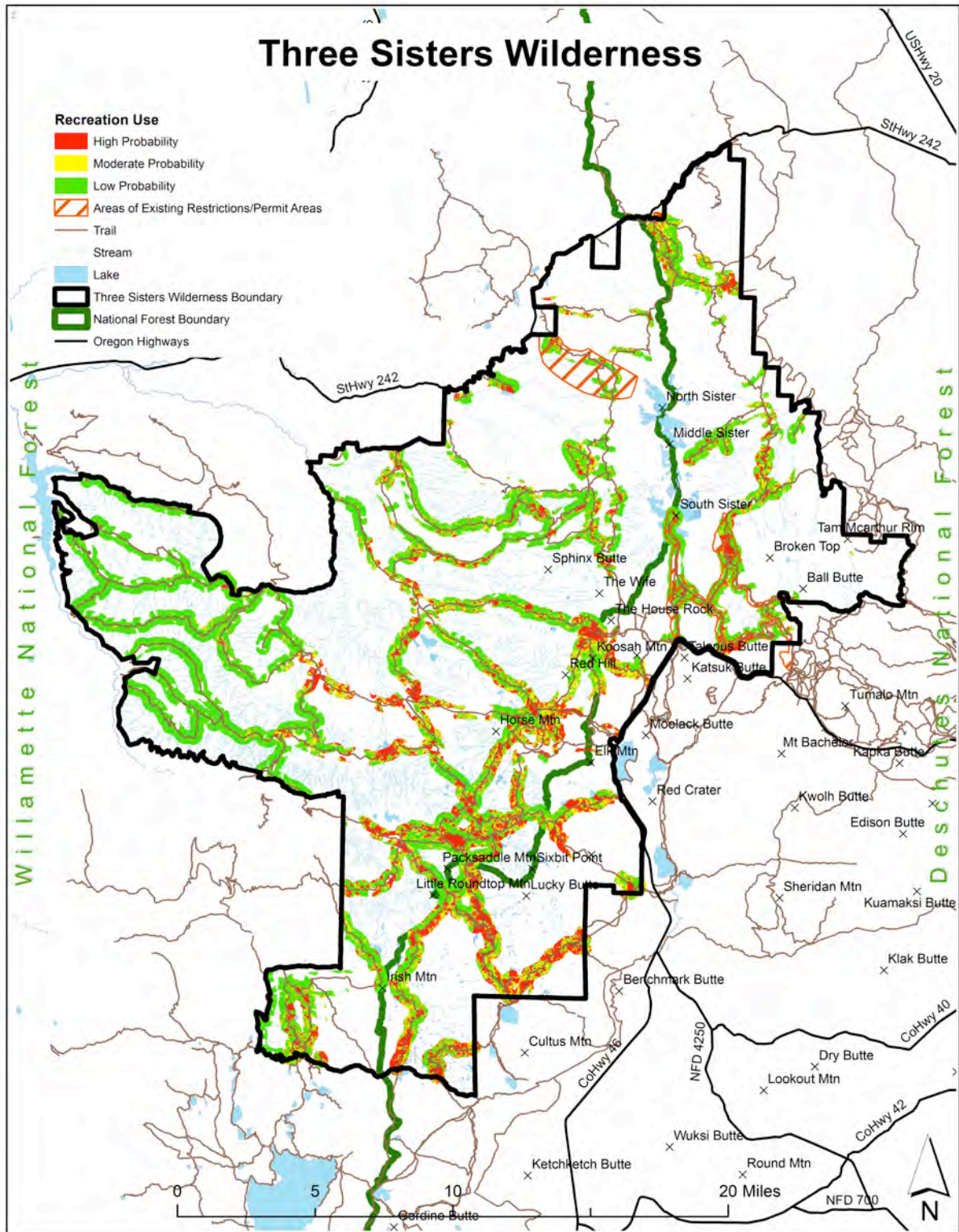
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Figure 2: Map of Three Sisters Wilderness showing high, moderate and low probability areas for recreation use within 0.25 miles of trails, 0.1 miles of streams, and 0.5 miles of lakes.
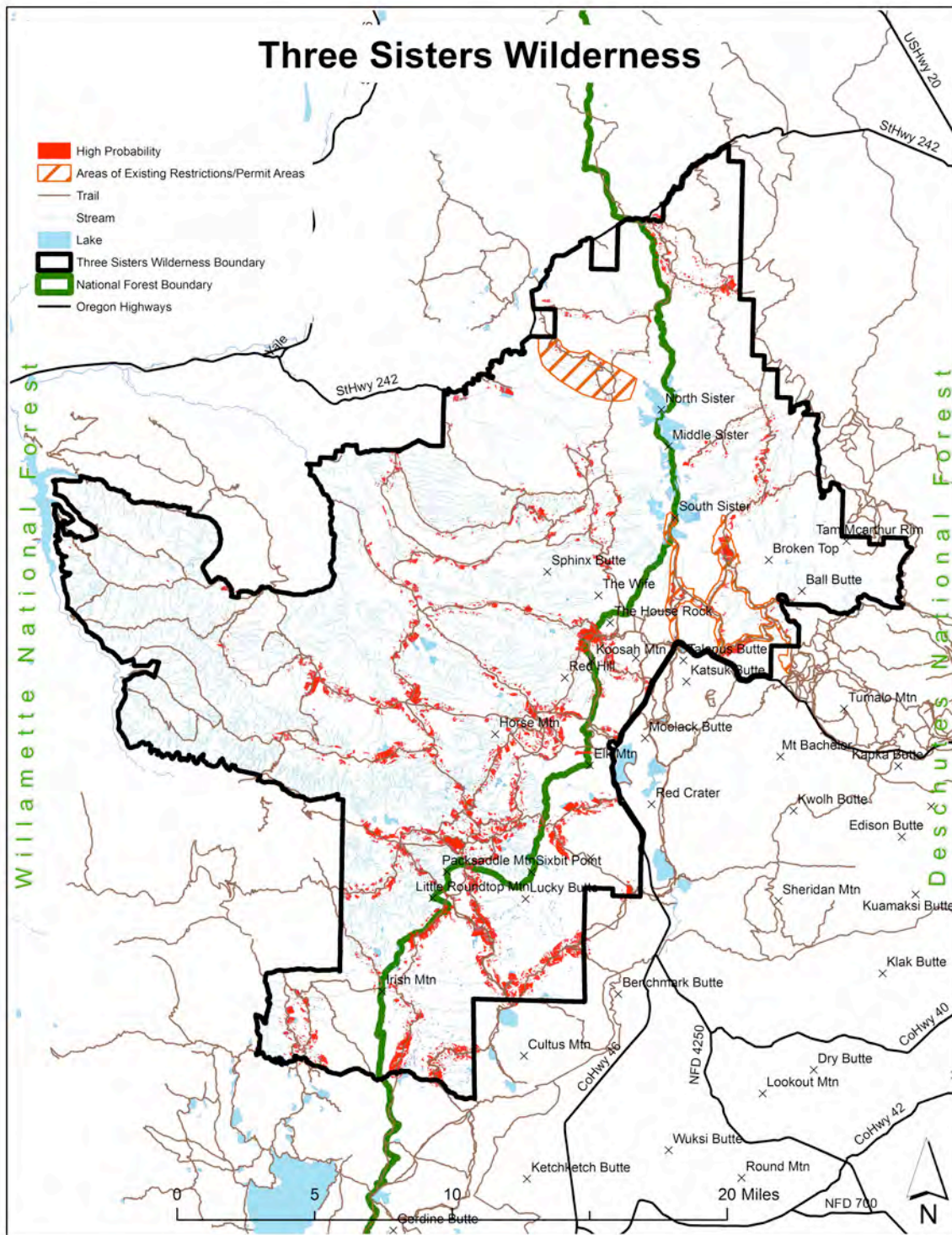
Figure 3: Map of Three Sisters Wilderness showing high probability areas for recreation use within 0.25 miles of trails, 0.1 miles of streams, and 0.5 miles of lakes.
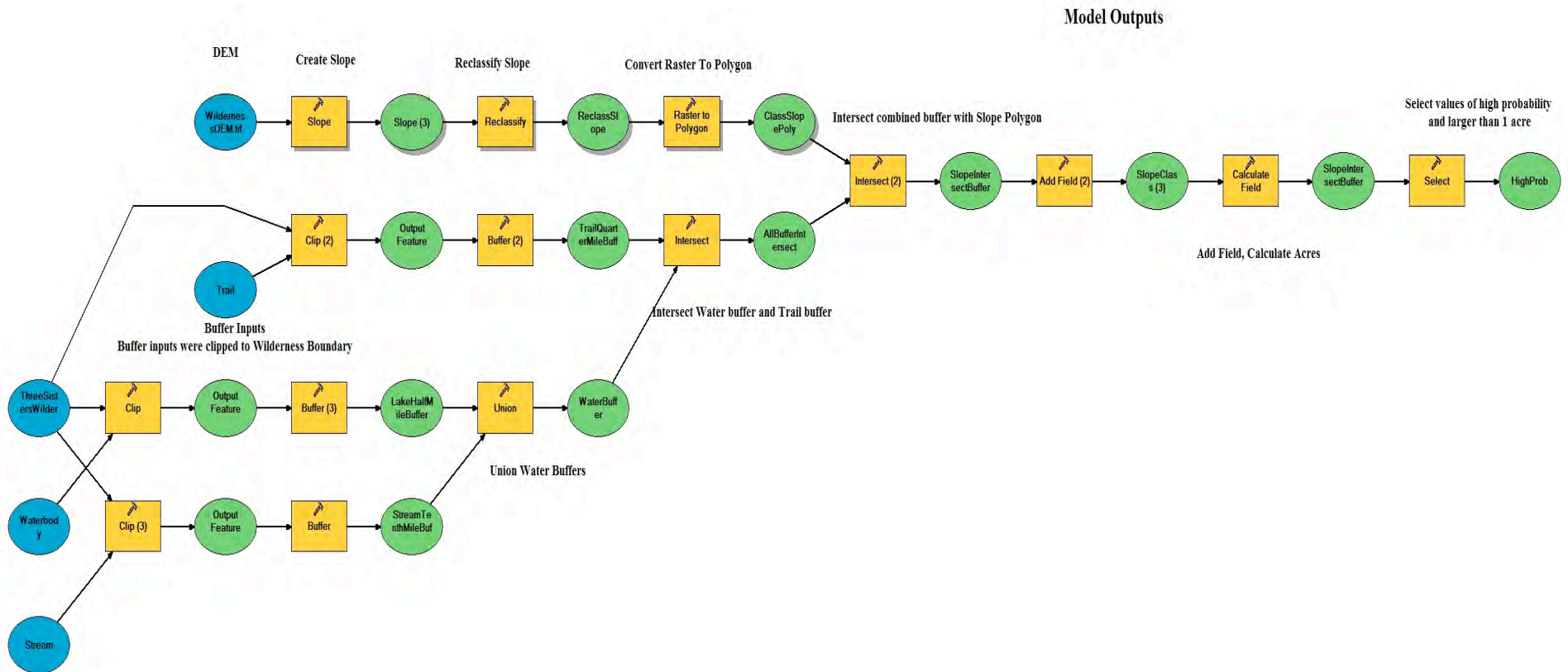
Figure 4: Model used for analysis. The flow of the analysis in the model is left to right: the analysis inputs are the blue circles on the left hand side and the final outputs are on the right hand side. Each green circle represents a dataset, whether it is a final output or intermediate. The yellow squares are the Tool used in that part of the analysis. The outputs used for map display were the 'HighProb' feature class created at the end of the analysis and the 'slopeIntersectBuffer' feature class.

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Results and Discussion

The resulting feature class showed that there were many areas that are most likely to attract high recreation use given the criteria used. Many areas that were shown as high probability were small and scattered. There are a number of reasons that this result was obtained.

The topography of the ground in the Three Sisters Wilderness is highly varied. There are steep mountains, lava flows, and many river canyons. The slope is highly variable across the landscape.

Other reasons for the resulting feature class were the analysis criteria. The criteria for distances from certain features, and a certain range of slopes meant that there were many potential areas for high recreation use.

The input data itself made it more likely that there would be widespread areas as a result of the analysis. The DEM used had a resolution of 10 meters, meaning that slope was examined for each 10 meter by 10 meter piece of land in the wilderness. For landscape-scale land management this is potentially too fine of a resolution. There are many streams and lakes in the Wilderness, and there are many places in the western half of the Wilderness that are less than a tenth of a mile from a stream. There also are many miles of trail in the Wilderness, giving people access to many parts of the Wilderness.

The results of this analysis are useful to resource managers. They can easily see on the map that there are many areas that are likely to have high recreation use and therefore potential resource damage in the Three Sisters Wilderness. They can also see that along a few trails, there is not a high likelihood that people will venture far away from the trail, since there is no nearby water, or if there is, the surrounding slopes are steep. Similarly, there are some trails with an abundance of high probability areas along their length, or at certain areas along the trail. It is those areas with a cluster of high probability areas that the resource managers and wilderness rangers could focus their management efforts.

For some of the trails, there are many scattered high potential areas. The high potential areas are scattered along the length of the trail, and in no recognizable patterns or clumps. For this reason, the analysis is perhaps too specific to small pieces of land to be useful at a landscape scale.

Another drawback of this analysis is that it perhaps did not recognize features other than water, slope, and proximity to a trail that are likely to draw people. There are other datasets that could have been considered that would strengthen the analysis.

A useful dataset that could be added to this analysis is user days for each trail section. If the trails that attract the biggest crowds were identified, those areas could be weighted in the analysis to show the higher trail use. The trails with the most user traffic are the ones with surrounding areas that are most likely to see highest resource damage. If a trail did not get much use, then it could be omitted from the analysis. The existing areas of the Wilderness that have restrictions were not shown as the only high potential recreation use areas in this analysis. There are restrictions in those areas because of the large numbers of people who visit those areas. The criteria in this analysis did not take into account any features that would attract visitors because of their natural beauty.

People are more likely to explore off-trail depending on the vegetation type. If there is an open meadow with a beautiful view of a mountain peak, there is more likely to be high recreation use off-trail, and people would be likely to travel further than a quarter of a mile off the trail. If there was heavy timber, or a brush field, people would be less likely to travel off trail, even if the slope is below 10 degrees and it is near a stream. The Three Sisters Wilderness has all types of land cover including meadow, alpine meadow, alpine forest, rock (lava and granite), and montane forest. All of those different vegetation types would affect the potential recreation use of an area.

The Three Sisters Wilderness has a volcanic history, so there is an area of obsidian flow that is currently under restriction. Visitors are required to obtain a permit before hiking there. There are also high mountain peaks that attract hikers to the summits. There are viewpoints that attract recreation use as well. These special points of interest could be incorporated into the analysis to strengthen it.

Within the Wilderness there may be places that are more easily negatively impacted by recreation than others. For example, if there were bald eagle nesting areas, resource managers would be more concerned about protection those areas. Information about threatened plant species, fragile meadow habitats, or endangered animal habitat could be included in this analysis.

Conclusion

This analysis successfully predicted places in the Three Sisters Wilderness that could be susceptible to resource damage from high recreation use. Resource managers and monitoring projects can focus on these areas to help them with their management of the Wilderness.

Improvements could be made to the analysis by including some additional data. Most helpful for the analysis would be a measure of visitor use. Other data that could be added to the analysis are known vegetation types, known points of natural beauty that attract visitor use, or endangered plant and animal habitat.

Model Builder was used to do this analysis. With a change in the input datasets, this model could be shared with other National Forests and other Wilderness areas to predict recreation use. Other inputs could easily be added to the model to do the analysis.