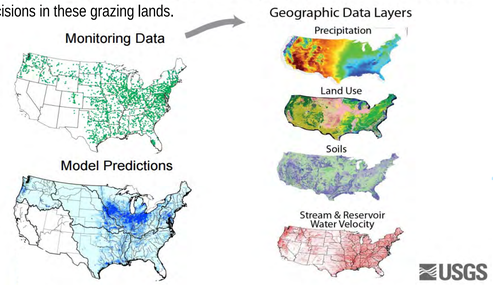
Potential Grazing Land in the Pacific Northwest and California Watersheds

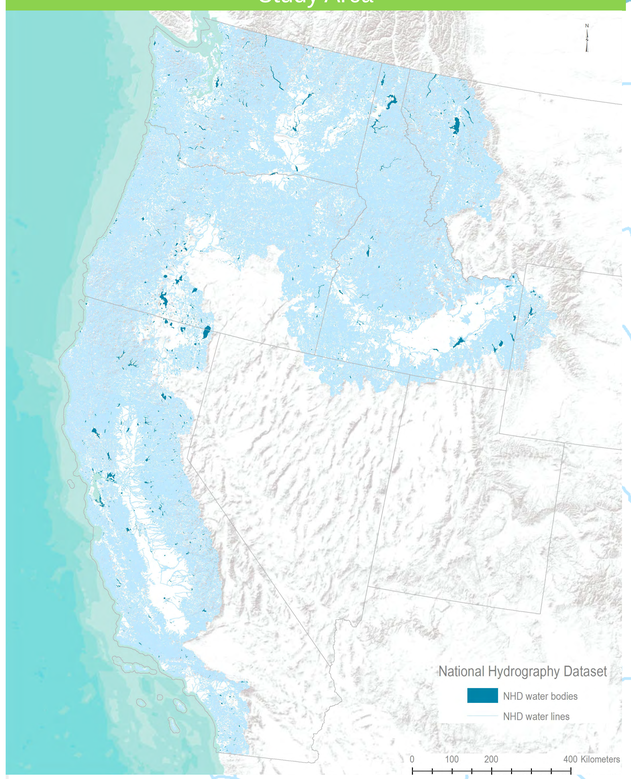
Problem Statement

The U.S. Geological Survey (USGS) is currently updating a watershed model of expected nutrient load called SPARROW (SPATially Related Regressions on Watershed Attributes). This model "relates in-stream water-quality measurements to spatially referenced characteristics of watersheds, including contaminant sources and factors influencing terrestrial and aquatic transport (Dan Wise, 2017)." This model is currently lacking several datasets from the western United States that could potentially affect data estimates for those regions. The grazing land datasets do not include shrub/scrublands and some forest lands as grazing land potential, which is a large portion of Western United States vegetation class for grazing. Generating these datasets and integrating them into the SPARROW model can therefore increase the effectiveness of this model, which may then better inform policy and land management decisions in these grazing lands.



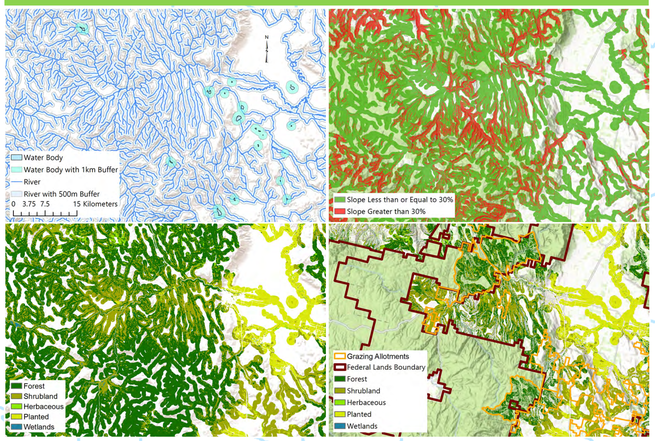
We developed a dataset that represents potential areas suitable for grazing throughout the western United States based on various attributes considered to characterize unconfined grazing land potential (not within a dairy or feedlot, slope aspect, proximity to water bodies) in both the shrub and forested land classes. The current dataset used in the model may greatly under represent potential grazing land due to these land classes being left out of the analysis. This data could then be used to estimate the effect unconfined grazing has on sediment and nutrient transport on total downstream nutrient load.

Study Area



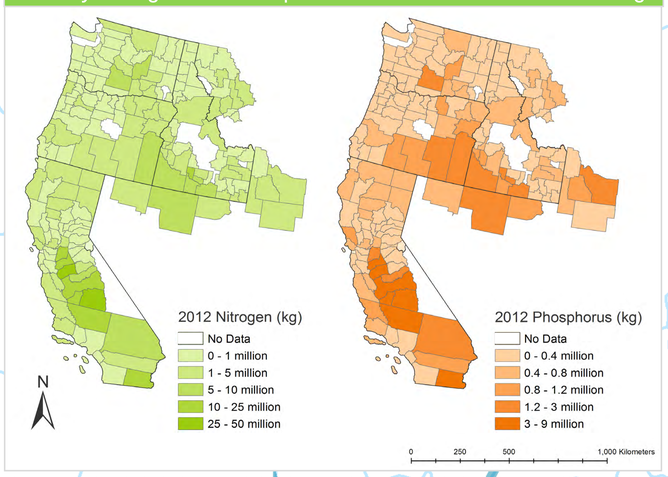
Our area of study consisted of the entirety of the Pacific and California Hydrographic Water Unit of the U.S., which feature all of Washington and parts of California, Nevada, Montana, Wyoming, Idaho, and Oregon.

Methods



The above map segments illustrate analyses for a portion of eastern Oregon. Pipeline, coastline, canals, and ditches classes were first removed from a waterline shapefile covering the entirety of the study area. A 500 meter buffer was applied on all remaining waterlines and a 1 kilometer buffer was applied to all water bodies, representing distance limitations to water sources within which cattle would preferentially graze. These distances also represent buffers where nutrients from manure are likely to be released to water bodies rather than mineralized or incorporated into plant materials. To account for terrain easily navigable by cattle, a 30 meter Digital Elevation Map was used to locate and then select land at or below 30% slope. NLCD was then used to reclass the area to remove all classes except forest, shrubland, herbaceous, planted, and wetland classes. Finally, all federal lands were removed leaving remaining grazing allotments to represent those lands potentially being grazed.

County Nitrogen and Phosphorous Level Estimates for Grazing



The concentrations for both nitrogen and phosphorus tended to be found in the highest quantities in about the same locations. Central inland California, central Washington, southeastern Oregon, northeastern Nevada, and southwestern Idaho showed the highest quantities of both, ranging from 25 - 50 million kg for nitrogen and 3 - 9 million kg for phosphorus. These results will get added to estimates of nutrient loading from other sources, including confined cattle operations (i.e., feedlots and dairy operations) to arrive at landuse-based estimates for nutrient loading.

Parameters	Data Format and Type	Data Manipulations	Source	Tool Used
NHD Water Lines - Pacific and California Regions	Discrete: Polyline	500 meter buffer	Daniel Wise—Hydrologist for USGS; National Hydrography Dataset: https://nhd.usgs.gov/data.html	Project, Buffer, clip, merge, dissolve, select
NHD Water Bodies - Pacific and California Regions	Discrete: Polygon	1 kilometer buffer	Daniel Wise—Hydrologist for USGS; National Hydrography Dataset: https://nhd.usgs.gov/data.html	Project, Buffer, clip, merge, dissolve, select
2011 NLCD - National Land Cover Data 30 Meter	Continuous: Raster	Forest, Shrubland, Herbaceous, Planted and Wetland	https://www.mrlc.gov/nlcd2011.php	Reclassify, Con, tabulate area
22.145 Meter DEM	Continuous: Raster	Slope = < 30%	Portland State University GIS Server; Geoffrey Duh	Resample to 30 m, slope, raster calculator
BLM Grazing Allotments:	Discrete: Polygon	Include for states: WA, OR, CA, ID, NV, UT, MT, and WY	Various State BLM datasets	Project, vector to raster, reclassify
Federal Lands of the US	Discrete: Polygon	Removed from potential grazing output (selected only allotments within federal land)	https://catalog.data.gov/dataset/federal-lands-of-the-united-states-direct-download	Project, Vector to raster, dissolve, merge, reclassify
State/County Boundary: WA, OR, CA, ID, NV, UT, MT and WY	Discrete: Polygon	Used for geoprocessing	https://www.census.gov/geo/maps-data/data/cbf/cbf_nation.html	Project, Select

Validation

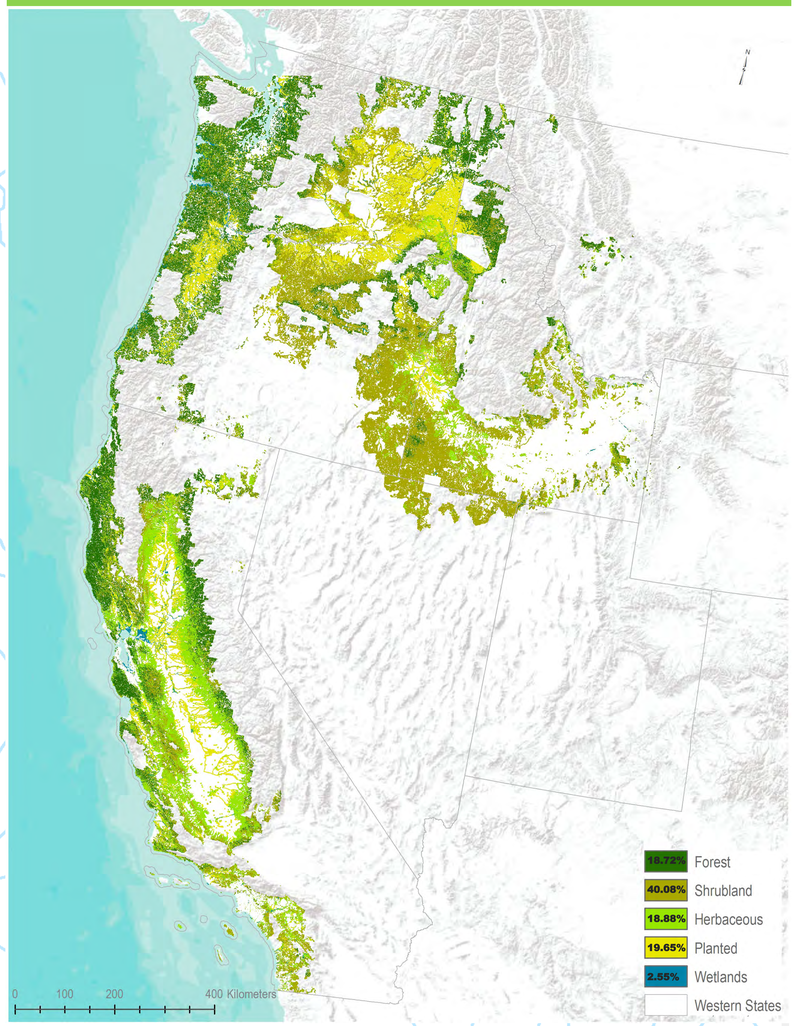
Because this dataset will be used to update and refine the scope of the SPARROW model, validation was difficult. This analysis could not be validated by instream measured nitrogen and phosphorous loads because there are other sources that contribute to in-stream nutrient loads in these areas and there are no comprehensive datasets of nutrient loading limited to grazing lands. Additional sources that would contribute to overall nutrient loads include geologic phosphorus, atmospheric N deposition, runoff from forest land, farm fertilizer, confined animal manure, and wastewater and urban stormwater discharges. In most areas these loads would be more important than runoff from grazing land, which is a highly diffused source. One of the goals of the SPARROW modeling is to determine the relative importance of each of those sources. We were also unable to implement a ground-truthing method that effectively validated our findings within the temporal constraints. A partial validation is found in our analysis by isolating all grazing allotments within federal lands as potential grazing land.

Concerns and Uncertainties

Some degrees of uncertainly exist within our study that should be considered. Private lands lack data required to make a detailed analysis on land available or used for the purposes of grazing. Not all land within these areas would be used for grazing, and therefore might affect total nutrient load estimations. Private inholding in federal public lands were also not considered in the analysis after these lands were removed from our scope. Some of these lands could conceivably be used for grazing but were not included due to lack of available data. Furthermore, tribal land policy varies from each jurisdiction and therefore might allow or disallow unconfined grazing. Because of the breadth of our scope, determining the suitability of grazing in these lands was not possible and was consequently not considered. Forested areas also vary in vegetation type and density and may often not be appropriate land for grazing activity. Including all forested lands may slightly skew estimates by over-representing land that may not actually be accessible by cattle. Lastly, analysis of large datasets such as the entire study area inherently creates many opportunities for error.

	Forest	Shrubland	Herbaceous	Planted	Wetland
MT total km^2	462.1617	201.2292	113.5179	39.1149	18.063
WY total km^2	9.7623	7.9803	3.0897	0.9432	1.7883
UT Total km^2	29.8098	112.9626	2.1951	3.708	0.4923
OR total km^2	8685.4248	27620.6076	3602.6334	9294.6096	1301.783
NV total km^2	52.6887	5244.1794	1.278	45.8541	33.9561
ID total km^2	4581.0432	19884.0087	5531.9832	2667.1284	368.982
CA total km^2	10390.159	10299.8088	23992.5987	10633.1796	1452.596
WA total km^2	11821.862	13770.8721	3094.4268	15124.6341	1738.895
Sq Km	36032.911	77141.6487	36341.7228	37809.1719	4916.556

Potential Grazing Lands



Results

This was an analysis on a regional scale of the national landcover dataset for the purpose of updating and refining potential grazing lands where cattle use could lead to elevated nutrient loads in rivers and streams draining effective watersheds. The analysis suggested that shrublands and forest lands would add approximately 113,174.59 sq. km to existing identified grazing lands. Taken together, the newly identified grazing areas could account for as much as 435 million kg per year of nitrogen and 102.6 million kg per year of phosphorus (these are estimated values as of 2012). This analysis will allow the USGS both to update results of prior (2007) SPARROW modeling, and better apportion nutrients to individual source categories for which improved management practices can be applied to reduce nutrient loads.

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Additional Sources:

Oberlie, Dennis and Bishop, Joseph. "Determining rangeland suitability for cattle grazing based on distance-to-water, terrain, and barriers-to-movement attributes." 2009: 1-42.

Holechek, J.L. 1988. An approach for setting stocking rate for cattle grazing capacity for different percentages of slope. Rangelands 10:10-14.

"USGS SPARROW Surface Water-Quality Modeling." USGS SPARROW Surface Water-Quality Modeling. N.p., n.d. Web. 19 Mar. 2017.