Rutgers University

Optimal Locations for Chanterelle Growth

A GIS Analysis

Western Oregon, 2014

Michael Borsellino

8 May 2015

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Introduction

Chanterelles are classified as a mycorrhiza type mushroom, meaning they form a symbiotic relationship with their host plant; they are incredibly important to their ecosystems. There are over forty known species of chanterelles, with the highest concentrations of them being found in the United States' Pacific Northwest region (United States ii). They are a species of fruiting mushrooms that are renowned for their earthy and aromatic flavor. As their culinary demand has increased over the past two decades, their prices have sky-rocketed; chanterelles could cost as much as $30 per pound. However, chanterelles have proven incredibly difficult to farm commercially (Patulsky 1). Chanterelle "farms" are, in actuality, large-scale foraging operations. Unfortunately, the rise of this multi-million dollar industry has coincided with declining production of chanterelles worldwide (United States 24, 43-44).

This project has two parts. First, to establish the locations where chanterelles will most likely be found in Western Oregon due to favorable growing conditions. Second, to cross-reference these optimal locations with crowd-sourced chanterelle-sighting data. Ideally, this will allow chanterelle conservation and sustainable harvest efforts to be efficiently targeted to areas of optimal growth potential.

A GIS approach was chosen because of its unique analytical abilities. GIS will allow multiple layers of dense quantitative data to be linked based on their spatial attributes. These data layers will then be combined as factors contributing to chanterelle growth. The end result should be a visual framework for suitable chanterelle locations. Chanterelles were chosen because of my own fondness for foraging (though I have only foraged for morel mushrooms and not chanterelles). The Western Oregon region was chosen simply because there is no chanterelle related GIS analysis in this area of the Pacific Northwest; there is analysis in both Washington and northern California.

Data Description

The initial analysis will rely on four data types: elevation, forest age, forest crown closure, and vegetation classification. There will also be minor data types that will assist in completing the analysis and providing context. These include state, county, and municipal borders, water bodies, and point data for mushroom sightings.

The digital elevation model was downloaded from the US Geological Survey's EarthExplorer interface. It is from the 1996 Global 30 Arc-Second Elevation (GTOPO30) data set. The layer spans from 40°N to 90°N and 100°W to 140°W and utilizes that World Geodetic System 1984 reference system. The layer has 6000 rows and 4800 columns, with each cell being 0.008333 by 0.008333 decimal degrees. The layer was originally titled *gt30w140n90*.

Forest age data came from Oregon's Bureau of Land Management website as a vector layer that originated in 1982. The layer spans from 41.99°N to 45.93°N and 120.90°W to 124.51°W and utilizes the D North American 1983 reference system. The layer was originally titled *foi_pub_poly*. While this layer did have crown closure and vegetation data, more comprehensive data was found elsewhere. As a result, this layer was only used for the attribute "ir", which was the age class of the stand in ten-year increments.

The forest crown closure data came from the Western Oregon Digital Imagery Project (WODIP), which was also found through Oregon's Bureau of Land Management website. It is a collection of thirty-one raster layers that originated in 1993. The layer spans from 41.58°N to 46.68°N and 116.06°W to 124.96°W and utilizes the Universal Transverse Mercator reference system. Each of the thirty-one layers contains a different number of rows and columns, but the cell resolution remained consistent at 25 by 25 meters. The collection of layers is originally referred to as *wodip*.

Vegetation classification came from the Northwest Habitat Institute's website as a raster layer that originated in 1993. The layer spans from 41.45°N to 45.30°N and 116.30°W to 124.30°W and utilizes the D North American 1983 reference system. The cell resolution is 25 by 25 meters. The layer was originally titled *orvgan4h4xcp*.

The Oregon state boundary, as well as the county, city, and water boundaries all came from the US Geological Survey's EarthExplorer interface as vector layers originating in 2013. The layer spans from 41.99°N to 46.30°N and 116.46°W to 124.70°W and utilizes the D North American 1983 reference system GCS North American 1983 reference system. The layers for the state boundary, county boundary, city boundary, water boundaries, and public spaces were *gu_stateorterritory*, *gu_countyorequivalent*, *gu_incorporatedplaces*, *gu_plssfirstdivision*, and *gu_reserve,* respectively. The attributes utilized in each layer were "State Name", "County Name", and "FIRSTDVTXT", respectively and with no attribute needed for the incorporated places layer or for the reserved public spaces.

Lastly, various mushroom foraging forums keep general data about where chanterelles and other mushroom species have been found on a year-to-year basis. The data is generalized to the county scale. Several of these forums were surveyed for their 2014 chanterelle sightings data which was used to randomly generate point data across those selected counties. While not entirely accurate, this should give a good visual approximation of where chanterelles have been found.

Data Analysis

The analysis was done entirely in ArcGIS. Fortunately, all the layers used were compatible with this software and no file conversion techniques had to be utilized. All layers were transformed to the Universal Transverse Mercator reference system. All raster layers were resampled to feature a 25 by 25 meter grid. These features were chosen because the computer had noticeable difficulties when manipulating the *wodip* layers. The cartographic model can be seen on Page 12.

The forest age vector (*foi_pub_poly*) was converted to raster, resampled, and then converted to point data. This layer covers the smallest spatial extent and also had several small gaps in data. As a result, an inverse distance weighted approach was used to fill out the layer. There was a high degree of autocorrelation within the data, so a power of 3.5 was used to ensure closer points were given more weight, and the nearest 20 points were sampled. The raster values from 0 to 120 were re-classed in increments of 20 and all other values were dismissed. It has been found that forests that are between 40 and 60 years old are optimal for chanterelle growth, with a symmetric drop-off between 40 and 0 as well as 60 to 120 (Ehlers 14). A potential problem with this layer is that the data was sampled in 1982. Ideally, thirty years should have been added to the age attributes. However, stand age is a dynamic variable, especially in Oregon where timber clear-cutting and forest fires are common. As a result, the data was left undisturbed. The end result of this analysis was titled *forestage*.

The vegetation layer (*orvgan4h4xcp*) was resampled and then re-classed by ASCII file. The re-class reflected the fact that chanterelles to form symbiotic relationship with Douglas fir and western hemlock tree varieties followed by all other coniferous trees. There is no evidence that chanterelles have been found in deciduous forests, fields, or any other types of vegetation, so all vegetation that was not coniferous was discarded (Ehlers 14, United States 19). A similar problem to the forest age data arose; the vegetation data is 20 years old. While it is not expected that vegetation type has changed dramatically, the boundaries and areas of some vegetation (e.g. in areas of urban and suburban development) may have changed. The end result of this analysis was titled *vegclass*.

The state boundary layer actually consisted of several states. As a result, select by attribute was used to export Oregon state to its own layer. This was then converted to raster and resampled for later use. The vector layer was titled *Oregon* while the raster layer was titled *Oregonr*.

The digital elevation model (*gt30w140n90*) was resampled and then re-classed. It is generally accepted that chanterelles grow equally well at elevations below 2500 feet (762 meters), so the re-class reflected this. Surveyed data from mushroom hunting forums suggested that chanterelles have been found as high as 3600 feet (1097 meters), so the re-class used a 50 meter step down approach to re-class all data between 762 meters and 1097 meters (Ehlers 13). All data above 1097 meters was discarded. At this point, the re-classed elevation model, which encompassed much of North America, was overlaid with the raster Oregon layer before being multiplied by itself to finish off the analysis. The end result was titled *ordem*.

The crown closure layers (*wodip*) consisted of 31 raster layers of crown closure data that roughly followed county lines. These layers had an extensive list of attributes. As a result, Model Builder was used to extract the crown closure data. The model converted each raster to a temporary polygon file before converting back to a raster file that preserved only the crown closure data. When the model finished, mosaic to new raster was used to combine all 31 layers into one raster layer. Research suggests that chanterelles prefer crown closure that is between

70% and 80% with a symmetric drop-off between 70% and 50% as well as 80% to 100% (Ehlers and Hobby 75). However, because there were only ten categories to work with, a re-class was not necessary. The final layer was titled *crownclosure*.

The layers *forestage, vegclass, ordem*, and *crownclosure* were then combined using ArcGIS' weighted overlay tool. Each attribute was weighted manually on a scale from 0 to 255 based on the optimal conditions highlighted above. Each layer was then weighted an analytical hierarchy process, the calculation of which was computed in Excel. *Forestage* controlled 21%, *vegclass* controlled 48%, *ordem* controlled 9%, and *crownclosure* controlled 22%. Vegetation was deemed most important due to chanterelles preference for hosts and its status as a mycorrhiza mushroom. Crown closure and forest age were weighted nearly the same, as these factors encouraged and facilitated growth, but not as strictly as vegetation. Elevation was given the least impact for two reasons, the researchers who devised the limits admitted to them being somewhat arbitrary, and almost the entire Western Oregon region is at less than 2500 feet. As a result, elevation served as more of a constraint of sorts than an actual factor. After the weighted overlay was complete, the layer was re-classed to a five-point scale, with 1 being the most suitable and 5 being the least suitable. This layer was titled *Suitable Areas*.

At this point, incorporated places, water, and the Oregon state boundary were added for context. The cartographic process can be seen on the attached cartographic model. The layers were titled *Oregon*, *Water*, and *Incorporated Areas*.

The last two parts of the analysis were unplanned and took shape after the initial analysis was completed. First, areas were chanterelles had been sighted within the past year were discovered. Several forums were manually surveyed to identify the counties where chanterelles were found, and this was used to create random point data within each county boundary

(Matherly). This method was certainly not ideal; it is vulnerable to many types of sampling biases. Further, using sightings from 2014 in conjunction with data that originated between 1970 and 2015 is not entirely truthful. This data could have also been represented by shading the counties proportional to their sightings, however, the number of sightings is less important than the location of sightings. This is why point data was used, as it allows one to see general locations in conjunction with suitable areas. This layer was titled *Chanterelle Sightings*.

The other part was to overlay a map of public space in Oregon with a map of suitable areas. The most suitable areas were extracted from the analysis (values of 1 and 2), and were overlaid with the layer of reserved public spaces (*gu_reserve*). Ideally, these public lands with high suitability will be the first to be targeted for conservation efforts to serve as a model for the rest of the region. This layer was titled *Targeted Areas*.

Results

The Pacific Northwest region is known as an ideal habitat for chanterelle mushroom growth. As a result, it was expected that the Western Oregon region, a subset of the Pacific Northwest, would be mostly suitable for chanterelle growth. The result of the analysis followed this hypothesis. A vast majority of the region is moderately to very suitable for chanterelle growth. The only contradictions to this trend are the strip of unsuitable land on the eastern face of the Cascade Range and a small area in the southeast corner of the region, which lies in Klamath County, Oregon. The former consists largely of arable land and suburbs while the latter consists of young, low density woodlands that show signs of relatively recent clear-cutting. Knowing this, the unsuitability of these regions is expected. The map of this analysis can be seen on Page 14.

From the secondary analysis of chanterelle sightings, more trends became apparent. Even though this data was aggregated at the county level, there is almost a total absence of sightings in areas that the initial analysis deemed unsuitable. This reinforces the validity of the initial analysis. More importantly, there is also a noticeable lack of chanterelle sightings in the northeast corner of the region. In 2014, there were no chanterelle sightings in any of Hood River County, Wasco County, or Jefferson County. This is despite the fact that these areas are all between moderately and optimally suitable for chanterelle growth. This fact is concerning. The analysis does not illustrate why there have been no recent sightings here, as a result, further analysis should be done in this region. The map of this analysis can be seen on Page 15.

For the final analysis, reserved public land with high suitability for chanterelle growth was targeted for early conservation efforts. The most promising part of the result is how dispersed the selected areas are; this includes a significant area in the northeast region that did not see any chanterelles in 2014.

Discussion

Based on analysis of each layer before the weighted overlay, it was expected that there would be a large amount of suitable areas for chanterelle growth in Western Oregon. As stated previously, the region is largely within the desirable elevation range. The region also has a high degree of coniferous forests, especially those containing Douglas fir and western hemlock varieties. The area has relatively few urban incorporated spaces, as well. This led to the belief that the variability within crown closure and forest age data would wield the largest effect on the final outcome.

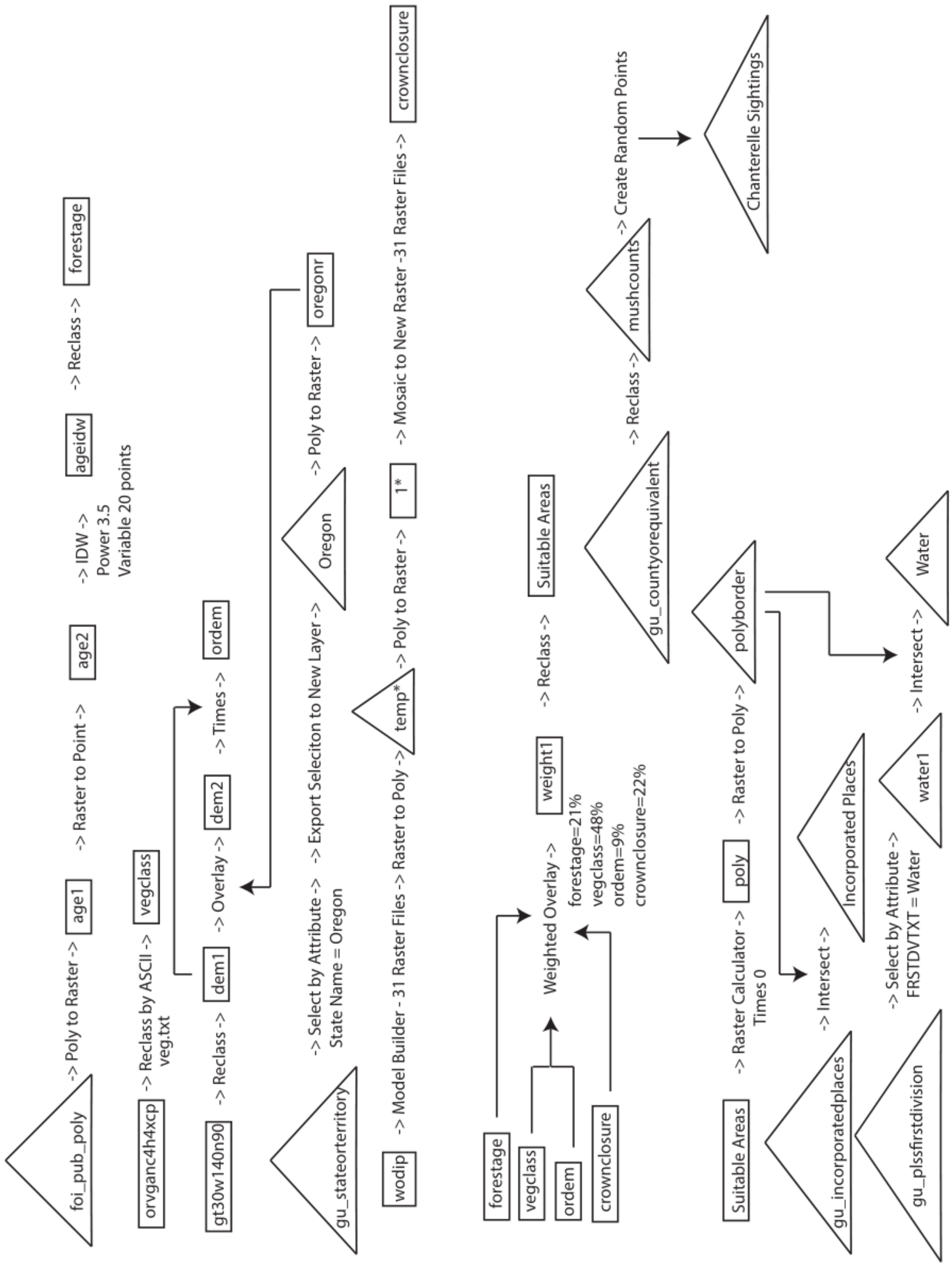
Using the inverse distance weighted analysis of forest age allowed that layer to be "smoothed", thus reducing its variability. While forest age still had an important impact, it is clear that the single most influential layer was crown closure. Most noticeably, a long stretch along the western face of the Cascade Range that has low crown closure was deemed almost entirely unsuitable. Further, all urban incorporated areas were deemed unsuitable, which makes sense because urban areas have little to no crown closure.

As stated previously, it was expected that there would be a large amount of suitable areas, and this was exactly the case. This is both promising and disappointing. Promising because having a large amount of suitable areas is fantastic for the region and will help to ensure the continued survival of this species. However, it is disappointing because the initial intention of this project was to define areas that should be targeted for conservation. From this early analysis, most of the region should be “targeted”. This is not efficient whatsoever.

As this initial analysis concluded, the project still did not seem substantial enough. Surveying forums for chanterelle sightings was a great idea, though the data is not without its problems. The biggest thing here was discovering that no chanterelle sightings were reported in the northeast quadrant of Western Oregon in 2014. Following from the initial objective, it could easily be said that this area should be targeted for conservation efforts. However, the better response would be to say that more analysis, including field analysis, should be done in this region to understand why chanterelles have not be sighted here in 2014. It could be a case of non-response bias, a crippling disease that overtook the fungus, or over foraging, among many other possible contributors to the lack of sightings.

Finally, to correct for the lack of targeted areas, a last bit on analysis was completed. These results may actually be useful for those interested in conservation, which was the goal all along. This layer could have easily been region grouped and an area threshold applied to select large swaths to focus on, however, that did not seem necessary. Mushrooms tend to grow in small, haphazard clusters. A larger area does not guarantee, by any stretch, a more effective conservation effort. As a result, this layer was left raw and open for interpretation.

Looking back, there are a lot of things that could have been done differently. Factors could have been weighted in so many different ways, and I likely should have consulted with someone who knew which factors were more important for chanterelle growth. I cannot help but think that an ordered weighted averaging approach would have decreased the suitable areas and allowed a more targeted response, which was the initial intention. The point data could have been displayed more effectively, and, ideally, more recent data would be used to create the layers. As a result, while I am not entirely happy with the outcome, I think this project is a good start. It demonstrates that there is a reason to do further analysis, but it also leaves a lot of work to be done.


foi_pub_poly
-> Poly to Raster ->
age1
-> Raster to Point ->
age2
-> IDW ->
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Variable 20 points
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-> Reclass ->
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gt30w140n90
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dem1
-> Overlay ->
dem2
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-> Select by Attribute ->
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-> Export Seleciton to New Layer ->
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vegclass=48%
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-> Reclass ->
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-> Create Random Points
Chanterelle Sightings
Suitable Areas
-> Raster Calculator ->
Times 0
poly
-> Raster to Poly ->
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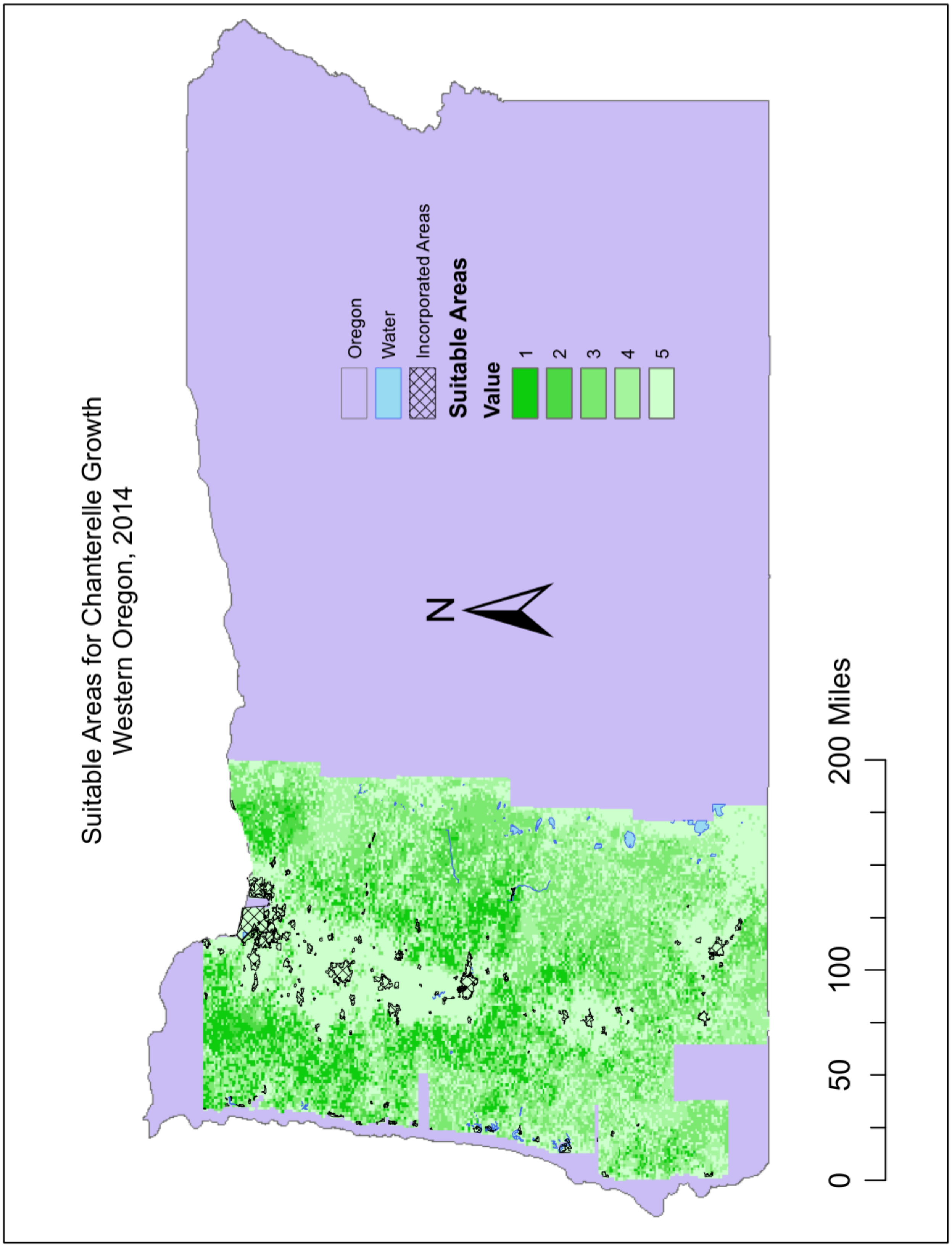
water1
-> Intersect ->
Water


Suitable Areas for Chanterelle Growth
Western Oregon, 2014
Oregon
Water
Incorporated Areas
Suitable Areas
Value
1
2
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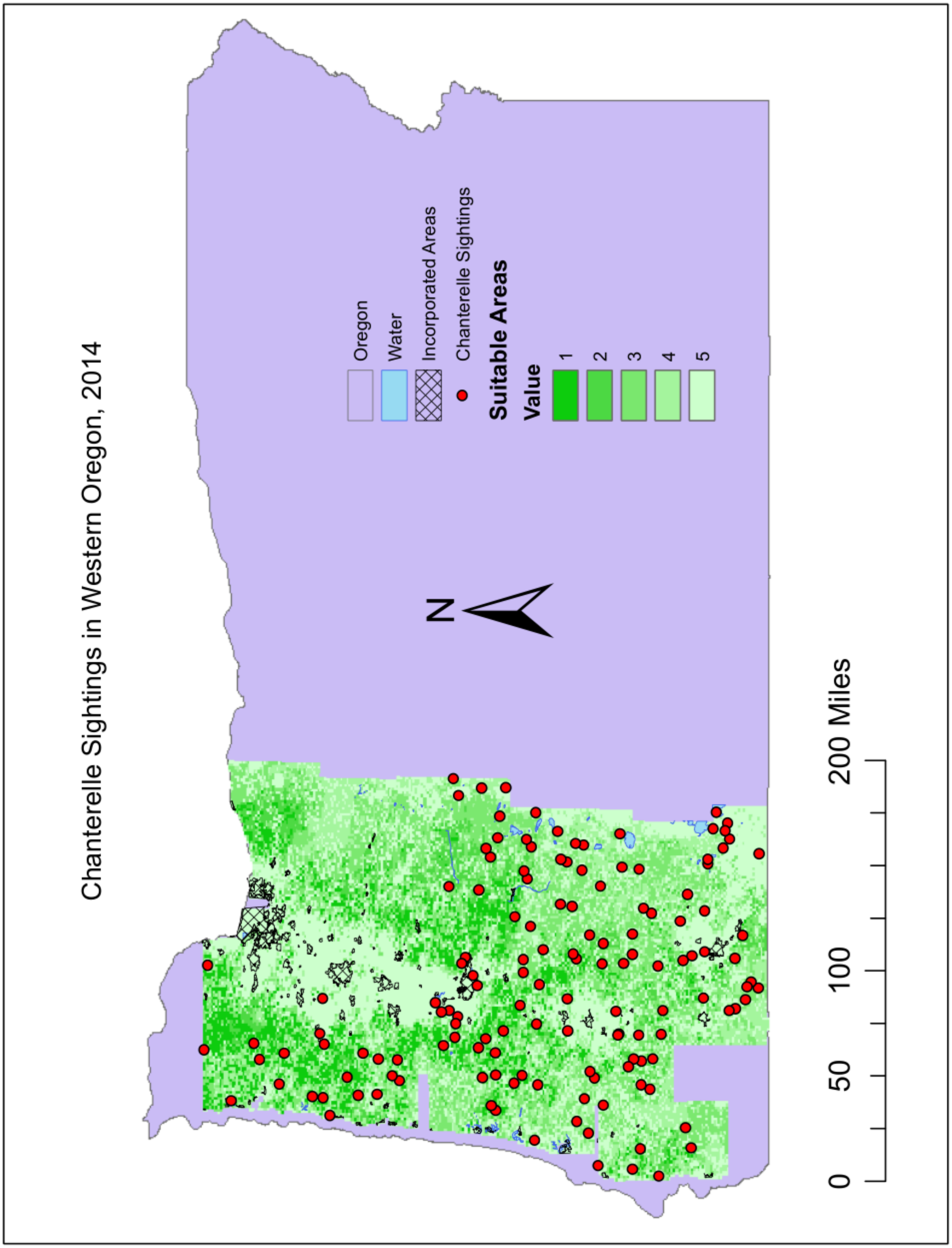
200 Miles


Chanterelle Sightings in Western Oregon, 2014
Oregon
Water
Incorporated Areas
Chanterelle Sightings
Suitable Areas
Value
1
2
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0
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200 Miles

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