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GEOG328 Lab 4 Marbled Murrelet

Introduction and Goal:

Marbled Murrelets, also known as Brachyamphus marmoratus, are small diving seabirds that are found in the North Pacific. These birds hunt in offshore areas as well as inshore-protected environments where they prey on small fish like anchovy, herring, and smelt (Fowler, J. 2015). Although Murrelets hunt in and around the ocean they nest on the branches of tall old growth and mature conifers such as spruce and yellow cedar, roughly 20m to 40m above ground (Fowler, J. 2015). They can travel up to 70km per day in-between the ocean and their nests in order to gather food. They also have the tendency to travel along streams to minimize the distance they have to travel. However, based on deforestation caused by logging and other human activities, the nesting habitat for this specie has been greatly reduced. Due to the habitat, the Murrelets are classified under the Red-listed in BC as an endangered species in Canada (Fowler, J. 2015).

The goal of this lab is to construct and locate the most suitable nesting habitat in the Carmanah Valley area for the Marbled Murrelet and to compare the results to the previously collected radar count. First, the study area of this suitable nesting habitat has to be generated based on the given two distance criteria. Secondly, the suitable raster model is constructed based on the six different habitat criteria values derived from the provided DEM and vector files. Each of the criteria is given a specific weight ratio based on the Murrelet's behavior for the construction of a final multi-criteria model. The monitoring of the bird's activities from the prior collected radar count and the habitat suitability are crucial for tracking population, identifying threats, and assisting the management of the species (Buger, A. 2004).

Data and Study Area:

These Marbled Murrelets movements can be well captured and identified on the radar from the individual stations placed at the area. The captured data count of the birds is crucial for indicating the size of the local population and the movements within the local area. In this lab the main study location is the Carmanah Valley which is within the Carmanah Walbran Provincial Park, located 20km north-west of Port Renfrew on the southwestern coast of Vancouver (BcParks. 2015). The park provides protection to the diverse forest ecosystems that host a large spruce population as well as a home to ancient cedars, making this a favorable environment for the Marbled Murrelets (BCparks. 2015).

In the lab file, it is provided with one raster continuous digital elevation model (DEM) and several vector line/polygon files. The provided single DEM file has a raster resolution of 100m and offers the elevation values of the entire Carmanah Valley. The given vector files provides the polygon study area, the polygon forest cover, the point location of radar stations, the coastline, the polygons of lakes, and the line local stream system. All of these given layers use the NAD_1983_Albers projection. From the provided vector forest cover file, it can be broken down into further detailed information of the existing trees such as the age class, height class, crown closure, and the dominant species within the area. The derived information from the vector forest file is converted into separated discrete raster files with assigned individual weight distribution. These weight distributions combined each discrete raster file into the final multi-criteria model.

Methods:

Marbled Murrelets required several specific criteria for its suitable habit. These birds tend to avoid forest habitats that are within 500m of the ocean, due to their unsuitability. They also avoid habitats that require flight distances that are greater than 20km because of the energy consumption (Fowler, J. 2015).

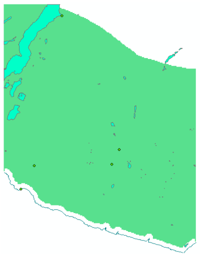
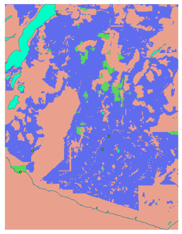
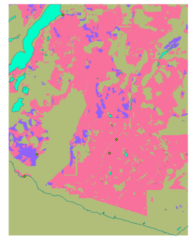
After understanding the provided information, the lab can begin by constructing the Murrelets suitable habitat frame (Figure.1) based on the two given distance criteria mentioned above. Firstly, the given coastline file has two additional attributes that represent the coastline of the unwanted study areas (two islands) and two attributes of the interested coastline. These unwanted attributes of the coastline can be deleted physically in the attribute table with the help of the editor tool. The editor tool is required once again to merge the two interested coastlines into one attribute for the simplification of further processes. Secondly, the newly merged single attribute coastline can be used to identify the Murrelets' habitat area with the help of the buffer tool. The process of buffering the coastline with a 500m distance and the settings of 'one side' and 'flat' is required to locate the unsuitability habitat. To find the habitat that requires flight distances of less than 20km, the buffer tool is needed to buffer the coastline with a 20km distance and the settings of 'both' and 'all'. Lastly, after the completion of identifying the unsuitable and suitable areas the combination of these two buffers can be merged into the interested study area. With the help of the clip tool, the input within the 20km buffer of the study area is kept, and the area that exceeds the 20km radius is deleted. The buffer of 500m unsuitable coast is deleted by the erase tool. However, after erasing the 500m unsuitable buffer it is necessary to erase the unwanted polygon that covers the ocean area. This can be completed by using the editor tool to performed the explode multi-part feature, which is used to split a polygon into multi-parts. Figure 1 presents the final product of the suitable habitat extent polygon.

The next step is to construct the multi criteria Marbled Murrelet nesting raster model based on the Burger's modification of Hobb's (2003) model for the Central Coast of BC (Fowler, J. 2015). The multi criteria raster model was constructed based on the six main criteria of the tree age, tree height, crown closure, elevation, slope and the contributing tree species. Each of these criteria was assigned with a specific weight, based on its influence to the quality of the habitat. First, a feature to the raster tool is used to derive the three interested criteria from the provided forest_cover file: tree age, tree height, and crown closure. Second, the reclassification process is performed on the raster layers of tree age, tree height, and crown closure based on the given attribute values out of the 0-20 scale. The figures of reclassified raster layers of age, height, and crown closure are presented below as Figure 2, Figure 3, and Figure 4. Third, the elevation raster (Figure 5) was the direct result of the performance of the reclassification on the provided BC_dem_100m raster file. Fourth, the slope raster layer is required to be derived from the provided DEM raster file using the slope tool. After putting the slope into its own raster layer, it is necessary to reclassify the slope raster layer based on the given scale (the result is presented as Figure 6). Lastly, the dominant tree species has to be derived again from the provided tree using the feature of the raster tool. The dominant tree species layer has to be reclassified twice; the first reclassification was to locate the interested tree species and the second reclassification was to reassign the interested tree species into the provided attribute values.

The six final reclassified criteria were combined into the multi criteria raster model with the help of the raster calculator based on its assigned weight. The combination of these six raster criteria can be done by entering the following equation into the raster calculator: "reclass_age" x30% + "re_height" x30% "reclass_crown" x14% + "reclass_elev" x 6%+ "reclass_slope" x6% + "re_spec_fin" x14%. The multi criteria raster model needed to be cropped by the suitable habitat extent polygon using the extract by the mask tool. This is due to the fact that the suitable polygon was a vector file and the multi criteria model was a raster file. The cropped multi criteria model is the final product of the Marbled Murrelet Suitable Nesting Habitat, presented in Figure 9.

Results:

Figure 1. Study Area   Figure 2. Age Class   Figure 3. Height Class

 - [( x 0.3) + ( x0.3)

re_height

Rowid	VALUE	COUNT
0	1	32154
1	18	2411
2	20	28355

Figure 4. Crown Closure

Figure 5. Elevation

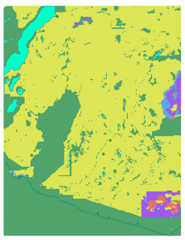
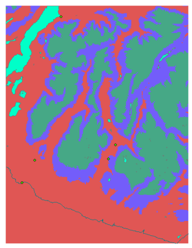
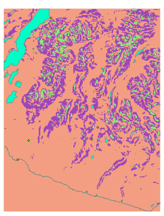
+ ( x0.14) + ( x0.06) +

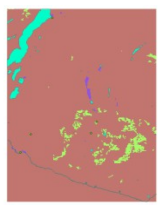
Figure 6. Slope

Figure 7. Tree Species

(

reclass_slope

Rowid	VALUE	COUNT
0	4	3116
1	12	13643
2	20	46161

x0.06) + (

re_spec_fin

Rowid	VALUE	COUNT
0	0	60836
1	12	1882
2	20	202

x0.14)

Figure 8. Suitability Area without distance criteria

Figure 9. Murrelet Suitable Nesting Habitat

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Discussion and Conclusion:

The Marbled Murrelet is quite different than most of the forest-nesting bird species. These birds do not build nests on branches or nest in cavities (Ministry. 1998). Instead Murrelets nest on a thick, mossy platform typically around 40m high on some kind of a trunk (Buger, A. 2004). Their nests' are found in Sitka spruces, spruces, and yellow cedars that are ranged from 300 to 800 years old (Wildlife. 1998). Sitka spruce forests are found less than 80km inland and at an elevation lower than 30m (BCparks.2015).

However, old-growth trees are the only sites that provide the kinds of conditions that favour Murrelets' nesting habitats and the Carmanah Valley represents the remaining 2% of old-growth forest in BC (BCparks. 2015). With that being said, the Carmanah Valley area has a large portion of land that favor's the Murrelet's habitat. The Carmanah Valley is home to many of the world's largest spruce trees, which exceed the height of 95m and live for longer than 800 years, as well as being home to ancient cedars estimated to be over 1000 years old (BCparks. 2015). Based on the multi criteria model, the overall habitat quality appears to be well because the lowest output value was 1.08. This indicates that the Carmanah Valley does not have a location that is not suitable for the Murrelet's habitat.

The Marbled Murrelet is positioned under the Red-listed Threatened in Canada. This is the direct result of human activities such as urban development and logging, which greatly reduced the nesting habitat. As mentioned above these birds typically tend to nest higher up, between 20- 40m above ground, which makes it difficult to estimate the distribution and size of the Murrelet's population (Buger, A. 2004). The distribution and the size of the population are essential information for monitoring and managing the specie. However, the high-frequency radar was found to be an effective instrument for locating and counting the active Murrelets (Buger, A. 2001). Murrelets can be well identified on the radar due to their flight speed, size indication, and their unique flight path (Buger, A. 2004). There are five radar stations placed all over the Carmanah Valley and near the shore to capture the Murrelets flying from the ocean towards the forest.

Despite the usefulness of the radar, the major limitations of the radar are caused by the reflections from obstacles such as trees and hills. These obstacles can interfere with the radar paths and produce misreading results (Burger, A.1997). This scenario can be observed from the Carmanah radar station, which is caused by the steep slope in the area altering with the radar paths. Radars are useful at an open and shallow part of the valley, but the Murrelet's habitats are rarely located at this kind of topography (Burger, A.1997). However, the Walbran station appears to be a perfect example of this kind of topography with a high count of 393. One unique scenario is the Carmanah radar station that is placed along the coastline, where there are no suitable habitats, but still appears to have 87 counts. This scenario occurred because of the Murrelets traveling passed this radar station in order to fly between the ocean and forest.

The constructed multi criteria model of the suitable nesting habitat for the Marbled Murrelet clearly represents the most suitable location within the Carmanah Valley. With this information, the Murrelets habitat areas are clearly identified and can be used to prevent further logging movements that will harm and destroy the habitats. In the future, radar stations should be placed closer to the coast and along the superior nesting habitat where they can capture the Murrelets' flights more accurately and prevent radar alteration caused by topography obstacles.

References:

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