Lab 1: Conservation Science and Geodatabases

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1 Introduction

The amount of accessible data and affordable processing power has allowed scientists to understand the world from a computer generated perspective. This relatively new form of understanding can be applied to help analyze human impact on biodiversity and determine measures to aid the planets endangered and high priority species.

Parks and protected areas have been shown to be effective at preserving biodiversity within their boundaries (Viciani et al, 2014). However, parks and protected areas have not been shown to be effective at preserving the biodiversity of a region (Viciani et al, 2014). One of the main reasons for this is due to the fact that parks and protected areas are not always located at the optimal locations (Viciani et al, 2014). In order to find the optimal locations to allocate resources for parks and protected areas, gap analysis is used.

Gap analysis identifies ”gaps” in conservation networks. The findings are then used as a basis for determining which gaps to absorb into the conservation network and where to allocate resources (Jennings, 2000). GIS software is often used to perform gap analysis due to the size and scale of the data involved. GIS can be used to display the data spatially and it is also able to work with large data sets and complexes processes data with ease. The results of this study aim to find the gaps in British Columbia's conservation network as well as finding where large quantities of high risk and at risk species (SARA) are located. These findings may be used to provide insight on where to effectively allocate resources in British Columbia's conservation efforts.

When working with continuous data such as animal locations over the province of British Columbia, the data sets can get quite large. File geodatabases are an excellent storage and organization tool for gap analysis. File geodatabases are optimized for data storage and allow for the creation of feature data sets, which can store related data such as parks, protected areas, and ecological zones as feature classes (Childs, 2009). Outputs can be stored in the geodatabases in a separate feature data set. The geodatabase can then be shared to another ArcGIS user and they will have the same file structure.

The goal of this study was to use gap analysis strategies and modern GIS tools to locate areas in British Columbia that contain large amounts of high risk and SARA species, and to determine if the current conservation network is effective at protecting British Columbia's biodiversity.

2 Methods

2.1 Study Area and Data

2.1.1 Study Area

British Columbia's vast parks and protected areas system covers 14,071,547 hectares (BC Parks, 2018). Over 10 million hectares, roughly twice the size of the Netherlands of the parks and protected areas system in British Columbia is deemed "class A" parks, or parks dedicated to the preservation of the natural environment (BC Parks, 2018). Figure 1 shows a small scale map of British Columbia with the the parks and protected areas depicted. The parks used in this study were classified as one of the following: ecological reserve, protected area, provincial park and recreation area.

2.1.2 Data

All data used in this study will be stored in a file geodatabase with a projection domain of NAD 1983 Alber's Conic. The structure of the geodatabase used in this study can be seen in Figure 8. The two main files used in this analysis were sourced from Hectares BC. The two raster files, one showing the count of high priority species in BC and one showing the count of SARA species in BC both use one hectare grid cells, covering a total area of 10,000 meters squared each. Both rasters contain a park designation attribute field that classifies the type of protected area or non-protected area as described in 2.1.1. Metadata summaries for these rasters are shown in Figures 6 and 7. Additional polygon files were used to display the extent of protected an non-protected areas in British Columbia. These polygon files were used to quantify the density of high priority species in parks and non-protected areas.

2.2 Analysis Methods

2.2.1 File Geodatabase Structure and Data Pre-Processing

A parks and not parks polygon file were first loaded into ArcGIS. A file geodatabase was then constructed with a NAD 1983 Alber's Conic projection. A feature data set was created to organize the parks data, and the parks and not parks files were imported to the parks data feature data set as feature classes. The two raster data sets, one containing data on high priority species and one containing data on SARA species per hectare grid cell in BC were loaded into ArcGIS software. The SARA and high priority species were then imported into the file geodatabase with domain conditions for maximum values set as the maximum of each data set, 66 and 225 respectively.

2.2.2 Zonal Statistics

A zonal statistics tool was then used on the SARA species count raster and the high priority species count raster. Each raster was used as input to the zonal statistic tool in combination with the parks and not parks polygon feature classes to create four tables. Table 1 shows summary statistics for SARA species in parks, Table 2 shows SARA species outside of parks, Table 3 shows high priority species inside of parks and Table 4 shows high priority species outside of parks.

2.2.3 Density Calculation and Mapping

Using the tables created in 2.2.2, a density field was added to each table to quantify the amount of SARA and high priority species in protected and non-protected areas for every 10,000 meters squared, or every hectare. The following calculation was used on each entry in every table:

$$SUM/AREA * 10,000 \tag{1}$$

2.2.4 Data Visualisation and Outputs

The tables with added density fields were then spatially joined with their corresponding feature class. A graphic for the high priority species raster as well as the SARA species raster was produced to the variance in SARA and high priority species in British Columbia. These graphics can be seen as Figures 2 and 3 respectively. Additionally, maps showing the variance in density inside and outside of British Columbia's conservation network were produced in Figures 4, 5, 6. Relationship classes were added in the geodatabase to organize SARA species and high priority species data within protected areas.

3 Results

3.1 High Priority and SARA Species inside of Parks

Table 3 shows the summary statistics for high priority species in British Columbia's conservation network. Protected areas had the highest density of animals per hectare at 75.42, and provincial parks had the lowest at 53.67 animals per hectare.

SARA animal density's were much lower than high priority species. Table 1 shows that protected areas had the highest density at 9.01 animals per hectare and provincial parks had the lowest once again with 4.3 animals per hectare.

3.2 High Priority and SARA Species outside of Parks

Figure 5 shows a map of the non-protected areas in British Columbia. The density of high priority species in non-protected areas was 65.96 animals per hectare. Alternatively the density of SARA species was determined to be 6.34 animals per hectare. Tables 2 and 4 show the summary statistics for SARA and high priority species in the unprotected areas of British Columbia.

4 Discussion

The density's of high priority and SARA species inside of protected areas appears to be very similar to that of the non-protected areas. The mean density of high priority species for all four categories of protected areas is 61.29 animals per hectare which is within 1 standard deviation of the mean density outside of parks. Similarly, the mean density of SARA species in protected areas is 6.51 animals per hectare which is also within 1 standard deviation of the mean density of SARA species outside of parks.

An audit of biodiversity in British Columbia created by the Auditor Generals office of BC in 2013 criticized the governments conservation efforts. The auditor general concluded that significant gaps existed in the conservation network, the conservation efforts were not being adequately measured and the conservation efforts were not being thoroughly understood (Doyle et al, 2013). From the results of this study, it is inconclusive whether protected areas have any detectable impact on biodiversity in British Columbia.

Figures 2 and 3, raster graphics of high priority and SARA species in British Columbia reveal many gaps in the conservation network. The most noticeable high density gaps are in southern BC however, these areas are largely inhabited and a large conservation effort is not possible. Additionally, a large high density region in north-eastern BC is almost entirely unprotected.

The gap analysis in this study is exploratory and provides insight on gaps in British Columbia's conservation efforts however, the analysis was not as in depth as needed to be conclusive. Additionally, the counts and density's of animals are just estimates as the counts rely on animals being observed. If an animal was not observed it would not be included in the data set. There is also a large degree of uncertainty due to the protected areas datasets. Since there is only four classes of parks, all polygons are classified as one of the four. This means that a protected area polygon's density in northen BC will have an impact on a protected area polygons density hundreds of kilometers away in central BC.

5 Conclusion

In conclusion this study demonstrated the effectiveness of the geodatabase as a tool for gap analysis. The geodatabase provides an effective solution for storing and sharing data and is a very useful tool for government efforts in the conservation of biodiversity. Although ultimately inconclusive, the study revealed uncertainty in current conservation efforts and raises questions as to the future of biodiversity in British Columbia. Without more funding, resources and training, the conservation efforts in British Columbia will not be able to be impactful enough to protect the endangered species of British Columbia.