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Determining Conservation Values and Potential Conservation Areas in Kitsap County, Washington

Introduction

Natural habitats are slowly disappearing as the human population grows and pushes the boundaries of cities outward. The purpose of this project is to examine the land cover, locations of wetlands and water, predicted wildlife distributions, current land use, and population density of Kitsap County, Washington and determine which areas have a high conservation value based on these attributes. Kitsap County belongs to the Georgia Basin/Puget Sound ecosystem, which is well-known for its high environmental values, including marine, estuarine and terrestrial habitats that are home to a large number of species (Fraser *et al.* 2006). One of the main draws of Kitsap County is its natural beauty; in order to preserve the allure and environmental value of these vital habitats, we must find a way to determine which areas should be the top priority for conservation. While there are many ways to evaluate habitats for conservation, this project looks at land cover, water quality, and predicted wildlife distributions. Large scale analyses such as the one used in this project can target potential conservation areas which can then be examined at a smaller scale (through field work and ground truthing) to determine which areas truly are the best choices for conservation.

Theoretical Foundation

In this project, a methodology was developed for determining conservation values through the creation of a decision cube. A decision cube is composed of multiple layers of data with attributes weighted and classified based on how desirable those traits are. A study in Costa Rica found that a decision cube could be used to figure out which areas are most in need of preservation based on whether or not they are already preserved, the quality of the habitat, and the presence of wildlife; this method is also referred to as gap analysis (Savitsky and Lacher 1998). Methods for this project were based on Savitsky and Lacher's Costa Rica study (1998). In addition, it should be noted that much of this project is also founded on Tobler's First Law of Geography, which states that everything is related to everything else, but near things are more related than distant things. This most specifically applies to the methods used to analyze population density. It is also important to take multiple factors (such as multiple wildlife species) into consideration when choosing areas to focus conservation efforts in order to protect the maximum number of species as opposed to picking areas suitable for only one species (Scott and Sullivan 2000).

Planning Process

This project was planned over a period of approximately four months. The project began with the idea to research areas in need of conservation in Kitsap County, WA and their relationship to population density and land use. It grew through extensive research on potential analysis strategies and development of custom methods to analyze the data. Project ideas and goals were repeatedly shared with and critiqued by peers throughout the entire planning process. Prior to implementation of the project, an extensive project workflow diagram was created using ArcGIS's Model Builder. The project workflow created a solid foundation to work from during the implementation of the project. The initial goal of the project was to determine the best areas for growth and the best areas for conservation in Kitsap County based on a variety of factors including land cover, water quality, wildlife presence, population density, and land use. However, due to time constraints and the availability of data, the project ended creating conservation values for land in Kitsap County and then comparing those values to population density and land use to determine the areas that are likely to be well-suited for conservation efforts. Another goal of this project was to design a decision cube for determining conservation areas by overlaying land

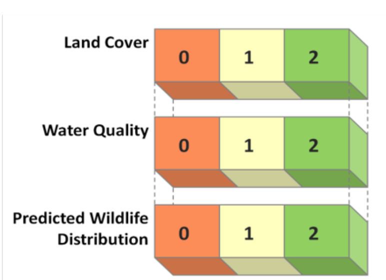

Figure 1. Model of the raster overlay used as a decision cube to determine conservation values.

cover, water quality, and wildlife data. A model of this decision cube is shown in Figure 1.

It was hypothesized that areas the areas of low conservation value would be found in areas with a high population density and areas of high conservation value would be found in areas with a low population density. In addition, it was hypothesized that many of the parcels that coincide with higher conservation values will be land that is used for natural resources or as open space.

Methods and Implementation

A variety of GIS analysis methods were used to complete this project. ArcGIS version 9.3.1. software was used to perform the analyses. All analyses were projected in NAD 1983 HARN State Plane North FIPS 4601 with 30 foot raster cells throughout all datasets.

1.1 Land Cover, Water Quality, and Predicted Wildlife Distribution Reclassification

National land cover data was obtained from the United States Geological Survey's Seamless Server (USGS 2006). Land cover data for Kitsap County was extracted using a basemap of Kitsap County from Kitsap County's Geographic Information Services website (Kitsap County GIS 2011). The initial land cover dataset contained fifteen classes for a variety of land cover types found in the region. These were reclassified into three classes (0, 1, and 2; 0 being the least desirable land cover and 2 being the most) in preparation for creation of the decision cube. Reclassification decisions were made based on the definitions for each land cover type as stated by the USGS; these definitions can be found in Appendix A. Low, medium, and high intensity development, barren land, and cultivated crops were classified as 0's. Developed open space, scrub/shrub, herbaceous grasslands, and pasture/hay were classified as 1's. Finally, open water, deciduous forests, evergreen forests, woody wetlands, and emergent herbaceous wetlands were classified as 2's (Figure 2).

Water quality was classified based on the proximity of water to roads, as long term monitoring studies have found that roads have significant impacts on water quality (DeCantazaro *et al.* 2009). A water and wetland shapefile was retrieved from Kitsap County's GIS website (Kitsap County GIS 2011).

In addition, TIGER line shapefile for all roads in Kitsap County were obtained from the U.S. Census Bureau's website. The roads were dissolved into a single line and a 165 foot buffer added. The buffer size was chosen based off more conservative buffer sizes used in previous watershed studies (Endreny and Wood 2003). Water and wetlands within the road buffer were selected and given a classification value of 0. Water and wetlands outside of the road buffer were selected and given a classification value of 2. All other terrain was classified with a value of 1. Lastly, the shapefile was converted to a raster (Figure 3).

Wildlife data was obtained in the form of ArcINFO files from Washington State Department of Fish and Wildlife's Gap Analysis Program (WDFW 1997). The Gap Analysis Program data was created by WDFW by analyzing known locations of species and habitats to predict the distribution of individual wildlife species (WDFW 1997). Ten mammal distributions were randomly chosen out of fifty available files for this project. This small, random sampling of files was used mainly due to time constraints. The ArcINFO files were converted to coverage files, then converted to shapefiles, then finally converted to rasters. The wildlife data came classified with values of 0 (no habitat for the species), 1 (core habitat for the species), and 2 (peripheral habitat for the species); as a result, they had to be reclassified to switch classes 1 and 2 in order to make 2 the most desirable value. Once all files were reclassified, they were merged using the raster calculator and then reclassified again using three natural breaks (Jenks). Finally, the dataset was extracted using the Kitsap County basemap (Figure 4).

1.2 Creating a Decision Cube for Kitsap County

The conservation value decision cube was created by overlaying the land cover, water quality, and predicted wildlife distribution raster datasets with the raster calculator. As mentioned before, this method was adopted from similar methods used to generate a

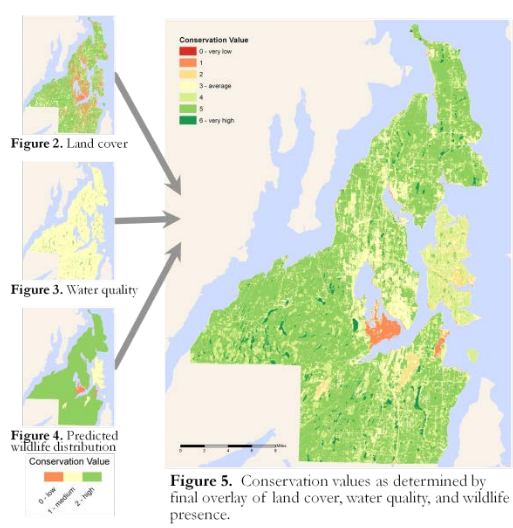

Figure 2. Land cover

Figure 3. Water quality

Figure 4. Predicted wildlife distribution

Figure 5. Conservation values as determined by final overlay of land cover, water quality, and wildlife presence.

decision cube for conservation gap analysis in Costa Rica (Savitsky and Lacher 1998). The resulting classes are the conservation values used in this project; they range from 0 (very low) to 6 (very high). A value of 0 means that all three datasets used had 0's in that particular cell when overlayed, while a value of 6 means all three datasets had 2's in the cell. Conservation values of 1 through 5 could be any combination of values from the three datasets used. The final raster dataset was converted to a shapefile and symbolized (Figure 5).

1.3 Analysis of Population Density

Total population for 2000 by Kitsap County block groups was obtained from the U.S. Census Bureau's website (U.S. Census Bureau 2000). The data was downloaded as a Microsoft Excel file and then joined in ArcMap to a shapefile containing block groups (U.S. Census Bureau 2000). Block group polygons were converted to centroids, and then the centroids were interpolated using inverse distance weighting (IDW) to show the population density for the region. The resulting data was reclassified using 0.5 standard deviations. The final step in analyzing population density was to convert the raster dataset to a shapefile and symbolize it (Figure 6).

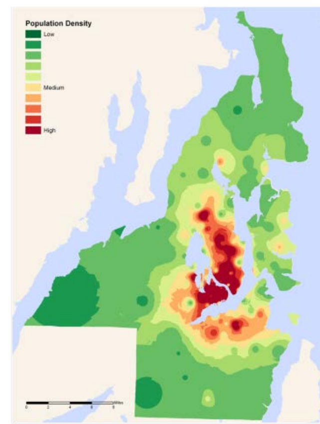

Figure 6. Population density of Kitsap County, WA. Population data from the U.S. Census 2000.

1.4 Land Use Analysis

A shapefile of all parcels in the study region was downloaded from Kitsap County GIS (Kitsap County 2011). In addition, a table with the property classes for parcels in Kitsap County was downloaded (Kitsap County 2011) and joined to the parcel shapefile. The property classes were reclassified into thirteen major categories: commercial, education, government, manufacturer, open space, recreation, resources, transportation, undeveloped, unknown, utilities, and water.

1.5 Conservation Value in Relationship to Population Density and Land Use

Land with a conservation value of 6 and a population density of 7 or higher were selected individually, and then a third selection was made to determine in which areas these attributes intersected one another. This represented areas with a high conservation value and high population density. The same process was used to find areas with a high conservation value and low population density (population density less than or equal to 2) as well as areas with a medium conservation value (equal to five or higher) and low population density and finally, for selecting areas with a medium conservation value and high population density.

In addition, parcels that intersected land with a high conservation value (6) were selected out. Summary statistics were run on these parcels to determine the distribution of the land use types and their average acreage.

Results

This analysis showed that while a majority of the land in Kitsap County with a medium to high conservation value is found in areas of low population density, there are some areas of medium to high conservation value found in areas of high population density, which only partially confirms the hypothesis made in this project (Figure 7). These areas are most likely residential properties or public parks. The parcel analysis portion of this project showed parcels intersecting land with a very high conservation value are mostly residential and undeveloped as opposed to the hypothesis that most of the land would be resources or open space (Figure 8). However, further analysis showed that while a majority of those parcels are residential and undeveloped, the average acreage for those parcels is relatively small. This shows that while the population density in those areas is low, there are still many people living in more natural settings. In Washington State, it has been found that

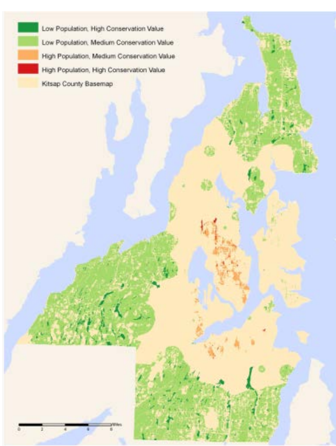

Figure 7. Comparison of land with high and low population densities to land with high and medium conservation values.

many smaller, at-risk vertebrate species live on privately owned lands (Cassidy and Grue 2000); the high volume of residential parcels in low population, high conservation value areas corresponds to this. Furthermore, Robinson *et al.* showed that in the Seattle region between 1974 and 1998, "sprawling low-density housing in rural and wildland areas constituted 72% of total land developed" (2005).

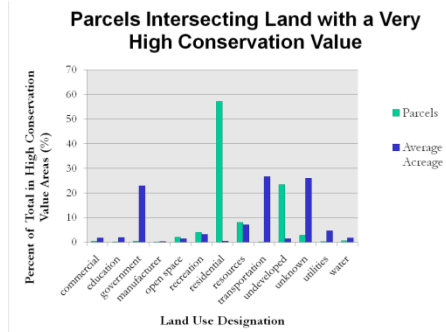

Figure 8. Comparison of the designated land use of parcels and the average size in acres of those parcels that intersect land with a high conservation value.

Outward growth of the population into areas with medium to high conservation value is a problem because of the impacts on the ecosystem that in turn affect the native wildlife. For example, a study done in the Central Puget Sound region of Washington State found that urban development causes a decrease in the number and in the species richness of bird species (Hepinstall *et al.* 2008). The deforestation of native forest communities has significant and persistent impacts on macrohabitat structures that result in fast changes in animal communities (Lomolino and Perault 2000). Furthermore, deforestation can cause fragmentation of habitats. Lomolino and Perault also found that mammal species in fragmented and disturbed habitats tend to have significantly smaller body sizes than those that do not (2007).

Areas with the highest conservation values and lowest population density should be looked at in depth through field studies as potential conservation areas. Areas that have been managed the least or undisturbed are the best options for focusing conservation efforts. However, it is likely that most areas have been managed historically in some way by humans; this was found to be the case in the nearby eastern Cascade Mountains (Hessburg *et al.* 1999).

Critical Analysis

While this analysis provides a foundational method for determining potential conservation areas, there are many limitations to the analysis itself. One major limitation is the actual scale of the project. The raster cell size (30 feet) used in the analysis was relatively small, but 30 feet can make a large difference on the ground and in terms of habitat preservation.

Furthermore, most of the data used for this project was five to fourteen years old. Two key pieces of this analysis, population and wildlife, were ten and fourteen years old respectively. Ecosystems tend to change rather quickly, especially as population growth and urban sprawl occur. In order to generate a more accurate decision cube, more recent data should be obtained.

The water quality portion of the decision cube is slightly flawed in two ways. The first being that a value of 2 was chosen to represent wetlands and water, but the presence of wetlands and water does not necessarily make it the best choice for habitat; water was weighted more heavily in this analysis than it should have been. In addition, many of the same wetlands and water areas that were classified as 2's are directly connected to water and wetlands that were classified as 0's. Pollutants tend to flow and spread rather easily through water, as a result, some of the areas classified as 2's may not be the optimal choice for conservation, especially of the nearby road is a major highway or frequently used. Furthermore, the absence of water does not necessarily mean the habitat should be rated as a 1 (medium desirability) because there are many terrestrial species that do not need to be in close proximity to water. In future analyses water quality should be weighted differently to create a more accurate conservation value decision cube.

There were major setbacks for this project in terms of wildlife data. Not only was it the oldest data used, it was also only available in a format that had to be converted multiple times which ended up being very time consuming and caused only a small sampling of wildlife data to be used in the project. In order to create a far more accurate wildlife layer for the decision cube, a much larger number of predicted species distributions should be used.

As a result of these limitations, conservation decisions should not be made based solely on this analysis. Newer data should be used in future analyses and urther analysis including field work to catalogue species presence and the true state of the habitat (essentially ground truthing) absolutely must be done to confirm results any analysis using methods similar to this one.

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APPENDIX A

Definitions for National Land Cover Data 2006 Land Cover Types as Stated by the USGS

Open Water - All areas of open water, generally with less than 25% cover of vegetation or soil.

Developed, Open Space - Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes

Developed, Low Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20-49 percent of total cover. These areas most commonly include single-family housing units.

Developed, Medium Intensity - Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50-79 percent of the total cover. These areas most commonly include single-family housing units.

Developed, High Intensity - Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80 to100 percent of the total cover.

Barren Land (Rock/Sand/Clay) - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Deciduous Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species shed foliage simultaneously in response to seasonal change.

Evergreen Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.

Mixed Forest - Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75 percent of total tree cover.

Shrub/Scrub - Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

Grassland/Herbaceous - Areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

Pasture/Hay -

Woody Wetlands - Areas where forest or shrubland vegetation accounts for greater than 20 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.