**Conservation scenarios**

We simulated four protected area network development strategies derived from four conservation theories described in the literature and enacted by conservation and land management agencies globally (Murdoch et al. 2007, Burkey 1989, Hjort et al. 2015).

*General scenario setup*:

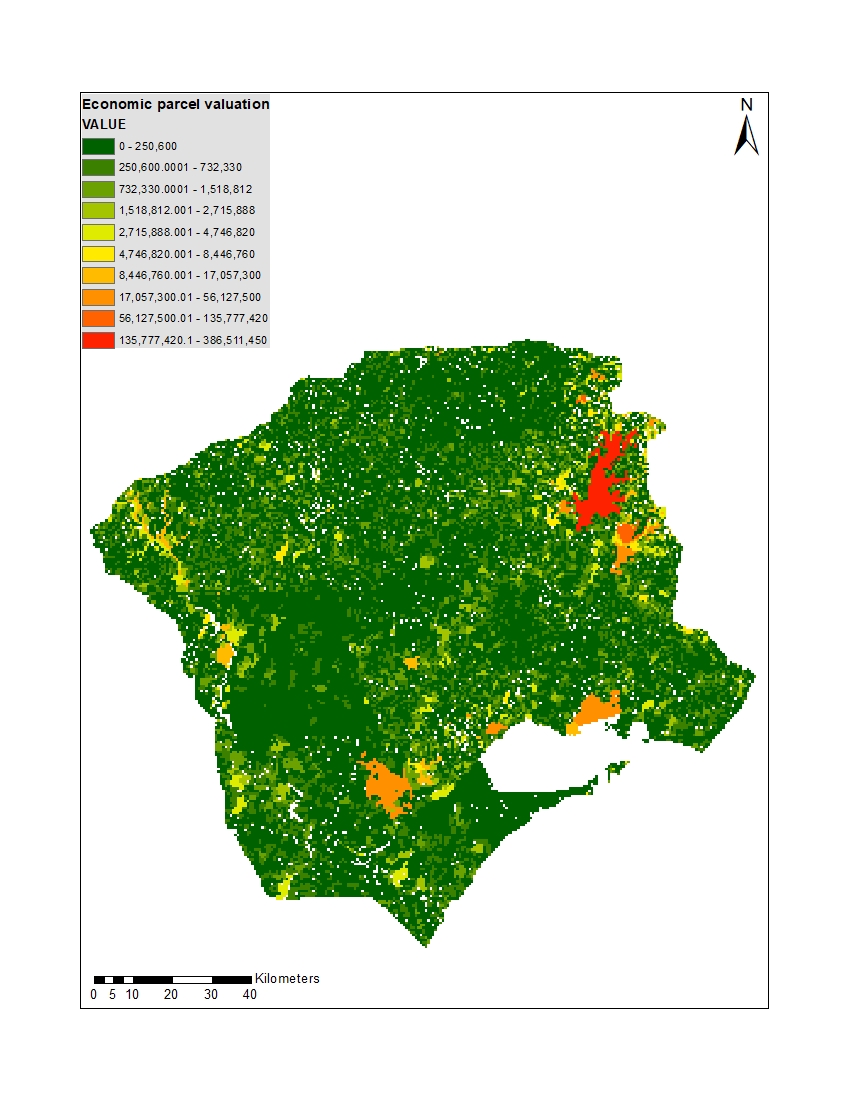
* Remove parcels characterized in NLCD 2016 as high, medium, or low density residential, or open water from consideration for acquisition/protection. Areas classified as open space residential were still available to be selected for protection. Open water stands were removed because these represented the stands that contained the greatest proportion of inactive cells. To remove these stands from analysis, I used zonal statistics in ArcGIS to assign NLCD values to stands (stands assigned whatever NLCD value represented that majority within them). I created a shapefile from the resulting zonal statistics raster then did a spatial join (by intersect) of my standmap shapefile and the zonal statistics shapefile. Finally, I removed stands with values 11, 22, 23, and 24 (open water, low density developed, medium density developed, and high density developed, respectively) and converted the attribute table to an excel spreadsheet to create my stands for analysis list.
* Remove stands whose center falls within an already managed and protected area (data from NC’s onemap titled managed areas, includes state and federal lands)
* Conducted a sensitivity analysis for random strategy vs. geodiversity to assess at which land acquisition percentage does a difference in connectivity occur.
* Because geographic transformation was required for many of the largescale datasets (NLCD, TNC Geodiv, etc.) shape area was recalculated for each to ensure no errors occurred from transformation.

*Economic*

One conservation strategy we assessed sought to maximize conservation return on investment (Polasky et al. 2008). This strategy emphasizes that economic costs should be balanced with intended biodiversity benefits when evaluating conservation action (hereafter, referred to as the economic strategy) (Robillard and Kerr 2017). For this protected area strategy, we focused on the acquisition of lower cost parcels of land allowing us to conserve 25% more land at each time step. We simplified the conservation return on investment framework, which usually incorporates metrics of biodiversity and/or habitat quality in addition to economic data when assessing where to invest for the greatest return. Rather, we considered the ability to acquire additional land for conservation to represent increased conservation return on investment. For the economic strategy, we used parcel valuation data from the NC OneMap geoportal to calculate cost per acre across the study extent and used zonal statistics in ArcMap 10.6 to assign an average cost per acre to individual forest stands (NC OneMap 2019, ESRI 2018). Hoke County was excluded from this analysis because it did not have parcel value data assigned, and any stands with a zero total dollar value were removed from consideration for acquisition. We then did a weighted random sort with stands of the lowest cost per acre having the highest probability of being selected. At each time step, stands were selected for acquisition and restoration based on this sort until approximately 1.25% of the total landscape amount was reached at each time step. Sorted stands are listed in the Econ\_parcels\_prob\_ord\_100.csv file in this folder.

Detailed methods:

* Economic strategy gets 25% more land
* Found economic value of each stand by averaging economic value per acre of each parcel found in that stand using zonal statistics
  + First had to rasterize shapefile of merged county polygons
  + Zonal statistics of landval field to stand100 shapefile
  + Output was floating point not integer so followed the steps described in geodiversity strat below
  + Converted raster to shapefile
  + Spatial join of econ shapefile and stand shapefile.
  + Removed any parcels with zero values, mostly in Hoke County (Ft. Bragg)
* Probability assigned sequentially from 0.9 to 0.0001 by -0.0002, remaining stands assigned 0.0001
* Random weighted sort to select stands for conservation/restoration

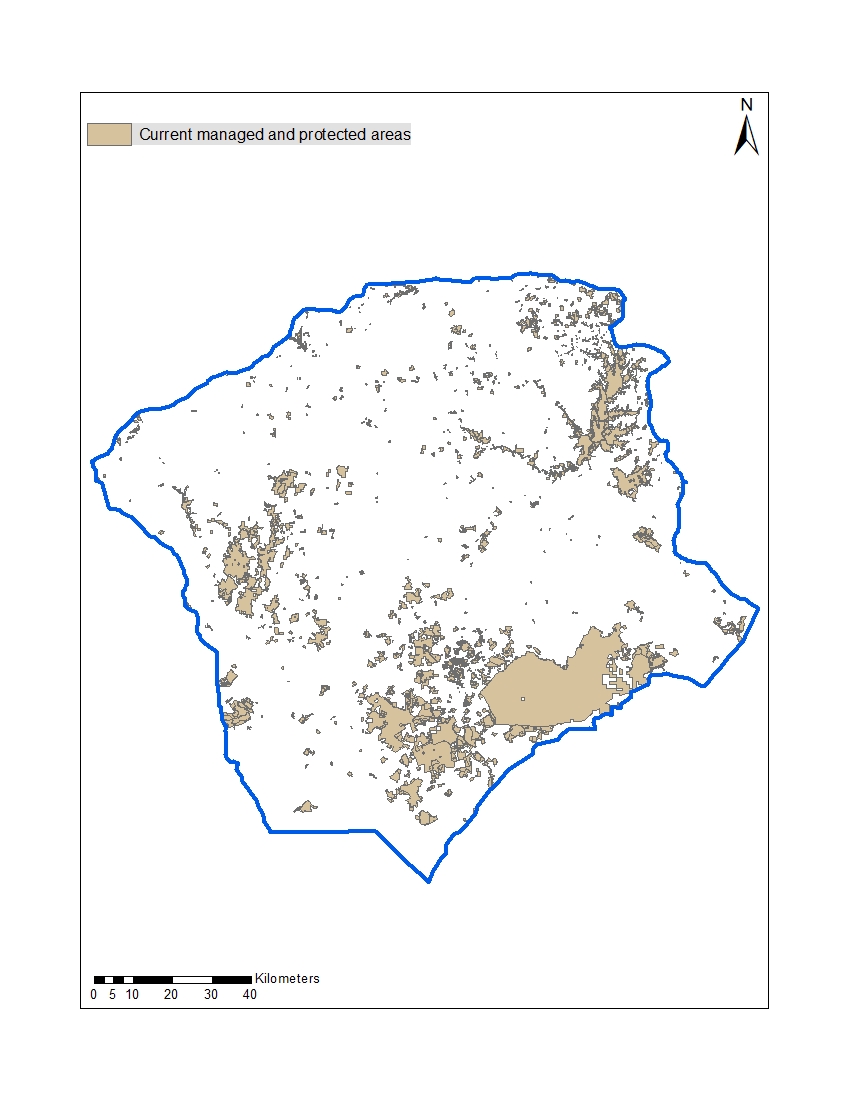


*Cluster*

Another conservation strategy we evaluated was clustering protected area development around already established conservation cores (hereafter, the cluster strategy), essentially creating larger core areas of protected habitat. This strategy reflects the SLOSS (single large or several small) debate in the reserve design literature, but has also been suggested as a more effective way to combat anthropogenic change than small, scattered protected areas (Diamond 1975, Maiorano et al. 2008). We created buffers at 100, 500, 1000, 2500 meters around already protected areas on our landscape identified in the US Geological Survey’s Protected Areas database (USGS 2018). Forest stands whose centers fell within the 100m buffer had the highest priority of being selected for conservation under this strategy, followed by stands that had centers within the 500m buffer, stands with centers in the 1000m buffer, and finally, stands with centers in the 2500m buffer. Stands that fell outside of these three buffers had the lowest probability of selection. We then conducted a weighted random sort and at each time step, stands were selected for acquisition and restoration until approximately 1% of the total landscape amount was protected at each time step. Sorted stands are listed in the stands\_cluster100.csv file in this folder.

Detailed methods:

* Buffers at 100m, 500m, 1000m, and 2500m
* Select layer by location tool, center of stand within buffer
* Stands with center in 100m buffer given greatest probability of selection, followed by 500m, 1000m, and 2500m; all others the same lowest probability
  + Stands with center in 100m buffer 🡪 0.9
  + Stands with center in 500m buffer 🡪 0.7
  + Stands with center in 1000m buffer 🡪 0.5
  + Stands with center in 2500m buffer 🡪 0.3
  + All other stands 🡪 0.1

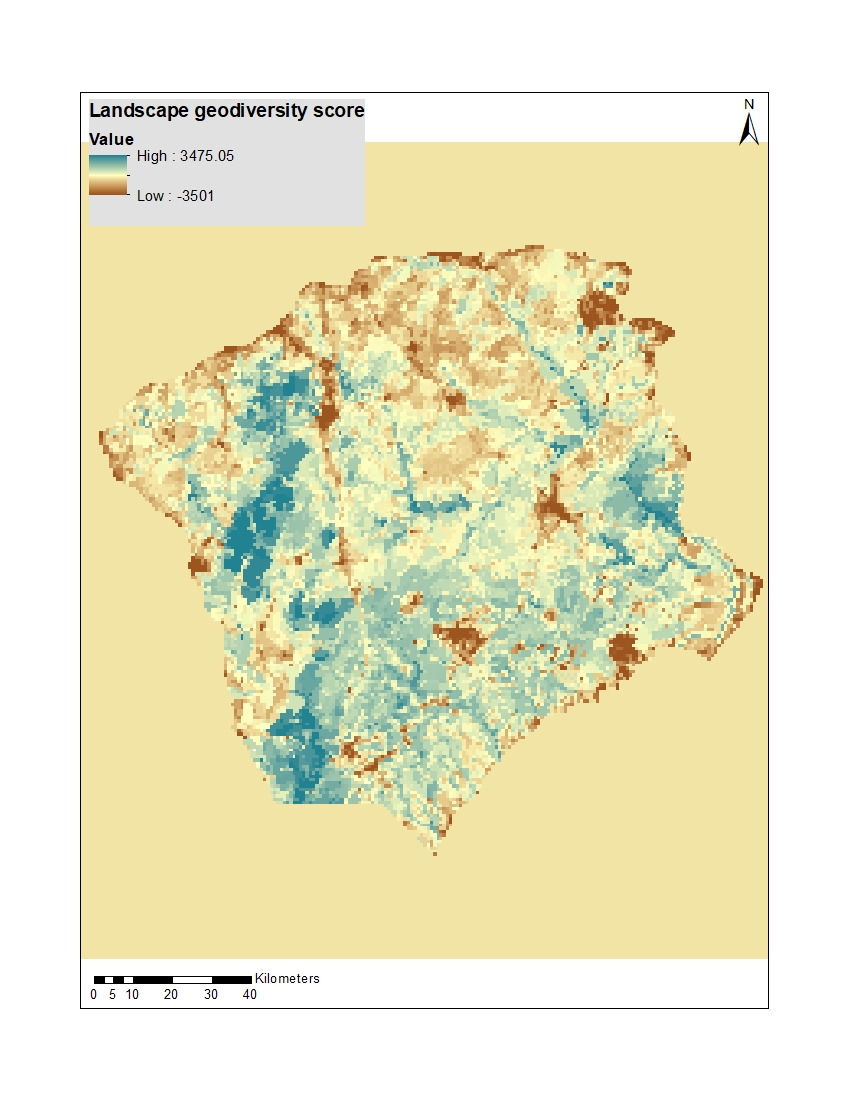


*Geodiversity*

The third conservation strategy we evaluated was conserving land with the highest geodiversity characteristics, a proxy for the ‘conserving nature’s stage’ theory (Lawler et al. 2015) (hereafter, geodiversity). The term geodiversity encompasses the natural range of variation in geological, geomorphological, and soil characteristics on a landscape (Gray 2008). High geodiversity in a landscape often means more environmental niches, resulting in higher levels of overall biodiversity (Comer et al. 2015). Prioritizing geodiversity in conservation has also been suggested as a strategy resilient to climate change, as sites with high geodiversity have greater capacity to maintain species diversity and ecological function as the climate changes (Anderson et al. 2015). For the geodiversity strategy, we used geodiversity data from the Nature Conservancy’s resilient and protected landscapes map and used zonal statistics in ArcMap 10.6 to assign an average geodiversity score to each stand (TNC 2016, ESRI 2018). We then performed a weighted random sort with forest stands scoring the highest in geodiversity having the highest probability of being selected. At each time step, stands were selected for acquisition and restoration based on this sort until approximately one percent of the total landscape amount was reached at each time step. Sorted stands are listed in the stands\_geo100.csv file in this folder.

Detailed methods:

* Zonal statistics for geodiversity characteristics
* When you do zonal statistics, output is floating point not integer class. Need integer so follow the steps from this thread (<https://support.esri.com/en/technical-article/000012554>).
  + Navigate to ArcToolbox > Spatial Analyst Tools > Math > Int.
  + Drag and drop the raster created in Step 1 as the input raster.
  + Specify the name and location for the output raster.
  + Click OK.
  + Convert raster to polygon.
* Random weighted sort to select stands for conservation/restoration
* Score/probability
  + g >3000 🡪 0.95
  + 2500 < g <= 3000 🡪 0.925
  + 2000 < g <= 2500 🡪 0.9
  + 1500 < g <= 2000 🡪 0.85
  + 1000 < g <= 1500 🡪 0.825
  + 500 < g <= 1000 🡪 0.775
  + 0 < g <= 500 🡪 0.65
  + -500 < g <= 0 🡪 0.6
  + -1000 < g <= -500 🡪 0.3
  + -1500 < g <= -1000 🡪 0.1
  + -2000 < g <= -1500 🡪 0.05
  + g < -2000 🡪 0.001



*Opportunistic*

The final conservation strategy we simulated was the opportunistic acquisition and restoration of land (hereafter, opportunistic). To do this, forest stands were randomly selected, representing the ad hoc nature of land acquisition that can sometimes occur when a parcel becomes unexpectedly available for conservation acquisition (e.g. when land is donated or voluntarily protected by easement). These stands were acquired and restored at the same rate, one percent per time step, and underwent the same restoration actions in the same proportions as the above conservation strategies. This strategy also served as a null model to compare the other conservation strategies against. Sorted stands are listed in the random\_stands\_base.csv file in this folder.

Detailed methods:

* Random selection of stands (without replacement!) until the hectare target is met at each time step

Citations

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