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Biological Reserve System Site Suitability Analysis Conducted by Jeanette Shutay

Biodiversity is important for healthy ecosystems and ecosystem services (Barnosky et al, 2011; Mannion, Upchurch, Benson, & Goswami, 2014). However, biodiversity is significantly threatened by human activities and development resulting in species decline and extinction (O'Bryan et al, 2017; Roberts, O'Leary, & Hawkins, 2020). In response to this loss of biodiversity, The Endangered Species Act of 1973 was implemented to help protect species from extinction. The purpose of this site suitability analysis is to identify optimal sites for a biological reserve system to help protect biodiversity.

As with any site suitability analysis, there are criteria that need to be meet when selecting the optimal site. For this use case, the biological reserve system site requirements were as follows (King, Walrath, & Zeiders, 1999-2020):

- Includes more than 70 bird and mammalian species combined
- Less than 10% of each study area containing buffered roads, highways, and interstates
- Must be designated as having high habitat potential
- Must be publicly owned land
- Must be forested areas
- Slopes less than 10%

Data Preparation and Analysis

Multiple data sources were leveraged for this analysis. The coordinate system used for this analysis was the NAD 1983 StatePlane Pennsylvania North FIPS 3701 (Meters). As part of the data preparation phase, datasets were combined, and new fields and features were created. The first field created was a species richness field where the number of birds and mammals were summed to obtain the total species richness within a location. Figure 1 shows the result of selecting records that meet the criterion of more than 70 birds and mammals combined, which resulted in a total of 48 rows and a newly created layer. A screenshot of the attribute table is provided in the Appendix.

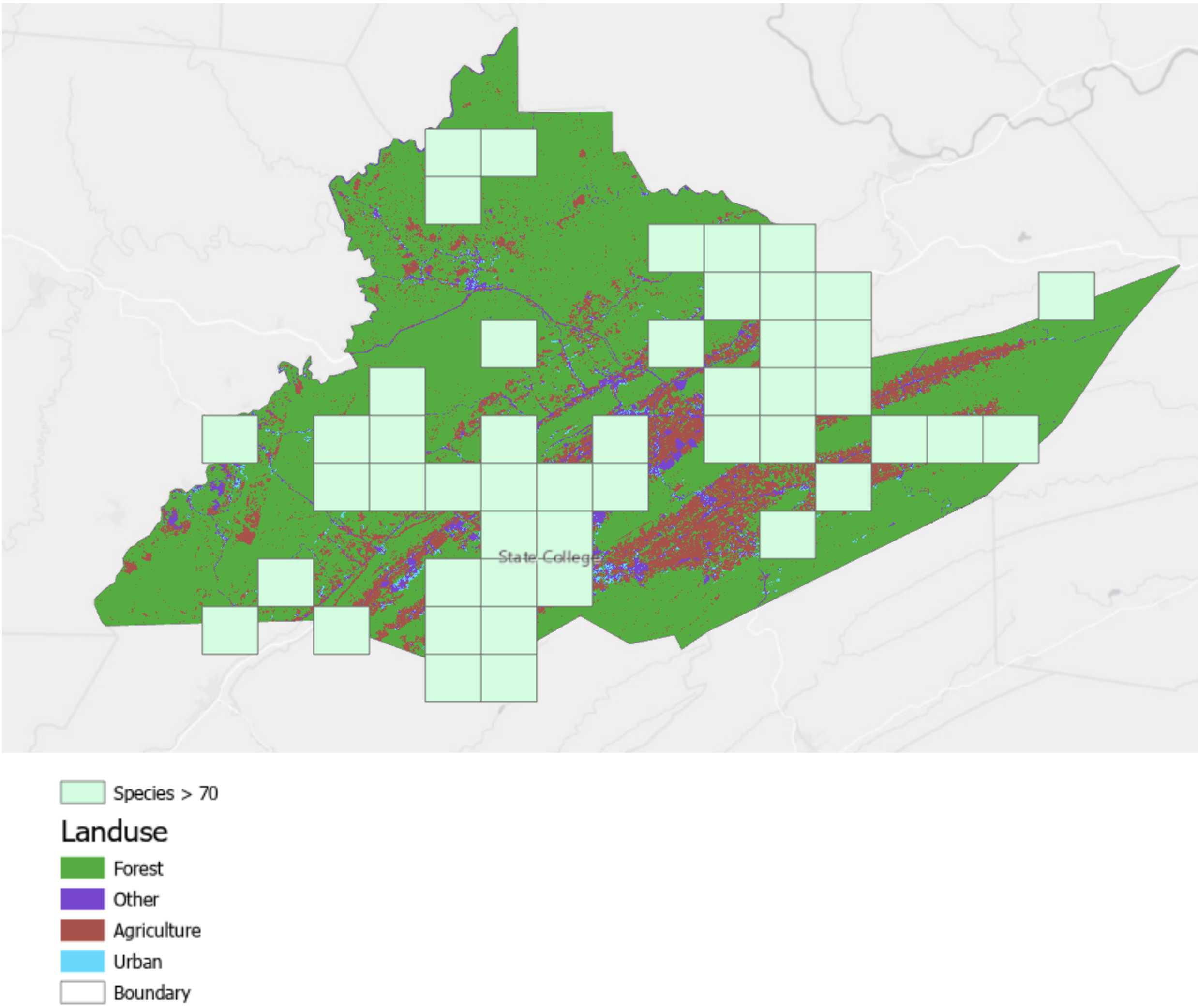

Figure 1. *Map of locations with species richness greater than 70.*

The next step of the analysis was to create a road buffer layer without dissolving the buffer barriers (King, Walrath, & Zeiders, 1999-2020). An intersection was performed to find all roads that intersect the species rich areas so that extraneous roads could be eliminated. From that intersection, a new layer was created. A field was created for the buffer distance and the buffers were created based on the *rd_type* attribute, whereby road buffers were set to 20 meters, highways to 50 meters, and interstates to 100 meters. From this result, a new layer was created (refer to Figure 2) and the buffered road are added to the map.

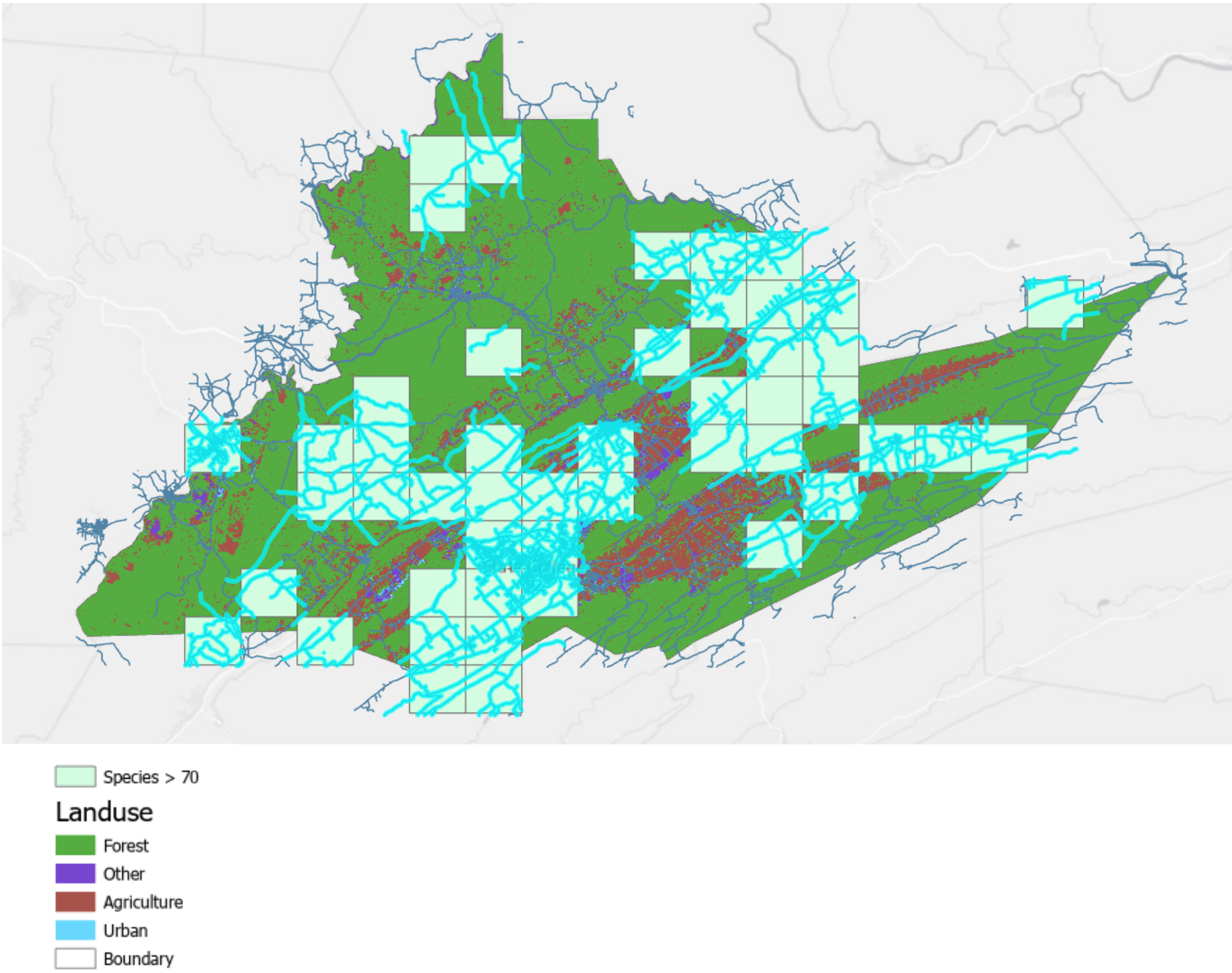

Figure 2. *Map of roads intersecting the species rich areas with buffer distances.*

The next step was to perform a union including the buffered roads layer and the species rich layer, perform a query to find the non-road portions of the study areas, and create a new layer based on the selection of those non-road portions (buffer distance = 0). Next, three new fields were added, and calculations were made to obtain (1) total new area, (2) road area, and (3) percent road area. The percent road area field was used to identify the study areas that have less than 10% of their area covered by roads (n = 40), which is shown in Figure 3. The attribute table is provided in the Appendix.

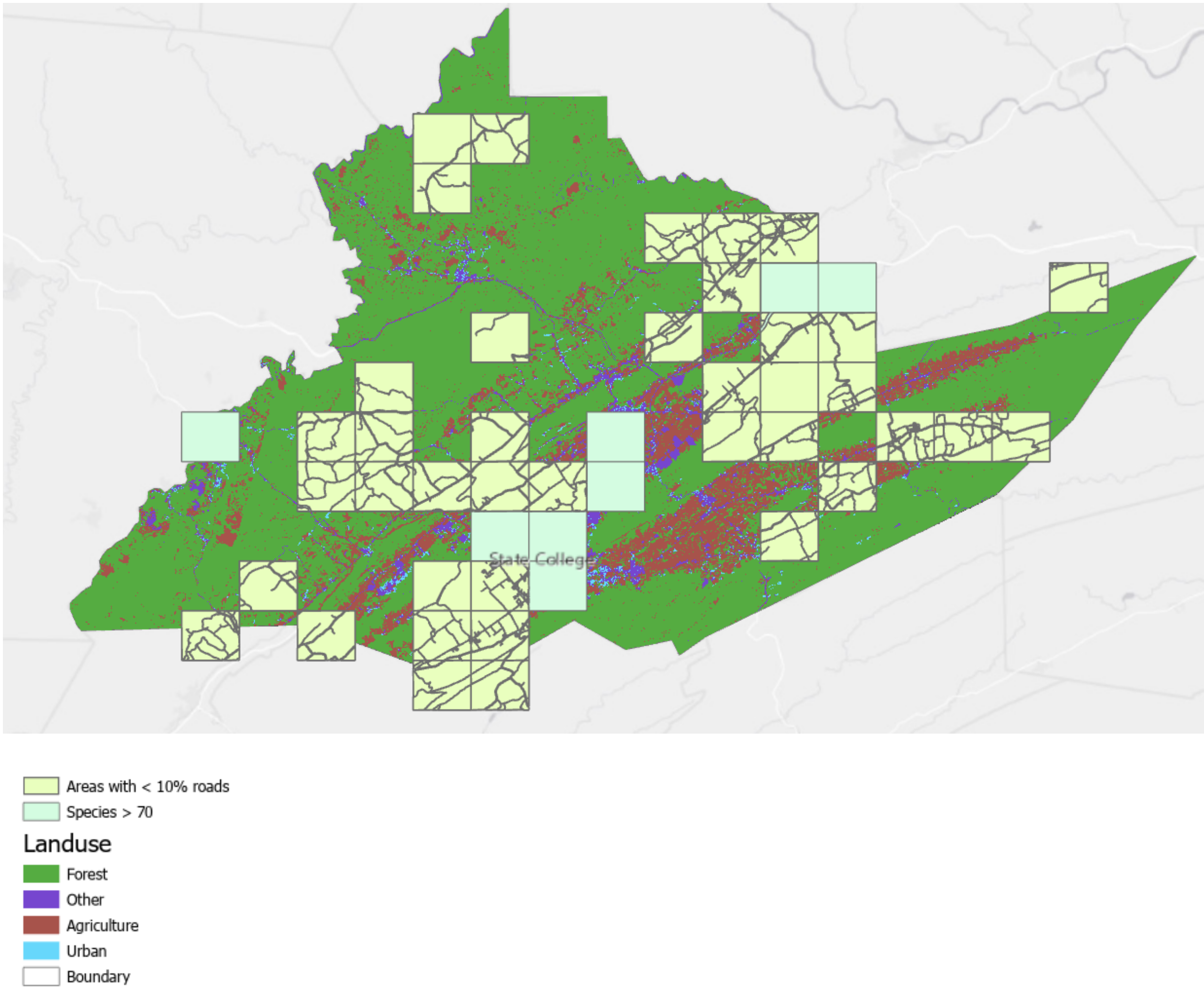

Figure 3. *Map of areas with less than 10% of area covered by roads.*

The following tasks consisted of identifying the study areas that met the site requirements in terms of having less than 10% covered by roads, habitat high potential, public ownership, forest landuse, and elevations with slopes less than 10%. Raster grids were created using a cell size of 220 for each of the data sources, a slope was created from the elevation grid, and reclassifications were conducted to prepare for the final map calculator step of the analysis (King, Walrath, & Zeiders, 1999-2020). The reclassified flag (binary) fields equaling 1 or 0 (values of 1 represented cases that met the criterion) were multiplied to combine all of the pertinent grids from the prior steps. The final results include the identification of suitable sites.

Results and Conclusions

The purpose of this project was to identify suitable sites for a biological reserve system. The final results for the analysis yielded 2,440 study areas that were identified as suitable for the biological reserve system (refer to Figure 4). The factors that were considered included species richness (greater than 70), areas with less than 10% covered by roads, habitats with high potential, land that is publicly owned, forest landuse, and elevations with slopes less than 10%.

While this analysis took several salient factors into consideration, one factor that needs to be considered is the role of climate change and how climate change may impact the areas selected as well as their ecosystems. Many species will need to either adapt to these climate changes or they will cease to exist (Catullo, Llewelyn, Phillips, & Moritz, 2019; Schoener, 2011). For example, Meester, Stoks, & Brans (2018) highlight the fact that climate change has profound impacts on ecosystems and their biota, which lead to species having novel interactions, changes to their food webs, ranges, and host-parasite dynamics, and extinctions. Therefore, the results of this site suitability analysis need to be complemented by the assessment of an environmental conservation expert. A conservation expert may want to consider soil and hydrology layers, as well as tree health, to determine if there are areas that are likely to experience a disproportionate impact of climate change.

Biological Reserve System Site Suitability Analysis

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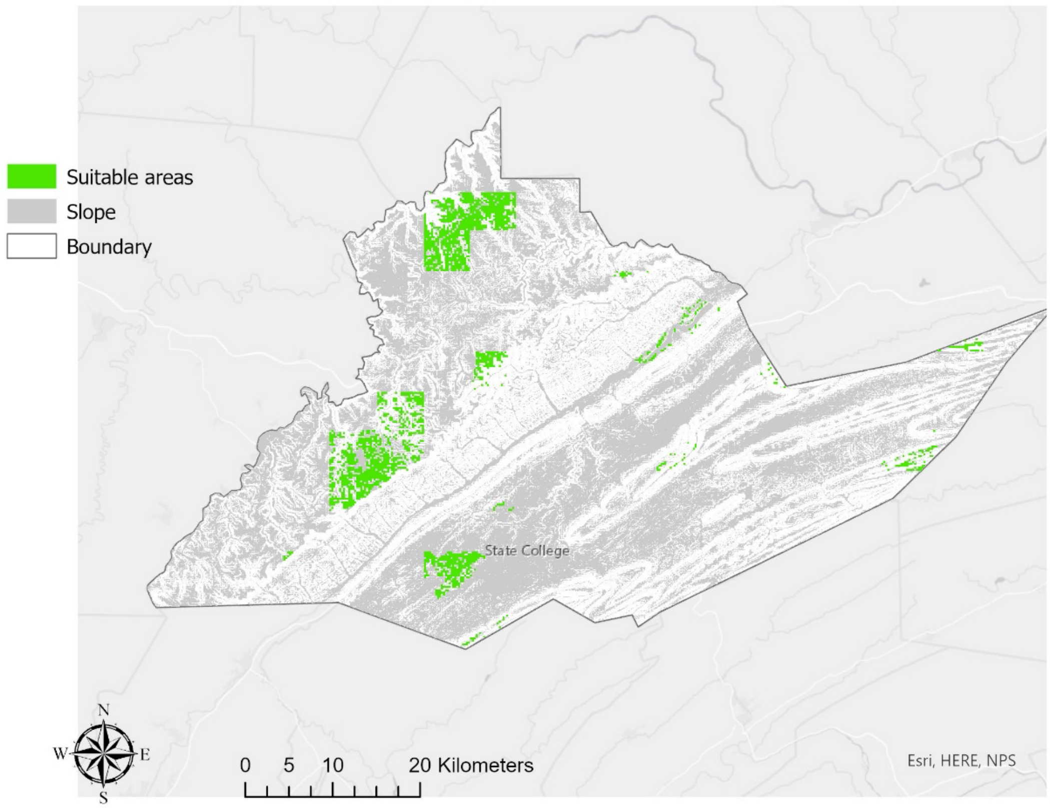

Biodiversity is important for healthy ecosystems and ecosystem services. However, biodiversity is significantly threatened by human activities resulting in species decline and extinction. The purpose of this site suitability analysis was to identify optimal sites for a biological reserve system to help protect biodiversity. A total of 2440 sites were identified that met all of the site requirements.

Suitable Areas

Field: Add Calculate **Selection:**

OBJECTID *	Value	Count
1	0	2896
2	1	2440

Figure 4. *Site suitability analysis for biological reserve system final area selections.*

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Appendix

Species70Plus

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

OBJECTID *	Shape *	BLOCK_ID	Area	OID	BLOCK_ID	BIRDS	MAMMALS	Total Species	Shape_Length	Shape_Area	OBJECTID	FNODE_	TNOI
1	Polygon	40077683	24387146	<Null>	40077683	52	24	76	19812.039541	24387145.338164	1	227	
2	Polygon	40077684	24387146	<Null>	40077684	75	35	110	19812.039741	24387145.795339	2	221	
3	Polygon	40078621	24387146	<Null>	40078621	60	28	88	19812.039341	24387144.880955	3	128	
4	Polygon	40078611	24387146	<Null>	40078611	69	32	101	19812.039541	24387145.33813	4	129	
5	Polygon	40077681	24387146	<Null>	40077681	68	31	99	19812.039541	24387145.338164	5	107	
6	Polygon	40077682	24387146	<Null>	40077682	63	29	92	19812.039741	24387145.795339	6	107	
7	Polygon	40078726	24387146	<Null>	40078726	58	27	85	19812.039941	24387146.328763	7	321	
8	Polygon	40077785	24387146	<Null>	40077785	66	31	97	19812.039741	24387145.871554	8	107	
9	Polygon	40077786	24387146	<Null>	40077786	67	31	98	19812.039941	24387146.328729	9	102	
10	Polygon	40077775	24387146	<Null>	40077775	56	26	82	19812.039541	24387145.414346	10	162	
11	Polygon	40077784	24387146	<Null>	40077784	56	26	82	19812.039741	24387145.795319	11	162	
12	Polygon	40077773	24387146	<Null>	40077773	65	30	95	19812.039341	24387144.880936	12	99	
13	Polygon	40077753	24387146	<Null>	40077753	57	26	83	19812.039541	24387145.338144	13	176	
14	Polygon	40078711	24387146	<Null>	40078711	52	24	76	19812.039541	24387145.33813	14	90	
15	Polygon	40078712	24387146	<Null>	40078712	50	23	73	19812.039541	24387145.338164	15	162	
16	Polygon	40077781	24387146	<Null>	40077781	62	29	91	19812.039541	24387145.338164	16	110	
17	Polygon	40077782	24387146	<Null>	40077782	78	36	114	19812.039741	24387145.795339	17	175	
18	Polygon	40077771	24387146	<Null>	40077771	64	30	94	19812.039341	24387144.880955	18	162	
19	Polygon	40077772	24387146	<Null>	40077772	65	30	95	19812.039741	24387145.795373	19	110	
20	Polygon	40077752	24387146	<Null>	40077752	52	24	76	19812.039741	24387145.795339	20	66	

0 of 48 selected Filters: 100%

Figure 5. *Locations with species richness greater than 70.*

FinalSpeciesRoads

Field: Add Calculate Selection: Select By Attributes Zoom To Switch Clear Delete Copy

OBJECTID *	Shape *	FID_BufferedRoads	FID_roads	FNODE_	TNODE_	length	IGDS_LAYER	rd_type	flag	FID_SpeciesGreater70	BLOCK_ID	Area	OID
1	Polygon	-1	0	0	0	0			0	0		0	0
2	Polygon	-1	0	0	0	0			0	0		0	0
3	Polygon	-1	0	0	0	0			0	0		0	0
4	Polygon	-1	0	0	0	0			0	0		0	0
5	Polygon	-1	0	0	0	0			0	0		0	0
6	Polygon	-1	0	0	0	0			0	0		0	0
7	Polygon	-1	0	0	0	0			0	0		0	0
8	Polygon	-1	0	0	0	0			0	0		0	0
9	Polygon	-1	0	0	0	0			0	0		0	0
10	Polygon	-1	0	0	0	0			0	0		0	0
11	Polygon	-1	0	0	0	0			0	0		0	0
12	Polygon	-1	0	0	0	0			0	0		0	0
13	Polygon	-1	0	0	0	0			0	0		0	0
14	Polygon	-1	0	0	0	0			0	0		0	0
15	Polygon	-1	0	0	0	0			0	0		0	0
16	Polygon	-1	0	0	0	0			0	0		0	0
17	Polygon	-1	0	0	0	0			0	0		0	0
18	Polygon	-1	0	0	0	0			0	0		0	0
19	Polygon	-1	0	0	0	0			0	0		0	0
20	Polygon	-1	0	0	0	0			0	0		0	0

0 of 40 selected Filters: 100%

Figure 6. *Locations with species richness greater than 70 and buffer distance equal to 0.*