Old Lyme Land Trust Conservation Prioritization Using GIS Overlay Analysis

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Introduction

The Old Lyme Land Trust (OLLT) is a non-profit organization dedicated to conserving land and water resources for the public of Old Lyme, a coastal town in Southeastern Connecticut (Map 1-2). Local land trusts like the OLLT are vital to natural resource conservation and education in the lower Connecticut River region. This area was identified by the Nature Conservancy as a focal area in their “Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region” report (Burns, 2018).

The OLLT currently protects 70 properties covering roughly 1,100 of 16,000 acres of land in the town and is continuously seeking new acquisitions (Old Lyme Land Trust, n.d.). Currently, these efforts are primarily placed on parcels that are adjacent to existing preserves or town open space, with a goal of linking these properties to create town-wide trail systems and wildlife corridors. However, there is not a comprehensive understanding of the spatial distribution of important natural resources.

This project aims to address this lack of insight into areas and parcels in Old Lyme with a high concentration of natural resources and thus an increased priority for conservation efforts. Taking into consideration both key natural resources criteria and OLLT Board Member concerns, the results will provide a basis for acquisition targets and support for grant applications. These criteria will be weighted and combined using a GIS overlay analysis. In all, the project will answer two principal questions: (1) what is the distribution of key natural resources in town, and (2) which parcels contain high values of natural resources and other conservation criteria?

Methods

The overlay analysis follows the standard methodology outline by Esri that can be applied in suitability modeling and optimal site selection (Esri, n.d.). These key steps include defining the problem, breaking into-sub models, determining significant layers, reclassifying these layers to be comparable, weighting based on specific project goals, then finally combining the inputs, and analyzing the results (ibid.).

Table 1 summarizes the sub-models, data layers, initial data types, and weights used for this analysis. Using this approach, each parcel will receive a value between 0 and 12 representing prioritization level for conservation and targeting by the land trust. The sub-models were devised by referencing the Lower CT River and Coastal Region Land Trust Exchange's (LTE) Natural Resource Based Strategic Conservation Plan, which is a similar regional model focusing on large-scale corridor connectivity, and supported by direct feedback from OLLT Board Members.

The analysis was conducted using QGIS 3.16.3, a free and open-source GIS desktop application. Numerous geoprocessing tasks were necessary to complete the overlay analysis. First, all input layers were clipped to the spatial extent of the project, the town boundary, and reprojected to EPSG projection 2234: NAD83 / Connecticut (ft. US). The "Natural Diversity Database Area" layer was not altered, but was rasterized so that diversity areas had a value of 1 and all other areas had a value of 0. The "Critical Habitat" layer was buffered by 300', which was chosen as a generally accepted minimum width for maintaining wildlife corridors and used in further steps of the analysis (Burns, 2018), then rasterized in the same manner.

The "Large Natural Areas" (LNA) layer was created using the Semi-Automatic Classification (SCP) Plugin to reclassify the land cover categories into values of 1 and 0.

Developed land features (developed, turf & grass, agriculture, barren land) and water features were assigned to 0. Similarly, the SCP plugin was used to create the “Early Successional Habitat” layer by reclassifying land cover to a value of 1 for the “Other Grasses” and “Utility Corridors” classes. Lastly, the “Core Forest Areas” layer was created by reclassifying the forest fragmentation land cover data to include values of 1 for core forest land cover.

The “Surface Hydrology” layer was created by buffering the hydrography line and polygon shapefiles by 300’. This buffered hydrography set was merged along with the inland wetland soils shapefile, then the polygons were dissolved. After rasterizing this layer, an intermediate developed land cover layer was subtracted from the hydrology layer to create a final intact hydrology raster. The six binary input raster layers are displayed in Figures 1-6. The raster calculator expression in Figure 7 was used to combine the weighted criteria into a single raster.

Next, the weighted natural resource raster was tied to the town parcels using the zonal statistics tool, which generated a mean natural resource value for each parcel. To incorporate the parcel-specific criteria, the field calculator was used to create an area ratio value column using the formula in Figure 8. Next, a csv file of parcels owned by the Old Lyme Land Trust, Town of Old Lyme, State of Connecticut, and the Nature Conservancy was joined to the parcel layer to identify these properties as non-targets. The select by location tool was used to identify properties adjacent to OLLT parcels, which were given a value of 1 in another column in the zonal statistics layer. These additional parcel criteria are visualized in Figures 9-10. Finally, the field calculator was used to sum the natural resources mean, proximity value, and size values to give final parcel values.

Since the results are heavily skewed by weights that are user-determined, it was important to allow for simple replication of this process and testing for different criteria weight. Thus, a model was created to automate the process of combining the weighted inputs and producing a zonal statistics layer. The graphical depiction of the model is shown in Figure 11. The model is used by inputting the raster layers representing the six key natural resource criteria and the parcel mask layer that will be used to generate zonal statistics.

Results

The raster layer representing the weighted matrix of natural resource criteria is seen in Map 3. The largest concentration of natural resources is in coastal and riparian zones of the Connecticut River, as well as marshy wetlands surrounding the Lieutenant and Black Hall rivers. The large forest areas in the central and North-East parts of the town also have high values. Map 4 shows the results of the parcel prioritization. Parcels in the areas listed above are of the highest conservation importance. However, some larger parcels and those close to existing Land Trust property have received a boosted focus. Notably, the large properties adjacent to the Upper Three Mile River preserve are identified as important targets. These properties are known priorities for the OLLT to complete the linkage of preserve property in that area.

Table 2 lists the highest valued parcels for conservation. All these properties are in coastal or riparian zones, with the highest concentration at the inlet of the Lieutenant River. It is quite notable that 75% of the top 20 properties are already owned and protected by the Town of Old Lyme, State of Connecticut, Old Lyme Land Trust, or Nature Conservancy, with an impressive 30% protected by the OLLT.

Discussion

Overall, the results of the project were predominantly as expected. The Connecticut River and coastal areas of the town are important ecological areas, as evidenced by the existing ownership by the land trust, town, state, and Nature Conservancy. Great Island and most other notable coastal features are already preserved, along with many wetland areas. The analysis effectively portrays the spatial distribution of natural resources and identifies parcels with high conservation value that largely align with the OLLT's existing acquisition goals.

In the future, the analysis could be expanded to include more detailed considerations from OLLT Board Members that were not completed within the timeline of this project. These include geological features, historical sites, and linkage of preserves. In addition, other details such as monetary value or ownership demographics could be incorporated. The existing criteria could be weighted differently upon further feedback from OLLT Board Members.

Conclusion

The objective of this project was to visualize the distribution of key natural resources and identify parcels with high conservation value in Old Lyme, CT. Using a GIS overlay analysis, this project supplements the Old Lyme Land Trust's acquisition strategy and could potentially support future grant applications. The spatial distribution of natural resources was found to be concentrated in the coastal and riparian zones, which have historically been conservation and preservation priorities. In addition, large parcels surrounding existing land trust property were identified as key targets. The results will be disseminated to the OLLT Board Members and improved based on criticism and suggested additions.

References

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Appendix A – Tables

Table 1: Summary of Criteria for Overlay Analysis

Category	Criteria Description	Data Source	Initial Data Type	Weight
Natural Resource	Core Forest Area	UCONN CLEAR	Raster	2
	Large Natural Area	UCONN CLEAR	Raster	1
	Early Successional Habitat Area	UCONN CLEAR	Raster	1
	Surface Hydrology	CT DEEP GIS	Vector	2
	Critical Habitats	CT DEEP GIS	Vector	2
	Natural Diversity Database Area	CT DEEP GIS	Vector	1
Parcel	Proximity to Existing Preserves	Old Lyme Tax Assessor	Vector	1
	Parcel size	Old Lyme Tax Assessor	Vector	1; 0.5
	Ownership Information	Old Lyme Tax Assessor	Vector	1

Table 2: Highest Valued Properties

Parcel ID	Area (square feet)	Owned by CT/OL/OLLT/NC	OLLT	Natural Resource Value	Adjacent Property Value	Area Ratio Value	**Parcel Value**
11 - 13	19,693	1		8.00	1	1	**10.00**
11 - 12	36,624	1		7.99	1	1	**9.99**
21 - 95	13,838	1	1	7.99	1	1	**9.99**
11 - 11	20,215	1		7.97	1	1	**9.97**
26 – 2	194,831			7.97	1	1	**9.97**
21 – 94	32,335	1	1	7.96	1	1	**9.96**
11 – OTHER	45,380			7.89	1	1	**9.89**
21 – 109	22,428			7.87	1	1	**9.87**
16 – 2	41,605	1	1	7.58	1	1	**9.58**
27 - 64	9,870	1	1	7.99	1	0.5	**9.49**
21 - 97	26,696	1	1	7.34	1	1	**9.34**
7 - 5	132,372	1		7.05	1	1	**9.05**
7 – 7	34,799	1		8.02	0	1	**9.02**
21 - 108	7,920			7.50	1	0.5	**9.00**
1 - 5	23,898	1		8.00	0	1	**9.00**
11 - 3	28,249			7.99	0	1	**8.99**
11 - 2	38,835	1		7.99	0	1	**8.99**
11 - 4	24,964	1		7.98	0	1	**8.98**
26 - 1	182,616	1	1	7.98	0	1	**8.98**
2 - 36	62,743	1		7.97	0	1	**8.97**

Appendix B – Figures

Figures 1-6 – Binary Input Rasters

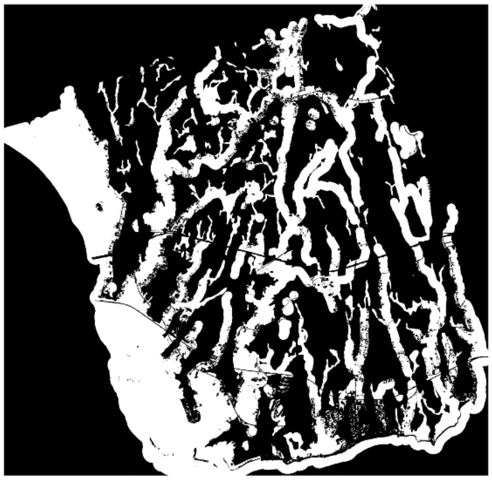


Figure 1. Surface Hydrology

Figure 2. Natural Diversity Database Areas

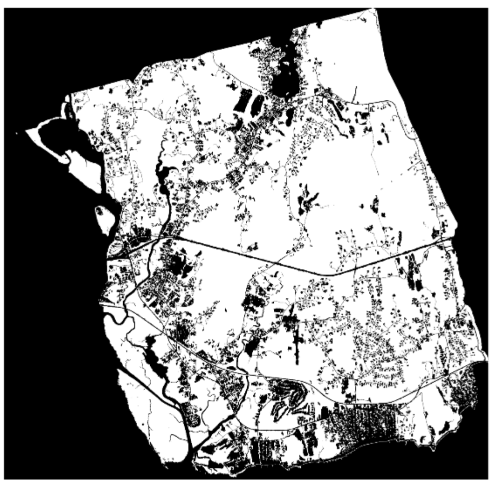


Figure 3. Large Natural Areas

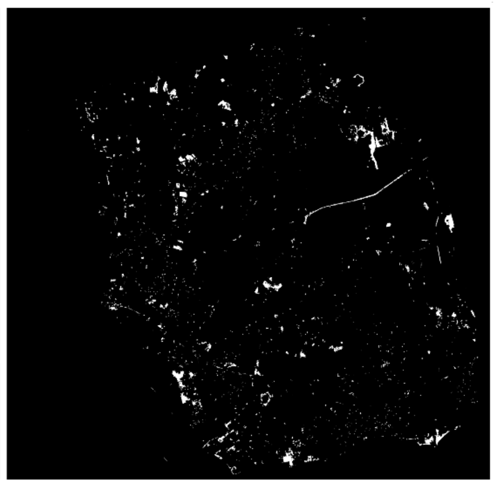


Figure 4. Early Successional Habitats

Figure 5. Critical Habitats

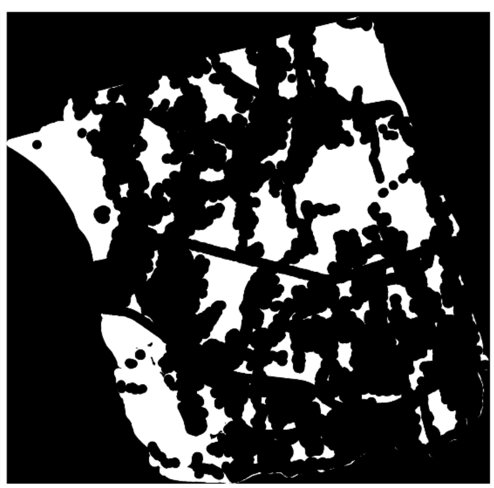


Figure 6. Core Forest Areas

Figure 7 – Raster Calculator Expression

*2 * “Core Forest@1” +*
*1 * “Large Natural Areas@1” +*
*1 * “Early Successional Habitats@1” +*
*2 * “Surface Hydrology@1” +*
*2 * “Critical Habitats@1” +*
*1 * “Natural Diversity Database Areas@1”*

Figure 8 – Area Ratio Field Calculator Expression

```
CASE
    WHEN "Area" < 2669 THEN 0        # Median Parcel Size
    WHEN "Area" < 10233 THEN 0.5     # Mean Parcel Size
    ELSE 1
END
```

Figures 9-10 – Parcel Criteria

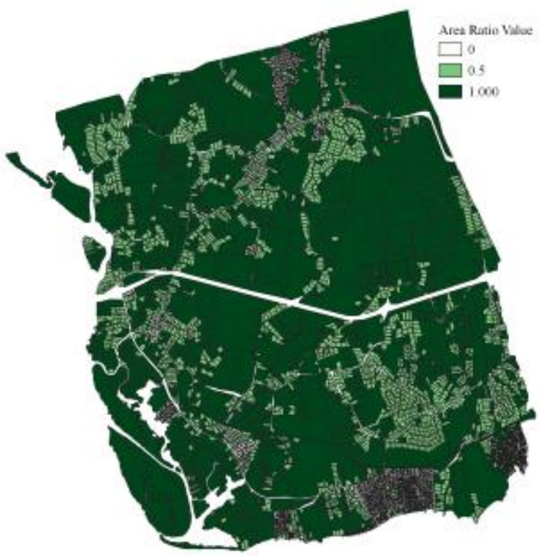


Figure 9. Area Ratio Value

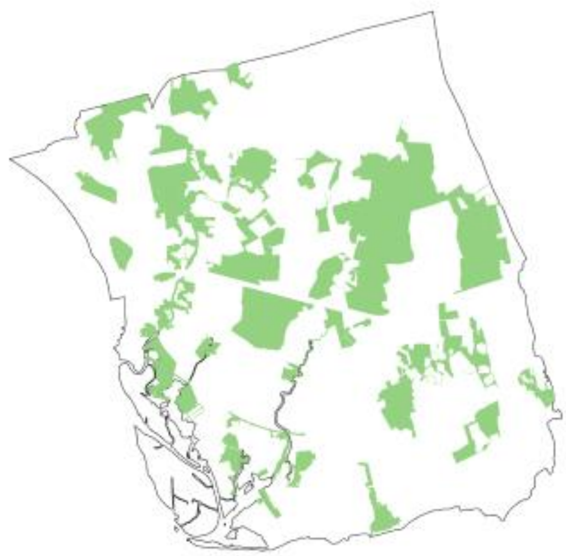
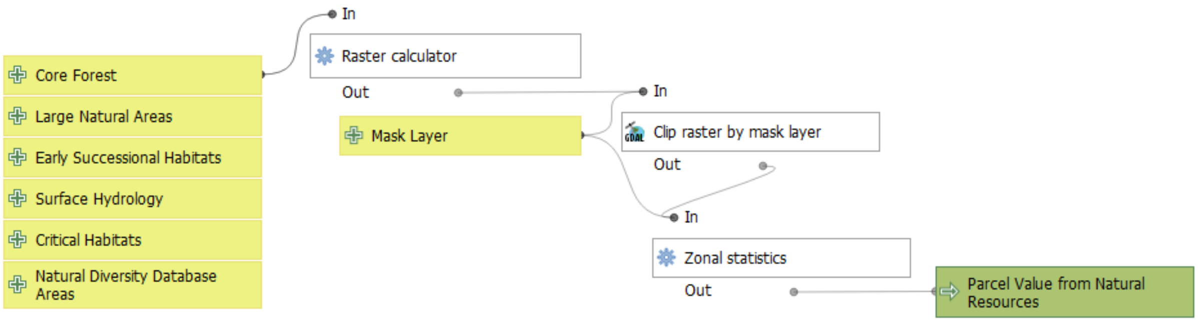


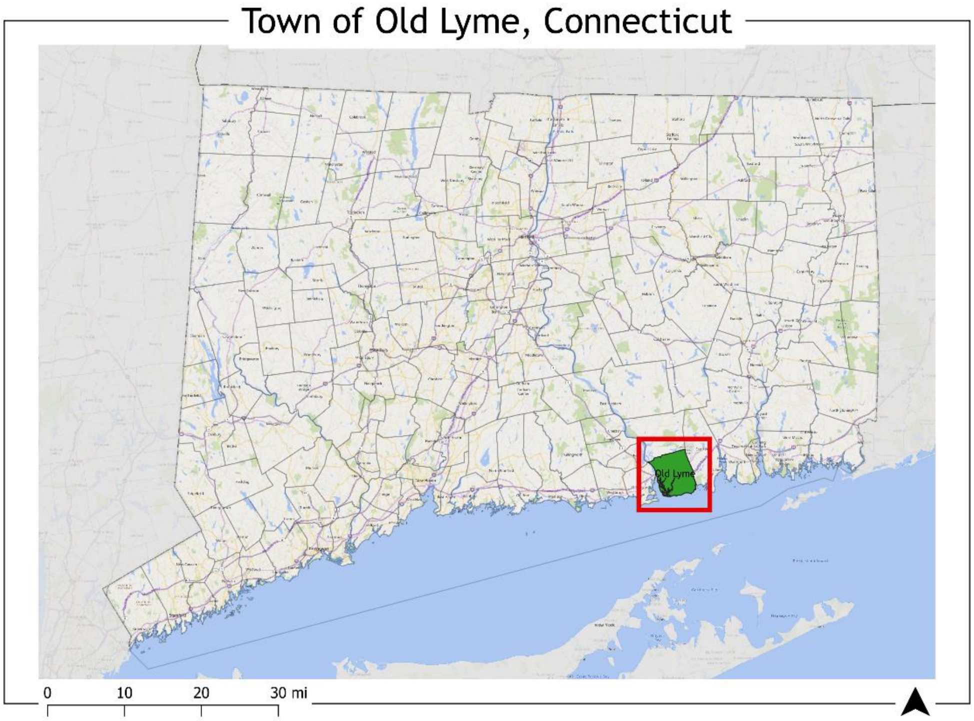
Figure 10. Existing and Adjacent Properties

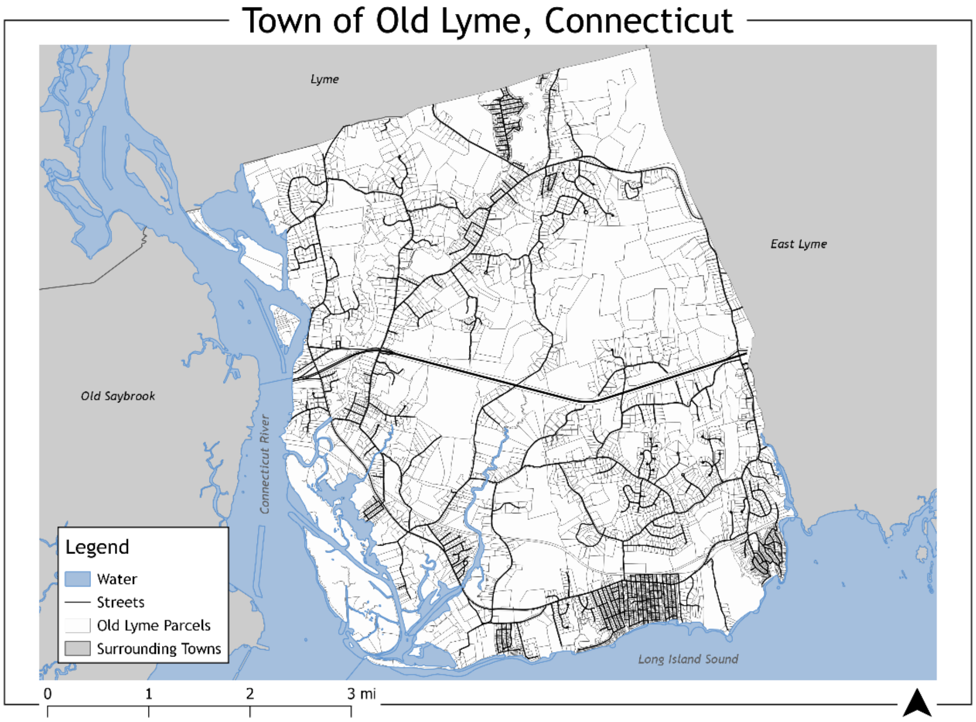
Figure 11 – Graphical Modeler



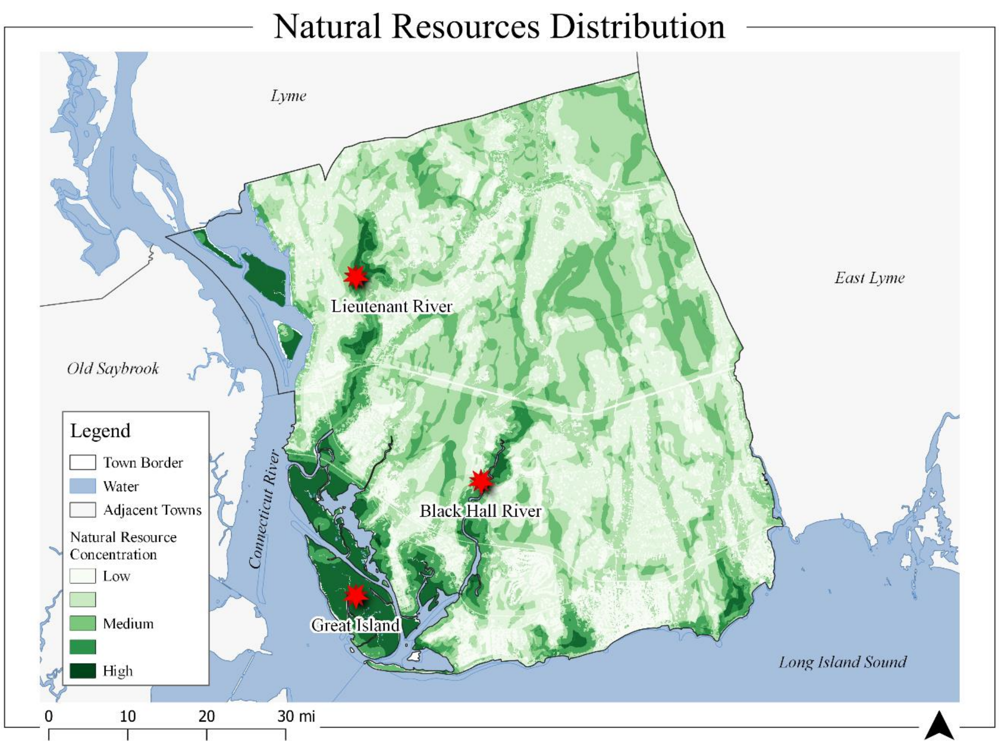
Appendix C – Maps

Map 1-2 – Maps of Project Area: Old Lyme, Connecticut





Map 3 – Spatial Distribution of Natural Resources



Map 4 – Parcel Prioritization Levels and Current Protected Properties