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# Land Use Projections and Vulnerability in the Broad Meadow Brook Wildlife Sanctuary, Worcester, Massachusetts

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## Introduction

This work explores land use change and parcel analyses in the Broad Meadow Brook Wildlife Sanctuary (BMB); a protected area of forest and wetlands, located in Worcester, MA. BMB provides habitat to local species and regulates stormwater flow for surrounding neighborhoods. An upcoming restoration project at BMB is aiming to understand past land use history, improve wildlife habitat, and increase flood storage capacity (among other goals), which the following research questions address:

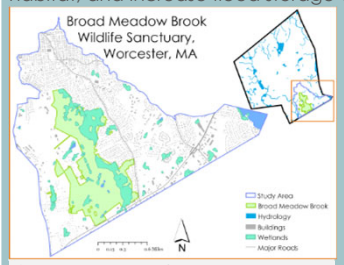



Figure 1: Study area map for the Broad Meadow Brook, Worcester, MA.

- How has **land use composition** changed overtime, and how will it change in the future?
- Which land parcels are most **vulnerable** to development by 2061?
- Which parcels could be key in **flood mitigation** through the implementation of green infrastructure?

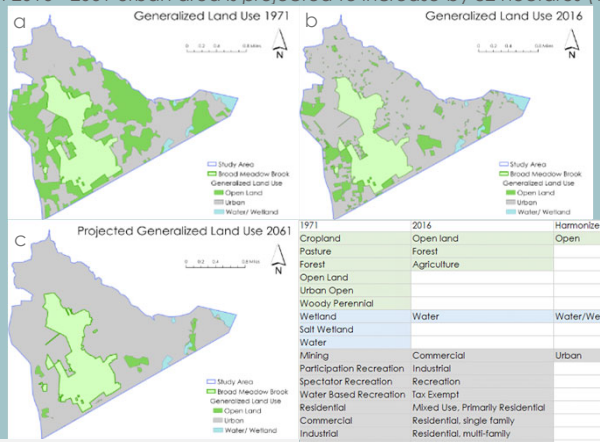
Identifying land use changes, vulnerable property, and opportunities for flood mitigation will allow managers to create a restoration plan that honors the historical legacy of the land, while anticipating future changes.

## Methods

- **Land Use Change Analysis:** Land use change was analyzed using TerrSet's Land Change Modeler from 1971 to 2016, and then forecasted from 2016 to 2061 to delineate future land use based on past trends.
- **Vulnerable Parcel Analysis:** This analysis provides the zoning and ownership dimension following the land use change analysis. Vulnerable land parcels were identified using the zoning & ownership criteria in a tiered structure.
- **Flood Mitigation Parcel Analysis:** Parcels that could be key in flood mitigation were identified using a DEM, land use, and ownership criteria.

## Land Change Analysis

From 1971 - 2016 urban area *increased* by 287 hectares (35%).
From 2016 - 2061 urban area is *projected to increase* by 82 hectares (10%).




Figu
2016
how

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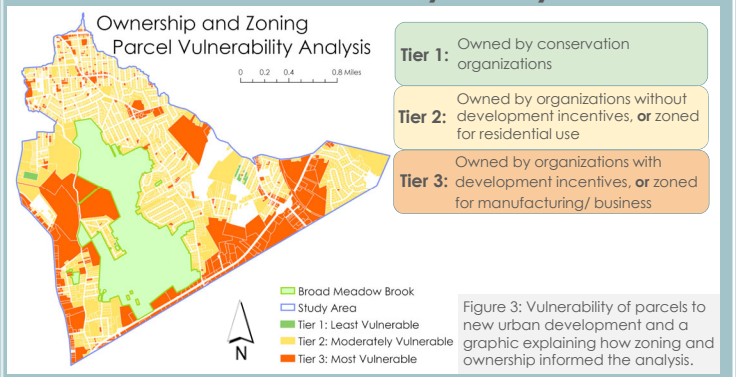
| 1971 | 2016 | Harmonized |
|---|---|---|
| Cropland | Open land | Open |
| Pasture | Forest | |
| Forest | Agriculture | |
| Open Land | | |
| Urban Open | | |
| Woody Perennial | | |
| Wetland | Water | Water/Wetland |
| Salt Wetland | | |
| Water | | |
| Mining | Commercial | Urban |
| Participation Recreation | Industrial | |
| Spectator Recreation | Recreation | |
| Water Based Recreation | Tax Exempt | |
| Residential | Mixed Use, Primarily Residential | |
| Commercial | Residential, single family | |
| Industrial | Residential, multi-family | |
| Transportation | Residential, other | |
| Waste Disposal | Mixed use, other | |
| | Mixed use, primarily commercial | |
| | Right of Way | |

Distance to roads, distance to water, elevation, and slope were used as driver variables. The model predicts that most of the remaining open land will be converted to urban land by 2061 based on past trends.

## Parcel Vulnerability Analysis




**Tier 1:** Owned by conservation organizations

**Tier 2:** Owned by organizations without development incentives, **or** zoned for residential use

**Tier 3:** Owned by organizations with development incentives, **or** zoned for manufacturing/ business

Figure 3: Vulnerability of parcels to new urban development and a graphic explaining how zoning and ownership informed the analysis.

This tiered analysis assigns a vulnerability designation to each parcel. It will aid BMB land managers in prioritizing new conservation land. Urban land use in T3 parcels is projected to increase by 84.7 hectares by 2061.

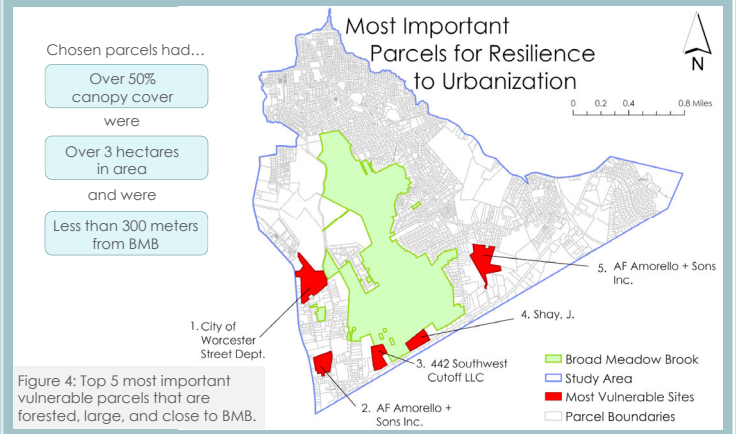



Figure 4: Top 5 most important vulnerable parcels that are forested, large, and close to BMB.

These parcels are the most important to keep forested because if they are urbanized, issues like flooding, the urban heat island effect, or species loss could be exacerbated for the BMB area.

## Flood Mitigation Parcel Analysis

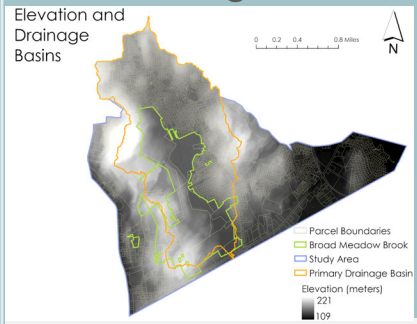



Figure 5: Elevation and the primary drainage basin for BMB.

When water falls on parcels within the primary drainage basin, the water flows directly into BMB. Parcels in this area are therefore important for flood mitigation as green infrastructure on high elevation parcels within this area could stop rainfall from ever reaching BMB. Green infrastructure achieves this by slowing down water enough to percolate into the ground or diverting water from its usual path.

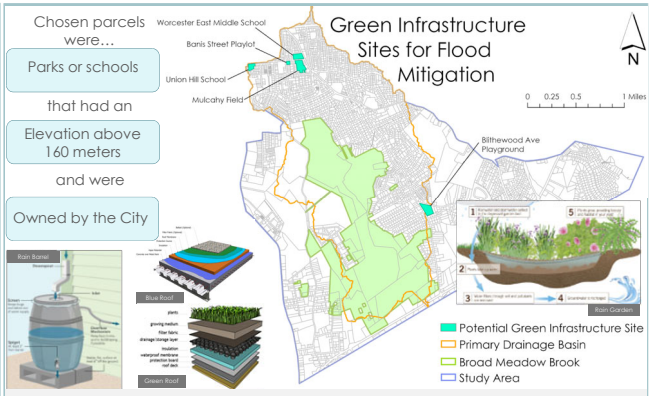


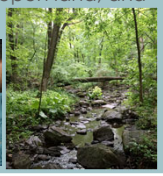

Figure 6: Five sites for green infrastructure that are at high elevation, city owned parks and schools within the watershed. Green infrastructure here would stop stormwater from flowing into BMB during rain events.

**Site Specific Mitigation:** All of these sites are parks or schools. Since the parks have ample open space, rain gardens should be implemented. For the schools that have existing infrastructure blue roofs, green roofs, or rain barrels could be installed.

**Education:** Since these sites are around schools and playgrounds BMB land managers and the city of Worcester could create an educational program for local Worcester youth to learn about green infrastructure, flooding, and sustainability.

## Major Findings

- **Urban land use** in the BMB area increased by 287 hectares from 1971 to 2016 directly to the east and west of BMB. Urban land use is expected to **increase** another 82 hectares by 2061 leaving only a few patches of open land in the south.
- The most important **vulnerable parcels** for resilience to urbanization are clustered to the southwest, with one to the southeast.
- Based on the Land Use Change Analysis, **urban land use** in vulnerable T3 parcels is projected to **increase** by 84.7 hectares by 2061.
- The parcels identified to have potential for flood mitigation are **city owned schools and playgrounds** located to the north and south-east of BMB.
- **Land managers** at BMB should prioritize the parcels identified as having a high risk of vulnerability or a high potential for flood mitigation and **work with the city** of Worcester to
  1) ensure conservation on remaining open land, and
  2) implement green infrastructure.



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