Highlights of the Baltimore Ecosystem Study: Urban Legends and Improved Management for Cities

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Abstract

Although urban areas are the dominant habitat of humans in this century, management and design have a scant ecological foundation. We identify nine assumptions that may be held by managers and decision makers concerned with urban systems. These assumptions involve ecological, hydrological, and social processes, and the interactions among them. We use ongoing research from the Baltimore Ecosystem Study LTER to counter or question these assumptions. We highlight a management implication for each of the assumptions examined.

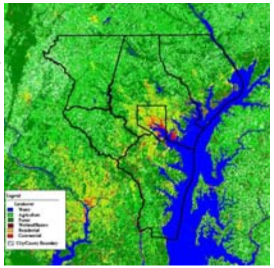


Figure 1. The Baltimore, Maryland metropolitan area, comprising Baltimore City and County, and the Counties of Anne Arundel, Carrol, Montgomery, and Harford.

Legend 1: Ecological Processes are Overwhelmed by Human Alterations in Urban Areas

•N retention in suburban watersheds is 75%, a level similar to natural systems[1].
•Management can reduce nitrogen export from suburban watersheds by maintaining and increasing natural retention processes in open areas.

Table 1. Nitrogen budget for suburban, forested, and agricultural components of the Baltimore Metropolitan area. Retention is estimated as the difference between regional atmospheric deposition, fertilizer use, and fluxes in stream flow of the Gwynns Falls.

	Suburban	Forested	Agriculture
	----------------- kg N ha^{-1} y^{-1} -------------		
Inputs			
Atmosphere	8.7	8.7	8.7
Fertilizer	13.9	0	100
TOTAL	22.6	8.7	108.7
Outputs			
Streamflow	6.5	0.52	16.4
Retention			
Mass	16.1	8.2	92.3
Percent	71	94	85

Legend 2: Class, Income, and Ethnicity Explain Levels of Concern about Environmental Quality.

•Environmental quality is assumed to be a "luxury good"[2].
•No significant difference for resident "awareness" or "concern for water or air quality" based upon household income.
•Management must account for concern about the environment among all socio-economic groups, but recognize that the motivations may differ.

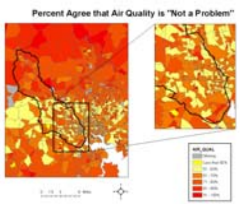


Figure 2. The percentage of surveyed households that agree that air quality is "not a problem" is not significantly different between neighborhoods with high social capital and neighborhoods with low social capital.

Legend 3: The Diversity of Urban Biota is Low and Lacks Value

•Biodiversity varies widely across the urban matrix.
•Pockets of rare plants exist[3-5].
•New soil invertebrate species discovered[6].
•Management can exploit spatial variance in urban biodiversity, and promote functionally significant native species.

Figure 3. Variation in abundance of an exotic species, Rock Pigeon (*Columba livia*), at sites randomly located across the city of Baltimore. Sizes of circles represent the mean number of individuals detected over three point counts in May-June 2002.

Legend 4: Environmental Inequities Affect Only Non-whites

•Whites are more likely than blacks to live near Toxic Release Inventory (TRI) sites[7].
•Management to mitigate TRI sites can help all groups in Baltimore. Concerns about environmental justice can unify groups.

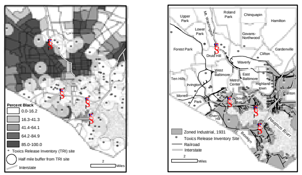


Figure 4. Left Panel: Correlation of Toxic Release Inventory (TRI) sites with ethnicity in Baltimore City. Right Panel: Correlation of TRI sites with industrial zoning in Baltimore City.

Legend 5: Urban Social Systems Are Unaffected by Environmental Change

•Traditions in ecology and social sciences neglect feedbacks between them.
•Low lying areas associated with 25% infant mortality before the construction of sewers[8].
•Metropolitan sewers eliminated water borne diseases, increased value of the low-lying areas and initiated the migration of white, middle class people from the central city[9].
•Policies that insulate social from ecological processes will have limited success, or unintended negative consequences.

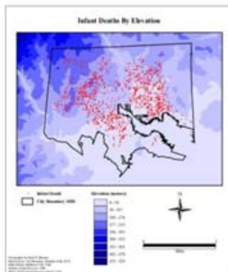
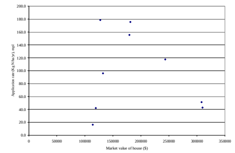


Figure 5. Infant mortality (shown in red) in 1880, before construction of the comprehensive sewer system in Baltimore. Denser shading indicates higher elevation, illustrating the significant correlation of infant mortality with low lying areas in the city.

Legend 6: Lawns Are Bad

•Nitrate leaching to ground water, and nitrous oxide fluxes to the atmosphere are low and comparable to forests.
•Well tended lawns in underserved areas may signify social cohesion.
•The percentage of fertilized lawns is lower than expected, especially in wealthier areas[10].
•Management may exploit lawns for mitigation of N pollution from urban areas.

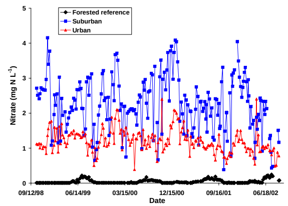
Figure 6. Application of fertilizer N (Kg/ha/yr) versus market value of house.



Legend 7: Urban Land Use Change Decreases Stream Water Quality

•Nitrate and phosphate levels in streams are lower in dense urban areas than in suburban or agricultural areas[11].
•The N and P in urban streams results from leaky sanitary sewers, which are controllable, while suburban septic systems have an engineered N loss similar to agriculture.
•Transformations from agriculture to urban can reduce N and P loading of streams; transition to suburban septic systems will result in lower and more variable water quality.

Figure 7. Nitrate concentration in stream flow in a forested reference watershed (Oregon Ridge County Park), and in suburban and urban subcatchments of the Gwyns Falls.



Legend 8: What You See Is What you Get: Social and Ecological Processes Occur at the Same Scales

•Vegetative characteristics of neighborhoods are best explained by the social characteristics of 20 years prior[12;13].
•Managing the contemporary landscape may require understanding social or ecological legacies, and different rates of change in each realm.

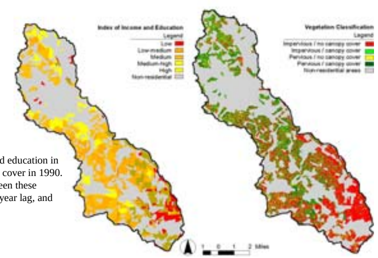


Figure 8. Index of income and education in 1970, compared to vegetation cover in 1990. The positive correlation between these variables is greatest at the 20 year lag, and less in the 10 and 0 year lags.

Legend 9: Conversions to Urban Land Uses Result in a Net Carbon Loss

•Assumed that recovery of Soil Organic Carbon (SOC) in urban systems will be slow or lacking[14].
•SOC in urban ecosystems is highly variable, in the matrix[15].
•Woody vegetation in residential areas contributes to the urban C pool[16, 17].
•Management of regional or global carbon sequestration may exploit pools of urban carbon.

Figure 9. One of Baltimore's leafy residential neighborhoods in the foreground, with the Inner Harbor skyline in the background.

Table 2. Biomass and C in forest and non-forest woody vegetation in Maryland. Urban C is a component of the non-forest woody vegetation.

	forest	nonforest
land area (thousand ac)	2701	3594
average biomass (Mg C ha^{-1})	72.25	17.80
wood-biomass increment (Mg C ha^{-1} yr^{-1})	1.90	0.42
total C storage (x 10^6 Mg C)	78.96	25.92
annual C storage (x 10^6 Mg C yr^{-1})	2.08	0.61

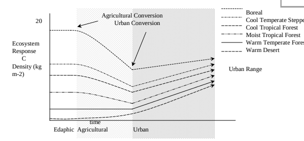


Figure 10. A hypothetical diagram of ecosystem carbon dynamics from the pre-agricultural "edaphic" phase, through the agricultural and urban phases in contrasting biomes. Inter-biome variation in agricultural C and convergence in urban C is proposed. Within the urban phase for each biome, high variation is expected, with all urban areas accumulating higher C than agriculture due to introduction and maintenance of trees and shrubs.

Conclusions

Unstated or untested assumptions about the structure and function of urban ecosystems may be held by managers and decision makers. We have identified nine examples, and indicated how research in the Baltimore Ecosystem Study LTER counters or questions the assumptions. While our research does not in all cases suggest that the *opposite* of a legend be accepted as true, questioning these assumptions does advance understanding of urban systems. We do not suggest that all people hold these assumptions, or that we have explored all the implications of each assumption here. But to the extent that such assumptions affect management decisions, the ecological effectiveness of management will be limited.

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