The Influence of Urban Stressors on Avian Diversity in Manhattan, KS

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Abstract

Urban environments expose birds to multiple stressors, including artificial light at night, noise pollution, traffic, and minimal green space. This study examines how these factors influence bird species richness and abundance across four different locations in Manhattan, Kansas. Field data were collected over two weeks, and artificial light and impervious surfaces were extracted using ArcGIS Pro. A multiple regression analysis showed that impervious surfaces was the strongest negative predictor of species richness and abundance, while light pollution was the strongest positive predictor. These results came after controlling the other variables. Noise and traffic did not have a significant independent effect. These results highlight the importance of habitat structure in shaping bird communities and show that artificial lighting may attract more generalist urban-tolerant species.

Methods

Sampling

- 4 sites with different urbanization levels in Manhattan
- 15 - minute intervals
- Weekdays - 6:00 AM–8:00 AM over a 3-week period
- Bird abundance and species richness recorded at each site
- Bird species and counts identified using Merlin Bird ID
- Noise levels measured using NIOSH Sound Level Meter
- Traffic volume measured through point-count traffic observations during each sampling period
- Light pollution data collected from ArcGIS Living Atlas VIIRS Nighttime Composite
- Impervious surface measured using GIS land-cover and surface data

Study Design:

- Compared bird communities across sites
- Evaluated relationships between urbanization factors and bird communities
- Urbanization variables included:
  - Noise Levels
  - Traffic Volume
  - Light Pollution
  - Impervious Surface Cover

Assessed impacts on:

- Bird Abundance
- Species Richness

Results

Bird communities differed across the study sites. Washington–Marlatt Park, which had the lowest light pollution (12.22 radiance units) and 0% impervious surface, consistently supported the highest species richness. Poyntz Avenue, the most urbanized site (90.25% impervious surface; 78.93 radiance units), had the lowest richness. City Park and the Ratone neighborhood fell between these extremes. Removing outliers improved model fit and revealed the independent effects of noise and traffic more clearly. Across both models, light pollution and impervious surfaces were the most consistent predictors, with light increasing richness and abundance once other stressors were controlled, and impervious surfaces consistently reducing both.

Table 1. Multiple Regression Predicting Species Richness (No Outliers)

Model R^2	0.7473
Adjusted R^2	0.6799
Standard Error Estimate	1.4229
Observations	22

Predictor	Coefficient	Standard Error	t-value	p-value	Lower 95%	Upper 95%
Intercept	11.3733	3.7717	3.0154	0.00869	3.3341	19.4125
Light Pollution	0.2844	0.0513	5.5419	0.000056	0.1750	0.3937
Average Noise	-0.1837	0.0851	-2.1582	0.04753	-0.3650	-0.0023
Impervious Surfaces	-0.1977	0.0309	-6.4044	0.000012	-0.2636	-0.1319
Traffic	-0.0244	0.0133	-1.8413	0.08544	-0.0527	0.0038

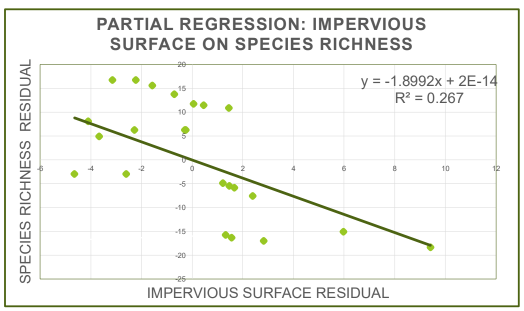
Multiple regression predicting species richness. Light pollution increased richness, while impervious surfaces and noise reduced it, traffic showed a weak, non-significant trend.

Table 2. Multiple Regression Predicting Bird Abundance (No Outliers)

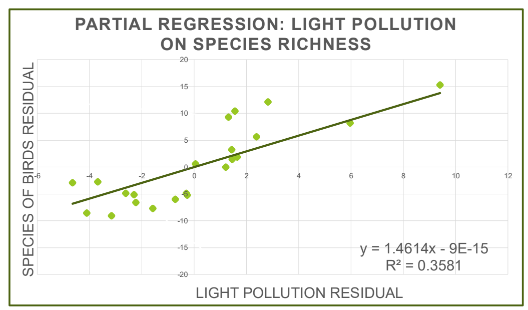
Model R^2	0.6343
Adjusted R^2	0.5428
Standard Error Estimate	2.3823
Observations	22

Predictor	Coefficient	Standard Error	t-value	p-value	Lower 95%	Upper 95%
Intercept	25.7788	6.4836	3.9699	0.0011	12.013	39.545
Light Pollution	0.3028	0.0708	4.2741	0.00058	0.1526	0.4530
Average Noise	-0.3653	0.1405	-2.5994	0.01937	-0.6632	-0.0674
Impervious Surfaces	-0.1902	0.0438	-4.3391	0.00051	-0.2831	-0.0973
Traffic	-0.0437	0.0207	-2.1152	0.05045	-0.0876	0.0001

Multiple regression predicting total bird abundance. Light pollution increased abundance, impervious surfaces and noise reduced it, and traffic showed a slight negative trend.



Partial regression plot showing the independent effect of impervious surface on species richness after controlling for light pollution, noise, and traffic. The negative slope indicates that higher impervious surface coverage corresponds to lower species richness once other stressors are removed. Each dot represents a sampling site, showing the residual species richness after accounting for other variables.



This partial regression plot shows the independent effect of light pollution on species richness after controlling for impervious surface, noise, and traffic. The positive slope indicates that higher light levels are associated with more species once other stressors are removed. The dots represent individual sampling sites, each showing the residual species richness after accounting for other variables

Sites

Highly Urbanized

Poyntz Ave by Mall

Moderately Urbanized

Neighborhood – Ratone St

Moderately Developed

City Park

Low Urbanization /Near-Natural

Washinton-Marlatt Memorial Park

Conclusions

Urban structure = strongest driver in Manhattan, KS

- **Impervious surface** → major declines in richness & abundance
  - Loss of vegetation
  - Fewer nesting sites
  - Reduced food availability
- **Light pollution** → increases richness & abundance
  - Attracts insects
  - Extends foraging time
  - Benefits disturbance-tolerant generalists
- **Noise pollution** → moderate negative effect
  - Disrupts communication
  - Interferes with predator detection
- **Traffic** → slight negative trend
  - Likely indirect or masked by noise/pavement

Overall Patterns

- Stressors overlap across the urban landscape
- **Multiple regression** needed to isolate independent effects
- **Most consistent patterns:**
  - Impervious surface = strongest negative predictor
  - Light pollution = strong positive predictor
- **Management implication:** preserve natural cover, reduce pavement, maintain habitat structure