Quantifying Relationships Between Impervious Surface Cover, Disturbance, and Chick Performance in *Troglodytes aedon*

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Impervious Surface Cover, Disturbance, and Chick Performance

- How variables are related
- Why they matter
- What has already been done
- Our questions defined
- Methods for data collection
- Methods for analysis
- Results and conclusions
- Discussion and future research

Introduction:
Justifications

- James City County is undergoing rapid expansion and development (Hellier and Timmons 2006)

- Human presence causes disturbance which can impact wildlife productivity
  - Frequently studied using birds (Beissinger and Osborne 1982, Lens *et al.* 1999, Juricic 2000)
  - Chick performance—which relates to breeding productivity—impacts population

- Determining impact is lengthy and expensive

- Can we predict impact without having to do field studies?

Introduction:
Background

- Habitat modeling has been done for other species (Birkhead 2006)
- Relationship between urban habitat <u>and disturbance</u> has not been studied
  - Urban areas have a unique ecology (Kaye *et al.* 2006)
- Impervious surface cover (ISC) (Paul and Meyer 2001, Shuster *et al.* 2005)
  - Readily accessible
  - Frequently used in other fields

Questions

- Is there a relationship between ISC and disturbance?

- Is there a relationship between disturbance and chick performance?

- Is there a relationship between ISC and chick performance?

Methods:
Impervious Surface Cover

- GIS
  - Digitized ISC
  - Categorized ISC
    - Building
    - Parking surface
    - Pedestrian surface
    - Recreational surface
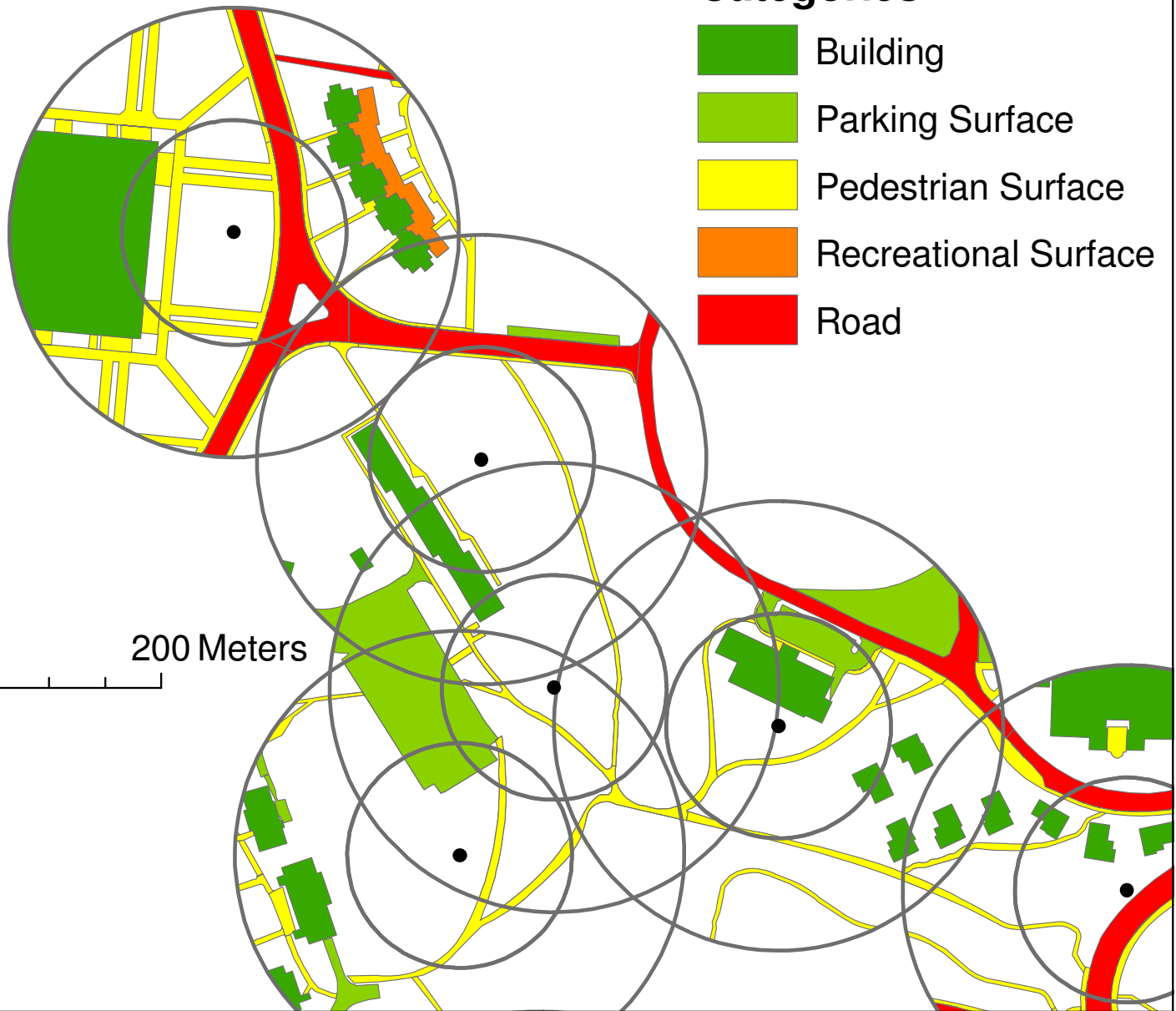   - Road
  - Calculated area and perimeter

N

Campus_08

Campus_52

Campus_34

Campus_48

0   50   100   200 Meters

Impervious_Surface

Categories
- Building
- Parking Surface
- Pedestrian Surface
- Recreational Surface
- Road

N

0 50 100   200 Meters

Methods:
Disturbance

- Study site: 57 bird boxes in woodland or woodland edge habitat
- 1-5 observations 90 minutes each
  - Duration
  - Proximity
  - Source
    - Automobile
    - Pedestrian
    - Animal
    - Bicycle
    - Golf cart
    - Other motorized vehicle
    - Pedestrian with animal

Methods:
Productivity

- House wrens (*Troglodytes aedon*) as study species
  - Tolerant of human activity
  - Abundant
  - Preference for man-made bird boxes
  - Commonly studied
    - (Johnson 1998)

Methods:
Chick Performance

- Chicks measured once each week of growth (1-3 measurements/box)
  - Adjusted brood condition
  - Adjusted growth rate
  - Number of chicks fledged

Methods:
Analysis techniques

- Principal component analysis for disturbance data to reduce variables

Component Matrix for Disturbance Independent of Source

	Component	
	1	2
ln_number_events	.757	.255
ln_variance_proximity	.645	-.103
ln_mean_proximity	.171	.893
ln_minimum_proximity	-.217	.897
ln_variance_duration	.835	-.085
ln_mean_duration	.811	-.200
ln_total_duration	.948	.064
diversity	.686	.128

Extraction Method: Principal Component Analysis.
a 2 components extracted.

Methods:
## Analysis techniques

- ISC to disturbance relationships: multiple regression

- Disturbance to chick performance: bivariate correlation

- ISC to chick performance: multiple regression
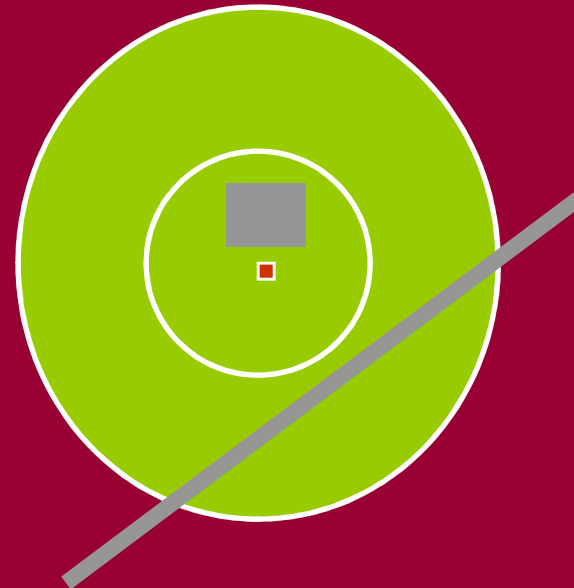
Conclusions:
Impervious Surface Cover and Disturbance

- Impervious surface cover can predict disturbance patterns for a specific location
  - Source independent $(F_{4,52}=19.72, p<0.001, r^2=0.603)$

Low Disturbance
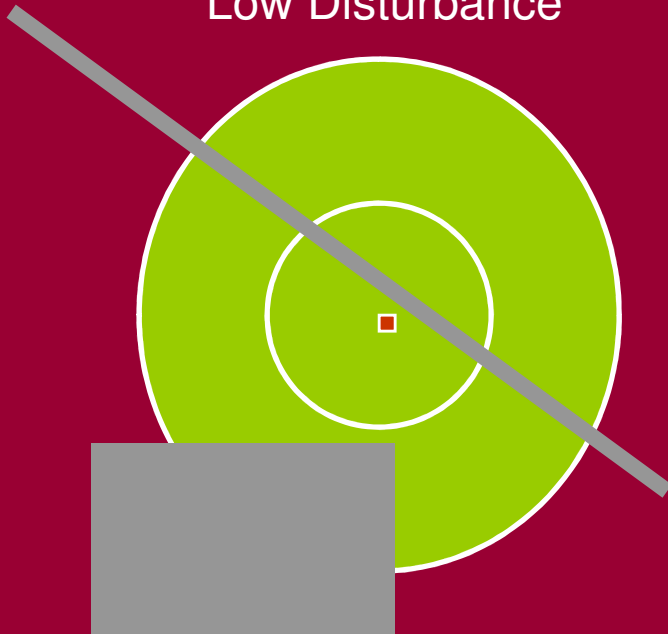
High Disturbance

Conclusions:
Impervious Surface Cover and Disturbance

Significant relationships by category

ISC category/measure	Component	Associated disturbance
High road area within 50m High pedestrian area within 50m	PC1	**Lots** of bike and pedestrian disturbance ($F_{2,54}=23.185, p<0.001, r^2=0.462$)
High road area within 50m	PC3	**Little** of "other" motorized vehicle disturbance ($F_{1,55}=6.948, p=0.011, r^2=0.112$)
High building area within 50m	PC2	**Little** animal disturbance, **lots** of golf car disturbance ($F_{1,55}=8.774, p=0.005, r^2=0.138$)

Conclusions:
Disturbance and Chick Performance

- Relationship between disturbance and productivity can be quantified
  - Source independent disturbance has no relationship with chick performance
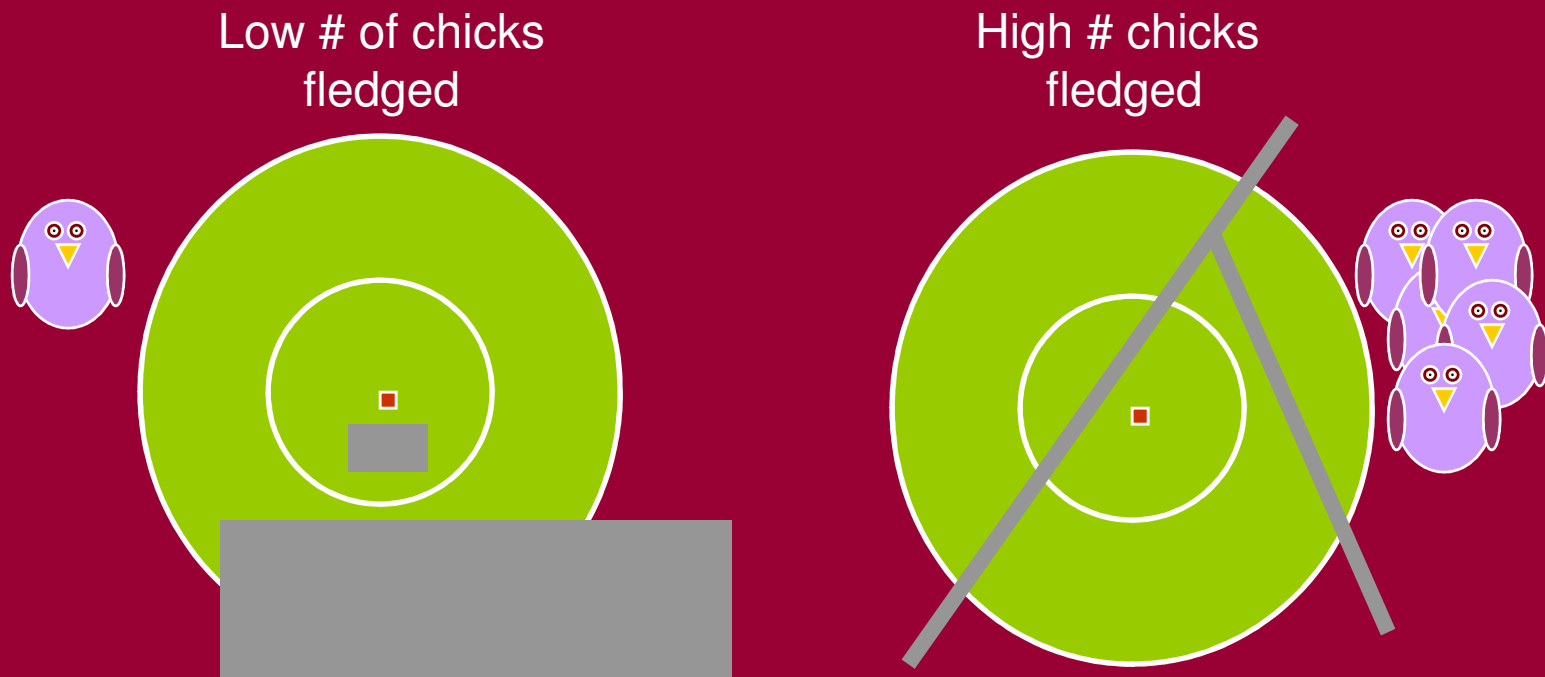
Conclusions:
Disturbance and Chick Performance

But the source of disturbance does matter

Chick performance	Component	Associated disturbance
Many chicks fledged	PC3	*Lots* of "other" motorized vehicle disturbance (r=0.453,p=0.045)
Good brood condition	PC1	*Little* bike and pedestrian disturbance (r= -0.487,p=0.029)
Good brood condition	PC2	*Lots* animal disturbance, *little* of golf car disturbance (r=0.613,p=0.004)

Conclusions:
Impervious Surface Cover and Chick Performance

- ISC can be used to predict chick performance
  - As ISC area increases and perimeter of ISC decreases, HOWR productivity decreases ($F_{4,17}=3.375, p=0.033, r^2=0.443$)

Low # of chicks
fledged

High # chicks
fledged

Conclusions:
Impervious Surface Cover and Chick Performance

- The type of ISC again matters
  - Pedestrian surface area within 100m negatively correlated with adjusted brood condition ($F_{1,20}$=5.141, p=0.035, r^2=0.204)
  - Parking surface area within 50m negatively correlated with number chicks fledged ($F_{1,20}$=7.805, p=0.011, r^2=0.281)

Discussion and Future Questions

- Impervious surface cover can be used to predict disturbance patterns for a specific location
  - Future research: are these predictions accurate in other locations? Can a general model be created?
- Relationship between disturbance and chick performance can be quantified (but the source of disturbance does matter)
  - Future research: effect of disturbance on chicks of other species
- ISC can be used to predict chick performance
  - Future research: testing these predictions in
    - Other locations
    - Other species
- Chick performance, especially productivity, has implications on population
  - Future research: incorporating this effect into population models

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