Testing the Accuracy of an HSI Model in an Urban County

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INTRODUCTION

Conservation efforts in urban and urbanizing areas increasingly focus on the protection of threatened and endangered species. Recent articles by Schaeffer (1988), Byers et al. (1988), and Beatley (1991) have described efforts by local governments to identify and protect habitats used by these rare species.

Wyandotte County, Kansas is typical of many urban areas. One of the eight counties making up the Kansas City metropolitan statistical area, Wyandotte County includes Kansas City, Kansas, the second largest central city in the region (Starsinic and Forstall 1989). Three state-listed endangered or threatened species, the bald eagle (Haliaeetus leucocephalus), northern red-belly snake (Storeria occipitomaculata occipitomaculata), and western earth snake (Virginia valeriae elegans) are thought to occur in the county (K. Brunson, Personal communication: 1990). Because a Kansas state law requires the protection of habitats for state listed threatened and endangered species (Kansas Department of Wildlife and Parks 1989), local governments and the county planning department are working to develop objective methods of habitat assessment for these species that can be used

to evaluate sites proposed for development.

Habitat suitability index models have been used in urban areas to evaluate the impacts of site development on selected species (Williams-Hopper 1988, Burley 1989). These models have not been validated in urban or urbanizing areas and little information is available on the their accuracy in these habitats.

In 1990 we started a project to develop and evaluate a western earth snake habitat suitability index model for Wyandotte County. Our goal was to design a model based on existing literature for the snake and determine the accuracy of the model on sites surrounded by different levels of urbanization. The objectives of the study were to: determine if western earth snake capture success is related to habitat suitability; to determine if capture success is related to degree of urbanization; to determine the relationship between capture success and habitat model variables; and to determine the relationship between capture success and measures of urbanization.

METHODS

Model development

Our first step in developing the model was an extensive search of the published and unpublished literature for information documenting the habitat features associated with western earth snake food and cover requirements. This included a search of the National Agricultural Library database and other on-line references services. We found no primary literature documenting these features. Due to this lack of information our

model is based on habitat descriptions from field guides for midwestern states.

Field guides for Kansas reptiles and amphibians report that western earth snakes inhabit rocky hillsides, riparian areas, moist woodlands and forest edges (Anderson 1965, Collins 1974, 1982, Johnson 1987). The Kansas Natural Heritage Program database includes old fields, vacant lots, and wooded or brushy residential areas as additional habitats for this species (W. Busby, Personal communication: 1990).

The primary foods of the snake are earthworms and invertebrates found in leaf litter (Minton 1972, Collins 1974,1982, Tennant 1984, Ernst and Barbour 1989). The snake forages for earthworms at night and spends the day hidden beneath logs, rocks or leaf litter (Webb 1970, Collins 1974, 1982).

We used this information to develop a habitat suitability index model based on five variables that assess food and cover requirements (Flood et al.1977). Percent ground cover by litter (LIT), distance to water (DTW), and slope and aspect (SL) were used to assess food suitability. Cover suitability was assessed by percent canopy cover (CC), site slope and aspect (SL), and percent ground debris (DEB).

We developed a graph for each variable showing the relationship between levels of the variable and habitat suitability (Figure 1). A suitability index value, ranging from 1 to 5, was assigned to indicate this relationship. We used these suitability values to calculate an overall habitat

suitability index (HSI). The western earth snake HSI is the sum of the suitability index values for each variable divided by the sum of the highest possible values for each variable.

Study areas

The 1100 acre (445 ha) Naish Boy Scout Reservation (Camp Naish) is the largest open space in Wyandotte County. Located in the least developed portion of the county, Camp Naish is the only site in the county where western earth snakes have been collected (W. Busby, Personal communication: 1990). Twenty trap sites were randomly located on forested areas of Camp Naish that were at least 2.5 ac (1 ha).

Sixteen forested trap sites were randomly located in southwest Kansas City. These upland hardwood sites were selected from a larger sample of sites used in a study of open spaces in Wyandotte County (Nilon 1991). Each site was a minimum of 2.5 ac (1 ha) size and surrounded by an average of 50% developed land.

Habitat assessment

We used the HSI model to assess western earth snake habitat suitability on the 36 trap sites in Camp Naish and Kansas City. Vegetation measurements were made using procedures developed by James and Shugart (1970). Ground and canopy cover were measured on four 49 ft (15 m) transects established in cardinal directions. Five observations for cover were made along each transect using a viewing tube. Percentages of leaf and woody litter were summed to obtain percent ground litter. Debris was the sum of percent woody litter, rock, and artificial structure.

The distance from trap site to permanent water was measured on topographic maps. Slope and aspect were measured at each site using a clinometer and compass.

Measures of urbanization

In addition to describing the sites based on habitat characteristics, various features of urbanization were measured in areas within a 0.3 mi (0.5 km) radius of each trap site. The percentage of developed land (URB) was measured on cover maps created for a study of Wyandotte County open spaces (Nilon 1991). The number of buildings/km^2 (BD) was measured by counting the number of buildings within 0.3 mi (0.5 km) of each trap site on 1989 1:2400 maps provided by the Wyandotte County Surveyor's Office. Distances (ft) from the trap site to the nearest building or campsite (DTB) and from the trap site to the nearest paved road (DTR) were also measured on these maps.

Model testing

The 36 sites were trapped from June - September 1992. Each trap station consisted of one 20.7 ft by 1.7 ft (6 m by 0.5 m) plastic drift fence, buried 2 in (5 cm) into the ground, and two funnel traps made of aluminum window screening. Funnel traps measured 29 in (0.7 m) long, 8.2 in (0.2 m) across at the mouth, with an opening of 1.5 in (3.5 cm) (Karns 1986, Fitch 1987). All snakes captured were identified and marked by scale clipping (Karns 1986). Each snake was weighed, measured and released within 58 yards (50 m) of the trap station.

Mean HSI scores, model variable values and urbanization

variable values were compared using t-tests. The Wilcoxon rank-sum test was used to determine if trap sites on Camp Naish and Kansas City with identical HSI scores differed in capture success.

RESULTS

Habitat assessment

HSI values for the western earth snake ranged from 0.56 - 0.76 on Camp Naish and from 0.52 - 0.80 in Kansas City. There were no differences in mean model variable values, or in mean HSI between Camp Naish and Kansas City sites (Table 1). A comparison of measures of urbanization showed that mean DTB and DTR were lower in Kansas City than at Camp Naish. The two additional measures of urbanization, URB and BD were higher in Kansas City than at Camp Naish (Table 1).

Model testing

Twelve western earth snakes were captured on eight trap sites, all at Camp Naish. There were no differences between mean HSI scores for capture and no-capture sites. The Wilcoxon rank-sum test showed a difference in capture success between Camp Naish and Kansas City trap sites with identical HSI scores (Table 2).

A comparison of model variables showed that CC was higher and LIT lower on capture sites. We also compared measures of urbanization, finding that DTB and DTR were higher on capture sites than no-capture sites (Table 3).

DISCUSSION

The literature-based western earth snake model found no difference in habitat suitability between trap sites in a large open space and similar sites surrounded by urban development. This indicates that the sites are similar in habitat structure and could be expected to have similar rates of trapping success. However we found a difference in western earth snake capture success between Camp Naish and Kansas City.

One explanation for this difference could be our validation procedure. Cole and Smith (1983) state that more than one year of habitat use data are required to accurate validate habitat suitability index models. While additional years of data collection may provide information on western earth snake habitat use, the relationship between capture success, model variables, and measures of urbanization provides an alternate explanation.

We found similarities between capture/no-capture locations on Camp Naish and between trap sites in Camp Naish and Kansas City. Model variables were identical on both sets of sets, while measures of surrounding urbanization were different. No-capture sites and sites in Kansas City were closer to buildings and roads. These results are similar to other studies of snakes in urban habitats.

Campbell (1974) stated that roads are the primary barriers to seasonal movements and dispersal of reptiles and amphibians in urban areas. Anderson (1965) found that bullsnake (Pituophis melanoleucus sayi) populations noticeably deceased near major

roads. A study of road kills in south-central Kansas found that many snakes are killed deliberately by drivers (Langley et al. 1989).

Western earth snakes may be sensitive to the impacts associated with adjacent urban development. Schlauch (1978) found that reptiles and amphibians vary in response to urban development. Some species show marked declines, while others are associated with building sites and human activities.

Our results indicate that land use and land cover variables are better predictors of western earth snake presence in urban and urbanizing areas of Wyandotte County. Further research is needed to determine if this variables are associated with actual patterns of habitat use, information that is needed to refine HSI models.

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Table 1. Mean HSI scores, model variable values, and measures of urbanization, for Camp Naish and Kansas City trap sites.

Variable	Camp Naish	Kansas City
Habitat suitability		
HSI	0.627	0.645
Model variables		
CC	73	78
LIT	43	33
DTW	228	225
SL	15	12
DEB	20	18
Measures of urbanization		
URB[a]	0	47
DTB[a]	293	83
DTR[a]	252	74
BD[a]	12	334

[a] Different between Camp Naish and Kansas City ($P < 0.05$)

Table 2. Results of Wilcoxon sign-rank test comparing Camp Naish and Kansas City trap sites with identical HSI scores ($P = 0.031$).

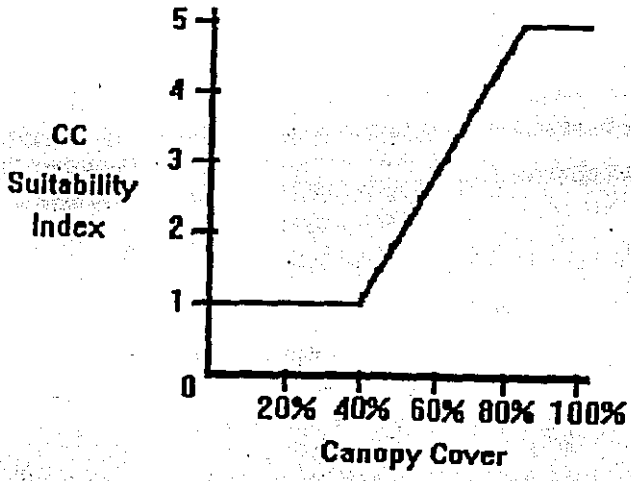
	Proportion of traps with captures			
HSI	Camp Naish	Kansas City	Difference	Rank
0.56	1/5	0/2	0.2	1.5
0.60	4/5	0/4	0.8	4
0.64	1/5	0/3	0.2	1.5
0.68	1/3	0/3	0.3	3
0.72	1/1	0/1	1.0	5

Table 3. Mean HSI scores, model variable values, and measures of urbanization, for Camp Naish capture and no-capture sites.

Variable	Capture sites	No-capture sites
Habitat suitability		
HSI	0.628	0.625
Model variables		
CC[a]	79	69
LIT[a]	39	46
DTW	214	240
SL	12	15
DEB	20	20
Measures of urbanization		
URB	0	48
DTB[a]	310	207
DTR[a]	367	176
BD	14	12

[a] Different between capture and no-capture sites ($P < 0.05$)

Figure 1. Western earth snake habitat suitability variables.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Suitability
Index
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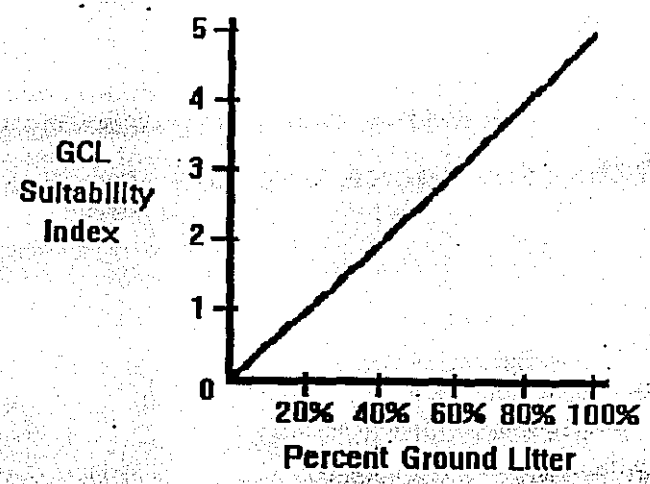
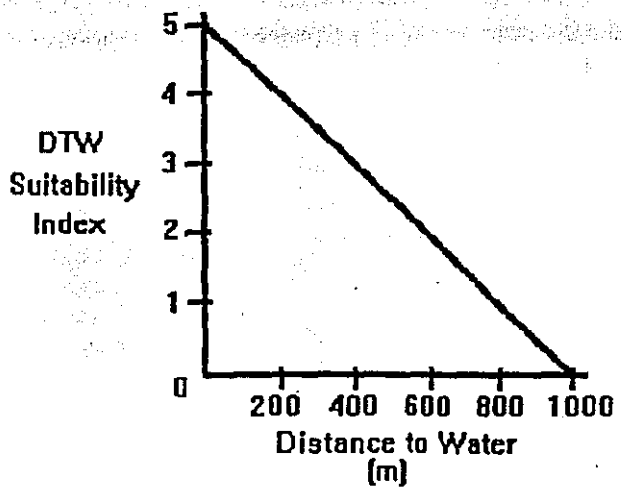
4
3
2
1
0
20% 40% 60% 80% 100%
Canopy Cover


GCL
Suitability
Index
5
4
3
2
1
0
20% 40% 60% 80% 100%
Percent Ground Litter


DTW
Suitability
Index
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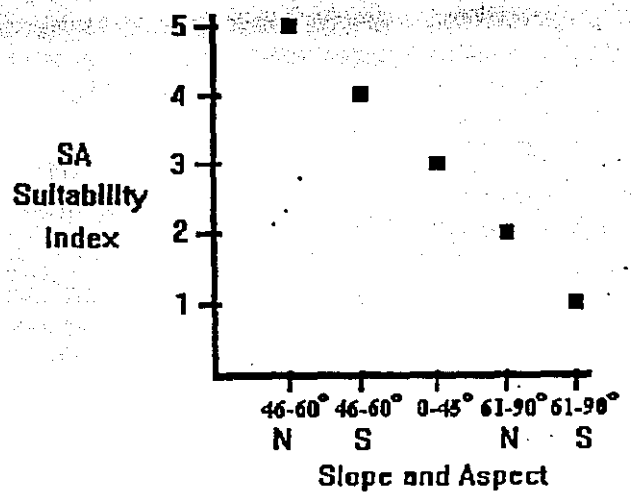
4
3
2
1
0
200 400 600 800 1000
Distance to Water
(m)


SA
Suitability
Index
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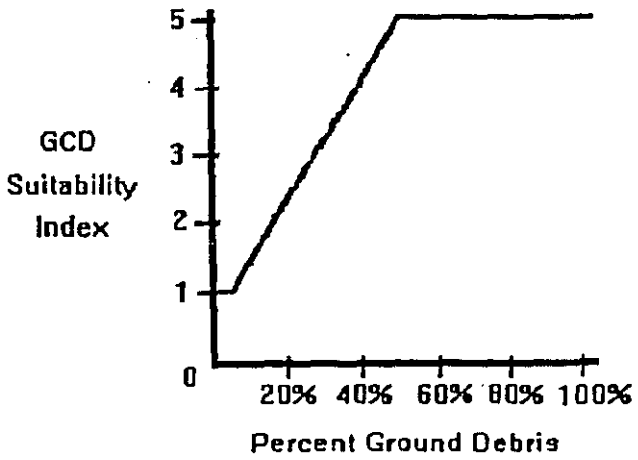
4
3
2
1
46-60° 46-60° 0-45° 61-90° 61-90°
N S N S
Slope and Aspect


GCD
Suitability
Index
5
4
3
2
1
0
20% 40% 60% 80% 100%
Percent Ground Debris