

# Multiscale Habitat Selection and Refuge Use of Common Kingsnakes, *Lampropeltis getula*, in Southwestern Georgia

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**The Common Kingsnake, *Lampropeltis getula*, is thought to be experiencing population declines in the southeastern portion of its geographic range. However, limited information exists regarding the natural history and habitat requirements of the species in this region. We conducted a radio-telemetry study to investigate habitat selection in *L. getula* at multiple scales in southwestern Georgia. At the home range scale, *L. getula* did not show habitat selection. However, at the study-area scale, *L. getula* selected for natural pine and hardwood forest types over other available habitats. At the microhabitat scale, *L. getula* were found in locations with more coarse woody debris and woody vegetation than random sites. *Lampropeltis getula* primarily used small mammal (*Peromyscus* spp.) burrows and stumpholes as below ground refuge sites. We demonstrate that habitat selection of *L. getula* is complex and occurs at multiple scales.**

**L**ONGLEAF Pine (*Pinus palustris*) forests of the southeastern coastal plain harbor diverse reptile communities (Guyer and Bailey, 1993; Dodd, 1995; Smith et al., 2006). These forests have been reduced to a fraction of their historic extent (Noss, 1989; Ware et al., 1993), and private hunting plantations represent some of the few remaining intact tracts of Longleaf Pine within the region. Hunting plantations are typically managed with frequent prescribed fire to maintain native groundcover (e.g., Wiregrass, *Aristida stricta*) as well as game species such as Northern Bobwhite (*Colinus virginianus*). It is important to understand the ecology of non-game wildlife species on these properties, as these lands may provide the only suitable habitat within a particular region.

The Common Kingsnake, *Lampropeltis getula*, is a wide ranging colubrid, found throughout the southern U.S. and west to California. Common Kingsnakes are large (reaching >200 cm total body length), generalist predators (Ernst and Ernst, 2003). In portions of the southeastern U.S., population declines of Common Kingsnakes have recently been reported. Although the causes of these declines are unknown, habitat loss (Winne et al., 2007), disease, drought (Stapleton et al., 2008), and collecting for the pet trade (Krysko and Smith, 2005) have all been suggested.

Our ability to understand the factors contributing to population declines of Common Kingsnakes, as well as how to effectively conserve them, is hampered by a lack of basic natural history information (Dodd, 1987). In this study, we examined habitat selection and refuge use of *L. getula* on a hunting plantation in southwestern Georgia. Because animals may select habitat differently depending on spatial scale (Johnson, 1980), we examined selection at both the landscape scale (second order selection) and home range scale (third order selection). We also described microhabitat selection and fossorial refuge use of *L. getula*. To our knowledge, this study represents the first published information examining habitat selection of this species in the Southeast.

## MATERIALS AND METHODS

**Study area.**—We conducted this study at Ichauway, the research site of the Joseph W. Jones Ecological Research

Center, approximately 16 km south of Newton, Georgia, USA. The 12,000 ha research site is predominantly second growth Longleaf Pine forest with both undisturbed native ground cover and old field vegetation. There are also numerous isolated wetlands within the Longleaf Pine forest. Scattered individual hardwoods and hardwood patches exist within the Longleaf Pine matrix. By the end of our study, selective harvest of hardwoods (*Quercus* spp.) had occurred on >2,000 ha of the property. The site is managed with prescribed fire on a 1–2-year rotation to maintain a pine-grassland community. Portions of the site are managed for Northern Bobwhite and White-tailed Deer (*Odocoileus virginianus*), resulting in a diverse habitat mosaic of active and abandoned food plots within the forest matrix. The property is bordered on the east by the Flint River and transected by approximately 23 km of Ichawaynochaway Creek. All *L. getula* were captured within the northern portion of the property, which is bordered by a paved road to the south (Highway 200) and large-scale agriculture to the north and east. Several snakes moved north of Ichauway; hence, we defined our study area as a 5,614 ha area north of Hwy 200, including a 1 km buffer around the property line.

**Radio-telemetry.**—From April 2005 through October 2007, 12 snakes (two females and ten males) were captured either by hand or in snake trap arrays (Burgdorf et al., 2005). Snake traps were located within Longleaf Pine and mixed pine-hardwood uplands but were within the vicinity of a diversity of habitat types. Snakes captured by hand were encountered in a variety of habitats across the study area. All snakes were measured (snout–vent length [SVL], total length, and body mass), marked with passive integrated transponders (PIT tags; Gibbons and Andrews, 2004), and sex was determined by cloacal probing (Table 1). Snakes were surgically implanted with 9 g radio transmitters (Holohil Systems Ltd., Carp, Ontario, Canada, model SI-2), using methods described in Reinert and Cundall (1982). Transmitter weight was <3.2% of the snake's body mass. Over the course of the study, we replaced transmitters in one female and four male snakes; the transmitter in one male snake was replaced twice. Radio-tagged snakes were located approximately once a week from June 2005 through August 2008; locations were

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**Table 1.** Location and Tracking Data for 12 Telemetered Common Kingsnakes, *Lampropeltis getula*, at Ichauway, Baker County, Georgia, 2005–2008.

Snake ID	Sex	SVL (mm)	Body mass (g)	Days tracked	# Tracking events	# Unique locations
1	M	860	296	369	66	52
2A3F	M	954	324	261	60	30
4B1E	M	910	371	1043	183	154
258	M	1341	826	348	63	50
586E	M	1152	619	235	56	32
655A	M	938	338	243	47	27
701E	M	872	285	624	106	79
1113	M	1144	440	554	98	83
5209	M	963	412	221	36	23
5803	M	1096	652	324	64	45
2225	F	1054	374	788	149	111
4937	F	920	321	357	77	62
Mean (SE)		1017 (41)	468 (49)	447 (74)	84 (13)	62 (11)

recorded with a GEO3 Global Positioning System (GPS, Trimble Navigation, Ltd., Sunnyvale, CA; accuracy 1–5 m).

**Statistical analysis.**—We used existing land cover data for the study area to differentiate seven habitat categories: agriculture, hardwood, mixed pine/hardwood, natural pine, pine plantation, wetland, and scrub/urban (Table 2). The land cover data had been photo interpreted from 1:12,000 scale color infrared photography and updated using 1:10,000 scale color infrared digital photography, annual GPS survey, and field corrections. Our ability to accurately characterize mixed pine/hardwood was constrained by ongoing harvest of hardwoods across the study area. However, given our findings we suggest this did not limit our interpretation.

We tested for second (landscape scale) and third order (home range scale) habitat selection (Johnson, 1980) in *L. getula* using a Euclidean distance approach (Conner and Plowman, 2001; Conner et al., 2003). To test for second order selection, mean distances from random points within home ranges to the seven different habitat types were compared to those of random points across the study area. To test for third order selection, mean distances from actual snake locations to habitats were compared to those of random points within home ranges. We used a MANOVA, with individual snakes as the experimental unit, to compare distances at both scales. When MANOVA detected a significant effect, univariate and pairwise t-tests were used to determine the habitat types with which snakes were significantly associated.

We used minimum convex polygon (Mohr, 1947) home ranges, which were derived from radio locations and constructed using ArcGis 9.1 (ESRI, Redlands, CA). Random points were generated in ArcGIS using Hawth's Tools (Beyer, 2004); 5,000 points were generated across the study area and 1,000 points were generated in each snake's home range (12,000 total points). Distances to habitat types were measured in ArcGis 9.1 using the "Near" feature; a value of zero was assigned to the habitat type in which the snake or random point was located.

At each unique snake location, we determined whether the animal was above or below ground, and when snakes were below ground we attempted to categorize the refuge type by inspecting external characteristics. Refuge types included small mammal (*Peromyscus* spp.) burrows, which had small (<5 cm) oval openings; Southeastern Pocket Gopher (*Geomys pinetus*) burrows, which were evident by large mounds of soil; Nine-banded Armadillo (*Dasyurus novemcinctus*) burrows, which were large (15 cm diameter) and oval in shape; and Gopher Tortoise (*Gopherus polyphemus*) burrows which are half-moon shaped. We also identified refuges in tree stumps in various stages of decay (i.e., stumpholes).

From 7 March 2006 through 27 May 2008 (excluding 5 May–16 June 2006), we estimated canopy cover with a spherical densiometer (Forestry Suppliers, Inc., Jackson, MS) and percent cover of bare ground, leaf and pine litter, coarse woody debris, woody vegetation, herbaceous vegetation, and grasses at the snake's location. Canopy cover and ground cover class categories (<1%, 1–5%, 6–15%, 16–25%,

**Table 2.** Habitat Categories Included in Distance-based Analyses of *Lampropeltis getula* Habitat Selection on Ichauway, Baker County, Georgia, from 2006–2008.

Category	Description	Proportion of study area (%)
Agriculture	Agricultural, wildlife food plots	22
Hardwood	Deciduous xeric hardwood forest, deciduous mesic hardwood forest, evergreen hardwood forest, mixed evergreen and deciduous hardwood forest	8
Mixed pine/hardwood forest	Mixed pine/hardwood forest	24
Natural pine	Longleaf pine forest (natural), other pine (natural)	21
Pine plantation	Evergreen coniferous forest	12
Wetland	Open water, cypress/tupelo forest, non-forested wetland	7
Scrub/urban	Scrub/shrub, urban	6

**Table 3.** Percent Cover Surrounding *Lampropeltis getula* Locations and Random Locations, 2006–2008. Means are presented with sample size in parentheses  $\pm 1$  standard deviation.

	Bare ground	Litter	CWD	Woody	Herbs	Grasses
Random locations	17.9(376) $\pm$ 27.8	43.7(376) $\pm$ 36.1	3.9(374) $\pm$ 8.5	7.4(376) $\pm$ 14.7	37.4(376) $\pm$ 33.2	22.0(307) $\pm$ 29.9
Snake locations	10.8(373) $\pm$ 20.0	45.2(373) $\pm$ 34.0	10.9(373) $\pm$ 20.8	10.9(373) $\pm$ 17.9	40.5(373) $\pm$ 34.7	20.8(302) $\pm$ 28.4
Wilcoxon test (z)	-3.73; $P < 0.01$	0.90; $P = 0.18$	4.12; $P < 0.01$	4.10; $P < 0.01$	1.04; $P = 0.15$	-0.02; $P = 0.49$

26–50%, 51–75%, and 76–100%) were measured in a 1 m<sup>2</sup> quadrat centered on the snake's location. The same data were collected in a 1 m<sup>2</sup> quadrat at random locations. Random locations were determined using a random number generator to produce a compass bearing and distance within 50 m of the snake's location. We used a Wilcoxon test to determine if mean percent cover (based on midpoint of cover classes) differed between snake and random locations. Statistical analyses were conducted with SAS (v. 9.1.3, SAS Institute Inc., Cary, NC). As only two females were monitored, we assumed no sex-specific differences in habitat selection and grouped both sexes for analysis. All snake locations were considered independent, as is standard in studies of this type (Blouin-Demers and Weatherhead, 2001).

## RESULTS

Radio-tagged *L. getula* ranged from 860–1,341 mm SVL; body mass ranged from 285–826 g (Table 1). We tracked snakes for 221–1,043 days (mean = 447.5 days). Snakes were located, on average, 83.8 (range = 36–183) times over the course of the study (Table 1).

Random locations contained more bare ground ( $z = -3.73$ ,  $P < 0.01$ ) and less coarse woody debris ( $z = 4.1$ ,  $P < 0.01$ ) and woody vegetation ( $z = 4.12$ ,  $P < 0.01$ ) than snake locations (Table 3). Canopy cover was similar between snake (47%) and random (48%) locations.

We located *L. getula* underground within an identifiable refuge 196 times (excluding tracking events when an animal was located within the same refuge). A variety of refuge types were recorded. Small mammal burrows were the most commonly identified refuge (54%), followed by stumpholes (28%), Southeastern Pocket Gopher tunnels (10%), Nine-banded Armadillo burrows (3%), Gopher Tortoise burrows (2%), and "Other" (3%), which included one canid burrow and two Eastern Woodrat (*Neotoma floridana*) burrows. We were unable to identify below ground refuge types on 164 additional occasions, excluding repeat locations.

Habitat selection was not detected at the third order scale (within home range; Table 4). At the second order scale (landscape scale; within study area), multivariate analysis of variance indicated non-random habitat use ( $F = 6.87$ ,  $df = 7,5$ ,  $P = 0.025$ ): *L. getula* were observed closer to natural pine ( $F = 21.31$ ,  $df = 11$ ,  $P < 0.001$ ) and hardwoods ( $F = 9.08$ ,  $df = 11$ ,  $P = 0.012$ ) than expected (Table 4). Of the two habitats, *L. getula* were observed closer to natural pine than hardwood habitat (Table 5).

## DISCUSSION

At Ichauway, *L. getula* exhibited selection at the study area (landscape) scale (Johnson's second order) for two upland forest types: natural pine and hardwood. However, *L. getula* did not select habitat at the home range scale (Johnson's third order). Although this species is suggested to use a variety of macrohabitats in the northeast (Wund et al., 2007), selection at this scale was not quantified. In contrast to anecdotal accounts (Kauffeld, 1957; Conant and Collins, 1998; Krysko, 2008), we found no association between *L. getula* and wetlands.

At the microhabitat scale, *L. getula* selected sites with more woody debris and shrub cover than found at random sites, which was consistent with Wund et al. (2007). This behavior may function to reduce predation by visual predators, particularly birds of prey, or may be related to thermoregulation. Sites with these characteristics may also have been used because that was where small mammals tended to construct burrows, commonly used as refuges by *L. getula* in our study.

Although *L. getula* used a variety of underground refuges, small mammal burrows and stumpholes were used most frequently. We suspect that use of small mammal burrows was underestimated because these burrows are often inconspicuous. Stumpholes have previously been identified as important refugia for *L. getula* and other snake species (Means, 2005, 2006), although this relationship has rarely been quantified for individual snakes. The frequent use of

**Table 4.** MANOVA Results for Habitat Selection by Common Kingsnakes, *Lampropeltis getula*, on Ichauway, Baker County, Georgia, from 2006–2008.

Habitat	Within home range scale (Johnson's third order)			Landscape/study area scale (Johnson's second order)		
	df	F-value	P-value	df	F-value	P-value
Agriculture	11	3.58	0.09	11	0.10	0.75
Hardwood	11	0.08	0.78	11	9.08	0.01
Mixed pine/hardwood forest	11	0.21	0.65	11	0.81	0.39
Natural pine	11	0.20	0.66	11	21.31	<0.01
Pine plantation	11	3.66	0.08	11	0.99	0.34
Wetland	11	4.27	0.06	11	0.54	0.48
Scrub/urban	11	0.54	0.48	11	1.23	0.29

**Table 5.** Simplified Ranking Matrix for Common Kingsnake, *Lampropeltis getula*, Landscape Scale (Johnson's [1980] Second Order) Habitat Selection. Ranks are based on a comparison of mean distances from random locations within minimum convex polygon home ranges to mean distances within the study area. Each mean element in the matrix was replaced by its sign; a triple sign indicates significant deviation from random at  $P < 0.05$  (see Table 4).

	Agriculture	Hardwood	Mixed pine/HW	Natural pine	Pine plantation	Wetland	Scrub/shrub
Agriculture		+++	-	+	+	-	-
Hardwood	---		---	+	-	---	---
Mixed pine/HW	+	+++		+++	+	-	-
Natural pine	-	-	---		---	---	---
Pine plantation	-	+	-	+++		-	-
Wetland	+	+++	+	+++	+		-
Scrub/shrub/urban	+	+++	+	+	+	+	
Rank	4	2	5	1	3	6	7

stumpholes as refugia may suggest that forest management practices could influence *L. getula* populations (Means, 2005, 2006).

That *L. getula* showed selection for natural pine and hardwood habitats in our study is interesting given recent changes in land use in the southeastern U.S. Old growth Longleaf Pine was harvested between the late 1880s and early 1900s. After harvest, much of the natural pine habitat was converted to Slash Pine (*Pinus elliotii*) and Loblolly Pine (*Pinus taeda*) plantations, agriculture, or urban areas (Frost, 1993). In contrast, hardwood forests, which are often associated with low lying areas or fire suppressed uplands, have increased in relative extent across the region (Ware et al., 1993). Ichauway, which has approximately 4,000 ha of fire-maintained Longleaf Pine/Wiregrass savanna, is not representative of the current landscape in the southeastern U.S., nor is it representative of southwestern Georgia, where agriculture is the primary land use (Goebel et al., 2001).

Our results would seem to suggest that habitat modification that fragments or degrades forested areas would be to the detriment of kingsnake populations. However, kingsnakes in the northeast were documented in upland dry oak forest, cedar swamp, red maple swamp, bog, and streambank habitats (Wund et al., 2007), and kingsnakes occur in diverse, and modified, habitats adjacent to our study area (unpubl. data). Interestingly, Winne et al. (2007) discussed how successional changes in forests, among other factors, may have been responsible for the apparent decline of a *L. getula* population in South Carolina. We suspect that although they are associated with two particular forest types at Ichauway, habitat selection in *L. getula* may vary across the region. Additional research is needed to better define the breadth of habitats used by *L. getula* in the southeast and to assess population viability in these areas.

Recent literature suggests that reptile habitat selection is complex and can occur at several scales (Fischer et al., 2004; Moore and Gillingham, 2006). Our findings regarding *L. getula* on a managed Longleaf Pine forest in southwest Georgia support this contention. Although we suspect that *L. getula* can persist in landscapes that differ from Ichauway, our study may offer important information about the behavior and habitat use and selection of the species under relatively natural conditions.

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#### LITERATURE CITED

- Beyer, H. L. 2004. Hawth's analysis tools for ArcGIS. <http://www.spatialecology.com/htools>
- Blouin-Demers, G., and P. J. Weatherhead. 2001. Habitat use by black rat snakes (*Elaphe obsoleta obsoleta*) in fragmented forests. *Ecology* 82:2882-2896.
- Burgdorf, S. J., D. C. Rudolph, R. N. Conner, D. Saenz, and R. R. Schaefer. 2005. A successful trap design for capturing large terrestrial snakes. *Herpetological Review* 36:421-424.
- Conant, R., and J. T. Collins. 1998. Reptiles and Amphibians of Eastern/Central North America. Houghton Mifflin, Boston.
- Conner, L. M., and B. W. Plowman. 2001. Using Euclidean distance to assess nonrandom habitat use, p. 275-290. *In: Radio Tracking and Animal Populations*. J. J. Millspaugh and J. M. Marzluff (eds.). Academic Press, San Diego, California.
- Conner, L. M., M. D. Smith, and L. W. Burger. 2003. A comparison of distance-based and classification-based analyses of habitat use. *Ecology* 84:526-531.
- Dodd, C. K., Jr. 1987. Status, conservation, and management, p. 478-513. *In: Snakes: Ecology and Evolution*. R. A. Seigel, J. T. Collins, and S. S. Novak (eds.). The Blackburn Press, Caldwell, New Jersey.
- Dodd, C. K., Jr. 1995. Reptiles and amphibians in the endangered longleaf pine ecosystem, p. 129-131. *In: Our Living Resources*. E. T. Laroe, G. S. Farris, C. E. Puckett, P. D. Doran, and M. J. Mac (eds.). National Biological Service, Washington, D.C.
- Ernst, C. H., and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Institution Press, Washington, D.C.

- Fischer, J. F., D. B. Lindenmayer, and A. Cowling.** 2004. The challenge of managing multiple species at multiple scales: reptiles in an Australian grazing landscape. *Journal of Applied Ecology* 41:32–44.
- Frost, C. C.** 1993. Four centuries of changing landscape patterns in the Longleaf Pine ecosystem, p. 17–43. *In: Proceedings of the Tall Timbers Fire Ecology Conference*, No. 18. The Longleaf Pine Ecosystem: Ecology, Restoration and Management. S. Hermann (ed.). Tall Timbers Research Station, Tallahassee, Florida.
- Gibbons, J. W., and K. M. Andrews.** 2004. PIT tagging: simple technology at its best. *BioScience* 54:447–454.
- Goebel, P. C., B. J. Palik, L. K. Kirkman, M. B. Drew, L. West, and D. C. Peterson.** 2001. Forest ecosystems of a Lower Gulf Coastal Plain landscape: multifactor classification and analysis. *Journal of the Torrey Botanical Society* 128:47–75.
- Guyer, C., and M. A. Bailey.** 1993. Amphibians and reptiles of longleaf pine communities, p. 139–158. *In: Proceedings of the Tall Timbers Fire Ecology Conference*. No. 18. The Longleaf Pine Ecosystem: Ecology, Restoration and Management. S. M. Hermann (ed.). Tall Timbers Research Station, Tallahassee, Florida.
- Johnson, D. H.** 1980. The comparison of usage and availability measurements for evaluating resource preference. *Ecology* 61:65–71.
- Kauffeld, C.** 1957. *Snakes and Snake Hunting*. Hanover House, Garden City, New York.
- Krysko, K. L.** 2008. Common kingsnake, p. 361–363. *In: Amphibians and Reptiles of Georgia*. J. B. Jensen, C. D. Camp, W. Gibbons, and M. J. Elliott (eds.). The University of Georgia Press, Athens, Georgia.
- Krysko, K. L., and D. J. Smith.** 2005. The decline and extirpation of the kingsnake in Florida, p. 132–141. *In: Amphibians and Reptiles: Status and Conservation in Florida*. W. E. Meshaka and K. J. Babbitt (eds.). Kreiger Publishing, Inc., Malabar, Florida.
- Means, D. B.** 2005. The value of dead tree bases and stumpholes as habitat for wildlife, p. 74–78. *In: Status and Conservation of Florida Amphibians and Reptiles*. W. Meshaka and K. Babbitt (eds.). Florida University Presses, Gainesville, Florida.
- Means, D. B.** 2006. Vertebrate faunal diversity in longleaf pine savannas, p. 155–213. *In: Longleaf Pine Ecosystems: Ecology, Management, and Restoration*. S. Jose, E. Jokela, and D. Miller (eds.). Springer, New York.
- Mohr, C. O.** 1947. Table of equivalent populations of North American small mammals. *The American Midland Naturalist* 37:223–249.
- Moore, J. A., and J. C. Gillingham.** 2006. Spatial ecology and multi-scale habitat selection by a threatened rattlesnake: the eastern massasauga (*Sistrurus catenatus catenatus*). *Copeia* 2006:742–751.
- Noss, R. F.** 1989. Longleaf pine and wiregrass: keystone components of an endangered ecosystem. *Natural Areas Journal* 9:211–213.
- Reinert, H. K., and D. Cundall.** 1982. An improved surgical implantation method for radio-tracking snakes. *Copeia* 1982:702–705.
- Smith, L. L., D. A. Steen, J. M. Stober, M. C. Freeman, S. W. Golladay, L. M. Conner, and J. Cochrane.** 2006. The vertebrate fauna of Ichauway, Baker County, GA. *Southeastern Naturalist* 5:599–620.
- Stapleton, S. P., K. J. Sash, D. B. Means, W. E. Palmer, and J. P. Carroll.** 2008. Eastern kingsnake (*Lampropeltis getula*) population decline in North Florida and South Georgia. *Herpetological Review* 39:33–35.
- Ware, S., C. Frost, and P. D. Doerr.** 1993. Southern mixed hardwood forest: the former longleaf pine forest, p. 447–493. *In: Biodiversity of the Southeastern United States: Lowland Terrestrial Communities*. W. H. Martin, S. G. Boyce, and A. C. Echternacht (eds.). John Wiley & Sons, Inc., New York.
- Winne, C. T., J. D. Willson, B. D. Todd, K. M. Andrews, and J. W. Gibbons.** 2007. Enigmatic decline of a protected population of eastern kingsnakes, *Lampropeltis getula*. *Copeia* 2007:507–519.
- Wund, M. A., M. E. Torocco, R. T. Zappalorti, and H. K. Reinert.** 2007. Activity ranges and habitat use of *Lampropeltis getula getula* (eastern kingsnakes). *Northeastern Naturalist* 14:343–360.