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On the Importance of Disturbed Sites to Habitat Selection by Pine Snakes in the Pine Barrens of New Jersey

Introduction

Unlike birds or mammals that have rapid forms of locomotion, most snakes move relatively slowly. Consequently a snake's choice of habitat might be expected to reflect its daily requirements. Reptiles are constrained in their habitat choices by requirements for food and safe areas for reproduction, as well as suitable basking, resting, and hiding, places. Presumably environmental factors such as light intensity, temperature, and food availability, could influence daily choices of microhabitat, although a combination of more constant factors might determine general habitat selection (Hearwold, 1977). Selection of a habitat implies use that makes it different from random choices from among the habitats available, and its understanding requires information on how the animal responds to immediate environmental stimuli (*Ibid.*).

There are few studies of habitat selection by snakes—*inier alia* because they are often difficult to locate, so that many years of data-collection can result in few captured snakes (Fitch & Fleet, 1970). In general, data on the behaviour and ecology of snakes have been gathered from a limited number of living captures (e.g. Blaesing, 1979; Stickel & Schmid, 1980; Sullivan, 1981) and museum specimens (Quinn, 1979), by radio-telemetry (Fitch & Shirer, 1971; Plummer, 1981), or from laboratory studies of recently-captured snakes (Gillingham, 1979).

We examined habitat selection by the Pine Snake (*Pituophis melanoleucus melanoleucus*) from 1978 to 1983 in the Pine Barrens of central New Jersey. Our objectives were (1) to compare general habitat selection (forest type) with all available habitats, (2) to determine microhabitat selection within the forest types used by Pine Snakes,* and (3) to determine the importance of Man-disturbed habitats to Pine Snakes. We were particularly interested in the effect of human activity on habitat selection in Pine Snakes, as the New Jersey Pine Barrens is constantly under pressure from development. The Pine Barrens has had a long history of

limited human use, with periodic abandonment of towns, fields, blueberry and cranberry bogs, and bog-iron lands;† and we were interested in assessing the importance of those areas to habitat selection by Pine Snakes. We defined disturbed habitats as all areas that showed any signs of disturbance, regardless of the length of time since the disturbance took place.

Pine Snakes are relatively rare along the east coast of North America, as in the Pine Barrens, and are listed as a 'threatened species' by the New Jersey Department of Environmental Protection (NJDEP), Division of Fish, Game and Wildlife, Endangered and Nongame Species Program.

Study Area and Methods

Pine Snakes were studied in a ca 7 km x 5 km study-plot located near Toms River in Ocean County, New Jersey (Fig. 1). The study area contained human residential communities and forested sections. Its vegetation is typical of Pine Barren vegetation near residential communities, being exposed to continuous pressures from developers. Areas of forest are predominantly of Pitch Pine (*Pinus rigida*), Scrub Oak (*Quercus marylandica*), and White Cedar (*Thuja occidentalis*). We defined four forest types on the basis of vegetation species-composition (Table I).

Data were collected from 1 April 1978 through August 1983, and over 4,653 Man-hours (using 11 people) were spent searching the study area for snakes. Approximately equal time was spent each year. Observations were usually made from 0700 to 1930 hours. Searching involved walking slowly through the woods and along roads, searching the ground, and looking under all dead logs, wood, and other debris where snakes might hide.

All the snakes located were captured, and the following data were collected on habitat preferences: disturbance type (disturbed or undisturbed), forest type, elevation, soil type (from USDA soil-maps), nearest vegetation (domi-

* e.g. not expected under dense pine-needles.—Ed.

† Where iron has been mined.—Ed.



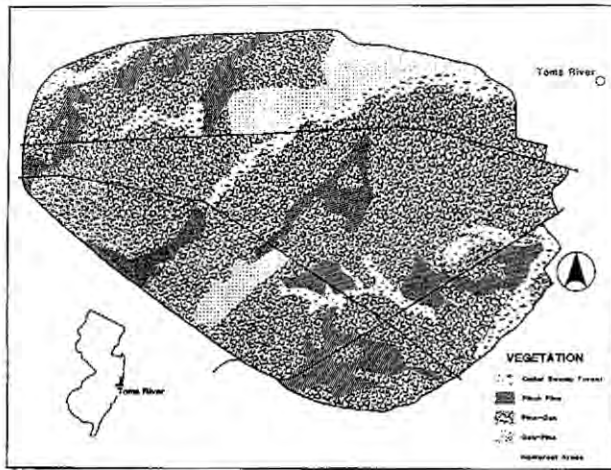


FIG. 1. Sketch-map of study area ca 7 by 5 km near Toms River, Ocean County, New Jersey, USA.

Specific Habitat Preferences:—Although we divided the study-plot into major forest types (Table I), within each type the species of trees present could vary. The snakes were randomly distributed with respect to these microhabitat types (Fig. 2, $X^2 = 6.0$, $df = 3$).

Several other microhabitat factors such as ground-cover, nearest vegetation-type, and soil type, could affect distribution of Pine Snakes, as they influence ground moisture and protection from the heat of the sun. Significantly more snakes were located on Lakehurst soil* than on other soil-types compared with the random points ($X^2 = 6.80$, $df = 2$, $P < .05$, Fig. 3). Significant differences existed in ground-cover preferences, as more snakes were found on pavement and bare sand, and fewer were found on moss and oak leaves ($X^2 = 27.05$, $df = 5$, $P < .001$, Fig. 4). We spent significantly more time walking through the forest searching for snakes than looking on pavement or bare sand, so this difference is not due to snakes being more obvious on pavement. Similarly, Pine Snakes were not distributed randomly with respect to the nearest vegetation: more were near or under the sedge *Carex pensylvanica* and Pitch Pine,

TABLE I

Forest Types and Snake Use in the New Jersey Pine Barrens (1978–83).

Forest Type	Percentage Oak	Percentage Pine	Percentage Ground Cover	Percentage of Study Area	Man-hours spent in each habitat number (%) ^a	Number of Pine Snakes
Cedar Swamp	0	0	100	15	10	0
Pitch Pine Lowland	10	80	90	18	15	6 (12)
Pine-Oak Forest ^b	30	60	40	59	60	45 (89)
Oak-Pine Forest ^c	55	40	75	8	15	0

^a Percentage of 4,653 Man-hours. ^b 60% dominance by pines. ^c 55% dominance by oaks.

nant species), ground-cover within 1 m, distance to water (bogs), and specific location (road, railroad bed, under log, etc.). Other data collected included sex, activity, cloacal temperature, air temperature, and substrate temperature. Snakes were marked, and in this study we recorded the habitat of a particular snake only on our first encounter with it.

We compared the general habitat-type of the 51 snakes encountered with the available habitat (computed from aerial maps and ground surveys) and with the amount of time we spent searching in each habitat. We then compared the microhabitats used by the snakes with habitat characteristics of randomly-selected points within the areas, by selecting 200 random points within the forest types used by snakes, and recording the same characteristics as we had recorded for the snakes.

Results

General Habitat Preference:—Pine-Oak was the predominant forest type in the study area, followed by pure stands of Pitch Pine (Fig. 1 and Table I). Pine Snakes occurred in those two forest Types significantly more than had been predicted on the basis of the availability of each type ($X^2 = 8.5$, $df = 1$, $P < .005$). However, within Pitch Pine and Pine-Oak forests, Pine Snakes preferentially occurred in Oak stands ($X^2 = 26.2$, $df = 3$, $P < .001$). Less than 20% of the study area was Man-disturbed, yet 88% of the Pine Snakes were observed in these areas. Man-disturbed areas were relatively open.

and fewer were near Sawbrier (*Similax glauca*), oak, and blueberry (*Vaccinium* sp.), than had been expected ($X^2 = 28.95$, $df = 3$, $P < .001$, Fig. 5). The major vegetation species grew on all the soil types; thus soil type was not an indication of vegetation type.

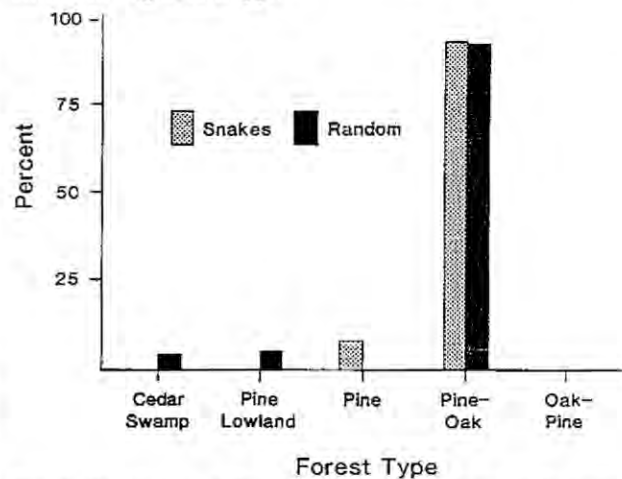


FIG. 2. Distribution of Pine Snakes and random points by major forest type.

*A particular designation used by geologists' (J. Burger, in litt.).—Ed.

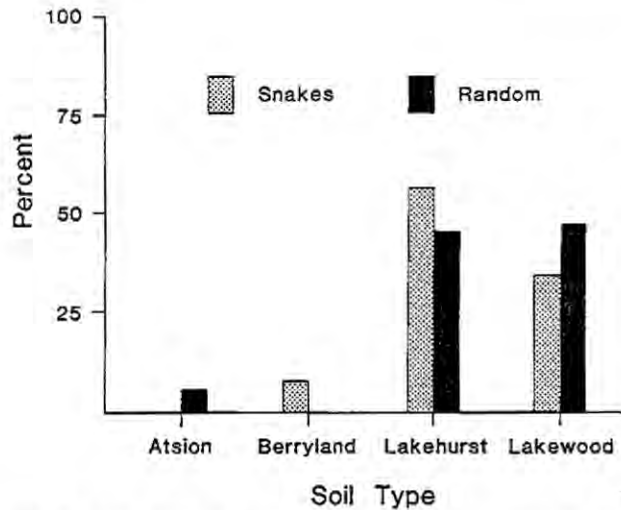


FIG. 3. Distribution of Pine Snakes and random points by soil type.

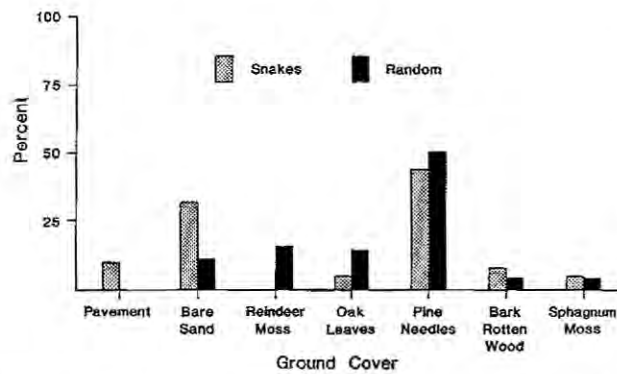


FIG. 4. Distribution of Pine Snakes and random points by ground-cover type.

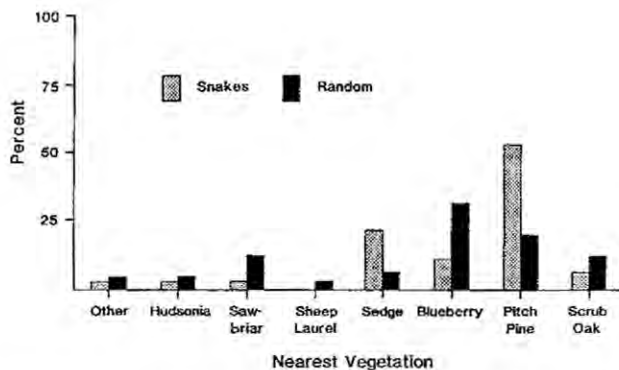


FIG. 5. Distribution of Pine Snakes and random points by characteristic species of low vegetation.

There were no significant sexual differences in where we found Pine Snakes with respect to any of the habitat variables. We did not include nesting females in the analysis as all were located in open, unvegetated sections of sand that were disturbed.

Discussion

General Habitat Preferences:—Pine Snakes were primarily found in open, Man-disturbed sections of Pine and Pine-Oak forests. These preferences are real, as we searched a proportionate amount of time in all the habitats. There is no clear reason why our observations should be biased when comparing Pine and Pine-Oak to Cedar swamp or Oak-Pine. However, snakes were easier to see in disturbed as opposed to undisturbed habitats, because there are fewer obstructions and the vivid pattern of the snakes is more obvious on the open sand of disturbed habitats. Some snakes were found hidden under hollow railroad ties, plywood, or sheets of iron, while others were in holes in rotten logs. Moving snakes are easier to find than stationary snakes. Another problem is that natural habitats provide abundant places for snakes to hide and pass undetected. Although we turned over boards or logs, snakes hiding inside logs, stumps, or burrows, or under leaves, might well go undetected. These possibilities suggest that Pine Snakes might be more abundant in undisturbed habitats than we found them to be, but to determine this would require observations on radiotagged snakes.

A preference for disturbed habitats may reflect differences in food supply or temperature considerations, at least early in the day when snakes are absorbing heat prior to becoming active. Basking snakes might select open habitats with few trees. A preference for Pine and Pine-Oak over the lower-elevation (Cedar swamps and Pitch Pine lowlands) or higher-elevation (Oak-Pine) sections, might reflect optimal conditions with respect to soil moisture and overstorey cover. Cedar swamps are wet and dark, providing few opportunities for basking.

Specific Habitat Preferences:—Within the Pine and Pine-Oak forests there were no preferences for tree species, indicating that a wide range of habitats are used. Pine Snakes were usually found in areas underlain by Lakehurst soil, which may affect ground-cover and ground vegetation. Pine Snakes were also commonly found on pavement, bare ground, or pine needles—all of them flat, dry surfaces. In contrast they were generally not found on moss, oak leaves, bark, or rotten wood. Such preferences indicate selection of flat, dry surfaces where they were often observed basking when not moving. They were usually near to open vegetation, which allowed light-penetration—rather than dense, thick, tangly vegetation which might be difficult to move through. Snakes could thus bask in full sunlight, while being sufficiently close to cover. Indeed, 58% of the snakes located were basking, 25% were moving, and only 17% were inactive (and not basking). It is, however, quite possible that we missed some inactive snakes because they were hidden under leaves, in logs, or in burrows.

All females that were excavating nests were located in open, bare sand in disturbed habitats. The nesting requirements of females may affect overall habitat selection in Pine Snakes, as they might be expected to remain near their nesting sites throughout the year.

Importance of Man-disturbed Habitats:—When considering preservation of the Pine Barrens, conservationists usually select places that most closely approximate to natural Pine Barrens ecosystems. Thus they avoid sections

that have been heavily impacted by Man, such as old abandoned farms, houses, or bog-iron towns. Further, old roads and railroad beds are often slated for 'restoration' to their natural state.

The results of this study clearly indicate that Pine Snakes not only use Man-disturbed habitats, but spend a great deal of time in them. Within disturbed areas they were found in places of low cover, which were generally areas of drastic disturbance. Nesting females were all located in disturbed habitats. As females take several hours to excavate a nest, it is unlikely that we missed nested females along our census routes. However, non-nesting Snakes also preferred disturbed habitats. Thus in selecting habitats to be preserved in the Pine Barrens it is essential to include some areas with early successional vegetation. These places may be a result of natural fire as well as Man's activities, but they are clearly being used heavily by Pine Snakes. Conservationists might accordingly consider selectively creating and maintaining small areas at an early successional stage.

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