Journal of Ecological Research, 3, 53-61 (2001)

EFFECT OF COLOUR PHASE ON WINTER HABITAT CHARACTERISTICS OF THE EASTERN SCREECH OWL, *OTUS ASIO*, IN CENTRAL PENNSYLVANIA

Brian Olsen and Paula Mooney

ABSTRACT

Previous studies have shown that the rufous phase of the eastern screech owl, *Otus asio*, has a higher metabolic rate than does the gray phase. We hypothesized that rufous phase owls need a greater caloric intake and choose milder environmental climes for their winter territories. We predicted that rufous screech owl territories in Huntingdon County, Pennsylvania would exhibit higher capture rates of small mammals, higher mean and maximum daily temperatures, and lower minimum daily temperatures and temperature ranges. We also hypothesized that *Peromyscus* mice within the rufous phase owl territories would have higher body masses than those in the gray phase owl territories. We found a significant difference between capture rates of small mammals in rufous owl territories (2.92 captures/night) versus gray owl territories (2.12 captures/night) (t = 1.94, n = 16, P = 0.047). We found no significance, however, between mean temperatures in rufous (4.64 ± 0.74°C) versus gray (5.08 ± 1.14°C) territories (t = -0.62, df = 8, P = 0.724), high temperatures in rufous (5.36 ± 0.40°C) versus gray (5.95 ± 1.92°C) territories (t = -0.41, df = 8, P = 0.654), low temepartures in rufous (3.72 ± 0.78°C) versus gray (3.54 ± 0.39°C) territories (t = -0.61, df = 8, P = 0.718), and temperature ranges in rufous (5.52 ± 0.57°C) versus gray (5.22 ± 2.00°C) territories (t = -0.27, df = 8, P = 0.603). Likewise, we found no significance differences in *Peromyscus* masses between rufous (18.78 ± 2.74g) and gray (19.25 ± 2.79g) territories (t = -0.76, df = 88, P = 0.774). Our data suggests that small mammal abundance plays an important role in the selection of territories by rufous and gray phase screech owls.

Keywords: color dimorphism, eastern screech owl, habitat selection, metabolism, Otus asio, Peromyscus *mice*

INTRODUCTION

Eastern screech owls, *Otus asio*, are found in two different color phases, rufous and gray. This characteristic has long piqued the interest of the scientific community. Until as late as 1853 the two phases were considered separate species, the rufous and mottled owls, and well after that it was hypothesized that one phase was the immature form while the other was the adult. Through careful observation of 3,600 owls, Hasbrouck (1893) determined that the color phases could not be attributed to gender, age, or season. He attributed the presence of one phase over another to local temperature and humidity. Studies by Martin (1950) agreed with Hasbrouck's conclusion that color was independent of gender. As theories of ecology and evolution have matured, many other ideas have been proposed about asexual dichromatism in different avian species. Berry and Davis (1970) cited mate-pairing advantages as the reason for skua dichromatism. Johnson and Brush (1972) proposed that dichromatism in sooty-capped bush tanagers was for microhabitat camouflage. Hrubant (1955) hypothesized that the two color phases of screech owls were due to the presence of two or three alleles, where rufous was dominant to gray, with a possible intermediate. Hrubant still didn't explain why owls are completely gray in the northern extremes of the range while in the southern edge of the range they are almost completely rufous (Weidensaul, 1997). Stullken and Hiestand (1953) showed that coat color can have a dramatic effect on metabolic rate at lower temperatures. They dyed the coats of a group of albino mice black and compared their oxygen consumption to white mice. They found that at lower temperatures (5°C) the blackened mice consumed 42% more oxygen because of the thermodynamic properties of their coat color. Rufous screech owls have also been shown to consume more oxygen than do their gray counterparts, especially at low temperatures (-5 to -10° C) (Mosher and Henry 1976). A study by Dexter (1996) also found evidence for this same property. He went on to note that rufous phase feathers were less efficient at absorbing solar radiation, and therefore rufous owls had higher metabolic rates to sustain the same body temperature as gray owls. According to Stullken and Hiestand (1953) this effect should be amplified during the winter because of the harsher environmental climes. Accordingly, winter territories should be influenced by small mammal abundance, because these small mammals make up the majority of the winter diet of the screech owl (Dexter 1996, Weidensaul 1997). Additionally, animals which have adapted to habitats with low food abundance or quality often have lower metabolic rates than do those animals in habitats with higher food abundance and quality (Dobson 1992, Flannery 1993, Lee and Martin 1990, Philips 1995, Procter-Gray 1990). Because of these effects, we formulated the following hypotheses:

1. The average per night capture rate of small mammals in rufous phase eastern screech owl territories should be greater than that of gray phase owl territories.
2. The average mass of *Peromyscus* mice in rufous phase eastern screech owl territories should be greater than that of gray phase owl territories.
3. The average, minimum, and maximum daily ambient air temperature in rufous phase eastern screech owl territories should be greater than that of gray phase owl territories.
4. The daily ambient air temperature ranges in gray phase eastern screech owl territories should be greater than that of rufous phase owl territories.

FIELD SITE

We located eight rufous and eight gray eastern screech owl territories in the ridge and valley region of Pennsylvania (Table 1, Figure 1).

Table 1. General descriptions of the screech-owl territories within six locales in Huntingdon County, Pennsylvania, 2001. Trap lines that were operated on the same night are paired (e.g., 1a, 1b).

#	Territory	Rufous	Description
1a*	Spillway	Rufous	Primarily evergreen, with scattered deciduous, bordered by small stream and pond, lowland
1b	Fire Ring	Gray	Exclusively mixed deciduous, no significant top soil, instead mostly boulders, elevated hillock
2a	Patrick's Lodge	Rufous	Mixed deciduous and evergreens, alongside very small pond formed by dammed stream
2b	Wetlands	Gray	Primarily deciduous with mixed evergreens, slightly higher peninsula amidst lowland wetlands.
3a	Grill	Rufous	Mixed deciduous and evergreens, stream lowlands
3b	Power Lines	Gray	Exclusive deciduous, immature forest, bordered by power line cut
4a	Stream	Rufous	Mixed deciduous and evergreens, stream lowlands
4b	Deer Path	Gray	Primarily deciduous with scattered evergreens, alongside small clearing

5a	House	Rufous	Primarily deciduous with scattered evergreens, melt-water stream-bed, nearly adjacent to Raystown Branch of the Juniata River
5b	Dam	Gray	Primarily deciduous with scattered evergreens, extremely steep slope on both sides of stream.
6a	Field	Rufous	Primarily deciduous with scattered evergreens, nearly adjacent to Raystown Branch of the Juniata River
6b	Logging Road	Gray	Primarily deciduous with scattered evergreens, slope on both sides of stream.
7a	James Creek	Rufous	An evergreen stand clearly divided from a deciduous stand by a ~20m wide swath of swampy lowlands
7b	RFS	Gray	Mixed deciduous and evergreens, exposed ridgetop
8a	Gravel Pit	Rufous	Primarily evergreen with scattered deciduous, small melt-water stream
8b	Suburbia	Gray	Primarily evergreens with mixed deciduous, steep incline

**a and b are paired territories where traps where operated on identical nights*

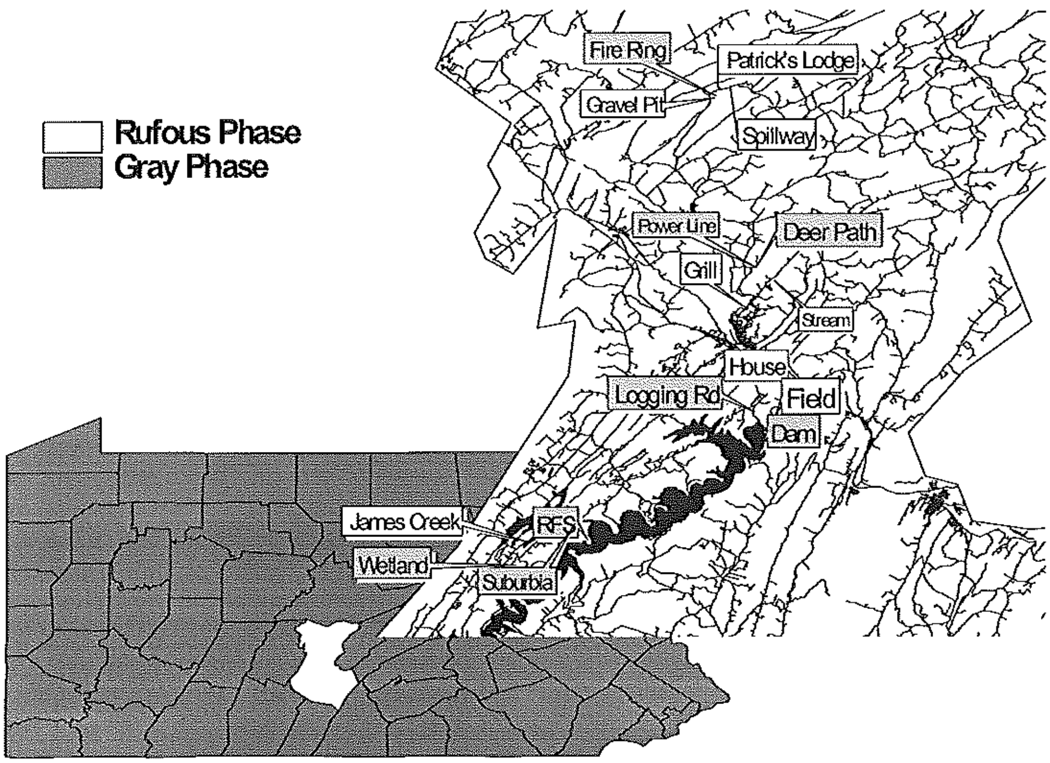

Figure 1. Location of screech owl territories within Huntingdon County, Pennsylvania.

METHODS AND MATERIALS

We attracted owls using broadcasted whinny and tremolo calls with a johnny caller (Adam 1987, Carpenter 1987, Smith, Devine and Walsh 1987). We repeated callbacks up to seven times at 1-minute intervals until an owl was positively identified with spotlights and 8x42 binoculars. During the course of the study we reconfirmed the color phase of the owl onto subsequent nights. In each territory, we established two transect lines, each with 8 stations of paired Tomahawk Live Traps. The transects converged at the initial point of owl observation, with each line running in a direction of observed owl behavior (i.e. , visual or vocal confirmation of a spotlighted owl or its mate, or spotlighted bird's exit flight) (Fig. 2). Trap pairs were separated by approximately 10 yards, although specific placement of each trap made allowances to take advantage of microhabitat cover. Trap lines were operated 3 successive nights in each territory, and captured mammals were marked by fur clipping and massed before release. To factor out the influence of weather conditions on trapping success, gray and rufous territory trap lines were paired and operated on the same nights (Table 1).

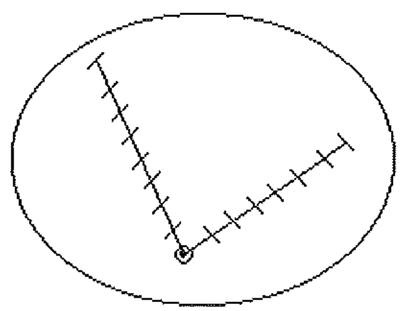

Figure 2. Two transect layouts in approximate boundaries of a screech owl territory, emanating from the initial point of observation, with two traps placed at this initial point and then every 10 yards in two different directions.

We placed HOBO temperature recorders in 14 of the 16 territories from 18 February to 15 March, 2001. Only one probe was placed between the two gray Spillway territories and one between the two rufous Spillway territories because these territories were adjacent to one another and our temperature recorder supply was limited. Temperature recorders were placed at the intersect of the two trap transect lines approximately 1 m above the ground and recorded air temperature every 36 minutes for 26 days.

We tested for normality using a Ryan-Joiner Normality test, and for homogeneity of variance with a Levene's test. We considered differences to be significant if $P \leq 0.05$. We compared capture rates using a one-tailed paired student's t test. We compared average *Peromyscus* masses, daily temperature lows and highs, temperature ranges, and average territory temperatures in rufous phase territories to those in gray phase territories using a one-tailed two-sample student's *t* test. We only massed rodents of the genus *Peromyscus* (92% of captures) because of the extremely low capture rate of all other small mammal prey.

RESULTS

We found a significant difference between the capture rates of small mammals in gray (2.12 captures/night) and rufous (2.92 captures/night) phase eastern screech owl territories ($t = 1.94$, $P = 0.047$) (Fig. 3).

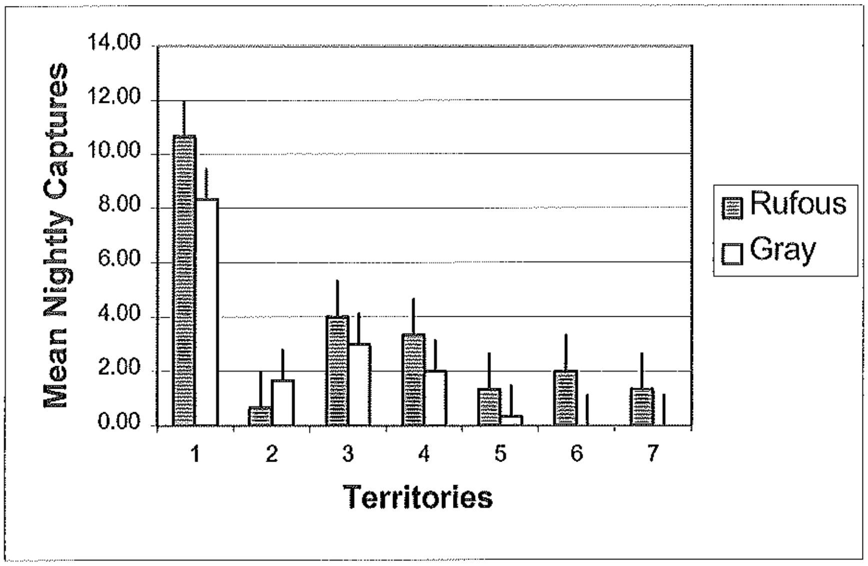

Figure 3. Mean nightly capture rates (± 1SE) *of small mammals in 8 gray phase and 8 rufous phase screech owl territories in Huntingdon County, Pennsylvania, 2001. Grouped territories were trapped on the same night.*

We found no significant difference, however, between the mean mass of *Peromyscus* mice in rufous (18.78 ± 2.74g) and gray (19.25 ± 2.79g) territories (t = -0.76, df = 88, P = 0.774) (Fig. 4).

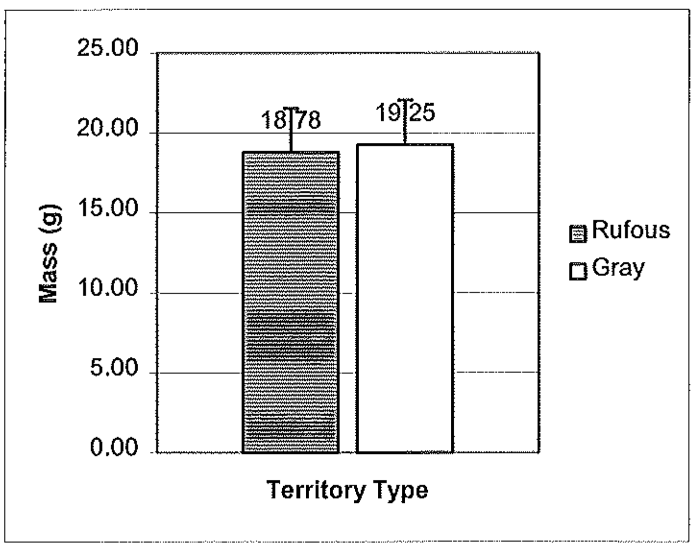

Figure 4. Mean masses (± 1SD) *of Peromyscus species captured in rufous and gray screech owl territories in Huntingdon County, Pennsylvania, 2001.*

Furthermore, we found no significant difference between temperature means (Fig. 5) in rufous (4.64 ± 0.74°C) versus gray (5.08 ± 1.14°C) territories (t = -0.62, df = 8, P= 0.724), lows (Fig. 6) in rufous (3.72 ± 0.78°C) versus gray (3.54 ± 0.39°C) territories (t = -0.61, df = 8, P = 0.718), highs (Fig. 7) in rufous (5.36 ± 0.40°C) versus gray (5.95 ± 1.92°C) territories (t = -0.41, df = 8, P = 0.654), and ranges (Fig. 8) in rufous (5.52 ± 0.57°C) versus gray (5.22 ± 2.00°C) territories (t = -0.27, df = 8, P = 0.603). During the study four of the temperature recorders malfunctioned leaving us with ten sampled territories, five rufous and five gray.

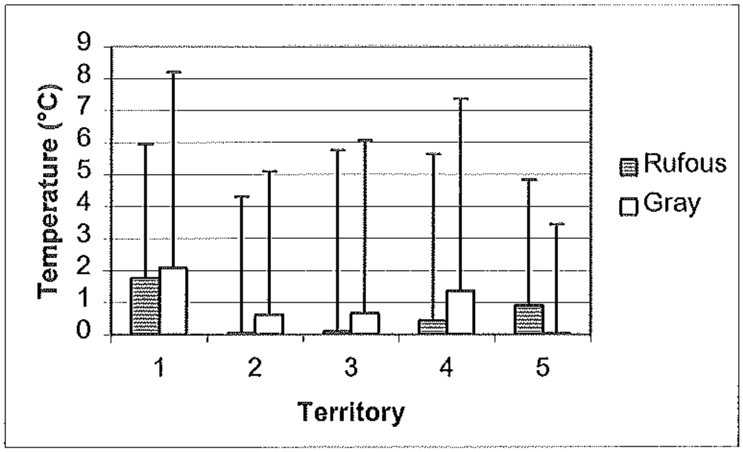

Figure 5. Mean daily ambient air temperatures (± 1 SD) *of 10 screech owl territories, 5 rufous and 5 gray, over 26 days in Huntingdon County, Pennsylvania, 2001.*

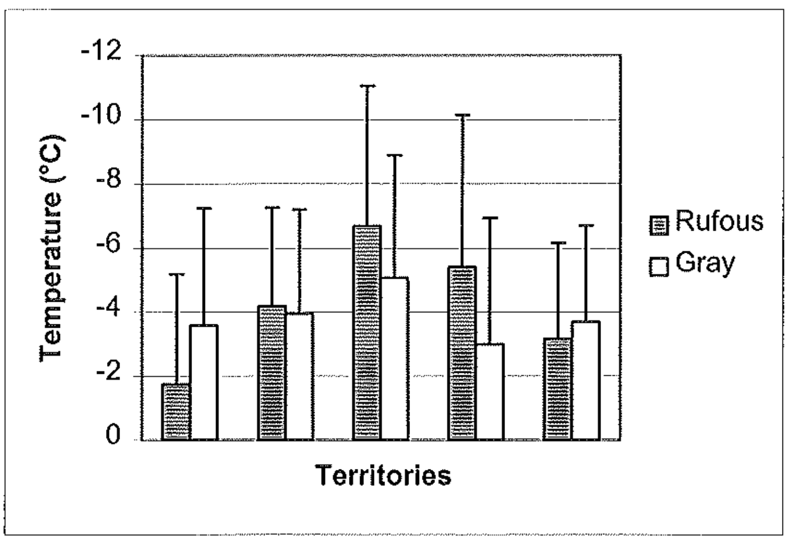

Figure 6. Mean daily ambient air temperature lows (± 1 SD) *of 10 screech owl territories, 5 rufous and 5 gray, over 26 days in Huntingdon County, Pennsylvania, 2001.*

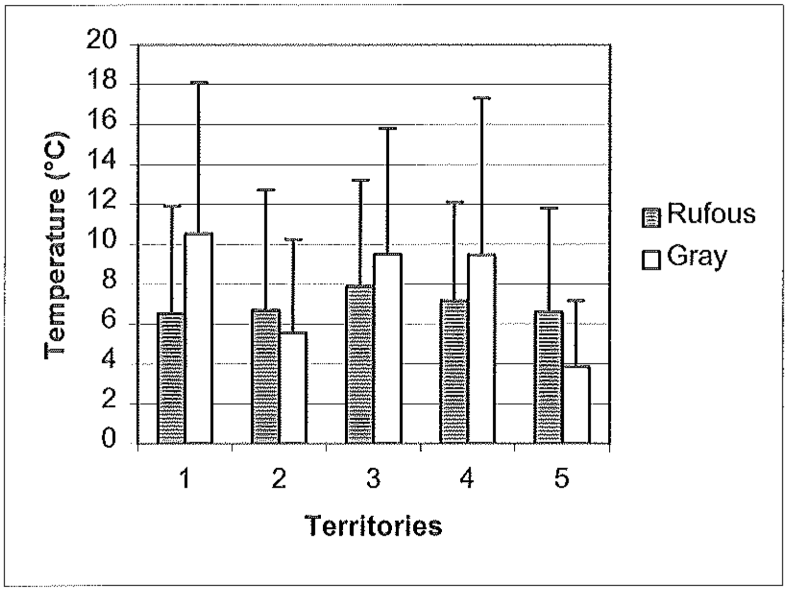

Figure 7. Mean daily ambient air temperature highs (± 1SD) *of 10 screech owl territories, 5 rufous and 5 gray, over 26 days in Huntingdon County, Pennsylvania, 2001.*

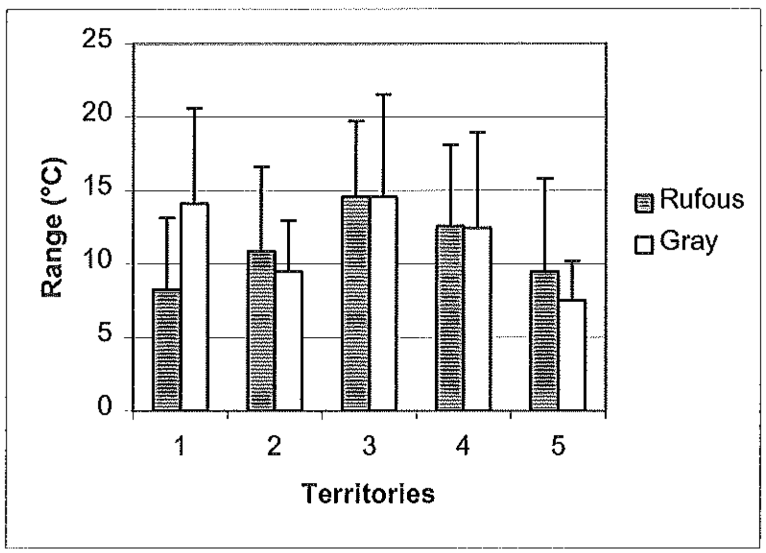

Figure 8. Mean daily ambient air temperature ranges (± 1SD) *of 10 screech owl territories, 5 rufous and 5 gray, over 26 days in Huntingdon County, Pennsylvania, 2001.*

DISCUSSION

Rufous screech owls in our study were associated with higher densities of small mammals as measured by relative capture rates. This finding may imply that rufous phase owls, with their higher metabolic rate (Dexter 1996, Mosher and Henry 1976) demand higher caloric intakes, and therefore must occupy territories where this demand can be satisfied. It remains to be seen how rufous owls are able to procure these territories, as they would be equally advantageous to gray phase owls. Whether there is a difference in competitive ability between the color phases remains to be seen. If rufous phase owls are occupying higher quality territories than gray phase owls, it is possible that there is some sort of behavioral isolation between the two phases that may have genetic implications. Although there are instances of inter-phase pairings (Dexter 1996), it is possible that these habitat demands may limit their occurrence. Mate selectivity in conjunction with habitat demands may act as a factor that limits the increase of genetically dominant red phase owls within the population.

A limitation of our study is that territory sizes were assumed equal between rufous and gray phases. If this were not the case, it allows for the possibility that gray and rufous phase territories have equal amounts of small mammals. Additionally, hunting time was assumed to be equal between the two phases. In actuality this may not be the case either, and could have an important effect on caloric intake.

Our study detected no difference in temperature among the territories, and thus it is unlikely that owls are using temperature as an environmental cue for habitat establishment. The dramatic variations and overlaps in daily and weekly temperatures make it very difficult to detect any possible differences. In all likelihood, these variations are such that the variations themselves would have more of an effect on the owls than any mean difference in temperature would. It is possible, however, that the color phases may choose roost sites with different temperatures. We also did not detect a difference in *Peromyscus* masses between the two territory types. Because *Peromyscus* mice are subject to the same environmental pressures and constraints among all of the territories, it would be unlikely that differences in mass would develop among these different populations.

Because many other avian species, including ruffed grouse, jaegers, and many hawks, exhibit color dimorphisms similar to the Eastern screech owl, our results could have important implications for habitat management and hunting regulations in order to maintain color phase diversity in various birds.

ACKNOWLEDGEMENTS

We would like to thank Andreas Evans, Chuck Yohn, Andy Watson, Rachel Skokan, Crystal Swan, Clayton Lutz, Nicholas Myers, William Koeppen, John Matter, the Raystown Field Station, and the Juniata College Environmental Science and Studies Department.

LITERATURE CITED

Adam, C. I.G. 1987. Status of the Eastern Screech Owl in Saskatchewan with a reference to adjacent areas. Biology and conservation of northern forest owls: symposium proceedings, Feb. 3-7, Winnipeg, Manitoba. USDA Forest Service General Technical Report RM-142: 268-276.

Berry, R. J. and P. E. Davis. 1970. Polymorphism and behaviour in the Arctic Skua (*Stercorarius parasiticus* (L.)). Proceedings of the Royal Society of London. Series B, Biological Sciences **175**: 255-267.

Bookhout, T. A. 1994. Research and management techniques for wildlife and habitats. Bethesda, Maryland: The Wildlife Society, USA.

Carpenter, T.W. 1987. Effects of environmental variables on responses of Eastern Screech Owls to playback. Biology and conservation of northern forest owls: symposium proceedings, Feb. 3-7, Winnipeg, Manitoba. USDA Forest Service General Technical Report RM-142: 277-280.

Cooperrider, A.Y. and R.J. Boyd. 1986. Inventory and monitoring of wildlife habitat. U.S. Department of the Interior, Bureau of Land Management.

Dexter, M.A. 1996. Plumage dichromatism and thermal ecology of the Eastern Screech Owl (*Otus asio*). Unpublished doctoral dissertation, Wake Forest University, Winston-Salem, USA.

Dobson, A. 1992. Withering heats. Natural History **101**: 2-8

Flannery, T. 1993. The case of the missing meat eaters. Natural History **102**: 40-45.

Fowler, L. J. 1985. Color phases of the Eastern Screech Owl in Tennessee. The Migrant **56**: 61-63.

Hasbrouck, E.M. 1893. Evolution and dichromatism in the genus *Megascops*. American Naturalist **27**: 521-533.

Hrubant, H.E. 1955. An analysis of the color phases of the Eastern Screech Owl, *Otus asio*, by gene frequency method. American Naturalist **89**: 223-230.

Johnson, N.K. and A.H. Brush. 1972. Analysis of polymorphism in the Sooty-Capped Bush Tanager. Systematic Zoology **21**: 245-262.

Kuzma, J.W. 1998. Basic statistics for the health sciences. Mayfield Publishing Company, London.

Lee, A. and R. Martin. 1990. Life in the slow lane. Natural History **99**: 34-43.

Martin, N.D. (1950). Color phase investigations on the screech owl in Ontario. Canadian Field Naturalist **64**: 208-211.

Mosher, J.A., and J.H. Charles. 1976. Thermal adaptiveness of plumage color in screech owls. Auk **93**: 614-619.

Philips, J. 1995. Rhythms of a desert lizard. Natural History **104**: 51-55.

Pittaway, R. 1995. Recognizable forms, morphs of the Eastern Screech-Owl. Ontario Birds **13**: 66-71.

Proctor-Gray, E.. 1990. Kangaroos up a tree. Natural History **99**: 60-67.

Smith, D.G., A. Devine, and D. Walsh. 1987. Censusing screech owl in southern Conneticut. Biology and conservation of Northern Forest Owls: symposium proceedings, Feb. 3-7, Winnipeg, Manitoba. USDA Forest Service General Technical Report RM-142: 255-267.

Stullken, D.E. and W.A. Hiestand. 1953. An experimental study of the influence of pelage pigmentation on metabolic rate and its possible relationship to body temperature control and ecological distribution. Ecology **34**: 610-613.

Walley, W. J. and C. F. Clyde. 1996. Occurrence and breeding of the Eastern Screech Owl north of the Riding Mountains, Manitoba. Blue Jay **54**: 89-100.

Wilson, D.E. 1996. Measuring and monitoring biological diversity, standard methods for mammals. Smithsonian Institution Press, Washington, D.C.