ARTHROPOD COMMUNITIES AND HABITAT CHARACTERISTICS OF SITES OCCUPIED BY SWAINSON'S WARBLERS IN THE WHITE RIVER NATIONAL WILDLIFE REFUGE, ARKANSAS

By

Jeremy D. Brown

A Thesis

Presented to the Faculty of the Graduate School

Arkansas State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Biology

May 2008
Jonesboro, Arkansas

James C. Bednarz, Ph.D.
Thesis Advisor

Aldemaro Romero, Ph.D.
Department Chair

Staria Vanderpool, Ph.D.
Committee Member

Andrew Sustich, Ph.D.
Dean of Graduate School

Tanja McKay, Ph.D.
Committee Member

ACKNOWLEDGMENTS

I thank Dr. Jim Bednarz, my advisor, for giving me the opportunity to feed the mosquitoes, become one with the wasps, and play with the “cujaws” (cottonmouths; *Agkistrodon piscivorus leucostoma*) that accompanied me while working on this great project. I am also thankful for all the knowledge obtained in wildlife ecology and management, ornithology, and bottomland hardwood forests that he has passed on to me throughout my academic career. I am also grateful to my committee, Drs. Staria Vanderpool and Tanja McKay, for their guidance and invaluable input on this project.

This project would not have been possible without financial and in-kind support from U.S. Fish and Wildlife Service (USFWS), Arkansas Game and Fish Commission (AGFC), Arkansas Audubon Society Trust, and Arkansas State University. In particular, I would like to thank Chuck Hunter (USFWS), Richard Hines (USFWS), and Catherine Rideout (AGFC) for their enthusiasm and continued support of this project. I would also like to express my gratitude to the entire refuge staff at White River National Wildlife Refuge for their assistance with housing, their patience, and their valuable insights on wildlife management.

I would especially like to thank T.J. Benson for his enlightenment on ecological processes and statistical assistance. I am forever indebted to the “Swainny woo woo” crew (T.J. Benson, Nick Anich, and Carolina Roa) at Arkansas State University for their countless hours of brain storming, humor, and avian knowledge. I am also thankful for all of the field and lab assistance from Troy Bader, Dean Townsend, Jason Jackson, Brandon Kellum, Kim Jones, Ken Levenstein, Erin Macchia, Dick Baxter, Laura Odom, and Waylon Edwards. Additionally, I thank all the professors and graduate students, whom I have crossed paths with, for their professionalism and thoughtful insights.

I would like to express my deep appreciation and love for bottomland hardwood forests and all of its inhabitants whom allowed me to witness their everyday activities. The floodplain ecosystem has forever made its mark on me and will always be respected and admired.

Finally, I would like to acknowledge my family. It is because of their love, financial support, encouragement, and patience that I have been able to achieve my goals. Lastly, I dedicate this thesis to my parents, Jerry and Joyce Brown, who have each inspired me in their own unique way. With the embedded strong work ethic from my father and the preaching of the importance of education from my mother, they are the reason I have been able to pursue my dreams in the wildlife field.

GENERAL ABSTRACT

The Swainson's warbler (*Limnothlypis swainsonii*) is a species of critical conservation concern in the southeastern U.S. As ground-foraging litter-specialists, these warblers likely are affected adversely by flooding. Consequently, previous studies on this species involving low-elevation flood-prone sites may not have represented its habitat affinities accurately. In this thesis, I examine relationships among Swainson's warbler occupancy, arthropod communities, and vegetation structure within relatively high-elevation bottomlands at White River National Wildlife Refuge (WRNWR). In 2004 and 2005, I conducted systematic surveys at 1,453 sites using song playbacks and collected vegetation data at 70 occupied sites (5% occupancy) and 106 randomly-selected unoccupied sites; arthropods were collected using litter samples and pitfall traps at 45 randomly-selected occupied and unoccupied sites.

Mean density of cane (*Arundinaria gigantea*; 30,750 stems/ha) and total stems (98,161 stems/ha), cover of cane (16%), and depth of litter (17.49 mm) were found to be significantly greater in occupied than unoccupied sites (means = 2,807 stems/ha, 71,580 stems/ha, <1%, and 14.90 mm, respectively). Also, vegetation density at all height intervals from 0–2.5 m was significantly greater at occupied than at unoccupied sites. Likewise, habitat characteristics from sites occupied in 2, 1, and 0 (unoccupied) years were also analyzed and similar relationships were found to those in the previous analysis. Additionally, cane, vine, and shrub stems as separate variables appeared to be good predictors of occupancy based on logistic regression analysis. However, cane stems may be the best single variable predictor of Swainson's warbler occupancy with a combined AIC_c weight that accounted for 99% of all variables considered.

Total mean abundance of arthropods (32.57/sample), abundance of large arthropods (arthropods 5–10 mm = 8.3/sample, arthropods 10–15 mm = 1.63/sample, arthropods >15 mm = 0.54/sample), and taxonomic richness (6.06 taxa/sample) were significantly greater in occupied than unoccupied sites (means = 21.84/sample, 5.00/sample, 0.86/sample, 0.12/sample, and 4.73 taxa/sample, respectively) for litter sample data. Additionally, in litter samples, the mean number of beetles (Coleoptera, 5.71/sample), click beetles (Elateridae, 0.88/sample), and centipedes (Chilopoda, 0.40/sample) were greater in occupied than in unoccupied sites (4.01/sample, 0.27/sample, 0.10/sample, respectively). Moreover, relative sample richness and large arthropods appeared to be good predictors of occupancy based on logistic regression analyses. Also, selected habitat variables appeared to be reasonable predictors of arthropod community attributes.

Overall, my data suggested that cane, uniformly dense understory vegetation, a well-developed layer of leaf litter, and relatively high arthropod abundance and richness were key habitat components related to occupancy of Swainson's warblers at WRNWR. These findings are relevant given the substantial decline of cane habitat throughout the Southeast. I suggest that Swainson's warbler management should include the creation of small canopy gaps that mimic natural disturbances to allow enough sunlight to reach the forest floor to promote dense understory development. Additionally, habitat management should consider the availability and structure of the leaf litter layer when implementing management because this is critical to maintaining the abundance and richness of ground-dwelling arthropods. Management for Swainson's warblers should promote a diverse forest canopy of uneven ages which should provide a more complex and consistent leaf litter layer that may accommodate an abundance of ground-dwelling arthropods utilized by this species.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF TABLES CONTINUED

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

GENERAL INTRODUCTION

The Swainson's warbler (*Limnothlypis swainsonii*) is a species of critical conservation concern in the southeastern U.S. and is one of 46 species of neotropical migratory landbirds in need of management attention (Hunter et al. 1993). Historically a common species in selected habitats (Morse 1989), the Swainson's warbler is now listed as one of the most endangered breeding songbirds in the southeastern U.S. because of habitat destruction in its breeding range, relatively low population density, and a small wintering range in the Caribbean basin (e.g., Morse 1989, Terborgh 1989, Hunter et al. 1993, Smith et al. 1993, Thompson et al. 1993, Brown and Dickson 1994, Rappole 1995, Mueller et al. 2000, Graves 2002). Partners in Flight classified the Swainson's warbler as a watch list species, which has an estimated U.S. population of approximately 84,000 individuals (Rich et al. 2004). A watch list species, as defined by Rich et al. (2004), is a species that has range-wide concerns and are most in need of conservation attention. Finally, the National Audubon Society (2004) watch list (http://www.audubon.org/bird/watchlist/bs-bc-what_is_the_watchlist.html) includes the Swainson's warbler as a species with very small populations or limited ranges that are declining rapidly and face major conservation threats.

Along with winter habitat loss, the modification of breeding grounds has been identified as the primary threat to the Swainson's warbler (Thompson et al. 1993, Stotz et al. 1996, Graves 2001). Due to extensive clearing of bottomland forest in the southeastern U.S., this insectivorous species has been restricted in many drainages to seasonally-inundated buffer zones bordering rivers and swamps (Graves 2001).

Importantly, the Swainson's warbler is a ground-foraging litter-specialist that forages by flipping over leaves on the forest floor (Graves 1998) to capture a variety of prey, including beetles (Coleoptera), spiders (Araneae), ants (Formicidae), orthopterans (Orthoptera), and geckos (Strong 2000, Strong and Sherry 2001). Therefore, this foraging strategy makes this migratory species especially vulnerable to flooding in riparian and wet-woodland sites. However, little is known about patterns of Swainson's warbler occupancy in different structural microhabitats within wetland ecotones (Graves 2001) and the affects flooding has on the arthropod community, the key prey base of this species.

Bednarz et al. (2005) reported that Swainson's warbler populations have been located in both remnant cane (*Arundinaria gigantea*) brakes and deciduous-shrub thickets within floodplain habitats in Arkansas. Graves (2002), in a study encompassing 5 localities in 4 states, found that canopy height, basal area, and floristics appeared to be relatively unimportant factors in habitat selection, provided understory requirements were met. Bednarz et al. (2005) found that characteristics such as litter depth, shrub stem density, canopy closure, shrub cover, and total green cover showed significant differences between occupied sites compared with random sites. However, Somershoe et al. (2003) looked at occupied sites in comparison with two random controls (adjacent controls and general controls) and found no significant differences in number of trees, basal area, and complete canopy cover, contrary to the results of Graves (2002) and Bednarz et al. (2005). Overall, Somershoe and associates concluded there were no significant differences in vegetation structure between occupied sites and controls. The different conclusions reported by these studies may be confounded by the fact that extant Swainson's warbler populations seem to only occur in higher-elevation sites within the floodplains (Bednarz et al. 2005). Studies that included sample sites at low elevations in a floodplain may have incorporated ecological “noise” that made it difficult to elucidate key characteristics associated with occupied Swainson’s warbler sites.

Understanding an insectivore’s foraging strategy, prey preference, prey availability, and habitat selection are critical to identifying niche relationships (Robinson and Holmes 1982) and patterns of habitat use (Karr and Brawn 1990, Wolda 1990). Understanding these patterns is a key to implementing effective conservation efforts (Petit et al. 1995). Strong and Sherry (2001) stated that much of the data necessary to characterize a species’ foraging strategy are lacking and this is especially true for the Swainson’s warbler. In order to determine the most effective management strategies for this species, documentation of habitat affinities, prey availability, and occupancy status in different habitat situations is crucial. A primary objective of my study was to determine relationships of occupancy in Swainson’s warblers to habitat structure and arthropod communities limited to suitable elevational areas within a large bottomland habitat reserve. With these data, I describe baseline habitat structure and arthropod community characteristics associated with occupied Swainson’s warbler sites that may be used as a basis for state and federal agencies to assess the efficacy of future management in restoring Swainson’s warbler populations.

In this thesis, I address three main research topics: (1) habitat characteristics used by Swainson’s warblers, (2) arthropod community characteristics of Swainson’s warbler habitat, and (3) the development of models that predict Swainson’s warbler occupancy. Further, I will provide management recommendations that should allow state and federal agencies to conserve Swainson's warbler populations on relatively high-elevation bottomland areas.

This thesis is organized into five chapters, an introductory chapter, three manuscript chapters, and a conclusion and synthesis chapter. The first manuscript chapter will address the habitat affinities of the Swainson’s warbler, the second chapter will describe the arthropod communities associated with sites used by Swainson's warblers, and a third chapter investigates linear and logistic regression models for predicting Swainson's warbler occupancy. This first chapter of this thesis is the general introduction, in which I supply background information, explain the primary research questions, and explain the layout of the thesis. Also, I have provided a brief summary of the historical and current population status, life history traits, and habitat characteristics of Swainson's warblers from a review of the literature.

In Chapter II, I address the following question: what are the key habitat characteristics associated with Swainson's warblers at White River National Wildlife Refuge, Arkansas? Based on previous studies by Graves (2001) and Bednarz et al. (2005), I predicted that sites occupied by Swainson's warblers would have a greater shrub stem density, litter density, and shrub cover than unoccupied sites. Also, based on previous studies by Brewster (1885) and Meanley (1945), I predicted that sites occupied by Swainson's warblers would have a greater cane stem density and cane cover than unoccupied sites. I collected vegetation data on 46 variables to document key habitat patterns between occupied versus unoccupied Swainson's warbler sites and among sites that were occupied by Swainson's warblers in 2 consecutive years versus sites that were occupied in only one of the 2 years and sites that were not occupied.

In Chapter III, I address two questions related to arthropod community characteristics in sites used by Swainson's warblers. The first question is what is the difference in arthropod abundance between occupied and unoccupied sites of the Swainson's warbler, if any? Inferring from existing information from Brown and Dickson (1994) and Strong and Sherry (2001), I predicted that sites occupied by Swainson's warblers would have a greater abundance of arthropods than unoccupied sites. The second question I addressed is what is the difference in arthropod richness between sites occupied by Swainson's warblers and unoccupied sites? Based on Strong and

Sherry (2001), I predicted that sites occupied by Swainson's warblers would have a greater litter arthropod richness than unoccupied sites. For this assessment, I used pitfall traps and litter samples to collect arthropods from an equal number of randomly-selected occupied and unoccupied sites. I also present data on family abundance and richness, size-class abundance, and age-class abundance for occupied versus unoccupied sites, as well as, sites that were occupied 2 years versus sites that were occupied in only one of the 2 years and sites that were not occupied during the study.

In Chapter IV, I employed logistic regression models to predict occupancy of the Swainson's warbler. Both arthropod community attributes and vegetation structure were evaluated to predict Swainson's warbler occupancy. Further, I examined whether measures of vegetation structure could be used to predict arthropod communities by using linear regressions. In this chapter, I synthesize measures of vegetation structure and the prey community to develop models to predict the occupancy of Swainson's warblers.

The fifth and final chapter of this thesis is a conclusion and synthesis of this research project. Here, I discuss management implications and recommendations to conserve Swainson's warblers. Specifically, I discuss the ecological interactions between habitat and arthropod communities in the bottomland hardwood forests and how manipulation of these interactions may be used to maintain and enhance Swainson's warbler populations.

This thesis has been organized in a manuscript format and chapters II–IV follow the format guidelines for the submission of manuscripts to the *Journal of Wildlife Management* (Chamberlain and Johnson 2007). Each chapter stands alone and contains an abstract, introduction, study area, methods, results, and discussion sections.

LITERATURE CITED

Bednarz, J. C., P. Stiller-Krehel, and B. Cannon. 2005. Distribution and habitat use of Swainson's warblers in eastern and northern Arkansas. Pages 576–588 *in* Ralph, C. J., and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference, Volume 1. USDA Forest Service General Technical Report PSW-GTR-191.

Brewster, W. 1885. Swainson's warbler. Auk 2:65–80.

Brown, R. E., and J. G. Dickson. 1994. Swainson's warbler (*Limnothlypis swainsonii*). No. 126 *in* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Chamberlain, M. J., and C. Johnson. 2007. Journal of Wildlife Management Guidelines. <http://www.wildlifejournals.org/perlserv/?request=for-authors>. Accessed 7 May 2007.

Graves, G. R. 1998. Stereotyped foraging behavior of the Swainson's warbler. Journal of Field Ornithology 69:121–127.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in Great Dismal Swamp. Auk 118:650–664.

Graves, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's warbler. Wilson Bulletin 114:210–220.

Hunter, W. C., D. N. Pashley, and R. E. F. Escano. 1993. Neotropical migratory landbird species and their habitat of special concern within the southeast region. Pages 159–171 *in* D. M. Finch and S. W. Strangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report. RM-229, Fort Collins, Colorado, USA.

Karr, J. R., and J. D. Brawn. 1990. Food resources of understory birds in central Panama: quantification and effects on avian populations. Pages 58–64 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Meanley, B. 1945. Notes on Swainson's warblers in central Georgia. Auk 62:395–401.

Morse, D. H. 1989. American warblers: an ecological and behavioral perspective. Harvard University Press: Cambridge, Missouri, USA.

Mueller, A. J., D. J. Twedt, and C. R. Loesch. 2000. Development of management objectives for breeding birds in the Mississippi Alluvial Valley. Pages 12–17 *in* R. Bonney, D. N. Pashley, R. J. Cooper, and L. Niles, editors. Strategies for bird conservation: The Partners in Flight planning process. Proceedings of the 3rd Partners in Flight Workshop. U.S. Forest Service General Technical Report RMRS-P-16. U.S. Department of Agriculture, Rocky Mountain Research Station, Ogden, Utah, USA.

National Audubon Society. 2004. National Audubon Society watch list <http://www.audubon.org/bird/watchlist/bs-bc-what_is_the_watchlist.html>. Accessed 7 May 2007.

Petit, D. R., J. F. Lynch, R. L. Hutto, J. G. Blake, and R. B. Waide. 1995. Habitat use and conservation in the neotropics. Pages 145–197 *in* T. E. Martin and D. M. Finch, editors. Ecology and management of neotropical migratory birds: A synthesis and review of critical issues. Oxford University Press, New York, New York, USA.

Rappole, J. H. 1995. The ecology of migrant birds. Smithsonian Institute Press, Washington, D.C., USA.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology, Ithaca, New York, USA.

Robinson, S. K., and R. T. Holmes. 1982. Foraging behavior of forest birds: The relationships among search tactics, diet, and habitat structure. Ecology 63:1918–1931.

Smith, C. R., D. M. Pence, and R. J. O'Conner. 1993. Status of neotropical migratory birds in the northeast: a preliminary assessment. Pages 172–188 *in* D. M. Finch and P. W. Stangel, editors. Status and management of Neotropical migratory birds. U.S. Forest Service General Technical Report RM-229, Fort Collins, Colorado, USA.

Somershoe, S. G., S. P. Hudman, and C. R. Chandler. 2003. Habitat use by Swainson's warblers in a manage bottomland forest. Wilson Bulletin 115:148–154.

Stotz, D. F., J. W. Fitzpatrick, T. A. Parker III, and D. K. Moskovits. 1996. Neotropical birds. Ecology and conservation. The University of Chicago Press, Chicago, Illinois, USA.

Strong, A. M. 2000. Divergent foraging strategies of two Neotropical migrant warblers: implications for winter habitat use. Auk 117:381–392.

Strong, A. and T. W. Sherry. 2001. Body condition of Swainson's warblers wintering in Jamaica and the conservation value of Caribbean dry forests. Wilson Bulletin 113:410–418.

Terborgh, J. 1989. Where have all the birds gone? Princeton University Press, Princeton, New Jersey, USA.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of neotropical migrant landbirds in the Midwest: identifying species of management concern. Pages 145–158 *in* D. M. Finch and P. W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229. Fort Collins, Colorado, USA.

Wolda, H. 1990. Food availability for an insectivore and how to measure it. Pages 38–43 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

CHAPTER II

VEGETATION CHARACTERISTICS ASSOCIATED WITH HABITAT OCCUPIED BY SWAINSON'S WARBLERS AT THE WHITE RIVER NATIONAL WILDLIFE REFUGE, ARKANSAS

ABSTRACT

The Swainson's warbler (*Limnothlypis swainsonii*) is a species of critical conservation concern in the southeastern U.S. Because these warblers are ground-foraging litter-specialists, they likely are affected adversely by flooding. Consequently, previous studies on this species involving low-elevation, flood-prone sites may not have accurately represented the habitat affinities of this species. In this study, relationships between Swainson's warbler occupancy and vegetation structure were examined at relatively high-elevation bottomlands at White River National Wildlife Refuge (WRNWR). I surveyed 1,453 sites systematically using song playbacks, and collected vegetation data at 70 occupied sites (5% occupancy) and 106 randomly-selected unoccupied sites in 2004 and 2005. Mean canopy cover (82%), sub-canopy height (12.60 m), density of cane (*Arundinaria gigantea*) stems (30,750 stems/ha), shrub stems (23,536 stems/ha), and total stems (98,161 stems/ha), cover of cane (16%), depth of litter (17.49 mm), litter volume (1.24 m^2), soil moisture (8.19), and density of small (16.45/ha) and large snags (17.95/ha) were found to be significantly greater in occupied than unoccupied sites (means = 77%, 11.76 m, 2,807 stems/ha, 9,590 stems/ha, 71,580 stems/ha, <1%, 14.90 mm, 1.03 m^2, 7.68, 12.21/ha, and 13.21/ha, respectively). However, occupied sites had a lower density (19.94/ha) of large trees (dbh >38 cm) than unoccupied sites (24.93/ha). Also, vegetation density at all height intervals from 0–2.5 m and total vegetation density

were significantly greater and variation of horizontal and vertical vegetation density were significantly lower in occupied sites than unoccupied sites.

Habitat characteristics from 28 sites that were occupied in 2 years, 37 sites that were occupied in only 1 year, and 38 sites that were occupied in 0 (unoccupied) years were also analyzed and similar habitat relationships were found to those in the previous analysis. Persistent occupancy was related to patterns in sub-canopy height, litter depth, soil moisture, density of cane stems, shrub stems, and total stems, cover of cane, density of large snags, heterogeneity of horizontal and total vegetation density, total vegetation density, and vegetation density at all height intervals from 0–2.5 m except the 0–0.5 m height interval. Additionally, noncane and vine stems were significantly lower in sites occupied in 2 years than sites occupied in only 1 year and unoccupied sites. Sites occupied in 1 or 2 years by Swainson's warblers also had less vine cover than sites that were unoccupied. Lastly, the best fit model for predicting Swainson's warbler occupancy contained the number of cane stems, vine stems, and shrub stems as separate variables and this model accounted for 83% of the total AIC_c weight of all habitat models considered. Moreover, cane stems may be the best single variable predictor of Swainson's warbler occupancy with a combined AIC_c weight that accounted for 99% of all variables considered. Overall, the data suggested that cane, dense understory habitat structure, and a well-developed layer of leaf litter were key habitat components for Swainson's warblers at WRNWR. These findings are especially relevant given the substantial decline of canebrakes throughout the southeast. Swainson's warbler management should include the preservation of cane habitat and creation of small canopy gaps that mimic natural disturbances to allow enough sunlight to reach the forest floor to promote dense understory development, without degrading the leaf litter layer.

INTRODUCTION

The Swainson's warbler (*Limnothlypis swainsonii*) is an insectivorous, medium-sized, inconspicuous wood-warbler that primarily inhabits bottomland hardwood forests in the southeastern U.S. (Meanley 1971, Eddleman et al. 1980, Brown and Dickson 1994, Graves 2002, Bednarz et al. 2005). As ground-foraging litter specialists that nest in the forest understory, Swainson's warblers are dependant on a well-developed layer of leaf litter and dense understory (Meanley 1971, Brown and Dickson 1994, Bednarz et al. 2005). Swainson's warblers breed in selected habitats throughout the southeastern U.S. and winter in the Yucatán Peninsula and the Caribbean islands (Brown and Dickson 1994).

Historically, a common species in specific habitat types (Morse 1989), the Swainson's warbler is now listed as a species of conservation concern in the southeastern U.S. because of habitat destruction on its breeding and wintering grounds, relatively low population density, and restricted range (Hunter et al. 1993, 1994; Peters 1999; Hunter and Collazo 2001). The Southeast and Midwest Working Groups for Partners in Flight ranked the Swainson's warbler as of extreme conservation concern in these respective regions of the U.S. (Hunter et al. 1993, Thompson et al. 1993, Bednarz et al. 2005). Finally, the National Audubon Society (2004) watch list (http://www.audubon.org/bird/watch/ Version 97.12) includes the Swainson's warbler as a species with very small populations or limited ranges that are declining rapidly and face major conservation threats.

Along with habitat loss on the wintering grounds, the loss of breeding habitat has been identified as a primary threat to the species (Thompson et al. 1993, Stotz et al. 1996, Graves 2001). Due to extensive clearing of bottomland forest, the Swainson's warbler has been restricted in many drainages to seasonally-inundated zones bordering rivers and swamps (Graves 2001). Moreover, this migratory species is especially vulnerable to flooding because of its ground-foraging ecology, but little is known about patterns of habitat occupancy at wetland ecotones (Graves 2001).

Within Arkansas, Bednarz et al. (2005) reported that Swainson's warbler populations were located in both remnant canebrakes (*Arundinaria gigantea*) and deciduous shrub thickets within floodplain habitats. Graves (2002), in a study at 5 localities in 4 states, found that canopy height, basal area, and floristics appeared to be relatively unimportant factors in habitat selection, provided that understory requirements are met. On 4 different study areas, Bednarz et al. (2005) found that litter depth, shrub stem density, canopy closure, shrub cover, and total green cover were significantly different between occupied and random sites. However, Somershoe et al. (2003), unlike Graves (2002) and Bednarz et al. (2005), compared occupied sites to adjacent control sites and general control sites and found no significant differences in vegetation structure between occupied and unoccupied sites. The different conclusions reported by these studies may be confounded by the fact that extant Swainson's warbler populations seem to only occur in higher-elevation sites within floodplains (Bednarz et al. 2005). Studies that include sample sites at low-elevation sites (unsuitable because of flooding) in floodplains may have incorporated ecological "noise" that may have made it difficult to elucidate key characteristics associated with occupied Swainson's warbler sites.

Understanding an insectivore's foraging strategy, prey preference, prey availability, and habitat selection is critical to identifying niche relationships (Robinson and Holmes 1982) and patterns of habitat use (Karr and Brawn 1990, Wolda 1990). Understanding these affiliations is crucial to applying effective conservation efforts (Petit et al. 1995). To determine the most effective management strategies for this species, documentation of habitat affiliations, prey availability, and population status in different habitat types is needed. My objective here was to investigate factors influencing habitat use by Swainson's warblers within the high-elevation portion of bottomland forests. Specifically, I tested the following hypotheses in the higher elevations of a floodplain: (1) Swainson's warbler occupied sites will have a greater density of shrub stems, leaf litter, and shrub cover than unoccupied sites (Graves 2001, Bednarz et al. 2005). (2) Swainson's warbler occupied sites will have a greater density of cane stems and cane cover than unoccupied sites (inferred from Brewster [1885] and Meanley [1945]). (3) Swainson's warbler occupied sites will have no significant differences in vegetation characteristics when compared to unoccupied sites (inferred from Somershoe et al. 2003).

STUDY AREA

Habitat use by Swainson's warblers was studied at White River National Wildlife Refuge (WRNWR) in eastern Arkansas. The WRNWR was established in 1935 for the protection of migratory birds and is open to the public for many recreational uses such as: birding, camping, hiking, hunting, and fishing. The refuge is located in the floodplain of the White River near its confluence with the Arkansas River Canal and encompasses Arkansas, Desha, Monroe, and Phillips counties while ranging from 4.8 to 16.0 km wide and is approximately 144 km long (Fig. 2.1). WRNWR is one of the largest remaining contiguous tracts of bottomland hardwood forest in the Mississippi River Valley and is listed in the Ramsar list of wetlands of international importance (Ramsar 2008). The refuge is approximately 64,750 ha and is divided into a north and south unit that is separated by Arkansas Highway 1. The WRNWR primarily consists of bottomland hardwood forest, but also has some upland forest, agricultural fields, moist-soil impoundments, and 356 natural and man-made lakes.

METHODS

Occupancy Determination

Swainson's warbler surveys were conducted at WRNWR from 1 April to 20 June in 2004 and 2005 (Fig. 2.1). This corresponds to the time of year that Swainson's warblers migrate into this area, establish territories, and respond most effectively to playback calling. Broadcast surveys were employed along transects at 200-m intervals at a minimum elevation of 45 m for the south unit and 48 m for the north unit. These elevational cut-offs were indicative of the bottomland areas not typically flooded on an annual basis (J. Denman, Forest Ecologist at WRNWR personal communication). Because Swainson's warblers likely are adversely affected by flooding, these elevation cutoffs were implemented to reduce the amount of "ecological noise" that could lead to confounding relationships with habitat variables. Also, the typical tree species that occurred in these higher elevations where Swainson's warblers were found consisted of Nuttall oak (*Quercus nuttallii*), water oak (*Q. nigra*), sugarberry (*Celtis laevigata*), sweetgum (*Liquidambar styraciflua*), hickory species (*Carya* spp.), and boxelder (*Acer negundo*). Broadcast surveys were conducted from sunrise to 1200 H daily. At each sample site, the Swainson's warbler's primary song was broadcasted for 90 sec from a dual-speaker CD player placed perpendicular to the transect line. Response songs, calls, and approaching birds were then recorded for 60 sec after the broadcast. The CD player was then turned to the opposite side of the transect line and the sequence was repeated (Bednarz et al. 2005). Audio output was set high so that observers could hear broadcasts from 50–70 m away on days with clear atmospheric conditions. Although, I only visited most sites only once and was unable to assess the probability of detection. However, Swainson's warblers are extremely aggressive and nearly always respond to playbacks during the peak of the breeding season; therefore; there is a very high probability of detecting a Swainson's warbler when one is present (Bednarz et al. 2005).

Although I did not account for imperfect detection probability, I believe that the misclassification probability was relatively low and similar for occupied and unoccupied sites. Thus, these comparisons of habitat characteristics between “occupied” and “unoccupied” sites should elucidate factors that are correlated with Swainson’s warbler presence.

Habitat Structure

Vegetation characteristics were measured from 21 June until 15 August in 2004 and 2005 on all occupied sites and an even greater number of randomly-selected unoccupied sites. Standard B-Bird field protocols (Martin et al. 1997, Bednarz et al. 2005) were used to collect data within 5-m and 11.3-m radius plots located at Swainson’s warbler occupied and unoccupied sites. The 5-m radius plot was divided into four quadrants and within each quadrant the percent cover of leaf litter, total green cover, shrubs, forbs, vines, cane, bare ground, logs, brush, grass, and water was estimated. Brush was defined as dead limbs or branches that were <8 cm diameter (dbh) and were in contact with the ground. The 11.3-m radius plot was also divided into four quadrants and within each quadrant all trees were placed into size classes based on diameter at breast height (dbh) measurements (saplings = <2.5 cm in diameter and >30 cm in height; poles = 2.5–8 cm dbh; small tree = 8–23 cm dbh; medium tree = 23–38 cm dbh; large tree = >38 cm dbh). The mean height of overstory and midstory were measured with a clinometer. The mean height of midstory included small trees and also lower lateral branches from medium and large trees. Snags were counted in each quadrant and placed into two size classes (small snags = <12 cm dbh, >1.4 m tall; large snags = >12 cm dbh, >1.4 m tall).

Depth of leaf litter and soil moisture at 1, 3, and 5 m were measured from the center of the plot in each cardinal direction. A small hole was dug into the litter down to the bare soil to measure the vertical height of the leaf litter layer with a ruler. Soil moisture was measured by inserting a probe from a soil moisture meter (LIC, Lincoln, NE) into the substrate approximately 5 cm.

Percent total canopy closure was measured from the center of the plot by taking four densiometer readings facing the four cardinal directions. Likewise, percent subcanopy cover was taken from the center of the plot by taking ocular estimates facing the four cardinal directions. Cane, vine, and shrub stems that are <2.5 cm in diameter and ≥30 cm in height were counted in four 1-m^2 plots at a distance of 5 m from the center of the plot in each of the quadrants.

At each site, ocular estimates of the mean shrub height were made. Percent cover of vines, number of vine tents, and density of vegetation from 0–2.5 m in height were only collected in 2005. Vine tents were defined as conspicuous accumulations of vines created from terrestrial or hanging vines. Vegetation density was measured between 0–2.5 m in height by taking readings from a vegetation cover board (Nudds 1977). After placing the board at the center of the plot, an observer estimated the percent covered in five height intervals: 0–0.5 m, 0.5–1.0 m, 1.0–1.5 m, 1.5–2.0 m, and 2.0–2.5 m. Measurements were taken at all four cardinal directions at a distance of 5 m and 11.3 m from the center of the plot. Because heterogeneity in density may be an important factor, I also computed the coefficient of variation (CV) of density readings at a point for the five vertical readings (vertical density CV) or the four cardinal directions (horizontal density CV).

Habitat Characteristics Data Analysis

Analysis of variance (ANOVA; SAS Institute 2004) was used to investigate differences in habitat characteristics at sites occupied and unoccupied by Swainson's warblers. To better meet the assumptions of ANOVA, I square-root transformed the percent of vegetation density at the 5-m radius plot at a height of 0.5–1.0 and 2.0–2.5 m, the coefficient of variation of total vegetation density at the 5-m radius plot, and the coefficient of variation of horizontal and vertical vegetation density in the 11.3-m radius plot. Also, I log transformed the percent cover of green vegetation and forbs, and total vegetation density of the 5-m radius plot, percent of vegetation density at the 5-m radius plot at a height of 1.0–1.5, 1.5–2.0 m, and the coefficient of variation of vertical vegetation density in the 5-m radius plot prior to analysis. For variables that did not meet the assumptions of normality or equal variances; I employed the WELCH option in ANOVA for analyses (SAS Institute 2004). Variables that the WELCH option was used on were the mean height of the shrub layer, cane stems, shrub stems, percent cover of cane and leaf litter, large trees, total vegetation density of the 11.3-m radius plot, and the percent of vegetation density at the 11.3-m radius plot at a height of 0.5–1.0, 1.5–2.0, and 2.0–2.5 m. The WELCH option involves the calculation of a Welch's variance-weighted one-way ANOVA, which may be used to test for differences between group means with unequal variances.

Means of the 4 estimates from each quadrant for the vegetation sampling in the 5-m and 11.3-m radius plots were used in the analysis. Additionally, means of the 12 soil moisture and litter depth measurements were used as the best estimate for each site in the data analysis. Litter volume was calculated by taking the product of the mean percent litter cover and the area of the 5-m radius plot and multiplying it by the mean litter depth for that site.

Additionally, I used ANOVA (SAS Institute 2004) to investigate relationships of habitat characteristics of sites that were occupied in 2, 1, and 0 (unoccupied) years by Swainson's warblers. Again, prior to the analyses, I square-root transformed large trees, percent of vegetation density in the 5-m radius plot at a height of 1.5–2.0 and 2.0–2.5 m, and percent of vegetation density in the 11.3-m radius plot at a height of 0–0.5 and 0.5–

1.0 m. Also, I log transformed the percent cover of cane, total vegetation density within the 5-m radius plot, and the percent of vegetation density in the 5-m radius plot at a height of 0.5–1.0 and 1.0–1.5 m variables to better meet the assumptions of ANOVA. For variables that did not meet the assumptions of normality or equal variances, the WELCH option in ANOVA was again employed. Variables that the WELCH option was used on were soil moisture and cane stems. Also, for variables where significant differences were found, pairwise contrasts were then considered.

Habitat Predictors of Swainson's Warbler Occupancy

In an effort to determine important habitat factors influencing the occupancy of Swainson's warblers, I used SAS to perform a correlation analyses (PROC CORR) to identify and to remove highly correlated variables ($r > 0.6$) and then performed logistic regression (SAS Institute 2004). I developed 15 *a priori* models including habitat variables that I felt would be predictors of occupancy based on factors suggested to be important for Swainson's warblers from previous studies and also based on my own field observations (Table 2.1). Regression models were then evaluated using Akaike's Information Criterion for small sample sizes (AIC_c; Cody and Smith 1997, Burnham and Anderson 2002) and an AIC_c weight was calculated for each model.

RESULTS

Occupancy Determination

In 2004 and 2005, I surveyed 1,453 sample locations and detected Swainson's warblers at 70 unique sites (Appendix A), providing an estimated 5% occupancy (Fig. 2.2). In the south unit of the refuge there were 53 Swainson's warbler detection sites at the Alligator Lake area, 3 at Rattlesnake Ridge, and 1 at Indian Bay (Fig. 2.3). In the north unit of the refuge there were 3 Swainson's warbler detection sites at the Crooked Lakes area, 2 at

Little Moon Lake, 1 at Red Cat Lake, 4 at Bear Slough, and 3 at the Dead Man's Point area (Fig. 2.3). Of the 70 unique detection sites, 28 (40%) were occupied in both years, 17 (24%) were occupied in only 2004, and 25 (36%) were occupied in only 2005 (Fig. 2.2).

Habitat Structure of Occupied and Unoccupied Sites

I collected vegetation data on 70 occupied sites and 106 randomly-selected unoccupied sites. Percent cover of vines, number of vine tents and vine and shrub stems, and density of vegetation from 0–2.5 m in height were only collected in 2005, when I sampled 53 occupied sites and 84 unoccupied sites. Overall, there were conspicuous habitat differences between occupied and unoccupied sites (Tables 2.2 and 2.3, Fig. 2.4). Of 70 Swainson's warbler detection sites, 57 (81%) had giant cane present within the vegetation plot compared to only 9 (9%) of the 106 unoccupied sites that had cane present.

Within the 5-m radius sample plot, occupied sites had a significantly greater ($P \leq 0.014$) high-canopy cover (82%), cane cover (16%), litter depth (17.49 mm), litter volume (1.24 m^2), and soil moisture (8.19) than unoccupied sites (77%, <1%, 14.90 mm, 1.03 m^2, and 7.68, respectively). Density of cane (30,750 stems/ha), shrub (23,536 stems/ha), and total stems (98,161 stems/ha) were significantly greater ($P < 0.001$) at occupied sites than unoccupied sites (2,807 stems/ha, 9,590 stems/ha, 71,580 stems/ha, respectively), but there were no significant differences in density of non-cane or vine stems (Table 2.2).

Within 11.3-m radius sample plot, occupied sites were associated with a greater sub-canopy height, density of small snags, and density of large snags than unoccupied sites (Table 2.3). Occupied sites were also associated with a lower density of large trees than unoccupied sites (Table 2.3). Additionally, no differences were detected between sites for number of saplings, poles, small trees, medium trees, and vine tents (Table 2.3). In the 11.3-m radius sample plots, vegetation density from the ground to a height of 2.5 m was greater at occupied than unoccupied sites (Table 2.3, Fig. 2.4). Also, occupied sites had significantly less ($P \leq 0.001$) horizontal (40%), vertical (24%), and total heterogeneity (52%) in density of vegetation than unoccupied sites (66%, 39%, and 83%, respectively; Table 2.3).

Habitat Structure of Sites with Variable Occupancy

I collected vegetation data from 28 sites that were occupied in both years, 37 sites that were occupied in only 1 of the 2 years, and 38 sites that were not occupied. Percent cover of vines, number of vine tents, vine and shrub stems, and density of vegetation from 0–2.5 m in height from the 5-m and 11.3-m radius sample plots were only collected in 2005; therefore, I present data on 28 sites that were occupied in 2 years, 37 sites that were occupied in only 1 of the 2 years, and 30 sites that were not occupied for these variables. Overall, dramatic differences in habitat characteristics were found between sites occupied in 2, 1, and 0 years by Swainson's warblers (Tables 2.4 and 2.5, Fig. 2.5). All 28 Swainson's warbler sites (100%) that had detections in 2 years had cane present within the vegetation plot. While 28 (76%) of the 37 sites that had a Swainson's warbler detection in 1 of the 2 years had cane present. However, only 5 (13%) of the 38 sites that were occupied in 0 years had cane present.

Within the 5-m radius sample plot, there was a consistent and significant trend observed with soil moisture being the highest (8.65) at sites occupied in 2 years and lowest at sites that were occupied in 0 years (7.10; Table 2.4). There were differences found in the mean high-canopy cover and litter depth of sites occupied 2, 1, and 0 years; however, the differences were only marginally significant (Table 2.4).

A gradient was observed when analyzing cane stem density. Sites occupied in 2 years by Swainson's warblers had the highest (49,598 stems/ha) cane stem density, sites occupied in only 1 year had an intermediate value (19,966 stems/ha), and sites that were not occupied had the lowest (4,803 stems/ha) density. Interestingly, there was a significantly greater ($P \leq 0.030$) density of shrub stems in sites occupied in only 1 (25,709 stems/ha) year than sites occupied in 2 (13,393 stems/ha) or 0 (8,583 stems/ha) years by Swainson's warblers (Table 2.4). Also, Swainson's warbler sites that were occupied in 2 years had significantly fewer non-cane stems and vine stems than at sites occupied in 1 or 0 years (Table 2.4). Furthermore, sites occupied in 1 (99,932 stems/ha) and 2 (94,955 stems/ha) years had significantly greater ($P \leq 0.030$) total stems than sites that were not occupied (77,632 stems/ha; Table 2.4).

As for vegetation cover, a gradient was observed when looking at cane cover in which sites occupied 2 years had the greatest (27%) cane cover, sites occupied 1 year had an intermediate value (10%), and sites that were not occupied had the lowest cane cover (2%; Table 2.4). Furthermore, sites that were not occupied by Swainson's warblers had significantly greater vine cover (23%) than sites occupied 1 (15%) or 2 years (13%; Table 2.4). Moreover, sites occupied 2 years by Swainson's warblers had significantly greater brush cover than sites occupied 1 year, while there were no differences between sites that were not occupied and 1 year and sites occupied 2 and 0 years (Table 2.4). Also, there was a marginally significant trend with grass cover being the highest at sites occupied for 2 years and lowest at sites that were not occupied (Table 2.4).

Within the 11.3-m radius plot, the mean sub-canopy height of sites occupied 2 years (13.04 m) was significantly greater ($P = 0.012$) than in sites that were not occupied (11.76 m) by Swainson's warblers; while there were no differences between sites occupied in only 1 (12.31 m) or 0 years and also between sites occupied 1 or 2 years (Table 2.5).

When considering tree densities, sites occupied 2 years (91.74 saplings/ha, 28.67 medium trees/ha) had significantly ($P \leq 0.020$) fewer saplings and more medium trees than sites occupied 0 years (158.05 saplings/ha, 21.94 medium trees/ha) by Swainson's warblers; while there were no differences found between sites occupied in only 1 (126.89 saplings/ha, 25.43 medium trees/ha) or 0 years and in sites occupied in only 1 or 2 years (Table 2.5). Furthermore, the mean density of large trees was significantly less ($P \leq 0.004$) in sites occupied 1 year (16.95 trees/ha) than sites occupied by Swainson's warblers in 0 years (24.93 trees/ha) or 2 years (24.18 trees/ha; Table 2.5). Also, sites occupied by Swainson's warblers 2 years (20.19 trees/ha) had a significantly greater ($P \leq 0.050$) density of small snags than sites occupied 1 (14.21 trees/ha) or 0 years (14.46 trees/ha; Table 2.5). Additionally, sites occupied 1 (17.45 trees/ha) and 2 years (20.19 trees/ha) had significantly greater ($P \leq 0.030$) densities of large snags than sites occupied zero years (11.97 trees/ha; Table 2.5).

When considering vegetation density, the 5-m and 11.3-m radius plots showed similar results. I feel that the 11.3-m radius plot may give the more accurate assessment because of the angle from the observers eye to the density board is more level than if the observer was 5 m away, perhaps providing a better estimate of horizontal density. Also, the closer the observer is to the cover board the more influence one leaf or one stem will have because of the short distance between the observer and the density board. Therefore, only vegetation density data from the 11.3-m radius plot will be discussed.

After analyzing the vegetation density, another gradient was observed in which sites occupied 2 years had the greatest vegetation density, sites occupied in 1 year had an intermediate value, and sites that were not occupied had the lowest vegetation density in all height intervals except the 0.0–0.5 m interval (Table 2.5, Fig. 2.5). In the 0.0–0.5 m height interval for the 11.3-m radius sample plot, sites occupied 2 years had significantly greater vegetation density than sites occupied 0 years, but there was no difference between sites occupied 1 year and 0 (Fig. 2.5). Moreover, Swainson's warbler sites occupied two years had significantly less ($P \leq 0.010$) horizontal heterogeneity (26%) in density of vegetation than sites occupied in only 1 (47%) and 0 years (61%; Table 2.5). As for the total heterogeneity of vegetation, sites occupied 2 years had significantly less ($P \leq 0.04$) variation in vegetation density (41%) than sites occupied 1 (60%) and 0 years (82%; Table 2.5).

Habitat Predictors of Swainson's warbler Occupancy

All 15 *a priori* models were better predictors of Swainson's warbler occupancy than the null model (Table 2.6). However, there were two models that performed substantially better than the other models. The best-fit model contained number of cane, vine, and shrub stems as separate variables and accounted for 83% of the total AIC_c weight of all models considered. The second highest-ranked model consisted of cane stems and canopy cover, this model accounted for 16% of the total AIC_c weight of all models considered. All other models combined accounted for <1% of the total AIC_c weight of all models considered. Sums of the AIC_c weights showed cane ($\omega_i = 0.9939$), shrub ($\omega_i = 0.8336$), and vine stems ($\omega_i = 0.8336$), and canopy cover ($\omega_i = 0.1637$) to be the best predictors of Swainson's warbler occupancy (Table 2.6). However, cane stems may be the best single-variable predictor of Swainson's warbler occupancy with a combined AIC_c weight of 99% of all models considered.

DISCUSSION

Previously, Brewster (1885) and Meanley (1945) proposed that there was a close association of cane with the presence of Swainson's warblers. More recent studies (e.g., Graves 2001, 2002; Bednarz et al. 2005) have provided evidence that cane is not a requirement, but do not evaluate if there was a preference for cane when it was present. However, Graves (2001) offers evidence that Swainson's warblers may prefer non-cane over cane areas in the Great Dismal Swamp of Virginia. Additionally, Graves (2001) also documents a positive correlation between the presence of cane and water at this site; I suggest that this absence of Swainson's warblers in cane areas is likely a response to the presence of water rather than the avoidance of cane. Also, Graves (2002) and Bednarz et al. (2005) did not provide comparisons of occupied sites to unoccupied sites. However, the results from the current study seem to support a cane-Swainson's warbler association in Arkansas. In fact, 57 (81%) of the 70 occupied sites contained cane. Of the 13 occupied sites that did not have cane present, four sites had cane present within 50 m and the remaining nine sites did not have cane in close proximity to them. This is also demonstrated in my comparison of sites occupied by Swainson's warblers 2, 1, and 0 years. The data showed a gradient response with all the sites occupied in 2 years (100%, $N = 28$) having cane present within the sample plot, 76% ($N = 37$) of the sites occupied in only 1 year had cane present, and 13% ($N = 38$) of sites occupied in 0 years had cane present in the sample plot.

Two notable variables, percent cover of cane and density of cane stems, were significantly greater at occupied than unoccupied sites (Table 2.2). Additionally, a gradient was observed with cane cover and cane stem density being the greatest in sites that were occupied 2 years, intermediate values at sites occupied 1 year, and the lowest percent cover and density of cane at sites that were not occupied by Swainson's warblers (Table 2.4). These results are consistent with data reported by Wright (2002), in which she analyzed 3 cane-related variables (cane stems, cane height, and cane area) and the results showed a clear relationship with the presence of cane in the breeding habitat of Swainson's warblers at the Bond Swamp National Wildlife Refuge in Georgia. Importantly, persistent use seems to occur in cane habitat with 100% of sites occupied 2 years containing cane, while shrub thickets may be only receiving intermittent use by Swainson's warblers. Interestingly, the cane stem density at occupied sites from this study area (30,800 stems/ha) does show similarities with the findings of Meanley (1971; 49,421 stems/ha), Eddleman et al. (1980; 26,390 stems/ha), and Thomas et al. (1996; 56,500 stems/ha). However, other reports from five studies encompassing four localities had less than 5,000 cane stems per ha (Peters 1999, Graves 2001, 2002, Somershoe et al. 2003, Thompson 2005). Additionally, Graves (2002) reported cane as being absent from his vegetation plots from Whiskey Bay and the Pearl River areas of Louisiana and from the Apalachicola River in Florida. Conclusions drawn from these studies are somewhat inconsistent with respect to cane. Differences in the habitat used by Swainson's warblers have been recognized in Arkansas and throughout the species' geographic range (Graves 2002, Bednarz et al. 2005). With that in mind, these results may be a function of Swainson's warblers showing a preference for cane at WRNWR, a function of the relatively high abundance of cane present at WRNWR, or a combination of these factors. Although, at least at WRNWR, persistent use by Swainson's warblers seems to occur in cane areas while shrub thickets seem to only get intermittent use. While most studies (e.g., Bednarz et al. 2005, Graves 2002) reporting the use of noncane habitats by Swainson's warblers have only one or two annual visits to the study sites. These short-term studies may miss the persistent use of cane versus shrub thicket habitat.

However, cane alone is not the only factor affecting Swainson's warbler habitat use. The data also suggest that uniformly dense understory vegetation seems to play an integral part of habitat selection by Swainson's warblers (Tables 2.2–2.5). The importance of dense understory vegetation to Swainson's warblers is also supported by previous studies (Eddleman 1978, Bassett-Touchell and Stouffer 2006). Dense understory cover with relatively low variation may be especially important in nesting habitats, where nest concealment is important. Although, advertisement may be especially important in perching and singing habitats, a uniformly dense understory still is a distinct characteristic of habitats utilized by Swainson's warblers. Also, a dense and uniform understory may contribute to a well-developed leaf litter layer. In fact, the amount of leaf litter present in a particular area may play the most crucial role in a Swainson's warbler's habitat. Past work by Graves (2001) and Bednarz et al. (2005) has recognized the presence of a well-developed leaf litter layer and this study supports the fact that leaf litter is correlated with the presence of Swainson's warblers. Leaf litter is likely important because Swainson's warblers forage mainly on ground-dwelling arthropods and a well established layer of leaf litter can support an abundance of ground-dwelling arthropods (Uetz et al. 1979, Bultman and Uetz 1984).

Because of the importance of ground-dwelling arthropods and a well-developed leaf litter layer, flooding is an important phenomenon affecting Swainson's warbler occupancy. Leaf litter is affected by flooding through removal, concentration, physical degradation, and siltation (Bell and Sipp 1975, Uetz et al. 1979) and this can negatively affect Swainson's warblers because of their foraging behavior. Also, flooding may change the structure of the arthropod community within a particular habitat and can restrict the amount of area available to Swainson's warblers to forage; thus, adversely affecting the availability of food resources to Swainson's warblers. Due to the high frequency of flooding in particular areas, Swainson's warblers may be selecting habitats on higher elevations that are inundated with water less frequently and, therefore, provide a more consistent supply of ground-dwelling arthropods and a more-developed layer of leaf litter.

Additionally, occupancy of the Swainson's warbler seems to be influenced by stem variables (Table 2.6). The 3-variable model including cane, vine, and shrubs stems as separate variables was the highest ranked model and accounted for 83% of the total AIC_c weight of all models considered. Also, the total stems model (pooled cane, vine, and shrub stems count) was a relatively ineffective predictor of Swainson's warbler occupancy, and only accounted for <1% of the total AIC_c weight of all models considered (Table 2.6). However, the total stems model was still better at predicting Swainson's warbler occupancy than the NULL model (Table 2.6). I can infer from this that the different types of stems each have a different affect on Swainson's warblers. Specifically, cane, vine, and shrub stems were positively associated with the presence of Swainson's warblers. In fact, cane stems seem to be the best predictor of Swainson's warbler occupancy which had a combined AIC_c weight that accounted for 99% of all models considered (Table 2.6).

The data from this study seem to support the hypothesis that occupied sites have a greater density of leaf litter and shrub stems than unoccupied sites. However, the data also showed no difference in shrub cover between occupied and unoccupied sites which led me to only partially support this hypothesis. Additionally, the data fully support my second hypothesis that occupied sites have a greater density of cane stems and cane cover than unoccupied sites. Therefore, this suggests that the presence of cane, dense understory, and leaf litter are important in habitat selection by Swainson's warblers.

Overall, Swainson's warblers can be characterized as using sites with more uniformly dense vegetation cover at the shrub layer level, greater cane, shrub, and total stem density, canopy cover, subcanopy height, litter depth, soil moisture, percent cover of cane, density of snags, and lower density of large trees than unoccupied sites (Tables

2.2–2.5, Figs. 2.4 and 2.5). These results are consistent with the results of other studies investigating Swainson's warbler habitat use throughout their breeding range (e.g., Meanley 1971, Graves 2002, Bednarz et al. 2005). Results from a combination of 9 studies including 9 states, consistently report that the key components of Swainson's warbler breeding habitat include dense canopy cover often associated with disturbance gaps, dense shrub-level vegetation (cane or other species) for nesting, abundant leaf litter and sparse herbaceous vegetation, moist floodplain soils, appropriate hydrologic regimes, and substantial forest cover at the landscape scale (Wright 2002).

Moreover, my findings seemed to highlight the importance of cane, which has been a drastically declining habitat in the southeastern United States. Canebrakes are endangered ecosystems that have disappeared faster than any other bottomland plant community (Meanley 1971, Noss et al. 1995, Gagnon 2006). Cane is considered an important understory component in bottomland hardwood forests and the largest canebrakes occur in alluvial floodplains (Platt and Brantley 1997). The Swainson's warbler is not the only species to benefit from the conservation of cane. Canebrakes provide seeds that are utilized by squirrels (*Sciurus* spp.; Deam 1929), wild turkey (*Meleagris gallopavo*; Janzen 1976), possibly northern bobwhite (*Colinus virginianus*; Janzen 1976), and provide foraging and concealment areas for white-tailed deer (*Odocoileus virginianus*), swamp rabbits (*Sylvilagus aquaticus*), and black bear (*Ursus americanus*), which are important game species in the southeastern U.S. Nongame species that are cane associates include timber rattlesnakes (*Crotalus horridus*; Conant and Collins 1998) and most likely the extinct Bachman's warbler (*Vermivora bachmanii*; Remsen 1986).

To demonstrate the historical abundance and importance of cane in Arkansas, Marsh (1977) found over 100 places in 56 counties and greater than 60 streams were named after cane in Arkansas. Less than 2% of the original population of canebrakes remains in the U.S. today (Noss et al. 1995). Further investigations of cane ecology including relationships with demography and ecology of Swainson's warblers are needed to understand this unique system. Clearly, the preservation of the cane community is vital to the conservation of the bottomland hardwood forest ecosystem as a whole, and probably, to the conservation of Swainson's warbler populations.

MANAGEMENT IMPLICATIONS

Past forest management was used to enhance habitat for common game species, and until recently managers have not focused on improving forest habitat for priority forest birds (e.g., Swainson's warbler, cerulean warbler [*Dendroica cerulea* Wilson], and swallow-tailed kite [*Elanoides forficatus* Linneaus], U.S. Department of Agriculture 2004). Based on the results of this study and the recommendations from previous studies (e.g., Platt and Brantley 1997, LMVJV Forest Resource Conservation Working Group 2007a), I suggest uneven-aged, group-selection timber harvests should be used to diversify canopy species while leaving several large residual trees for continued growth. Group-selection cuts should remain small to mimic natural disturbances and provide canopy gaps of sufficient size to promote dense understory development, while maintaining 60–80% canopy cover (LMVJV Forest Resource Conservation Working Group 2007a).

Also, these small group-selection cuts should expand and rejuvenate present cane habitat and increase structural diversity of the forest. Ideally, group-selection cuts should be implemented on matrices surrounding existing cane habitat because the size and intensity at which disturbances become detrimental to cane habitat is unknown. Therefore, I discourage the use of clearcuts on existing cane habitat. Conversely, Graves (2002) suggests small clearcuts spatially configured to serve as territorial nuclei may be an effective management strategy for Swainson's warblers and could provide early-successional stands and disturbance gaps in mature forests. I suggest that such clearcuts should be implemented in areas adjacent to cane habitat and the size of clearcuts should depend on the quality of habitat present at each site. Timber stands with a variety of age classes, good understory development, and a well-developed leaf litter layer should be considered management priorities for Swainson's warblers and should provide benefits to Swainson's warbler as well as other wildlife species, therefore should not be disturbed with timber harvests. Alternatively, clearcuts may be beneficial in timber stands of intermediate age classes, little understory development, and a relatively undeveloped leaf litter layer. Given the uncertainty in size effects of clearcuts on Swainson's warblers, I suggest clearcuts should be no greater than 5 ha in size at this time. Clearcuts that are 5 ha in size will prevent the overall reduction of the forest area while minimizing the magnitude of habitat disturbances. This will provide a relatively-large disturbance gap that should promote shrub-level vegetation density, add vigor to adjacent cane, and provide an opportunity for existing cane habitat to increase in size. Management should consider the effects of all prescribed timber harvests on cane habitat, and harvest operations should be avoided during the Swainson's warblers breeding season (1 April–31 August). A better understanding of cane and the restoration of this habitat type may be important to the conservation of Swainson's warbler populations. However, comparative studies looking at varying sizes and intensities of group-selection cuts to clearcuts and their long-term effects on Swainson's warblers would be very beneficial in understanding the most effective way to manage this species (Peters et al. 2005).

In addition to timber harvesting, I suggest that a rotation of small prescribed minimum-intensity fires every 10–15 years may be beneficial to Swainson's warbler habitat. Platt and Brantley (1997) argued that fires approximately every 10 years will maintain stands of cane (Shepard et al. 1951, Hughes 1957), but fires of greater frequencies would likely have a negative impact. However, Gagnon (2006) suggested burning canebrakes every 5 to 10 years will replace weaker, older cane with vigorous new ones that will be more resistant to environmental stresses such as drought. Importantly, canebrakes under complete fire exclusion will lose vigor and will be gradually replaced by woody vegetation (Hughes 1957, 1966). While understanding that a minimum intensity fire in a bottomland hardwood forest is difficult to achieve, I suggest opportunistically timing the fire in which it is implemented during a relatively wet year and taking precautions to keep the fire at a low intensity. Platt and Brantley (1997) emphasize that if the area is too dry, canebrakes could be seriously damaged because the high fuel loads will increase the intensity of the fire (Hughes 1957). Both winter (Hughes 1957) and spring burns (Stevenson 1991) are reported to improve conditions for cane by setting back the growth of competing woody vegetation and I suggest burning in areas of sparse cane density that are adjacent to larger, more dense canebrakes. Additionally, I suggest that planting cane is an inefficient management effort because of the difficulty in propagation and unpredictability of cane growth (Platt and Brantley 1997).

Another management concern is hydrology; management for ground-foraging species like the Swainson's warbler requires sustaining water levels below the ground level during the breeding season when possible. Many floodplain systems, including WRNWR, are restricted by levees, which makes some floodplain areas subject to frequent and severe flooding. Because timing, depth, and duration of flooding in bottomland hardwood forests are major factors affecting species composition (Wharton et al. 1982), efforts should be made to control human-induced, excessive flooding. Also, some studies have shown shifts in plant species composition from the less water-tolerant species to the more water-tolerant species when frequent and excessive flooding occurs (e.g., Malecki et al. 1983; Karr et al. 1990; King 1994, 1995). Establishing and monitoring water gauge readings in or adjacent to occupied Swainson's warbler areas to determine levels of flooding that may inundate suitable habitat is important. Such monitoring could be used to determine appropriate flood levels that would not destroy Swainson's warbler habitat and allow for the management of water control structures to minimize damage to the habitat. Graves (2001) suggests that abandonment of a particular area by Swainson's warblers is stimulated by the inundation of leaf litter, which is a critical foraging resource, and nest sites. Also, Platt and Brantley (1997) suggested that persistent floods could become detrimental to canebrakes. My data suggest that this species was using mostly high-elevation bottomland areas, because frequent flooding negatively affects Swainson's warblers by washing away the leaf litter on the forest floor which supports most of the arthropod communities that is used as food (Chapter 3). Moreover, management of low-elevation areas have been a priority while higher-elevation bottomland sites have been overlooked (LMVJV 2007b). Likewise, cane is generally found on the higher elevations of a bottomland forest (Gagnon 2006) and this is where most conversion to agriculture occurs (Twedt and Loesch 1999, LMVJV 2007b). Therefore, I suggest these higher elevations of a bottomland forest be given priority for future management. Finally, further investigations are needed on demography, habitat use, and home-range sizes to ensure that suggested management practices are truly benefiting Swainson's warbler populations.

Finally, I suggest establishing long-term monitoring surveys on the refuge to document Swainson's warbler use of cane versus shrub thickets and movements between the two habitats. I suggest locating long-term monitoring sites before a prescribed timber harvest in cane habitat and in adjacent areas and re-evaluating these sites the following year after harvest and every 3 years thereafter. These surveys will provide invaluable before and after data on ensuing timber harvests and allow shifts in the use of habitat by Swainson's warblers. I provide a base-line of data on occupied and unoccupied Swainson's warbler locations in 2004 and 2005 for WRNWR in Appendix A.

LITERATURE CITED

Bassett-Touchell, C.A., and P.C. Stouffer. 2006. Habitat selection by Swainson's warblers breeding in loblolly pine plantations in southeastern Louisiana. Journal of Wildlife Management 70:1013–1019.

Bednarz, J. C., P. Stiller-Krehel, and B. Cannon. 2005. Distribution and habitat use of Swainson's warblers in eastern and northern Arkansas. Pages 576–588 *in* Ralph, C. J., and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. U.S. Forest Service General Technical Report PSW-GTR-191. U.S. Department of Agriculture, Pacific Southwest Research Station, Albany, California, USA.

Bell, D. T., and S. K. Sipp. 1975. The litter stratum in the streamside forest ecosystem. Oikos 26:391–397.

Brewster, W. 1885. Swainson's warbler. Auk 2:65–80.

Brown, R. E., and J. G. Dickson. 1994. Swainson's warbler (*Limnothlypis swainsonii*). No. 126 *in* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Bultman, T. L., and G. W. Uetz. 1984. Effect of structure and nutritional quality of litter on abundances of litter-dwelling arthropods. American Midland Naturalist 111:165–172.

Burnham, K.P., and D.R. Anderson. 2002. Model selection and multi-model inference: a practical information-theoretic approach. Springer-Verlag, New York, USA.

Cody, R. P., and J. K. Smith. 1997. Applied statistics and the SAS programming language. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Conant, R., and J. T. Collins 1998. A field guide to reptiles and amphibians of eastern and central North America. Third edition, Expanded. The Peterson Field Guide Series. Houghton Mifflin Company, New York, New York, USA.

Deam, C. C. 1929. Grasses of Indiana. Publication No. 82. Department of Conservation, Division of Forestry, Indianapolis, Indiana, USA.

Eddleman, W. R. 1978. Selection and management of Swainson's warbler habitat. Thesis, University of Missouri, Columbia, Missouri, USA.

Eddleman, W. R., K. E. Evans, and W. H. Elder. 1980. Habitat characteristics and management of Swainson's warblers in southern Illinois. Wildlife Society Bulletin 8:228–233.

Gagnon, P. R. 2006. Population biology and disturbance ecology of a native North American bamboo (*Arundinaria gigantea*). Dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, USA.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in Great Dismal Swamp. Auk 118:650–664.

Graves, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's warbler. Wilson Bulletin 114:210–220.

Hughes, R. H. 1957. Response of cane to burning in the North Carolina coastal plain. North Carolina Agricultural Experiment Station, Technical Bulletin 402.

Hughes, R. H. 1966. Fire ecology of canebrakes. Proceedings of the Tall Timbers Fire Ecology Conference 5:149–158.

Hunter, W. C., and Collazo, J. A. 2001. Partners in Flight South Atlantic Coastal Plain Bird Conservation Plan. American Bird Conservancy: The Plains, Virginia, USA.

Hunter, W. C., D. N. Pashley, and R. E. F. Escano. 1993. Neotropical migratory landbird species and their habitat of special concern within the southeast region. Pages 159–171 *in* D. M. Finch, and S. W. Strangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229. U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Hunter, W. C., A. J. Mueller, and C. L. Hardy. 1994. Managing for Red-cockaded Woodpeckers and neotropical migrants—is there a conflict? Proceedings of the Annual Conference Southeast Association of Fish Wildlife Agencies 48:383–394.

Janzen, D. H. 1976. Why bamboos wait so long to flower. Annual Review of Ecological Systems 7:347–391.

Karr, B. L., G. L. Young, J. D. Hodges, B. D. Leopold, and R. M. Kaminski. 1990. Effect of flooding on green-tree reservoirs. Technical Completion Report G1571–03. U.S. Department of the Interior, Washington, D.C., USA.

Karr, J. R., and J. D. Brawn. 1990. Food resources of understory birds in central Panama: quantification and effects on avian populations. Pages 58–64 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

King, S. L. 1994. The effects of flooding regimes and green-tree reservoir management on succession of bottomland hardwoods. Dissertation, Texas A&M University, College Station, Texas, USA.

King, S. L. 1995. Effects of flooding regimes on two impounded bottomland hardwood stands. Wetlands 15:272–284.

LMVJV Forest Resource Conservation Working Group. 2007a. Management of Bottomland Hardwood Forests. Pages 20–28 *in* R. Wilson, K. Ribbeck, S. King, and D. Twedt, editors. Restoration, management, and monitoring of forest resources in the Mississippi alluvial valley: recommendations for enhancing wildlife habitat. Lower Mississippi Valley Joint Venture, Vicksburg, Mississippi, USA.

LMVJV Forest Resource Conservation Working Group. 2007b. Restoration of Bottomland Hardwood Forests. Pages 29–38 *in* R. Wilson, K. Ribbeck, S. King, and D. Twedt, editors. Restoration, management, and monitoring of forest resources in the Mississippi alluvial valley: recommendations for enhancing wildlife habitat. Lower Mississippi Valley Joint Venture, Vicksburg, Mississippi, USA.

Malecki, R. A., J. R. Lassoie, E. Rieger, and T. Seamans. 1983. Effects of long-term artificial flooding on a northern bottomland hardwood community. Forest Science 29:535–544.

Marsh, D. L. 1977. The taxonomy and ecology of cane, *Arundinaria gigantea* (Walter) Muhlenburg. Dissertation, University of Arkansas, Little Rock, Arkansas, USA.

Martin, T. E., C. R. Paine, C. J. Conway, W. M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD Field Protocol. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana, USA.

Meanley, B. 1945. Notes on Swainson's warblers in central Georgia. Auk 62:395–401.

Meanley, B. 1971. Natural history of the Swainson's warbler. North American Fauna 69. U.S. Department of Interior, Washington, D.C., USA

Morse, D.H. 1989. American warblers: an ecological and behavioral perspective. Harvard University Press, Cambridge, Massachusetts, USA.

National Audubon Society. 2004. National Audubon Society watch list <http://www.audubon.org/bird/watchlist/bs-bc-what_is_the_watchlist.html>. Accessed 7 May 2007.

Noss, R. F., E. T. Laroe, III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. U.S. Department of Interior, National Biological Service, Biological Report 28, Washington D.C., USA.

Nudds, T. D. 1977. Quantifying the vegetative structure of wildlife cover. Wildlife Society Bulletin 5:113–117.

Peters, K. A. 1999. Swainson's warbler (*Limnothlypis swainsonii*) habitat selection in a managed bottomland hardwood forest in South Carolina. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Peters, K. A., R. A. Lancia, and J. A. Gerwin. 2005. Swainson's warbler habitat selection in a managed bottomland hardwood forest. Journal of Wildlife Management 69:409–417.

Petit, D.R., J.F. Lynch, R.L. Hutto, J. G. Blake, and R.B. Waide. 1995. Habitat use and conservation in the neotropics. Pages 145-197 *in* T. E. Martin and D. M. Finch, editors. Ecology and management of neotropical migratory birds: A synthesis and review of critical issues. Oxford University Press, New York, New York, USA.

Platt, S. G. and C. G. Brantley. 1997. Canebrakes: An ecological and historical perspective. Castanea 62:8–21.

Ramsar (Ramsar Convention Secretariat). 1971. The Ramsar list of wetlands of international importance. Article 2.1 of the Convention on Wetlands (1989 amendment). Ramsar, Iran.

Remsen, J. V. Jr. 1986. Was Bachman's warbler a bamboo specialist? The Auk 103:216–219.

Robinson, S. K., and R. T. Holmes. 1982. Foraging behavior of forest birds: the relationships among search tactics, diet, and habitat structure. Ecology 63:1918–1931.

SAS Institute. 2004. Version 9.1. SAS Institute, Cary, North Carolina, USA.

Shepard, W. O., E. U. Dillard, and H. L. Lucas. 1951. Grazing and fire influences in pond pine forests. North Carolina Agricultural Experiment Station, Technical Bulletin 97.

Somershoe, S. G., S. P. Hudman, and C. R. Chandler. 2003. Habitat use by Swainson's warblers in a managed bottomland forest. Wilson Bulletin 115:148–154.

Stevenson, J. A. 1991. Shift to lightning-season burns aids pineland restoration in Florida. Restoration and Management Notes 9:113–114.

Stotz, D. F., J. W. Fitzpatrick, T. A. Parker III, and D. K. Moskovits. 1996. Neotropical birds. Ecology and conservation. The University of Chicago Press, Chicago, Illinois, USA.

Thomas, B. G., E. P. Wiggers, and R. L. Clawson. 1996. Habitat selection and breeding status of Swainson's warblers in southern Missouri. Journal of Wildlife Management 60:611–616.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of neotropical migrant landbirds in the Midwest: identifying species of management concern. Pages 145-158 *in* D. M. Finch, and P. W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229, U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Thompson, J. L. 2005. Breeding biology of Swainson's warblers in a managed South Carolina bottomland forest. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Twedt, D. J., and C. R. Loesch. 1999. Forest area and distribution in the Mississippi Alluvial Valley: implications for breeding bird conservation. Journal of Biogeography 26:1215–1224.

Uetz, G. W., K. L. Van Der Laan, G. F. Summers, P. A. K. Gibson, and L. L. Getz. 1979. The effects of flooding on floodplain arthropod distribution, abundance, and community structure. American Midland Naturalist 101:286–299.

United States Department of Agriculture. 2004. Wetlands reserve program forest land compatible use guidelines. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, D.C., USA.

United States Fish and Wildlife Service [USFWS]. 2006. Daily use permit brochure for White River National Wildlife Refuge. Refuge Map, St. Charles, Arkansas. <http://www.fws.gov/whiteriver/mapspage.htm>. Accessed 20 Nov 2006.

Wharton, C. H., W. M. Kitchen, E. C. Pendleton, and T. W. Sipe. 1982. The ecology of bottomland hardwood swamps of the southeast: a community profile. FWS/OBS-81/37. U.S. Fish and Wildlife Service, Washington, D.C., USA.

Wolda, H. 1990. Food availability for an insectivore and how to measure it. Pages 38–43 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Wright, E. A. 2002. Breeding population density and habitat use of Swainson's warblers in a Georgia floodplain forest. Thesis, University of Georgia, Athens, Georgia, USA.

Table 2.1. *A priori* candidate models used to predict Swainson's warbler occupancy at White River National Wildlife Refuge in eastern Arkansas.

Candidate Model	Variables
Shrub stems model	shrub stems[a]
Cane stems model	cane stems
Total stems model	total stems[b]
Understory density model	understory density[c]
Litter volume model	litter volume[d]
Understory heterogeneity model	understory horizontal CV[e], understory vertical CV
Understory density and litter volume model	understory density, litter volume
Cane stems and litter volume model	cane stems, litter volume
Cane stems and canopy cover model	cane stems, canopy cover[f]
Shrub and vine stems model	shrub stems, vine stems
Stem type model	cane stems, vine stems, shrub stems
Understory density and understory heterogeneity model	understory density, understory horizontal CV, understory vertical CV
Foraging characteristics model	forb cover[g], litter volume, understory density
Canopy cover, understory density, and litter volume model	canopy cover, total stems, understory density, litter volume
Canopy cover, understory heterogeneity, and litter volume model	canopy cover, total stems, understory horizontal CV, understory vertical CV, litter volume

[a] Stem counts within four 1-m^2 quadrats.
[b] Sum of cane, vine, and shrub stem counts.
[c] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[d] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[e] Coefficient of variation.
[f] Total canopy cover taken from the center of the plot with a densiometer.
[g] Percent cover of forbs with the 5-m radius plot.

Table 2.2. Pooled mean habitat characteristics, standard errors, and results of analysis of variance for differences between Swainson's warbler occupied (n = 70) and unoccupied (n = 106) sites within the 5-m radius sample plot at White River National Wildlife Refuge in 2004 and 2005.

Variable	Occupied $\overline{X}$	Occupied SE	Unoccupied $\overline{X}$	Unoccupied SE	F[a]	P
High-canopy cover (%)	81.75	0.98	77.38	1.04	8.43	0.0042*
Sub-canopy cover (%)	41.29	2.52	39.12	2.08	0.44	0.5087
Litter depth (mm)	17.49	0.70	14.90	0.59	7.95	0.0054*
Litter volume (m^2)	1.24	0.06	1.03	0.05	7.00	0.0089*
Soil moisture	8.19	0.14	7.68	0.14	6.17	0.0140*
Shrub-layer height (m)[b]	1.32	0.65	1.37	0.67	0.47	0.4950
Stem density (per ha)						
Cane stems	30,750	4,113	2,807	1,035	43.42	<0.0001*
Non-cane stems	67,411	5,000	68,774	3,766	0.05	0.8253
Vine stems[c]	47,929	4,537	53,134	4,603	0.65	0.4221
Shrub stems[c]	23,536	3,232	9,590	952	17.13	<0.0001*
Total stems	98,161	4,046	71,580	3,953	20.49	<0.0001*
Percent cover (%)						
Green vegetation	39.01	2.21	43.2	2.46	0.25	0.6188
Grasses and sedges	3.42	0.57	3.83	0.81	0.13	0.7144
Forbs	14.96	1.37	20.63	1.99	1.99	0.1600
Shrubs	8.41	0.66	9.74	0.67	1.80	0.1812
Vines[c]	14.54	1.31	17.43	1.54	2.07	0.1526
Cane	16.25	2.16	0.82	0.35	73.27	<0.0001*
Brush	4.93	0.47	6.64	0.78	2.75	0.0992
Leaf litter	87.08	1.73	81.93	2.30	2.64	0.1057
Logs	1.87	0.30	2.22	0.31	0.63	0.4278
Bare ground	13.06	1.79	13.58	1.47	0.05	0.8232
Water	0.00	0.00	0.40	0.32	1.03	0.3111
Density cover board (%)[c]						
0.0–0.5 m	16.54	2.17	12.53	1.52	2.25	0.1356
0.5–1.0 m	18.51	2.42	9.67	1.18	10.49	0.0015*
1.0–1.5 m	20.46	2.47	8.31	1.10	23.57	<0.0001*
1.5–2.0 m	22.38	2.60	7.97	1.17	32.61	<0.0001*
2.0–2.5 m	19.70	2.18	8.28	1.13	29.17	<0.0001*
Total vegetation density[d]	19.52	2.29	9.35	1.06	20.84	0.0001*
Horizontal CV[e]	52.55	4.60	67.52	5.46	4.46	0.0366*
Vertical CV[f]	42.28	4.16	71.40	6.52	14.42	0.0002*
Total CV[g]	79.43	6.73	117.32	7.60	11.42	0.0010*

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Occupied sample size is 68 and unoccupied sample size is 103.
[c] Unoccupied sample size is 67 instead of 106 because this variable was only measured in 2005.
[d] Density-board reading averaged over all height intervals.
[e] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals.
[f] Coefficient of variation in density-board readings for five height-interval measurements averaged over all horizontal directions.
[g] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals and five height-interval measurements averaged over all horizontal directions.
* Means were significantly different (P < 0.050).

Table 2.3. Pooled mean habitat characteristics, standard errors, and results of analysis of variance for differences between Swainson's warbler occupied (*n* = 70) and unoccupied (*n* = 106) sites within the 11.3-m radius sample plot at White River National Wildlife Refuge in 2004 and 2005.

Variable	Occupied $\bar{X}$	Occupied SE	Unoccupied $\bar{X}$	Unoccupied SE	F[a]	P
Canopy height (m)	26.44	0.48	26.89	0.32	0.69	0.4086
Sub-canopy height (m)	12.63	0.25	11.76	0.23	6.10	0.0145*
Tree density (per ha)						
Saplings	129.88	15.46	156.55	10.22	2.28	0.1332
Poles	123.89	12.71	148.57	9.97	2.35	0.1275
Small trees	63.32	2.74	60.33	2.74	0.54	0.4653
Medium trees	25.93	1.50	23.43	1.25	1.30	0.2564
Large trees	19.94	1.00	24.93	1.25	7.59	0.0065*
Small snags	16.45	1.50	12.21	1.00	5.38	0.0215*
Large snags	17.95	1.25	13.21	1.25	7.03	0.0088*
Vine tents[b]	2.00	0.50	1.50	0.50	0.44	0.5064
Density cover board (%)[b]						
0.0 – 0.5 m	38.21	3.04	30.13	2.64	4.01	0.0473*
0.5 – 1.0 m	42.85	2.99	27.72	2.37	15.57	0.0001*
1.0 – 1.5 m	45.54	2.89	26.60	2.43	24.90	<0.0001*
1.5 – 2.0 m	49.07	3.04	24.92	2.51	37.19	<0.0001*
2.0 – 2.5 m	45.71	3.02	23.57	2.38	32.74	<0.0001*
Total vegetation density[bc]	44.28	2.85	26.59	2.19	23.91	<0.0001*
Horizontal CV[bd]	39.97	3.84	66.01	4.62	18.93	<0.0001*
Vertical CV[be]	23.92	1.84	39.30	4.32	11.05	0.0011*
Total CV[bf]	52.25	4.75	83.14	4.93	18.07	<0.0001*

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Unoccupied sample size is 67 instead of 106 because this variable was only measured in 2005.
[c] Density-board reading averaged over all height intervals.
[d] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals.
[e] Coefficient of variation in density-board readings for five height-interval measurements averaged over all horizontal directions.
[f] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals and five height-interval measurements averaged over all horizontal directions.
* Means were significantly different ($P < 0.050$).

Table 2.4. Pooled mean habitat characteristics, standard errors, and results of analysis of variance for differences between sites occupied 2 (n = 28), 1 (n = 37), and 0 (n = 38) years by Swainson's warblers within the 5-m radius sample plot at White River National Wildlife Refuge in 2004 and 2005.

	Occupied 2 yr		Occupied 1 yr		Occupied 0 yr			
Variable	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	F[a]	P
High-canopy cover (%)	79.97	1.95	83.32	1.05	79.26	1.15	2.77	0.0677
Sub-canopy cover (%)	37.97	3.16	41.95	3.58	40.04	3.11	0.33	0.7185
Litter depth (mm)	17.05	0.99	18.39	1.02	15.38	0.77	2.86	0.0619
Litter volume (m^2)	1.23	0.08	1.26	0.09	1.07	0.07	1.64	0.1986
Soil moisture	8.65	0.18	7.90	0.18	7.10	0.24	13.35	<0.0001*
Shrub-layer height (m)[b]	1.31	0.09	1.24	0.09	1.30	0.10	0.19	0.8278
Stem density (per ha)								
Cane stems	49,598	8,283	19,966	2,972	4,803	2,219	18.92	<0.0001*
Non-cane stems	45,357	6,489	79,966	6,185	72,828	5,188	8.51	0.0004*
Vine stems[c]	31,964	4,674	54,257	5,906	59,667	5,474	6.48	0.0023*
Shrub stems[c]	13,393	4,212	25,709	4,651	8,583	1,328	6.50	0.0032*
Total stems	94,955	5,596	99,932	5,346	77,632	5,586	4.80	0.0102*
Percent cover (%)								
Green vegetation	39.53	3.50	39.02	3.04	45.38	3.40	1.20	0.3046
Grasses and sedges	3.90	0.94	3.28	0.79	1.52	0.45	2.94	0.0572
Forbs	13.83	1.96	16.43	2.06	18.87	3.18	0.66	0.5202
Shrubs	7.42	1.18	8.61	0.80	10.07	0.86	1.97	0.1445
Vines[c]	13.27	2.07	15.20	1.80	23.04	2.50	5.68	0.0047*
Cane	26.85	4.11	10.05	1.75	2.09	0.95	36.19	<0.0001*
Brush	6.32	0.80	4.20	0.58	5.64	0.58	2.77	0.0672
Leaf litter	90.34	1.66	84.01	2.86	85.34	2.48	1.58	0.2102
Logs	2.12	0.46	1.89	0.43	1.29	0.31	1.15	0.3195
Bare ground	10.17	1.91	15.25	2.74	14.34	2.43	1.07	0.3481
Water	0.00	0.00	0.00	0.00	0.22	0.17	1.50	0.2289
Density cover board (%)[c]								
0.0–0.5 m	22.29	4.67	13.13	1.81	12.33	1.90	2.19	0.1173
0.5–1.0 m	25.93	5.19	14.05	1.95	11.23	1.90	3.80	0.0260*
1.0–1.5 m	29.10	5.07	15.35	2.10	9.63	1.78	7.32	0.0011*
1.5–2.0 m	30.11	5.18	18.02	2.53	9.65	2.04	10.08	0.0001*
2.0–2.5 m	24.41	4.27	16.64	2.22	9.67	1.99	7.96	0.0007*
Total vegetation density[cd]	26.37	4.78	15.44	1.99	10.50	1.78	6.80	0.0018*
Horizontal CV[ce]	39.58	7.96	58.27	5.64	59.58	7.81	2.36	0.0999
Vertical CV[cf]	42.28	4.16	42.28	4.16	71.40	6.52	14.42	0.0002*
Total CV[cg]	67.06	10.25	88.21	7.44	107.68	13.12	3.63	0.0303*

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Sites occupied in only one year is 35 instead of 37 for this variable.
[c] Sites occupied zero years are 30 instead of 38 because this variable was only measured in 2005.
[d] Density-board reading averaged over all height intervals.
[e] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals.
[f] Coefficient of variation in density-board readings for five height-interval measurements averaged over all horizontal directions.
[g] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals and five height-interval measurements averaged over all horizontal directions.
* Means were significantly different ($P < 0.050$).

Table 2.5. Pooled mean habitat characteristics, standard errors, and results of analysis of variance for differences between sites occupied 2 (*n* = 28), 1 (*n* = 37), and 0 (*n* = 38) years by Swainson's warblers within the 11.3-m radius sample plot at White River National Wildlife Refuge in 2004 and 2005.

	Occupied 2 yr		Occupied 1 yr		Occupied 0 yr			
Variable	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	F^a	*P*
Canopy height (m)	26.64	0.78	26.12	0.69	26.67	0.41	0.34	0.7094
Sub-canopy height (m)	13.04	0.36	12.31	0.36	11.76	0.31	3.24	0.0431*
Tree density (per ha)								
Saplings	91.74	15.95	126.89	15.46	158.05	17.20	3.85	0.0245*
Poles	107.94	17.20	134.11	19.94	157.55	17.45	1.69	0.1901
Small trees	65.81	3.99	64.56	4.24	60.83	3.99	0.41	0.6650
Medium trees	28.67	2.24	25.43	2.24	21.94	1.74	2.67	0.0745
Large trees	24.18	1.50	16.95	1.50	24.93	2.24	6.20	0.0029*
Small snags	20.19	2.24	14.21	1.74	14.46	1.99	2.59	0.0799
Large snags	20.19	1.50	17.45	1.99	11.97	1.74	5.33	0.0063*
Vine tents[b]	1.25	0.50	2.49	1.00	1.99	0.75	0.77	0.4678
Density Cover board (%)[b]								
0 – 0.5 m	45.22	5.52	35.80	3.61	29.48	3.50	2.90	0.0600
0.5 – 1.0 m	51.87	5.26	39.07	3.52	27.88	3.46	7.15	0.0013*
1.0 – 1.5 m	57.27	4.77	39.50	3.36	27.13	3.50	14.23	<0.0001*
1.5 – 2.0 m	59.29	5.14	44.05	3.67	26.63	3.72	14.28	<0.0001*
2.0 – 2.5 m	53.38	5.18	41.03	3.81	25.47	3.57	10.31	<0.0001*
Total vegetation density[bc]	53.41	4.99	39.90	3.37	27.32	3.35	10.37	<0.0001*
Horizontal CV[bd]	26.43	5.21	47.10	5.32	61.27	6.21	8.90	0.0003*
Vertical CV[be]	21.34	2.78	24.45	2.42	34.20	6.56	1.83	0.1708
Total CV[bf]	40.68	5.98	60.17	5.81	81.67	7.70	9.09	0.0002*

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Sites occupied zero years is 30 instead of 38 because this variable was only measured in 2005.
[c] Density-board reading averaged over all height intervals.
[d] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals.
[e] Coefficient of variation in density-board readings for five height-interval measurements averaged over all horizontal directions.
[f] Coefficient of variation in density-board readings for north, south, east, and west measurements averaged over all height intervals and five height-interval measurements averaged over all horizontal directions.
* Means were significantly different (*P* < 0.050).

Table 2.6. Habitat models and logistic regression results used to predict occupancy by Swainson's warblers at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	Concordance
Cane stems[b] (+), Vine stems (+), Shrub stems (+)	4	134.08	0.00	0.8336	89.90
Cane stems (+), Canopy cover[c] (+)	3	137.41	3.45	0.1576	85.00
Canopy cover (+), Total stems[d] (+), Understory density[e] (+), Litter volume[f] (+)	5	144.55	10.31	0.0044	84.30
Canopy cover (+), Total stems (+), Horizontal CV[g] (–), Vertical CV (–), Litter volume (+)	6	146.50	12.08	0.0017	85.20
Cane stems (+), Litter volume (+)	3	146.76	12.80	0.0015	83.10
Cane stems (+)	2	147.23	13.36	0.0012	69.30
Understory density (+), Litter volume (+)	3	166.12	32.16	<0.001	76.10
Forbs[h] (+), Litter volume (+), Understory density (+)	4	166.93	32.85	<0.001	76.70
Understory density (+), Horizontal CV (–), Vertical CV (–)	4	168.84	34.76	<0.001	75.90
Total stems (+)	2	169.50	35.63	<0.001	73.60
Horizontal CV (–), Vertical CV (–)	3	170.75	36.79	<0.001	74.20
Understory density (+)	2	171.23	37.37	<0.001	72.20
Shrub stems (+)	2	183.44	49.57	<0.001	60.50
Shrub stems (+), Vine stems (–)	3	184.75	50.79	<0.001	64.20
Litter volume (+)	2	187.75	53.88	<0.001	62.30
Null (intercept only)	1	191.89	58.08	<0.001	

[a] Number of model parameters.
[b] Stem counts within four 1-m^2 quadrats.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Sum of cane, vine, and shrub stem counts.
[e] Measurement taken with a 2.5 m vegetation density coverboard.
[f] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[g] Coefficient of variation.
[h] Percent cover of forbs with the 5-m radius plot.

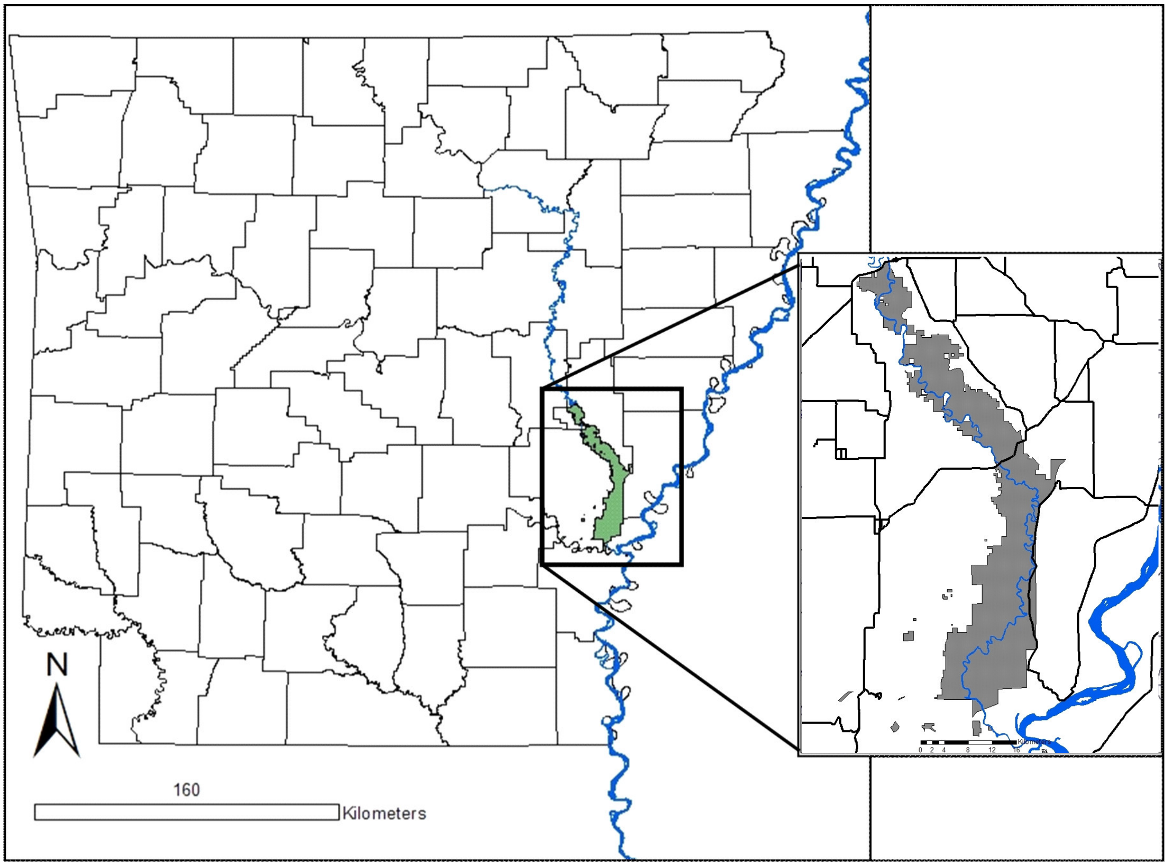


Figure 2.1. Location of White River National Wildlife Refuge in Arkansas where habitat and arthropod data at sites both occupied and not occupied by Swainson's warblers were collected in 2004 and 2005.

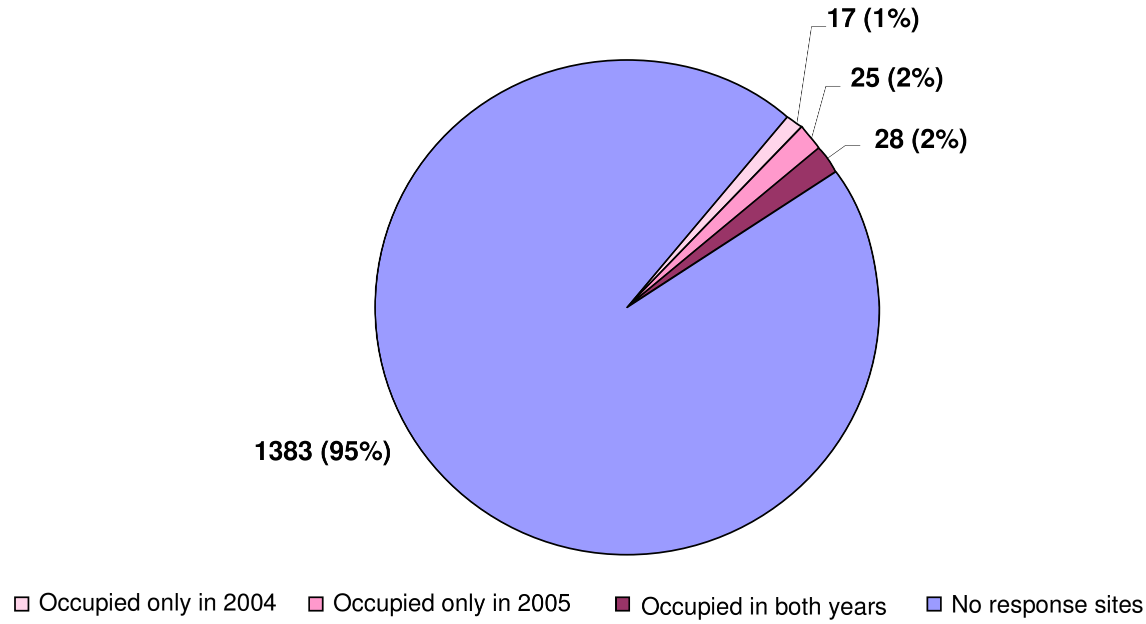


Figure 2.2. Frequency of sites surveyed with broadcast sampling that were occupied by Swainson's warblers in 2004 and 2005 at White River National Wildlife Refuge.

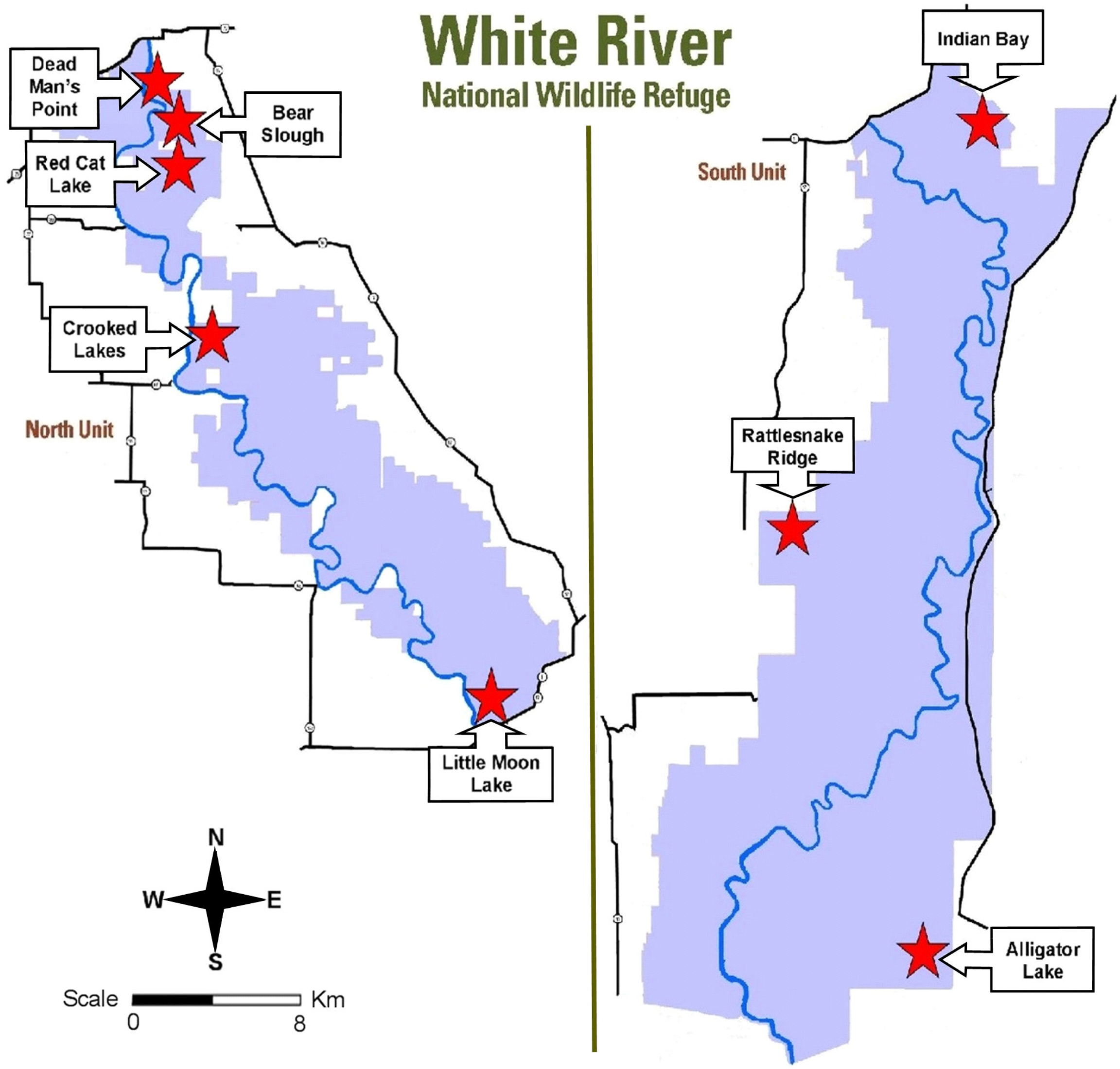


Figure 2.3. Locations of general areas where Swainson's warblers were detected in 2004 and 2005 at White River National Wildlife Refuge, Arkansas (USFWS 2006).

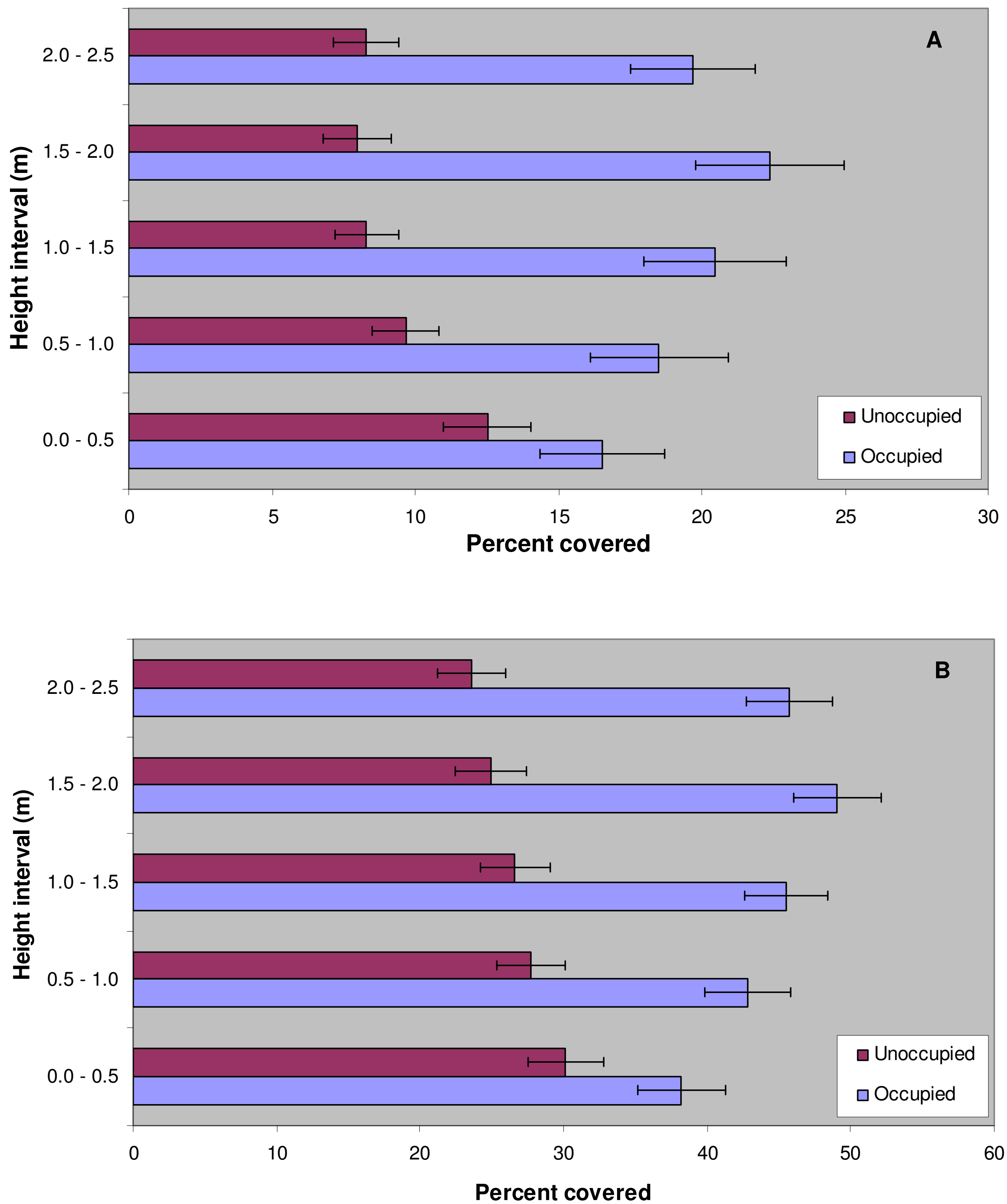
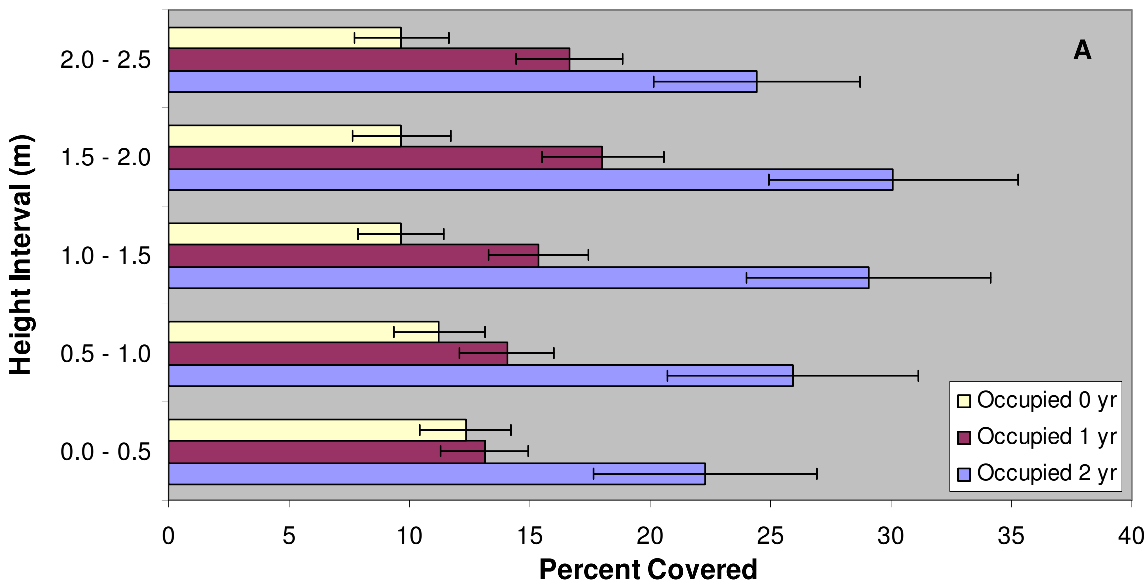


Figure 2.4. (A) Density-board measurements at 5-m radius sample plots, and (B) 11.3-m radius sample plots for 5 different height intervals at sites occupied and unoccupied by Swainson's warblers at White River National Wildlife Refuge in 2004 and 2005.



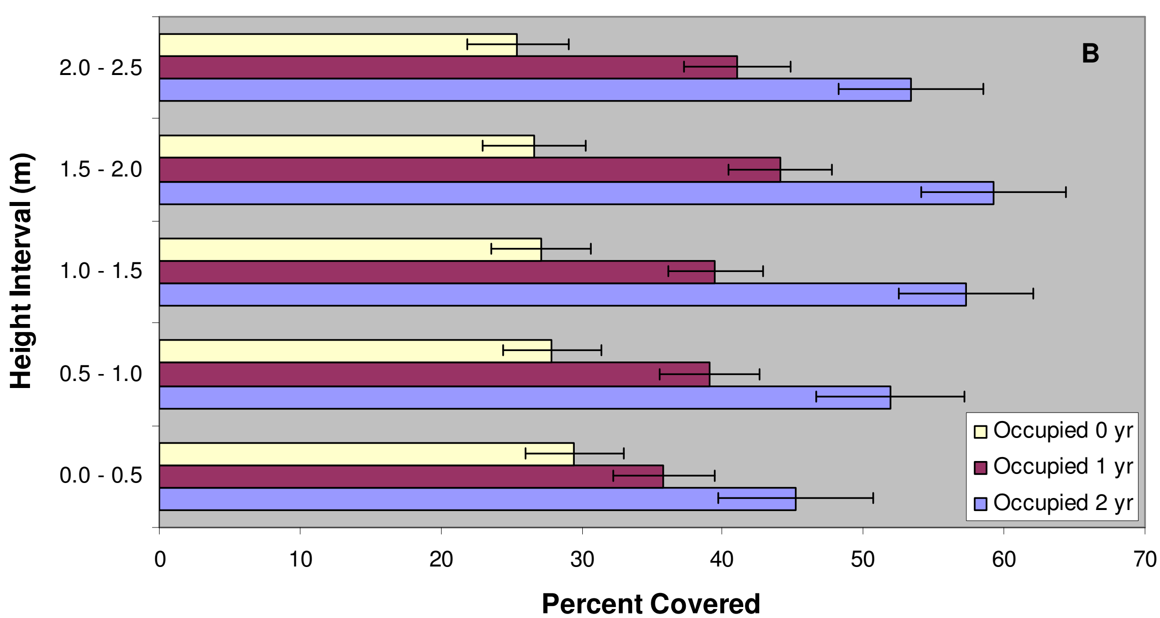


Figure 2.5. (A) Density-board measurements at 5-m radius sample plots, and (B) 11.3-m radius sample plots for 5 different height intervals at sites occupied 2, 1, and 0 years by Swainson's warblers at White River National Wildlife Refuge in 2004 and 2005.

CHAPTER III

ARTHROPOD COMMUNITY RELATIONSHIPS WITH HABITAT OCCUPANCY BY SWAINSON'S WARBLERS AT THE WHITE RIVER NATIONAL WILDLIFE REFUGE, ARKANSAS

ABSTRACT

The Swainson's warbler (*Limnothlypis swainsonii*) is a species of critical conservation concern in the southeastern U.S. Because these warblers are ground-foraging litter specialists, they are dependent on a well-developed layer of leaf litter. Here, I examine relationships between Swainson's warbler occupancy and arthropod communities in relatively high-elevation bottomlands at White River National Wildlife Refuge (WRNWR). In 2004 and 2005, systematic surveys were conducted at 1,453 sites using song playbacks and arthropods were collected using litter samples and pitfall traps at 45 randomly-selected occupied and unoccupied sites. Total mean abundance of arthropods (32.57/sample), abundance of large arthropods (arthropods 5–10 mm = 8.3/sample, arthropods 10–15 mm = 1.63/sample, arthropods >15 mm = 0.54/sample), total adult abundance (26.62/sample), and taxonomic richness (8.89 taxa/site, 6.06 taxa/sample) were significantly greater in occupied than unoccupied sites (means = 21.84/sample, 5.00/sample, 0.86/sample, 0.12/sample, 17.23/site, 1.21/sample, 7.27 taxa/site, and 4.73 taxa/sample, respectively) for litter sample data. There were no differences detected in the pitfall trap analysis. Additionally, mean number of beetles (Coleoptera, 5.71/sample), click beetles (Elateridae, 0.88/sample), centipedes (Chilopoda, 0.40/sample), flies (Diptera, 4.36/sample), snipe flies (Rhagionidae, 2.35/sample), and snails (Gastropoda, 0.17/sample) were greater in occupied sites than

in unoccupied sites (4.01/sample, 0.27/sample, 0.10/sample, 2.38/sample, 0.64/sample, and 0.17/sample, respectively). Relative sample richness and large arthropods were good predictors of occupancy based on logistic regression analyses. Overall, these results suggest that arthropod abundance and richness are key habitat components related to occupancy of Swainson's warblers at WRNWR. Indeed, the arthropod community may be a driving factor influencing the presence or absence of Swainson's warblers, while habitat components such as leaf litter may be an indirect or correlated factor associated with the occupancy of warblers.

INTRODUCTION

The Swainson's warbler (*Limnothlypis swainsonii*) is a medium-sized, inconspicuous wood-warbler that primarily breeds in bottomland hardwood forests in the southeastern U.S., while their wintering grounds are relatively confined to the Yucatán Peninsula and the Caribbean islands (Brown and Dickson 1994). As ground-foraging specialists that nest in the forest understory, Swainson's warblers seem to be dependent on a well-developed layer of leaf litter and dense understory (e.g., Brown and Dickson 1994, Graves 2001, 2002, Bednarz et al. 2005).

Historically common in limited sections of woodlands with dense understories (Morse 1989), the Swainson's warbler is now listed as a species of conservation concern in the southeastern U.S. because of habitat destruction on its breeding and wintering grounds, relatively low population density, and restricted range (Hunter et al. 1993, 1994; Peters 1999; Hunter and Collazo 2001). The Southeast and Midwest Working Groups for Partners in Flight ranked the Swainson's warbler as of extreme conservation concern in these respective regions of the U.S. (Hunter et al. 1993, Thompson et al. 1993, Bednarz et al. 2005). Finally, the National Audubon Society watch list (2004) list (http://www.audubon.org/bird/watch/ Version 97.12) includes the Swainson's warbler as a species with very small populations or limited ranges that are declining rapidly and face major conservation threats.

Along with habitat loss on the wintering grounds, the loss of breeding habitat has been identified as the primary threat to the species (Thompson et al. 1993, Stotz et al. 1996, Graves 2001). Due to extensive clearing of bottomland forest in the southeastern U.S., the Swainson's warbler has been restricted in many drainages to seasonally-inundated zones bordering rivers and swamps (Graves 2001). Moreover, this species is especially vulnerable to flooding because of its ground foraging ecology, but little is known about patterns of habitat occupancy at wetland ecotones (Graves 2001) and the relationship between occupancy and abundance or richness of potential arthropod food resources. To my knowledge, no previous research has addressed the availability of arthropod communities and their relation to occupancy by Swainson's warblers. However, Strong (2000) has reported information on diet by looking at the regurgitation samples from Swainson's warblers in their wintering grounds. Also, Meanley (1966) investigated the gut contents of 4 Swainson's warblers in Georgia during the breeding period. Ants (Formicidae), beetles (Coleoptera), and spiders (Araneae) have been documented to be common prey items in the Swainson's warbler's diet (Meanley 1966, Strong 2000).

An insectivore's foraging strategy, prey preference, prey availability, and habitat selection are critical to identifying niche relationships (Robinson and Holmes 1982) and patterns of habitat use (Karr and Brawn 1990, Wolda 1990). Understanding these affiliations is crucial to applying effective conservation efforts (Petit et al. 1995). To determine the most effective management strategies for this species, documentation of habitat associations, prey availability, and population status in different habitat types is needed. My objective was to investigate the effects of arthropod community characteristics on habitat use by Swainson's warblers. Specifically, I tested the following hypotheses:

(1) Swainson's warbler occupied sites will have a greater arthropod abundance than unoccupied sites, and

(2) Swainson's warbler occupied sites will have a greater taxonomic richness of arthropods than unoccupied sites.

STUDY AREA

I studied Swainson's warbler habitat use and arthropod availability at White River National Wildlife Refuge (WRNWR) in eastern Arkansas. WRNWR was established in

1935 for the protection of migratory birds and is open to the public for many recreational uses such as: birding, camping, hiking, hunting, and fishing. The refuge is located in the floodplain of the White River near its confluence with the Arkansas River Canal and encompasses Arkansas, Desha, Monroe, and Phillips counties while ranging from 4.8 km to 16.0 km wide and is approximately 144 km long (Fig. 2.1). WRNWR is one of the largest remaining contiguous tracts of bottomland hardwood forest in the Mississippi River Valley and is included in the Ramsar list of wetlands of international importance (Ramsar 2008). The refuge is approximately 64,750 ha and is divided into a north and south unit that is separated by Arkansas Highway 1 (Fig. 2.1). WRNWR is primarily bottomland hardwood forest, but also contains some upland forest, agricultural fields, moist-soil impoundments, and 356 natural and man-made lakes.

METHODS

Occupancy Determination

Swainson's warbler broadcast surveys were conducted between sunrise and 1200 H at WRNWR from 1 April to 20 June in 2004 and 2005 (Fig. 2.1). This corresponds to the time of year that Swainson's warblers migrate into this area, establish territories, and respond most effectively to playback calling. Broadcast surveys were employed along transects at 200-m intervals at a minimum elevation of 45 m for the south unit and 48 m for the north unit. These elevational cut-offs were indicative of the bottomland areas not typically flooded on an annual basis (J. Denman, Forest Ecologist at WRNWR personal communication). At each sample site, I broadcast the Swainson's warbler's primary song for 90 sec from a dual-speaker CD player placed perpendicular to the transect line. I then recorded response songs and calls and approaching birds for 60 sec after the broadcast. I then repeated the process on the opposite side of the transect line (Bednarz et al. 2005). Audio output was set high so broadcasts were audible from

50–70 m away on days with clear atmospheric conditions. Although I only visited most sites only once and were therefore unable to account for detectability, Swainson's warblers are extremely aggressive and nearly always respond to playbacks during the peak of the breeding season. Therefore, there is a very high probability of detecting a Swainson's warbler when one is present using playbacks (Bednarz et al. 2005). Thus, I believe that the misclassification probability is relatively low and similar for occupied and unoccupied sites and these comparisons of habitat characteristics between "occupied" and "unoccupied" sites should elucidate factors that are correlated with Swainson's warbler presence.

Arthropod Abundance and Diversity

Pitfall traps and litter samples were used to estimate relative abundance and richness of arthropods and a few non-arthropods (snails, Gastropoda; crawfish, Decapoda; red worms, Haplotaxidae; toads, Anura). Berlese funnels, with a 7 × 7 mm mesh wire as a filter, were also use to extract arthropods from the litter samples. Berlese funnels use heat and light to extract arthropods from a cross sectional sample of leaf litter, and thus, provide a sample of potential prey from throughout the leaf litter strata (Strong and Sherry 2001). However, pitfall traps, sample arthropods at or near the surface of the substrate. The combination of these two sampling methods provides a reasonable index of prey availability.

Five pitfall traps were placed at each of 45 randomly-selected occupied and 45 randomly-selected unoccupied sites. One pitfall trap was placed in the center of the habitat plot while the remaining four pitfall traps were located 5 m away from the center of the plot in all four cardinal directions. Pitfall traps consisted of a 473-ml plastic cup with the rim of the cup flush with the top layer of soil. A piece of wood, from the forest floor, approximately 3 cm wide × 12 cm long was placed across the top of each cup to deflect precipitation and large debris from entering the cup while allowing arthropods to enter. Pitfall traps were filled with approximately 90 ml of either 50% propylene glycol solution (50% water and 50% propylene glycol) or 70% ethanol solution (70% ethanol and 30% water) for preserving the samples and the traps were collected after a 5-day sample period. Samples were then transferred into labeled whirl-pak bags and transported to the lab for sorting and identification. Additionally, I collected two 0.1-m^2 litter samples 3 m from the center of habitat sample points at a randomly-determined direction (north and south or east and west) at each randomly-selected occupied and unoccupied plot. I pushed the 0.1-m^2 cylinder of aluminum flashing in the substrate and collected all litter within the cylinder (Levings and Windsor 1982, Strong 2000). Litter was stored in a labeled zip-lock bag and brought to the field station where it was placed in a berlese funnel to extract the arthropods (Strong and Sherry 2001). Leaf litter was left in the berlese funnel for a minimum of 24 hours or until the litter was completely dry. I placed arthropods into one of five size classes (very small = 0–2 mm, small = 2–5 mm, intermediate = 5–10 mm, large = 10–15 mm, and very large = >15 mm), identified individuals to the family level (when possible; Triplehorn and Johnson 2005), and to developmental stage (immature or adult) to obtain estimates of arthropod abundance and richness. Using pitfall traps and litter samples as separate analyses, I investigated the abundance of arthropods in each taxonomic group and determined the ten most frequently occurring arthropod groups (including families) and the ten most frequently occurring classes and orders (excluding families) for occupied and unoccupied sites and sites with variable occupancy. Sites classified as variable occupancy were occupied by Swainson's warblers in only one of the 2 years they were sampled.

Determining prey availability in the manner it is perceived by birds is difficult and may incorporate some potential biases (Johnson 1980, Cooper and Whitmore 1990, Wolda 1990). The data reported in this study provided an index of relative abundance and richness. I also sampled all sites for arthropods in the same manner and assumed that capture probability was equal among all sites. Moorman et al. (2007) found that arthropod use by birds was consistent from spring through fall migration, with no apparent seasonal shift in diet. Thus, I feel that the sampling effort in this study was sufficient to provide a baseline inventory of available arthropods in occupied and unoccupied sites.

Data Analyses

I used analysis of variance (ANOVA; Cody and Smith 1997) to investigate differences in arthropod communities between sites that were occupied and unoccupied as well as sites that were occupied 2, 1 (variable occupancy), and 0 (unoccupied) years. I used the 10 most frequently occurring arthropod taxa that were available to Swainson's warblers in two separate sets of comparisons. The first comparison included taxa that were identified down to the family level whenever possible. If I could not identify the specimen to the family level, then specimens were identified to class or order. The second comparison excluded all families and all taxa were pooled into classes or orders. To better meet the assumptions of ANOVA, I log transformed variables such as: arthropods 10–15 mm in length and harvestmen (Opiliones) for my litter samples and immature arthropods 2–5 mm in length, immature arthropods, total abundance of arthropods, and spiders (Araneae) for my pitfall traps prior to the analysis of occupied and unoccupied sites. For variables that did not meet the assumption of equal variances after transformation; I employed the WELCH option in SAS for analyses (SAS Institute 2004). I used the WELCH option on the following variables: arthropods >15 mm in length, adult arthropods 10–15 mm and >15 mm in length, immature arthropods 5–10 mm in length, butterflies and moths (Lepidoptera), red worms (Haplotaxidae), centipedes (Chilopoda), common ground beetles (Carabidae), click beetles (Elateridae), and hump-backed flies

(Phoridae) for litter samples and arthropods >15 mm in length, adult arthropods >15 mm in length, beetles (Coleoptera), ants, bees, and wasps (Hymenoptera), flies (Diptera), snails (Gastropoda), millipedes (Diplopoda), common ground beetles (Carabidae), darkling beetles (Tenebrionidae), snipe flies (Rhagionidae), and narrow-mouthed toads (Microhylidae) for pitfall traps in my comparison of occupied and unoccupied sites. The WELCH option involves the calculation of a Welch's variance-weighted one-way ANOVA which may be used to test for differences between group means with unequal variances (SAS Institute 2004). Likewise, I square root transformed total arthropod abundance, adult arthropod abundance, adults >15 mm in length, crickets (Gryllidae), and ants (Formicidae) for the comparison of pitfall traps in sites occupied in 2, 1, and 0 years by Swainson's warblers. I log transformed arthropods >15 mm in length and ticks and mites (Acari) for litter samples and arthropods >15 mm in length, crickets and grasshoppers (Orthoptera), and ants, bees, and wasps (Hymenoptera) for pitfall traps in sites occupied 2, 1, and 0 years. I also employed the WELCH option on harvestmen (Opiliones), flies, hump-backed flies, fungus gnats (Mycetophilidae), soldier flies (Stratiomyidae), and darkling beetles for litter samples and arthropods 10–15 mm in length, immature arthropods, adults 10–15 mm in length, immatures 2–5 and >15 mm in length, true toads (Bufonidae), fungus gnats, snipe flies, water striders (Gerridae), soldier beetles (Cantharidae), and butterflies and moths for pitfall traps in the analysis of sites occupied in 2, 1, and 0 years by Swainson's warblers. For variables for which significant differences were found in the analysis of sites occupied in 2, 1, and 0 years, I then considered pairwise contrasts.

In an effort to determine the best arthropod predictors of site occupancy by Swainson's warblers, I used logistic regression (Cody and Smith 1997). Prior to model development, I used SAS to perform correlation analysis (PROC CORR; SAS Institute 2004) and removed highly correlated variables ($r > 0.6$). I developed 15 *a priori* models that I felt may likely be predictors of occupancy based on factors suggested to be important for Swainson's warblers from previous studies, and also based on my own field observations (Table 3.1). I then evaluated the regression models using Akaike's Information Criterion for small sample sizes (AIC_c; Cody and Smith 1997, Burnham and Anderson 2002) and calculated an AIC_c weight for each model.

RESULTS

Occupancy Determination

In 2004 and 2005, I surveyed 1,453 sample locations and detected Swainson's warblers at 70 unique sites (5%; Fig. 2.2, Appendix A). In the south unit of the refuge, I detected Swainson's warblers at 53 sites in the Alligator Lake area, three at Rattlesnake Ridge, and one at Indian Bay (Fig. 2.3). In the north unit of the refuge, I had three detection sites at the Crooked Lakes area, two at Little Moon Lake, one at Red Cat Lake, four at Bear Slough, and three at the Dead Man's Point area (Fig. 2.3). Of the 70 unique detection sites, 28 were occupied in both years, 17 were occupied in only 2004, and 25 were occupied in only 2005 (Fig. 2.2).

Arthropod Community Characteristics of Occupied and Unoccupied Sites

I sampled arthropods at 45 randomly-selected occupied (64%) and 45 randomly-selected unoccupied sites (3%) in 2004 and 2005. In 2004, I identified 6,931 arthropods that comprised 69 different taxonomic groups and in 2005, I classified 15,793 arthropods that included 90 taxonomic groups. Overall, I identified 22,724 arthropods from 99 taxonomic groups in 2004 and 2005 and found conspicuous arthropod abundance and richness differences between occupied and unoccupied sites (Table 3.2; Appendix B).

Litter samples.—Occupied sites had greater total abundance of arthropods and richness of arthropod groups per sample and per site than unoccupied sites (Table 3.2).

Additionally, litter samples of occupied sites had greater abundance of arthropods 5–10, 10–15, and >15 mm in length, adults in all size classes except adult arthropods 0–2 mm, total adults, and immature arthropods 5–10 mm in length than unoccupied sites (Table 3.2).

Ants were the most frequently occurring arthropod group in the litter samples (Fig. 3.1). Of the 10 most frequently occurring arthropod groups in litter samples, occupied sites had significantly greater mean abundance of click beetles (Elateridae, 0.88/sample) than unoccupied sites (0.27/sample; $P = 0.002$, Fig. 3.1). Although not quite significant, occupied sites also had more ground beetles (0.92/sample), millipedes (0.78/sample), and butterflies and moths (1.92/sample) than unoccupied sites (0.34/sample, 0.31/sample, and 1.22/sample, respectively; $P = 0.058$, $P = 0.068$, $P = 0.063$, respectively; Fig. 3.1). There were no other significant differences or trends among the 10 most frequently occurring taxonomic groups of arthropods collected in litter samples.

Hymenoptera (ants, bees, and wasps) was the most frequently occurring order of arthropods in the litter samples (Fig. 3.2). Of the 10 most frequently occurring classes and orders in the litter samples, occupied sites had significantly greater mean abundance of beetles (5.71/sample) than sites that were unoccupied (4.01/sample) by Swainson's warblers ($P = 0.045$). Also, although only marginally significant, sites occupied by Swainson's warblers had a greater butterfly and moth (Lepidoptera, 1.92/sample) and millipede (Diplopoda, 0.78/sample) abundance than unoccupied sites (1.22/sample, 0.31/sample, respectively; $P = 0.063$, $P = 0.067$, respectively).

In sites that were occupied by Swainson's warblers in 2, 1, and 0 years, I found no significant differences for all size and age class variables (Table 3.3). Ants were the most frequently occurring arthropod group in the litter samples (Fig. 3.3) and no significant differences were found in the 10 most frequently occurring taxonomic groups (including families) or classes and orders (Fig. 3.4).

Litter sample regressions showed that 8 of the 14 *a priori* models were better predictors of Swainson's warbler occupancy than the null model (Table 3.4). However, two models received considerable support relative to the others. The model that best fit the data based on the litter sample analysis involved the single variable sample richness and it accounted for 63% of the total AIC_c weight of all models considered. The second best model consisted of arthropods ≥10 mm in length (large arthropods model), and accounted for 33% of the total AIC_c weight of all models considered. All other models combined accounted for 4% of the total AIC_c weight of all models considered (Table 3.4). Other models that were better than the null model included the total abundance (ω_i = 0.0086), intermediate-size arthropods (ω_i = 0.0076), common ground beetles (ω_i = 0.0046), all beetles (ω_i = 0.0045), butterflies and moths (ω_i = 0.0038), and the millipedes model (ω_i = 0.0037). Sums of the AIC_c weights showed sample richness (ω_i = 0.6289), arthropods 10–15 mm in length (ω_i = 0.3385), and arthropods >15 mm in length (ω_i = 0.3309) to be the best single variable predictors of Swainson's warbler occupancy.

Pitfall traps.—I found no significant differences in abundance and richness between sites occupied and unoccupied by Swainson's warblers (Table 3.5). Also, although only marginally significant, sites occupied by Swainson's warblers had fewer arthropods >15 mm in length and adult arthropods >15 mm in length than unoccupied sites (P = 0.057, P = 0.060, respectively).

Crickets were the most frequently occurring arthropod group in pitfall traps (Fig. 3.1). Based on the 10 most frequently occurring arthropod groups in pitfall traps, occupied sites had significantly greater abundance of snipe flies (Rhagionidae; 2.35/sample) than unoccupied sites (0.64/sample; P = 0.014, Fig. 3.1). There were no other significant differences found among the 10 most frequently occurring taxonomic groups of arthropods that were collected by pitfall traps (Fig. 3.1).

Coleoptera, which consisted of all beetles collectively, was the most frequently occurring order within the pitfall traps (Fig. 3.2). Of the 10 most frequently occurring classes and orders in pitfall traps, occupied sites had significantly greater flies (4.36/sample) and snails (0.49/sample) than sites that were unoccupied (2.38/sample, 0.17/sample, respectively) by Swainson's warblers ($P = 0.016$, $P = 0.006$, respectively).

Within sites of variable occupancy, I found no significant differences for any abundance or richness variables considered (Table 3.6). When analyzing the 10 most frequently occurring arthropod groups (including families) for sites occupied in 2, 1, and 0 years by Swainson's warblers, again crickets (Gryllidae) were the most frequently occurring arthropod group for pitfall traps (Fig. 3.3). However, beetles (Coleoptera) were the most frequently occurring order for pitfall traps among sites occupied 2, 1, and 0 years by Swainson's warblers (Fig. 3.4). There were no other significant differences found in the ten most frequently occurring taxonomic groups (including families) or classes and orders (excluding families) for pitfall traps in the comparison of sites occupied 2, 1, and 0 years.

Pitfall trap regressions showed that only 3 of the 14 *a priori* models were better predictors of Swainson's warbler occupancy than the null model (Table 3.7). The best model based on pitfall trap sampling abundance contained arthropods ≥10 mm in length (large arthropods model), which accounted for 65% of the total AIC_c weight of all models considered. The second best model was the millipedes model (Diplopoda), which accounted for 12% of the total AIC_c weight of all models considered. The spiders model ($\omega_i = 0.0429$; Araneae), was the only other model that was a better predictor of Swainson's warbler occupancy than the null model. All other models performed worse than the null model in terms of predicting Swainson's warbler occupancy and combined accounted for <19% of the total AIC_c weight of all models considered (Table 3.7).

DISCUSSION

Swainson's warblers are leaf-litter specialists and the presence of a well-developed leaf-litter layer is a critical component of their foraging habitat (Brown and Dickson 1994, Graves 1998, Strong and Sherry 2001). Recently, Bednarz et al. (2005) found that Swainson's warbler occupied sites had significantly greater cover of litter than unoccupied sites at multiple locations in Arkansas. Likewise, in this current study (Chapter 2), I found that occupied sites had significantly greater litter depth and litter volume than unoccupied sites and, although not significant, a moderately greater percent cover of litter. This is important because Swainson's warblers have been documented to have a limited repertoire of foraging behaviors (Graves 1998). Meanley (1970) stated that insects are the principal food of the Swainson's warbler and are located when warblers poke their bill under a leaf, pushing it upwards, searching the ground beneath it, or examining its underside. Additionally, Barrow (1990) reported that Swainson's warblers in Louisiana (n = 17) foraged primarily in the ground stratum (71%). In a study of 399 individual Swainson's warblers encompassing 70 localities in the southeastern U.S., Graves (1998) reported 99% of those performed only leaf-lifting maneuvers and opportunistic gleaning maneuvers appeared to be incidental and of secondary importance. Also, Strong (2000) reported from two study areas in Jamaica (n = 13) that leaf-lifting accounted for 80% of their foraging maneuvers. These reports of the Swainson's warblers foraging behavior support that leaf litter is an important component of this species habitat. Although leaf litter appears to be an important habitat component, this occupancy–leaf-litter association may reveal a selection by Swainson's warblers for arthropod abundance and richness rather than for the amount of leaf litter *per se* at WRNWR. My data clearly show that occupied Swainson's warbler sites have higher arthropod diversity and abundance, which appears to be associated with the greater litter presence, than unoccupied sites (Table 3.2). To my knowledge, this aspect of linking arthropod communities to habitat relationships has not been investigated for Swainson's warblers.

Common arthropod groups collected with pitfall traps and litter samples consisted of ants, bees, and wasps (Hymenoptera), ants (Formicidae), beetles (Coleoptera), rove beetles (Staphyllindae), common ground beetles (Carabidae), spiders (Araneae), mites and ticks (Acari), flies (Diptera), and springtails (Collembola; Figs. 3.1 and 3.2). Relatively little is known about the diet of the Swainson's warbler. Meanley (1966) investigated the stomach contents of 4 Swainson's warblers in Georgia and found that spiders, ground beetles, crickets, and ants, as well as insect and spider eggs, larvae, and pupae were important components of their diet. Furthermore, Strong (2000) analyzed regurgitation samples of Swainson's warblers (n = 13) in 2 distinctly different habitat types in Jamaica and found that beetles (39%), spiders (22%), and ants (19%) were the most commonly consumed prey items of 267 total prey items. Interestingly, beetles, ants, spiders, and crickets are among the most abundant and frequently occurring arthropod taxa in litter samples and pitfall traps that were collected during this study (Figs. 3.1–3.4). In addition to affecting habitat use, abundance and richness of arthropods may have an affect on where Swainson's warblers locate their home range and influence territory size as well as nest success. For example, Smith and Shugart (1987) found that arthropod abundance had an affect on territory size in Ovenbirds (*Seiurus aurocapillus*), which is another ground-foraging species; specifically fewer arthropods were associated with larger territories.

Logistic regressions of the litter sample data showed that the sample richness model and large arthropods model were better than the other 12 models at predicting Swainson's warbler occupancy. While the large arthropods model and millipedes model were better than the other 12 models for predicting occupancy for pitfall traps. Interestingly, given the AIC_c values of all models considered, it appears that the top two litter sample models (sample richness model and large arthropods model) were much better predictors than any pitfall trap model (Tables 3.4 and 3.7). Moreover, Swainson's warbler occupancy appears to be mostly influenced by sample richness, abundance of large arthropods, and millipedes with these variables representing positive relationships.

Inconsistencies between litter samples and pitfall traps for collecting arthropods have also been documented. These distinct differences in total number of arthropods collected between years can partially be explained by a larger sampling effort in 2005. Also, there was a noticeable difference in water levels at WRNWR during my field season each year and this may help explain why the total number of arthropods collected in each year was so different (Fig. 3.5). While ranking the most frequently occurring arthropod taxa (including families) for occupied and unoccupied Swainson's warbler sites, litter samples and pitfall traps showed some similarities. However, inconsistencies were noticed with each sampling method having a different set of the 10 most frequently occurring arthropod taxa (Fig. 3.1). Some of these differences can be explained by the different array of arthropods that each collecting method captures effectively. Pitfall traps are more apt to collect arthropods with no limitations in respect of size, but require the arthropods to be mobile; at least at the ground surface and thus the actual sampling area is unknown. Also, Greenslade (1964) stated that pitfall traps suffer from the disadvantage that arthropod captures depend both on the density of the population being sampled and the activity of the individuals in these populations. Likewise, the susceptibility of a species being trapped differs among arthropods according to their behavior (Greenslade 1964). Because of this variation in arthropod activity, pitfall traps may have less of an emphasis on collecting arthropods that live directly within the leaf litter where the Swainson's warbler feeds. While litter samples may be more likely to include arthropods that live extended periods of time in the leaf litter. Also, litter samples may consist of arthropods with some limitations in respect to size and mobility. This is because litter samples target arthropods within the present leaf litter, rather than on the surface of the forest floor. Also, litter sample arthropods were extracted using a berlese funnel which uses heat to push the arthropods through a funnel with wire mesh and different arthropods can tolerate different intensities of heat and a very large arthropod may be incapable of fitting through the 7 × 7 mm mesh wire. Given these inconsistencies between methods and the reported foraging behavior of Swainson's warblers, I suggest that litter samples may provide a more accurate representation of arthropods that were available to Swainson's warblers because they directly sample within the leaf litter where this warbler primarily forages.

Because no known sampling method assesses prey availability in the same way that a bird does (Cooper and Whitmore 1990, Strong 2000), I opted to use these two sampling methods to better assess the complete arthropod community. Importantly, with the use of two complementary sampling methods (litter samples and pitfalls), I feel that I obtained a fair assessment of relative arthropod abundance and richness at sites occupied and unoccupied by Swainson's warblers (Appendix B). Moreover, my results seem to support that arthropod abundance and richness may be an influence on habitat preference by Swainson's warblers. In fact, I suggest that arthropods could be the driving factor in Swainson's warbler habitat selection where as, leaf litter may be a correlated factor that provides habitat for the insects or represents a proximate factor that warblers use to select habitats with desired arthropod communities. Nevertheless, I feel that comparative studies investigating relationships of Swainson's warbler abundance and reproductive success with arthropod availability between different habitats are needed to more accurately assess the influence of arthropods.

Further investigation of the diet of Swainson's warblers should be pursued to obtain a more in-depth understanding of food item selection as it relates to arthropod availability and habitat preference. Studies could focus on the arthropod communities of different habitat types such as bottomland hardwood forests with and without cane present, commercial pine forests, and rhododendron thickets at different aged timber stands would provide informative data. To investigate how important of a selection factor arthropod abundance and richness is, it would be useful to assess if the abundance of arthropods varied between habitat types and if occupied sites were consistently higher in abundance and richness than unoccupied sites throughout the entire breeding season. From the data collected in this study (Chapter 2 and 4), where the majority of occupied sites had cane present and the majority of unoccupied sites had cane absent; it seems that there may be a relationship between the density of cane stems and arthropod richness within litter samples.

MANAGEMENT IMPLICATIONS

Based on the results of my study, I suggest that efforts should be made to maintain habitat characteristics that promote a well-developed layer of leaf litter which supports ground-dwelling arthropods. Timber harvest prescriptions should take into account the amount of leaf litter that will remain on the ground and how much could accrue after the harvest. Additionally, in an effort to provide consistent litter fall from the forest canopy, large even-aged forests (clear cuts) should be avoided when prescribing timber harvests. The more complex canopy structure may provide a more diverse and continuous leaf litter layer. Schowalter et al. (1981) and Greenberg and Forest (2003) state reductions in leaf litter cover, depth, and moisture that are associated with canopy disturbances may affect the diversity and abundance of ground-dwelling arthropods. Likewise, Duguay et al. (2000) and Haskell (2000) documented fewer ground-occurring arthropods in roadsides and harvested areas with reduced leaf litter than in adjacent forests.

Water levels on WRNWR should be managed (to the extent possible) to keep the magnitude and duration of flooding to a minimum, in an effort to keep the existing leaf litter from being altered. Leaf litter is affected by flooding through removal, concentration, physical degradation, and siltation (Bell and Sipp 1975, Uetz et al. 1979) and this can negatively affect Swainson's warblers because of their foraging within the litter layer. Also, flooding may change the structure of the arthropod community within a particular habitat and can restrict the amount of area available to Swainson's warblers to forage; thus, adversely affecting the availability of food resources to Swainson's warblers. WRNWR, even though is a large bottomland system, has many man-made structures present which have altered the natural flow of waters in this system. Importantly, the presence of a man-made levee system has restricted the natural flooding regime of WRNWR during high flow periods and may increase the depth of the floodwaters (Bader 2007). This increase in depth of floodwaters is now inundating some of the higher elevations of the floodplain which are historically dry in most years. This flooding of higher elevational areas in a floodplain decreases the available habitat for many terrestrial-feeding species that rely on ground-dwelling arthropods as a food source such as Ovenbird (*Seiurus aurocapillus*; Van Horn and Donovan 1994), Kentucky warbler (*Oporornis formosus*; McDonald 1998), and Hooded warbler (*Wilsonia citrine*; Ogden and Stutchbury 1994). Also, this flooding is probably detrimental to the arthropod–litter association needed by Swainson's warblers. These altered hydrological conditions may result in the degradation of habitat and this is true of many bottomland habitat remnants. Finally, further investigations looking at arthropod community associations with demography, home-range sizes, and reproductive output are needed to ensure the best management practices are being used. This will give managers insight to whether a greater abundance and diversity of arthropods an area has leads to higher reproductive success, smaller home ranges, and a healthier population of Swainson's warblers.

LITERATURE CITED

Bader, T. J. 2007. Reproductive success, causes of nesting failures, and habitat use of Swallow-tailed and Mississippi Kites in the White River National Wildlife Refuge, Arkansas. Thesis, Arkansas State University, Jonesboro, Arkansas, USA.

Barrow, W. C. 1990. Ecology of small insectivorous birds in a bottomland hardwood forest. Dissertation, Louisiana State University, Baton Rouge, Louisiana, USA.

Bednarz, J. C., P. Stiller-Krehel, and B. Cannon. 2005. Distribution and habitat use of Swainson's warblers in eastern and northern Arkansas. Pages 576–588 *in* Ralph, C. J., and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. U.S. Forest Service General Technical Report PSW-GTR-191. U.S. Department of Agriculture, Pacific Southwest Research Station, Albany, California, USA.

Bell, D. T., and S. K. Sipp. 1975. The litter stratum in the streamside forest ecosystem. Oikos 26:391–397.

Brown, R. E., and J. G. Dickson. 1994. Swainson's warbler (*Limnothlypis swainsonii*). No. 126 *in* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multi-model inference: a practical information-theoretic approach. Springer-Verlag, New York, USA.

Cody, R. P., and J. K. Smith. 1997. Applied statistics and the SAS programming language. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Cooper, R. J., and R. C. Whitmore. 1990. Arthropod sampling methods in ornithology. Pages 29–37 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: Theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Duguay, J. P., P. B. Wood, and G. W. Miller. 2000. Effects of timber harvests on invertebrate biomass and avian nest success. Wildlife Society Bulletin 28:1123–1131.

Graves, G. R. 1998. Stereotyped foraging behavior of the Swainson's warbler. Journal of Field Ornithology 69:121–127.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in Great Dismal Swamp. Auk 118:650–664.

Graves, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's warbler. Wilson Bulletin 114:210–220.

Greenberg, C. H., and T. G. Forrest. 2003. Seasonal abundance of ground-occurring macroarthropods in forest and canopy gaps in the southern Appalachians. Southeastern Naturalist 2:591–608.

Greenslade, P. J. M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology 33:301–310.

Haskell, D. G. 2000. Effects of forest roads on macroinvertebrate soil fauna of the southern Appalachian Mountains. Conservation Biology 14:57–63.

Hunter, W. C., and Collazo, J. A. 2001. Partners in Flight South Atlantic Coastal Plain Bird Conservation Plan. American Bird Conservancy: The Plains, Virginia, USA.

Hunter, W. C., D. N. Pashley, and R. E. F. Escano. 1993. Neotropical migratory landbird species and their habitat of special concern within the southeast region. Pages 159–171 *in* D. M. Finch, and S. W. Strangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229. U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Hunter, W. C., A. J. Mueller, and C. L. Hardy. 1994. Managing for Red-cockaded Woodpeckers and neotropical migrants—is there a conflict? Proceedings of the Annual Conference Southeast Association of Fish Wildlife Agencies 48:383–394.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65–71.

Karr, J. R., and J. D. Brawn. 1990. Food resources of understory birds in central Panama: quantification and effects on avian populations. Pages 58–64 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Levings, S. C., and D. M. Windsor. 1982. Seasonal and annual variation in litter arthropod populations. Pages 355–387 *in* E. G. Leigh, Jr., A. S. Rand, and D. M. Finch, editors. The ecology of a tropical forest: Seasonal rhythms and long-term changes. Smithsonian Institution Press, Washington, D.C., USA.

McDonald, M. V. 1998. Kentucky warbler (*Oporornis formosus*). No. 324 *In* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Meanley, B. 1966. Some observations on habitats of the Swainson's warbler. Living Bird 5:151–165.

Meanley, B. 1970. Method of searching for food by the Swainson's warbler. Wilson Bulletin 82:228.

Meanley, B. 1971. Natural history of the Swainson's warbler. North American Fauna 69. Department of Interior, Washington, D.C., USA.

Moorman, C. E., L. T. Bowen, J. C. Kilgo, C. E. Sorenson, J. L. Hanula, S. Horn, and M. D. Ulyshen. 2007. Seasonal diets of insectivorous birds using canopy gaps in a bottomland forest. Journal of Field Ornithology 78:11–20.

Morse, D.H. 1989. American warblers: an ecological and behavioral perspective. Harvard University Press, Cambridge, Massachusetts, USA.

National Audubon Society. 2004. National Audubon Society watch list <http://www.audubon.org/bird/watchlist/bs-bc-what_is_the_watchlist.html>. Accessed 7 May 2007.

Ogden, L. J. E., and B. J. Stutchbury. 1994. Hooded warbler (*Wilsonia citrina*). No. 110 *In* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Peters, K. A. 1999. Swainson's warbler (*Limnothlypis swainsonii*) habitat selection in a managed bottomland hardwood forest in South Carolina. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Petit, D. R., J. F. Lynch, R. L. Hutto, J. G. Blake, and R. B. Waide. 1995. Habitat use and conservation in the neotropics. Pages 145–197 *in* T. E. Martin and D. M. Finch, editors. Ecology and management of neotropical migratory birds: A synthesis and review of critical issues. Oxford University Press, New York, New York, USA.

Ramsar (Ramsar Convention Secretariat). 1971. The Ramsar list of wetlands of international importance. Article 2.1 of the Convention on Wetlands (1989 amendment). Ramsar, Iran.

Robinson, S. K., and R. T. Holmes. 1982. Foraging behavior of forest birds: The relationships among search tactics, diet, and habitat structure. Ecology 63:1918–1931.

SAS Institute. 2004. Version 9.1. SAS Institute, Cary, North Carolina, USA.

Schowalter, T. D., J. W. Webb, and D. A. Crossley, Jr. 1981. Community structure and nutrient content of canopy arthropods in clearcut and uncut forest ecosystems. Ecology 62:1010–1019.

Smith, T. M., and H. H. Shugart. 1987. Territory size variation in the Ovenbird: the role of habitat structure. Ecology 68:695–704.

Stotz, D. F., J. W. Fitzpatrick, T. A. Parker III, and D. K. Moskovits. 1996. Neotropical birds. Ecology and conservation. The University of Chicago Press, Chicago, Illinois, USA.

Strong, A. M. 2000. Divergent foraging strategies of two neotropical migrant warblers: implications for winter habitat use. The Auk 117:381–392.

Strong, A. M., and T. W. Sherry. 2001. Body condition of Swainson's warblers wintering in Jamaica and the conservation value of Caribbean dry forests. Wilson Bulletin. 113:410–418.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of neotropical migrant landbirds in the Midwest: identifying species of management concern. Pages 145-158 *in* D. M. Finch, and P. W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229, U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Triplehorn, C. A., and N. F. Johnson. 2005. Borror and DeLong's introduction to the study of insects. Seventh edition. Thomson Brooks/Cole, Belmont, California, USA.

Uetz, G. W., K. L. Van Der Laan, G. F. Summers, P. A. K. Gibson, and L. L. Getz. 1979. The effects of flooding on floodplain arthropod distribution, abundance, and community structure. American Midland Naturalist 101:286–299.

United States Fish and Wildlife Service [USFWS]. 2006. Daily use permit brochure for White River National Wildlife Refuge. Refuge Map, St. Charles, Arkansas. <http://www.fws.gov/whiteriver/mapspage.htm>. Accessed 20 Nov 2006.

United States Army Corps of Engineers. 2007. Water Levels of Rivers and Lakes. Water gauge readings for St. Charles, Arkansas. <http://www2.mvr.usace.army.mil/WaterControl/stationinfo2.cfm?sid=WR118&fid=&dt=S>. Accessed 12 March 2008.

Van Horn, M. A. and T. M. Donovan. 1994. Ovenbird (*Seiurus aurocapillus*). No. 88 *In* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Wolda, H. 1990. Food availability for an insectivore and how to measure it. Pages 38–43 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas USA.

Table 3.1. *A priori* candidate models used to predict Swainson's warbler occupancy at White River National Wildlife Refuge.

Candidate Model	Variables
Common ground beetles model	Carabidae (common ground beetles)
Crickets model	Gryllidae (crickets)
Ants model	Formicidae (ants)
Rove beetles model	Staphyllinidae (rove beetles)
Spiders model	Araneae (spiders)
Beetles model	Coleoptera (beetles)
Millipedes model	Diplopoda (millipedes)
Butterflies and moths model	Lepidoptera (butterflies and moths)
Arthropod abundance model	Total abundance of arthropods per sample
Arthropod richness model	Taxonomic richness per sample
Small arthropods model	Abundance of 0–2 mm arthropods, abundance of 2–5 mm arthropods
Large arthropods model	Abundance of 10–15 mm arthropods, abundance of ≥15 mm arthropods
Abundance and richness of arthropods model	Total abundance of arthropods per sample, taxonomic richness per sample
Common food items model	Coleoptera, Araneae, Formicidae
Intermediate-size arthropods model	Abundance of 2–5 mm arthropods, abundance of 5–10 mm arthropods, abundance of 10–15 mm arthropods

Table 3.2. Pooled mean arthropod numbers by size, abundance, and richness from litter samples at sites occupied by Swainson's warblers (n = 45) and unoccupied (n = 45) sites at WRNWR in 2004 and 2005.

Litter Samples	Occupied $\bar{X}$	Occupied SE	Unoccupied $\bar{X}$	Unoccupied SE	F [a]	P
Very small (0–2 mm)	7.88	1.24	5.49	1.14	2.00	0.1607
Small (2–5 mm)	14.22	1.97	10.38	1.61	2.29	0.1340
Intermediate (5–10 mm)	8.30	1.07	5.00	0.74	6.41	0.0131*
Large (10–15 mm)[b]	1.63	0.26	0.86	0.15	7.82	0.0063*
Very large (>15 mm)[c]	0.54	0.12	0.12	0.06	10.54	0.0019*
Adults						
Total adults	26.62	3.24	17.23	2.09	5.91	0.0171*
Very small (0–2 mm)	7.07	1.18	5.12	1.09	1.46	0.2297
Small (2–5 mm)	12.04	1.77	7.93	0.97	4.16	0.0444*
Intermediate (5–10 mm)	6.28	0.91	3.79	0.62	5.12	0.0261*
Large (10–15 mm)[c]	0.93	0.18	0.34	0.10	8.30	0.0052*
Very large (>15 mm)[c]	0.30	0.07	0.04	0.03	10.25	0.0022*
Immatures						
Total immatures	5.96	1.02	4.61	0.99	0.90	0.3448
Very small (0–2 mm)	0.81	0.44	0.37	0.34	0.64	0.4275
Small (2–5 mm)	2.18	0.51	2.44	0.83	0.07	0.7853
Intermediate (5–10 mm)[c]	2.02	0.33	1.21	0.22	4.18	0.0444*
Large (10–15 mm)	0.70	0.16	0.51	0.10	1.00	0.3194
Very large (>15 mm)	0.24	0.09	0.08	0.04	2.78	0.0990
Total abundance	32.57	3.83	21.84	2.96	4.92	0.0291*
Site richness[bd]	8.89	0.37	7.27	0.30	11.35	0.0011*
Sample richness[be]	6.06	0.28	4.73	0.20	13.03	0.0005*

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Represents data that were log transformed for analysis.
[c] Because of heterogeneous variances, differences were tested using the WELCH option in SAS PROC GLM (SAS Institute 2004).
[d] Mean number of taxonomic groups per site.
[e] Mean number of taxonomic groups per sample.
* Means were significantly different (P < 0.050) based on analysis of variance.

Table 3.3. Pooled mean arthropod numbers by size, abundance, and richness for litter samples collected at sites occupied 2 (n = 17), 1 (n = 23), and 0 (n = 12) years by Swainson's warblers at WRNWR in 2004 and 2005.

	Occupied 2 yr		Occupied 1 yr		Occupied 0 yr			
Litter Samples	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	F [a]	P
Very small (0–2 mm)	6.85	1.17	9.54	2.23	8.00	3.70	0.38	0.6877
Small (2–5 mm)	15.91	3.12	15.00	2.99	13.29	3.03	0.14	0.8676
Intermediate (5–10 mm)	7.15	0.91	10.35	1.86	8.17	2.35	0.96	0.3893
Large (10–15 mm)	1.56	0.44	1.91	0.39	1.58	0.36	0.26	0.7751
Very large (≥15 mm)	0.85	0.25	0.41	0.12	0.29	0.18	2.39	0.1026
Adults								
Total adults	25.91	3.31	30.67	5.64	23.86	6.21	0.44	0.6477
Very small (0–2 mm)	6.12	1.11	8.54	2.13	7.96	3.70	0.33	0.7218
Small (2–5 mm)	13.47	2.90	12.63	2.65	8.75	1.39	0.69	0.5041
Intermediate (5–10 mm)	5.03	0.88	8.11	1.56	6.21	1.99	1.20	0.3102
Large (10–15 mm)	0.88	0.34	1.11	0.23	0.79	0.31	0.33	0.7217
Very large (≥15 mm)	0.41	0.16	0.28	0.08	0.17	0.11	0.91	0.4109
Immatures								
Total immatures	6.41	1.98	6.54	1.29	7.46	2.52	0.08	0.9240
Very small (0–2 mm)	0.74	0.56	1.00	0.76	0.04	0.04	0.47	0.6257
Small (2–5 mm)	2.44	1.13	2.37	0.55	4.54	2.17	0.92	0.9411
Intermediate (5–10 mm)	2.12	0.52	2.24	0.50	1.96	0.64	0.06	0.9411
Large (10–15 mm)	0.68	0.25	0.80	0.25	0.79	0.23	0.08	0.9255
Very large (≥15 mm)	0.44	0.22	0.13	0.07	0.13	0.09	1.60	0.2120
Total abundance	32.32	3.85	37.22	6.63	31.33	8.49	0.25	0.7784
Site richness[b]	9.65	0.67	8.87	0.43	8.50	0.67	0.93	0.3997
Sample richness[c]	6.59	0.46	6.13	0.35	5.67	0.36	1.09	0.3427

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Mean number of taxonomic groups per site.
[c] Mean number of taxonomic groups per sample.

Table 3.4. Logistic regression results from litter-sample arthropod models used to predict occupancy by Swainson's warblers at White River National Wildlife Refuge. The sign in the parentheses indicates the direction of the relationship. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	Concordance
Sample richness[b] (+)	2	114.90	0.00	0.6289	66.90
Arthropods 10–15 mm (+), >15 mm (+)	3	116.18	1.28	0.3309	69.10
Total abundance[c] (+)	2	123.47	8.57	0.0086	68.40
Arthropods 2–5 mm (+), 5–10 mm (+), 10–15 mm (+)	4	123.73	8.83	0.0076	69.40
Carabidae (+)	2	124.73	9.83	0.0046	36.70
Coleoptera (+)	2	124.75	9.86	0.0045	60.70
Lepidoptera (+)	2	125.10	10.21	0.0038	51.00
Diplopoda (+)	2	125.18	10.28	0.0037	36.30
Null (intercept only)	1	126.81	11.92	0.0016	
Formicidae (+)	2	127.20	12.31	0.0013	64.80
Araneae (+)	2	127.28	12.39	0.0013	53.40
Arthropods 0–2 mm (+), 2–5 mm (+)	3	128.11	13.21	0.0009	63.80
Coleoptera (+), Araneae (+), Formicidae (+)	4	128.16	13.26	0.0008	63.00
Staphyllinidae (+)	2	128.54	13.64	0.0007	49.60
Gryllidae (–)	2	128.66	13.76	0.0006	10.50

[a] Number of model parameters.
[b] Mean number of taxa per litter sample.
[c] Mean total number of arthropods counted in pitfall traps.

Table 3.5. Pooled mean arthropod numbers by size, abundance, and richness from pitfall traps at sites occupied by Swainson's warblers (n = 45) and unoccupied (n = 45) sites at WRNWR in 2004 and 2005.

	Occupied		Unoccupied			
Pitfall Traps	$\overline{X}$	SE	$\overline{X}$	SE	F [a]	P
Very small (0–2 mm)	2.38	0.48	2.73	0.45	0.29	0.5894
Small (2–5 mm)	12.25	0.98	13.19	1.13	0.39	0.5340
Intermediate (5–10 mm)	16.63	1.74	15.71	1.89	0.13	0.7214
Large (10–15 mm)	6.25	0.53	5.26	0.92	0.88	0.3518
Very large (≥15 mm)[c]	3.41	0.33	5.44	0.99	3.77	0.0573
Adults						
Total adults	39.31	2.86	40.15	3.90	0.03	0.8638
Very small (0–2 mm)	2.25	0.48	2.69	0.45	0.47	0.4952
Small (2–5 mm)	11.27	0.92	11.57	0.95	0.05	0.8208
Intermediate (5–10 mm)	16.45	1.73	15.45	1.87	0.15	0.6957
Large (10–15 mm)	6.06	0.53	5.14	0.91	0.78	0.3809
Very large (≥15 mm)[c]	3.28	0.33	5.29	0.99	3.68	0.0603
Immatures						
Total immatures[b]	1.61	0.26	2.18	0.67	0.32	0.5726
Very small (0–2 mm)	0.13	0.06	0.04	0.02	2.55	0.1139
Small (2–5 mm)[b]	0.98	0.26	1.61	0.65	0.07	0.7987
Intermediate (5–10 mm)	0.18	0.04	0.26	0.06	1.29	0.2593
Large (10–15 mm)	0.19	0.06	0.12	0.05	0.75	0.3896
Very large (≥15 mm)	0.14	0.04	0.15	0.06	0.05	0.8216
Total abundance[b]	40.92	2.88	42.33	3.95	0.05	0.8189
Site richness[d]	16.07	0.61	15.16	0.64	1.06	0.3064
Sample richness[e]	7.29	0.29	6.85	0.26	1.28	0.2609

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Represents data that were log transformed for analysis.
[c] Because of heterogeneous variances, differences were tested using the WELCH option in SAS PROC GLM (SAS Institute 2004).
[d] Mean number of taxonomic groups per site.
[e] Mean number of taxonomic groups per sample.
* Means were significantly different (P < 0.050) based on analysis of variance.

Table 3.6. Pooled mean arthropod numbers by size, abundance, and richness for pitfall traps collected at sites occupied 2 (n = 17), 1 (n = 23), and 0 (n = 12) years by Swainson's warblers at WRNWR in 2004 and 2005.

	Occupied 2 yr		Occupied 1 yr		Occupied 0 yr			
Pitfall Traps	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	F [a]	P
Very small (0–2 mm)	3.15	0.93	1.82	0.44	2.13	0.59	1.16	0.3222
Small (2–5 mm)	14.56	1.90	11.17	1.01	16.20	2.30	2.58	0.0857
Intermediate (5–10 mm)	15.04	2.79	15.63	2.25	21.22	4.36	1.09	0.3458
Large (10–15 mm)[d]	6.05	0.89	5.95	0.77	8.33	2.85	0.32	0.7323
Very large (≥15 mm)[c]	3.26	0.44	3.56	0.55	4.37	1.11	0.23	0.7959
Adults								
Total adults[b]	40.15	4.78	36.50	3.68	48.81	7.69	1.11	0.3391
Very small (0–2 mm)	2.98	0.93	1.69	0.45	2.10	0.59	1.06	0.3559
Small (2–5 mm)	13.38	1.84	10.16	0.89	14.03	1.51	2.41	0.1005
Intermediate (5–10 mm)	14.80	2.78	15.50	2.25	20.78	4.25	1.01	0.3701
Large (10–15 mm)[d]	5.94	0.89	5.68	0.76	7.98	2.84	0.30	0.7429
Very large (≥15mm)[b]	3.05	0.43	3.48	0.55	3.92	1.10	0.12	0.8833
Immatures								
Total immatures[d]	1.90	0.36	1.63	0.40	3.45	1.47	0.73	0.4914
Very small (0–2 mm)	0.17	0.09	0.13	0.08	0.03	0.02	0.55	0.5783
Small (2–5 mm)[d]	1.18	0.41	1.02	0.40	2.18	1.38	0.33	0.7256
Intermediate (5–10 mm)	0.24	0.09	0.13	0.05	0.44	0.17	2.56	0.0880
Large (10–15 mm)	0.11	0.05	0.27	0.11	0.35	0.17	1.12	0.3343
Very large (≥15mm)[d]	0.21	0.08	0.08	0.03	0.45	0.22	2.25	0.1325
Total abundance[b]	42.06	4.66	38.13	3.80	52.26	8.20	1.43	0.2502
Site richness[e]	17.00	0.88	15.87	0.89	17.42	1.24	0.69	0.5077
Sample richness[f]	7.54	0.43	7.12	0.44	7.97	0.48	0.80	0.4543

[a] Differences were tested using ANOVA (SAS PROC GLM, SAS Institute 2004).
[b] Square root transformed
[c] Log transformed data
[d] Welch option data
[e] Mean number of taxonomic groups per site.
[f] Mean number of taxonomic groups per sample.

Table 3.7. Logistic regression results for pitfall trap arthropod models used to predict occupancy by Swainson's warblers at White River National Wildlife Refuge. The sign in parentheses indicates the direction of the relationship. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	Concordance
Arthropods 10–15 mm (+), >15 mm (–)	3	120.58	0.00	0.6489	73.30
Diplopoda (+)	2	123.89	3.31	0.1237	23.50
Araneae (–)	2	126.01	5.43	0.0429	54.70
Null (intercept only)	1	126.81	6.23	0.0287	
Formicidae (+)	2	127.49	6.91	0.0205	60.80
Coleoptera (–), Araneae (–), Formicidae (+)	4	127.50	6.92	0.0204	59.90
Sample richness[b] (+)	2	127.60	7.03	0.0193	53.90
Carabidae (–)	2	127.61	7.03	0.0193	44.80
Coleoptera (–)	2	127.63	7.05	0.0191	49.40
Lepidoptera (+)	2	127.92	7.34	0.0165	38.40
Gryllidae (–)	2	128.51	7.93	0.0123	49.70
Staphyllinidae (–)	2	128.82	8.24	0.0105	47.40
Total abundance[c] (–)	2	128.82	8.24	0.0105	45.20
Arthropods 0–2 mm (–), 2–5 mm (–)	3	130.46	9.88	0.0046	54.00
Arthropods 2–5 mm (–), 5–10 mm (+), 10–15 mm (+)	4	131.66	11.09	0.0025	62.80

[a] Number of model parameters.
[b] Mean number of taxa per pitfall trap.
[c] Mean total number of arthropods counted in pitfall traps.

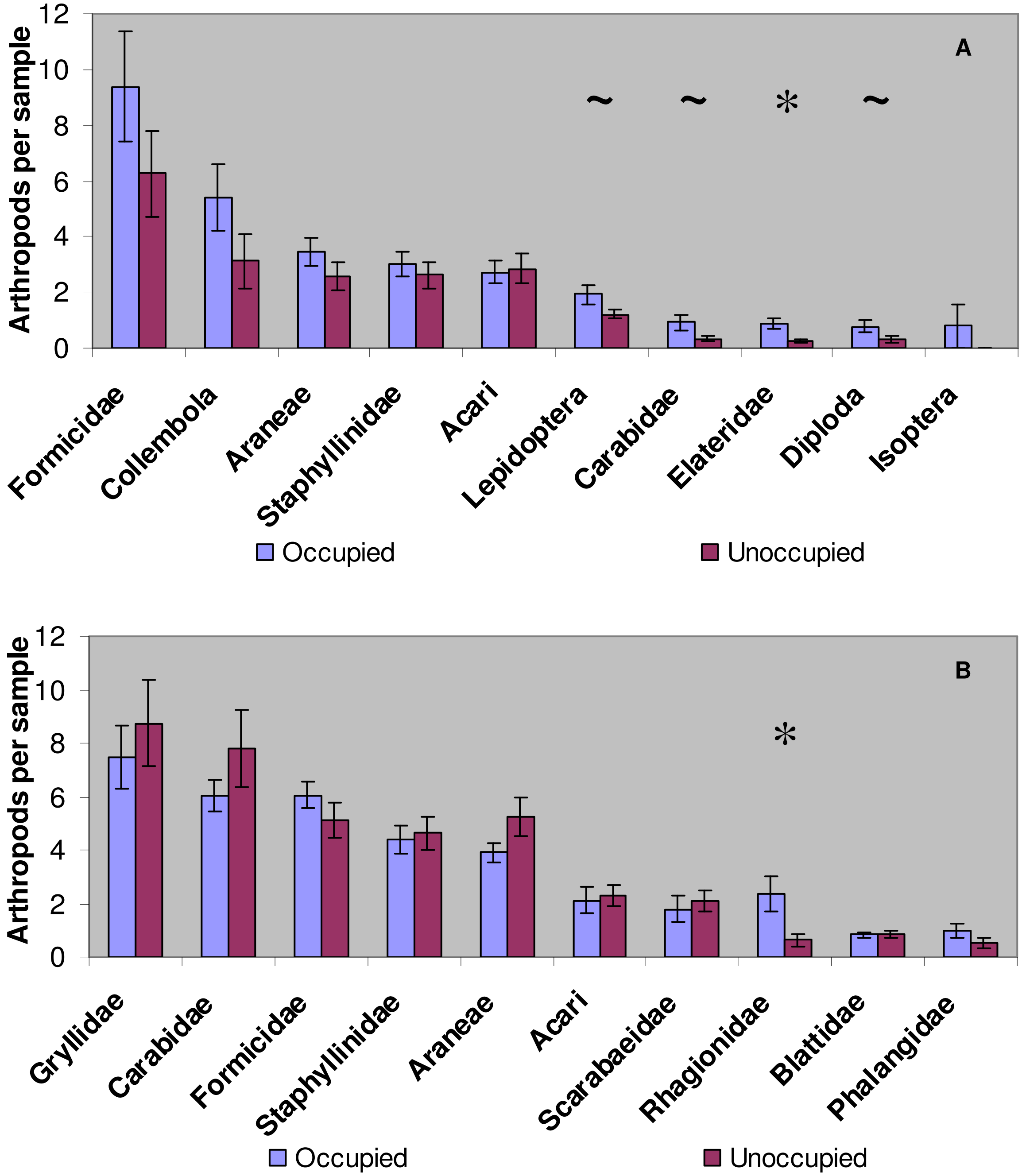


Figure 3.1. The ten most frequently occurring taxonomic groups within (A) litter samples and (B) pitfall traps for occupied and unoccupied Swainson's warbler sites at White River National Wildlife Refuge in 2004 and 2005. The standard error is represented with error bars, significant differences ($P < 0.050$) are represented with asterisks, and marginal differences ($0.100 > P > 0.050$) are represented with the tilde.

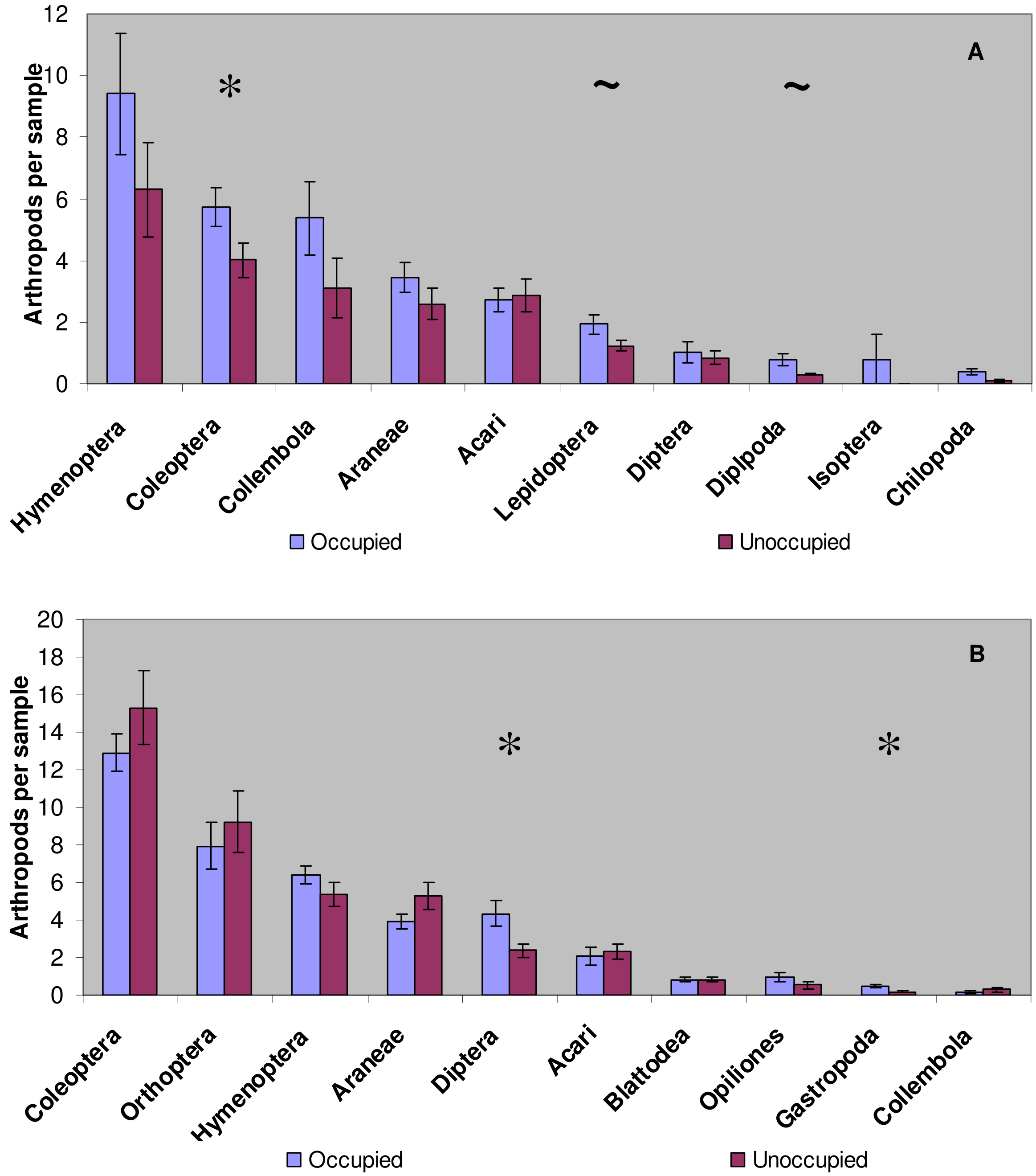


Figure 3.2. The ten most frequently occurring classes and orders within (A) litter samples and (B) pitfall traps for occupied and unoccupied Swainson's warbler sites at White River National Wildlife Refuge in 2004 and 2005. The standard error is represented with error bars, significant differences ($P < 0.050$) are represented with asterisks, and marginal differences ($0.100 > P > 0.050$) are represented with the tilde.

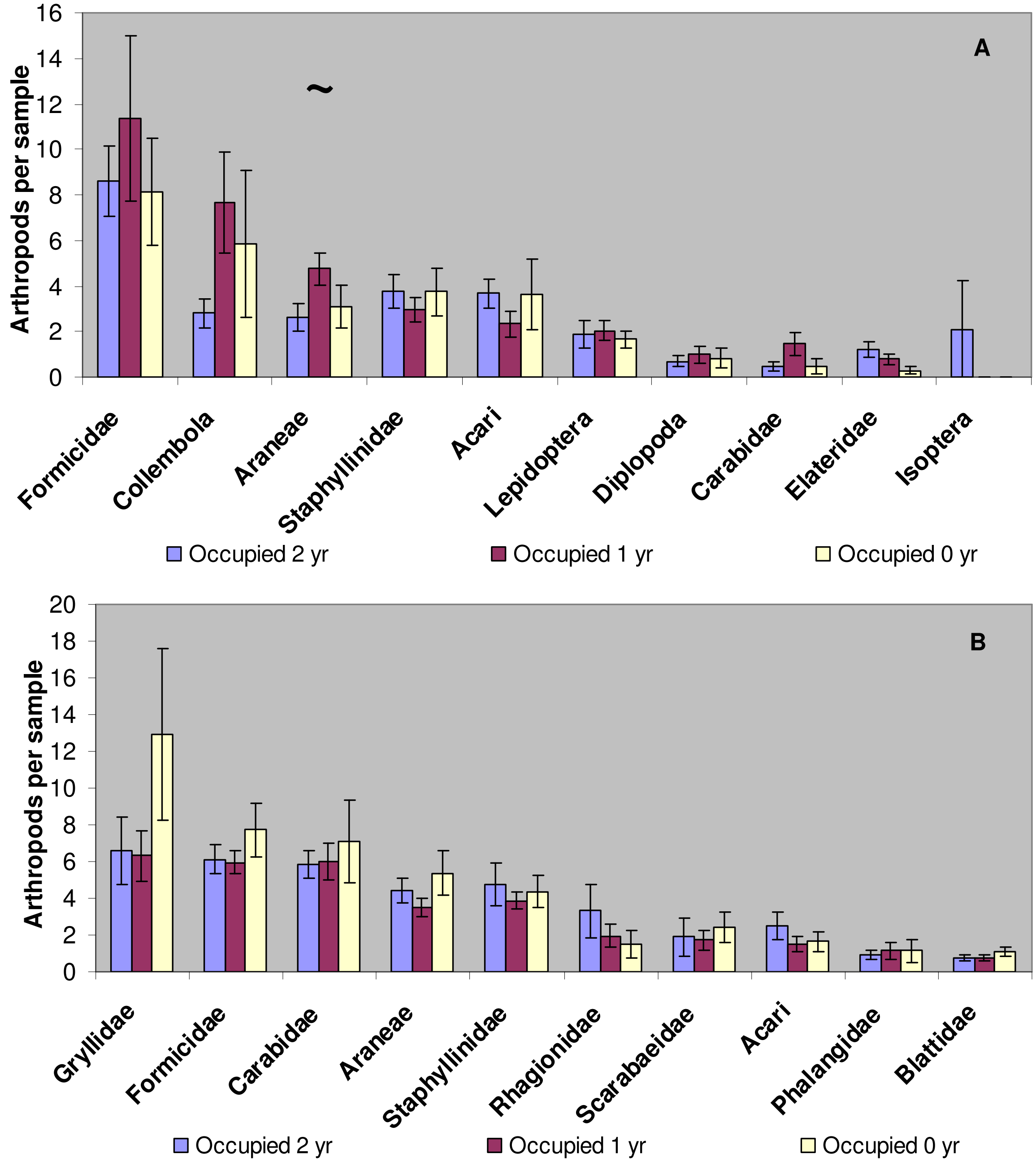


Figure 3.3. The ten most frequently occurring taxonomic groups (including families) within (A) litter samples and (B) pitfall traps for sites occupied in 2, 1, and 0 years by Swainson's warblers at White River National Wildlife Refuge in 2004 and 2005. The standard error is represented with error bars and marginal differences (0.100 > *P* > 0.050) are represented with the tilde.

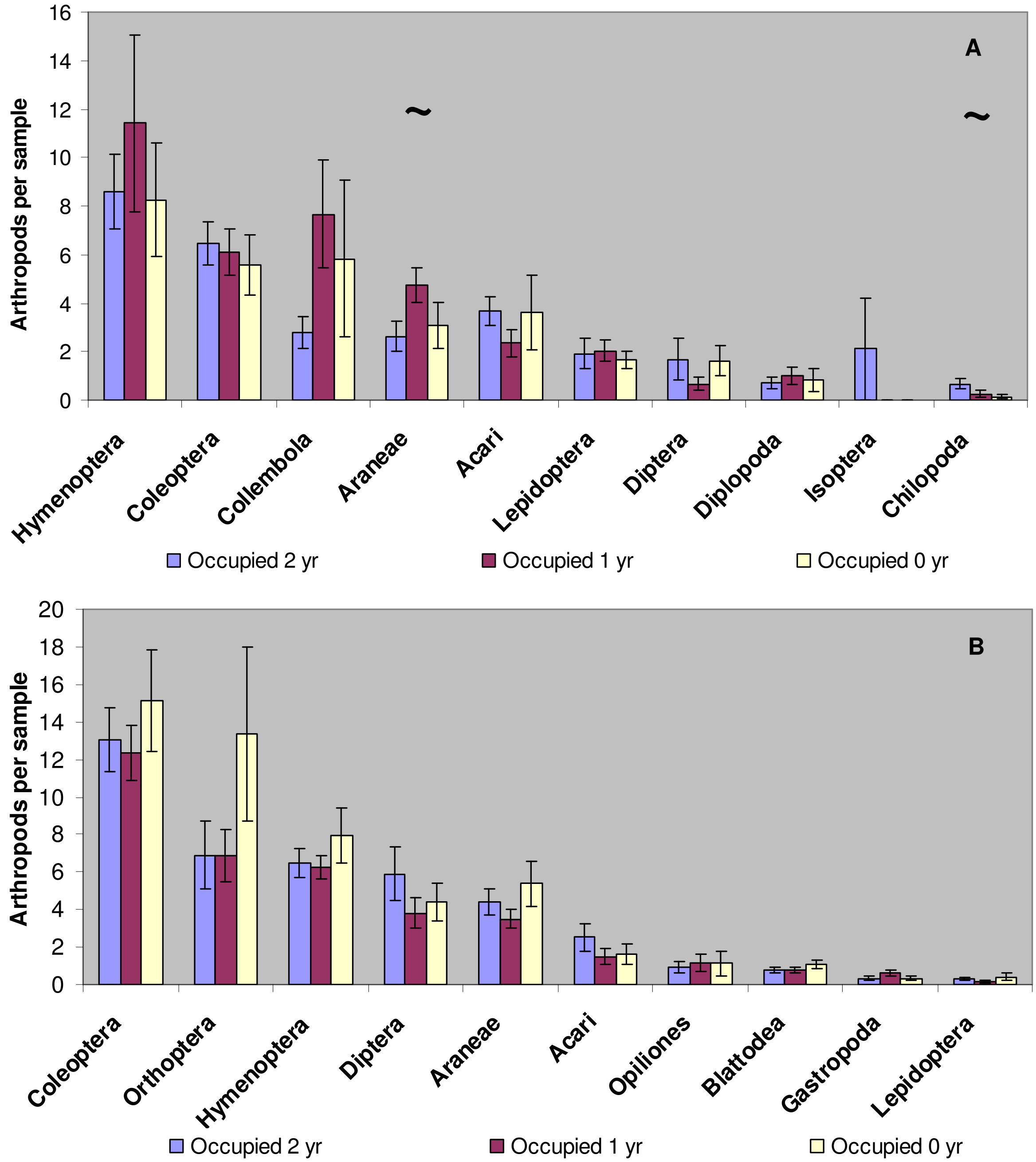


Figure 3.4. The ten most frequently occurring classes and orders within (A) litter samples and (B) pitfall traps for sites occupied in 2, 1, and 0 years by Swainson's warblers at White River National Wildlife Refuge in 2004 and 2005. The standard error is represented with error bars and marginal differences (0.100 > *P* > 0.050) are represented with the tilde.

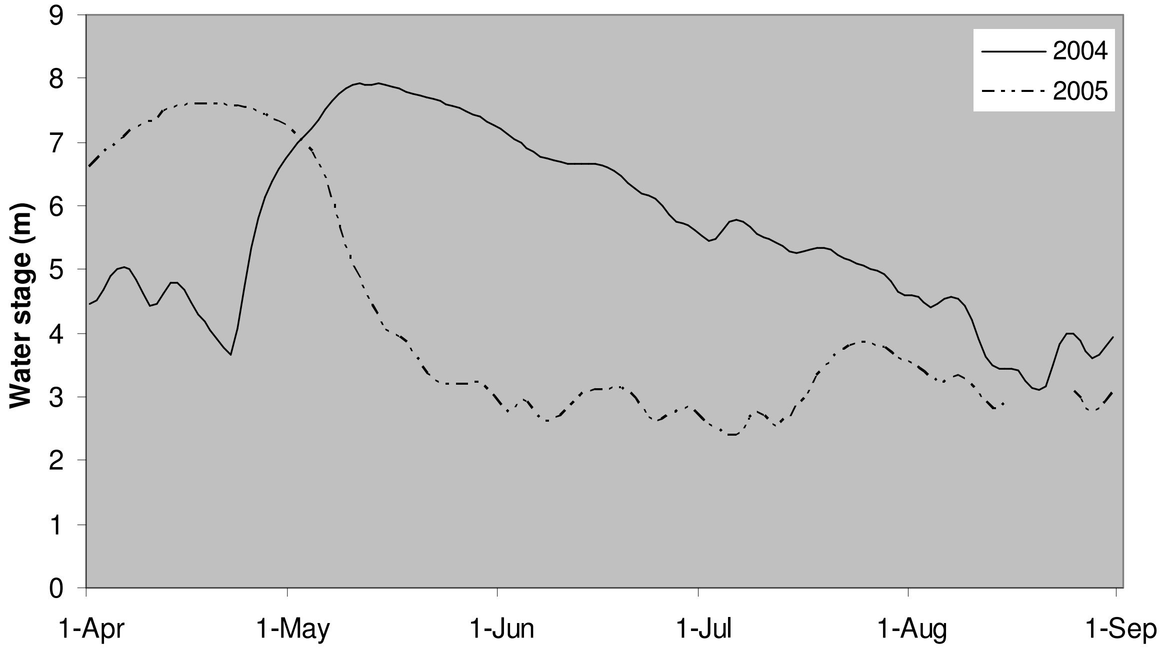


Figure 3.5. Water levels at White River National Wildlife Refuge from 1 April–31 August in 2004 and 2005 (St. Charles, AR river gage, U.S. Army Corps of Engineers 2007).

CHAPTER IV

USING ARTHROPOD COMMUNITY AND HABITAT CHARACTERISTICS AS PREDICTORS OF OCCUPANCY FOR SWAINSON'S WARBLERS AT THE WHITE RIVER NATIONAL WILDLIFE REFUGE, ARKANSAS

ABSTRACT

The Swainson's warbler (*Limnothlypis swainsonii*) is a species of critical conservation concern in the southeastern U.S. Because these warblers are ground-foraging litter-specialists, they are dependant on a well-developed layer of leaf litter, which may cause them to be negatively affected by flooding. I investigated whether arthropod communities and habitat characteristics combined were good predictors of Swainson's warbler occupancy and whether habitat characteristics were good predictors of the arthropod community. Systematic surveys were conducted at 1,453 sites using song playbacks, and vegetation data at 70 occupied (5% occupancy) and 106 randomly-selected unoccupied sites were collected in relatively high-elevation bottomlands at White River National Wildlife Refuge (WRNWR). Additionally, arthropods were collected at 45 randomly-selected occupied and unoccupied sites in 2004 and 2005 using litter samples and pitfall traps. Using logistical regressions, I found that habitat variables (ω_i >0.9898) were better single variable predictors than arthropod variables (ω_i <0.0507) at predicting Swainson's warbler occupancy in litter and pitfall trap samples. After modeling habitat and arthropod variables combined, I found that the best supported model for predicting Swainson's warbler occupancy including litter sample (ω_i = 0.9431) and pitfall trap (ω_i = 0.5800) measures of arthropod abundance was the cane stem and total canopy cover model. Specifically, there was a positive relationship between cane

stems and total canopy cover with Swainson's warbler occupancy. I found cane stems, understory density variables, total canopy cover, medium-sized and large trees, and large snags to be predictors of the separate response variables of arthropod richness, arthropod abundance, common prey (ants, beetles, and spiders), arthropods 2–15 mm, and arthropods >10 mm in length based on litter sample data. Likewise, from my pitfall trap data, I found that total canopy cover, medium and large trees, large snags, variation in understory density, stem variables, and litter volume were predictors of the response variables of arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length. Based on these results, I recommend preserving large continuous forests, while maintaining and creating a dense understory with a well-developed layer of leaf litter to conserve Swainson's warblers. Swainson's warbler management should include the preservation of cane habitat and opening of small canopy gaps that mimic natural disturbances to allow enough sunlight to reach the forest floor to promote dense understory development and without degrading the leaf litter layer.

INTRODUCTION

The Swainson's warbler (*Limnothlypis swainsonii*) is a medium-sized, inconspicuous wood-warbler that primarily breeds in bottomland hardwood forests in the southeastern U.S. During the winter, this species is relatively confined to the Yucatán Peninsula and the Caribbean islands (Brown and Dickson 1994). As ground-foraging litter specialists that nest in the forest understory, Swainson's warblers seem to be dependent on a well-developed layer of leaf litter and dense understory (e.g., Brown and Dickson 1994; Graves 2001, 2002; Bednarz et al. 2005).

Historically common in limited sections of woodlands with dense understories (Morse 1989), the Swainson's warbler is now listed as a species of conservation concern in the southeastern U.S. because of habitat destruction on its breeding and wintering grounds, relatively low population density, and restricted range (Hunter et al. 1993, 1994; Peters 1999; Hunter and Collazo 2001). The Southeast and Midwest Working Groups for Partners in Flight ranked the Swainson's warbler as of extreme conservation concern in these respective regions of the U.S. (Hunter et al. 1993, Thompson et al. 1993, Bednarz et al. 2005).

Along with habitat loss on the wintering grounds, the loss of breeding habitat has been identified as the primary threat to the species (Thompson et al. 1993, Stotz et al. 1996, Graves 2001). In the Southeast, bottomland hardwood forests have declined by 55–80% (Noss et al. 1995). This extensive clearing of bottomland forest in the southeastern U.S. has restricted Swainson's warblers in many drainages to seasonally-inundated zones bordering rivers and swamps (Graves 2001). Moreover, this species is especially vulnerable to adverse effects by flooding because of its ground foraging ecology, but little is known about patterns of habitat occupancy at wetland ecotones (Graves 2001) and the relationship between occupancy and abundance or richness of potential arthropod food resources. Likewise, flooding regimes of bottomlands have been anthropogenically altered which increases the intensity and duration of flooding from its historical state (Bednarz et al. 2005). To my knowledge, no previous research has addressed whether the combination of arthropod community and habitat characteristics could be associated with Swainson's warbler occupancy.

Importantly, only two previous studies provide a limited quantitative insight to the diet of Swainson's warblers. Strong (2000) reported information on diet by looking at the regurgitation samples from 13 Swainson's warblers in their wintering grounds, while Meanley (1966) investigated the gut contents of 4 Swainson's warblers in Georgia during the breeding period. However, there are a few scattered reports of stomach contents from Swainson's warblers in Alabama and Georgia (see Howell 1924, Meanley 1971) and in Cuba (Eaton 1953), but these reports only give an anecdotal analysis.

An insectivorous avian species' foraging strategy, prey preference, prey availability and habitat selection are critical to identifying niche relationships (Robinson and Holmes 1982) and patterns of habitat use (Karr and Brawn 1990, Wolda 1990). Understanding these affiliations is crucial to applying effective conservation management (Petit et al. 1995). To determine the most effective management strategies for this species, documentation of habitat associations, prey availability, and population status in different habitat types is needed. My objective was to investigate whether arthropod community and habitat characteristics combined could predict Swainson's warbler occupancy and whether habitat characteristics could predict arthropod community abundance and diversity. Specifically, I tested the following hypotheses:

(1) Swainson's warbler occupancy should be associated with a combination of high levels of cane stems, litter volume (e.g., Eddleman 1978, Graves 2001, Bednarz et al. 2005), arthropods 10–15 mm in length, and arthropods >15 mm in length (the most energetically valuable food items).

(2) High relative arthropod abundance, richness, and common Swainson's warbler prey (Meanley 1966, Strong 2000) are associated with a combination of high densities of cane stems, litter volume, and understory density.

STUDY AREA

I studied Swainson's warbler habitat use and arthropod availability at White River National Wildlife Refuge (WRNWR) in eastern Arkansas. WRNWR was established in 1935 for the protection of migratory birds and is open to the public for many recreational uses such as: birding, camping, hiking, hunting, and fishing. The refuge is located in the floodplain of the White River near its confluence with the Arkansas River Canal and encompasses Arkansas, Desha, Monroe, and Phillips counties ranging from 4.8 km to 16.0 km wide and is approximately 144 km long (Fig. 2.1). WRNWR is one of the largest remaining contiguous tracts of bottomland hardwood forest in the Mississippi River Valley and is included in the Ramsar list of wetlands of international importance (Ramsar 2008). The refuge is approximately 64,750 ha and is divided into a north and south unit that is separated by Arkansas Highway 1 (Fig. 2.1). WRNWR is primarily bottomland hardwood forest, but also contains upland forest, agricultural fields, moist-soil impoundments, and 356 natural and man-made lakes.

METHODS

Occupancy Determination

Swainson's warbler broadcast surveys were conducted between sunrise and 1200 H at WRNWR from 1 April to 20 June in 2004 and 2005 (Fig. 2.1). This corresponds to the time of year that Swainson's warblers migrate into this area, establish territories, and respond most effectively to playback calling. Broadcast surveys were employed along transects at 200-m intervals at a minimum elevation of 45 m for the south unit and 48 m for the north unit. These elevational cut-offs were indicative of the bottomland areas not typically flooded on an annual basis (J. Denman, Forest Ecologist at WRNWR personal communication). At each sample site, the Swainson's warbler's primary song was broadcasted for 90 sec from a dual-speaker CD player placed perpendicular to the transect line. I then recorded response songs and calls and approaching birds for 60 sec after the broadcast. The CD player was then turned to the opposite side of the transect line and the sequence was repeated (Bednarz et al. 2005). Audio output was set high so broadcasts were audible from 50–70 m away on days with clear atmospheric conditions. Although, I only visited most sites only once and were therefore unable to account for detectability. However, Swainson's warblers are extremely aggressive and nearly always respond to playbacks during the peak of the breeding season; therefore; there is a very high probability of detecting a Swainson's warbler when one is present (Bednarz et al. 2005). Although I did not account for imperfect detection probability, I believe that the misclassification probability is relatively low and similar for occupied and unoccupied sites and these comparisons of habitat characteristics between "occupied" and "unoccupied" sites should elucidate factors that are correlated with Swainson's warbler presence.

Arthropod Abundance and Diversity

I obtained estimates of relative abundance and richness of arthropods and a few non-arthropods (snails, Gastropoda; crawfish, Decapoda; red worms, Haplotaxidae; toads, Anura) with two sampling techniques: pitfall traps and litter samples. Berlese funnels, with a 7 × 7 mm mesh wire as a filter, were also use to extract arthropods from the litter samples. Berlese funnels use heat and light to extract arthropods from a cross sectional sample of leaf litter, and thus, provide a sample of potential prey from throughout the leaf litter strata (Strong and Sherry 2001). However, pitfall traps, sample arthropods at or near the surface of the substrate. The combination of these two sampling methods provides a reasonable index of prey availability.

Five pitfall traps were placed at each of 45 randomly-selected sites occupied by Swainson's warblers and 45 randomly-selected unoccupied sites. One pitfall trap was placed in the center of the habitat plot while the remaining four pitfall traps were located 5 m away from the center of the plot in all four cardinal directions. Pitfall traps consisted of a 473-ml plastic cup with the rim of the cup flush with the top layer of soil. A piece of wood, from the forest floor, approximately 3 cm wide × 12 cm long was placed across the top of each cup to deflect precipitation and large debris from entering the cup while allowing arthropods to enter. Pitfall traps were filled with approximately 90 ml of either 50% propylene glycol solution (50% water and 50% propylene glycol) or 70% ethanol solution (70% ethanol and 30% water) for preserving the samples and the traps were collected after a 5-day sample period. Samples were then transferred into labeled whirl-pak bags and transported to the lab for sorting and identification. Additionally, I collected two 0.1-m^2 litter samples 3 m from the center of habitat sample points at a randomly-determined direction (north and south or east and west) at each randomly-selected occupied and unoccupied plot. I pushed the 0.1-m^2 cylinder of metal flashing in the litter substrate until it met firm resistance from the ground and collected all litter within the cylinder (Levings and Windsor 1982, Strong 2000). Litter was stored in a labeled zip-lock bag and brought to the field station where it was placed in a berlese funnel to extract the arthropods (Strong and Sherry 2001). Leaf litter was left in the berlese funnel for a minimum of 24 hours or until the litter was completely dry. I classified arthropods into one of five size classes (0–2 mm, 2–5 mm, 5–10 mm, 10–15 mm, and >15 mm), identified individuals to the family level (when possible; Triplehorn and Johnson 2005), and to developmental stage (immature or adult) to obtain estimates of arthropod abundance and richness. I then used pitfall traps and litter samples as separate analyses in logistic and linear regression models to model occupancy. In this study, arthropods 0–2 mm in length were excluded from analyses because of their small size, the minimum energy value, and the low likelihood that Swainson's warblers receive nutrient or energy benefits from such small arthropods.

Determining prey availability in the manner it is perceived by birds is difficult and may incorporate some potential biases (Johnson 1980, Cooper and Whitmore 1990, Wolda 1990). The data reported in this study provided an index of relative abundance and richness. I also sampled all sites for arthropods in the same way and assumed that capture probability was equal among all sites. Moorman et al. (2007) found that arthropod use by birds was consistent from spring through fall migration, with no apparent seasonal shift in diet. Thus, I feel that the sampling effort in this study was sufficient enough to provide a baseline inventory of available arthropods in occupied and unoccupied sites.

Data Analyses

In an effort to determine the best arthropod and habitat predictors that may be used to model site occupancy by Swainson's warblers, I employed logistic regression (Cody and Smith 1997). Prior to model development, I used SAS to perform correlation analysis (PROC CORR; SAS Institute 2004) and removed highly correlated variables ($r > 0.7$). I developed 15 *a priori* models (Table 4.1) that I suggest may predict Swainson's warbler occupancy based on factors reported to be important for this species from previous studies, and also based on my own field observations. I then evaluated the regression models using Akaike's Information Criterion for small sample sizes (AIC_c; Cody and Smith 1997, Burnham and Anderson 2002) and calculated an AIC_c weight for each model.

I also investigated whether habitat models could accurately predict arthropod community characteristics through linear regressions. Again, I used SAS to perform correlation analysis (PROC CORR) and removed highly correlated variables ($r > 0.7$). I developed 12 *a priori* models (Table 4.2) that I felt may likely be predictors of the five predetermined arthropod community attributes based on factors reported to be important for Swainson's warblers from previous studies (Brown and Dickson 1994, Graves 2001, Peters 2005) and also based on my own field observations. I then evaluated the regression models using AIC_c (Cody and Smith 1997, Burnham and Anderson 2002) and R^2 values for each model. For my response variables, I grouped arthropod community characteristics into 5 categories, which were arthropod richness (number of arthropod taxa per sample), total abundance (total number of arthropods per sample), common prey consumed by Swainson's warblers (ants; Formicidae, ground beetles; Carabidae, spiders; Araneae), medium to large arthropods (arthropods 2–15 mm in length), and large arthropods (arthropods >10 mm).

I ran each analysis of linear and logistic regression twice. The first analysis considered a sample size of 45 occupied and unoccupied sites, but did not include the variables shrub and vine stems, percent cover of vines, understory density, and coefficient of variation (CV) of understory density because they were only sampled in the second year of the study. The other analysis considered 45 occupied sites and 26 unoccupied sites and included the variables vine stems, understory density, and CV understory density that were only measured in 2005. As the results of both analyses were similar, I present results based on 45 occupied sites and 26 unoccupied sites here because this analysis included vine stem and understory variables that may be important to Swainson's warbler occupancy and arthropod communities.

RESULTS

Occupancy Determination

In 2004 and 2005, I surveyed 1,453 sample locations and detected Swainson's warblers at 70 unique sites (5%; Fig. 2.2; Appendix A). In the south unit of the refuge, I detected Swainson's warblers at 53 sites in the Alligator Lake area, three at Rattlesnake Ridge, and one at Indian Bay (Fig. 2.3). In the north unit of the refuge, I had three detection sites at the Crooked Lakes area, two at Little Moon Lake, one at Red Cat Lake, four at Bear Slough, and three at the Dead Man's Point area (Fig. 2.3). Of the 70 unique detection sites, 28 were occupied in both years, 17 were occupied in only 2004, and 25 were occupied in only 2005 (Fig. 2.2).

Arthropod Community Characteristics of Occupied and Unoccupied Sites

I sampled arthropods at 45 randomly-selected occupied (64%) and 45 randomly-selected unoccupied sites (3%) in 2004 and 2005. Overall, I identified 22,724 arthropods from 99 taxonomic groups in 2004 and 2005 and found conspicuous arthropod abundance and richness differences between occupied and unoccupied sites (Chapter 3, Appendix B).

Litter samples.—Logistic regressions of the litter samples showed that 13 of the 15 *a priori* models were better predictors of Swainson's warbler occupancy than the null model (Table 4.3). However, one model received considerable support relative to the others. The model that best fit the data based on the litter sample analysis consisted of cane stems and canopy cover and it accounted for 94% of the total AIC_c weight of all models considered. All other models combined accounted for <6% of the total AIC_c weight of all models considered (Table 4.3). Sums of the AIC_c weights showed that selected habitat variables ($\omega_i = 0.9999$) to be better single variable predictors of Swainson's warbler occupancy than arthropod variables ($\omega_i = 0.0507$) for litter samples.

Specifically, combined AIC_c weights for cane stems ($\omega_i = 0.9363$) and total canopy cover ($\omega_i = 0.6322$) demonstrated that these two variables were strongly related to Swainson's warbler occupancy relative to all other variables considered for litter samples and pitfall traps.

After analyzing linear regressions of habitat models predicting arthropod richness of arthropods from litter samples, I found that the cane stems model was the best fit with the data and it accounted for 39% of the AIC_c weight of all models considered (Table 4.4). The second best model consisted of cane stems, litter volume, and understory density, and accounted for 27% of the AIC_c weight of all models considered, and understory density CV made up the third best model, which accounted for 16% of the AIC_c weight of all models considered. All other models considered had an AIC_c weight that accounted for <9%. However, 7 of the 12 *a priori* models were better predictors of arthropod richness than the null model (Table 4.4). Sums of the AIC_c weights for single variables showed that cane stems ($\omega_i = 0.7162$), understory density ($\omega_i = 0.3573$), litter volume ($\omega_i = 0.2815$), and understory density CV ($\omega_i = 0.1597$) were the most important single variable predictors of Swainson's warbler occupancy, while all other variables had a combined AIC_c weight of <0.0600.

Due to model selection uncertainty there was no distinct habitat model that stood out as performing better than the others for predicting total arthropod abundance in litter samples (Table 4.5). The total canopy cover, medium and large trees, and large snags model ($\omega_i = 0.1973$), understory density CV model ($\omega_i = 0.1878$), cane stems model ($\omega_i = 0.1671$), sapling, pole, and small trees model ($\omega_i = 0.1299$), and the understory density model ($\omega_i = 0.0922$) were the only 5 of the 12 *a priori* models that were better predictors of total arthropod abundance than the null model (Table 4.5). All other models considered each had an AIC_c weight of <0.0400. Sums of the AIC_c weights for single variables showed that cane stems ($\omega_i = 0.2365$), total canopy cover ($\omega_i = 0.2283$), medium trees, large trees, and large snags ($\omega_i = 0.1973$), and understory density CV ($\omega_i = 0.1878$) were the best single variable predictors of Swainson's warbler occupancy, while all other variables had a combined AIC_c weight of <0.1000.

Also, when using habitat models to predict common prey from litter sample data, there was a considerable amount of model selection uncertainty (Table 4.6). The CV understory density model ($\omega_i = 0.2119$), cane stems model ($\omega_i = 0.2077$), total canopy cover, medium and large trees, and large snags model ($\omega_i = 0.1695$), and the understory density model ($\omega_i = 0.1409$) were the only four of the 12 *a priori* models that were better predictors of Swainson's warblers common prey than the null model (Table 4.6). All other models considered had an AIC_c weight of <0.0600. Sums of the AIC_c weights for single variables showed that cane stems ($\omega_i = 0.2767$), understory density CV ($\omega_i = 0.2119$), total canopy cover ($\omega_i = 0.1903$), medium trees, large trees, and large snags ($\omega_i = 0.1695$), and understory density ($\omega_i = 0.1728$) were the best single variable predictors of Swainson's warbler common prey, while all other variables each had a combined AIC_c weight of <0.0600.

Similar results were observed when predicting arthropods 2–15 mm (small to medium sized arthropods) in length from litter samples. There were 6 of the 12 *a priori* models that were better predictors of arthropods 2–15 mm in length than the null model (Table 4.7). I found that the cane stems model was the best model and it accounted for 26% of the AIC_c weight of all models considered. The remaining 5 models that were better at predicting arthropods 2–15 mm in length than the null model were the CV understory density model ($\omega_i = 0.1839$), understory density model ($\omega_i = 0.1303$), cane stems, litter volume, and understory density model ($\omega_i = 0.1187$), total canopy cover, medium and large trees, and large snags model ($\omega_i = 0.1007$), and the cane stems, vine stems, and shrub stems model ($\omega_i = 0.0433$). Sums of the AIC_c weights for single variables showed that cane stems ($\omega_i = 0.4248$), understory density ($\omega_i = 0.2489$), CV understory density (ω_i = 0.1839), litter volume (ω_i = 0.1621), total canopy cover (ω_i = 0.1181), and medium trees, large trees, and large snags (ω_i = 0.1007) were the best single variable predictors of Swainson's warbler common prey, while all other variables each had a combined AIC_c weight of <0.0500 (Table 4.7).

Linear regressions of the litter samples showed that only 1 of the 12 *a priori* models was a better predictor of arthropods >10 mm (medium to large sized arthropods) in length than the null model (Table 4.8). This model received considerable support relative to the others. The model that best fit the data based on the litter sample analysis consisted of the coefficient of variation of understory density and it accounted for 50% of the total AIC_c weight of all models considered. All other models each accounted for <9% of the total AIC_c weight of all models considered (Table 4.8).

Pitfall traps.— Logistic regressions of the pitfall traps showed that 14 of the 15 *a priori* models were better predictors of Swainson's warbler occupancy than the null model (Table 4.9). However, three models received considerable support relative to the others. Similar to the litter sample analysis, the model that best fit the data based on the pitfall trap analysis consisted of cane stems and canopy cover and it accounted for 58% of the total AIC_c weight of all models considered. Also, a four variable model consisting of cane stems, litter volume, arthropods 10–15 mm, and arthropods >15 mm in length accounted for 19% of the total AIC_c weight of all models considered. While the cane stems, vine stems, shrub stems, arthropods 10–15 mm, and arthropods >15 mm in length model accounted for 14% of the total AIC_c weight of all models considered. All other models combined accounted for <9% of the total AIC_c weight of the models considered (Table 4.9). Sums of the AIC_c weights showed habitat variables used in this modeling analysis (ω_i = 0.9898) to be better at predicting Swainson's warbler occupancy than arthropod variables (ω_i = 0.4158). Sums of the AIC_c weights for single variables showed that cane stems (ω_i = 0.9255), canopy cover (ω_i = 0.6322), arthropods 10–15 and >15 mm in length (ω_i = 0.3682), and litter volume (ω_i = 0.2301) were the best single variable predictors of Swainson's warbler occupancy, while all other variables had a combined AIC_c weight of <0.1500.

Based on pitfall traps, I found that four of 12 *a priori* models were better predictors of arthropod richness than the null model (Table 4.10). The litter volume model was the best model and it accounted for 39% of the AIC_c weight of all models considered. The second best model consisted of total canopy cover, medium and large trees, and large snags and accounted for 27% of the AIC_c weight of all models considered. The third best model included cane stems, litter volume, and understory density, which accounted for 16% of the AIC_c weight of all models considered, while the fourth best model contained litter volume and the percent of area covered by logs and brush and it accounted for 15% of the AIC_c weight of all models considered. All other models considered had an AIC_c weight that accounted for <1% and were worse predictors of arthropod richness than the null model (Table 4.10). Sums of the AIC_c weights for single variables showed that litter volume (ω_i = 0.7053), total canopy cover (ω_i = 0.2683), and medium trees (ω_i = 0.2660), large trees (ω_i = 0.2660), and large snags (ω_i = 0.2660) were the best single variable predictors of Swainson's warbler occupancy, while all other variables had a combined AIC_c weight of <0.1700.

Linear regressions of the pitfall trap data showed that 8 of the 12 *a priori* models were better predictors of total abundance of arthropods than the null model (Table 4.11). The model that clearly best fit the data based on the pitfall trap analysis consisted of total canopy cover, medium and large trees, and large snags and it accounted for 98% of the total AIC_c weight of all models considered. This model received considerable support relative to the others. All other models combined accounted for <2% of the total AIC_c weight of all models considered (Table 4.11).

Similar results were obtained when looking at linear regressions of habitat models predicting the common prey of Swainson's warblers from pitfall traps (Table 4.12). I found that 4 of 12 *a priori* models were better predictors of common prey than the null model. However, one model received considerable support relative to the others. Again, the best model consisted of total canopy cover, medium and large trees, and large snags and it accounted for 92% of the AIC_c weight of all models considered. The second best model consisted of cane stems, vine stems, and shrub stems and accounted for 3% of the AIC_c weight of all models considered. All other models considered had an AIC_c weight that accounted for <5% and were worse predictors of common prey than the null model (Table 4.12).

Again, similar results were observed in linear regressions of the pitfall traps where habitat variables were used to predict arthropods 2–15 mm (small to medium sized arthropods) in length. I found that 8 of the 12 *a priori* models were better predictors of arthropods 2–15 mm in length than the null model (Table 4.13). The model that best fit the data based on the pitfall trap analysis consisted of total canopy cover, medium and large trees, and large snags and it accounted for 96% of the total AIC_c weight of all models considered. This model received considerable support relative to the others. All other models combined accounted for <4% of the total AIC_c weight of all models considered (Table 4.13).

Lastly, there was model selection uncertainty when I used habitat variables to predict arthropods >10 mm (medium to large sized arthropods) in length from pitfall traps. I found that 5 of 12 *a priori* models were better predictors of arthropods >10 mm in length than the null model (Table 4.14). However, the analysis did not clearly indicate which model was the best predictor of all models considered. There were two models that received considerable support relative to the other models. The top two models were the coefficient of variation of understory density which accounted for 38% of the total AIC_c weight and a model consisting of cane stems, vine stems, and shrub stems which accounted for 38% of the total AIC_c weight of all models. All other models considered each accounted for <8% of the total AIC_c weight. Sums of the AIC_c weights for single variables showed that cane stems ($\omega_i = 0.4598$), CV understory density ($\omega_i = 0.3819$), and vine stems and shrub stems ($\omega_i = 0.3784$) were the best single variable predictors of arthropods >10 mm in length from pitfall traps, while all other variables had a combined AIC_c weight of <0.2300 (Table 4.14).

DISCUSSION

Swainson's warblers are leaf-litter specialists and the presence of a well-developed leaf-litter layer is a critical component of their foraging habitat (Brown and Dickson 1994, Graves 1998, Strong and Sherry 2001, Bednarz et al. 2005). Reports of the Swainson's warbler foraging behavior by Meanley (1970), Barrow (1990), Graves (1998), and Strong (2000) confirm that leaf litter is an important component of this species habitat. However, after reviewing the literature, I found that relatively little is known about the diet of the Swainson's warbler. Meanley (1966) investigated the stomach contents of four Swainson's warblers in Georgia and found that spiders, ground beetles, crickets, and ants, as well as insect and spider eggs, larvae, and pupae were important components of their diet. In addition, Strong (2000) analyzed regurgitation samples of 13 Swainson's warblers in two distinctly different habitat types in Jamaica and found that beetles (39%), spiders (22%), and ants (19%) were the most commonly consumed prey items of 267 total prey items. However, due to varying degrees of digestibility these studies were unable to collect data pertaining to lengths of prey. With this limited amount of information, one can infer that the abundance and richness of arthropods may be an important factor in habitat selection for Swainson's warblers. Likewise, my data suggest that habitat variables (Tables 2.2–2.6, 4.3, 4.9), as well as, arthropod abundance and diversity (Tables 3.2, 3.4, 3.7, 4.9) seem to be related to Swainson's warbler occupancy at WRNWR. Importantly, Swainson's warblers may be using habitat characteristics as an indicator of food resources because of the relationship between habitat and arthropod communities. To my knowledge, the interrelationship of prey and habitat has not been investigated for Swainson's warblers.

Logistic regressions of both litter sample and pitfall trap data showed that the model containing cane stems and total canopy cover together was the best model of the 15 *a priori* models for predicting Swainson's warbler occupancy (Tables 4.3 and 4.9). Also, sums of the AIC_c weights showed that collectively habitat variable in the litter sample ($\omega_i = 0.9999$) and pitfall trap ($\omega_i = 0.9898$) analyses were better predictors of Swainson's warbler occupancy than arthropod variables ($\omega_i = 0.0507$ and $\omega_i = 0.4158$, respectively). Therefore, I must reject my first hypothesis because the model consisting of cane stems, litter volume, arthropods 10–15 mm in length, and arthropods >15 mm in length was not the best model in either of my two types of samples (litter samples or pitfall traps). Rather, this model was the fourth best model in the litter samples which accounted for <1% of the AIC_c weights of all models considered (Table 4.3) and the second best model in the pitfall trap analysis which accounted for 19% of the AIC_c weights of all models considered (Table 4.9). For litter samples, cane stems, litter volume, and arthropods >15 mm were positively correlated with Swainson's warbler occupancy while arthropods 10–15 mm in length showed a negative relationship (Table 4.3). In pitfall traps, cane stems, litter volume, and arthropods 10–15 mm were positively correlated with Swainson's warbler occupancy while arthropods >15 mm showed a negative relationship (Table 4.9).

There is considerable model selection uncertainty at WRNWR for predicting arthropod richness, arthropod abundance, common prey, and arthropods 2–15 mm in length with litter sample data. The top 3–5 models in each of these analyses all have similar AIC_c weights (Tables 4.4–4.8). However, when using habitat models to predict arthropods >10 mm in length, the best supported model consisted of the coefficient of variation (CV) in understory density, which accounted for 50% of the AIC_c weights of all models considered. Overall, of the five linear regression analyses performed with litter sample data, the cane stem model was the best supported model in two of five analyses, CV understory model was the best supported model in two of five analyses, and the model containing total canopy cover, medium and large trees, and large snags was the best supported model in one of the analyses (Tables 4.4–4.8). Density of cane stems and CV understory density appear to have the most influence on arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length when considering litter sample data. Cane stems had a positive relationship with arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length, while CV understory density had an inverse relationship within the litter sample analyses. This is consistent with historical records documenting that Swainson's warblers use bottomland forests with canebrakes (Meanley 1966), while other studies cite the importance of a dense understory (Meanley 1971, Eddleman 1978, Bassett-Touchell and Stouffer 2006). Also, Peters et al. (2005) found that the more uniform the habitat the greater density of Swainson's warblers that would be present and this supports the importance of habitat uniformity (CV understory density) as I found.

The mature forest model, which contained total canopy cover, medium and large trees, and large snags, received considerable support relative to the others predicting arthropod abundance, common prey, and arthropods 2–15 mm in length in the pitfall trap analysis (Tables 4.10–4.14). There was model selection uncertainty when predicting arthropod richness and arthropods >10 mm in length with pitfall trap data, as the top two models in each analysis had similar AIC_c weights (Tables 4.10 and 4.14). However, models containing litter volume accounted for 71% of the overall AIC_c weight when used as a predictor of arthropod richness. Also, when habitat models were used as predictors of arthropods >10 mm in length, the best supported model consisted of variation in understory density and it accounted for 38% of the total AIC_c weight of all models considered. Although, when calculating the sums of single variable AIC_c weights, cane stems ($\omega_i = 0.4598$), variation of understory density ($\omega_i = 0.3819$), and vine stems and shrub stems ($\omega_i = 0.3784$) were the best predictors of arthropods >10 mm in length from pitfall traps. Overall, of the five linear regression analysis performed with pitfall trap data, the litter volume model was the best supported model in one of the analyses, CV understory density model was the best supported model in one analysis, and the model containing total canopy cover, medium and large trees, and large snags was the best supported model in three of five analyses (Tables 4.10–4.14). Arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length seem to be influenced mostly by the variables: total canopy cover, medium and large trees, and large snags, density of cane stems, litter volume, and CV understory density when considering pitfall trap data. Total canopy cover, large trees, CV understory density, and litter volume showed a positive relationship with arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length (Tables 4.10–4.14). Interestingly, the density of medium trees, large snags, and cane stems had an inverse relationship when predicting the same arthropod characteristics (Tables 4.10–4.14). The directional relationships for variables: density of medium and large trees, large snags, cane stems, and CV understory density were not consistent between litter sample and pitfall trap analyses (Tables 4.4–4.8 and 4.10–4.14). However, importance of litter volume found here was consistent with other studies reporting the importance of leaf litter characteristics (e.g., Bednarz et al. 2005).

Overall, within both litter samples and pitfall traps, cane stems and total canopy cover are clearly the most influential variables when predicting Swainson's warbler occupancy with habitat and arthropod data combined (Tables 4.3 and 4.9). Interestingly, cane stems and total canopy cover, along with litter volume, CV understory density, density of medium and large trees, and large snags were also good predictors of arthropod richness and abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length (Tables 4.4–4.8 and 4.10–4.14). These results show many similarities with other analyses from the current study (Chapter 2), as well as past studies (e.g., Wright 2002, Somershoe et al. 2003, Bednarz et al. 2005), but also provide some insights on how arthropod populations may be influenced by habitat structure. Moreover, it appears that there was a positive relationship between density of cane stems, total vegetation density, total canopy cover, and litter volume with the relative abundance and richness of arthropods.

I have also documented inconsistencies between litter samples and pitfall traps for collecting arthropods. Some of these differences can be explained by the different array of arthropods that each sample type targets. Pitfall traps are more apt to collect arthropods with no limitations in respect of size, but require the arthropods to be mobile; at least at the ground surface, and thus, the actual sampling area is unknown. Also, Greenslade (1964) stated that pitfall traps suffer from the disadvantage that arthropod captures depend both on the density of the population being sampled and the activity of the individuals in these populations. Likewise, the susceptibility of a species being trapped differs among arthropods according to their behavior (Greenslade 1964). Because of this diversity in arthropod activity, pitfall traps will have less of an emphasis on collecting arthropods that live directly in the leaf litter where the Swainson's warbler feeds. While litter samples are more likely to include arthropods that live extended periods of time in the leaf litter. Also, litter samples may consist of arthropods with some limitations in respect to size and mobility. Moreover, litter sample arthropods were extracted using a berlese funnel which uses heat to push the arthropods through a funnel with wire mesh and different arthropods can tolerate different intensities of heat and a very large arthropod may be incapable of fitting through the mesh wire. Given these inconsistencies and the previously reported foraging behavior of Swainson's warblers, I suggest that litter samples may have provided a more accurate representation of arthropods that were available to this bird. Because no known sampling method assesses prey availability in the same way that a bird does (Cooper and Whitmore 1990, Strong 2000), I opted to use these two sampling methods to better assess the complete arthropod community. With the use of two complimentary sampling methods (litter samples and pitfalls) I feel that a fair assessment of arthropod community characteristics was obtained at occupied and unoccupied sites (Appendix B).

The cane stems, litter volume, and understory density model was shown to be a reasonable predictor of arthropod community characteristics, by ranking in the top three best models that fit the data in 4 of 10 analyses in litter samples and pitfall traps combined. However, this model also was ranked below the null model in three of five litter sample analyses and in two of five pitfall trap analyses. It also failed to rank as the best supported model in all 10 of the linear regression analyses; therefore, I must reject my second hypothesis, in that the cane stem litter volume, and understory density model was not the best model for predicting arthropod community characteristics.

Given the Swainson's warblers foraging technique (e.g., Graves 1998) and reports from the current (Chapter 2) and other studies (e.g. Bednarz et al. 2005) that Swainson's warblers rely on a well developed layer of leaf litter. Likewise, based on the data from this study, there appears to be a positive association between arthropod abundance and diversity and a greater leaf litter presence. I would suggest that both appropriate habitat structure (e.g., uniformly dense understory, moderate cane and total canopy cover, and a well-developed layer of leaf litter) and arthropod abundance and diversity are important to the selection of habitats by Swainson's warblers. However, further investigations on the interrelationship of habitat characteristics and arthropod communities for Swainson's warblers are needed. Studies should focus on the occupancy of different habitat types such as bottomland hardwood forests with and without cane present, commercial pine forests, and rhododendron thickets in different-aged timber stands would provide invaluable data. To investigate how important of a selection factor arthropod abundance and richness is, it would be informative to determine if the abundance of arthropods varied between habitat types and if occupied sites were consistently higher in abundance and richness than unoccupied sites in all of these habitats. After evaluating data collected in this study, I suggest that comparative studies investigating relationships of Swainson's warbler abundance and reproductive success with arthropod availability between different habitats are needed.

MANAGEMENT IMPLICATIONS

Related to management, I suggest that efforts should be made to maintain habitat characteristics that promote dense understory vegetation, high stem densities, and a well-developed layer of leaf litter. Also, I support previous recommendations made by Eddleman (1978) and Somershoe (2003) to maintain or expand canebrakes because this habitat is drastically declining and it provides a dense understory needed to support Swainson's warblers. Also, because of the importance of ground dwelling arthropods and a well-developed leaf litter layer, flooding is an important phenomenon that may adversely affect Swainson's warbler occupancy. Graves (2001) suggested that abandonment of a particular area is stimulated by the inundation of leaf litter, which is a critical foraging resource and support for nest sites. Bednarz et al. (2005) and this current study provide evidence suggesting that this species was using mostly high elevation areas, because frequent flooding probably negatively effects Swainson's warblers by washing away or compacting the leaf litter on the forest floor which houses these ground-dwelling arthropods (J. Brown and J. Bednarz unpublished data). Therefore, I concur with Graves (2001) in that management of water levels is a major concern for Swainson's warblers throughout their entire range. Further, I emphasize that management of water levels should be implemented to ensure that human-induced excessive flood levels do not intrude on Swainson's warbler foraging habitat.

LITERATURE CITED

Barrow, W. C. 1990. Ecology of small insectivorous birds in a bottomland hardwood forest. Dissertation, Louisiana State University, Baton Rouge, Louisiana, USA.

Bassett-Touchell, C. A., and P. C. Stouffer. 2006. Habitat selection by Swainson's warblers breeding in loblolly pine plantations in southeastern Louisiana. Journal of Wildlife Management 70:1013–1019.

Bednarz, J. C., P. Stiller-Krehel, and B. Cannon. 2005. Distribution and habitat use of Swainson's warblers in eastern and northern Arkansas. Pages 576–588 *in* Ralph, C. J., and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. U.S. Forest Service General Technical Report PSW-GTR-191. U.S. Department of Agriculture, Pacific Southwest Research Station, Albany, California, USA.

Brown, R. E., and J. G. Dickson. 1994. Swainson's warbler (*Limnothlypis swainsonii*). No. 126 *in* A. Poole and F. Gill, editors. The Birds of North America. Academy of Natural Sciences, Philadelphia, Pennsylvania and the American Ornithologists' Union, Washington, D.C., USA.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multi-model inference: a practical information-theoretic approach. Springer-Verlag, New York, USA.

Cody, R. P., and J. K. Smith. 1997. Applied statistics and the SAS programming language. Fourth edition. Prentice Hall, Upper Saddle River, New Jersey, USA.

Cooper, R. J., and R. C. Whitmore. 1990. Arthropod sampling methods in ornithology. Pages 29–37 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: Theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Eddleman, W. R. 1978. Selection and management of Swainson's warbler habitat. Thesis, University of Missouri, Columbia, Missouri, USA.

Eaton, S. W. 1953. Wood warblers wintering in Cuba. The Wilson Bulletin 65:169–174.

Graves, G. R. 1998. Stereotyped foraging behavior of the Swainson's warbler. Journal of Field Ornithology 69:121–127.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in Great Dismal Swamp. Auk 118:650–664.

Graves, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's warbler. Wilson Bulletin 114:210–220.

Greenslade, P. J. M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology 33:301–310.

Howell, A. H. 1924. Birds of Alabama. Department of Game and Fisheries of Alabama. Brown Printing Company, Montgomery, Alabama, USA.

Hunter, W. C., and Collazo, J. A. 2001. Partners in Flight South Atlantic Coastal Plain Bird Conservation Plan. American Bird Conservancy: The Plains, Virginia, USA.

Hunter, W. C., D. N. Pashley, and R. E. F. Escano. 1993. Neotropical migratory landbird species and their habitat of special concern within the southeast region. Pages 159–171 *in* D. M. Finch, and S. W. Strangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229. U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Hunter, W. C., A. J. Mueller, and C. L. Hardy. 1994. Managing for Red-cockaded Woodpeckers and neotropical migrants—is there a conflict? Proceedings of the Annual Conference Southeast Association of Fish Wildlife Agencies 48:383–394.

Johnson, D. H. 1980. The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65–71.

Karr, J. R., and J. D. Brawn. 1990. Food resources of understory birds in central Panama: quantification and effects on avian populations. Pages 58–64 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Levings, S. C., and D. M. Windsor. 1982. Seasonal and annual variation in litter arthropod populations. Pages 355–387 *in* E. G. Leigh, Jr., A. S. Rand, and D. M. Finch, editors. The ecology of a tropical forest: Seasonal rhythms and long-term changes. Smithsonian Institution Press, Washington, D.C., USA.

Meanley, B. 1966. Some observations on habitats of the Swainson's warbler. Living Bird 5:151–165.

Meanley, B. 1970. Method of searching for food by the Swainson's warbler. Wilson Bulletin 82:228.

Meanley, B. 1971. Natural history of the Swainson's warbler. North American Fauna 69. U.S. Department of Interior, Washington, D.C., USA.

Morse, D. H. 1989. American warblers: an ecological and behavioral perspective. Harvard University Press, Cambridge, Massachusetts, USA.

Moorman, C. E., L. T. Bowen, J. C. Kilgo, C. E. Sorenson, J. L. Hanula, S. Horn, and M. D. Ulyshen. 2007. Seasonal diets of insectivorous birds using canopy gaps in a bottomland forest. Journal of Field Ornithology 78:11–20.

Noss, R. F., E. T. Laroe, III, and J. M. Scott. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. U.S. Department of Interior, National Biological Service, Biological Report 28, Washington D.C., USA.

Nudds, T. D. 1977. Quantifying the vegetative structure of wildlife cover. Wildlife Society Bulletin 5:113–117.

Peters, K. A. 1999. Swainson's warbler (*Limnothlypis swainsonii*) habitat selection in a managed bottomland hardwood forest in South Carolina. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Peters, K. A., R. A. Lancia, and J. A. Gerwin. 2005. Swainson's warbler habitat selection in a managed bottomland hardwood forest. Journal of Wildlife Management 69:409–417.

Petit, D.R., J.F. Lynch, R.L. Hutto, J. G. Blake, and R.B. Waide. 1995. Habitat use and conservation in the neotropics. Pages 145–197 *in* T. E. Martin and D. M. Finch, editors. Ecology and management of neotropical migratory birds: A synthesis and review of critical issues. Oxford University Press, New York, New York, USA.

Robinson, S. K., and R. T. Holmes. 1982. Foraging behavior of forest birds: the relationships among search tactics, diet, and habitat structure. Ecology 63:1918–1931.

SAS Institute. 2004. Version 9.1. SAS Institute, Cary, North Carolina, USA.

Somershoe, S. G., S. P. Hudman, and C. R. Chandler. 2003. Habitat use by Swainson's warblers in a managed bottomland forest. Wilson Bulletin 115:148–154.

Stotz, D. F., J. W. Fitzpatrick, T. A. Parker III, and D. K. Moskovits. 1996. Neotropical birds. Ecology and conservation. The University of Chicago Press, Chicago, Illinois, USA.

Strong, A. M. 2000. Divergent foraging strategies of two neotropical migrant warblers: implications for winter habitat use. The Auk 117:381–392.

Strong, A. M., and T. W. Sherry. 2001. Body condition of Swainson's warblers wintering in Jamaica and the conservation value of Caribbean dry forests. Wilson Bulletin. 113:410–418.

Thompson, F. R., S. J. Lewis, J. Green, and D. Ewert. 1993. Status of neotropical migrant landbirds in the Midwest: identifying species of management concern. Pages 145–158 *in* D. M. Finch, and P. W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229, U.S. Department of Agriculture, Fort Collins, Colorado, USA.

Triplehorn, C. A., and N. F. Johnson. 2005. Borror and DeLong's introduction to the study of insects. Seventh edition. Thomson Brooks/Cole, Belmont, California, USA.

United States Fish and Wildlife Service [USFWS]. 2006. Daily use permit brochure for White River National Wildlife Refuge. Refuge Map, St. Charles, Arkansas. <http://www.fws.gov/whiteriver/mapspage.htm>. Accessed 20 Nov 2006.

Wolda, H. 1990. Food availability for an insectivore and how to measure it. Pages 38–43 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Wright, E. A. 2002. Breeding population density and habitat use of Swainson's warblers in a Georgia floodplain forest. Thesis, University of Georgia, Athens, Georgia, USA.

Table 4.1. *A priori* candidate models used in logistical regression analyses to predict Swainson's warbler occupancy at White River National Wildlife Refuge.

Candidate Model	Variables
Arthropod richness model	Arthropod richness[a]
Cane stems and total canopy cover model	Cane stems[b], total canopy cover[c]
Large arthropods model	Abundance of 10–15 mm arthropods, abundance of ≥15 mm arthropods
Cane stems and arthropod richness model	Cane stems, arthropod richness
Litter volume and arthropod richness model	Litter volume[d], arthropod richness
Litter volume and arthropod abundance model	Litter volume, arthropod abundance[e]
Stem type model	Cane stems, vine stems, shrub stems
Vine stems, shrub stems, and arthropod abundance model	Vine stems, shrub stems, arthropod abundance
Total canopy cover, understory density, and arthropod richness model	Total canopy cover, understory density[f], arthropod richness
Stem density and arthropod richness model	Cane stems, vine stems, shrub stems, arthropod richness
Cane stems, litter volume, and large arthropods model	Cane stems, litter volume, abundance of arthropods 10–15 mm, abundance of arthropods ≥15 mm
Total canopy cover, litter volume, and large arthropods model	Total canopy cover, litter volume, abundance of arthropods 10–15 mm, abundance of arthropods ≥15 mm
Cane stems, litter volume, and common prey model	Cane stems, litter volume, Coleoptera (beetles), Formicidae (ants), Araneae (spiders)
Stem density and large arthropods model	Cane stems, vine stems, shrub stems, arthropods10–15 mm, abundance of arthropods ≥15 mm
Litter volume and common arthropods model	Litter volume, Coleoptera, Formicidae, Araneae, Diplopoda (millipedes)

[a] Taxonomic richness per sample.
[b] Stem counts within four 1-m^2 quadrats.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[e] Total abundance of arthropods calculated per sample.
[f] Measured using a 2.5-m coverboard (Nudds 1977).

Table 4.2. *A priori* candidate models used in linear regressions to predict arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm (small to medium arthropods), and arthropods ≥10 mm (medium to large arthropods) in length at White River National Wildlife Refuge.

Candidate Model	Variables
Cane stems model	Cane stems[a]
Stem type model	Cane stems, vine stems, shrub stems
Litter volume model	Litter volume[b]
Total canopy cover model	Total canopy cover[c]
Soil moisture model	Soil moisture[d]
Understory density model	Understory density[e]
Understory density CV model	CV[f] understory density
Forbs and bare ground model	Percent forbs[g], percent bare ground
Early successional forest model	Saplings[h], poles[i], small trees[j]
Litter volume and percent cover of logs and brush model	Litter volume, percent logs, percent brush
Cane stems, litter volume, and understory density model	Cane stem, litter volume, understory density
Mature forest model	Total canopy cover, medium trees[k], large trees[l], large snags[m]

[a] Stem counts within four 1-m^2 quadrats.
[b] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Readings taken with a soil moisture meter at every arthropod trap location.
[e] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[f] Coefficient of variation among understory density.
[g] Estimated cover within 5-m radius circle.
[h] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[i] Trees and shrubs 2.5–8 cm in diameter at breast height.
[j] Trees and shrubs 8–23 cm in diameter at breast height.
[k] Trees and shrubs 23–38 cm in diameter at breast height.
[l] Trees and shrubs >38 cm in diameter at breast height.
[m] Dead snags >12 cm in diameter at breast height and >1.4 m in height.

Table 4.3. Logistic regression results for arthropod and habitat models from litter samples used to predict occupancy by Swainson's warblers (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	Concordance
Cane stems[b] (+), Total canopy cover[c] (+)	3	73.01	0.00	0.9431	84.10
Total canopy cover (+), Understory density[d] (+), Arthropod richness[e] (+)	4	81.18	8.17	0.0159	79.00
Cane stems (+), Arthropod richness (+)	3	81.51	8.51	0.0134	77.40
Cane stems (+), Litter volume[f] (+), Arthropods 10–15 mm (–), Arthropods >15 mm (+)	5	82.25	9.24	0.0093	80.80
Cane stems (+), Vine stems (–), Shrub stems (+)	4	82.87	9.86	0.0068	84.50
Cane stems (+), Vine stems (–), Shrub stems (+), Arthropod richness (+)	5	83.13	10.13	0.0060	83.00
Cane stems (+), Vine stems (–), Shrub stems (+), Arthropods 10–15 mm (–), Arthropods >15 mm (+)	6	83.66	10.65	0.0046	83.90
Cane stems (+), Litter volume (+), Coleoptera (+), Formicidae (+), Araneae (+)	6	87.50	14.49	0.0007	81.40
Arthropod richness (+)	2	90.70	17.70	0.0001	63.20
Total canopy cover (+), Litter volume (+), Arthropods 10–15 mm (–), Arthropods >15 mm (+)	5	92.29	19.28	<.0001	75.90
Litter volume (+), Arthropod richness (+)	3	92.49	19.48	<.0001	66.20
Arthropods 10–15 mm (+), Arthropods >15 mm (+)	3	93.00	20.00	<.0001	62.60
Litter volume (+), Arthropod abundance[g] (+)	3	95.17	22.16	<.0001	67.10
Null (intercept only)	1	95.34	22.33	<.0001	
Vine stems (–), Shrub stems (+), Arthropod abundance (+)	4	96.22	23.21	<.0001	70.30
Litter volume (+), Coleoptera (+), Formicidae (+), Araneae (+), Diplopoda (–)	6	98.94	25.94	<.0001	71.20

[a] Number of model parameters.
[b] Stem counts within four 1-m^2 quadrats.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[e] Taxonomic richness per sample.
[f] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[g] Total abundance of arthropods calculated per sample.

Table 4.4. Habitat models used as predictors of arthropod richness of arthropods from litter samples (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Cane stems[b] (+)	2	75.16	0.00	0.3935	0.13
Cane stems (+), Litter volume[c] (+), Understory density[d] (+)	4	75.91	0.74	0.2712	0.18
CV[e] understory density (–)	2	76.97	1.80	0.1597	0.11
Understory density (+)	2	78.20	3.04	0.0861	0.09
Canes stems (+), Vine stems (+), Shrub stems (+)	4	79.23	4.07	0.0515	0.14
Sapling[f] (–), Pole[g] (–), Small[h] (+)	4	82.12	6.96	0.0121	0.10
Litter volume (+)	2	83.04	7.88	0.0077	0.03
Null (intercept only)	1	83.09	7.93	0.0075	
Total canopy cover[i] (+)	2	84.86	9.70	0.0031	<0.01
Soil moisture[j] (+)	2	85.03	9.87	0.0028	<0.01
Litter volume (+), % Log[k] (+), % Brush (–)	4	85.21	10.05	0.0026	0.06
% Forb (–), % Bare ground (+)	3	86.68	11.51	0.0012	0.01
Total canopy cover (+), Medium trees[l] (+), Large trees[m] (–), Large snags[n] (–)	5	87.09	11.92	0.0010	0.07

[a] Number of model parameters.
[b] Stem counts within four 1-m^2 quadrats.
[c] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[d] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[e] Coefficient of variation among understory density.
[f] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[g] Trees and shrubs 2.5–8 cm in diameter at breast height.
[h] Trees and shrubs 8–23 cm in diameter at breast height.
[i] Total canopy cover taken from the center of the plot with a densiometer.
[j] Readings taken with a soil moisture meter at every arthropod trap location.
[k] Estimated cover within 5-m radius circle.
[l] Trees and shrubs 23–38 cm in diameter at breast height.
[m] Trees and shrubs >38 cm in diameter at breast height.
[n] Dead snags >12 cm in diameter at breast height and >1.4 m in height.

Table 4.5. Habitat models used as predictors of total arthropod abundance from litter samples (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Total canopy cover (+), Medium trees[b] (+), Large trees[c] (–), Large snags[d] (–)	5	454.22	0.00	0.1973	0.15
CV[e] understory density (–)	2	454.32	0.10	0.1878	0.06
Cane stems[f] (+)	2	454.56	0.33	0.1671	0.06
Sapling[g] (–), Pole[h] (–), Small[i] (+)	4	455.06	0.84	0.1299	0.11
Understory density (+)	2	455.74	1.52	0.0922	0.05
Null (intercept only)	1	456.97	2.75	0.0500	
Cane stems (+), Litter volume[j] (+), Understory density[k] (+)	4	457.62	3.40	0.0361	0.08
Canes stems (+), Vine stems (–), Shrub stems (–)	4	457.78	3.56	0.0333	0.08
Total canopy cover[l] (+)	2	457.92	3.70	0.0311	0.02
Litter volume (+)	2	458.31	4.09	0.0255	0.01
Soil moisture[m] (+)	2	458.46	4.24	0.0237	0.01
Litter volume (+), % Log[n] (–), % Brush (–)	4	459.22	5.00	0.0161	0.06
% Forb (–), % Bare ground (+)	3	460.24	6.01	0.0098	0.01

[a] Number of model parameters.
[b] Trees and shrubs 23–38 cm in diameter at breast height.
[c] Trees and shrubs >38 cm in diameter at breast height.
[d] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[e] Coefficient of variation among understory density.
[f] Stem counts within four 1-m^2 quadrats.
[g] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[h] Trees and shrubs 2.5–8 cm in diameter at breast height.
[i] Trees and shrubs 8–23 cm in diameter at breast height.
[j] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[k] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[l] Total canopy cover taken from the center of the plot with a densiometer.
[m] Readings taken with a soil moisture meter at every arthropod trap location.
[n] Estimated cover within 5-m radius circle.

Table 4.6. Habitat models used as predictors of common prey of Swainson's warblers from litter samples (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
CV[b] understory density (–)	2	387.58	0.00	0.2119	0.07
Cane stems[c] (+)	2	387.62	0.04	0.2077	0.07
Total canopy cover[d] (+), Medium trees[e] (+), Large trees[f] (–), Large snags[g] (–)	5	388.03	0.45	0.1659	0.15
Understory density[h] (+)	2	388.40	0.82	0.1409	0.06
Null (intercept only)	1	390.39	2.81	0.0521	
Sapling[i] (–), Pole[j] (–), Small[k] (+)	4	390.60	3.01	0.0470	0.09
Canes stems (+), Vine stems (–), Shrub stems (–)	4	391.07	3.49	0.0371	0.08
% Forb[l] (–), % Bare ground (+)	3	391.22	3.64	0.0342	0.05
Cane stems (+), Litter volume[m] (+), Understory density (+)	4	391.37	3.79	0.0319	0.08
Soil moisture[n] (+)	2	391.93	4.35	0.0241	0.01
Total canopy cover (+)	2	392.23	4.64	0.0208	<0.01
Litter volume (–)	2	392.51	4.93	0.0181	<0.01
Litter volume (–), % Log[k] (–), % Brush (–)	4	395.22	7.64	0.0047	0.02

[a] Number of model parameters.
[b] Coefficient of variation among understory density.
[c] Stem counts within four 1-m^2 quadrats.
[d] Total canopy cover taken from the center of the plot with a densiometer.
[e] Trees and shrubs 23–38 cm in diameter at breast height.
[f] Trees and shrubs >38 cm in diameter at breast height.
[g] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[j] Trees and shrubs 2.5–8 cm in diameter at breast height.
[k] Trees and shrubs 8–23 cm in diameter at breast height.
[l] Estimated cover within 5-m radius circle.
[m] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[n] Readings taken with a soil moisture meter at every arthropod trap location.

Table 4.7. Habitat models used as predictors of arthropods 2–15 mm (small to medium arthropods) in length from litter samples (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Cane stems[b] (+)	2	405.64	0.00	0.2628	0.08
CV[c] understory density (–)	2	406.35	0.71	0.1839	0.07
Understory density[d] (+)	2	407.04	1.40	0.1303	0.06
Cane stems (+), Litter volume[e] (+), Understory density (+)	4	407.23	1.59	0.1187	0.12
Total canopy cover[f] (+), Medium trees[g] (+), Large trees[h] (–), Large snags[i] (–)	5	407.55	1.92	0.1007	0.14
Canes stems (+), Vine stems (+), Shrub stems (+)	4	409.24	3.60	0.0433	0.09
Null (intercept only)	1	409.52	3.88	0.0378	
Sapling[j] (–), Pole[k] (–), Small[l] (+)	4	409.54	3.91	0.0372	0.09
Litter volume (+)	2	409.83	4.20	0.0322	0.03
Soil moisture[m] (+)	2	411.01	5.37	0.0179	0.01
Total canopy cover (+)	2	411.07	5.43	0.0174	0.01
Litter volume (+), % Log[n] (+), % Brush (–)	4	411.95	6.31	0.0112	0.06
% Forb (–), % Bare ground (+)	3	413.05	7.41	0.0065	0.01

[a] Number of model parameters.
[b] Stem counts within four 1-m^2 quadrats.
[c] Coefficient of variation among understory density.
[d] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[e] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[f] Total canopy cover taken from the center of the plot with a densiometer.
[g] Trees and shrubs 23–38 cm in diameter at breast height.
[h] Trees and shrubs >38 cm in diameter at breast height.
[i] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[j] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[k] Trees and shrubs 2.5–8 cm in diameter at breast height.
[l] Trees and shrubs 8–23 cm in diameter at breast height.
[m] Readings taken with a soil moisture meter at every arthropod trap location.
[n] Estimated cover within 5-m radius circle.

Table 4.8. Habitat models used as predictors of arthropods >10 mm (medium to large arthropods) in length from litter samples (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
CV[b] understory density (–)	2	83.80	0.00	0.5009	0.07
Null (intercept only)	1	87.19	3.39	0.0921	
Understory density[c] (+)	2	87.44	3.64	0.0813	0.03
% Forb[d] (–), % Bare ground (+)	3	87.90	4.10	0.0644	0.05
Total canopy cover[e] (+)	2	87.99	4.19	0.0616	0.02
Cane stems[f] (+)	2	88.47	4.67	0.0483	0.01
Soil moisture[g] (+)	2	88.82	5.02	0.0407	0.01
Sapling[h] (–), Pole[i] (–), Small[j] (+)	4	89.16	5.36	0.0342	0.06
Litter volume[k] (–)	2	89.29	5.49	0.0321	<0.01
Total canopy cover (+), Medium trees[l] (+), Large trees[m] (–), Large snags[n] (–)	5	90.31	6.51	0.0193	0.08
Cane stems (+), Litter volume (–), Understory density (+)	4	91.85	8.05	0.0089	0.03
Litter volume (+), % Log (+), % Brush (–)	4	91.86	8.06	0.0089	0.03
Canes stems (+), Vine stems (+), Shrub stems (+)	4	92.31	8.51	0.0071	0.02

[a] Number of model parameters.
[b] Coefficient of variation among understory density.
[c] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[d] Estimated cover within 5-m radius circle.
[e] Total canopy cover taken from the center of the plot with a densiometer.
[f] Stem counts within four 1-m^2 quadrats.
[g] Readings taken with a soil moisture meter at every arthropod trap location.
[h] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[i] Trees and shrubs 2.5–8 cm in diameter at breast height.
[j] Trees and shrubs 8–23 cm in diameter at breast height.
[k] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[l] Trees and shrubs 23–38 cm in diameter at breast height.
[m] Trees and shrubs >38 cm in diameter at breast height.
[n] Dead snags >12 cm in diameter at breast height and >1.4 m in height.

Table 4.9. Logistic regression results for arthropod and habitat models from pitfall traps used to predict occupancy by Swainson's warblers (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	Concordance
Cane stems[b] (+), Total canopy cover[c] (+)	3	72.65	0.00	0.5800	84.10
Cane stems (+), Litter volume[d] (+), Arthropods 10–15 mm (+), Arthropods >15 mm (–)	5	75.20	2.20	0.1934	84.80
Cane stems (+), Vine stems (–), Shrub stems (+), Arthropods 10–15 mm (+), Arthropods >15 mm (–)	6	75.85	2.84	0.1400	86.10
Total canopy cover (+), Understory density[e] (+), Arthropod richness[f] (–)	4	79.09	6.09	0.0276	81.00
Total canopy cover (+), Litter volume (+), Arthropods 10–15 mm (+), Arthropods >15 mm (–)	5	79.32	6.32	0.0246	80.10
Cane stems (+), Litter volume (+), Coleoptera (–), Formicidae (–), Araneae (–)	6	80.98	7.98	0.0108	82.50
Arthropods 10–15 mm (+), Arthropods >15 mm (–)	3	81.10	8.09	0.0101	77.70
Cane stems (+), Arthropod richness (–)	3	82.38	9.38	0.0053	81.10
Cane stems (+), Vine Stems (–), Shrub stems (+)	4	82.87	9.86	0.0042	84.50
Cane stems (+), Vine Stems (+), Shrub stems (+), Arthropod richness (–)	5	83.78	10.77	0.0027	83.80
Litter volume (+), Arthropod abundance[g] (–)	3	85.86	12.86	0.0009	74.40
Litter volume (+), Coleoptera (–), Formicidae (–), Araneae (–), Diplopoda (+)	6	88.25	15.24	0.0003	76.90
Vine stems (–), Shrub stems (+), Arthropod abundance (–)	4	92.01	19.00	<.0001	71.50
Litter volume (+), Arthropod richness(–)	3	94.85	21.84	<.0001	63.20
Null (intercept only)	1	95.34	22.33	<.0001	
Arthropod richness	2	95.78	22.77	<.0001	61.20

[a] Number of model parameters.
[b] Stem counts within four 1-m^2 quadrats.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[e] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[f] Taxonomic richness per sample.
[g] Total abundance of arthropods calculated per sample.

Table 4.10. Habitat models used as predictors of arthropod richness of arthropods from pitfall traps (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Litter volume[b] (+)	2	74.09	0.00	0.3926	0.14
Total canopy cover[c] (+), Medium trees[d] (–), Large trees[e] (+), Large snags[f] (–)	5	74.87	0.78	0.2660	0.21
Cane stems[g] (–), Litter volume (+), Understory density[h] (+)	4	75.85	1.76	0.1629	0.17
Litter volume (+), % Log[i] (+), % Brush (–)	4	76.02	1.93	0.1497	0.17
Null (intercept only)	1	82.39	8.30	0.0062	
% Forb (–), % Bare ground (–)	3	82.64	8.55	0.0054	0.06
Soil moisture[j] (–)	2	83.60	9.51	0.0034	0.01
Cane stems (–)	2	83.64	9.55	0.0033	0.01
Canes stems (–), Vine stems (+), Shrub stems (+)	4	83.74	9.65	0.0032	0.07
Understory density (–)	2	84.31	10.23	0.0024	<0.01
Total canopy cover (–)	2	84.38	10.29	0.0023	<0.01
CV[k] understory density (–)	2	84.48	10.39	0.0022	<0.01
Sapling[l] (+), Pole[m] (+), Small[n] (+)	4	87.75	13.66	0.0004	0.02

[a] Number of model parameters.
[b] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[c] Total canopy cover taken from the center of the plot with a densiometer.
[d] Trees and shrubs 23–38 cm in diameter at breast height.
[e] Trees and shrubs >38 cm in diameter at breast height.
[f] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[g] Stem counts within four 1-m^2 quadrats.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Estimated cover within 5-m radius circle.
[j] Readings taken with a soil moisture meter at every arthropod trap location.
[k] Coefficient of variation among understory density.
[l] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[m] Trees and shrubs 2.5–8 cm in diameter at breast height.
[n] Trees and shrubs 8–23 cm in diameter at breast height.

Table 4.11. Habitat models used as predictors of total arthropod abundance from pitfall traps (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Total canopy cover[b] (+), Medium trees[c] (–), Large trees[d] (+), Large snags[e] (–)	5	428.32	0.00	0.9862	0.30
Cane stems[f] (–), Litter volume[g] (+), Understory density[h] (–)	4	438.39	10.08	0.0064	0.17
Litter volume (+)	2	440.23	12.09	0.0023	0.09
CV[i] understory density (+)	2	441.34	13.03	0.0015	0.08
Cane stems (–)	2	441.43	13.03	0.0014	0.08
Litter volume (+), % Log[j] (+), % Brush (–)	4	443.04	14.72	0.0006	0.11
Understory density (–)	2	443.11	14.79	0.0006	0.06
Canes stems (–), Vine stems (+), Shrub stems (–)	4	444.47	16.16	0.0003	0.10
Null (intercept only)	1	445.10	16.79	0.0002	
% Forb (–), % Bare ground (–)	3	445.30	16.99	0.0002	0.06
Soil moisture[k] (–)	2	446.81	18.49	<0.0001	0.01
Total canopy cover (+)	2	447.16	18.85	<0.0001	<0.01
Sapling[l] (+), Pole[m] (+), Small[n] (+)	4	449.33	21.01	<0.0001	0.03

[a] Number of model parameters.
[b] Total canopy cover taken from the center of the plot with a densiometer.
[c] Trees and shrubs 23–38 cm in diameter at breast height.
[d] Trees and shrubs >38 cm in diameter at breast height.
[e] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[f] Stem counts within four 1-m^2 quadrats.
[g] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Coefficient of variation among understory density.
[j] Estimated cover within 5-m radius circle.
[k] Readings taken with a soil moisture meter at every arthropod trap location.
[l] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[m] Trees and shrubs 2.5–8 cm in diameter at breast height.
[n] Trees and shrubs 8–23 cm in diameter at breast height.

Table 4.12. Habitat models used as predictors of common prey of Swainson's warblers from pitfall traps (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Total canopy cover[b] (–), Medium trees[c] (–), Large trees[d] (+), Large snags[e] (–)	5	354.03	0.00	0.9243	0.24
Canes stems[f] (–), Vine stems (–), Shrub stems (–)	4	361.11	7.08	0.0268	0.14
Cane stems (–)	2	361.67	7.82	0.0185	0.07
CV[g] understory density (+)	2	362.39	8.36	0.0141	0.06
Null (intercept only)	1	365.00	10.97	0.0038	
Understory density[h] (–)	2	365.37	11.34	0.0032	0.02
Cane stems (–), Litter volume[i] (+), Understory density (+)	4	365.66	11.63	0.0028	0.08
Total canopy cover (–)	2	366.41	12.38	0.0019	0.01
Litter volume (+)	2	366.42	12.39	0.0019	0.01
Soil moisture[j] (–)	2	367.08	13.05	0.0014	<0.01
% Forb[k] (–), % Bare ground (–)	3	368.52	14.49	0.0007	0.01
Sapling[l] (+), Pole[m] (+), Small[n] (+)	4	369.66	15.63	0.0004	0.03
Litter volume (+), % Log (–), % Brush (–)	4	370.44	16.41	0.0003	0.02

[a] Number of model parameters.
[b] Total canopy cover taken from the center of the plot with a densiometer.
[c] Trees and shrubs 23–38 cm in diameter at breast height.
[d] Trees and shrubs >38 cm in diameter at breast height.
[e] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[f] Stem counts within four 1-m^2 quadrats.
[g] Coefficient of variation among understory density.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[j] Readings taken with a soil moisture meter at every arthropod trap location.
[k] Estimated cover within 5-m radius circle.
[l] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[m] Trees and shrubs 2.5–8 cm in diameter at breast height.
[n] Trees and shrubs 8–23 cm in diameter at breast height.

Table 4.13. Habitat models used as predictors of arthropods 2–15 mm (small to medium arthropods) in length from pitfall traps (n = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
Total canopy cover[b] (+), Medium trees[c] (–), Large trees[d] (+), Large snags[e] (–)	5	404.79	0.00	0.9647	0.29
Cane stems[f] (–), Litter volume[g] (+), Understory density[h] (–)	4	412.88	8.10	0.0168	0.18
Litter volume (+)	2	413.70	8.92	0.0112	0.12
Litter volume (+), % Log[i] (+), % Brush (–)	4	416.12	11.33	0.0033	0.14
Cane stems (–)	2	417.99	13.20	0.0013	0.06
CV[j] understory density (+)	2	419.28	14.49	0.0007	0.05
Understory density (–)	2	419.56	14.78	0.0006	0.04
Canes stems (–), Vine stems (+), Shrub stems (–)	4	420.58	15.79	0.0004	0.09
Null (intercept only)	1	420.61	15.83	0.0004	
% Forb (–), % Bare ground (–)	3	421.04	16.25	0.0003	0.05
Soil moisture[k] (–)	2	422.27	17.48	0.0002	0.01
Total canopy cover (+)	2	422.63	17.84	0.0001	<0.01
Sapling[l] (+), Pole[m] (+), Small[n] (+)	4	425.10	20.32	<0.0001	0.03

[a] Number of model parameters.
[b] Total canopy cover taken from the center of the plot with a densiometer.
[c] Trees and shrubs 23–38 cm in diameter at breast height.
[d] Trees and shrubs >38 cm in diameter at breast height.
[e] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[f] Stem counts within four 1-m^2 quadrats.
[g] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Estimated cover within 5-m radius circle.
[j] Coefficient of variation among understory density.
[k] Readings taken with a soil moisture meter at every arthropod trap location.
[l] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[m] Trees and shrubs 2.5–8 cm in diameter at breast height.
[n] Trees and shrubs 8–23 cm in diameter at breast height.

Table 4.14. Habitat models used as predictors of arthropods ≥10 mm (medium to large arthropods) in length from pitfall traps (*n* = 71) at White River National Wildlife Refuge. Models with the lowest AIC_c and highest weight (ω_i) are the best-supported models. Sign in parentheses indicates the direction of the relationship.

Model	K[a]	AIC_c	ΔAIC_c	ω_i	R^2
CV[b] understory density (+)	2	300.42	0.00	0.3819	0.12
Canes stems[c] (–), Vine stems (–), Shrub stems (–)	4	300.44	0.02	0.3784	0.17
Total canopy cover[d] (+), Medium trees[e] (+), Large trees[f] (+), Large snags[g] (–)	5	303.56	3.14	0.0795	0.16
Cane stems (–)	2	303.85	3.42	0.0690	0.07
Understory density[h] (–)	2	305.05	4.63	0.0378	0.06
Null (intercept only)	1	307.02	6.59	0.0141	
Cane stems (–), Litter volume[i] (+), Understory density (–)	4	307.28	6.86	0.0124	0.08
Soil moisture[j] (–)	2	307.63	7.21	0.0104	0.02
Litter volume (+)	2	308.64	8.21	0.0062	0.01
Total canopy cover (+)	2	308.93	8.51	0.0054	<0.01
% Forb[k] (–), % Bare ground (+)	3	310.31	9.90	0.0027	0.01
Litter volume (+), % Log (+), % Brush (–)	4	311.80	11.38	0.0013	0.02
Sapling[l] (+), Pole[m] (+), Small[n] (+)	4	312.81	12.39	0.0008	0.01

[a] Number of model parameters.
[b] Coefficient of variation among understory density.
[c] Stem counts within four 1-m^2 quadrats.
[d] Total canopy cover taken from the center of the plot with a densiometer.
[e] Trees and shrubs 23–38 cm in diameter at breast height.
[f] Trees and shrubs >38 cm in diameter at breast height.
[g] Dead snags >12 cm in diameter at breast height and >1.4 m in height.
[h] Measurement taken with a 2.5 m vegetation density coverboard (Nudds 1977).
[i] Calculated by taking the product of the mean leaf litter depth and the mean percent cover of leaf litter in the 5-m radius plot.
[j] Readings taken with a soil moisture meter at every arthropod trap location.
[k] Estimated cover within 5-m radius circle.
[l] Trees and shrubs <2.5 cm in diameter at breast height and >30 cm in height.
[m] Trees and shrubs 2.5–8 cm in diameter at breast height.
[n] Trees and shrubs 8–23 cm in diameter at breast height.

CHAPTER V

GENERAL CONCLUSIONS

In this thesis, I have provided ecological data on the Swainson's warbler (*Limnothlypis swainsonii*), a neotropical migrant of critical conservation concern. The results of this study provide: 1) a baseline inventory of Swainson's warbler occupancy at White River National Wildlife Refuge (WRNWR), 2) data on habitat characteristics, 3) a baseline inventory of available arthropods at Swainson's warbler sites, 4) insights into factors that influence habitat selection, and 5) assessment of the capability of using vegetation structure to predict arthropod community characteristics. This thesis also includes data on other topics related to the Swainson's warbler biology. Importantly, this study also reveals insights into management practices that may benefit Swainson's warblers and other understory-dwelling birds. In chapter I, I provided an introduction to the Swainson's warbler and this study. In this final chapter, I briefly summarize the results of this study, outline how it has contributes to current knowledge, and combine and synthesize the findings of the individual chapters. Finally, I suggest future research needs and management implications.

Swainson's warblers are ground-foraging litter-specialists and due to this foraging behavior, they likely are affected adversely by flooding. Consequently, previous studies on this species involving low-elevation flood-prone sites may not have represented the habitat affinities of this species accurately. I examined relationships between Swainson's warbler occupancy, vegetation structure, and arthropod community characteristics at relatively high-elevation bottomlands at White River National Wildlife Refuge (WRNWR).

In Chapter II, my objective was to investigate habitat characteristics that may influence habitat use by Swainson's warblers within the high-elevation portion of bottomland forests. Specifically, I predicted Swainson's warbler occupied sites would have a greater shrub stem density, litter density, and shrub cover than unoccupied sites (Graves 2001, Bednarz et al. 2005). Alternatively, Swainson's warbler occupied sites may not have shown any significant differences in vegetation characteristics when compared to unoccupied sites (inferred from Somershoe et al. 2003).

I systematically surveyed a total of 1,453 sites and collected vegetation data on 70 sites occupied by Swainson's warblers and 106 randomly-selected unoccupied sites in 2004 and 2005. I also collected arthropod data on 45 randomly-selected occupied and unoccupied sites. Given that WRNWR is approximately 64,750 ha and I documented an occupancy frequency of 5% of the sites sampled, this indicated there was a large amount of unsuitable or unoccupied habitat for Swainson's warblers in the high-elevation bottomland habitat.

I found that mean canopy cover (82%), sub-canopy height (12.60 m), density of cane (*Arundinaria gigantea*) stems (30,750 stems/ha), shrub stems (23,536 stems/ha), and total stems (98,161 stems/ha), cover of cane (16%), depth of litter (17.49 mm), litter volume (1.24 m^2), soil moisture (8.19), and density of small (16.25/ha) and large snags (17.95/ha) were significantly greater in occupied than unoccupied sites (means = 77%, 11.76 m, 2,807 stems/ha, 9,590 stems/ha, 71,580 stems/ha, <1%, 14.90 mm, 1.03 m^2, 7.68, 12.21/ha, and 13.21/ha, respectively; Tables 2.2 and 2.3). However, occupied sites had a lower density (19.94 trees/ha) of large trees (dbh >38 m) than unoccupied sites (24.93 trees/ha). Also, vegetation density at all height intervals 0–2.5 m and total understory vegetation density were significantly greater and variation of horizontal and vertical vegetation density were significantly lower in occupied than unoccupied sites (Figure 2.4; Tables 2.2 and 2.3).

I further analyzed habitat characteristics from 28 sites that were occupied in 2 years, 37 sites that were occupied in only 1 year, and 38 sites that were not occupied. These results showed very similar relationships (Fig. 2.5; Tables 2.4 and 2.5) to those found in my occupied versus unoccupied comparisons. I found that persistent occupancy was related to patterns in sub-canopy height, litter depth, soil moisture, density of cane stems, shrub stems, and total stems, cover of cane, density of large snags, heterogeneity of horizontal and total vegetation density, total vegetation density, and vegetation density at all height intervals from 0–2.5 m except the 0–0.5 m height interval (Figure 2.5; Tables 2.4 and 2.5).

Using logistic regression, I found that the occupancy of the Swainson's warbler seemed to be influenced by stem count variables (Table 2.6). The 3-variable model including cane, vine, and shrubs stems as separate variables was the highest ranked model and accounted for 83% of the total AIC_c weight of all models considered. On the other hand, the total stems model (pooled cane, vine, and shrub stems count) was a relatively ineffective predictor of Swainson's warbler occupancy, and only accounted for <1% of the total AIC_c weight of all models considered (Table 2.6). I can infer from these seemingly conflicting results that the different types of stems each have a different affect on Swainson's warblers. Specifically, cane and shrub stems were positively associated with Swainson's warbler occupancy and vine stems were negatively associated with the presence of Swainson's warblers. In fact, I suggest that cane stems may be the best single variable predictor of Swainson's warbler occupancy and this variable had a combined AIC_c weight that accounted for 99% of all models considered.

Results of my habitat characteristics and habitat modeling analyses in chapter II indicated that a moderately high stem density with an emphasis on cane stems, a uniformly dense understory habitat structure, moderately high canopy cover, and a well-developed layer of leaf litter are key habitat components for Swainson's warbler breeding habitat at White River National Wildlife Refuge (WRNWR; Tables 2.2–2.5, Figs. 2.4 and 2.5). My habitat results showed many similarities to those studies conducted previously at various locations within the Swainson's warbler breeding range. Previously, Brewster (1885) and Meanley (1971) proposed that there was a close association of cane with the presence of Swainson's warblers. More recent studies done by Graves (2002) and Bednarz et al. (2005) provided evidence that cane is not an essential requirement of the Swainson's warbler habitat. However, no previous study has investigated if cane, when present, was preferred. Interestingly, the results from the current study clearly support a cane-Swainson's warbler association in WRNWR. In fact, 57 (81%) of the 70 occupied sites contained giant cane. Of the 13 occupied sites that did not have cane present, four sites had cane present within 50 m and the remaining nine sites did not have cane in close proximity to them. This was also demonstrated in my comparison of sites occupied by Swainson's warblers 2, 1, and 0 years. The data showed a gradient response with all the sites occupied in 2 years (100%, $N = 28$) having cane present within the sample plot, 76% ($N = 37$) of the sites occupied in only 1 year had cane present, and 13% ($N = 38$) of sites occupied in 0 years had cane present in the sample plot. In conclusion, cane habitat was associated with a high degree of occupancy persistence, which is perhaps a good indicator of long-term population viability.

Two notable variables, percent cover of cane and density of cane stems, were significantly greater at occupied than unoccupied sites (Table 2.2). Additionally, a gradient was observed with cane cover and cane stem density being the greatest in sites that were occupied 2 years, intermediate values at sites occupied 1 year, and the lowest percent cover and density of cane at sites that were not occupied by Swainson's warblers (Table 2.4). These results were consistent with data reported by Wright (2002), in which she analyzed three cane-related variables (cane stems, cane height, and cane area), that showed a clear relationship with the presence of cane in the breeding habitat of Swainson's warblers at the Bond Swamp National Wildlife Refuge in Georgia. Importantly, in my study, persistent use occurred in cane habitat with 100% of sites occupied 2 years containing cane, while shrub thickets only received intermittent use by Swainson's warblers. Interestingly, the cane stem density at occupied sites from this study area (30,800 stems/ha) does show similarities with the findings of Meanley (1971; 49,421 stems/ha), Eddleman et al. (1980; 26,390 stems/ha), and Thomas et al. (1996; 56,500 stems/ha). However, other reports from five studies encompassing four localities had less than 5,000 cane stems per ha (Peters 1999, Graves 2001, 2002, Somershoe et al. 2003, Thompson 2005). Additionally, Graves (2002) reported cane as being absent from his vegetation plots from Whiskey Bay and the Pearl River areas of Louisiana and from the Apalachicola River in Florida. Conclusions drawn from these collective studies were somewhat inconsistent with respect to cane. Differences in the habitat used by Swainson's warblers have been recognized in Arkansas and throughout the species' geographic range (Graves 2002, Bednarz et al. 2005). With that in mind, my results may be a function of Swainson's warblers showing a preference for cane at my study site, a function of the relatively high abundance of cane present at the study site, or a combination of these factors. Nevertheless, this question was beyond the scope of this study. Although, at least at the WRNWR, persistent use by Swainson's warblers seems to occur in cane areas, while shrub thickets seem to only get intermittent use. However, future studies should focus on comparisons between Swainson's warbler habitat use, reproductive success, and survival between cane habitat and other habitats, such as pine and hardwood forests.

Cane alone is not the only factor affecting Swainson's warbler habitat use. My data also suggested that dense understory vegetation and the uniformity of this vegetation density seems to play an integral part of habitat selection by Swainson's warblers (Tables 2.2–2.5). The presence of dense understory vegetation being important to Swainson's warblers was also supported by previous studies (Eddleman 1978, Bassett-Touchell and Stouffer 2006).

Dense understory cover with relatively low variation may be especially important in nesting habitats, where concealment is a priority. Also, advertisement may be especially important in perching and singing habitats and this uniformly dense understory is may be a beneficial characteristic of these habitats used by Swainson's warblers. Additionally, a dense and uniform understory may contribute to a well-developed leaf litter layer. In fact, the amount of leaf litter present in a particular area may play the most crucial role in a Swainson's warbler's habitat. Past work by Graves (2001) and Bednarz et al. (2005) has recognized the presence of a well-developed leaf litter layer and my study supports the fact that leaf litter is correlated with the presence of Swainson's warblers. Leaf litter is likely important because Swainson's warblers forage mainly on ground-dwelling arthropods and a well established layer of leaf litter can support an abundance of ground dwelling arthropods (Uetz 1976, Seastedt and Crossley 1981, Bultman et al. 1982, Bultman and Uetz 1984).

In chapter III, my objective was to investigate the relationship of arthropod community characteristics to habitat use by Swainson's warblers. Specifically, I predicted that Swainson's warbler occupied sites will have a greater arthropod abundance and a greater taxonomic diversity of arthropods than unoccupied sites. Recently, Bednarz et al. (2005) found that Swainson's warbler occupied sites had significantly greater cover of litter than unoccupied sites at four locations in Arkansas. Likewise, in this current study (Chapter 2), I found that occupied sites had significantly greater litter depth and litter volume than unoccupied sites and, although not significant, a trend of greater percent cover of litter. This habitat component is likely an important attribute because Swainson's warblers have been documented to have a limited repertoire of foraging behaviors (Graves 1998). Meanley (1970) stated that insects were the principal food of Swainson's warblers and were located when warblers poke their bill under a leaf, pushing it upwards, searching the ground beneath it, or examining its underside (also see Strong 2000, Graves 1998, Barrow 1990). Although leaf litter appears to be an important habitat component for this species, this occupancy–leaf-litter association may reveal a selection by Swainson's warblers for arthropod abundance and richness rather than for the amount of leaf litter *per se* at WRNWR. My data clearly showed that occupied Swainson's warbler sites had higher arthropod diversity and abundance, which appeared to be associated with the greater litter presence, than unoccupied sites (Tables 3.2 and 3.5). To my knowledge, this aspect of linking arthropod communities to habitat relationships has not been investigated for Swainson's warblers.

I found that in my litter samples, the total abundance of arthropods (32.57/sample), abundance of large arthropods (arthropods 5–10 mm = 8.30/sample, arthropods 10–15 mm = 1.63/sample, arthropods >15 mm = 0.54/sample), total adult abundance (26.62/sample), and taxonomic richness (8.89 taxa/site, 6.06 taxa/sample) were significantly greater in occupied than unoccupied sites (means = 21.84/sample, 5.00/sample, 0.86/sample, 0.12/sample, 17.23/site, 1.21/sample, 7.27 taxa/site, and 4.73 taxa/sample, respectively). Additionally, in litter samples, beetles (Coleoptera, 5.71/sample), click beetles (Elateridae, 0.88/sample), common ground beetles (Carabidae, 0.92/sample), and centipedes (Chilopoda, 0.40/sample) were more abundant in occupied sites than in unoccupied sites (4.01/sample, 0.27/sample, 0.34/sample, and 0.10/sample, respectively). In pitfall traps, flies (Diptera, 4.36/sample), snipe flies (Rhagionidae, 2.35/sample), and snails (Gastropoda, 0.49/sample) were more abundant in occupied sites than in unoccupied sites (2.38/sample, 0.64/sample, and

0.17/sample respectively). Although not always representing significant patterns, some of the most common arthropod groups collected with pitfall traps and litter samples consisted of ants, bees, and wasps (Hymenoptera), ants (Formicidae), beetles, rove beetles (Staphyllindae), common ground beetles, spiders (Araneae), and mites and ticks (Acari), flies, and springtails (Collembola; Figs. 3.1 and 3.2).

Relatively little is known about the diet of the Swainson's warbler. Meanley (1966) investigated the stomach contents of 4 Swainson's warblers in Georgia and found that spiders, ground beetles, crickets (Gryllidae), and ants, as well as spider eggs, larvae, and pupae were important components of their diet. In addition, Strong (2000) analyzed regurgitation samples of Swainson's warblers (n = 13 birds) in two distinctly different habitat types in Jamaica and found that beetles (39%), spiders (22%), and ants (19%) were the most commonly consumed prey items of 267 total prey items. Furthermore, there are limited amounts of scattered descriptive observations (e.g., Howell 1928, Eaton 1953, Meanley 1971) that lack a quantitative analysis of the Swainson's warbler's diet, but all seem to show similar findings as the former studies reported. Interestingly, beetles, ants, spiders, and crickets are among the most abundant and frequently occurring arthropod taxa in litter samples and pitfall traps that were collected during this study (Figs. 3.1–3.4).

Logistic regressions of the litter sample arthropod data being used as predictors of Swainson's warbler occupancy showed that the sample richness model and large arthropods model were better than all other models considered at predicting Swainson's warbler occupancy. While the large arthropods model and millipedes model were better than all other models for predicting occupancy for pitfall traps. Interestingly, the top two litter sample models (sample richness model and large arthropods model) showed a much better fit to the data than any pitfall trap model (Tables 3.4 and 3.7). However, there were inconsistencies between litter samples and pitfall traps when evaluating abundances of each taxa between occupied and unoccupied sites. Nevertheless, the combined results suggested that arthropod abundance and richness were key habitat components related to occupancy of Swainson's warblers at WRNWR. The results from this study support both hypotheses proposed in chapter III, in that, occupied sites had greater arthropod abundance and diversity than unoccupied sites. Additionally, I suggest that the arthropod community may be a driving factor influencing the presence or absence of Swainson's warblers, while habitat components such as leaf litter may be indirect or correlated factors associated with the occupancy of warblers.

In Chapter IV, my objective was to investigate whether arthropod community and habitat characteristics combined are good predictors of Swainson's warbler occupancy and whether habitat characteristics are good predictors of arthropod community attributes. I first hypothesized that Swainson's warbler occupancy should be associated with a combination of high levels of cane stems, litter volume, arthropods 10–15 mm in length, and arthropods >15 mm in length. Secondly, I hypothesized that high arthropod abundance and richness as well as common Swainson's warbler prey are associated with a combination of high densities of cane stems, litter volume, and understory density.

Using logistical regression, I found that the best supported model for predicting Swainson's warbler occupancy for litter samples ($\omega_i = 0.9431$) and pitfall traps ($\omega_i = 0.5800$) was a model with a positive relationship with cane stems and total canopy cover. Also, within litter samples ($\omega_i = 0.9999$) and pitfall traps ($\omega_i = 0.9898$), sums of the AIC_c weights showed that collectively habitat variables were better single variable predictors of Swainson's warbler occupancy than arthropod variables ($\omega_i = 0.0507$ and $\omega_i = 0.4158$, respectively). Therefore, I must reject my first hypothesis proposed in chapter IV, which associates Swainson's warbler occupancy with a combination of high levels of cane stems, litter volume, arthropods 10–15 mm, and arthropods >15 mm in length. Rather, the model combining all of these variables was ranked the fourth best model based on litter samples and accounted for <1% of the AIC_c weights of all models considered (Table 4.3) and was the second best model in the pitfall trap analysis, which accounted for 19% of the AIC_c weights of all models considered (Table 4.9).

With linear regression models, there was considerable model selection uncertainty at WRNWR for predicting relative sample richness of arthropods, arthropod abundance, Swainson's warbler common prey, and arthropods 2–15 mm in length as separate response variables with litter sample data. A minimum of the top three models in each of these analyses all have similar AIC_c weights (Tables 4.5–4.8). However, when using habitat models to predict arthropods >10 mm in length the best supported model consisted of the coefficient of variation in understory density, which accounted for 50% of the AIC_c weights of all models considered. Overall, of the five linear regression analyses performed with litter sample data, the cane stem model was the best supported model in two analyses, CV understory model was the best supported model in two analyses, and the model containing total canopy cover, medium and large trees, and large snags was the best supported model in one analysis (Tables 4.5–4.8). Sample richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length seemed to be influenced mostly by variables such as cane stems, coefficient of variation of understory density, understory density, total canopy cover, medium and large tree, and large snags when considering litter sample data. Importantly, cane stems, understory density, total canopy cover, and medium trees had a positive relationship with arthropod richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length, while CV understory density, large trees, and large snags had an inverse relationship. This is consistent with historical records documenting the Swainson's warbler associations with bottomland forests supporting canebrakes (Meanley 1966). Other studies have documented the importance of a dense understory (Meanley 1971, Eddleman 1978, Bassett-Touchell and Stouffer 2006). Also, Peters et al. (2005) found that the more uniform the habitat, the greater density of Swainson's warblers present.

The mature forest model, which contained total canopy cover, medium and large trees, and large snags, received considerable support relative to the others predicting arthropod abundance, common prey, and arthropods 2–15 mm in length in the pitfall trap analysis (Tables 4.11–4.13). However, there was model selection uncertainty when predicting sample richness and arthropods >10 mm in length with pitfall trap data, as the top two models in each analysis had similar AIC_c weights (Table 4.14). Overall, of the five linear regression analyses performed with pitfall trap data, the litter volume model was the best supported model in only one analysis, CV understory density model was the best supported model in only one analysis, and the model containing total canopy cover, medium and large trees, and large snags was the best supported model in three analyses (Tables 4.10–4.14). Sample richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length seemed to be influenced mostly by variables such as total canopy cover, medium and large trees, and large snags, as well as stem variables, litter volume, and understory density variables when considering pitfall trap data. Total canopy cover, large trees, variation in understory density, and litter volume showed a positive relationship with sample richness, arthropod abundance, common prey, arthropods 2–15 mm, and arthropods >10 mm in length in every model. Interestingly, medium trees, large snags, understory density, and all stem variables had an inverse relationship when predicting the same arthropod characteristics. These inverse relationships were not consistent with what was found in my litter sample analyses. Also, the positive relationships of large trees and variation in understory density were not consistent with litter sample data as well. My second hypothesis for chapter IV was that high arthropod abundance and richness as well as common

Swainson's warbler prey should be associated with high densities of cane stems, litter volume, and understory density, but given these inconsistencies and the presence of model selection uncertainty, I must reject this hypothesis. Although, cane stem, litter volume, and understory density variables seem to be important in predicting occupancy of Swainson's warblers and predicting arthropod community characteristics, they are not the best model for predicting arthropods when combined.

Due to the inconsistencies between litter sample and pitfall sample results in chapters III and IV, I considered the potential biases and the accuracy of these two techniques in representing the arthropod community present at WRNWR. Some of these differences may be explained by the different array of arthropods that each collecting method effectively captures. Pitfall traps are more apt to collect arthropods with no limitations in respect of size, but require the arthropods to be mobile; at least at the ground surface and thus, the true sampling area is unknown. Also, Greenslade (1964) stated that pitfall traps include the disadvantage that catches are highly variable depending on the density of the population being sampled, activity levels of the individuals, and their behavior. Because of this diversity in arthropod activity, pitfall traps will sample fewer arthropods that live directly in the leaf litter where the Swainson's warbler feeds. While litter samples are more likely to represent populations of arthropods that live extended periods of time in the leaf litter. Also, litter samples may consist of arthropods with some limitations in respect to size and mobility. Moreover, litter sample arthropods were extracted using a berlese funnel, which uses heat to push the arthropods through a funnel with wire mesh and different arthropods can tolerate different intensities of heat and a very large arthropod may be incapable of fitting through the mesh wire. Given these inconsistencies and the previously reported foraging behavior of Swainson's warblers, I suggest that litter samples may provide a more accurate representation of arthropods that are available to this species of bird. Because no known sampling method assesses prey availability in the same way that a bird does (Cooper and Whitmore 1990, Strong 2000), I opted to use these two sampling methods to better assess the full arthropod community present in my study area.

Another interesting observation was that my data clearly showed that occupied sites had greater litter depth, litter cover, and litter volume than unoccupied sites (Table 2.2), and also showed a greater abundance and diversity of arthropods in litter samples than unoccupied sites (Table 3.2). Given these findings, the abundance and diversity of arthropods seemed to be associated with the leaf litter. However, while leaf litter was an important habitat component to Swainson's warblers and ground-dwelling arthropods, this was not the only underlying determinant for the presence of arthropods (Chapter 4). Litter volume variable best predicted arthropod richness in pitfall traps, but there was also model selection uncertainty in this analysis (Table 4.10). Also, in other analyses in which litter volume was used in models to predict arthropod community characteristics, litter volume rarely accounted for a significant percentage of the total AIC_c weight of the models considered (Tables 4.4–4.8 and 4.10–4.14).

So, why was there a greater abundance and diversity of ground dwelling arthropods in Swainson's warbler habitats? One explanation may simply be elevation; Uetz et al. (1979) investigated arthropod abundance and diversity at a gradient of elevations in an Illinois floodplain and found that arthropod abundance and species richness increased with elevation above the floodplain. Given that Swainson's warblers occurred in these higher elevations of a floodplain it was logical to expect that a greater abundance and diversity of arthropods would also occur at these sites, in part, because flooding may have a negative impact on arthropod communities. However, Uetz et al.(1979) also stated there were numerous other factors in addition to flooding that likely influenced the distribution of arthropods (e.g., litter energy content, litter habitat space, soil moisture, and soil surface temperatures). Furthermore, Bultman and Uetz (1984) investigated the effect of structure of litter on litter-dwelling arthropods in Ohio and found that arthropod abundances increased with the structural complexity of the leaf litter rather than litter depth. I did not measure litter structure complexity in my study. The structural complexity of leaf litter may also influence the arthropod richness of that area. Arthropod richness is important because it increases the probability that suitable prey items will be available to Swainson's warblers. Also, arthropod richness has a potential advantage of providing a diverse community of arthropods maturing at varying rates and times, thus a more consistent supply of food for warblers than an area of low arthropod richness.

Findings from this study seem to highlight the importance of cane habitat for Swainson's warblers, which has drastically declined in the southeastern United States (Noss et al. 1995). Indeed, canebrakes have disappeared faster than any other bottomland plant community (Meanley 1971, Gagnon 2006). Less than 2% of the original population of canebrakes remains in the United States today (Noss et al. 1995). In addition to being an important understory component in bottomland hardwood forests, cane is used by a wide range of game and nongame wildlife species (Platt and Brantley 1997).

Past forest management was used to enhance habitat for common game species, and until recently managers have not focused on improving forest habitat for priority forest birds (e.g., Swainson's warbler, cerulean warbler [*Dendroica cerulea* Wilson], and swallow-tailed kite [*Elanoides forficatus* Linneaus]; U.S. Department of Agriculture 2004). Based on the results of this study and recommendations from previous studies, I suggest uneven-aged group selection timber harvests should be used to diversify canopy species while leaving several large residual trees for expanded growth. Group selection cuts should remain small to mimic natural disturbances and provide canopy gaps of sufficient size to promote dense understory development, while maintaining 60–80% canopy cover (LMVJV Forest Resource Conservation Working Group 2007a). Selectively thinning the matrices around these group selection cuts is also recommended. Further, I suggest that efforts should be made to conserve and expand existing cane habitats (e.g., Eddleman et al. 1980, Thomas et al. 1996, Graves 2001, Somershoe et al. 2003). Group selection cuts should be implemented on matrices surrounding existing canebrakes. Importantly, I suggest that efforts should be made to maintain habitat characteristics that promote a well-developed layer of leaf litter, which houses ground-dwelling arthropods. Timber harvest prescriptions should take into account the amount of leaf litter that will remain on the ground, litter complexity, and how much could accrue after the harvest. Additionally, in an effort to provide consistent litter fall from the forest canopy, even-height canopy forests should be avoided when prescribing timber harvests.

Clearcutting has been another management tool discussed in managing Swainson's warblers; however, the size and intensity of disturbances which become detrimental to cane habitat is unknown. Therefore, I suggest clearcuts should not be implemented on cane habitat at this time. However, Graves (2002) suggests small clearcuts spatially configured to serve as territorial nuclei may be an effective management strategy for Swainson's warblers that could provide early successional stands and suitable disturbance gaps in mature forests. I would advise that such clearcuts should be implemented in areas adjacent to cane habitat and the size of clearcuts should depend on the quality of habitat present at each site. Timber stands with a variety of age classes, good understory development, and a well-developed layer of leaf litter should be considered priority sites for Swainson's warbler conservation and provide benefits for other wildlife species as well. Such sites should be maintained and not receive clearcut management. Alternatively, sites where clearcuts might be employed to improve habitat experimentally for Swainson's warblers involve timber stands of intermediate age classes, little understory development, and a relatively undeveloped layer of leaf litter. Well-developed leaf litter layers would have characteristics such as >80% litter cover, >15 mm in litter depth, and have a relatively uniform distribution of leaf litter, while an underdeveloped layer of leaf litter may consist of <60% litter cover, <10 mm litter depth, and have a patchy distribution of leaf litter.

Given the uncertainty in size effects of clearcuts on Swainson's warblers, I suggest clearcuts should probably be ≤5 ha in size at this time. Clearcuts that are 5 ha in size will minimize the overall reduction of the forest area while providing fairly sizeable habitat disturbances. This management would implement a relatively-large disturbance gap that should promote shrub-level vegetation density, add vigor to adjacent cane, and provide an opportunity for existing cane habitat to increase in size. Managers at WRNWR should consider the effects of all prescribed timber harvests on cane habitat, and harvest operations should be avoided during the Swainson's warbler breeding season (1 April–31 August). However, comparative studies looking at varying sizes and intensities of group-selection cuts to small clearcuts and their long-term effects on Swainson's warblers would be very beneficial in understanding the most effective way to manage this species (Peters et al. 2005).

In addition to timber harvesting, I suggest that a rotation of small prescribed minimum-intensity fires every 10–15 years may be beneficial to cane habitat. Platt and Brantley (1997) argued that fires about once every 10 years will maintain stands of cane (Shepard et al. 1951, Hughes 1957), but fires of greater frequencies would likely have a negative impact. However, Gagnon (2006) suggested burning canebrakes every 5 to 10 years will replace weaker, older cane with vigorous new stems and that this new cane will be resistant to environmental stresses such as drought. Importantly, canebrakes under complete fire exclusion generally lose vigor and are gradually replaced by woody vegetation (Hughes 1957, 1966). While understanding that a minimum intensity fire in a bottomland hardwood forest is difficult to achieve, I suggest opportunistically timing the fire to where it is implemented during a relatively wet year and taking precautions to keep the fire at a low intensity. Platt and Brantley (1997) emphasize that if too dry, canebrakes could be seriously damaged because the high fuel loads will increase the intensity of the fire (Hughes 1957). Also, I suggest only burning areas of sparse cane density that is adjacent to the larger more dense canebrakes. This may provide an opportunity for cane to spread and increase in density. High density cane areas should not be disturbed as these habitat patches seem to provide highly suitable habitat for Swainson's warblers and other wildlife. Canebrakes can be maintained by fire because the competing woody vegetation is set back by the fire, which in turn, allows cane to get a head start on growth and to out-compete the woody vegetation. Both winter (Hughes 1957) and spring burns (Stevenson 1991) are reported to improve conditions for cane. Additionally, I suggest the planting of cane is an inefficient management effort in a bottomland forest because of the unpredictability of cane growth (Platt and Brantley 1997).

Hydrology is another management concern for Swainson's warblers. Leaf litter is affected by flooding through transportation, concentration, physical destruction, and siltation (Bell and Sipp 1975, Uetz et al. 1979) and this can negatively affect Swainson's warblers because of their foraging behavior. Also, flooding may change the structure of the arthropod community within a particular habitat and can restrict the amount of area available to Swainson's warblers to forage; thus, adversely affecting the availability of food resources to Swainson's warblers. Due to the high frequency of flooding in particular areas, Swainson's warblers may be selecting habitats of higher elevations that are inundated less frequently, and therefore, exploit a more consistent supply of ground-dwelling arthropods and a more-developed layer of leaf litter.

Even though WRNWR is a large bottomland system, many man-made structures have altered the natural flow of waters in this system. Importantly, the presence of a man-made levee system has restricted the natural flooding regime of WRNWR during high flow periods and may increase the depth of the floodwaters (Bader 2007). This increase in depth of floodwaters has resulted in the inundation of some of the higher elevations of the floodplain which were normally dry in the past. Because timing, depth, and duration of flooding in bottomland hardwood forests are major factors affecting species composition (Wharton et al. 1982), efforts should be made to control human-induced, excessive flooding. Also, some studies have shown shifts in plant species composition from the less water-tolerant species to the more water-tolerant species and also the thinning of the understory vegetation density when frequent and excessive flooding occurs (e.g., Malecki et al. 1983; Karr et al. 1990; King 1994, 1995). This flooding of higher elevational areas in a floodplain decreases the available habitat for many terrestrial-feeding species that rely on ground-dwelling arthropods as a food source. Also, this flooding is probably detrimental to the arthropod–litter association needed by Swainson's warblers and probably other understory-associated species. These altered hydrological conditions may result in the degradation of habitat and this is true of many bottomland habitat remnants. Water levels on WRNWR should be managed (to the extent possible) to keep the magnitude and duration of flooding similar to the natural cycle, in an effort to keep the existing leaf litter from washing away. Monitoring water gauge readings in or adjacent to occupied Swainson's warbler areas to determine levels of flooding would assist in minimizing flooding by allowing for the management of water control structures. Such monitoring could be used to determine appropriate flood levels that would not destroy Swainson's warbler habitat and allow for the management of water to minimize damage to the habitat.

Graves (2001) suggests that abandonment of a particular area by Swainson's warblers is stimulated by the inundation of leaf litter, which is a critical foraging resource, and nest sites. Also, Platt and Brantley (1997) suggested that persistent floods could become detrimental to canebrakes because they cannot withstand long, intensive flooding. Moreover, management of low-elevation areas have been a priority while higher elevation bottomland sites have been overlooked (LMVJV Forest Resource Conservation Working Group 2007b). Likewise, cane is generally found on the higher elevations of a bottomland forest (Gagnon 2006) and this is where most conversion to agriculture occurs (Twedt and Loesch 1999, LMVJV Forest Resource Conservation Working Group 2007b). Therefore, I suggest these higher elevations of a bottomland forest be given priority for future conservation and management.

I propose the establishment of a permanent monitoring system on the refuge to document Swainson's warbler use of cane habitat versus shrub thickets and movements between the two habitats. I suggest establishing permanent monitoring sites before a prescribed timber harvest in canebrakes and in adjacent areas and re-evaluating these sites the following year after harvest and every 3 years thereafter. These surveys will provide invaluable before-and-after data on ensuing timber harvests and allow for the detection of shifts in Swainson's warbler habitat use. I have provided a base-line of data on occupied and unoccupied locations in 2004 and 2005 in Appendix A (also see Brown and Bednarz 2007). Studies on the occupancy of different habitat types such as bottomland hardwood forests with and without cane present, commercial pine forests, and rhododendron thickets at different aged timber stands would also provide informative data on use by Swainson's warblers.

Further, I suggest that comparative studies investigating relationships of Swainson's warbler abundance and reproductive success with arthropod availability between different habitats are needed to determine if there is a relationship and what that affect is on the Swainson's warbler population. Further investigations of the diet of Swainson's warblers should be pursued to obtain a more in-depth understanding of arthropods selected related to the available arthropods in the litter layer and in various habitats. To investigate how important of a selection factor that arthropod abundance and richness is, it would be interesting to see if the abundance of arthropods varied between habitat types and if occupied sites were consistently higher in abundance and richness than unoccupied sites in other habitat types not considered in my study. Lastly, I suggest that studies that document responses of arthropod communities to disturbances such as fire and timber harvests in a bottomland forest are needed to document if management practices are in fact benefiting or adversely impacting Swainson's warbler populations.

LITERATURE CITED

Bader, T. J. 2007. Reproductive success, causes of nesting failures, and habitat use of Swallow-tailed and Mississippi Kites in the White River National Wildlife Refuge, Arkansas. Thesis, Arkansas State University, Jonesboro, Arkansas, USA.

Barrow, W. C. 1990. Ecology of small insectivorous birds in a bottomland hardwood forest. Dissertation, Louisiana State University, Baton Rouge, Louisiana, USA.

Bassett-Touchell, C. A., and P. C. Stouffer. 2006. Habitat selection by Swainson's warblers breeding in loblolly pine plantations in southeastern Louisiana. Journal of Wildlife Management 70:1013–1019.

Bednarz, J. C., P. Stiller-Krehel, and B. Cannon. 2005. Distribution and habitat use of Swainson's warblers in eastern and northern Arkansas. Pages 576–588 *in* Ralph, C. J., and T. D. Rich, editors. Bird Conservation Implementation and Integration in the Americas: Proceedings of the Third International Partners in Flight Conference. U.S. Forest Service General Technical Report PSW-GTR-191. U.S. Department of Agriculture, Pacific Southwest Research Station, Albany, California, USA.

Bell, D. T., and S. K. Sipp. 1975. The litter stratum in the streamside forest ecosystem. Oikos 26:391–397.

Brewster, W. 1885. Swainson's warbler. Auk 2:65–80.

Brown, J. D., and J. C. Bednarz. 2007. Arthropod communities and vegetation characteristics associated with habitat occupancy by Swainson's warblers at the White River National Wildlife Refuge, Arkansas. Final Research Report. St. Charles, Arkansas, USA.

Bultman, T. L., G. W. Uetz, and A. R. Brady. 1982. A comparison of cursorial spider communities along a successional gradient. Journal Arachnology 10:23–34.

Bultman, T. L., and G. W. Uetz. 1984. Effect of structure and nutritional quality of litter on abundances of litter-dwelling arthropods. American Midland Naturalist 111:165–172.

Cooper, R. J., and R. C. Whitmore. 1990. Arthropod sampling methods in ornithology. Pages 29–37 *in* M. L. Morrison, C. J. Ralph, J. Verner, and J. R. Jehl, Jr., editors. Avian foraging: Theory, methodology, and applications. Proceedings of an international symposium of the Cooper Ornithological Society. Studies in Avian Biology No. 13. Cooper Ornithological Society, Lawrence, Kansas, USA.

Eaton, S. W. 1953. Wood warblers wintering in Cuba. Wilson Bulletin. 65:169–174.

Eddleman, W. R. 1978. Selection and management of Swainson's warbler habitat. Thesis, University of Missouri, Columbia, Missouri, USA.

Eddleman, W. R., K. E. Evans, and W. H. Elder. 1980. Habitat characteristics and management of Swainson's warblers in southern Illinois. Wildlife Society Bulletin 8:228–233.

Gagnon, P. R. 2006. Population biology and disturbance ecology of a native North American bamboo (*Arundinaria gigantea*). Dissertation, Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisiana, USA.

Graves, G. R. 1998. Stereotyped foraging behavior of the Swainson's warbler. Journal of Field Ornithology 69:121–127.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in Great Dismal Swamp. Auk 118:650–664.

Graves, G. R. 2002. Habitat characteristics in the core breeding range of the Swainson's warbler. Wilson Bulletin 114:210–220.

Greenslade, P. J. M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). Journal of Animal Ecology 33:301–310.

Howell, A. H. 1928. Birds of Alabama. Department of Game and Fisheries of Alabama. Birmingham, Alabama, USA.

Hughes, R. H. 1957. Response of cane to burning in the North Carolina coastal plain. North Carolina Agricultural Experiment Station, Technical Bulletin 402.

Hughes, R. H. 1966. Fire ecology of canebrakes. Proceedings of the Tall Timbers Fire Ecology Conference. 5:149–158.

Karr, B. L., G. L. Young, J. D. Hodges, B. D. Leopold, and R. M. Kaminski. 1990. Effect of flooding on green-tree reservoirs. Technical Completion Report G1571–03. U.S. Department of the Interior, Washington, D.C., USA.

King, S. L. 1994. The effects of flooding regimes and green-tree reservoir management on succession of bottomland hardwoods. Dissertation, Texas A&M University, College Station, Texas, USA.

King, S. L. 1995. Effects of flooding regimes on two impounded bottomland hardwood stands. Wetlands 15:272–284.

LMVJV Forest Resource Conservation Working Group. 2007a. Management of Bottomland Hardwood Forests. Pages 20–28 *in* R. Wilson, K. Ribbeck, S. King, and D. Twedt, editors. Restoration, management, and monitoring of forest resources in the Mississippi alluvial valley: recommendations for enhancing wildlife habitat. Lower Mississippi Valley Joint Venture, Vicksburg, Mississippi, USA.

LMVJV Forest Resource Conservation Working Group. 2007b. Restoration of Bottomland Hardwood Forests. Pages 29–38 *in* R. Wilson, K. Ribbeck, S. King, and D. Twedt, editors. Restoration, management, and monitoring of forest resources in the Mississippi alluvial valley: recommendations for enhancing wildlife habitat. Lower Mississippi Valley Joint Venture, Vicksburg, Mississippi, USA.

Malecki, R. A., J. R. Lassoie, E. Rieger, and T. Seamans. 1983. Effects of long-term artificial flooding on a northern bottomland hardwood community. Forest Science 29:535–544.

Meanley, B. 1966. Some observations on habitats of the Swainson's warbler. Living Bird 5:151–165.

Meanley, B. 1970. Method of searching for food by the Swainson's warbler. Wilson Bulletin 82:228.

Meanley, B. 1971. Natural history of the Swainson's warbler. North American Fauna 69. U.S. Department of Interior, Washington, D.C., USA.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. Biological Report 28. National Biological Service, Washington, D.C., USA.

Peters, K. A. 1999. Swainson's warbler (*Limnothlypis swainsonii*) habitat selection in a managed bottomland hardwood forest in South Carolina. Thesis, North Carolina State University, Raleigh, USA.

Peters, K. A., R. A. Lancia, and J. A. Gerwin. 2005. Swainson's warbler habitat selection in a managed bottomland hardwood forest. Journal of Wildlife Management 69:409–417.

Platt, S. G., and C. G. Brantley. 1997. Canebrakes: An ecological and historical perspective. Castanea 62:8–21.

Seastedt, T. R., and D. A. Crossley, Jr. 1981. Microarthropod response following cable logging and clear-cutting in the southern Appalachians. Ecology 62:126–135.

Shepard, W. O., E. U. Dillard, and H. L. Lucas. 1951. Grazing and fire influences in pond pine forests. North Carolina Agricultural Experiment Station, Technical Bulletin 97.

Somershoe, S. G., S. P. Hudman, and C. R. Chandler. 2003. Habitat use by Swainson's warblers in a managed bottomland forest. Wilson Bulletin 115:148–154.

Stevenson, J. A. 1991. Shift to lightning-season burns aids pineland restoration in Florida. Restoration and Management Notes 9:113–114.

Strong, A. M. 2000. Divergent foraging strategies of two neotropical migrant warblers: implications for winter habitat use. The Auk 117:381–392.

Thomas, B. G., E. P. Wiggers, and R. L. Clawson. 1996. Habitat selection and breeding status of Swainson's warblers in southern Missouri. Journal of Wildlife Management 60:611–616.

Thompson, J. L. 2005. Breeding biology of Swainson's warblers in a managed South Carolina bottomland forest. Thesis, North Carolina State University, Raleigh, North Carolina, USA.

Twedt, D. J., and C. R. Loesch. 1999. Forest area and distribution in the Mississippi Alluvial Valley: implications for breeding bird conservation. Journal of Biogeography 26:1215–1224.

Uetz, G. W. 1976. Gradient analysis of spider communities in a stream-side forest. Oecologia 22:373–385.

Uetz, G. W., K. L. Van Der Laan, G. F. Summers, P. A. K. Gibson, and L. L. Getz. 1979. The effects of flooding on floodplain arthropod distribution, abundance, and community structure. American Midland Naturalist 101:286–299.

United States Department of Agriculture. 2004. Wetlands reserve program forest land compatible use guidelines. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, D.C., USA.

Wharton, C. H., W. M. Kitchen, E. C. Pendleton, and T. W. Sipe. 1982. The ecology of bottomland hardwood swamps of the southeast: a community profile. FWS/OBS-81/37. U.S. Fish and Wildlife Service, Washington, D.C., USA.

Wright, E. A. 2002. Breeding population density and habitat use of Swainson's warblers in a Georgia floodplain forest. Thesis, University of Georgia, Athens, Georgia, USA.

Appendix A. Broadcast survey results for Swainson's warblers in 2004 and 2005 at White River National Wildlife Refuge. Coordinates are in NAD 83 zone 15.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Red Cat Lake	1T21P10	19-May-05	No Response	15S 0655048	3833554
Red Cat Lake	1T28P1	19-May-05	No Response	15S 0653242	3832139
Red Cat Lake	1T28P8	19-May-05	No Response	15S 0655446	3832136
Alligator Lake	AL10P10	30-Apr-04	No Response	15S 0675350	3769648
Alligator Lake	AL10P11	29-Apr-04	No Response	15S 0674548	3769647
Alligator Lake	AL10P11	28-Apr-05	No Response	15S 0674548	3769647
Alligator Lake	AL10P12	29-Apr-04	No Response	15S 0674348	3769647
Alligator Lake	AL10P12	28-Apr-05	No Response	15S 0674348	3769647
Alligator Lake	AL10P13	29-Apr-04	No Response	15S 0674148	3769646
Alligator Lake	AL10P13	28-Apr-05	No Response	15S 0674148	3769646
Alligator Lake	AL10P17	24-Apr-04	No Response	15S 0673348	3769646
Alligator Lake	AL11P10	29-Apr-04	No Response	15S 0675149	3769851
Alligator Lake	AL11P10	28-Apr-05	No Response	15S 0675149	3769851
Alligator Lake	AL11P11	29-Apr-04	No Response	15S 0674949	3769851
Alligator Lake	AL11P11	28-Apr-05	No Response	15S 0674949	3769851
Alligator Lake	AL10P2	25-Apr-04	No Response	15S 0676953	3769652
Alligator Lake	AL10P2	17-Apr-05	No Response	15S 0676953	3769652
Alligator Lake	AL10P3	25-Apr-04	No Response	15S 0676753	3769651
Alligator Lake	AL10P3	17-Apr-05	No Response	15S 0676753	3769651
Alligator Lake	AL11P1	25-Apr-04	No Response	15S 0677153	3769852
Alligator Lake	AL11P1	17-Apr-05	No Response	15S 0677153	3769852
Alligator Lake	AL11P2	25-Apr-04	No Response	15S 0676953	3769852
Alligator Lake	AL11P2	17-Apr-05	No Response	15S 0676953	3769852
Alligator Lake	AL11P3	25-Apr-04	No Response	15S 0676752	3769852
Alligator Lake	AL11P3	17-Apr-05	No Response	15S 0676752	3769852
Alligator Lake	AL12P2	25-Apr-04	No Response	15S 0676953	3770079
Alligator Lake	AL12P2	30-Apr-05	No Response	15S 0676953	3770079
Alligator Lake	AL12P3	25-Apr-04	No Response	15S 0676752	3770078
Alligator Lake	AL12P3	30-Apr-05	No Response	15S 0676752	3770078
Alligator Lake	AL12P9	29-Apr-04	No Response	15S 0675350	3770075
Alligator Lake	AL12P9	28-Apr-05	No Response	15S 0675350	3770075
Alligator Lake	AL13P2	25-Apr-04	No Response	15S 0676952	3770279
Alligator Lake	AL13P2	30-Apr-05	No Response	15S 0676952	3770279
Alligator Lake	AL13P3	25-Apr-04	No Response	15S 0676752	3770279
Alligator Lake	AL13P3	30-Apr-05	No Response	15S 0676752	3770279
Alligator Lake	AL15P1	24-Apr-04	No Response	15S 0677153	3770705
Alligator Lake	AL15P1	30-Apr-05	No Response	15S 0677153	3770705
Alligator Lake	AL16	30-Apr-04	No Response	15S 0677146	3770930
Alligator Lake	AL16	30-Apr-05	No Response	15S 0677146	3770930
Alligator Lake	AL17	30-Apr-04	No Response	15S 0676946	3770931
Alligator Lake	AL17	30-Apr-05	No Response	15S 0676946	3770931
Alligator Lake	AL18	30-Apr-04	No Response	15S 0677147	3771131
Alligator Lake	AL18	30-Apr-05	No Response	15S 0677147	3771131
Alligator Lake	AL19	30-Apr-04	No Response	15S 0676947	3771131
Alligator Lake	AL19	30-Apr-05	No Response	15S 0676947	3771131
Alligator Lake	AL1P1	27-Apr-04	No Response	15S 0677141	3767750
Alligator Lake	AL1P10	28-Apr-04	No Response	15S 0675350	3767706
Alligator Lake	AL1P11	28-Apr-04	No Response	15S 0675149	3767706
Alligator Lake	AL1P14	20-Apr-04	No Response	15S 0674348	3767708
Alligator Lake	AL1P14	1-May-05	No Response	15S 0674348	3767708
Alligator Lake	AL1P15	20-Apr-04	No Response	15S 0674148	3767707
Alligator Lake	AL1P15	1-May-05	No Response	15S 0674148	3767707

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	AL1P16	20-Apr-04	No Response	15S 0673947	3767707
Alligator Lake	AL1P17	20-Apr-04	No Response	15S 0673747	3767707
Alligator Lake	AL1P18	20-Apr-04	No Response	15S 0673547	3767707
Alligator Lake	AL1P19	23-Apr-04	No Response	15S 0673346	3767706
Alligator Lake	AL1P2	27-Apr-04	No Response	15S 0676950	3767746
Alligator Lake	AL1P20	23-Apr-04	No Response	15S 0673145	3767706
Alligator Lake	AL1P22	23-Apr-04	No Response	15S 0672745	3767706
Alligator Lake	AL1P23	23-Apr-04	No Response	15S 0672545	3767706
Alligator Lake	AL1P24	23-Apr-04	No Response	15S 0672344	3767707
Alligator Lake	AL1P26	23-Apr-04	No Response	15S 0671944	3767707
Alligator Lake	AL1P27	23-Apr-04	No Response	15S 0671744	3767707
Alligator Lake	AL1P3	27-Apr-04	No Response	15S 0676749	3767742
Alligator Lake	AL1P4	28-Apr-04	No Response	15S 0676548	3767748
Alligator Lake	AL1P5	28-Apr-04	No Response	15S 0676357	3767740
Alligator Lake	AL1P6	28-Apr-04	No Response	15S 0676151	3767706
Alligator Lake	AL1P7	28-Apr-04	No Response	15S 0675951	3767706
Alligator Lake	AL1P8	28-Apr-04	No Response	15S 0675751	3767706
Alligator Lake	AL1P9	28-Apr-04	No Response	15S 0675550	3767706
Alligator Lake	AL21	30-Apr-04	No Response	15S 0677150	3771555
Alligator Lake	AL21	30-Apr-05	No Response	15S 0677150	3771555
Alligator Lake	AL23	30-Apr-04	No Response	15S 0677152	3771980
Alligator Lake	AL23	29-Apr-05	No Response	15S 0677152	3771980
Alligator Lake	AL24	30-Apr-04	No Response	15S 0677152	3772205
Alligator Lake	AL24	29-Apr-05	No Response	15S 0677152	3772205
Alligator Lake	AL25	30-Apr-04	No Response	15S 0677152	3772405
Alligator Lake	AL25	29-Apr-05	No Response	15S 0677152	3772405
Alligator Lake	AL26	30-Apr-04	No Response	15S 0675348	3774542
Alligator Lake	AL2P1	27-Apr-04	No Response	15S 0677155	3767940
Alligator Lake	AL2P10	18-Apr-04	No Response	15S 0675150	3767935
Alligator Lake	AL2P10	1-May-05	No Response	15S 0675150	3767935
Alligator Lake	AL2P13	18-Apr-04	No Response	15S 0674547	3767939
Alligator Lake	AL2P13	1-May-05	No Response	15S 0674547	3767939
Alligator Lake	AL2P14	18-Apr-04	No Response	15S 0674349	3767936
Alligator Lake	AL2P14	1-May-05	No Response	15S 0674349	3767936
Alligator Lake	AL2P15	20-Apr-04	No Response	15S 0674149	3767932
Alligator Lake	AL2P15	1-May-05	No Response	15S 0674149	3767932
Alligator Lake	AL2P16	20-Apr-04	No Response	15S 0673947	3767932
Alligator Lake	AL2P17	20-Apr-04	No Response	15S 0673747	3767932
Alligator Lake	AL2P18	20-Apr-04	No Response	15S 0673547	3767932
Alligator Lake	AL2P19	23-Apr-04	No Response	15S 0673346	3767931
Alligator Lake	AL2P2	27-Apr-04	No Response	15S 0676953	3767939
Alligator Lake	AL2P20	23-Apr-04	No Response	15S 0673146	3767931
Alligator Lake	AL2P21	23-Apr-04	No Response	15S 0672946	3767931
Alligator Lake	AL2P22	23-Apr-04	No Response	15S 0672746	3767931
Alligator Lake	AL2P23	23-Apr-04	No Response	15S 0672546	3767931
Alligator Lake	AL2P24	23-Apr-04	No Response	15S 0672346	3767931
Alligator Lake	AL2P25	23-Apr-04	No Response	15S 0672146	3767931
Alligator Lake	AL2P26	23-Apr-04	No Response	15S 0671946	3767931
Alligator Lake	AL2P27	23-Apr-04	No Response	15S 0671746	3767931
Alligator Lake	AL2P28	23-Apr-04	No Response	15S 0671546	3767931
Alligator Lake	AL2P3	27-Apr-04	No Response	15S 0676753	3767938
Alligator Lake	AL2P3	16-Apr-05	No Response	15S 0676753	3767938
Alligator Lake	AL2P6	28-Apr-04	No Response	15S 0676152	3767937

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	AL2P7	28-Apr-04	No Response	15S 0675951	3767937
Alligator Lake	AL2P8	28-Apr-04	No Response	15S 0675751	3767936
Alligator Lake	AL30	17-May-04	No Response	15S 0677353	3771356
Alligator Lake	AL30	30-Apr-05	No Response	15S 0677353	3771356
Alligator Lake	AL31	17-May-04	No Response	15S 0677353	3771555
Alligator Lake	AL31	30-Apr-05	No Response	15S 0677353	3771555
Alligator Lake	AL35	17-May-04	No Response	15S 0677352	3772405
Alligator Lake	AL35	29-Apr-05	No Response	15S 0677352	3772405
Alligator Lake	AL37	16-May-04	No Response	15S 0677354	3772880
Alligator Lake	AL37	29-Apr-05	No Response	15S 0677354	3772880
Alligator Lake	AL38	16-May-04	No Response	15S 0677354	3773079
Alligator Lake	AL39	16-May-04	No Response	15S 0677354	3773279
Alligator Lake	AL3P1	27-Apr-04	No Response	15S 0677153	3768144
Alligator Lake	AL3P1	17-Apr-05	No Response	15S 0677153	3768144
Alligator Lake	AL3P10	18-Apr-04	No Response	15S 0675150	3768144
Alligator Lake	AL3P10	1-May-05	No Response	15S 0675150	3768144
Alligator Lake	AL3P11	18-Apr-04	No Response	15S 0674950	3768144
Alligator Lake	AL3P15	20-Apr-04	No Response	15S 0674146	3768145
Alligator Lake	AL3P15	23-Apr-05	No Response	15S 0674146	3768145
Alligator Lake	AL3P16	20-Apr-04	No Response	15S 0673948	3768145
Alligator Lake	AL3P16	23-Apr-05	No Response	15S 0673948	3768145
Alligator Lake	AL3P17	20-Apr-04	No Response	15S 0673748	3768145
Alligator Lake	AL3P17	23-Apr-05	No Response	15S 0673748	3768145
Alligator Lake	AL3P18	20-Apr-04	No Response	15S 0673546	3768145
Alligator Lake	AL3P18	23-Apr-05	No Response	15S 0673546	3768145
Alligator Lake	AL3P19	23-Apr-04	No Response	15S 0673346	3768144
Alligator Lake	AL3P19	24-Apr-05	No Response	15S 0673346	3768144
Alligator Lake	AL3P2	27-Apr-04	No Response	15S 0676953	3768144
Alligator Lake	AL3P2	17-Apr-05	No Response	15S 0676953	3768144
Alligator Lake	AL3P20	23-Apr-04	No Response	15S 0673146	3768144
Alligator Lake	AL3P20	24-Apr-05	No Response	15S 0673146	3768144
Alligator Lake	AL3P21	23-Apr-04	No Response	15S 0672946	3768144
Alligator Lake	AL3P22	23-Apr-04	No Response	15S 0672746	3768144
Alligator Lake	AL3P23	23-Apr-04	No Response	15S 0672546	3768144
Alligator Lake	AL3P24	23-Apr-04	No Response	15S 0672346	3768144
Alligator Lake	AL3P25	23-Apr-04	No Response	15S 0672146	3768144
Alligator Lake	AL3P3	27-Apr-04	No Response	15S 0676753	3768143
Alligator Lake	AL3P3	16-Apr-05	No Response	15S 0676753	3768143
Alligator Lake	AL3P4	28-Apr-04	No Response	15S 0676552	3768143
Alligator Lake	AL3P4	16-Apr-05	No Response	15S 0676552	3768143
Alligator Lake	AL3P7	28-Apr-04	No Response	15S 0675951	3768143
Alligator Lake	AL3P9	18-Apr-04	No Response	15S 0675350	3768143
Alligator Lake	AL3P9	1-May-05	No Response	15S 0675350	3768143
Alligator Lake	AL40	16-May-04	No Response	15S 0675350	3773279
Alligator Lake	AL41	16-May-04	No Response	15S 0677554	3773079
Alligator Lake	AL42	16-May-04	No Response	15S 0677554	3772880
Alligator Lake	AL42	29-Apr-05	No Response	15S 0677554	3772880
Alligator Lake	AL4P1	27-Apr-04	No Response	15S 0677154	3768372
Alligator Lake	AL4P1	17-Apr-05	No Response	15S 0677154	3768372
Alligator Lake	AL4P10	20-Apr-04	No Response	15S 0674950	3768368
Alligator Lake	AL4P10	23-Apr-05	No Response	15S 0674950	3768368
Alligator Lake	AL4P11	20-Apr-04	No Response	15S 0674747	3768364
Alligator Lake	AL4P11	23-Apr-05	No Response	15S 0674747	3768364

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	AL4P16	20-Apr-04	No Response	15S 0673747	3768366
Alligator Lake	AL4P16	23-Apr-05	No Response	15S 0673747	3768366
Alligator Lake	AL4P17	20-Apr-04	No Response	15S 0673547	3768366
Alligator Lake	AL4P17	23-Apr-05	No Response	15S 0673547	3768366
Alligator Lake	AL4P18	23-Apr-04	No Response	15S 0673346	3768364
Alligator Lake	AL4P18	24-Apr-05	No Response	15S 0673346	3768364
Alligator Lake	AL4P21	24-Apr-04	No Response	15S 0672746	3768364
Alligator Lake	AL4P3	27-Apr-04	No Response	15S 0676753	3768371
Alligator Lake	AL4P3	16-Apr-05	No Response	15S 0676753	3768371
Alligator Lake	AL4P9	18-Apr-04	No Response	15S 0675350	3768369
Alligator Lake	AL50	17-May-04	No Response	15S 0677753	3772406
Alligator Lake	AL50	29-Apr-05	No Response	15S 0677753	3772406
Alligator Lake	AL52	16-May-04	No Response	15S 0677755	3772880
Alligator Lake	AL52	29-Apr-05	No Response	15S 0677755	3772880
Alligator Lake	AL53	16-May-04	No Response	15S 0677754	3773080
Alligator Lake	AL54	16-May-04	No Response	15S 0677754	3773280
Alligator Lake	AL55	16-May-04	No Response	15S 0677955	3773280
Alligator Lake	AL56	16-May-04	No Response	15S 0677955	3773080
Alligator Lake	AL57	16-May-04	No Response	15S 0677955	3772881
Alligator Lake	AL57	29-Apr-05	No Response	15S 0677955	3772881
Alligator Lake	AL58	16-May-04	No Response	15S 0678155	3773281
Alligator Lake	AL59	16-May-04	No Response	15S 0678155	3773081
Alligator Lake	AL5P10	21-Apr-04	No Response	15S 0674545	3768573
Alligator Lake	AL5P10	23-Apr-05	No Response	15S 0674545	3768573
Alligator Lake	AL5P12	21-Apr-04	No Response	15S 0674148	3768572
Alligator Lake	AL5P12	23-Apr-05	No Response	15S 0674148	3768572
Alligator Lake	AL5P13	21-Apr-04	No Response	15S 0673947	3768579
Alligator Lake	AL5P13	24-Apr-05	No Response	15S 0673947	3768579
Alligator Lake	AL5P14	21-Apr-04	No Response	15S 0673747	3768572
Alligator Lake	AL5P14	24-Apr-05	No Response	15S 0673747	3768572
Alligator Lake	AL5P15	21-Apr-04	No Response	15S 0673546	3768572
Alligator Lake	AL5P15	24-Apr-05	No Response	15S 0673546	3768572
Alligator Lake	AL5P17	24-Apr-04	No Response	15S 0673146	3768572
Alligator Lake	AL5P17	24-Apr-05	No Response	15S 0673146	3768572
Alligator Lake	AL5P18	24-Apr-04	No Response	15S 0672946	3768572
Alligator Lake	AL5P19	24-Apr-04	No Response	15S 0672746	3768572
Alligator Lake	AL5P3	27-Apr-04	No Response	15S 0676752	3768572
Alligator Lake	AL5P3	16-Apr-05	No Response	15S 0676752	3768572
Alligator Lake	AL5P4	28-Apr-04	No Response	15S 0676552	3768572
Alligator Lake	AL5P4	16-Apr-05	No Response	15S 0676552	3768572
Alligator Lake	AL5P8	21-Apr-04	No Response	15S 0675751	3768572
Alligator Lake	AL5P8	1-May-05	No Response	15S 0675751	3768572
Alligator Lake	AL5P9	21-Apr-04	No Response	15S 0674749	3768572
Alligator Lake	AL5P9	23-Apr-05	No Response	15S 0674749	3768572
Alligator Lake	AL6P10	21-Apr-04	No Response	15S 0673948	3768794
Alligator Lake	AL6P10	24-Apr-05	No Response	15S 0673948	3768794
Alligator Lake	AL6P11	21-Apr-04	No Response	15S 0673547	3768794
Alligator Lake	AL6P12	24-Apr-04	No Response	15S 0673346	3768793
Alligator Lake	AL6P12	24-Apr-05	No Response	15S 0673346	3768793
Alligator Lake	AL6P2	27-Apr-04	No Response	15S 0676953	3768799
Alligator Lake	AL6P2	17-Apr-05	No Response	15S 0676953	3768799
Alligator Lake	AL6P3	27-Apr-04	No Response	15S 0676753	3768799
Alligator Lake	AL6P3	16-Apr-05	No Response	15S 0676753	3768799

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	AL6P4	28-Apr-04	No Response	15S 0676552	3768799
Alligator Lake	AL6P4	16-Apr-05	No Response	15S 0676552	3768799
Alligator Lake	AL6P7	21-Apr-04	No Response	15S 0675751	3768797
Alligator Lake	AL6P7	1-May-05	No Response	15S 0675751	3768797
Alligator Lake	AL6P8	21-Apr-04	No Response	15S 0674949	3768796
Alligator Lake	AL6P9	21-Apr-04	No Response	15S 0674749	3768795
Alligator Lake	AL6P9	23-Apr-05	No Response	15S 0674749	3768795
Alligator Lake	AL7P11	21-Apr-04	No Response	15S 0674949	3769000
Alligator Lake	AL7P3	27-Apr-04	No Response	15S 0676752	3769000
Alligator Lake	AL7P3	16-Apr-05	No Response	15S 0676752	3769000
Alligator Lake	AL8P10	30-Apr-04	No Response	15S 0674949	3769223
Alligator Lake	AL8P10	28-Apr-05	No Response	15S 0674949	3769223
Alligator Lake	AL8P11	30-Apr-04	No Response	15S 0674749	3769222
Alligator Lake	AL8P11	28-Apr-05	No Response	15S 0674749	3769222
Alligator Lake	AL8P12	30-Apr-04	No Response	15S 0674549	3769222
Alligator Lake	AL8P13	30-Apr-04	No Response	15S 0674348	3769222
Alligator Lake	AL8P14	28-Apr-05	No Response	15S 0673947	3769221
Alligator Lake	AL8P15	24-Apr-04	No Response	15S 0673346	3769220
Alligator Lake	AL8P15	24-Apr-05	No Response	15S 0673346	3769220
Alligator Lake	AL8P3	25-Apr-04	No Response	15S 0676753	3769226
Alligator Lake	AL8P3	16-Apr-05	No Response	15S 0676753	3769226
Alligator Lake	AL8P8	21-Apr-04	No Response	15S 0675550	3769224
Alligator Lake	AL8P8	1-May-05	No Response	15S 0675550	3769224
Alligator Lake	AL9P10	30-Apr-04	No Response	15S 0675343	3769426
Alligator Lake	AL9P11	30-Apr-04	No Response	15S 0675149	3769426
Alligator Lake	AL9P13	30-Apr-04	No Response	15S 0674744	3769428
Alligator Lake	AL9P15	29-Apr-04	No Response	15S 0674147	3769427
Alligator Lake	AL9P15	28-Apr-05	No Response	15S 0674147	3769427
Alligator Lake	AL9P3	25-Apr-04	No Response	15S 0676752	3769427
Alligator Lake	AL9P3	16-Apr-05	No Response	15S 0676752	3769427
Alligator Lake	AL9P4	25-Apr-04	No Response	15S 0676552	3769427
Alligator Lake	AL9P4	16-Apr-05	No Response	15S 0676552	3769427
Big Island Chute	BI3	12-May-05	No Response	15S 0675490	3797987
Big Island Chute	BI4	12-May-05	No Response	15S 0675490	3797791
Big Island Chute	BI5	12-May-05	No Response	15S 0675491	3797595
Big Island Chute	BI6	12-May-05	No Response	15S 0675291	3797595
Big Island Chute	BI7	12-May-05	No Response	15S 0675291	3797397
Brushy Lake	BL1	23-May-05	No Response	15S 0661245	3819970
Brushy Lake	BL1	23-May-05	No Response	15S 0661245	3819970
Brushy Lake	BL10	23-May-05	No Response	15S 0660043	3820582
Brushy Lake	BL11	23-May-05	No Response	15S 0659843	3820582
Brushy Lake	BL2	23-May-05	No Response	15S 0661045	3819970
Brushy Lake	BL3	23-May-05	No Response	15S 0660845	3819970
Brushy Lake	BL4	23-May-05	No Response	15S 0660644	3819970
Brushy Lake	BL5	23-May-05	No Response	15S 0660444	3819970
Brushy Lake	BL6	23-May-05	No Response	15S 0660244	3820376
Brushy Lake	BL7	23-May-05	No Response	15S 0660043	3820376
Brushy Lake	BL8	23-May-05	No Response	15S 0660444	3820582
Brushy Lake	BL9	23-May-05	No Response	15S 0660243	3820582
Bear Slough	BS10	25-May-04	No Response	15S 0654651	3835994
Bear Slough	BS10	15-Jun-05	No Response	15S 0654651	3835994
Bear Slough	BS11	17-May-05	No Response	15S 0656454	3835789
Bear Slough	BS12	17-May-05	No Response	15S 0656254	3835789

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Bear Slough	BS13	17-May-05	No Response	15S 0656054	3835790
Bear Slough	BS14	25-May-04	No Response**	15S 0655252	3835791
Bear Slough	BS14	15-Jun-05	No Response	15S 0655252	3835791
Bear Slough	BS15	17-May-05	No Response	15S 0656053	3835582
Bear Slough	BS17	9-May-04	No Response**	15S 0655652	3835583
Bear Slough	BS17	15-Jun-05	No Response	15S 0655652	3835583
Bear Slough	BS18	17-May-05	No Response	15S 0656453	3835380
Bear Slough	BS19	17-May-05	No Response	15S 0656053	3835381
Bear Slough	BS2	17-May-05	No Response	15S 0656254	3835990
Bear Slough	BS20	17-May-05	No Response	15S 0655852	3835381
Bear Slough	BS21	9-May-04	No Response**	15S 0655652	3835381
Bear Slough	BS21	15-Jun-05	No Response	15S 0655652	3835381
Bear Slough	BS22	9-May-04	No Response**	15S 0655451	3835381
Bear Slough	BS22	15-Jun-05	No Response	15S 0655451	3835382
Bear Slough	BS23	9-May-04	No Response**	15S 0655251	3835382
Bear Slough	BS23	15-Jun-05	No Response	15S 0655251	3835382
Bear Slough	BS24	9-Jun-04	No Response	15S 0655051	3835382
Bear Slough	BS24	13-May-05	No Response	15S 0655051	3835382
Bear Slough	BS25	9-Jun-04	No Response	15S 0654850	3835382
Bear Slough	BS25	13-May-05	No Response	15S 0654850	3835382
Bear Slough	BS26	13-May-05	No Response	15S 0654650	3835383
Bear Slough	BS27	17-May-05	No Response	15S 0656252	3835173
Bear Slough	BS28	17-May-05	No Response	15S 0656052	3835174
Bear Slough	BS29	9-May-04	No Response**	15S 0655852	3835174
Bear Slough	BS29	15-Jun-05	No Response	15S 0655852	3835174
Bear Slough	BS3	17-May-05	No Response	15S 0656054	3835991
Bear Slough	BS30	9-Jun-04	No Response	15S 0655651	3835175
Bear Slough	BS30	15-Jun-05	No Response	15S 0655651	3835175
Bear Slough	BS31	9-May-04	No Response**	15S 0655451	3835175
Bear Slough	BS31	15-Jun-05	No Response	15S 0655451	3835175
Bear Slough	BS32	8-Jun-04	No Response**	15S 0655250	3835176
Bear Slough	BS32	13-May-05	No Response	15S 0655250	3835176
Bear Slough	BS33	8-Jun-04	No Response**	15S 0655050	3835176
Bear Slough	BS33	13-May-05	No Response	15S 0655050	3835176
Bear Slough	BS34	9-Jun-04	No Response	15S 0654649	3835177
Bear Slough	BS34	13-May-05	No Response	15S 0654649	3835177
Bear Slough	BS35	17-May-05	No Response	15S 0656452	3834971
Bear Slough	BS36	17-May-05	No Response	15S 0656052	3834972
Bear Slough	BS37	9-May-04	No Response**	15S 0655851	3834972
Bear Slough	BS37	15-Jun-05	No Response	15S 0655851	3834972
Bear Slough	BS38	9-May-04	No Response**	15S 0655651	3834972
Bear Slough	BS38	15-Jun-05	No Response	15S 0655651	3834972
Bear Slough	BS39	9-May-04	No Response**	15S 0655451	3834972
Bear Slough	BS39	15-Jun-05	No Response	15S 0655451	3834972
Bear Slough	BS4	17-May-05	No Response	15S 0655853	3835991
Bear Slough	BS40	8-Jun-04	No Response	15S 0655250	3834972
Bear Slough	BS40	13-May-05	No Response	15S 0655250	3834972
Bear Slough	BS41	13-May-05	No Response	15S 0655050	3834972
Bear Slough	BS44	17-May-05	No Response	15S 0656452	3834764
Bear Slough	BS45	17-May-05	No Response	15S 0656251	3834764
Bear Slough	BS46	17-May-05	No Response	15S 0656051	3834765
Bear Slough	BS49	19-May-04	No Response	15S 0654849	3834564
Bear Slough	BS49	13-May-05	No Response	15S 0654849	3834564

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Bear Slough	BS5	15-Jun-05	No Response	15S 0655653	3835992
Bear Slough	BS50	8-Jun-04	No Response	15S 0654848	3834362
Bear Slough	BS50	13-May-05	No Response	15S 0654848	3834362
Bear Slough	BS51	19-May-04	No Response	15S 0654649	3834767
Bear Slough	BS6	15-Jun-05	No Response	15S 0655453	3835992
Bear Slough	BS7	25-May-04	No Response	15S 0655252	3835993
Bear Slough	BS7	15-Jun-05	No Response	15S 0655252	3835993
Bear Slough	BS8	25-May-04	No Response	15S 0655052	3835993
Bear Slough	BS8	15-Jun-05	No Response	15S 0655052	3835993
Bear Slough	BS9	25-May-04	No Response	15S 0654852	3835994
Bear Slough	BS9	15-Jun-05	No Response	15S 0654852	3835994
Brown Shanty Lake	BSL1	10-Jun-05	No Response	15S 0667860	3813390
Brown Shanty Lake	BSL10	10-Jun-05	No Response	15S 0668460	3813589
Brown Shanty Lake	BSL11	10-Jun-05	No Response	15S 0668860	3812150
Brown Shanty Lake	BSL12	10-Jun-05	No Response	15S 0669060	3812150
Brown Shanty Lake	BSL13	10-Jun-05	No Response	15S 0669260	3812150
Brown Shanty Lake	BSL14	10-Jun-05	No Response	15S 0669460	3812150
Brown Shanty Lake	BSL15	10-Jun-05	No Response	15S 0669460	3811950
Brown Shanty Lake	BSL16	10-Jun-05	No Response	15S 0669260	3811940
Brown Shanty Lake	BSL17	10-Jun-05	No Response	15S 0669060	3812350
Brown Shanty Lake	BSL18	10-Jun-05	No Response	15S 0669260	3812350
Brown Shanty Lake	BSL2	10-Jun-05	No Response	15S 0668060	3813390
Brown Shanty Lake	BSL3	10-Jun-05	No Response	15S 0668260	3813390
Brown Shanty Lake	BSL4	10-Jun-05	No Response	15S 0668460	3813390
Brown Shanty Lake	BSL5	10-Jun-05	No Response	15S 0668660	3813190
Brown Shanty Lake	BSL6	10-Jun-05	No Response	15S 0667860	3813190
Brown Shanty Lake	BSL7	10-Jun-05	No Response	15S 0668060	3813190
Brown Shanty Lake	BSL8	10-Jun-05	No Response	15S 0668260	3813190
Brown Shanty Lake	BSL9	10-Jun-05	No Response	15S 0668460	3813190
Crooked Lakes	CL1P2	27-May-04	No Response	15S 0657240	3825692
Crooked Lakes	CL1P2	15-May-05	No Response	15S 0657240	3825692
Crooked Lakes	CL1P3	27-May-04	No Response**	15S 0657841	3825692
Crooked Lakes	CL2P1	27-May-04	No Response	15S 0657040	3825492
Crooked Lakes	CL2P1	15-May-05	No Response	15S 0657040	3825492
Crooked Lakes	CL2P3	27-May-04	No Response	15S 0657440	3825492
Crooked Lakes	CL2P4	27-May-04	No Response	15S 0657641	3825491
Crooked Lakes	CL2P6	27-May-04	No Response	15S 0658843	3825489
Crooked Lakes	CL3P2	27-May-04	No Response	15S 0657040	3825279
Crooked Lakes	CL3P2	15-May-05	No Response	15S 0657040	3825279
Crooked Lakes	CL3P3	27-May-04	No Response	15S 0657240	3825279
Crooked Lakes	CL3P3	15-May-05	No Response	15S 0657240	3825279
Crooked Lakes	CL3P4	27-May-04	No Response**	15S 0657440	3825279
Crooked Lakes	CL3P4	15-May-05	No Response	15S 0657440	3825279
Crooked Lakes	CL4P1	31-May-04	No Response	15S 0656839	3825080
Crooked Lakes	CL4P1	15-May-05	No Response	15S 0656839	3825080
Crooked Lakes	CL4P2	31-May-04	No Response	15S 0657039	3825080
Crooked Lakes	CL4P2	15-May-05	No Response	15S 0657039	3825079
Crooked Lakes	CL4P3	15-May-05	No Response	15S 0657240	3825079
Crooked Lakes	CL4P4	15-May-05	No Response	15S 0657440	3825070
Crooked Lakes	CL5P1	31-May-04	No Response	15S 0656839	3824867
Crooked Lakes	CL5P1	15-May-05	No Response	15S 0656839	3824867
Crooked Lakes	CL5P2	31-May-05	No Response**	15S 0657040	3824867
Crooked Lakes	CL5P2	15-May-05	No Response	15S 0657040	3824867

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Crooked Lakes	CL5P3	15-May-05	No Response	15S 0657240	3824867
Crooked Lakes	CL5P4	15-May-05	No Response	15S 0657440	3824867
Crooked Lakes	CL5P5	15-May-05	No Response	15S 0657641	3824867
Crooked Lakes	CL6P1	29-May-04	No Response**	15S 0656839	3824667
Crooked Lakes	CL6P1	18-May-05	No Response	15S 0656839	3824667
Crooked Lakes	CL6P2	29-May-04	No Response**	15S 0657039	3824667
Crooked Lakes	CL6P2	18-May-05	No Response	15S 0657039	3824667
Crooked Lakes	CL6P3	18-May-05	No Response	15S 0657240	3824667
Crooked Lakes	CL6P4	18-May-05	No Response	15S 0657440	3824666
Crooked Lakes	CL6P5	18-May-05	No Response	15S 0657640	3824666
Crooked Lakes	CL6P6	18-May-05	No Response	15S 0657841	3824666
Crooked Lakes	CL7P1	29-May-04	No Response**	15S 0656639	3824454
Crooked Lakes	CL7P1	18-May-05	No Response	15S 0656639	3824454
Crooked Lakes	CL7P10	29-May-04	No Response**	15S 0658442	3824454
Crooked Lakes	CL7P2	18-May-05	No Response	15S 0656839	3824454
Crooked Lakes	CL7P3	29-May-04	No Response	15S 0657039	3824454
Crooked Lakes	CL7P3	18-May-05	No Response	15S 0657039	3824454
Crooked Lakes	CL7P4	29-May-04	No Response**	15S 0657240	3824454
Crooked Lakes	CL7P4	18-May-05	No Response	15S 0657240	3824454
Crooked Lakes	CL7P5	29-May-04	No Response	15S 0657440	3824454
Crooked Lakes	CL7P5	18-May-05	No Response	15S 0657440	3824454
Crooked Lakes	CL7P6	29-May-04	No Response	15S 0657640	3824454
Crooked Lakes	CL7P6	18-May-05	No Response	15S 0657640	3824454
Crooked Lakes	CL8P1	27-May-05	No Response**	15S 0656839	3824254
Crooked Lakes	CL8P1	18-May-05	No Response	15S 0656839	3824254
Crooked Lakes	CL8P2	29-May-04	No Response**	15S 0657039	3824254
Crooked Lakes	CL8P2	18-May-05	No Response	15S 0657039	3824253
Crooked Lakes	CL8P3	29-May-04	No Response	15S 0657239	3824253
Crooked Lakes	CL8P3	18-May-05	No Response	15S 0657239	3824253
Crooked Lakes	CL8P4	29-May-04	No Response**	15S 0657440	3824253
Crooked Lakes	CL8P4	18-May-05	No Response	15S 0657440	3824253
Crooked Lakes	CL8P5	29-May-04	No Response	15S 0657640	3824253
Crooked Lakes	CL8P5	18-May-05	No Response	15S 0657640	3824253
Crooked Lakes	CL9P5	31-May-05	No Response**	15S 0659444	3824041
Crooked Lakes	CL9P6	31-May-05	No Response**	15S 0659644	3824041
Crooked Lakes	CL9P7	31-May-05	No Response**	15S 0659844	3824042
Crooked Lakes	CL9P8	31-May-04	No Response	15S 0660045	3824042
Coon Point	CP1	16-May-05	No Response	15S 0678493	3799358
Coon Point	CP2	16-May-05	No Response	15S 0678693	3799359
Coon Point	CP3	16-May-05	No Response	15S 0678894	3799360
Coon Point	CP4	16-May-05	No Response	15S 0679094	3799360
Coon Point	CP5	16-May-05	No Response	15S 0679294	3799361
Coon Point	CP6	16-May-05	No Response	15S 0679294	3799550
Coon Point	CP7	16-May-05	No Response	15S 0679494	3799748
Coon Point	CP8	16-May-05	No Response	15S 0679494	3799937
Dry Lake	DL1	5-May-04	No Response	15S 0668133	3776694
Dry Lake	DL2	5-May-04	No Response	15S 0667933	3776694
Dry Lake	DL3	5-May-04	No Response	15S 0667933	3776899
Dry Lake	DL4	5-May-04	No Response	15S 0668133	3776900
Dry Lake	DL5	5-May-04	No Response	15S 0668133	3777120
Dry Lake	DL6	5-May-04	No Response	15S 0668333	3777120
Dry Lake	DL7	5-May-04	No Response	15S 0668133	3777326
Dead Man's Point	DM1	2-Jun-04	No Response	15S 0654657	3838617

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Dead Man's Point	DM1	5-May-05	No Response	15S 0654657	3838617
Dead Man's Point	DM10	2-Jun-04	No Response	15S 0654656	3838016
Dead Man's Point	DM10	5-May-05	No Response	15S 0654656	3838016
Dead Man's Point	DM14	2-Jun-04	No Response	15S 0654456	3837817
Dead Man's Point	DM14	5-May-05	No Response	15S 0654456	3837817
Dead Man's Point	DM16	2-Jun-04	No Response	15S 0654855	3837816
Dead Man's Point	DM16	5-May-05	No Response	15S 0654855	3837816
Dead Man's Point	DM2	5-May-05	No Response	15S 0654657	3838416
Dead Man's Point	DM20	6-May-05	No Response	15S 0654855	3837414
Dead Man's Point	DM20	5-May-05	No Response	15S 0654856	3837414
Dead Man's Point	DM21	21-May-04	No Response	15S 0655056	3837414
Dead Man's Point	DM21	6-May-05	No Response	15S 0655056	3837414
Dead Man's Point	DM22	21-May-04	No Response**	15S 0655256	3837414
Dead Man's Point	DM22	6-May-05	No Response	15S 0655256	3837414
Dead Man's Point	DM26	21-May-04	No Response	15S 0655055	3837212
Dead Man's Point	DM26	10-May-05	No Response	15S 0655055	3837212
Dead Man's Point	DM27	21-May-04	No Response**	15S 0655256	3837211
Dead Man's Point	DM27	10-May-05	No Response	15S 0655256	3837211
Dead Man's Point	DM28	21-May-04	No Response**	15S 0655055	3837011
Dead Man's Point	DM28	10-May-05	No Response	15S 0655055	3837011
Dead Man's Point	DM29	21-May-04	No Response	15S 0655255	3837011
Dead Man's Point	DM29	10-May-05	No Response	15S 0655255	3837011
Dead Man's Point	DM30	21-May-04	No Response	15S 0655456	3837011
Dead Man's Point	DM30	10-May-05	No Response	15S 0655456	3837011
Dead Man's Point	DM31	21-May-04	No Response**	15S 0655656	3837011
Dead Man's Point	DM32	21-May-04	No Response**	15S 0655857	3837010
Dead Man's Point	DM33	19-May-04	No Response	15S 0655255	3836805
Dead Man's Point	DM33	10-May-05	No Response	15S 0655255	3836805
Dead Man's Point	DM34	19-May-04	No Response	15S 0655455	3836805
Dead Man's Point	DM34	10-May-05	No Response	15S 0655455	3836805
Dead Man's Point	DM35	21-May-04	No Response**	15S 0655656	3836804
Dead Man's Point	DM36	21-May-04	No Response**	15S 0655856	3836804
Dead Man's Point	DM38	19-May-04	No Response	15S 0655455	3836604
Dead Man's Point	DM38	10-May-05	No Response	15S 0655455	3836604
Dead Man's Point	DM39	21-May-04	No Response**	15S 0655655	3836604
Dead Man's Point	DM39	10-May-05	No Response	15S 0655655	3836604
Dead Man's Point	DM40	21-May-04	No Response**	15S 0655856	3836604
Dead Man's Point	DM40	10-May-05	No Response	15S 0655856	3836604
Dead Man's Point	DM41	21-May-04	No Response	15S 0655454	3836398
Dead Man's Point	DM41	10-May-05	No Response	15S 0655454	3836398
Dead Man's Point	DM42	21-May-04	No Response	15S 0655653	3836398
Dead Man's Point	DM42	10-May-05	No Response	15S 0655655	3836398
Dead Man's Point	DM43	21-May-04	No Response**	15S 0655855	3836398
Dead Man's Point	DM43	10-May-05	No Response	15S 0655855	3836398
Dead Man's Point	DM5	2-Jun-04	No Response	15S 0654456	3838216
Dead Man's Point	DM5	5-May-05	No Response	15S 0654456	3838216
Dead Man's Point	DM6	2-Jun-04	No Response	15S 0654656	3838215
Dead Man's Point	DM6	5-May-05	No Response	15S 0654656	3838216
Dead Man's Point	DM9	2-Jun-04	No Response	15S 0654456	3838017
Dead Man's Point	DM9	5-May-05	No Response	15S 0654456	3838017
Eagle Nest Lake	ENLT1P1	15-Apr-04	No Response	15S 0672518	3788378
Eagle Nest Lake	ENLT1P2	15-Apr-04	No Response	15S 0672718	3788378
Eagle Nest Lake	ENLT2P1	15-Apr-04	No Response	15S 0672120	3788167

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Eagle Nest Lake	ENLT2P2	15-Apr-04	No Response	15S 0672320	3788171
Eagle Nest Lake	ENLT2P3	15-Apr-04	No Response	15S 0672520	3788174
Eagle Nest Lake	ENLT2P4	15-Apr-04	No Response	15S 0672721	3788178
Eagle Nest Lake	ENLT2P5	17-Apr-04	No Response	15S 0672920	3788181
Eagle Nest Lake	ENLT2P6	17-Apr-04	No Response	15S 0673122	3788186
Eagle Nest Lake	ENLT3P1	17-Apr-04	No Response	15S 0672120	3787967
Eagle Nest Lake	ENLT3P2	17-Apr-04	No Response	15S 0672320	3787973
Eagle Nest Lake	ENLT3P3	17-Apr-04	No Response	15S 0672520	3787977
Eagle Nest Lake	ENLT3P4	17-Apr-04	No Response	15S 0672725	3787980
Eagle Nest Lake	ENLT3P5	17-Apr-04	No Response	15S 0672924	3787984
Eagle Nest Lake	ENLT3P6	17-Apr-04	No Response	15S 0673125	3787987
Eagle Nest Lake	ENLT3P7	17-Apr-04	No Response	15S 0673325	3787991
Eagle Nest Lake	ENLT4P1	17-Apr-04	No Response	15S 0672127	3787770
Eagle Nest Lake	ENLT4P2	17-Apr-04	No Response	15S 0672328	3787773
Eagle Nest Lake	ENLT4P3	17-Apr-04	No Response	15S 0672528	3787777
Eagle Nest Lake	ENLT4P4	17-Apr-04	No Response	15S 0672928	3787384
Eagle Nest Lake	ENLT4P5	17-Apr-04	No Response	15S 0673129	3787788
Eagle Nest Lake	ENLT4P6	17-Apr-04	No Response	15S 0673329	3787792
Eagle Nest Lake	ENLT5P1	22-Apr-04	No Response	15S 0672131	3787570
Eagle Nest Lake	ENLT5P2	22-Apr-04	No Response	15S 0672331	3787574
Eagle Nest Lake	ENLT5P3	22-Apr-04	No Response	15S 0672532	3787577
Eagle Nest Lake	ENLT6P1	22-Apr-04	No Response	15S 0672134	3787370
Eagle Nest Lake	ENLT6P2	22-Apr-04	No Response	15S 0672331	3787374
Eagle Nest Lake	ENLT6P3	22-Apr-04	No Response	15S 0672531	3787374
Flat Lake	FL1	6-May-04	No Response	15S 0664329	3767918
Flat Lake	FL2	6-May-04	No Response	15S 0664329	3767718
Flat Lake	FL3	6-May-04	No Response	15S 0664330	3767488
Flat Lake	FL4	6-May-04	No Response	15S 0664329	3767288
Flat Lake	FL5	6-May-04	No Response	15S 0664129	3767286
Flat Lake	FL6	6-May-04	No Response	15S 0664129	3767065
Flat Lake	FL7	6-May-04	No Response	15S 0664129	3766865
Flat Lake	FL8	6-May-04	No Response	15S 0664129	3766652
Flat Lake	FL9	6-May-04	No Response	15S 0664129	3766451
Hickory Ridge	HR10	13-May-04	No Response	15S 0669692	3781540
Hickory Ridge	HR11	13-May-04	No Response	15S 0669696	3781340
Hickory Ridge	HR12	13-May-04	No Response	15S 0669492	3781340
Hickory Ridge	HR13	13-May-04	No Response	15S 0668688	3781325
Hickory Ridge	HR14	13-May-04	No Response	15S 0668488	3781322
Hickory Ridge	HR15	13-May-04	No Response	15S 0668287	3781318
Hickory Ridge	HR2	13-May-04	No Response	15S 0669791	3783936
Hickory Ridge	HR3	13-May-04	No Response	15S 0669795	3783736
Hickory Ridge	HR4	13-May-04	No Response	15S 0669995	3783740
Hickory Ridge	HR5	13-May-04	No Response	15S 0670057	3783542
Hickory Ridge	HR6	13-May-04	No Response	15S 0670060	3783342
Hickory Ridge	HR7	13-May-04	No Response	15S 0670064	3783143
Indian Bay	IB10	4-Jun-04	No Response**	15S 0676461	3808630
Indian Bay	IB12	4-Jun-04	No Response**	15S 0676662	3808431
Indian Bay	IB13	4-Jun-04	No Response	15S 0676462	3808431
Indian Bay	IB15	4-Jun-04	No Response**	15S 0676662	3808232
Indian Bay	IB16	4-Jun-04	No Response**	15S 0676462	3808231
Indian Bay	IB18	4-Jun-04	No Response**	15S 0676663	3808032
Indian Bay	IB19	4-Jun-04	No Response	15S 0676463	3808032
Indian Bay	IB21	4-Jun-04	No Response**	15S 0676664	3807833

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Indian Bay	IB22	4-Jun-04	No Response	15S 0676463	3807832
Indian Bay	IB23	4-Jun-04	No Response**	15S 0676664	3807634
Indian Bay	IB24	4-Jun-04	No Response**	15S 0676464	3807633
Indian Bay	IB26	4-Jun-04	No Response**	15S 0676665	3807435
Indian Bay	IB27	4-Jun-04	No Response	15S 0676464	3807434
Indian Bay	IB30	4-Jun-04	No Response**	15S 0676665	3807235
Indian Bay	IB31	4-Jun-04	No Response	15S 0676465	3807235
Indian Bay	IB32	1-Jun-04	No Response**	15S 0677067	3807038
Indian Bay	IB33	1-Jun-04	No Response	15S 0676866	3807038
Indian Bay	IB35	1-Jun-04	No Response	15S 0676466	3807036
Indian Bay	IB36	1-Jun-04	No Response	15S 0676265	3807036
Indian Bay	IB37	11-May-04	No Response	15S 0677468	3806840
Indian Bay	IB38	11-May-04	No Response**	15S 0677268	3806840
Indian Bay	IB39	1-Jun-04	No Response	15S 0677067	3806839
Indian Bay	IB40	1-Jun-04	No Response	15S 0676867	3806839
Indian Bay	IB42	1-Jun-04	No Response	15S 0676466	3806838
Indian Bay	IB43	1-Jun-04	No Response	15S 0676266	3806838
Indian Bay	IB44	11-May-04	No Response**	15S 0677469	3806650
Indian Bay	IB45	11-May-04	No Response**	15S 0677268	3806650
Indian Bay	IB46	1-Jun-04	No Response	15S 0677068	3806649
Indian Bay	IB47	1-Jun-04	No Response	15S 0676867	3806648
Indian Bay	IB49	4-Jun-04	No Response**	15S 0675865	3806644
Indian Bay	IB53	11-May-04	No Response**	15S 0677469	3806462
Indian Bay	IB54	11-May-04	No Response**	15S 0677269	3806461
Indian Bay	IB55	1-Jun-04	No Response	15S 0677068	3806461
Indian Bay	IB56	1-Jun-04	No Response	15S 0676868	3806461
Indian Bay	IB57	12-May-04	No Response**	15S 0676668	3806460
Indian Bay	IB58	4-Jun-04	No Response**	15S 0676067	3806458
Indian Bay	IB59	4-Jun-04	No Response**	15S 0675866	3806458
Indian Bay	IB60	11-May-04	No Response**	15S 0678271	3806275
Indian Bay	IB60	14-Jun-05	No Response	15S 0678271	3806275
Indian Bay	IB61	11-May-04	No Response	15S 0678071	3806274
Indian Bay	IB61	14-Jun-05	No Response	15S 0678071	3806274
Indian Bay	IB63	12-May-04	No Response	15S 0677069	3806270
Indian Bay	IB64	12-May-04	No Response	15S 0676868	3806269
Indian Bay	IB65	4-Jun-04	No Response**	15S 0675866	3806265
Indian Bay	IB66	4-Jun-04	No Response**	15S 0675666	3806264
Indian Bay	IB67	11-May-04	No Response	15S 0678472	3806085
Indian Bay	IB68	11-May-04	No Response	15S 0678272	3806084
Indian Bay	IB68	14-Jun-05	No Response	15S 0678272	3806084
Indian Bay	IB69	12-May-04	No Response**	15S 0676869	3806081
Indian Bay	IB71	4-Jun-04	No Response**	15S 0675667	3806078
Indian Bay	IB72	4-Jun-04	No Response**	15S 0675467	3806077
Indian Bay	IB73	11-May-04	No Response	15S 0678673	3805897
Indian Bay	IB74	11-May-04	No Response	15S 0678473	3805896
Indian Bay	IB75	12-May-04	No Response**	15S 0676870	3805890
Indian Bay	IB77	4-Jun-04	No Response**	15S 0675467	3805884
Indian Bay	IB78	11-May-04	No Response**	15S 0678874	3805706
Indian Bay	IB79	11-May-04	No Response	15S 0678674	3805706
Indian Bay	IB80	11-May-04	No Response	15S 0678474	3805705
Indian Bay	IB80	14-Jun-05	No Response	15S 0678474	3805705
Indian Bay	IB81	6-Jun-04	No Response**	15S 0678073	3805704
Indian Bay	IB82	6-Jun-04	No Response**	15S 0677873	3805704

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Indian Bay	IB83	6-Jun-04	No Response	15S 0677672	3805703
Indian Bay	IB84	11-May-04	No Response	15S 0678474	3805515
Indian Bay	IB84	14-Jun-05	No Response	15S 0678474	3805515
Indian Bay	IB87	11-May-04	No Response	15S 0678475	3805323
Indian Bay	IB87	14-Jun-05	No Response	15S 0678475	3805323
Indian Bay	IB88	1-Jun-04	No Response	15S 0678475	3805133
Indian Bay	IB88	14-Jun-05	No Response	15S 0678475	3805133
Indian Bay	IB89	1-Jun-04	No Response	15S 0678676	3805134
Indian Bay	IB89	14-Jun-05	No Response	15S 0678676	3805134
Indian Bay	IB91	11-May-04	No Response	15S 0678476	3804941
Indian Bay	IB91	14-Jun-05	No Response	15S 0678476	3804941
Indian Bay	IB92	14-Jun-05	No Response	15S 0678877	3804942
Indian Bay	IB93	14-Jun-05	No Response	15S 0679077	3804942
Indian Bay	IB95	1-Jun-04	No Response	15S 0678476	3804752
Indian Bay	IB95	14-Jun-05	No Response	15S 0678476	3804752
Indian Bay	IB96	14-Jun-05	No Response	15S 0678677	3804752
Indian Bay	IB97	1-Jun-04	No Response	15S 0678477	3804554
Indian Bay	IB97	14-Jun-05	No Response	15S 0678477	3804554
Jack's Bay	JB1	3-May-04	No Response	15S 0664926	3777521
Jack's Bay	JB10	3-May-04	No Response**	15S 0665127	3777122
Jack's Bay	JB11	3-May-04	No Response	15S 0665327	3777122
Jack's Bay	JB12	3-May-04	No Response	15S 0665527	3777121
Jack's Bay	JB13	3-May-04	No Response	15S 0665127	3776895
Jack's Bay	JB14	3-May-04	No Response	15S 0664927	3776895
Jack's Bay	JB15	3-May-04	No Response	15S 0664927	3776696
Jack's Bay	JB16	3-May-04	No Response	15S 0664526	3776696
Jack's Bay	JB17	3-May-04	No Response	15S 0664326	3776696
Jack's Bay	JB18	3-May-04	No Response	15S 0664125	3776696
Jack's Bay	JB2	3-May-04	No Response	15S 0650025	4001774
Jack's Bay	JB20	4-May-04	No Response	15S 0664126	3776467
Jack's Bay	JB21	4-May-04	No Response	15S 0664326	3776468
Jack's Bay	JB22	4-May-04	No Response	15S 0664526	3776468
Jack's Bay	JB23	4-May-04	No Response	15S 0664727	3776468
Jack's Bay	JB24	4-May-04	No Response	15S 0664526	3776267
Jack's Bay	JB26	4-May-04	No Response	15S 0664125	3776267
Jack's Bay	JB29	4-May-04	No Response	15S 0664126	3776038
Jack's Bay	JB3	3-May-04	No Response	15S 0665327	3777520
Jack's Bay	JB30	4-May-04	No Response	15S 0664326	3776038
Jack's Bay	JB31	4-May-04	No Response	15S 0664126	3775838
Jack's Bay	JB37	4-May-04	No Response	15S 0663926	3775178
Jack's Bay	JB4	3-May-04	No Response	15S 0665528	3777520
Jack's Bay	JB41	6-May-04	No Response	15S 0663726	3774747
Jack's Bay	JB42	6-May-04	No Response	15S 0663726	3774547
Jack's Bay	JB45	6-May-04	No Response**	15S 0663726	3774316
Jack's Bay	JB46	6-May-04	No Response	15S 0663726	3774115
Jack's Bay	JB49	6-May-04	No Response	15S 0663727	3773883
Jack's Bay	JB5	3-May-04	No Response**	15S 0665527	3777322
Jack's Bay	JB50	6-May-04	No Response	15S 0663727	3773683
Jack's Bay	JB53	6-May-04	No Response	15S 0663727	3773458
Jack's Bay	JB54	6-May-04	No Response	15S 0663727	3773257
Jack's Bay	JB55	6-May-04	No Response**	15S 0663526	3773258
Jack's Bay	JB56	2-May-04	No Response	15S 0668334	3774753
Jack's Bay	JB57	2-May-04	No Response	15S 0668535	3774753

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Jack's Bay	JB58	2-May-04	No Response	15S 0668334	3774543
Jack's Bay	JB59	2-May-04	No Response	15S 0668335	3774322
Jack's Bay	JB6	3-May-04	No Response**	15S 0665327	3777322
Jack's Bay	JB60	2-May-04	No Response	15S 0668135	3774321
Jack's Bay	JB61	2-May-04	No Response	15S 0668134	3774112
Jack's Bay	JB62	2-May-04	No Response	15S 0668135	3773889
Jack's Bay	JB63	2-May-04	No Response	15S 0667332	3774975
Jack's Bay	JB7	3-May-04	No Response	15S 0665127	3777321
Jack's Bay	JB8	3-May-04	No Response	15S 0664926	3777321
Jack's Bay	JB9	3-May-04	No Response	15S 0664926	3777122
Jones Lake	JL11	8-May-04	No Response	15S 0673895	3794831
Jones Lake	JL12	8-May-04	No Response	15S 0673894	3795027
Jones Lake	JL13	8-May-04	No Response**	15S 0673894	3795226
Jones Lake	JL4	8-May-04	No Response	15S 0673897	3793843
Jones Lake	JL5	8-May-04	No Response	15S 0673897	3794042
Jones Lake	JL6	8-May-04	No Response	15S 0673896	3794238
Jones Lake	JL8	8-May-04	No Response	15S 0673896	3794437
Jones Lake	JL9	8-May-04	No Response	15S 0673895	3794632
Little Moon Lake	LM3	20-May-05	No Response	15S 0671879	3807659
Little Moon Lake	LM4	20-May-05	No Response	15S 0672882	3806859
Little Moon Lake	LM5	20-May-05	No Response	15S 0672882	3806659
Little Moon Lake	LM6	20-May-05	No Response	15S 0673082	3806659
Maddox Bay	MB1	3-Jun-05	No Response	15S 0665253	3821191
Maddox Bay	MB10	3-Jun-05	No Response	15S 0664451	3820785
Maddox Bay	MB11	3-Jun-05	No Response	15S 0664251	3820785
Maddox Bay	MB12	3-Jun-05	No Response	15S 0665453	3820580
Maddox Bay	MB13	3-Jun-05	No Response	15S 0665253	3820580
Maddox Bay	MB14	3-Jun-05	No Response	15S 0664652	3820580
Maddox Bay	MB2	3-Jun-05	No Response	15S 0665052	3821191
Maddox Bay	MB3	3-Jun-05	No Response	15S 0665253	3820987
Maddox Bay	MB4	3-Jun-05	No Response	15S 0665654	3820786
Maddox Bay	MB5	3-Jun-05	No Response	15S 0665453	3820786
Maddox Bay	MB6	3-Jun-05	No Response	15S 0665253	3820786
Maddox Bay	MB7	3-Jun-05	No Response	15S 0665053	3820785
Maddox Bay	MB8	3-Jun-05	No Response	15S 0664853	3820785
Maddox Bay	MB9	3-Jun-05	No Response	15S 0664652	3820785
Moon Lake	ML29	6-Jun-04	No Response**	15S 0675874	3803973
Moon Lake	ML34	6-Jun-04	No Response**	15S 0676076	3803784
Moon Lake	ML35	6-Jun-04	No Response**	15S 0676276	3803784
Moon Lake	ML36	6-Jun-04	No Response**	15S 0676476	3803785
Moon Lake	ML37	6-Jun-04	No Response	15S 0676677	3803785
Moon Lake	ML38	6-Jun-04	No Response**	15S 0676877	3803785
Moon Lake	ML39	6-Jun-04	No Response**	15S 0677078	3803786
Moon Lake	ML40	6-Jun-04	No Response**	15S 0677278	3803786
Moon Lake	ML44	6-Jun-04	No Response	15S 0676076	3803592
Moon Lake	ML45	6-Jun-04	No Response	15S 0676276	3803592
Moon Lake	ML46	6-Jun-04	No Response	15S 0676477	3803592
Moon Lake	ML47	6-Jun-04	No Response	15S 0676677	3803594
Moon Lake	ML48	6-Jun-04	No Response**	15S 0676878	3803595
Moon Lake	ML49	6-Jun-04	No Response**	15S 0677078	3803596
Moon Lake	ML52	6-Jun-04	No Response	15S 0676477	3803403
Passmore Lake	PAS1	7-May-05	No Response	15S 0654057	3838617
Passmore Lake	PAS10	7-May-05	No Response	15S 0654056	3838218

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Passmore Lake	PAS11	7-May-05	No Response	15S 0653655	3838218
Passmore Lake	PAS13	11-May-05	No Response	15S 0653254	3838219
Passmore Lake	PAS14	11-May-05	No Response	15S 0653054	3838219
Passmore Lake	PAS15	11-May-05	No Response	15S 0652854	3838219
Passmore Lake	PAS16	6-May-05	No Response	15S 0652453	3838220
Passmore Lake	PAS17	7-May-05	No Response	15S 0654055	3838017
Passmore Lake	PAS18	7-May-05	No Response	15S 0653655	3838018
Passmore Lake	PAS19	7-May-05	No Response	15S 0653454	3838019
Passmore Lake	PAS2	7-May-05	No Response	15S 0653856	3838618
Passmore Lake	PAS21	11-May-05	No Response	15S 0653053	3838019
Passmore Lake	PAS22	6-May-05	No Response	15S 0652853	3838020
Passmore Lake	PAS23	6-May-05	No Response	15S 0652653	3838020
Passmore Lake	PAS24	6-May-05	No Response	15S 0652452	3838021
Passmore Lake	PAS25	7-May-05	No Response	15S 0653454	3837818
Passmore Lake	PAS27	11-May-05	No Response	15S 0653053	3837819
Passmore Lake	PAS28	6-May-05	No Response	15S 0652853	3837820
Passmore Lake	PAS29	6-May-05	No Response	15S 0652652	3837820
Passmore Lake	PAS3	11-May-05	No Response	15S 0653656	3838618
Passmore Lake	PAS30	6-May-05	No Response	15S 0652452	3837820
Passmore Lake	PAS31	7-May-05	No Response	15S 0653654	3837617
Passmore Lake	PAS32	7-May-05	No Response	15S 0653453	3837617
Passmore Lake	PAS33	7-May-05	No Response	15S 0653253	3837617
Passmore Lake	PAS35	6-May-05	No Response	15S 0652652	3837620
Passmore Lake	PAS36	6-May-05	No Response	15S 0652451	3837620
Passmore Lake	PAS37	7-May-05	No Response**	15S 0653653	3837416
Passmore Lake	PAS38	7-May-05	No Response	15S 0653453	3837416
Passmore Lake	PAS39	7-May-05	No Response	15S 0653052	3837417
Passmore Lake	PAS4	7-May-05	No Response	15S 0654056	3838417
Passmore Lake	PAS40	20-May-05	No Response	15S 0652852	3837417
Passmore Lake	PAS41	6-May-05	No Response	15S 0652652	3837418
Passmore Lake	PAS42	6-May-05	No Response	15S 0652451	3837418
Passmore Lake	PAS45	6-May-05	No Response	15S 0652451	3837218
Passmore Lake	PAS46	11-May-05	No Response	15S 0652450	3837016
Passmore Lake	PAS47	11-May-05	No Response	15S 0652440	3836813
Passmore Lake	PAS48	11-May-05	No Response	15S 0652249	3836813
Passmore Lake	PAS49	11-May-05	No Response**	15S 0652049	3836814
Passmore Lake	PAS5	7-May-05	No Response	15S 0653856	3838418
Passmore Lake	PAS50	11-May-05	No Response	15S 0651849	3836814
Passmore Lake	PAS51	11-May-05	No Response	15S 0652249	3836610
Passmore Lake	PAS52	6-Jun-05	No Response	15S 0653651	3836403
Passmore Lake	PAS53	6-Jun-05	No Response	15S 0653451	3836403
Passmore Lake	PAS54	20-May-05	No Response	15S 0653250	3836404
Passmore Lake	PAS55	20-May-05	No Response	15S 0653049	3836405
Passmore Lake	PAS57	6-Jun-05	No Response	15S 0653650	3836201
Passmore Lake	PAS58	6-Jun-05	No Response	15S 0653449	3836201
Passmore Lake	PAS59	20-May-05	No Response	15S 0653249	3836202
Passmore Lake	PAS60	20-May-05	No Response	15S 0653049	3836202
Passmore Lake	PAS63	6-Jun-05	No Response	15S 0653649	3835997
Passmore Lake	PAS64	6-Jun-05	No Response	15S 0653449	3835998
Passmore Lake	PAS65	6-Jun-05	No Response	15S 0653249	3835998
Passmore Lake	PAS66	20-May-05	No Response	15S 0653049	3835999
Passmore Lake	PAS7	11-May-05	No Response	15S 0653455	3838419
Passmore Lake	PAS72	6-Jun-05	No Response	15S 0654049	3835792

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Passmore Lake	PAS73	6-Jun-05	No Response	15S 0653849	3835794
Passmore Lake	PAS74	6-Jun-05	No Response	15S 0653649	3835793
Passmore Lake	PAS75	6-Jun-05	No Response	15S 0653449	3835793
Passmore Lake	PAS76	6-Jun-05	No Response	15S 0653249	3835794
Passmore Lake	PAS77	6-Jun-05	No Response	15S 0653049	3835794
Passmore Lake	PAS79	6-Jun-05	No Response	15S 0653449	3835589
Passmore Lake	PAS8	11-May-05	No Response	15S 0653254	3838419
Passmore Lake	PAS80	6-Jun-05	No Response	15S 0653249	3835589
Passmore Lake	PAS81	6-Jun-05	No Response	15S 0653049	3835590
Passmore Lake	PAS9	11-May-05	No Response	15S 0653053	3838419
Prairie Landing	PL1	6-May-04	No Response	15S 0665130	3771984
Prairie Landing	PL11	6-May-04	No Response	15S 0663528	3770059
Prairie Landing	PL12	6-May-04	No Response	15S 0663528	3769859
Prairie Landing	PL13	6-May-04	No Response	15S 0663528	3769633
Prairie Landing	PL14	6-May-04	No Response	15S 0663328	3769633
Prairie Landing	PL15	6-May-04	No Response	15S 0663328	3769434
Prairie Landing	PL16	6-May-04	No Response	15S 0663328	3769208
Prairie Landing	PL2	6-May-04	No Response	15S 0665330	3771983
Prairie Landing	PL3	6-May-04	No Response	15S 0665330	3771761
Prairie Landing	PL4	6-May-04	No Response	15S 0665130	3771761
Prairie Landing	PL5	6-May-04	No Response	15S 0664930	3771761
Prairie Landing	PL6	6-May-04	No Response	15S 0664930	3771559
Prairie Landing	PL7	6-May-04	No Response	15S 0665130	3771559
Prairie Landing	PL8	6-May-04	No Response	15S 0665130	3771336
Sandy Bayou	SB1	16-May-05	No Response	15S 0678683	3802835
Sandy Bayou	SB10	16-May-05	No Response	15S 0678685	3801857
Sandy Bayou	SB12	16-May-05	No Response	15S 0678685	3801456
Sandy Bayou	SB2	16-May-05	No Response	15S 0678684	3802641
Sandy Bayou	SB3	16-May-05	No Response	15S 0678884	3802642
Sandy Bayou	SB4	16-May-05	No Response	15S 0679085	3802642
Sandy Bayou	SB5	16-May-05	No Response	15S 0679285	3802643
Sandy Bayou	SB6	16-May-05	No Response	15S 0678684	3802452
Sandy Bayou	SB7	16-May-05	No Response	15S 0678885	3802452
Sandy Bayou	SB8	16-May-05	No Response	15S 0678685	3802257
Sandy Bayou	SB9	16-May-05	No Response	15S 0678685	3802057
Smokehouse Hill	SH12	8-May-04	No Response**	15S 0673100	3792266
Smokehouse Hill	SH13	8-May-04	No Response**	15S 0673300	3792266
Smokehouse Hill	SH15	8-May-04	No Response	15S 0673100	3792659
Smokehouse Hill	SH16	8-May-04	No Response	15S 0673300	3792660
Smokehouse Hill	SH17	8-May-04	No Response	15S 0673098	3792859
Smokehouse Hill	SH18	8-May-04	No Response	15S 0673300	3792859
Smokehouse Hill	SH2	8-May-04	No Response	15S 0673100	3791680
Smokehouse Hill	SH20	8-May-04	No Response	15S 0673098	3793053
Smokehouse Hill	SH21	8-May-04	No Response	15S 0673298	3793054
Smokehouse Hill	SH4	8-May-04	No Response**	15S 0673100	3791872
Smokehouse Hill	SH8	8-May-04	No Response	15S 0673100	3792072
Rattlesnake Ridge	SWWA 1	13-Apr-04	Occupied	15S 0670350	3786340
Rattlesnake Ridge	SWWA 1	25-May-05	No Response	15S 0670350	3786340
Alligator Lake	SWWA 10	20-Apr-04	Occupied	15S 0674349	3768366
Alligator Lake	SWWA 10	23-Apr-05	No Response	15S 0674349	3768366
Alligator Lake	SWWA 10	18-Jun-05	No Response	15S 0674349	3768366
Alligator Lake	SWWA 11	20-Apr-04	Occupied	15S 0674349	3768572
Alligator Lake	SWWA 11	23-Apr-05	Occupied	15S 0674349	3768572

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	SWWA 12	21-Apr-04	Occupied	15S 0675751	3769000
Alligator Lake	SWWA 12	1-May-05	No Response	15S 0675751	3769000
Alligator Lake	SWWA 12	3-May-05	Occupied	15S 0675751	3769000
Alligator Lake	SWWA 12	18-Jun-05	Occupied	15S 0675751	3769000
Alligator Lake	SWWA 13	23-Apr-04	Occupied	15S 0672946	3768365
Alligator Lake	SWWA 13	24-Apr-05	Occupied	15S 0672946	3768365
Alligator Lake	SWWA 14	24-Apr-04	Occupied	15S 0673147	3768365
Alligator Lake	SWWA 14	24-Apr-05	No Response	15S 0673147	3768365
Alligator Lake	SWWA 14	18-Jun-05	Occupied	15S 0673147	3768365
Alligator Lake	SWWA 15	24-Apr-04	Occupied	15S 0672946	3768792
Alligator Lake	SWWA 15	24-Apr-05	Occupied	15S 0672946	3768792
Alligator Lake	SWWA 16	24-Apr-04	Occupied	15S 0673147	3768792
Alligator Lake	SWWA 16	24-Apr-05	Occupied	15S 0673147	3768792
Alligator Lake	SWWA 17	24-Apr-04	Occupied	15S 0673347	3769000
Alligator Lake	SWWA 17	24-Apr-05	No Response	15S 0673347	3769000
Alligator Lake	SWWA 17	18-Jun-05	Occupied	15S 0673347	3769000
Alligator Lake	SWWA 18	25-Apr-04	Occupied	15S 0677153	3770280
Alligator Lake	SWWA 18	30-Apr-05	No Response	15S 0677153	3770279
Alligator Lake	SWWA 18	18-Jun-05	No Response	15S 0677153	3770279
Alligator Lake	SWWA 19	25-Apr-04	No Response	15S 0677154	3769653
Alligator Lake	SWWA 19	17-Apr-05	Occupied	15S 0677154	3769653
Rattlesnake Ridge	SWWA 2	13-Apr-04	Occupied	15S 0670346	3786540
Rattlesnake Ridge	SWWA 2	25-May-05	No Response	15S 0670346	3786540
Alligator Lake	SWWA 20	24-Apr-04	Occupied	15S 0677154	3770505
Alligator Lake	SWWA 20	30-Apr-05	No Response	15S 0677154	3770505
Alligator Lake	SWWA 20	18-Jun-05	Occupied	15S 0677154	3770505
Alligator Lake	SWWA 21	27-Apr-04	Occupied	15S 0677154	3768800
Alligator Lake	SWWA 21	17-Apr-05	No Response	15S 0677154	3768800
Alligator Lake	SWWA 21	18-Jun-05	Occupied	15S 0677154	3768800
Alligator Lake	SWWA 22	27-Apr-04	Occupied	15S 0676953	3768572
Alligator Lake	SWWA 22	17-Apr-05	Occupied	15S 0676953	3768572
Alligator Lake	SWWA 23	27-Apr-04	Occupied	15S 0676954	3768372
Alligator Lake	SWWA 23	17-Apr-05	Occupied	15S 0676954	3768372
Alligator Lake	SWWA 24	28-Apr-04	Occupied	15S 0676553	3768371
Alligator Lake	SWWA 24	16-Apr-05	No Response	15S 0676553	3768371
Alligator Lake	SWWA 24	18-Jun-05	No Response	15S 0676553	3768371
Alligator Lake	SWWA 25	28-Apr-04	Occupied	15S 0676553	3767938
Alligator Lake	SWWA 25	16-Apr-05	No Response	15S 0676553	3767938
Alligator Lake	SWWA 25	18-Jun-05	No Response	15S 0676553	3767938
Alligator Lake	SWWA 26	28-Apr-04	Occupied	15S 0675952	3768572
Alligator Lake	SWWA 26	1-May-05	Occupied	15S 0675952	3768572
Alligator Lake	SWWA 27	28-Apr-04	Occupied	15S 0677154	3770079
Alligator Lake	SWWA 27	30-Apr-05	No Response	15S 0677154	3770079
Alligator Lake	SWWA 27	18-Jun-05	No Response	15S 0677154	3770079
Alligator Lake	SWWA 28	30-Apr-04	Occupied	15S 0674148	3769000
Alligator Lake	SWWA 28	28-Apr-05	Occupied	15S 0674148	3769000
Alligator Lake	SWWA 29	30-Apr-04	Occupied	15S 0674549	3769000
Alligator Lake	SWWA 29	28-Apr-05	Occupied	15S 0674549	3769000
Alligator Lake	SWWA 3	18-Apr-04	Occupied	15S 0675752	3768370
Alligator Lake	SWWA 3	1-May-05	No Response	15S 0675752	3768370
Alligator Lake	SWWA 30	16-May-04	Occupied	15S 0677756	3772651
Alligator Lake	SWWA 30	29-Apr-05	Occupied	15S 0677756	3772651
Alligator Lake	SWWA 31	16-May-04	Occupied	15S 0677555	3772651

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	SWWA 31	29-Apr-05	No Response	15S 0677555	3772651
Alligator Lake	SWWA 31	18-Jun-05	Occupied	15S 0677555	3772651
Alligator Lake	SWWA 32	16-May-04	Occupied	15S 0677355	3772650
Alligator Lake	SWWA 32	29-Apr-05	No Response	15S 067735	3772650
Alligator Lake	SWWA 32	18-Jun-05	No Response	15S 0677355	3772650
Alligator Lake	SWWA 33	17-May-04	Occupied	15S 0677553	3772406
Alligator Lake	SWWA 33	29-Apr-05	Occupied	15S 0677553	3772406
Alligator Lake	SWWA 34	17-May-04	Occupied	15S 0677554	3772206
Alligator Lake	SWWA 34	29-Apr-05	Occupied	15S 0677554	3772206
Alligator Lake	SWWA 35	17-May-04	Occupied	15S 0677554	3771981
Alligator Lake	SWWA 35	29-Apr-05	Occupied	15S 0677554	3771981
Alligator Lake	SWWA 36	17-May-04	Occupied	15S 0677554	3771780
Alligator Lake	SWWA 36	30-Apr-05	Occupied	15S 0677554	3771780
Alligator Lake	SWWA 37	17-May-04	Occupied	15S 0677354	3771781
Alligator Lake	SWWA 37	30-Apr-05	Occupied	15S 0677354	3771781
Alligator Lake	SWWA 38	18-May-04	Occupied	15S 0677353	3771980
Alligator Lake	SWWA 38	29-Apr-05	No Response	15S 0677353	3771980
Alligator Lake	SWWA 38	18-Jun-05	No Response	15S 0677353	3771980
Alligator Lake	SWWA 39	18-May-04	Occupied	15S 0677353	3772206
Alligator Lake	SWWA 39	29-Apr-05	No Response	15S 0677353	3772206
Alligator Lake	SWWA 39	18-Jun-05	No Response	15S 0677353	3772206
Alligator Lake	SWWA 4	18-Apr-04	Occupied	15S 0656840	3825279
Alligator Lake	SWWA 4	1-May-05	No Response	15S 0656840	3825279
Alligator Lake	SWWA 4	18-Jun-05	No Response	15S 0656840	3825279
Bear Slough	SWWA 40	19-May-04	Occupied	15S 0654849	3834768
Bear Slough	SWWA 40	13-May-05	No Response	15S 0654849	3834768
Crooked Lakes	SWWA 41	27-May-04	Occupied	15S 0657040	3825692
Crooked Lakes	SWWA 41	15-May-05	Occupied	15S 0657040	3825692
Crooked Lakes	SWWA 42	27-May-04	Occupied	15S 0656839	3825279
Crooked Lakes	SWWA 42	15-May-05	Occupied	15S 0656839	3825279
Dead Man's Point	SWWA 43	2-Jun-04	Occupied	15S 0654655	3837817
Dead Man's Point	SWWA 43	5-May-05	No Response	15S 0654655	3837817
Lost Lake	SWWA 44	2-Jun-04	Occupied	15S 0655056	3837614
Lost Lake	SWWA 44	5-May-05	Occupied	15S 0655056	3837614
Bear Slough	SWWA 45	8-Jun-04	Occupied	15S 0654850	3834973
Bear Slough	SWWA 45	13-May-05	No Response	15S 0654850	3834973
Alligator Lake	SWWA 5	18-Apr-04	Occupied	15S 0674750	3767934
Alligator Lake	SWWA 5	1-May-05	Occupied	15S 0674750	3767934
Alligator Lake	SWWA 6	18-Apr-04	Occupied	15S 0674950	3767935
Alligator Lake	SWWA 6	1-May-05	Occupied	15S 0674950	3767935
Alligator Lake	SWWA 7	18-Apr-04	Occupied	15S 0675351	3767935
Alligator Lake	SWWA 7	1-May-05	No Response	15S 0675351	3767935
Alligator Lake	SWWA 8	20-Apr-04	Occupied	15S 0673947	3768366
Alligator Lake	SWWA 8	23-Apr-05	Occupied	15S 0673947	3768366
Alligator Lake	SWWA 9	20-Apr-04	Occupied	15S 0674147	3768368
Alligator Lake	SWWA 9	23-Apr-05	No Response	15S 0674147	3768368
Alligator Lake	SWWA 9	18-Jun-05	No Response	15S 0674147	3768368
Alligator Lake	SWWA4605	25-Apr-04	No Response	15S 0676954	3769227
Alligator Lake	SWWA4605	16-Apr-05	Occupied	15S 0676954	3769227
Alligator Lake	SWWA4705	25-Apr-04	No Response	15S 0676953	3769427
Alligator Lake	SWWA4705	16-Apr-05	Occupied	15S 0676953	3769427
Alligator Lake	SWWA4805	25-Apr-04	No Response	15S 0677154	3769427
Alligator Lake	SWWA4805	16-Apr-05	Occupied	15S 0677154	3769427

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Alligator Lake	SWWA4905	25-Apr-04	No Response	15S 0677148	3769227
Alligator Lake	SWWA4905	16-Apr-05	Occupied	15S 0677148	3769227
Alligator Lake	SWWA5005	27-Apr-04	Occupied	15S 0676953	3769000
Alligator Lake	SWWA5005	17-Apr-05	Occupied	15S 0676953	3769000
Alligator Lake	SWWA5105	27-Apr-04	Occupied	15S 0677154	3768572
Alligator Lake	SWWA5105	17-Apr-05	Occupied	15S 0677154	3768572
Alligator Lake	SWWA5205	27-Apr-04	Occupied	15S 0677154	3769000
Alligator Lake	SWWA5205	17-Apr-05	Occupied	15S 0677154	3769000
Alligator Lake	SWWA5305	21-Apr-04	No Response	15S 0675150	3769000
Alligator Lake	SWWA5305	23-Apr-05	Occupied	15S 0675150	3769000
Alligator Lake	SWWA5405	20-Apr-04	No Response	15S 0674548	3768361
Alligator Lake	SWWA5405	23-Apr-05	Occupied	15S 0674548	3768361
Alligator Lake	SWWA5505	24-Apr-04	No Response	15S 0673347	3768572
Alligator Lake	SWWA5505	24-Apr-05	Occupied	15S 0673347	3768572
Rattlesnake Ridge	SWWA5605	14-Apr-04	No Response	15S 0669137	3786917
Rattlesnake Ridge	SWWA5605	25-May-05	Occupied	15S 0669137	3786917
Alligator Lake	SWWA5705	30-Apr-04	No Response	15S 0674348	3769000
Alligator Lake	SWWA5705	28-Apr-05	Occupied	15S 0674348	3769000
Alligator Lake	SWWA5805	30-Apr-04	No Response	15S 0677151	3771780
Alligator Lake	SWWA5805	30-Apr-05	Occupied	15S 0677151	3771780
Alligator Lake	SWWA5905	30-Apr-04	No Response	15S 0677154	3771355
Alligator Lake	SWWA5905	30-Apr-05	Occupied	15S 0677154	3771355
Alligator Lake	SWWA6005	21-Apr-04	No Response	15S 0675351	3769224
Alligator Lake	SWWA6005	1-May-05	Occupied	15S 0675351	3769224
Alligator Lake	SWWA6105	1-May-05	No Response	15S 0674549	3767706
Alligator Lake	SWWA6105	3-May-05	Occupied	15S 0674549	3767706
Alligator Lake	SWWA6205	3-May-05	Occupied	15S 0672740	3769420
East Bayou	SWWA6305	19-May-04	No Response	15S 0655255	3836605
East Bayou	SWWA6305	10-May-05	Occupied	15S 0655255	3836605
Crooked Lakes	SWWA6405	27-May-04	No Response	15S 0657240	3825491
Crooked Lakes	SWWA6405	15-May-05	Occupied	15S 0657240	3825491
Little Moon Lake	SWWA6505	20-May-05	Occupied	15S 0671879	3807459
Little Moon Lake	SWWA6605	20-May-05	Occupied	15S 0672079	3807459
Red Cat Lake	SWWA6705	24-May-05	Occupied	15S 0656049	3833145
Bear Slough	SWWA6805	15-Jun-05	Occupied	15S 0655853	3835582
Bear Slough	SWWA6905	15-Jun-05	Occupied	15S 0655852	3835783
Indian Bay	SWWA7005	16-May-05	Occupied	15S 0678685	3801657
Indian Bay	SWWA7005	21-Jun-05	Occupied	15S 0678685	3801657
Rattlesnake Ridge	T10P2	13-Apr-04	No Response	15S 0670146	3786536
Rattlesnake Ridge	T10P2	25-Apr-05	No Response	15S 0670146	3786536
Rattlesnake Ridge	T10P3	13-Apr-04	No Response	15S 0669945	3786532
Rattlesnake Ridge	T10P3	25-Apr-05	No Response	15S 0669945	3786532
Rattlesnake Ridge	T10P4	13-Apr-04	No Response	15S 0669745	3786529
Rattlesnake Ridge	T10P4	25-Apr-05	No Response	15S 0669745	3786529
Rattlesnake Ridge	T11P1	13-Apr-04	No Response	15S 0670550	3786344
Rattlesnake Ridge	T11P1	25-Apr-05	No Response	15S 0670550	3786344
Rattlesnake Ridge	T11P3	15-May-04	No Response	15S 0668346	3786304
Rattlesnake Ridge	T11P4	15-May-04	No Response	15S 0668146	3786300
Rattlesnake Ridge	T12P1	13-Apr-04	No Response	15S 0670754	3786148
Rattlesnake Ridge	T12P1	25-Apr-05	No Response	15S 0670754	3786148
Rattlesnake Ridge	T12P2	13-Apr-04	No Response	15S 0670554	3786144
Rattlesnake Ridge	T12P2	25-Apr-05	No Response	15S 0670554	3786144
Rattlesnake Ridge	T12P3	15-May-04	No Response	15S 0668149	3786101

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Rattlesnake Ridge	T13P1	15-May-04	No Response	15S 0668554	3785909
Rattlesnake Ridge	T13P2	15-May-04	No Response	15S 0668153	3785902
Rattlesnake Ridge	T14P1	15-May-04	No Response	15S 0668557	3785709
Rattlesnake Ridge	T14P2	15-May-04	No Response	15S 0668157	3785702
Rattlesnake Ridge	T15P1	15-May-04	No Response	15S 0668559	3785503
Rattlesnake Ridge	T15P2	15-May-04	No Response	15S 0668160	3785503
Rattlesnake Ridge	T16P1	13-May-04	No Response	15S 0669165	3785321
Rattlesnake Ridge	T16P2	14-May-04	No Response	15S 0668965	3785318
Rattlesnake Ridge	T16P3	14-May-04	No Response	15S 0668765	3785314
Rattlesnake Ridge	T16P4	15-May-04	No Response	15S 0668564	3785310
Rattlesnake Ridge	T16P5	15-May-04	No Response	15S 0668164	3785303
Rattlesnake Ridge	T17P1	13-May-04	No Response	15S 0669369	3785125
Rattlesnake Ridge	T17P2	13-May-04	No Response	15S 0669169	3785122
Rattlesnake Ridge	T17P3	14-May-04	No Response	15S 0668969	3785118
Rattlesnake Ridge	T17P4	14-May-04	No Response	15S 0668768	3785115
Rattlesnake Ridge	T17P5	15-May-04	No Response	15S 0668368	3785107
Rattlesnake Ridge	T17P6	15-May-04	No Response	15S 0668167	3785104
Red Cat Lake	T18P3	19-May-05	No Response**	15S 0655249	3834159
Red Cat Lake	T18P3	13-May-05	No Response	15S 0655249	3834159
Red Cat Lake	T18P4	19-May-05	No Response**	15S 0655049	3834159
Red Cat Lake	T18P4	13-May-05	No Response	15S 0655049	3834159
Red Cat Lake	T18P5	19-May-05	No Response**	15S 0654848	3834159
Red Cat Lake	T18P5	13-May-05	No Response	15S 0654848	3834159
Red Cat Lake	T19P1	27-May-05	No Response	15S 0656651	3833954
Red Cat Lake	T19P2	27-May-05	No Response	15S 0656451	3833954
Red Cat Lake	T19P3	27-May-05	No Response	15S 0656250	3833954
Red Cat Lake	T19P4	27-May-05	No Response	15S 0656050	3833955
Red Cat Lake	T19P5	27-May-05	No Response	15S 0655850	3833955
Red Cat Lake	T19P7	8-Jun-04	No Response	15S 0655048	3833955
Red Cat Lake	T19P7	13-May-05	No Response	15S 0655048	3833955
Red Cat Lake	T19P8	19-May-05	No Response**	15S 0654847	3833955
Red Cat Lake	T19P8	13-May-05	No Response	15S 0654848	3833955
East Bayou	T20P1	25-May-05	No Response	15S 0657252	3833752
East Bayou	T20P2	25-May-05	No Response	15S 0657052	3833753
East Bayou	T20P3	25-May-05	No Response	15S 0656851	3833753
Red Cat Lake	T20P4	27-May-05	No Response	15S 0656050	3833753
Red Cat Lake	T20P5	27-May-05	No Response	15S 0655849	3833754
Red Cat Lake	T20P6	27-May-05	No Response	15S 0655649	3833754
Red Cat Lake	T20P7	27-May-05	No Response	15S 0655449	3833754
Red Cat Lake	T20P8	27-May-05	No Response	15S 0655248	3833754
Red Cat Lake	T20P9	8-Jun-04	No Response	15S 0655048	3833755
Red Cat Lake	T20P9	13-May-05	No Response	15S 0655048	3833755
East Bayou	T21P1	25-May-05	No Response	15S 0657251	3833548
Red Cat Lake	T21P10	27-May-05	No Response	15S 0655248	3833552
Red Cat Lake	T21P11	25-May-05	No Response	15S 0654847	3833552
East Bayou	T21P2	25-May-05	No Response	15S 0657051	3833548
Red Cat Lake	T21P3	25-May-05	No Response	15S 0656851	3833549
Red Cat Lake	T21P4	25-May-05	No Response	15S 0656650	3833549
Red Cat Lake	T21P5	27-May-05	No Response	15S 0656250	3833550
Red Cat Lake	T21P6	27-May-05	No Response	15S 0656049	3833550
Red Cat Lake	T21P7	27-May-05	No Response	15S 0655849	3833550
Red Cat Lake	T21P8	27-May-05	No Response	15S 0655649	3833551
Red Cat Lake	T21P9	27-May-05	No Response	15S 0655448	3833551

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
East Bayou	T22P1	25-May-05	No Response	15S 0657251	3833348
Red Cat Lake	T22P10	19-May-05	No Response	15S 0655047	3833350
Red Cat Lake	T22P11	25-May-05	No Response	15S 0654847	3833350
Red Cat Lake	T22P12	25-May-05	No Response	15S 0654646	3833350
East Bayou	T22P2	25-May-05	No Response	15S 0657051	3833348
East Bayou	T22P3	25-May-05	No Response	15S 0656851	3833348
Red Cat Lake	T22P4	25-May-05	No Response	15S 0656650	3833348
Red Cat Lake	T22P5	25-May-05	No Response	15S 0656450	3833348
Red Cat Lake	T22P6	25-May-05	No Response	15S 0656249	3833349
Red Cat Lake	T22P7	27-May-05	No Response	15S 0656049	3833349
Red Cat Lake	T22P8	27-May-05	No Response	15S 0655849	3833349
Red Cat Lake	T22P9	19-May-05	No Response	15S 0655648	3833349
East Bayou	T23P1	26-May-05	No Response	15S 0658052	3833142
Red Cat Lake	T23P11	21-May-05	No Response	15S 0655848	3833146
Red Cat Lake	T23P12	21-May-05	No Response	15S 0655648	3833146
Red Cat Lake	T23P13	19-May-05	No Response	15S 0655448	3833147
Red Cat Lake	T23P14	19-May-05	No Response	15S 0655247	3833147
Red Cat Lake	T23P15	19-May-05	No Response	15S 0655047	3833147
Red Cat Lake	T23P16	28-May-05	No Response	15S 0654846	3833148
Red Cat Lake	T23P17	28-May-05	No Response	15S 0654446	3833149
Red Cat Lake	T23P18	28-May-05	No Response	15S 0654245	3833149
Red Cat Lake	T23P19	16-Jun-04	No Response**	15S 0653845	3833150
Red Cat Lake	T23P19	31-May-05	No Response	15S 0653845	3833150
East Bayou	T23P2	26-May-05	No Response	15S 0657852	3833142
Aberdeen	T23P20	16-Jun-04	No Response**	15S 0653644	3833150
Aberdeen	T23P20	31-May-05	No Response	15S 0653644	3833150
Aberdeen	T23P21	16-Jun-04	No Response**	15S 0653444	3833151
Aberdeen	T23P21	31-May-05	No Response	15S 0653444	3833151
East Bayou	T23P3	26-May-05	No Response	15S 0657652	3833142
East Bayou	T23P4	25-May-05	No Response	15S 0657451	3833143
East Bayou	T23P5	25-May-05	No Response	15S 0657251	3833143
East Bayou	T23P6	25-May-05	No Response	15S 0657051	3833144
Red Cat Lake	T23P9	24-May-05	No Response	15S 0656249	3833145
East Bayou	T24P1	26-May-05	No Response	15S 0658052	3832942
Horseshoe Lake	T24P10	24-May-05	No Response	15S 0656249	3832944
Red Cat Lake	T24P11	24-May-05	No Response	15S 0656049	3832944
Red Cat Lake	T24P12	21-May-05	No Response	15S 0655848	3832945
Red Cat Lake	T24P13	21-May-05	No Response	15S 0655648	3832945
Red Cat Lake	T24P14	19-May-05	No Response	15S 0655447	3832945
Red Cat Lake	T24P15	19-May-05	No Response	15S 0655247	3832945
Red Cat Lake	T24P16	19-May-05	No Response	15S 0655047	3832945
Red Cat Lake	T24P17	28-May-05	No Response	15S 0654846	3832945
Aberdeen	T24P19	16-Jun-04	No Response**	15S 0654446	3832945
Horseshoe Lake	T24P2	26-May-05	No Response	15S 0657852	3832943
Aberdeen	T24P20	16-Jun-04	No Response**	15S 0654245	3832946
Aberdeen	T24P21	16-Jun-04	No Response**	15S 0654045	3832947
Aberdeen	T24P22	16-Jun-04	No Response**	15S 0653845	3832947
Aberdeen	T24P22	31-May-05	No Response	15S 0653845	3832947
Aberdeen	T24P23	16-Jun-04	No Response**	15S 0653644	3832947
Aberdeen	T24P23	31-May-05	No Response	15S 0653644	3832947
Aberdeen	T24P24	16-Jun-04	No Response**	15S 0653444	3832947
Aberdeen	T24P24	31-May-05	No Response	15S 0653444	3832947
Horseshoe Lake	T24P3	26-May-05	No Response	15S 0657651	3832943

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Horseshoe Lake	T24P4	26-May-05	No Response	15S 0657451	3832943
Horseshoe Lake	T24P5	26-May-05	No Response	15S 0657251	3832943
Horseshoe Lake	T24P9	24-May-05	No Response	15S 0656449	3832944
Horseshoe Lake	T25P1	26-May-05	No Response	15S 0658052	3832738
Red Cat Lake	T25P10	24-May-05	No Response	15S 0656048	3832741
Red Cat Lake	T25P11	21-May-05	No Response	15S 0655848	3832742
Red Cat Lake	T25P12	21-May-05	No Response	15S 0655647	3832742
Red Cat Lake	T25P13	19-May-05	No Response	15S 0655447	3832742
Red Cat Lake	T25P14	19-May-05	No Response	15S 0655247	3832743
Red Cat Lake	T25P15	19-May-05	No Response	15S 0655046	3832743
Red Cat Lake	T25P16	28-May-05	No Response	15S 0654846	3832744
Red Cat Lake	T25P19	28-May-05	No Response	15S 0654245	3832745
Horseshoe Lake	T25P2	26-May-05	No Response	15S 0657851	3832738
Red Cat Lake	T25P20	28-May-05	No Response	15S 0654044	3832745
Aberdeen	T25P23	16-Jun-04	No Response**	15S 0653443	3832747
Horseshoe Lake	T25P3	26-May-05	No Response	15S 0657651	3832738
Horseshoe Lake	T25P5	26-May-05	No Response	15S 0657250	3832739
Horseshoe Lake	T25P6	24-May-05	No Response	15S 0657050	3832739
Horseshoe Lake	T25P7	24-May-05	No Response	15S 0656850	3832740
Horseshoe Lake	T25P8	24-May-05	No Response	15S 0656449	3832740
Horseshoe Lake	T25P9	24-May-05	No Response	15S 0656248	3832740
Horseshoe Lake	T26P1	26-May-05	No Response	15S 0658052	3832538
Red Cat Lake	T26P10	21-May-05	No Response	15S 0655847	3832540
Red Cat Lake	T26P12	19-May-05	No Response	15S 0655447	3832541
Red Cat Lake	T26P13	19-May-05	No Response	15S 0655246	3832541
Red Cat Lake	T26P14	19-May-05	No Response	15S 0655046	3832541
Aberdeen	T26P15	28-May-05	No Response	15S 0654846	3832541
Aberdeen	T26P16	28-May-05	No Response	15S 0654645	3832541
Aberdeen	T26P17	28-May-05	No Response	15S 0654445	3832541
Aberdeen	T26P19	16-Jun-04	No Response	15S 0653443	3832543
Horseshoe Lake	T26P2	26-May-05	No Response	15S 0657851	3832538
Aberdeen	T26P20	16-Jun-04	No Response**	15S 0653243	3832543
Aberdeen	T26P21	16-Jun-04	No Response**	15S 0653042	3832544
Aberdeen	T26P22	16-Jun-04	No Response**	15S 0652842	3832544
Aberdeen	T26P23	16-Jun-04	No Response**	15S 0652642	3832544
Horseshoe Lake	T26P3	26-May-05	No Response	15S 0657651	3832538
Horseshoe Lake	T26P4	26-May-05	No Response	15S 0657250	3832539
Horseshoe Lake	T26P5	24-May-05	No Response	15S 0657050	3832539
Horseshoe Lake	T26P6	24-May-05	No Response	15S 0656849	3832539
Horseshoe Lake	T26P7	24-May-05	No Response	15S 0656649	3832539
Red Cat Lake	T26P8	21-May-05	No Response	15S 0656248	3832540
Red Cat Lake	T26P9	21-May-05	No Response	15S 0656048	3832540
Red Cat Lake	T27P10	19-May-05	No Response	15S 0655446	3832338
Red Cat Lake	T27P11	19-May-05	No Response	15S 0655246	3832339
Red Cat Lake	T27P12	19-May-05	No Response	15S 0655045	3832339
Clear Lake	T27P13	28-May-05	No Response	15S 0654845	3832339
Clear Lake	T27P14	28-May-05	No Response	15S 0654645	3832340
Clear Lake	T27P16	28-May-05	No Response	15S 0654244	3832341
Aberdeen	T27P17	14-May-04	No Response	15S 0653442	3832342
Aberdeen	T27P18	14-May-04	No Response**	15S 0653242	3832343
Aberdeen	T27P19	14-May-04	No Response	15S 0653042	3832343
Horseshoe Lake	T27P2	24-May-05	No Response	15S 0657049	3832335
Aberdeen	T27P20	14-May-04	No Response	15S 0652841	3832344

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Aberdeen	T27P21	14-May-04	No Response**	15S 0652641	3832344
Aberdeen	T27P22	14-May-04	No Response**	15S 0652441	3832345
Horseshoe Lake	T27P3	24-May-05	No Response	15S 0656849	3832335
Horseshoe Lake	T27P4	24-May-05	No Response	15S 0656648	3832336
Red Cat Lake	T27P5	21-May-05	No Response	15S 0656448	3832336
Red Cat Lake	T27P6	21-May-05	No Response	15S 0656248	3832337
Red Cat Lake	T27P7	21-May-05	No Response	15S 0656047	3832337
Red Cat Lake	T27P8	21-May-05	No Response	15S 0655847	3832337
Horseshoe Lake	T28P1	26-May-05	No Response	15S 0657249	3832135
Clear Lake	T28P10	28-May-05	No Response	15S 0654845	3832137
Clear Lake	T28P12	28-May-05	No Response	15S 0654444	3832138
Clear Lake	T28P13	28-May-05	No Response	15S 0654244	3832138
Aberdeen	T28P14	11-May-04	No Response**	15S 0654043	3832138
Aberdeen	T28P15	11-May-04	No Response**	15S 0653843	3832138
Aberdeen	T28P16	14-May-04	No Response**	15S 0653643	3832139
Aberdeen	T28P17	14-May-04	No Response**	15S 0653442	3832139
Aberdeen	T28P18	14-May-04	No Response	15S 0653041	3832139
Aberdeen	T28P19	14-May-04	No Response**	15S 0652841	3832140
Horseshoe Lake	T28P2	21-May-05	No Response	15S 0656648	3832135
Aberdeen	T28P20	14-May-04	No Response**	15S 0652641	3832140
Aberdeen	T28P21	14-May-04	No Response**	15S 0652440	3832140
Aberdeen	T28P22	14-May-04	No Response**	15S 0652240	3832141
Horseshoe Lake	T28P3	21-May-05	No Response	15S 0656448	3832135
Horseshoe Lake	T28P4	21-May-05	No Response	15S 0656247	3832136
Horseshoe Lake	T28P5	21-May-05	No Response	15S 0656047	3832136
Horseshoe Lake	T28P6	21-May-05	No Response	15S 0655847	3832136
Horseshoe Lake	T28P8	19-May-05	No Response	15S 0655246	3832137
Horseshoe Lake	T28P9	19-May-05	No Response	15S 0655045	3832137
Horseshoe Lake	T29P1	26-May-05	No Response	15S 0657048	3831931
Mud Lake	T29P10	8-Jun-05	No Response	15S 0655245	3831934
Mud Lake	T29P11	8-Jun-05	No Response	15S 0655045	3831935
Mud Lake	T29P12	7-Jun-05	No Response	15S 0654844	3831935
Mud Lake	T29P13	7-Jun-05	No Response	15S 0654644	3831935
Aberdeen	T29P14	7-Jun-05	No Response	15S 0654444	3831936
Aberdeen	T29P15	11-May-04	No Response**	15S 0654043	3831937
Aberdeen	T29P16	11-May-04	No Response	15S 0653842	3831937
Aberdeen	T29P17	11-May-04	No Response**	15S 0653642	3831938
Aberdeen	T29P18	11-May-04	No Response**	15S 0653442	3831938
Aberdeen	T29P19	11-May-04	No Response**	15S 0653241	3831938
Horseshoe Lake	T29P2	1-Jun-05	No Response	15S 0656848	3831931
Aberdeen	T29P20	11-May-04	No Response**	15S 0653041	3831939
Aberdeen	T29P21	11-May-04	No Response**	15S 0652841	3831939
Aberdeen	T29P22	11-May-04	No Response**	15S 0652641	3831940
Aberdeen	T29P23	11-May-04	No Response**	15S 0652440	3831940
Aberdeen	T29P24	11-May-04	No Response**	15S 0652240	3831941
Horseshoe Lake	T29P3	1-Jun-05	No Response	15S 0656648	3831932
Horseshoe Lake	T29P4	1-Jun-05	No Response	15S 0656447	3831932
Horseshoe Lake	T29P5	1-Jun-05	No Response	15S 0656247	3831932
Horseshoe Lake	T29P6	1-Jun-05	No Response	15S 0656046	3831933
Horseshoe Lake	T29P7	1-Jun-05	No Response	15S 0655846	3831933
Horseshoe Lake	T29P8	1-Jun-05	No Response	15S 0655647	3831933
Horseshoe Lake	T29P9	8-Jun-05	No Response	15S 0655445	3831934
Rattlesnake Ridge	T2P10	14-May-04	No Response	15S 0668113	3788095

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Rattlesnake Ridge	T2P2	16-Apr-04	No Response	15S 0669916	3788128
Rattlesnake Ridge	T2P3	16-Apr-04	No Response	15S 0669716	3788124
Rattlesnake Ridge	T2P4	16-Apr-04	No Response	15S 0669515	3788120
Rattlesnake Ridge	T2P5	16-Apr-04	No Response	15S 0669315	3788117
Rattlesnake Ridge	T2P6	16-Apr-04	No Response	15S 0669115	3788113
Rattlesnake Ridge	T2P7	16-Apr-04	No Response	15S 0668914	3788110
Rattlesnake Ridge	T2P8	16-Apr-04	No Response	15S 0668714	3788106
Rattlesnake Ridge	T2P9	14-May-04	No Response	15S 0668313	3788099
Horseshoe Lake	T30P1	1-Jun-05	No Response	15S 0656848	3831731
Mud Lake	T30P10	8-Jun-05	No Response	15S 0655044	3831733
Mud Lake	T30P11	7-Jun-05	No Response	15S 0654844	3831733
Mud Lake	T30P12	7-Jun-05	No Response	15S 0654644	3831733
Mud Lake	T30P13	7-Jun-05	No Response	15S 0654443	3831733
Aberdeen	T30P14	11-May-04	No Response**	15S 0654243	3831733
Aberdeen	T30P15	11-May-04	No Response**	15S 0654043	3831733
Aberdeen	T30P16	11-May-04	No Response**	15S 0653842	3831733
Aberdeen	T30P17	11-May-04	No Response**	15S 0653642	3831733
Aberdeen	T30P18	11-May-04	No Response**	15S 0653441	3831735
Aberdeen	T30P19	11-May-04	No Response**	15S 0653241	3831735
Horseshoe Lake	T30P2	1-Jun-05	No Response	15S 0656647	3831731
Aberdeen	T30P20	11-May-04	No Response**	15S 0653041	3831735
Aberdeen	T30P21	11-May-04	No Response	15S 0652840	3831735
Aberdeen	T30P22	11-May-04	No Response	15S 0652640	3831735
Horseshoe Lake	T30P3	1-Jun-05	No Response	15S 0656442	3831728
Horseshoe Lake	T30P4	1-Jun-05	No Response	15S 0656247	3831731
Horseshoe Lake	T30P5	1-Jun-05	No Response	15S 0656046	3831731
Horseshoe Lake	T30P6	1-Jun-05	No Response	15S 0655846	3831732
Horseshoe Lake	T30P7	1-Jun-05	No Response	15S 0655646	3831732
Horseshoe Lake	T30P8	8-Jun-05	No Response	15S 0655445	3831732
Horseshoe Lake	T30P9	8-Jun-05	No Response	15S 0655245	3831732
Mud Lake	T31P10	8-Jun-05	No Response	15S 0655044	3831531
Mud Lake	T31P12	7-Jun-05	No Response	15S 0654643	3831532
Mud Lake	T31P13	7-Jun-05	No Response	15S 0654443	3831532
Aberdeen	T31P14	13-Jun-04	No Response**	15S 0654242	3831532
Aberdeen	T31P15	13-Jun-04	No Response**	15S 0654042	3831533
Aberdeen	T31P16	13-Jun-04	No Response**	15S 0653842	3831533
Aberdeen	T31P17	13-Jun-04	No Response**	15S 0653641	3831534
Aberdeen	T31P18	13-Jun-04	No Response**	15S 0653441	3831534
Aberdeen	T31P19	13-Jun-04	No Response**	15S 0653241	3831535
Horseshoe Lake	T31P2	1-Jun-05	No Response	15S 0656647	3831528
Aberdeen	T31P20	22-May-04	No Response	15S 0653040	3831535
Aberdeen	T31P21	13-Jun-04	No Response	15S 0652840	3831535
Horseshoe Lake	T31P3	1-Jun-05	No Response	15S 0656446	3831528
Horseshoe Lake	T31P4	1-Jun-05	No Response	15S 0656246	3831528
Horseshoe Lake	T31P5	1-Jun-05	No Response	15S 0656046	3831529
Horseshoe Lake	T31P6	1-Jun-05	No Response	15S 0655845	3831529
Horseshoe Lake	T31P7	1-Jun-05	No Response	15S 0655645	3831530
Horseshoe Lake	T31P8	8-Jun-05	No Response	15S 0655445	3831530
Horseshoe Lake	T31P9	8-Jun-05	No Response	15S 0655244	3831530
Horseshoe Lake	T32P1	1-Jun-05	No Response	15S 0656446	3831328
Mud Lake	T32P10	7-Jun-05	No Response	15S 0654643	3831330
Mud Lake	T32P12	13-Jun-04	No Response**	15S 0654242	3831330
Aberdeen	T32P13	13-Jun-04	No Response**	15S 0654042	3831331

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Aberdeen	T32P14	13-Jun-04	No Response**	15S 0653841	3831331
Aberdeen	T32P15	13-Jun-04	No Response	15S 0653641	3831331
Aberdeen	T32P16	22-May-04	No Response	15S 0653441	3831330
Aberdeen	T32P17	22-May-04	No Response	15S 0653240	3831330
Aberdeen	T32P18	22-May-04	No Response	15S 0653040	3831330
Horseshoe Lake	T32P2	2-Jun-05	No Response	15S 0656246	3831330
Horseshoe Lake	T32P3	2-Jun-05	No Response	15S 0656045	3831330
Horseshoe Lake	T32P4	2-Jun-05	No Response	15S 0655845	3831330
Horseshoe Lake	T32P5	2-Jun-05	No Response	15S 0655645	3831330
Horseshoe Lake	T32P6	2-Jun-05	No Response	15S 0655444	3831330
Mud Lake	T32P7	8-Jun-05	No Response	15S 0655244	3831330
Mud Lake	T32P8	8-Jun-05	No Response	15S 0655044	3831330
Mud Lake	T32P9	8-Jun-05	No Response	15S 0654843	3831330
Horseshoe Lake	T33P1	1-Jun-05	No Response	15S 0656446	3831126
Mud Lake	T33P10	7-Jun-05	No Response	15S 0654642	3831130
Mud Lake	T33P12	7-Jun-05	No Response	15S 0654242	3831130
Aberdeen	T33P13	13-Jun-04	No Response**	15S 0654041	3831130
Aberdeen	T33P14	13-Jun-04	No Response**	15S 0653841	3831131
Aberdeen	T33P15	10-Jun-04	No Response	15S 0653641	3831131
Aberdeen	T33P16	10-Jun-04	No Response**	15S 0653440	3831132
Aberdeen	T33P17	10-Jun-04	No Response	15S 0653240	3831132
Aberdeen	T33P18	22-May-04	No Response	15S 0653039	3831132
Horseshoe Lake	T33P2	2-Jun-05	No Response	15S 0656245	3831129
Horseshoe Lake	T33P3	2-Jun-05	No Response	15S 0656045	3831129
Horseshoe Lake	T33P4	2-Jun-05	No Response	15S 0655845	3831129
Horseshoe Lake	T33P5	2-Jun-05	No Response	15S 0655644	3831129
Horseshoe Lake	T33P6	2-Jun-05	No Response	15S 0655444	3831129
Horseshoe Lake	T33P7	8-Jun-05	No Response	15S 0655244	3831129
Horseshoe Lake	T33P8	8-Jun-05	No Response	15S 0655043	3831129
Horseshoe Lake	T33P9	8-Jun-05	No Response	15S 0654843	3831129
Horseshoe Lake	T34P1	2-Jun-05	No Response	15S 0656245	3830927
Aberdeen	T34P10	13-Jun-04	No Response	15S 0654041	3830930
Aberdeen	T34P12	10-Jun-04	No Response**	15S 0653640	3830930
Aberdeen	T34P13	10-Jun-04	No Response**	15S 0653440	3830930
Aberdeen	T34P14	22-May-04	No Response	15S 0653240	3830930
Aberdeen	T34P15	22-May-04	No Response	15S 0653039	3830931
Horseshoe Lake	T34P2	2-Jun-05	No Response	15S 0656045	3830927
Horseshoe Lake	T34P3	2-Jun-05	No Response	15S 0655444	3830928
Horseshoe Lake	T34P4	8-Jun-05	No Response	15S 0655243	3830928
Horseshoe Lake	T34P5	8-Jun-05	No Response	15S 0655043	3830928
Mud Lake	T34P6	8-Jun-05	No Response	15S 0654843	3830929
Mud Lake	T34P7	7-Jun-05	No Response	15S 0654642	3830929
Aberdeen	T35P10	13-Jun-04	No Response	15S 0654041	3830729
Aberdeen	T35P11	13-Jun-04	No Response**	15S 0653840	3830730
Aberdeen	T35P12	10-Jun-04	No Response**	15S 0653640	3830730
Aberdeen	T35P13	10-Jun-04	No Response**	15S 0653440	3830730
Aberdeen	T35P14	22-May-04	No Response	15S 0653239	3830731
Aberdeen	T35P4	8-Jun-05	No Response	15S 0655243	3830727
Aberdeen	T35P5	8-Jun-05	No Response	15S 0655043	3830727
Aberdeen	T35P6	8-Jun-05	No Response	15S 0654842	3830728
Aberdeen	T36P11	13-Jun-04	No Response**	15S 0654040	3830529
Aberdeen	T36P12	10-Jun-04	No Response**	15S 0653840	3830529
Aberdeen	T36P13	2-Jun-05	No Response	15S 0653640	3830529

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
East Bayou	T36P2	2-Jun-05	No Response	15S 0655844	3830526
East Bayou	T36P3	2-Jun-05	No Response	15S 0655643	3830526
Aberdeen	T36P4	2-Jun-05	No Response	15S 0655443	3830527
Aberdeen	T37P1	25-May-04	No Response	15S 0654441	3830328
Aberdeen	T37P2	25-May-04	No Response	15S 0654240	3830328
Aberdeen	T37P3	25-May-04	No Response	15S 0654040	3830329
Aberdeen	T37P4	25-May-04	No Response	15S 0653840	3830329
East Bayou	T38P1	9-Jun-05	No Response	15S 0656444	3830124
Aberdeen	T38P10	25-May-04	No Response	15S 0654440	3830127
Aberdeen	T38P10	9-Jun-05	No Response	15S 0654440	3830127
Aberdeen	T38P2	26-May-04	No Response	15S 0656043	3830125
Aberdeen	T38P3	26-May-04	No Response	15S 0655843	3830125
Aberdeen	T38P4	26-May-04	No Response	15S 0655643	3830125
Aberdeen	T38P5	26-May-04	No Response	15S 0655442	3830126
Aberdeen	T38P6	25-May-04	No Response	15S 0655242	3830126
Aberdeen	T38P6	9-Jun-05	No Response	15S 0655242	3830126
Aberdeen	T38P7	25-May-04	No Response	15S 0655041	3830126
Aberdeen	T38P7	9-Jun-05	No Response	15S 0655041	3830126
Aberdeen	T38P8	25-May-04	No Response	15S 0654841	3830126
Aberdeen	T38P8	9-Jun-05	No Response	15S 0654841	3830126
Aberdeen	T38P9	25-May-04	No Response	15S 0654641	3830127
Aberdeen	T38P9	9-Jun-05	No Response	15S 0654641	3830127
East Bayou	T39P1	9-Jun-05	No Response	15S 0656644	3829923
East Bayou	T39P2	9-Jun-05	No Response	15S 0656444	3829923
Aberdeen	T39P3	26-May-04	No Response	15S 0655642	3829924
Aberdeen	T39P4	26-May-04	No Response	15S 0655442	3829925
Aberdeen	T39P4	9-Jun-05	No Response	15S 0655442	3829925
Rattlesnake Ridge	T3P1	12-Apr-04	No Response	15S 0670320	3787936
Rattlesnake Ridge	T3P1	27-Apr-05	No Response	15S 0670320	3787936
Rattlesnake Ridge	T3P2	12-Apr-04	No Response	15S 0670120	3787932
Rattlesnake Ridge	T3P2	27-Apr-05	No Response	15S 0670120	3787932
Rattlesnake Ridge	T3P3	12-Apr-04	No Response	15S 0669920	3787928
Rattlesnake Ridge	T3P4	12-Apr-04	No Response	15S 0669719	3787925
Rattlesnake Ridge	T3P5	12-Apr-04	No Response	15S 0669519	3787921
Rattlesnake Ridge	T3P5	8-May-05	No Response	15S 0669519	3787921
Rattlesnake Ridge	T3P6	12-Apr-04	No Response	15S 0669319	3787917
Rattlesnake Ridge	T3P6	8-May-05	No Response	15S 0669319	3787917
Rattlesnake Ridge	T3P7	12-Apr-04	No Response	15S 0669118	3787914
Rattlesnake Ridge	T3P7	8-May-05	No Response	15S 0669118	3787914
Rattlesnake Ridge	T3P8	12-Apr-04	No Response	15S 0668918	3787910
Rattlesnake Ridge	T3P8	8-May-05	No Response	15S 0668918	3787910
East Lake	T40P1	9-Jun-05	No Response	15S 0656443	3829723
East Lake	T40P2	9-Jun-05	No Response	15S 0656243	3829723
East Lake	T40P3	9-Jun-05	No Response	15S 0656043	3829723
Aberdeen	T40P4	9-Jun-05	No Response	15S 0655842	3829724
Aberdeen	T40P5	26-May-04	No Response	15S 0655642	3829724
Aberdeen	T40P5	9-Jun-05	No Response	15S 0655642	3829724
Rattlesnake Ridge	T4P1	16-Apr-04	No Response	15S 0670327	3787729
Rattlesnake Ridge	T4P1	27-Apr-05	No Response	15S 0670327	3787729
Rattlesnake Ridge	T4P2	12-Apr-04	No Response	15S 0670124	3787732
Rattlesnake Ridge	T4P2	27-Apr-05	No Response	15S 0670124	3787732
Rattlesnake Ridge	T4P3	12-Apr-04	No Response	15S 0669523	3787722
Rattlesnake Ridge	T4P3	8-May-05	No Response	15S 0669523	3787722

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Rattlesnake Ridge	T4P4	12-Apr-04	No Response	15S 06693223	3787718
Rattlesnake Ridge	T4P4	8-May-05	No Response	15S 0669323	3787718
Rattlesnake Ridge	T4P5	12-Apr-04	No Response	15S 0669122	3787714
Rattlesnake Ridge	T4P5	8-May-05	No Response	15S 0669122	3787714
Rattlesnake Ridge	T4P6	12-Apr-04	No Response	15S 0668922	3787711
Rattlesnake Ridge	T4P6	8-May-05	No Response	15S 0668922	3787711
Rattlesnake Ridge	T4P7	12-Apr-04	No Response	15S 0668721	3787707
Rattlesnake Ridge	T4P7	8-May-05	No Response	15S 0668721	3787707
Rattlesnake Ridge	T4P8	14-May-04	No Response	15S 0668320	3787700
Rattlesnake Ridge	T4P9	8-May-05	No Response	15S 0668120	3787696
Rattlesnake Ridge	T5P1	15-Apr-04	No Response	15S 0670129	3787530
Rattlesnake Ridge	T5P1	27-Apr-05	No Response	15S 0670129	3787530
Rattlesnake Ridge	T5P2	16-Apr-04	No Response	15S 0669526	3787522
Rattlesnake Ridge	T5P3	16-Apr-04	No Response	15S 0669325	3787519
Rattlesnake Ridge	T5P3	8-May-05	No Response	15S 0669325	3787518
Rattlesnake Ridge	T5P4	16-Apr-04	No Response	15S 0669125	3787515
Rattlesnake Ridge	T5P4	8-May-05	No Response	15S 0669125	3787515
Rattlesnake Ridge	T5P5	16-Apr-04	No Response	15S 0668925	3787511
Rattlesnake Ridge	T5P5	8-May-05	No Response	15S 0668925	3787511
Rattlesnake Ridge	T5P6	16-Apr-04	No Response	15S 0668724	3787508
Rattlesnake Ridge	T5P6	8-May-05	No Response	15S 0668724	3787508
Rattlesnake Ridge	T5P7	14-May-04	No Response	15S 0668123	3787497
Rattlesnake Ridge	T6P1	15-Apr-04	No Response	15S 0670133	3787330
Rattlesnake Ridge	T6P1	27-Apr-05	No Response	15S 0670133	3787330
Rattlesnake Ridge	T6P2	15-Apr-04	No Response	15S 0669930	3787330
Rattlesnake Ridge	T6P2	27-Apr-05	No Response	15S 0669930	3787330
Rattlesnake Ridge	T6P3	15-Apr-04	No Response	15S 0669730	3787326
Rattlesnake Ridge	T6P4	16-Apr-04	No Response	15S 0668728	3787308
Rattlesnake Ridge	T6P5	14-May-04	No Response	15S 0668127	3787297
Rattlesnake Ridge	T7P1	15-Apr-04	No Response	15S 0670136	3787136
Rattlesnake Ridge	T7P1	27-Apr-05	No Response	15S 0670136	3787136
Rattlesnake Ridge	T7P2	15-Apr-04	No Response	15S 0669933	3787131
Rattlesnake Ridge	T7P2	27-Apr-05	No Response	15S 0669933	3787131
Rattlesnake Ridge	T7P3	15-Apr-04	No Response	15S 0669733	3787127
Rattlesnake Ridge	T7P4	15-Apr-04	No Response	15S 0669533	3787123
Rattlesnake Ridge	T7P5	15-Apr-04	No Response	15S 0669332	3787120
Rattlesnake Ridge	T7P5	25-Apr-05	No Response	15S 0669332	3787120
Rattlesnake Ridge	T7P6	14-May-04	No Response	15S 0668130	3787098
Rattlesnake Ridge	T8P1	14-Apr-04	No Response	15S 0670140	3786931
Rattlesnake Ridge	T8P1	25-Apr-05	No Response	15S 0670140	3786931
Rattlesnake Ridge	T8P2	14-Apr-04	No Response	15S 0669937	3786931
Rattlesnake Ridge	T8P2	25-Apr-05	No Response	15S 0669937	3786931
Rattlesnake Ridge	T8P3	14-Apr-04	No Response	15S 0669737	3786927
Rattlesnake Ridge	T8P3	25-Apr-05	No Response	15S 0669737	3786927
Rattlesnake Ridge	T8P4	14-Apr-04	No Response	15S 0669537	3786924
Rattlesnake Ridge	T8P4	25-Apr-05	No Response	15S 0669537	3786924
Rattlesnake Ridge	T8P5	14-Apr-04	No Response	15S 0669336	3786920
Rattlesnake Ridge	T8P5	25-Apr-05	No Response	15S 0669336	3786920
Rattlesnake Ridge	T8P7	14-May-04	No Response	15S 0668134	3786899
Rattlesnake Ridge	T9P1	14-Apr-04	No Response	15S 0670144	3786726
Rattlesnake Ridge	T9P1	25-Apr-05	No Response	15S 0670144	3786726
Rattlesnake Ridge	T9P2	14-Apr-04	No Response	15S 0669941	3786732
Rattlesnake Ridge	T9P2	25-Apr-05	No Response	15S 0669941	3786732

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Rattlesnake Ridge	T9P3	14-Apr-04	No Response	15S 0669741	3786728
Rattlesnake Ridge	T9P3	25-Apr-05	No Response	15S 0669741	3786728
Rattlesnake Ridge	T9P4	14-Apr-04	No Response	15S 0669540	3786724
Rattlesnake Ridge	T9P4	25-Apr-05	No Response	15S 0669540	3786724
Rattlesnake Ridge	T9P5	14-Apr-04	No Response	15S 0669340	3786721
Rattlesnake Ridge	T9P5	25-Apr-05	No Response	15S 0669340	3786721
Tarleton Creek	TC11	10-May-04	No Response	15S 0670700	3789530
Tarleton Creek	TC12	10-May-04	No Response	15S 0670900	3789530
Tarleton Creek	TC18	10-May-04	No Response	15S 0670700	3789729
Tarleton Creek	TC19	10-May-04	No Response	15S 0670900	3789729
Tarleton Creek	TC2	10-May-04	No Response	15S 0670712	3788542
Tarleton Creek	TC26	10-May-04	No Response	15S 0671100	3789921
Tarleton Creek	TC27	10-May-04	No Response	15S 0671501	3789921
Tarleton Creek	TC3	10-May-04	No Response**	15S 0670704	3788940
Tarleton Creek	TC32	10-May-04	No Response**	15S 0671100	3790120
Tarleton Creek	TC33	10-May-04	No Response**	15S 0671300	3790120
Tarleton Creek	TC34	10-May-04	No Response	15S 0671500	3790120
Tarleton Creek	TC36	10-May-04	No Response	15S 0671700	3790312
Tarleton Creek	TC38	10-May-04	No Response	15S 0671700	3790511
Tarleton Creek	TC4	10-May-04	No Response	15S 0670701	3789140
Tarleton Creek	TC40	9-May-04	No Response	15S 0671900	3790702
Tarleton Creek	TC41	9-May-04	No Response	15S 0671900	3790900
Tarleton Creek	TC42	9-May-04	No Response	15S 0672100	3790901
Tarleton Creek	TC43	9-May-04	No Response	15S 0672300	3791093
Tarleton Creek	TC44	9-May-04	No Response	15S 0672501	3790901
Tarleton Creek	TC45	9-May-04	No Response	15S 0672701	3791094
Tarleton Creek	TC46	9-May-04	No Response	15S 0672500	3791094
Tarleton Creek	TC47	9-May-04	No Response	15S 0672300	3790901
Tarleton Creek	TC48	9-May-04	No Response	15S 0672099	3791093
Tarleton Creek	TC49	9-May-04	No Response	15S 0671899	3791092
Tarleton Creek	TC58	9-May-04	No Response	15S 0671498	3791289
Tarleton Creek	TC59	9-May-04	No Response	15S 0671698	3791289
Tarleton Creek	TC6	10-May-04	No Response	15S 0670901	3789143
Tarleton Creek	TC60	9-May-04	No Response	15S 0671899	3791290
Tarleton Creek	TC61	9-May-04	No Response	15S 0672099	3791290
Tarleton Creek	TC62	9-May-04	No Response	15S 0672300	3791290
Tarleton Creek	TC63	9-May-04	No Response	15S 0672500	3791290
Tarleton Creek	TC64	9-May-04	No Response	15S 0672700	3791290
Tarleton Creek	TC65	9-May-04	No Response**	15S 0672901	3791290
Tarleton Creek	TC7	10-May-04	No Response	15S 0670700	3789339
Tarleton Creek	TC75	9-May-04	No Response	15S 0672700	3791482
Tarleton Creek	TC76	9-May-04	No Response**	15S 0672900	3791483
Tarleton Creek	TC8	10-May-04	No Response	15S 0670901	3789340
Walker's Cypress	W10P11	23-Jun-05	No Response	15S 0662851	3826298
Walker's Cypress	W10P12	23-Jun-05	No Response	15S 0662650	3826298
Walker's Cypress	W10P13	23-Jun-05	No Response	15S 0662450	3826298
Walker's Cypress	W10P4	22-Jun-05	No Response	15S 0664253	3826298
Walker's Cypress	W10P7	23-Jun-05	No Response	15S 0663652	3826298
Walker's Cypress	W10P8	22-Jun-05	No Response	15S 0663452	3826298
Walker's Cypress	W10P9	22-Jun-05	No Response	15S 0663251	3826298
Walker's Cypress	W11P10	23-Jun-05	No Response	15S 0662450	3826501
Walker's Cypress	W11P7	22-Jun-05	No Response	15S 0663051	3826501
Walker's Cypress	W11P8	22-Jun-05	No Response	15S 0662851	3826501

Appendix A. Continued.

General Location	Site	Date Sampled	Occupancy	UTM Coordinates	
Walker's Cypress	W11P9	23-Jun-05	No Response	15S 0662651	3826501
Walker's Cypress	W12P8	22-Jun-05	No Response	15S 0662049	3827105
Walker's Cypress	W12P9	23-Jun-05	No Response	15S 0661849	3827105
Walker's Cypress	W3P7	22-Jun-05	No Response	15S 0664453	3824871
Walker's Cypress	W4P8	22-Jun-05	No Response	15S 0664453	3825072
Walker's Cypress	W4P9	22-Jun-05	No Response	15S 0664253	3825072
Walker's Cypress	W5P10	22-Jun-05	No Response	15S 0664453	3825283
Walker's Cypress	W5P11	23-Jun-05	No Response	15S 0664053	3825282
Walker's Cypress	W5P12	22-Jun-05	No Response	15S 0663852	3825282
Walker's Cypress	W6P6	23-Jun-05	No Response	15S 0662249	3825486
Walker's Cypress	W6P7	23-Jun-05	No Response	15S 0662049	3825486
Walker's Cypress	W7P14	23-Jun-05	No Response	15S 0662249	3825692
Walker's Cypress	W7P15	23-Jun-05	No Response	15S 0662049	3825692
Walker's Cypress	W7P3	22-Jun-05	No Response	15S 0664454	3825694
Walker's Cypress	W7P4	22-Jun-05	No Response	15S 0664253	3825693
Walker's Cypress	W7P5	23-Jun-05	No Response	15S 0664053	3825693
Walker's Cypress	W7P6	22-Jun-05	No Response	15S 0663852	3825693
Walker's Cypress	W7P7	23-Jun-05	No Response	15S 0663652	3825693
Walker's Cypress	W8P3	22-Jun-05	No Response	15S 0663852	3825894
Walker's Cypress	W8P4	23-Jun-05	No Response	15S 0663652	3825894
Walker's Cypress	W9P4	22-Jun-05	No Response	15S 0664253	3826098
Walker's Cypress	W9P5	22-Jun-05	No Response	15S 0664053	3826098
Walker's Cypress	W9P6	22-Jun-05	No Response	15S 0663853	3826097

**Site that was at least partially flooded or had been flooded (based on clear evidence, e.g., fresh water marks and/or dead ground vegetation) earlier during the season of sampling.

Appendix B. Total abundance of arthropods and a few non-arthropods collected with litter samples and pitfall traps for randomly-selected occupied and unoccupied sites sampled at White River National Wildlife Refuge in 2004 and 2005.

2004 Litter Sample Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae[a]	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	5	5	0	0	4	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
AL2P2	unoccupied	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AL2P7	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0
AL3P15	unoccupied	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
CL7P5	unoccupied	0	0	0	0	0	0	0	0	0	4	4	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DL1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ENL6P2	unoccupied	0	0	0	0	0	0	0	0	0	7	7	0	0	15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FL8	unoccupied	0	0	0	0	0	0	0	0	0	12	12	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IB91	unoccupied	0	0	0	0	0	0	0	0	0	3	3	0	0	13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
JB56	unoccupied	0	0	0	0	0	0	0	0	0	3	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
JL4	unoccupied	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0
ML37	unoccupied	0	0	0	0	0	0	0	0	0	34	34	0	0	8	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7
ML52	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SH17	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 13	occupied	1	1	0	0	0	0	0	0	4	5	0	0	5	4	3	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0
SWWA 17	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	6	11	0	0	0	0	0	0	0	0	0	0
SWWA 2	occupied	0	0	0	0	0	0	0	0	0	8	8	0	0	8	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	3
SWWA 22	occupied	0	0	0	0	0	0	0	0	0	2	2	0	0	8	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 23	occupied	0	0	0	0	0	0	0	0	0	4	4	0	0	7	2	0	0	0	2	8	0	0	0	0	0	0	0	0	0	0
SWWA 24	occupied	0	0	0	0	0	0	0	0	0	15	15	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
SWWA 25	occupied	0	0	0	0	0	0	0	0	0	7	7	0	0	8	0	0	0	4	0	11	3	0	0	0	0	0	0	0	0	0
SWWA 26	occupied	2	2	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
SWWA 27	occupied	0	0	0	0	0	0	0	0	0	8	8	0	0	2	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	0
SWWA 28	occupied	0	0	0	0	0	0	0	0	0	4	4	0	0	8	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
SWWA 32	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	11	0	0	0	0	0	1	0	0	0	1
SWWA 33	occupied	1	1	0	0	0	0	0	0	0	7	7	0	0	7	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	2

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0
AL2P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	0
AL2P7	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	15	0	0
AL3P15	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0
CL7P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0
DL1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	0	8	0	0
ENL6P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	1	0	0	0	0	0	14	0	0
FL8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	2	0	0	0	0	0	7	0	0
IB91	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	1	1	0	0	0	0	0	11	0	0
JB56	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	3	0	0	0	0	0	0	6	0	0
JL4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	4	0	0
ML37	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0	0	0
ML52	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0
SH17	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	15	0	0
SWWA 13	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	9	0	2
SWWA 17	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	7	0	0
SWWA 2	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	11	0	0
SWWA 22	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	5	0	0
SWWA 23	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	7	0	0
SWWA 24	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	4	0	0
SWWA 25	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	2	0	0	0	0	0	0	8	0	0
SWWA 26	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	19	0	0
SWWA 27	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	13	0	0	0	0	0	0	9	0	0
SWWA 28	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	15	0	0
SWWA 32	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	0	4	0	0
SWWA 33	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera[b]	Diptera	Misc. Diptera[c]	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AL2P2	unoccupied	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
AL2P7	unoccupied	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
AL3P15	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
CL7P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
DL1	unoccupied	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ENL6P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FL8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
IB91	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
JB56	unoccupied	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
JL4	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
ML37	unoccupied	0	0	2	0	0	0	0	0	0	0	0	0	2	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5
ML52	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SH17	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SWWA 13	occupied	0	0	0	0	0	0	8	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA 17	occupied	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SWWA 2	occupied	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SWWA 22	occupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA 23	occupied	0	0	0	0	2	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
SWWA 24	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 25	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 26	occupied	0	0	0	0	1	0	5	0	0	0	0	0	0	5	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
SWWA 27	occupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 28	occupied	3	0	0	0	0	0	5	0	0	0	0	0	0	24	0	22	0	0	0	0	2	0	0	0	0	0	0	0	0	22
SWWA 32	occupied	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SWWA 33	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Misc. Lepidoptera[d]	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown[e]
AL2P16	unoccupied	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0
AL2P2	unoccupied	2	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
AL2P7	unoccupied	2	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0
AL3P15	unoccupied	1	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
CL7P5	unoccupied	1	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0
DL1	unoccupied	1	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
ENL6P2	unoccupied	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0
FL8	unoccupied	1	0	0	0	0	0	11	0	0	0	0	0	0	0	11	0	0	0	0
IB91	unoccupied	3	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0	0	0	0
JB56	unoccupied	2	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0	0	0	0
JL4	unoccupied	5	0	0	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	0
ML37	unoccupied	5	0	0	0	0	0	31	0	0	0	0	0	0	0	31	0	0	0	0
ML52	unoccupied	1	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
SH17	unoccupied	3	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
SWWA 13	occupied	1	0	0	0	0	0	24	0	0	0	0	0	0	0	24	0	0	0	0
SWWA 17	occupied	3	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
SWWA 2	occupied	3	0	0	0	0	0	17	0	0	0	0	0	0	0	17	0	0	0	0
SWWA 22	occupied	1	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
SWWA 23	occupied	6	0	0	0	0	0	17	0	0	0	0	0	0	0	17	0	0	0	0
SWWA 24	occupied	0	0	0	0	0	0	25	0	0	2	0	0	0	0	23	0	0	0	0
SWWA 25	occupied	2	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
SWWA 26	occupied	0	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0
SWWA 27	occupied	2	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0	0	0	0
SWWA 28	occupied	22	0	0	0	0	0	36	0	0	0	0	0	0	0	36	0	0	0	0
SWWA 32	occupied	3	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0
SWWA 33	occupied	1	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
SWWA 34	occupied	1	1	0	0	0	0	0	0	0	11	11	0	0	0	3	1	0	4	2	5	0	0	0	0	0	0	0	0	0	0
SWWA 35	occupied	0	0	0	0	0	0	0	0	0	14	14	0	0	13	0	0	0	3	4	7	0	0	0	0	0	0	0	0	0	0
SWWA 38	occupied	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	0	0	0	3	28	0	0	0	0	0	0	0	0	0	0
SWWA 39	occupied	0	0	0	0	0	0	0	0	0	13	9	0	4	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 40	occupied	0	0	0	0	0	0	0	0	4	4	4	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
SWWA 45	occupied	0	0	0	0	0	0	0	0	0	11	11	0	0	0	0	0	0	0	1	11	0	0	0	0	0	0	0	0	0	0
SWWA 7	occupied	1	1	0	0	0	0	0	0	0	14	12	2	0	14	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	3
SWWA 8	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
T12P1	unoccupied	0	0	0	0	0	0	0	0	0	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T17P2	unoccupied	0	0	0	0	0	0	0	0	0	9	9	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
T32P18	unoccupied	0	0	0	0	0	0	0	0	0	9	9	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T38P4	unoccupied	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0
TC43	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TC47	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
SWWA 34	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	1	0	0
SWWA 35	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	4	0	0	0	0	1	0	8	0	6
SWWA 38	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	17	0	1
SWWA 39	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	3	0	0
SWWA 40	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	5	0	0
SWWA 45	occupied	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	15	6	0	1	0	0	0	0	8	0	0
SWWA 7	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	17	0	0	0	0	0	0	7	0	0
SWWA 8	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	1	0	0	0	0	0	0	17	0	0
T12P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	8	0	0	0	0	0	0	3	0	0
T17P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	17	0	0
T32P18	unoccupied	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0
T38P4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	2	0	0	0	0	0	0	17	0	0
TC43	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0
TC47	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	2	0	0	0	0	0	0	0	0

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
SWWA 34	occupied	0	0	0	0	2	0	5	0	0	0	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	4
SWWA 35	occupied	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	3
SWWA 38	occupied	0	0	3	0	3	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
SWWA 39	occupied	0	0	0	0	2	0	6	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	6
SWWA 40	occupied	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	7
SWWA 45	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 7	occupied	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 8	occupied	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
T12P1	unoccupied	0	0	3	0	0	0	0	0	0	0	0	0	0	6	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
T17P2	unoccupied	0	0	0	0	1	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T32P18	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
T38P4	unoccupied	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TC43	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
TC47	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Appendix B. Continued.

2004 Litter Sample Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
SWWA 34	occupied	4	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
SWWA 35	occupied	3	0	0	0	0	0	56	0	0	0	0	0	0	0	56	0	0	0	0
SWWA 38	occupied	7	0	0	0	0	0	30	0	0	0	0	0	0	0	30	0	0	0	0
SWWA 39	occupied	6	0	0	0	0	0	158	0	0	0	0	0	0	0	158	0	0	0	0
SWWA 40	occupied	7	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0
SWWA 45	occupied	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0
SWWA 7	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 8	occupied	2	0	0	0	0	0	16	0	0	0	0	0	0	0	16	0	0	0	0
T12P1	unoccupied	1	0	0	0	0	0	25	0	0	0	0	0	0	0	25	0	0	0	0
T17P2	unoccupied	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0
T32P18	unoccupied	7	0	0	0	0	0	126	0	0	0	0	0	0	0	126	0	0	0	0
T38P4	unoccupied	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0
TC43	unoccupied	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31	0	0	0	0
TC47	unoccupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	17	15	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
AL2P2	unoccupied	2	2	0	1	1	0	0	0	0	18	13	3	2	1	9	0	0	1	0	2	0	0	0	1	0	4	0	1	0	3
AL2P7	unoccupied	0	0	0	0	0	0	0	0	0	16	16	0	0	0	0	0	0	0	0	0	0	4	0	0	0	12	0	0	0	12
AL3P15	unoccupied	1	1	0	0	0	0	0	0	0	23	23	0	0	0	22	0	0	0	0	0	0	0	0	0	0	10	0	0	0	10
CL7P5	unoccupied	0	0	0	0	0	0	0	0	0	11	11	0	0	29	0	0	0	0	0	0	0	2	0	0	0	11	0	0	0	11
DL1	unoccupied	1	1	0	0	0	0	0	0	0	83	79	4	0	16	3	0	0	0	0	0	5	0	0	0	0	32	0	0	0	32
ENL6P2	unoccupied	1	1	0	0	0	0	0	0	0	8	8	0	0	24	0	0	0	0	0	0	1	3	0	0	0	9	0	2	0	7
FL8	unoccupied	4	4	0	0	0	0	0	0	0	29	29	0	0	14	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0
IB91	unoccupied	1	1	0	1	0	1	0	0	0	16	16	0	0	6	0	0	0	0	0	0	0	3	0	0	0	9	0	1	1	7
JB56	unoccupied	0	0	0	0	0	0	0	0	0	6	6	0	0	4	4	0	0	0	0	0	0	2	0	0	0	10	0	0	7	3
JL4	unoccupied	0	0	0	0	0	0	0	0	2	10	10	0	0	0	3	0	0	2	0	2	0	0	0	0	0	12	0	0	1	11
ML37	unoccupied	0	0	0	0	0	0	0	0	0	25	24	1	0	23	0	0	7	0	0	0	0	3	0	0	0	21	0	0	0	21
ML52	unoccupied	0	0	0	0	0	0	0	0	0	126	19	107	0	2	0	0	2	0	0	0	0	2	0	0	0	5	0	0	0	5
SH17	unoccupied	2	2	0	2	2	0	0	0	0	26	26	0	0	34	0	0	0	0	0	0	0	7	0	0	0	19	2	0	1	16
SWWA 13	occupied	0	0	0	0	0	0	0	0	0	52	50	2	0	2	9	0	0	0	0	0	0	0	0	0	1	18	1	0	3	14
SWWA 17	occupied	1	1	0	0	0	0	0	1	0	42	42	0	0	0	10	0	0	0	5	0	2	7	0	0	0	12	0	0	3	9
SWWA 2	occupied	0	0	0	0	0	0	0	0	0	10	10	0	0	7	0	0	0	0	0	0	0	5	0	0	0	14	0	0	0	14
SWWA 22	occupied	1	1	0	0	0	0	0	0	0	19	19	0	0	12	9	0	0	0	0	0	0	1	0	0	0	17	0	0	0	17
SWWA 23	occupied	0	0	0	0	0	0	0	0	0	5	3	0	2	0	7	0	0	3	1	0	0	2	0	0	0	11	0	0	0	11
SWWA 24	occupied	0	0	0	1	1	0	0	0	0	10	10	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5	0	0	0	5
SWWA 25	occupied	2	2	0	1	1	0	0	0	0	29	25	4	0	0	19	0	0	2	2	0	1	0	0	0	0	10	0	0	0	10
SWWA 26	occupied	2	2	0	1	0	0	1	0	0	34	32	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3
SWWA 27	occupied	6	6	0	0	0	0	0	0	0	10	4	6	0	1	2	0	0	0	0	1	0	4	0	0	0	6	0	3	0	3
SWWA 28	occupied	0	0	0	0	0	0	0	0	0	6	6	0	0	1	21	0	0	0	0	0	0	4	0	0	0	34	1	0	0	33
SWWA 32	occupied	2	2	0	0	0	0	0	0	0	19	19	0	0	2	0	0	0	2	0	0	0	3	0	0	0	10	0	0	0	10
SWWA 33	occupied	1	1	0	0	0	0	0	0	0	18	15	3	0	12	0	0	0	0	0	0	0	0	0	0	0	8	0	0	3	5

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	7	0	0	0	0	0	0	10	0	1
AL2P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	106	62	8	0	0	0	0	0	35	0	0
AL2P7	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	10	0	0	0	0	0	0	32	0	0
AL3P15	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	4	0	0	0	0	0	0	24	0	0
CL7P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	5	0	0	0	0	0	0	15	0	0
DL1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	21	1	0	0	0	0	0	34	0	0
ENL6P2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	9	0	0	0	0	0	0	13	0	0
FL8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	21	9	0	0	0	0	0	0	0	0
IB91	unoccupied	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	6	0	0	0	0	0	0	4	0	0
JB56	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	15	12	0	0	0	0	0	16	0	0
JL4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	7	0	0
ML37	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	10	0	0	0	0	0	0	14	0	0
ML52	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	5	1	0	0	0	0	0	5	0	0
SH17	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	26	0	0
SWWA 13	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	38	14	3	0	0	0	0	0	12	0	0
SWWA 17	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	47	8	0	0	0	0	0	55	0	0
SWWA 2	occupied	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	32	13	2	0	0	0	0	0	17	0	0
SWWA 22	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	14	0	0	0	0	0	0	0	0	0
SWWA 23	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	11	0	0	0	0	0	0	18	0	0
SWWA 24	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	4	0	0
SWWA 25	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	22	0	0	0	0	0	0	4	0	0
SWWA 26	occupied	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	38	16	2	0	0	0	0	0	20	0	0
SWWA 27	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	89	56	4	0	0	0	0	0	29	0	0
SWWA 28	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	46	0	0	0	0	0	0	25	0	0
SWWA 32	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	19	0	0	0	0	0	0	15	0	0
SWWA 33	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	18	0	0	0	0	0	0	7	0	0

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
AL2P16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AL2P2	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
AL2P7	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
AL3P15	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	9	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0
CL7P5	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	3
DL1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
ENL6P2	unoccupied	0	0	4	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
FL8	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	1	4	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
IB91	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
JB56	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	11	0	0	9	2	0	0	0	0	0	0	0	0	0	0	0	0
JL4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1
ML37	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
ML52	unoccupied	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
SH17	unoccupied	0	0	5	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 13	occupied	1	0	7	0	0	0	1	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 17	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 2	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0
SWWA 22	occupied	0	0	0	0	0	0	2	0	0	0	0	0	1	9	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 23	occupied	0	0	0	0	4	0	0	0	0	0	0	0	0	17	2	0	0	9	0	0	0	0	0	0	0	0	6	0	0	1
SWWA 24	occupied	0	0	6	0	0	0	0	0	0	0	0	0	0	6	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	1
SWWA 25	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0
SWWA 26	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 27	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	1
SWWA 28	occupied	6	0	0	0	0	0	0	0	0	0	0	0	0	7	0	2	0	3	2	0	0	0	0	0	0	0	0	0	0	0
SWWA 32	occupied	0	0	3	0	0	0	0	0	0	0	0	0	0	8	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 33	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
AL2P16	unoccupied	0	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
AL2P2	unoccupied	0	0	0	0	0	0	23	0	0	0	0	0	0	0	22	0	0	1	0
AL2P7	unoccupied	0	0	0	0	0	0	19	0	0	0	0	0	0	0	19	0	0	0	0
AL3P15	unoccupied	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
CL7P5	unoccupied	3	0	0	0	0	0	20	0	1	0	0	0	0	0	19	0	0	0	0
DL1	unoccupied	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23	0	0	0	0
ENL6P2	unoccupied	0	0	0	0	0	0	20	0	0	0	0	0	0	0	19	0	0	1	0
FL8	unoccupied	0	0	0	0	0	0	26	0	0	0	0	0	0	0	26	0	0	0	0
IB91	unoccupied	0	0	0	0	0	0	15	0	0	0	0	0	0	0	15	0	0	0	0
JB56	unoccupied	0	0	0	0	0	0	11	0	0	0	0	0	0	0	11	0	0	0	0
JL4	unoccupied	1	0	0	0	0	0	14	0	2	0	0	0	0	0	11	0	0	1	0
ML37	unoccupied	0	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0
ML52	unoccupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
SH17	unoccupied	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
SWWA 13	occupied	0	0	0	0	0	0	31	0	0	0	0	0	0	0	26	0	0	5	0
SWWA 17	occupied	0	0	0	0	0	0	46	0	0	0	0	1	0	4	41	0	0	0	0
SWWA 2	occupied	0	0	0	0	0	0	25	0	0	0	0	0	0	2	23	0	0	0	0
SWWA 22	occupied	0	0	0	0	0	0	29	0	0	0	0	0	0	0	29	0	0	0	0
SWWA 23	occupied	1	0	0	0	0	0	30	0	0	0	0	0	0	0	30	0	0	0	0
SWWA 24	occupied	1	0	0	0	0	0	12	0	3	0	0	1	0	0	8	0	0	0	0
SWWA 25	occupied	0	0	0	0	0	0	27	0	0	0	0	0	0	0	27	0	0	0	0
SWWA 26	occupied	2	0	0	0	0	0	37	0	1	0	0	1	0	0	35	0	0	0	0
SWWA 27	occupied	1	0	0	0	0	0	64	0	2	0	0	0	0	0	58	0	4	0	0
SWWA 28	occupied	0	0	0	0	0	0	32	0	0	0	0	0	0	0	32	0	0	0	0
SWWA 32	occupied	0	0	0	0	0	0	18	0	0	0	0	0	0	0	18	0	0	0	0
SWWA 33	occupied	0	0	0	0	0	0	9	0	0	0	0	1	0	0	8	0	0	0	0

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
SWWA 34	occupied	0	0	0	0	0	0	0	0	0	16	16	0	0	3	3	0	0	1	0	0	0	3	0	0	0	15	0	0	0	15
SWWA 35	occupied	1	1	0	0	0	0	0	0	0	16	16	0	0	19	2	0	0	0	1	0	0	3	0	0	0	3	0	0	1	2
SWWA 38	occupied	2	2	0	0	0	0	0	0	0	0	0	0	0	7	3	0	0	0	0	0	0	8	0	0	0	3	0	0	0	3
SWWA 39	occupied	6	6	0	0	0	0	0	0	0	34	29	5	0	4	7	0	0	0	0	0	1	0	0	0	0	5	0	0	0	5
SWWA 40	occupied	0	0	0	0	0	0	0	0	1	14	14	0	0	4	5	0	0	0	0	0	0	0	0	0	0	7	1	0	1	5
SWWA 45	occupied	0	0	0	0	0	0	0	0	0	5	5	0	0	9	10	0	0	0	0	4	0	2	0	0	0	14	0	0	5	9
SWWA 7	occupied	10	10	0	1	0	0	1	0	0	36	33	3	0	36	0	0	0	4	0	0	2	12	0	0	0	11	0	0	0	11
SWWA 8	occupied	0	0	0	0	0	0	0	0	0	25	24	1	0	0	6	0	0	0	0	0	0	0	0	0	0	10	0	0	1	9
T12P1	unoccupied	2	2	0	0	0	0	0	0	0	17	17	0	0	0	0	0	0	0	0	0	0	1	0	0	0	19	0	1	1	17
T17P2	unoccupied	0	0	0	0	0	0	0	0	0	16	15	1	0	5	3	0	0	0	0	0	1	2	0	0	0	12	0	0	0	12
T32P18	unoccupied	1	0	1	0	0	0	0	0	0	18	18	0	0	23	2	0	0	0	0	0	0	0	0	0	0	8	0	0	0	8
T38P4	unoccupied	0	0	0	0	0	0	0	0	0	12	12	0	0	3	1	0	0	0	0	0	0	2	0	0	0	11	0	0	0	11
TC43	unoccupied	0	0	0	0	0	0	0	0	0	11	11	0	0	3	0	0	0	0	0	0	0	1	0	0	0	23	0	0	3	20
TC47	unoccupied	0	0	0	0	0	0	0	0	0	17	17	0	0	2	0	0	0	0	0	0	0	1	0	0	0	11	0	0	0	11

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
SWWA 34	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	31	0	0	2	0	0	1	6	0	0
SWWA 35	occupied	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	26	17	0	0	0	0	0	0	7	0	0
SWWA 38	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	16	0	0	0	0	0	0	15	0	0
SWWA 39	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	43	36	1	0	0	0	0	0	5	0	0
SWWA 40	occupied	0	0	0	8	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	2	0	0
SWWA 45	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	11	1	0	0	0	0	0	8	0	0
SWWA 7	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	112	64	15	0	0	0	0	0	31	0	1
SWWA 8	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	14	0	0	0	0	0	0	99	0	1
T12P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	11	2	0	0	0	0	0	22	0	1
T17P2	unoccupied	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0	0	0	0	0
T32P18	unoccupied	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	17	3	1	0	1	0	0	0	2	0	0
T38P4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	37	0	0	0	0	0	0	11	0	0
TC43	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	3	0	0	0	0	0	0	19	0	0
TC47	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	8	0	0	0	0	0	0	11	0	0

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
SWWA 34	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1
SWWA 35	occupied	0	0	1	0	0	0	1	0	0	0	0	0	0	11	0	2	5	2	2	0	0	0	0	0	0	0	0	0	0	0
SWWA 38	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	8	0	0	2	6	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 39	occupied	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 40	occupied	0	0	0	0	1	0	0	0	0	0	0	0	0	14	0	0	7	6	0	0	0	0	1	0	0	0	0	0	0	0
SWWA 45	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 7	occupied	0	0	1	0	0	0	0	0	0	0	0	0	0	7	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 8	occupied	0	0	2	0	0	0	1	0	0	0	0	0	0	52	12	0	14	26	0	0	0	0	0	0	0	0	0	0	0	2
T12P1	unoccupied	1	0	6	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T17P2	unoccupied	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T32P18	unoccupied	0	0	10	0	0	0	0	0	0	0	0	0	0	10	0	0	3	7	0	0	0	0	0	0	0	0	0	0	0	1
T38P4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0
TC43	unoccupied	0	0	2	0	0	0	0	0	0	0	0	0	0	6	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	1
TC47	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1

Appendix B. Continued.

2004 Pitfall Trap Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
SWWA 34	occupied	0	0	0	0	1	0	9	0	0	1	0	0	0	0	8	0	0	0	0
SWWA 35	occupied	0	0	0	0	0	0	25	0	0	0	0	0	0	0	25	0	0	0	1
SWWA 38	occupied	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31	0	0	0	0
SWWA 39	occupied	0	0	0	0	0	0	25	0	0	0	0	0	0	0	25	0	0	0	0
SWWA 40	occupied	0	0	0	0	0	0	15	0	0	0	0	0	0	0	15	0	0	0	0
SWWA 45	occupied	0	0	0	0	0	0	6	0	0	1	0	0	0	0	3	2	0	0	0
SWWA 7	occupied	0	0	0	0	0	0	31	0	0	0	0	0	0	0	31	0	0	0	0
SWWA 8	occupied	2	0	0	0	0	0	22	0	0	0	0	4	0	0	17	1	0	0	0
T12P1	unoccupied	0	0	0	0	0	0	35	0	0	4	0	2	0	0	28	1	0	0	0
T17P2	unoccupied	0	0	0	0	0	0	13	0	0	0	0	0	0	0	11	2	0	0	0
T32P18	unoccupied	1	0	0	0	0	0	11	0	1	0	0	0	0	0	10	0	0	0	0
T38P4	unoccupied	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0
TC43	unoccupied	1	0	0	0	0	0	18	0	0	0	0	0	0	0	18	0	0	0	0
TC47	unoccupied	1	0	0	0	0	0	14	0	0	0	0	0	0	0	14	0	0	0	0

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
AL 31	unoccupied	0	0	0	0	0	0	0	0	0	19	19	0	0	33	0	0	0	7	0	79	0	0	0	0	0	0	0	0	0	0
AL2P3	unoccupied	0	0	0	0	0	0	0	0	0	5	5	0	0	0	1	0	0	9	1	7	0	0	0	0	0	0	0	0	0	0
AL5P9	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
AL6P12	unoccupied	2	2	0	0	0	0	0	0	0	11	11	0	0	7	0	0	0	3	0	16	0	0	0	0	0	0	0	0	0	0
BI 5	unoccupied	0	0	0	0	0	0	0	0	0	4	4	0	0	7	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0
BL 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
BS 2	unoccupied	0	0	0	0	0	0	0	0	0	12	12	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BSL 8	unoccupied	0	0	0	0	0	0	0	0	0	14	14	0	0	0	0	0	0	0	0	24	0	0	0	0	0	7	0	0	0	7
CL8P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	2	0	14	0	0	0	0	1	0	0	0	0	0
IB80	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
IB87	unoccupied	0	0	0	0	0	0	0	0	0	16	16	0	0	16	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
MB 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
MB 9	unoccupied	0	0	0	0	0	0	0	0	0	11	11	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAS 16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAS 22	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	3	3	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
PAS 29	unoccupied	0	0	0	0	0	0	0	0	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 11	occupied	0	0	0	0	0	0	0	0	0	2	2	0	0	7	0	0	0	0	0	4	0	0	72	0	0	0	0	0	0	0
SWWA 12	occupied	0	0	0	0	0	0	0	0	1	5	5	0	0	6	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0	0
SWWA 15	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 16	occupied	0	0	0	0	0	0	0	0	1	7	7	0	0	10	0	0	0	3	0	12	0	0	0	0	0	0	0	0	0	0
SWWA 41	occupied	1	1	0	0	0	0	0	0	0	13	13	0	0	14	0	0	0	0	3	17	0	0	0	0	0	0	0	0	0	0
SWWA 44	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
SWWA 5	occupied	0	0	0	0	0	0	0	0	0	15	15	0	0	0	0	0	0	7	2	10	0	1	0	0	0	4	0	0	0	4
SWWA4905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	0	0	0	0	0	1	0	0	0	0	0
SWWA5005	occupied	0	0	0	0	0	0	0	0	0	13	13	0	0	0	0	0	0	4	0	12	0	1	0	0	0	0	0	0	0	0

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
AL 31	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	22	0	0
AL2P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0
AL5P9	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	17	0	0
AL6P12	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	6	0	0
BI 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	3
BL 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
BS 2	unoccupied	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0
BSL 8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1
CL8P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
IB80	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
IB87	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	5	2	0	0	0	0	0	0	3	0	0
MB 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0
MB 9	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
PAS 16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	4	0	1
PAS 22	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0
PAS 29	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0
SWWA 11	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	0	2	0	0	0	0	0	0	0
SWWA 12	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0
SWWA 15	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	2	0	0	0	0	0	0	0	0	0
SWWA 16	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	13	0	0	0	0	0	0	0	13	0	0
SWWA 41	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	17	2	0	0	0	0	0	1	13	0	0
SWWA 44	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	10	0	0
SWWA 5	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1	2	0	0	0	0	0	4	0	0
SWWA4905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0
SWWA5005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	5	1	0	0	16	0	0	0	0	0	0	0	11	0	2

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
AL 31	unoccupied	0	0	0	0	8	0	0	0	0	1	0	0	0	6	5	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3
AL2P3	unoccupied	0	0	0	0	5	0	0	0	0	0	0	0	0	5	0	2	0	2	0	0	1	0	0	0	0	0	0	0	0	4
AL5P9	unoccupied	0	0	0	0	0	0	4	0	1	1	0	0	0	15	10	2	2	0	0	0	1	0	0	0	0	0	0	0	0	3
AL6P12	unoccupied	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
BI 5	unoccupied	2	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
BL 5	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
BS 2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
BSL 8	unoccupied	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
CL8P1	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	3	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4
IB80	unoccupied	4	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
IB87	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2
MB 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
MB 9	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	1
PAS 16	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	1
PAS 22	unoccupied	0	0	2	0	0	0	0	0	0	0	0	0	0	5	0	0	2	2	0	0	0	0	1	0	0	0	0	0	0	1
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAS 29	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA 11	occupied	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 12	occupied	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
SWWA 15	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 16	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
SWWA 41	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA 44	occupied	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
SWWA 5	occupied	0	0	0	0	5	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4
SWWA4905	occupied	0	0	0	0	1	0	1	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	12
SWWA5005	occupied	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
AL 31	unoccupied	3	0	0	0	0	0	64	0	0	0	0	0	0	0	64	0	0	0	0
AL2P3	unoccupied	4	0	0	0	0	0	20	0	0	0	0	0	0	0	20	0	0	0	0
AL5P9	unoccupied	3	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
AL6P12	unoccupied	2	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0
BI 5	unoccupied	4	0	0	0	2	0	8	0	0	0	0	0	0	0	8	0	0	0	0
BL 5	unoccupied	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
BS 2	unoccupied	1	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
BSL 8	unoccupied	4	0	0	0	0	0	11	0	0	0	0	0	0	0	11	0	0	0	0
CL8P1	unoccupied	4	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	0
IB80	unoccupied	6	4	0	0	0	0	14	0	0	0	0	0	0	0	14	0	0	0	0
IB87	unoccupied	2	0	0	0	0	0	19	0	0	0	0	0	0	0	19	0	0	0	0
MB 5	unoccupied	1	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0
MB 9	unoccupied	1	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0
PAS 16	unoccupied	0	0	0	0	0	1	3	0	0	0	0	0	0	0	3	0	0	0	0
PAS 22	unoccupied	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
PAS 28	unoccupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
PAS 29	unoccupied	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA 11	occupied	2	0	0	0	0	0	15	0	0	0	0	0	0	0	15	0	0	0	0
SWWA 12	occupied	1	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
SWWA 15	occupied	2	0	0	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	0
SWWA 16	occupied	6	0	0	0	0	0	17	0	0	0	0	0	0	0	17	0	0	0	0
SWWA 41	occupied	2	0	0	0	0	0	15	0	0	0	0	0	0	0	15	0	0	0	0
SWWA 44	occupied	5	0	0	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	0
SWWA 5	occupied	4	0	0	0	0	0	26	0	0	0	0	0	0	0	26	0	0	0	0
SWWA4905	occupied	12	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
SWWA5005	occupied	9	0	0	0	0	0	23	0	0	0	0	0	0	0	23	0	0	0	0

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
SWWA5205	occupied	0	0	0	0	0	0	0	0	0	12	12	0	0	9	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0
SWWA5305	occupied	0	0	0	0	0	0	0	0	2	20	20	0	0	12	0	0	0	12	0	32	0	0	0	0	0	0	0	0	0	0
SWWA5405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0
SWWA5605	occupied	0	0	0	0	0	0	0	0	0	5	5	0	0	0	0	0	0	1	0	10	0	0	0	0	0	0	0	0	0	0
SWWA5805	occupied	0	0	0	0	0	0	0	0	0	1	1	0	0	5	0	0	0	1	0	25	0	0	0	0	0	0	0	0	0	0
SWWA5905	occupied	0	0	0	0	0	0	0	0	0	17	17	0	0	12	0	0	0	0	2	23	0	0	0	0	0	0	0	0	0	0
SWWA6005	occupied	0	0	0	0	0	0	0	0	6	28	28	0	0	14	0	0	0	13	0	99	0	0	0	0	0	0	0	0	0	0
SWWA6205	occupied	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	3	0	5	0	0	0	0	0	0	0	0	0	0
SWWA6305	occupied	0	0	0	0	0	0	0	0	0	7	7	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA6405	occupied	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
SWWA6505	occupied	1	1	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
SWWA6605	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	2	0	0	0	2
SWWA6705	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
SWWA6805	occupied	0	0	0	0	0	0	0	0	0	4	4	0	0	7	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0
SWWA6905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0
SWWA7005	occupied	0	0	0	0	0	0	0	0	0	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	10	10	0	0	4	0	0	0	0	0	6	0	0	0	0	0	4	0	0	0	4
T23P19	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
T25P8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T30P4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0
T32P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
T3P1	unoccupied	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0
W7P6	unoccupied	0	0	0	0	0	0	0	0	0	7	7	0	0	0	0	0	0	0	1	30	0	2	0	0	0	0	0	0	0	0
W9P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
SWWA5205	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
SWWA5305	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
SWWA5405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
SWWA5605	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	14	12	1	0	0	0	0	0	0	0	0
SWWA5805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0
SWWA5905	occupied	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	14	2	0	0	0	0	0	0	11	0	0
SWWA6005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	6	0	0	0	0	0	0	18	0	0
SWWA6205	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	1	0	0	0	0	0	8	0	0
SWWA6305	occupied	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	4	0	0	0	0	0	0	0	4	0	0
SWWA6405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0
SWWA6505	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA6605	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
SWWA6705	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	0	0	0	0	2	0	0
SWWA6805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	5	0	0
SWWA6905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA7005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	4	0	0
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	3	0	0
T23P19	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T25P8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0
T30P4	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	0	0	0
T32P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0
T3P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0
W7P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W9P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	5	0	0	0	0	0	0	17	0	0

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
SWWA5205	occupied	0	0	0	0	0	0	4	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
SWWA5305	occupied	0	0	0	0	6	0	2	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
SWWA5405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SWWA5605	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA5805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
SWWA5905	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7
SWWA6005	occupied	0	0	0	0	2	0	9	0	0	2	0	0	0	12	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0
SWWA6205	occupied	0	0	0	0	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
SWWA6305	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
SWWA6405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
SWWA6505	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA6605	occupied	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA6705	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SWWA6805	occupied	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	11
SWWA6905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA7005	occupied	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
T23P19	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
T25P8	unoccupied	0	0	0	0	1	0	0	0	0	0	0	0	0	3	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3
T30P4	unoccupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
T32P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
T3P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	4
W7P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	6
W9P5	unoccupied	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Appendix B. Continued.

2005 Litter Sample Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
SWWA5205	occupied	5	0	0	0	0	0	28	0	0	0	0	0	0	0	28	0	0	0	0
SWWA5305	occupied	15	0	0	0	0	0	12	0	0	0	0	0	0	0	12	0	0	0	0
SWWA5405	occupied	0	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0
SWWA5605	occupied	0	0	0	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	0
SWWA5805	occupied	1	0	0	0	0	1	14	0	0	0	0	0	0	0	14	0	0	0	0
SWWA5905	occupied	7	0	0	0	0	0	23	0	0	0	0	0	0	0	23	0	0	0	0
SWWA6005	occupied	0	0	0	0	0	0	93	0	0	0	0	0	0	0	93	0	0	0	0
SWWA6205	occupied	2	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
SWWA6305	occupied	6	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0
SWWA6405	occupied	4	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0
SWWA6505	occupied	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA6605	occupied	1	0	0	0	0	0	13	0	0	0	0	0	0	0	13	0	0	0	0
SWWA6705	occupied	1	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0
SWWA6805	occupied	11	0	0	0	0	0	5	0	0	0	0	0	0	0	5	0	0	0	0
SWWA6905	occupied	0	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
SWWA7005	occupied	2	0	0	0	0	0	11	0	0	0	0	0	0	0	11	0	0	0	0
T21P6	unoccupied	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
T23P19	unoccupied	1	0	0	0	5	0	7	0	0	0	0	0	0	0	4	0	3	0	0
T25P8	unoccupied	3	0	0	0	0	0	6	0	0	0	0	1	0	0	5	0	0	0	0
T30P4	unoccupied	6	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
T32P3	unoccupied	0	0	0	0	1	0	14	0	0	0	0	0	0	0	14	0	0	0	0
T3P1	unoccupied	4	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
W7P6	unoccupied	3	3	0	0	0	0	20	0	0	0	0	0	0	0	20	0	0	0	0
W9P5	unoccupied	2	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
AL 31	unoccupied	0	0	0	1	1	0	0	0	0	13	11	2	0	4	0	0	0	0	1	0	0	7	0	0	0	24	0	0	1	23
AL2P3	unoccupied	7	7	0	0	0	0	0	0	0	29	28	1	0	14	3	0	0	0	0	12	2	3	0	0	0	3	0	0	0	3
AL5P9	unoccupied	5	5	0	0	0	0	0	0	0	58	56	2	0	21	0	0	0	0	0	0	0	10	0	0	0	60	3	0	0	57
AL6P12	unoccupied	0	0	0	0	0	0	0	0	0	9	9	0	0	7	0	0	0	0	0	17	0	3	0	0	0	40	0	0	4	36
BI 5	unoccupied	0	0	0	0	0	0	0	0	0	6	6	0	0	43	5	0	0	1	0	8	2	13	0	0	0	161	3	0	0	158
BL 5	unoccupied	0	0	0	0	0	0	0	0	0	9	9	0	0	9	0	0	0	0	0	0	0	6	0	0	0	68	1	0	2	65
BS 2	unoccupied	0	0	0	0	0	0	0	0	0	30	30	0	0	40	0	0	0	0	0	0	0	2	0	0	0	53	0	0	0	53
BSL 8	unoccupied	2	2	0	0	0	0	0	0	0	20	20	0	0	0	2	0	0	0	0	6	0	4	0	0	0	34	0	1	1	32
CL8P1	unoccupied	0	0	0	0	0	0	0	0	0	11	11	0	0	3	2	0	0	2	0	0	0	3	0	0	0	53	0	1	0	52
IB80	unoccupied	0	0	0	0	0	0	0	1	0	15	11	4	0	0	0	0	0	0	0	0	1	3	0	0	0	89	0	0	0	89
IB87	unoccupied	0	0	0	0	0	0	0	0	0	75	75	0	0	8	19	0	0	0	0	3	3	10	0	0	0	227	0	0	1	226
MB 5	unoccupied	0	0	0	0	0	0	0	0	0	44	44	0	0	34	0	0	2	1	0	0	0	6	0	0	0	132	0	0	3	129
MB 9	unoccupied	0	0	0	0	0	0	0	0	0	84	84	0	0	47	0	0	0	0	0	1	0	7	0	0	0	126	0	0	0	126
PAS 16	unoccupied	0	0	0	0	0	0	0	0	0	5	5	0	0	12	0	0	0	0	0	0	0	1	0	0	0	29	0	0	1	28
PAS 22	unoccupied	0	0	0	0	0	0	0	0	0	10	10	0	0	14	0	0	0	0	0	0	0	2	0	0	0	22	2	0	0	20
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	30	30	0	0	5	0	0	0	0	0	0	0	2	0	0	0	42	1	0	0	41
PAS 29	unoccupied	0	0	0	0	0	0	0	0	0	27	27	0	0	0	1	0	0	0	0	0	0	8	0	0	0	21	0	0	0	21
SWWA 11	occupied	5	5	0	1	0	0	1	0	0	26	24	2	0	23	0	0	0	3	0	0	0	8	0	0	0	53	0	2	1	50
SWWA 12	occupied	10	10	0	0	0	0	0	0	0	14	13	1	0	15	0	0	0	0	0	0	0	5	0	0	0	32	0	2	0	30
SWWA 15	occupied	3	3	0	0	0	0	0	0	0	33	33	0	0	11	1	0	0	2	2	0	0	8	0	0	0	84	1	0	0	83
SWWA 16	occupied	1	1	0	0	0	0	0	0	0	26	24	2	0	18	0	0	0	1	0	3	2	1	0	0	0	30	0	0	0	30
SWWA 41	occupied	0	0	0	0	0	0	0	0	0	5	5	0	0	23	9	0	0	0	0	4	0	10	0	0	0	70	3	0	1	66
SWWA 44	occupied	1	1	0	0	0	0	0	0	0	11	10	1	0	59	0	0	0	0	0	0	0	5	0	0	0	151	0	0	1	150
SWWA 5	occupied	0	0	0	0	0	0	0	0	0	9	9	0	0	3	0	0	0	0	0	0	0	5	0	0	0	32	3	0	0	29
SWWA4905	occupied	5	5	0	0	0	0	0	0	0	16	16	0	0	13	1	0	0	0	0	0	0	2	0	0	0	20	2	0	0	18
SWWA5005	occupied	7	7	0	0	0	0	0	0	0	31	30	1	0	6	0	0	0	3	0	0	0	4	0	0	0	50	1	0	1	48

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
AL 31	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	82	36	31	0	0	0	0	0	11	0	0
AL2P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	40	14	0	3	0	0	0	20	0	0
AL5P9	unoccupied	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	172	144	4	0	0	0	0	0	11	0	2
AL6P12	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	12	10	0	0	0	0	0	12	0	0
BI 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77	18	33	0	0	0	0	0	21	0	3
BL 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	55	7	0	0	0	0	0	0	0	0
BS 2	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	16	8	0	0	0	0	1	2	0	0
BSL 8	unoccupied	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	62	12	17	0	0	0	0	0	33	0	0
CL8P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	15	3	0	0	0	0	0	12	0	0
IB80	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124	33	19	0	0	0	0	0	59	0	0
IB87	unoccupied	0	0	0	1	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	129	48	47	0	0	0	0	0	26	0	0
MB 5	unoccupied	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	291	175	1	0	0	0	0	0	114	0	0
MB 9	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	243	182	2	0	0	0	0	2	53	0	0
PAS 16	unoccupied	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	138	29	69	0	1	0	0	2	34	0	0
PAS 22	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	72	16	0	1	0	0	0	31	0	0
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68	31	24	0	0	0	0	0	13	0	0
PAS 29	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	132	67	12	0	1	0	0	0	46	0	0
SWWA 11	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	18	0	0	0	0	0	0	38	0	0
SWWA 12	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	79	69	3	0	0	0	0	0	4	0	0
SWWA 15	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	29	6	0	0	0	0	0	22	0	0
SWWA 16	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	24	7	0	0	0	0	0	19	0	0
SWWA 41	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	136	28	91	0	0	0	0	0	15	0	0
SWWA 44	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	101	41	21	0	1	0	0	0	30	0	0
SWWA 5	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	78	40	18	0	0	0	0	0	17	0	0
SWWA4905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	15	0	0	0	2	1	0	16	0	0
SWWA5005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	28	30	0	0	0	0	0	26	0	0

2005 Pitfall Trap Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
AL 31	unoccupied	1	0	1	2	0	0	0	0	0	0	0	0	0	56	0	0	0	5	0	25	0	0	2	0	24	0	0	0	0	4
AL2P3	unoccupied	0	0	0	0	1	1	0	0	0	1	0	0	0	32	0	0	5	2	0	10	0	0	0	0	0	15	0	0	0	2
AL5P9	unoccupied	0	0	6	0	5	0	0	0	0	0	0	0	0	43	0	0	2	2	0	39	0	0	0	0	0	0	0	0	0	0
AL6P12	unoccupied	0	0	0	0	0	0	0	0	0	4	0	0	0	22	0	0	10	2	0	10	0	0	0	0	0	0	0	0	0	9
BI 5	unoccupied	1	0	0	1	0	0	0	0	0	0	0	0	0	23	0	0	0	2	2	0	0	0	0	0	19	0	0	0	0	0
BL 5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	4	0	0	5	0	0	0	0	0	0	0	0	0	0
BS 2	unoccupied	0	0	3	0	2	0	2	0	0	0	0	0	0	14	0	0	4	2	0	8	0	0	0	0	0	0	0	0	0	1
BSL 8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	1	9	0	11	0	0	0	0	0	1	0	0	0	2
CL8P1	unoccupied	0	0	0	0	2	0	0	0	0	0	0	0	0	14	0	0	2	1	0	11	0	0	0	0	0	0	0	0	0	0
IB80	unoccupied	0	0	2	0	11	0	0	0	0	0	0	0	0	44	0	5	9	0	2	0	0	0	0	0	28	0	0	0	0	6
IB87	unoccupied	0	0	5	0	2	0	0	0	1	0	0	0	0	12	0	0	3	2	0	0	0	0	0	0	7	0	0	0	0	0
MB 5	unoccupied	0	0	0	0	1	0	0	0	0	0	0	0	0	11	0	0	2	4	1	0	0	0	0	0	0	4	0	0	0	0
MB 9	unoccupied	0	0	0	0	2	0	2	0	0	0	0	0	0	32	0	0	2	25	0	2	0	0	2	0	0	1	0	0	0	1
PAS 16	unoccupied	0	0	3	0	0	0	0	0	0	0	0	0	0	10	0	0	4	2	2	0	0	0	0	0	0	2	0	0	0	1
PAS 22	unoccupied	0	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
PAS 28	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
PAS 29	unoccupied	0	0	0	0	3	2	1	0	0	0	0	0	0	6	0	0	0	1	0	4	0	0	0	0	0	1	0	0	0	0
SWWA 11	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	100	0	0	0	2	0	98	0	0	0	0	0	0	0	0	0	3
SWWA 12	occupied	0	0	3	0	0	0	0	0	0	0	0	0	0	62	0	0	2	2	0	58	0	0	0	0	0	0	0	0	0	4
SWWA 15	occupied	0	0	2	0	0	0	0	0	0	0	0	0	0	84	0	0	0	9	1	72	0	1	0	0	0	0	0	0	1	1
SWWA 16	occupied	0	0	2	0	0	0	0	0	0	0	0	0	0	31	0	11	0	2	0	18	0	0	0	0	0	0	0	0	0	0
SWWA 41	occupied	0	0	1	0	0	1	0	0	0	0	0	0	0	21	0	0	1	4	0	12	0	0	1	0	2	1	0	0	0	0
SWWA 44	occupied	4	0	3	0	1	0	0	0	0	0	0	0	0	40	0	0	32	2	0	6	0	0	0	0	0	0	0	0	0	3
SWWA 5	occupied	0	0	2	0	0	0	0	0	1	0	0	0	0	26	0	0	0	4	1	18	0	0	0	0	0	1	2	0	0	9
SWWA4905	occupied	0	0	5	3	0	0	0	0	0	0	0	0	0	52	0	0	0	2	0	49	0	0	0	0	1	0	0	0	0	1
SWWA5005	occupied	0	0	0	0	9	0	0	1	0	0	0	0	0	35	0	0	4	3	0	26	0	0	0	0	1	1	0	0	0	2

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
AL 31	unoccupied	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AL2P3	unoccupied	0	0	2	0	0	0	84	0	0	0	0	1	0	0	83	0	0	0	0
AL5P9	unoccupied	0	0	0	0	0	0	71	0	0	0	0	0	0	2	69	0	0	0	0
AL6P12	unoccupied	9	0	0	0	0	0	51	0	0	0	0	1	0	0	50	0	0	0	0
BI 5	unoccupied	0	0	0	0	0	0	39	0	0	0	0	0	0	0	39	0	0	0	0
BL 5	unoccupied	0	0	0	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	0
BS 2	unoccupied	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BSL 8	unoccupied	0	0	1	1	0	0	81	0	0	0	0	1	0	0	80	0	0	0	0
CL8P1	unoccupied	0	0	0	0	0	0	39	0	0	0	0	0	0	0	37	0	0	2	0
IB80	unoccupied	6	0	0	0	0	0	67	0	0	0	0	0	0	0	65	0	2	0	16
IB87	unoccupied	0	0	0	0	0	0	26	0	0	0	0	0	0	0	26	0	0	0	0
MB 5	unoccupied	0	0	0	0	0	0	5	0	0	0	0	0	0	0	2	0	3	0	0
MB 9	unoccupied	0	0	0	1	0	0	63	0	0	0	0	0	0	2	61	0	0	0	0
PAS 16	unoccupied	1	0	0	0	0	0	30	0	0	0	0	0	0	1	26	0	1	2	0
PAS 22	unoccupied	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23	0	0	0	2
PAS 28	unoccupied	0	0	0	0	0	0	17	0	0	1	0	0	0	0	13	0	0	3	0
PAS 29	unoccupied	0	0	0	0	0	0	22	0	0	0	0	0	0	0	21	0	0	1	0
SWWA 11	occupied	3	0	0	0	0	0	57	0	0	2	0	0	0	0	54	0	1	0	0
SWWA 12	occupied	4	0	0	0	0	0	9	0	0	0	0	0	0	0	9	0	0	0	0
SWWA 15	occupied	0	0	0	1	0	0	38	0	0	0	0	0	0	2	34	0	1	1	1
SWWA 16	occupied	0	0	0	0	0	0	44	0	0	0	0	1	0	0	42	1	0	0	0
SWWA 41	occupied	0	0	0	0	0	0	16	0	0	0	0	1	0	0	13	0	0	2	0
SWWA 44	occupied	2	0	0	1	0	0	65	0	0	1	0	0	0	0	64	0	0	0	0
SWWA 5	occupied	0	0	7	2	0	0	26	0	0	0	0	0	0	0	26	0	0	0	0
SWWA4905	occupied	1	0	0	0	0	0	37	1	0	0	0	0	0	0	36	0	0	0	0
SWWA5005	occupied	2	0	0	0	0	0	55	0	0	1	0	0	0	0	54	0	0	0	0

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Gastropoda	Gastropoda (Snails)	Gastropoda (Slugs)	Anura	Ranidae	Bufonidae	Microhylidae	Squamata	Haplotaxidae	Araneae	Misc. Araneae	Lycosidae	Thomisidae	Acari	Opiliones	Isopoda	Decopoda	Diplopoda	Chilopoda	Collembola	Microcoryphia	Blattodea	Isoptera	Psocoptera	Neuroptera	Orthoptera	Acrididae	Tettigoniidae	Rhaphidophoridae	Gryllidae
SWWA5205	occupied	0	0	0	1	1	0	0	0	0	10	10	0	0	7	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4
SWWA5305	occupied	2	2	0	0	0	0	0	0	0	8	8	0	0	0	0	0	0	0	0	0	0	4	0	0	0	35	0	0	3	32
SWWA5405	occupied	4	4	0	1	0	0	1	0	0	6	6	0	0	2	0	0	0	0	0	0	3	0	0	0	0	43	5	0	2	36
SWWA5605	occupied	1	1	0	0	0	0	0	0	0	22	20	2	0	11	50	0	0	0	3	5	3	4	0	0	0	73	2	0	1	70
SWWA5805	occupied	4	4	0	0	0	0	0	0	0	1	1	0	0	3	1	0	0	0	0	2	0	1	0	0	0	27	0	0	8	19
SWWA5905	occupied	6	6	0	0	0	0	0	0	0	15	15	0	0	0	0	0	0	0	0	0	0	10	0	0	0	14	0	2	2	10
SWWA6005	occupied	7	7	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	38	1	1	1	35
SWWA6205	occupied	1	1	0	0	0	0	0	1	0	45	45	0	0	33	0	0	0	0	2	0	3	2	0	0	0	116	3	0	0	113
SWWA6305	occupied	0	0	0	0	0	0	0	0	0	3	2	1	0	15	6	0	0	1	0	11	5	6	0	0	0	44	0	0	6	38
SWWA6405	occupied	0	0	0	0	0	0	0	0	0	27	27	0	0	2	17	0	0	0	0	0	0	5	0	0	0	106	1	0	0	105
SWWA6505	occupied	5	5	0	0	0	0	0	0	0	7	7	0	0	0	1	0	1	0	0	0	0	3	0	0	0	25	0	0	0	25
SWWA6605	occupied	1	1	0	0	0	0	0	0	0	12	12	0	0	0	0	0	0	0	0	0	0	2	0	0	0	34	0	0	0	34
SWWA6705	occupied	0	0	0	0	0	0	0	0	0	17	17	0	0	0	2	0	0	0	0	0	0	4	0	0	0	32	0	0	0	32
SWWA6805	occupied	0	0	0	0	0	0	0	0	0	23	19	4	0	83	4	0	0	0	0	4	0	14	0	0	0	199	0	0	13	186
SWWA6905	occupied	0	0	0	0	0	0	0	0	0	27	27	0	0	5	2	0	0	0	0	2	0	6	0	0	0	69	0	0	3	66
SWWA7005	occupied	0	0	0	0	0	0	0	0	0	30	29	0	1	2	2	0	0	5	0	0	0	10	0	0	0	50	0	0	0	50
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	6	6	0	0	0	3	0	0	0	0	0	0	3	0	0	0	24	0	0	0	24
T23P19	unoccupied	0	0	0	1	0	1	0	0	0	13	13	0	0	9	5	0	0	0	0	0	0	12	0	0	0	231	1	0	0	230
T25P8	unoccupied	2	2	0	0	0	0	0	0	0	16	16	0	0	15	1	0	0	0	0	0	0	5	0	0	0	33	0	0	1	32
T30P4	unoccupied	0	0	0	0	0	0	0	0	0	22	20	2	0	0	2	0	0	0	2	0	2	15	0	0	0	9	0	0	0	9
T32P3	unoccupied	1	1	0	0	0	0	0	0	0	13	12	1	0	9	0	0	0	0	0	0	0	7	0	0	0	32	0	0	0	32
T3P1	unoccupied	4	4	0	0	0	0	0	0	0	28	27	0	1	0	4	0	0	1	2	0	1	10	0	0	0	71	4	0	8	59
W7P6	unoccupied	2	2	0	0	0	0	0	0	0	29	29	0	0	19	8	0	0	0	0	0	2	3	0	0	0	101	2	0	3	96
W9P5	unoccupied	0	0	0	0	0	0	0	0	0	38	38	0	0	5	2	0	0	0	0	13	0	9	0	0	0	119	3	0	40	76

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Phasmatodea	Thysanoptera	Trichoptera	Hemiptera	Belostomatidae	Gerridae	Lygaeidae	Reduviidae	Coreidae	Pentatomidae	Miridae	Cydnidae	Aradidae	Homoptera	Membracidae	Cicadellidae	Acanalonidae	Flatidae	Cixiidae	Coleoptera	Carabidae	Scarabaeidae	Dytisidae	Lucanidae	Passalidae	Meloidae	Tenebrionidae	Staphyllinidae	Silphidae	Chrysomelidae
SWWA5205	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	28	0	0	0	0	0	0	14	0	0
SWWA5305	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	71	0	0	0	0	0	0	26	0	0
SWWA5405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62	31	4	0	0	0	0	0	23	0	0
SWWA5605	occupied	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	57	11	10	0	0	0	0	0	34	0	0
SWWA5805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	25	0	0	0	0	0	0	8	0	0
SWWA5905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	46	2	0	0	0	0	0	8	0	0
SWWA6005	occupied	0	0	0	20	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	74	44	21	0	0	0	0	0	7	0	0
SWWA6205	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	71	10	32	0	0	0	0	0	24	0	0
SWWA6305	occupied	0	0	0	3	0	0	0	2	0	0	1	0	0	1	0	1	0	0	0	49	5	6	0	0	0	0	0	18	1	0
SWWA6405	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	26	17	0	0	0	0	0	37	0	0
SWWA6505	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	36	4	0	0	0	0	0	13	0	0
SWWA6605	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	11	4	0	0	0	0	0	16	0	0
SWWA6705	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	12	5	0	0	0	0	0	27	0	0
SWWA6805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	37	7	0	0	0	0	0	38	0	0
SWWA6905	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	54	21	0	0	0	0	0	21	0	0
SWWA7005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	34	34	0	0	0	0	0	36	0	0
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	31	22	0	0	0	0	0	22	0	0
T23P19	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	60	2	0	0	0	0	0	16	1	0
T25P8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	125	65	8	0	1	0	0	0	51	0	0
T30P4	unoccupied	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	246	210	15	0	0	0	0	0	20	0	0
T32P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	67	19	0	0	0	0	3	28	0	0
T3P1	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76	24	15	0	0	0	0	0	26	0	0
W7P6	unoccupied	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	118	23	25	0	1	0	0	0	48	0	0
W9P5	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	22	4	0	0	0	0	0	0	0	0

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Curculionidae	Hydrophilidae	Nitidulidae	Coccinellidae	Lampyridae	Cantharidae	Elateridae	Buprestidae	Bostrichidae	Lycidae	Histeridae	Mordellidae	Misc. Coleoptera	Diptera	Misc. Diptera	Stratiomyidae	Mycetophilidae	Phoridae	Sciaridae	Rhagionidae	Tabaanidae	Calliphoridae	Tipulidae	Culicidae	Asilidae	Sarcophagidae	Dolicopodidae	Chironomedae	Heleomyzidae	Lepidoptera
SWWA5205	occupied	0	0	2	0	2	0	0	0	0	0	0	0	0	18	0	0	0	2	0	16	0	0	0	0	0	0	0	0	0	2
SWWA5305	occupied	0	0	0	0	0	0	2	0	0	0	0	0	0	19	0	0	0	2	0	16	0	0	0	0	0	1	0	0	0	0
SWWA5405	occupied	0	0	2	0	0	0	2	0	0	0	0	0	0	22	0	0	0	2	0	11	0	0	0	0	9	0	0	0	0	3
SWWA5605	occupied	0	0	2	0	0	0	0	0	0	0	0	0	0	55	0	0	0	2	0	0	0	0	0	0	52	1	0	0	0	1
SWWA5805	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
SWWA5905	occupied	0	0	2	0	0	0	1	0	0	0	0	0	0	25	0	1	2	2	0	20	0	0	0	0	0	0	0	0	0	0
SWWA6005	occupied	0	0	2	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0
SWWA6205	occupied	0	0	2	0	2	0	1	0	0	0	0	0	0	64	0	0	0	0	0	7	0	0	0	0	56	1	0	0	0	1
SWWA6305	occupied	0	0	5	0	11	0	0	0	1	0	1	1	0	12	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	3
SWWA6405	occupied	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
SWWA6505	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SWWA6605	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0
SWWA6705	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	1	1	1	0	0	0	0	0	0	4	0	0	0	0	0
SWWA6805	occupied	0	1	1	0	0	0	1	0	0	1	0	0	0	18	0	0	7	0	0	11	0	0	0	0	0	0	0	0	0	2
SWWA6905	occupied	0	0	0	0	0	0	1	0	0	0	0	0	0	7	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	3
SWWA7005	occupied	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
T21P6	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
T23P19	unoccupied	0	0	1	0	0	0	0	0	0	0	0	0	0	12	0	6	0	0	0	6	0	0	0	0	0	0	0	0	0	0
T25P8	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	0
T30P4	unoccupied	0	0	0	0	0	0	1	0	0	0	0	0	0	8	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0
T32P3	unoccupied	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	6	8	0	0	0	0	0	0	0	1	0	0	0	0
T3P1	unoccupied	0	0	0	0	9	0	1	0	1	0	0	0	0	17	0	7	0	10	0	0	0	0	0	0	0	0	0	0	0	1
W7P6	unoccupied	4	0	9	0	6	0	1	0	1	0	0	0	0	10	0	6	0	0	0	0	0	0	0	0	0	4	0	0	0	0
W9P5	unoccupied	0	0	2	0	2	0	1	1	0	0	0	0	0	13	0	0	0	5	0	8	0	0	0	0	0	0	0	0	0	0

Appendix B. Continued.

2005 Pitfall Trap Sites	Occupancy	Misc. Lepidoptera	Geometridae	Nymphalidae	Sphingidae	Noctuidae	Pyralidae	Hymenoptera	Siricidae	Chalcidoidea	Braconidae	Ichneumonidae	Tiphiidae	Mutillidae	Apidae	Formicidae	Pompilidae	Sphecidae	Halictidae	Unknown
SWWA5205	occupied	0	0	2	0	0	0	62	0	0	0	0	0	0	0	62	0	0	0	0
SWWA5305	occupied	0	0	0	0	0	0	30	0	0	0	1	0	0	0	29	0	0	0	0
SWWA5405	occupied	3	0	0	0	0	0	7	0	0	0	0	0	0	0	7	0	0	0	0
SWWA5605	occupied	0	0	0	1	0	0	27	0	0	0	0	0	0	0	26	0	0	1	0
SWWA5805	occupied	0	0	0	0	0	0	19	0	0	0	0	0	0	0	19	0	0	0	0
SWWA5905	occupied	0	0	0	0	0	0	23	0	0	0	0	0	0	0	23	0	0	0	0
SWWA6005	occupied	0	0	0	0	0	0	24	0	0	1	0	2	0	0	21	0	0	0	0
SWWA6205	occupied	1	0	0	0	0	0	29	0	0	0	0	3	0	0	24	0	0	2	1
SWWA6305	occupied	3	0	0	0	0	0	23	0	1	0	0	0	0	0	22	0	0	0	0
SWWA6405	occupied	0	0	0	0	0	0	34	0	0	0	0	0	0	0	33	0	0	1	0
SWWA6505	occupied	0	0	0	0	0	0	54	0	0	0	0	0	1	0	53	0	0	0	0
SWWA6605	occupied	0	0	0	0	0	0	19	0	0	0	0	0	0	0	19	0	0	0	0
SWWA6705	occupied	0	0	0	0	0	0	10	0	0	0	0	0	0	0	10	0	0	0	0
SWWA6805	occupied	2	0	0	0	0	0	24	0	0	0	0	0	1	0	22	0	1	0	0
SWWA6905	occupied	2	0	0	1	0	0	16	0	0	0	0	0	0	0	16	0	0	0	0
SWWA7005	occupied	1	0	0	0	0	0	44	0	0	0	0	0	0	0	43	0	1	0	0
T21P6	unoccupied	0	0	0	0	0	0	35	0	0	0	0	1	0	0	34	0	0	0	0
T23P19	unoccupied	0	0	0	0	0	0	48	0	0	0	0	0	0	0	48	0	0	0	0
T25P8	unoccupied	0	0	0	0	0	0	15	0	0	0	0	0	0	0	15	0	0	0	0
T30P4	unoccupied	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0	0	2
T32P3	unoccupied	0	0	0	0	0	0	30	0	0	0	0	0	0	0	30	0	0	0	0
T3P1	unoccupied	1	0	0	0	0	0	45	0	0	0	0	0	0	0	43	1	0	1	0
W7P6	unoccupied	0	0	0	0	0	0	55	0	0	0	0	2	0	0	50	0	2	1	0
W9P5	unoccupied	0	0	0	0	0	0	20	0	0	0	0	0	0	0	20	0	0	0	0

[a] Miscellaneous spiders that I was unable to identify to the family level.
[b] Miscellaneous beetles that I was unable to identify to the family level.
[c] Miscellaneous flies that I was unable to identify to the family level.
[d] Miscellaneous butterflies and moths that I was unable to identify to the family level.
[e] Miscellaneous arthropods that I was unable to identify.