The Relationships Between Wildlife Openings and Avian Use and Abundance in the East Gulf Coastal Plain

by

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A thesis submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Master of Science

Auburn, Alabama
December 13, 2010

Keywords: abundance, bird use, occupancy, wildlife opening,
Alabama, coastal plain

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Abstract

Wildlife openings are forest openings created predominately for game species. Many bird species, some of which are exhibiting population declines, utilize openings during the breeding season. Openings can vary in size, shape, edge length, forest type, and management style. Point counts were conducted in openings of 2 study areas in south Alabama. We used occupancy analysis to determine how bird use as well as bird abundance were related to those 5 characteristics of openings. We incorporated detection into our analysis to account for imperfect detections. Bird use for many bird species showed strong relationships to size, edge, and management, while abundance for many species was strongly related to size, shape and management. Forest type did not have strong relationships with either use or abundance. These results may be incorporated into management plans to increase or control species distributions as well as to help maintain abundances of species of interest.

Acknowledgments

Project funding was provided by the Alabama Department of Conservation and Natural Resources State Wildlife Grants and The School of Forestry and Wildlife Sciences at Auburn University. I would like to give great thanks to my committee including Dr. Barry Grand, Dr. Gary Hepp, and Eric Soehren for their guidance and support throughout my graduate career. I would also like to thank my collegues in the Alabama Cooperative Fish and Wildlife Research Unit, especially Amy Silvano, Alan Hitch, and Mark Mackenzie for their support and help throughout this process. For administrative support I would like to thank Judy Christian. I would like to thank my research technicians for their help collecting field work: Paige Aplin, Marcus Collado, Mike Gagin, Donna Hestermann, Karen Tenaglia, and Erika Taketa. Last I would like to thank family and friends, especially Todd Threadgill for their support.

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CHAPTER I: INTRODUCTION

Many Neotropical migratory bird species are exhibiting population declines throughout their breeding ranges (Sauer et al. 2007). These declines are caused by many factors including predation and habitat loss. One source of decline that is common throughout the southeastern U.S. is the increase in fragmentation across landscapes. Forest fragmentation is the division of large contiguous tracts of forest habitat into smaller patches (Keyser et al. 1998) by creating early succesional fields, agriculture, and urban development. Fragmentation is a problem on both wintering and breeding grounds but has been found to be more detrimental on breeding grounds of Neotropical migrant species (Hagen and Johnston 1992, Böhning-Gaese et al. 1993).

Anthropogenic disturbances are an increasing source of fragmentation throughout the south. One anthropogenic factor that is prevalent throughout the south is the conversion of forest habitat to agricultural fields. This conversion creates early successional areas and decreases the amount of core area available in the forest interior; core area is essential for many species (Robbins et al. 1989). Along with agriculture, increases in logging of hardwood forests (USDA Forest Service 1988) in the southeastern U.S. over the last few decades may be altering the bird communities (Krements and Christie 2000, Lichstein et al. 2002, Wallendorf et al. 2007, Vitz and Rodewald 2007) by creating more early-succesional and edge habitat further fragmenting mature forest stands. Another man-made disturbance that causes fragmentation in forest stands and is prevalent throughout the southeast is the creation of wildlife openings. Wildlife openings are often created for large game animals such as white-tailed deer (*Odocoileus virginianus*) and wild turkey (*Meleagris gallopavo*) for supplemental feeding purposes. Frequently, they are planted with row crops such as soybeans (*Glycine max*) and corn (*Zea mays*) or forbs such as partridge pea (*Chamaecrista fasciculate*, Harper 2007). Occasionally openings in forested habitats are maintained as open fields but not managed heavily to provide more hunting opportunities. These openings are created to increase densities of game species while giving hunters an increased chance of harvesting an animal.

While little information is known about the importance of wildlife openings to non-target species such as songbirds (Chandler et al. 2009, King et al. 2009), openings have been found to benefit those species at certain times of the year. When openings are planted during spring and summer months for deer and turkey, they also provide good foraging habitat for migrant birds during the breeding season when finding adequate food sources is imperative for adults as well as fledglings (Martin 1988, Anders et al. 1998). Planted forbs such as partridge pea are good for many species such as northern bobwhite (*Colinus virginianus*) and passerine birds (Harper 2007). Insectivorous species such as blue-gray gnatcatcher (*Polioptila caerulea*) may also benefit from increased foraging opportunities in wildlife openings. Berries, such as blackberries (*Rubus* spp.) and blueberries (*Vaccinium* spp.), often grow along edges and within openings that are not managed intensely or mowed frequently.

Along with foraging opportunities, openings also provide suitable nesting habitat and escape cover for some birds. Ground nesters will nest in these openings on bare ground and in warm season grasses like broomsedge (*Andropogon* spp., Harper 2007). When thickets are present in openings they are often used by non-raptorial birds for nesting and escape cover from avian predators such as red-shouldered hawks (*Buteo lineatus*). Edge habitat found around openings is often utilized for nesting as well.

There are many characteristics of wildlife openings which could affect bird species such as size, shape, edge, surrounding forest type, and management. The size of openings may be important when managing for bird species. Wildlife openings range in size from a small forest clearing of a few trees to large open fields over 50 hectares in size. Openings can differ in size based on the original intent for the opening. When managing for mourning dove or northern bobwhite, openings can to be larger (>5ha). For other game species such as white-tailed deer and eastern cottontail (*Silvilagus floridanus*), openings can be much smaller forest openings or food plots (e.g., <5ha). With this range in sizes for openings, it is important to know how the opening size affects bird use and abundance. Forest species may be deterred from forests adjacent to larger openings, and early successional species may require a minimum size of opening. One study in Illinois found that bird abundance began to increase in openings of 0.3ha (Overcash and Roseberry 1987).

Another characteristic of openings that may have an impact on bird occupancy is the length of edge habitat surrounding the opening (i.e., perimeter length). Nest predators often concentrate along forest edges, possibly because of increased density of nests in and around edge habitat (Wilcove 1985, Paton 1994, King et al. 1998). Also, several studies have suggested that brown-headed cowbirds (*Molothrus ater*) concentrate along edges which may increase the chance of parasitism on nests (Helzer and Jelinski 1999, Moorman et al. 2002, Howell et al. 2007). If this is the case then brown-headed cowbird occupancy should also show a positive relationship with the amount of edge present in an opening. Therefore, with the increase in edge habitat, predation and parasitism on nests may also increase. While there are negative associations with edge habitat, these areas often provides foraging opportunities as well as escape cover from many avian predators. Some bird species prefer edge habitat along forest edges for breeding as well, so with an increase in amount of edge habitat available within an opening, occupancy as well as density of those species may increase. Multiple species, such as northern cardinal (*Cardinalis cardinalis*) and field sparrows (*Spizella pusilla*), nest in thickets and briars along edges of wildlife openings (Fink et al. 2006, Harper 2007, Vitz and Rodewald 2007). When there is more edge habitat available for escape cover and foraging, more forest species may be found along wildlife openings. Therefore, the length of edge of an opening may be an important factor in managing for bird species along with increasing densities within different communities.

Similar to area and edge, the shape of the wildlife openings may also be a factor in the probability of bird occupancy for several bird species. Openings can range from irregular and oblong shapes to perfectly round. As an opening becomes more round the edge-to-core ratio of the opening decreases. This ratio is the perimeter of an opening divided by its area; consequently circular openings have the lowest edge-to-core ratio. Forest bird species may prefer openings with large edge-to-core ratios because there is more edge habitat for them to utilize and less open field. Many forest species will avoid flying through open habitats and fields (Desrochers and Hannon 1997). Therefore, the shape of the opening may be an important characteristic for forest species, as well as others.

The management of openings can vary greatly depending on intent. Some openings are intensely managed with plowing and planting of supplemental food for wildlife, while others are maintained as pastures or fields with no other management actions. While planted forbs such as common ragweed (*Ambrosia artemisiifolia*) and partridge pea are good for game species such as northern bobwhite, they also can be good foraging habitat for non-game bird species (Harper 2007). Due to the abundance of food, forest interior species, such as wood thrush (*Hylocichla mustelina*), may use these openings during the post-breeding season for foraging with their fledglings (Anders et al. 1998, Rivera et al. 1998, Marshall et al. 2003). While certain species, such as white-tailed deer and mourning dove (*Zenaida macroura*), are the focus of these management actions to create openings, some other species, both game and non-game, are likely affected by management practices. Therefore, it is important to examine the potential affects of management on other species found in the area.

Many bird species are associated with certain forest types, so the forest type surrounding an opening may also be a factor affecting their use by some species. One such species is the brown-headed nuthatch (*Sitta pusilla*), which is primarily associated with mature pine forests (Conner and Dickson 1997, Hamel 1992, Johnston and Odum 1956). Therefore, the likelihood that that species would be found within and around an opening surrounded by pine forest should be much greater than one surrounded by hardwoods.

Wildlife openings are often used by migrant bird species yet we have little understanding of the relationships between use and characteristics of openings. To better manage openings for bird species that are declining, it is important to know how species use and density are related to characteristics of openings (size, shape, edge length, management style, and forest type). To determine these relationships, we conducted field surveys on 2 study sites within the East Gulf Coastal Plain of South Alabama. We tested our *a priori* hypotheses using occupancy models to see if relationships existed between bird occupancies and abundances and characteristics of wildlife openings.

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CHAPTER II: THE RELATIONSHIP BETWEEN PROBABILTY OF AVIAN USE AND WILDLIFE OPENINGS IN THE EAST GULF COASTAL PLAIN

ABSTRACT

Wildlife openings, maintained in early successional stages or planted food plots, are often created with the intention of providing forage for wildlife and hunting opportunities. Many non-target species may benefit from wildlife openings including some declining Neotropical bird species. My objectives were to determine how avian use was related to size, edge length, shape, forest type, and management of openings. I developed an *a priori* set of hypotheses and corresponding models to examine factors that influenced detection and occupancy of bird species in openings on two study areas in the East Gulf Coastal Plain of Alabama. We found the prior detection model was the best model for most species. Date and temperature also were found to be important sources of variation in detection rates. While probabilities of use by 31 species were not strongly related to any of the characteristics of openings that we measured, opening size, edge length, and management were the most important factors that were related to bird use. Several species exhibited weak positive relationships to larger openings. Edge length relationships varied with species as did management style relationships, although there generally were higher probabilities of use for planted openings. Opening shape and surrounding forest type were not related to bird use. The results of this study can be incorporated into management plans to increase probabilities of use for bird species of

interest.

INTRODUCTION

Wildlife openings, man-made clearings in forest lands, are often created to benefit wildlife and create hunting opportunities. Little is known about the quantitative relationships of wildlife openings to non-target species such as songbirds (Chandler et al. 2009, King et al. 2009), however these species use openings at certain times of the year.

There are many characteristics of wildlife openings such as size, shape, edge, surrounding forest type, and management that may affect their use by birds. Openings often range in size from small forest clearings resulting from the removal of a few trees to large open fields over 50 ha. Opening size also may be related to the management intent. For example, when created for hunting mourning doves (*Zenaida macroura*) or northern bobwhite (*Colinus virginianus*), openings are usually large (>5ha). For hunting other game species such as white-tailed deer (*Odocoileus virginianus*) and eastern cottontail (*Sylvilagus floridanus*), openings are usually made much smaller (e.g., <5 ha) forest openings or food plots. With this range in sizes for openings, it is important to understand how opening size affects non-game bird use and abundance. Non-game forest birds may avoid forest adjacent to large openings. In contrast, early successional and grassland species may require openings larger than some threshold size.

Another characteristic of openings that may have an impact on bird use is the length of edge. As an opening becomes larger, the amount of edge increases, and this may have positive or negative effects on use by non-game birds. Some nongame bird species may avoid edges because predation and parasitism on nests may increase. Nest predators often concentrate along forest edges, possibly because of increased density of nests in and around edge habitat (Wilcove 1985, Paton 1994, King et al. 1998). Conversely, other species of birds select forest edge habitat for breeding, therefore, their use of openings is expected to increase as the amount of edge increases. Also, several studies have suggested that brown-headed cowbirds (*Molothrus ater*) concentrate along edges which may increase the chance of parasitism on nests (Helzer and Jelinski 1999, Moorman et al. 2002, Howell et al. 2007). Thus, brown-headed cowbird use should be positively related to the amount of edge. While predation and parasitism may be negative effects of edge habitat, edges often provide foraging opportunities and escape cover from avian predators, which may attract some forest bird species.

Similar to area and edge, the shape of the wildlife openings may be related to their use by several bird species. Openings shapes may range from irregular and oblong to perfectly round. As an opening becomes less round, the ratio of edge length to area increases. Forest bird species may select openings with large edge-to-core ratios because there is more edge habitat for them to use and less non-forested area. Many forest species avoid flying through open habitats and fields (Desrochers and Hannon 1997). Circular openings have the smallest edge-to-core ratio, and openings with large core areas may be more attractive to species that are typically associated with grasslands or early successional habitats.

Many birds are associated with certain forest types, so the forest surrounding an opening may affect use by some species. One such species is the brown-headed nuthatch (*Sitta pusilla*), which is primarily associated with mature pine forests (Conner and Dickson 1997). Therefore, the likelihood that this species would be found within and around an opening surrounded by pine forest would be much greater than one surrounded by hardwoods.

While certain species, such as white-tailed deer and mourning dove, are the focus of management actions to create openings, all species, both game and non-game, are affected by mechanical alterations to wildlife openings. Some openings are intensely managed with plowing and planting to cultivate food for wildlife, while others are maintained as early-successional fields with no other management actions. Some planted forbs such as common ragweed (*Ambrosia artemisiifolia*) and partridge pea (*Chamaecrista fasciculate*) are selected by game species such as northern bobwhite, and they also can be good foraging habitat for non-game birds (Harper 2007).

Wildlife openings are frequently used by migrant bird species, but understanding the relationships between bird use and characteristics of openings is limited. My objectives were to determine how four characteristics of wildlife openings (size, shape, edge, and forest type), along with management actions, are related to avian use. With this information, we may be able to design openings that could potentially benefit desired bird species. I measured probability of use using occupancy analysis (MacKenzie et al. 2002). I developed an *a priori* set of hypotheses and corresponding models to examine factors that influenced detection and occupancy of wildlife openings on two study areas in the East Gulf Coastal Plain of Alabama.

STUDY AREAS AND METHODS

The study sites selected for this project were located in southern Alabama in the East Gulf Coastal Plain, Alabama. The first area included Fred T. Stimpson (31.38°N, 87.87°W) and Upper State Sanctuaries (31.56°N, 87.96°W) in Clarke County, Alabama which were 20km apart but managed as a single unit (2,230ha). The second study site, Barbour County Wildlife Management Area (31.99°N 85.46°W, 7,660ha), (Barbour) was located 235km east of the sanctuaries in Barbour and Bullock counties in southeast Alabama. The landcover and habitat management on both study areas were similar. Both areas were primarily upland pine and bottomland hardwood forests. During this study hunting was prohibited in the Sanctuaries, and management included the creation and maintainance of numerous wildlife openings primarily for white-tailed deer and wild turkey. Barbour WMA was open to the public for hunting; therefore, the primary management actions on this area were intended to provide hunting opportunities and habitat for game species. Wildlife openings were prevalent throughout Barbour WMA. Most openings were managed with row crops and seasonal grasses, but some were maintained as early successional habitat.

The Alabama Gap Analysis Project Landcover map (Kleiner et al. 2007), which was based on satellite imagery from 1999-2001, was used in combination with aerial photography from 1992 and 2006 to locate wildlife openings within the two study areas. Once openings were identified, the perimeter of each opening was digitized, and area and perimeter were calculated using ArcGis (version 9.1 ESRI, Inc.). The area of the openings ranged from 0.05ha to 30ha. Thirty openings were chosen from each study site using a stratified random sample based on size of the opening. An additional 30 alternate openings were chosen for each study area to replace those openings which could not be used at each site. Alternates were used when ground-truthing indicated that openings had not been maintained or they were swamps or ponds.

More accurate estimates of the perimeter (edge length) and area of each selected opening were obtained by mapping the perimeter using handheld Global Positioning System (GPS) and importing these data into ArcGIS. GPS data was also obtained from the area manager of Barbour WMA for wildlife openings that were planted as food plots for game species (A. Pritchett,Alabama Department of Conservation and Natural Resources, unpublished data) Length of edge and area were found to be closely related (R=0.906), therefore, we used a shape index (perimeter/area) to incorporate this relationship ($R_{\text{shape and area}}$= -0.477, $R_{\text{shape and edge}}$= -0.622).

Point count surveys for birds were conducted no later than 4 hours after sunrise twice during the breeding season (May – July) within each selected opening. All 60 openings were surveyd in 2008, but in 2009, five sites were not surveyed because the surrounding area had been clearcut or they were flooded. For the smaller openings (50m or less in diameter), the center of the point count was located in the center of the opening. In openings greater than 50m in width, the center of the survey point was located 50m from the forest edge at the widest portion of the opening to include species within the opening as well as in the adjacent forest. All survey points were located at least 250m apart to prevent double counting birds. Each survey consisted of three, four-minute counts performed successively. Each bird that was seen or heard was recorded along with the estimated direction and also the distance band (0-25m, 25-50m, greater than 50m) (modified from Hamel et al. 1996). We recorded date, time, and temperature at the beginning of each survey.

During June – August 2008, habitat data were collected on a 6.25m grid of 49 points within a 25m radius of each survey site (Figure 2.1). At each point on the grid, presence or absence of tree canopy (dominant tree cover), midstory (4m to canopy), shrub layer (2-4m), and ground cover (less than 2m) were recorded using a moosehorn densitometer (Robinson 1947). To establish the majority forest edge type for each opening, the proportion of each forest type present around the opening was estimated visually and assigned to one of three categories: deciduous forest, mixed forest, or coniferous forest. Mixed forest was any forest that was less than 70 percent of pine or hardwood. The management type for each opening was classified as planted or unplanted, planted openings were those that were plowed and planted with row crops or seasonal grasses and unplanted openings were those maintained as early succession habitat without mechanical tillage. For those openings with more than one management type, the most prevalent type was used to label the opening as planted or unplanted. The forest and management type of our openings ranged in size, edge length, and shape (Appendix A).

Hypotheses

My hypotheses regarding detection included that detection of a species would not vary among sites or surveys ($p.$). I also hypothesized that detection probability would decline through in the morning (p_{tenp}) because male birds may not sing as frequently as temperature increases (Mayfield 1981, Robbins 1981). Additionally, I hypothesized that detectability would decline through the breeding season (p_{date}) because males sing more at the beginning of the breeding season when they are choosing and attracting mates (Best 1981, Skirvin 1981). I also hypothesized differences in detection among observers (p_{obs}), because not all observers have the same skills at detecting species by sight and sound (Sauer et al. 1994 and Alldredge et al. 2007). I also hypothesized that observers would share information about the locations of rare species; and, thus detection rates for rare species at their known locations would increase once they had been detected (p_{memory}). Finally, I hypothesized that once an observer had detected any species at a site, detection rates for that species would increase on subsequent surveys by that observer at that site ($p_{prior\ detect}$).

My *a priori* occupancy hypotheses consisted of a set of common models that were applied to all species. Additional hypotheses were included for species with specific habitat requirements, which were based on literature review for each species. The common hypotheses addressed the size, shape, length of edge, forest type and management of openings. The size hypothesis (Ψ_{size}) suggests that species occupancy will differ as the size of the opening increases. The edge hypothesis (Ψ_{edge}) predicts that as the length of edge habitat surrounding an opening (i.e., perimeter) increases species occupancy will be either positively or negatively related. The shape hypothesis (Ψ_{shape}) predicts that as an opening becomes more irregularly shaped (i.e., core area decreases) species occupancy will differ among species. The fourth hypothesis, forest type (Ψ_{forest}) suggests that bird occupancy will differ within openings surrounded by different forest types (deciduous, coniferous, and mixed) with fewer species associated with coniferous forest. I also hypothesized that the effect of forest type would be additive to the effects of other opening characteristics for species that were primarily associated with a single forest type. I believed that since some species have strong associations with certain forest types, this may be an additive affect to their relationships with other opening characteristics. My hypotheses with regard to management type ($\Psi_{management}$) are related to the intensity of management. I expected openings that were tilled or tilled and planted with row crops or seasonal grasses to be used more frequently by all species because of foraging opportunities than unplanted openings that are maintained as pastures or open fields only. Species-specific hypotheses were based on specific vegetative requirements from literature (Hamel 1992) and were included for those species with certain habitat requirements with regards to ground and shrub cover.

I hypothesized that some species would respond to specific habitat structure in addition to opening characteristics. For these species, additional additive models including ground or shrub cover were included (Table 2.2).

Analysis

I estimated occupancy (Ψ – probability of use) and detection probability (p) (Mackenzie et al. 2002) for each species that was encountered at least 6 times using models corresponding to each of my *a priori* hypotheses. Goodness of fit was calculated to test for overdispersion and lack of fit of the models to the data with the chi-squared goodness-of-fit statistic ($\hat{c}$) (Mackenzie et al. 2006). To account for any lack of fit in the model sets, QAICc was calculated (Burnham and Anderson 2002). Models with ΔQAICc ≤ 2 were considered best approximating models (Burnham and Anderson 2002). Model weights (w_i) were calculated as evidence of the relative support for each model (hypothesis). Estimates of log odds (βs) and unconditional estimates of SEs were calculated for each species from the best approximating models to determine the effects of each habitat characteristic on the probability of use (occupancy) of openings. We used the number of sites surveyed to correct for small sample size. Models with inestimable parameters were removed from the analysis for that species.

First, we fit detection models for each species (Table 2.1) with the null occupancy model (Ψ.). Observer and prior detection models were removed if an observer never conducted surveys at a site where a species was known to occur, because observer-specific detection rates could not be estimated. Observers were also removed from prior detection models if they never conducted a survey subsequent to the initial detection of a species at a site. An intercept only model ($\Psi.$) that estimated only the average probability of use among sites was included for each species for comparison to habitat relationship models. Once the best fit detection models (ΔQAICc < 2.0) were selected for each species, they were then used in combination with occupancy models (Table 2.2) for each respective species.

RESULTS

We analyzed 9,271 detections of 75 bird species for both years (Appendix A). black vulture, turkey vulture, and great egret were not used in the analysis, because they were considered transients not making use of the survey sites. There was adequate data for 54 species for the analysis with a total of 9,195 individual detections for those species.

We found that the prior detection model was the best approximating detection model for 25 of the 54 species in this analysis (Table 2.3). The date model was the best approximating model for 20 species of birds. For 13 species the temperature model fit best. The observer effects model was a top ranked model for 3 species. For 14 species the null model was included in the top detection models, which suggests that detection rates did not vary among sites for those species.

Opening size strongly influenced use of 15 species of birds (Table 2.4). This model was the unequivocal best fit model (Δ=0) for pattern of use for 5 species. The area model recieved strong support for American crow (*Corvus brachyrhynchos*, $w_i = 0.354$,

β=2.226±6.713) and barred owl (*Strix varia*, w_i = 0.273, β=0.506±0.328). American crows were less likely to occur as opening size increased, while barred owls were more likely to occur. Similarly, chipping sparrow (*Spizella passerine*, w_i = 0.193, β=1.245±0.88), indigo bunting (*Passerina cyanea*, w_i = 0.390, β=9.255±6.542), and barn swallow (*Hirundo rustica*, w_i = 0.232, β=1.698±0.979) were more likely to use openings as size increased. The parameter estimates or odds of occurence for most species were not affected or had a slight positive impact from larger openings (Figure 2.2).

The length of edge habitat surrounding an opening (i.e., perimeter length) had a strong influence on use by 13 species (Table 2.5). The edge model was the unequivocal best model for the pattern of use for one species, American goldfinch (*Spinus tristis*, Δ=0, w_i = 0.183, β=1.058±0.585). American goldfinch was more likely to occur as the length of edge habitat increased. The odds of use for the majority of the species showed low sensitivity to length of edge with small parameter estimates (Figure 2.3). Those species supporting the edge model varied with species such as black-and-white warbler (*Mniotilta varia*, β=-0.673±0.654) being negatively related to increased edge length while other species such as indigo bunting (β=2.907±1.748) having strong positive relationships towards increased edge length.

Based on model selection results, shape of an opening had a strong influence on the probability of use of 7 species (Δ<2, Table 2.6). However, the shape model was the unequivocal best fit for the pattern of use for only one species, Eastern bluebird (*Sialia sialis*, Δ=0, w_i = 0.321, β=-1.115±0.601). Eastern bluebirds were more likely to occur as openings became more round. Parameter estimates for most species were close to zero, therefore the odds of occurrence for those species did not differ much (Figure 2.4).

However, for those species showing strong support for the shape model, Kentucky warbler (*Oporornis formosus, β*=1.636±0.686*)* did have strong positive relationships towards irregular shaped openings.

Forest type surrounding an opening had a strong influence on probabilities of use by 7 species (Table 2.7). The forest type model was the unequivocal best fit model for only the hairy woodpecker (Δ=0, w_i = 0.313). However, most species showed high variability to forest types (deciduous, coniferous, or mixed forest) surrounding openings (Figure 2.5). Very few species were significantly related to forest type. For those having strong support for the forest model, field sparrow had strong positive relationships only for deciduous forest (β=1.115±1.191). Also, ruby-throated hummingbirds (*Archilochus colubris, β*=-19.198±11350) illustrated a strong negative relationship towards pine forest openings.

The management style of an opening had a strong influence on use by the greatest number of species. The probability of use for 22 species was affected by management (Table 2.8). The management model was the unequivocal best fit for 9 species (Δ<2, w_i >0.24, Table 3). Two woodpecker species, northern flicker (*Colaptes auratus*, w_i = 0.941, β=-45.901±5.696) and red-headed woodpecker (*Melanerpes erythrocephalus*, w_i = 0.248, β=-2.002±0.705), were more likely to occur in unplanted openings. Five species typically associated with forest were more likely to occur within planted openings, American redstart (*Setophaga ruticilla, β*=1.985±0.631), northern parula (*Parula Americana, β*=2.185±0.817), Swainson's warbler (*Limnothlypis swainsonii, β*=3.031±1.111), wood thrush (β=2.259±0.668), and yellow-throated warbler (*Dendroica dominica β*=1.892±0911). Conversely, one forest species, pine warbler (*Dendroica pinus, β*=-

1.924±0.617), showed a lower probability of occurrence in planted openings. Fish crow (*Corvus ossifragus*, w_i = 0.673, β=-1.524±0.7) was also more likely to occur in unplanted openings. Overall, the odds of occurrence in relation to opening management varied greatly and the majorities of species had positive parameter estimates and were more likely to occur in planted openings (Figure 2.6). Some species that showed strong support for the management model and are more likely to be found in planted openings include brown-headed cowbird and American goldfinch.

Ground cover, a species-specific model, was the best fitting model (Δ=0) for two species, white-eyed vireo and brown-headed cowbird. White-eyed vireo (*Vireo griseus*) was found more frequently in openings with little ground cover (w_i =0.459, β=-1.024±0.497) as was cowbird (w_i = 0.417, β=-0.979±0.406). Another species, yellow-breasted chat (*Icteria virens*), showed evidence of a negative relationship to ground cover (Δ=1.533, w_i =0.078, β=-0.372±0.332), though not as strong as white-eyed vireo and brown-headed cowbird. Yellow-breasted chat was also the only species with use related to shrub cover in an opening (Δ=1.011, w_i =0.101, β=0.509±0.362).

The null model was among the top-ranked models for 31 species (Δ<2.0, Table 2.9). It was the best fit model (Δ=0, w_i >0.43) for the pattern of use of 13 of those species. These species were found within all openings and did not appear to select for certain conditions.

DISCUSSION

Model selection results were used for the basis of our inferences. While we include estimates of odds ratios, in our analysis and acknowledge that the confidence intervals for many species indicate high imprecision, we relied on our model selection results to identify important relationships between species and opening characteristics. The lack of precision in our estimates may indicate a high degree of variability within our results or unmodeled heterogeneity due to the simplicity of the models we compared. Nonetheless, we feel that our results indicate the strongest relationships within the data, and suggest that more data or less parsimonious models would improve the precision of the estimated relationships, but would not change our conclusions.

As expected, prior detection by individual observers influenced our detection rates for certain species. This model suggests that if an observer detects a species at a familiar site, they are more likely to detect that species on subsequent surveys at that site. The date model was also important for many species suggesting that detection rates changed over the breeding season. Date is important because males sing at different frequencies throughout the breeding season (Hamel et al. 1996). As expected from my hypotheses, temperature was also an important factor in detection rates for some species. Lynch (1995) found that later in the day detection rates decreased for birds, which was similar to my temperature hypothesis because typically in the late spring and early summer temperatures increase with time of day. Observer effects, which I felt would be important because of the range of observer skills, was not as important as the other detection variables.

Use by many species was influenced by certain attributes of wildlife openings. These species showed more selective habitat associations, and may therefore be affected by habitat alterations. Thus, occupancy could be an indicator that management is benefiting or possibly increasing their populations. If not detected, additional management actions may need to be implemented to ensure those species of interest will occur. At the same time this could be an indication of ecological traps as was found in a study of indigo buntings that showed preference for openings with increased edge habitat where they also experienced lower reproduction rates (Weldon and Haddad 2005). It is important to remember that our site placement of our point counts was used to make inferences about species found associated with openings as well as the surrounding habitat. Therefore, some forest species with relationships with may not have necessarily been located within the opening. Instead, those species may have been found in the adjacent forest edge habitat.

I hypothesized that use by some species would be related to opening size, and that the relationship would differ depending upon whether species were typically associated with grasslands, forests, or edges. A similar study examined the size of canopy gaps (0.13-0.5ha) and found more species to be associated with those canopy gaps in comparison to dense forest (Bowen et al. 2007). Also, a study in South Carolina that examined bird use of gaps ranging from 0.06-0.5 ha found more species in larger gaps (0.5 ha, Moorman and Guynn 2001). We found that more species used similar size openings, but our range of opening sizes was much greater (0.5-20 ha).

As expected, several species such as indigo bunting, a species typically associated with early successional habitats, selected for large openings. This differs from previous studies that showed indigo buntings had no size preference (Greenberg and Lanham 2001, Chandler et al. 2009). However, some forest species, like downy woodpecker (*Picoides pubescens*) unexpectedly showed a positive relationship with opening size. Forest species would not typically be found within openings, and often times avoid areas of fragmentation such as wildlife openings. One study in Canada found that forest species would fly greater distances thru forest cover to avoid openings of any size (Desrochers and Hannon 1997).

Some studies have shown the impact of predation may be reduced in large openings in comparison to smaller openings. This may explain why some forest species selected larger openings (Saurez et al. 1997). By contrast, other forest species like Eastern wood-pewee (*Contopus virens*) selected for smaller openings, which was in keeping with my hypothesis that forest species would be less likely to occur in larger openings. While not a strong relationship, Eastern towhee also was found to not use larger openings as much. As an edge species, they may be deterred from areas such as large wildlife openings, because of the extensive amount of open habitat. On the other hand, some edge species such as brown-headed cowbird and northern cardinal (*Cardinalis cardinalis*) were shown to select larger openings. Selection of larger openings may be a response of increased foraging opportunities that occur within those openings. Also predation risks may not be as great within larger openings as Saurez et al. suggests (1997) because of the increased amount of core area.

I hypothesized that the edge length of an opening would be related to bird use, with early successional species negatively related and forest and edge species positively related to edge habitat. American goldfinch, an early successional species, selected edge habitat which was not expected. This could be because edge habitat provides valuable foraging habitat for them (Anders et al. 1998).

Use of openings by the majority of species varied. In one study in South Carolina hooded warblers were found most often during the breeding season in edge habitat

(Bowen et al. 2007). Given those results, we would expect hooded warblers to be found more often as edge habitat increases. However, use by hooded warbler and ruby-throated hummingbird, two species that predominately use forest, was unaffected by the length of opening edge. These two species were just as likely to occur in an opening with little edge habitat as an opening with increased perimeter. One reason why there may not be any relationships with those two species is that our study areas were both predominately forested areas and therefore those species may have been prevalent throughout all of the openings.

The high variability to edge habitat exhibited by most species encountered within openings may be a response to high predation and parasitism associated with edges (Chalfoun et al. 2002, Fink et al. 2006). Brown-headed cowbirds were not affected by the amount of edge habitat present, which was not expected based on previous studies that suggest cowbirds are associated with edge habitat (Helzer and Jelinski 1999, Moorman et al. 2002, Howell et al. 2007). We believed that because of this association with edge habitat, cowbirds would have a higher probability of use with increased amounts of perimeter. On the other hand, there were also several species showing positive relationships to edge habitat. Often there is an abundance of blackberry bushes along field edges that are beneficial for many species and their fledglings (Anders et al. 1998), which could be why those species, such as red-eyed vireo occur more frequently with increased amounts of edge habitat.

Indigo buntings showed similar relationships from those of a previous study with their use being highly related to edge length (Weldon and Haddad 2005). That same study also found that buntings had increased nest predation with increased edge length.

Even with increased predation they selected for increased edge length. However, there may be increased foraging in openings with more perimeter, which may be why there are so many species with positive associations to edge length even with possible increased predation risks.

As an opening becomes more round, I hypothesized that species use would differ with early successional species positively related to round openings and both edge and forest species negatively related to round openings. Eastern bluebird, an early successional and open habitat species, was more likely to occur in irregularly-shaped openings as opposed to round openings. These birds may be more likely to inhabit openings with more edge and less core habitat because they like open fields where they can perch to watch for prey on the ground such as insects (Hamel 1992). Even though shape was not an important influencing factor for most species, there was a high sensitivity of some species to the shape of an opening.

The wood thrush, a forest species, did respond as I had hypothesized. I believed that forest species would not be found in openings with a small edge-to-core ratio but would be much more prevalent within irregularly-shaped openings because there wouldn't be as much open habitat for those species to fly through. One study in Missouri found that the wood thrush, along with their fledglings, would cross through small openings to get to foraging areas, while larger openings deterred them from dispersing (Anders et al. 1998). Therefore, we felt that they would be found more often around irregularly shaped openings because they were relatively less open.

Other forest species also followed my hypotheses, such as the Kentucky warbler and yellow-throated warbler (*Dendroica dominica*), which were less likely to occur in round openings. These species were more likely to occur in irregularly-shaped openings with more edge habitat available. One study found that linear patches of habitat, as opposed to round patches, had higher densities of nests and higher nest success (Bollinger and Switzer 2002), which could be why these species selected the irregularly shaped openings over round openings.

I hypothesized that species use would also differ within openings in different forest types. The forest type surrounding an opening influenced some species, but not to a great extent. The hairy woodpecker was most affected by forest type and selected for mixed forests. Multiple studies have shown that more species are often present within deciduous forests as opposed to coniferous forests (James and Wamer 1982, Johnston and Odum 1956). While we hypothesized that we would find more species in openings within mixed forest because species associated with both forest types might be present, we found similar results as previous studies with more species having highly positive relationships towards openings within deciduous forests. Ruby-throated hummingbird showed this relationship, having the strongest preference with deciduous forests. This relationship was expected because ruby-throated hummingbirds are found to avoid coniferous forests (Hamel 1992).

Lastly, I hypothesized that the probability of use by individual species would differ between management practices, with more species found in planted openings. This was the most common factor related to occupancy. As expected, planted openings were selected by most species. Planted openings may provide more foraging and feeding opportunities for these species during a crucial time of their life, the breeding season. Some planted species such as partridge pea and native lespedezas can provide seeds for foraging and also escape cover for many songbirds (Harper 2007).

Many forest species, such as Acadian flycatcher and wood thrush selected for planted, heavily managed openings. These species may also be using openings for foraging. Forest species such as these sometimes leave their breeding grounds with fledglings to find better foraging habitat such as field edges (Anders et al. 1998). This could be why those species are found to utilize planted openings more often than unplanted. Also, if these planted openings provide cover habitat, there may be more forest species utilizing the openings because they are less vulnerable to predation. Insectivorous species such as summer tanager and red-eyed vireo may not find planted openings beneficial for foraging, which could be why they do not have strong relationships with planted openings. Anders et al. 1998 found red-eyed vireos in early successional areas and field edges where blackberries were abundant which could also explain why these species are found more often within unplanted openings. They may be utilizing the native berries that are located along field edges and thickets.

The additional variables I included for only certain species, ground and shrub cover were indeed important for some species. Both white-eyed vireo and brown-headed cowbird were found selected wildlife openings with less ground cover. For the cowbird this makes sense because they like to forage for insects and seeds and such on bare ground (Hamel 1992). This was not expected for the white-eyed vireo, which tends to be found in more dense areas such as thickets and early successional areas (Hopp et al. 1995).

Some species did not respond to any of the characteristics of openings that we measured. These species were considered generalists because the null model was the best supporting model. Thus, we could not detect any selection among openings by these species. Although this may have occurred because we lacked sufficient data for rare species like Bachman's sparrow (*Peucaea aestivalis*), a species of greatest conservation concern for Alabama because of low population size (Mirarchi et al. 2004, Sauer et al. 2007, Blancher et al. 2007). While we documented 11 encounters, there was little evidence that this species selected wildlife openings with any specific characteristics. Bachman's sparrow is associated with open pine and early successional habitat in the coastal plain (Hamel 1992, Dunning 1993); therefore, it is interesting that there were no associations with forest type, or any other characteristic of openings.

Another species that is exclusively associated with pine forests, the Brown-headed Nuthatch (Johnston and Odum 1956, Hamel 1992), was encountered 29 times on surveys, and like Bachman's sparrow, we were unable to detect any association with any of the opening characteristics we measured. For this species and several others where the null model was the best model, there was little evidence that any factors we measured affected their use of openings. One reason we had so few encounters for this species and some other forest birds, may be that they usually avoid open habitats such as wildlife openings. Our study was designed only to examine the relationships between use and opening characteristics and we could not determine how commonly other habitats were used. There may also be additional characteristics of openings that we did not measure or include in our analysis that are related to use by birds. We did not incorporate information about surrounding forest patch size within our study. Therefore the surrounding habitats may have an impact on densities of forest species as well as others. Future research could be done to look at the affects of adjacent forests on our species densities.

While there may be some exceptions, several species were found to be generalists in agreement with other studies. Tufted Titmouse (*Baeolophus bicolor*), a typical habitat generalist (Hamel 1992), was also found to be a generalist species in our study. The titmouse was prevalent throughout all openings with no selection for opening characteristics. Other species showed similar relationships as the titmouse including species such as blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), and mourning dove.

More species showed sensitivity to the shape and amount of edge habitat present within openings. Therefore, they may benefit from irregularly-shaped openings that have increased amounts of edge habitat. Management was also important, so it may be beneficial for more species to have some openings heavily managed, while still leaving a proportion of openings in early successional habitat. For example, the hooded warbler wasn't affected by edge but was affected by the management of the openings. These birds may have been more interested in planted openings because of the increased foraging available as opposed to unplanted early successional areas. The amount of food available in those openings may take precedence over the importance of edge habitat for that species. One study found that wildlife openings which are plowed and planted may have more abrupt edges with higher predation rates than shrubby, unmanaged openings would have (Saurez et al. 1997), which is why it may also be important to still have a proportion of unplanted openings available. Two opening characteristics, size and forest type, did not have as much of an impact on probability of use in our study. These factors may not be as important to consider when managing for bird use or higher species richness of openings.

We found that in general, wildlife openings were used frequently and appeared to be beneficial for many species of birds—specialists and generalists alike. When managing for birds, it is important to manage for the needs of selective species, because generalists do not have specific habitat requirements. It is important to look at the layout of openings to provide for more species. Obviously, if diversity of birds is desired it may be more beneficial to provide a variety of opening types to support the most species. So, when managing wildlife openings for songbirds, as well as game species, look at the overall matrix of openings available to provide different habitats to benefit the most species.

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Table 2.1. Hypotheses and corresponding models for species detection rates for birds on Barbour WMA and Stimpson and Upper State Sanctuaries, Alabama 2008-09.

Hypothesis	Model
Does not vary among sites or surveys	$p.$
Varies by temperature	p_{temp}
Varies by time of year	p_{date}
Varies by observer	p_{obs}
Varies with shared information on rare species.	p_{memory}
Varies with subsequent detections by each observer	$p_{prior\ detect}$

*Only best detection models were then run in combination with occupancy models.

Table 2.2. Hypotheses and corresponding models for occupancy rates of birds encountered on Barbour WMA and Stimpson and Upper State Sanctuaries, Alabama 2008-09.

Hypothesis	Model
Opening size affects occupancy rates	Ψ_{size}
Length of edge affects occupancy rates	Ψ_{edge}
Opening shape affects occupancy rates	Ψ_{shape}
Forest type affects occupancy rates	Ψ_{forest}
Management style affects occupancy rates	$\Psi_{\text{management}}$
The effect of forest type is additive to other opening characteristics[1]	$\Psi_{\text{forest+size}}$, $\Psi_{\text{forest+edge}}$, $\Psi_{\text{forest+shape}}$
Ground cover affects occupancy[2]	Ψ_{ground}
Shrub cover affects occupancy[3]	Ψ_{shrub}
Ground and Shrub cover both affect occupancy[4]	$\Psi_{\text{ground+shrub}}$

[1]Species-specific model for: American Redstart, Bachman's Sparrow, Blue-gray Gnatcatcher, Brown-headed Nuthatch, Blue Grosbeak, Downy Woodpecker, Hairy Woodpecker, Kentucky Warbler, Northern Parula, Pine Warbler, Red-headed Woodpecker

[2]Species-specific model for: American Goldfinch, Bachman's Sparrow, Brown-headed Cowbird, Carolina Wren, Chipping Sparrow, Common Yellowthroat, Eastern Towhee, Great-crested Flycatcher, Indigo Bunting, Kentucky Warbler, Northern Mockingbird, Prairie Warbler, White-eyed Vireo, Yellow-breasted Chat

[3]Species-specific model for: American Goldfinch, American Redstart, Bachman's Sparrow, Black-and-white Warbler, Blue-gray Gnatcatcher, Brown-headed Cowbird, Blue Grosbeak, Carolina Wren, Chipping Sparrow, Common Yellowthroat, Eastern Bluebird, Eastern Towhee, Hooded Warbler, Indigo Bunting, Kentucky Warbler, Northern Mockingbird, Prairie Warbler, Tufted Titmouse, White-eyed Vireo, Wood Thrush, Yellow-breasted Chat, Yellow-billed Cuckoo

[4]Species-specific model for: American Goldfinch, Bachman's Sparrow, Brown-headed Cowbird, Carolina Wren, Chipping Sparrow, Common Yellowthroat, Eastern Towhee, Indigo Bunting, Kentucky Warbler, Prairie Warbler, White-eyed Vireo, Yellow-breasted Chat

Table 2.3. Best detection models (Δ<2.0) for each species of bird[1] observed in wildlife openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain of Alabama, 2008-09. For this comparison, detection models were fit with a null model of occupancy (ψ.). Species with more than one best model appear under multiple models.

Model	Species				
$p_{prior\ detect}$					
	acadian flycatcher	blue-gray gnatcatcher	brown-headed cowbird	blue jay	Carolina chickadee
	Carolina wren	common yellowthroat	eastern towhee	eastern wood-pewee	great-crested flycatcher
	hooded warbler	indigo bunting	mourning dove	northern bobwhite	northern cardinal
	pileated woodpecker	red-eyed vireo	red-shouldered hawk	summer tanager	tufted titmouse
	white-eyed vireo	wood thrush	yellow-breasted chat	yellow-billed cuckoo	yellow-throated vireo
p_{obs}					
	blue grosbeak	northern parula	red-bellied woodpecker		
p_{date}					
	American goldfinch	American redstart	Bachman's sparrow	barn swallow	brown-headed nuthatch
	chipping sparrow	downy woodpecker	fish crow	field sparrow	hairy woodpecker
	Kentucky warbler	northern mockingbird	pine warbler	prairie warbler	purple martin
	red-headed woodpecker	Swainson's warbler	wood thrush	yellow-breasted chat	yellow-throated warbler
p_{temp}					
	American crow	American goldfinch	Bachman's sparrow	barred owl	barn swallow
	black-and-white warbler	brown-headed nuthatch	eastern bluebird	northern flicker	orchard oriole
	red-headed woodpecker	ruby-throated hummingbird		wild turkey	

Table 2.3. Best detection models (Δ<2.0) for each species of bird[1] observed in wildlife openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain of Alabama, 2008-09. For this comparison, detection models were fit with a null model of occupancy (ψ.). Species with more than one best model appear under multiple models.

Model	Species				
p.	American goldfinch	American redstart	Bachman's sparrow	barn swallow	black-and-white warbler
	brown-headed nuthatch	downy woodpecker	northern mockingbird	orchard oriole	prairie warbler
	red-headed woodpecker	ruby-throated hummingbird	wood thrush	yellow-throated warbler	

Table 2.4. The relative importance of the area model (Ψ_{area}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American crow	$\Psi_{\text{area}}\, p_{\text{temp}}$	792.243	931.914	0.000	1.000	0.354	4
American goldfinch	$\Psi_{\text{area}}\, p.$	77.211	70.782	1.432	0.489	0.089	3
Bachman's sparrow	$\Psi_{\text{area}}\, p.$	73.232	66.803	1.017	0.601	0.049	3
Bachman's sparrow	$\Psi_{\text{area}}\, p_{\text{temp}}$	73.372	64.644	1.157	0.561	0.046	4
Bachman's sparrow	$\Psi_{\text{area}}\, p_{\text{date}}$	73.987	65.260	1.773	0.412	0.034	4
barred owl	$\Psi_{\text{area}}\, p_{\text{temp}}$	82.802	74.075	0.000	1.000	0.273	4
barn swallow	$\Psi_{\text{area}}\, p.$	124.426	117.997	0.000	1.000	0.232	3
brown-headed nuthatch	$\Psi_{\text{area}}\, p_{\text{temp}}$	233.769	225.042	0.254	0.881	0.103	4
brown-headed nuthatch	$\Psi_{\text{area}}\, p_{\text{date}}$	235.133	226.406	1.619	0.445	0.052	4
brown-headed nuthatch	$\Psi_{\text{area}}\, p.$	235.448	229.019	1.933	0.380	0.045	3
blue grosbeak	$\Psi_{\text{area}}\, p_{\text{obs}}$	205.830	232.203	0.841	0.657	0.214	9
chipping sparrow	$\Psi_{\text{area}}\, p_{\text{date}}$	164.520	155.793	0.000	1.000	0.193	4
downy woodpecker	$\Psi_{\text{area}}\, p_{\text{date}}$	423.225	414.497	1.441	0.486	0.154	4
eastern-wood pewee	$\Psi_{\text{area}}\, p_{\text{prior detect}}$	413.267	372.357	1.649	0.438	0.181	15
indigo bunting	$\Psi_{\text{area}}\, p_{\text{prior detect}}$	725.744	681.092	0.000	1.000	0.390	16
northern bobwhite	$\Psi_{\text{area}}\, p_{\text{prior detect}}$	352.032	311.123	1.381	0.501	0.158	15
orchard oriole	$\Psi_{\text{area}}\, p.$	143.964	137.536	1.205	0.547	0.127	3

Table 2.4. The relative importance of the area model (Ψ_{area}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
pine warbler	$\Psi_{\mathrm{area}}\ p_{\mathrm{date}}$	119.663	473.406	1.966	0.374	0.120	4
wild turkey	$\Psi_{\mathrm{area}}\ p_{\mathrm{temp}}$	228.819	220.092	1.855	0.396	0.146	4

Table 2.5. The relative importance of the edge model (Ψ_{edge}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American crow	$\Psi_{\text{edge}}\ p_{\text{temp}}$	793.607	933.536	1.363	0.506	0.179	4
American goldfinch	$\Psi_{\text{edge}}\ p.$	75.779	69.351	0.000	1.000	0.183	3
American goldfinch	$\Psi_{\text{edge}}\ p_{\text{temp}}$	77.387	68.659	1.607	0.448	0.082	4
American goldfinch	$\Psi_{\text{edge}}\ p_{\text{date}}$	77.695	68.968	1.916	0.384	0.070	4
Bachman's sparrow	$\Psi_{\text{edge}}\ p.$	72.859	66.430	0.644	0.725	0.059	3
Bachman's sparrow	$\Psi_{\text{edge}}\ p_{\text{temp}}$	73.000	64.272	0.785	0.675	0.055	4
Bachman's sparrow	$\Psi_{\text{edge}}\ p_{\text{date}}$	73.615	64.888	1.401	0.496	0.040	4
barred owl	$\Psi_{\text{edge}}\ p_{\text{temp}}$	84.236	75.508	1.433	0.488	0.133	4
barn swallow	$\Psi_{\text{edge}}\ p.$	125.891	119.462	1.465	0.481	0.112	3
barn swallow	$\Psi_{\text{edge}}\ p_{\text{temp}}$	126.346	117.619	1.920	0.383	0.089	4
black-and-white warbler	$\Psi_{\text{edge}}\ p.$	48.316	145.265	1.796	0.407	0.091	3
brown-headed nuthatch	$\Psi_{\text{edge}}\ p_{\text{temp}}$	234.956	226.229	1.442	0.486	0.057	4
chipping sparrow	$\Psi_{\text{edge}}\ p_{\text{date}}$	165.438	156.711	0.918	0.632	0.122	4
downy woodpecker	$\Psi_{\text{edge}}\ p_{\text{date}}$	423.015	414.288	1.231	0.540	0.171	4
eastern bluebird	$\Psi_{\text{edge}}\ p_{\text{temp}}$	126.277	182.073	1.474	0.478	0.153	4
indigo bunting	$\Psi_{\text{edge}}\ p_{\text{prior detect}}$	726.168	681.517	0.424	0.809	0.316	16
orchard oriole	$\Psi_{\text{edge}}\ p.$	144.620	138.192	1.861	0.394	0.091	3

Table 2.5. The relative importance of the edge model (Ψ_{edge}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
wild turkey	$\Psi_{\text{edge}}\ p_{\text{temp}}$	228.681	219.954	1.717	0.424	0.156	4

Table 2.6. The relative importance of the shape model (Ψ_{shape}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
Bachman's sparrow	$\Psi_{\text{shape}}\ p.$	72.560	66.131	0.345	0.841	0.068	3
Bachman's sparrow	$\Psi_{\text{shape}}\ p_{\text{temp}}$	72.689	63.961	0.474	0.789	0.064	4
Bachman's sparrow	$\Psi_{\text{shape}}\ p_{\text{date}}$	73.318	64.591	1.104	0.576	0.047	4
eastern bluebird	$\Psi_{\text{shape}}\ p_{\text{temp}}$	124.803	179.789	0.000	1.000	0.321	4
Kentucky warbler	$\Psi_{\text{shape}}\ p_{\text{date}}$	254.125	416.661	0.612	0.736	0.220	4
red-eyed vireo	$\Psi_{\text{shape}}\ p_{\text{prior detect}}$	822.796	778.144	0.067	0.967	0.313	16
wild turkey	$\Psi_{\text{shape}}\ p_{\text{temp}}$	228.684	219.956	1.719	0.423	0.156	4
yellow-breasted chat	$\Psi_{\text{shape}}\ p_{\text{date}}$	403.568	718.846	0.870	0.647	0.108	4
yellow-throated warbler	$\Psi_{\text{shape}}\ p.$	143.222	136.793	0.823	0.663	0.214	3

Table 2.7. The relative importance of the surrounding forest type model (Ψ_{forest}) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
barred owl	$\Psi_{\text{forest}}\ p_{\text{temp}}$	83.242	72.130	0.440	0.803	0.219	5
brown-headed nuthatch	$\Psi_{\text{forest}}\ p_{\text{temp}}$	234.821	223.710	1.306	0.520	0.061	5
field sparrow	$\Psi_{\text{forest}}\ p_{\text{date}}$	84.230	73.119	0.976	0.614	0.182	5
hairy woodpecker	$\Psi_{\text{forest}}\ p_{\text{date}}$	160.929	149.818	0.000	1.000	0.313	5
hairy woodpecker	$\Psi_{\text{forest+shape}}\ p_{\text{date}}$	161.597	148.012	0.668	0.716	0.224	6
hairy woodpecker	$\Psi_{\text{forest+edge}}\ p_{\text{date}}$	162.911	149.326	1.981	0.371	0.116	6
Kentucky warbler	$\Psi_{\text{forest+shape}}\ p_{\text{date}}$	254.284	408.684	0.771	0.680	0.203	6
purple martin	$\Psi_{\text{forest}}\ p_{\text{date}}$	73.005	61.894	1.035	0.596	0.178	5
ruby-throated hummingbird	$\Psi_{\text{forest}}\ p.$	165.193	156.466	0.000	1.000	0.488	4
ruby-throated hummingbird	$\Psi_{\text{forest}}\ p_{\text{temp}}$	166.945	155.834	1.752	0.416	0.203	5

Table 2.8. The relative importance of the opening management model ($\Psi_{management}$) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American goldfinch	$\Psi_{\text{management}}\ p.$	77.535	71.106	1.755	0.416	0.076	3
American redstart	$\Psi_{\text{management}}\ p_{\text{date}}$	99.064	348.873	0.000	1.000	0.204	4
American redstart	$\Psi_{\text{management}}\ p.$	100.242	362.300	1.178	0.555	0.113	3
Bachman's sparrow	$\Psi_{\text{management}}\ p.$	74.193	67.764	1.978	0.372	0.030	3
black-and-white warbler	$\Psi_{\text{management}}\ p.$	48.485	145.851	1.965	0.374	0.084	3
brown-headed cowbird	$\Psi_{\text{management}}\ p_{\text{prior detect}}$	257.978	324.623	1.291	0.524	0.219	14
brown-headed nuthatch	$\Psi_{\text{management}}\ p_{\text{temp}}$	235.136	226.409	1.621	0.445	0.052	4
downy woodpecker	$\Psi_{\text{management}}\ p_{\text{date}}$	423.610	414.883	1.827	0.401	0.127	4
fish crow	$\Psi_{\text{management}}\ p_{\text{date}}$	230.840	222.113	0.000	1.000	0.673	4
field sparrow	$\Psi_{\text{management}}\ p_{\text{date}}$	83.903	75.175	0.649	0.723	0.214	4
hooded warbler	$\Psi_{\text{management}}\ p_{\text{prior detect}}$	653.035	640.081	0.988	0.610	0.232	16
northern bobwhite	$\Psi_{\text{management}}\ p_{\text{prior detect}}$	351.126	310.217	0.475	0.789	0.248	15
northern flicker	$\Psi_{\text{management}}\ p_{\text{temp}}$	76.348	67.621	0.000	1.000	0.941	4
northern mockingbird	$\Psi_{\text{management}}\ p.$	75.773	69.344	0.093	0.954	0.192	3
northern mockingbird	$\Psi_{\text{management}}\ p_{\text{date}}$	76.097	67.370	0.417	0.812	0.163	4
northern parula	$\Psi_{\text{management}}\ p_{\text{obs}}$	648.469	626.869	0.000	1.000	0.896	9
orchard oriole	$\Psi_{\text{management}}\ p.$	144.129	137.701	1.370	0.504	0.117	3

Table 2.8. The relative importance of the opening management model ($\Psi_{management}$) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
pine warbler	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	117.696	465.015	0.000	1.000	0.319	4
prairie warbler	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	225.686	216.959	0.963	0.618	0.086	4
prairie warbler	$\Psi_{\mathrm{management}}\, p.$	226.526	220.098	1.803	0.406	0.057	3
purple martin	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	72.539	63.811	0.568	0.753	0.224	4
red-headed woodpecker	$\Psi_{\mathrm{management}}\, p.$	190.396	385.136	0.000	1.000	0.248	3
red-headed woodpecker	$\Psi_{\mathrm{management}}\, p_{\mathrm{temp}}$	191.822	383.308	1.426	0.490	0.122	4
red-headed woodpecker	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	192.216	384.135	1.820	0.402	0.100	4
Swainson’s warbler	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	184.792	176.065	0.000	1.000	0.982	4
wood thrush	$\Psi_{\mathrm{management}}\, p.$	142.208	349.144	0.000	1.000	0.291	3
wood thrush	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	142.526	344.052	0.318	0.853	0.248	4
yellow-throated warbler	$\Psi_{\mathrm{management}}\, p.$	142.399	135.970	0.000	1.000	0.324	3
yellow-throated warbler	$\Psi_{\mathrm{management}}\, p_{\mathrm{date}}$	143.878	135.151	1.480	0.477	0.154	4

Table 2.9. The relative importance of the null model ($\Psi.$) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
Acadian flycatcher	$\Psi.p_{\text{prior detect}}$	426.434	482.051	0.000	1.000	0.410	14
Bachman's sparrow	$\Psi.\ p.$	72.214	68.004	0.000	1.000	0.081	2
black-and-white warbler	$\Psi.\ p.$	46.519	146.728	0.000	1.000	0.224	2
blue-gray gnatcatcher	$\Psi.p_{\text{prior detect}}$	829.385	792.051	0.000	1.000	0.501	14
brown-headed nuthatch	$\Psi.\ p_{\text{temp}}$	233.515	227.086	0.000	1.000	0.117	3
blue grosbeak	$\Psi.\ p_{\text{obs}}$	204.988	234.642	0.000	1.000	0.326	8
blue jay	$\Psi.p_{\text{prior detect}}$	292.670	641.587	0.000	1.000	0.595	15
Carolina chickadee	$\Psi.p_{\text{prior detect}}$	543.444	506.110	0.000	1.000	0.609	14
Carolina wren	$\Psi.p_{\text{prior detect}}$	788.354	842.594	0.000	1.000	0.508	15
common yellowthroat	$\Psi.p_{\text{prior detect}}$	414.246	373.337	0.000	1.000	0.347	15
downy woodpecker	$\Psi.\ p_{\text{date}}$	421.784	415.355	0.000	1.000	0.316	3
eastern towhee	$\Psi.p_{\text{prior detect}}$	417.267	379.934	0.000	1.000	0.439	14
eastern wood-pewee	$\Psi.p_{\text{prior detect}}$	411.617	374.284	0.000	1.000	0.412	14
field sparrow	$\Psi.\ p_{\text{date}}$	83.254	76.825	0.000	1.000	0.296	3
great-crested flycatcher	$\Psi.p_{\text{prior detect}}$	466.069	731.380	0.000	1.000	0.449	14
hooded warbler	$\Psi.p_{\text{prior detect}}$	652.047	642.978	0.000	1.000	0.381	15
mourning dove	$\Psi.p_{\text{prior detect}}$	512.783	745.325	0.000	1.000	0.591	15

Table 2.9. The relative importance of the null model ($\Psi_{.}$) as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, and should not be used for interspecific comparisons.

Species	Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
northern cardinal	$\Psi.p_{\text{prior detect}}$	768.673	756.438	0.000	1.000	0.558	15
orchard oriole	$\Psi.p.$	142.759	138.548	0.000	1.000	0.231	2
pileated woodpecker	$\Psi.p_{\text{prior detect}}$	509.530	472.196	0.000	1.000	0.590	14
prairie warbler	$\Psi.\ p_{\text{date}}$	224.723	218.294	0.000	1.000	0.140	3
purple martin	$\Psi.\ p_{\text{date}}$	71.970	65.542	0.000	1.000	0.298	3
red-bellied woodpecker	$\Psi.p_{\text{obs}}$	652.710	935.299	0.000	1.000	0.486	8
red-eyed vireo	$\Psi.\ p_{\text{prior detect}}$	822.728	781.819	0.000	1.000	0.323	15
red-shouldered hawk	$\Psi.p_{\text{prior detect}}$	328.393	463.334	0.000	1.000	0.517	13
summer tanager	$\Psi.p_{\text{prior detect}}$	515.770	746.054	0.000	1.000	0.595	15
tufted titmouse	$\Psi.p_{\text{prior detect}}$	827.200	789.867	0.000	1.000	0.537	14
wild turkey	$\Psi.p_{\text{temp}}$	226.964	220.536	0.000	1.000	0.368	3
yellow-breasted chat	$\Psi.\ p_{\text{date}}$	402.698	721.448	0.000	1.000	0.167	3
yellow-billed cuckoo	$\Psi.p_{\text{prior detect}}$	676.653	635.744	0.000	1.000	0.521	15
yellow-throated vireo	$\Psi.p_{\text{prior detect}}$	458.687	428.049	0.000	1.000	0.468	12

Figure 2.1Grid used for collecting vegetative structure data. Plot was 25m radius circle around point center with ground and shrub layer measurements made at each 6.25m interval around the plot.

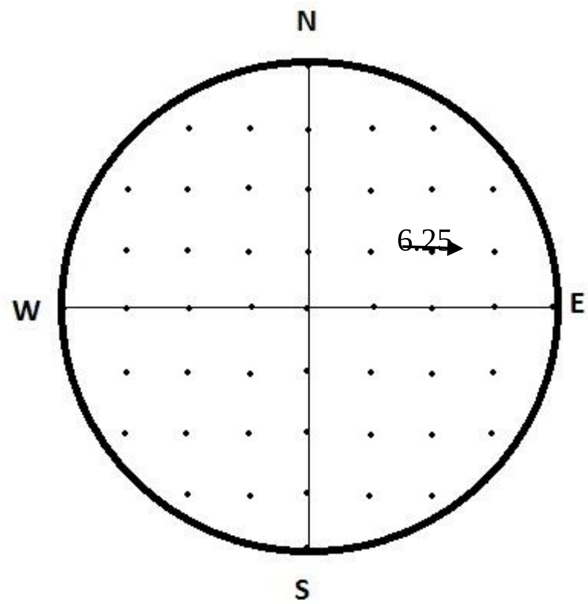

Figure 2.2. The relative sensitivity of bird species use to the size of wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening size and the log-odds of occupancy for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur as opening size increased. Conversely, species encountered in openings with negative β were less likely to occur as opening size increased.

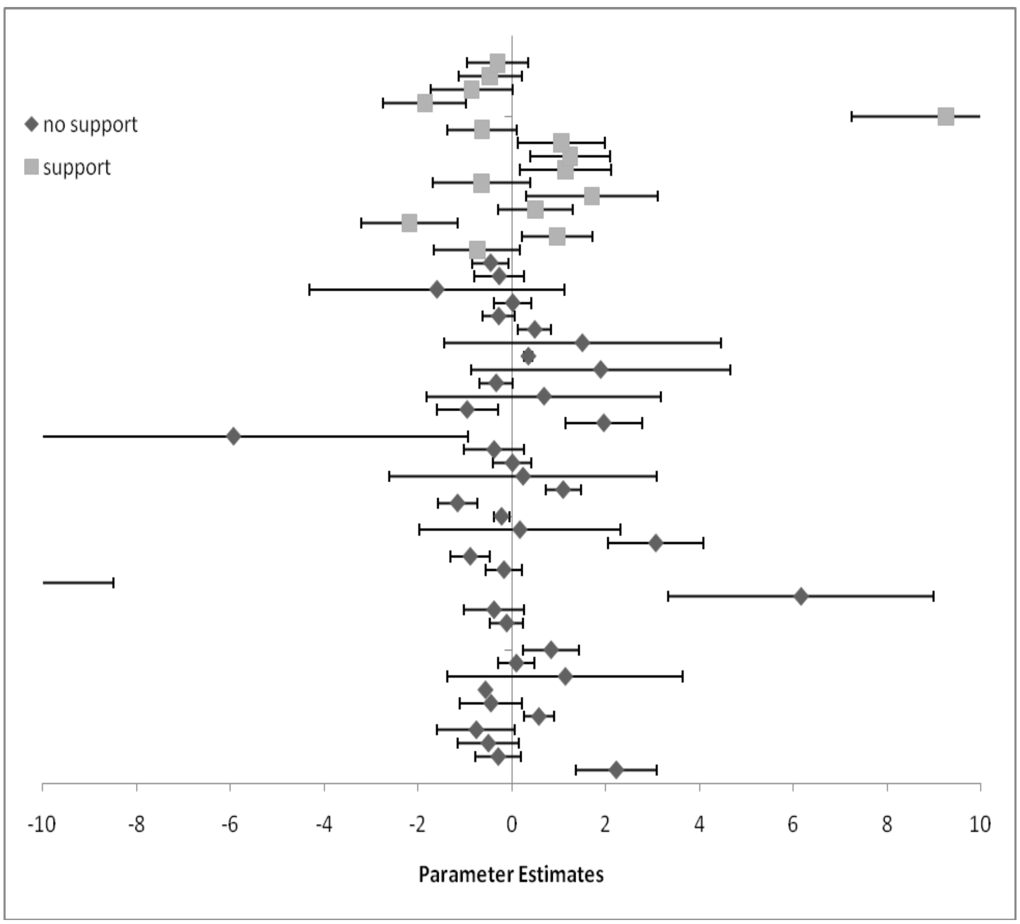

Figure 2.3. The relative sensitivity of bird species use to the amount of edge surrounding wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening size and the log-odds of occupancy for the edge model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur as opening edge increased. Conversely, species encountered in openings with negative β were less likely to occur as opening edge increased.

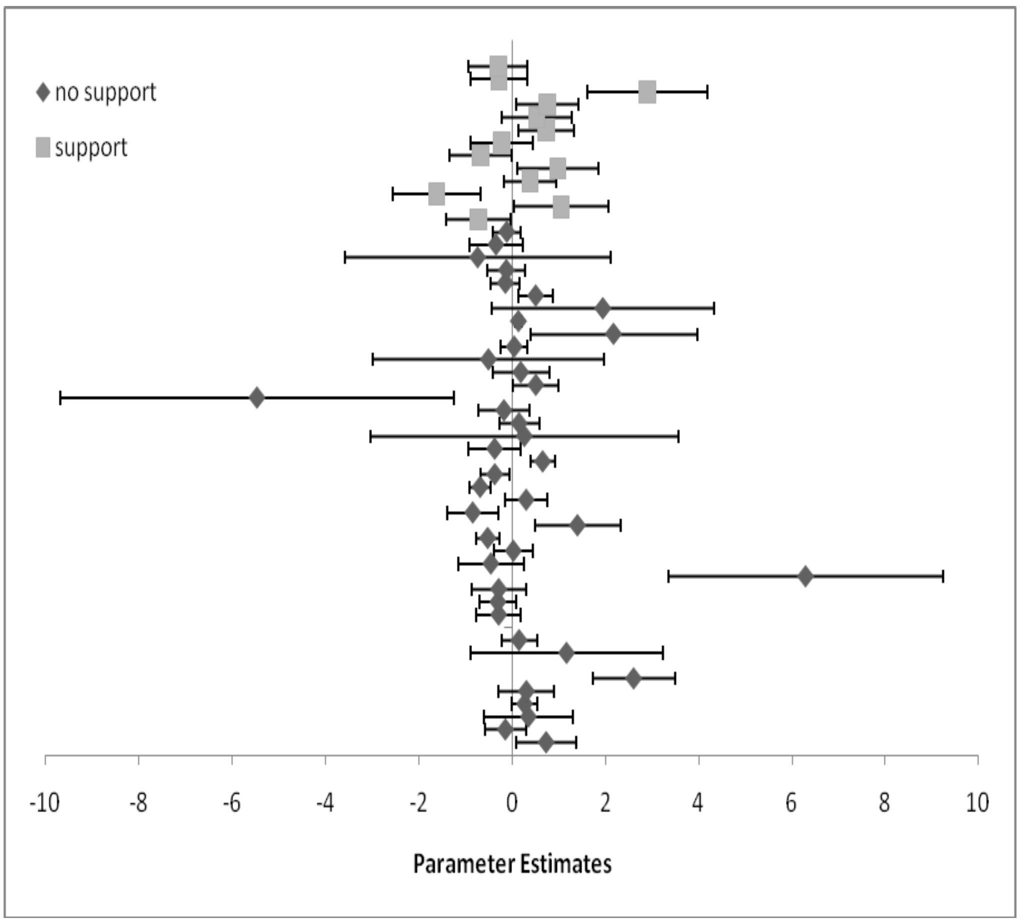

Figure 2.4. The relative sensitivity of bird species use to the shape of wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening shape and the log-odds of occupancy for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur as openings became more irregular. Conversely, species encountered in openings with negative β were less likely to occur as openings became more round.

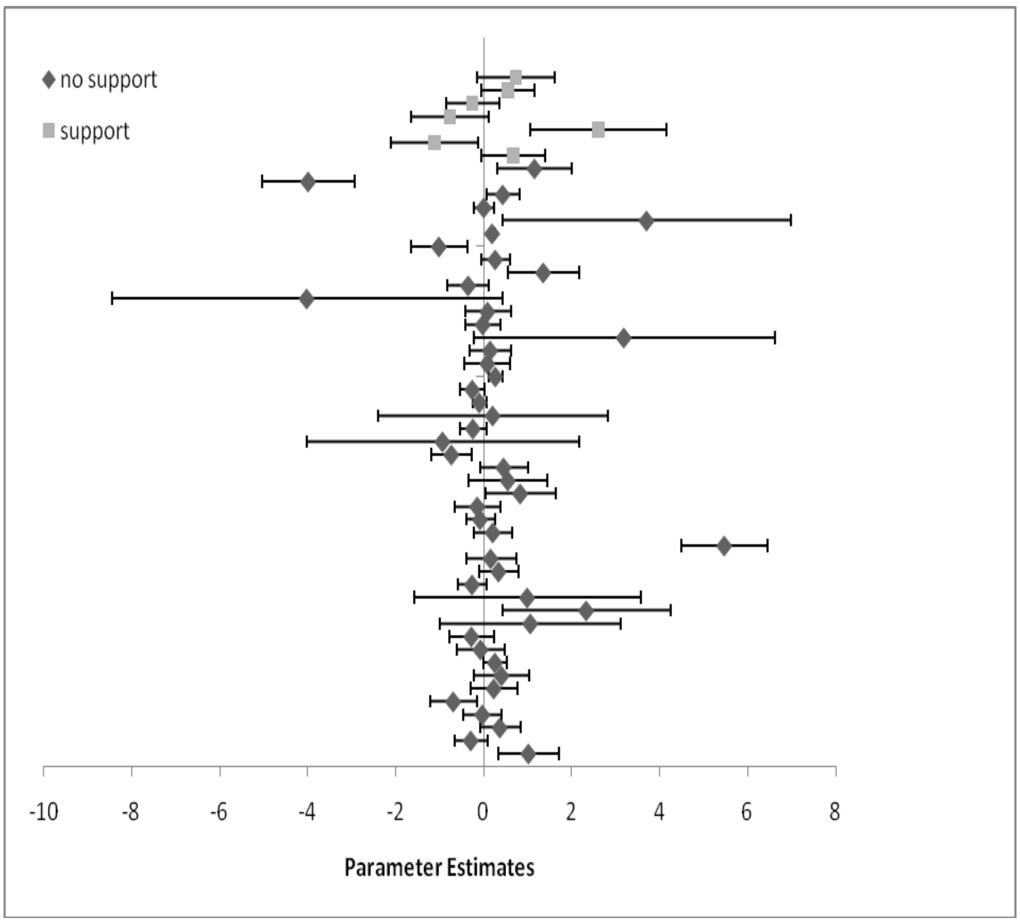

Figure 2.5a. The relative sensitivity of bird species use to the deciduous forest type surrounding wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the size (β, and 95% confidence limits) of the relationship between deciduous forest and the log-odds of occupancy for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur in openings in deciduous forest. Conversely, species encountered in openings with negative β were less likely to occur openings in deciduous forest.

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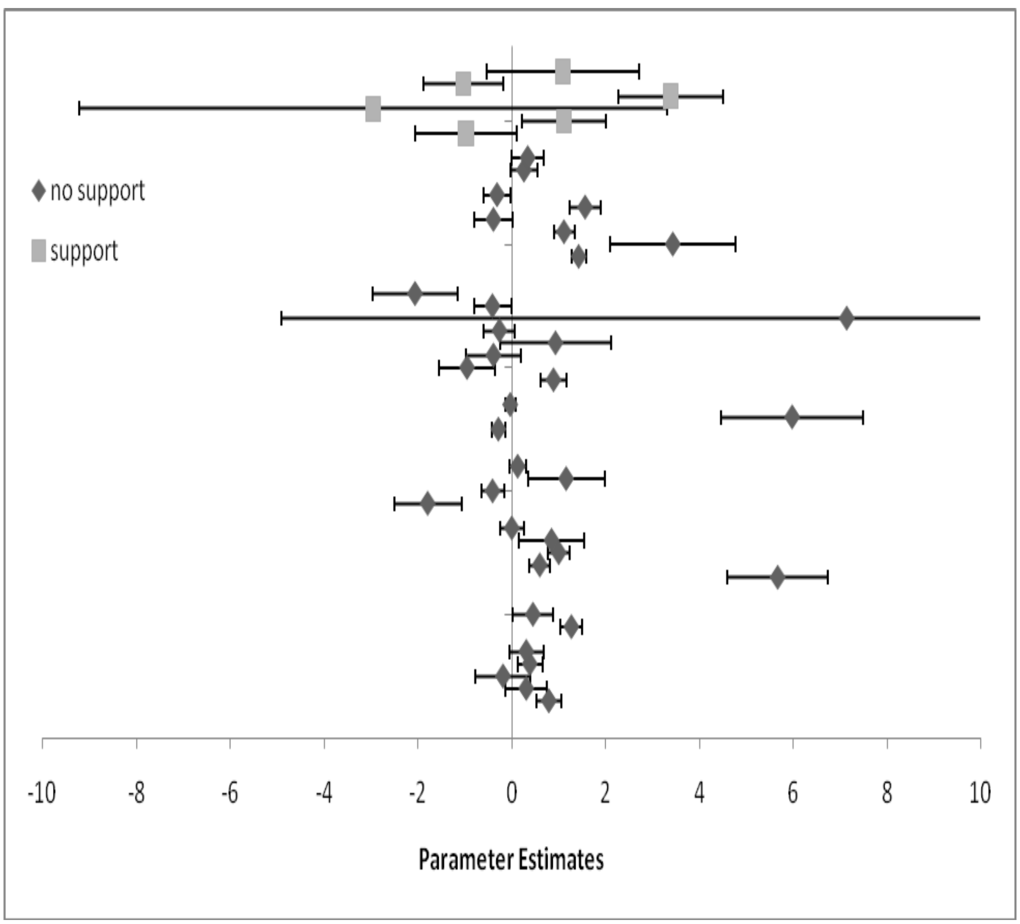


Figure 2.5b. The relative sensitivity of bird species use to the mixed forest type surrounding wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the size (β, and 95% confidence limits) of the relationship between mixed forest and the log-odds of occupancy for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur in openings in mixed forest. Conversely, species encountered in openings with negative β were less likely to occur openings in mixed forest.

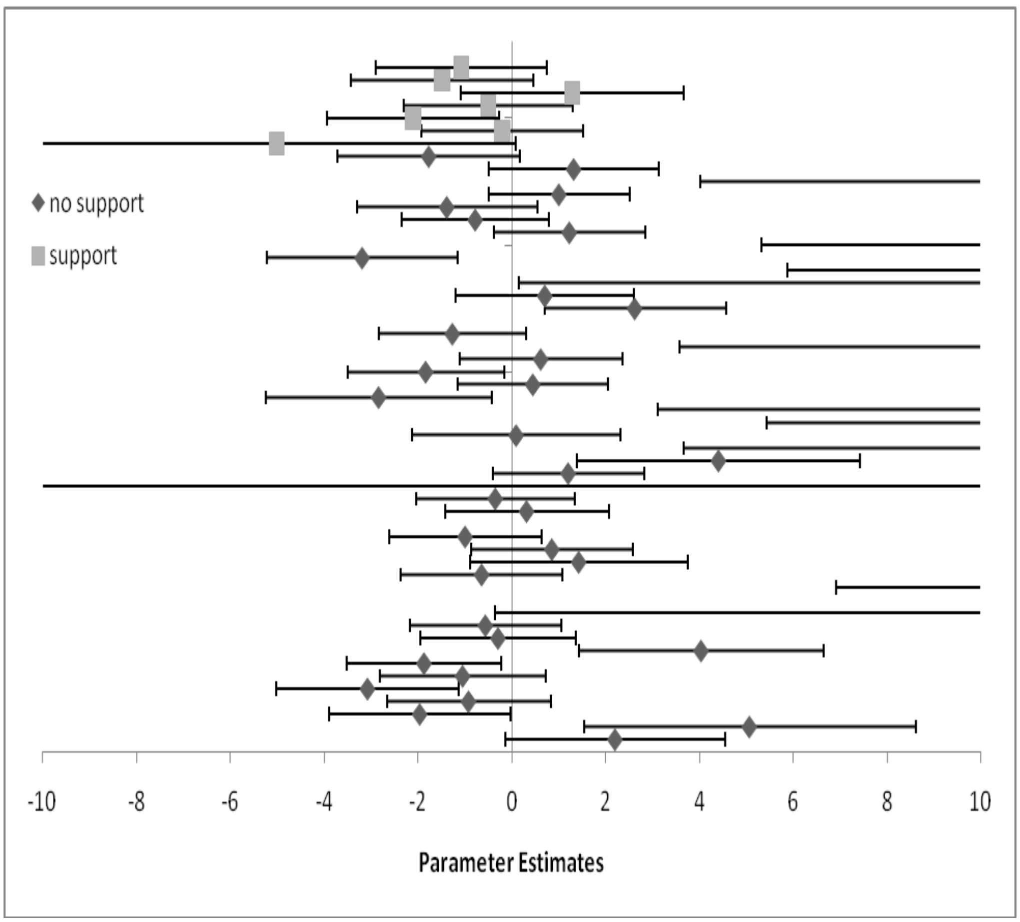


Figure 2.5c. The relative sensitivity of bird species use to the pine forest type surrounding wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the size (β, and 95% confidence limits) of the relationship between deciduous forest and the log-odds of occupancy for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur in openings in pine forest. Conversely, species encountered in openings with negative β were less likely to occur openings in pine forest.

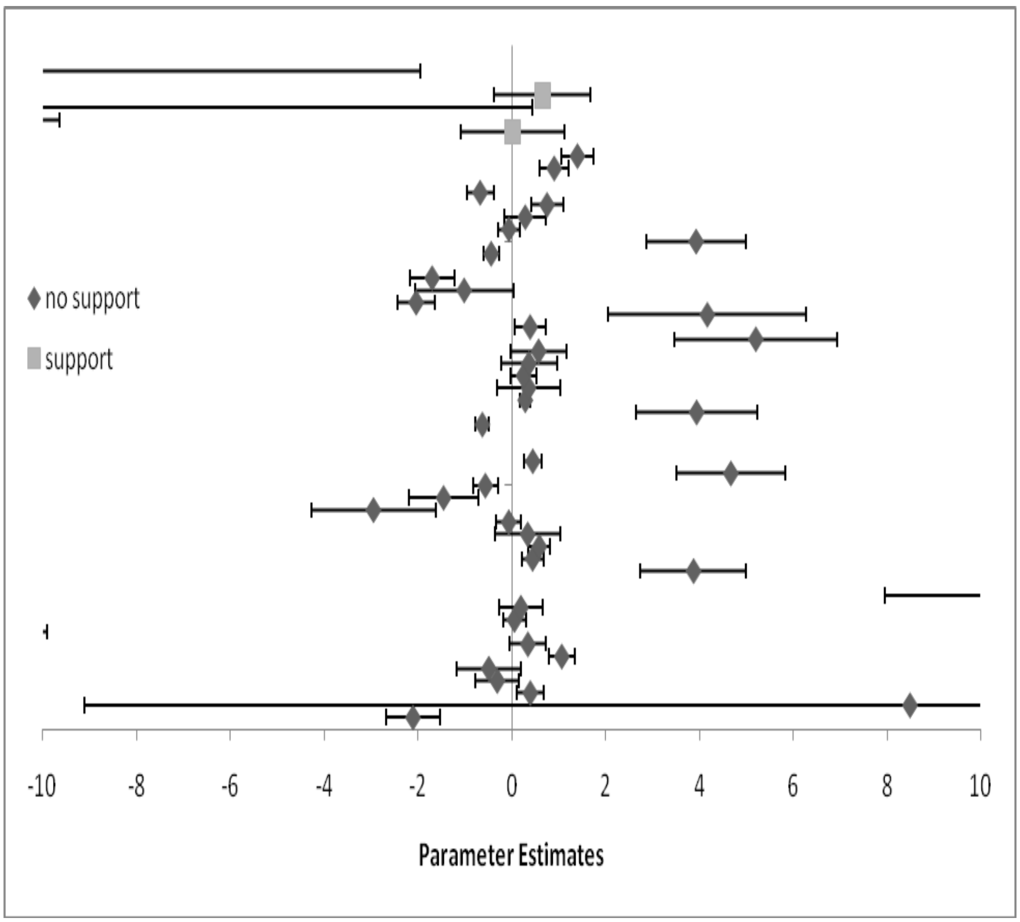
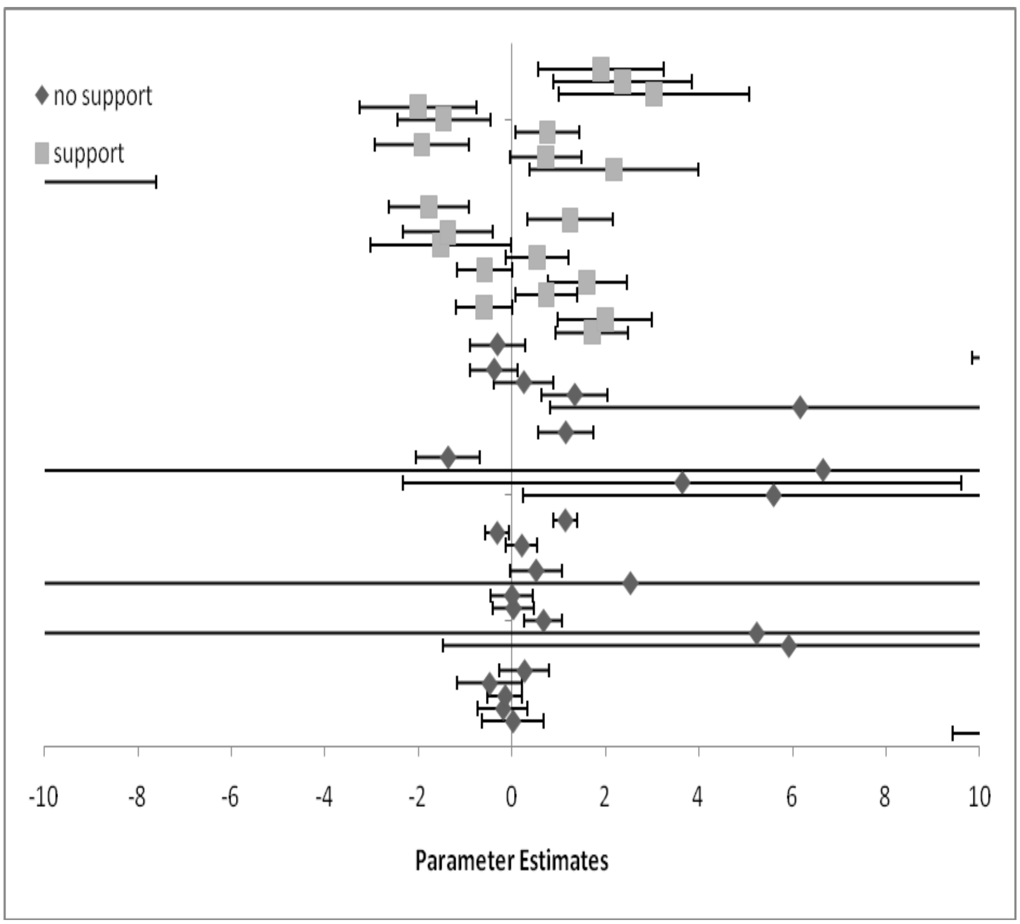


Figure 2.6. The relative sensitivity of bird species use to the management of wildlife openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the size (β, and 95% confidence limits) of the effect of planting on the log-odds of occupancy. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more likely to occur in planted openings. Conversely, species encountered in openings with negative β were less likely to occur in planted openings.



CHAPTER III: THE RELATIONSHIP BETWEEN AVIAN DENSITY AND WILDLIFE OPENINGS IN THE EAST GULF COASTAL PLAIN

ABSTRACT

Wildlife openings, maintained in early successional stages or planted food plots, are often created with the intention of providing forage for wildlife and hunting opportunities. Many non-target species benefit from wildlife openings including some declining Neotropical bird species. My objectives were to determine how bird abundance was related to size, edge length, shape, forest type, and management of openings. I developed an *a priori* set of hypotheses and corresponding models to examine factors that influenced detection and abundance of bird species in openings on two study areas in the East Gulf Coastal Plain of Alabama. We found the prior detection model was the best model for most species. Size, shape and management style were found to be the most important characteristics of openings with the most relationships to bird abundances. Even though size was related to density of more species, the responses we estimated were not large. Abundances of slightly more species were positively related to irregularly-shaped openings as opposed to round openings. Also, more species responded with positive increases in density to planted openings. Forest type and edge were not as strongly related to bird densities. Thirty-four species did not show strong relationships to any of our 5 characteristics. These relationships can be incorporated into management plans to help maintain and possibly increase abundance of species of interest within

wildlife openings.

INTRODUCTION

Wildlife openings, man-made clearings in forest lands that are maintained in early successional stages or planted food plots, are often created with the intention of providing forage for wildlife and hunting opportunities. Many non-target species benefit from wildlife openings (hereafter openings) including some Neotropical bird species whose populations are in decline (Sauer et al. 2007, Blancher et al. 2007). If populations of Neotropical migrants and other songbirds are to benefit from the management of openings, It is important to understand the factors such as size, shape, and vegetation management that influence their use.

Size and shape are among the characteristics that could influence the densities of birds using openings. Openings can vary greatly in size from <0.5ha to 50ha fields planted in agricultural crops. Bird species that prefer early successional habitats may select for and be found in higher densities in large regularly-shaped openings used for breeding and foraging. Species associated with forests may occur in greater densities near small, irregularly shaped openings because large openings increase forest fragmentation.

The amount of edge habitat also varied greatly among openings. While edge habitat may be used by some species for nesting and foraging, there are negative edge effects on bird populations. Many studies suggest that there may be higher concentrations of predators along edges (Andrén and Angelstam 1988, Donovan et al. 1997, Chalfoun et al. 2002) because of the increased abundance of nests found there.

Also, brown-headed cowbirds (*Molothrus ater*) have been found in higher numbers along edges. Some studies suggest more nest parasitism occurs along field and forest edges than in other habitats (Donovan et al. 1997, Suarez et al. 1997, Fink et al. 2006, and Chalfoun et al. 2002). We feel the previous findings may be because of increased densities of birds found along edges, which have been found in a study done in Texas (Strelke and Dickson 1980). Therefore bird abundance may be positively related to increased edge length.

The size and amount of edge of openings are measured simultaneously using the regularity of their shape—the ratio of perimeter and size. Openings can vary greatly in shape from circular openings with a maximal core area to oblong strips with long perimeters and very little core open area. Oblong openings may be more beneficial to forest species because they avoid flying through forest gaps and openings and instead will fly along the perimeter (Desrochers and Hannon 1997). Thus, forest birds may be more willing to fly across or use the edge habitat along an oblong opening because there is not much open area. On the other hand, round openings with much greater core open habitat than edge habitat may be more beneficial to early successional species that forage and nest within open fields. Also, with less edge habitat surrounding an opening, there may be lower predation and parasitism risks for those species using openings. Therefore, different species may select openings of different shapes.

The type of forest surrounding openings can also differ and may influence bird abundance. Openings within deciduous forests may have higher abundances of birds than those openings within pine forests since there are not many species found within pine forests and there are typically low densities of birds found there (Johnston and

Odum 1956, James and Wamer 1982). Also, deciduous forests may provide more foraging along edges with fruit bearing trees and bushes such as blackberry (*Rubus* spp.) which can be found in bottomland hardwoods (Bowen et al. 2007). One study showed there were more nest predators existing along the edge of pine forests (King et al. 1998), which could also reduce the number of birds using openings within them. Openings within mixed forests may have the greatest abundances of forest birds because bird species that use both types of forest may be present.

Openings also differ in the management that is implemented within them. Many openings are plowed and planted seasonally to provide food or foraging opportunities for game species. Plantings can range from agricultural crops such as corn (*Zea mays*) and soybeans (*Glycine max*), to seasonal grasses and forbs such as lespedezas (*Lespedeza* spp.) and partridge pea (*Chamaecrista fasciculate*) (Harper 2007). These planted openings are often used by migratory birds. Some openings are maintained as early successional habitat with mechanical disturbance such as mowing. These openings can benefit bird species greatly by providing annual and biennial grasses and forbs, as well as shrub habitat for foraging, nesting, and escape cover. Bird densities may vary between both types of openings.

My objectives were to determine how bird abundance was related to size, edge, shape, forest type, and management of openings. This information could be used by managers to benefit bird populations of conservation concern, like Neotropical migrants. I developed an *a priori* set of hypotheses and corresponding models to examine factors that influenced detection and abundance of bird species in openings on two study areas in the East Gulf Coastal Plain of Alabama.

STUDY AREAS AND METHODS

The study sites selected for this project were located in southern Alabama in the East Gulf Coastal Plain, Alabama. The first area included Fred T. Stimpson (31.38°N, 87.87°W) and Upper State Sanctuaries (31.56°N, 87.96°W) in Clarke County, Alabama which were 20km apart but managed as a single unit (two, 2,230ha). The second study site, Barbour County Wildlife Management Area (31.99°N 85.46°W, 7,660ha), (Barbour) was located 235km east of the sanctuaries in Barbour and Bullock counties in southeast Alabama. The landcover and habitat management on both study areas were similar. Both areas were primarily upland pine and bottomland hardwood forests. During this study hunting was prohibited in the Sanctuaries, and management included creating and maintaining numerous openings primarily for white-tailed deer (*Odocoileus virginianus*) and wild turkey (*Meleagris gallopavo*). Barbour was open to the public for hunting small and large game animals. Therefore, the primary management actions on this area were intended to provide hunting opportunities and habitat for game species. Openings were prevalent throughout Barbour. The majority of openings were managed with agricultural crops and seasonal grasses, but some were maintained as early successional habitat.

Alabama Gap Analysis Project Landcover maps (Kleiner et al. 2007), which were based on satellite imagery from 1991-2001, were used in combination with aerial photography from 1992 and 2006 to locate openings within the two study areas. Once openings were identified, the perimeter of each opening was digitized, and area and perimeter were calculated using ArcGis (version 9.1 ESRI, Inc.). The area of the openings ranged from 0.05ha to 30ha. Thirty openings were chosen from each study site using a stratified random sample based on size of the opening. An additional 30 alternate openings were chosen for each study area to replace those openings that could not be used at each site. Alternates were used when ground truthing indicated that openings had not been maintained or they were swamps or ponds. In 2009, five sites were not surveyed because the surrounding area had been clearcut or they were flooded.

More accurate estimates of the perimeter (edge length) and area of each selected opening were obtained by mapping the perimeter using handheld GPS and importing these data into ArcGIS. Also, GPS data was obtained from the area manager of Barbour County Wildlife Management Area for openings that were planted as food plots for game species (A. Pritchett, Alabama Department of Conservation and Natural Resources, unpublished data) Length of edge and area were found to be closely related (R=0.906), therefore, we used a shape index (perimeter/area) to incorporate this relationship ($R_{shape\ and\ area}$= -0.477, $R_{shape\ and\ edge}$= -0.622).

Point count surveys for birds were conducted within each selected opening twice during the breeding season (May-July) no later than four hours after sunrise. For the smaller openings (50m or less in diameter), the center of the point count was located in the center of the opening. In openings greater than 50m in width, the center of the survey point was located 50m from the forest edge at the widest portion of the opening to include species within the opening as well as in the adjacent forest. All survey points were at least 250m apart to prevent double-counting birds. Each survey consisted of three four minute counts during which each bird that was seen or heard was recorded along with the estimated direction and distance band (0-25m, 25-50m, greater than 50m) (Hamel et al. 1996). At the beginning of each survey, the temperature was recorded (°C) along with the date and time the count began.

During June – August 2008, habitat information was collected on a 6.25m grid of 49 points within 25m radius of each survey site (Figure 3.1). At each point on the grid, presence or absence of tree canopy (dominant tree cover), midstory (4m to canopy), shrub layer (two-4m), and ground cover (less than 2m) were recorded using a moosehorn densitometer (Robinson 1947). To establish the majority forest edge type for each opening, the proportion of each forest type present around the opening was estimated visually and assigned to one of three categories: deciduous forest, mixed forest, or coniferous forest. Mixed forest was any forest that had less than 70 percent of pine or hardwood. The management type for each opening was classified as planted or unplanted, where planted openings were those that were plowed and planted with agricultural crops or seasonal grasses and unplanted openings were those that were maintained as early succession habitat without mechanical tillage. For those openings with more than one management type, the opening was assigned to the cover present in the greatest proportion. The forest and management type of our openings ranged in size, edge length, and shape (Appendix A).

Hypotheses

My hypotheses regarding detection included that detection of a species would not vary among sites or surveys ($p.$). I also hypothesized that detection probability would decline through the morning (p_{temp}) because male birds may not sing as frequently as temperature increases (Mayfield 1981, Robbins 1981). Additionally, I hypothesized that detectability would decline through the breeding season (p_{date}) because males sing more at the beginning of the breeding season when they are choosing and attracting mates (Best 1981, Skirvin 1981). I also hypothesized differences in detection among observers

(p_{obs}), because not all observers have the same skills at detecting species by sight and sound (Sauer et al. 1994 and Alldredge et al. 2007). I also hypothesized that observers would share information about the locations of rare species; and, thus detection rates for rare species would increase after they had been detected. Finally, I hypothesized that once an observer had detected any species at a site, detection rates for that species would increase on subsequent surveys by that observer at that site.

After I determined the best detection models for each species, I compared abundance models. My *a priori* abundance hypotheses included a set of common models that were evaluated for each species. The common hypotheses addressed the size, shape, perimeter length, forest type and management of openings. The size hypothesis (λ_{size}) suggested that species abundance would differ as the size of the opening increased. The edge hypothesis (λ_{edge}) predicted that as the perimeter length of an opening (i.e., edge) increased species abundance would vary. The shape hypothesis (λ_{shape}) predicted that as an opening became more irregularly shaped (i.e., core area decreases) species abundance would differ. The fourth hypothesis, forest type (λ_{forest}) suggested that bird abundance would differ among openings surrounded by different forest types (deciduous, coniferous, and mixed) and fewer species would be associated with coniferous forest. My hypotheses with regard to management type ($\lambda_{management}$) were related to the intensity of management. I expected openings that were tilled or tilled and planted with agricultural crops or seasonal grasses would be used more frequently by more individuals than unplanted openings that are maintained as pastures or open fields.

Analysis

I estimated abundance (λ) and detection probability (p) for each species that was encountered at least 6 times using models corresponding to each of my *a priori* hypotheses. N-mixture models were used to estimate density as well as detection rates from repeated counts data (Royle 2004). Models with a ΔAICc value less than two were considered best approximating models (Burnham and Anderson 2002). Model weights (w_i) were calculated as evidence of the relative support for each model (hypothesis). Estimates of the log rate of change in abundance and unconditional estimates of standard errors (SEs) were calculated from the best approximating models for each species to determine the relationships of each habitat characteristic of openings with abundance of each species. We used the number of sites surveyed to correct for small sample size. Models with inestimable parameters were removed from the analysis for that species.

First, for each species all detection models (Table 3.1) were run with the mean abundance model (λ.). Observer and prior detection models were removed from a species if an observer never conducted surveys at a site where a species was known to occur because observer-specific detection rates could not be estimated. Individual Observers were also removed from prior detection models if they never conducted a survey subsequent to the initial detection of a species at a site. The best detection models were then used in combination with the abundance models (Table 3.2) for each respective species.

RESULTS

Bird surveys were conducted with a total of 9,271 detections from 75 species for both years. Black vulture, turkey vulture, and great egret were not used in the analysis, because they were considered transients not making use of the survey sites. Therefore, there was adequate data for 54 species for the analysis with a total of 9,195 individual detections for those species.

We found that the prior detection model was the best approximating detection model for 29 of the 54 species in this analysis (Table 3.3). The date model was the best approximating model for 12 species of birds (Table 3.3). For 10 species the temperature model fit best. The observer effects model was incorporated into four species' detection probabilities as well. Along with these detection models, for 9 species the intercept only model, which estimated the average detection rate, all sites and surveys for that species, was included in the top detection models.

Opening size had a strong association with abundance for 18 species of birds (Δ<two, Table 3.4). The area model was the unequivocal best fit model ($\Delta=0$), for abundance of birds for four species. Barred owl (*Strix varia*) showed the strongest relationship towards openings size (area model as the only top model) with a positive relationship for larger openings ($w_i=0.471$, $\beta=0.53\pm0.18$). Also, brown-headed cowbird ($w_i=0.537$, $\beta=0.464\pm0.061$) and chipping sparrow (*Spizella passerine*, $w_i=0.416$, $\beta=0.382\pm0.137$) densities had a positive relationship with openings size. One forest species showed a negative association with opening size, Kentucky warbler (*Oporornis formosus*, $w_i=0.348$, $\beta=-0.751\pm0.422$). Overall, species abundances were not strongly related to opening size, having little change in densities for most species (log of density change was close to one, Figure 3.2).

The perimeter length of an opening had a strong influence on abundance of 12 species (Δ<two), but the edge model was the unequivocal best for only two species ($\Delta=0$)(Table 3.5). Barn swallow (*Hirundo rustica*) density was positively related to edge length ($w_i = 0.269$, $\beta=0.583\pm0.152$), while pine warbler (*Dendroica pinus*) density was

negatively related to edge habitat (w_i = 0.353, β=-0.364±0.173). Based on overall abundance changes (Figure 3.3), more species' densities declined as perimeter increased than vice-versa.

The shape of an opening had a strong influence on abundance for 20 species (Δ<two, Table 3.6). The shape model was the unequivocal best fit model for abundance for 8 species (Δ=0). The two opening species with shape as the best model are Eastern bluebird (*Sialia sialis*, w_i =0.571, β=-0.779±0.377) and indigo bunting (*Passerina cyanea*, w_i = 0.81, β=-0.284±0.097). The density of both species was positively related to roundness of openings. Eastern towhee (*Pipilo erythrophthalmus*), the only edge species with shape as the best model, had increased densities as openings became more irregularly-shaped (w_i = 0.826, β=0.319±0.108). The remaining five species, Carolina chickadee (*Poecile carolinensis*, w_i = 0.474, β=0.164±0.072), hooded warbler (*Wilsonia citrine*, w_i = 0.413, β=0.219±0.093), tufted titmouse (*Baeolophus bicolor*, w_i = 0.572, β=0.150±0.062), wood thrush (*Hylocichla mustelina*, w_i = 0.589, β=0.404±0.145), and yellow-throated warbler (*Dendroica dominica*, w_i = 0.49, β=0.64±0.211), all had abundances with a positive relationship to irregularly-shaped openings as well. There were slightly more species' with abundance negatively related to roundness of openings as opposed to irregular-shaped openings (Figure 3.4).

Forest type surrounding an opening had a strong influence on abundance for 10 species (Δ<two, Table 3.7). There were only three species with the forest model as the unequivocal best fit model for abundance (Δ=0). Hairy woodpecker (*Picoides villosus*) abundance was greatest in openings surrounded by deciduous forest (β=-0.166±0.171). Northern mockingbird (*Mimus polyglottos*) abundance was greatest in pine forests

(β=0.37±1.002). Ruby-throated hummingbirds (*Archilochus colubris*) showed strong relationships between abundance and deciduous forest (β=0.823±0.662). Overall, bird densities had varying relationships to forest type (Figure 3.5). However, there were slightly more species, such as field sparrow (*Spizella pusilla*), that were more dense in openings associated with deciduous forests (β=0.966±1.117).

The management style of an opening had a strong influence on abundance for 17 species (Δ<two, Table 3.8). Of those species, 9 had the management model as the unequivocal best fit model for abundance (Δ=0). Two woodpecker species had a negative relationship towards heavily managed and planted openings, northern flicker (*Colaptes auratus*, w_i = 0.98, β=-21.431±17918) and red-headed woodpecker (*Melanerpes erythrocephalus*, w_i = 0.37, β=-0.725±0.379). Also, fish crows (*Corvus ossifragus*, w_i = 0.994, β=-1.656±0.508) and purple martins (*Progne subis*, w_i = 0.459, β=-1.68±1.073), both exhibited negative relationships towards heavily managed openings. American goldfinch (w_i = 0.886, β=2.04±0.923) and white-eyed vireo (*Vireo griseus*, w_i = 0.803, β=1.045±0.137), both early successional species, showed positive relationships towards managed openings. Two forest species, American redstart (*Setophaga ruticilla*, w_i =0.999, β=1.339±0.311) and red-shouldered hawk (*Buteo lineatus*, w_i = 0.665, β=0.628±0.293) also exhibited positive relationships towards managed openings. The last species, yellow-throated vireo (*Vireo flavifrons*), an edge species, had a positive relationship towards managed openings (w_i = 0.536, β=0.397±0.234). Management style of openings was shown to have varying relationships with species abundances, with more species having positive changes in density with planted openings (Figure 3.6).

The intercept only model, or null model, was among the best models for abundance of 34 species (Δ<0, Table 3.9). For these species the intercept model was the unequivocal best fit model (Δ=0), for abundance of 28 of those species. These species did not show any relationship between characteristics of openings and their abundance.

DISCUSSION

We used model selection results as the basis for inferences. While we include estimates of log odds ratios, in our analysis and acknowledge that the confidence intervals on the estimates for many species indicate high imprecision, we relied on our model selection results to identify important relationships between species and opening characteristics. The lack of precision in our estimates may indicate a high degree of variability within our results or unmodeled heterogeneity due to the simplicity of the models we compared. Nonetheless, we feel that our results indicate the strongest relationships within the data, and suggest that more data or less parsimonious models would improve the precision of the estimated relationships, but would not change our conclusions.

I found the prior detection model was the best model for most species, thus once a species was detected at a site it was more likely to be detected on subsequent counts. This was expected, and likely resulted from observers becoming familiar with the species that were present at site. The date model was also an important detection model for some species. This likely occurred because later in the breeding season, there were more individuals out foraging for or with fledglings making them easier to detect.

We interpreted species densities as indicators of selectivity. When a large number of individuals of a species were present, we assumed that their abundance indicated openings with characteristics they selected for. Conversely, we assumed that low numbers or absence indicated that alternative management actions could result in increased densities of those species of interest. Our site placement of our point counts was used to make inferences about species found associated with openings and the surrounding habitat, therefore some forest species with relationships with may not have necessarily been located within the opening. Instead, those species may have been found in the adjacent forest edge habitat.

I hypothesized that selection of openings by some species would be related to opening size. More specifically, species typically associated with forests would respond negatively with decreased densities, while species typically associated with grasslands and early successional habitat would respond positively with increased densities. Desrochers and Hannon (1997) suggested that forest birds may be deterred by large openings. Also larger openings increase the amount of forest fragmentation which has been shown to negatively affect forest birds (Blake and Karr 1987). Although we did not find significant relationships, our findings were similar to Moorman and Guynn (2001) that found Acadian flycatchers (*Empidonax virescens*), a forest species, had a negative change in density with larger openings. Also as expected, we found that the abundance of another forest species, Kentucky warbler, was negatively related to opening size. Bowen et al. (2007) suggested that smaller openings would have higher densities of forest species. The openings they studied ranged from 0.13-0.5ha, much smaller than the range of openings we studied. Our results suggested the same patterns for forest species, with forest bird abundance being negatively related to size.

As expected, several early successional species such as indigo bunting and white-eyed vireo showed preference for larger openings and their densities increased as openings become larger. While not significant relationships, these results were similar to those of one study in South Carolina which found increased densities for these species as opening size increased (Moorman and Guynn 2001). In this study their largest opening was only 0.5 ha, which is much smaller than our largest opening, but the relationships were similar with higher densities in larger openings. By contrast, we found that abundance of one edge species, Eastern towhee, was negatively related to larger openings, which was contrary to findings in another study of openings over a similar range in sizes that found the towhee as the only species that had increased abundances in larger openings (Askins et al. 2007). These findings may be different because the openings in this study were created by harvesting practices. Therefore, these clearcut areas may have more shrub layer within the openings than the openings in our study. Edge species such as the eastern wood-pewee may not select large openings because there is more core open area in the opening and they may prefer the shrubby habitat along edges or found within clearcuts.

I believed that as the perimeter of openings increased, species abundances would be affected and some species would increase while others decreased. Over half of the species we examined showed abundances that were negatively related to increases in edge habitat. These species may have negative relationships with edge because of increased fragmentation caused by openings, as in one study in Illinois (Blake and Karr 1987). Also edges along openings may have increased predation rates over other edge habitats (Andrén and Angelstam 1988, Donovan et al. 1997, Suarez et al. 1997, Chalfoun et al. 2002). In our study, wood thrush, a typical forest species, illustrated a negative change in abundance as edge length increased, although this relationship was not significant. This was contrary to what was expected, because we felt that forest species would be more likely to use an opening if there was more edge habitat and escape cover for them. Also, one study on wood thrush nestlings found that nestlings near edges grew faster, which may be beneficial for survival (Kaiser and Lindell 2007). Two other forest species, hooded warbler and Kentucky warbler, also showed negative relationships towards edge length. This does not agree with the findings of another study that found both species were most often associated with edge habitat (Bowen et al. 2007). However, Moorman et al. (2002) found that hooded warblers experienced higher rates of parasitism along clearcut edges, which could be why they were found in lower density as perimeter increased. Similarly, several studies found that parasitism by brown-headed cowbirds increased with increased edge habitat (Donovan et al. 1997, Suarez et al. 1997, Fink et al. 2006, and Chalfoun et al. 2002). Brown-headed cowbird density was positively associated with perimeter length, perhaps because there are more host nests available along edges.

By contrast, abundance of some species associated with edges illustrated positive relationships between density and perimeter. While not significant, indigo bunting had a positive relationship towards increased edge habitat. Weldon and Haddad (2005) also found similar results. During the breeding season, these birds often use high perches in trees along the edges of openings to sing. Thus, increased edge habitat may provide more perching sites.

As the shape of openings changed from round to irregular, I predicted that species abundances would differ with early successional species having lower densities while forest and edge species would have higher densities. Several forest species were found to be negatively associated with opening roundness. This is what I expected, because I believed they would prefer more irregularly-shaped openings with less open core area. Also, one study found that forest species tend to avoid flying through openings and instead would travel twice as far through the woods to get to the other side of an opening (Desrochers and Hannon 1997). Therefore, I felt forest birds would select oblong openings where there was not as much open area to avoid. One species typically associated with openings, indigo bunting, was positively related to round openings. These results were not expected, and did not agree with another study that found they prefer irregular openings with more edge habitat because of the increased availability of perching sites (Weldon and Haddad 2005). Instead, they were shown to prefer round openings with more core area. One possible reason for this association was increased predation risks along edges (Andrén and Angelstam 1988, Donovan et al. 1997, Chalfoun et al. 2002).

Overall, around half of our species showed positively relationships to irregularly-shaped openings. This was similar to findings from another study on forest patches that found oblong patches, which have much more edge habitat, had higher densities of nests than round patches (Bollinger and Switzer 2002).

I predicted that species abundances would also be related to forest types surrounding openings. I believed openings within pine forests would have the lowest densities of most species, while mixed pine and deciduous forest would have higher densities of birds because they offer a greater diversity of habitats. Overall, densities varied among openings in the three forest types. However, there were slightly more positive relationships between species densities and mixed forests. Some studies have found fewer species and birds within pine forests (Johnston and Odum 1956, James and Wamer 1982). Because of the lower species diversity, there may be lower densities as well in openings within pine forests. Those forests may not provide adequate food sources to provide for higher densities. Also, there may be more foraging opportunities in and around deciduous forests because of the wider variety of foraging sites.

Pine Warblers, which are usually associated with pine forests (Johnston and Odum 1956), did exhibit the relationship to forest type that was expected. Their densities were highly related to pine forests and were negatively related to openings within deciduous forest. Pine warblers also showed higher densities within mixed forest because of the percentage of pine trees that were present within the mixed forest openings. Ruby-throated hummingbird, which is rarely found within pine forests (Hamel 1992), showed relationships which were expected. They showed much higher densities within deciduous forest, and lower densities within both mixed and pine forests. While not significant, brown-headed cowbird exhibited a higher positive change in density within openings in deciduous forest. This could indicate that parasitism levels may be higher within deciduous forest openings as opposed to the other two forest types. Even with higher cowbird densities, deciduous forests still had higher densities of most species.

Lastly, I hypothesized that there would be higher densities of birds found within heavily managed and planted openings than in early successional openings which were not planted. Planted openings are often planted in agricultural crops or forbs such as partridge pea and native lespedezas which are good food sources for birds (Harper 2007). As predicted, more species abundances were positively related to managed openings.

Those species may find planted food sources more beneficial than native shrubs. Some forest species, such as American redstart, showed positive relationships with managed openings. These species may be using openings for foraging to provide food for their offspring. Anders et al. (1998) found that later in the breeding season some forest interior species use other habitats, such as early successional areas and field edges, while foraging with fledglings. We also found higher densities of other forest species such as hooded warbler and northern parula in managed openings.

Early successional species such as American goldfinch and white-eyed vireo were positively related to planted openings. While providing food for these species, these areas may also be providing important cover for nesting and escape cover from predators. One study suggests that edge species may prefer unmanaged openings more (Schlossberg and King 2008). This could be because openings that are planted may not have much of the early successional or shrub cover that they prefer. This was the case for one edge species, blue grosbeak (*Passerina caerulea*), which showed higher densities in planted openings.

Some species did not respond to characteristics of openings that we measured. For these species the best model one with no differences in density across all sites. These species also could be considered generalists because they exhibited no measurable habitat relationship. However, exceptions to this rule include species that were rarely observed in openings. This included Bachman's sparrow, a species of Greatest Conservation Concern, in Alabama because of low densities (Mirarchi et al. 2004, Sauer et al. 2007, Blancher et al. 2007). While we had enough data to include this species in our analysis with 11 encounters, there was little evidence of strong relationships between this species' density and any one opening characteristics we measured. Bachman's sparrow is closely associated with open pine and early successional habitat in the coastal plain (Hamel 1992, Dunning 1993); therefore, it is interesting that there were no associations with forest type, or any other characteristic of openings. We did not incorporate information about surrounding forest patch size within our study. Therefore the surrounding habitats may have an impact on densities of forest species as well as others. Future research could be done to look at the affects of adjacent forests on our species densities.

In contrast, species like northern cardinal (*Cardinalis cardinalis*) are found in many habitats with no specific requirements (Hamel 1992). Similarly, mourning doves (*Zenaida macroura*) also are found in many habitat types such as open woods, residential areas, roadsides, farmlands, and open fields (Hamel 1992). These species appeared to use openings regardless of their characteristics.

Openings are used by large densities of both generalist and selective species. It is important when managing for the most species to look at the relationships of specialist species with openings. Generalist species are going to be found in all openings but there may be specific requirements to maintain higher densities of specialist species within openings. Of our five characteristics, opening size was found to have the most relationships with species densities, but bird densities were not found to change greatly. However, management style had the strongest relationships with more species having higher densities with tilled and planted openings. Therefore managers may want to consider this when trying to provide habitat for higher densities of birds. The brown-headed cowbird, as predicted, showed higher densities within large openings with more edge habitat. If managing for decreased cowbird abundance is needed, managers may want smaller openings that minimize the amount of edge habitat. Also, most species were negatively related to edge, so less edge habitat may help increase densities of those species. While relationships varied among forest types, there were more positive relationships between bird densities and openings in mixed and deciduous forests. Therefore openings in pine forests may not be ideal to maintain higher bird densities. Managers should consider these relationships when creating or maintain openings to maximize bird densities within them.

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Table 3.1. Hypotheses and corresponding models for detection rates of birds detected on Barbour WMA and Stimpson and Upper State Sanctuaries, Alabama 2008-09.

Detection hypothesis	Model
Does not vary among sites or surveys	$p.$
Varies by temperature	p_{temp}
Varies by time of year	p_{date}
Varies by observer	p_{obs}
Varies with shared information on rare species.	p_{memory}
Varies with subsequent detections by each observer	$p_{prior\ detect}$

*Only best detection models were then run in combination with occupancy models.

Table 3.2. Hypotheses and corresponding models for abundance for birds encountered on Barbour WMA and Stimpson and Upper State Sanctuaries, Alabama 2008-09

Hypothesis	Model
Opening size affects abundance	λ_{size}
Perimeter length affects abundance	λ_{edge}
Opening shape affects abundance	λ_{shape}
Forest type affects abundance	λ_{forest}
Management style affects abundance	$\lambda_{\text{management}}$

Table 3.3. Best fit detection models (Δ<2.0) for each species of bird[1] observed on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain of Alabama, 2008-09. For this comparison, detection models were fit with a null model of abundance (λ.). Species with more than one best model appear under multiple models.

Model	Species				
p_{prior} detect	acadian flycatcher	American redstart	blue-gray gnatcatcher	brown-headed nuthatch	blue grosbeak
	blue jay	Carolina chickadee	Carolina wren	eastern towhee	eastern wood-pewee
	great-crested flycatcher	indigo bunting	Kentucky warbler	mourning dove	northern bobwhite
	northern cardinal	northern parula	pileated woodpecker	red-bellied woodpecker	red-eyed vireo
	red-headed woodpecker	red-shouldered hawk	summer tanager	tufted titmouse	white-eyed vireo
	wood thrush	yellow-breasted chat	yellow-billed cuckoo	yellow-throated vireo	
p_{obs}					
	American crow	Carolina wren	common yellowthroat	downy woodpecker	
p_{date}					
	American goldfinch	Bachman's sparrow	chipping sparrow	fish crow	field sparrow
	hairy woodpecker	northern mockingbird	pine warbler	prairie warbler	purple martin
	Swainson's warbler	yellow-throated warbler			
p_{temp}					
	Bachman's sparrow	barred owl	barn swallow	black-and-white warbler	brown-headed cowbird
	eastern bluebird	northern flicker	orchard oriole	ruby-throated hummingbird	wild turkey
$p.$					
	Bachman's sparrow	barn swallow	black-and-white warbler	hairy woodpecker	northern mockingbird

Table 3.3. Best fit detection models ($\Delta<2.0$) for each species of bird[1] observed on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain of Alabama, 2008-09. For this comparison, detection models were fit with a null model of abundance ($\lambda.$). Species with more than one best model appear under multiple models.

Model	Species			
	orchard oriole	prairie warbler	ruby-throated hummingbird	yellow-throated warbler

Table 3.4. The relative importance of the area model (λ_{area}) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American crow	$\lambda_{area}\ p_{obs}$	1506.480	1484.880	1.669	0.434	0.193	9
Bachman's sparrow	$\lambda_{area}\ p.$	73.395	66.967	1.056	0.590	0.070	3
Bachman's sparrow	$\lambda_{area}\ p_{temp}$	73.523	64.796	1.184	0.553	0.065	4
Bachman's sparrow	$\lambda_{area}\ p_{date}$	74.152	65.424	1.812	0.404	0.048	4
barred owl	$\lambda_{area}\ p_{temp}$	81.121	72.394	0.000	1.000	0.471	4
barn swallow	$\lambda_{area}\ p_{temp}$	185.335	176.608	0.136	0.934	0.251	4
barn swallow	$\lambda_{area}\ p.$	186.470	180.041	1.271	0.530	0.143	3
black-and-white warbler	$\lambda_{area}\ p.$	157.628	151.199	1.348	0.510	0.099	3
brown-headed cowbird	$\lambda_{area}\ p_{temp}$	561.775	553.048	0.000	1.000	0.537	4
brown-headed nuthatch	$\lambda_{area}\ p_{prior\ detect}$	244.364	207.031	0.321	0.852	0.328	14
blue grosbeak	$\lambda_{area}\ p_{prior\ detect}$	224.470	193.831	1.857	0.395	0.150	12
blue jay	$\lambda_{area}\ p_{prior\ detect}$	932.525	887.873	1.244	0.537	0.263	16
chipping sparrow	$\lambda_{area}\ p_{date}$	223.597	214.870	0.000	1.000	0.416	4
eastern wood-pewee	$\lambda_{area}\ p_{prior\ detect}$	451.294	410.385	1.914	0.384	0.151	15
Kentucky warbler	$\lambda_{area}\ p_{prior\ detect}$	426.564	395.926	0.000	1.000	0.348	12
northern cardinal	$\lambda_{area}\ p_{prior\ detect}$	1809.457	1764.806	0.387	0.824	0.268	16
orchard oriole	$\lambda_{area}\ p.$	154.518	148.089	1.225	0.542	0.133	3

Table 3.4. The relative importance of the area model (λ_{area}) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
pine warbler	$\lambda_{area}\ p_{\text{date}}$	709.516	700.789	0.907	0.635	0.225	4
red-headed woodpecker	$\lambda_{area}\ p_{\text{prior detect}}$	415.976	388.476	1.683	0.431	0.160	11
Swainson's warbler	$\lambda_{area}\ p_{\text{date}}$	198.403	189.676	1.940	0.379	0.102	4
yellow-billed cuckoo	$\lambda_{area}\ p_{\text{prior detect}}$	885.735	841.084	0.600	0.741	0.275	16

Table 3.5. The relative importance of the edge model (λ_{edge}) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
Bachman's sparrow	$\lambda_{edge}\ p.$	73.045	66.617	0.706	0.703	0.083	3
Bachman's sparrow	$\lambda_{edge}\ p_{\text{temp}}$	73.165	64.438	0.826	0.662	0.078	4
Bachman's sparrow	$\lambda_{edge}\ p_{\text{date}}$	73.804	65.076	1.464	0.481	0.057	4
barn swallow	$\lambda_{edge}\ p_{\text{temp}}$	185.199	176.472	0.000	1.000	0.269	4
barn swallow	$\lambda_{edge}\ p.$	186.531	180.102	1.332	0.514	0.138	3
black-and-white warbler	$\lambda_{edge}\ p.$	156.299	149.870	0.019	0.991	0.192	3
black-and-white warbler	$\lambda_{edge}\ p_{\text{temp}}$	157.204	148.477	0.925	0.630	0.122	4
brown-headed cowbird	$\lambda_{edge}\ p_{\text{temp}}$	562.078	553.351	0.303	0.859	0.462	4
brown-headed nuthatch	$\lambda_{edge}\ p_{\text{prior detect}}$	245.772	208.438	1.728	0.421	0.162	14
chipping sparrow	$\lambda_{edge}\ p_{\text{date}}$	225.197	216.470	1.600	0.449	0.187	4
downy woodpecker	$\lambda_{edge}\ p_{\text{obs}}$	427.185	405.585	1.752	0.416	0.151	9
Kentucky warbler	$\lambda_{edge}\ p_{\text{prior detect}}$	427.115	396.477	0.550	0.759	0.265	12
northern cardinal	$\lambda_{edge}\ p_{\text{prior detect}}$	1810.447	1765.795	1.376	0.502	0.163	16
orchard oriole	$\lambda_{edge}\ p.$	155.126	148.697	1.833	0.400	0.098	3
pine warbler	$\lambda_{edge}\ p_{\text{date}}$	708.609	699.881	0.000	1.000	0.353	4
prairie warbler	$\lambda_{edge}\ p_{\text{date}}$	239.236	230.508	0.813	0.666	0.180	4

Table 3.6. The relative importance of the shape model (λ_{shape}) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American crow	$\lambda_{shape}\ p_{\mathrm{obs}}$	1506.808	1485.208	1.997	0.368	0.164	9
Bachman's sparrow	$\lambda_{shape}\ p.$	72.819	66.390	0.479	0.787	0.093	3
Bachman's sparrow	$\lambda_{shape}\ p_{\mathrm{temp}}$	72.891	64.164	0.551	0.759	0.090	4
Bachman's sparrow	$\lambda_{shape}\ p_{\mathrm{date}}$	73.586	64.859	1.246	0.536	0.063	4
barn swallow	$\lambda_{shape}\ p_{\mathrm{temp}}$	186.809	178.081	1.610	0.447	0.120	4
black-and-white warbler	$\lambda_{shape}\ p.$	157.834	151.406	1.555	0.460	0.089	3
Carolina chickadee	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	886.899	845.989	0.000	1.000	0.474	15
eastern bluebird	$\lambda_{shape}\ p_{\mathrm{temp}}$	218.719	209.992	0.000	1.000	0.571	4
eastern towhee	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	538.452	497.542	0.000	1.000	0.826	15
eastern wood-pewee	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	450.729	409.820	1.349	0.509	0.201	15
hooded warbler	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	986.213	941.561	0.000	1.000	0.413	16
indigo bunting	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	1514.929	1470.278	0.000	1.000	0.810	16
Kentucky warbler	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	427.189	396.551	0.624	0.732	0.255	12
prairie warbler	$\lambda_{shape}\ p_{\mathrm{date}}$	240.334	231.606	1.911	0.385	0.104	4
red-bellied woodpecker	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	1492.294	1447.643	1.810	0.405	0.229	16
Swainson's warbler	$\lambda_{shape}\ p_{\mathrm{date}}$	198.337	189.610	1.875	0.392	0.106	4
tufted titmouse	$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	1378.330	1337.421	0.000	1.000	0.572	15

Table 3.6. The relative importance of the shape model (λ_{shape}) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
wild turkey	$\lambda_{shape}\ p_{\text{temp}}$	248.829	240.101	0.692	0.707	0.274	4
wood thrush	$\lambda_{shape}\ p_{\text{prior detect}}$	372.817	328.166	0.000	1.000	0.589	16
yellow-breasted chat	$\lambda_{shape}\ p_{\text{prior detect}}$	1001.047	956.396	0.791	0.673	0.323	16
yellow-billed cuckoo	$\lambda_{shape}\ p_{\text{prior detect}}$	886.268	841.617	1.134	0.567	0.211	16
yellow-throated warbler	$\lambda_{shape}\ p.$	150.089	143.660	0.000	1.000	0.490	3
yellow-throated warbler	$\lambda_{shape}\ p_{\text{date}}$	151.156	142.428	1.067	0.587	0.287	4

Table 3.7. The relative importance of the surrounding forest type model (λforest) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
field sparrow	$\lambda_{forest}\ p_{\text{date}}$	84.559	73.448	1.148	0.563	0.211	5
hairy woodpecker	$\lambda_{forest}\ p_{\text{date}}$	178.880	167.769	0.000	1.000	0.437	5
hairy woodpecker	$\lambda_{forest}\ p.$	180.496	171.768	1.616	0.446	0.195	4
northern cardinal	$\lambda_{forest}\ p_{\text{prior detect}}$	1810.785	1762.214	1.715	0.424	0.138	17
northern mockingbird	$\lambda_{forest}\ p.$	78.308	69.581	0.000	1.000	0.226	4
northern mockingbird	$\lambda_{forest}\ p_{\text{date}}$	78.884	67.773	0.576	0.750	0.169	5
orchard oriole	$\lambda_{forest}\ p.$	155.146	146.419	1.854	0.396	0.097	4
pine warbler	$\lambda_{forest}\ p_{\text{date}}$	708.852	697.741	0.243	0.885	0.313	5
purple martin	$\lambda_{forest}\ p_{\text{date}}$	93.349	82.238	0.828	0.661	0.303	5
ruby-throated hummingbird	$\lambda_{forest}\ p.$	165.862	157.135	0.000	1.000	0.507	4
ruby-throated hummingbird	$\lambda_{forest}\ p_{\text{temp}}$	167.456	156.345	1.594	0.451	0.229	5
summer tanager	$\lambda_{forest}\ p_{\text{prior detect}}$	1091.169	1042.597	0.182	0.913	0.346	17
Swainson’s warbler	$\lambda_{forest}\ p_{\text{date}}$	197.272	186.161	0.810	0.667	0.180	5

Table 3.8. The relative importance of the opening management model ($\lambda_{management}$) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
American goldfinch	$\lambda_{management}\ p_{\text{date}}$	158.058	151.630	0.000	1.000	0.886	3
American redstart	$\lambda_{management}\ p_{\text{prior detect}}$	443.438	412.800	0.000	1.000	1.000	12
blue grosbeak	$\lambda_{management}\ p_{\text{prior detect}}$	223.670	196.170	1.058	0.589	0.224	11
chipping sparrow	$\lambda_{management}\ p_{\text{date}}$	224.916	218.487	1.319	0.517	0.215	3
common yellowthroat	$\lambda_{management}\ p_{\text{obs}}$	529.163	510.340	0.044	0.978	0.318	8
downy woodpecker	$\lambda_{management}\ p_{\text{obs}}$	426.123	407.300	0.690	0.708	0.258	8
fish crow	$\lambda_{management}\ p_{\text{date}}$	364.390	357.962	0.000	1.000	0.994	3
hooded warbler	$\lambda_{management}\ p_{\text{prior detect}}$	987.038	946.129	0.825	0.662	0.273	15
northern bobwhite	$\lambda_{management}\ p_{\text{prior detect}}$	458.715	417.806	0.945	0.623	0.297	15
northern flicker	$\lambda_{management}\ p_{\text{temp}}$	74.346	67.917	0.000	1.000	0.980	3
northern parula	$\lambda_{management}\ p_{\text{prior detect}}$	1412.679	1371.770	1.622	0.444	0.216	15
purple martin	$\lambda_{management}\ p_{\text{date}}$	92.521	86.092	0.000	1.000	0.459	3
red-headed woodpecker	$\lambda_{management}\ p_{\text{prior detect}}$	414.293	389.803	0.000	1.000	0.370	10
red-shouldered hawk	$\lambda_{management}\ p_{\text{prior detect}}$	558.956	518.047	0.000	1.000	0.665	15
Swainson's warbler	$\lambda_{management}\ p_{\text{date}}$	196.569	190.141	0.106	0.948	0.255	3

Table 3.8. The relative importance of the opening management model ($\lambda_{management}$) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
white-eyed vireo	$\lambda_{management}\ p_{\text{prior detect}}$	1162.450	1121.541	0.000	1.000	0.803	15
yellow-throated vireo	$\lambda_{management}\ p_{\text{prior detect}}$	558.941	528.303	0.000	1.000	0.536	12

Table 3.9. The relative importance of the null model ($\lambda.$) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
Acadian flycatcher	$\lambda..p_{\text{prior detect}}$	725.444	688.111	0.000	1.000	0.531	14
American crow	$\lambda.\ p_{\text{obs}}$	1504.811	1485.988	0.000	1.000	0.444	8
Bachman's sparrow	$\lambda.p.$	72.340	68.129	0.000	1.000	0.118	2
Bachman's sparrow	$\lambda.p_{\text{temp}}$	72.396	65.967	0.056	0.972	0.115	3
Bachman's sparrow	$\lambda.p_{\text{date}}$	73.009	66.580	0.669	0.716	0.085	3
black-and-white warbler	$\lambda.p.$	156.280	152.069	0.000	1.000	0.194	2
black-and-white warbler	$\lambda.\ p_{\text{temp}}$	157.051	150.622	0.771	0.680	0.132	3
blue-gray gnatcatcher	$\lambda.p_{\text{prior detect}}$	1288.076	1247.167	0.000	1.000	0.521	15
brown-headed nuthatch	$\lambda.p_{\text{prior detect}}$	244.043	210.130	0.000	1.000	0.385	13
blue grosbeak	$\lambda.p_{\text{prior detect}}$	222.612	195.112	0.000	1.000	0.381	11
blue jay	$\lambda.p_{\text{prior detect}}$	931.281	890.372	0.000	1.000	0.490	15
Carolina chickadee	$\lambda.p_{\text{prior detect}}$	888.097	850.764	1.198	0.549	0.260	14
Carolina wren	$\lambda.p_{\text{prior detect}}$	1512.915	1472.006	0.000	1.000	0.380	15
Carolina wren	$\lambda.p_{\text{obs}}$	1514.100	1495.276	1.185	0.553	0.210	8
common yellowthroat	$\lambda.\ p_{\text{obs}}$	529.119	510.295	0.000	1.000	0.326	8
downy woodpecker	$\lambda.p_{\text{obs}}$	425.433	406.610	0.000	1.000	0.364	8
eastern wood-pewee	$\lambda.p_{\text{prior detect}}$	449.380	412.046	0.000	1.000	0.394	14

Table 3.9. The relative importance of the null model ($\lambda.$) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
field sparrow	$\lambda.p_{date}$	83.411	76.982	0.000	1.000	0.375	3
great-crested flycatcher	$\lambda.p_{prior\ detect}$	966.679	925.770	0.000	1.000	0.597	15
hooded warbler	$\lambda.p_{prior\ detect}$	987.480	946.571	1.267	0.531	0.219	15
mourning dove	$\lambda.p_{prior\ detect}$	1207.284	1166.375	0.000	1.000	0.609	15
northern bobwhite	$\lambda.p_{prior\ detect}$	457.770	416.861	0.000	1.000	0.476	15
northern cardinal	$\lambda.p_{prior\ detect}$	1809.070	1768.161	0.000	1.000	0.325	15
northern mockingbird	$\lambda.p.$	79.098	74.887	0.790	0.674	0.152	2
northern mockingbird	$\lambda.p_{date}$	79.491	73.063	1.183	0.553	0.125	3
northern parula	$\lambda.p_{prior\ detect}$	1411.057	1370.148	0.000	1.000	0.487	15
orchard oriole	$\lambda.p.$	153.292	149.082	0.000	1.000	0.246	2
orchard oriole	$\lambda.p_{temp}$	154.539	148.111	1.247	0.536	0.132	3
pileated woodpecker	$\lambda.p_{prior\ detect}$	601.255	560.346	0.000	1.000	0.719	15
prairie warbler	$\lambda.\ p_{date}$	238.423	231.994	0.000	1.000	0.270	3
prairie warbler	$\lambda.\ p.$	239.933	235.722	1.510	0.470	0.127	2
red-bellied woodpecker	$\lambda.\ p_{prior\ detect}$	1490.484	1449.575	0.000	1.000	0.567	15
red-eyed vireo	$\lambda.\ p_{prior\ detect}$	1308.716	1267.807	0.000	1.000	0.517	15
red-headed woodpecker	$\lambda.\ p_{prior\ detect}$	415.423	390.933	1.130	0.568	0.210	10

Table 3.9. The relative importance of the null model ($\lambda.$) of density as indicated by model likelihood and weights for species found in openings on Barbour Wildlife Management Area and Sanctuaries in the East Gulf Coastal Plain May-July 2008-09. While QAICc, -2*ln(Lik), and Delta are presented for informative purposes, they should not be used for interspecific comparisons.

Species	Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Weight	K
summer tanager	$\lambda.\ p_{\text{prior detect}}$	1090.987	1050.078	0.000	1.000	0.379	15
Swainson's warbler	$\lambda.\ p_{\text{date}}$	196.463	190.034	0.000	1.000	0.269	3
tufted titmouse	$\lambda.\ p_{\text{prior detect}}$	1380.096	1342.762	1.765	0.414	0.236	14
wild turkey	$\lambda.\ p_{\text{temp}}$	248.136	241.708	0.000	1.000	0.388	3
yellow-breasted chat	$\lambda.\ p_{\text{prior detect}}$	1000.256	959.347	0.000	1.000	0.480	15
yellow-billed cuckoo	$\lambda.\ p_{\text{prior detect}}$	885.135	844.225	0.000	1.000	0.371	15
yellow-throated vireo	$\lambda.\ p_{\text{prior detect}}$	560.006	529.368	1.065	0.587	0.315	12

Figure 3.1 Grid used for collecting vegetative structure data. Plot was 25m radius circle around point center with ground and shrub layer measurements made at each 6.25m interval around the plot.

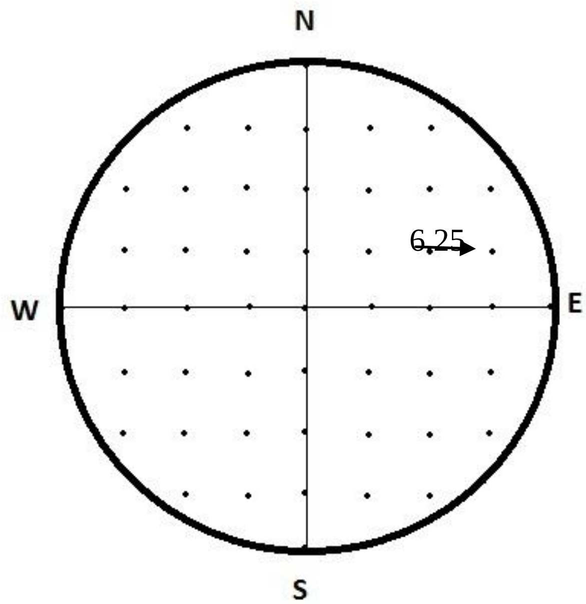


Figure 3.2. Relative sensitivity of bird species density to the size of openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening size and the log of density for the size model. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density as opening size increased. Conversely, species encountered in openings with negative β occurred in lower density as opening size increased.

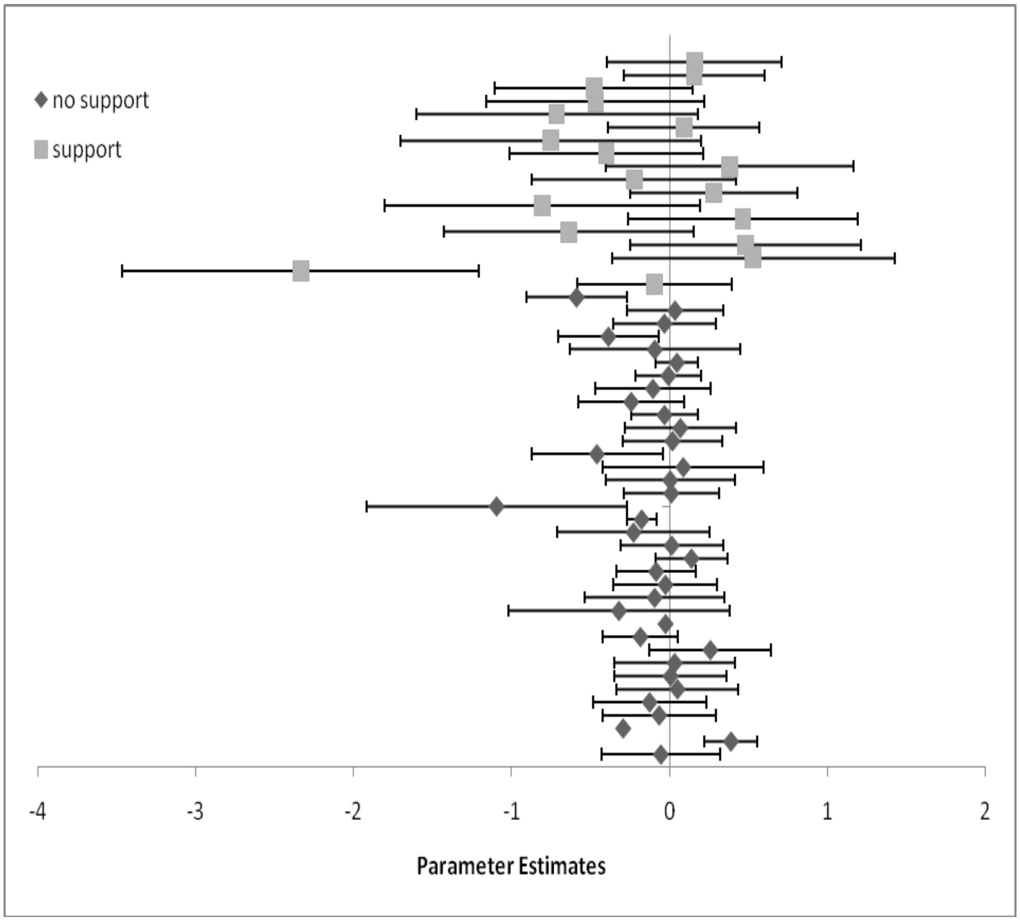


Figure 3.3. Relative sensitivity of bird species density to the edge length (perimeter) of openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain, Alabama. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening edge length and the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density as opening edge increased. Conversely, species encountered in openings with negative β occurred in lower density as opening edge increased.

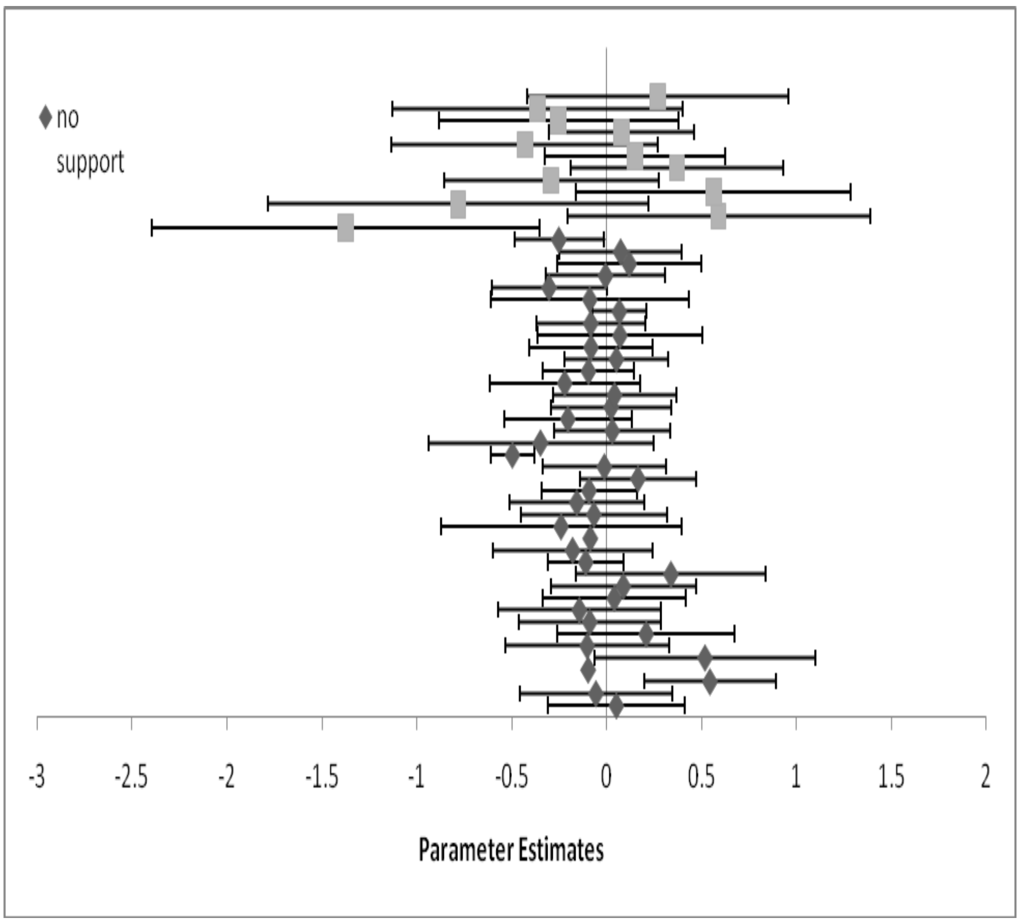


Figure 3.4. Relative sensitivity of bird species density to the shape of openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the slopes (β, and 95% confidence limits) of the relationship between opening shape and the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density as openings become more irregular in shape. Conversely, species encountered in openings with negative β occurred in lower density as openings became more rounded.

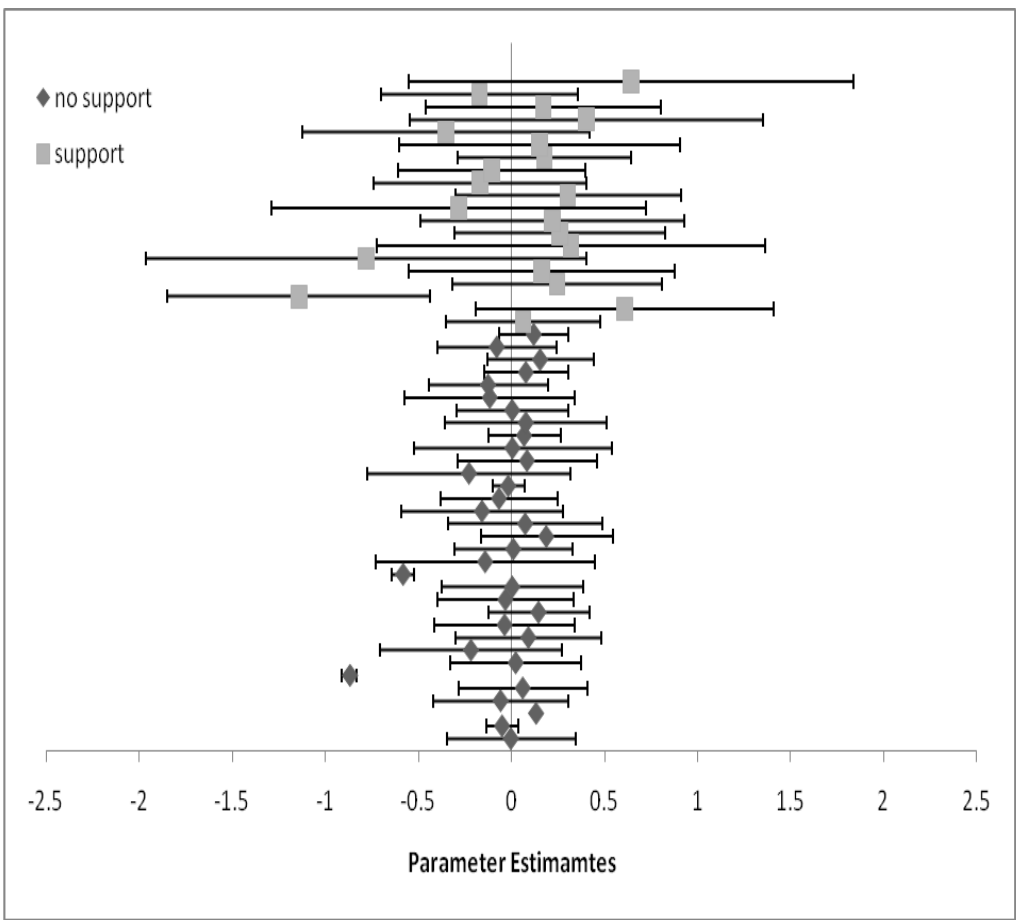


Figure 3.5a. Relative sensitivity of bird species density to deciduous forest surrounding openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the effect (β, and 95% confidence limits) of deciduous forest on the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density in openings in deciduous forest. Conversely, species encountered in openings with negative β occurred in lower density in openings in deciduous forest.

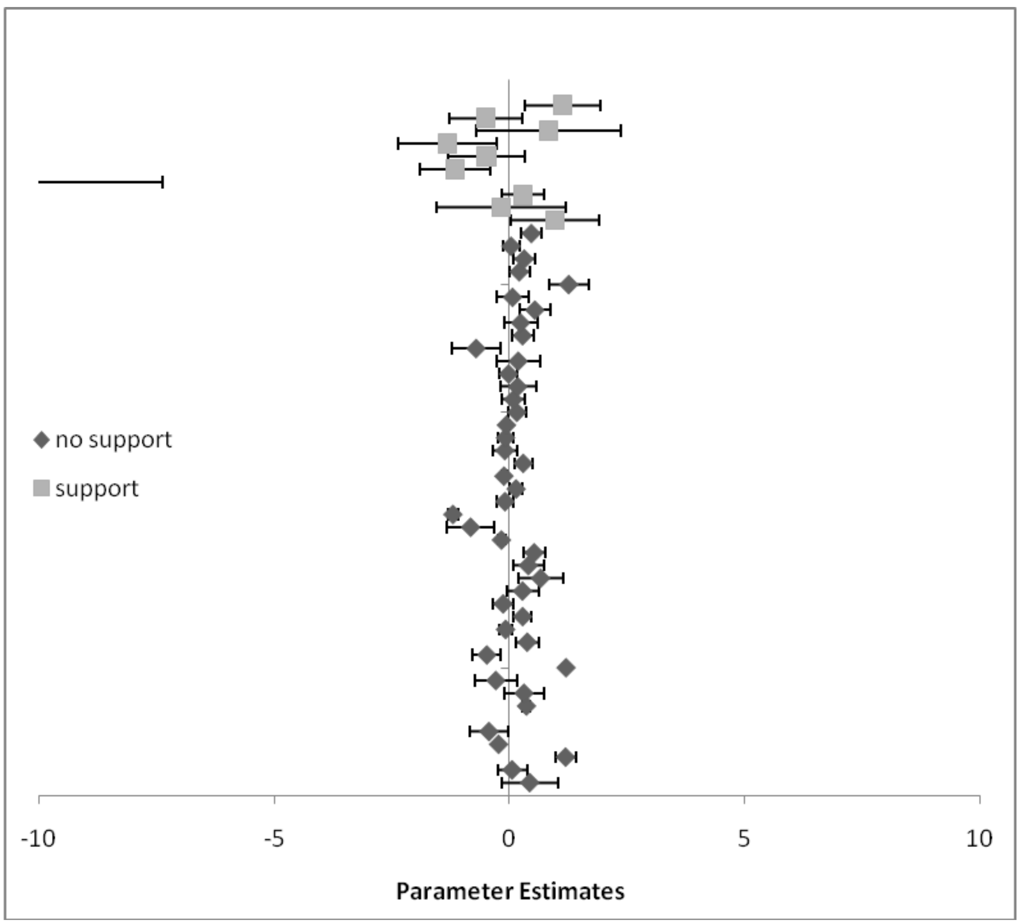


Figure 3.5b. Relative sensitivity of bird species density to mixed forest surrounding openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the effect (β, and 95% confidence limits) of mixed forest on the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density in openings in mixed forest. Conversely, species encountered in openings with negative β occurred in lower density in openings in mixed forest.

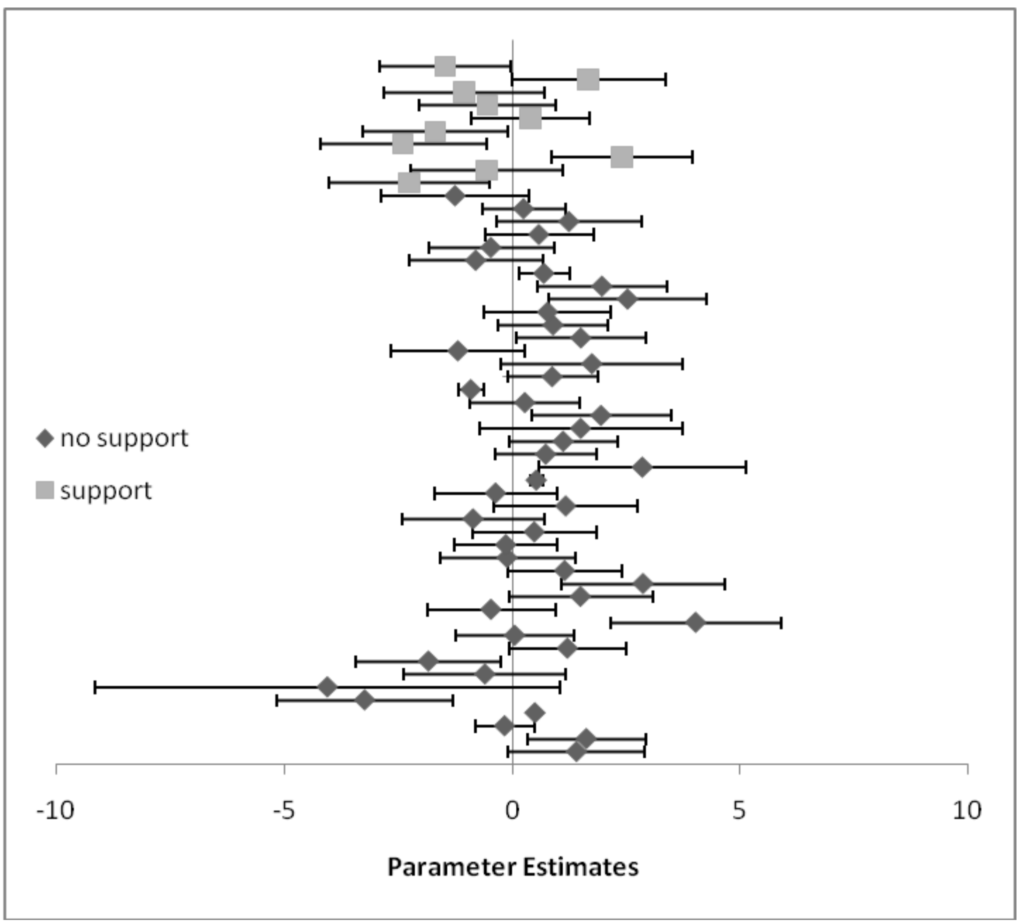


Figure 3.5c. Relative sensitivity of bird species density to pine forest surrounding openings on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the effect (β, and 95% confidence limits) of deciduous forest on the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density in openings in pine forest. Conversely, species encountered in openings with negative β occurred in lower density in openings in pine forest.

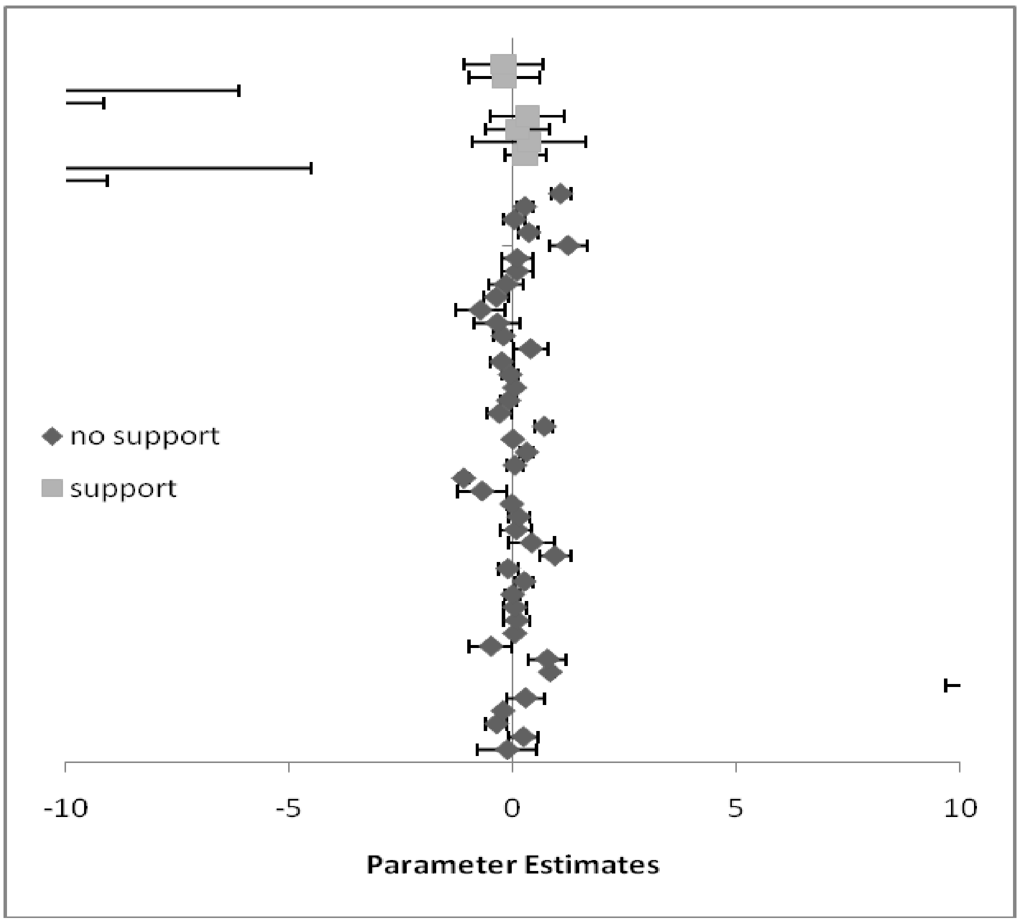
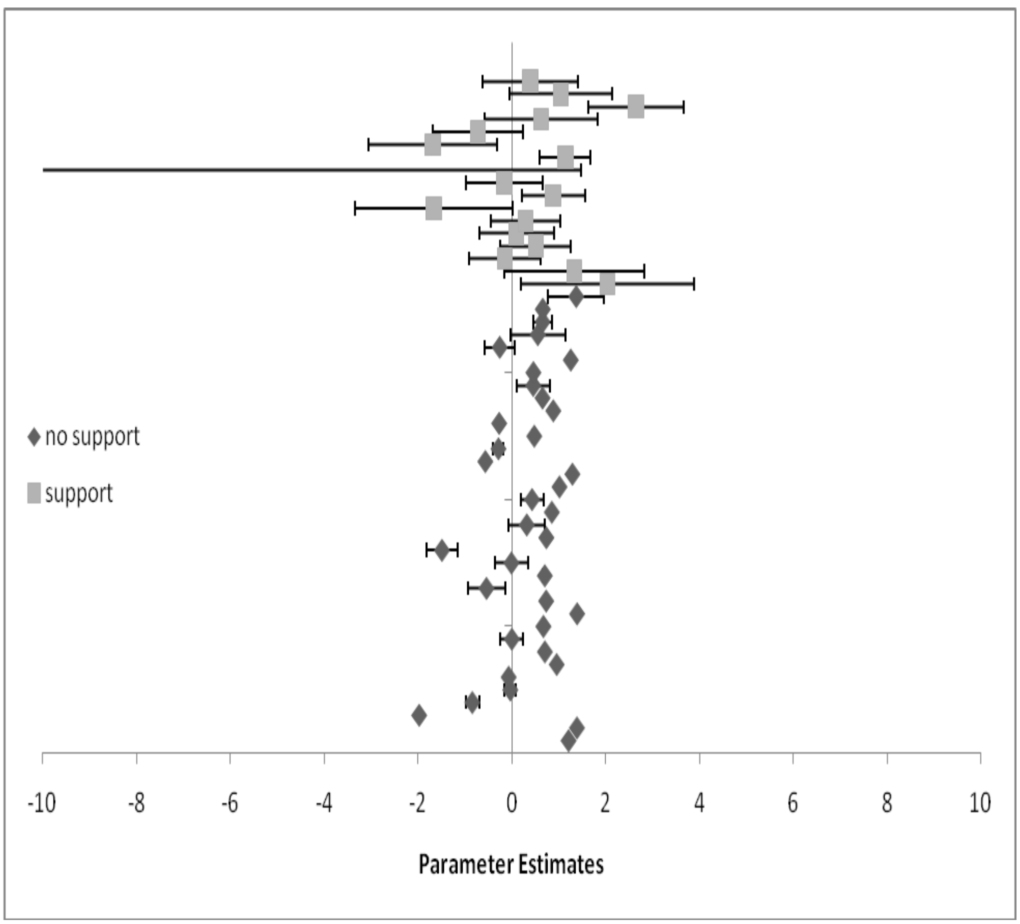


Figure 3.6. Relative sensitivity of the bird species density to management on Barbour Wildlife Management Area and the Sanctuaries in the East Gulf Coastal Plain. Parameter estimates are the effect (β, and 95% confidence limits) of planting in openings on the log of density. Supported models were best approximating models (Δ≤ 2.0). Of species encountered in openings, those with positive β were more found in greater density in planted openings. Conversely, species encountered in openings with negative β occurred in lower density in planted openings.



CHAPTER IV: CONCLUSIONS

Wildlife openings are often used by songbirds and there is little quantitative information to predict the relationships between those species and characteristics of openings. To assist with management for birds, we wanted to estimate relationships between bird use and density and 5 characteristics of wildlife openings: size, edge length, shape, management, and forest type. Based on occupancy analysis, we found varying relationships between both bird usage and density and the characteristics of openings we studied. Over half of the species included in our analysis showed no strong relationship to any opening characteristic. For the remaining species, we found evidence for relationships between our 5 characteristics of openings and bird use and abundance.

For about 1/3 of the species we examined, size of opening was related to both use and density. However, for most species neither density nor use by birds was strongly affected by opening size. Probabilities of use as well as density decreased as opening size increased for many of the species exhibiting this relationship. For those birds, creating smaller openings may increase probability of use as well as species density.

Length of edge (opening perimeter) was not as important as opening size in relation to bird use or density. However, there was high variability in the relationships to edge, and some species responses were highly positive while others were strongly negative towards increased edge. Slightly more species demonstrated strong negative relationships between edge and density, which may be the result of predation and parasitism risks associated with edge habitat. As expected from this hypothesis, brown-headed cowbird, a nest parasite, showed higher densities within large openings with more edge habitat. If decreased cowbird abundance is desired, managers may want smaller openings that minimize the amount of edge habitat, which may in turn result in higher densities of songbirds sensitive to edge effects.

While both size and edge showed similar relationships with regards to use and density, the relationship of use and density with opening shape varied. Species use was not strongly related to shape, but species density was. Irregularly-shaped openings were found to have higher species densities than round openings. Therefore, when managing for species abundance, it may be important to create irregular openings as opposed to round ones.

In terms of use, more species responded to management within an opening than any other characteristic we examined. Management was also related to density for many species. Twice as many species exhibited positive relationships in terms of use and density to planted openings. For these species density was more than twice as high in planted versus unplanted openings. These species may have found more foraging opportunities in planted openings. Therefore, to increase both use and density with respect to management style, it would be important to have more openings planted.

The forest type surrounding an opening was not an important characteristic related to bird use and density. Although there were no strong relationships found, there were slightly more positive relationships with bird density and deciduous forests. Therefore, there may be higher abundances of species found within openings surrounded by deciduous forests as opposed to mixed or pine forests.

It is important to consider the distribution of sizes, shapes, lengths of edge, and management of openings when making management decisions to benefit species of concern or entire bird communities. The desired distribution may depend on your management objectives and the expected response of the species occurring in the region. Certain characteristics of openings may greater effects on use, while other characteristics may affect species densities. Therefore, it is important to know if use or density of species of interest is the goal of management actions. Further analysis could be directed towards the relationships of opening characteristics to bird communities. These relationships, if incorporated in management plans for maintaining and creating wildlife openings, may be beneficial for bird species.

Appendix A. Summary statistics for characteristics of openings on Barbour WMA and Stimpson and Upper State Sanctuaries included as survey sites. Openings were broken into categories of forest type and management type, with summaries of size, shape and edge length of openings for each category.

Forest Type		Size (ha)	Shape (edge/size)	Edge (m)
Deciduous (*n* = 28)				
	Mean	2.618	664.001	788.472
	Standard Error	0.819	87.321	118.482
Mixed (n=18)				
	Mean	0.611	850.785	373.207
	Standard Error	0.124	92.55	40.043
Pine (n=14)				
	Mean	0.954	887.829	400.046
	Standard Error	0.407	137.372	72.645
Management Style				
Planted (n=32)				
	Mean	1.831	804.811	675.042
	Standard Error	0.521	107.672	95.917
Not Planted (n=28)				
	Mean	1.45	743.783	484.201
	Standard Error	0.625	60.458	84.015
All Openings (n=60)				
	Mean	1.628	772.263	573.260
	Standard Error	0.41	59.295	64.003

Appendix B. List of AOU 4-letter codes ,common names, scientific names, and species encounters for birds encountered on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

AOU Species Code	Common Name	Scientific Name	Encounters
ACFL	Acadian Flycatcher	*Empidonax virescens*	190
AMCR	American Crow	*Corvus brachyrhynchos*	460
AMGO	American Goldfinch	*Spinus tristis*	16
AMRE	American Redstart	*Setophaga ruticilla*	103
BACS	Bachman's Sparrow	*Peucaea aestivalis*	11
BARS	Barn Swallow	*Hirundo rustica*	21
BADO	Barred Owl	*Strix varia*	7
BEKI	Belted Kingfisher	*Ceryle alcyon*	1
BLVU	Black Vulture	*Coragyps atratus*	6
BAWW	Black-and-white Warbler	*Mniotilta varia*	22
BLGR	Blue Grosbeak	*Passerina caerulea*	37
BLJA	Blue Jay	*Cyanocitta cristata*	224
BGGN	Blue-gray Gnatcatcher	*Polioptila caerulea*	417
BWHA	Broad-winged Hawk	*Buteo platypterus*	5
BRTH	Brown Thrasher	*Toxostoma rufum*	3
BHCO	Brown-headed Cowbird	*Molothrus ater*	132
BHNU	Brown-headed Nuthatch	*Sitta pusilla*	37
CACH	Carolina Chickadee	*Poecile carolinensis*	197
CARW	Carolina Wren	*Thryothorus ludovicianus*	554
CAEG	Cattle Egret	*Bubulcus ibis*	1
CHSW	Chimney Swift	*Chaetura pelagica*	4
CHSP	Chipping Sparrow	*Spizella passerina*	25
CWWI	Chuck-will's-widow	*Caprimulgus carolinensis*	1
COGR	Common Grackle	*Quiscalus quiscula*	5
COYE	Common Yellowthroat	*Geothlypis trichas*	96
DOWO	Downy Woodpecker	*Picoides pubescens*	68
EABL	Eastern Bluebird	*Sialia sialis*	28
EAKI	Eastern Kingbird	*Tyrannus tyrannus*	5

Appendix B. List of AOU 4-letter codes ,common names, scientific names, and species encounters for birds encountered on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

AOU Species Code	Common Name	Scientific Name	Encounters
EAPH	Eastern Phoebe	*Sayornis phoebe*	4
EATO	Eastern Towhee	*Pipilo erythrophthalmus*	108
EAWP	Eastern Wood-Pewee	*Contupus virens*	96
FISP	Field Sparrow	*Spizella pusilla*	9
FICR	Fish Crow	*Corvus ossifragus*	50
GRCA	Gray Catbird	*Dumetella carolinensis*	1
GBHE	Great Blue Heron	*Ardea herodias*	4
GCFL	Great Crested Flycatcher	*Myiarchus crinitus*	233
GREG	Great Egret	*Ardea alba*	10
HAWO	Hairy Woodpecker	*Picoides villosus*	21
HOWA	Hooded Warbler	*Wilsonia citrina*	266
INBU	Indigo Bunting	*Passerina cyanea*	596
KEWA	Kentucky Warbler	*Oporornis formosus*	63
LBHE	Little Blue Heron	*Egretta caerulea*	3
LOWA	Louisiana Waterthrush	*Parkesia motacilla*	3
MODO	Mourning Dove	*Zenaida macroura*	348
NOBO	Northern Bobwhite	*Colinus virginianus*	101
NOCA	Northern Cardinal	*Cardinalis cardinalis*	739
NOFL	Northern Flicker	*Colaptes auratus*	8
NOMO	Northern Mockingbird	*Mimus polyglottos*	9
NOPA	Northern Parula	*Parula americana*	630
OROR	Orchard Oriole	*Icterus spurious*	17
PIWO	Pileated Woodpecker	*Dryocopus pileatus*	107
PIWA	Pine Warbler	*Dendroica pinus*	162
PRAW	Prairie Warbler	*Dendroica discolor*	34
PUMA	Purple Martin	*Progne subis*	9
RBWO	Red-bellied Woodpecker	*Melanerpes carolinus*	504
REVI	Red-eyed Vireo	*Vireo olivaceus*	432

Appendix B. List of AOU 4-letter codes ,common names, scientific names, and species encounters for birds encountered on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

AOU Species Code	Common Name	Scientific Name	Encounters
RHWO	Red-headed Woodpecker	*Melanerpes erythrocephalus*	75
RSHA	Red-shouldered Hawk	*Buteo lineatus*	99
RTHA	Red-tailed Hawk	*Buteo jamaicensis*	3
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*	2
RTHU	Ruby-throated Hummingbird	*Archilochus colubris*	19
SNEG	Snowy Egret	*Egretta thula*	2
SUTA	Summer Tanager	*Piranga rubra*	287
SWWA	Swainson's Warbler	*Limnothlypis swainsonii*	27
TUTI	Tufted Titmouse	*Baeolophus bicolor*	403
TUVU	Turkey Vulture	*Cathartes aura*	9
WEVI	White-eyed Vireo	*Vireo griseus*	395
WITU	Wild Turkey	*Meleagris gallopavo*	34
WODU	Wood Duck	*Aix sponsa*	3
WOTH	Wood Thrush	*Hylocichla mustelina*	84
YBCU	Yellow-billed Cuckoo	*Coccyzus americanus*	173
YBCH	Yellow-breasted Chat	*Icteria virens*	276
YTVI	Yellow-throated Vireo	*Vireo flavifrons*	120
YTWA	Yellow-throated Warbler	*Dendroica dominica*	16

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
ACFL (n = 127, ĉ = 1.239)						
$\Psi . p_{\text{prior detect}}$	426.434	482.051	0.000	1.000	0.410	14
$\Psi_{\text{management}}\ p_{\text{prior detect}}$	427.619	479.089	1.185	0.553	0.227	15
$\Psi_{\text{edge}}\ p_{\text{prior detect}}$	429.815	481.810	3.381	0.184	0.076	15
$\Psi_{\text{shape}}\ p_{\text{prior detect}}$	429.831	481.829	3.397	0.183	0.075	15
$\Psi_{\text{area2}}\ p_{\text{prior detect}}$	429.924	481.944	3.490	0.175	0.072	15
$\Psi_{\text{area}}\ p_{\text{prior detect}}$	429.949	481.976	3.515	0.172	0.071	15
$\Psi_{\text{forest}}\ p_{\text{prior detect}}$	429.992	477.393	3.558	0.169	0.069	16
AMCR (n = 310, ĉ = 1.189)						
$\Psi_{\text{area}}\ p_{\text{temp}}$	792.243	931.914	0.000	1.000	0.354	4
$\Psi .\ p_{\text{temp}}$	792.838	935.355	0.594	0.743	0.263	3
$\Psi_{\text{edge}}\ p_{\text{temp}}$	793.607	933.536	1.363	0.506	0.179	4
$\Psi_{\text{forest}}\ p_{\text{temp}}$	794.375	931.614	2.132	0.344	0.122	5
$\Psi_{\text{management}}\ p_{\text{temp}}$	795.136	935.355	2.893	0.235	0.083	4
AMGO (n = 7, ĉ = 1)						
$\Psi_{\text{edge}}\ p.$	75.779	69.351	0.000	1.000	0.183	3
$\Psi_{\text{area}}\ p.$	77.211	70.782	1.432	0.489	0.089	3
$\Psi_{\text{edge}}\ p_{\text{temp}}$	77.387	68.659	1.607	0.448	0.082	4
$\Psi_{\text{management}}\ p.$	77.535	71.106	1.755	0.416	0.076	3
$\Psi_{\text{edge}}\ p_{\text{date}}$	77.695	68.968	1.916	0.384	0.070	4
$\Psi .\ p.$	77.741	73.530	1.961	0.375	0.069	2
$\Psi_{\text{ground}}\ p.$	78.291	71.863	2.512	0.285	0.052	3
$\Psi_{\text{area}}\ p_{\text{temp}}$	78.784	70.056	3.004	0.223	0.041	4
$\Psi_{\text{area}}\ p_{\text{date}}$	79.099	70.372	3.320	0.190	0.035	4
$\Psi .\ p_{\text{temp}}$	79.283	72.855	3.504	0.173	0.032	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{management}\ p_{temp}$	79.302	70.575	3.523	0.172	0.031	4
$\Psi_{management}\ p_{date}$	79.604	70.877	3.825	0.148	0.027	4
$\Psi_{shrub}\ p.$	79.604	73.176	3.825	0.148	0.027	3
$\Psi.\ p_{date}$	79.613	73.185	3.834	0.147	0.027	3
$\Psi_{shape}\ p.$	79.700	73.271	3.921	0.141	0.026	3
$\Psi_{ground}\ p_{temp}$	80.084	71.356	4.305	0.116	0.021	4
$\Psi_{ground+shrub}\ p.$	80.298	71.571	4.519	0.104	0.019	4
$\Psi_{ground}\ p_{date}$	80.321	71.593	4.542	0.103	0.019	4
$\Psi_{shrub}\ p_{temp}$	81.189	72.461	5.409	0.067	0.012	4
$\Psi_{shape}\ p_{temp}$	81.299	72.572	5.520	0.063	0.012	4
$\Psi_{shrub}\ p_{date}$	81.544	72.817	5.765	0.056	0.010	4
$\Psi_{shape}\ p_{date}$	81.642	72.915	5.863	0.053	0.010	4
$\Psi_{forest}\ p.$	81.816	73.089	6.037	0.049	0.009	4
$\Psi_{ground+shrub}\ p_{temp}$	82.124	71.012	6.344	0.042	0.008	5
$\Psi_{ground+shrub}\ p_{date}$	82.408	71.297	6.629	0.036	0.007	5
$\Psi_{forest}\ p_{temp}$	83.586	72.475	7.807	0.020	0.004	5
$\Psi_{forest}\ p_{date}$	83.873	72.762	8.094	0.017	0.003	5
AMRE (n = 72, ĉ = 3.862)						
$\Psi_{management}\ p_{date}$	99.064	348.873	0.000	1.000	0.204	4
$\Psi.\ p_{date}$	99.709	360.238	0.644	0.725	0.148	3
$\Psi_{management}\ p.$	100.242	362.300	1.178	0.555	0.113	3
$\Psi.\ p.$	101.039	373.942	1.975	0.373	0.076	2
$\Psi_{shape}\ p_{date}$	101.549	358.468	2.484	0.289	0.059	4
$\Psi_{area2}\ p_{date}$	101.666	358.921	2.602	0.272	0.056	4
$\Psi_{area}\ p_{date}$	101.829	359.550	2.765	0.251	0.051	4
$\Psi_{shrub}\ p_{date}$	101.982	360.139	2.917	0.233	0.047	4
$\Psi_{edge}\ p_{date}$	101.989	360.168	2.925	0.232	0.047	4
$\Psi_{shape}\ p.$	102.785	372.119	3.721	0.156	0.032	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{area2}\ p.$	102.898	372.556	3.834	0.147	0.030	3
$\Psi_{area}\ p.$	103.065	373.200	4.001	0.135	0.028	3
$\Psi_{shrub}\ p.$	103.228	373.828	4.163	0.125	0.025	3
$\Psi_{edge}\ p.$	103.234	373.854	4.170	0.124	0.025	3
$\Psi_{forest}\ p_{date}$	104.259	359.728	5.195	0.074	0.015	5
$\Psi_{forest}\ p.$	105.428	373.448	6.363	0.042	0.008	4
$\Psi_{forest+shape}\ p_{date}$	106.126	357.386	7.062	0.029	0.006	6
$\Psi_{forest+size2}\ p_{date}$	106.298	358.047	7.233	0.027	0.005	6
$\Psi_{forest+size}\ p_{date}$	106.438	358.588	7.373	0.025	0.005	6
$\Psi_{forest+edge} p_{date}$	106.645	359.390	7.581	0.023	0.005	6
$\Psi_{forest+shape}\ p.$	107.189	371.044	8.125	0.017	0.004	5
$\Psi_{forest+size2}\ p.$	107.355	371.686	8.291	0.016	0.003	5
$\Psi_{forest+size}\ p.$	107.499	372.242	8.435	0.015	0.003	5
$\Psi_{forest+edge} p.$	107.715	373.075	8.651	0.013	0.003	5
BACS (n = 11, ĉ = 1)						
$\Psi.\ p.$	72.214	68.004	0.000	1.000	0.081	2
$\Psi.\ p_{temp}$	72.274	65.846	0.060	0.970	0.079	3
$\Psi_{shape}\ p.$	72.560	66.131	0.345	0.841	0.068	3
$\Psi_{shape}\ p_{temp}$	72.689	63.961	0.474	0.789	0.064	4
$\Psi_{edge}\ p.$	72.859	66.430	0.644	0.725	0.059	3
$\Psi.\ p_{date}$	72.884	66.455	0.669	0.716	0.058	3
$\Psi_{edge}\ p_{temp}$	73.000	64.272	0.785	0.675	0.055	4
$\Psi_{area}\ p.$	73.232	66.803	1.017	0.601	0.049	3
$\Psi_{shape}\ p_{date}$	73.318	64.591	1.104	0.576	0.047	4
$\Psi_{area}\ p_{temp}$	73.372	64.644	1.157	0.561	0.046	4
$\Psi_{edge}\ p_{date}$	73.615	64.888	1.401	0.496	0.040	4
$\Psi_{area}\ p_{date}$	73.987	65.260	1.773	0.412	0.034	4
$\Psi_{management}\ p.$	74.193	67.764	1.978	0.372	0.030	3
$\Psi_{shrub}\ p.$	74.285	67.857	2.071	0.355	0.029	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{management}\ p_{temp}$	74.338	65.610	2.123	0.346	0.028	4
$\Psi_{ground}\ p.$	74.376	67.948	2.162	0.339	0.028	3
$\Psi_{shrub}\ p_{temp}$	74.422	65.694	2.207	0.332	0.027	4
$\Psi_{ground}\ p_{temp}$	74.518	65.791	2.304	0.316	0.026	4
$\Psi_{management}\ p_{date}$	74.935	66.208	2.721	0.257	0.021	4
$\Psi_{shrub}\ p_{date}$	75.039	66.311	2.824	0.244	0.020	4
$\Psi_{ground}\ p_{date}$	75.122	66.395	2.908	0.234	0.019	4
$\Psi_{forest}\ p.$	76.457	67.730	4.243	0.120	0.010	4
$\Psi_{ground+shrub}\ p.$	76.518	67.790	4.303	0.116	0.009	4
$\Psi_{forest}\ p_{temp}$	76.690	65.579	4.476	0.107	0.009	5
$\Psi_{ground+shrub}\ p_{temp}$	76.741	65.629	4.526	0.104	0.008	5
$\Psi_{forest+shape}\ p.$	77.145	66.033	4.930	0.085	0.007	5
$\Psi_{forest}\ p_{date}$	77.297	66.186	5.082	0.079	0.006	5
$\Psi_{ground+shrub}\ p_{date}$	77.353	66.241	5.138	0.077	0.006	5
$\Psi_{forest+shape}\ p_{temp}$	77.454	63.869	5.240	0.073	0.006	6
$\Psi_{forest+edge} p.$	77.500	66.389	5.285	0.071	0.006	5
$\Psi_{forest+edge} p_{temp}$	77.820	64.235	5.606	0.061	0.005	6
$\Psi_{forest+size}\ p.$	77.847	66.736	5.633	0.060	0.005	5
$\Psi_{forest+shape}\ p_{date}$	78.081	64.496	5.866	0.053	0.004	6
$\Psi_{forest+size}\ p_{temp}$	78.168	64.583	5.953	0.051	0.004	6
$\Psi_{forest+edge} p_{date}$	78.433	64.849	6.219	0.045	0.004	6
$\Psi_{forest+size}\ p_{date}$	78.781	65.196	6.566	0.038	0.003	6
BADO (n = 9, ĉ = 1)						
$\Psi_{area}\ p_{temp}$	82.802	74.075	0.000	1.000	0.273	4
$\Psi.\ p_{temp}$	83.156	76.727	0.354	0.838	0.229	3
$\Psi_{forest}\ p_{temp}$	83.242	72.130	0.440	0.803	0.219	5
$\Psi_{edge}\ p_{temp}$	84.236	75.508	1.433	0.488	0.133	4
$\Psi_{management}\ p_{temp}$	85.411	76.683	2.609	0.271	0.074	4

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{shape}\ p_{temp}$	85.452	76.724	2.650	0.266	0.073	4
BARS (n = 13, ĉ = 1)						
$\Psi_{area}\ p.$	124.426	117.997	0.000	1.000	0.232	3
$\Psi_{area}\ p_{temp}$	125.006	116.279	0.580	0.748	0.174	4
$\Psi_{edge}\ p.$	125.891	119.462	1.465	0.481	0.112	3
$\Psi_{edge}\ p_{temp}$	126.346	117.619	1.920	0.383	0.089	4
$\Psi_{area}\ p_{date}$	126.397	117.670	1.971	0.373	0.087	4
$\Psi.\ p.$	127.417	123.206	2.991	0.224	0.052	2
$\Psi_{shape}\ p.$	127.680	121.251	3.254	0.197	0.046	3
$\Psi_{edge}\ p_{date}$	127.846	119.119	3.420	0.181	0.042	4
$\Psi.\ p_{temp}$	127.857	121.428	3.431	0.180	0.042	3
$\Psi_{shape}\ p_{temp}$	128.318	119.590	3.892	0.143	0.033	4
$\Psi.\ p_{date}$	129.268	122.839	4.842	0.089	0.021	3
$\Psi_{management}\ p.$	129.590	123.162	5.164	0.076	0.018	3
$\Psi_{shape}\ p_{date}$	129.639	120.911	5.213	0.074	0.017	4
$\Psi_{management}\ p_{temp}$	130.139	121.412	5.713	0.057	0.013	4
$\Psi_{forest}\ p.$	131.056	122.329	6.630	0.036	0.008	4
$\Psi_{management}\ p_{date}$	131.536	122.809	7.110	0.029	0.007	4
$\Psi_{forest}\ p_{temp}$	131.773	120.662	7.347	0.025	0.006	5
$\Psi_{forest}\ p_{date}$	133.061	121.950	8.635	0.013	0.003	5
BAWW (n = 21, ĉ = 3.468)						
$\Psi.\ p.$	46.519	146.728	0.000	1.000	0.224	2
$\Psi.\ p_{temp}$	47.917	143.881	1.397	0.497	0.111	3
$\Psi_{shrub}\ p.$	48.302	145.218	1.783	0.410	0.092	3
$\Psi_{edge}\ p.$	48.316	145.265	1.796	0.407	0.091	3
$\Psi_{management}\ p.$	48.485	145.851	1.965	0.374	0.084	3
$\Psi_{area}\ p.$	48.575	146.163	2.055	0.358	0.080	3
$\Psi_{shape}\ p.$	48.620	146.318	2.100	0.350	0.078	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{shrub}\ p_{temp}$	49.759	142.298	3.239	0.198	0.044	4
$\Psi_{edge}\ p_{temp}$	49.793	142.417	3.274	0.195	0.044	4
$\Psi_{management}\ p_{temp}$	49.952	142.966	3.432	0.180	0.040	4
$\Psi_{area}\ p_{temp}$	50.049	143.305	3.530	0.171	0.038	4
$\Psi_{shape}\ p_{temp}$	50.090	143.445	3.570	0.168	0.038	4
$\Psi_{forest}\ p.$	50.995	146.585	4.476	0.107	0.024	4
$\Psi_{forest}\ p_{temp}$	52.558	143.739	6.039	0.049	0.011	5
BGGN (n = 313, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	829.385	792.051	0.000	1.000	0.501	14
$\Psi_{edge}\ p_{prior\ detect}$	832.395	791.486	3.011	0.222	0.111	15
$\Psi_{shape}\ p_{prior\ detect}$	832.779	791.869	3.394	0.183	0.092	15
$\Psi_{shrub}\ p_{prior\ detect}$	832.858	791.949	3.473	0.176	0.088	15
$\Psi_{management}\ p_{prior\ detect}$	832.896	791.987	3.512	0.173	0.087	15
$\Psi_{area}\ p_{prior\ detect}$	832.958	792.049	3.573	0.168	0.084	15
$\Psi_{forest}\ p_{prior\ detect}$	835.347	790.696	5.963	0.051	0.025	16
$\Psi_{forest+edge}\ p_{prior\ detect}$	838.832	790.261	9.448	0.009	0.004	17
$\Psi_{forest+shape}\ p_{prior\ detect}$	839.118	790.546	9.733	0.008	0.004	17
$\Psi_{forest+size}\ p_{prior\ detect}$	839.263	790.691	9.878	0.007	0.004	17
BHCO (n = 72, ĉ = 1.471)						
$\Psi_{ground}\ p_{prior\ detect}$	256.687	322.724	0.000	1.000	0.417	14
$\Psi_{management}\ p_{prior\ detect}$	257.978	324.623	1.291	0.524	0.219	14
$\Psi.\ p_{prior\ detect}$	259.049	331.230	2.362	0.307	0.128	13

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{ground+shrub}$ $p_{prior\ detect}$	259.558	321.687	2.871	0.238	0.099	15
Ψ_{shrub} $p_{prior\ detect}$	261.708	330.111	5.021	0.081	0.034	14
Ψ_{shape} $p_{prior\ detect}$	261.898	330.389	5.210	0.074	0.031	14
Ψ_{area} $p_{prior\ detect}$	261.959	330.480	5.272	0.072	0.030	14
Ψ_{edge} $p_{prior\ detect}$	262.121	330.718	5.434	0.066	0.028	14
Ψ_{forest} $p_{prior\ detect}$	263.277	327.158	6.589	0.037	0.015	15
BHNU (n = 29, ĉ = 1)						
$\Psi.$ p_{temp}	233.515	227.086	0.000	1.000	0.117	3
Ψ_{area} p_{temp}	233.769	225.042	0.254	0.881	0.103	4
$\Psi.$ p_{date}	234.775	228.346	1.260	0.533	0.062	3
Ψ_{forest} p_{temp}	234.821	223.710	1.306	0.520	0.061	5
Ψ_{edge} p_{temp}	234.956	226.229	1.442	0.486	0.057	4
Ψ_{area} p_{date}	235.133	226.406	1.619	0.445	0.052	4
$\Psi_{management}$ p_{temp}	235.136	226.409	1.621	0.445	0.052	4
$\Psi.$ $p.$	235.148	230.938	1.633	0.442	0.052	2
Ψ_{area} $p.$	235.448	229.019	1.933	0.380	0.045	3
Ψ_{forest} p_{date}	235.706	224.595	2.191	0.334	0.039	5
Ψ_{shape} p_{temp}	235.808	227.081	2.293	0.318	0.037	4
Ψ_{forest} $p.$	235.889	227.161	2.374	0.305	0.036	4
Ψ_{edge} p_{date}	236.283	227.556	2.768	0.251	0.029	4
$\Psi_{management}$ p_{date}	236.405	227.677	2.890	0.236	0.028	4
$\Psi_{forest+size}$ p_{temp}	236.529	222.944	3.014	0.222	0.026	6
$\Psi_{management}$ $p.$	236.547	230.119	3.032	0.220	0.026	3
Ψ_{edge} $p.$	236.593	230.164	3.078	0.215	0.025	3
Ψ_{shape} p_{date}	237.073	228.346	3.559	0.169	0.020	4
$\Psi_{forest+shape}$ p_{temp}	237.129	223.544	3.614	0.164	0.019	6
$\Psi_{forest+edge}$ p_{temp}	237.281	223.696	3.766	0.152	0.018	6
Ψ_{shape} $p.$	237.364	230.936	3.849	0.146	0.017	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{forest+size}\ p_{date}$	237.490	223.905	3.975	0.137	0.016	6
$\Psi_{forest+size}\ p.$	237.612	226.501	4.098	0.129	0.015	5
$\Psi_{forest+shape}\ p_{date}$	237.963	224.378	4.448	0.108	0.013	6
$\Psi_{forest+shape}\ p.$	238.013	226.902	4.498	0.105	0.012	5
$\Psi_{forest+edge} p_{date}$	238.174	224.589	4.659	0.097	0.011	6
$\Psi_{forest+edge} p.$	238.269	227.158	4.755	0.093	0.011	5
BLGR (n = 38, ĉ = 1.260)						
$\Psi.\ p_{obs}$	204.988	234.642	0.000	1.000	0.326	8
$\Psi_{area}\ p_{obs}$	205.830	232.203	0.841	0.657	0.214	9
$\Psi_{edge}\ p_{obs}$	207.032	233.718	2.043	0.360	0.117	9
$\Psi_{shape}\ p_{obs}$	207.174	233.897	2.186	0.335	0.109	9
$\Psi_{shrub}\ p_{obs}$	207.458	234.255	2.469	0.291	0.095	9
$\Psi_{management}\ p_{obs}$	207.626	234.467	2.638	0.267	0.087	9
$\Psi_{forest}\ p_{obs}$	210.114	233.960	5.125	0.077	0.025	10
$\Psi_{forest+size}\ p_{obs}$	211.537	231.961	6.549	0.038	0.012	11
$\Psi_{forest+shape}\ p_{obs}$	212.685	233.407	7.697	0.021	0.007	11
$\Psi_{forest+edge}\ p_{obs}$	212.690	233.414	7.702	0.021	0.007	11
BLJA (n = 178, ĉ = 2.548)						
$\Psi.\ p_{prior\ detect}$	292.670	641.587	0.000	1.000	0.595	15
$\Psi_{management}\ p_{prior\ detect}$	296.141	640.896	3.471	0.176	0.105	16
$\Psi_{edge}\ p_{prior\ detect}$	296.212	641.078	3.542	0.170	0.101	16
$\Psi_{area}\ p_{prior\ detect}$	296.406	641.572	3.736	0.154	0.092	16
$\Psi_{shape}\ p_{prior\ detect}$	296.412	641.587	3.742	0.154	0.092	16
$\Psi_{forest}\ p_{prior\ detect}$	299.953	640.621	7.283	0.026	0.016	17
CACH (n = 116, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	543.444	506.110	0.000	1.000	0.609	14

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{edge}\ p_{prior\ detect}$	546.019	505.110	2.576	0.276	0.168	15
$\Psi_{shape}\ p_{prior\ detect}$	547.020	506.110	3.576	0.167	0.102	15
$\Psi_{management}\ p_{prior\ detect}$	547.020	506.110	3.576	0.167	0.102	15
$\Psi_{forest}\ p_{prior\ detect}$	550.378	505.726	6.934	0.031	0.019	16
$\Psi_{area}\ p_{prior\ detect}$	578.658	537.749	35.214	0.000	0.000	15
CARW (n = 408, ĉ = 1.127)						
$\Psi.\ p_{prior\ detect}$	788.354	842.594	0.000	1.000	0.508	15
$\Psi_{management}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{ground}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{area}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{edge}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{shape}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{shrub}\ p_{prior\ detect}$	792.096	842.594	3.742	0.154	0.078	16
$\Psi_{forest}\ p_{prior\ detect}$	796.016	842.594	7.662	0.022	0.011	17
$\Psi_{ground+shrub}\ p_{prior\ detect}$	796.016	842.594	7.662	0.022	0.011	17
CHSP (n = 20, ĉ = 1)						
$\Psi_{area}\ p_{date}$	164.520	155.793	0.000	1.000	0.193	4
$\Psi_{ground+shrub}\ p_{date}$	164.547	153.436	0.027	0.987	0.191	5
$\Psi_{ground}\ p_{date}$	164.951	156.224	0.431	0.806	0.156	4
$\Psi_{shrub}\ p_{date}$	165.297	156.570	0.777	0.678	0.131	4
$\Psi_{edge}\ p_{date}$	165.438	156.711	0.918	0.632	0.122	4
$\Psi.\ p_{date}$	165.757	159.329	1.237	0.539	0.104	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{management}\ p_{date}$	167.318	158.590	2.797	0.247	0.048	4
$\Psi_{shape}\ p_{date}$	167.584	158.857	3.064	0.216	0.042	4
$\Psi_{forest}\ p_{date}$	170.003	158.892	5.483	0.064	0.012	5
COYE (n = 88, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	414.246	373.337	0.000	1.000	0.347	15
$\Psi_{ground}\ p_{prior\ detect}$	414.275	369.624	0.029	0.986	0.342	16
$\Psi_{shape}\ p_{prior\ detect}$	417.334	372.683	3.088	0.214	0.074	16
$\Psi_{edge}\ p_{prior\ detect}$	417.835	373.184	3.589	0.166	0.058	16
$\Psi_{shrub}\ p_{prior\ detect}$	417.894	373.243	3.648	0.161	0.056	16
$\Psi_{area}\ p_{prior\ detect}$	417.930	373.279	3.684	0.159	0.055	16
$\Psi_{management}\ p_{prior\ detect}$	417.987	373.336	3.741	0.154	0.054	16
$\Psi_{forest}\ p_{prior\ detect}$	420.765	372.194	6.519	0.038	0.013	17
$\Psi_{ground+shrub}\ p_{prior\ detect}$	436.476	387.904	22.229	0.000	0.000	17
DOWO (n = 66, ĉ = 1)						
$\Psi.\ p_{date}$	421.784	415.355	0.000	1.000	0.316	3
$\Psi_{edge}\ p_{date}$	423.015	414.288	1.231	0.540	0.171	4
$\Psi_{area}\ p_{date}$	423.225	414.497	1.441	0.486	0.154	4
$\Psi_{management}\ p_{date}$	423.610	414.883	1.827	0.401	0.127	4
$\Psi_{shape}\ p_{date}$	423.916	415.189	2.132	0.344	0.109	4
$\Psi_{forest}\ p_{date}$	425.148	414.037	3.365	0.186	0.059	5
$\Psi_{forest+shape}\ p_{date}$	427.129	413.545	5.346	0.069	0.022	6
$\Psi_{forest+edge} p_{date}$	427.349	413.764	5.565	0.062	0.020	6
$\Psi_{forest+size}\ p_{date}$	427.549	413.964	5.765	0.056	0.018	6
$\Psi.\ p.$	432.269	428.059	10.486	0.005	0.002	2
$\Psi_{edge}\ p.$	433.654	427.225	11.870	0.003	0.001	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{management}\ p.$	433.760	427.332	11.977	0.003	0.001	3
$\Psi_{area}\ p.$	433.951	427.522	12.167	0.002	0.001	3
$\Psi_{shape}\ p.$	434.234	427.805	12.450	0.002	0.001	3
$\Psi_{forest}\ p.$	435.350	426.623	13.566	0.001	0.000	4
$\Psi_{forest+shape}\ p.$	437.056	425.945	15.273	0.000	0.000	5
$\Psi_{forest+edge} p.$	437.642	426.531	15.858	0.000	0.000	5
$\Psi_{forest+size}\ p.$	437.692	426.581	15.908	0.000	0.000	5
EABL (n = 26, ĉ = 1.549)						
$\Psi_{shape}\ p_{temp}$	124.803	179.789	0.000	1.000	0.321	4
$\Psi.\ p_{temp}$	125.840	184.956	1.037	0.595	0.191	3
$\Psi_{shrub}\ p_{temp}$	126.220	181.984	1.417	0.492	0.158	4
$\Psi_{edge}\ p_{temp}$	126.277	182.073	1.474	0.478	0.153	4
$\Psi_{area}\ p_{temp}$	127.175	183.463	2.372	0.305	0.098	4
$\Psi_{management}\ p_{temp}$	128.139	184.956	3.336	0.189	0.061	4
$\Psi_{forest}\ p_{temp}$	130.518	184.949	5.715	0.057	0.018	5
EATO (n = 84, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	417.267	379.934	0.000	1.000	0.439	14
$\Psi_{edge}\ p_{prior\ detect}$	420.030	379.121	2.764	0.251	0.110	15
$\Psi_{area}\ p_{prior\ detect}$	420.030	379.121	2.764	0.251	0.110	15
$\Psi_{shape}\ p_{prior\ detect}$	420.510	379.601	3.243	0.198	0.087	15
$\Psi_{shrub}\ p_{prior\ detect}$	420.843	379.934	3.576	0.167	0.074	15
$\Psi_{ground}\ p_{prior\ detect}$	420.843	379.934	3.576	0.167	0.074	15
$\Psi_{management}\ p_{prior\ detect}$	420.843	379.934	3.576	0.167	0.074	15
$\Psi_{ground+shrub}\ p_{prior\ detect}$	423.518	378.867	6.251	0.044	0.019	16

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{forest}\ p_{prior\ detect}$	424.283	379.632	7.016	0.030	0.013	16
EAWP (n = 90, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	411.617	374.284	0.000	1.000	0.412	14
$\Psi_{area}\ p_{prior\ detect}$	413.267	372.357	1.649	0.438	0.181	15
$\Psi_{forest}\ p_{prior\ detect}$	413.915	369.264	2.298	0.317	0.131	16
$\Psi_{edge}\ p_{prior\ detect}$	414.538	373.629	2.921	0.232	0.096	15
$\Psi_{management}\ p_{prior\ detect}$	414.570	373.661	2.953	0.228	0.094	15
$\Psi_{shape}\ p_{prior\ detect}$	414.731	373.822	3.114	0.211	0.087	15
FICR (n = 33, ĉ = 1)						
$\Psi_{management}\ p_{date}$	230.840	222.113	0.000	1.000	0.673	4
$\Psi.\ p_{date}$	233.876	227.447	3.036	0.219	0.147	3
$\Psi_{edge}\ p_{date}$	235.520	226.793	4.680	0.096	0.065	4
$\Psi_{area}\ p_{date}$	236.099	227.372	5.259	0.072	0.049	4
$\Psi_{shape}\ p_{date}$	236.116	227.389	5.276	0.071	0.048	4
$\Psi_{forest}\ p_{date}$	238.053	226.942	7.213	0.027	0.018	5
FISP (n = 9, ĉ = 1)						
$\Psi.\ p_{date}$	83.254	76.825	0.000	1.000	0.296	3
$\Psi_{management}\ p_{date}$	83.903	75.175	0.649	0.723	0.214	4
$\Psi_{forest}\ p_{date}$	84.230	73.119	0.976	0.614	0.182	5
$\Psi_{area}\ p_{date}$	85.307	76.580	2.053	0.358	0.106	4
$\Psi_{edge}\ p_{date}$	85.320	76.593	2.067	0.356	0.105	4
P $\Psi_{shape}\ p_{date}$	85.479	76.752	2.225	0.329	0.097	4
GCFL (n = 204, ĉ = 1.706)						

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi. \; p_{\text{prior detect}}$	466.069	731.380	0.000	1.000	0.449	14
$\Psi_{\text{ground}} \; p_{\text{prior detect}}$	467.610	727.909	1.541	0.463	0.208	15
$\Psi_{\text{management}} \; p_{\text{prior detect}}$	468.963	730.217	2.894	0.235	0.106	15
$\Psi_{\text{shape}} \; p_{\text{prior detect}}$	469.639	731.370	3.570	0.168	0.075	15
$\Psi_{\text{edge}} \; p_{\text{prior detect}}$	469.645	731.380	3.576	0.167	0.075	15
$\Psi_{\text{area}} \; p_{\text{prior detect}}$	469.645	731.380	3.576	0.167	0.075	15
$\Psi_{\text{forest}} \; p_{\text{prior detect}}$	473.387	731.380	7.318	0.026	0.012	16
HAWO (n = 19, ĉ = 1)						
$\Psi_{\text{forest}} \; p_{\text{date}}$	160.929	149.818	0.000	1.000	0.313	5
$\Psi_{\text{forest+shape}} \; p_{\text{date}}$	161.597	148.012	0.668	0.716	0.224	6
$\Psi_{\text{forest+edge}} p_{\text{date}}$	162.911	149.326	1.981	0.371	0.116	6
$\Psi. \; p_{\text{date}}$	163.165	156.737	2.236	0.327	0.102	3
$\Psi_{\text{forest+size}} \; p_{\text{date}}$	163.403	149.818	2.474	0.290	0.091	6
$\Psi_{\text{shape}} \; p_{\text{date}}$	164.460	155.733	3.531	0.171	0.053	4
$\Psi_{\text{edge}} \; p_{\text{date}}$	165.329	156.602	4.400	0.111	0.035	4
$\Psi_{\text{management}} \; p_{\text{date}}$	165.386	156.659	4.456	0.108	0.034	4
$\Psi_{\text{area}} \; p_{\text{date}}$	165.445	156.718	4.516	0.105	0.033	4
HOWA (n = 212, ĉ = 1.05)						
$\Psi. \; p_{\text{prior detect}})$	652.047	642.978	0.000	1.000	0.381	15
$\Psi_{\text{management}} \; p_{\text{prior detect}}$	653.035	640.081	0.988	0.610	0.232	16
$\Psi_{\text{shape}} \; p_{\text{prior detect}}$	654.429	641.548	2.382	0.304	0.116	16
$\Psi_{\text{area2}} \; p_{\text{prior detect}}$	655.231	642.391	3.184	0.203	0.077	16
$\Psi_{\text{shrub}} \; p_{\text{prior detect}}$	655.637	642.818	3.590	0.166	0.063	16
$\Psi_{\text{area}} \; p_{\text{prior detect}}$	655.653	642.835	3.606	0.165	0.063	16

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{edge}\ p_{prior\ detect}$	655.786	642.975	3.739	0.154	0.059	16
$\Psi_{forest}\ p_{prior\ detect}$	659.521	642.780	7.474	0.024	0.009	17
INBU (n = 380, ĉ = 1)						
$\Psi_{area}\ p_{prior\ detect}$	725.744	681.092	0.000	1.000	0.390	16
$\Psi_{edge}\ p_{prior\ detect}$	726.168	681.517	0.424	0.809	0.316	16
$\Psi.\ p_{prior\ detect}$	728.445	687.536	2.701	0.259	0.101	15
$\Psi_{shape}\ p_{prior\ detect}$	728.753	684.102	3.010	0.222	0.087	16
$\Psi_{ground}\ p_{prior\ detect}$	730.954	686.303	5.211	0.074	0.029	16
$\Psi_{forest}\ p_{prior\ detect}$	731.129	682.558	5.386	0.068	0.026	17
$\Psi_{shrub}\ p_{prior\ detect}$	731.139	686.488	5.396	0.067	0.026	16
$\Psi_{management}\ p_{prior\ detect}$	732.071	687.420	6.328	0.042	0.017	16
$\Psi_{ground+shrub}\ p_{prior\ detect}$	733.591	685.020	7.848	0.020	0.008	17
KEWA (n = 70, ĉ = 1.698)						
$\Psi_{ground}\ p_{date}$	253.513	415.622	0.000	1.000	0.298	4
$\Psi_{shape}\ p_{date}$	254.125	416.661	0.612	0.736	0.220	4
$\Psi_{forest+shape}\ p_{date}$	254.284	408.684	0.771	0.680	0.203	6
$\Psi_{ground+shrub}\ p_{date}$	255.020	414.133	1.507	0.471	0.140	5
$\Psi_{area}\ p_{date}$	257.979	423.204	4.466	0.107	0.032	4
$\Psi_{shrub}\ p_{date}$	258.355	423.842	4.842	0.089	0.026	4
$\Psi.\ p_{date}$	258.497	427.987	4.984	0.083	0.025	3
$\Psi_{edge}\ p_{date}$	259.003	424.943	5.490	0.064	0.019	4
$\Psi_{management}\ p_{date}$	259.035	424.998	5.522	0.063	0.019	4
$\Psi_{forest+size}\ p_{date}$	260.401	419.068	6.888	0.032	0.010	6

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{forest+edge} p_{date}$	261.530	420.985	8.017	0.018	0.005	6
$\Psi_{forest}\ p_{date}$	262.706	427.184	9.193	0.010	0.003	5
MODO (n = 249, ĉ = 1.579)						
$\Psi.\ p_{prior\ detect}$	512.783	745.325	0.000	1.000	0.591	15
$\Psi_{management}\ p_{prior\ detect}$	516.142	744.720	3.359	0.186	0.110	16
$\Psi_{area}\ p_{prior\ detect}$	516.437	745.186	3.654	0.161	0.095	16
$\Psi_{edge}\ p_{prior\ detect}$	516.501	745.286	3.718	0.156	0.092	16
$\Psi_{shape}\ p_{prior\ detect}$	516.525	745.325	3.742	0.154	0.091	16
$\Psi_{forest}\ p_{prior\ detect}$	519.538	743.892	6.755	0.034	0.020	17
NOBO (n = 74, ĉ = 1)						
$\Psi_{area2}\ p_{prior\ detect}$	350.651	309.742	0.000	1.000	0.315	15
$\Psi_{management}\ p_{prior\ detect}$	351.126	310.217	0.475	0.789	0.248	15
$\Psi.\ p_{prior\ detect}$	351.941	314.608	1.290	0.525	0.165	14
$\Psi_{area}\ p_{prior\ detect}$	352.032	311.123	1.381	0.501	0.158	15
$\Psi_{edge}\ p_{prior\ detect}$	353.464	312.555	2.812	0.245	0.077	15
$\Psi_{shape}\ p_{prior\ detect}$	355.207	314.297	4.555	0.103	0.032	15
$\Psi_{forest}\ p_{prior\ detect}$	358.924	314.273	8.273	0.016	0.005	16
NOCA (n = 450, ĉ = 1.039)						
$\Psi.\ p_{prior\ detect}$	768.673	756.438	0.000	1.000	0.558	15
$\Psi_{management}\ p_{prior\ detect}$	772.416	756.438	3.742	0.154	0.086	16
$\Psi_{shrub}\ p_{prior\ detect}$	772.416	756.438	3.742	0.154	0.086	16
$\Psi_{edge}\ p_{prior\ detect}$	772.416	756.438	3.742	0.154	0.086	16

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{shape}\ p_{prior\ detect}$	772.416	756.438	3.742	0.154	0.086	16
$\Psi_{area}\ p_{prior\ detect}$	772.416	756.438	3.742	0.154	0.086	16
$\Psi_{forest}\ p_{prior\ detect}$	776.336	756.438	7.662	0.022	0.012	17
NOFL (n = 8, ĉ = 1)						
$\Psi_{management}\ p_{temp}$	76.348	67.621	0.000	1.000	0.941	4
$\Psi.\ p_{temp}$	83.548	77.119	7.199	0.027	0.026	3
$\Psi_{edge}\ p_{temp}$	84.825	76.098	8.477	0.014	0.014	4
$\Psi_{area}\ p_{temp}$	85.711	76.984	9.363	0.009	0.009	4
$\Psi_{shape}\ p_{temp}$	85.820	77.093	9.472	0.009	0.008	4
$\Psi_{forest}\ p_{temp}$	88.161	77.050	11.813	0.003	0.003	5
NOMO (n = 9, ĉ = 1)						
$\Psi_{ground}\ p.$	75.680	69.251	0.000	1.000	0.201	3
$\Psi_{management}\ p.$	75.773	69.344	0.093	0.954	0.192	3
$\Psi_{ground}\ p_{date}$	75.946	67.219	0.267	0.875	0.176	4
$\Psi_{management}\ p_{date}$	76.097	67.370	0.417	0.812	0.163	4
$\Psi_{forest}\ p.$	78.033	69.305	2.353	0.308	0.062	4
$\Psi_{forest}\ p_{date}$	78.592	67.481	2.912	0.233	0.047	5
$\Psi.\ p.$	78.942	74.732	3.263	0.196	0.039	2
$\Psi.\ p_{date}$	79.329	72.901	3.650	0.161	0.032	3
$\Psi_{area}\ p.$	80.448	74.020	4.769	0.092	0.019	3
$\Psi_{edge}\ p.$	80.861	74.432	5.181	0.075	0.015	3
$\Psi_{area}\ p_{date}$	80.928	72.200	5.248	0.073	0.015	4
$\Psi_{shape}\ p.$	80.973	74.545	5.294	0.071	0.014	3
$\Psi_{edge}\ p_{date}$	81.337	72.609	5.657	0.059	0.012	4
$\Psi_{shape}\ p_{date}$	81.431	72.704	5.752	0.056	0.011	4
NOPA (n = 369, ĉ = 1)						
$\Psi_{management}\ p_{obs}$	648.469	626.869	0.000	1.000	0.896	9

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{area}\ p_{obs}$	655.326	633.726	6.858	0.032	0.029	9
$\Psi.\ p_{obs}$	655.523	636.699	7.054	0.029	0.026	8
$\Psi_{edge}\ p_{obs}$	655.839	634.239	7.370	0.025	0.022	9
$\Psi_{forest}\ p_{obs}$	657.847	633.357	9.378	0.009	0.008	10
$\Psi_{shape}\ p_{obs}$	657.864	636.264	9.395	0.009	0.008	9
$\Psi_{forest+size}\ p_{obs}$	659.449	631.949	10.980	0.004	0.004	11
$\Psi_{forest+shape}\ p_{obs}$	659.503	632.003	11.034	0.004	0.004	11
$\Psi_{forest+edge}\ p_{obs}$	660.026	632.526	11.557	0.003	0.003	11
OROR (*n* = 19, ĉ = 1)						
$\Psi.\ p.$	142.759	138.548	0.000	1.000	0.231	2
$\Psi_{area}\ p.$	143.964	137.536	1.205	0.547	0.127	3
$\Psi_{management}\ p.$	144.129	137.701	1.370	0.504	0.117	3
$\Psi.\ p_{temp}$	144.479	138.051	1.720	0.423	0.098	3
$\Psi_{edge}\ p.$	144.620	138.192	1.861	0.394	0.091	3
$\Psi_{shape}\ p.$	144.919	138.490	2.160	0.340	0.079	3
$\Psi_{forest}\ p.$	145.296	136.569	2.537	0.281	0.065	4
$\Psi_{area}\ p_{temp}$	145.771	137.044	3.012	0.222	0.051	4
$\Psi_{management}\ p_{temp}$	145.956	137.228	3.197	0.202	0.047	4
$\Psi_{edge}\ p_{temp}$	146.424	137.697	3.665	0.160	0.037	4
$\Psi_{shape}\ p_{temp}$	146.723	137.996	3.964	0.138	0.032	4
$\Psi_{forest}\ p_{temp}$	147.154	136.043	4.395	0.111	0.026	5
PIWA (*n* = 119, ĉ = 4.267)						
$\Psi_{management}\ p_{date}$	117.696	465.015	0.000	1.000	0.319	4
$\Psi.\ p_{date}$	118.042	476.298	0.345	0.841	0.269	3
$\Psi_{area}\ p_{date}$	119.663	473.406	1.966	0.374	0.120	4
$\Psi_{edge}\ p_{date}$	119.786	473.931	2.089	0.352	0.112	4
$\Psi_{shape}\ p_{date}$	120.253	475.925	2.557	0.279	0.089	4
$\Psi_{forest}\ p_{date}$	121.558	471.320	3.861	0.145	0.046	5

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{forest+size}\, p_{date}$	123.657	469.724	5.961	0.051	0.016	6
$\Psi_{forest+edge}\, p_{date}$	123.856	470.572	6.160	0.046	0.015	6
$\Psi_{forest+shape}\, p_{date}$	124.022	471.280	6.326	0.042	0.014	6
PIWO (n = 97, ĉ = 1)						
$\Psi.\, p_{prior\ detect}$	509.530	472.196	0.000	1.000	0.590	14
$\Psi_{area}\, p_{prior\ detect}$	513.106	472.196	3.576	0.167	0.099	15
$\Psi_{management}\, p_{prior\ detect}$	513.106	472.196	3.576	0.167	0.099	15
$\Psi_{shape}\, p_{prior\ detect}$	513.106	472.196	3.576	0.167	0.099	15
$\Psi_{edge}\, p_{prior\ detect}$	513.106	472.196	3.576	0.167	0.099	15
$\Psi_{forest}\, p_{prior\ detect}$	516.848	472.196	7.318	0.026	0.015	16
PRAW (n = 34, ĉ = 1)						
$\Psi.\, p_{date}$	224.723	218.294	0.000	1.000	0.140	3
$\Psi_{ground}\, p_{date}$	225.507	216.780	0.784	0.676	0.095	4
$\Psi_{management}\, p_{date}$	225.686	216.959	0.963	0.618	0.086	4
$\Psi.\, p.$	225.729	221.519	1.006	0.605	0.085	2
$\Psi_{shrub}\, p_{date}$	225.904	217.177	1.181	0.554	0.078	4
$\Psi_{ground}\, p.$	226.360	219.931	1.637	0.441	0.062	3
$\Psi_{management}\, p.$	226.526	220.098	1.803	0.406	0.057	3
$\Psi_{ground+shrub}\, p_{date}$	226.548	215.437	1.825	0.401	0.056	5
$\Psi_{edge}\, p_{date}$	226.807	218.079	2.084	0.353	0.049	4
$\Psi_{shrub}\, p.$	226.862	220.433	2.139	0.343	0.048	3
$\Psi_{area}\, p_{date}$	227.019	218.292	2.296	0.317	0.044	4
$\Psi_{shape}\, p_{date}$	227.020	218.292	2.297	0.317	0.044	4
$\Psi_{ground+shrub}\, p.$	227.332	218.604	2.609	0.271	0.038	4
$\Psi_{edge}\, p.$	227.754	221.325	3.031	0.220	0.031	3
$\Psi_{shape}\, p.$	227.946	221.517	3.223	0.200	0.028	3

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{area}\ p.$	227.947	221.518	3.224	0.200	0.028	3
$\Psi_{forest}\ p_{date}$	228.741	217.630	4.018	0.134	0.019	5
$\Psi_{forest}\ p.$	229.573	220.846	4.851	0.088	0.012	4
PUMA (n = 7, $\hat{c}$ = 1)						
$\Psi.\ p_{date}$	71.970	65.542	0.000	1.000	0.298	3
$\Psi_{management}\ p_{date}$	72.539	63.811	0.568	0.753	0.224	4
$\Psi_{forest}\ p_{date}$	73.005	61.894	1.035	0.596	0.178	5
$\Psi_{area}\ p_{date}$	74.038	65.311	2.068	0.356	0.106	4
$\Psi_{edge}\ p_{date}$	74.180	65.452	2.209	0.331	0.099	4
$\Psi_{shape}\ p_{date}$	74.233	65.506	2.263	0.323	0.096	4
RBWO (n = 392, $\hat{c}$ = 1.476)						
$\Psi.\ p_{obs}$	652.710	935.299	0.000	1.000	0.486	8
$\Psi_{edge}\ p_{obs}$	655.486	935.299	2.776	0.250	0.121	9
$\Psi_{management}\ p_{obs}$	655.486	935.299	2.776	0.250	0.121	9
$\Psi_{area}\ p_{obs}$	655.486	935.299	2.776	0.250	0.121	9
$\Psi_{shape}\ p_{obs}$	655.486	935.299	2.776	0.250	0.121	9
$\Psi_{forest}\ p_{obs}$	658.376	935.299	5.666	0.059	0.029	10
REVI (n = 299, $\hat{c}$ = 1)						
$\Psi.\ p_{prior\ detect}$	822.728	781.819	0.000	1.000	0.323	15
$\Psi_{shape}\ p_{prior\ detect}$	822.796	778.144	0.067	0.967	0.313	16
$\Psi_{area}\ p_{prior\ detect}$	825.062	780.411	2.334	0.311	0.101	16
$\Psi_{management}\ p_{prior\ detect}$	825.224	780.573	2.496	0.287	0.093	16
$\Psi_{area2}\ p_{prior\ detect}$	825.639	780.988	2.911	0.233	0.075	16
$\Psi_{edge}\ p_{prior\ detect}$	825.953	781.302	3.224	0.199	0.064	16
$\Psi_{forest}\ p_{prior\ detect}$	827.453	778.882	4.725	0.094	0.030	17

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
RHWO (n = 63, ĉ = 2.094)						
$\Psi_{management}\ p.$	190.396	385.136	0.000	1.000	0.248	3
$\Psi_{management}\ p_{temp}$	191.822	383.308	1.426	0.490	0.122	4
$\Psi_{management}\ p_{date}$	192.216	384.135	1.820	0.402	0.100	4
$\Psi.\ p.$	192.940	395.105	2.544	0.280	0.070	2
$\Psi_{forest}\ p.$	193.506	386.833	3.109	0.211	0.052	4
$\Psi_{area}\ p.$	193.828	392.320	3.431	0.180	0.045	3
$\Psi.\ p_{temp}$	194.252	393.209	3.856	0.145	0.036	3
$\Psi_{edge}\ p.$	194.502	393.731	4.106	0.128	0.032	3
$\Psi.\ p_{date}$	194.770	394.293	4.374	0.112	0.028	3
$\Psi_{shape}\ p.$	194.879	394.520	4.482	0.106	0.026	3
$\Psi_{forest+shape}\ p.$	194.999	384.970	4.603	0.100	0.025	5
$\Psi_{forest}\ p_{temp}$	195.018	385.010	4.622	0.099	0.025	5
$\Psi_{area}\ p_{temp}$	195.193	390.365	4.796	0.091	0.023	4
$\Psi_{forest+size}\ p.$	195.518	386.056	5.122	0.077	0.019	5
$\Psi_{forest}\ p_{date}$	195.521	386.062	5.125	0.077	0.019	5
$\Psi_{area}\ p_{date}$	195.754	391.541	5.358	0.069	0.017	4
$\Psi_{forest+edge} p.$	195.883	386.821	5.487	0.064	0.016	5
$\Psi_{edge}\ p_{temp}$	195.884	391.813	5.488	0.064	0.016	4
$\Psi_{shape}\ p_{temp}$	196.298	392.679	5.902	0.052	0.013	4
$\Psi_{edge}\ p_{date}$	196.425	392.944	6.028	0.049	0.012	4
$\Psi_{forest+shape}\ p_{temp}$	196.640	383.225	6.243	0.044	0.011	6
$\Psi_{shape}\ p_{date}$	196.786	393.700	6.389	0.041	0.010	4
$\Psi_{forest+shape}\ p_{date}$	197.101	384.191	6.705	0.035	0.009	6
$\Psi_{forest+size}\ p_{temp}$	197.105	384.198	6.708	0.035	0.009	6
$\Psi_{forest+edge} p_{temp}$	197.486	384.997	7.090	0.029	0.007	6
$\Psi_{forest+size}\ p_{date}$	197.633	385.305	7.237	0.027	0.007	6
$\Psi_{forest+edge} p_{date}$	197.990	386.051	7.593	0.022	0.006	6

RSHA (n = 97, ĉ = 1.573)

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{.}\ p_{prior\ detect}$	328.393	463.334	0.000	1.000	0.517	13
$\Psi_{management}\ p_{prior\ detect}$	330.731	461.631	2.338	0.311	0.161	14
$\Psi_{shape}\ p_{prior\ detect}$	331.763	463.255	3.370	0.185	0.096	14
$\Psi_{edge}\ p_{prior\ detect}$	331.813	463.334	3.420	0.181	0.094	14
$\Psi_{area}\ p_{prior\ detect}$	331.813	463.334	3.420	0.181	0.094	14
$\Psi_{forest}\ p_{prior\ detect}$	333.582	460.492	5.189	0.075	0.039	15
RTHU (n = 19, ĉ = 1)						
$\Psi_{forest}\ p_{.}$	165.193	156.466	0.000	1.000	0.488	4
$\Psi_{forest}\ p_{temp}$	166.945	155.834	1.752	0.416	0.203	5
$\Psi_{management}\ p_{.}$	169.085	162.656	3.891	0.143	0.070	3
$\Psi_{.}\ p_{.}$	169.100	164.889	3.906	0.142	0.069	2
$\Psi_{shape}\ p_{.}$	170.845	164.417	5.652	0.059	0.029	3
$\Psi_{management}\ p_{temp}$	170.849	162.122	5.656	0.059	0.029	4
$\Psi_{.}\ p_{temp}$	170.858	164.429	5.665	0.059	0.029	3
$\Psi_{area}\ p_{.}$	170.929	164.500	5.736	0.057	0.028	3
$\Psi_{edge}\ p_{.}$	171.304	164.875	6.110	0.047	0.023	3
$\Psi_{shape}\ p_{temp}$	172.648	163.921	7.455	0.024	0.012	4
$\Psi_{area}\ p_{temp}$	172.752	164.025	7.559	0.023	0.011	4
$\Psi_{edge}\ p_{temp}$	173.145	164.418	7.952	0.019	0.009	4
SUTA (n = 235, ĉ = 1.571)						
$\Psi_{.}\ p_{prior\ detect}$	515.770	746.054	0.000	1.000	0.595	15
$\Psi_{management}\ p_{prior\ detect}$	518.984	745.224	3.214	0.200	0.119	16
$\Psi_{shape}\ p_{prior\ detect}$	519.282	745.693	3.512	0.173	0.103	16
$\Psi_{edge}\ p_{prior\ detect}$	519.512	746.054	3.742	0.154	0.092	16
$\Psi_{area}\ p_{prior\ detect}$	519.512	746.054	3.742	0.154	0.092	16
$\Psi_{forest}\ p_{prior\ detect}$	542.277	775.661	26.507	0.000	0.000	17

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
SWWA (n = 27, ĉ = 1)						
$\Psi_{management}\ p_{date}$	184.792	176.065	0.000	1.000	0.982	4
$\Psi_{forest}\ p_{date}$	194.872	183.761	10.080	0.006	0.006	5
$\Psi.\ p_{date}$	195.246	188.817	10.453	0.005	0.005	3
$\Psi_{area}\ p_{date}$	196.869	188.142	12.076	0.002	0.002	4
$\Psi_{shape}\ p_{date}$	197.164	188.437	12.372	0.002	0.002	4
$\Psi_{edge}\ p_{date}$	197.399	188.672	12.607	0.002	0.002	4
TUTI (n = 279, ĉ = 1)						
$\Psi.\ p_{prior\ detect}$	827.200	789.867	0.000	1.000	0.537	14
$\Psi_{management}\ p_{prior\ detect}$	830.776	789.867	3.576	0.167	0.090	15
$\Psi_{area}\ p_{prior\ detect}$	830.776	789.867	3.576	0.167	0.090	15
$\Psi_{shape}\ p_{prior\ detect}$	830.776	789.867	3.576	0.167	0.090	15
$\Psi_{shrub}\ p_{prior\ detect}$	830.776	789.867	3.576	0.167	0.090	15
$\Psi_{edge}\ p_{prior\ detect}$	830.776	789.867	3.576	0.167	0.090	15
$\Psi_{forest}\ p_{prior\ detect}$	834.518	789.867	7.318	0.026	0.014	16
WEVI (n = 261, ĉ = 1.042)						
$\Psi_{ground}\ p_{prior\ detect}$	683.067	665.421	0.000	1.000	0.459	16
$\Psi.\ p_{prior\ detect}$	685.258	671.605	2.191	0.334	0.153	15
$\Psi_{management}\ p_{prior\ detect}$	685.385	667.837	2.318	0.314	0.144	16
$\Psi_{ground+shrub}\ p_{prior\ detect}$	686.374	664.782	3.307	0.191	0.088	17
$\Psi_{edge}\ p_{prior\ detect}$	687.402	669.939	4.335	0.114	0.053	16
$\Psi_{area}\ p_{prior\ detect}$	688.034	670.598	4.967	0.083	0.038	16

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{shrub}\ p_{prior\ detect}$	688.725	671.318	5.658	0.059	0.027	16
$\Psi_{shape}\ p_{prior\ detect}$	688.999	671.604	5.932	0.052	0.024	16
$\Psi_{forest}\ p_{prior\ detect}$	690.027	668.589	6.960	0.031	0.014	17
WITU (n = 31, ĉ = 1)						
$\Psi.\ p_{temp}$	226.964	220.536	0.000	1.000	0.368	3
$\Psi_{edge}\ p_{temp}$	228.681	219.954	1.717	0.424	0.156	4
$\Psi_{shape}\ p_{temp}$	228.684	219.956	1.719	0.423	0.156	4
$\Psi_{area}\ p_{temp}$	228.819	220.092	1.855	0.396	0.146	4
$\Psi_{management}\ p_{temp}$	229.117	220.390	2.153	0.341	0.125	4
$\Psi_{forest}\ p_{temp}$	230.976	219.865	4.012	0.135	0.050	5
WOTH (n = 69, ĉ = 2.571)						
$\Psi_{management}\ p.$	142.208	349.144	0.000	1.000	0.291	3
$\Psi_{management}\ p_{date}$	142.526	344.052	0.318	0.853	0.248	4
$\Psi_{management}\ p_{prior\ detect}$	145.058	258.189	2.851	0.240	0.070	16
$\Psi.\ p.$	145.384	363.016	3.176	0.204	0.059	2
$\Psi.\ p_{date}$	145.670	358.047	3.462	0.177	0.051	3
$\Psi_{shape}\ p.$	146.613	360.471	4.405	0.111	0.032	3
$\Psi_{shrub}\ p.$	146.654	360.577	4.446	0.108	0.031	3
$\Psi.\ p_{prior\ detect}$	146.682	271.986	4.474	0.107	0.031	15
$\Psi_{shape}\ p_{date}$	146.973	355.486	4.765	0.092	0.027	4
$\Psi_{shrub}\ p_{date}$	147.017	355.600	4.809	0.090	0.026	4
$\Psi_{area}\ p.$	147.371	362.421	5.163	0.076	0.022	3
$\Psi_{edge}\ p.$	147.516	362.793	5.308	0.070	0.020	3
$\Psi_{area}\ p_{date}$	147.731	357.436	5.523	0.063	0.018	4
$\Psi_{edge}\ p_{date}$	147.880	357.818	5.672	0.059	0.017	4
$\Psi_{forest}\ p.$	148.019	358.177	5.811	0.055	0.016	4
$\Psi_{forest}\ p_{date}$	148.477	353.225	6.270	0.044	0.013	5

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{shrub}\ p_{prior\ detect}$	149.674	270.058	7.467	0.024	0.007	16
$\Psi_{shape}\ p_{prior\ detect}$	149.730	270.200	7.522	0.023	0.007	16
$\Psi_{area}\ p_{prior\ detect}$	150.235	271.499	8.027	0.018	0.005	16
$\Psi_{edge}\ p_{prior\ detect}$	150.377	271.866	8.170	0.017	0.005	16
$\Psi_{forest}\ p_{prior\ detect}$	151.956	265.845	9.748	0.008	0.002	17
YBCH (n = 215, ĉ = 1.821)						
$\Psi.\ p_{date}$	402.698	721.448	0.000	1.000	0.167	3
$\Psi.\ p_{prior\ detect}$	403.146	659.489	0.448	0.799	0.133	15
$\Psi_{shape}\ p_{date}$	403.568	718.846	0.870	0.647	0.108	4
$\Psi_{shrub}\ p_{date}$	403.709	719.104	1.011	0.603	0.101	4
$\Psi_{ground}\ p_{date}$	404.232	720.055	1.533	0.465	0.078	4
$\Psi_{management}\ p_{date}$	404.763	721.022	2.064	0.356	0.059	4
$\Psi_{edge}\ p_{date}$	404.897	721.266	2.199	0.333	0.056	4
$\Psi_{area}\ p_{date}$	404.994	721.443	2.296	0.317	0.053	4
$\Psi_{shape}\ p_{prior\ detect}$	405.479	656.922	2.780	0.249	0.042	16
$\Psi_{ground+shrub}\ p_{date}$	405.500	718.024	2.802	0.246	0.041	5
$\Psi_{shrub}\ p_{prior\ detect}$	405.677	657.284	2.979	0.225	0.038	16
$\Psi_{ground}\ p_{prior\ detect}$	406.139	658.125	3.441	0.179	0.030	16
$\Psi_{management}\ p_{prior\ detect}$	406.646	659.048	3.948	0.139	0.023	16
$\Psi_{edge}\ p_{prior\ detect}$	406.793	659.316	4.095	0.129	0.022	16
$\Psi_{area}\ p_{prior\ detect}$	406.886	659.486	4.188	0.123	0.021	16
$\Psi_{forest}\ p_{date}$	406.993	720.742	4.295	0.117	0.019	5
$\Psi_{ground+shrub}\ p_{prior\ detect}$	409.003	656.201	6.305	0.043	0.007	17
$\Psi_{forest}\ p_{prior\ detect}$	410.388	658.723	7.690	0.021	0.004	17

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
YBCU (n = 154, ĉ = 1)						
$\Psi_{.}\ p_{\text{prior detect}}$	676.653	635.744	0.000	1.000	0.521	15
$\Psi_{\text{shrub}}\ p_{\text{prior detect}}$	679.490	634.839	2.837	0.242	0.126	16
$\Psi_{\text{shape}}\ p_{\text{prior detect}}$	680.118	635.467	3.465	0.177	0.092	16
$\Psi_{\text{management}}\ p_{\text{prior detect}}$	680.324	635.673	3.671	0.160	0.083	16
$\Psi_{\text{edge}}\ p_{\text{prior detect}}$	680.395	635.744	3.742	0.154	0.080	16
$\Psi_{\text{area}}\ p_{\text{prior detect}}$	680.395	635.744	3.742	0.154	0.080	16
$\Psi_{\text{forest}}\ p_{\text{prior detect}}$	683.422	634.850	6.769	0.034	0.018	17
YTVI (n = 105, ĉ = 1)						
$\Psi_{.}\ p_{\text{prior detect}}$	458.687	428.049	0.000	1.000	0.468	12
$\Psi_{\text{shape}}\ p_{\text{prior detect}}$	460.721	426.808	2.034	0.362	0.169	13
$\Psi_{\text{edge}}\ p_{\text{prior detect}}$	461.288	427.374	2.600	0.272	0.128	13
$\Psi_{\text{area}}\ p_{\text{prior detect}}$	461.469	427.556	2.782	0.249	0.117	13
$\Psi_{\text{management}}\ p_{\text{prior detect}}$	461.838	427.925	3.151	0.207	0.097	13
$\Psi_{\text{forest}}\ p_{\text{prior detect}}$	464.867	427.533	6.180	0.046	0.021	14
YTWA (n = 16, ĉ = 1)						
$\Psi_{\text{management}}\ p_{.}$	142.399	135.970	0.000	1.000	0.324	3
$\Psi_{\text{shape}}\ p_{.}$	143.222	136.793	0.823	0.663	0.214	3
$\Psi_{\text{management}}\ p_{\text{date}}$	143.878	135.151	1.480	0.477	0.154	4
$\Psi_{\text{shape}}\ p_{\text{date}}$	144.847	136.120	2.448	0.294	0.095	4
$\Psi_{.}\ p_{.}$	145.421	141.210	3.022	0.221	0.071	2
$\Psi_{.}\ p_{\text{date}}$	146.996	140.567	4.597	0.100	0.032	3
$\Psi_{\text{area}}\ p_{.}$	147.096	140.667	4.697	0.096	0.031	3
$\Psi_{\text{edge}}\ p_{.}$	147.571	141.142	5.172	0.075	0.024	3
$\Psi_{\text{forest}}\ p_{.}$	147.917	139.190	5.519	0.063	0.020	4
$\Psi_{\text{area}}\ p_{\text{date}}$	148.751	140.024	6.353	0.042	0.014	4

Appendix C. Model selection tables for species occupancy in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	QAICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\Psi_{edge}\ p_{date}$	149.227	140.500	6.829	0.033	0.011	4
$\Psi_{forest}\ p_{date}$	149.679	138.568	7.281	0.026	0.008	5

Appendix D. Log odds (β) of occupancy for best approximating model of each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
	β	SE	β	SE	β	SE	β	SE	β	SE
ACFL	2.444	1.523	2.226	6.713	16.783	7016.165	2.020	1.281	-2.103	1.485
AMCR	3.296	0.801	-0.735	0.356	-14.388	12.916	16.676	13.232	8.487	404865.266
AMGO	-1.657	0.738	0.969	0.738	0.809	1.284	-2.164	1.191	0.395	1.564
AMRE	-1.060	0.162	-0.301	0.410	0.290	0.645	-0.650	0.508	-0.194	0.789
BACS	-2.920	0.594	-2.423	3.119	-0.455	1.449	-2.818	1.030	0.295	1.464
BADO	-1.793	0.481	0.506	0.328	15.021	0.000	-16.278	0.000	14.262	0.000
BARS	-0.989	0.591	1.698	0.979	0.365	1.037	-1.422	0.907	1.083	1.213
BAWW	-1.770	0.390	-0.500	0.860	0.310	0.934	-2.002	0.759	0.351	1.087
BGGN	3.615	0.924	-0.039	0.766	-13.776	0.000	17.183	0.000	-14.455	0.000
BHCO	-0.092	0.336	0.577	0.769	1.275	0.747	-0.716	0.576	0.058	0.851
BHNU	-0.276	0.422	-0.909	0.876	-1.211	0.851	0.170	0.706	0.201	0.988
BLGR	-0.604	0.341	1.184	1.040	0.617	0.759	-0.997	0.612	0.430	0.898
BLJA	11.035	1790.336	-0.444	1.376	15.258	3189.172	2.485	1.309	17.887	0.000
CACH	17.801	2353.213	-0.560	0.513	17.833	0.000	2.016	1.802	16.478	3444.324
CARW	19.696	2313.496	1.142	0.000	5.672	0.000	19.743	5185.439	3.875	0.000
CHSP	-0.540	0.514	1.245	0.880	0.601	0.920	-0.941	0.793	0.445	1.100
COYE	0.726	0.560	0.097	0.431	1.006	1.010	0.174	0.696	0.589	1.054
DOWO	0.911	0.441	1.149	1.570	0.986	0.932	0.435	0.618	0.230	0.981

Appendix D. Log odds (β) of occupancy for best approximating model of each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
	β	SE	β	SE	β	SE	β	SE	β	SE
EABL	-0.897	0.383	0.837	0.841	0.005	0.804	-0.883	0.645	-0.064	0.942
EATO	22.972	9603.272	-18.140	3107.742	-22.592	0.000	24.551	0.000	-2.944	0.000
EAWP	0.194	0.392	-0.636	0.577	-1.788	0.990	1.381	0.942	-1.452	1.102
FICR	-0.793	0.323	-0.109	0.405	-0.405	0.708	-0.487	0.547	-0.560	0.875
FISP	-2.105	0.529	-0.378	0.942	1.115	1.191	-2.583	1.065	-17.863	8622.735
GCFL	21.707	0.000	6.163	0.000	1.163	0.000	16.237	1780.102	4.670	0.000
HAWO	-0.850	0.455	0.053	0.385	-0.092	0.818	-0.420	0.696	-22.801	13479.993
HOWA	1.327	0.361	-0.166	0.375	0.130	0.792	1.172	0.619	0.450	1.047
INBU	2.305	0.450	9.255	6.542	-15.223	0.000	16.828	0.000	-14.250	0.000
KEWA	0.563	0.345	-1.221	0.771	0.593	0.758	0.295	0.562	0.023	0.841
MODO	16.872	1981.761	3.068	7.183	17.160	5923.458	2.230	1.102	15.445	4129.806
NOBO	0.374	0.521	-1.851	1.553	-0.282	1.013	0.686	0.950	-0.624	1.114
NOCA	20.299	2882.486	0.173	181.024	5.981	2236.518	19.555	4477.698	3.940	1164.824
NOFL	-0.728	0.933	-0.218	0.620	-0.029	1.223	-0.792	1.244	0.289	1.395
NOMO	-2.483	0.539	-1.159	1.860	-18.942	6465.403	-1.939	0.774	0.370	1.098
NOPA	1.099	0.298	1.255	1.010	1.099	0.736	0.693	0.500	-0.104	0.750
OROR	-1.760	0.392	-0.851	1.153	-0.948	0.980	-1.513	0.647	0.366	0.932
PIWA	0.318	0.267	-0.657	0.496	-0.698	0.625	0.468	0.488	0.908	0.845

Appendix D. Log odds (β) of occupancy for best approximating model of each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
	β	SE	β	SE	β	SE	β	SE	β	SE
PIWO	19.145	4901.035	0.241	423.513	0.936	538.273	17.165	2851.406	5.203	0.000
PRAW	-1.181	0.325	0.017	0.358	-0.260	0.766	-1.166	0.580	0.392	0.845
PUMA	-1.736	0.719	-0.377	0.953	-1.031	1.082	-0.897	0.951	-19.506	9689.090
RBWO	20.292	2999.135	-5.928	2660.575	7.144	0.000	18.801	2778.831	4.169	1509.306
REVI	2.340	0.529	1.962	2.758	-0.408	1.670	3.165	1.433	-2.036	1.583
RHWO	0.072	0.308	-0.805	0.659	-2.144	0.880	1.415	0.774	-1.339	0.986
RSHA	15.992	2589.238	0.687	0.000	14.212	1910.947	2.222	2.137	-1.695	2.194
RTHU	-0.791	0.472	-0.333	0.604	1.093	0.900	-1.099	0.748	-19.198	11350.167
SUTA	17.687	2263.907	1.895	435.644	-61.504	0.000	64.302	0.000	38.152	0.000
SWWA	-1.135	0.359	0.352	0.510	1.429	0.889	-1.883	0.774	-0.438	1.307
TUTI	21.275	5446.527	1.505	588.373	3.437	1055.827	19.456	0.000	3.930	402.424
WEVI	1.176	0.318	0.489	0.650	1.116	0.770	0.740	0.516	-0.060	0.784
WITU	-0.757	0.354	-0.304	0.513	-0.387	0.762	-0.630	0.599	0.289	0.925
WOTH	-0.642	0.279	-0.271	0.395	1.508	0.746	-1.586	0.635	0.748	0.877
YBCH	0.941	0.289	0.020	0.296	-0.316	0.710	1.257	0.569	-0.667	0.797
YBCU	17.340	2372.710	-1.595	0.000	14.685	1834.339	2.334	1.265	17.017	3919.641
YTVI	1.209	0.546	-0.268	0.341	0.264	0.979	0.885	0.738	0.905	1.353
YTWA	-1.139	0.459	-0.451	0.749	0.342	0.984	-1.674	0.824	1.405	1.092

Appendix D. Model-averaged log odds (*β*) of occupancy for each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Shape		Management		Area2		Ground		Shrub	
Species	*β*	SE	*β*	SE	*B*	SE	*β*	SE	*β*	SE	*B*	SE
ACFL	0.732	1.870	1.025	2.398	16.251	2631.115						
AMCR	-0.724	0.448			0.018	1.636						
AMGO	1.058	0.585	-0.282	0.580	1.732	1.230			-0.627	0.522	-0.349	0.623
AMRE	-0.080	0.302	0.366	0.280	1.985	0.631					0.087	0.275
BACS	-1.441	1.479	0.668	0.465	-0.599	1.255			0.149	0.646	0.213	0.536
BADO	0.387	0.339	-0.023	0.414	-0.192	0.916						
BARS	0.967	0.593	-0.686	0.548	-0.179	0.846						
BAWW	-0.673	0.654	0.233	0.356	0.730	0.792					0.435	0.347
BGGN	-0.468	0.556	0.416	1.072	-0.482	1.986					-0.241	0.724
BHCO	0.270	0.408	0.262	0.290	1.605	0.670			-0.979	0.406	0.327	0.325
BHNU	-0.369	0.417	0.029	0.394	-0.573	0.703						
BLGR	0.380	0.442	-0.274	0.329	0.264	0.632					-0.195	0.320
BLJA	2.608	3.618	1.069	0.000	-15.196	0.000						
CACH	-73.412	57593.3	2.338	80.141	5.916	0.000						
CARW	1.170	0.000	0.997	0.000	5.230	0.000			0.353	0.690	0.875	517.104
CHSP	0.738	0.522	-0.257	0.385	0.669	0.782			-0.780	0.529	-0.731	0.492
COYE	0.151	0.409	0.345	0.488	0.025	0.799			-3.159	2.001	0.143	0.500

Appendix D. Model-averaged log odds (*β*) of occupancy for each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Shape		Management		Area2		Ground		Shrub	
Species	*β*	SE	*β*	SE	*B*	SE	*β*	SE	*β*	SE	*B*	SE
DOWO	0.520	0.538	0.144	0.363	0.532	0.785						
EABL	0.761	0.532	-1.115	0.601	-0.005	0.691					-0.759	0.502
EATO	-29.746	41891.7	5.475	7.820	2.528	0.000			-0.310	512.005	3.317	0.000
EAWP	-0.284	0.351	0.212	0.321	0.513	0.656						
FICR	-0.303	0.394	-0.074	0.308	-1.524	0.700						
FISP	-0.284	0.638	-0.139	0.523	-1.371	1.172						
GCFL	6.294	0.000	0.837	4.305	18.466	5458.508			-81.455	0.000		
HAWO	-0.146	0.405	0.367	0.384	0.207	0.739						
HOWA	0.029	0.510	0.459	0.416	1.245	0.783	-0.292	0.331			0.142	0.361
INBU	2.907	1.748	-0.726	0.387	-0.321	0.950			0.474	0.418	-0.433	0.411
KEWA	-0.612	0.372	1.636	0.686	1.136	0.695			-3.735	1.777	0.827	0.541
MODO	1.404	5.294	-0.927	0.000	-15.949	0.000						
NOBO	-0.841	0.907	-0.236	0.433	-1.779	0.567	-9.827	6.667				
NOCA	0.304	0.359	0.212	0.000	5.591	7012.16					0.203	295.604
NOFL	-0.682	0.787	-0.093	0.575	-45.901	5.696						
NOMO	-0.372	0.754	-0.250	0.606	-19.809	10142.4			2.946	2.069		
NOPA	0.631	0.472	0.209	0.327	2.185	0.817						

Appendix D. Model-averaged log odds (β) of occupancy for each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Shape		Management		Area2		Ground		Shrub	
Species	β	SE	β	SE	*B*	SE	β	SE	β	SE	*B*	SE
OROR	-0.279	0.502	0.091	0.374	0.719	0.793						
PIWA	-0.464	0.317	0.167	0.277	-1.924	0.617						
PIWO	0.264	769.387	3.192	877.591	3.636	0.000						
PRAW	0.155	0.333	-0.015	0.321	0.749	0.656			-0.377	0.306	-0.382	0.385
PUMA	-0.172	0.600	0.096	0.503	-1.462	1.215						
RBWO	-5.467	1346.82	-4.014	0.000	6.647	0.000						
REVI	0.511	0.892	-0.767	0.395	-1.370	1.537	5.020	9.358				
RHWO	-0.391	0.348	-0.232	0.306	-2.002	0.705						
RSHA	-0.504	0.000	1.362	2.954	16.929	4085.97						
RTHU	0.050	0.425	0.268	0.406	1.144	0.792						
SUTA	2.176	76.069	-1.010	0.938	-33.199	0.000						
SWWA	0.138	0.362	0.198	0.318	3.031	1.111						
TUTI	1.947	0.000	3.710	0.000	6.158	6306.07					3.618	0.000
WEVI	0.510	0.453	0.011	0.313	1.339	0.756			-1.024	0.497	-0.164	0.302
WITU	-0.297	0.409	-0.253	0.344	0.251	0.656						
WOTH	-0.142	0.307	0.441	0.283	2.259	0.668					0.434	0.284
YBCH	-0.120	0.277	0.541	0.367	-0.379	0.581			-0.372	0.332	0.509	0.362
YBCU	-0.735	0.000	-3.981	8.732	14.003	2709.81					-2.019	2.350

Appendix D. Model-averaged log odds (*β*) of occupancy for each parameter for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Shape		Management		Area2		Ground		Shrub	
Species	*β*	SE	*β*	SE	*B*	SE	*β*	SE	*β*	SE	*B*	SE
YTVI	-0.344	0.391	1.162	1.115	-0.316	0.808						
YTWA	-0.110	0.428	0.737	0.384	1.892	0.911						

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
ACFL (*n* = 190)						
$\lambda.p_{\text{prior detect}}$	725.444	688.111	0.000	1.000	0.531	14
$\lambda_{forest}\ p_{\text{prior detect}}$	727.584	682.933	2.140	0.343	0.182	16
$\lambda_{edge}\ p_{\text{prior detect}}$	728.785	687.876	3.341	0.188	0.100	15
$\lambda_{area}\ p_{\text{prior detect}}$	728.839	687.930	3.395	0.183	0.097	15
$\lambda_{shape}\ p_{\text{prior detect}}$	729.019	688.110	3.575	0.167	0.089	15
$\lambda_{management}$ $p_{\text{prior detect}}$	739.938	702.605	14.494	0.001	0.000	14
AMCR (*n* = 476)						
$\lambda.\ p_{\text{obs}}$	1504.811	1485.988	0.000	1.000	0.444	8
$\lambda_{area}\ p_{\text{obs}}$	1506.480	1484.880	1.669	0.434	0.193	9
$\lambda_{shape}\ p_{\text{obs}}$	1506.808	1485.208	1.997	0.368	0.164	9
$\lambda_{edge}\ p_{\text{obs}}$	1507.095	1485.495	2.284	0.319	0.142	9
$\lambda_{forest}\ p_{\text{obs}}$	1508.871	1484.381	4.060	0.131	0.058	10
$\lambda_{management}\ p_{\text{obs}}$	1556.890	1538.066	52.079	0.000	0.000	8
AMGO (*n* = 16)						
$\lambda_{\text{management}}\ p_{\text{date}}$	158.058	151.630	0.000	1.000	0.886	3
$\lambda_{edge}\ p_{\text{date}}$	163.129	154.401	5.070	0.079	0.070	4
$\lambda_{area}\ p_{\text{date}}$	165.871	157.144	7.813	0.020	0.018	4
$\lambda_{forest}\ p_{\text{date}}$	166.594	155.483	8.536	0.014	0.012	5
$\lambda.p_{\text{date}}$	166.941	160.512	8.882	0.012	0.010	3
$\lambda_{shape}\ p_{\text{date}}$	169.207	160.480	11.149	0.004	0.003	4
AMRE (*n* = 106)						
$\lambda_{management}$ $p_{\text{prior detect}}$	443.438	412.800	0.000	1.000	1.000	12
$\lambda.p_{\text{prior detect}}$	463.869	433.231	20.431	0.000	0.000	12

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{area}\ p_{\mathrm{prior\ detect}}$	465.876	431.963	22.438	0.000	0.000	13
$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	466.300	432.387	22.862	0.000	0.000	13
$\lambda_{edge}\ p_{\mathrm{prior\ detect}}$	466.848	432.934	23.409	0.000	0.000	13
$\lambda_{forest}\ p_{\mathrm{prior\ detect}}$	470.115	432.782	26.677	0.000	0.000	14
BACS (n = 11)						
$\lambda.p.$	72.340	68.129	0.000	1.000	0.118	2
$\lambda.p_{\mathrm{temp}}$	72.396	65.967	0.056	0.972	0.115	3
$\lambda_{shape}\ p.$	72.819	66.390	0.479	0.787	0.093	3
$\lambda_{shape}\ p_{\mathrm{temp}}$	72.891	64.164	0.551	0.759	0.090	4
$\lambda.p_{\mathrm{date}}$	73.009	66.580	0.669	0.716	0.085	3
$\lambda_{edge}\ p.$	73.045	66.617	0.706	0.703	0.083	3
$\lambda_{edge}\ p_{\mathrm{temp}}$	73.165	64.438	0.826	0.662	0.078	4
$\lambda_{area}\ p.$	73.395	66.967	1.056	0.590	0.070	3
$\lambda_{area}\ p_{\mathrm{temp}}$	73.523	64.796	1.184	0.553	0.065	4
$\lambda_{shape}\ p_{\mathrm{date}}$	73.586	64.859	1.246	0.536	0.063	4
$\lambda_{edge}\ p_{\mathrm{date}}$	73.804	65.076	1.464	0.481	0.057	4
$\lambda_{area}\ p_{\mathrm{date}}$	74.152	65.424	1.812	0.404	0.048	4
$\lambda_{forest}\ p.$	76.588	67.861	4.249	0.120	0.014	4
$\lambda_{forest}\ p_{\mathrm{temp}}$	76.821	65.710	4.482	0.106	0.013	5
$\lambda_{forest}\ p_{\mathrm{date}}$	77.425	66.314	5.086	0.079	0.009	5
$\lambda_{management}\ p.$	97.974	93.764	25.635	0.000	0.000	2
$\lambda_{management}\ p_{\mathrm{temp}}$	98.660	92.231	26.320	0.000	0.000	3
$\lambda_{management}\ p_{\mathrm{date}}$	98.868	92.439	26.528	0.000	0.000	3
BADO (n = 9)						
$\lambda_{area}\ p_{\mathrm{temp}}$	81.121	72.394	0.000	1.000	0.471	4
$\lambda_{edge}\ p_{\mathrm{temp}}$	83.274	74.546	2.152	0.341	0.161	4

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda.p_{\mathrm{temp}}$	83.278	76.849	2.157	0.340	0.160	3
$\lambda_{forest}\ p_{\mathrm{temp}}$	83.394	72.283	2.273	0.321	0.151	5
$\lambda_{shape}\ p_{\mathrm{temp}}$	85.556	76.829	4.435	0.109	0.051	4
$\lambda_{management}\ p_{\mathrm{temp}}$	89.956	83.527	8.835	0.012	0.006	3
BARS (n = 21)						
$\lambda_{edge}\ p_{\mathrm{temp}}$	185.199	176.472	0.000	1.000	0.269	4
$\lambda_{area}\ p_{\mathrm{temp}}$	185.335	176.608	0.136	0.934	0.251	4
$\lambda_{area}\ p.$	186.470	180.041	1.271	0.530	0.143	3
$\lambda_{edge}\ p.$	186.531	180.102	1.332	0.514	0.138	3
$\lambda_{shape}\ p_{\mathrm{temp}}$	186.809	178.081	1.610	0.447	0.120	4
$\lambda_{shape}\ p.$	188.168	181.739	2.969	0.227	0.061	3
$\lambda.p_{\mathrm{temp}}$	192.401	185.972	7.202	0.027	0.007	3
$\lambda_{management}\ p_{\mathrm{temp}}$	193.807	187.379	8.608	0.014	0.004	3
$\lambda.p.$	194.224	190.014	9.025	0.011	0.003	2
$\lambda_{forest}\ p_{\mathrm{temp}}$	195.744	184.633	10.545	0.005	0.001	5
$\lambda_{management}\ p.$	196.123	191.912	10.924	0.004	0.001	2
$\lambda_{forest}\ p.$	197.215	188.488	12.017	0.002	0.001	4
BAWW (n = 22)						
$\lambda.p.$	156.280	152.069	0.000	1.000	0.194	2
$\lambda_{edge}\ p.$	156.299	149.870	0.019	0.991	0.192	3
$\lambda.p_{\mathrm{temp}}$	157.051	150.622	0.771	0.680	0.132	3
$\lambda_{edge}\ p_{\mathrm{temp}}$	157.204	148.477	0.925	0.630	0.122	4
$\lambda_{area}\ p.$	157.628	151.199	1.348	0.510	0.099	3
$\lambda_{shape}\ p.$	157.834	151.406	1.555	0.460	0.089	3
$\lambda_{area}\ p_{\mathrm{temp}}$	158.490	149.763	2.210	0.331	0.064	4

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{shape}\ p_{\text{temp}}$	158.672	149.945	2.393	0.302	0.059	4
$\lambda_{forest}\ p.$	160.012	151.284	3.732	0.155	0.030	4
$\lambda_{forest}\ p_{\text{temp}}$	161.042	149.931	4.763	0.092	0.018	5
$\lambda_{management}\ p.$	176.630	172.419	20.350	0.000	0.000	2
$\lambda_{management}\ p_{\text{temp}}$	177.440	171.011	21.160	0.000	0.000	3
BGGN (*n* = 431)						
$\lambda.p_{\text{prior detect}}$	1288.076	1247.167	0.000	1.000	0.521	15
$\lambda_{edge}\ p_{\text{prior detect}}$	1290.534	1245.883	2.458	0.293	0.152	16
$\lambda_{forest}\ p_{\text{prior detect}}$	1291.062	1242.491	2.986	0.225	0.117	17
$\lambda_{shape}\ p_{\text{prior detect}}$	1291.259	1246.607	3.182	0.204	0.106	16
$\lambda_{area}\ p_{\text{prior detect}}$	1291.303	1246.652	3.227	0.199	0.104	16
$\lambda_{management}\ p_{\text{prior detect}}$	1325.826	1284.917	37.749	0.000	0.000	15
BHCO (*n* = 133)						
$\lambda_{area}\ p_{\text{temp}}$	561.775	553.048	0.000	1.000	0.537	4
$\lambda_{edge}\ p_{\text{temp}}$	562.078	553.351	0.303	0.859	0.462	4
$\lambda_{shape}\ p_{\text{temp}}$	574.612	565.885	12.837	0.002	0.001	4
$\lambda_{management}\ p_{\text{temp}}$	579.609	573.180	17.834	0.000	0.000	3
$\lambda_{forest}\ p_{\text{temp}}$	580.533	569.422	18.758	0.000	0.000	5
$\lambda.p_{\text{temp}}$	592.219	585.790	30.444	0.000	0.000	3
BHNU (*n* = 34)						
$\lambda.p_{\text{prior detect}}$	244.043	210.130	0.000	1.000	0.385	13
$\lambda_{area}\ p_{\text{prior detect}}$	244.364	207.031	0.321	0.852	0.328	14
$\lambda_{edge}\ p_{\text{prior detect}}$	245.772	208.438	1.728	0.421	0.162	14

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{shape}\ p_{\text{prior detect}}$	247.449	210.116	3.406	0.182	0.070	14
$\lambda_{forest}\ p_{\text{prior detect}}$	249.045	208.135	5.001	0.082	0.032	15
$\lambda_{management}\ p_{\text{prior detect}}$	249.684	215.771	5.641	0.060	0.023	13
BLGR (n = 38)						
$\lambda_{.}p_{\text{prior detect}}$	222.612	195.112	0.000	1.000	0.381	11
$\lambda_{management}\ p_{\text{prior detect}}$	223.670	196.170	1.058	0.589	0.224	11
$\lambda_{area}\ p_{\text{prior detect}}$	224.470	193.831	1.857	0.395	0.150	12
$\lambda_{shape}\ p_{\text{prior detect}}$	225.008	194.370	2.396	0.302	0.115	12
$\lambda_{edge}\ p_{\text{prior detect}}$	225.103	194.465	2.491	0.288	0.110	12
$\lambda_{forest}\ p_{\text{prior detect}}$	228.497	194.584	5.885	0.053	0.020	13
BLJA (n = 232)						
$\lambda_{.}p_{\text{prior detect}}$	931.281	890.372	0.000	1.000	0.490	15
$\lambda_{area}\ p_{\text{prior detect}}$	932.525	887.873	1.244	0.537	0.263	16
$\lambda_{shape}\ p_{\text{prior detect}}$	933.938	889.287	2.658	0.265	0.130	16
$\lambda_{edge}\ p_{\text{prior detect}}$	934.344	889.692	3.063	0.216	0.106	16
$\lambda_{forest}\ p_{\text{prior detect}}$	938.767	890.196	7.487	0.024	0.012	17
$\lambda_{management}\ p_{\text{prior detect}}$	962.027	921.118	30.747	0.000	0.000	15
CACH (n = 209)						
$\lambda_{shape}\ p_{\text{prior detect}}$	886.899	845.989	0.000	1.000	0.474	15
$\lambda_{.}p_{\text{prior detect}}$	888.097	850.764	1.198	0.549	0.260	14
$\lambda_{edge}\ p_{\text{prior detect}}$	889.235	848.326	2.336	0.311	0.147	15
$\lambda_{area}\ p_{\text{prior detect}}$	890.027	849.118	3.128	0.209	0.099	15
$\lambda_{forest}\ p_{\text{prior detect}}$	893.236	848.585	6.338	0.042	0.020	16

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{management}$ $p_{\text{prior detect}}$	947.059	909.725	60.160	0.000	0.000	14
CARW (n = 575)						
$\lambda_{.} p_{\text{prior detect}}$	1512.915	1472.006	0.000	1.000	0.380	15
$\lambda_{.}$ p_{obs}	1514.100	1495.276	1.185	0.553	0.210	8
λ_{area} $p_{\text{prior detect}}$	1516.215	1471.564	3.301	0.192	0.073	16
λ_{edge} $p_{\text{prior detect}}$	1516.353	1471.702	3.439	0.179	0.068	16
λ_{shape} $p_{\text{prior detect}}$	1516.516	1471.865	3.601	0.165	0.063	16
λ_{area} p_{obs}	1516.533	1494.933	3.619	0.164	0.062	9
λ_{shape} p_{obs}	1516.625	1495.025	3.710	0.156	0.059	9
λ_{edge} p_{obs}	1516.665	1495.065	3.750	0.153	0.058	9
λ_{forest} p_{obs}	1519.210	1494.720	6.296	0.043	0.016	10
λ_{forest} $p_{\text{prior detect}}$	1520.112	1471.540	7.197	0.027	0.010	17
$\lambda_{management}$ $p_{\text{prior detect}}$	1573.919	1533.010	61.005	0.000	0.000	15
$\lambda_{management}$ p_{obs}	1581.428	1562.605	68.514	0.000	0.000	8
CHSP (n = 29)						
λ_{area} p_{date}	223.597	214.870	0.000	1.000	0.416	4
$\lambda_{management}$ p_{date}	224.916	218.487	1.319	0.517	0.215	3
λ_{edge} p_{date}	225.197	216.470	1.600	0.449	0.187	4
$\lambda_{.} p_{\text{date}}$	226.411	219.982	2.814	0.245	0.102	3
λ_{shape} p_{date}	228.236	219.509	4.639	0.098	0.041	4
λ_{forest} p_{date}	228.363	217.252	4.766	0.092	0.038	5
COYE (n = 103)						
$\lambda_{.}$ p_{obs}	529.119	510.295	0.000	1.000	0.326	8
$\lambda_{management}$ p_{obs}	529.163	510.340	0.044	0.978	0.318	8

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{edge}\ p_{\text{obs}}$	531.513	509.913	2.394	0.302	0.098	9
$\lambda_{forest}\ p_{\text{obs}}$	531.617	507.127	2.498	0.287	0.093	10
$\lambda_{shape}\ p_{\text{obs}}$	531.856	510.256	2.738	0.254	0.083	9
$\lambda_{area}\ p_{\text{obs}}$	531.893	510.293	2.775	0.250	0.081	9
DOWO (n = 69)						
$\lambda.\ p_{\text{obs}}$	425.433	406.610	0.000	1.000	0.364	8
$\lambda_{management}\ p_{\text{obs}}$	426.123	407.300	0.690	0.708	0.258	8
$\lambda_{edge}\ p_{\text{obs}}$	427.185	405.585	1.752	0.416	0.151	9
$\lambda_{area}\ p_{\text{obs}}$	428.167	406.567	2.734	0.255	0.093	9
$\lambda_{shape}\ p_{\text{obs}}$	428.209	406.609	2.776	0.250	0.091	9
$\lambda_{forest}\ p_{\text{obs}}$	429.676	405.186	4.242	0.120	0.044	10
EABL (n = 29)						
$\lambda_{shape}\ p_{\text{temp}}$	218.719	209.992	0.000	1.000	0.571	4
$\lambda_{edge}\ p_{\text{temp}}$	221.401	212.673	2.681	0.262	0.149	4
$\lambda.p_{\text{temp}}$	222.021	215.593	3.302	0.192	0.110	3
$\lambda_{area}\ p_{\text{temp}}$	222.325	213.597	3.605	0.165	0.094	4
$\lambda_{management}\ p_{\text{temp}}$	223.261	216.833	4.542	0.103	0.059	3
$\lambda_{forest}\ p_{\text{temp}}$	225.755	214.644	7.036	0.030	0.017	5
EATO (n = 112)						
$\lambda_{shape}\ p_{\text{prior detect}}$	538.452	497.542	0.000	1.000	0.826	15
$\lambda.p_{\text{prior detect}}$	542.405	505.072	3.954	0.139	0.114	14
$\lambda_{area}\ p_{\text{prior detect}}$	545.054	504.145	6.602	0.037	0.030	15
$\lambda_{edge}\ p_{\text{prior detect}}$	545.480	504.571	7.028	0.030	0.025	15
$\lambda_{forest}\ p_{\text{prior detect}}$	549.340	504.688	10.888	0.004	0.004	16

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{management}$ $p_{\text{prior detect}}$	552.854	515.520	14.402	0.001	0.001	14
EAWP (n = 96)						
$\lambda_{.}p_{\text{prior detect}}$	449.380	412.046	0.000	1.000	0.394	14
λ_{shape} $p_{\text{prior detect}}$	450.729	409.820	1.349	0.509	0.201	15
λ_{area} $p_{\text{prior detect}}$	451.294	410.385	1.914	0.384	0.151	15
λ_{forest} $p_{\text{prior detect}}$	452.115	407.464	2.736	0.255	0.100	16
λ_{edge} $p_{\text{prior detect}}$	452.270	411.361	2.891	0.236	0.093	15
$\lambda_{management}$ $p_{\text{prior detect}}$	453.116	415.783	3.737	0.154	0.061	14
FICR (n = 50)						
$\lambda_{management}$ p_{date}	364.390	357.962	0.000	1.000	0.994	3
λ_{forest} p_{date}	375.358	364.247	10.967	0.004	0.004	5
λ_{shape} p_{date}	376.801	368.074	12.411	0.002	0.002	4
$\lambda_{.}p_{\text{date}}$	382.317	375.888	17.927	0.000	0.000	3
λ_{edge} p_{date}	384.418	375.691	20.028	0.000	0.000	4
λ_{area} p_{date}	384.601	375.874	20.211	0.000	0.000	4
FISP (n = 9)						
$\lambda_{.}p_{\text{date}}$	83.411	76.982	0.000	1.000	0.375	3
λ_{forest} p_{date}	84.559	73.448	1.148	0.563	0.211	5
λ_{area} p_{date}	85.502	76.775	2.092	0.351	0.132	4
λ_{edge} p_{date}	85.519	76.791	2.108	0.349	0.131	4
λ_{shape} p_{date}	85.621	76.894	2.210	0.331	0.124	4
$\lambda_{management}$ p_{date}	88.651	82.223	5.240	0.073	0.027	3
GCFL (n = 235)						

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{.} p_{\text{prior detect}}$	966.679	925.770	0.000	1.000	0.597	15
$\lambda_{area}\ p_{\text{prior detect}}$	969.274	924.622	2.594	0.273	0.163	16
$\lambda_{edge}\ p_{\text{prior detect}}$	969.736	925.085	3.057	0.217	0.129	16
$\lambda_{shape}\ p_{\text{prior detect}}$	970.399	925.748	3.720	0.156	0.093	16
$\lambda_{forest}\ p_{\text{prior detect}}$	973.764	925.193	7.085	0.029	0.017	17
$\lambda_{management}\ p_{\text{prior detect}}$	991.146	950.237	24.467	0.000	0.000	15
HAWO (*n* = 21)						
$\lambda_{forest}\ p_{\text{date}}$	178.880	167.769	0.000	1.000	0.437	5
$\lambda_{forest}\ p_{.}$	180.496	171.768	1.616	0.446	0.195	4
$\lambda_{.} p_{\text{date}}$	181.711	175.283	2.832	0.243	0.106	3
$\lambda_{shape}\ p_{\text{date}}$	183.400	174.673	4.520	0.104	0.046	4
$\lambda_{.} p_{.}$	183.494	179.284	4.614	0.100	0.044	2
$\lambda_{edge}\ p_{\text{date}}$	183.759	175.032	4.880	0.087	0.038	4
$\lambda_{management}\ p_{\text{date}}$	183.933	177.504	5.053	0.080	0.035	3
$\lambda_{area}\ p_{\text{date}}$	184.002	175.275	5.122	0.077	0.034	4
$\lambda_{shape}\ p_{.}$	185.135	178.706	6.255	0.044	0.019	3
$\lambda_{edge}\ p_{.}$	185.454	179.026	6.575	0.037	0.016	3
$\lambda_{management}\ p_{.}$	185.495	181.285	6.615	0.037	0.016	2
$\lambda_{area}\ p_{.}$	185.706	179.277	6.826	0.033	0.014	3
HOWA (*n* = 283)						
$\lambda_{shape}\ p_{\text{prior detect}}$	986.213	941.561	0.000	1.000	0.413	16
$\lambda_{management}\ p_{\text{prior detect}}$	987.038	946.129	0.825	0.662	0.273	15
$\lambda_{.} p_{\text{prior detect}}$	987.480	946.571	1.267	0.531	0.219	15
$\lambda_{edge}\ p_{\text{prior detect}}$	990.637	945.986	4.425	0.109	0.045	16
$\lambda_{area}\ p_{\text{prior detect}}$	990.797	946.145	4.584	0.101	0.042	16

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{forest}\ p_{\text{prior detect}}$	993.988	945.416	7.775	0.020	0.008	17
INBU (n = 624)						
$\lambda_{shape}\ p_{\text{prior detect}}$	1514.929	1470.278	0.000	1.000	0.810	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1519.313	1474.662	4.384	0.112	0.090	16
$\lambda_{area}\ p_{\text{prior detect}}$	1520.399	1475.747	5.469	0.065	0.053	16
$\lambda.p_{\text{prior detect}}$	1520.656	1479.747	5.727	0.057	0.046	15
$\lambda_{forest}\ p_{\text{prior detect}}$	1527.822	1479.251	12.893	0.002	0.001	17
$\lambda_{management}\ p_{\text{prior detect}}$	1585.878	1544.969	70.949	0.000	0.000	15
KEWA (n = 78)						
$\lambda_{area}\ p_{\text{prior detect}}$	426.564	395.926	0.000	1.000	0.348	12
$\lambda_{edge}\ p_{\text{prior detect}}$	427.115	396.477	0.550	0.759	0.265	12
$\lambda_{shape}\ p_{\text{prior detect}}$	427.189	396.551	0.624	0.732	0.255	12
$\lambda.p_{\text{prior detect}}$	429.388	401.888	2.824	0.244	0.085	11
$\lambda_{management}\ p_{\text{prior detect}}$	431.478	403.978	4.913	0.086	0.030	11
$\lambda_{forest}\ p_{\text{prior detect}}$	432.550	398.637	5.985	0.050	0.017	13
MODO (n = 355)						
$\lambda.p_{\text{prior detect}}$	1207.284	1166.375	0.000	1.000	0.609	15
$\lambda_{shape}\ p_{\text{prior detect}}$	1209.912	1165.261	2.627	0.269	0.164	16
$\lambda_{area}\ p_{\text{prior detect}}$	1210.997	1166.346	3.712	0.156	0.095	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1211.006	1166.355	3.721	0.156	0.095	16
$\lambda_{forest}\ p_{\text{prior detect}}$	1212.838	1164.267	5.554	0.062	0.038	17
$\lambda_{management}\ p_{\text{prior detect}}$	1278.030	1237.121	70.746	0.000	0.000	15
NOBO (n = 101)						

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda.p_{\text{prior detect}}$	457.770	416.861	0.000	1.000	0.476	15
$\lambda_{management}$ $p_{\text{prior detect}}$	458.715	417.806	0.945	0.623	0.297	15
λ_{shape} $p_{\text{prior detect}}$	460.676	416.025	2.907	0.234	0.111	16
λ_{area} $p_{\text{prior detect}}$	460.789	416.137	3.019	0.221	0.105	16
λ_{forest} $p_{\text{prior detect}}$	465.372	416.801	7.602	0.022	0.011	17
NOCA (n = 790)						
$\lambda.p_{\text{prior detect}}$	1809.070	1768.161	0.000	1.000	0.325	15
λ_{area} $p_{\text{prior detect}}$	1809.457	1764.806	0.387	0.824	0.268	16
λ_{edge} $p_{\text{prior detect}}$	1810.447	1765.795	1.376	0.502	0.163	16
λ_{forest} $p_{\text{prior detect}}$	1810.785	1762.214	1.715	0.424	0.138	17
λ_{shape} $p_{\text{prior detect}}$	1811.304	1766.653	2.234	0.327	0.106	16
$\lambda_{management}$ $p_{\text{prior detect}}$	1996.888	1955.979	187.818	0.000	0.000	15
NOFL (n = 8)						
$\lambda_{management}$ p_{temp}	74.346	67.917	0.000	1.000	0.980	3
$\lambda.p_{\text{temp}}$	83.793	77.365	9.447	0.009	0.009	3
λ_{edge} p_{temp}	85.158	76.430	10.812	0.004	0.004	4
λ_{area} p_{temp}	85.947	77.220	11.601	0.003	0.003	4
λ_{shape} p_{temp}	86.090	77.363	11.744	0.003	0.003	4
λ_{forest} p_{temp}	88.463	77.352	14.117	0.001	0.001	5
NOMO (n = 9)						
λ_{forest} $p.$	78.308	69.581	0.000	1.000	0.226	4
λ_{forest} p_{date}	78.884	67.773	0.576	0.750	0.169	5
$\lambda.p.$	79.098	74.887	0.790	0.674	0.152	2

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda.p_{\text{date}}$	79.491	73.063	1.183	0.553	0.125	3
$\lambda_{area}\ p.$	80.623	74.194	2.315	0.314	0.071	3
$\lambda_{edge}\ p.$	81.027	74.598	2.719	0.257	0.058	3
$\lambda_{area}\ p_{\text{date}}$	81.109	72.382	2.801	0.246	0.056	4
$\lambda_{shape}\ p.$	81.146	74.718	2.838	0.242	0.055	3
$\lambda_{edge}\ p_{\text{date}}$	81.509	72.782	3.201	0.202	0.046	4
$\lambda_{shape}\ p_{\text{date}}$	81.610	72.883	3.302	0.192	0.043	4
NOPA (n = 675)						
$\lambda.p_{\text{prior detect}}$	1411.057	1370.148	0.000	1.000	0.487	15
$\lambda_{management}\ p_{\text{prior detect}}$	1412.679	1371.770	1.622	0.444	0.216	15
$\lambda_{shape}\ p_{\text{prior detect}}$	1413.810	1369.159	2.753	0.252	0.123	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1414.676	1370.025	3.619	0.164	0.080	16
$\lambda_{area}\ p_{\text{prior detect}}$	1414.783	1370.132	3.726	0.155	0.076	16
$\lambda_{forest}\ p_{\text{prior detect}}$	1417.530	1368.958	6.473	0.039	0.019	17
OROR (n = 20)						
$\lambda.p.$	153.292	149.082	0.000	1.000	0.246	2
$\lambda_{area}\ p.$	154.518	148.089	1.225	0.542	0.133	3
$\lambda.p_{\text{temp}}$	154.539	148.111	1.247	0.536	0.132	3
$\lambda_{edge}\ p.$	155.126	148.697	1.833	0.400	0.098	3
$\lambda_{forest}\ p.$	155.146	146.419	1.854	0.396	0.097	4
$\lambda_{shape}\ p.$	155.510	149.081	2.218	0.330	0.081	3
$\lambda_{area}\ p_{\text{temp}}$	155.844	147.116	2.551	0.279	0.069	4
$\lambda_{edge}\ p_{\text{temp}}$	156.446	147.719	3.154	0.207	0.051	4
$\lambda_{forest}\ p_{\text{temp}}$	156.478	145.367	3.186	0.203	0.050	5
$\lambda_{shape}\ p_{\text{temp}}$	156.838	148.111	3.546	0.170	0.042	4

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{management}\ p.$	169.872	165.661	16.579	0.000	0.000	2
$\lambda_{management}\ p_{\text{temp}}$	171.713	165.285	18.421	0.000	0.000	3
PIWA (n = 168)						
$\lambda_{edge}\ p_{\text{date}}$	708.609	699.881	0.000	1.000	0.353	4
$\lambda_{forest}\ p_{\text{date}}$	708.852	697.741	0.243	0.885	0.313	5
$\lambda_{area}\ p_{\text{date}}$	709.516	700.789	0.907	0.635	0.225	4
$\lambda.p_{\text{date}}$	711.724	705.295	3.115	0.211	0.074	3
$\lambda_{shape}\ p_{\text{date}}$	713.655	704.928	5.047	0.080	0.028	4
$\lambda_{management}\ p_{\text{date}}$	716.616	710.188	8.008	0.018	0.006	3
PIWO (n = 113)						
$\lambda.p_{\text{prior detect}}$	601.255	560.346	0.000	1.000	0.719	15
$\lambda_{shape}\ p_{\text{prior detect}}$	604.521	559.870	3.267	0.195	0.140	16
$\lambda_{area}\ p_{\text{prior detect}}$	604.996	560.345	3.741	0.154	0.111	16
$\lambda_{forest}\ p_{\text{prior detect}}$	607.675	559.104	6.420	0.040	0.029	17
$\lambda_{management}\ p_{\text{prior detect}}$	615.849	574.940	14.594	0.001	0.000	15
PRAW (n = 37)						
$\lambda.p_{\text{date}}$	238.423	231.994	0.000	1.000	0.270	3
$\lambda_{edge}\ p_{\text{date}}$	239.236	230.508	0.813	0.666	0.180	4
$\lambda.p.$	239.933	235.722	1.510	0.470	0.127	2
$\lambda_{shape}\ p_{\text{date}}$	240.334	231.606	1.911	0.385	0.104	4
$\lambda_{area}\ p_{\text{date}}$	240.586	231.858	2.163	0.339	0.092	4
$\lambda_{edge}\ p.$	240.701	234.273	2.279	0.320	0.086	3
$\lambda_{shape}\ p.$	241.784	235.355	3.361	0.186	0.050	3
$\lambda_{area}\ p.$	242.031	235.603	3.608	0.165	0.044	3

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{forest}\ p_{\text{date}}$	242.785	231.674	4.363	0.113	0.030	5
$\lambda_{forest}\ p.$	244.135	235.408	5.713	0.057	0.016	4
$\lambda_{management}\ p_{\text{date}}$	254.460	248.032	16.037	0.000	0.000	3
$\lambda_{management}\ p.$	256.769	252.558	18.346	0.000	0.000	2
PUMA (*n* = 9)						
$\lambda_{management}\ p_{\text{date}}$	92.521	86.092	0.000	1.000	0.459	3
$\lambda_{forest}\ p_{\text{date}}$	93.349	82.238	0.828	0.661	0.303	5
$\lambda.p_{\text{date}}$	95.278	88.849	2.757	0.252	0.116	3
$\lambda_{area}\ p_{\text{date}}$	97.137	88.410	4.617	0.099	0.046	4
$\lambda_{edge}\ p_{\text{date}}$	97.387	88.659	4.866	0.088	0.040	4
$\lambda_{shape}\ p_{\text{date}}$	97.576	88.849	5.056	0.080	0.037	4
RBWO (*n* = 523)						
$\lambda.p_{\text{prior detect}}$	1490.484	1449.575	0.000	1.000	0.567	15
$\lambda_{shape}\ p_{\text{prior detect}}$	1492.294	1447.643	1.810	0.405	0.229	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1494.122	1449.471	3.638	0.162	0.092	16
$\lambda_{area}\ p_{\text{prior detect}}$	1494.170	1449.519	3.686	0.158	0.090	16
$\lambda_{forest}\ p_{\text{prior detect}}$	1496.928	1448.356	6.443	0.040	0.023	17
$\lambda_{management}\ p_{\text{prior detect}}$	1560.824	1519.914	70.339	0.000	0.000	15
REVI (*n* = 463)						
$\lambda.p_{\text{prior detect}}$	1308.716	1267.807	0.000	1.000	0.517	15
$\lambda_{shape}\ p_{\text{prior detect}}$	1310.968	1266.316	2.251	0.324	0.168	16
$\lambda_{forest}\ p_{\text{prior detect}}$	1311.631	1263.060	2.914	0.233	0.120	17
$\lambda_{area}\ p_{\text{prior detect}}$	1311.870	1267.219	3.154	0.207	0.107	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1312.245	1267.594	3.529	0.171	0.089	16
$\lambda_{management}$	1348.075	1307.166	39.358	0.000	0.000	15

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$p_{\text{prior detect}}$						
RHWO (n = 75)						
$\lambda_{management}$ $p_{\text{prior detect}}$	414.293	389.803	0.000	1.000	0.370	10
$\lambda_{.}p_{\text{prior detect}}$	415.423	390.933	1.130	0.568	0.210	10
λ_{area} $p_{\text{prior detect}}$	415.976	388.476	1.683	0.431	0.160	11
λ_{forest} $p_{\text{prior detect}}$	416.654	386.016	2.361	0.307	0.114	12
λ_{edge} $p_{\text{prior detect}}$	417.226	389.726	2.933	0.231	0.085	11
λ_{shape} $p_{\text{prior detect}}$	417.919	390.419	3.626	0.163	0.060	11
RSHA (n = 104)						
$\lambda_{management}$ $p_{\text{prior detect}}$	558.956	518.047	0.000	1.000	0.665	15
$\lambda_{.}p_{\text{prior detect}}$	561.383	520.473	2.426	0.297	0.198	15
λ_{edge} $p_{\text{prior detect}}$	564.546	519.895	5.590	0.061	0.041	16
λ_{shape} $p_{\text{prior detect}}$	564.605	519.954	5.649	0.059	0.039	16
λ_{area} $p_{\text{prior detect}}$	565.075	520.424	6.118	0.047	0.031	16
λ_{forest} $p_{\text{prior detect}}$	565.455	516.884	6.499	0.039	0.026	17
RTHU (n = 19)						
λ_{forest} $p_{.}$	165.862	157.135	0.000	1.000	0.507	4
λ_{forest} p_{temp}	167.456	156.345	1.594	0.451	0.229	5
$\lambda_{.}p_{.}$	169.748	165.537	3.886	0.143	0.073	2
$\lambda_{management}$ $p_{.}$	171.355	167.145	5.493	0.064	0.033	2
$\lambda_{.}p_{\text{temp}}$	171.408	164.979	5.546	0.062	0.032	3
λ_{shape} $p_{.}$	171.628	165.200	5.766	0.056	0.028	3
λ_{area} $p_{.}$	171.636	165.207	5.774	0.056	0.028	3
λ_{edge} $p_{.}$	171.933	165.504	6.071	0.048	0.024	3

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{shape}\ p_{\mathrm{temp}}$	173.318	164.590	7.456	0.024	0.012	4
$\lambda_{management}\ p_{\mathrm{temp}}$	173.320	166.892	7.459	0.024	0.012	3
$\lambda_{area}\ p_{\mathrm{temp}}$	173.357	164.629	7.495	0.024	0.012	4
$\lambda_{edge}\ p_{\mathrm{temp}}$	173.678	164.951	7.816	0.020	0.010	4
SUTA (n = 302)						
$\lambda.p_{\mathrm{prior\ detect}}$	1090.987	1050.078	0.000	1.000	0.379	15
$\lambda_{forest}\ p_{\mathrm{prior\ detect}}$	1091.169	1042.597	0.182	0.913	0.346	17
$\lambda_{area}\ p_{\mathrm{prior\ detect}}$	1093.622	1048.971	2.635	0.268	0.102	16
$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	1093.944	1049.293	2.958	0.228	0.086	16
$\lambda_{edge}\ p_{\mathrm{prior\ detect}}$	1093.946	1049.295	2.959	0.228	0.086	16
$\lambda_{management}\ p_{\mathrm{prior\ detect}}$	1135.352	1094.443	44.365	0.000	0.000	15
SWWA (n = 27)						
$\lambda.p_{\mathrm{date}}$	196.463	190.034	0.000	1.000	0.269	3
$\lambda_{management}\ p_{\mathrm{date}}$	196.569	190.141	0.106	0.948	0.255	3
$\lambda_{forest}\ p_{\mathrm{date}}$	197.272	186.161	0.810	0.667	0.180	5
$\lambda_{shape}\ p_{\mathrm{date}}$	198.337	189.610	1.875	0.392	0.106	4
$\lambda_{area}\ p_{\mathrm{date}}$	198.403	189.676	1.940	0.379	0.102	4
$\lambda_{edge}\ p_{\mathrm{date}}$	198.704	189.977	2.241	0.326	0.088	4
TUTI (n = 428)						
$\lambda_{shape}\ p_{\mathrm{prior\ detect}}$	1378.330	1337.421	0.000	1.000	0.572	15
$\lambda.p_{\mathrm{prior\ detect}}$	1380.096	1342.762	1.765	0.414	0.236	14
$\lambda_{forest}\ p_{\mathrm{prior\ detect}}$	1382.278	1337.627	3.947	0.139	0.079	16
$\lambda_{edge}\ p_{\mathrm{prior\ detect}}$	1382.455	1341.546	4.125	0.127	0.073	15
$\lambda_{area}\ p_{\mathrm{prior\ detect}}$	1383.661	1342.752	5.330	0.070	0.040	15

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{management}$ $p_{\text{prior detect}}$	1472.051	1434.718	93.721	0.000	0.000	14
WEVI (n = 405)						
$\lambda_{management}$ $p_{\text{prior detect}}$	1162.450	1121.541	0.000	1.000	0.803	15
$\lambda.p_{\text{prior detect}}$	1166.998	1126.089	4.548	0.103	0.083	15
λ_{forest} $p_{\text{prior detect}}$	1167.783	1119.211	5.333	0.070	0.056	17
λ_{shape} $p_{\text{prior detect}}$	1169.139	1124.488	6.689	0.035	0.028	16
λ_{edge} $p_{\text{prior detect}}$	1170.228	1125.577	7.778	0.020	0.016	16
λ_{area} $p_{\text{prior detect}}$	1170.498	1125.847	8.048	0.018	0.014	16
WITU (n = 34)						
$\lambda.p_{\text{temp}}$	248.136	241.708	0.000	1.000	0.388	3
λ_{shape} p_{temp}	248.829	240.101	0.692	0.707	0.274	4
λ_{edge} p_{temp}	250.325	241.598	2.189	0.335	0.130	4
λ_{area} p_{temp}	250.336	241.608	2.199	0.333	0.129	4
$\lambda_{management}$ p_{temp}	252.600	246.171	4.463	0.107	0.042	3
λ_{forest} p_{temp}	252.795	241.684	4.659	0.097	0.038	5
WOTH (n = 84)						
λ_{shape} $p_{\text{prior detect}}$	372.817	328.166	0.000	1.000	0.589	16
$\lambda.p_{\text{prior detect}}$	375.714	334.805	2.897	0.235	0.138	15
$\lambda_{management}$ $p_{\text{prior detect}}$	375.788	334.879	2.971	0.226	0.133	15
λ_{forest} $p_{\text{prior detect}}$	377.522	328.951	4.705	0.095	0.056	17
λ_{edge} $p_{\text{prior detect}}$	378.017	333.366	5.200	0.074	0.044	16
λ_{area} $p_{\text{prior detect}}$	378.210	333.558	5.392	0.067	0.040	16

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
YBCH (*n* = 294)						
$\lambda.p_{\text{prior detect}}$	1000.256	959.347	0.000	1.000	0.480	15
$\lambda_{shape}\ p_{\text{prior detect}}$	1001.047	956.396	0.791	0.673	0.323	16
$\lambda_{area}\ p_{\text{prior detect}}$	1003.923	959.272	3.667	0.160	0.077	16
$\lambda_{edge}\ p_{\text{prior detect}}$	1003.997	959.346	3.740	0.154	0.074	16
$\lambda_{management}\ p_{\text{prior detect}}$	1006.228	965.319	5.972	0.050	0.024	15
$\lambda_{forest}\ p_{\text{prior detect}}$	1006.413	957.842	6.157	0.046	0.022	17
YBCU (*n* = 193)						
$\lambda.p_{\text{prior detect}}$	885.135	844.225	0.000	1.000	0.371	15
$\lambda_{area}\ p_{\text{prior detect}}$	885.735	841.084	0.600	0.741	0.275	16
$\lambda_{shape}\ p_{\text{prior detect}}$	886.268	841.617	1.134	0.567	0.211	16
$\lambda_{edge}\ p_{\text{prior detect}}$	887.447	842.796	2.312	0.315	0.117	16
$\lambda_{forest}\ p_{\text{prior detect}}$	890.471	841.899	5.336	0.069	0.026	17
$\lambda_{management}\ p_{\text{prior detect}}$	901.033	860.124	15.899	0.000	0.000	15
YTVI (*n* = 124)						
$\lambda_{management}\ p_{\text{prior detect}}$	558.941	528.303	0.000	1.000	0.536	12
$\lambda.p_{\text{prior detect}}$	560.006	529.368	1.065	0.587	0.315	12
$\lambda_{edge}\ p_{\text{prior detect}}$	562.986	529.073	4.045	0.132	0.071	13
$\lambda_{area}\ p_{\text{prior detect}}$	563.218	529.305	4.277	0.118	0.063	13
$\lambda_{forest}\ p_{\text{prior detect}}$	566.164	528.831	7.223	0.027	0.014	14
YTWA (*n* = 17)						
$\lambda_{shape}\ p.$	150.089	143.660	0.000	1.000	0.490	3
$\lambda_{shape}\ p_{\text{date}}$	151.156	142.428	1.067	0.587	0.287	4

Appendix E. Model selection tables for abundance (λ) of species encountered in wildlife openings at Barbour WMA and Stimpson and Upper State Sanctuaries, May-July 2008-09.

Model	AICc	-2*ln(Lik)	Delta	Model Likelihood	Model Probability	K
$\lambda_{management}\ p.$	154.114	149.903	4.025	0.134	0.065	2
$\lambda_{management}\ p_{\mathrm{date}}$	155.049	148.621	4.960	0.084	0.041	3
$\lambda.p.$	155.419	151.208	5.330	0.070	0.034	2
$\lambda.p_{\mathrm{date}}$	156.511	150.083	6.422	0.040	0.020	3
$\lambda_{area}\ p.$	156.693	150.265	6.604	0.037	0.018	3
$\lambda_{edge}\ p.$	157.192	150.764	7.103	0.029	0.014	3
$\lambda_{area}\ p_{\mathrm{date}}$	157.864	149.137	7.775	0.020	0.010	4
$\lambda_{forest}\ p.$	158.229	149.502	8.140	0.017	0.008	4
$\lambda_{edge}\ p_{\mathrm{date}}$	158.366	149.639	8.277	0.016	0.008	4
$\lambda_{forest}\ p_{\mathrm{date}}$	159.479	148.368	9.390	0.009	0.004	5

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE	ln(λ).	SE	ln(λ)	SE
ACFL	1.443	0.307	-0.054	0.133	0.435	0.234	1.276	0.337	-0.122	0.360
AMCR	1.632	0.174	-0.094	0.096	0.060	0.171	1.564	0.207	0.238	0.193
AMGO	-0.174	0.658	0.388	0.165	1.199	0.775	-0.804	0.966	-0.360	1.225
AMRE	0.512	0.348	-0.293	0.301	-0.228	0.318	0.689	0.377	-0.219	0.207
BACS	-2.967	0.578	-2.331	3.049	-0.435	1.414	-2.873	1.000	0.288	1.414
BADO	-1.873	0.453	0.530	0.180	14.528	800.725	-15.911	802.246	13.836	800.778
BARS	-0.638	0.456	0.475	0.116	0.380	0.703	-1.046	0.676	0.822	0.727
BAWW	-1.738	0.347	-0.641	0.926	0.309	0.866	-2.090	0.711	0.789	0.913
BGGN	1.186	0.167	-0.066	0.096	-0.287	0.183	1.435	0.201	-0.485	0.242
BHCO	0.095	0.157	0.464	0.061	1.210	0.389	-0.596	0.359	0.045	0.540
BHNU	4.173	0.760	-0.804	0.580	-0.478	0.495	4.112	1.058	0.091	0.507
BLGR	-0.460	0.396	0.282	0.215	0.383	0.609	-0.644	0.620	0.046	0.719
BLJA	1.472	0.374	-0.223	0.158	-0.079	0.214	1.498	0.399	-0.001	0.247
CACH	2.836	0.631	-0.126	0.108	0.286	0.202	2.682	0.696	0.255	0.248
CARW	-1.088	0.207	0.053	0.077	-0.125	0.188	1.213	0.191	-0.106	0.225
CHSP	-0.081	0.463	0.382	0.137	0.282	0.593	-0.416	0.672	0.941	0.612
COYE	-0.082	0.184	0.007	0.149	0.667	0.390	-0.489	0.339	0.422	0.471
DOWO	0.462	0.417	0.032	0.151	0.406	0.369	0.414	0.548	0.075	0.465

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE	ln(λ).	SE	ln(λ)	SE
EABL	-0.714	0.357	0.259	0.155	0.530	0.597	-0.997	0.551	0.135	0.755
EATO	1.164	0.366	-0.184	0.214	-0.167	0.290	1.223	0.386	-0.023	0.350
EAWP	-0.407	0.208	-0.400	0.386	-0.822	0.405	0.055	0.272	-0.685	0.509
FICR	0.174	0.340	-0.025	0.211	-1.200	0.394	0.747	0.319	-1.097	0.521
FISP	-2.164	0.514	-0.320	0.862	0.966	1.117	-2.578	1.035	-17.146	6022.223
GCFL	2.721	1.442	-0.094	0.091	-0.091	0.171	2.895	1.590	0.048	0.208
HAWO	-0.856	0.422	-0.027	0.307	-0.166	0.541	-0.438	0.538	-19.547	8951.612
HOWA	0.748	0.176	-0.085	0.139	0.145	0.258	0.591	0.256	0.311	0.290
INBU	1.115	0.116	0.139	0.062	-0.113	0.188	1.165	0.165	0.004	0.217
KEWA	1.627	1.647	-0.751	0.422	0.296	0.318	3.245	7.230	0.706	0.372
MODO	1.940	0.341	0.013	0.077	-0.094	0.163	2.126	0.392	-0.299	0.208
NOBO	0.286	0.264	-0.228	0.304	-0.080	0.376	0.349	0.376	-0.095	0.446
NOCA	2.390	0.334	0.091	0.046	0.283	0.125	2.320	0.401	0.281	0.144
NOFL	-0.889	0.886	-0.176	0.520	-0.060	0.916	-0.870	1.151	0.042	1.004
NOMO	-2.540	0.521	-1.095	1.781	-18.515	6151.095	-2.047	0.722	0.370	1.002
NOPA	0.881	0.096	0.011	0.088	0.160	0.204	0.813	0.170	-0.060	0.255
OROR	-1.716	0.350	-0.712	0.964	-1.150	0.866	-1.336	0.513	0.100	0.761
PIWA	0.372	0.142	-0.468	0.281	-0.485	0.292	0.531	0.227	0.322	0.293

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Intercept		Area		Deciduous		Mix		Pine	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE	ln(λ).	SE	ln(λ)	SE
PIWO	1.737	0.958	0.004	0.142	0.087	0.259	2.327	2.117	-0.247	0.338
PRAW	-1.170	0.275	0.089	0.228	0.174	0.624	-1.345	0.507	0.399	0.703
PUMA	-1.045	0.849	-0.459	0.899	-1.316	0.832	-0.139	0.948	-19.609	8197.551
RBWO	1.497	0.249	0.018	0.077	-0.014	0.167	1.556	0.276	-0.210	0.212
REVI	0.903	0.122	0.069	0.085	0.190	0.208	0.883	0.193	-0.347	0.285
RHWO	0.726	0.570	-0.477	0.379	-0.707	0.368	1.054	0.502	-0.723	0.446
RSHA	1.821	4.781	-0.032	0.125	0.281	0.292	1.489	2.466	-0.369	0.501
RTHU	-0.928	0.459	-0.241	0.488	0.823	0.662	-1.068	0.723	-21.461	0.000
SUTA	1.473	0.402	-0.105	0.107	-0.506	0.182	2.013	0.533	-0.192	0.210
SWWA	-1.312	0.324	0.158	0.237	1.130	0.782	-1.982	0.717	-0.197	1.217
TUTI	1.945	0.236	-0.007	0.071	0.239	0.156	1.903	0.270	-0.147	0.207
WEVI	0.780	0.119	0.047	0.092	0.544	0.238	0.485	0.215	0.093	0.302
WITU	-0.792	0.310	-0.093	0.315	0.070	0.562	-0.846	0.482	0.094	0.666
WOTH	-0.315	0.243	-0.386	0.422	1.268	0.626	-1.343	0.597	1.237	0.677
YBCH	0.594	0.131	-0.032	0.120	0.211	0.262	0.404	0.226	0.359	0.297
YBCU	1.215	0.392	0.159	0.078	0.317	0.233	1.130	0.466	0.035	0.293
YTVI	0.254	0.206	0.035	0.134	0.037	0.340	0.181	0.316	0.268	0.392
YTWA	-1.103	0.443	-0.589	0.799	0.465	0.835	-1.611	0.783	1.069	0.859

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Management		Shape	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE
ACFL	0.052	0.106	1.207	0.187	-0.002	0.112
AMCR	-0.055	0.080	1.385	0.122	0.063	0.070
AMGO	0.544	0.184	2.040	0.923	-0.050	0.280
AMRE	-0.096	0.181	1.339	0.311	0.134	0.142
BACS	-1.372	1.431	-1.960	1.064	0.604	0.421
BADO	0.518	0.280	-0.837	0.820	-0.058	0.412
BARS	0.583	0.152	-0.011	0.488	-1.137	0.475
BAWW	-0.786	0.639	-0.084	0.560	0.243	0.284
BGGN	-0.101	0.093	0.955	0.140	0.062	0.081
BHCO	0.563	0.080	0.703	0.186	-0.871	0.225
BHNU	-0.292	0.243	0.002	0.412	0.024	0.195
BLGR	0.209	0.246	-0.146	0.399	-0.218	0.266
BLJA	-0.087	0.108	0.674	0.173	0.092	0.087
CACH	-0.143	0.096	1.389	0.159	0.164	0.072
CARW	0.045	0.081	0.732	0.140	-0.032	0.085
CHSP	0.372	0.177	0.513	0.423	0.147	0.205
COYE	0.089	0.139	0.098	0.247	-0.032	0.163
DOWO	0.150	0.136	0.295	0.274	0.005	0.162

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Management		Shape	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE
EABL	0.339	0.176	-0.537	0.433	-0.779	0.377
EATO	-0.109	0.160	0.704	0.228	0.319	0.108
EAWP	-0.178	0.227	-0.005	0.281	0.260	0.161
FICR	-0.085	0.196	-1.656	0.508	-0.584	0.236
FISP	-0.239	0.592	-1.482	1.073	-0.141	0.490
GCFL	-0.066	0.080	0.737	0.173	0.011	0.074
HAWO	-0.155	0.326	0.341	0.522	0.191	0.235
HOWA	-0.092	0.124	0.887	0.169	0.219	0.093
INBU	0.166	0.068	0.853	0.134	-0.284	0.097
KEWA	-0.431	0.215	0.433	0.259	0.303	0.129
MODO	-0.011	0.077	1.014	0.136	0.075	0.069
NOBO			-0.160	0.308	-0.158	0.180
NOCA	0.079	0.050	1.290	0.110	-0.066	0.055
NOFL	-0.494	0.592	-21.431	17918.336	-0.017	0.425
NOMO	-0.348	0.719			-0.225	0.575
NOPA	0.031	0.086	1.143	0.118	0.085	0.083
OROR	-0.253	0.442	-0.545	0.559	0.007	0.330
PIWA	-0.364	0.173	-0.281	0.230	0.069	0.112

Appendix F. Change in log density (ln(λ)) values for each parameter from best approximating abundance (λ) models for all species encountered in wildlife openings on Barbour WMA and Stimpson and Upper State Sanctuaries, May-July, 2008-09.

	Edge		Management		Shape	
Species	ln(λ)	SE	ln(λ)	SE	ln(λ)	SE
PIWO			0.479	0.224	0.078	0.112
PRAW	0.271	0.200	-0.282	0.404	-0.169	0.281
PUMA	-0.203	0.500	-1.680	1.073	0.005	0.378
RBWO	0.024	0.075	0.882	0.137	-0.105	0.077
REVI	0.043	0.091	0.655	0.148	-0.116	0.098
RHWO	-0.220	0.213	-0.725	0.379	-0.125	0.179
RSHA	-0.094	0.126	0.628	0.293	0.079	0.106
RTHU	0.054	0.289	0.455	0.519	0.152	0.253
SUTA	-0.081	0.094	0.460	0.173	-0.078	0.090
SWWA	0.071	0.288	2.650	1.045	0.177	0.262
TUTI	-0.082	0.078	1.254	0.132	0.150	0.062
WEVI	0.068	0.093	1.045	0.137	0.121	0.093
WITU	-0.088	0.272	-0.254	0.395	-0.352	0.297
WOTH	-0.301	0.273	0.555	0.403	0.404	0.145
YBCH	-0.005	0.112	0.657	0.161	0.172	0.096
YBCU	0.120	0.095	0.660	0.181	-0.173	0.111
YTVI	0.074	0.133	0.397	0.234		
YTWA	-0.251	0.407	1.346	0.674	0.640	0.211