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NEST SUCCESS RATES OF FOUR SHRUBLAND SPECIALISTS IN CONSERVATION-MANAGED FIELDS WITH COMPARISIONS TO OTHER MANAGED AND UNMANAGED SHRUBLANDS

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Abstract. Shrubland birds are disturbance dependent species and are experiencing population declines of 1–3%/year rangewide. In our study, we determined nest success rates of four shrubland species, Blue-winged Warbler (*Vermivora pinus*), Prairie Warbler (*Dendroica discolor*), Indigo Bunting (*Passerina cyanea*), and Field Sparrow (*Spizella pusilla*), at Bent of the River Audubon Center, Southbury, Connecticut, USA. Field sites were conservation-managed fields that were actively managed for shrubland specialists. Data were collected on 123 nests (May–August, 2004–2006) and nest success rates (calculated using the Mayfield method) were 0.37 ± 0.003 for Blue-winged Warbler, 0.35 ± 0.013 for Prairie Warbler, 0.65 ± 0.009 for Indigo Bunting, and 0.50 ± 0.014 for Field Sparrow. Our study of these species is one of only three from the New England/ Mid-Atlantic Coast Region. We compiled data from studies from all regions reporting nest success of these species, conducted in a variety of managed and unmanaged shrublands. We compared our results to these studies and found nest success rates in conservation-managed fields to be similar to or higher than studies in different habitat management types in different regions. Based on our comparision of results from the limited number of studies on nest success rates of shrubland birds, the rotational mowing, selective tree removal, and invasive plant control regimes used to maintain conservation-managed shrublands are effective management practices to maintain high to moderate rates of nest success and may even be preferable to other management practices where shrubland species are targets for conservation.

Key Words: early successional birds, habitat management, nest success, old field, powerline, shrubland birds, silviculture.

TASAS DE ÉXITO DE ANIDACIÓN DE CUATRO ESPECIALISTAS DE ARBUSTOS EN CAMPOS MANEJADOS PARA LA CONSERVACIÓN CON COMPARACIONES A OTROS ARBUSTOS MANEJADOS Y NO MANEJADOS

Resumen. Las aves que habitan los arbustos son especies que dependen de los disturbios y están experimentando una declinación de poblaciones del 1–3% anual en todo su rango de distribución. En nuestro estudio, nosotros determinamos las tasas de éxito de anidación de cuatro especies que habitan en arbustos, el mosquitero de alas azules (*Vermivora pinus*), el mosquitero de praderas (*Dendroica discolor*), el gorrión de campo (*Spizella pusilla*), y el azulejo (*Passerina cyanea*), en la Curva del Centro del Centro Río Audubon, Southbury, Connecticut, E.E.U.U. Los sitios de estudio fueron campos manejados para la conservación que fueron activamente manejados para las aves especialistas en arbustos. Los datos fueron colectados en 123 nidos (Junio–Agosto, 2004–2006) y las tasas de anidación (calculadas usando el método Mayfield) fueron 0,37 ± 0,003 para el mosquitero de alas azules, 0,35± 0,013 para el mosquitero de pradera 0,50 ± 0,014 para el gorrión de campo, y 0,65± 0,009 para el azulejo. Nuestro estudio sobre estas especies es uno de solamente tres en la región costera del Medio Atlántico/Nueva Inglaterra. Nosotros compilamos todos los estudios de todas las regiones que han reportado el éxito de anidación de estas especies, realizados en una variedad de tierras manejadas y no manejadas. Comparamos nuestros resultados con los de estos estudios y encontramos que las tasas de éxito de anidación en campos manejados para la conservación son similares o más altos que los estudios en diferentes tipos de hábitat manejados en diferentes tipos de regiones. Basado en nuestra comparación de los resultados de un limitado número de estudios en tasas de éxito de anidación de aves que habitan arbustos, la poda rotativa, la remoción selectiva de árboles, y los regimenes de control de plantas invasivas usados para mantener los arbustos manejados para la conservación son prácticas efectivas de manejo para mantener tasas de éxito de anidación de moderadas a altas y pueden aún ser preferidas a otras practicas de manejo donde las especies de arbustos son blancos para la conservación.

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INTRODUCTION

Like many early successional habitats, shrubland habitat has steadily declined in New England since the 1920s due to land development, fire and flood suppression, beaver eradication, agricultural abandonment and post-settlement reforestation (DeGraaf and Yamasaki 2001, Askins 2002, DeGraaf and Yamasaki 2003). Early successional land in southern New England has decreased from 36% to 5% in recent years (Brooks 2003). Habitat loss in the Northeast United States has created a perilous situation for shrubland specialists that breed exclusively in early successional habitats. Over 50% of 22 species of shrubland birds have significantly declined in the New England and mid-Atlantic Coast regions between 1966 and 2007 (Sauer et al. 2008). During the same time period, Connecticut experienced large population declines of shrubland specialists such as Blue-winged Warbler (–3.3%), Prairie Warbler (–7.0%), Indigo Bunting (–4.9%), and Field Sparrow (–9.5%), with these species declining steadily at 1–3% annually across their respective breeding ranges (Sauer et al. 2008). Few studies have estimated nest success of these species in the New England region (Askins et al. 2007, Folsom 2008). Oehler (2003) found that early successional habitat management by state agencies was low across 11 mid-Atlantic and northeastern states, with Pennsylvania managing the most (8215 ha/yr) and New Hampshire the least (20 ha/yr).

Most studies of these species have been conducted in the Central Hardwoods region with few studies in the other regions where they occur. There may be regional effects of habitat, land use, and timber management that make ubiquitous recommendations unfeasible for shrubland birds. There are also likely to be landscape level effects that influence Brown-headed Cowbird (*Molothrus ater*) parasitism rates which influence nest success (Robinson et al. 1995, Burhans and Thompson 2006).

Estimates of abundance, density, and nesting success of shrubland species have been used to assess the effects of uneven-aged and even-aged silviculture treatments. Uneven-aged (group, selective or single tree) harvests, where few trees are removed in an area, result in limited light for growth of herbaceous plants and shrubs used by early successional species (Thompson and DeGraaf 2001). Robinson and Robinson (1999) found Indigo Bunting to be the only shrubland species in small (0.02–0.4 ha) plots that were group or selectively cut, likely due lack of shrub cover (Thompson and DeGraff 2001). Heltzel and Leberg (2006) found shrubland species in recent selective timber harvests in Louisiana. Five shrubland specialists were more abundant in clearcuts than shelterwood, and more abundant in these two treatments combined than in uneven-aged cuts or mature forest (Annand and Thompson 1997). Bird communities of uneven-aged cuts in northern hardwood forests of New England are similar to those of mature forest composition (DeGraaf and Chadwick 1987). Studies in other regions have had similar results with mature forest birds being the community found in uneven-aged harvests (Annand and Thompson 1997, Robinson and Robinson 1999). Chesnut-sided Warbler (*Dendroica pensylvanica*), in New Hampshire showed no difference in daily survival rates between uneven and even-aged cuts, though most other nests found were of gap and forest species (King et al. 2001).

Even-aged silviculture treatments (clearcut and shelterwood) remove all or most of the overstory and create a uniform patch of trees of the same age (Nyland 1996). The shrublands generated from even-aged harvests are predominantly comprised of young trees and few shrubs which succeed to young forests within 10–15 years without management to set back succession. Most studies on the nesting success and predation rates of shrubland specialists have been conducted on clearcuts in the Central Hardwoods Region and have found nest success to be moderate to high for the four species of interest (Annand and Thompson1997, Brito-Aquilar 2005, Woodward 2001, Fink 2006). Yet, Lehnen (2008) found combined daily nest survival to be low (0.94) for shrub guild on clearcuts in Ohio. Abundance estimates of shrubland birds in regenerating clearcuts have shown that some shrub specialists are abundant in clearcuts in years immediately following harvest and abundance declines after 10 years of succession (DeGraaf and Chadwick 1987, Brawn et al. 2001, Schlossberg and King 2009). However, several studies of nesting success rates in clearcuts, found that some species of shrubland specialists were not abundant or were absent (Hanski et al. 1996, Brito-Aguilar 2005, Bullock and Buehler 2006).

In addition to silvicultural methods and resulting forest structure, the size of harvest openings may be important to shrubland specialists (Krementz and Christie 2000, Annand and Thompson 1997, Askins et al. 2007). Krementz and Christie (2000) found that shrubland bird species richness was not significantly related to clearcut size when only smaller cuts were considered (2–33 ha); however, richness declined significantly when large cuts (34–57 ha) were included in the analysis. Similarly, Askins et al. (2007) found that the abundance of shrubland specialists were not affected by the size

of small and medium sized harvest openings (0.5–21 ha) created by clearcuts, shelterwood cuts, derferment cuts, and wildlife openings. Costello et al. (2000) found that clearcuts (8–12 ha) have greater richness and abundance of shrubland specialists than small group selection cuts (0.13–0.65 ha). Similarly, Robinson and Robinson (1999) found Blue-winged Warbler, Prairie Warbler, and Yellow-Breasted Chat to be absent on 0.02–0.40 ha group cut and single cut openings. Since shrubland specialists are typically found to be abundant in a variety of even-aged habitat areas (0.5–33 ha), there is more flexibility for habitat management of these species that utilize existing fields and clearcuts as compared to management required for grassland and interior forest species which often need large, unbroken tracts of habitat.

Powerline corridors can serve as breeding habitats for shrubland species. In the Northeast and Appalachians regions, management of these corridors with selective herbicide application on trees and tall shrubs has created a stable shrub community which attracts breeding shrubland birds (Niering and Goodwin 1974, King et al. 2002, Yahner et al. 2002, Confer and Pascoe 2003, Yahner et al. 2003, Bullock and Buehler 2006, Folsom 2008).

Confer and Pascoe (2003) reported pooled Mayfield nest success of 0.55 and low Brown-headed Cowbird parasitism, 5.6%, for nests found on powerline corridors in New York, Maine and Massachusetts. King and Byers (2002) found high nest success rates, 89%, and low parasitism, 2.3%, for one shrubland specialist, Chestnut-sided Warbler in powerline corridors in Massachusetts. In Connecticut, the highest nest success rates in powerline corridors for Prairie Warbler and Field Sparrow were 0.19 ± 0.022 and 0.20 ± 0.036 respectively (Folsom 2008). Average Brown-headed Cowbird parasitism rates were higher for Prairie Warbler, 38%, than they were for Field Sparrow, 9.5%, along corridors (Folsom 2008). In New York, cowbirds penetrated the forest interior (1300 ha) parasitizing significantly more forest nests (32.3%) than adjacent field/edge nests (6.7%) and distance to edge was not a factor in parasitism (Hahn and Hatfield 1995). Thus, differences in cowbird parasitism occur at a landscape level that are not strictly regional or temporal and are hard to predict (Hahn and Hatfield 1995).

Studies found that abundance of some shrubland birds was higher in wider powerline corridors which may be due to edge avoidance (King and Byers 2002, Folsom 2008). A similar response was found in shrubland birds in clearcuts who were twice as abundant at 80 m than 20 m from the forest edge but further study did not support active edge avoidance in territory/nest site selection nor were there any negative effects of edge on nest success (Rodewald and Vitz 2005, Lehnen 2008). Thus, powerline corridors and clearcuts may provide breeding habitat in areas of habitat loss but differences in nesting success may be due to the regional variation in landuse and the surrounding landscape habitat features where these openings are found.

Thus, best management practices for improving shrubland bird nest success rates need standardization and greater definition. Our study was conducted to determine the nest success rates of shrubland specialists in conservation-managed fields, habitat that is actively managed for these bird species. Conservation-managed fields are composed mostly of shrub, forb and grass species that are maintained at a low height preferred by shrubland specialists. These fields differ from clear cuts or other openings created by forest management which are dominated by young tree species that succeed to young forest rapidly. Powerline corridors maintained for stable shrub communities have a different flora than conservation-managed fields (Niering and Goodwin 1974). On our sites the clonal shrub, Gray Dogwood (*Cornus racemosa*), was the dominant woody cover. This shrub is native to the eastern U.S. and creates dense stands that average 1–3 m tall and shade out tree species. These stands spread easily and canopy closure rates are rapid at up to 85%/yr (Dickinson et al. 1993). Our study estimates the nest success rates of four shrubland specialists in conservation-managed fields and reviews other nest success studies of these species in the literature to determine whether conservation-managed fields provide favorable breeding habitat for declining shrubland specialists.

METHODS

We conducted this three-year study from May to August 2004–06 on a total of 23 ha of conservation-managed fields at Bent of the River Audubon Center in Southbury, Connecticut, USA. The field sites, owned by the National Audubon Society, are designated as an Audubon Connecticut Important Bird Area. In a 10 km area surrounding the sites, the landscape is dominated by forest (61%) with development being the next largest land class (17%) (CLEAR 2008). Agriculture, wetlands and powerline corridors are smaller parts of the landscape (7%, 1%, and 1% respectively). The sites have been managed since 2000 by rotational mowing,

manual tree removal and invasive plant control. The management goal was to maintain extensive patches of Gray Dogwood less than 2 m in height, mixed with forbs and grasses.

We detected males as they arrived at the study site in spring by their singing, and we mapped their territories. We searched daily for nests of Blue-winged Warbler, Prairie Warbler, Indigo Bunting, and Field Sparrow. For each nest, we recorded the date, time, location, species, and presence and number of host and cowbird eggs/nestlings. Nests were monitored every three days because daily visits may cause abandonment (Martin and Geupel 1993). Fledglings typically remained in the nest area for several days and we made efforts to visually locate them to account for fledging success. Videotaping was also used to determine fledging success for those nests (n = 12) that were part of a predator surveillance study.

A comprehensive literature search was conducted using multiple databases (BioOne, Google Scholar, JSTOR, ProQuest, Science Direct, and Sora) to identify studies containing nest success rates, daily predation rates (DPR), or daily survival rates (DSR) for these species to compare to our study.

Statistical Analysis

Nest success was calculated using the Mayfield method (Mayfield 1961, Mayfield 1975) though more robust analyses are available through Program Mark (White and Burnham 1999), which will be used for further analyses beyond the scope of this paper. The decision to use the Mayfield (1961,1975) method was for comparison purposes to other studies. Standard error was calculated using Johnson (1979). Incubation and nestling stages were included in Mayfield analysis. For studies reporting DSR we raised DSR to the power of the nest interval given. For studies reporting DPR we used (1-DPR) raised to the power of the nest interval given. We recognize that estimates may be inflated if there were differences in survival between incubation and nestling stages or if there was nest abandonment or other failures which would not be accounted for in DPR for these studies. For those studies that did not give nest intervals we used a nest interval from a study in the same Bird Conservation Region. We reported standard errors from studies who published those values for overall nest success. Standard errors of overall nest success could not be calculated for studies only reporting DSR, DPR or averages (number of successful nests/number of total nests).

RESULTS

We located 123 nests which we used to estimate nesting success of early successional species. Three-year combined Mayfield nest success rates in this study were highest for Indigo Bunting (0.65) and Field Sparrow (0.50) (Table 1). Blue-winged Warbler and Prairie Warbler had similar nest success rates, 0.37 and 0.35, respectively. Cowbird parasitism was 8.7% for Blue-winged Warbler, 6.1% for Prairie Warbler, 2.2% for Field Sparrow, and 0% for Indigo Bunting.

DISCUSSION

In comparison to other studies, nest success of Prairie Warbler was highest (≥0.49) in multiple managed habitats (Woodward et al. 2001). This species had moderate nest success (≥0.30) in conservation-managed fields and clearcuts (Jennelle 2000, Fink et al. 2006). Prairie Warbler nest success is lowest (≤0.25) in old fields, glades, powerline corridors and clearcut/shelterwood combined (Nolan 1963, Nolan 1978, Annand and Thompson 1997, Fink et al. 2006, Folsom 2008). Indigo Bunting nest success was highest in conservation-managed fields and was also high (≥0.45) in clearcut, old field, and small forest openings. (Saurez et al. 1997, Payne and Payne 1998, Brito-Aguilar 2005). Indigo Buntings had moderate success (0.31–0.38) in mixed forest management and had lower nest success (≤0.25) in bottomland hardwoods, clearcuts, edge, glade, managed cottonwood, and old field (Nolan 1963, Annand and Thompson 1997, Saurez et al. 1997, Jennelle 2000, Twedt 2001, Woodward et al. 2001, Fink et al. 2006). Field Sparrow nest success was highest in conservation-managed fields and old fields (≥0.50) and was moderate (0.30–0.35) in clearcuts and mixed management (Carey et al. 1994, Woodward 2001, Thompson and Burhans 2003). Field Sparrows in powerline corridors, old field, edge, and glade habitat had lower nesting success (0.27–0.10) (Nolan 1963, Best 1978, Fink et al. 2006, Folsom 2008). Blue-winged Warbler nest success was moderate (0.37) in conservation-managed fields but was high (≥0.43) in clearcuts, wetland/ forest openings, glades, and clearcut/shelterwood combined (Annand and Thompson 1997,Gill et al. 2001, Fink et al. 2006, Askins et al. 2007). For most studies, Blue-winged Warbler sample size was very low, likely due to the cryptic nature of their ground level nests (Table 1).

Our review suggests that conservation-managed shrublands provide habitat that yields moderate to high nesting success for declining

TABLE 1. A COMPARISON OF NEST SUCCESS RATES IN CONSERVATION-MANAGED FIELDS TO PUBLISHED STUDIES AND THESES FOR FOUR SHRUBLAND SPECIALISTS IN A VARIETY OF HABITATS. NEST SUCCESS RATES REPORTED AS MAYFIELD NEST SUCCESS RATES UNLESS OTHERWISE NOTED. THE AUTHORS CALCULATED MAYFIELD NEST SUCCESS RATES FOR STUDIES REPORTING DPR OR DSR. STANDARD ERRORS ARE GIVEN FOR STUDIES THAT REPORTED THOSE VALUES.

		Blue-winged Warbler		Prairie Warbler		Indigo Bunting		Field Sparrow	
Habitat Management Type	North American Bird Conservation Region	# of Nests	Nest success rate	# of Nests	Nest success rate	# of Nests	Nest success rate	# of Nests	Nest success rate
a. conservation-managed fields	Northeast/Mid-Atlantic Coast	23	0.37 ± 0.003	33	0.35 ± 0.013	22	0.65 ± 0.009	45	0.50 ± 0.014
b. powerline corridors	Northeast/Mid-Atlantic Coast			41	0.19 ± 0.022			21	0.20 ± 0.036
c. clearcuts	Northeast/Mid-Atlantic Coast	8	0.43						
*d. wetland edge/ forest opening***	Appalachians	183	0.59						
e. old fields	Appalachians							369	0.39
*f. multiple habitats***	Prairie/ Hardwood Transition					1,321	0.56		
*g. old fields/ grassland***	Eastern Tallgrass Prairie							147	0.10
*h. glades**	Central Hardwoods	6	0.60 ± 0.30	55	0.20 ± 0.10	117	0.25 ± 0.05	59	0.20 ± 0.15
clearcuts		–	0.70 ± 0.25	–	0.30 ± 0.10	–	0.45 ± 0.05	–	0.35 ± 0.10
edges						–	20 ± 0.05	–	25 ± 0.10
i. clearcuts	Central Hardwoods					19	0.64 ± 0.00		
*j. multiple habitats****	Central Hardwoods			54	0.49	111	0.38	57	0.30
k. clearcuts/ shelterwood combined	Central Hardwoods	7	0.51	10	0.21	16	0.31		
*l. forest openings * ,***	Central Hardwoods					225	0.48		
agricultural edges						–	0.18		
*m. old field/ forest****	Central Hardwoods					–	0.51	–	0.54
*n. old field***	Central Hardwoods			700	0.21				
*o. old field***	Central Hardwoods			55	0.15	10	0.20	33	0.27
*p. clearcut***	Gulf Coastal Plain/ Ouachitas			41	0.34 ± 0.03	47	0.23 ± 0.02		
q. bottomland hardwood/	Mississippi Alluvial Plain					22	0.18		
managed cottonwood						84	0.11		

a. This study; b. Folsom 2008; c. Askins et al. 2007; d. Gill et al. 2001; e. Carey 1994; f. Payne and Payne 1998**; g. Best 1978**; h. Fink et al. 2006*;i. Brito-Aguilar 2005; j. Woodward et al. 2001***; k. Annand and Thompson 1997; l. Saurez et al. 1997***; m. Thompson and Burhans 2003*** ; n. Nolan 1978**; o. Nolan 1963**, p. Jennelle 2000**; q. Twedt et al. 2001.
* Nest success reported by habitat type, # of nest reported is total nests found in all habitats.
** Nest success calculated as a direct percent (# successful nests/ # total nests).
*** Authors calculated Mayfield nest success from Daily Survival Rates (DSR) or Daily Predation Rates (DPR). Highest reported DSR or lowest DPR were used.

shrubland specialists. It is possible that studies we reported as having "lower" nest success may be population sources given regional differences in juvenile survival and mortality as we did not evaluate source/sink dynamics for these studies. Given that species specific nest success rates are not always reported or are reported in varying metrics (E.g., overall nest success, DSR, DPR, or averages), it is difficult to make comparisons across all shrubland bird studies. While there are several parameters that can be estimates of habitat quality, nest success is important for making conservation and management recommendations (Martin and Geupel 1993).

Impacts to nesting success of the study species from Brown-headed Cowbirds was lower in conservation-managed fields and clearcuts than powerline studies from the same region (Askins et al. 2007, Folsom 2008). Annand and Thompson (1997) had only one parasitized nest of Prairie Warbler in clearcut and shelterwood habitats though cowbird densities were highest in these treatments in Missouri. Thus, the impacts on breeding productivity from Brown-headed Cowbird may be lower in conservation-managed fields and regenerating clearcuts than some powerline corridors, depending on landscape context. Areas with large amounts of forest cover may provide cowbirds with an abundance of forest bird hosts so that shrubland species experience less parasitism (Hahn and Hatfield 1995). However, cowbirds not only require suitable nesting habitat in the breeding season, but also require suitable feeding sites (Thompson 1994) which may preclude their occurrence in what appears to be suitable habitat.

Further research on breeding success of shrubland specialists in clearcuts or other shrubland types in the New England region are needed to make adequate management recommendations for these species. Overall, the amount of shrubland in New England is thought to be <15% and is decreasing below presettlement, historic levels (Brooks 2003, DeGraff and Yamasaki 2003, Dettmers 2003). Much of the timber management that creates shrubland in the New England region is in northern New England which is near or beyond the range limits of the species in this study making these forest management practices of little or no effect for these species but may be beneficial for others.

The intensive, rotational maintenance of conservation-managed fields is often thought to be cost prohibitive. However, through grants and planning such management can be affordable for state and federal land managers, especially in areas where clonal, fast growing shrubs like Gray Dogwood are native. Conservation-managed fields can be funded through federal, state, and non-government organization grants, as well as state license plate and stamp programs (Oehler 2003).

Peterjohn (2006) detailed methods for conservation field management for historical and cultural parks owned by the National Park Service, and this methodology could be used by other agencies. He emphasized that intensive long-term management is necessary to maintain specific successional communities for shrubland birds. Based on our results and literature review, conservation-managed fields provide beneficial habitat that supports moderate to high nesting success for declining shrubland bird species in the northeast. The maintenance regimes that create conservation-managed shrublands may be more effective techniques than some forest management practices or powerline corridors in New England where shrubland bird species are targets for conservation. Further studies are needed to determine the best management practices for these species in New England and other regions where they occur.

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