Proceedings of the Fourth International
Partners in Flight Conference: Tundra to Tropics
341–353

HISTORICAL TRENDS IN RUSTY BLACKBIRD NONBREEDING HABITAT IN FORESTED WETLANDS

Paul B. Hamel,[1,3] Diane De Steven,[1] Ted Leininger,[1] and Randy Wilson[2]

[1]*Center for Bottomland Hardwoods Research, P. O. Box 227, 432 Stoneville Road, Stoneville, Mississippi 38776, USA; and*

[2]*U.S. Fish and Wildlife Service, 6578 Dogwood View Parkway, Suite B, Jackson, Mississippi 39213, USA*

Abstract. Rusty Blackbird (*Euphagus carolinus*) populations have declined perhaps 95% in the recent past, creating legitimate concern that the species may become endangered. During the nonbreeding period the species occurs predominantly in southern U.S. forested wetland habitats, with concentrations in the Mississippi Alluvial Valley and in the southeastern Coastal Plain of the Carolinas and Georgia. Both these areas have experienced substantial historic conversion of forested wetlands and bottomland hardwood forests to other land uses. We review available information on the status of forested wetlands in the southern U.S. and estimate the proportion of potential Rusty Blackbird habitat that may have been lost. Substantial areas formerly covered in forested wetlands in the region are today devoted to land uses incompatible with the bird's known habitat. Especially in the Mississippi Alluvial Valley, an area of intensive agriculture, land use may change annually with commodity price fluctuations and can affect existing forest lands. In recent years, in response to changing economic conditions, federal Wetland Reserve and Conservation Reserve Programs have converted marginal agricultural lands back to forest lands and wetlands. These conversions, as well as current interest in afforestation and forest restoration for purposes of carbon sequestration, suggest a future increase in Rusty Blackbird nonbreeding habitat.

Key Words: bottomland forest, Christmas Bird Count, forested wetlands, Mississippi alluvial valley, southeastern coastal plain.

TENDENCIAS HISTÓRICAS DE LOS HABITATS NO REPRODUCTIVAS DEL ICTÉRIDO *EUPHAGUS CAROLINUS* EN BOSQUES HÚMEDOS

Resumen. Las poblaciones del ictérido *Euphagus carolinus* han disminuido un 95% en tiempos recientes lo que ha generado inquietud sobre si la especie puede estar en peligro de extinción. Durante el periodo no reproductivo la especie ocurre mayormente en bosques húmedos de tierras bajas dentro del valle del Rió Mississippi y en la planicie costera de Georgia y las Carolinas. Ambas regiones han sufrido extensamente la transformación de sus bosques húmedos de tierras bajas a otros usos, mayormente agrícolas. Para este trabajo revisamos la historia de los bosques pantanosos del sureste de los EEUU y estimamos la proporción de hábitat adecuado para la especie que puede haberse perdido debido a usos alternos del terreno. La mayoría de lo que fue bosque húmedo de tierra baja hoy es hábitat que *Euphagus carolinus* no puede utilizar. En la región del valle del Mississippi, el cual es dominado por agricultura intensiva, el uso de la tierra puede cambiar rápidamente de un año para otro junto con la fluctuación en precios de los productos agrícolas, y puede afectar aun a áreas forestadas. En años recientes y en respuesta a cambios en condiciones económicas para terrenos agrícolas así como otros usos, los programas de Reservas de Humedales (WRP, por sus siglas en ingles) y Reservas de Conservación (CRP, por sus siglas en ingles) han transformado áreas de poco valor para la agricultura en bosques pantanosos. Esta transformación así como el interés en aforestación y restauración de bosques sugiere un aumento en hábitat de invierno para el ictérido *Euphagus carolinus*.

INTRODUCTION

Rusty Blackbird populations have experienced reported declines estimated at 95% in the past 40–50 years, creating great concern that the species may become endangered in the near future (Niven et al. 2004). The declines are well documented from Christmas Bird Count (CBC) data (Sauer and Link 2002), and they correspond to equally well-documented but qualitatively

[3] E-mail: phamel@fs.fed.us

defined declines in numbers stretching back 150 years (Greenberg and Droege 1999). Causes of these declines have been proffered but have not been demonstrated conclusively. Habitat destruction or degradation is usually identified as a major contributor to declines; however, other potential factors include negative effects of climate change on breeding habitats in the northern boreal forest, physiological contamination by methylmercury, competition with other blackbirds on the nonbreeding grounds, and disturbance at communal roost sites in the late winter period (Avery 1995, Evers 2007, cf. Finley et al. 1979).

Few studies of Rusty Blackbirds in their nonbreeding range have been published, but current work (Mettke-Hofmann et al. 2007, Luscier 2007) confirms the general understanding that "nonbreeding habitat" is in and near forested wetland habitats across the southern United States. Suitable habitat in association with forested wetlands is concentrated in the Lower Mississippi Alluvial Valley (MAV) and in the Southeastern Coastal Plain (SCP) of the Carolinas and Georgia (Avery 1995, Hamel and Ozdenerol 2007). In both concentration areas of the Rusty Blackbird nonbreeding range southern forested wetlands have experienced extensive destruction and degradation (Hefner and Brown 1985, Rudis and Birdsey 1986, Brody et al. 1989, Dahl 1990, Koneff and Royle 2004, Atlantic Coast Joint Venture 2005, Fredrickson 2005, De Steven and Lowrance, unpubl. ms). In recent years, this pattern of forest loss has reversed in some areas due to restoration of bottomland hardwood forests on lands formerly cleared for agriculture (Langner and Heimlich 1989, Haynes 2004). Restorations associated with the Wetland Reserve Program (WRP; King et al. 2007), Conservation Reserve Program (CRP; Burger 2006), and carbon sequestration (Leininger and Hamel 2007) may promote increases in nonbreeding habitat for Rusty Blackbirds.

In a preliminary attempt to evaluate the potential role of nonbreeding habitat loss in Rusty Blackbird population declines, we assembled information on bird population trends and patterns of forested wetland loss across the South at regional and subregional scales. Any correspondence between the degree of population decline and the extent of forested wetland loss at subregional scales would support the value of increased emphasis on forest restoration for landbird conservation in the nonbreeding range (Twedt and Loesch 1999, Twedt et al. 2006). Conversely, lack of corresondence could suggest that decline of the species is a result of additional factors outside the nonbreeding period.

METHODS

Rusty Blackbird Population Trends

Rusty Blackbird population trends reported by Niven et al. (2004) were based on data from the CBC (Chapman 1900, Arbib 1981) for the years 1965–present, which matched the time period of the Breeding Bird Survey (Robbins et al. 1986). Niven et al. (2004) summarized trends in terms of bird conservation regions commonly used to address issues concerning breeding birds (Rich et al. 2004, Partners in Flight 2005). For purposes of our investigation, we assessed the adequacy of CBC data for summarization over the entire CBC period, 1900–2001 (National Audubon Society 2002). Early records of Rusty Blackbirds on the CBC are sparse, and the first year that the species was recorded on at least 100 CBCs was 1953. Therefore, we defined a data subset as the group of CBCs on which the birds were recorded in 1953 (108 circles), and compared that group of counts graphically to the entire CBC data set of 1953–2001 (1731 circles) to determine if the larger data set was representative of population trends from CBCs where birds were consistently detected. We conducted these analyses in SAS (SAS Institute Inc. 2002–2003).

We also subdivided the CBC data roughly in terms of regions comparable to two migration flyways (Atlantic and Mississippi) in an effort to isolate data for the two Rusty Blackbird subspecies—*E. c. carolinus* in the central and western portion of the breeding range, and *E. c. nigrans* in the eastern maritime provinces of Canada and the New England portion of the United States (Avery 1995). We evaluated this division between western and eastern populations by examining vectors connecting capture and recovery locations of all Rusty Blackbirds banded and recovered through 2004 (Bird Banding Laboratory 2004). Of 201 vectors mapped, only six crossed a dividing line between CBC circles attributed to the eastern and western subpopulations (Fig. 1). This suggested that the division is reasonable for purposes of this study, but that movement between subpopulations may also occur. Because the CBC occurs in early winter, the distribution of birds could reflect either the ultimate nonbreeding residency distribution, or the transient effects of mild autumn weather and facultative bird presence in passage areas that will be abandoned as more severe late-winter weather forces birds to move farther south.

We analyzed effort-adjusted (*i.e.* per birding party-hour) annual distribution of CBCs reporting Rusty Blackbirds using a spatial

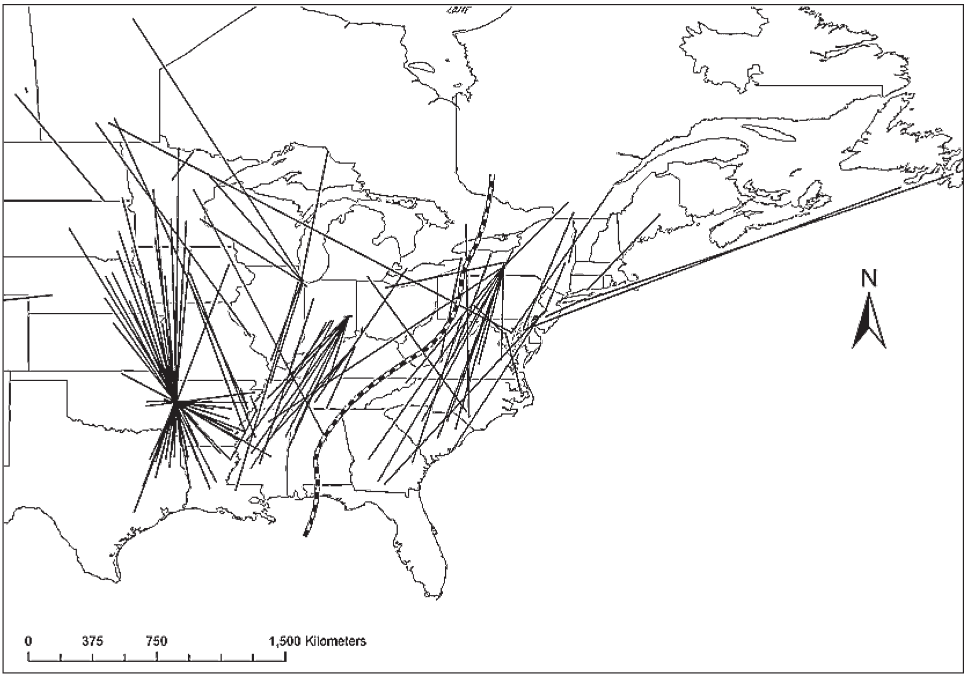

FIGURE 1. Paths of banding and recovery locations of 201 Rusty Blackbirds through 2004. Solid lines indicate endpoints of banding-recovery paths. Broad dashed line indicates location of separation of Christmas Bird Count circles into eastern and western subregions.

filtering technique (Department of Geography University of Iowa 1997, Baldy 2005, Hamel and Ozdenerol 2009) to identify clusters of CBCs representing higher than expected frequency of occurrence of the birds. In this technique, we compared the distribution of observed data against a null expectation derived from 1000 Monte Carlo simulations of the data for each count year. The data and simulations were filtered against a 50 mi x 50 mi grid of points to assess the rate of occurrence of birds in CBCs within 100 miles of each grid point. Clusters were identified as those areas where the observed rate of occurrence exceeded the 90% probability of occurrence based on the distribution of the simulations. We summarized these data to reflect areas in which such clusters were frequently recorded over the entire CBC data set using ArcGIS software (ESRI 2001–2005; Fig. 2). We also graphically summarized the average trends in bird counts for all CBCs and for the data subset of CBCs on which the birds were recorded in 1953 (Figs. 3, 4).

Trends in Forested Wetland Habitats

To determine if patterns of bird population change could be linked qualitatively to patterns of habitat loss in the nonbreeding range, we reviewed trends in forested wetland area in the southeastern U.S. and summarized estimates of the proportion of suitable habitats that may have been lost to other land uses. Several published data sets and appraisals are available for this purpose, but each is developed from a particular perspective. Forest stand data (Rudis 1993, Rudis 1995, Miles 2008), wetland status and trend data (Hefner and Brown 1985, Dahl 1990, Hefner et al. 1994, Tiner et al. 1994, Ainslie 2002), and land use change data (Farm Service Agency 2006, Natural Resources Conservation Service 2003, 2006, U.S. Department of Agriculture 2006) have been compiled by different agencies and individuals. Consequently, differences in subregional compilation boundaries, reporting time periods, habitat definitions, and scale of summary reporting yield a heterogeneous collection of somewhat conflicting tallies (Shepard et al. 1998).

We attempted to assemble and synthesize the published information for trends in forested wetland loss and land use change, focusing particularly on comparison between the western and eastern nonbreeding ranges. We divided the Southeastern states into three subregional aggregations representing the Lower Mississippi Alluvial Valley (covering the Mississippi flyway and western portion of

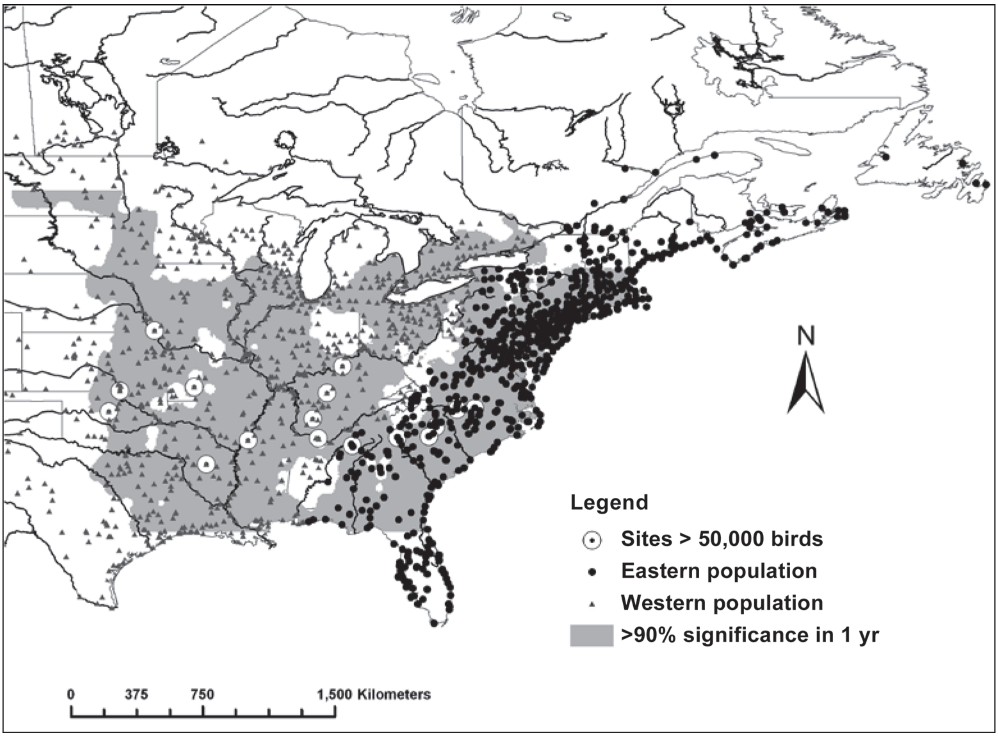

FIGURE 2. Christmas Bird Count circles reporting Rusty Blackbirds,1900–2001. Shading indicates areas of the nonbreeding range where Rusty Blackbirds occurred at higher than expected frequency in at least one year, based on simple presence/absence data from individual circles (as analyzed by Hamel and Ozdenerol 2009). Sites reporting at least 50 000 Rusty Blackbirds in at least one year are noted by circled points.

the Rusty Blackbird nonbreeding range) and two subregions of the Atlantic Coastal Plain (covering the Atlantic flyway and eastern nonbreeding range) (Table 3). For the latter, reports from the Carolinas and Georgia represent the South Atlantic Coastal Plain concentration of nonbreeding habitats, while reports from New Jersey, Delaware, Maryland, and Virginia reflect conditions in the mid-Atlantic/Chesapeake Bay area to differing extents.

As statistical comparisons were not feasible, we explored the potential relationship between Rusty Blackbird population declines and forested wetland loss by qualitatively comparing trends between the eastern and western nonbreeding ranges. We hypothesized that if a higher rate of habitat loss in one range was paralleled by higher rates of bird population decline in that same range, then this would offer coarse-scale evidence for a link between nonbreeding habitat loss and bird population trends. Lack of correspondence would suggest either that such a linkage is weak, or that the available data do not provide sufficient resolution to determine if nonbreeding habitat loss is the critical factor in Rusty Blackbird declines.

RESULTS

Population Trends from Christmas Bird Counts

For the years 1953–2001, Rusty Blackbirds were reported from a total of 1731 CBC circles (Fig. 2). The highest total number of the birds recorded in a given year, 1.3 million birds, was reported in 1969. Eighteen CBC circles have reported at least 50 000 birds in one or more years; these sites account for substantial proportions of all Rusty Blackbirds reported on the CBC (Fig. 2).

Whether viewed on a range-wide basis, considering all CBCs or restricted to CBCs reporting Rusty Blackbird in 1953 (Fig. 3), or whether considering eastern vs. western populations (Fig. 4), the prevailing pattern is a decrease in reported Rusty Blackbirds throughout the period since 1953. Great variability in mean bird count totals is evident, especially in the period from the 1950s to the early 1970s, but median abundance values show a steady decline. There is little indication of differences in abundance or rate of decline between the eastern and western populations (Fig. 4).

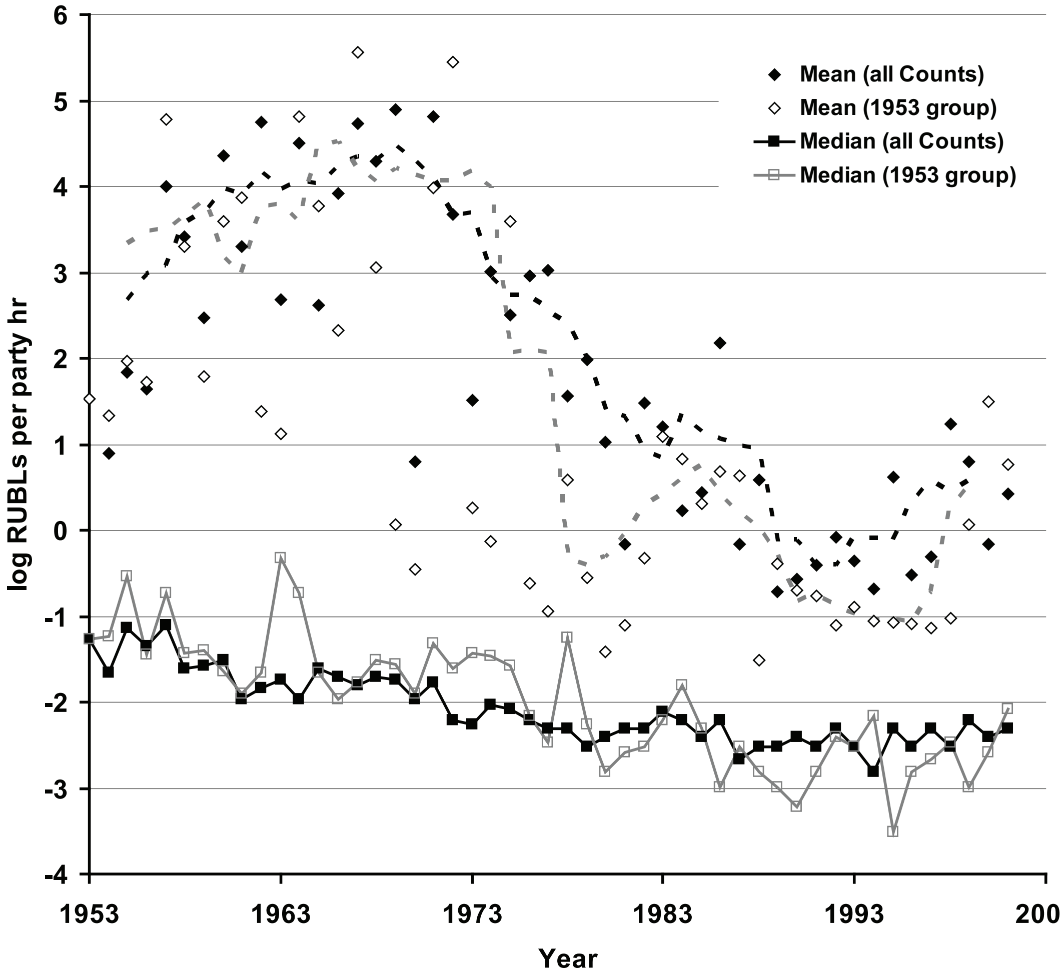

FIGURE 3. Rusty Blackbird (RUBL) abundance on Christmas Bird Counts (CBCs), 1953–2001, for all Counts conducted each year (filled symbols) and for the subset of CBCs that reported RUBLs in 1953 (unfilled symbols). Diamonds are mean abundance values, and squares are median values connected by solid lines. Five-year moving averages fit to the mean values are shown as dashed lines (black for all CBCs and gray for the restricted 1953 group; see Methods).

Forested Wetland and Land Use Trends

Southern wetlands have experienced substantial losses from the time of European settlement to the modern period. Across the entire Southeast region, cumulative historic loss of all wetland types from the 1780s to 1980s has been estimated at 49% of original extent (Dahl 1990). Estimated historic losses were greater in states of the Lower Mississippi Alluvial Valley (57%) than in the South Atlantic Coastal Plain (36%), resulting in equivalent wetland area remaining by the mid-1980s (~15.6 million acres in each subregion). Cumulative historic loss in states of the mid-Atlantic, an area smaller than the other two by an order of magnitude, was similar (56%) to that in the Mississippi Alluvial Valley states (Dahl 1990).

Over a more recent time period (Table 1) compatible with the record for Rusty Blackbird population trends, region-wide rates of freshwater wetland loss were high from the 1950s–1980s, then decreased substantially following institution of federal wetland regulations (Clean Water Act Section 404, "Swampbuster") in the mid-1980s (Holmberg 1989, Russell 1989, Dahl 2000). Within this pattern, region-wide loss rates for forested wetlands peaked later than rates of overall wetland loss, being higher in the 1970s–1980s than in the previous 20 years

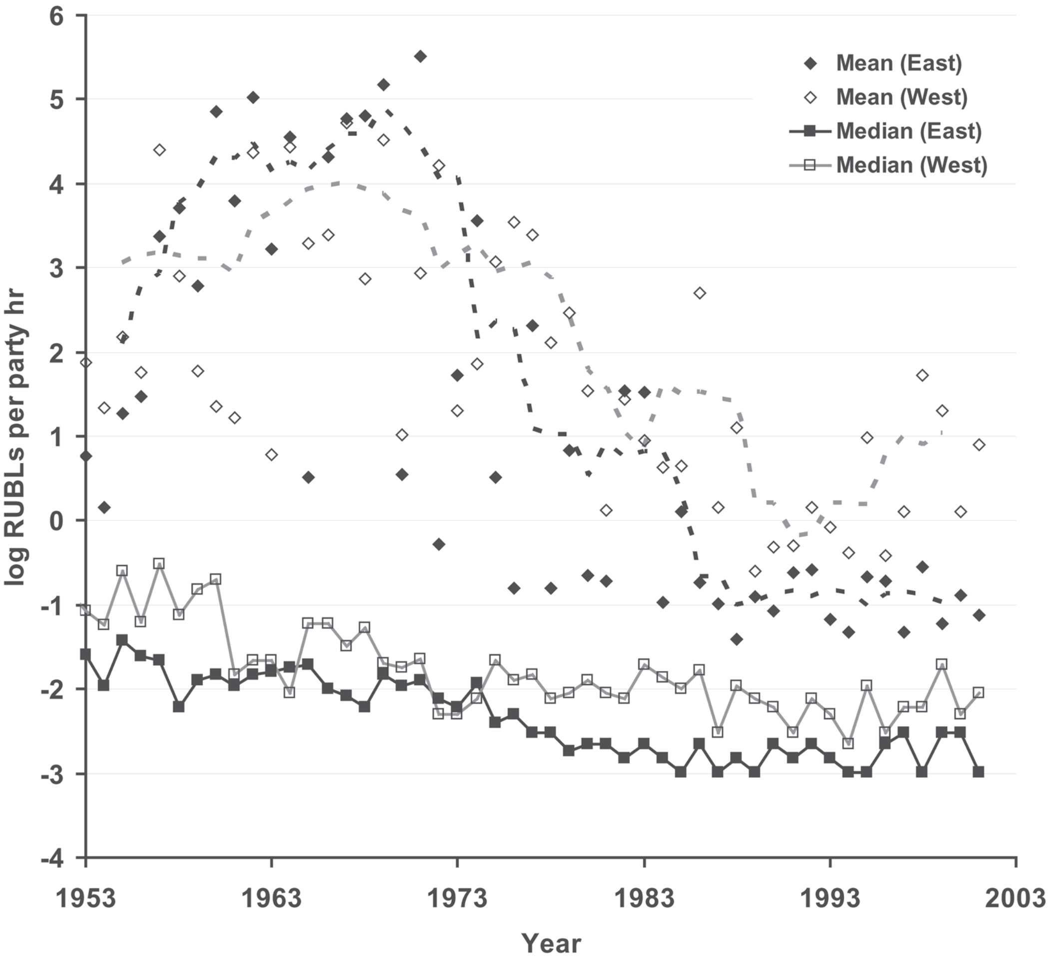

FIGURE 4. Rusty Blackbird (RUBL) abundance on Christmas Bird Counts (CBCs) in the eastern (filled symbols) and western (unfilled symbols) nonbreeding range, 1953–2001. Data represent all CBCs conducted each year. Diamonds are mean abundance values, and squares are median values connected by solid lines. Five-year moving averages fit to the mean values are shown as dashed lines (dark for eastern CBCs, light for western CBCs).

TABLE 1. Annual region-wide net loss rates and remaining area of wetlands in the Southeastern United States [a], mid-1950s to mid-1990s. Forested wetland "conversions" include change to a non-forested wetland type through silvicultural harvest and change to pine silviculture on some drained sites.

		Southeast Region-wide Net Loss Rates (10^3 ac yr^{-1})		
Survey period	*n* (years)	All freshwater wetlands	Forested wetlands	Main cause of forested wetland loss
1950s to 1970s	20	370	276	agriculture
1970s to 1980s	9	253	345	conversions and agriculture
1980s to 1990s	11	26	~99 [b]	conversions
Wetland acres remaining in the mid-1980s (x 1000)		44 568	32 845	

[a] Southeast includes NC, SC, GA, FL, AL, MS, LA, AR (with minor contributions from TN and KY).
[b] From Ainslie (2002), uncertain estimate.
Sources: Hefner and Brown 1985, Hefner et al. 1994, Dahl unpublished.

(Table 1). Clearing for agriculture was initially the major cause of forested wetland loss; however, over time, an increasing portion of net loss reflected silvicultural harvests or conversion of wetland forests to managed pine forests.

For forested wetlands, detailed quantitative data on loss rates at a subregional scale were not publicly available, except for the decade of the 1970s–1980s (Table 2). Still, instructive qualitative patterns appeared in the record with respect to the causes of loss between reporting periods. In the Southeast region (cf. Table 1) losses of forested wetlands in each subregion during the 1950s–1970s were attributed primarily to conversion to agricultural land uses (Table 2). In the 1970s–1980s, agriculture continued as the primary cause of forested wetland loss in the Mississippi Alluvial Valley, while in the Chesapeake and South Atlantic states, wetland losses were partly or mostly attributable to silvicultural conversions (particularly in the North Carolina Coastal Flats; Hefner et al. 1994). Following the dramatic reduction in rates of net wetland loss after the mid-1980s, forested wetland changes have been mainly from silvicultural conversions, which do not necessarily remove wetland habitat functions.

Current land uses on a state-level basis (Table 3) also indicate some potential habitat differences between the two concentration areas of the Rusty Blackbird nonbreeding range. Forest land is the predominant land use in both subregions, but the Lower Mississippi Valley states have higher agricultural land use (28%) compared to the South Atlantic states (16%). Agricultural land use has been declining region-wide over the past 20 years, but at a slower rate in the Lower Mississippi Valley than in the South Atlantic (–12% versus –25%, respectively; data for 1983–2003 from Natural Resources Conservation Service 2003). Urban land is a small percentage of land use in both

TABLE 2. Annual net loss rates of forested wetlands and causes of loss for states in three coastal sub-regions (Lower Mississippi Alluvial Valley, South Atlantic, and the mid-Atlantic/Chesapeake Bay area), 1950s to 1990s. Forested wetland "conversions" include change to a non-forested wetland type through silvicultural harvest and change to pine silviculture on some drained sites.

		Forested Wetland Net Loss Rates (10^3 ac yr^{-1}), by Sub-Region		
Survey period	*n* (years)	Lower Miss. MS, AR, LA	South Atlantic NC, SC, GA	Chesapeake Bay watershed[a]
1950s to 1970s	20	n.a.	n.a.	0.2
main cause		agriculture	agriculture	agriculture
1970s to 1980s	9	134	174	2
main cause		agriculture	conversions	conversions, reservoirs
1980s to 1990s	11	n.a.	n.a.	n.a.
main cause		conversions	conversions	-
Forested wetland acres remaining in the 1980s (x 1000)		11 300	13 040	990

n.a. = data not available.
[a] includes portions of MD, VA, DE, PA, NY; survey dates span 1956–1979 and 1982–1989.
Sources: Hefner and Brown 1985, Hefner et al. 1994, Tiner et al. 1994, Shepard et al. 1998.

TABLE 3. Existing land use the Southeast in 2002, showing relative distribution for states in three coastal sub-regions (South Atlantic, Lower Mississippi Alluvial Valley, and mid-Atlantic).

	Percent (%) Land Use, by Sub-Region		
Land use type	Lower Miss. MS, AR, LA	South Atlantic NC, SC, GA	Mid-Atlantic NJ, DE, MD [w/ VA][a]
Agricultural land[b]	28	16	22 [22]
Forest land	56	63	34 [52]
Urban/developed land	2	7	26 [12]
Total land area (x 10^6 ac)	91	88	12 [38]

[a] Data in brackets show NJ, DE, MD and VA combined; VA differs from other mid-Atlantic states in relative land use (61% forested, 6% urban).
[b] Includes cropland and grazing land.
Source: USDA Agricultural Statistics 2006.

TABLE 4. Cumulative enrollments through Fiscal Year 2006 in selected wetland conservation programs and practices of the U.S. Department of Agriculture's Wetland Reserve Program (WRP) and Conservation Reserve Program (CRP), for states of two coastal subregions (Lower Mississippi Alluvial Valley, South Atlantic).

	Lower Miss. MS, AR, LA	South Atlantic NC, SC, GA
WRP:		
Number of enrolled contracts	1562	284
(% of national contracts)	(16)	(3)
Enrolled acreage	589 677	87 414
(% of national enrolled acres)	(32)	(5)
CRP:		
Enrolled program acreage in practice CP31– Bottomland Hardwood Trees	18 376	27
(% of national enrolled CP31 acres)	(72)	(<1)
Enrolled CRP acreage in other wetland practices[a]	77 214	7967
(% of national enrolled practices acres)	(4)	(<1)

[a] Including Wetland restoration (CP23), Shallow Water Management for Wildlife (CP9).
Sources: FSA 2006; NRCS 2006.

subregions (Table 3), but urbanization is increasing more rapidly in the South Atlantic than in the Lower Mississippi Valley (+79% versus +40%, respectively; data for 1983–2003 from Natural Resources Conservation Service 2003). The smaller mid-Atlantic area is generally more developed and less forested (Table 3), although inclusion of data for Virginia is problematic (statewide land use resembles that of the South Atlantic, but the more developed Chesapeake Bay portion of Virginia could not be extracted from the statewide data). However, it is impossible to separate forested wetlands from upland forests in the land use data. An approximation comes from Forest Inventory and Analysis (FIA) data (Miles 2008), which indicates that wetland forest types constitute approximately 14% of forest land (7.8 of 88 million total land acres) in the South Atlantic states and approximately 20% of forest land (10.7 of 91 million total land acres) in states of the MAV. These estimates of forested wetland extent differ somewhat from status and trend data (Table 2) that indicated slightly more forested wetland area in the South Atlantic (13 million acres) than in the MAV (11 million acres) by the time that wetland losses began to decline sharply (cf. Table 1).

DISCUSSION

Specification of Rusty Blackbird nonbreeding habitat (e.g. Hamel 1992, Avery 1995, Potter et al. 2006) in terms compatible with existing measures for trends in abundance of forested wetland habitats is difficult. Steinkamp (2008) associates the species with forested uplands rather than with wetlands, but other studies suggest that the latter are the preferred habitat (Luscier 2007, Mettke-Hofmann et al. 2007). Few studies of nonbreeding habitat use are available, and these reflect only local conditions in the areas studied (Avery 1995). None takes account of demonstrated variation in food supplies for the birds among potential wetland habitats within a local area (Haack et al. 1989). No existing study satisfactorily explains how Rusty Blackbirds use habitat at the landscape scale, or what the size of such a landscape might be. Until there is more detailed information on central tendency and associated variability in home range size, proportions of different habitat elements within typical nonbreeding ranges, and relationship of each of these to local weather and climate conditions, specification of what constitutes habitat is necessarily general. Fortunately, ongoing studies by Mettke-Hofmann et al. (2007) and Luscier (2007) are beginning to address these deficiencies. At minimum, our understanding of what is "nonbreeding habitat" matches our current capacity to specify areas and areal changes in forested wetland habitats.

During the 1950s–1960s, Rusty Blackbird numbers were high and variable as measured on the CBC. Subsequent to that period, they experienced the steep decline evaluated by Niven et al. (2004) for the period after 1965. Median abundance values (Fig. 3) suggest the decline was in progress in the 1950s and even earlier (Hamel, unpublished data), as Greenberg and Droege (1999) asserted. This pattern exists in the entire CBC data set, in the data set restricted to CBCs where birds were present in 1953, and in both eastern and western portions of the range.

Equally clear as the decline in bird numbers has been the decrease in abundance of forested wetlands over the same time period in both the eastern and western portions of the bird's nonbreeding range. Our examination of forest and forested wetland habitats in the Southeast indicated parallel but not identical trends in the two areas. In the MAV region, loss of forest to agriculture was more extensive and continued longer than in the South Atlantic Coastal Plain. In the SCP, a substantial portion of wetland change, especially later in the 1950–1990 period, represents silvicultural activities, both timber harvest and forest type conversions from forested or pocosin wetlands to plantation loblolly pine (*Pinus taeda*). Harvesting stands and allowing regeneration into new stands of wetland forest has fundamentally different habitat consequences than clearing and draining land for agriculture, and thus the impacts on Rusty Blackbird populations are less clear. The South Atlantic states retained more of their original wetland extent than the MAV states, but total areas of forested wetlands are not markedly different between the two subregions. In both areas, the most evident recent change in land use has been a decrease in agricultural land and an increase in urban lands, especially in the SCP.

We were unable in this investigation to effect a satisfactory comparison of wetland habitat change with Rusty Blackbird population trajectory. Limited data availability, variations in measurement technique, definition of wetland types covered, and particularly area of data aggregation permitted only weak connections between the two sets of trends. More detailed quantitative data on changes in forested wetland extent exist, but are not publicly available in a form appropriate for comparison at even a sub-regional scale (cf. Table 2). Efforts by Koneff and Royle (2004) to estimate forested wetland change along the Atlantic Coast represented retrospective modeling, with insufficient resolution or extent for our purposes. While it might be suggested that the South Atlantic nonbreeding range has experienced less overall loss of forested wetland habitat than the MAV range, this is not reflected in any marked differences in Rusty Blackbird abundance or rate of decline between the two subregions. Detailed habitat examination from aerial photography of CBC circles in which large numbers of birds were reported may be one avenue of inquiry that could offer some explanation, as could an evaluation of changes in agricultural land uses in those same circles. It could also be useful to examine specific rates of loss among different types of forested wetlands, as not all types may be equally favorable habitat for nonbreeding Rusty Blackbirds.

It is commonly accepted that the historic pattern of land clearing for agriculture at the landscape scale was not random with respect to the hydroperiod of the lands. Rather, land clearing proceeded from drier to wetter sites (Rudis 1995). In this respect, lands converted in the latter half of the 20th century conform to a long established pattern that land clearing and drainage have proceeded from less flood-prone to more flood-prone areas. Given that Rusty Blackbirds preferentially utilize wetter sites (Avery 1995), we hypothesize that early land clearing would have less effect on Rusty Blackbird habitat than the recent clearing and draining of wetter sites. Indeed, ecotones between agricultural and forested wetland sites initially may have offered favorable habitats to wintering birds. However, when land use reached the point where most lands being cleared were suitable or preferred Rusty Blackbird habitats, the effect of wetland conversions could be proportionately greater than the proportion of land cleared. At least in the MAV subregion, the observed decline in Rusty Blackbird abundance over the period of record (Fig. 3) is consistent with the major declines in presumed nonbreeding habitat, as forested wetlands there were being intensively cleared for agriculture until the mid-1980s.

Trends in Forest Restoration

Substantial areas of marginal farmland are currently enrolled in federal agricultural programs that foster restoration of forest toward wetland functions. In the MAV region, large areas planted in wetland or bottomland trees represent a considerable increase in potential forest area (Allen et al. 2001, Stanturf et al. 2003); in the SCP, such restoration is more limited and impacts are less well documented (Table 4; De Steven and Lowrance, unpubl. ms.). Data on Rusty Blackbird use of such plantings in the MAV come from a large-scale forest restoration experiment in Sharkey Co., Mississippi (Schweitzer et al. 1997, Gardiner and Oliver 2005). The replicated experiment compared different methods of afforestation (natural regeneration, oak seeding, planted oak seedlings, and a faster-developing cottonwood-oak [*Populus deltoides* – *Quercus nuttallii*] interplanting). A study of winter bird communities on the site was initiated in 1998, three years after the experiment began. Prior to that time, there were no incidental observations of Rusty Blackbirds despite intensive surveys for raptor use of the study area throughout the winter period. During the winter-bird community study, Rusty Blackbirds were observed infrequently until 2002–2003, when substantial use of a cottonwood-oak plot was documented. Since 2002, Rusty Blackbirds have been seen annually, and by 2007–2008 were observed almost daily and were seen using three of the four afforestation treatments and all three experimental replicate blocks (Hamel 2003, P.B. Hamel and C.G. Smith, III, unpublished data).

Thus, Rusty Blackbirds use forest restoration areas in increasing frequency with the age of restored stands. Conservation efforts such as the WRP and certain CRP afforestation practices, as well as other reforestation, can apparently provide additional nonbreeding habitat to Rusty Blackbird populations in the future. This is a desired outcome anticipated in ongoing conservation planning activities in the MAV coordinated through the Lower Mississippi Valley Joint Venture (Twedt et al. 2006, LMVJV Forest Resource Conservation Working Group 2007). In the South Atlantic Coastal Plain, anticipated reforestation activities of the Atlantic Coast Joint Venture suggest that a similar restoration of nonbreeding habitats for these birds is possible (Atlantic Coast Joint Venture 2005, Watson and Malloy 2006).

CONCLUSIONS

Our qualitative analysis suggests that recent loss of forested wetlands in the Southeast has not been as steep as the decline in Rusty Blackbird populations over the same period. Habitat change and loss has not proceeded equally, either in extent or in type, between the South Atlantic Coastal Plain and Mississippi Alluvial Valley portions of the Rusty Blackbird nonbreeding range. Changes in nonbreeding habitat quality, although suspected, could not be examined in this study. Population declines in the two areas have been nearly equivalent in spite of differences in the pattern of habitat change. Thus, it is premature to conclude that loss of nonbreeding habitat is the primary cause of population decline, though it likely has contributed. However, we are hampered by unavailability of adequate data on habitat change at the needed scales. For example, within the wetland status and trends program (Dahl 2000), there is a rich data set for changes in Southeastern wetlands over a 50-year period, only some of which has been processed beyond national-level summaries (e.g., Hefner et al. 1994). A comprehensive analysis of wetland trends at finer spatial scales (state, physiographic sub-region, etc.) over all survey periods would be invaluable for many purposes, including understanding habitat change across the nonbreeding range of Rusty Blackbirds. In the meantime, afforestation and forest restoration programs are producing new nonbreeding habitats for Rusty Blackbird, and can promote an increased carrying capacity for the birds in the future.

ACKNOWLEDGMENTS

We dedicate this paper to the memory of Victor A. Rudis, who was struck down too early. His contributions to our thinking are important. Tito Vilella kindly translated the abstract into Spanish. The paper has been improved by the comments of Craig Watson, Nathan Dias, Ray Souter, Robin Corcoran, Michael Avery, and an anonymous reviewer. We are grateful to the National Audubon Society for making the Christmas Bird Count data available for us to use.

LITERATURE CITED

Ainslie, W. B. 2002. Chapter 20: Forested Wetlands, pp. 479–499. *In* D. N. Wear and J. G. Gries [eds.], Southern Forest Resource Assessment. USDA Forest Service, Southern Research Station, Asheville, NC.

Allen, J. A., B. D. Keeland, J. A. Stanturf, A. F. Clewell, and H. E. Kennedy, Jr., 2001 (revised 2004). A guide to bottomland hardwood restoration. U.S. Geological Survey, Biological Resources Division Information and Technology Report USGS/BRD/ITR-2000-0011 and U.S. Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-40. Asheville, NC.

Arbib, R. S. 1981. The Christmas Bird Count: constructing an "ideal model", pp. 30–33. *In* C. J. Ralph and J. M. Scott [eds.], Estimating Numbers of Terrestrial Birds. Studies in Avian Biology, No. 6.

Atlantic Coast Joint Venture. 2005. Atlantic Coast Joint Venture waterfowl implementation plan revision draft. Atlantic Coast Joint Venture, Hadley, MA. [Online.] <http://www.acjv.org/acjv_publications.htm> (25 March 2009).

Avery, M. L. 1995. Rusty Blackbird (*Euphagus carolinus*). *In* A. Poole and F. Gill [eds.], The Birds of North America, No. 200. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC

Baldy, J. J. 2005. Climate preferences of the Cerulean Warbler on summer territory. MS. Thesis, University of Memphis, Memphis, TN.

Bird Banding Laboratory. 2004. Banding and Recovery Counts. [Online.] <http://www.pwrc.usgs.gov/BBL/homepage/start.htm> (25 March 2009).

BRODY, M., W. CONNER, L. PEARLSTINE, AND W. KITCHENS. 1989. Modeling bottomland forest and wildlife habitat changes in Louisiana's Atchafalaya Basin, pp. 991–1004. *In* R. R. Sharitz and J. W. Gibbons [eds], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Energy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Technical Information, Oak Ridge, TN.

BURGER, L. W., JR. 2006. Creating Wildlife Habitat Through Federal Farm Programs: An Objective-Driven Approach. Wildlife Society Bulletin 34:994–999.

CHAPMAN, F.M. 1900. A Christmas bird-census. Bird-Lore 2:192.

DAHL, T. E. 1990. Wetlands Losses in the United States, 1780s to 1980s. U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, DC

DAHL, T. E. 2000. Status and Trends of Wetlands in the Conterminous United States, 1986 to 1997. U.S. Department of Interior, U.S. Fish and Wildlife Service, Washington, DC.

DE STEVEN, D. AND R. LOWRANCE. Unpublished ms. Agricultural conservation practices and wetland ecosystem services in a wetland-dominated landscape: the Piedmont-Coastal Plain region. In review, Ecological Applications.

ESRI. 2001-2005. ArcGIS 9: "What is ArcGIS 9.2?" ESRI, Redlands, CA.

EVERS, D. 2007. Mercury as a threat to the Rusty Blackbird: What do we know and where are we going? International Rusty Blackbird Technical Group Workshop, 12–13 April 2007, Stoneville, MS. [Online.] <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Rusty_Blackbird/Workshop_07/1555_Evers_Mercury%20in%20Songbirds%20for%20RUBL%20Group.pdf> (25 March 2009).

FARM SERVICE AGENCY. 2006. Conservation Reserve Program summary and enrollment statistics, FY2006. U.S. Department of Agriculture, Washington, DC. [Online.] <http://www.fsa.usda.gov/Internet/FSA_File/06rpt.pdf> (25 March 2009).

FINLEY, M. T., W. H. STICKEL, AND R. E. CHRISTENSEN. 1979. Mercury residues in tissues of dead and surviving birds fed methylmercury. Bulletin of Environmental Contamination and Toxicology 21:105–110.

FREDRICKSON, L. H. 2005. Contemporary bottomland hardwood systems: structure, function, and hydrologic condition resulting from two centuries of anthropogenic activities, pp. 19–35. *In* L. H. Fredrickson, S. L. King, and R. M. Kaminski [eds.], Ecology and management of bottomland hardwood systems: the state of our understanding. University of Missouri-Columbia, Gaylord Memorial Laboratory Special Publication No. 10, Puxico, MO.

GARDINER, E. S., AND J. M. OLIVER. 2005. Restoration of bottomland hardwood forests in Lower Mississippi Aluvial Valley, U.S.A, pp. 235 – 251. *In* J. A. Stanturf and P. Madsen [eds.], Restoration of boreal and temperate forests. Restoration of bottomland hardwood forests in the Lower Mississippi Alluvial Valley, U.S.A. CRC Press, Boca Raton, FL.

GREENBERG, R., AND S. DROEGE. 1999. On the decline of the Rusty Blackbird and the use of ornithological literature to document long-term population trends. Conservation Biology 13:553–559.

HAACK, S. K., R. B. BEST, AND T. L. CRISMAN. 1989. Aquatic macroinvertebrate communities in a forested wetland: Interrelationships with environmental gradients, pp. 437–454. *In* R. R. Sharitz and J. W. Gibbons [eds.], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Energy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Techinical Information, Oak Ridge, TN.

HAMEL, P. B. 1992. The land manager's guide to the birds of the south. The Nature Conservancy, Chapel Hill, NC.

HAMEL, P. B. 2003. Winter bird community differences among methods of bottomland hardwood forest restoration: results after seven growing seasons. Forestry 76:189–197.

HAMEL, P. B., AND E. OZDENEROL. 2007. Evaluation of dynamics of Rusty Blackbird nonbreeding range using Spatial Filtering. International Rusty Blackbird Technical Group Workshop, 12–13 April 2007, Stoneville, MS. [Online.] <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Rusty_Blackbird/Workshop_07/1115_Hamel&Ozdenerol_Spatial_Filtering.pdf> (25 March 2009).

HAMEL, P. B., AND E. OZDENEROL. 2009. Using the spatial filtering process to evaluate the nonbreeding range of Rusty Blackbird *Euphagus carolinus*, pp. 334–340. *In* T. D. Rich, C. Arizmendi, D. W. Demarest, and C. Thompson [eds.], Tundra to Tropics: Connecting Birds, Habitats and People. Proceedings of the 4th International Partners in Flight Conference, 13–16 February 2008. McAllen, TX. Partners in Flight.

HAYNES, R. J. 2004. The development of bottomland forest restoration in the lower Mississippi Alluvial Valley. Ecological Restoration 22:170–182.

Hefner, J. M., and J. D. Brown. 1985. Wetland trends in the Southeastern United States. Wetlands 4:1–11.

Hefner, J. M., B. O. Wilen, T. E. Dahl, and W. E. Frayer. 1994. Southeast wetlands: status and trends, mid-1970s to mid-1980s. U.S. Department of Interior, U.S. Fish and Wildlife Service, Atlanta, GA.

Holmberg, N. D. 1989. The U.S. Fish and Wildlife Service and the Wetland Regulatory Process, pp. 869–872. *In* R. R. Sharitz and J. W. Gibbons [eds.], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Energy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Techinical Information, Oak Ridge, TN.

King, S. L., D. J. Twedt, and R. R. Wilson. 2007. The role of the Wetland Reserve program in conservation efforts in the Mississippi River Alluvial Valley. Wildlife Society Bulletin 34:914–920.

Koneff, M. D., and J. A. Royle. 2004. Modeling wetland change along the United States Atlantic Coast. Ecological Modelling 177:41–59.

Langner, L. L., and R. E. Heimlich. 1989. Economics of wetland preservation: The agricultural connection, pp. 877–888. *In* R. R. Sharitz and J. W. Gibbons [eds.], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Energy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Technical Information, Oak Ridge, TN.

Leininger, T., and P. Hamel. 2007. Historical trends in wetlands loss and efforts to intervene. International Rusty Blackbird Technical Group Workshop, 12–13 April 2007, Stoneville, MS. [Online.] <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Rusty_Blackbird/Workshop_07/1520_Leininger_Historical%20Trends%20in%20Wetlands%20Loss%20and%20Effor.pdf> (25 March 2009).

Lower Mississippi Valley Joint Venture Forest Resource Conservation Working Group. 2007. Restoration, management, and monitoring of forest resources in the Mississippi Alluvial Valley: Recommendations for enhancing wildlife habitat. R. Wilson, K. Ribbeck, S. King, and D. Twedt, [eds.] Lower Mississippi Valley Joint Venture, Vicksburg, MS.

Luscier, J. D. 2007. Presence/absence surveys for estimating occupancy as a system state variable for wintering Rusty Blackbirds (*Euphagus carolinus*). International Rusty Blackbird Technical Group Workshop, 12–13 April 2007, Stoneville, MS. [Online.] <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Rusty_Blackbird/Workshop_07/1705_Luscier_Winter%20surveys.pdf> (25 March 2009).

Mettke-Hofmann, C., P. B. Hamel, and R. Greenberg. 2007. Winter ecology of the Rusty Blackbird in the Lower Mississippi Alluvial Valley. International Rusty Blackbird Technical Group Workshop, 12–13 April 2007, Stoneville, MS. [Online.] <http://nationalzoo.si.edu/ConservationAndScience/MigratoryBirds/Research/Rusty_Blackbird/Workshop_07/1335a_Stoneville_Mettke_Hofmann_2007.pdf> (25 March 2009).

Miles, P. D. 2008. Forest inventory mapmaker web-application version 3.0. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. [Online.] <http://www.ncrs2.fs.fed.us/4801/fiadb/index.htm> FIA forest proportions for various states (24 January 2008).

National Audubon Society. 2002. The Christmas Bird Count Historical Results. [Online.] <http://www.audubon.org/bird/cbc> (30 January 2003).

Natural Resources Conservation Service. 2003. Natural Resources Inventory 2003 summary. U.S. Department of Agriculture, Washington, DC. [Online.] <http://www.nrcs.usda.gov/technical/NRI/2003/nri03landuse-mrb.html> (25 March 2009).

Natural Resources Conservation Service. 2006. Wetland Reserve Program cumulative contract information. U.S. Department of Agriculture, Washington, DC. [Online.] <www.nrcs.usda.gov/programs/wrp/> (25 March 2009).

Niven, D. K., J. R. Sauer, G. S. Butcher, and W. A. Link. 2004. Christmas Bird Count provides insights into population change in land birds that breed in the boreal forest. American Birds 58:10–20.

Partners in Flight website. 2005. [Online.] <http://www.partnersinflight.org/cont_plan/> (Version March 2005) (25 March 2009).

Potter, E. F., J. F. Parnell, R. P. Teulings, and R. Davis. 2006. Birds of the Carolinas, 2nd ed. University of North Carolina Press, Chapel Hill, NC.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North

American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY.

Robbins, C. S., D. A. Bystrak, and P. H. Geissler. 1986. The Breeding Bird Survey: its first fifteen years, 1965–1979. U.S. Department of Interior, U.S. Fish and Wildlife Service Resource Publication 157. Washington, DC.

Rudis, V. A. 1993. Forest fragmentation of southern U.S. bottomland hardwoods, pp. 35–46. *In* J. C. Brissette [ed.], Proceedings of the seventh biennial southern silvicultural research conference. 1992 November 17–19. Mobile, AL. USDA Forest Service Southern Forest Experiment Station. New Orleans, LA.

Rudis, V. A. 1995. Regional forest fragmentation effects on bottomland hardwood community types and resource values. Landscape Ecology 10:291–307.

Rudis, V. A., and R. A. Birdsey. 1986. Forest resource trends and current conditions in the Lower Mississippi Valley. U.S. Department of Agriculture Forest Service Resource Bulletin SO–116.

Russell, M. 1989. Keeping promises: EPA and the protection of wetlands, pp. 711–717. *In* R. R. Sharitz and J. W. Gibbons [eds.], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Energy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Technical Information, Oak Ridge, TN.

SAS Institute Inc. 2002–2003. SAS, version 9.1. SAS Institute. Cary, NC.

Sauer, J. R., and W. A. Link. 2002. Using Christmas Bird Count data in analysis of population change. American Birds 56:10–14.

Schweitzer, C. J., J. A. Stanturf, J. P. Shepard, T. M. Wilkins, C. J. Portwood, and L. C. Dorris, Jr. 1997. Large-scale comparison of reforestation techniques commonly used in the lower Mississippi alluvial valley: first year results, pp. 313–320. *In* S. G. Pallardy, R. A. Cecich, H. G. Garrett, and P. S. Johnson [eds.], Proceedings of the 11th Central Hardwood Forest Conference. USDA General Technical Report NC-188. USDA Forest Service, North Central Forest Experiment Station. St. Paul, MN.

Shepard, J. P., S. J. Brady, N. D. Cost, and C. G. Storrs. 1998. Classification and inventory, pp. 1–28. *In* M. G. Messina and W. H. Conner [eds.], Southern Forested Wetlands: Ecology and Management. CRC Press, Boca Raton, FL.

Stanturf, J. A., E. S. Gardiner, and M. L. Warren, Jr. 2003. Restoring Forested Wetland Ecosystems, pp. 193–220. *In* M. M. Holland, E. R. Blood, and L. Shaffer [eds.], Achieving Sustainable Freshwater Systems. Island Press, Washington, DC.

Steinkamp, M. 2008. New England/Mid-Atlantic Coast Bird Conservation Region (BCR 30) Implementation Plan. Atlantic Coast Joint Venture, Laurel, MD. [Online.] <http://www.acjv.org/BCR_30/BCR30_June_23_2008_final.pdf> (23 March 2009).

Tiner, R. W., Jr. 1989. Recent changes in the extent of palustrine vegetated wetlands in the Chesapeake Bay Region, pp. 791–800. *In* R. R. Sharitz and J. W. Gibbons [eds.], Freshwater Wetlands and Wildlife, CONF-8603101, Department of Eneregy Symposium Series No. 61, U.S. Department of Energy Office of Scientific and Technical Information, Oak Ridge, TN.

Tiner, R. W., I. Kenenski, T. Nuerminger, J. Eaton, D. B. Foulis, G. S. Smith, and W. E. Frayer. 1994. Recent wetland status and trends in the Chesapeake watershed (1982–1989): technical report. U.S. Department of Interior, U.S. Fish and Wildlife Service, Annapolis, MD.

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

Twedt, D. J., W. B. Uihlein, III, and A. B. Elliott. 2006. Habitat restoration for forest bird conservation: a spatially explicit decision support model. Conservation Biology 20:100–110.

United States Department of Agriculture. 2006. Agricultural Statistics. USDA National Agricultural Statistics Service, Washington, DC.

Department of Geography, University of Iowa. 1997. Demo: Spatial analysis of health data. [Online.] <http://www.uiowa.edu/~geog/health/index11.html> (10 October 2004).

Watson, C., and K. Malloy. 2006. The South Atlantic Migratory Bird Initiative Implementation Plan—An Integrated Approach to Conservation of All Birds Across All Habitats, version 3.1. Atlantic Coast Joint Venture, Charleston, SC. [Online.] <http://www.acjv.org/documents/SAMBI_Plan3.2.pdf> (23 March 2009).