Attitudes of Vermont dairy farmers regarding adoption of management practices for grassland songbirds

Austin R. Troy, Allan M. Strong, Sidney C. Bosworth, Therese M. Donovan, Neil J. Buckley, and Megan L. Wilson

Abstract In the northeastern United States, most populations of grassland songbirds occur on private lands. However, little information exists about the attitudes of farmers toward habitat management for this guild. To address this information gap, we surveyed 131 dairy farmers in Vermont's Champlain Valley to assess current hayfield management practices and farmers' willingness to adopt more "bird-friendly" practices. Our results showed a clear trend toward earlier and more frequent hayfield cuts. Farmers indicated they have little flexibility to alter the timing of their cuts on most of their land. However, many farmers (49%) indicated a willingness to adopt alternative management practices on at least a small portion of their land. Combined with the fact that many farmers characterized parts of their land as "wasteland," or economically unproductive land, this result suggests that some leeway exists for increasing songbird habitat quality on at least portions of dairy farms. Although significant differences existed in the amount of land for which farmers were willing to adopt alternative management based on herd size, acreage, and experience, the directionality of these relationships could not be established except tentatively for herd size, in which case it appeared that farmers with smaller herds were more likely to dedicate a greater percentage of their land to alternative management. The results of this study likely have relevance to dairy farms throughout the northern-tier dairy states. Given the increasing trend for agricultural land to be converted into housing, we recommend that extension and education efforts target farmers with large hayfield acreages, encouraging the maintenance of high-quality habitat for grassland songbirds.

Key words agricultural management practices, attitudinal surveys, Champlain Valley, dairy farms, forage crops, grassland songbirds, hayfields

Grassland songbird populations have been significantly affected by changes in land use and have shown steep, consistent population declines throughout North America (Knopf 1994, Peterjohn and Sauer 1999). The reasons for these declines are varied, but most relate to the conversion of native prairie to agricultural land and to intensification of agricultural practices on cultivated land (Frawley and Best 1991, Samson and Knopf 1994). While the northeastern United States probably supported limited native grassland acreage prior to European settlement (though few data exist to assess this), cultivation of grasses and legumes for domestic animal forage in the 1800s and early 1900s has created substantial habitat for grassland songbirds (Askins 1999). Species that were probably rare historically in the Northeast, including bobolink (*Dolichonyx oryzivorus*), savannah sparrow (*Passerculus sand-*

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wichensis), grasshopper sparrow (*Ammodramus savannarum*), and upland sandpiper (*Bartramia longicauda*), are now found from New York to Maine (Askins 2000). In the last 30 years, however, these species have declined in the Northeast and throughout North America (Knopf 1994, Peterjohn and Sauer 1999), presumably due to more intensive management of hayfields, conversion of grasslands to row crops (Rodenhouse et al. 1995) and housing, succession of abandoned farmland to forest (Foster et al. 1998), and perhaps high nonbreeding season mortality (e.g., Basili and Temple 1999).

Throughout the eastern United States, most grassland acreage is in private agricultural ownership. Much of New England's agricultural lands are managed hayfields, providing forage for the region's dairy cattle industry. Hayfield management practices, however, are increasingly incompatible with the reproductive cycle of grassland songbirds (e.g., Bollinger et al. 1990, Bollinger and Gavin 1992). Farmers typically harvest their first cut by early June, which is well before grassland songbirds can successfully fledge young. Further, relatively little acreage in the northeastern United States is protected through conservation enrollment programs. For instance, in Vermont, only 500 ha are enrolled in the Conservation Reserve Program (CRP; Farm Services Agency 2003) and <750 ha are enrolled annually in the Wildlife Habitat Incentives Program (WHIP; Toby Alexander, Natural Resource Conservation Service, personal communication 2003). Because dairy farmers have increased the intensity of their hayfield cutting schedules over the last few decades, it would appear that population viability of grassland songbirds today depends considerably upon the degree to which those farmers have the ability and willingness, both practically and economically, to reduce management intensity on at least some of their land.

Because dairy farmers have come under increasing economic duress over the past few decades, understanding their preferences as well as their perceptions of economic tradeoffs and constraints in implementing alternative management regimes is critical to designing successful conservation plans (Napier and Brown 1993). Although there is a substantial literature on the effects of wildlife damage on crops (e.g., Conover 1998), the extent to which landowners are willing or able to alter their management to benefit wildlife is poorly understood (Gobster 2001), and the few studies that have looked at this issue are inconclusive and often equivocal. Jacobson et al. (2003) found in Florida that the majority of farmers, including organic and conventional farmers, liked having birds on their farms as a means of reducing pests, although only one-third actually managed fields to attract birds. Most farmers felt that their land was already good bird habitat, suggesting that an important barrier to adopting conservation strategies on farms is that most farmers do not think a problem exists. Nevertheless, no economic, social, or experiential factors were correlated with the willingness to attract birds to farms. Other studies have shown that lack of participation in voluntary ecosystem management programs may stem from a fear of more stringent governmental regulations (Raedeke et al. 2001*b*).

While demographic variables, such as income, education, and age (Gould et al. 1989), as well as number of years farming (Cary and Wilkinson 1997) have been found to predict willingness to adopt certain conservation strategies, institutional factors such as farm size are not as well established as predictors. For instance, while Filson (1993) found that farm size was inversely related to the likelihood of adopting conservation strategies, Featherstone and Goodwin (1993) found the opposite, in particular where farmers had long-term plans for their heirs to continue farming. Generally, willingness to undertake conservation measures was most closely related to their compatibility and consistency with a farm's commercial viability (Cary and Wilkinson 1997). Finally, propensity to manage farmland for wildlife has been found to be negatively associated with the proportion of income from farming on CRP land in Missouri, which seems consistent with the previously mentioned finding since "commercial viability" can be easier to obtain when the scale of operation is small and costs are compensated for by other income (Kurzejeski et al. 1992).

We conducted a survey to characterize the management practices of dairy farmers in Vermont's Champlain Valley that are relevant to songbird habitat, and the factors that affect those management practices. Our objectives were to understand current management practices, quantify changes in management practices over time, characterize dairy farmers' flexibility to alter management strategies in ways that would benefit songbirds, and assess feasibility for altering management practices without compromising economic viability. Our hope was that these results might have some applicabili-

ty to farmers throughout the "traditional northern dairy belt" (typically considered to consist of Wisconsin, Minnesota, Michigan, Ohio, Pennsylvania, New York, and Vermont), a region where dairy farms tend to be similar in characteristics such as number of cows per farm, average farm size, and average farm income from hay, milk, and other dairy products (United States Department of Agriculture 2004). This region is home to nearly half of all dairy farms and nearly 40% of all dairy cows in the country (United States Department of Agriculture 1999).

If we can accurately predict farmers' willingness to alter management practices from readily quantifiable characteristics, then planners and agency personnel may be able to target particular groups of farmers to pursue conservation initiatives in regions of the traditional dairy belt where dairy farms and grassland songbirds coexist. Toward this end we assessed how a variety of factors (herd size, acreage of farmland, length of time farming, and hay self-sufficiency) predicted the likelihood and extent to which farmers would adopt alternative management techniques.

Study area

The Lake Champlain Basin covers a land area of 21,326 km^2, of which 56% is in Vermont, 37% is in New York, and 7% is in the Province of Quebec. This study focused on the Vermont portion of the basin, which included the land between Lake Champlain and the Green Mountains of Vermont. As of 1987, there were approximately 4,840 farms in the entire Basin, with roughly two-thirds of those located in Vermont and one-third in New York. The Champlain Basin of Vermont was an extremely important agricultural resource for the state, accounting for approximately 64% of all Vermont farm revenues as of 1990, with roughly 70% of that revenue coming from dairy farming (Lake Champlain Steering Committee 2003). In total, the Champlain Basin included roughly 145,000 ha of managed grassland (United States Department of Agriculture 2004).

Methods

We created a draft survey and engaged 5 dairy farmers in a focus group meeting in early 2002 to provide commentary and suggestions about how to make the survey more understandable and meaningful to the target group of farmers. After these changes were incorporated, we mailed the survey in March 2002 to 400 of 697 dairy farmers in the Champlain Valley, Vermont (Chittenden, Addison, Franklin, and Grand Isle counties) that were identified in a University of Vermont Center for Rural Studies database. The farmers were stratified by county and were randomly sampled from within each stratum based on the following sampling algorithm:

$$R_i = \left(\frac{1}{\log(N_i)} \right)^k,$$

where R_i = rate of sampling for stratum i, N_i = the number of observations in stratum i, and k, a constant = 0.665. The parameter k was set so that the total number of samples equaled 400, or a 57% population sample (n = 135, 51, 190, and 24 for Addison, Chittenden, Franklin, and Grand Isle counties, respectively). The mailer included a questionnaire, a color cover letter with pictures of common grassland birds, and a postage-paid return envelope. We waited about 6 weeks until responses stopped coming in and then sent out an identical follow-up survey in early May. A final follow-up survey was sent out in mid-July.

The first section of the survey asked farmers to describe characteristics of their fields, such as how much acreage was in pasture, hayfield, and nonproductive (wasteland) fields. The second section contained questions on cutting characteristics (e.g., the percentage of fields cut once, twice, and three times, as well as questions on timing of cuts and changes to that timing over the years). The third section contained questions on farmers' attitudes toward changing hayfield management to improve habitat quality. It asked farmers to rate the likely hood that they would delay the first cuts on at least some of their fields if it were found that it would improve bird habitat. That section also asked how much they would need to be compensated for financial losses resulting from these delays. It additionally asked on what percentage of fields farmers would be willing to enact delayed first cuts. The fourth section gathered background information about the farmers' operations, such as how many cows they had, whether they purchased hay, and whether they were full-time farmers.

Responses were entered into a database, where summary statistics were generated for each response, including counts, measures of central ten-

dency, and measures of spread. Statistical analyses were then conducted to look for significant differences in key response variables by our hypothesized predictor variables.

We analyzed whether the percent of fields on which farmers were willing to alter their first cut varied by farm size, herd size, length of time farming, and hay self-sufficiency. This was first done by creating a set of ordinal categories for each predictor variable and using ANOVA to determine whether there were differences in responses among categories. Categories for the first three variables were based on quartiles, whereas hay self-sufficiency was a binominal variable based on farmer response (Y/N). Univariate regressions were conducted to determine whether a linear relationship existed between the response and each predictor. Pearson's χ^2 tests were performed to assess whether the stated importance of the financial loss from a delayed first cut was related to a variety of categorical predictors, including herd size-class and the frequency for off-farm hay purchase. A Wilcoxon rank-sum test was conducted to assess the relationship between stated importance of financial loss from delayed first cut and the binomial variable representing whether the farmer produced excess hay.

Results

Of the 400 surveys, 21 were returned for wrong or out-of-date addresses. Because no additional samples were added to the sample, 379 was the denominator used to calculate response rates. After 3 mailings, the total number of responses was 140, resulting in a 37% response rate (140/379). Of those, 9 contained only comments and generally lacked quantitative responses, yielding an effective response rate of 35% (131/379). Because not every question was answered by each respondent (either because of deliberate nonresponse or because the question was not applicable), the responder populations specific to each question are given in parentheses after the reported results.

Given the relatively low response rate, we conducted a statistical assessment of nonresponse bias. We address-geocoded the location of respondent and nonrespondent households (80% of all samples were successfully geocoded), grouped them by United States census block group, and assessed differences between the 2 groups. We hypothesized that if nonresponse bias existed, it likely would manifest itself through overselection of households with certain economic, demographic, or spatial characteristics. However, one-way ANOVAs showed no significant differences between responders and nonresponders for all variables tested, including distance to downtown Burlington ($F_{1, 317} = 0.703$, $P = 0.402$); population density ($F_{1, 317} = 1.255$, $P = 0.263$); percent population on rural farms ($F_{1, 317} = 0.419$, $P = 0.516$); median home value ($F_{1, 317} = 0.583$, $P = 0.445$); and median household income ($F_{1, 317} = 0.732$, $P = 0.393$). We assessed the last 4 variables at the census block group level.

Farmer characteristics

Ninety-four percent of respondents (n = 122/130) were full-time dairy farmers. The average respondent received 87% of their farm income from dairy farming and 13% from other farm activities. Respondents (n = 126) owned on average 109 ha of land (SD = 88.8), with 65 ha in hayfields (SD = 65), and 22 ha in pasture (SD = 19; in Vermont alfalfa is an uncommon forage crop with >85% of forage crop acreage either in grass or grass–legume mixtures; pasture also is grass-dominated). An average of 15 ha were in wasteland (land considered to be economically unproductive for forage crops; SD = 30). Forty-two of the respondents (32%) also said that they keep some land in mixed hayfield or pasture. Those that did had a mean of 22 ha (SD = 34), although the mean value was only 8 ha when averaged over the whole population of respondents. Summarized as percentages (based on averaging individually reported field area proportions, not proportions of average areas), respondents reported that 55% of their fields were in hay (SD = 0.27, or 27%), 25% in pasture (SD = 0.21, or 21%), 10% in a combination of both (SD = 0.21, or 21%), and 11% were considered wasteland (SD = 0.12, or 12%). The average number of years that respondents (n = 115) had been farming was 36 (SD = 23.8), with a median of 32. Ninety-six percent of respondents (n = 124/129) had cows on their farm (there were a small number of respondents who owned and managed hayfields but did not own cows; for instance, one such respondent had just bought his farm), with the average number of milk cows being 128 (n = 125, SD = 129) and a median of 85. Ninety-eight percent (n = 122/127) used their own hay as at least a partial source of feed (n = 124), but only 24% of respondents (n = 29/123) sold their hay off farm and those farmers only sold an average of 13% of their hay (n = 123, SD = 12%). Overall, 39% (n =

Table 1. Changes in the timing of first cuts and the number of cuts per season over the past 10, 20, and 30 years based on a 2001 survey of dairy farmers in the Champlain Valley, Vermont. Note that sample sizes decrease from left to right as fewer current farmers were practicing 30 years ago.

Timing of first cut relative to								
10 years ago (n = 114)			20 years ago (n = 94)			30 years ago (n = 79)		
Earlier	Same	Later	Earlier	Same	Later	Earlier	Same	Later
54%	41%	5%	64%	29%	7%	72%	18%	10%
Number of cuts relative to								
10 years ago (n = 116)			20 years ago (n = 97)			30 years ago (n = 78)		
Greater	Same	Less than	Greater	Same	Less than	Greater	Same	Less than
47%	48%	5%	58%	37%	5%	71%	23%	6%

47/121) produced excess hay, but the previous result suggested that many of those who produced excess hay did not sell it. This may be produced as a buffer in case some of their hay in storage goes bad or inclement spring weather delays pasturing. Nearly half of respondents (n = 59/122) never buy off-farm hay, and only about 19% purchased hay every year.

Cutting characteristics

Determining the number of cuts undertaken by farmers was complicated by the fact that many farmers cut a variable number of times on different fields and that the average number of cuts varied from year to year. Hence, in the survey we asked for "typical" cutting schedules. Forty-seven percent of respondents had at least a portion of their fields cut only once (n = 124), 74% twice (n = 125), 77% 3 times (n = 125), and 17% 4 times (n = 123). Thus, the vast majority of farmers cut either 2 or 3 times per summer. Mean percentages for the amount of fields undergoing 2 and 3 cuts were 41% (median = 30%, n = 125, SD = 0.37) and 48% (median = 50%, n = 125, SD = 0.38), respectively. Roughly three-quarters of the first cuts occurred within one week of the first week of June, with that week representing the statistical mode (42/100), 13 in the preceding week (fourth week of May), and 20 in the second week of June. Fourteen additional first cuts occurred in the first 3 weeks of May and 11 first cuts occurred between the third week of June and first week of July.

Over recent decades, farmers have intensified their cutting schedules, starting earlier and cutting more frequently (Table 1). For example, 72% of farmers cut fields earlier and 71% harvest more frequently today than 30 years ago.

Attitudes toward alternative management practices

We asked farmers on what percentage of fields they would be willing to delay first cuts for songbird conservation. Fifty-one respondents (49%; n = 105) said that they would be willing to delay their first cut on at least some of their land. Those 51 respondents said they would be willing to delay the first cut on an average of 29% of their fields (SD = 27%). When the percentage given for this question was multiplied by individual hayfield area, we find that farmers would be willing to delay their first cut on 9% of total area (1,255 ha out of a total of 13,866 ha). The fact that this value was considerably lower than the acreage we obtained when multiplying the average proportion of land on which a farmer would be willing to alter management by total acreage (1,940 ha) suggested that those farmers who would alter management tend to have smaller farms.

We asked respondents to estimate how much money they would need to be compensated per acre for delays in the first cut. The median response was $190 (U.S.; or $470/ha), and the mean was $238 (or $588/ha; n = 54, SD = $475; with the elimination of one outlier of $10,000). While the low response rate and the high standard deviation on this question suggested its limited usefulness, it still provided a rough idea of the magnitude of the perceived financial damage from delaying the first cut.

Respondents also were asked to give their attitudes on a delayed first cut. The first set of questions asked about the likelihood of delaying cutting on at least some of their fields. Responses were from 1 to 10, with 1 being very unlikely and 10 being very likely. The mean response for altering the first cut was 3.09 (n = 114) and modal response

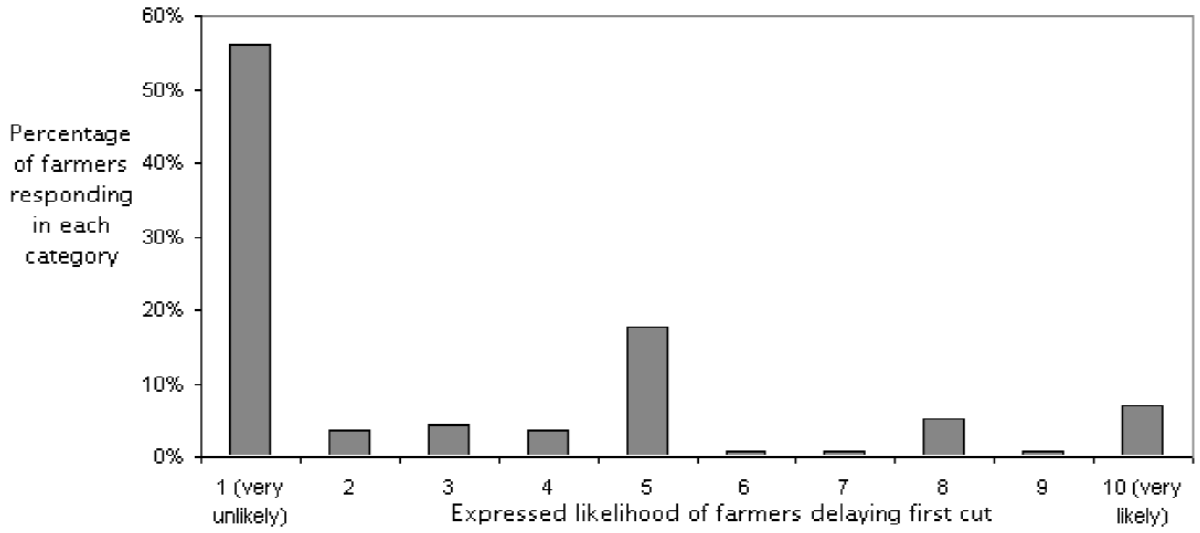

Figure 1. Likelihood of Vermont dairy farmers (n = 114) delaying their first cut, where 1 = very unlikely and 10 = very likely based on a 2001 survey in the Champlain Valley.

was 1 (56%). Sixty-eight percent of responses were below a 5 for the first cut, and 19% percent of responses fell in the zone of indecision (5–6). Despite the generally low scores, a few farmers responded with 10 (7%) for the first cut (Figure 1).

Respondents also were asked to rate the importance of the financial loss stemming from a delay in cutting as very important, somewhat important, slightly important, and not important at all. Consistent with the results of the previous questions, most respondents predicted that cutting delays would have severe financial repercussions with a mean score of 3.74 (n = 114, SD = 0.59). Eighty one percent of respondents who answered the question said that the financial effects of delaying the first cut would be "very important," 14.9% said it would be "somewhat important," 2.6% said it would be "slightly important," and 1.8% said it would be "not important at all."

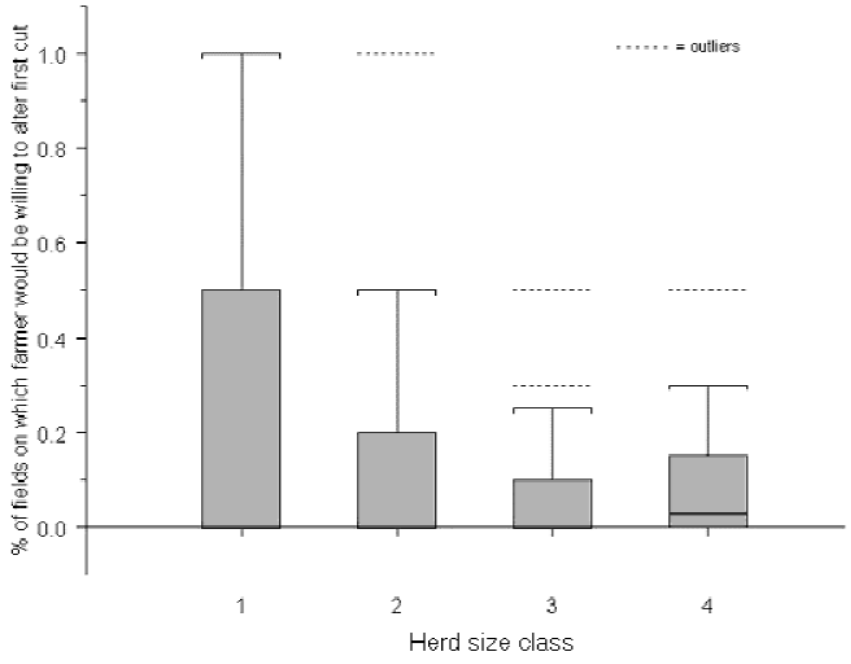

Figure 2. Proportion of fields on which Vermont dairy farmers (n = 125) would be willing to delay their first cut by herd size-classes based on a 2001 survey in the Champlain Valley. Herd size-classes 1, 2, 3, and 4 represent 12–134, 135–214, 215–300, and 301–1,705 dairy cattle, respectively.

Predictor variables

The percentage of fields on which respondents would be willing to delay their first cut differed among cow herd-size classes (one-way ANOVA, $F_{3,99}$ = 3.06, P = 0.031). The pattern displayed in the bar chart suggested that farmers with smaller herds were more likely to delay their first cut on a larger percentage of fields (Figure 2). Percentage of fields on

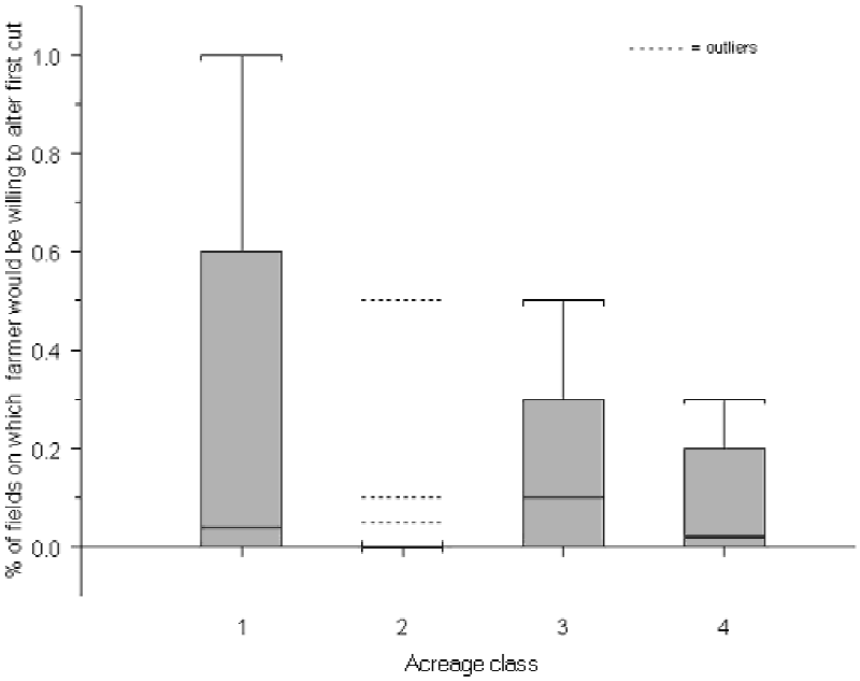

Figure 3. Proportion of fields on which Vermont dairy farmers (n = 98) would be willing to delay their first cut by acreage size-classes based on a 2001 survey in the Champlain Valley. Acreage size-classes 1, 2, 3, and 4 represent 5–53, 54–86, 87–122, and 122–691 ha farmland, respectively.

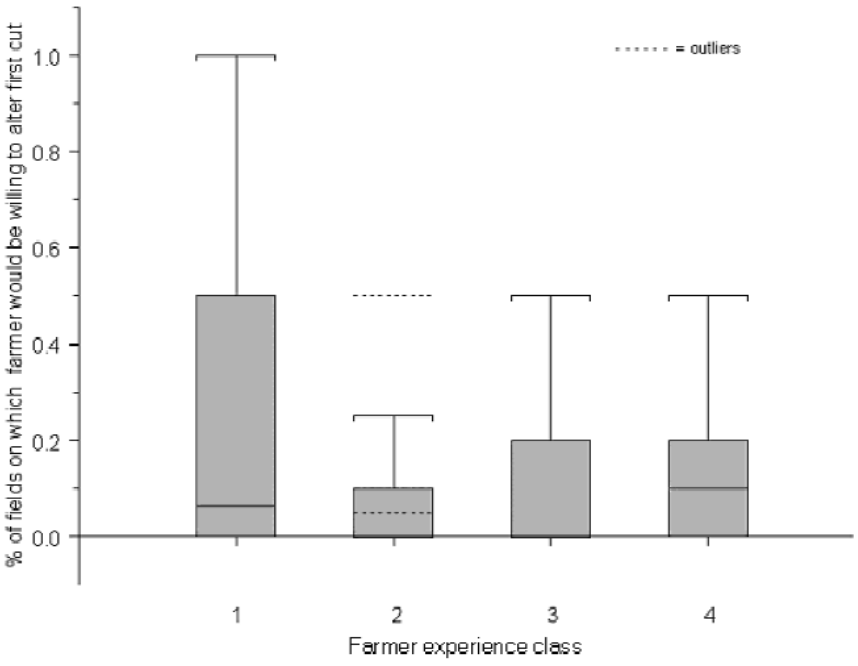

Figure 4. Proportion of fields on which Vermont dairy farmers (n = 98) would be willing to delay their first cut by farmer experience classes based on a 2001 survey in the Champlain Valley. Farmer experience classes 1, 2, 3, and 4 represent 0–15, 16–32, 33–54, and ≥55 years farming, respectively.

which farmers were willing to alter their first cut also varied based on farm acreage ($F_{3, 98} = 5.69$, $P = 0.0012$), although the pattern was somewhat ambiguous (Figure 3), since the response for the second acreage class (54–87 ha) was not significantly different from zero. We also found significant differences based on years farming categories ($F_{3, 97} = 6.05$, $P < 0.001$), again with a somewhat ambiguous pattern (Figure 4). Hay self-sufficiency, however, did not predict the outcome variable (one-way ANOVA, $F_{1, 100} = 0.539$, $P = 0.464$). Based on these results, we ran univariate regressions to determine whether there were linear relationships between the response variable (percent land on which farmer would alter first cut) and the first 3 predictors, represented as uncategorized ratio-interval data. No regression was significant at the 90% confidence level (all P values > 0.1).

We found significant nonrandomness in the count relationships between herd size-class and the importance of the financial loss resulting from a delayed first cut ($\chi^2 = 35.5$, $P = 0.0034$). The results suggested that the importance of financial losses from delayed cuts were greater for farmers with larger herds. Additionally, we found a nonrandom relationship between the frequency of off-farm hay purchase and the importance

of the financial loss resulting from a delayed first cut ($\chi^2 = 32.7, P = 0.036$). A Wilcoxon rank-sum test, however, indicated no relationship between the response and the binomial variable representing production of excess hay ($Z = 0.85, P = 0.39$).

Discussion

One of the clearest survey results was that agricultural habitat quality for grassland birds has decreased over the past 30 years due to changes in cutting practices. Many farmers are cutting earlier than even 10 years ago. In New York a similar result was reported in the late 1980s (Bollinger and Gavin 1992), which suggested that trends toward earlier cuts may continue, particularly in light of climatic changes (e.g., Root et al. 2003). Additionally, cuts are more frequent, which provides little opportunity for birds to re-nest following nest failure as a result of harvest. Early cutting is problematic for grassland songbirds in the Champlain Valley because most are incubating or feeding nestlings when most first cuts occur (N. Perlut, University of Vermont, unpublished data). Most importantly, dairy farmers appear to have little economic flexibility to alter their current management practices to accommodate the breeding schedules of grassland songbirds on most of their farm acreage. We found overwhelming agreement that most farmers would be highly unlikely to delay their first cut because of the significant financial loss it would entail. In the narrative comments section of the survey, 8 respondents who did not answer the question on compensation indicated that they would not delay their cutting for any amount of money. Several of them elaborated by saying that even slight delays can result in drastically reduced protein content and in turn lead to much lower milk yields. Several also said that any delay would be equivalent to giving up their hay crop: "Might as well not farm at all"; "Hay is worthless after June 25." Sixteen respondents who did not answer that question stated in their comments that they did not know how much compensation would be required, and several of them qualified that it would depend on many factors in that particular season.

These results taken alone suggest the substantial limitations to altering the first cut. It is likely that these limitations apply to dairy farmers throughout the traditional northern dairy belt. This is likely not only because of the comparably low profit margins of dairy farms in many of these states (e.g., Dartt et al. 1999 [Michigan], Jackson-Smith et al. 2000 [Wisconsin]), but also because of the similar characteristics of those dairy farms relative to Vermont dairy farms, and the general economic uncertainty of dairy farming due to income volatility and high capital investment costs (Mishra et al. 2002).

Bobolinks, like this male pictured above are one of several species of grassland songbirds that nest in Vermont's Champlain Valley.

Despite these constraints, there appears to be some potential for habitat improvement on dairy farmland, given the large percentage of respondents (49%) who expressed willingness to enact these delayed haying measures on at least a portion of their fields. Multiplying the percentage of land upon which respondent farmers would be willing to delay cuts by the reported acreage of those farms yields 1,255 hectares of improved songbird nesting habitat. Because cutting is the primary determinant of nest success in many dairy farming areas (Bollinger et al. 1990, N. Perlut, University of Vermont, unpublished data), this conversion of low-quality habitat to high-quality habitat has important conservation implications, especially because birds in early cut fields may fledge 0 young, as compared to 2–3 females per adult female in late cut fields (Bollinger et al. 1990). If enough birds use these delayed cut fields for breeding, it could substantially increase the reproductive output for grassland birds as a whole, depending on the number of females that nest in these fields.

Understanding the characteristics of farmers who are more likely to adopt alternative management strategies for improving wildlife habitat is useful in designing outreach and extension efforts. Although no statistically significant linear relationship was found, our ANOVA and box-plot results tentatively suggested that farmers with smaller herd sizes were more likely to alter management on

Because hay cutting typically requires machinery to pass over each field 3 times, disturbance to nesting birds is extreme. This picture shows windrowed hay ready for baling.

Following hay cutting, nests and eggs, like these bobolink eggs, are exposed to predators. Nearly 100% of nests fail following harvest.

a larger portion of their land than those with larger herd sizes. This pattern appeared strongest for herd size but less clear for acreage and experience class (although the visual pattern appears to suggest a negative correlation). This result suggests the limitations of targeting dairy farmers for the purposes of grassland conservation. If only those with smaller herds would be willing to participate, the aggregate amount of land affected will remain small. This generally is consistent with results from studies in other agricultural regions (Gould et al. 1989, Cary and Wilkinson 1997, Jacobson et al. 2003).

The lack of willingness of dairy farmers to voluntarily alter their management practices and the high levels of compensation necessary to alter management practices suggest that subsidy programs may have limited value to alter hayfield management in general. Currently, the CRP, WHIP, and GRP are the 3 most likely set-aside programs to provide habitat for grassland songbirds in the region. Given the relatively low current funding levels for these programs and the low total enrollment (<1,500 ha in Vermont), it is unlikely that these programs will prove sufficient for large-scale habitat conservation. However, regardless of mechanism, the results of our research suggest that subsidies could be used to pay farmers to take sub-optimal land out of hay production, or to limit cutting on those lands to late cuts for mulch or bedding.

Historically, the agricultural industry in New England has been a key force in maintaining habitat for grassland songbirds (Vickery and Dunwiddie 1997). However, as cutting intensity has increased on hayfields in recent years, the habitat quality of these lands has decreased. Our results suggest that economic constraints keep farmers from being able to significantly decrease cutting intensity so as to improve habitat. While many farmers responded that they were willing to enact less intensive management on a small portion of their land, this may not provide enough habitat to maintain viable populations of birds. These results are likely applicable to other states in the traditional dairy belt.

Although we have identified characteristics that correlate with the potential for farmers to alter management practices, extension efforts to promote conservation of grassland bird populations may need to be targeted toward landowners with less severe economic constraints. Throughout the northeastern United States there is a growing population of large-lot homeowners who occupy grasslands formerly managed as hayfields. The relatively low intensity of this exurban development pattern suggests that much of the acreage that has been lost to production is not necessarily lost as habitat for grassland songbirds. For instance, in a survey of 142 grasslands in the Champlain Valley, Shustack (2004) found that only approximately 50% of fields were cut by the first week in July. This suggests that a large proportion of grasslands in the Champlain Valley are not owned by dairy farmers. In particular large-lot residences on former hayfields may provide higher habitat quality than actively managed dairy farms because nonagricultural landowners are likely to have fewer economic constraints in management (sensu Raedeke et al. 2001*a*).

The declining agricultural industry in the Northeast may also create opportunities for state and federal agencies to purchase farmland (or easements) in areas that have high populations of grass-

land songbirds. Because grassland songbirds appear to preferentially select open landscapes upon initial settlement (Shustack 2004), it is critical to provide late-cut refugia in areas with high proportions of agricultural lands. Efforts that target enrollment programs for private lands adjacent to state wildlife management areas or national wildlife refuges may create reserves that provide high-quality habitat for individuals displaced by cutting on intensively managed agricultural lands. Targeting landowners for enrollment programs in suitable landscapes will likely provide greater benefits to grassland songbirds than scattered high-quality habitat in more forested areas. Perhaps most importantly, there likely is no single prescription that will be amenable to all landowners. Thus, greater contact between wildlife managers and private landowners will be critical to improve habitat quality for this declining suite of birds.

Directions for future research

A critical unanswered question is how much high-quality habitat is needed to maintain viable populations of grassland birds. Regional population viability analyses should be undertaken to estimate how much dairy farm acreage is both suitable bird habitat (in terms of site characteristics, size, and spatial arrangement) and poor enough in quality that farmers would be likely to alter their management practices. Future research should also assess the acreage and configuration of large-lot residential grasslands, the flexibility of these property owners in their management regimes (since many are dependent on neighboring farmers to do the cutting), and the minimum size for such suburban patches to constitute suitable habitat. Not only should an inventory be taken of the acreage of and rate of conversion to these types of suburban lots, but surveys and interviews should be conducted to assess the attitudes of these landowners toward wildlife on their property, willingness to maintain grassland conditions, and willingness to engage in longer cutting cycles. This information could serve as a basis for devising a landscape-scale management plan to sustain viable populations of grassland songbirds.

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