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Note

A Model for Integrating Wildlife Science and Agri-Environmental Policy in the Conservation of Declining Species

NOAH G. PERLUT,[1] *Department of Environmental Studies, University of New England, 11 Hills Beach Road, Biddeford, ME 04005, USA*
ALLAN M. STRONG, *The Rubenstein School of Environment and Natural Resources, University of Vermont, 347 Aiken Center, Burlington, VT 05405, USA*
TOBY J. ALEXANDER, *USDA NRCS, 356 Mountain View Drive, Suite 105, Colchester, VT 05446, USA*

ABSTRACT We examined a case study where a successful wildlife-friendly model for intensively managed hayland was developed from field data and implemented locally as policy by a federal agency. Farmers were ensured a first hay-harvest with high protein content; after a 65-day delay (compared to the normal 35–40-day cutting cycle) farmers took a second harvest of greater quantity but decreased quality. Farmers were paid $247–333/ha in 2008–2010 to offset costs associated with the decreased nutritional content caused by the approximately 25-day second harvest delay. Bobolink (*Dolichonyx oryzivorus*) reproductive rates improved from 0.0 to 2.8 fledglings per female per year. Creation and implementation of this policy required communication among scientists, federal agricultural agencies, farmers, and state and federal fish and wildlife departments. Data collection, analyses, and communication processes served as an effective global model for practitioners to apply to other agricultural products and taxa.

KEY WORDS agri-environmental policy, bobolink, *Dolichonyx oryzivorus*, eastern meadowlark, Grassland Bird Conservation Incentive, hayland management, *Passerculus sandwichensis*, Savannah sparrow, *Sturnella magna*, wildlife friendly farming.

Globally, large-scale agricultural production has contributed to dramatic declines in grassland-dependent wildlife through land conversion and intensive land management. More than 70% of the world's temperate grasslands are now devoted to agriculture (Hannah et al. 1995). In both North America and Europe, agricultural lands now serve as the primary breeding habitat for many grassland bird species (Rodenhouse et al. 1995, Wilson et al. 2005). However, agricultural lands are generally low quality breeding habitats, either due to habitat structure (e.g., conversion to rowcrops) or management intensity (e.g., frequent hay-harvests). In forage crops, nests of grassland birds are destroyed by machinery during harvest, thereby decreasing reproductive success (Klett et al. 1988, Bollinger et al. 1990, Perlut et al. 2006). Intensive management of these forages decreases adult apparent survival (Grüebler et al. 2008; Perlut et al. 2008*a*) and these demographic effects have contributed to precipitous population declines (North America: Peterjohn and Sauer 1999, Sauer et al. 2005; Europe: Chamberlain et al. 2000, Donald et al. 2006). As important, agriculture's negative influence on grassland species and other wildlife communities continues to expand, particularly with increasing world food and energy demands (Green et al. 2005).

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[1]*E-mail: nperlut@une.edu*

In response to agriculture's impact on natural resources, national-scale agri-environmental policies have been created to balance farming and ecological concerns of which wildlife habitat has increasingly become a significant factor in these policies. Agri-environmental policies follow either a wildlife-friendly or land-sparing farming scheme. Wildlife-friendly farming decreases the intensity of production and increases habitat heterogeneity, although due to decreased intensity, production may occur at greater spatial extents (Green et al. 2005, Fischer et al. 2008). In the land-sparing scheme, homogenous areas are farmed intensively to maximize yields, leaving islands or corridor reserves to support ecological communities (Waggoner 1996, Green et al. 2005, Fischer et al. 2008). Both schemes have been funded at the national scale in several countries. In 2008, the United States Department of Agriculture (USDA) Farm Bill directed $1.8 billion to the Conservation Reserve Program (CRP; Cowan 2008). In European Union countries, between 1994 and 2003, $32.1 billion was spent on agri-environmental schemes (Kleijn and Sutherland 2003). These large-scale agri-environmental policies have had mixed success and have been criticized for not having used sound science during their original conception (Kleijn et al. 2001, Kleijn and Sutherland 2003) or implementation (Weber et al. 2002).

United States agri-environmental programs have shown successively greater emphasis on wildlife in the last 4 Farm Bills (e.g., 1990, 1996, 2002, and 2008

Amendments to the 1985 Food Security Act or Farm Bill) but the language is often general. Farm Bill programs such as CRP, the Wildlife Habitat Incentive Program (WHIP), Environmental Quality Incentives Program (EQIP), and Wetlands Reserve Program (WRP) encourage or allow for habitat improvements but at a national scale cannot specify innovative management practices targeted to local conditions. That grassland birds continue to decline despite national conservation programs illustrates the need for programs that are adapted to the requirements of both farmer and wildlife (while acknowledging that populations are also affected by ecological conditions on the non-breeding grounds). Such adaptation can be achieved through local research and implementation of innovative management schemes that may be applied at a wider geographic scale.

In the United States, habitat conservation plans for grassland birds have primarily followed the wildlife-friendly scheme, delaying agricultural management until after birds have concluded breeding (Massachusetts Audubon Society 2003). Within the USDA, the Natural Resources Conservation Service (NRCS) and Farm Service Agency have established species-specific breeding season dates that recommend when management must not take place, ensuring that breeding opportunities for birds are not directly compromised by management. Because this scheme significantly limits agricultural opportunities, few farmers have the flexibility to adopt such programs on their most productive lands. As important, in regions where intensive agricultural management comprises a significant portion of the landscape, negative population growth rates on the most productive agricultural lands for forage crops may drive large-scale population declines of wildlife (Perlut et al. 2008*b*). Therefore, agri-environmental programs tailored toward local conditions are needed in areas managed intensively for agriculture.

In Vermont, USA, WHIP has been used to implement traditional wildlife-friendly schemes for grassland birds through delayed haying. This cost-shared management allows mowing or other disturbances outside the primary nesting season: 15 April-1 August. The dates were established to include most breeding bird species in Vermont due to the variety of habitats managed through Farm Bill programs. The Wildlife Habitat Incentive Program practices are implemented through a conservation plan and associated cost share contract, as incentive payments are not allowed by statute. The Wildlife Habitat Incentive Program can only reimburse the landowner for up to 75% of the management practice cost; the 2008–2009 delayed mowing reimbursement was $62/ha. Therefore, the cost-share was based upon the mowing cost and no incentive payments were allowed to compensate for lost production. Although WHIP has been a popular program in Vermont, most participants have not been farmers; enrolees often own small fields in a forested, non-agricultural landscape where grassland bird densities are, by nature, low. As a result, WHIP management practices have not been systematically applied to promote grassland bird conservation on economically viable agricultural lands in target regions.

We developed a model in Vermont of how field data combined with policy decisions at the local level can be used as a model for successful agri-environmental policy. Through an intensive demographic study of obligate grassland songbirds and recognition of farmers' inability or unwillingness to idle productive land, we developed the Grassland Bird Conservation Incentive (GBCI) for productive hayland. In 2007, NRCS in Vermont applied the science supporting this scheme to EQIP, creating an agri-environmental model intended to balance grassland bird conservation and farmer needs. We determined that success of this model would be defined by: 1) farmers expressing satisfaction that their economic and production needs were met and 2) raising avian reproductive rates to $\geq$2 offspring fledged per female per year. In 2008–2010, we evaluated the incentive program outcomes.

STUDY AREA

Our field research took place in Vermont and New York's Champlain Valley. Hayfields, pastures, and corn fields comprised 62%, 18%, and 20%, respectively, of agricultural lands (Perlut et al. 2008*b*). Dairy accounted for most agricultural land in this region. Hay-harvest occurred asynchronously across 146,000 ha of managed grasslands (USDA 2007). Harvest began in mid- to late-May as forage protein levels are highest at this time (Cherney et al. 1993), and lactating dairy cows require high protein diets (Bosworth and Stringer 1985). Annual variation in the timing of rainfall determined the temporal pattern of hay-harvest, where heavy precipitation sometimes limited early-season farming activities. In general, hayfields harvested in May or early-June continued to be managed intensively with $\geq$2 additional cuts during the growing season on an approximately 35–40-day cycle. Between 19% and 50% of the Champlain Valley's grassland habitat was managed during this period (Perlut et al. 2008*b*). Beef cattle and horses have lower forage protein requirements such that harvests typically began in late-June or early-July with only one additional cut during the growing season.

Diverse management objectives created a mosaic of management intensities in which bird reproductive success and apparent survival were determined by the timing of management operations. For example, bobolinks (*Dolichonyx oryzivorus*) show extreme demographic variation between fields managed for dairy cows (cut before 11 Jun, and $\geq$2 additional cuts through growing season) and those managed for beef cattle and horses (cut 21 Jun to 10 Jul, and $\geq$1 additional cut through growing season). Bobolink nest success and annual productivity (no. fledglings per female per year) were 5% and 0.0, respectively, on fields managed for dairy cows and 32% and 2.22, respectively, on fields managed for horses and beef cattle (Perlut et al. 2006) with differences directly attributable to management operation timing and intensity. Bobolink per-hectare densities were 0.25, 0.33, and 0.36 for fields cut before 11 June, 21 June–10 July, and after 1 August, respectively (Perlut et al. 2008*b*).

METHODS

We created the GBCI by examining nest initiation timing relative to the timing of hay-harvest and subsequent behavioral responses to harvesting. We focused on 3 obligate grassland songbird species, the bobolink, savannah sparrow (*Passerculus sandwichensis*), and eastern meadowlark (*Sturnella magna*), and we designed the model around the more sensitive bobolink's habitat requirements. We applied data from 2002 to 2007 to understand annual variation in population and management processes and identified the following 4 critical factors for model development. First, all active nests failed within 48 hr of hay-harvests (Perlut et al. 2006). Second, response to haying-induced nest failure varied among species. Savannah sparrows initiated renesting activities immediately after the haying process, whereas the more sensitive bobolink abandoned the field immediately after nest failure and did not return until suitable vegetative structure had regrown, generally a minimum of 15 days. Once they returned, females needed approximately 9 additional days to settle, select a mate, and initiate nest building (Fig. 1). Third, as the date of first harvest moved further into the breeding season, the probability of recolonization decreased, particularly for bobolinks, such that fields hayed after 2 June were rarely recolonized. Fourth, incorporating the length of nesting cycle and period of juvenile dependence was critical. In this system, the egg laying, incubation, and nestling periods took 26–29 days (Perlut et al. 2006), and we assumed the fledgling care period took $\geq$12 days (Wheelwright and Templeton 2003). We thus estimated total recolonization time and a second full nesting cycle to be 65 days.

Vermont NRCS reviewed findings from Perlut et al. (2006) to determine their applicability to Farm Bill programs. The program would require that farmers complete all management on their hayfields by 2 June (preferably earlier) and not mow the field again for 65 days. This program would allow for a typical quality first cut, lower quality (but larger) second cut, and typical quality third cut late in the season. During discussions it became apparent that this scenario may be acceptable to farmers, would fit well into an active agricultural landscape, and would benefit grassland birds. However, significant changes to hayland management that benefit grassland birds would require a reasonable incentive payment to the farmer. Because WHIP did not offer incentive payments, EQIP was selected as the best possible choice to implement the model. This proposed EQIP incentive was the first in Vermont that specifically addressed declining wildlife species rather than the traditional primary focus on soil and water conservation.

In 2006, the concept of an EQIP GBCI (NRCS 2007) on hayland was introduced to the Vermont State Technical Committee (STC). Because this was a non-traditional use of EQIP funds there was some disagreement among partners as to whether it should be supported. However, only one member of the STC opposed the incentive, whereas the United States Fish and Wildlife Service (USFWS) and Vermont Department of Fish and Wildlife (VDFW) voiced their support. The Vermont NRCS State Conservationist, as committee chair and final decision maker, considered all recommendations and agreed to offer this incentive within EQIP to address the promotion of at-risk species habitat conservation national priority of the program.

In March 2006, we developed criteria for land managers to implement an incentive through EQIP. The model focused on intensively managed hayland where a change in management would be necessary to benefit nesting grassland birds. Fields only cut once later in the season were not eligible as there would be no change in management that significantly increased nesting productivity. Eligible fields were required to be $\geq$8.1 ha, have a low perimeter-to-area ratio (approx. square), and have been used as hayland for 3 of the last 5 years (Bollinger 1995, Bollinger and Gavin 2004). Field vegetation was required to be 50–75% grass (Bollinger 1995) with only $\leq$10% allowed as reed canary grass (*Phalaris arundinacea*) due to the poor nesting habitat it provides for target species. The

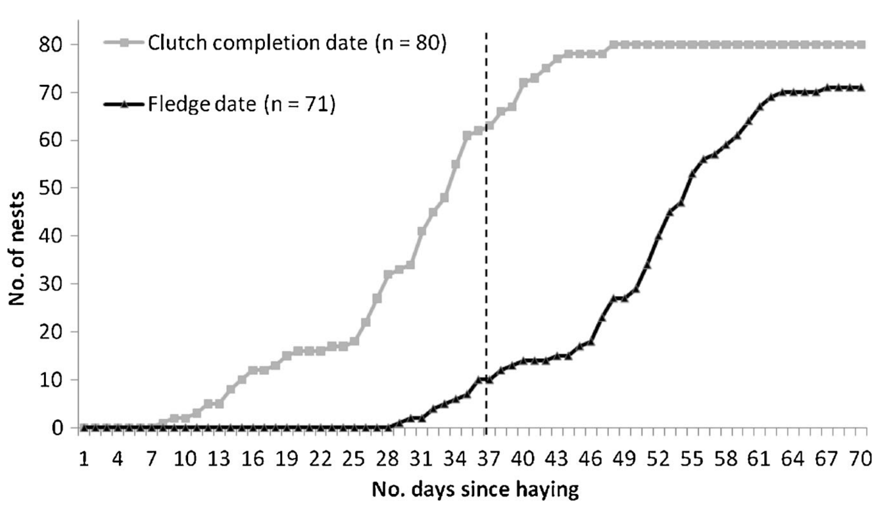

Figure 1. Bobolink (*Dolichonyx oryzivorus*) clutch completion and fledging dates on 2 hayfields harvested on 22 May 2008, 25 May 2009, and 16–17 May 2010, Champlain Valley, Vermont. Clutch completion date is the day the last egg in a given clutch is laid, and fledging date is the day nestlings walk out of the nest. The vertical dotted line indicates the standard second harvest date, 35–40 days after the first hay-harvest.

first hay harvest and all associated management operations including raking, baling, and nutrient application must be completed by 2 June, although early completion (by 31 May) is encouraged. Because bobolinks begin nesting in mid- to late-May, under this cutting date all first nesting attempts fail; however, farmers gain the critical first harvest for feed. The second harvest can occur no earlier than 65 days after the last management activity. Once during the 3-year contract, if weather conditions do not allow a 2 June completion, harvest may occur as early as 15 July. In return for following this plan landowners received $247/ha (US) in 2008 and $333/ha in 2009 each for 3 1-year periods. Payment is designed to compensate farmers for the loss in value of a delayed second cut and was established primarily by using typical hay yields and current prices for second cut hay as listed in the Hay and Forage Directory of the Vermont Agency of Agriculture's "Agriview" newsletter (Vermont Agency of Agriculture 2010).

In the initial pilot year, 2008, 6 farms enrolled 6 fields totaling 93.9 ha ($\bar{x} \pm$ SD field size = 13.4 $\pm$ 10.1 ha). Participants were in Chittenden County ($n = 1$), Grande Isle County ($n = 1$), and Rutland County ($n = 4$). Participants were identified at a state level by news releases, partner newsletters, workshops, and field agent outreach. However, most interest came as the result of 2 front page news articles in the largest newspaper in the region (Page 2007, 2009). Due to logistics of moving machinery, one farm chose to manage additional fields under the plan without receiving financial incentives. Two farms failed to follow program guidelines and were therefore not included in the analysis. In total, 4 farms, including 5 fields and 72.4 ha (14.5 $\pm$ 4.0 ha), participated in the program's first year (2008). In 2010, following the 2009 newspaper article, the program grew substantially; 24 farms participated, encompassing 411 ha ($n = 29$ fields; 14.2 $\pm$ 8.0 ha).

Beginning in mid-May we evaluated nesting phenology and reproductive success for all breeding bobolinks on one enrolled 18.1-ha field and one similarly managed 19-ha field. In the Champlain Valley, 23% of hayfields have a similar timed first hay-harvest as these fields (Perlut et al. 2008*b*). These regular-shaped, well drained fields were primarily composed of alfalfa (*Medicago sativa*), red clover (*Trifolium pratense*), white clover (*Trifolium repens*), dandelion (*Taraxacum officinale*), orchard grass (*Dactylis glomerata*), and reed canary grass. These fields were approximately 1.5 km apart, separated by a forested parcel and a hayfield. No birds moved among fields within the breeding season. Because these fields were managed at the same time, and breeding populations were independent, we pooled their associated data. Hay was harvested from both fields on 22 May 2008, 25 May 2009, and 16–17 May 2010. Post-harvest, we found nests through behavioral observations of breeding females or by flushing incubating females off nests. We visited nests every 1–2 days, recording the status of nest contents, until fledging or failure.

For comparison, we evaluated bobolink nesting phenology and reproductive success on 2 fields (17.6 ha and 8.4 ha) where hay was first harvested after 1 August (delayed mowing). In the Champlain Valley 45% of hayfields are managed after 1 August (Perlut et al. 2008*b*). These fields were >8 km apart, had moderate drainage, and were grass dominated, including orchard grass, timothy (*Phleum pretense*), bluegrass (*Poa* sp.), reed canary grass, and vetch (*Vicia* sp.). One of these fields also included sedge (*Carex* spp.) and bedstraw (*Galium* sp.). In this management regime, annual productivity was highest in the Champlain Valley (Perlut et al. 2006). We followed the same field protocols on these fields as outlined above. In 2008–2009, we conducted informal interviews with participating farmers after the growing season concluded to see if they met their management objectives.

RESULTS

After the first hay-harvests in 2008–2010, we found nests for 88 female bobolinks. Per-hectare female density on these fields was 0.88 (SD = 0.18). Fifty-eight of 80 (72.5%) females completed clutches 25–42 days after the late-May harvests (Fig. 1). Seventy-two of 86 females (84%) successfully fledged $\geq$1 young. Annual productivity was 2.83 (SD = 1.61) fledged per female per year; mean clutch size was 4.20 (SD = 0.91). By comparison, on the 2 fields harvested after the nesting season (after 1 Aug), annual productivity for 79 females was 3.37 (SD = 2.12) fledged per female per year; mean clutch size was 4.95 (SD = 0.87; Fig. 2). Sixty-one of 76 females (80%) successfully fledged $\geq$1 young. Per-hectare female density on these fields was 1.16 (SD = 0.12). In 2009–2010 we located 15 (7 F, 8 M) adult bobolinks born in 2008–2009 on the 2 study fields enrolled in the GBCI, indicating that habitat provided by this scheme produced high-quality young who were fit enough to migrate to South America, return to Vermont, and recruit into the breeding population.

We conducted informal interviews with participating farmers ($n = 7$) after the growing season concluded. Each farmer was able to meet their management objectives under the plan and thought that the incentive payment was reasonable. All farmers reported that the second harvest was larger, although slightly less in quality. In 2009, farmers used both the first and second harvests for feeding dairy ($n = 4$) and beef ($n = 3$) cows. Two farms that used the feed for beef cows also sold hay as horse feed. The 2 farms that were unable to meet the objectives in 2008 did not receive the incentive and did not attempt to participate in 2009. One of these farms enrolled due to the attractive incentive payment, however they realized that the necessary timing of management was 1–2 weeks earlier than what would be appropriate on their low-lying land where early growth was delayed due to saturated soils. The second farm changed management objectives after signing up for the program and did not cut the field during the 2008 breeding season.

DISCUSSION

The GBCI was successful, balancing intensive agriculture and bird reproductive needs. Although this conservation success was important to document, the process—open communication between researchers and a government agency

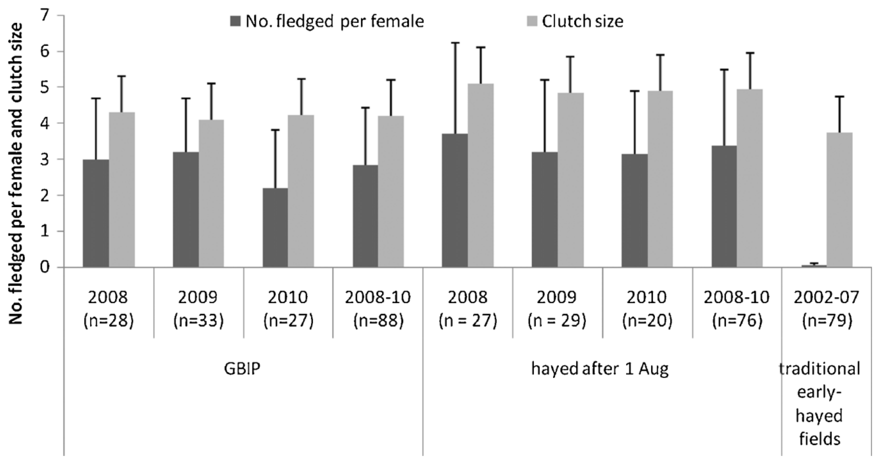

Figure 2. Annual productivity and average clutch size for bobolinks breeding on fields enrolled in Vermont's Natural Resource Conservation Service (NRCS) Grassland Bird Incentive Program (GBIP; hayed before 2 Jun, with a 65-day interval before the second harvest) was similar to that of fields hayed after 1 August and signficantly greater than traditionally managed early hayed fields (cut in late-May or early-June and again after 35–40 days).

that has direct contact with farmers—is equally important to create economically viable agri-environmental policies. Whereas these policies may also have indirect benefits for other ecological features (e.g., benefiting soil quality by keeping productive land out of corn rotation), it has narrow goals, which provide an improved breeding opportunity for grassland birds while ensuring the farmers' economic and production needs are met. Underlying these goals, this program aims to: 1) end species decline within the study region and 2) serve as a model that illustrates the types of biological data and communication necessary to create similar programs and policies elsewhere.

In summary, songbird reproductive rates improved dramatically and farmers were ensured a first hay-harvest with high protein content; in conversations with participating farmers, although the sample was small, all indicated that they were satisfied with the program. This program offered a notably higher monetary incentive compared to other conservation programs in the state. For example, WHIP payments in Vermont were $62/ha and GRP were $25–40/ha (general whole field CRP was not an active program in this state). Importantly, these programs required a significantly delayed first harvest.

In this GBCI, early nesting attempts will fail during the first harvest; however, at that time in the nesting season females have made only modest energetic investment because most are in the egg laying or early incubation stages. Timing of initial harvest and delay in the second harvest provided sufficient time for females to renest. The level of reproductive success on GBCI fields was nearly equivalent to the most productive habitats in the landscape (i.e., fields hayed after 1 Aug). For our study region, 2 June is the latest possible date in which the most sensitive species, the bobolink, could receive a positive effect because females do not re-colonize fields hayed after this date. However, cutting as early as possible in May is ideal, as more birds settle in fields that have been cut earlier. We caution practitioners to time their management activities such that both farmers and wildlife benefit, but we encourage dialog on the costs and benefits of modest changes in policy guidelines. For example, the summer of 2011 management guidelines have been revised from 2 June to 31 May to ensure an optimal return on investments.

With sufficient funding to support both researchers and farmers, the principles within this scheme are easily transferable to diverse regions and taxa where nesting habitat is managed during the breeding season. To apply this scheme to other regions and taxa, researchers will need a fundamental understanding of species reproductive behavior and, more importantly, how this behavior varies annually. We assessed the response of first nesting attempts to first hay-harvest (always nest failure). Additionally, though not detailed here, we evaluated the response of multiple species to harvest and focused on the most sensitive species. In this program, the habitat requirements of an umbrella species (i.e., bobolink) were sufficient for the other species. Then we evaluated how the timing of first harvest (16, 17, 22, 26, 27, 28 May; 3, 5, 7 June) affected recolonization probability. Finally, we evaluated the length of the entire reproductive cycle and established a necessary window for successful field-level reproduction (Perlut et al. 2006).

After the contract lifespan, the farmer may revert to previous management regimes. As evident from significant enrollments in agri-environmental schemes like CRP (fiscal year 2008: approx. 14,050,000 ha; Cowan 2008) farmers are clearly interested in agri-environmental programs that fit their economic needs and are convenient to implement. The scientific, policy, farming, and conservation communities need to reconsider how to maximize positive benefits of such subsidies, as temporary contracts for conservation programs can result in land-use practices extending beyond contract periods (Roberts and Lubowski 2007). Therefore, sound, practical policies have the potential to affect change during and after subsidy contract periods.

Because attitudes and requirements of farmers will change over time, researchers, land managers, agency personnel, and other partners need to be capable of adapting to ensure wildlife needs are met. The Farm Bill is the primary funding mechanism in the United States but it is generally amended every 5–6 years. Although Farm Bill conservation programs are well funded and popular, specifics of implementing programs locally can be complicated and confusing. Potentially, program rules and purposes, national and state priorities, and methods of payment will change and entirely new programs may be added with each successive Farm Bill. Mechanisms for implementation of this incentive or any other innovative management, currently through an EQIP incentive, may need to be adapted to new policy conditions. Therefore, it is critical for research scientists and agency personnel to maintain communication on existing management programs as well as to explore other habitat management or restoration opportunities.

This wildlife-friendly scheme is intended to complement, not supplement, current agri-environmental land-sparing policies. Because hay-harvest occurs throughout the summer, neither wildlife-friendly nor land-sparing schemes could apply exclusively to conservation of grassland species within this or comparably diverse agricultural landscapes (Mattison and Norris 2005). In our study region, the wildlife-friendly cost-share for delayed hay-harvest (after 1 Aug) through WHIP is the optimal management plan for birds, as it avoids the significant evolutionary implications created by the first hay-harvest (Perlut et al. 2008*c*). However, the late-harvest model cannot meet farmer management objectives for intensively managed forage crop fields, particularly in regions where intensive agriculture accounts for a significant proportion of land use practices. Instead, conservation partnerships in developed or developing agricultural regions should seek to apply both models.

Management Implications

Successful, science-based agri-environmental programs can only be created in environments that encourage open dialog and research efforts among scientists, policy-makers, agricultural producers, non-governmental organizations, and agencies at the local level who implement policy. Federal conservation programs cannot afford to purchase and permanently idle large grassland reserves, and human food and economic needs cannot afford to ignore biodiversity (e.g., Allen-Wardel et al. 1998) and other natural resource concerns. Consequently, successful programs should be evaluated by their ability to integrate economic and human welfare needs of food systems with those of wildlife. We examined a successfully implemented conservation practice, including the necessary demographic (i.e., behavioral and reproductive) and management data and collaborative processes. By incorporating detailed data with diverse local partners we created and implemented an agri-environmental scheme that met its own goals: this program increased bird reproductive rates to at least replacement values while satisfying farmers' economic and production requirements.

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