Articles

Financial Analysis of Converting Rural Lawns to Pollinator Habitat in the Corn Belt

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Abstract

Conservation efforts in rural landscapes seek to improve the multifunctional nature of land uses for people and the biotic communities that support them. In these environments, existing turfgrass lawns mowed routinely through the summer present an opportunity where changes in management from intensively managed monocultures to diverse native perennial vegetation can stack environmental benefits by improving soil health, water quality, and wildlife habitat. Conversion of lawns to pollinator habitat can help achieve continental goals of reversing declines in high-profile species such as the monarch butterfly *Danaus plexippus* and native bees. Here, we examine the financial implications for landowners and managers considering conversion of lawns to pollinator habitat in rural landscapes. We examined financial factors over a 10-y management horizon in three unique scenarios with a range of expenses: self-maintenance of lawns, contracted maintenance of lawns, and establishment and management of pollinator habitat. Our analyses indicate conversion to pollinator habitat was appreciably less expensive ($54–$167·acre^{-1}·y^{-1}) than continued self-care ($637–$1,007·acre^{-1}·y^{-1}) or contracted care ($326–$1,034·acre^{-1}·y^{-1}) of lawns over a 10-y period. These results establish the financial benefits for landowners or land managers considering an alternative management paradigm of existing lawns. These financial benefits complement existing literature, demonstrating multiple ecological benefits of diverse native perennial vegetation.

Keywords: Corn Belt; financial analysis; monarch butterfly; mowing; pollinator habitat; prairie; turfgrass lawns

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Introduction

Extensive changes in midwestern agricultural landscapes are leading to a reduction in their capacity to support biological diversity. Production practices in row cropped areas reduce diversity of crops grown in rotation, consolidate livestock production, and increase the use of genetically engineered crops to manage weeds and insect pests that, in total, promote uniform stands of crops (Krapu et al. 2004; Hartzler 2010; Brown and Schulte 2011; Pleasants and Oberhauser 2013). Pasturelands managed as monocultures of introduced forage grasses or native warm season grasses suitable for grazing or haying typically do not include a diversity of forbs. These crop- and grass-dominated landscapes provide limited nectar or pollen forage to support honeybees, native bees, or other pollinators (Naug 2009; Goulson et al. 2015). In nonagricultural components of the landscape, such as field edges, drainage areas, roadside ditches, and grassed industrial, home, and farmstead areas, homogenization of the plant communities manifests via a combination of invasive species (Bahm et al. 2017) and mowing, burning, or herbicide applications (Hopwood et al. 2015; Wheeler et al. 2017). Collectively, these extensive trends toward homogenization in rural midwestern landscapes precipitate growing challenges for the monarch butterfly *Danaus plexippus* (Thogmartin et al. 2017), pollinators (Naug 2009; Goulson et al. 2015), and grassland birds (Stanton et al. 2018).

Various conservation, land use, and research organizations promote policy and investments to facilitate monarch butterfly and pollinator habitat establishment in varied land use contexts (Hopwood et al. 2016; Thogmartin et al. 2017; Hall and Steiner 2019). In row crop–dominated areas, farmer and landowner interest in strips or patches of high-diversity, perennial native grasses and forbs planted in field contours and edges shows great promise to enhance multiple ecosystem service outcomes, including pollinator conservation (Schulte et al. 2017). Since 2008, we have seen conversion of just over 162,000 ha of row crop (largely in midwestern states; Iowa farmland accounts for just over half) to high-diversity pollinator habitat through the U.S. Department of Agriculture's Conservation Reserve Program CP-42 Pollinator Habitat (USDA FSA 2020). In roadside areas, state transportation agencies collectively manage approximately 4 million ha to promote native grass and forb species, minimize noxious or invasive plants, prevent erosion, and create pollinator habitat (Glass and Smith 2018; Cariveau et al. 2019).

Despite these efforts, a need for significant habitat establishment remains. Monarch butterfly conservation requires coordinated efforts to establish 1.3–1.6 billion milkweed stems in the Upper Midwest over the next 20 y (Pleasants 2017; Thogmartin et al. 2017). Thogmartin et al. (2017) modeled a variety of monarch butterfly conservation scenarios in the midwestern core of their summer breeding range and determined an "all hands on deck" effort including natural areas, farmland enrolled in the Conservation Reserve Program, road rights of way, and grass-dominated sites across rural, suburban, and urban landscapes will most likely reverse trends in monarch butterfly population declines.

Across each of these land use contexts, monarch butterfly habitat improvements are likely to have positive spillover effects on pollinators, grassland birds, and other imperiled organisms in working agricultural landscapes. Meaningful improvements in a broad suite of ecosystem goods and services, including water quality, soil health, and wildlife habitat, come from increases in diversity of native plants in existing or new natural areas in rural landscapes (Fornara and Tilman 2008; Pérez-Suárez et al. 2014; Schulte et al. 2017). In those landscapes, policy makers and conservationists find promise for progress in areas where existing land use practices are mismatched with landowner goals for profitability or cost management (Muth 2014; McConnell and Burger 2016; McConnell 2019). Here, we explore one such area: managed turfgrass monocultures (hereafter lawns). Establishing diverse native perennial vegetation that can support pollinators and other wildlife in these environments could serve as a means to reintroducing landscape heterogeneity into agroecosystems (sensu Kremen and Merenlender 2018) and urban spaces (Hall et al. 2017) without cost to the capacity of this system to produce crops for food, feed, fuel, or fiber.

Lawns feature prominently in urban and rural landscapes (Larson et al. 2016). There is an estimated 163,800 km^2 (63,244 mi^2) of lawns in the continental United States (Milesi et al. 2005). In some midwestern locations, lawn footprints are among the more dominant land use; for example, in one largely urban county in Ohio, 23% of land area was in lawns (Robbins and Birkenholtz 2003). Most lawns, under prevailing management paradigms, are functional monocultures of nonnative plants (Wheeler et al. 2017) that contribute little to native biological diversity and generate few ecosystem functions compared with comparable natural landscapes or deliberately diverse landscaping (Smith et al. 2015). Thus, areas currently in lawns present an opportunity for provisioning additional ecosystem goods and services outside agricultural production and in urban and suburban "green spaces" when considering management alternatives.

There is a lack of study on the financial implications of alternatives to lawns, such as pollinator habitat, in these environments, particularly across time spans that capture the financial dynamics of establishing and managing pollinator habitat that feature short-term establishment costs, but decreasing, periodic management costs in the long run (Aronson et al. 2017). Here, we examine the financial implications of converting lawns (or portions thereof) to pollinator habitat with diverse native perennial vegetation that supports monarch butterflies, pollinators, and other wildlife. Our objectives were to evaluate costs of conventional large lot lawn maintenance routines for home and industrial landowners under various management strategies and compare these costs with estimates of costs associated with establishment and maintenance of pollinator habitat. Although our analytical frame and analyses focus on rural settings, our findings also provide a conservative estimate of the financial context of establishing pollinator habitat in industrial, suburban, or urban lawns, where expenses for care tend to be higher (Blaine et al. 2012).

Methods

In rural landscapes in the core of the monarch butterfly summer breeding range, large patches of unused lawns can be found in myriad contexts: animal facilities; home and farmsteads; equipment storage sites; agricultural service and education centers; and city, town, or village open spaces (Figure 1). Our analysis assumes one of these contextual situations, as shown in Figure 1, where private landowners make decisions about management routines for relatively large lawns (>1 acre [>0.4 ha]). This study provides comparative cost information over time for establishing and managing pollinator habitat versus managing extant lawns. We define pollinator habitat as a diversity of native flowering herbaceous forbs and grasses typical of tallgrass prairie environments in the midwestern United States. Custom

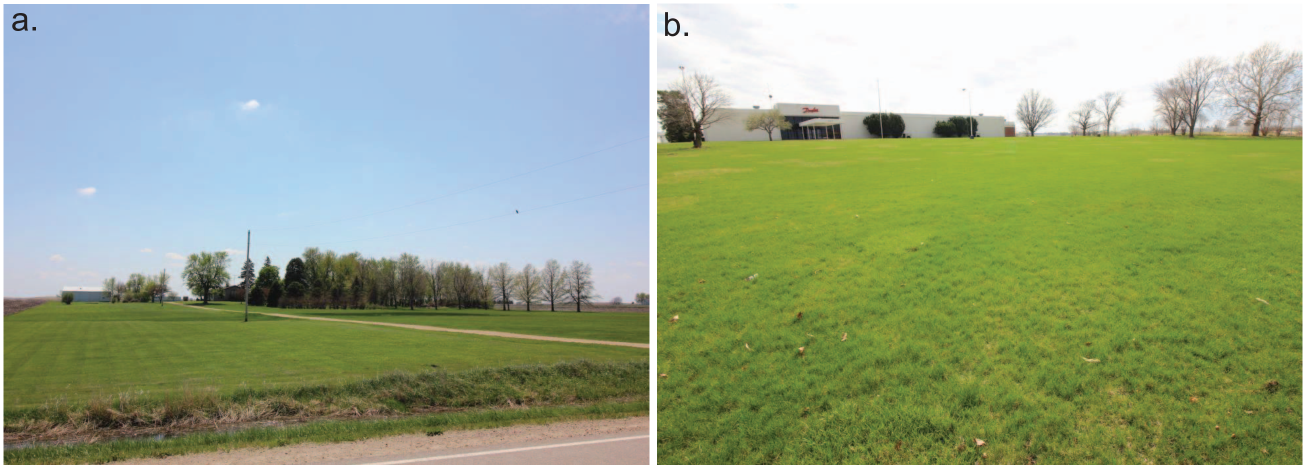

Figure 1. Large lawns around home acreages (**a**) and businesses (**b**) such as those from Iowa in 2020 pictured here present opportunities for diversifying rural landscapes in areas already on the margin of modern agricultural production operations.

seed mixes are generally available through commercial seed dealers, targeting primarily programs under the Conservation Reserve Program, such as Conservation Practice CP-42 Pollinator Habitat. Typical seed mixes favorable for pollinators include a mixture of grass and forb seeds ranging from balanced 1:1-to-1:3 grass seed–to–forb seed ratios (Meissen et al. 2019).

We created enterprise budgets by using 2020 regional custom rates and retail prices for three scenarios: 1) lawn with landowner doing all management activities, 2) lawn with hired care service for all management activities, and 3) pollinator habitat established and managed in place of lawns by contractors.

For each scenario, we conducted a partial budget discounted cash flow analysis over a 10-y horizon by using a 2% real discount rate. There are significant differences between the scenarios in terms of their one-time only and periodic management costs, which complicates comparisons. Consequently, we used a capital recovery factor to annualize present value costs of the scenarios, which facilitates evaluating the enterprise budgets on a comparative temporal basis (Canada et al. 2005; Tyndall and Roesch 2014). Our assessments report low, medium, and high cost estimates for each management option. The range reflects variability in the following: custom rates for various actions, labor pay scale differences based on experience, and regional differences in retail prices for materials and equipment. We report our analyses on a per-acre basis, rather than in the metric system, because this is the measurement convention routinely used by landowners that reside in the landscapes that are the focus of this study.

Relevant Financial Factors

Lawn systems

We primarily considered settings with established lawns. However, we also presented costs estimates for construction sites in which new lawns would be established in bare ground. We assumed the use of grass species typical of the Midwest (e.g., fine fescue *Festuca* spp., Kentucky bluegrass *Poa pratensis*, or perennial ryegrass *Lolium perenne*) for establishing new lawns. In new construction sites, where the starting land cover is bare ground, the analysis assumed the following: two herbicide applications, to completely eradicate weed seed in the soil bank; tillage and turfgrass seed purchase; and broadcast seeding with a tractor. Mowing is the primary management activity for established lawns. On lawns less than 2 acres ($<$0.8 ha), this may involve a riding mower with a 42- to 48-in.-wide (107- to 122-cm-wide) deck; for lawns greater than 2 acres, a deck of 50–72 in. (127–183 cm), or a subcompact or larger tractor with mower attachment are typically used. Because our analysis focused on large lawns in residential, farm, and confined livestock production sites, we assumed use of a 72-in. zero turn mower to estimate costs and time commitment in a hypothetical lawn. Fertilization, herbicide and insecticide applications, and soil aeration are common annual, periodic, or ad hoc management practices (Adams and Christians 2014a, 2014b). For our assessment, we assumed a once-per-year use of 1) a standard turf-grade complete fertilizer (nitrogen–phosphate–potash, 2–1–1 ratio) and 2) spring application of a pre-emergent herbicide that targets undesirable annual grasses. Depending on annual precipitation conditions, seasonal irrigation is also common; however, in the Midwest, we assumed no requirement for irrigation. Management activities can involve the landowner performing all actions with owned or rented equipment, a hired lawn care service, or a combination. For the self-managed scenario, we assumed the landowner performed all activities, purchased all inputs, and used owned equipment.

In general, the most expensive fixed component of self-management is equipment. Riding mowers or tractors with mowing attachments large enough to comfortably mow acreages can cost several thousands of dollars, even in used markets for mowers or aftermarkets for parts and upgrades. The lifespan of a mower can vary considerably across equipment and level of maintenance, but 7–10 y is typical (Edwards 2015). Depreciation is typically 10–20%/y, and resale value is therefore low (Edwards 2015). Variable costs involve inputs such as fuel, fertilizers, herbicides, and annual equipment repairs or maintenance. Our assessment included the initial purchase of a riding mower with a 72-in. deck at the beginning of the assessment period, with an assumed 10-y lifespan (accruing 140 equipment h/acre over a 10-y period). We determined average mower prices in U.S. dollars (USD) with a regional 2020 retail transaction evidence survey across several mid- and major-market brands. We do not account for resale value or equipment replacement at the end of the assessment period. We accounted for estimated variable costs associated with fuel and oil use and typical maintenance expenditures, including repairs, sharpening and replacing blades, and replacing sparkplugs, carburetor, and air filters.

In a comparative analysis such as detailed herein, the value of one's labor also should be considered in self-management situations because it represents an opportunity cost that can be weighed against hired labor alternatives (Zick and Bryant 1983). A market alternative cost approach determines how much it would cost to hire labor to perform individual household activities, such as lawn care, and the use of a price as a lower bound estimate of the value of one's labor. This cost is considered a lower bound cost because it often ignores transaction costs, or any supervisory management and monitoring actions taken on by the homeowner when he or she hires outside labor (Zick and Bryant 1983). We estimated landowner labor value by using market alternatives rates for groundskeepers as reported by the U.S. Department of Labor Statistics (USBLS 2019). To calculate the costs of a self-managed lawn, we used the methodology recommended by Landscape Management (1992).

We evaluated another scenario where lawn care services are hired to perform all management activities as an alternative to conducting all lawn care independently. When hiring a lawn care service to perform all actions, usually the landowner and service provider enter into a contract that stipulates management responsibilities, the various actions to be undertaken, the timing of events, and the degree of service bundling (e.g., adding tree care, removing winter snow). The scale of the fee agreed upon is relative to regional competition for services and variously covers a service provider's labor cost, equipment cost and depreciation, all variable costs, liability and other legal fees, and general overhead. Availability of service options varies among communities, but with expanded Internet capacity, online search engines, feedback-based marketing applications, and strong markets for lawn and landscaping services, pricing for these services tends to be competitive and price ranges tend to be narrow (Lawn and Landscape 2019). For the hired lawn care scenario in our analysis, we assumed a complete lawn care service does all activities. For this assessment, we used the 2020 custom rate survey from Iowa State University that captured transaction evidence from 13 lawn care contractors (Plastina and Johanns 2020).

The typical timing and number of lawn care actions needed in a given year are a function of geographic location. The location influences length of season and general growing conditions; weather; vegetative system being managed; lawn care history; lot size; weed, insect pests, and pathogen dynamics; and homeowner interests. Although the nature and extent of these factors vary by site, there are general biological and climatic conditions in the Midwest that support reasonable assumptions for the analysis. Most lawns consist of cool season grass species that regionally experience rapid growth periods during spring and fall, with a mowing season extending from late March to late October (Jones et al. 2016). Across a given year, a lawn in this region could be mowed between 20 and 30 times (Jones et al. 2016); we assumed a mowing cycle of 26 times per year.

Pollinator habitat systems

Establishment of pollinator habitat involves several direct costs, including site preparation, seeding, short-term postplanting maintenance, long-term management, and monitoring. There is little empirical data in the primary literature on pollinator habitat establishment in midwestern landscapes, but we drew on a few published studies from tallgrass prairie reconstruction (e.g., Rowe 2010; Tyndall et al. 2013; Alexandra and Kristen 2016; Meissen et al. 2019), gray literature (e.g., USDA NRCS 2018), and first-hand experience of the authors (e.g., Figure 2). Site preparation is critical to establishing a high-quality pollinator habitat planting (Millikin et al. 2016). For lawns with established stands of turfgrass as assumed in our scenario, there is a need for multiple actions to create ideal establishment conditions. Although there are various ways to kill a lawn to open the site for a diversity of warm season grasses and forbs, multiple herbicide treatments (glyphosate or another nonresidual, broad-spectrum, general-use herbicide) combined with some form of tillage are common and most appropriate for large-scale conversions that are the focus of this analysis. We assumed the lawn was relatively weed free and underwent herbicide treatments for several years. In these situations, two herbicide treatments (fall and the following spring) and late spring tillage that turns the soil over killing all prior vegetation (rhizomes and weedy plants), followed by spring planting, are generally sufficient. For our analysis, we assumed all planting activities take place in the spring. Establishment can involve several different seeding techniques (e.g., frost seeding, broadcast seeding by machine or by hand, hydroseeding, or seed drilling). Our analysis assumed drilling purchased seed followed by cultipacking to ensure good seed-to-soil contact. The costs of seeds can be highly variable depending on seed mix and site-level goals. Typically, local or online seed

Figure 2. Lawns around buildings and other structures can be converted to pollinator habitat to save money and provision ecosystem goods and services, as illustrated with this pork production facility in Iowa (**a**) before conversion to pollinator habitat in 2016 and (**b**) after conversion to pollinator habitat in 2018.

vendors offer a range of lower cost, mid-to-high species diversity mixes as well as higher cost high-diversity pollinator mixes, which include rare plants or plants of conservation concern. Depending on the type of pollinator habitat desired (e.g., the number and diversity of plants, desired seasonal wildflower bloom patterns), premade locally or regionally sourced pollinator seed mixes are broadly available for different soil and moisture conditions (Meissen et al. 2019). When selecting a seed mix, it is important to note that maximum benefit for monarch butterflies, native bees, and sustainability of honeybee hives is realized using a seed mix with a mixture of forbs that bloom from early spring through early fall (Bradbury et al. 2019; Iowa State University Extension and Outreach 2020). For our analysis, we used a range of seed prices based on premade, economy pollinator mixes and higher cost mixes designed with a higher diversity and amount of seeds from native plant species. The cost of native plant seed for our analysis ranged from $150 to $500/acre.

Once seeding is established and plants begin to grow, establishment actions involve multiple mowing events with biomass removal as needed to stimulate seedling establishment by reducing competition of annual weeds and grass (Bradbury et al. 2019; Meissen et al. 2019; Iowa State University Extension and Outreach 2020). Fertilization is unnecessary. A well-established pollinator habitat planting will take 3–4 y to mature. Spot herbicide treatments for weed management may be needed in the first or second year postplanting and sporadically in subsequent years; we included spot management as part of overall monitoring actions and costs. Long-term management involves mowing or burning every 3–5 y. Burning is a widely used practice in prairie reconstructions (Rowe 2010; Alexandra and Kristen 2016) because it has multiple benefits, including removing dead plant material, encouraging seed germination, reducing competition by nonnative or otherwise undesirable plants, and enhancing nutrient cycling. Burning does have logistical implications, including permitting depending on location relative to neighbors (e.g., homes, businesses, recreational areas) or roads, coordination with local fire services, and communication with neighbors who may be temporarily impacted by fire management activities (e.g., smoke, increased traffic, fire risk; Harr et al. 2014). Nevertheless, because of the ecological benefits of burning, we assume this as the long-term management action in our assessment. We based cost estimates on a prescribed burn once every 3 y following prices from Tyndall et al. (2013). We also recognize that landowners will probably continue to mow certain turfgrass areas, for example, around homes and buildings or for access trails. Therefore, we included a supplemental assessment of the ancillary cost of a mid-sized riding mower (36- to 42-in. [91- to 107-cm]-wide deck).

Results

In established lawn situations, if a landowner were to take on all care activities over the course of a typical growing season by using their own equipment and labor, the average cost ranges from approximately $637 to $1,007·acre^{-1}·y^{-1} (Table 1); comprehensive budgets, documentation of assumptions, and data used for the analysis are provided in Tables S1–S3 (see *Supplemental Material*). The range largely depends on the initial cost of mowing equipment used and how the property owner or operator values their own labor input. The fixed cost of the mower is the highest cost input on an annual basis, with an average between $289 and $371·acre^{-1}·y^{-1}. Note that landowners can control fixed costs by purchasing smaller mowers, and landowners can experience economies of scale relative to fixed costs as the scale of the mowing activities increases. Personal labor costs are the next largest cost component (on average, between $142 and $307·acre^{-1}·y^{-1}). In new

Table 1. Annualized per-acre cost of three different land use and management options for rural lawns on a hypothetical parcel in the midwestern United States. Lawn care (self) includes expenses related to land owners or managers who maintain a turfgrass lawn on their own. Lawn care (hired service) includes expenses related to contracted lawn care. Pollinator habitat includes expenses for converting a lawn to habitat. All costs are in USD 2020.

	Total present value cost (USD) ($cost{\cdot}acre^{-1}{\cdot}y^{-1}$)[a]			
Management alternative	**Low cost**	**Mean cost**	**High cost**	**Key notes, assumptions**[b]
Lawn care (self)	5,727 (637)	7,368 (820)	9,046 (1,007)	Accounts for equipment purchase (72-in. zero turn mower), maintenance, and fuel and oil. Market value of personal labor. Activities include mowing (26 times/y), annual fertilization and weed management, spot weeding, and overhead.
Lawn care (hired service)	2,928 (326)	6,090 (678)	9,288 (1,034)	Accounts for market value of complete lawn care contract services. Activities include mowing (26 times/y), annual fertilization, and weed management.
Pollinator habitat	485 (54)	994 (111)	1,503 ($167)	Assumes a well-managed lawn initial condition. Site preparation includes fall and spring herbicide applications and tillage. Establishment assumes a seed drill and cultipacker. Mowing is used in years 1 and 2 during establishment. Seed costs were based on a range of regional premade pollinator seed mixes. Burning is the primary long-term management. All work is contracted out.

[a] Assumes a 10-y management horizon and a 2% discount rate. We used a capital recovery factor of 0.1113 to annualize costs.
[b] See Tables S1–S3 for detailed enterprise data, calculations, and assumptions.

construction sites, where the starting point is bare ground, the analysis assumed two herbicide applications to eradicate weed seed in the soil bank, tillage, turfgrass seed (choosing between fescue, bluegrass, or perennial ryegrass; 2020 retail seed prices range from $1.33 to $4.71/lb, with each acre planted with 87 lb of grass seed), and broadcast seeding with tractor or all-terrain vehicle. In total, this would add a range from $13 to $45/y over the 10-y planning horizon.

We estimated hiring a lawn care service to mow and maintain lawns would cost between $326 and $1,034·acre^{-1}·y^{-1} (Table 1). These costs include mowing and general maintenance (e.g., manage clippings, edging, sweeping), annual fertilization, and basic weed management, which are similar to costs considered for the self-lawn care scenario. Costs for hired lawn management could be higher or lower than self-lawn care depending on the presence of any bundled services. Because competition for lawn care services appears to be regionally strong and consistent (Lawn and Landscape 2019), we assume the year-to-year costs of hired lawn care services to be relatively stable across the analysis period. Similar to the self-lawn care scenario, if the starting point was a new construction site with bare ground, the added costs for establishment would range from $13 to $45/y.

Assuming a contractor is hired for pollinator habitat establishment and management the cost for a landowner, on average, would range between $54·acre^{-1}·y^{-1} and $167·acre^{-1}·y^{-1}, largely depending on initial seed mix cost and overall labor costs (Table 1). Note that pollinator habitat has a comparatively unique pattern of labor needs. In the lawn management scenarios, annual labor needs are reasonably consistent over the 10-y period. A different pattern of annual labor is associated with pollinator habitat establishment and maintenance. In the first 2–3 y after establishment, annual labor inputs are similar to those required for lawn management; however, after the third year, labor is needed every 3–5 y. Outside of the per-acre partial budget analysis presented here for the pollinator habitat, landowners will probably still have mowing equipment used to tend turfgrass areas near buildings or for access trails (Figure 2). As

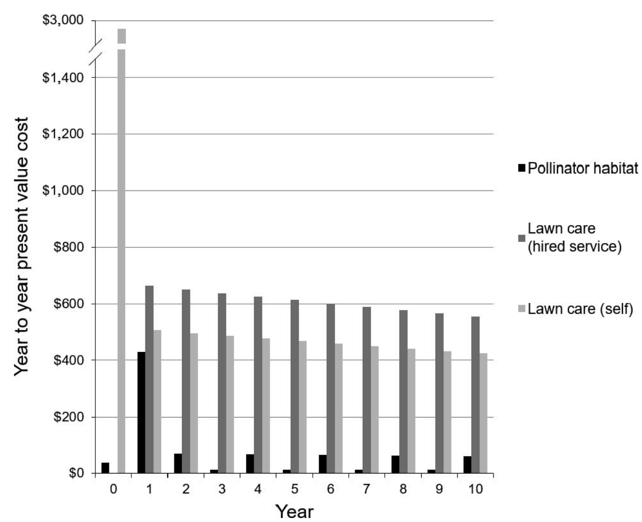

Figure 3. Average per acre year-to-year present value costs and annualized costs of three different land use and management options for rural lawns across a 10-y management horizon and a 2% discount rate on a hypothetical 1-acre midwestern parcel. Lawn care (self) includes expenses related to land owners or managers maintain a lawn on their own. Lawn care (hired) includes expenses related to contracted lawn care. Pollinator habitat includes expenses related to conversion of lawns to pollinator habitat in the midwestern United States. All costs are in USD 2020.

such, additional costs related to the purchase of a midsized riding mower would be $134 to $178/y (assuming a riding mower with a 36- to 42-in. deck; 2020 purchase price ranging from $1,200 to $1,600).

On average, over a 10-y time frame, pollinator habitat was between 80 and 90% less expensive than maintaining lawns. There are also important differences in the timing of different costs across the three management options. Although presenting annualized costs is useful for comparative cost analyses, such a method can mask temporal variability in actions and expenditures. As such, Figure 3 presents average year-to-year present value of costs. Hired lawn care has the most consistent and generally highest year-to-year present value costs, followed by self-lawn care. Self-lawn care, however, has a comparatively high year 0 cost, which assumes the purchase of a mower the fall before the first year of the 10-y analysis horizon. Pollinator habitat shows the most year-to-year variability and also the lowest present value costs in any given year. On a per-acre basis, site preparation and seed costs in year 1 combine to be the largest one-time annual cost for pollinator habitat. However, costs for pollinator habitat during years 0 and 1 are still lower than those for the lawn scenario when a mower is purchased in year 0 and year-to-year pollinator habitat costs after year 1 are considerably lower and more periodic than both lawn scenarios.

Discussion

Our financial analysis provides a compelling economic case that establishing pollinator habitat in place of lawns provides landowners and managers appreciable savings over a 10-y period. Converting a single 2.47-acre (∼1-ha) lawn managed by a hired lawn care service to pollinator habitat would save $12,586 in present value terms over a 10-y period in our average-cost scenario. Our economic analysis is the first to directly compare the economics of wholesale conversion of lawns to pollinator habitat. When taken together with the wealth of research demonstrating the positive ecological outcomes expected with such a paradigm shift in land management (Milesi et al. 2005; Cheng et al. 2008; Eisenhauer et al. 2016), our findings make a case for the mutually beneficial outcomes for landowners, wildlife, and downstream beneficiaries of the ecosystem goods and services provided by native perennial vegetation in rural landscapes (Figure 2).

Previous work considered the economics of reduced-frequency mowing and made a clear case for its value in some applications. This so-called "lazy lawnmower" strategy (Lerman et al. 2018, p. 167) demonstrated ecological and economic values (Watson et al. 2019). Our analysis of a wholesale shift in management from lawns to pollinator habitat makes a stronger economic case and has potential to provide greater secondary environmental benefits beyond those gained by simple cessation or reduction of mowing (Norton et al. 2019). In evaluating the economics of reduced mowing frequency, Watson et al. (2019) reported a 36% reduction in costs annually. Our analysis, found an 80–90% reduction in costs over a 10-y period, although annual expenses were dynamic over that period.

Any changes to lawn management include trade-offs in utility or function of the managed areas (Ramer et al. 2019). The management strategy examined here will not find application in all lawns in rural or urban settings. Rather, this approach offers a promising alternative to lawns not conventionally used in high-traffic areas, such as recreational fields, parking areas, or entertainment areas. Anecdotal observations of lawns in rural landscapes suggest mowing is done as a proactive management practice in idle areas, strictly for aesthetics, or possibly as recreation or a hobby by homeowners (Figure 1). If mowing is recreational, our valuation of labor may overrepresent perceived costs. Pollinator habitat requires periodic mowing and otherwise specialized care (Rowe 2010) and could thus serve as a recreational substitute and still allow for occasional secondary uses such as parking or entertainment.

Comparison with Past Studies and Input Assumptions

We considered a range of possible expense and management strategies for lawns and pollinator habitat; however, our results may not be directly applicable in all cases and are sensitive to input assumptions. Our cost scenarios were based on similar data sources (namely, an Iowa-specific custom rate survey from Plastina and Johanns [2020]); consequently, relative difference between the three treatments should remain the same. Our enterprise budgets provide practitioners the means to simulate alternative management scenarios with realized expenses for specific individual operations. For example, our lawn management cost scenarios may be modest because we included costs for only two herbicide applications and no irrigation. In addition, establishing pollinator habitat on sites with high extant weed or sod-forming grass will probably require additional herbicide applications than considered in our scenario that assumed weed-free turfgrass stands (Bahm et al. 2017). If the site has existing weed pressure or has recently converted from a pasture or fallow field to a lawn, a total of up to four herbicide applications (fall and the following spring, summer, and fall) followed by dormant planting may be needed (see Tyndall et al. 2013; USDA NRCS 2018; Bradbury et al. 2019; Iowa State University Extension and Outreach 2020), which would increase total present value costs in the mean cost scenario to $1,065/acre, compared with $994/acre in our current scenario. Even with a doubling of input costs for establishment, conversion to pollinator habitat would still be appreciably less expensive over the 10-y management horizon in our study than either of the lawn management scenarios.

In our analysis, personal labor was typically the costliest component on an annual basis ($168 and $360/y). Personal labor value is often discounted or ignored completely when landowners evaluate household or family farm costs (Farm Financial Standards Council 2014; Cockshott 2020). Among landowners who view mowing as recreation, our valuation of labor would overrepresent perceived costs. However, ignoring labor cost entirely and considering only equipment and input costs, the pollinator habitat establishment scenario was still less costly than each lawn care scenario.

Previous estimates of lawn management expenses are highly variable. Watson et al. (2019) estimated \$143/ha, or approximately \$58$\cdot$acre$^{-1}\cdot$y^{-1}, for equipment and labor costs in a park mowed 15 times/y. This estimate was appreciably lower than ours, which ranged from \$295 to \$961$\cdot$acre$^{-1}\cdot$y^{-1} (\$738 to \$2,400$\cdot$ha$^{-1}\cdot$y^{-1}) for mowing 26 times/y. Similarly, Meyer et al. (2001) provided self-reported estimates of lawn care expenses in Minnesota of \$150–200$\cdot$y$^{-1}\cdot$lawn^{-1}. Our estimates were lower than those of Hedblom et al. (2017), who reported average mowing expenses in Sweden municipalities of \$3,822$\cdot$ha$^{-1}\cdot$y^{-1} (\$1,547$\cdot$acre$^{-1}\cdot$y^{-1}); fertilization, pesticide applications, and watering expenses were not included in their analyses. Lawn care costs are also thought to be higher in urban than rural areas (Blaine et al. 2012), which is the primary focus of our analysis.

Context for Converting Lawns to Pollinator Habitat

Previous research has shown a clear ecological rationale for converting lawns to diverse native perennial vegetation (e.g., Milesi et al. 2005; Cheng et al. 2008; Eisenhauer et al. 2016) and our work, along with that of others (e.g., Watson et al. 2019) makes a strong economic case. Notwithstanding this financial analysis, a body of research demonstrates that entrenched behaviors and norms surrounding lawns that have facilitated their increase globally (Robbins and Birkenholtz 2003; Hedblom et al. 2017) may remain a barrier. Across the United States, the aesthetic of a homogenous lawn is ubiquitous (Wheeler et al. 2017) and associated with social status or affluence (e.g., Peterson et al. 2012). Sisser et al. (2016) reported 88% of respondents in Minnesota mentioned social norms surrounding lawn maintenance in their communities, and most communities had these norms codified through ordinances governing vegetation composition or height in private lawns. Indeed, these deeply entrenched normative behaviors also prevail in rural environments (Kaufman 2000), where except for biosecurity immediately adjacent to livestock production buildings (B. Crawford, Prestage Foods of Iowa, personal communication), lawn establishment and maintenance seem to be implemented strictly for aesthetics. Overcoming these entrenched behaviors to change attitudes about the potential functions of pollinator habitat will be central to adoption of the practice in rural communities.

Research in urban spaces offers guidance on best practices for increasing acceptability of alternative lawn maintenance paradigms, for example, the "cues to care" approach that messages positive function of alternative management strategies (Nassauer et al. 2009). Being intentional about placement of pollinator habitat within designed landscapes could also increase acceptance (Helfand et al. 2006). Research on midwestern landowners has shown that aesthetics and ecosystem goods and services are factors considered in making decisions about land management (Blaine et al. 2012; Lute et al. 2018). Positive messaging and education on the societal value of pollinator habitat may similarly yield more support for changing management of lawns (Peterson et al. 2012). As early adopters change behaviors and share their positive experiences and successes with the practice, a social contagion of acceptance and change (e.g., Nassauer et al. 2009) may be plausible and lead to landscape-level changes in the management of rural lawns.

An additional barrier to converting lawns to pollinator habitat could be presented by the technical expertise and transition costs associated with the practice. Prairie reconstruction is challenging and requires, in some cases, access to specialized equipment that may not be readily available in some locations (Rowe 2010; Alexandra and Kristen 2016). Steps for converting a lawn to pollinator habitat are more complex and intensive than habitat establishment projects in retired row-crop fields (Bahm et al. 2071; Rowe 2010). Our analysis shows that labor and overall effort to establish and maintain pollinator habitat are front loaded in a 10-y planning horizon, which may present planning challenges related to capital availability. During the first 3 y of conversion from lawn to pollinator habitat, expenses include those related to initial site preparation (herbicide application and disking), purchase of the seed and planting, and regular mowing to promote seedling establishment (Meissen et al. 2019). Taken together, these initial labor needs and overall degree of effort probably parallel or exceed that of managing lawns. Nevertheless, after the first 3 y, labor needs are restricted considerably and typically include only those related to periodic burning or mowing. Consequently, our analysis that annualized actions and effort over 10 y could mask an initial barrier to adoption. To overcome the perceived technical or financial limitations of pollinator habitat establishment, government support programs may play an important role, if they are suitably tailored to meet landowner needs and are not overly complex (Lute et al. 2018). Furthermore, technical assistance from skilled prairie restorationists in these landscapes will be critical to ensure success of early adopters and diffusion of the practice in supportive communities (Dayer et al. 2018).

Conclusions

Despite a general cultural proclivity toward establishing and maintaining lawns in the United States, there are many preferential and pragmatic reasons why landowners may desire alternatives. Landowners have indicated various concerns about lawn management, including rising costs, time constraints, personal safety when using lawn equipment, use of pesticides and fertilizers, environmental impacts, and an unwillingness to hire lawn care services (Blaine et al. 2012). Landowners also tend to prefer inclusion of native landscape elements over lawns when presented with alternatives (Peterson et al. 2012). Furthermore, production margins in agriculture are increasingly tight, and considerable research in a diversity of disciplines is identifying opportunities to increase farm profitability while simultaneously achieving important societal outcomes related to the provision of ecosystem goods and services (e.g., McConnell 2019). Our analysis, combined with related research findings, documents cost-effective approaches to increase biodiversity and the likelihood of reaching conservation targets (e.g., Thogmartin et al. 2017) through the conversion of lawns to pollinator habitat. Adoption of this pollinator conservation approach provides financial savings for landowners and positive spillover benefits to water quality, soil health, wildlife habitat, and aesthetics. Embracing the potential cost for effectively converting lawns to pollinator habitat in rural landscapes builds on momentum to foster multifunctional landscapes that are mutually beneficial to people and the ecosystems that support their well-being (Aronson et al. 2017; Kremen and Merenlender 2018).

Supplemental Material

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Table S1. Annualized per-acre cost of lawn care on a hypothetical parcel in the midwestern United States. All expenses assume established turfgrass stands in year 0 and account for a range of cost scenarios encumbered by the landowner over a 10-y management horizon. Each scenario includes a 2% discount rate. We used a capital recovery factor of 0.1113 to annualize costs. All costs are in 2020 USD.

Found at DOI: https://doi.org/10.3996/JFWM-20-075.S1 (34 KB DOCX).

Table S2. Annualized per-acre cost of lawn care contracted with a lawn care service on a hypothetical parcel in the midwestern United States. All expenses assume established turfgrass stands in year 0 and account for a range of cost scenarios encumbered by the landowner for contracted services over a 10-y management horizon. Each scenario includes a 2% discount rate. We used a capital recovery factor of 0.1113 to annualize costs. All costs are in 2020 USD.

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Table S3. Annualized per-acre cost of pollinator habitat establishment and maintenance contracted with service providers on a hypothetical parcel in the midwestern United States. All expenses assume conversion from turfgrass in year 0 and account for a range of cost scenarios encumbered by the landowner for contracted services over a 10-y management horizon. Each scenario includes a 2% discount rate. We used a capital recovery factor of 0.1113 to annualize costs. All costs are in 2020 USD.

Found at DOI: https://doi.org/10.3996/JFWM-20-075.S1 (34 KB DOCX).

Reference S1. Hopwood J, Black S, Lee-Müder E, Charlap A, Preston R, Mozumder K, Fleury S. 2015. Literature review: pollinator habitat enhancement and best management practices in highway rights-of-way. Washington, D.C.: Federal Highway Administration.

Found at DOI: https://doi.org/10.3996/JFWM-20-075.S2 (894 KB PDF).

Reference S2. Hopwood J, Black S, Fleury S. 2016. Pollinators and roadsides: best management practices for managers and decision makers. Washington, D.C.: U.S. Department of Transportation and the Federal Highway Administration. Volume 8. Report no. FHWA-HEP-16-020.

Found at DOI: https://doi.org/10.3996/JFWM-20-075.S3 (5.91 MB PDF).

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Found at DOI: https://doi.org/10.3996/JFWM-20-075.S5 (657 KB PDF); also available at https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/Conservation/PDF/Summary%20JAN%202020.pdf

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