The Red Cedar Learning Hub: A Systems-Level Approach to Watershed Management

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Project background

Farming systems in the Upper Mississippi River Valley (UMRV) of the United States are rapidly consolidating and becoming increasingly simplified (Blesh et al., 2023). Historically, the UMRV relied on agricultural systems that integrated livestock and crop production within a single farming operation (Hudson, 1994). The relationship between livestock and cropping systems was necessary to feed animals and then return manure to the fields to improve fertility (Hart, 1986). The connection between livestock and crop production created a mosaic of land-use practices across many private farms (Hart, 1986; Riley, 1985). The mixed land-use approach, once a hallmark of farming in the UMRV, has been replaced with a homogeneous form of agriculture focused on row-crop commodity production (Hart, 1986; Spangler et al., 2020). Today, there are dramatically fewer operations in the UMRV that integrate livestock and row crop production. The current agricultural landscape is predominantly centered on growing corn and soybeans for biofuels and feed for confined animal feeding operations (Aguilar et al., 2015). The impacts of this agricultural transition on rural communities throughout the UMRV have been dramatic and well documented. The overall output of commodities has increased while the costs to the environment and communities have been catastrophic (Burchfield et al., 2019).

The expansive reach of monoculture row crops has been associated with reduced biodiversity (Rosenberg et al., 2019; Stanton et al., 2018), diminished water quality (Porter et al., 2015; Stephenson et al., 2022; Tomczyk et al., 2023), and declining soil health (Quarrier et al., 2023; Thaler et al., 2021, 2022). Increasing the amount of agricultural land in well-managed grasslands is likely the best way to have profitable farming operations, provide a wide array of ecosystem services, and produce a meaningful amount of meat and dairy products (Jackson, 2022a, 2022b; Kriegl, 2005; Wepking et al., 2022; Winsten, 2024). In Wisconsin's Red Cedar Watershed, there is a desire to increase the number of acres dedicated to well-managed perennial grasslands to protect water and soil health. However, implementing transformative agricultural landscape change is complex and requires collaborative efforts that reach beyond the boundaries of any singular farm (Blesh et al., 2023; Darnhofer, 2021; Hebinck et al., 2021; Klerkx & Begemann, 2020; Seymour & Connelly, 2023). To attain shared water quality and soil health goals, community members have expressed a desire to develop the Red Cedar Learning Hub. The learning hub concept builds on Grassland 2.0, a USDA CAP-funded project. Learning hubs create a platform for place-based dialogue that appreciates diverse perspectives. By bringing together expert and experiential knowledge, learning hubs offer a way to develop a well-thought-out land-use strategy.

Changes in the Red Cedar Context

As we look to create change going forward, a helpful starting point is to consider the characteristics of the changes that communities have already experienced. A logical starting point for making sense of past change is a simple review of the USDA Agricultural Census data. With our project focused on the Red Cedar River Valley (RCRV), we reviewed the census data from Dunn and Barron Counties. Please note that, since the agricultural census data are available at the county level, we used the census data for these two counties, where the majority of the watershed is located, as a proxy for changes in the RCRV. What quickly jumps out in a review is that over the past forty years, the agriculture sector in the RCRV has undergone systemic changes. There has been a notable decline in the number of farms and farmland. What is also evident is that the average farm size has increased while the median farm size has decreased (Table 1). What this suggests is that large farms are getting larger, small farms are staying small, and middle-sized farms are disappearing. That phenomenon has been widely documented and is commonly referred to as the agriculture of the middle (DeMaster, 2018; Stevenson & Pirog, 2008). The common explanation for the agriculture of the middle phenomenon is that in the US agricultural system, producers are disciplined into two predominant strategies to generate profits. One strategy is to become extremely large and rely on economies of scale to generate a profit. The other is to remain small and develop a specialty product that commands a premium price. The increasing mean and decreasing median farm size in Dunn and Barron counties would suggest that middle-sized farms are becoming less common, meaning the RCRV has not been immune to the agriculture of the middle phenomenon.

Table 1: Change in farm characteristics over the years – Dunn & Barron Counties

	Farms		Farmland*		Average Farm Size*		Median Farm Size*	
	Barron	Dunn	Barron	Dunn	Barron	Dunn	Barron	Dunn
1987	1,659	1,515	374,552	400,589	226	264	n/a	n/a
1992	1,474	1,383	350,866	366,593	238	265	n/a	n/a
1997	1,384	1,397	325,009	368,618	235	264	180	163
2002	1,647	1,683	351,930	398,768	214	237	160	154
2007	1,484	1,690	324,196	382,545	218	226	120	105
2012	1,322	1,404	309,750	372,259	234	265	115	122
2017	1,200	1,288	305,604	348,301	255	270	107	106
2022	1,118	1,209	282,265	372,774	252	308	100	100

*Acres; All data from USDA agricultural census

Over the past decades, there has also been a substantial shift in animal agriculture in the RCRV (Table 2). Hog farming has essentially disappeared from Wisconsin and is now concentrated in states such as North Carolina, Minnesota, and Iowa (Davis et al., 2022; Furuseth, 1997). Consequently, there has been a considerable decline in the number of hog farms and hogs in Dunn and Barron Counties. The number of dairy farms has also significantly changed. Between 1987 and 2022, the number of dairy farms in Dunn and Barron Counties declined by 91%. Over the same time, there has been a notable but less dramatic 49% decline in the number of dairy cows. The consolidation in dairy farming observed in the RCRV is consistent with patterns across Wisconsin (USDA NASS, 2023). It is also notable that as the number of dairy farms continues to decrease, we have seen an increase in beef farming. The shift is likely driven by farms transitioning out of dairy and pivoting to beef. The consolidation of livestock farming in the RCRV is consistent with patterns seen throughout the UMRV.

Table 2: Livestock Distribution in Dunn & Barron Counties

	Beef		Milk		Hogs and Pigs	
	Farms	*Number*	*Farms*	*Number*	*Farms*	*Number*
1987	416	5,537	1,925	84,642	251	28,795
1992	510	7,356	1,538	72,369	226	28,568
1997	648	10,798	1,125	59,078	108	18,917
2002	754	11,079	784	49,979	88	12,003
2007	791	12,067	588	46,655	96	11,129
2012	722	12,065	463	44,444	69	3,268
2017	732	12,992	296	39,520	76	5,308
2022	671	11,759	179	43,002	54	6,804

All data from USDA Agricultural Census

As livestock farming has been rapidly concentrated, cropping rotations are increasingly simplified. With many farms moving out of livestock and into cropping, the need for forage crops has dramatically decreased. Due to the large decline in forage crops, there has been a focus predominantly on the cultivation of corn and soybeans (Burchfield et al., 2019). In the 1980s, soybeans as a commodity crop were relatively uncommon in Dunn and Barron Counties. Since that time, soybean acres have increased significantly (Table 3). Corn has consistently been a primary crop in the Red Cedar River Valley, but over the past four decades, corn acreage has notably increased while the number of corn farms has decreased. Based on these trends, many of the acres once dedicated to forage crops have been replaced by a simplified rotation of corn and soybeans.

Table 3: Cropping Distribution in Dunn & Barron Counties

	Corn		Soybeans		Forage	
	Farms	*Acres*	*Farms*	*Acres*	*Farms*	*Acres*
1987	2,244	65,992	137	9,754	2,725	236,643
1992	1,622	110,933	362	19,033	2,302	195,431
1997	1,646	136,807	363	28,910	2,032	179,682
2002	1,239	132,305	596	60,532	2,041	148,354
2007	1,037	148,352	523	63,085	1,806	123,755
2012	1,171	182,994	730	90,380	1,503	95,796
2017	934	156,501	760	119,121	1,326	81,655
2022	815	159,364	682	120,572	1,247	83,161

All data from USDA Agricultural Census

Cumulatively, the USDA Agricultural Census data (tables 1-3) begin to tell a story of a rapidly changing agricultural landscape. It is unlikely that a random assortment of individual decisions drives changes of that magnitude; rather, they are driven by systemic shifts in the agri-food sector. Despite it being relatively obvious that systemic influences shape agricultural landscapes, most farm conservation and watershed planning efforts do not account for how these systemic factors influence land-use decisions (Blesh et al., 2023; Gillon et al., 2016; Prokopy et al., 2019; Reimer et al., 2021). With a clear disconnect between conservation programs and the drivers of agricultural land-use change, we sought to better understand the experiences of people who have lived through these landscape transitions in the RCRV and the influences these changes have on community vitality and water quality. Beyond uncovering how residents have perceived the agricultural transformation in the RCRV, we aimed to learn about their desired future. Through interviews with residents, we discussed and envisioned the ways to attain a future with vibrant farms, thriving communities, and clean water.

Research Techniques

With widely documented undesirable outcomes from our current agricultural regimes (Hendrickson, 2020; Hendrickson et al., 2019, 2020; Lobao & Stofferahn, 2008; Mathewson et al., 2020; Porter et al., 2015; Rosenberg et al., 2019; Southard, 2022; Stanton et al., 2018; Stephenson et al., 2022; Thaler et al., 2021, 2022; Volzer et al., 2025), there has been a widespread effort to try to understand how agricultural land use change could be implemented (Arts et al., 2017; Baumgart-Getz et al., 2012; Blesh et al., 2023; Gratton et al., 2024; Hebinck et al., 2021; Köhler et al., 2019; Prokopy et al., 2019; Ranjan et al., 2019). From that research, it is increasingly clear that efforts to shape individual behavior within current regimes have been largely unpredictable and inconsistent (Prokopy et al., 2019; Reimer et al., 2021). With that, there has been growing acknowledgement that agriculture's role in addressing the challenges of the Anthropocene will likely require a systemic approach that operates concurrently across different spatial scales (Blesh et al., 2023; Gratton et al., 2024; Reimer et al., 2021; Strauser et al., 2022). Aware of the need for systemic shifts in our agri-food systems, our project sought to work with the RCRV community to 1) better understand how community members felt about these dramatic agricultural shifts, 2) identify what people desire for the future of their community, 3) develop conceptual scenarios for what it might take to meaningfully progress toward water quality goals desired by community members in the RCRV.

To carry out our project, a coalition of community actors, in conjunction with participatory researchers from the Universities of Wisconsin, gathered in 2023 to begin developing the Red Cedar Learning Hub (RCLH). Initial meetings involved a steering team, and in the first meeting, we sought to identify what made the RCRV special. We also went on to identify what people desired for their community's future. From that conversation, we identified that the RCRV is a special place with many opportunities, due to its diverse businesses, educational opportunities, recreational amenities, and proximity to metropolitan centers. While there are many positives, we also discussed the need to address a myriad of challenges to ensure long-term community health for the RCLH. Among those challenges were: 1) an aging farmer population/changing agricultural landscape, 2) unfair agricultural markets, 3) social norms that are unnecessarily restrictive to innovative ideas, 4) sharply declining biodiversity, 5) soil degradation, and 6) diminished water quality. Following the initial meetings, there was a clear need to expand the conversation beyond the steering team.

To gain greater diversity of perspectives, the research team at UW-Stout conducted 21 semi-structured interviews between April and August 2024. These community members were selected using a purposive sampling technique; people were chosen for their involvement in community and/or agricultural work. Interviewees included non-profit leaders, healthcare workers, conservationists, educators, and livestock, produce, and grain crop farmers throughout the RCLH. The interviews ranged from thirty minutes to two hours and took place both on Microsoft Teams and in person. These conversations were audio-recorded and subsequently transcribed verbatim. We analyzed the interview transcripts to identify recurring themes that emerged across the conversations. In that process, our research team identified three themes: frustration with agricultural systems, frustration with water quality, and the need for a systems-level approach.

A strong motivating force behind the formation of the RCLH was the goal of improving water quality in the RCRV. Based on prior watershed planning efforts in the RCRV, achieving water quality goals will require addressing nonpoint-source nutrient pollution (James, 2015; James, 2019). While addressing nonpoint source water pollution has been a consistent goal, there remains a need to map the potential changes in social and ecological systems necessary to achieve the water quality desired by community members. Our RCLH project sought to bolster community-led efforts by employing a novel landscape modeling tool called SmartScape™ in conjunction with participatory research processes that examine the social and economic opportunities in the RCRV. SmartScape™ (available at: https://scapetools.grasslandag.org/) is a decision-support tool (DST) that helps communities envision where and to what extent land use/cover change can impact biophysical outcomes at the watershed scale, such as nutrient runoff and crop yield, as well as economic indicators such as the cost of agricultural production (Tayyebi, Meehan, et al., 2016; Tayyebi, Tayyebi, et al., 2016). The development of SmartScape™ was intended to provide communities, such as the RCLH, with salient, credible, and legitimate information. The primary model underlying SmartScape™ is SnapPlus, a nutrient management software product (available at https://snapplus.wisc.edu) that is widely used, trusted, and familiar to the agricultural community in Wisconsin (Good et al., 2012; Vadas et al., 2015). SmartScape™ enables users to quickly and easily design scenarios for agricultural land-use and management changes across entire watersheds of interest using a free and open-source web-based application with a simple point-and-click interface, requiring no technical modeling knowledge, making SmartScape™ accessible to a diverse audience.

The goal of integrating SmartScape™ with participatory, community-engaged research is to collaboratively map the socio-ecological system changes that could plausibly achieve the water quality outcomes that community members desire, and then translate those into actionable plans.

With significant loading reductions called for in the RCRV (James, 2019), there will be a need to weigh multiple variables concurrently, and we found that there is no single risk-free option; rather, it will be essential for communities to consider the costs and benefits of different watershed futures. The objective is not only to develop models for potential future biophysical systems, but also to consider the societal implications of that landscape change through a series of interviews and community conversations.

Findings

From the interviews, we uncovered growing dissatisfaction with agricultural and water-quality outcomes. People identified the loss of dairy farms as a major hit to their identity and community. It was felt that systemic factors, such as policy changes, drove the dramatic decline in dairy farms. Coinciding with frustration about changes in farming, there is disappointment about water quality outcomes. People detail how current pollution levels lead to harmful algal blooms that limit community members' ability to enjoy public water resources. When considering how to address these issues, community members recognize the problems they face as systemic, meaning they see that solutions need to operate not only at a local level but also in concurrent efforts at a systems level, a multi-scalar approach (Gratton et al., 2024).

Frustration with agricultural systems

Community members in the RCLH expressed frustration with how agriculture has evolved over many decades. Specifically, many pointed out that the quintessential Wisconsin dairy farm has been pushed out. It is often described that the agricultural systems in which people grew up with are no longer. One community member says it well when speaking fondly about the "good old days."

> *"Yeah, unfortunately, I like the good old days when I was growing up in the early 90s as a kid, everybody had 50 to 100 dairy cows. Everybody had 150 to 200 acres, and there was a lot of alfalfa and a lot of legumes, a lot of small grains. We were more diversified back then, as far as crops go… everybody could run their couple hundred acres and people were happy, but as time went on, we lost more dairy farms. We lost our identity… I think eventually you're going to see less farmers and they're just going to be bigger farmers and we've seen that over the last 10 years, 20 years. It's all about industry and it's all about making money at the end of the day, we* [farmers] *love the environment. We want to take care of it* [the land and water]. *We want, you know, farmers drink the same water that everybody else does… A lot of really, really good cattle guys, dairy guys, good with animals could uh grow good crops and take care of the land. The prices were just so poor on milk that the state of Wisconsin. Yeah, we have lost our identity as the dairy state, and I don't think it's coming back. I really don't."*
>
> *– Red Cedar Community Member*

The quote illustrates how farming has changed over the years. The loss of dairy farms and the shared identity that came with that agriculture were at the forefront of people's minds in the

RCLH. The expressed sense of loss describes the lived experience in terms of what is observed in the agricultural census numbers (Table 2). Over the past decades, there has been a fundamental shift in what it means to be a Wisconsin dairy farmer. Furthermore, the quote acknowledges that farmers want to steward environmental resources, but, in the view of those on the ground, that is difficult when they must operate within an agricultural industry that is solely focused on profit maximization for a select few (Clapp, 2025). When explaining the changes in Wisconsin dairy farming, people are quick to point out that these changes are consistent with broader market forces across the agricultural sector.

> *"I'm heartsick about what's happened to our dairy industry in Wisconsin, and those economic factors aren't just present in dairy. They've happened in poultry. They've happened in hogs… We're not going to stop consolidation* [at a community level]. *If anybody knew how to stop consolidation, they'd have done it already. It is not just in agriculture, it's in distribution. It's in every part of our fabric* [the economy]. *It's a result of the economic system we live in… I mean, our government has the tools, the antitrust legislation, they have the tools to put a stop to some of this on a much higher level… And occasionally they step in and do something, but by and large, they've* [the government] *allowed the monopolies to happen repeatedly."*
>
> *– Red Cedar Community Member*

People in the RCLH are wise enough to recognize that their agricultural landscapes are shaped by exogenous forces that extend well beyond their community and watershed. There is also an underlying frustration that monopolies, or at the minimum companies with extreme market influence, seem not to be checked by government institutions (Clapp, 2025; Frerick, 2024; Hendrickson et al., 2019). Aware of extreme power imbalance, many residents are making a pragmatic assessment that addressing issues, such as farm consolidation or water quality concerns, will require a multi-scalar approach that considers community needs in the context of broader forces such as anti-trust enforcement and federal agricultural policy that have a shaping influence on the landscape of the RCRV. Community members also identified that it is tough for new producers to enter the agricultural sector. A key barrier to entry is land cost, driving high start-up investment.

> *"Uh, you know, land has almost doubled from when we bought it… so you know, and think about our mortgage and how a young farmer would be able to afford land at this point. And I am not sure that it pencils. Um, so you know that isn't a personal failure on behalf of any young farmer. That is a systemic issue that is prohibiting people from acquiring land."*
>
> *– Red Cedar Community Member*

The quotes highlight how the inability to enter or even stay in farming is not a personal failure but rather driven by systemic factors. Often, these influences occur well beyond the RCLH, and localized actors feel they have little to no agency in shaping those decisions. With a sense of limited power, it can feel as if people are being disciplined into managing their landscapes in a way that is not consistent with their values or community needs. Not only did community members identify systemic challenges facing agriculture in the RCRV, but they also shared a rather consistent conceptualization of when these external influences began to take root. Many point toward a focus on production that was emphasized under the Nixon administration, and specifically the policies of Secretary of Agriculture Earl Butz.

> *"So, let's go back to Earl Butz, who was the ag secretary under Nixon. You can go a generation before that as well. So, but one of the things Butz did was. He's famous for the phrase get big or get out. And so policy, a set of policies were created that rewarded production, and we went away from a supply management system which kept the prices higher for most farmers. And so then through a series of other events, inflation, you know. US foreign policy, like with Russia, you know? When we had the farm crisis of the 80s. So, for example, in my graduating class, there were 150 kids. Maybe 25 farmed. I think there are maybe three farming now."*
>
> *– Red Cedar Community Member*

People on the ground are aware that farming has been, and continues to be, shaped by factors well beyond the farm gate and the boundaries of their watershed. Moreover, because people are situated in a place, they have a lived memory of how these policies have impacted themselves, their fellow community members, and the landscape in which they reside. Across a wide range of professions and backgrounds, there was a shared frustration with the trajectory of agriculture. Even more concerning, localized actors felt that many of the forces shaping agriculture were beyond their local control, and those external to their community had little vested interest in doing what is best for the people who reside in the RCLH. Such shaping forces are particularly relevant when we consider the need for agricultural landscape change to address water quality concerns in the RCLH.

Frustration with Water Quality

Compounding the frustration with the farming system is a recognition that agriculture is a significant source of water pollution for the Red Cedar River. Recent watershed plans indicate that roughly 45% of the Red Cedar Watershed consists of cropland, pasture, and hay (James, 2015). Knowing that land use is not static, an assessment as part of the University of Wisconsin-Stout (UW-Stout) LAKES Research Experience for Undergraduates program found that between 2011 and 2015, 82,047 acres of grassland were converted to cropland in the Red Cedar Watershed (Torres & McKinnon, 2016). Those cropland acres are more susceptible to erosion and phosphorus loss, leaving many in the RCLH disappointed with the water quality and desiring a future in which water pollution is meaningfully addressed. Pictured below are Lake Menomin and Tainter Lake, two central impoundments in the Red Cedar Watershed that turn green in the summer due to cyanobacterial blooms, making them unsafe for recreational activities.

Algae Blooms in Lake Menomin and Tainter Lake

Lake Menomin (Peters, 2015)

Tainter Lake (Reed, 2022)

When trying to pinpoint the cause of the pollution, community members consistently identify agricultural nonpoint pollution as the main pollutant. That judgment is consistent with detailed assessments of the Red Cedar Watershed (James, 2015; James, 2019).

> *I think about Lake Menomin. And how sad it is to live in a place like this where we have what looks like a beautiful lake that really can't be used for recreation…The watershed as a whole is obviously, you know, just really being affected by agricultural runoff and other land uses that stuff, I guess. I think of it as mostly ag runoff as being a problem… I think it's both sad from an environmental perspective, but also sad from a social perspective because it just really limits the way people can interact with the watershed."*
>
> *– Red Cedar Community Member*

The quote identifies how agricultural pollution is affecting people's ability to interact with water resources. This is not to say that agriculture is the only source of pollution to the Red Cedar River. However, it acknowledges that meaningfully addressing pollution in the Red Cedar River will require dramatic reductions in agricultural nonpoint-source pollution (James, 2015). Such a recognition is in addition to the existing frustration that many in the RCLH already have with the trajectory of agricultural systems. The Red Cedar River and its impoundments, Lakes Tainter and Menomin, are central focal points that serve as critical cultural, recreational, and scenic assets for communities in the RCLH. Many of our interview participants interacted with the waterbodies and consistently expressed frustration about pollution. In describing Lake Menomin, one area resident called it a cesspool.

> *"I also think of disgusting, polluted water come August. You'll see it* [the water] *literally turns green, like it's disgusting and it's like a cesspool… my husband loves fishing, I won't eat anything that comes out of Lake Menomin."*
>
> *– Red Cedar Community Member*

The green water described in Lake Menomin has been attributed to excessive nonpoint-source pollution. With excess nutrients and warm summer temperatures, it becomes possible to have large algal blooms. These algal blooms turn the lake into a green film and can be toxic, creating health concerns and worries over fish kills and preventing public recreational opportunities such as swimming. Another area resident details how rampant water pollution impacts the lived experience of those in the RCRV.

> *"We don't even go near the water. We have a little cottage on Tainter* [Lake] *in my husband's family that's beautiful. It's right on the water, but it's like rancid. Yeah, so it takes out fishing. It takes out swimming, it takes out boating, takes out tubing. It takes out all the fun things."*
>
> *– Red Cedar Community Member*

The community member details how the pollution impacts people's ability to use the public body of water. The Clean Water Act (CWA) specifically states that our public waters should be swimmable and fishable. As this community member details, for significant portions of the summer, the Red Cedar River, including Lakes Tainter and Menomin, does not meet the fishable and swimmable standard outlined in the CWA. Beyond direct interactions, community members also detail how pollution affects cultural and social events proximate to the waterbody. A community member explained how the rancid smell of the polluted water impacts things like the public library's summer concert series.

> *"The* [Menomonie] *public library they are right on the water, and they have these outdoor concerts every Thursday in the summer which is beautiful. But then once the smell comes, like you're smelled out like it's disgusting. So, it's just like it impacts so many other things that are great."*
>
> *- Red Cedar Community Member*

When there are blue-green algae blooms, the water bodies have a rotting smell that is not enjoyable, and if the bloom is toxic, it can pose a public health risk. These sentiments capture a widely shared feeling about the impact of rampant water pollution on the public. Those perspectives from community members about water pollution are important because, when considering measures to curtail nonpoint source pollution, it has been common to focus on how actions could inconvenience agricultural producers and, in doing so, diminish or obscure how people are deprived of access to public water resources (Strauser & Booth, 2024).

In the RCLH, there is widespread frustration with the agricultural systems and water quality. In simple terms, people feel they are living through a lose-lose scenario. The logical objective of any future land-use planning process must be to identify win-win scenarios in which people feel that water and agricultural systems are on positive trajectories. When asked what could be done to create a future with profitable and vibrant farms and improved water quality, many identified the need to address systemic challenges facing agriculture. Such logic shifts the focus of watershed planning away from individual-level supports, such as cost-share programs and one-on-one technical assistance, toward an approach that recognizes the systemic challenges facing farmers and the support networks needed to advance the RCLH's goals.

The need for a systems-level approach

Having seen concerning water quality trends concurrent with dramatic shifts in agricultural regimes, there was an expressed desire for a new path forward in the RCLH. There was a stated desire to move beyond a framing that required people to choose between agriculture and water quality. Rather, there is a growing view that a win-win land-use configuration exists that improves quality of life and profitability for agricultural producers while concurrently addressing water quality concerns. To create that win-win scenario, people in the RCLH consistently emphasized the need for policies that provide entry points for new agricultural producers and sustain smaller family-run farms. Such policies would help restore the quintessential Wisconsin dairy identity that many yearn for, and feel has been undermined by policies and market forces for decades.

> *"I would advocate for policies that support more people in an economically healthy way on smaller farms. I think diverse ownership is better than consolidated ownership. I think that your local communities would do better. I think right now a lot of what we do is generate wealth and export it… We used to say we are a community of farmers. But we are not anymore."*
>
> *– Red Cedar Community Member*

As these systems of simplification and concentration intensify, community members increasingly feel that their labor, natural resources, and community identity are being extracted to generate wealth for those elsewhere. Community members expressed frustration that it feels like people are coming in and exploiting the RCRV's labor and resources. To address these issues, policy shifts have been seen as essential to better value the RCRV's labor and resources. The acknowledged need for policy change is consistent with the premise that improvements in water quality will result from systemic change, rather than merely from an aggregation of individual behavior changes. Along those lines, the people pointed out that the landscape changes needed to support water quality are unlikely to occur unless the federally subsidized food system is critically assessed.

> *"We have such a highly subsidized food system that you know, unless you start to look at that. There's not a lot going to change on the ground."*
>
> *– Red Cedar Community Member*

Such a perspective conveys the view that federal agricultural policies are shaping on-the-ground outcomes in the RCLH. Knowing that such changes required coordinated pushes, it would be helpful to have institutional support. However, there was concern that public institutions - such as the state university system – have lost taxpayer support and are therefore increasingly dependent on serving private interests. Such a phenomenon could mean that these public institutions are disciplined to serve private interests rather than the best interests of the communities in the RCLH.

> *"You know, crop insurance, university research... As public institutions lose their public dollars and are funded increasingly by corporations that have an interest in an outcome.*

Then you're going to get research that is directed towards that kind of you know, use corn as an example." – Well, you know, we have decades of research geared towards production as a goal. And we put a lot of money towards that."

– Red Cedar Community Member

The cumulative impact is that people in agricultural communities have identified systemic challenges, but they feel isolated in seeking the changes they desire. To advocate for their community's needs, there have been many concerted efforts to organize and share ideas. A notable example is the Red Cedar Conference, which is hosted annually on the UW-Stout campus. At this event, speakers share ideas, and people come together for meals and conversation about future opportunities for the watershed. Many recognized a continued need to bring people together to exercise their agency and power in developing a positive shared regional identity.

"I think a lot of people don't understand how much like power they hold. And so like getting community members to understand like how much power they have within our community and how like their opinion and voice matters when it comes to organizations or politicians, or politics in general."

- Red Cedar Community Member

When people come together and provide a shared vision, there is great power. That ethos is the essence of the RCLH concept. By bringing a diversity of actors together to 1) identify a desired future, 2) identify pathways toward that desired future, and 3) create and implement actionable steps toward that desired future. At this juncture, in the RCLH, there is a growing vision for place. Still, there are critical roles for community leaders and institutions in facilitating consistent community organizing and implementation.

SmartScape Scenarios for Loading Reductions

In the RCLH, there is a strong desire for improved water quality. As part of trying to create a shared vision for the future, we sought to incorporate SmartScape™ models to project land-use scenarios that could meaningfully improve water-quality outcomes. In 2015, it was estimated that a 61% reduction in phosphorus loading would be needed to reach the Total Maximum Daily Load (TMDL) goals for the Red Cedar System (James, 2015). Based on the projections from the TMDL implementation plan, a reasonable question becomes, what types of social and ecological systems would facilitate a 61% reduction in phosphorus loading? Employing SmartScape™, a web-based decision support tool, we examined a handful of land use scenarios and their potential impacts on water quality. SmartScape™ is a publicly available modeling tool developed at the University of Wisconsin-Madison (training video). Since SmartScape™ is ideally operated at the HUC 10 and HUC 12 scale, we focused our modeling efforts on the agriculturally intensive Hay Creek subwatershed. In all three scenarios, the base assumption is an agricultural system with no cover crops and no-till (see the appendix for model parameters). We acknowledge that this is a very simplified modeling effort and is not comprehensive. Rather, the intended goal is to try to provide a general idea of the types of landscape change that would need to be supported to roughly move the needle on water quality goals. In simple terms, we sought to create a ballpark estimate of the social and ecological systems necessary to obtain community-identified goals.

Scenario 1: Current Trend in Cover Crops and No-Till

In scenario one, we want to consider the impact of the current adoption of cover crops and no-till. In Dunn County, WI, 30% of the crop acres are in no-till and 17% are in cover crops. Likewise, in Barron County, 29% are in no-till with 13% in cover crops. In this modeling scenario, we made an optimistic assumption that 30% of the crop acres would be in cover crops and no-till.

SmartScape Run: Adoption of cover crops and no-till was 30% on the continuous corn, cash grain, and dairy rotation acres (Appendix I).

Total Watershed Area: 163,335 Acres

Total Area Transformed: 14,118 Acres

Scenario 1: Current Trend in Cover Crops and No-Till

Variable	Base	Transformation	Units	Relative Change
Yield	1.46	1.46	tons-dry matter/acre/year	0%
Erosion	0.46	0.40	tons/acre/year	-13%
Phosphorus Loss	1.05	0.84	lb/acre/year	-20%
P Delivery to Water	0.86	0.69	lb/acre/year	-20%
Total Nitrogen Loss to Water	18.96	17.72	lb/acre/year	-7%
Runoff (3 inch storm)	0.92	0.91	inches	-1%
Honey Bee Toxicity	0.08	0.08	insecticide index	0%
Bird Friendliness	0.18	0.18	bird friendliness index	0%

Total Area Transformed: 14,118 Acres

Takeaway: We see that the effort to place cover crops and no-till has been beneficial. We estimate these practices reduce phosphorus loading to the Red Cedar River by about 20%. While that is a notable positive, that type of reduction is not in the ballpark of the roughly 60% reduction that is likely needed to meet water quality goals.

Scenario 2: All out BMPs

A logical question becomes, what if we implemented cover crops and no-till on all the crop acres? Is it possible to move the needle on water quality goals?

SmartScape Run: Adoption of cover crops and no-till was 100% on the continuous corn, cash grain, and dairy rotation acres.

Total Watershed Area: 163,335 Acres

Total Area Transformed: 47,061 Acres

Scenario 2: All out BMPs

Variable	Base	Transformation	Units	Relative Change
Yield	1.46	1.46	tons-dry matter/acre/year	0%
Erosion	0.46	0.24	tons/acre/year	-48%
Phosphorus Loss	1.05	0.36	lb/acre/year	-66%
P Delivery to Water	0.86	0.30	lb/acre/year	-65%
Total Nitrogen Loss to Water	18.96	14.82	lb/acre/year	-22%
Runoff (3 inch storm)	0.92	0.88	inches	-4%
Honey Bee Toxicity	0.08	0.08	insecticide index	0%
Bird Friendliness	0.18	0.18	bird friendliness index	0%

Total Area Transformed: 47,061 Acres

Takeaway: With 100% adoption of cover crops and no-till, modeling suggests that it could be possible to see meaningful improvements in water quality. However, when posed with this scenario there was a stated worry by community members about a limited set of co-benefits beyond the notable water quality improvements. For instance, it seems unlikely that widespread adoption would address issues of biodiversity decline or farm profitability, both of which were also identified as concerning trends.

Scenario 3: Conversion to Grassland

SmartScape Run: In this scenario, we want to move away from the cover crops and no-till path to consider alternative agricultural configurations. In this scenario, we model the number of acres that would need to be converted to well-managed rotational grazing (WMRG) to achieve the 61% reduction in phosphorus loading for the Hay Creek Subwatershed. We found that 80% or 37,649 acres of continuous corn, corn-soybean rotation, and dairy rotation would need to be converted to WMRG.

Total Watershed Area: 163,335 Acres

Total Area Transformed: 37,649 Acres

Scenario 3: Conversion to Grassland

Variable	Base	Transformation	Units	Relative Change
Yield	1.46	1.40	tons-dry matter/acre/year	-4%
Erosion	0.46	0.16	tons/acre/year	-65%
Phosphorus Loss	1.05	0.40	lb/acre/year	-62%
P Delivery to Water	0.86	0.33	lb/acre/year	-62%

Total Nitrogen Loss to Water	18.96	6.90	lb/acre/year	-64%
Runoff (3 inch storm)	0.92	0.76	inches	-17%
Honey Bee Toxicity	0.08	0.02	insecticide index	-75%
Bird Friendliness	0.18	0.30	bird friendliness index	67%

Total Area Transformed: 37,649 Acres

Takeaway: Like the all-out cover crop and no-till approach, we see indications for improved water quality outcomes. We also see that there could be positive impacts for biodiversity indicators. The profitability of such a system is likely to be determined, but research suggests there is a path to profitability by dramatically reducing producer input expenditures (Dartt et al., 1999; Kriegl, 2005; Winsten, 2024). It is also essential to note that for approximately 40,000 acres of land to be transitioned into WMRG, supply chains, social support networks, and technical assistance must be tailored to support such a land transition.

SmartScape Summary

The model runs indicate that, regardless of the path selected, widespread implementation is essential to move toward water quality goals. To address non-point source pollution, the benefits provided by a select few can be brought down by poor performance in other sections of land. While we acknowledge the imperfections and the rough approach to modeling taken, we do feel it provides an overview that further underscores the need for a systems-based approach for addressing water quality concerns.

Discussion

For many years, people across the UMRV have expressed frustration with the trajectory of agricultural systems and subsequently water quality outcomes (Jones, 2023; Nassauer et al., 2007; Porter et al., 2015; Strauser & Stewart, 2024). From our project, we found that people in the RCLH are frustrated with the consolidation and the loss of agricultural diversity. Notably, people noted a sense of lost identity about what it means to be a Wisconsin dairy farmer. Concurrently, there is frustration that those undesirable agricultural regimes perpetuate poor water quality. Taken together, these concerns create a sense among community members that they are in a lose-lose scenario in which they do not receive the desired agricultural or water quality outcomes. To address these concerning trends, people in the RCLH recognize the need to take meaningful action locally (endogenous factors), but they are also cognizant that outcomes in their watershed are influenced by systemic forces (exogenous factors). In other words, widespread improvements in agricultural and water quality outcomes will likely require diverse coalitions that bring together individual and institutional actors – such as non-profits, state agencies, and the university system – working around a shared vision for change. Perhaps more importantly, economic changes that would enable easier access to land, the development of stable markets and supply chains for a wider range of crops, and action to enforce anti-trust laws might also be needed to start shifting the larger agricultural system.

In Wisconsin, like much of the United States (Tomczyk et al., 2023), excessive phosphorus (P) is the most common reason for a waterbody being listed as impaired. Nonpoint-source P pollution remains a persistent concern despite decades of efforts. In 1978 – over 4 decades ago – the Wisconsin Department of Natural Resources (WDNR) launched the priority watershed and lakes programs as an initial attempt to address nonpoint source pollution in Wisconsin (Wisconsin Department of Natural Resources, 2021). Then, in 2002, Wisconsin began transitioning to the statewide agricultural performance standard outlined in NR 151 (Wisconsin Department of Natural Resources, 2021). As a part of these efforts, a common first step is to assess the sources and extent of nutrient loading with a Total Maximum Daily Load (TMDL) report, followed by a TMDL implementation plan, such as a nine-key element plan. A common thread among many community planning initiatives, especially TMDLs, is the expressed need to substantially reduce sediment and/or P loading to waterways by implementing changes to agricultural practices that reduce the application of nutrients (fertilizer and manure), limit soil disturbance (e.g., no-till), increase ground cover (e.g., cover crops), and promote infiltration. The Red Cedar Watershed is no exception, with a TMDL plan that was written in 2012 (La Liberte et al., 2012), and a TMDL implementation plan that was developed in 2015 (James, 2015). Unfortunately, after decades of meaningful efforts to expand nutrient management planning and advance TMDLs, insufficient progress has been made -in reducing the loading of nonpoint source agricultural pollutants into water bodies (Rissman et al., 2024; Tomczyk et al., 2023).

A common observation regarding programs trying to bring waterbodies into compliance is that the CWA, and the programs that have come from it, stemmed from a focus on point rather than non-point source pollution (Porter et al., 2015). These are fundamentally different pollution challenges. A notable difference is that achieving progress on point source pollution is about improvements at a specific location (i.e., improved performance of an individual). With focus on a single spot, it is relatively easy to focus monitoring as well as programmatic efforts whether it be incentives (i.e., carrots) or enforcement (i.e., sticks). In contrast, non-point source pollution outcomes are indicative of collective performance at a watershed scale, making it difficult to pinpoint exact sources. This reality complicates efforts to incentivize or enforce change. In practice, the improved performance by a handful of well-meaning actors can be – and often is – weighed down by extreme weather events or lackluster land management by others in a watershed. While improved collective performance is needed to advance water quality outcomes, many watershed management efforts focus on using cost-share and one-on-one technical support to influence individual behaviors. In doing so, watershed management efforts have underestimated the extent to which long-term and systemic changes in climate and agriculture complicate efforts to improve water quality outcomes (Gillon et al., 2016). These efforts also leave the larger agricultural system unchanged, one that incentivizes the status quo and constrains the choices of individual actors. All of these points to the need for system changes to provide space for producers to implement new practices.

Inducing collective behavior change necessitates a watershed management that shifts the focus from a reductionist to a systems-level approach (Nelson et al., 2017). Systems-level thinking is a holistic approach that appreciates how complex systems are constructed and reconstructed through a relational set of influences across spatial scales (Voulvoulis et al., 2022). We cannot begin to consider addressing agricultural non-point source pollution without first acknowledging how local decisions occurring on a farm or within a watershed are influenced by dynamic contexts that are actively being shaped by events occurring at hyper-local, local, state, national, and international scales (Blesh et al., 2023; Reimer et al., 2021; Strauser et al., 2022). By adopting a systems-level approach, we begin to recognize the context that shapes individual-level outcomes. With that, the focus of watershed management should be on working with people to shape the context in which they operate, rather than trying to induce individual behavior change through temporary incentives.

A foundational starting point in this process of system-level change is recognizing that context is constantly being designed and re-designed (Strauser et al., 2022). All too often, our research, policies, and programs make a faulty assumption that the realities of our climate, policies, markets, and social systems are static. The RCLH case example clearly illustrates that farming, communities, and ecological systems are constantly evolving. Therefore, a key focus of watershed management should be recognizing our shared agency in shaping a dynamic context (Strauser & Booth, 2024). In such an approach, institutional actors – such as NGOs, local government, or universities – can be beneficial in helping organize a coalition of actors to create opportunities to deliberate, develop, revisit, and engage with a shared vision for the future. Developing these shared visions for a novel agricultural future does not happen by accident but requires investment in time, knowledge, and resources, as well as trusted models to assess the potential biophysical and socioeconomic consequences of those visions. We conclude by identifying a handful of actions that institutional actors could take to help communities implement a system-level approach to watershed management.

<u>Invest in developing and sustaining meaningful relationships</u>

Establishing and nurturing trusting relationships is key to implementing a system-level approach to watershed management. When engaging communities, beyond the circle of those ‘bought-in’ to the need for change, conversations typically start at a point of distrust and sometimes antagonism. Trust grows when actors observe and understand that each will care for others’ needs and interests (Bell, 1998). This type of care work is time- and resource-intensive, given travel and opportunity costs. Often, our institutions do a poor job of valuing or recognizing the time-consuming, emotionally involved work of building meaningful relationships (Horlings et al., 2020; Keeler et al., 2017). It is essential that our institutions adapt to put a premium on building and sustaining community relationships.

Organize shared visions for the future

It is common for TMDLs in Wisconsin to identify a need for P load reductions of 40-80%. These types of load reductions likely require significant and sustained land-use changes (Campbell et al., 2022). Institutional actors can and should play a critical role in helping communities consider the scale, processes, and coordination required to facilitate land-use change over multiple decades. A key aspect of this effort is identifying what people desire for the future, how they perceive their current situation, and what they see as barriers to change. Our RCLH project began to take on this process, but further efforts are needed to better organize community members, gain broader perspectives, and workshop and implement novel systems.

Map out social and ecological systems

Having worked with communities throughout Wisconsin to address nonpoint-source agricultural pollution, we have found that communities express land-use visions focused on outcomes-based goals. The goals might be to maintain a clean lake for outdoor recreation or to implement land management practices that mitigate costly flooding events. At the same time, agricultural producers might have goals to be a profitable farm or an operation that allows the next generation to farm. A challenge for communities is to translate these outcomes-based goals into strategic plans and identify potential socio-ecological landscape configurations that would enable the manifestation of these outcomes-based goals. Tools such as SmartScape™ can help translate complex models – like Snap+ - into user-friendly formats and help empower communities to translate desired outcomes into a specific and actionable land use vision. A key consideration should be a back-casting exercise. For instance, in Scenario 3 of this report, we identified a need for a 37,649-acre conversion to WMRG. To create that type of landscape conversion, it will be critical to consider how much market demand, processing infrastructure, and shipping capacity will be required to support it. Changes of that magnitude require coordination among actors, something that is completely ignored in the common cost-share and one-on-one technical-assistance approach.

Need to invest in a system-level approach

With much of our watershed planning focused on reductionist approaches, we have invested heavily in programs and expertise aimed at inducing individual behavior change (Prokopy et al., 2019). If a system-level approach is to become widespread, it will be critical to invest in the expertise and systems necessary to carry it out (Voulvoulis et al., 2022). We will need to train a next generation of watershed managers who embrace the complexity and dynamism of systems-level thinking, then empower those actors with the resources to carry out systems change. Such an approach is not unprecedented in Wisconsin. The state played a critical role in facilitating a shift from wheat to dairy farming through a cooperative effort among our universities, the public sector, and the private sector to develop markets, policies, and agricultural operations that stood up a novel approach to farming (Ehlert, 1970).

Conclusion

Through research, conceptual development, and practical experience, it is increasingly evident that efforts to address major sustainability challenges in agrifood systems would benefit greatly from a systems-level approach that considers how innovation occurs across societal sectors and spatial scales (Barrett et al., 2022; Herrero et al., 2020; Midgley & Lindhult, 2021). In vivid contrast, most policy, research, and technical support in the U.S. does not reflect these understandings. Rather, it is focused on efforts to help individual farmers fine-tune their current farming operations (Blesh et al., 2023; Jackson, 2008; Stuart & Houser, 2018; Weisberger et al., 2021). Such incremental approaches to addressing shortcomings of our agricultural systems have consistently failed to make headway on major sustainability challenges; worse yet, they appear to reinforce the status quo and implicitly lay blame for poor water quality on individual farmers rather than the extractive systems within which they operate (Lowe et al., 2023; Prokopy et al., 2020).

Our institutions have much to gain by providing the critical investment and support to help communities navigate these transformational changes. Communities appear to be losing hope that our institutions will be serious actors in supporting a future with clean water, biodiversity, climate resilience, and vibrant and thriving agricultural operations (Fazey et al., 2021; Strauser & Stewart, 2024). Therefore, our public institutions face a very important challenge: demonstrating that they can create public value by making progress on societal issues, particularly on intractable, complex, and wicked problems (Reid et al., 2021). With mounting public frustration over minimal progress in addressing wicked problems, there is a major opportunity for our institutions to showcase their value by implementing novel strategies to make meaningful progress on these challenges, such as nonpoint source water pollution. In other words, our institutions should not only pursue a systems-level approach to watershed management because it is the right thing to do, but also do so in pursuit of their own self-interest to showcase their critical value to society. For such an essential transition to occur, those in leadership positions must speak out and show leadership to help usher in an era of meaningful change and, in doing so, address the agricultural and water quality challenges that are frustrating those in the RCRV and beyond.

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Appendix A.

Model inputs for Scenario 1: Current Trend in Cover Crops and No-Till

Base Assumptions

Name	Base Continuous Corn	Base Corn and Soybeans	Base Dairy Rotation	Base Pasture
New Land Cover	NA	NA	NA	NA
Grass Species Yield Groups	NA	NA	NA	Medium
Grazing System	NA	NA	NA	Continuous High Density
Rotational Frequency	NA	NA	NA	Once a day
Interseeded Legume	NA	NA	NA	False
Cover Crop	No Cover	No Cover	No Cover	No Cover
Tillage	Spring Cultivation	Spring Cultivation	Spring Cultivation	Spring Cultivation
On Contour	Yes	Yes	Yes	NA
Percent Nitrogen Manure	0	0	100	100
Percent Nitrogen Fertilizer	125	125	25	25
Percent Phosphorous Manure (Calculated)	100	100	0	0
Percent Phosphorous Fertilizer	0	0	254	254

Transformation Assumptions

Name	Cont. Corn in 30% CC & NT	Cash Grain in 30% CC & NT	Dairy Rotation in 30% CC & NT
New Land Cover	Continuous Corn	Cash Grain	Dairy Rotation (Corn Silage to Corn Grain to Alfalfa 3 yrs)
Grass Species Yield Groups	Medium	Medium	Medium
Grazing System	Rotational	Rotational	Rotational
Rotational Frequency	Once a day	Once a day	Once a day
Interseeded Legume	True	True	True
Cover Crop	Small Grain	Small Grain	Small Grain
Tillage	No Till	No Till	No Till
On Contour	No	No	No
Percent Nitrogen Manure	0	0	100
Percent Nitrogen Fertilizer	125	125	25
Percent Phosphorous Manure (Calculated)	100	100	0
Percent Phosphorous Fertilizer	0	0	0
Adoption Rate	30	30	30
Current Land Covers	Continuous Corn	Cash Grain	Dairy Rotation
Well Suited for Cropland I (Best)	False	False	False
Well Suited for Cropland II	False	False	False
Well Suited for Cropland III	False	False	False
Well Suited for Cropland IV	False	False	False
Generally Unsuited for Agriculture V	False	False	False
Generally Unsuited for Agriculture VI	False	False	False
Generally Unsuited for Agriculture VII	False	False	False
Generally Unsuited for Agriculture VIII (Worst)	False	False	False
All Areas are Prime Farmland	False	False	False
Farmland of Statewide Importance	False	False	False
Not Prime Farmland	False	False	False
Prime Farmland if Modified I	False	False	False
Prime Farmland if Modified II	False	False	False
Prime Farmland if Modified III	False	False	False
Min Slope(%)	0	0	0
Max Slope(%)	700	700	700
Minimum Distance to Stream (ft)	0	0	0
Maximum Distance to Stream (ft)	16000	16000	16000

Appendix B.

Model inputs for Scenario 2: All out BMPs

Base Assumptions

Name	**Base Continuous Corn**	**Base Corn and Soybeans**	**Base Dairy Rotation**	**Base Pasture**
New Land Cover	NA	NA	NA	NA
Grass Species Yield Groups	NA	NA	NA	Medium
Grazing System	NA	NA	NA	Continuous High Density
Rotational Frequency	NA	NA	NA	Once a day
Interseeded Legume	NA	NA	NA	False
Cover Crop	No Cover	No Cover	No Cover	No Cover
Tillage	Spring Cultivation	Spring Cultivation	Spring Cultivation	Spring Cultivation
On Contour	Yes	Yes	Yes	NA
Percent Nitrogen Manure	0	0	100	100
Percent Nitrogen Fertilizer	125	125	25	25
Percent Phosphorous Manure (Calculated)	100	100	0	0
Percent Phosphorous Fertilizer	0	0	254	254

Transformation Assumptions

Name	Cont. Corn in 100% CC & NT	Cash Grain in 100% CC & NT	Dairy Rotation in 100% CC & NT
New Land Cover	Continuous Corn	Cash Grain	Dairy Rotation (Corn Silage to Corn Grain to Alfalfa 3 yrs)
Grass Species Yield Groups	Medium	Medium	Medium
Grazing System	Rotational	Rotational	Rotational
Rotational Frequency	Once a day	Once a day	Once a day
Interseeded Legume	True	True	True
Cover Crop	Small Grain	Small Grain	Small Grain
Tillage	No Till	No Till	No Till
On Contour	No	No	No
Percent Nitrogen Manure	0	0	100
Percent Nitrogen Fertilizer	125	125	25
Percent Phosphorous Manure (Calculated)	100	100	0
Percent Phosphorous Fertilizer	0	0	0
Adoption Rate	100	100	100
Current Land Covers	Continuous Corn	Cash Grain	Dairy Rotation
Well Suited for Cropland I (Best)	False	False	False
Well Suited for Cropland II	False	False	False
Well Suited for Cropland III	False	False	False
Well Suited for Cropland IV	False	False	False
Generally Unsuited for Agriculture V	False	False	False
Generally Unsuited for Agriculture VI	False	False	False
Generally Unsuited for Agriculture VII	False	False	False
Generally Unsuited for Agriculture VIII (Worst)	False	False	False
All Areas are Prime Farmland	False	False	False
Farmland of Statewide Importance	False	False	False
Not Prime Farmland	False	False	False
Prime Farmland if Modified I	False	False	False
Prime Farmland if Modified II	False	False	False
Prime Farmland if Modified III	False	False	False
Min Slope(%)	0	0	0
Max Slope(%)	700	700	700
Minimum Distance to Stream (ft)	0	0	0
Maximum Distance to Stream (ft)	16000	16000	16000

Appendix C.

Model inputs for Scenario 3: Conversion to Grassland

Base Assumptions

Name	Base Continuous Corn	Base Corn and Soybeans	Base Dairy Rotation	Base Pasture
New Land Cover	NA	NA	NA	NA
Grass Species Yield Groups	NA	NA	NA	Medium
Grazing System	NA	NA	NA	Continuous High Density
Rotational Frequency	NA	NA	NA	Once a day
Interseeded Legume	NA	NA	NA	False
Cover Crop	No Cover	No Cover	No Cover	No Cover
Tillage	Spring Cultivation	Spring Cultivation	Spring Cultivation	Spring Cultivation
On Contour	Yes	Yes	Yes	NA
Percent Nitrogen Manure	0	0	100	100
Percent Nitrogen Fertilizer	125	125	25	25
Percent Phosphorous Manure (Calculated)	100	100	0	0
Percent Phosphorous Fertilizer	0	0	254	254

Transformation Assumption

Name	80% conversion to WMRG
New Land Cover	Pasture
Grass Species Yield Groups	Medium
Grazing System	Rotational
Rotational Frequency	Once a day
Interseeded Legume	True
Cover Crop	Small Grain
Tillage	NA
On Contour	No
Percent Nitrogen Manure	0
Percent Nitrogen Fertilizer	0
Percent Phosphorous Manure (Calculated)	0
Percent Phosphorous Fertilizer	0
Adoption Rate	80
Current Land Covers	Continuous Corn; Cash Grain; Dairy Rotation
Well Suited for Cropland I (Best)	False
Well Suited for Cropland II	False
Well Suited for Cropland III	False
Well Suited for Cropland IV	False
Generally Unsuited for Agriculture V	False
Generally Unsuited for Agriculture VI	False
Generally Unsuited for Agriculture VII	False
Generally Unsuited for Agriculture VIII (Worst)	False
All Areas are Prime Farmland	False
Farmland of Statewide Importance	False
Not Prime Farmland	False
Prime Farmland if Modified I	False
Prime Farmland if Modified II	False
Prime Farmland if Modified III	False
Min Slope(%)	0
Max Slope(%)	700
Minimum Distance to Stream (ft)	0
Maximum Distance to Stream (ft)	16000