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Farmer willingness to implement constructed wetlands in the Western Lake Erie Basin

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ABSTRACT

Harmful algal blooms (HABs) remain a persistent issue that threatens both the physical and economic health of the Western Lake Erie basin (WLEB). Edge-of-field conservation practices are recommended to help manage agricultural runoff and reach phosphorus reduction targets in freshwater systems like the Great Lakes (in the USA). Constructed wetlands (CWs) are a specific edge-of-field practice that could prove critical to these efforts. While we know less about why wetlands are installed or implemented than many other private lands conservation practices, prior research does indicate that offsetting the costs of land taken out of production, or targeting land that is not suitable for production will be critical. Our research builds on these findings by assessing how the perceived productivity of the land moderates the relationship between other potential motivating factors and willingness to install wetlands. We also assess how these critical motivations may vary by the conservation-mindedness of the farmer. Our results indicate that the decision to install a constructed wetland is not entirely dependent on the productivity of the land. Associated beneficial functions (e.g., aesthetics, hunting opportunities) positively influence willingness, even on productive land for those farmers who value conservation. We suggest that program providers emphasize the diverse benefits of constructed wetlands, and target farmers who exhibit stronger conservation identities as they may be more likely to consider wetlands regardless of the productivity of their land.

1. Introduction

Annual harmful algal blooms (HABs) continue to plague the Western Lake Erie Basin (WLEB). Agricultural runoff is a concern in many agricultural areas without the hydric soils of the WLEB, and the tile-drained landscape, coupled with the removal of natural filtration systems, has exacerbated the rate and intensity of phosphorous that drains into Lake Erie (Mitsch, 2017; Ho and Michalak, 2017). While non-point source pollution in agriculture is not regulated through the Clean Water Act, there are programs targeting non-point source pollution through voluntary means. For example, the United States Environmental Protection Agency and Great Lakes National Program Office, 2018 action plan for Lake Erie aims for a 40% reduction in total phosphorous loads from a 2008 baseline (or a spring reduction in the load of 860 metric tons of total phosphorus and 186 metric tons of soluble reactive phosphorus) (EPA, 2018). In turn, a variety of state and federal programs provide funds to support the adoption of recommended conservation practices aimed at reducing phosphorus loads and meeting this target.

Edge-of-field practices such as riparian buffers and grassed waterways (i.e., drainage ditches planted with well-established grasses) have been vital in working to reach these targeted reductions. Due to the need to manage the excess water delivered during spring rain events under a changing climate (Michalak et al., 2013), it is unlikely that targets will be met by just focusing on in-field practices to improve soil health, such as cover crops and no-till (Scavia et al., 2016). While the acres draining through filter strips, one such edge-of-field practice, increased from 18% to 31% in the WLEB between 2003 and 2012 (Conservation Effects Assessment Project – Cropland, 2016), there is a need for much greater use of such practices (Scavia et al., 2017). Constructed wetlands (CWs) function like other edge-of-field buffers and filters, but they are highly engineered to mimic natural processes. Numerous studies have confirmed the potential for phosphorous removal through constructed wetlands for agricultural run-off and municipal wastewater treatment (Ghermandi et al., 2007; Wu et al., 2014; Zhang et al., 2014; Gorgoglione and Torretta, 2018).

Overall use of wetlands as an edge-of-field practice to improve water quality is currently limited. Historical drainage of the WLEB, which occurred primarily from 1870 to 1920, is estimated to have destroyed

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90% of the former one-million-acre wetland known as the Great Black Swamp (Hallett, 2011). Between the late 1930s and 1970s, the United States Department of Agriculture (USDA) offered cost-sharing for wetland drainage across the United States, and the state of Ohio lost more than 50% of remaining wetland acreage between the 1970s and 1980s (Dahl, 1990). However, the establishment of the Wetland Reserve Program (WRP), a voluntary program under the USDA, led to the restoration of 300,000 acres of wetlands in the central region of the United States (Midwest) from the early 1990's to 2010 (United States Department of Agriculture Natural Resources Conservation Service, 2021). Since 2005, the USDA's Natural Resources Conservation Service has restored more than 25,000 acres of wetlands in Ohio, and work is ongoing (Ohio's Country Journal, 2020). Mitsch (2017) argues for 5–10% of the former Great Black Swamp to be restored, which could reduce annual phosphorous loading from the Maumee River into the WLEB by 18–37%. However, the targeted use of wetlands to reach nutrient reduction targets will require a better understanding of how willing farmers and other private landowners are to implement these practices.

The goal of the research reported here is to statistically model farmer willingness to implement constructed wetlands on private lands by identifying the set of farm and farmer characteristics that are associated with increased or decreased willingness. We hope to highlight pathways for encouraging constructed wetlands on private lands, while determining what factors constitute barriers to participation in incentive-based programs. Increasing our understanding of support for retiring land for conservation is critical, as approximately four million acres of Conservation Reserve Program (CRP) coverage expired in the Midwest between 2012 and 2017 (United States Department of Agriculture Natural Resources Conservation Service, 2021), and 30% of that land was reverted to intensive agricultural use (Philip et al. 2016). If we can better design programs that support constructed wetlands and other alternative uses of targeted agricultural land, it could help to slow this trend, or, potentially, increase participation rates. Irreversible measures, such as the creation of wetlands, are generally met with more resistance than temporary ones (e.g., grass buffers, limited tillage, cover crop use) (Lemke et al., 2011). The paradox here being that long-term agreements are more beneficial for overarching societal objectives (Hansson et al., 2012), or those objectives pursued for societal benefits (such as the health of downstream water bodies).

1.1. Prior literature

Hansson et al. (2012) identified food production as the priority motivation for landowners when making a decision to enroll in a wetland program, leading to them ruling out productive (crop-bearing) land for these initiatives. This finding is consistent with other work on edge-of-field practices that indicates a lack of interest in BMPs if they require land be taken out of production (Liu et al., 2018). However, for unproductive land, practices like wetlands would be considered if they provide income or benefits of personal interest to the farmer (e.g., opportunities for hunting). Much of the research on farmer willingness to implement constructed wetlands focuses on this former point about offsetting costs and/or providing income to landowners. For example, Franzén et al. (2016) found that approximately 30% of Swedish landowners were interested in installing wetlands, but the 70% who were not interested were largely concerned about incurring costs. Yu and Belcher (2011) argue that it is increasingly important to measure cost from the landowners' perspective, as perceived private costs and benefits influence the attitudes of Canadian farmers toward conserving riparian areas on their property. Zhang et al. (2011) found that compensation systems, specifically those focused on covering construction and providing payments for land taken out of production, could play a significant role, both in their study area in China, but for developing countries in general. Hodge and McNally (2000) further advocate for flexibility in payment structures to incentivize action among a group of adjacent landowners, such as offering grants to those who would take action to restore wetlands on a large scale in England. Hansson et al. (2012) refer to these factors as business considerations, or the need for a practice with environmental benefits to also provide an economic benefit (e.g., subsidies for construction and maintenance, the provision of income over time). While economic factors are important for constructed wetlands, they are also important considerations for private lands conservation in general (e.g., see Arbuckle and Roesch-McNally, 2015; Rolfe and Gregg, 2015; Liu et al., 2018).

While cost and payment considerations are critical, nutrient retention and other ancillary cultural benefits, such as aesthetics and biodiversity, are still considered by landowners (Ghermandi and Fichtman, 2015). For example, Wachenheim et al. (2018, 2019) found that likely enrollment in a wetland program was greater among those farmers who believed such programs were important for water quality and who perceived other potential benefits to their operation. Wei et al. (2021) found that farmers will accept lower payments when they understand the environmental benefits of wetlands. These perceived beneficial functions of the land, such as aesthetics and amenity values, are often positive predictors of edge-of-field BMP adoption in general (Odgaard et al., 2017). Other considerations raised in the literature include having sufficient knowledge about wetlands, positive experiences with a wetland either personally or through the stories shared by peers, feeling treated fairly by others, and feeling supported by program providers (Hansson et al., 2012). This idea of social support is consistent with prior research that indicates that the higher the degree of approval and support from trusted sources and fellow farmers, the greater the rate of BMP adoption (Rolfe and Gregg, 2015).

Finally, there are likely characteristics of the farmer or their operation that might influence their interest in wetland construction either directly, or through the beliefs described above. Hansson et al. (2012) suggest that farmers with a sense of personal responsibility, or a belief that they are only borrowing the land from nature and should follow local and national environmental laws, as well as consider future generations when making land management decisions are more likely to support wetland construction. This finding is consistent with research on wetland construction among farmers in Iran, where the greatest predictor was moral norms, or a sense of obligation to act based on what is morally right (Valizadeh et al., 2021). As might be expected, belief that good farmers should do conservation is positively correlated with willingness to engage in conservation (Floress et al., 2017), as well as actual BMP adoption across decades of literature. However, these values and moral norms can conflict with the business interests of the farm, a complexity that makes increasing conservation difficult, as noted in previous reviews of the literature (see Ranjan et al., 2019).

In summary, constructed wetlands are a seldom-adopted edge-of-field practice (García et al., 2020) that could be critical to solving water quality issues in the Western Lake Erie basin (Mitsch, 2017) and beyond (Singh et al., 2019; Cheng et al., 2020). While we know something about why farmers engage in conservation (e.g., conservation is more likely on bigger farms, and among farmers who value the environment and feel pressure from their peers to act) (Ranjan et al., 2019), we know less about constructed wetland adoption specifically. Our research, therefore, aims to examine farmer willingness to implement constructed wetlands, and the set of farm and farmer characteristics that increase or decrease that willingness by quantifying the framework laid out by Hansson et al. (2012) (Fig. 1). Hansson et al. (2012) suggest that constructed wetlands will be more likely on unproductive land when a

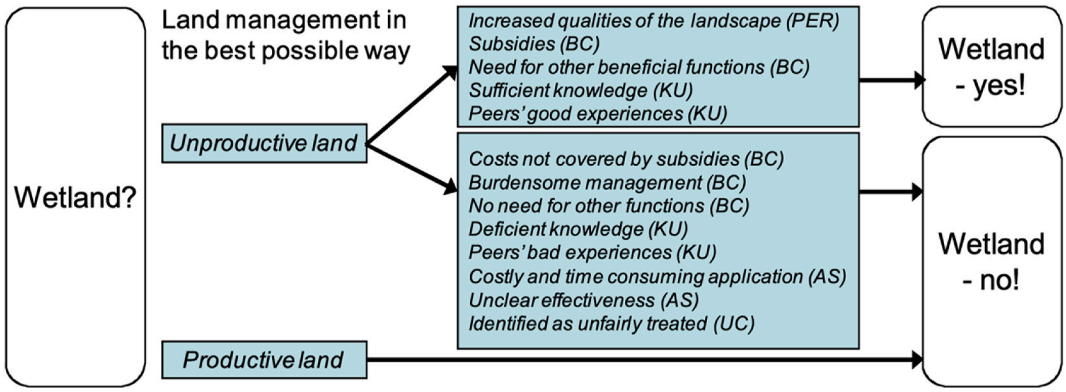

Fig. 1. Hansson's model for determining farmer willingness to implement constructed wetlands where the status of the land is the primary consideration, followed by five additional motives determining wetlands on unproductive land (Hansson et al., 2012).

landowner believes the wetland will increase the quality of the landscape, provide subsidies or income generation, and when the landowner has sufficient knowledge about the wetland and its functions and feels supported. On the other hand, wetlands will be less likely on unproductive land when these factors are lacking, and when the landowner believes the wetland will be costly or ineffective or feels unfairly targeted as the cause of water quality issues.

1.2. Research questions and hypotheses

We first pose the following question: are farmers in this midwestern United States sample driven by the same motivations (i.e., negative and positive beliefs) found in the analysis of the Swedish landowners regarding constructed wetlands? We expect that they will be driven by similar motivations, and as a result we pose the following hypotheses. The more participants a) value other beneficial functions (OBF) and b) feel that their farming practices contribute to problems in Lake Erie (PER), the greater the likelihood of adoption (H1). And, the more participants a) perceive conditions to be unfair (UC), b) perceive acknowledgement and support to be lacking (LackAS), c) personally lack knowledge and understanding (LackKS), d) feel that they cannot justify the cost or have regulatory concerns (BCON), or e) believe that their land is too productive (PROD), the lower the likelihood of adoption (H2).

We then pose the following question: how does perceived productivity of the land influence the relationship between the primary motivations and the likelihood of implementing a constructed wetland? We expect that the hypothesized motivations above will only increase willingness on unproductive land. As a result, we pose the following hypothesis. The effect of a) other beneficial functions (OBF), b) unfair conditions (UC), c) lack of acknowledgement and support (LackAS), d) lack of knowledge and understanding (LackKU), e) personal environmental responsibility (PER), and f) business considerations (BCON) will be dependent on levels of productivity such that high levels of belief in productivity of the land will result in a non-significant relationship between each motivational belief and the likelihood of implementing a constructed wetland (H3).

Finally, we ask, are conservation-minded farmers more likely to hold positive motivational beliefs and less likely to hold negative beliefs, and as a result be more likely to implement CWs? Building on prior literature, we expect that they will hold different beliefs than those with weaker conservation identities. As a result, we pose the following hypotheses. There will be a positive relationship between conservation identity and likelihood of implementation (H4). The positive relationship between conservation identity and likelihood of implementation will be partially mediated by a) other beneficial functions (OBF), b) unfair conditions (UC), c) lack of acknowledgement and support (LackAS), d) lack of knowledge and understanding (KU) LackKU, e) personal environmental responsibility (PER), f) productivity of the land (PRODUC), and g) business considerations (BCON) (H5). And finally, the positive relationship between conservation identity and likelihood of implementation will be fully mediated by all the motivations together (H6).

2. Material and methods

2.1. Sample and survey administration

We purchased a sample of mailing addresses for agricultural operations in the WLEB from Farm Market ID (Fig. 2). Specifically, we selected 1000 potential participants from across the WLEB, stratifying by subbasin and farm size. The farm size categories used for stratification

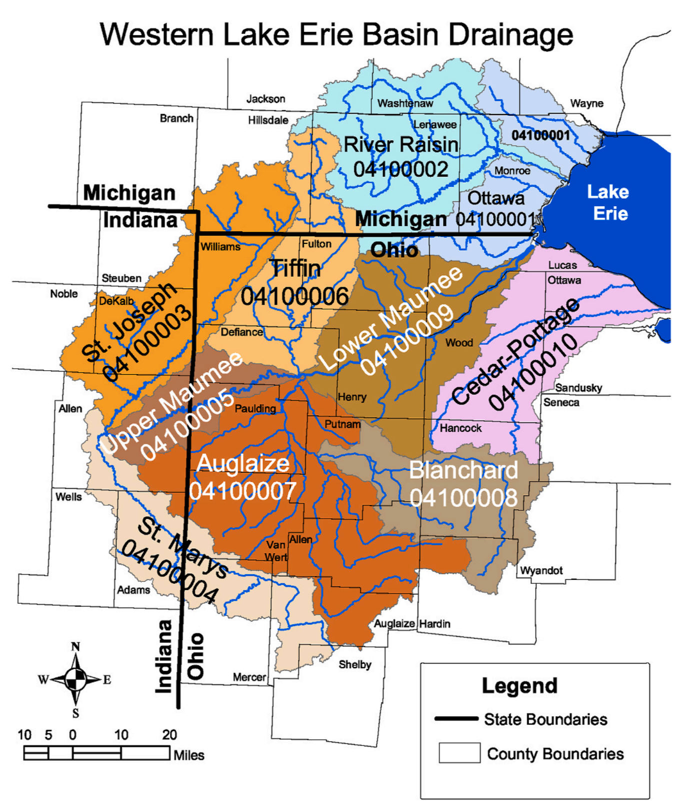

Fig. 2. Western Lake Erie basin drainage area (credit: USDA Natural Resources Conservation Service, URL: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_029097.pdf).

Table 1
Primary variables inspired by Hansson et al. (2012) with qualitative interview examples.

Variables	Example of Pertinent Quote
Other Beneficial Functions (OBF)	"I would love to have had a pond for my own interest, to have some fish and ducks in. Then, I would have been able to fish and hunt a little, something I would have thought was fun …"
Unfair Conditions (UCMOD)	"But then, I personally think that agriculture is put under a magnifying glass when it comes to emissions …"
Lack of Acknowledgement and Support (Lack AS)	"It does look beautiful, I must say. But otherwise I don't know, there has never been anyone who has been there and taken some samples to my knowledge … It's a pity; I'd like to have known if it was of any use"
Knowledge and Understanding (Lack KU)	"I suppose that I have never really understood when they say it pays back to nature for the money it costs, especially when you consider it is no small project …"
Personal Environmental Responsibility (PER)	"We only borrow the land; the next generation needs to have healthy and workable land too"
Productivity (PRODUC)	"We can't play around with wetlands. Everyone wants food, so it is not right to put land under water"
Business Considerations (BCON)	"As it was so expensive, it made you think more about being extra economical … Then you used less fertilizer, which was probably good for the environment … But you don't want to have higher prices, of course"

were the following: 20–249, 250–499, 500–999, 1000+ acres. We then oversampled an additional 400 subjects each from the Blanchard and Auglaize sub-basins, for a total of ~1800 operations in our initial sample. The Blanchard and Auglaize are target areas for wetland construction and were of particular interest to the funder.

We mailed a survey through the U.S. postal service from August to September of 2019. The specific measures used in this analysis are detailed in the following section. Potential respondents were mailed: 1) an initial letter, 2) a full mailing of the 8-page survey with a cover letter including a return envelope and a $2 bill, 3) a reminder postcard, 4) a second full mailing with a cover letter and return envelope, and 5) a postcard (sent only to non-respondents).[1] For this analysis, we received 613 out of 1776 responses for a 34.5% response rate. We then removed 138 cases because the participants did not answer the question regarding the likelihood of adopting a constructed wetland in the future, which was critical for our analysis.

2.2. Measurement

The dependent variable in this analysis was the willingness of the farmer to install a constructed wetland on their property. We measured willingness on a scale of likelihood to install constructed wetlands in the future, from 0 (not at all likely) to 4 (very likely). The independent variables of interest in this proposal were those related to conservation identity and the landowner motivations and constraints identified in Hansson et al., (2012) (see Table 1). The measure of conservation identity was derived from the good farmer identity scale (Arbuckle, 2013; McGuire et al., 2015). Respondents rated the importance of various traits of a "good farmer" from 0 ('not important at all') to 4 ('very important'). Nine items related to the "conservationist" identity (e.g., a good farmer minimizes soil erosion) were averaged for this measure (see McGuire et al., 2015).

Table 2
Full list of variables and constitutent items used in the survey with the reliability of multi-item variables.

Variables	Constituent Items	Cronbach's Alpha
OBF	Constructed wetlands would enhance the beauty of my farm Constructed wetlands would provide me with valuable hunting opportunities Constructed wetlands would attract desirable waterfowl to my property Constructed wetlands can help me diversify my income	0.720
ConsID	A good farmer is one who … Scouts before spraying for pests/weeds/disease Puts long-term conservation of farm resources before short-term profits Maintains or increases soil organic matter Thinks beyond their own farm to the social and ecological health of their watershed Minimizes nutrient runoff into waterways Minimizes soil erosion Manages for both profitability and minimization of environmental impact Considers the health of streams that run through or along their land to be their responsibility Minimizes tillage	0.874
UC	Farmers should not be asked to construct wetlands on their land	N/A
LackAS	Other farmers I respect would not approve of me installing a wetland My neighbors would not approve of me installing a constructed wetland	0.728
LackKU	I do not know enough about the risks and/or benefits of having a constructed wetland on my farm The conservation benefits of constructed wetlands are unclear to me	0.675
PER	My farming practices contribute to problems in Lake Erie Farming practices in the western Lake Erie basin contribute to problems in Lake Erie.	0.824
PRODUC	My land is too productive to justify a constructed wetland	N/A
BCON	I do not want the responsibility of maintaining a constructed wetland I do not want the cost of maintaining a constructed wetland	0.700

The motivations and constraints items were measured on a Likert scale from strongly disagree (0) to strongly agree (4), where 2 equals neither disagree nor agree. They were created for this study and meant to largely replicate the qualitative themes from Hansson et al., (2012) (Table 1). The specific items and reliability coefficients are found in Table 2, but we measured *Other Beneficial Functions* (OBF) by taking the mean of 4 items. We measured *Productivity* (PRODUC) and *Unfair Conditions* (UC) each using a single item, and *Lack of Acknowledgement and* Support (LackAS), *Lack of Knowledge and Understanding* (LackKU), *Personal Environmental Responsibility* (PER) and *Business Considerations* (BCON) by taking the mean of two items for each. It is important to note that there are multiple differences between our measures and the themes in Hansson et al. (2012). We split Hansson's measure of "*Land Management in the Best Possible Way*" into two distinct variables – *Other Beneficial Functions* (OBF) and *Productivity* (PRODUC), as we felt those were the major components of the variable identified through their qualitative interview analysis. As a result, several of the items grouped into our measure of *Other Beneficial Functions* (OBF) fall under Hansson's

[1] As soon as a respondent returned a survey, no further Correspondence was issued. For those who indicated that they did not wish to participate by returning a blank survey or failing to respond after the full sequence of mailings, we deleted all contact information. All useable responses were assigned a numerical identification number, thereby making survey responses anonymous and devoid of personally identifiable information. The data were stored and analyzed with a numerical code only.

original qualitative measure of *Business Considerations* (BC). However, we felt it prudent to group aesthetics, recreation, and diversification of revenue streams into one variable – here, our variable of OBF – separating these ideas from other business considerations such as cost and management. Finally, the *Acknowledgement and* Support (LackAS) concept was based on program provider follow-up and support, or installers regularly checking in on the landowner's property. Given the relatively low adoption rates of constructed wetlands in the United States, we chose to focus on general, normative acknowledgement and support, choosing items capturing hypothetical approval of the practice, both of farmers that the subject respects, as well as neighbors.

We also measured a set of farmer characteristics to include as controls (i.e., age (years), gender, succession plan to a family member (binary), presence of off-farm income (binary), farm size (total acres in crops), and if the farmer was retired (binary)). Farmers in our sample were, on average, 62 years old, male (96%) and not retired (69%). 76% of participants responded that they received off-farm income in 2018, while 71% indicated that they planned to pass their farm down to a member of their immediate or extended family when they retired. The majority indicated farms over 300 acres, with 41% reporting between 300 and 1000 acres, while 28% farmed an operation larger than 1000 acres. While 7% of the farmers sampled report already having a wetland on their property, they were on average "not likely" to construct one in the next five years to minimize nutrient loss. Specifically, 69% reported they were *not likely* or *not likely at all*, 25% reported they were *somewhat likely*, and the remaining 6% reported they were *likely* or *very likely* to install a wetland in the next 5 years.

2.3. Analysis

As an initial look at the relationships between our variables, we ran a correlation matrix with bivariate correlations for the continuous variables and point-biserial correlations for the dichotomous categorical variables (see Appendix 1). Next, to identify whether the themes observed by Hansson et al. (2012) were consistent in our data (H1 and H2), we ran an ordinal logistic regression analysis using self-reported likelihood of implementing constructed wetlands as the primary dependent variable.[2] We included the six concepts from Hansson (split into seven variables for our analysis) and conservation identity as predictors, along with the seven demographic variables as controls. To assess whether the effect of the themes identified in Hansson depended on low beliefs in the productivity of the land (H3), we ran a series of moderated regressions that allowed the effect of each motivation to vary as a function of the perceived productivity of the land. We ran a series of five models, each included an interaction term between one motivation and productivity.[3] Finally, to assess the role of conservation identity in explaining motivations and subsequent adoption of a constructed wetland (H4, H5, and H6), we ran a mediated regression analysis. This analysis treated conservation identity as the focal predictor, and the motivations from Hansson as mediators in a model of the likelihood of installing a constructed wetland. We assessed the significance of the indirect effects through 95% bias-corrected bootstrap confidence intervals. All analyses were conducted in SPSS Version 26 (IBM Corp. Released, 2019). For all regressions, continuous predictors were z-scored in order to create meaningful zero-values for the interpretation of coefficients, as well as coefficients that could be compared to each other in magnitude.

3. Results

3.1. Correlations

Our correlation matrix (see Appendix 1) indicated that conservation identity was positively correlated with other beneficial functions ($r = 0.122$, $p = .011$), having a succession plan ($r = 0.123$, $p = .009$) and larger farm ($r = 0.105$, $p = .028$), and personal environmental responsibility ($r = 0.099$, $p = .035$). Conservation identity also negatively predicted lack of acknowledgement and support to install a wetland ($r = -0.101$ $p = .035$), and perceived unfairness of being asked to install a wetland ($r = -0.163$, $p < .001$).

Overall, correlational results supported the idea that some farmers view wetlands as part of a diversified farm landscape. Perceiving wetlands as having beneficial functions was associated with higher off-farm income ($r = 0.103$, $p = .029$) and personal environmental responsibility ($r = 0.273$, $p < .001$), and lower perception that requests to install wetlands are unfair ($r = -0.413$, $p < .001$). Benefits of wetlands also predicted lower land productivity ($r = -0.380$, $p < .001$) and business considerations ($r = -0.305$, $p < .001$).

The correlations also supported the theory that some farmers view wetlands as being in opposition to more typical farm functions. Belief that it is unfair to ask farmers to build wetlands was positively correlated with lack of acknowledgement and support to install wetlands ($r = 0.337$, $p < .001$), higher land productivity ($r = 0.425$, $p < .001$), and lower perceptions of personal environmental responsibility ($r = -0.300$, $p < .001$). Personal environmental responsibility was negatively correlated with productivity ($r = -0.179$, $p < .001$) and business concerns ($r = -0.103$, $p = .028$). Perceiving a lack of acknowledgement and support for installing wetlands was positively correlated with productivity ($r = 0.285$, $p < .001$), while negatively correlated with personal environmental responsibility ($r = -0.115$, $p = .014$).

On the other hand, lack of knowledge and understanding was positively correlated with personal environmental responsibility ($r = 0.105$, $p = .026$), greater business concerns ($r = 0.114$, $p = .015$), and smaller farm size ($r = -0.104$, $p = .029$). These results suggest that although farmers with a higher sense of personal environmental responsibility may desire to install a wetland, they may face several practical barriers related to resource concerns.

3.2. Regression analyses

For the ordinal logistic regression analysis, the proposed model explained 18–40% of the variance in farmer willingness to install a constructed wetland. The model was significant (Chi-square (13) = 186.16, $p < .001$), and met the assumption of proportional odds (Chi-square (39) = 34.17, $p = .690$). Notably, off-farm income was excluded from the model due to multicollinearity with retirement status.

As hypothesized, self-reported likelihood of installing a wetland was associated with higher conservation identity, greater sense of personal environmental responsibility, and perceiving greater benefits of wetlands. Further, beliefs that being asked to install a wetland is unfair predicted lower willingness to install a wetland, as did business concerns related to wetlands, and higher land productivity (Table 3). The strongest of these effects was belief in the beneficial functions of wetlands. Compared to the average perception of wetland benefits, those high in benefit perceptions were estimated to be 2.12-times more likely to have one greater level of willingness to support wetlands.

In sum, the ordinal logistic regression largely supported H1 and H2, but lack of understanding and support for installation was not related to likelihood of installing a wetland. Also, in support of H4, being higher in beliefs that a good farmer engages in conservation predicted higher willingness to install a wetland. In sum, we do see some evidence that the motivations driving Swedish farmers are similar to those driving

[2] In addition to the ordinal regression analyses, we conducted these analyses using weighted least squares regression in order to compare results, as both can be used to account for the heteroskedasticity present in the data. Conclusions from the WLS regression were consistent with the ordinal regression. However, because the outcome variable is ordinal in nature, the ordinal regression results are presented here.

[3] The moderated regression analyses were conducted using Hayes PROCESS version 4.1 for SPSS.

Table 3
Ordinal logistic regression results explaining farmer willingness to install a constructed wetland.

Variable	B	SE	p-value
Conservation Identity (ConsID)	0.231	.107	.031[a]
Other Beneficial Functions (OBF)	0.751	0.125	<.001[a]
Unfair Conditions (UC)	−0.456	0.125	<.001[a]
Lack of Acknowledgement and Support (LackAS)	−0.183	0.113	.103
Lack of Knowledge and Understanding (LackKU)	0.149	0.106	.158
Personal Environmental Responsibility (PER)	0.279	0.108	.010[a]
Productivity (PRODUC)	−0.393	0.121	.001[a]
Business Considerations (BC)	−0.304	0.115	.008[a]
Off-farm Income			
Succession Plan	−0.040	0.220	.856
Gender	0.432	0.566	0.445
Age	0.026	0.091	0.775
Retire	−0.147	0.232	.527
Farm size (in hundreds of acres)	0.126	0.099	.204
R-square value			
Cox and Snell	.369		
Nagelkerke	.400		
McFadden	.180		
Number of Observations	475		

Note: Coefficients of the ordinal logistic regression are presented as log-odds in order to easily interpret directionality of each effect. Odds ratios can be obtained by raising *e* to the power of the log-odds.
[a] Indicates significance at $p < .05$.

midwestern US farmers.

For the moderated regression, we found little support for our hypothesis (H3). Specifically, land productivity did not significantly interact with perceptions of unfairness regarding wetlands, lack of knowledge and support for installing wetlands, personal environmental responsibility, nor business concerns about maintaining wetlands ($p > .05$). However, there was a significant interaction between perceived benefits of wetlands and land productivity, $F(1, 446) = 4.21$, $p = .041$ (see Table 4). Probing this interaction showed that the simple effect of perceived benefits on likelihood of installing a wetland is strongest when productivity is low, and trends toward becoming weaker when productivity is high, although the confidence intervals around these coefficients overlap slightly (see Table 4).[4] In sum, the perceived productivity of the land only influences the relationship between perceived other beneficial functions and willingness. However, the effect of other beneficial functions remained significant at all levels of perceived productivity in the data, suggesting that high land productivity does not preclude the importance of wetland benefit beliefs, it only influences the strength of the effect.

For the mediated regression (Fig. 3, Table 5), we find additional support for H4, limited support for H5, but no support for H6 (full mediation). Specifically, we see a direct effect of conservation identity on likelihood of installing a wetland ($b = 0.087$, $SE = 0.038$ $p = .022$). We also see two significant indirect effects of conservation identity through perceived unfairness ($b = 0.021$, $SE = 0.011$, 95% bias corrected bootstrap confidence interval = 0.004 to 0.048), and through perceived other beneficial functions ($b = 0.030$, $SE = 0.014$, bias corrected bootstrap confidence interval = .004 to .058). In other words, conservation identity predicted lower perceived unfairness ($b = -0.149$, $SE = 0.048$, $p = .002$) and greater perceived benefits of wetlands ($b = 0.111$, $SE = 0.048$, $p = .020$). In turn, perceived unfairness predicted lower likelihood of installing wetlands ($b = -0.144$, $SE = 0.051$, $p = .005$) and greater perceived benefits predicted higher willingness to install wetlands ($b = 0.270$, $SE = 0.049$, $p < .001$). These results are consistent with the hypothesis that those with stronger conservation identities are less likely to believe that being asked to install a wetland is unfair, more likely to see wetlands as beneficial, and in turn more likely to install wetlands. The full mediation hypothesis was not supported, as effect of conservation identity remained significant when controlling for the proposed mediators.

[4] Because interactions are statistically bidirectional, we also explored this interaction with perceived benefits as the moderator. The simple effect of productivity remained a significant, negative predictor of likelihood of installing wetlands across values of perceived benefits. Confidence intervals around these coefficients suggest that the magnitude of the effect of productivity has little change (see Table 4). Therefore, the pattern of the interaction appears to be driven by productivity as the moderator.

Table 4
Interaction of perceived benefits of wetlands and land productivity.

Variable	B	95% C.I.	SE	p-value
Other Beneficial Functions (OBF)	0.375	0.284, 0.467	0.047	<.001
Productivity (PRODUC)	−0.216	−0.301, −0.131	0.043	<.001
Simple effects of OBF at values of PRODUC				
Low PRODUC	0.432	0.317, 0.547	0.059	<.001
Moderate PRODUC	0.352	0.262, 0.441	0.046	<.001
High PRODUC	0.271	0.150, 0.392	0.062	<.001
Simple effects of PRODUC at values of OBF				
Low OBF	−0.143	−0.242, −0.043	0.051	.005
Moderate OBF	−0.225	−0.312, −0.138	0.044	<.001
High OBF	−0.280	−0.394, −0.166	0.058	<.001

Note: The overall model was significant, $F(3, 446) = 5.337$, $p < .001$, $R^2 = 0.284$, as was the interaction term, $F(1, 446) = 4.21$, $p = .041$. In all moderated regression models, heteroscedasticity-consistent standard errors were estimated using the Cribari-Neto et al. (2000) method (Hayes and Cai, 2007) in Hayes PROCESS Model 1. Low, medium, and high values of the moderator are defined as the 16th, 50th, and 84th percentiles, respectively.

4. Discussion

Hansson et al. (2012) proposed a two-stage choice, with the perceived productivity of the land as the ultimate determinant. In other words, if a wetland is proposed on land that is currently suitable for production, then the proposal would be immediately rejected. It is only on unproductive land that the additional benefits of the wetland are then considered or the other motivations come into play. While we do find a significant negative effect of the productivity of the land on willingness, the significance of the other motivations were not dependent on levels of perceived productivity suggesting that some farmers will set aside productive farmland for wetland creation. For some, the productivity of the land may be the sole driving factor. For others, the decision is more of an identity-driven decision, where the farmers who are motivated to set aside productive land for wetlands are those with a stronger conservation identity who are interested in the other beneficial functions, and do not feel that it is unfair that they are being asked to set aside land for this purpose. It is likely that these conservation-minded farmers believe that implementing wetlands is the "right" course of action, consistent with their values and identity as a farmer, which focuses on more than just production but also on the health of local waterways (Perry-Hill and Prokopy, 2014). This result is consistent with the broader literature that indicates an important role for values and identity (Burton and Wilson, 2006; McGuire et al., 2012; Sulemana and James Jr., 2014). This idea is also consistent with the concept of compatibility from Diffusion of Innovations theory or the degree to which an innovation fits with the existing values, past experiences, and needs of potential adopters (Rogers, 1995).

4.1. Policy implications

Our results suggest that programs aimed at supporting the construction of wetlands should, firstly, emphasize the secondary benefits of

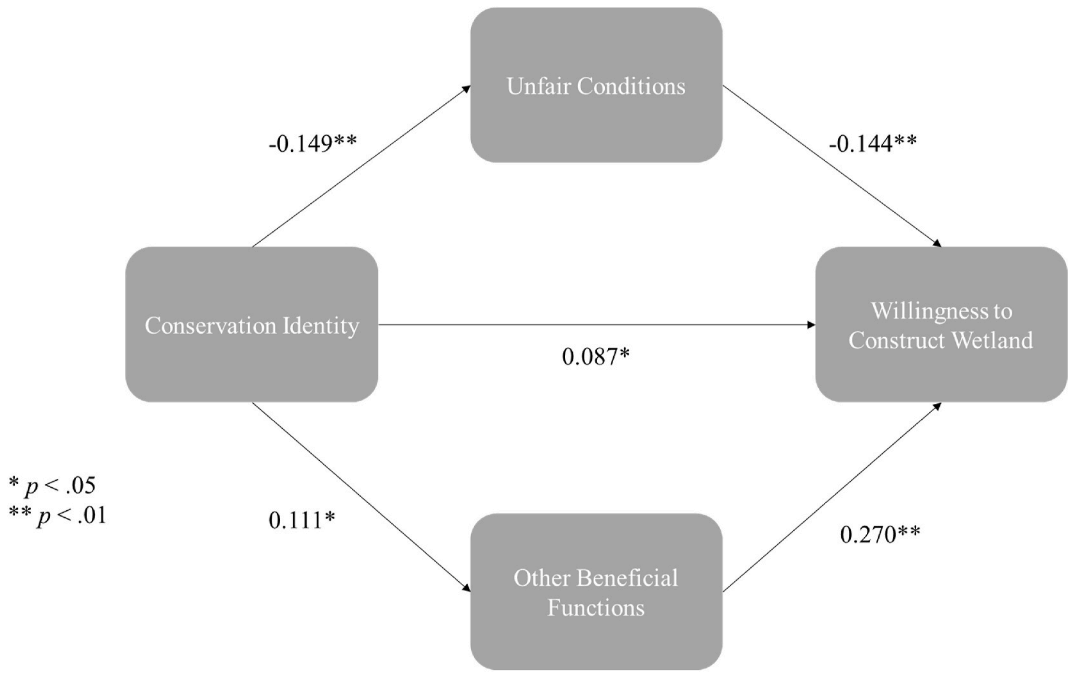

Fig. 3. Mediated regression model showing the significant direct effects between each pair of variables and indicating how conservation identity affects willingness to implement a wetland through the key motivations.

Table 5
Mediated regression results identifying the indirect effect of identity on willingness through each of the measured beliefs or motivations.

Variable	*B*	*SE*	95% C.I.	
			LL	UL
Unfair Conditions	0.021*	0.011	0.004	0.048
Other Beneficial Functions	0.030*	0.014	0.004	0.058
Productivity	−0.006	0.007	−0.022	0.006
Personal Environmental Responsitiblity	0.009	0.006	−0.001	0.022
Lack of Knowledge	0.001	0.004	−0.006	0.009
Lack of Support	0.005	0.005	−0.004	0.016
Business Considerations	0.004	0.008	−0.010	0.021

Note: * Indicates significance at 95% bias corrected bootstrap confidence interval. Indirect effect coefficients, bootstrapped standard errors, and bootstrapped confidence intervals are shown for each proposed mediator. Heteroscedasticity-consistent standard errors were estimated using the Cribari-Neto et al. (2000) method (Hayes and Cai, 2007) in Hayes PROCESS Model 4. F(1, 422 = 5.43, p = .020, R^2 = 0.013.

wetlands, particularly since edge-of-field practices do not provide on-farm production benefits. These benefits will be motivating to those most interested in this practice. Secondly, given the medium-sized correlation between believing that land is too productive and lower willingness to install wetlands, it may still be necessary to target less productive land as this should still be more appealing than a program that targets productive land. This second recommendation focuses on the challenge of incorporating those who are not conservation-minded, do not value the tangential benefits, or perceive the request to be particularly unfair. Conservation minded farmers who believe in the co-benefits of conservation are likely the farmers who already participate in programs, or will be more easily engaged (i.e., the first 25% of farmers in a population who are willing to consider a new practice). Additionally, they are most likely to come to the local conservation office to learn about new opportunities (Arbuckle, 2011). To reach those who are not already engaged (the remaining 75%), higher financial incentives (both at the front end to cover construction and throughout the lifetime of the wetland) may be necessary. Previous literature has suggested that early adopters are primarily driven by monetary considerations (Welch and Marc-Aurele, 2001), and for wetlands we can argue that we are still in the early adopter phase (Rogers, 1995). If new, potential participants can be convinced by higher payments (particularly throughout the life of the wetland), prior research suggests that later adopters will follow as the practice becomes more common. The mechanism of this effect includes increased peer pressure and positive support and acknowledgement from family and peers (Prokopy et al., 2014; Rolfe and Gregg, 2015). We see some evidence in our results that conservation-minded farmers are more likely to feel acknowledged and supported, but this support may be lacking for more production-minded farmers. Although not the focus of this paper, our data did include the Productionist Identity subscale of the Arbuckle (2013) and McGuire et al. (2015) measure. Indeed, there was a positive correlation between productivist identity and lacking support (r = 0.17, p < .001).

4.2. Limitations

There are challenges that arise when translating qualitative findings into a quantitative survey instrument, such as we did here by quantifying the qualitative themes from Hansson et al. (2012). As a result, our measured Likert-scale items may not be capturing the full extent of the themes expressed through the qualitative interview analysis. For example, personal environmental responsibility did not mediate the relationship between conservation identity and willingness to install wetlands, but this could be due to the constituent items making up the variable. Our items focused on the impact of personal and general farming practices on local environmental issues, while the concept from Hansson et al. (2012) also centered on global environment health. However, in the model predicting willingness to install wetlands, personal environmental responsibility showed a significant *direct* effect, above and beyond conservation identity, which includes one's views about what individual actions a farmer ought to do. Thus beliefs about personal responsibility for environmental problems appear separable from general beliefs about conservation in farming, demonstrating the potential importance of this effect.

In addition, we used regression analyses to capture the effect of each of the primary motivations on a landowner's willingness to implement constructed wetlands on their property. In order to study these motivations in a Western Lake Erie Basin sample, it was necessary to transform concepts from Hansson into short measures to maintain survey brevity. This method does not allow us to capture the qualitative nuances that are afforded by Hansson's methods. However, our quantitative methods allow us to compare the relative impact of each of these motivations, accounting for their theoretical overlap. In sum, making comparisons between the motivations for landowners in Sweden and in the Western Lake Erie Basin is difficult for reasons related to variations in how qualitative versus quantitative variables are measured and analyzed, not to mention the varying contexts between the two locations that might influence the relative importance of different motivations and constraints.

4.3. Future research

It is vital to study those farmers who are not primarily conservation minded, and who fall into the group of potential early adopters driven by financial compensation. The implementation of wetlands in this region is likely in the "innovation to early adopter stage" (Rogers, 1995), as wetlands are only being used by a self-reported 7% of the population, with 6–25% willing to consider their future use. In the diffusion of innovation literature, the early adopters are driven largely by financial compensation, whereas here we see the greatest willingness among the conservation-minded farmers. Future studies should more directly assess how farmers of varying identities respond to differences in payments and subsidies to better understand the appeal of different types of program structures for both conservation and profit driven audiences.

Additionally, in this study, the differences identified between landowners in Sweden and those in the western Lake Erie basin may be due to high variation in each context, and such structural variation will be present in future study populations worldwide, warranting additional region-specifc research on the role of contextual factors versus individual motivations. Relatedly, though not directly addressed in our data, there were several respondents who noted in the open-ended comments that they were hesitant to install wetlands due to familial legacy and the fact that previous tiling and drainage decisions were undertaken by their ancestors. This is important to consider in efforts moving forward as many of the farmers in this region have historical ties to the draining of land for agriculture in this region (Hallett, 2011).

5. Conclusions

Farmers who are most likely to implement a constructed wetland are those who are conservation-minded, who value the other beneficial functions that a wetland can provide (e.g., aesthetics, hunting opportunities, diversification of income), who believe it is appropriate for farmers to be asked to construct wetlands and in some cases believe the land is suitable for something other than primary production. We did not find support for Hansson et al. (2012)'s two-stage decision model, wherein land productivity prevents other motivating factors from affecting willingness to install wetlands. However, we do see an independent direct effect of land productivity, suggesting that targeting less productive land may be the most inclusive to a variety of farmer motivations. However, if there is a specific location that would be particularly valuable for a wetland, and this land happens to be very productive, a conservation-minded farmer may value this wetland enough to participate in the program. The conservation-minded farmers may also be those who possess more positive environmental attitudes, have greater access to information and more supportive social networks, and generate higher income (Prokopy et al., 2008). In our correlational data, we see some evidence that the more conservation-minded have larger farms and are more likely to have a succession plan. As a result, programs aimed at supporting the construction of wetlands should first identify the most ideal locations for constructed wetlands based on the potential benefits to water quality, and then emphasize the tangential benefits, and perhaps target larger farms with succession plans. These types of farms and farmers may be more likely to consider wetlands, regardless of the productivity of their land. If the ideal locations are owned by those not as motivated by the secondary benefits, less productive land may best be targeted through a pay-for-performance structure.

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Author Contributions

Cole Soldo: Writing – original draft, Investigation, Formal analysis, Conceptualization. Robyn Wilson: Writing – review & editing, Supervision, Project administration, Funding acquisition, Formal analysis, Resources, Data curation, C. Dale Shaffer-Morrison: Formal analysis, Writing – review & editing, Hugh Walpole: Formal analysis, Visualization, Supervision, Writing – review & editing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix 1. Correlations of the motivations for likelihood of wetland installation

		Willingness	Age	Gender	Succession Plan	Off-Farm Income	Farm Size	Retire	OBF	UC	LackKU	LackAS	PER	PRODUC	BC	ConsID
Willingness to Install Wetland	*r*	–														
	N	475														
Age	*r*	−.028	–													
	p	.543														
	N	470	470													
Gender	*r*	−.024	.057	–												
	p	.596	.217													
	N	473	469	473												
Succession Plan	*r*	−.007	.047	.034	–											
	p	.883	.308	.464												
	N	472	469	470	472											
Off-Farm Income	*r*	.043	−.083	.060	−.143[a]	–										
	p	.359	.072	.197	.002											
	N	468	466	466	467	468										
Farm size (hundreds of acres)	*r*	.054	−.091	−.084	.217[a]	−.135[a]	–									
	p	.252	.053	.073	<.001	.004										
	N	460	456	458	458	455	460									
Retire	*r*	.043	−.083	.060	−.143[a]	1.000[a]	−.135[a]	–								
	p	.359	.072	.197	.002	.000	.004									
	N	468	466	466	467	468	455	468								
OBF	*r*	.479[a]	−.063	−.078	−.062	.103[b]	−.085	.103[b]	–							
	p	<.001	.184	.098	.190	.029	.077	.029								
	N	451	449	450	449	446	437	446	451							
UC	*r*	−.398[a]	.074	.005	.060	−.052	−.062	−.052	−.413[a]	–						
	p	<.001	.116	.916	.197	.266	.189	.266	<.001							
	N	460	456	458	458	454	446	454	448	460						
LackKU	*r*	.032	.033	.081	.009	.028	−.104[b]	.028	.042	.069	–					
	p	.496	.483	.083	.845	.553	.029	.553	.374	.139						
	N	456	453	454	454	451	442	451	446	454	456					
LackAS	*r*	−.204[a]	.032	−.047	−.018	−.009	−.083	−.009	−.107[b]	.337[a]	.089	–				
	p	<.001	.494	.320	.705	.854	.084	.854	.024	<.001	.061					
	N	454	451	452	452	449	440	449	445	451	448	454				
PER	*r*	.256[a]	.058	−.034	−.031	.072	−.005	.072	.273[a]	−.300[a]	.105[b]	−.115[b]	–			
	p	<.001	.208	.461	.502	.123	.912	.123	<.001	<.001	.026	.014				
	N	470	466	468	467	464	455	464	449	457	454	453	470			
PRODUC	*r*	−.376[a]	.070	−.035	.151[a]	−.051	.047	−.051	−.380[a]	.425[a]	−.030	.285[a]	−.179[a]	–		
	p	<.001	.136	.450	.001	.275	.324	.275	<.001	<.001	.521	<.001	<.001			
	N	463	459	461	461	457	449	457	450	460	455	453	460	463		
BC	*r*	−.337[a]	.019	−.035	−.022	−.022	−.015	−.022	−.305[a]	.291[a]	.114[b]	.311[a]	−.103[b]	.369[a]	–	
	p	<.001	.694	.461	.647	.638	.759	.638	<.001	<.001	.015	<.001	.028	<.001		
	N	458	455	456	456	453	444	453	449	455	452	451	456	457	458	
ConsID	*r*	.159[a]	−.011	−.001	.123[a]	−.011	.105[b]	−.011	.122[b]	−.163[a]	.021	−.101[b]	.099[b]	.037	−.044	–
	p	<.001	.816	.991	.009	.822	.028	.822	.011	<.001	.661	.035	.035	.436	.356	
	N	454	450	452	451	448	440	448	437	442	441	439	452	445	443	454

[a] Correlation is significant at the 0.01 level (2-tailed).
[b] Correlation is significant at the 0.05 level (2-tailed).

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