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Direct Mailing Education Campaign Impacts on the Adoption of Grazing Management Practices

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Abstract: The Texas Commission on Environmental Quality facilitates the Clean Rivers Program where many of Texas' waters are monitored for various parameters. A common approach to address water quality impairments is to develop and implement Watershed Protection Plans, where a key management measure is to increase the adoption of best management practices through existing government programs that provide technical and financial assistance. A key role for watershed managers during implementation is to raise awareness that technical and financial resources are available to assist producers with adoption. Outreach approaches thus far have included in-person education programs, attendance at local Soil and Water Conservation District (SWCD) meetings, newsletters, and other efforts that have only had minimal reach. As a result, we initiated a mass mailing campaign where 4,921 landowners within Lavaca County, Texas were reached four times in approximately six months with the same message. Partnering with the local SWCD and United States Department of Agriculture Natural Resources Conservation Service offices, the number of individual best management practices were acquired for the current and previous five federal fiscal years to measure changes. Results suggest directly mailing educational materials to landowners is an effective outreach approach to increase the adoption of best management practices. Model results indicate a significant 300% increase in adoption of practices compared to historic levels.

Keywords: *nonpoint source pollution, adoption, best management practices, education, direct mailing*

Nonpoint source pollution is the leading cause of water quality impairments in the United States, and Texas waters are monitored for and impacted by point and nonpoint source pollution (U.S. EPA 2017). In Texas, the Texas State Soil and Water Conservation Board (TSSWCB) and Texas Commission on Environmental Quality (TCEQ) are responsible for maintaining and improving water quality through many programs including the Clean Rivers Program, the Total Maximum Daily Load (TMDL) program, and the Texas Nonpoint Source Management Program (TCEQ 2020). The Texas Integrated Report, delivered in compliance with the federal Clean Water Act Sections 305(b) and 303(d), evaluates the state's natural surface waters' quality based on historical records and criteria aligning with the Texas surface water quality standards (TCEQ 2019b). Water bodies not meeting the established water quality standards are considered impaired for their designated uses and included on the 303(d) list as not meeting standards. This report is created every two years yet can take three years to be approved. The 2016 report approved by the U.S. Environmental Protection Agency (EPA) in August 2019 found the Lavaca River Above Tidal contained a geometric mean of 260.84 *Escherichia coli* cfu/100mL and that Rocky Creek had 311.13 cfu/100mL (TCEQ 2019a). Under the current assessment approach, water bodies are considered impaired if the geometric mean and 80% confidence interval of all water body samples over seven years exceed 126 cfu/100mL *E. coli* bacteria (TCEQ 2019a). These numbers show a significant need for action and change to decrease the *E. coli* concentrations.

To address water quality impairments identified in the Texas Integrated Report, TMDLs and Watershed Protection Plans (WPPs) are created and implemented. A major component of these

Research Implications

- Direct mailing educational materials is an effective method to reach landowners unable to attend in-person education programs.
- Direct mailing campaign increases adoption of best management practices.
- Water quality improvement is an anticipated effect of increasing adoption of best management practices through direct mailing outreach.

response strategies is encouraging the adoption of agricultural best management practices (BMPs). The United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) and TSSWCB provide technical and financial assistance to landowners and agricultural producers for the adoption of practices that both improve operations and have water quality benefits. While TMDLs have regulatory aspects, WPPs are entirely voluntary and have been developed in watersheds following the EPA nine element guide (U.S. EPA 2008). To develop these plans, stakeholders meet to identify causes and sources of nonpoint source pollution, loading reductions needed to meet water quality standards, management measures that should be taken to reduce the pollutant, sources of technical and financial assistance, interim measurable milestones, and other elements outlined in the above-mentioned EPA guidance. These comprehensive plans are also adaptive to accommodate changes that occur in the watershed (such as population growth and land use changes) as well as the approaches taken to implement the plan.

The Lavaca River Watershed is located in southeast Texas and consists mainly of two counties, Lavaca and Jackson (Schramm et al. 2018). Most land in Lavaca County is used for livestock production and, according to the USDA, Lavaca County is one of the most concentrated beef cattle producing counties in Texas (National Agriculture Statistics by State 2019). An inventory report from 2018 indicated 105,000 head of cattle in Lavaca County, including calves (National Agriculture Statistics by State 2019). Landowners using improper stocking rates can damage the land quality and diminish forage availability by overgrazing, which leaves little soil protection or vegetation to filter runoff from rainfall events. Therefore, livestock production was identified by stakeholders as a potential contributor to the bacteria impairments within the Lavaca River Watershed, and BMPs which can help support proper stocking rates and have a positive impact on water quality were included in the Lavaca River WPP. BMPs included were cross fencing, alternative water sources, alternative feed/salt/mineral locations, alternative shade structures, and calculating stocking rates using grazeable acres. Cross fencing can be used to keep cattle from entering riparian areas while also supporting rotational grazing (Beef Cattle Research Council 2020). Rotational grazing allows landowners to move cattle to different pastures on the property and gives the forage a recovery period. This also ensures the cattle are grazing the properties evenly. Alternative water sources, alternative shade structures, and alternative feed/salt/mineral locations also encourage cattle to keep away from riparian areas and graze the forage evenly (Clary et al. 2016).

Calculating stocking rates using grazeable acres requires the landowner to consider how many acres are grazeable by subtracting the acreage that includes rocky areas, ponds, and other areas cattle cannot graze (Beef Cattle Research Council 2020). Excluding these areas gives an accurate measure for stocking rate and ensures landowners are not overstocking. Additionally, this calls attention to stocking rates for landowners who might have previously overlooked that aspect of their operation.

Watershed managers have provided outreach through in-person workshops, meetings, newsletters, and other communication channels; however, these approaches are limited in the number of landowners that can be reached. According to watershed managers and sign-in sheet records, outreach efforts within the watershed, including in-person education programs (30 people per event on average), Soil and Water Conservation District Meetings (6 people on average), and newsletters (84 subscribers), have had minimal impact at reaching intended audiences (E. Monroe, personal communication, August 24, 2021). Often, the workshops are during the day and a limited number

of the target audience is able to attend. Additionally, it is not uncommon for the same people to attend various events, creating a need for Extension personnel to explore strategies to diversify their audience. There is a continuous need to utilize better communication approaches that can reach more stakeholders. A study conducted in a rural Central Texas watershed by Dewald et al. (2018) showed that landowners, especially those whose age range falls in the 50's and up, preferred to be contacted quarterly through direct mailings from a trusted source (such as Texas A&M AgriLife Extension Service) about conservation practices to improve water quality.

Political campaigns use a variety of communication channels to reach the public. While television commercials and social media are a popular and productive means of advertising, direct mailing is still largely used (Van Diepen et al. 2009). In 2019, 142.57 billion items were directly mailed to U.S. households (Mazareanu 2021). Promotional mailings are used as a "call to action" piece to relay information and appear to have a positive short-term response versus a long-term response. Gázaquez-Abad et al. (2011) conducted a study relating to the role of direct mailing in apparel retail and found the marketing strategy to have an influence on their sample. The direct mailings influenced purchase decisions, with dependence on the timing and nature of the mailing (Gázaquez-Abad et al. 2011).

Additionally, Benoit and Stein (2006) list several other advantages of direct mailing over other forms of media, including amount of information relayed and ability to target a particular audience. Brochures, for example, allow for more information to be dispersed than spot advertising (Trent and Friedenberg 2004). Benoit and Stein (2006) compared a sample of Benoit's (1999) study on television ads to the direct mail from the current study and found the television ads contained 5.2-5.5 themes while the direct mail allowed for 25.8-33.9 themes. This suggests direct mail postcards can provide an adequate and successful platform for disseminating information. Trent and Friedenberg (2004) also noted the advantage in direct mailing relating to targeting audiences. In Benoit and Stein's (2006) study, reports indicated 53% of the general campaign direct mailings and 8% of the primary campaign direct mailings targeted a particular audience.

Direct mail can have a larger impact on consumers than other mediums. One study conducted by Gerber et al. (2011) analyzed the effect of direct mail on election turnout and voter share. While turnout did not increase because of direct mailing, voter share for one party increased by 1.5 to 3.5 percentage points. The direct mailing changed already decided votes to the opposing party on the ballot. Other similar political studies which used direct mailing flyers, conducted by Green and Gerber (2008) as well as Gerber et al. (2008), also found an increase in percentage points for the targeted party as a result of the intervention.

Virtual communication is a common outreach method for marketing, education, and many other industries. Advancing technology in the last twenty years has led to email replacing various tasks like sending memos via fax (Turville 2019) or mail. Many people both professionally and otherwise now use email to send meeting invitations, share calendar events, receive digital purchases such as tickets, and more (Turville 2019). However, with email used for both personal and work purposes, there is the potential for email overload.

Thousands of emails are sent weekly and can be simply deleted or remain unopened. Turville (2019) pointed out that some people are diligent in managing emails while others are not. Langer (2015) tweeted "[t]here are 2 kinds of people in this world" with a photo of two apple email icons – one with no email notifications and the other indicating there were 13,678 emails unread. This tweet went viral and received thousands of retweets from people who could relate (Langer 2015).

Aside from emails, social media and other apps have also become a major source of information, as well as communication. One example includes the Texas A&M AgriLife Extension Nutrition Department's Instagram page which provides nutritional information to anyone who follows the account. Several accounts and pages such as this one are free to the public to view, which can contribute to information overload. Benselin and Ragsdell (2016) conducted a study relating to information overload as it relates to age. Similar to many past literature articles, Benselin and

Ragsdell (2016) had asked participants to identify information overload and results concluded that no single definition or single source could be provided. However, technology was a common theme in responses from older aged groups when asked for a source of information overload (Benselin and Ragsdell 2016). Even so, all age groups reported to have likely experienced information overload (Benselin and Ragsdell 2016).

Given the crowded digital space and the positive outcome that political campaigns have had through direct mailing, there is potential to use this as an educational approach to influence behavioral change. By directly mailing educational flyers to landowners to raise awareness on the impacts of stocking rates and available sources of technical and financial assistance, an increase in the adoption of BMPs may be realized. Additionally, this outreach approach may also be a more cost-effective method to connect with landowners than previous efforts.

Purpose and Objectives

This study sought to evaluate the efficacy of direct mailing educational flyers as a method that increases the adoption of BMPs through USDA NRCS and SWCDs. To evaluate the approach, the following were key study objectives during the course of the project:

1. Collect pre-intervention survey data, including knowledge of stocking rates, awareness of USDA NRCS and local SWCDs and intention to adopt, and assessment of potential differences in both the treatment and control Texas counties of Lavaca and Goliad, respectively.
2. Conduct an intervention by developing a single educational flyer regarding stocking rates, and distribute via mail four times in one year to all Lavaca County landowners who own 10 or more acres.
3. Evaluate changes in the adoption of BMPs through Conservation Plans/WQMPs over the previous five years within each respective county (before and after intervention), as well as adoption change trends between treatment and control counties.

Methods

Lavaca and Goliad Counties are Texas counties similar in percent of land use types and percent of total farms by farm size (see Table 1), and agricultural production is dominated by beef cattle production, specifically cow-calf, in both counties. Because of these similarities, researchers hypothesized that populations would also be similar regarding methods of determining beef cattle stocking rates, awareness of sources for technical and financial assistance, and intentions to adopt grazing BMPs.

A survey instrument was administrated prior to the educational intervention to help explain potential differences in adoption between the two counties. The instrument consisted of 19 questions, and each survey was labeled with an identification number to ensure easy tracking of responses and removal of respondents from the mailing list to reduce survey fatigue. The survey questions were divided into sections. The first section consisted of questions about landowners' knowledge of stocking rates and contained four constructs: strategies to determine stocking rates, indicators of overstocking, results of overstocking, and advantages of properly stocking. The second section assessed intention to adopt, and the third, awareness of USDA NRCS and TSSWCB. The final two sections recorded farm and personal characteristics.

Landowner contact lists were acquired through the local county appraisal districts and were further developed by eliminating parcels under 10 acres and duplicate listings. The final Lavaca County contact list included 4,921 landowners, while Goliad's final list had 1,959 landowners. For the survey mailing, a simple random sample was drawn from both populations. As a result, 1,200 surveys were mailed to Lavaca County and 500 to Goliad County through a modified Dillman et al. (2014) Tailored Design Method.

The survey mailing schedule consisted of four stages. First, a pre-notice postcard was mailed in early June 2020, followed by a survey package one week later, a thank you and reminder postcard one week after that, and a final survey package two weeks later. Data collection ended in the final week of July 2020, having been extended due to COVID-19 delays in return mail. The final

combined response rate was 37%, with a total of 271 usable responses and 64 undeliverable.

To analyze data collected through surveying landowners, a quantitative research design was used. Nonresponse error was tested by comparing early and late responders and no significant differences were found, meaning that it can be assumed that respondents were representative of the population (Lindner et al. 2001). All scale constructs were found reliable ($\alpha \geq 0.70$) and data were analyzed using t-tests.

The educational intervention was the mailing out of an identical information flyer containing overstocking indicators, implications of overstocking, advantages of properly stocking, practices to assist in proper stocking, a call to action, and local contact information for technical and financial assistance. The educational flyer was mailed through the U.S. Postal Service to the entire population of 4,921 in Lavaca County every other month, starting in July 2020 and ending in January 2021. No mailing of the educational flyer occurred in Goliad County. Two months after the final mailing, researchers worked with USDA NRCS to gather data on the number of BMPs and plans (both Conservation Plans and WQMPs) adopted in both Lavaca County (the intervention county) and Goliad County (the control county). On March 24, 2021, USDA NRCS provided summary data via email message regarding the number of BMPs and plans adopted using financial assistance for both Lavaca and Goliad Counties.

To infer potential effects of mailings on the number of practices adopted, we modelled the effect of year, presence or absence of mailing (binary variable), and county on the count of practices adopted, using a generalized linear model (GLM). The GLM was fit with a poisson error structure and log link. GLMs were fit using the R statistical software version 4.0.5 (R Core Team 2021). Under the assumption that within county measurements are not independent, we considered a random effect model that included county as a random intercept. However, the estimates of random effects with only two groups are not reliable and in practice showed little improvement in model performance, with harder-to-interpret results. Given the small sample size, the model is not intended to be predictive of results but to provide reasonable insight into the effect that mailing might have on practice counts.

Results

Demographics for both Lavaca and Goliad County are given in Table 2. Lavaca and Goliad County samples consisted of primarily white males, 51+ years-old, who receive 0-20% of their household income from the beef operations.

The following results from the pre-intervention evaluation are broken down by variable. Independent t-tests were used to compare Lavaca and Goliad County landowners. Table 3 presents a comparison of landowners' knowledge of strategies to determine stocking rates, indicators

Table 1. Lavaca and Goliad County 2017 land use type and percent of total farms by farm size.

	Lavaca County (%)	Goliad County (%)
Land Use Type		
Cropland	15	10
Pastureland	67	72
Woodland	15	13
Other	3	5
Farm Size		
1 to 9 acres	7	6
10 to 49 acres	28	26
50 to 179 acres	41	31
180 to 499 acres	18	25
500 to 999 acres	4	6
1,000+ acres	2	5

Note. Data acquired from National Agriculture Statistics by State 2017 Census of Agriculture Report.

Table 2. Descriptive statistics for respondents' personal characteristics.

	Lavaca		*Goliad*	
	f	*%*	*f*	*%*
Gender				
Male	135	75	59	79
Female	44	25	16	21
Age				
51-70	88	48	41	54
71 and over	69	38	25	33
31-50	26	14	8	10
18-30	1	1	2	3
Ethnicity				
White	167	94	69	96
Spanish, Hispanic, or Latino	6	3	3	4
American Indian or Alaskan Native	3	2	0	0
Black or African American	1	1	0	0
Education Level				
Bachelor's Degree	55	29	23	31
Graduate Degree	39	21	16	21
High School Graduate	38	20	11	15
Some College	31	16	18	24
Associate degree	21	11	6	8
Less than High School	6	3	1	1
Percentage of Income from Beef Production				
1-20%	119	68	43	57
0%	26	15	22	29
21-40%	20	11	2	3
41-60%	8	5	3	4
61-80%	1	1	4	5
81-100%	2	1	1	1
Operation Type				
Commercial Cow/Calf	145	83	57	81
Other	15	9	9	13
Backgrounder/Stocker	6	3	1	1
Feedlot/Finishing Operation	5	3	1	1
Seedstock	3	2	2	3
Years in Production				
11-25 years	52	29	16	21
26-40 years	45	25	19	25
41-60 years	37	21	18	24
0-10 years	23	13	13	17
None – I lease my property for ag production.	15	8	5	7
61+ years	8	4	5	7

of overstocking, results of overstocking, and advantages of using appropriate stocking rates from each county prior to mailing the flyer. There was no significant difference between Lavaca and Goliad County landowners in terms of knowledge of strategies to determine stocking rates based on county appraisal district recommendations, forage availability, calculated grazeable acres, and preparation for change in season. However, there was a significant difference between the two counties as it relates to methods used to determine stocking rates based on current or anticipated market prices. Lavaca County landowners somewhat disagreed with using current or anticipated market prices to determine stocking rates while Goliad County landowners somewhat agreed with the strategy. There was no significant difference between Lavaca and Goliad landowners regarding indicators of overstocking, results of overstocking, and advantages of properly stocking. Both counties presented knowledge in each construct.

Table 4 details the intention of Lavaca and Goliad County landowners to adopt BMPs prior to receiving the educational flyer. There were no significant differences between Lavaca and Goliad County landowners related to their intentions to adopt calculating grazeable acres for stocking rates, grazing plans, and alternative water sources. Both samples of landowners plan to adopt calculating grazeable acres and grazing plans. Lavaca County landowners already adopted alternative water sources while Goliad County landowners plan to adopt the practice.

There were significant differences ($p < .05$) between Lavaca and Goliad County landowners in relation to their intentions to adopt cross fencing ($p = .01$), alternative feed/salt/mineral locations ($p = .02$), and alternative shade structures ($p = .001$). Lavaca County landowners have already begun to adopt cross fencing and alternative feed/salt/mineral locations while Goliad County landowners plan to adopt these practices. Landowners in both counties plan to adopt alternative shade structures, but Lavaca County held a significantly higher mean.

Lavaca and Goliad County landowners' awareness of USDA NRCS and SWCDs prior to the mailing of the flyer is reported in Table 5. Both Lavaca and Goliad County landowners reported an overall awareness of USDA NRCS and SWCDs. However, landowners reported lack of awareness of offered financial assistance and that working with the agencies is confidential. Fifty-one percent of Lavaca County landowners and 50% of Goliad County landowners were not aware the USDA NRCS offers financial assistance to implement practices on eligible landowner's property. Additionally, 64% of Lavaca County landowners and 59% of Goliad County landowners were unaware technical and financial assistance received from the USDA NRCS is confidential.

The summary of the number of BMPs by year presented in Table 6 includes, for 2021, both practices that have been implemented and practices that are currently planned by the county office. Figure 1 shows the increase of practices from 2016-2021 in Lavaca County upon the mailing of the flyers. Mailing of the educational flyer began in July 2020 and practices adopted increased in both 2020 and 2021 in Lavaca County as compared to previous years.

The GLM indicates significant effects for each model term on the number of practices adopted (Table 7). Figure 2 shows the predicted marginal effects of mailings and year on the number of practices adopted. Based on the limited sample size, the GLM indicates a significant and likely substantial effect of mailings on the number of practices adopted. Holding both year and county constant, the GLM predicted count of practices for counties without mailings is 72.80 (95% CI = 55.60 – 90.20) compared to 228.89 (95% CI = 199.50 – 260.02) for counties with mailings.

Conclusions, Implications, and Recommendations

Results suggest that Lavaca County and Goliad County landowners were overall similar in their knowledge about stocking rates and their awareness of technical and financial resources available through local USDA NRCS and SWCD offices prior to our mailing of the educational flyer. There was, however, a difference between the two groups as it relates to their intention to adopt cross fencing and alternative feed/salt/mineral locations. This result suggests Lavaca County landowners

Table 3. Lavaca and Goliad County landowners' strategies to determine stocking rates, indicators of overstocking, results of overstocking, and advantages to properly stocking.

	Lavaca			Goliad			
Knowledge Items	***n***	***M***	***SD***	***n***	***M***	***SD***	***p***
Strategies to Determine Stocking Rate							
Based on forage availability.	175	5.00	1.06	71	5.11	1.06	0.82
Based on calculated grazeable acres for my pastures.	175	4.62	1.23	69	4.67	1.21	0.62
Based on preparation for change in season.	173	4.48	1.26	70	4.61	1.07	0.07
Based on current or anticipated market prices.	173	3.28	1.50	68	3.50	1.26	0.02*
Based on the county appraisal district's recommendations.	162	3.18	1.48	68	2.88	1.46	0.83
Indicators of Overstocking							
Bare patches on the land.	181	4.86	1.08	73	4.95	0.91	0.06
Weed/brush encroachment.	179	4.63	1.23	72	4.57	1.28	0.65
Visible hooves from a distance.	173	4.49	1.26	70	4.66	1.26	0.46
Noticeable manure visible from a distance.	177	4.40	1.23	71	4.54	1.36	0.69
Less desirable body scores.	171	4.85	1.04	71	4.93	1.09	0.76
Results of Overstocking							
Susceptibility to drought.	179	5.09	0.96	73	5.07	0.86	0.45
Increased soil erosion and rainfall runoff.	179	5.08	0.96	70	5.09	0.90	0.24
Increased external parasites.	174	4.73	0.94	71	4.69	1.05	0.71
Increased feeding period.	179	5.00	0.91	72	5.15	0.69	0.75
Increase in supplemental feeding needs.	180	5.12	0.84	71	5.25	0.65	0.49
Decrease in forage production.	180	5.11	0.89	70	5.19	0.69	0.36
Decrease in herd performance.	180	5.11	0.75	71	5.23	0.66	0.97
Reduced land carrying capacity.	177	5.12	0.74	72	5.19	0.62	0.74
Advantages to Properly Stocking							
Drought resilience.	180	4.99	0.85	72	4.96	0.86	0.78
Protection of soil and water resources.	180	5.19	0.82	72	5.25	0.58	0.15
Decreased feeding period.	179	5.08	0.79	72	5.13	0.60	0.42
Decrease in supplemental feeding needs.	180	5.04	0.88	71	5.18	0.54	0.07
Higher body scores.	175	5.09	0.78	72	5.10	0.59	0.12
Increased forage production.	179	5.21	0.72	72	5.22	0.59	0.28
Increased plant resiliency.	173	5.12	0.74	71	5.27	0.58	0.81

Note. *$p < 0.05$. Scale: 1 = *Strongly Disagree*, 2 = *Disagree*, 3 = *Somewhat Disagree*, 4 = *Somewhat Agree*, 5 = *Agree*, 6 = *Strongly Agree*.

Table 4. Lavaca and Goliad County landowners' intention to adopt.

	Lavaca			Goliad			
Grazing Management Practices	***n***	***M***	***SD***	***n***	***M***	***SD***	***p***
Calculating Grazable Acres for Stocking Rates.	175	3.29	1.01	71	3.08	1.08	0.13
Grazing Plan/Prescribed Grazing.	171	3.30	0.96	69	3.26	1.12	0.09
Cross Fencing.	178	3.60	0.92	71	3.38	1.10	0.01*
Alternative Water Sources.	179	3.60	1.00	70	3.31	1.07	0.11
Alternative Feed/Salt/Mineral Locations.	178	3.53	0.92	70	3.40	1.06	0.02*
Alternative Shade Structures.	180	3.34	1.22	70	3.04	1.48	0.00*

Note. *$p < 0.05$. Scale: 1 = *Will Not Adopt*, 2 = *Undecided*, 3 = *Plan to Adopt*, 4 = *Already Adopted,* 5 = *Not Applicable*.

Table 5. Lavaca and Goliad County landowners' awareness of the USDA NRCS and TSSWCB.

	Lavaca				Goliad			
	--- Yes ---		--- No ---		--- Yes ---		--- No ---	
	n	***%***	***n***	***%***	***n***	***%***	***n***	***%***
Are you aware of Lavaca Soil and Water Conservation District?	149	82	32	18	18	25	54	75
Are you aware of the USDA-Natural Resources Conservation Services?	135	75	44	25	58	78	16	22
Did you know that the agencies mentioned above work to protect and enhance your working lands and natural resources?	144	80	36	20	52	70	22	30
Did you know that the agencies mentioned above offer free technical assistance?	118	66	62	34	45	61	29	29
Did you know that the agencies mentioned above offer financial assistance?	88	49	92	51	37	50	37	50
Did you know that any technical and financial assistance that you receive is confidential?	64	36	114	64	30	41	44	60
Did you know that the agencies mentioned above work with you to develop a water conservation plan that will help attain your goals?	104	59	73	41	36	49	39	51

Table 6. Number of USDA NCRS practices adopted by year for Lavaca and Goliad Counties.

Year	Practice Status	Lavaca County Practices (Treatment Group)	Goliad County Practices (Control Group)
2016	Implemented	92	52
2017	Implemented	95	34
2018	Implemented	82	60
2019	Implemented	59	61
2020	Implemented	136	141
2021	Implemented + Planned	321	53

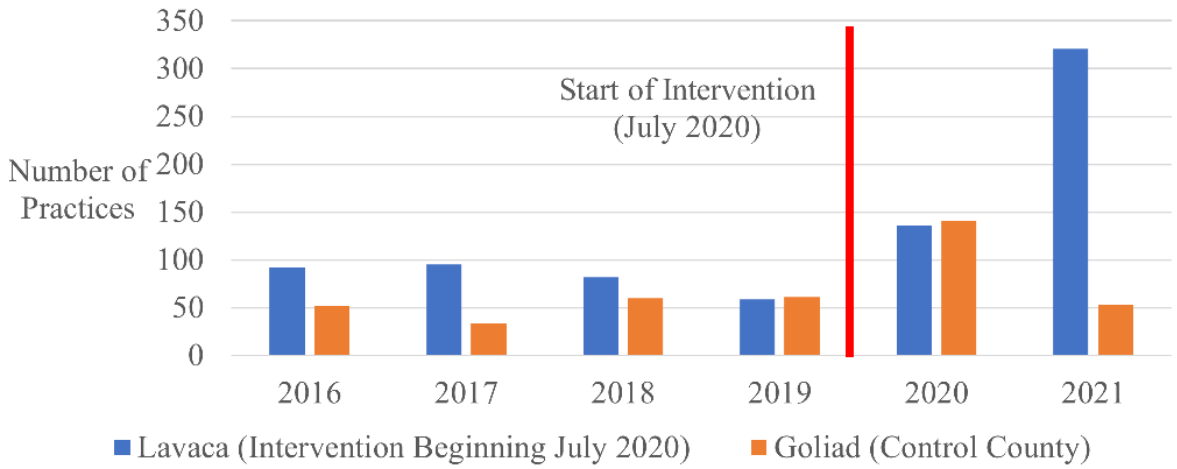

Figure 1. Practices adopted by county from 2016-2021 in Lavaca and Goliad Counties steadily increased. However, a significant increase is visible 2020-2021 in Lavaca County following the mailing of educational flyers.

Table 7. GLM terms and model estimates for USDA NRCS practice counts (estimates and confidence intervals reported on the log scale). Response = Practice Count.

Predictors	Estimate	Confidence Interval	*p*-value
(Intercept)	-235.83	-333.30 – -138.92	<0.001
Year	0.12	0.07 – 0.17	<0.001
Mailings [1]	0.68	0.48 – 0.87	<0.001
County [Lavaca]	0.34	0.18 – 0.49	<0.001

may be more willing to adopt these practices than landowners in Goliad County, but the populations are similar enough to compare adoption rate changes and draw conclusions.

Landowners reported awareness of the USDA NRCS and SWCDs; however, landowners were not aware of the technical and financial assistance and confidentiality they offer, which may explain a lack of interaction with the USDA NRCS and SWCD. Finances are a significant factor in the decision to adopt a practice, just as Rogers (2003) highlights in the persuasion stage of the innovation decision process. Rogers (2003) also emphasizes that trust is an important aspect in the adoption process. If landowners are not aware their interaction with the USDA NRCS and SWCD is confidential, this may be affecting their choice to reach out to the agency.

The GLM provides evidence of substantial correlative increases in practices and mailings. We estimated a nearly 314% increase in the modeled adopted practices following mailing activity. This impact is consistent with the influence of direct mailing as described in the presidential campaign studies (Gerber et al. 2008; Green and Gerber 2008; Gerber et al. 2011) and follows the general demographic communication preferences of a similar demographic identified by Dewald et al. (2018). Although the correlation is compelling, the results should be interpreted with a few caveats. First, the sample size is limited since results are aggregated at the county level. Future work could examine the impacts of mailing at the landowner level or incorporate many more counties in a block testing design. Second, we must consider potential confounders in the analysis, which include landowners with property in both counties, changes in funding levels between years, and unaccounted existing practices. For example, the increase in Goliad County practices in 2020 could have also been a result of 29 landowners on the mailing list owning land in both Lavaca County and Goliad County as well as communication between other landowners about assistance programs. Therefore,

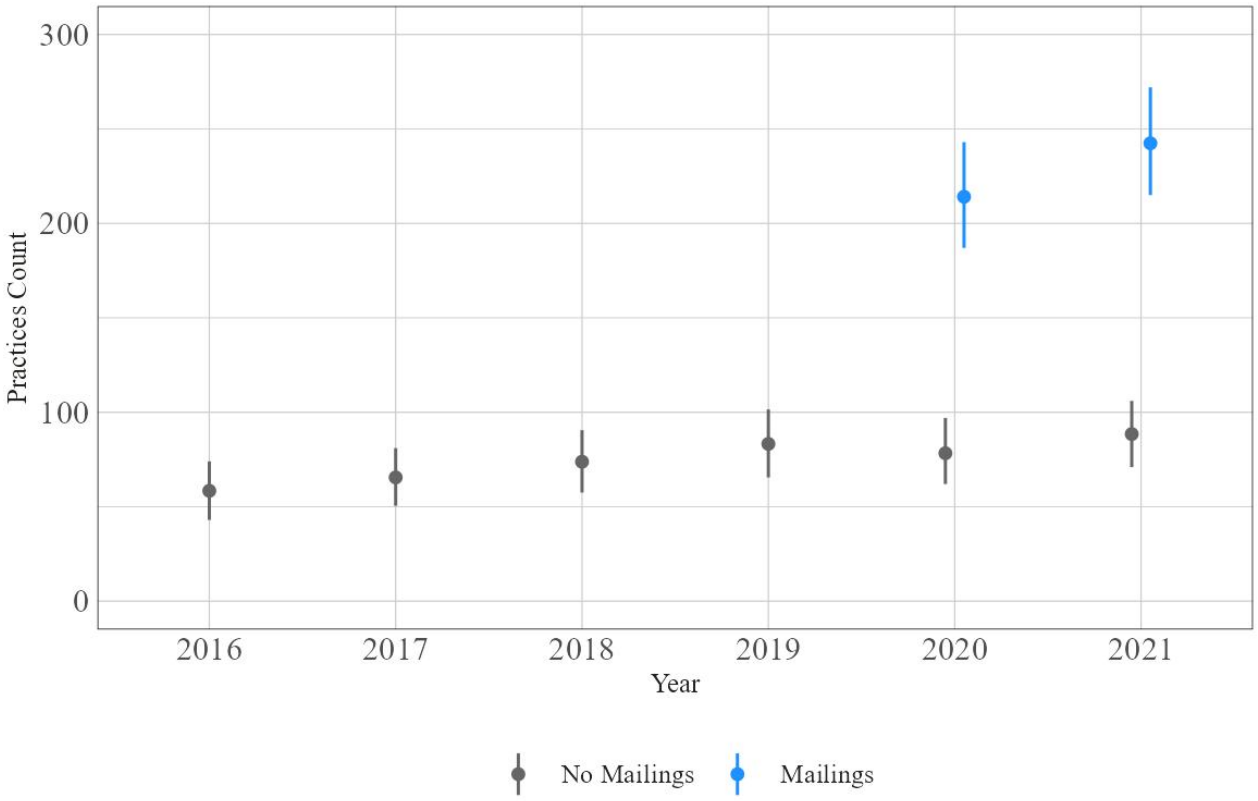

Figure 2. Marginal effects plot displaying the estimated marginal means of the response variable (count of practices) by mailings and year. Points are the model estimated predictions and vertical lines are the 95% confidence intervals.

select Goliad County residents may have also received the educational mailer, but due to privacy rules, researchers were not able to obtain this information.

Through personal communication with K. Isom, USDA NRCS, on March 24, 2021, it was learned that there were no increases in funding available and in fact, total funding for the zone dropped from $11 million to $7.5 million during the course of this study. In considering unaccounted practices, we assume that in counties with already high adoption rates that additional advertising would result in small changes in adoption. For example, an individual that already has operational BMPs on their property is unlikely to approach USDA NRCS for funding after receiving a mailing. Ideally, a dataset with farm-level BMP adoption would be available to compare counties. In absence of that data, we considered the similar responses between county respondents on intention to adopt practice (Table 2) as indicative that there are generally non-significant differences in unaccounted practices between the two counties. USDA NRCS also indicated that there were no changes in advertising for their programs during the study period, so the conclusion is drawn that the increase suggests the educational mailers were effective in increasing the adoption of BMPs.

It should be noted that researchers are unsure how the COVID-19 virus impacted the number of practices that were adopted. It could be speculated that landowners would not want agency personnel to come to their property due to fear of the virus, which could have suppressed potential adoption of practices, or that landowners had more time available which could have inflated the practices adopted. Also because of COVID-19, there was a decrease in the number of in-person education programs delivered by county Extension as compared to previous years.

Due to the slow response to water quality changes from upland and riparian practice implementation, it is yet to be determined whether the change in practice implementation has improved local water

quality in the Lavaca River Watershed. In-stream data will continue to be collected and analyzed, but lag effects, shifts in climate and streamflow, and the high variance in in-stream *E. coli* concentrations can hinder the detection of significant responses of in-stream concentrations and result in many years before significant improvements are detected (Meals et al. 2010; Tomer and Locke 2011; Schramm 2021). Since failing septic systems, wildlife, illicit discharges, and sanitary sewer overflows also contribute to *E. coli* loadings in the Lavaca River Watershed, adoption of conservation practices alone is not anticipated to result in attainment of water quality standards. However, the Lavaca River WPP estimated a load reduction in the Lavaca River of 1.00×10^{15} cfu *E. coli*/year based on the adoption of 100 plans with the practices listed in this study, as well as a reduction of 2.25 x 10^{14} cfu *E. coli*/year in Rocky Creek with the adoption of 30 plans (Schramm et al. 2018).

From this study, there are a few recommendations that can be made. First, working with the local USDA NRCS office in advance is extremely important because if there is an increase in applications but no funding available, landowners could lose trust or interest in working with local agencies and may not return. By also working with the local office, educational information can be sent out in months that align with the application process already in place, and may better align with the end of the fiscal year. Mailing lists will need to be periodically updated, especially if mailing extends over multiple years. Landowner contact information changes rapidly, especially as land is sold or a landowner passes and the property is inherited by someone else. By keeping an up-to-date list, not only do you reduce the number of non-deliverable education mailers but you also reach new landowners that would not have been reached otherwise. It is also important to conduct a survey prior to the development and distribution of an education mailer. Through this survey, barriers to adoption, ideal communication channels, distribution frequency, and other information can be learned to most effectively reach the target audience and alleviate barriers.

More research is needed to determine if this educational flyer mailing approach is effective in increasing the number of BMPs adopted in other regions across Texas and the United States. Additionally, research could focus on what frequency of mailing is most effective in influencing the adoption of practices and which is the most cost effective.

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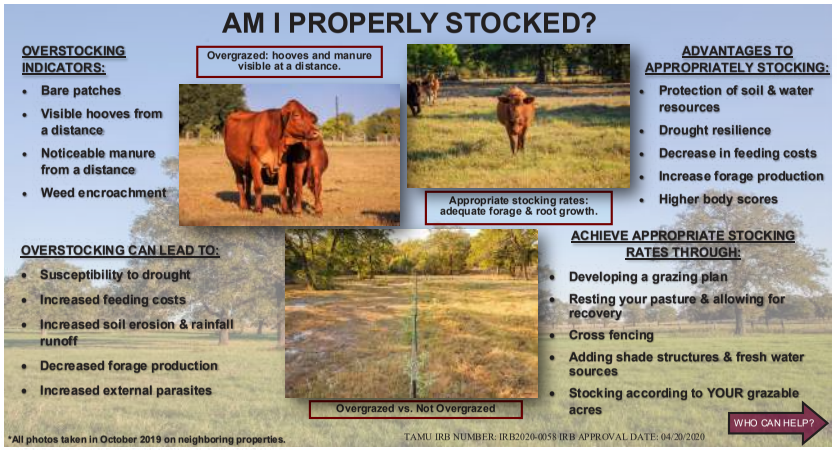
Supplementary Data



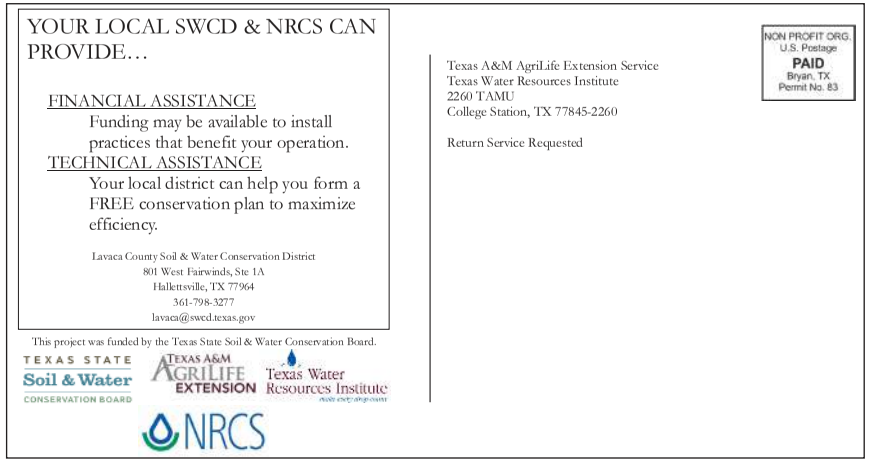


Figure S-1. Educational grazer mailer.

Table S-1. Summary of practices adopted by Golliad County, Texas.

			2016		2017		2018		2019		2020		2021			
Code	Name	Units	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	*Planned Amount*	*Planned Count*
314	Brush Management	acres	2162.7	8	2572.7	12	1143.1	1	355.5	4	726.4	8	623.3	14	182	5
584	Channel Bed Stabilization	feet					1,795.00	1								
340	Cover Crop	acres	22.9	2												
342	Critical Area Planting	acres					3.5	1								
382	Fence	feet	40352	12	47,499.00	6	75755.4	14	49,820.80	7	20135	14	9083	7		
394	Firebreak	feet	60,692.00	5							107359.8	4				
561	Heavy Use Area Protection	acres	2	2					2	2	16	16	1	1		
315	Herbaceous Weed Treatment	acres	72.6	3	54.7	3	51.3	4	51.3	4	492.2	29				
325	High Tunnel System	sq ft					2,880.00	1								
516	Livestock Pipeline	feet	2,695.10	4	8427.1	4			77672.2	7	24,177.20	10	430	1		
590	Nutrient Management	acres	25.2	1												
512	Pasture and Hay Planting	acres	115.4	4											90	1
338	Prescribed Burning	acres	3,390.00	2	586.6	1					3317.3	4			34	1
528	Prescribed Grazing	acres	39.1	2	2,149.10	2	17967.5	32	12352	17	24705.6	34			2079	22
533	Pumping Plant	number			1.00	1	3	3	4	4	3	3				
550	Range Planting	acres	49.8	3												
578	Stream Crossing	number					1	1								
612	Tree/Shrub Establishment	acres					3	1								
614	Watering Facility	number	4	4	4	4			13	13	17	17				
642	Water Well	number			1	1	1	1	2	2	1	1	1	1		
351	Well Decommissioning	number							1	1	1	1				

Table S-2. Summary of practices adopted by Lavaca County, Texas.

			2016		2017		2018		2019		2020		2021			
Code	Name	Units	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	Applied Amount	Applied Count	*Planned Amount*	*Planned Count*
472	Access Control	acres													47	1
314	Brush Management	acres	167	10	158	8	320	12	64.3	2	224.4	15	145.2	8	513.8	25
E646A	Close structures to capture and retain rainfall for waterfowl and wading bird winter habitat	acres									272.6	3			556	6
342	Critical Area Planting	acres			4.1	1			1.4	1					5.9	2
362	Diversion	feet	4,287.00	4												
E300EAP1	Existing Activity Payment-Land Use	acres									1433.5	16			1433.5	16
E300EAP2	Existing Activity Payment-Resource Concern	number									13	2			13	2
E646B	Extend retention of captured rainfall for migratory waterfowl and wading bird late winter habitat	acres									217	2			190.2	3
382	Fence	feet	16048	12	22,671.90	18	10272	8	5,098.00	5	8032	5	10537	8	21245	19
412	Grassed Waterway	acres	6.00	2												
561	Heavy Use Area Protection	acres	1	5	4	7	1	6	1	6	2	11	1	7	4	25
315	Herbaceous Weed Treatment	acres	168	7	61.6	5	243.1	8	166.7	5	311.3	4	200.9	10	405.8	21
325	High Tunnel System	sq ft			3,024.00	1										
E590118Z	Improving nutrient uptake efficiency and reducing risk of nutrient losses to surface water	acres													272.1	3
464	Irrigation Land Leveling	acres	404.1	5	591.7	7	258.9	3	122.5	2	1258.8	14	399.8	5	318.2	3
466	Land Smoothing	acres									33	3			15	2
516	Livestock Pipeline	feet	15,851.00	10	7769	9	6039	9	4278	7	11,059.20	12	4735	8	19102	25
576	Livestock Shelter Structure	number											5	5		
E647A	Manipulate vegetation on fields with captured rainfall for waterfowl & wading bird winter habitat	acres									489.6	5			272.1	3
512	Pasture and Hay Planting	acres	153.7	7	14.7	2	26.3	4	10.5	1	22.8	2	4.7	1	41	4
378	Pond	number			1	1	1	1	1	1	1	1				
528	Prescribed Grazing	acres	111.9	5	307.90	7	751	8	1150.5	12	136.3	2	172.9	6	660.7	5
E647B	Provide early successional shorebird habitat between first crop and ratoon crop	acres													746.2	9
533	Pumping Plant	number	4	4	2.00	2	1	1	3	3	3	3	1	1	5	5
550	Range Planting	acres													127	7
E595116X	Reduce risk of pesticides in surface water by utilizing precision pesticide application techniques	acres													272.1	3
391	Riparian Forest Buffer	acres													25	1
587	Structure for Water Control	number	32	3	76	11	69	10	30	3	109	20	76	9	74	18
600	Terrace	feet	14,022.00	3												
614	Watering Facility	number	13	12	11	11			8	8	13	12	9	8	32	32
642	Water Well	number	2	2	3	3	3	3	1	1	1	1	1	1	1	1
351	Well Decommissioning	number	1	1	2	2	9	9	2	2	3	3	1	1	2	2