Extension Education Methods

Exploring the Effects of Extension Workshops on Household Water-use Behavior

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ADDITIONAL INDEX WORDS. effectiveness, outreach program, residential irrigation

SUMMARY. The effectiveness of 2-hour extension workshops focused on residential water conservation is examined. We used a sample of irrigation water-use data for 57 workshop participants and 43 nonparticipants, and applied a fixed effect regression analysis method. The results show that the workshops were effective in reducing attendees' irrigation water use; however, the effect was short-lived. Furthermore, the effect of the workshop attendance depended on the household sample considered, and for a subsample of low-use workshop participants, water use tended to increase following the workshop.

Population growth, droughts, and saltwater intrusion are adding growing pressure on finite water sources, even in water-rich eastern states such as Florida. Despite an average annual rainfall of 55 inches (Marella, 2009), the Natural Resources Defense Council (2010) included Florida in the list of states with the greatest risk of water shortages in the coming years. One of the reasons is that while the daily per capita domestic water use in Florida (96 gal/person/day) is close to the national average, the daily total state domestic water use in Florida (1530 million gal/day) is the fourth highest in the country (after California,

Texas, and New York, respectively). A large proportion of this water is not used for human consumption, but instead is applied to landscapes. Haley et al. (2007) reported that in a sample of central Florida households, the average fraction of total water used by homeowners for outdoor irrigation was 64%. Similarly, the South Florida Water Management District (2008) reported that outdoor water use in their area constitutes up to 50% of total household water consumption, and up to 50% of the water applied to lawns is wasted through evaporation or overwatering.

Landscape management outreach programs have been implemented by regional and local agencies, Cooperative Extension Services, and other organizations to encourage more

efficient irrigation water use and residential water conservation; however, limited information exists about the effectiveness of such programs. Outreach professionals typically rely on information collected through surveys to evaluate changes in participants' knowledge, attitudes, and reported behaviors (e.g., Borisova et al., 2012; Hostetler et al., 2008; Hurd, 2006; McKenney and Terry, 1995). However, such surveys do not allow an assessment of the actual water-use reductions associated with the educational programs.

In addition, studies that use actual water-use data typically examine water demand on city- or utility-wide scales and do not evaluate the programs targeting specific audiences (Kenney et al., 2008; Syme et al., 2000). For example, although Michelsen et al. (1999) found that nonprice conservation programs (such as public service announcements, bill inserts, water conservation device distribution, demonstration gardens, and ordinances and regulations) reduced water use by 1.1% to 4.0% in seven southwestern U.S. cities, specific activities were not consistently included in the nonprice conservation programs in each city, and hence, the study results cannot be generalized. Therefore, more detailed and consistent information about nonprice programs needs to be collected to allow the evaluation of individual programs.

The results of the few studies that evaluated the effects of specific outreach programs with water-use data for the targeted households are mixed (Syme et al., 2000). For example, Geller et al. (1983) examined educational programs targeting residents of 129 townhouses and single family homes in Blacksburg, VA, with the result that the educational programs had no statistically significant effect on water use. Specifically, the residents in the study were randomly assigned to one control group and three treatment groups that received 1) information about wasteful water use and water conservation strategies,

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Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.0929	ft ²	m ²	10.7639
3.7854	gal	L	0.2642
40.7458	gal/ft ²	L·m ⁻²	0.0245
25.4	inch(es)	mm	0.0394

2) daily and weekly written feedback about their water use and changes in comparison with the baselines, and 3) low-cost water-saving devices. Using analysis of variance, only the group that received water-saving devices showed a statistically significant reduction in water use. Lack of in-person contacts and the inability to send the educational messages to all members of the participating households were suggested among the reasons for the lack of effects from the educational programs.

In contrast, in a study of a program conducted in southern California, Thompson and Stoutemyer (1991) demonstrated that the effectiveness of mailed educational materials depends on the target audience and the educational message. In their study, 171 homeowners who agreed to participate in the study were randomly assigned to one control group (received only water conservation tips) and two treatment groups (received other educational messages in addition to water conservation tips). In addition, 36 households were assigned to a second control group that was not contacted about the study. The study then compared mean water use before and after the educational program, and compared the treatment and control groups. The authors found that the effectiveness of the programs depended on the socioeconomic status of the target areas. Residents in the lower-middle class survey area were the most responsive to the educational programs; moreover, those in this survey area who received information about the long-term consequences of water use conserved more water in comparison with those who learned only about the economic advantages of water conservation. In contrast, neither educational message was effective in the upper-middle class survey area.

Finally, in a recent study, Fielding et al. (2013) showed that educational programs can be effective in the short run, but require continuous reinforcement of the water conservation message to be effective in the long run. Specifically, the authors examined educational programs targeting 221 residents in South East Queensland, Australia, via mail. The participants were randomly assigned to four groups as follows: one control group and three treatment groups receiving a combination of water conservation tips,

feedback about their water use, and/or information about water conservation of other households. Participants' water-use data were collected for the periods before, during, and after the educational campaign. Panel data analysis techniques were used to examine the differences in water use among the control and treatment groups over time. It was found that over the program implementation period, water consumption per person, per day increased for the control group, but decreased for the three treatment groups. However, after the program ended, water use of the treatment groups showed an upward trend. The period over which the groups' average water use reached the preprogram levels ranged from ≈ 4 to 12 months. Fielding et al. (2013) concluded that the long-term effectiveness of educational programs depends on "the continued implementation of strategies and a context of water scarcity."

Overall, proponents of educational programs emphasize that such programs are more politically acceptable in comparison with mandatory water-use restrictions and conservation pricing, and result in water-use reduction. On the other hand, opponents show that the programs are not cost-effective, result in temporary water-use reductions only when immediate water shortages are apparent to the public, and serve primarily as a public relations tool (Fielding et al., 2013; Syme et al., 2000). Additional studies evaluating the short- and long-term effectiveness of educational programs can help better design and implement such programs to ensure their effectiveness (Fielding et al., 2013; Syme et al., 2000).

In this article, we evaluate the effectiveness of a specific horticultural extension program—irrigation management workshops—conducted by the Florida Cooperative Extension Service in cooperation with a local water provider. The objective is to examine potential short- and long-term impacts of workshop attendance using monthly irrigation water use of the workshop participants. The use of actual water-use data for 12 months before and after the workshop, and the comparison of the water-use data of workshop participants with the water use of households that did not participate in the workshop helps differentiate

seasonal water-use changes from the effects of the workshop attendance.

Program description

Free 2-h irrigation management workshops are offered semimonthly by Osceola County Cooperative Extension (Florida) in cooperation with the local water provider, Toho Water Authority. These workshops are part of a larger program focused on educating homeowners and industry professionals about sustainable landscape management (Florida-Friendly Landscaping™ Program, 2009). The workshops are held at the local Cooperative Extension office, and cover three main topics: 1) adjusting irrigation system timers to satisfy local irrigation restrictions (no irrigation is allowed between 10:00 AM and 4:00 PM), 2) measuring irrigation sprinkler output (to select duration of the irrigation periods to match plants' requirements and avoid wasting water), and 3) operating different types of timers that control automatic irrigation systems. Presentations and demonstrations are made by the natural resource extension agent or the Toho Water Authority's water conservation coordinator, followed by a question-and-answer session and hands-on exercises.

The workshops in our analysis were advertised through Cooperative Extension newsletters and brochures, as well as through periodic water utility bill inserts and local newspaper advertisements. In addition, households that violated local irrigation ordinances (by irrigating at the wrong times) were sent invitations to attend an irrigation workshop as an alternative to paying the citation. The number of people attending the workshops ranged from 2 to 20, and anecdotal evidences suggest that 25% to 50% of participants attended the workshop to avoid the citations (E. Block, personal communication). The other participants came to learn about their irrigation systems, especially new homeowners and new Florida residents; to explore installation of alternative irrigation systems; or to find ways to reduce their water bills and conserve water (J. Sullivan, personal communication). It is possible that water-use patterns are different for those who are interested in water conservation, as opposed to those trying to avoid citations or those wanting to learn about new irrigation systems; unfortunately,

Table 1. Average monthly irrigation water use for the sample of household groups ($N = 57$ participants with 1425 monthly observations and 43 nonparticipants with 2665 monthly observations).

Household group	Avg monthly irrigation water use (1000 gal)*			
	Mean	Median	Minimum	Maximum
Participants	8.1	7.1	0.4	18.4
Nonparticipants	10.2	8.9	0.2	29.5

*1 gal = 3.7854 L.

information about the reasons for workshop attendance that would allow differentiating categories of attendees was unavailable.

Data

Monthly irrigation water-use data were provided by the Toho Water Authority water conservation coordinator (E. Block) for 57 Florida households (referred to as “participants” below). These households participated in one of several irrigation workshops conducted between Apr. 2007 and Mar. 2010, and for them, irrigation water use was metered separately from the indoor water use with irrigation (for the water of tap water quality) or reclaimed water meters. In this panel dataset, monthly irrigation water-use information is available for each household for 12 months before the date of the workshop, the month of the workshop, and 12 months after the workshop.

Monthly household water use was measured in thousands of gallons and rounded to the closest integer. Based on the water-use data for the 25-month period available for each household, average monthly water use was estimated per household (Table 1). Some households in the sample used little water (the minimum was 400 gal/month), while others used much more water (the maximum was 18,400 gal/month), with an average of 8100 gal/month. The range of the actual monthly irrigation water use was even wider. For almost every household in the sample, irrigation water use was equal to zero for a few months over the observation period. At the same time, peak monthly irrigation observed in the sample was 52,000 gal/month.

For each household, Toho Water Authority also provided certified values of the houses acquired from the local property appraiser dataset, for the year 2010 and irrigated area of the lots [estimated via subtracting the

lot areas classified as the base area, driveway area, sidewalk, and other area, from the total lot size (E. Block, personal communication)]. The sample includes households with certified home values ranging from \$51,800 to \$230,500, and with estimated irrigation areas ranging from 1105 to 12,366 ft². Higher certified home values and larger estimated irrigation areas were generally associated with higher irrigation water use.

For each household, the irrigation volume (1000 gal/ft²/month) was calculated by dividing monthly irrigated water use (gal/month) by the estimated size of the irrigated area (square feet). In addition, the depth of water (inches) is often used as a standardized unit of irrigation system output. The volume of water can then be estimated as a product of depth and irrigated area. For example, 1 gal/ft² is equal to ≈ 1.6 inches applied to 1 ft². Based on the existing studies summarized in Dukes (2011), irrigation depth of 1.9–5.7 inches/month is usually sufficient for the turfgrasses grown in Florida. To examine if the households in the sample meet the irrigation requirements reported in Dukes (2011), we estimated irrigation depth in inches per year by multiplying the irrigation volume values (in gallons per square foot per month) by 1.6. The maximum estimated irrigation depth was 42.1 inches/month, which is at least seven times higher than the sufficient irrigation volume reported in Dukes (2011).

In addition, monthly irrigation water-use data were provided for 43 households that had never attended the workshops and that were selected from the same neighborhoods as those that attended the workshops. These households are referred to as “nonparticipants” below, and they were selected by the Toho Water Authority Conservation Coordinator to be the close neighbors of those who attended the workshops (E. Block, personal

communication). No information about the certified values of the houses and estimated irrigation areas was provided, but given the fact that these households were selected from the same neighborhoods, it is expected that the workshop participants and nonparticipants have similar house and yard characteristics. Descriptive statistics for the households that never attended the workshops are summarized in Table 1. Maximum monthly irrigation water use among nonparticipants was 192,000 gal/month. On average, the households used 200–29,500 gal/month, with the overall average of 10,200 gal/month (compare with 8100 gal/month for participants).

No information was available about water conservation messages that workshop participants and nonparticipants might have received from sources unrelated to the irrigation workshops. Given that the participants and nonparticipants resided in the same neighborhood, it could be possible that the households exchanged information about the water conservation techniques learned at the workshop. However, no studies have been found showing social network effects on the adoption of water conservation strategies among urban residents.

Analytical methods

The average effect of the irrigation workshop on water use given the seasonal variations is evaluated using a fixed effect regression model. The regression model allows examining the changes in water use over time, and comparing participants’ water use before and after the workshop, as well as the water use of nonparticipants. The regression model is first estimated using the water use of all participants and nonparticipants. Next, the water use of a subsample of the participants and nonparticipants who used little water is examined. We expect the effect of the workshop attendance to be smaller for the households with low water use, in comparison with the complete household sample. Below, we describe the fixed effect regression model and the selection of the subsample of participants and nonparticipants in more detail.

COMPARISON OF THE WATER USE OF WORKSHOP PARTICIPANTS AND NONPARTICIPANTS. The evaluation of extension programs usually focuses

Fig. 1. Conceptual model for the analysis of irrigation workshop effectiveness: comparison of irrigation water use of workshop participants and nonparticipants in the periods before (T₁) and after (T₃) the workshop.

on behaviors of program participants only. Yet the participants' behavioral changes may be related to factors other than the extension program, such as changes in weather conditions or the start of planting seasons. For example, as conceptually illustrated in Fig. 1, even before the workshop (i.e., in the period T₁–T₂), there may be a trend in water use. To account for such time trends, the behavioral choices of program participants should be compared with that of nonparticipants. For example, the water use of nonparticipants, before and after the workshop (T₁–T₂ and T₂–T₃), can be used to improve the estimation of the seasonal effects and other factors affecting water use, which need to be isolated from the workshop attendance effect.

However, the water use, over time, of participants and nonparticipants can be shaped by factors that vary across households. Thus, preexisting differences in water usage across participants and nonparticipants should be identified. Specifically, the observed participants' water use in time periods before workshop attendance should be examined relative to the usage of nonparticipants in those same periods. When these differences exist, a regression approach that controls for such preexisting differences, such as the fixed effect regression model described in the next section, is warranted.

REGRESSION MODEL AND EXPECTED WORKSHOP EFFECTS. When comparing water-use patterns before and after attending the workshop, it is important to account for the following factors. First, different households attended workshops at different dates; thus, the before and after periods correspond to different months, across households, and often even different years. Therefore, in the analysis of the water use before and after the workshop, it is important to control for the specific calendar periods. Second, increases in water usage across households may be related to systematic changes in atmospheric temperature and precipitation, or plant water requirements, rather than to workshop attendance, and hence, seasonal water-use changes should be accounted for in the analysis.

To control for or identify the effect of all these factors simultaneously, we use a fixed effect regression model. A fixed effect model is a linear regression model in which a unique intercept is estimated for each household in a sample. In other words, for each household, the model focuses on changes in the dependent variable (e.g., irrigation water use) over time as compared with each household's own mean; then these changes in water use are averaged across all households in the sample (Allison, 2006). A fixed effect model, in fact, examines changes in water-use

time trends, making the differences in absolute water usage levels (e.g., among participants and nonparticipants) irrelevant in the estimation. Furthermore, given that each household is compared with its own mean, the model accounts for the preexisting differences among households and controls for the effect on water use of both observed and unobserved household characteristics that generally do not vary over time (such as the size of the lawn, income level, household composition, or attitudes toward water conservation). The fixed effects regression model can be presented as follows:

$$y_{it} = u_i + x_{it}\beta + z_{it}\gamma + \varepsilon_{it} \quad [1]$$

where y_{it} denote the irrigation water use (in 1000 gal/month) by household i in month t . Matrix x_{it} denotes dummy variables indicating the periods before and after attending the irrigation workshop (for workshop participants only). Matrix z_{it} identifies explanatory variables that are used to account for seasonal and annual changes in water use that are unrelated to workshop attendance, such as extreme maximum daily precipitation for t th month (inches), and calendar-month and calendar-year dummy variables. Note that the model does not include water rate as an independent variable since the rates were relatively constant during the period of the study. In turn, u_i is a household-specific

Fig. 2. Example of the definition of dummy variables for periods before and after irrigation workshop for two participants (indexed by letter i , where $i=1$ is the first participant and $i=2$ is the second participant) that attended the workshops on different dates (note that monthly irrigation water-use data are available for each participants for 12 months before the workshop, the month of the workshop, and 12 months after the workshop; the calendar months generally characterized by hot and dry weather conditions fall into different periods before and after the workshop attendance for the two participants).

parameter that integrates all time-invariant characteristics of the households (Allison, 2005). Finally, ϵ_{it} is a random variable, assumed to be normally distributed, with the mean of zero and variance of σ^2 .

We define periods before and after the workshop (i.e., the dummy variables included in x_{it}) for participants, by dividing the 25-month period (i.e., the period over which the water-use observations were available) into five intervals (Fig. 2). The 4 months before the month of the workshop were taken as a base period against which water use in the other time periods are compared (referred to as Period2). We hypothesized that water use in the base period may be higher or lower than the water use in the previous months. For example, households may observe a spike in water use and decide to attend the workshop to manage their increasing water bills. In this case, the water use

in the base period would be larger than in the previous months. Alternatively, households may switch off irrigation systems for a few months, and then attend the irrigation workshop before turning the systems back on. In this case, the water use in the base period would be smaller than in the previous months. To examine such changes in water use, a dummy referred to as Period1 is used to identify the period of 5 to 12 months preceding the workshop. In turn, the month of the workshop is identified as Period3. The irrigation workshops were held in the beginning, middle, or end of the calendar months, and hence, it was difficult to combine Period3 with the periods preceding or following it.

We assume that the 4-month time period following the month of the workshop is long enough to implement water conservation techniques studied during the workshop

and reduce irrigation water use. This period is identified using the Period4 dummy variable. Finally, the Period5 dummy variable was used to identify the 5 to 12 months after attending the workshop. In sum, the Period3–Period5 variables capture the workshop or treatment effects, which we allow to vary over time, depending on time since the workshop was taken.

Given that participants attended the workshops on different dates, the periods before and after workshops do not always occur in the same seasons. For example, in Fig. 2, April and May of each calendar year are shaded. These 2 months are usually characterized by hot and dry weather conditions that increase irrigation water use. In Fig. 2, these calendar months fall in Period1, Period3, Period4, and Period5 for the first participant and in Period2 and Period5 for the second household. This difference in weather conditions in the periods before and

after the workshops among the households allows distinguishing the effect of weather changes from the effect of workshop attendance. In addition, the water use of nonparticipants is also used to better characterize seasonal variations unrelated to workshop attendance. Finally, the calendar-month dummy and precipitation variables are included in the model to explicitly capture the seasonal changes in water use.

The model [1] was estimated using the *xreg* procedure in STATA software (version 13; StataCorp LP, College Station, TX). To account for possible similarity in water use among the households living in proximity to each other, we allow for clustering of the error term in Eq. [1], ϵ_{it} , by the streets fronting the households' addresses.

HOUSEHOLDS INCLUDED IN THE ANALYSIS. Two fixed effect models were estimated: the first model examines the water use of the complete sample of all workshop participants and nonparticipants (Model I). The second model (Model II) examines a subsample of 20 participants and 15

nonparticipants with low water use. The subsample was selected to ensure that before the workshop attendance, participants and nonparticipants in the subsample had similar water-use temporal patterns. Our assumption was that the similarity in the water-use pattern between nonparticipants and participants can allow for a more precise identification of the participants' water-use change after the workshop.

Specifically, we used *proc distance* in SAS (version 9.2; SAS Institute, Cary, NC) to estimate the difference in monthly water use between participants and nonparticipants. For each participant, we selected the period of 7 to 12 months before the workshop and compared the water use of that particular participant with the use of each nonparticipant for the corresponding calendar time period. We selected participants and nonparticipants for which water use over the 6-month period differed by at most 5500 gal. The analysis was conducted separately for the households on irrigation and reclaimed water

meters. The results showed that water use of only 35 households with relatively low water use were comparable (Table 2).

Although the number of households in these subsamples is small (i.e., 35 in total), the relatively large number of monthly water-use observations available for each household makes the total number of monthly water-use observations (i.e., 995) sufficient to make the asymptotic assumptions of our statistical methods valid.

Results

To illustrate the general water-use trends for the periods before and after the workshop, we first estimated the participants' average water use for these periods (Fig. 3). Average water use exhibits similar patterns for the complete sample and the subsample of workshop participants. Average water use is higher in the baseline period (i.e., the 4 months before the workshop), as compared with the average for the preceding months (compare Period1 and Period2; Fig. 3). Average water use drops in the month of the workshop (Period3), and then increases again in the following months (Period4 and Period5). When the complete sample and the subsample of households are compared, average water use is significantly smaller in the subsample. The exception is Period4 (i.e., 4 months following the workshop), when the average water use in the complete sample and the subsample are about the same. However, the average water use presented in Fig. 3 does not account for the fact that the households attend workshops held on different dates, and hence, the periods before and after the workshop occur in different months and even years for different households. The regression analysis results reported below allow us to account for possible seasonal and year-to-year patterns in water use.

The results of the regression analysis for the complete sample of the participants and nonparticipants (Model I) generally confirm the water-use patterns observed in Fig. 3 (Table 3). Based on the value of coefficient for the Period1 variable, monthly irrigation water use increases on average by 1340 gal in the 4 months before the workshop (i.e., the baseline period). The water use then drops by 2620 gal on average in the month of the

Table 2. Average monthly irrigation water use for the subsample of household groups ($N = 20$ participants with 500 monthly observations and 15 participants with 495 monthly observations).

Household group	Avg monthly irrigation water use (1000 gal) ^a			
	Mean	Median	Minimum	Maximum
Subsample of participants	4.2	3.6	0.4	10.1
Subsample of nonparticipants	3.3	3.1	0.2	7.4

^a1 gal = 3.7854 L.

Fig. 3. Average monthly water use for the complete sample and the subsample of the irrigation workshop participants, by time periods before and after the workshop (averaged across households, weather conditions, and calendar years); 1 gal = 3.7854 L.

Table 3. Estimation results for the fixed effect regression of monthly household irrigation water use. Model 1 (columns 2 to 4) are results for the complete sample, and Model 2 (columns 5 to 7) are the results for the subsample of workshop participants and nonparticipants (with estimated coefficients statistically significant at the 90%, 95%, and 99% levels highlighted in bold font).

Variable	Estimated monthly household irrigation water use (1000 gal) ^w					
	Model 1 (all participants and nonparticipants)			Model 2 (subsample of participants and nonparticipants)		
	Estimate	SE	t value	Estimate	SE	t value
Period1	-1.34	0.79	-1.70 ^x	-1.80	0.65	-2.76 ^y
Period3	-2.62	0.82	-3.19 ^x	-0.77	0.62	-1.25
Period4	-0.36	0.98	-0.37	2.55	1.27	2.01 ^z
Period5	-1.35	1.44	-0.94	1.62	1.00	1.62

^x90% significance level.

^y95% significance level.

^z99% significance level.

^w1 gal = 3.7854 L.

workshop (Period3). Note that the 95% confidence interval for this coefficient is from 980 to 4270 gal.

The average water use remains slightly below the baseline level in Period4 and Period5. However, the coefficients for these periods' dummy variables are not statistically significant, and hence, we cannot reject the hypothesis that the average water use after the workshop is the same as in the baseline period. To summarize, we found statistically significant reduction in water use only in the month of the workshop. Although the workshop has an impact on water use, this impact is very short-lived. Reinforcement of the educational message received during the workshop is probably required to sustain water-use reductions over time.

Based on the analysis for the subsample of households (Model II), for the low-water-use households, an attendance at the irrigation workshop does not lead to water-use reductions. Similar to the results for Model I, irrigation water use increases in the months preceding the workshop (by 1800 gal on average). However, the average water-use reduction in the month of the workshop is not statistically significant (see the coefficient for the Period3 dummy variable). Moreover, the water use increases, on average, by 2550 gal in the 4 months following the workshop, as compared with the water use in the 4 months before the workshop (see the coefficient for the Period4 dummy variable). The coefficient for the Period5 dummy variable is positive, but not statistically significant.

Estimated seasonal and annual variations in water use are available from the authors upon request. In the complete sample of households (Model I), the seasonal and year-to-year water-use patterns differ among the workshop participants and nonparticipants. Specifically, both participants and nonparticipants increase their irrigation water use in the beginning of Florida's wet season (i.e., May–June), when the temperature is high and the yard plants may require additional irrigation. However, for workshop participants, average irrigation water use also increases in August–November (as compared with January). Similar results were reported in Ozan and Alsharif (2013) who found an increase in water use of Florida's residents in the fall. In addition, the average irrigation water use of nonparticipants seems to decrease from year to year, while the water use of participants did not show a statistically significant trend. In turn, for the subsample of low-water-use households (Model II), on average, the irrigation water use increased in May, as well as in October–December (in comparison with January average water use). No statistically significant changes in water use from year to year were detected.

Discussion

Although at first glance the non-impact of workshop attendance on water use in the subsample seems surprising, this result makes intuitive sense if one recalls that the subsample includes the households with low irrigation water use. Learning about

water conservation may not result in significant water-use reduction if households already use lower volumes of water for irrigation. The increase in water use following the month of the workshop is still difficult to explain. One explanation could be that low-use households adjusted their timers upward following the irrigation workshop to better meet plants' water needs. For example, existing studies summarized in Dukes (2011) suggest that even during the winter months (i.e., when the weather conditions are generally dry and cool, and turfgrass can enter a dormant state), grass may still need more than 1.9 inches/month. Some households in the sample reported zero irrigation water use for some months, so they may increase water use following the workshop. Alternatively, there may be an upward trend in water use among the workshop participants, relative to nonparticipants, that is unrelated to workshop attendance. For example, the participants included in the subsample may correspond to new homeowners or other households specifically interested in learning how to properly irrigate. Finally, an increase in water use may be attributed to offsetting behavior, such as when households change their behavior following implementation of a water conservation strategy, that is, increase in irrigation acreage after reducing the irrigation intensity (Geller et al., 1983; Nieswiadomy, 1992).

Conclusions

The analysis of irrigation water use leads to the following key conclusions. First, the workshops were effective in reducing attendees' irrigation water use when the complete sample of workshop attendees was examined. Irrigation water use dropped, on average, by ≈2160 gal in the month of the workshop (as compared with water use in the preceding 4 months). Given that the average irrigation water use of all participants during the 4 months before the workshop was 8400 gal, the reduction constitutes ≈31%.

Second, the effect of the workshop was very short-lived. For the complete sample of workshop participants and nonparticipants, water use returns to the base level immediately in the months following the workshop. Fielding et al. (2013) suggested

that the long-run effectiveness of an educational program depends on the continued reinforcement of the educational message. Given that there were no follow-ups for the irrigation workshops, it is not surprising that the effect of the workshop was noticeable only in the short run.

Third, the effect of workshop attendance depended on the sample of the households considered. Specifically, for the subsample of the low-water-use households, water use tended to *increase* following the workshop. The overall objective of the workshop was to improve the irrigation efficiency by reducing water wastes. However, households with low average water use may already be technically efficient, and in this case, workshop attendance cannot reduce their irrigation water use further without negatively affecting the yard aesthetics and plant health. Such “demand hardening” is reported in other studies (e.g., Maddaus and Maddaus, 2008; Wilby and Miller, 2009). It is also possible that low-use households are using less water than is needed to maintain their turfgrass, and for such households, attending the workshop may increase their water use. In general, broader efforts should be taken to increase workshop attendance of large water users for whom workshop attendance can result in significant water-use reductions.

Fourth, irrigation water use tended to increase in the months preceding the workshop. This result implies that the desire to combat spikes in water use, or warning letters from the local authorities indicating violations of watering restrictions, are likely among the primary reasons for attending the workshop.

It is important to emphasize that this study focuses specifically on evaluating the impacts of the irrigation workshops on water use. We did not evaluate the value of the educational program for the community as a whole for promoting conservation ethics (Kenney et al., 2008) or educating residents about local irrigation restrictions, which can be important components of the program.

Overall, proper design of the evaluation stage is extremely important for any extension program. Analysis of the water use of workshop participants could be significantly more informative if the information were available about

households’ characteristics such as the primary reason for attendance (e.g., interest in water conservation, citation avoidance, or new home ownership), attitudes toward environmental protection, household composition and socio-demographics, and the use of outdoor water conservation strategies (such as rain barrels and drought-tolerant plants). Such information can be easily collected via a survey. Combining water-use data with the information from household surveys and the property appraisers’ databases can lead to better understanding of the audiences reached by the educational programs, and the differences in the effects of the educational program on water use, depending on types of households. Information about other water conservation messages workshop participants and nonparticipants might have been receiving would also improve evaluation results.

This study is an important step in developing a comprehensive approach to evaluating the effectiveness of water conservation outreach programs. For example, Borisova et al. (2011) find that consistent evaluation of the outcomes of landscape management programs is a key challenge identified for the *Yards and Neighborhoods* programs in Florida, South Carolina, and Tennessee. Developing a comprehensive evaluation approach can help quantify the impacts of such programs, help in the design of more effective educational programs, and better target the programs. Evaluating actual water-use reductions should be a key component of the evaluation process.

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