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Where's the Water Going?

Factors related to outdoor water use

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Center for ReSource Conservation

Residential Outdoor Water Use In Colorado Front Range

- Over 50% of total residential water is used outdoors (Mayer et al., 1999)
- An estimated 5-40% of this water is wasted due to overwatering (CWW & Aquacraft, 2010)
- Newer homes (built post-2001) with in-ground sprinkler systems use more water on average than older homes which tend to not have underground sprinkler systems (DeOreo, 2011)

image from lawnprosprinklersystems.com

Our main approach to reducing outdoor residential water use:

Slow The Flow Colorado (STF)

- STF is a sprinkler inspection program
- Trained water technicians test sprinkler system and note any problems
- Goals of the program
  - To provide homeowners with a customized watering schedule for a green, long lasting landscape
  - To teach practical, easy, do-it-yourself sprinkler maintenance
  - To teach how to maximize the life of a sprinkler system
  - To teach how to improve system performance
  - To help conserve water

STF Impact Analysis

- Trying to answer a variety of questions
  - What is the effect of the sprinkler inspection on outdoor water use?
  - Are there measurable water savings?
  - How long do savings last?
  - **What factors contributed to water savings?**
  - **What are the factors contribute to efficient and inefficient outdoor water use?**

Data Used

Homeowner data

- Collected during audit
- Landscape size, type, sprinkler system specs, watering habits, indoor and outdoor conservation features, household information

Water usage data

- From the water provider
- Monthly water billing data for at least 2 yrs pre- and 2 yrs-post audit

Weather data

- From Northern Colorado Water Conservancy District (8) and City of Castle Rock (4) weather stations
- ET_o (reference evapotranspiration) and P (precipitation) both in inches per year

Possible Sources of Error

- Inconsistency in auditor collection methods
- Data entry mistakes or vacancies
- Aggregation of multi-year data sets
- Lack of separate meters for indoor and outdoor use

Terminology

- **Pre-Audit** – the 2 years prior to the audit year.
- **Post-Audit** – at least 1 year following the audit year.
- **Application Ratio** (**AR**) (%) = Actual Water Used/Water Needed
  - 100% = perfect watering
  - AR >100% = over watering
  - AR <100% = under watering
- **Water Savings** (gal) = Predicted Use – Actual Use
- **Predicted Use** (gal) = Pre-Audit AR*Water Needed

Example:
If Audit was 2009
Pre-Audit = 2007 & 2008
Post-Audit = 2010, 2011, 2012

STF Participants Summary Stats

Study sample

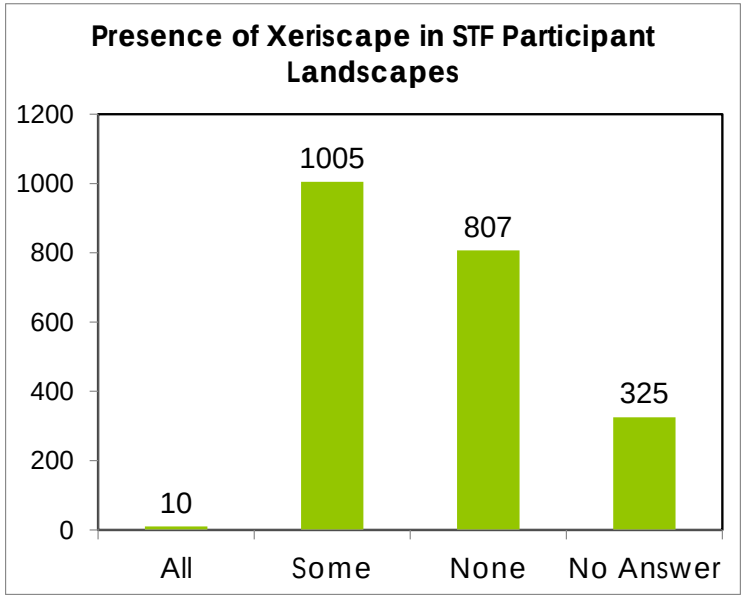
- 2,081 participants
- Received audits in 2007-2011
- Water use data from 2005-2012

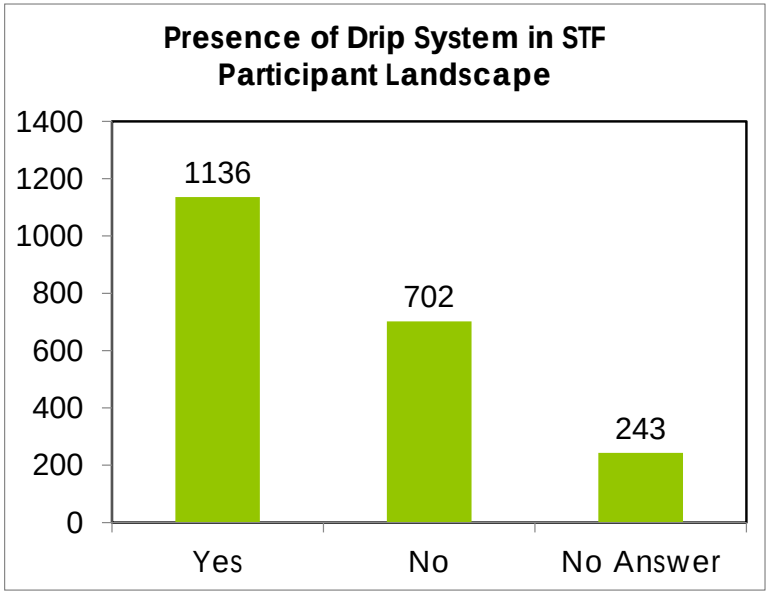
Resident information

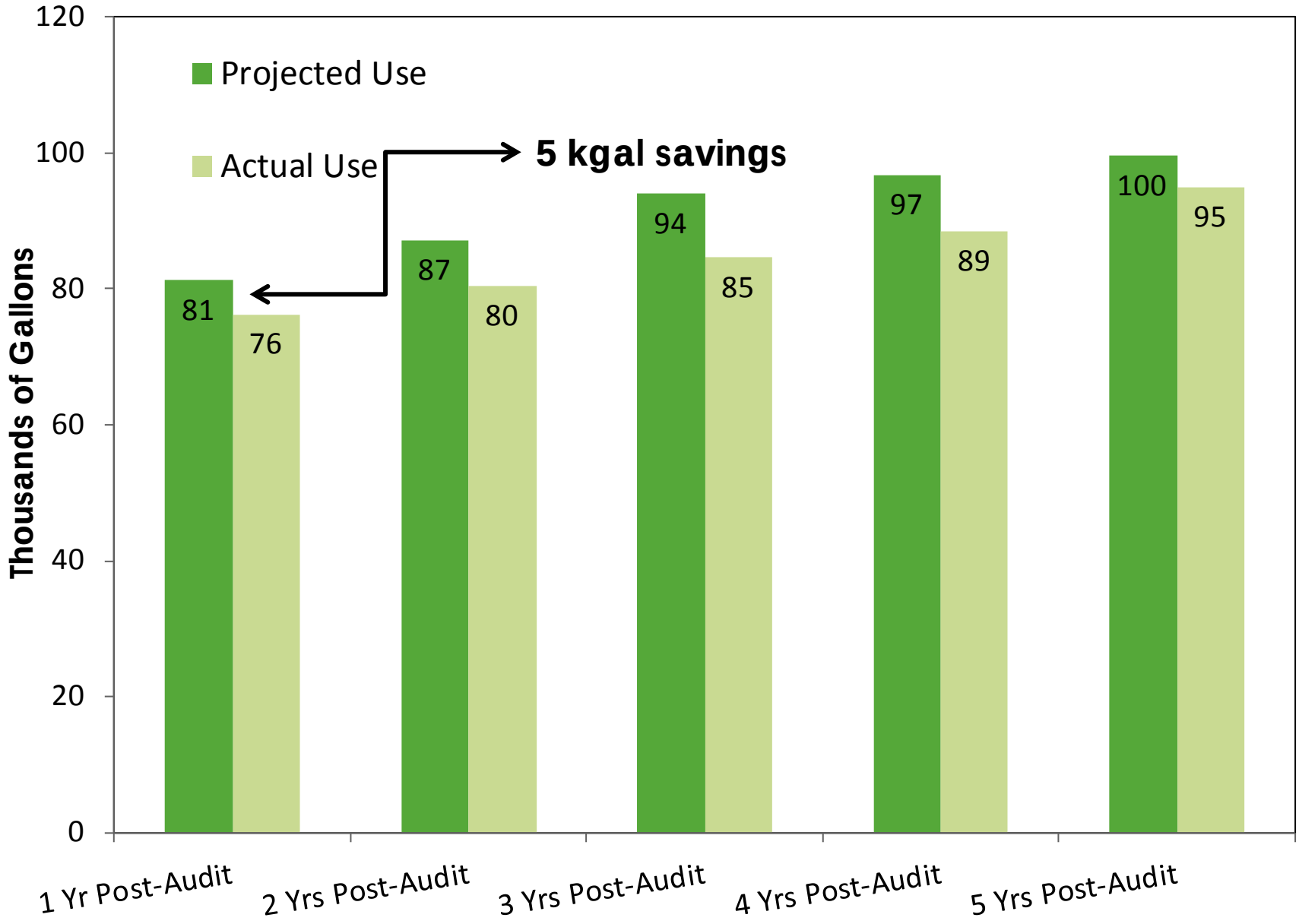
- Average number residents in summer: 2.9 ± 1.3
- Average number of years in current home: 9 ± 8.3
- Average year home was built: 1992 ± 13.8
- Average year of sprinkler system install: 1998 ± 7

Landscape Summary Stats

	Turf (sq. ft)	Shrub (sq. ft)
Average	3000	1155
Standard Dev.	3740	1845






120
100
80
60
40
20
0
Thousands of Gallons
Projected Use
Actual Use
5 kgal savings
81
76
87
80
94
85
97
89
100
95
1 Yr Post-Audit
2 Yrs Post-Audit
3 Yrs Post-Audit
4 Yrs Post-Audit
5 Yrs Post-Audit

What worked?

- Identifying/fixing sprinkler system issues?
- Sprinkler system properties (e.g. DU)?
- Technology?
- Landscape features?

Does identifying sprinkler system issues appear to help participants save water?

ANOVA/Wilcoxon to assess factors affecting water savings

- Scale is 0-3: 0=None, 1=Minor (0-20% of zones), 2=Significant (20-50% of zones), 3=Major (>50% of zones)
- Factors with **significant** differences in Water Savings
  - Bad schedule
- Factors with **no significant** differences in Water Savings
  - Broken Valves
  - Low Heads
  - Clogged Heads
  - Broken Valves
  - Overspray
  - Unmatched PR rates
  - Tilted Heads
  - Blocked Heads
  - Improper Pressure
  - Mixed heads
  - Incorrect Nozzles
  - Poor Spacing

Do sprinkler system issues affect watering efficiency?

ANOVA/Wilcoxon to assess other Factors Affecting Pre-Audit AR

- Scale is 0-3: 0=None, 1=Minor (0-20% of zones), 2=Significant (20-50% of zones), 3=Major (>50% of zones)
- Factors with **significant** differences in Pre-Audit AR
  - Bad schedule
- Factors with **no significant** differences in Pre-Audit AR
  - Broken Valves
  - Low Heads
  - Clogged Heads
  - Broken Valves
  - Overspray
  - Unmatched PR rates
  - Tilted Heads
  - Blocked Heads
  - Improper Pressure
  - Mixed heads
  - Incorrect Nozzles

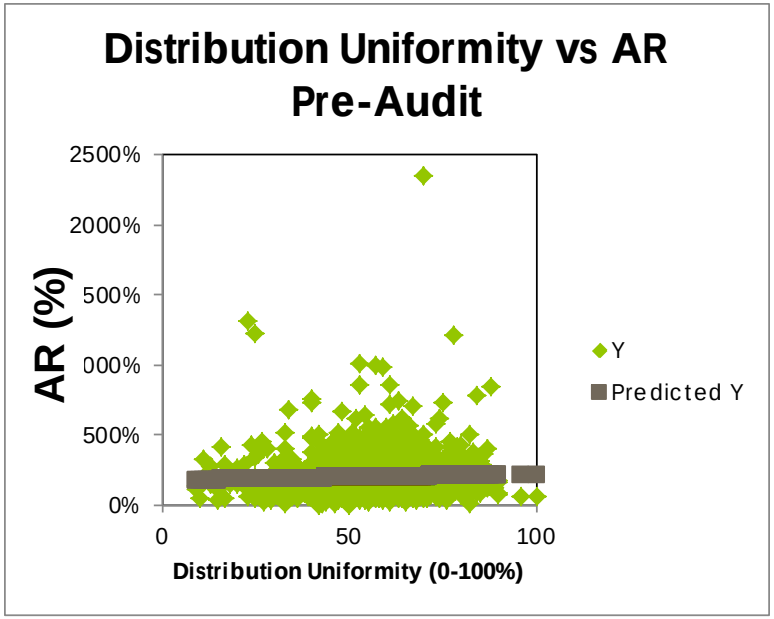
Does DU affect watering efficiency?

Conclusion: Distribution Uniformity is not a good predictor of Pre-Audit AR

Adj. R^2 = 0.00

Intercept = 1.76, p<0.0001

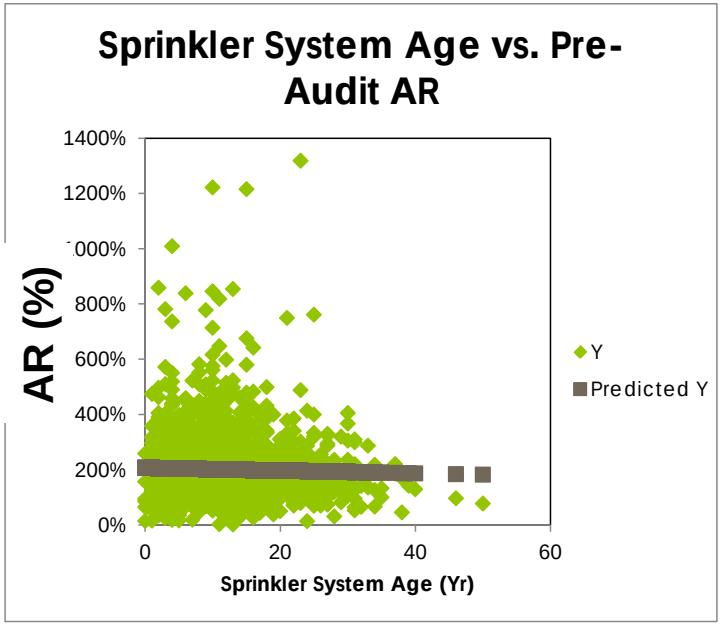
Coefficient = -0.0045, p<0.0001



Does sprinkler system age affect watering efficiency?

Conclusion: Sprinkler system age is not a good predictor of Pre-Audit AR

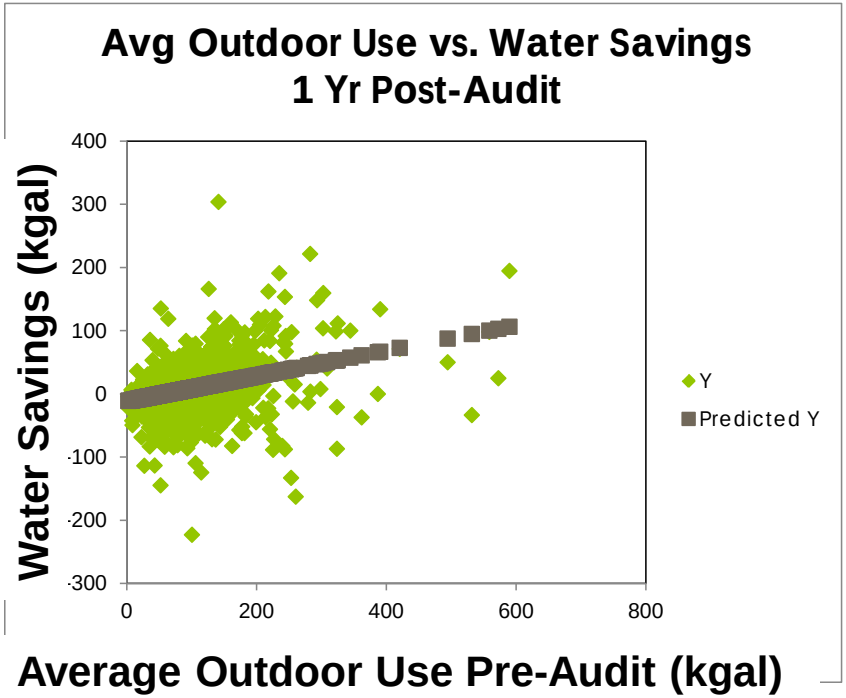
Adj. R^2 = 0.03
Intercept = 2.06, p<0.0001
Coefficient = -0.00498, p=0.24



So what factors do affect water savings and water efficiency?

Pre-audit outdoor use does correlate with water savings

Conclusion: Avg Outdoor Pre-Audit is a predictor of Savings from the audit.
Adj. R^2 = 0.33
Intercept = -11.9, p<0.0001
Coefficient = 0.20, p<0.0001



Xeriscape is related to efficiency

Xeriscape

	All	Some	None
Avg AR Pre	141%	207%	190%
Avg AR Post	138%	196%	176%

Note:
All differences, pre to post, are significant, at a = 0.05, using the Wilcoxon/Kruskal Wallis test

What have other researchers found to affect outdoor residential water use?

- Front Range MP Rotator Retrofit
  - No decrease in outdoor water use and possibly an increase in water use.
  - No pre-screening or education. Just first-come, first served.
- Zamora, 2012, *Fact or Fiction: Are water savings projections real or fabricated,* WSI presentation
  - No water savings from free HE sprinkler nozzle voucher program (24,000 distributed)
- Jackson & Lopez, 2004, *Slow the Flow Save H20*
  - Found that overall water savings of 1.9-11.8% per year
- DeOreo, 2011, *Analysis of Water Use in New Single-Family Homes*, Report to Salt Lake City and US EPA
  - Significant predictors of outdoor use included income, Net ET, Irrigable Area, Landscape Ratio (ratio of landscape to turf), Excess (marks excess irrigators), and Person at home. None significant predictors include age of home, years in home, number of residents in the home, outdoor water features (pool, fountain), pool system leaks, knowledge of the cost of water.

What works best?

- Water savings were achieved from Slow the Flow irrigation inspections, but perhaps not for the reasons that we expected.
  - Water savings not related to sprinkler system issues, but to ancillary factors as well as pre-audit water use
  - Inefficient water use was not related to sprinkler system issues, sprinkler system age, or DU
- Could education be the key to outdoor water conservation?

Thank you!

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  - City of Lafayette
  - Loveland
  - Parker W&S District
  - City of Thornton
  - Westminster

Extra Material

Cited Sources

- Cited Sources
  - Mayer et al. 1999. *Residential End Uses of Water.* AWWA Research Foundation.
  - Colorado Water Wise (CWW). 2010. *Guidebook of Best Practices for Municipal Water Conservation in Colorado*. Prepared by Aquacraft, Inc.
  - DeOreo, W. 2011. *Analysis of Water Use in New Single-Family Homes*. Submitted to Salt Lake City Corp. and US EPA.
  - Zamora, J. 2012. *Fact or Fiction: Are water savings projections real or fabricated,* WSI presentation. Las Vegas, Nevada.
  - Jackson & Lopez. 2004. *Slow the Flow Save H20*, Utah State University Extension

How much does the weather account for outdoor use?

Annual ET (in.) vs. Outdoor Water Use (kgal)