Beyond Implementation

Measuring a Region-Wide, Municipal Landscape Water Conservation Program

Upper Colorado River Basin Conference

November 8, 2012

Center for ReSource Conservation

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Background

- CRC works with over 27 water providers to implement water conservation programs
- In general, lack of rigorous metrics for measuring conservation
  - Problematic for conservation community as a whole
  - Problematic for CRC in particular

Emphasis

- How can we measure an outdoor water conservation program in a meaningful way?
- In particular, answer the question of how much water is saved as a result of CRC's outdoor audit service
  - Provide answers on numerous scales:
    - Individual participant
    - Individual participant average
    - Community level per year
    - Community level in aggregate
    - Program level per year
    - Program level in aggregate

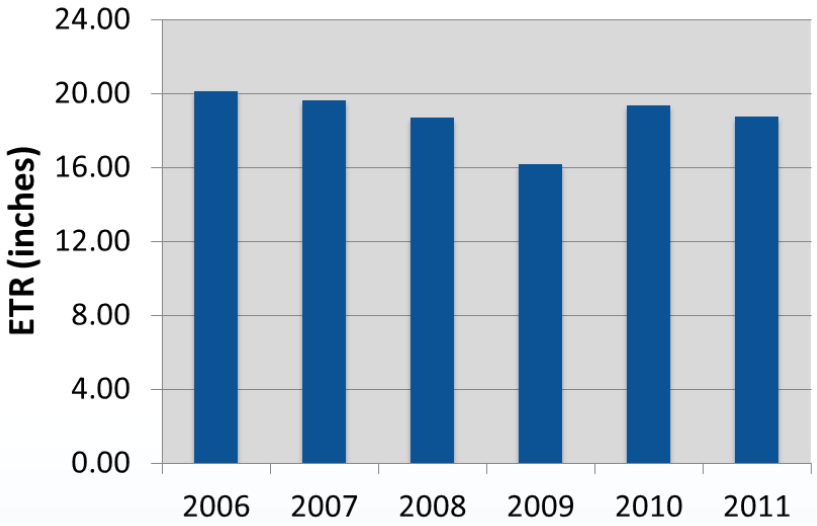
Program Information

- Slow the Flow
  - Outdoor water audit service
  - Offered since 2004
  - 2,000 residential audits offered in 2012
  - 10,000+ audits offered to date, with 27 water providers
  - Service includes customized watering schedule and identification and prioritization of system repairs

Data Sources

- STF participant records (from CRC)
- Water usage (from water service providers)
  - Outdoor water usage in gallons per year
    - Calculated from monthly water usage data
- Climate information (from Denver Water and Northern Colorado Water Conservancy District
  - Allows us to determine ET Requirement

(ETR)= ET – P



Current Data

- 9 communities
  - Aurora
  - Boulder
  - Castle Pines North
  - Erie
  - Left Hand Water District
  - Parker
  - South Adams County
  - Thornton
  - Westminster
- 6 years
  - 2006 –2011
- 1,650 complete data records (5 full years of data)

Impact Analysis Methodology

- Water savings = Projected water use – actual water use
- Projected water use: How much water the participant would have used, had they not participated in the audit
  - Based on historical consumption records as compared to climate conditions
- Actual water use: Directly from water usage records

Terms

- Application Ratio (AR) = Actual Water Used / Water needed to meet ETR (gal)
- Year 1 and Year 2 = Pre-Audit Years
- Year 3 = Audit Year
- Year 4 and Year 5 = Post-Audit Years

Impact Analysis Calculations

CRC Method: An Example

Pre-Audit

ID	Outdoor Use (gal) Yr 1	ETR (in) Yr 1	Water needed to meet ETR (gal) Yr 1	Water over/under ETR (gal) Yr 1	AR Yr 1
User1	68,143	19.63	60,325	7,818	113%

<--Over-watering pre-audit

ID	Outdoor Use (gal) Yr 2	ETR (in) Yr 2	Water needed to meet ETR (gal) Yr 2	Water over/under ETR (gal) Yr 2	AR Yr 2
User1	72,033	20.11	62,457	9,576	115%

Average Pre-Audit AR

User 1 = 114%

Impact Analysis Calculations

CRC Method: An Example

Post-Audit

ID	Outdoor Use (gal) Yr 4	ETR (in) Yr 4	Water needed to meet ETR (gal) Yr 4	Water over/under ETR (gal) Yr 4	AR Yr 4
User1	65,322	19.34	59,876	5,446	109%

<--Reduced water use post-audit

ID	Pre-Audit AR	Yr 4 AR	Projected Use Yr 4	Savings Yr 4
User1	114%	109%	59,876*114% = 68,259	68,259 – 65,322 = **2,937**

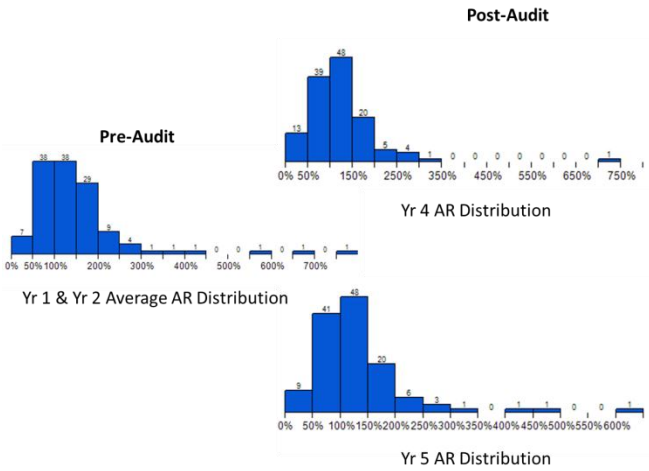
Preliminary Results

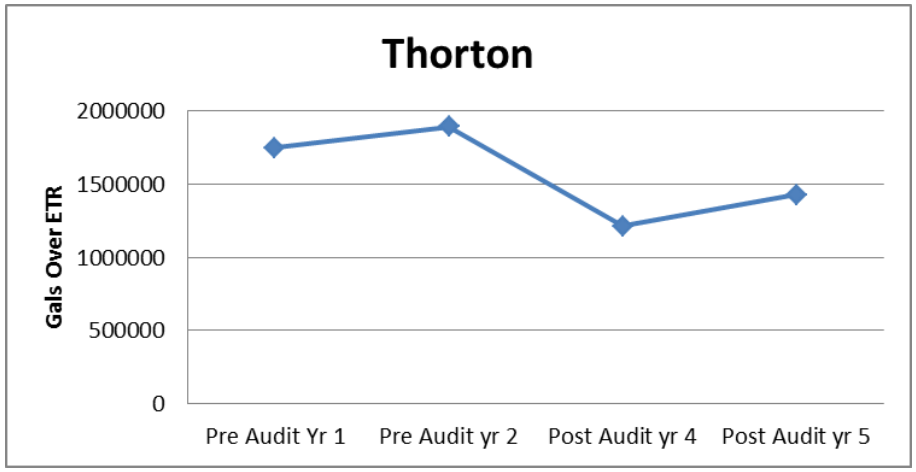
Totals and Averages	Mean	7,789
	SD	30,892
	Max	123,868
	Min	-83,758
	Median	6,647
	Sum	26,768,066
	N	1,650
	Outliers	157

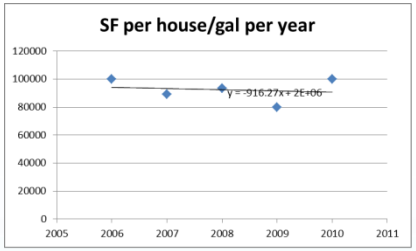
Preliminary Results

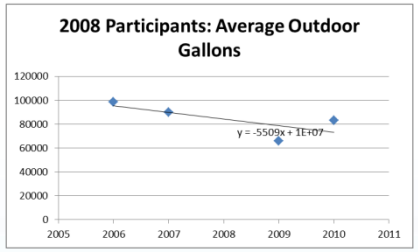
		2008		2009		Totals
		Year 4 Savings	Year 5 Savings	Year 4 Savings	Year 5 Savings	
Thornton	Mean	10818	11179	4915	2750	7,415
	SD	20895	29531	20442	20519	22,847
	Max	39479	108811	108811	58680	78,945
	Min	-31177	-29949	-45472	-58192	-41,198
	Median	15601	6213	2822	1409	6,511
	Sum	216352	223571	231016	129252	800,190
	N	20	20	47	47	134
	Outliers	5		1		6
Westminster	Mean	10590	8653	6397	4276	7,479
	SD	28470	30237	24293	29762	28,190
	Max	125046	137868	99323	97929	115,042
	Min	-62049	-84133	-63054	-120064	-82,325
	Median	7167	5580	5889	4651	5,822
	Sum	1175476	960505	652544	436118	3,224,644
	N	111	111	102	102	426
	Outliers	14		7		21

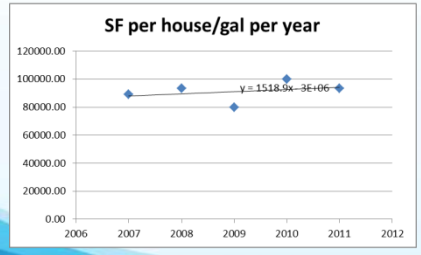
Preliminary Results

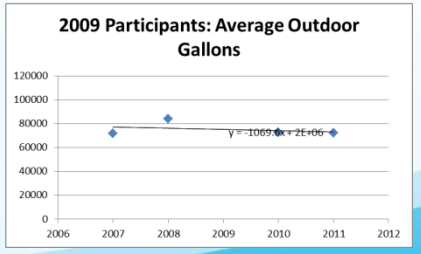




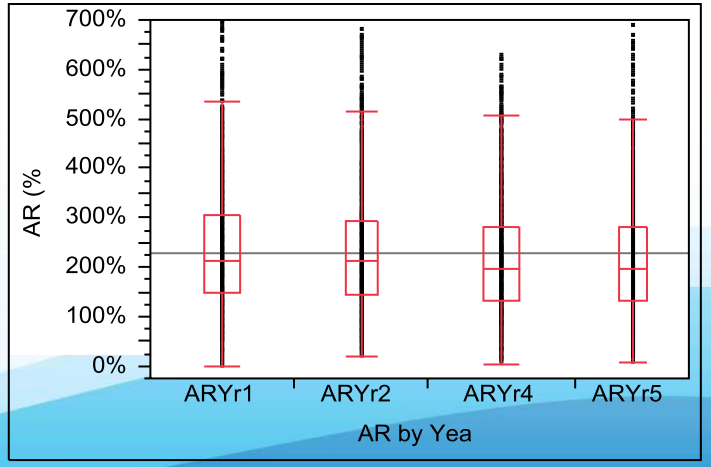






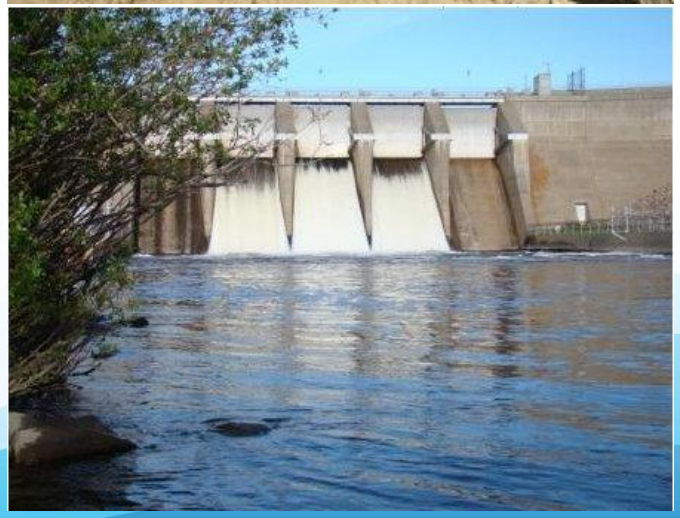


Statistical Analysis



Cost Analysis

- STF audit fee: ~$100 per audit
- $4,220 per AF of “saved” water
- New supply = $12,000 - $30,000 per AF



Future Work

- Incorporate these results into programmatic decisions
- Utilize this method to study other outdoor waater conservation programs
- Gather data for more communities and more years
- Improved and localized climate data
- Run additional statistical relevancy tests and sensitivity analyses
- Formalize presentation and publish work

Outstanding Questions

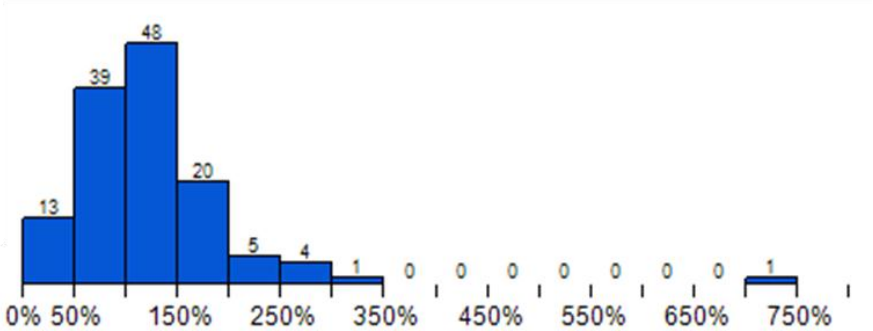
- What are other metrics that should be used to measure water conservation programs?
- Who should measure water conservation programs?
- Can "average" savings be meaningfully presented?
- Can water conservation programs, if measured appropriately and rigorously, represent a viable alternative to generating new sources of supply?

Thank you!

Questions?

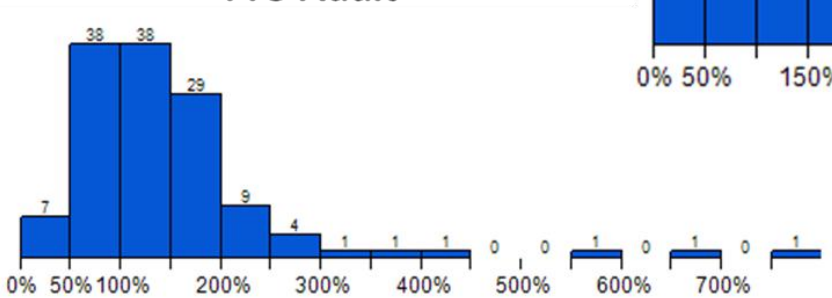
Preliminary Results

Post-Audit

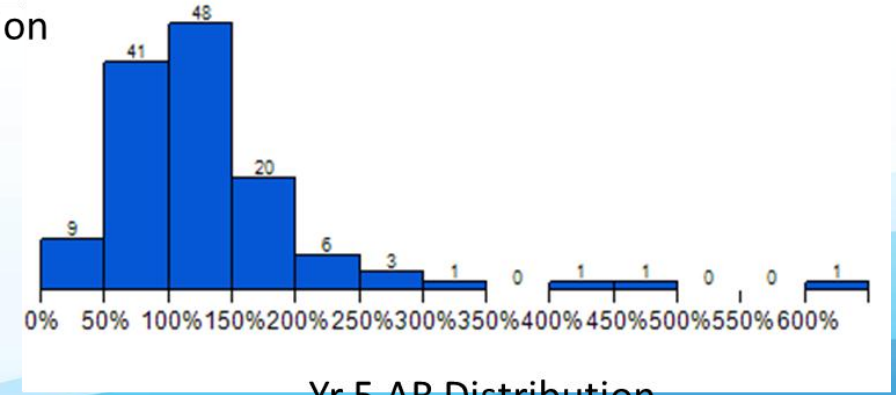


Yr 4 AR Distribution

Pre-Audit

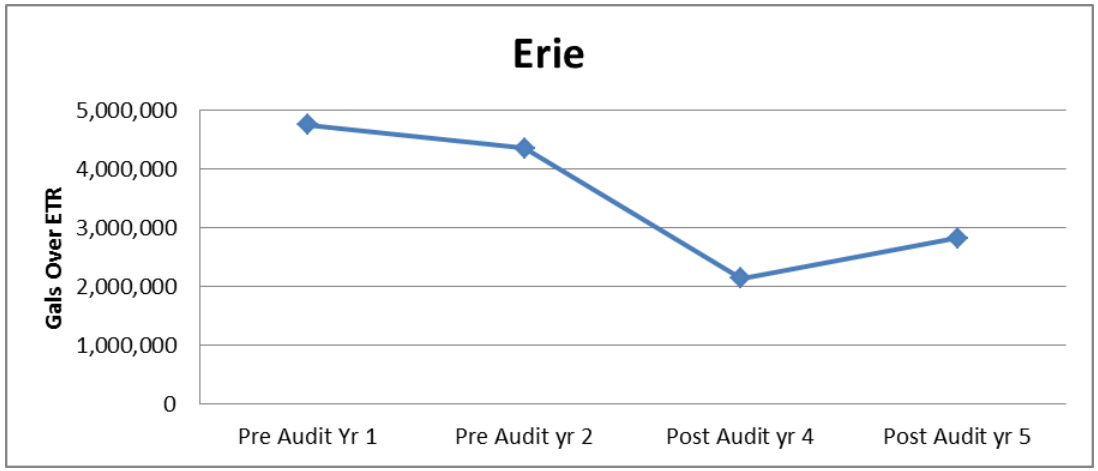


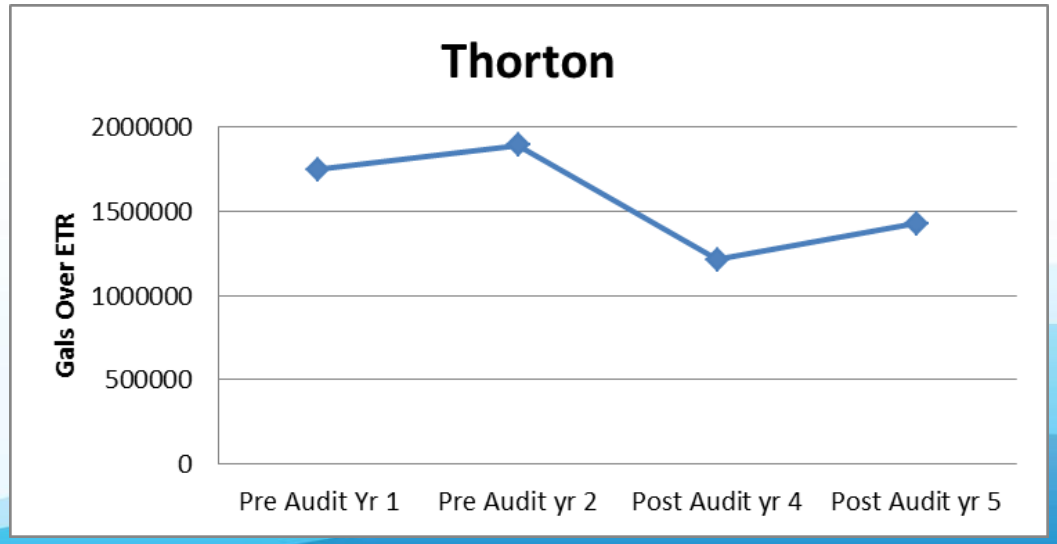
Yr 1 & Yr 2 Average AR Distribution



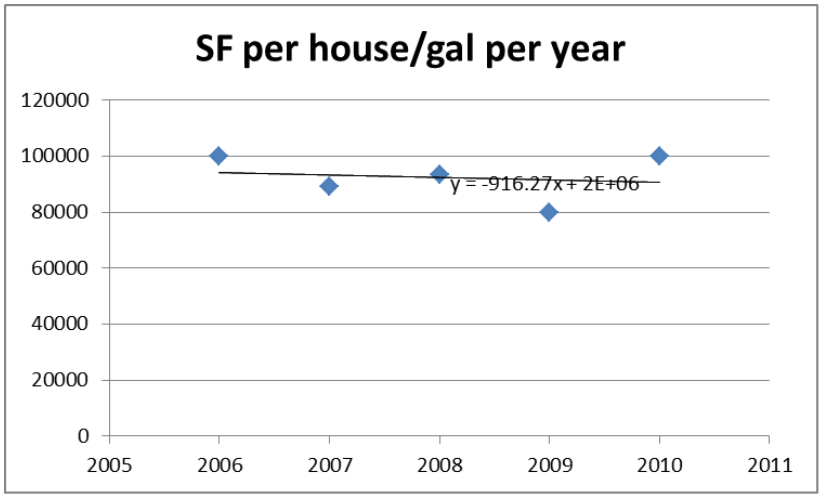
Yr 5 AR Distribution

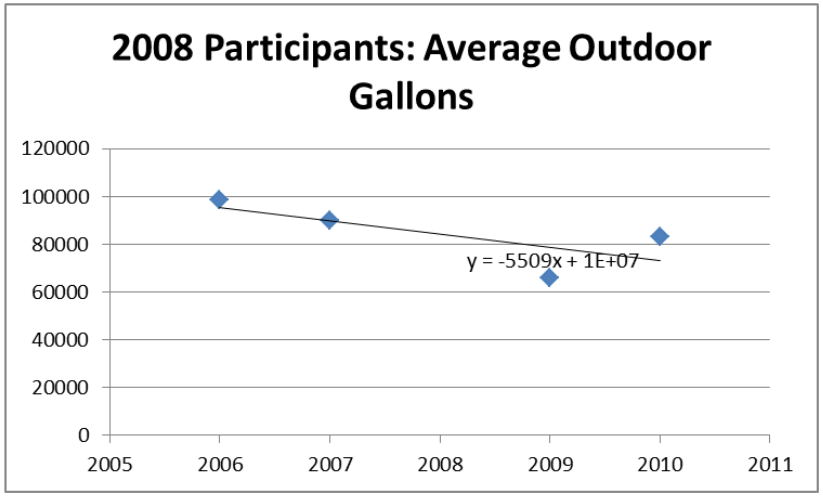
Preliminary Results

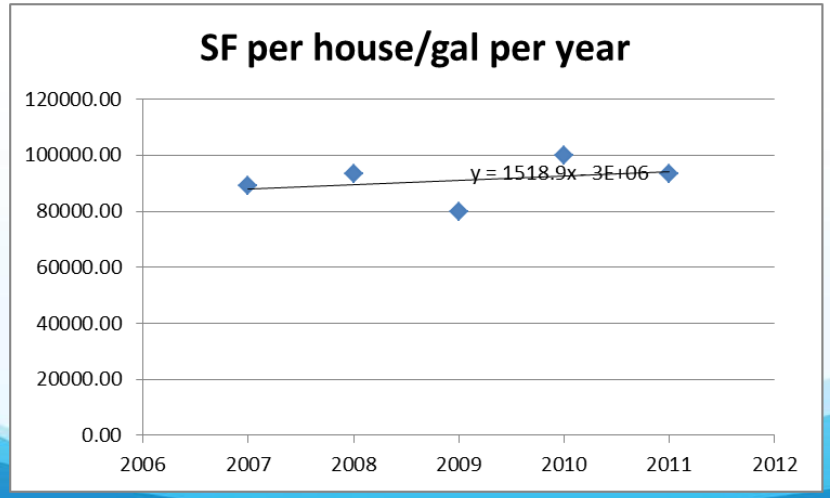


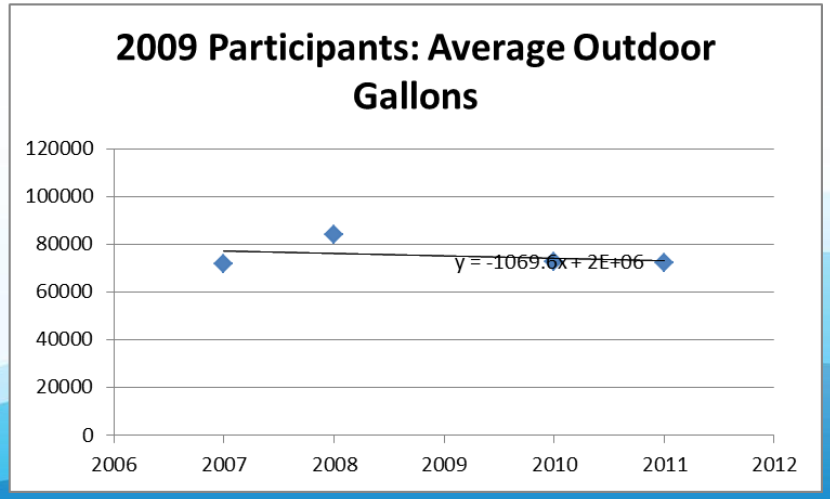


Results – Control Group Comparison



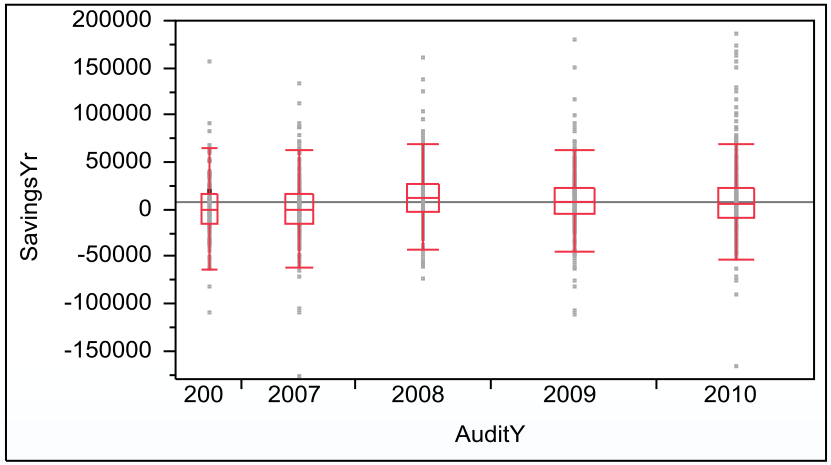




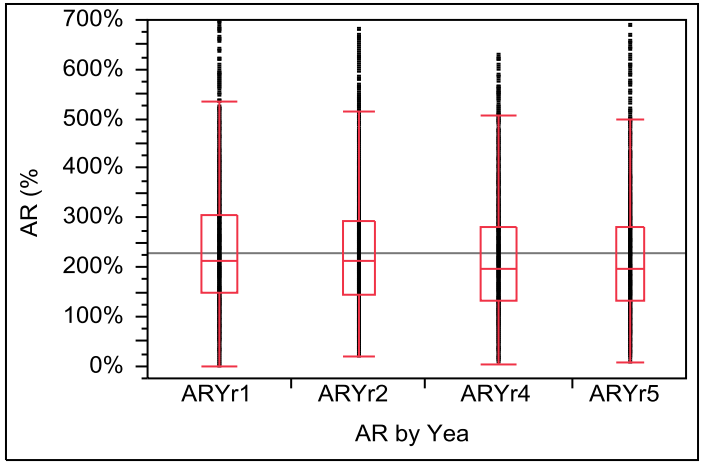


Results – Analysis

Year 4 Savings
Normal Distribution



Statistical Analysis



<u>ANOVA results:</u> F: 8.39, $p<0.0001$. Difference between all means is significant.

<u>Tukey HSD results</u>: Only ARYr1-ARY2 and ARY4-ARY5 pairs are not significantly different ($p>0.05$).

<u>Kruskal-Wallis results:</u> X^2:28.12, $p<0.0001$. Difference between all means is significant.