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Opportunities for reducing water use by Wisconsin Golf Courses: Final Report

Principal Investigators:

Doug Soldat, Asst. Professor, Dept. of Soil Science, University of Wisconsin-Madison John Stier, Professor and Chair, Dept. of Horticulture, University of Wisconsin-Madison

This will serve as the final report for this project. Unfortunately, the departures of Dr. John Stier in 2011 and Dr. Jim Kerns shortly after left me as the only full time faculty member left at UW during much of this project. This drastically increased my teaching responsibilities (four courses instead of my usual 1) and extension load (full responsibilities for field days, winter meetings, and many other training events). Therefore, I am sorry to report that I was unable to complete many of the tasks outlined in the original proposal. I requested and was granted a one-year nocost extension in hopes of finding the time to accomplish more aspects of the grant, was unable to do so. I apologize to the WDNR and the Groundwater Coordinating Council for my failure to complete the project as proposed.

The original proposal outlined a plan to survey golf courses in Wisconsin regarding their water use, identify opportunities for improving water use efficiency from the survey data, and then conduct detailed water use analysis of four golf courses. From that information, we planned to develop and educational plan to facilitate the adoption of water saving practices using factsheets and workshops. However, limits on my time described above prevented me from accomplishing anything beyond the survey and identification of the opportunities for improving water use efficiency. The report that follows summarizes these findings.

A water use survey (Appendix 1) was developed in late 2010 and mailed out to 491 golf courses in Wisconsin for which addresses could be obtained. This mailing list is available upon request. We mailed the survey out twice to improve the response rate. We received 102 responses for a response rate of 21%. The surveys were de-identified and entered into a spreadsheet which was then compiled and analyzed. The raw survey data will also be made available upon request. From the survey data, a summary was made of the findings and opportunities for improving water use efficiency were identified. An article was written for the May 2012 edition of *The Grass Roots*, the official publication of the Wisconsin Chapter of the Golf Course Superintendents Association of America (Appendix 2).

SURVEY RESULTS

General Findings

- The average maintenance budget was \$370,000 per 18 holes (which ranged from \$20,000 to \$1.4 million).
- 80% of those surveyed reported water use, 90% of that data came from a flow meter, with the remaining 10% estimated from run time.

- The average total irrigated acreage was 65 acres. 70% of courses had kept the same irrigated acreage over the last five years, with 15% increasing the acreage, and 15% decreasing it.
- The average amount of irrigation applied was 12.6 inches per year from 2007-2010.
- The average reported cost of annual water use was \$2,656 (range: \$0 to \$28,000)

Water Use By Year

- 2010: 11 inches (56 acre feet)
- 2009: 12 inches (67 acre feet)
- 2008: 13 inches (71 acre feet)
- 2007: 14 inches (79 acre feet)

Calculated Irrigation Efficiency [water deficit¹/water use]

- 2010: 82%
- 2009: 87%
- 2008: 85%
- 2007: 48%*

*The poor efficiency in 2007 is related to an extremely wet August where 17 inches of rain fell over a 24 day period. The assumption that half of the precipitation will be plant available fails in that case.

Irrigation Timing

- March/April = 6% of water use
- May/June = 28% of water use
- July/August = 48% of water use
- Sept/Oct = 17% of water use

Irrigated Areas

98% of tees, 96% of greens, and 86% of fairways were irrigated daily or 2-4 times per week.
 42% of roughs were not irrigated.

Irrigation Water Sources:

- 57% Groundwater
- 35% Surface Water
- 5.2% Municipal Water
- 2.3% Other (harvested water)

¹ Water Deficit = (0.5*precipitation) - (0.8*reference ET), precipitation and reference ET data taken from Madison, WI

Water Conservation Practices in Place

- 87% use wetting agents on putting greens, 45% use them on fairways
- 60% handwater portions of the golf course
- 40% have partially upgraded their irrigation
- 39% have raised mowing heights
- 31% say they irrigate fewer acres this is interesting when you consider that bullet point #2 in the "general" category above indicated that only 15% decreased the area they were irrigating.
- 14% employ a rain shut off switch
- 14% are monitoring soil moisture to schedule irrigation
- 13% are using ET-based irrigation
- 10% have recently completely upgraded their irrigation
- 10% practice root pruning
- 9% use drought tolerant landscape plants
- 7% are harvesting some water for re-use
- 6% have switched to lower water using species or varieties
- 4% conducted an in-house irrigation audit
- 4% use drip irrigation
- 2% reported "other" but did not elaborate
- 1% have had an outside irrigation audit

Irrigation Technology for Water Conservation

- 55% recently installed new irrigation heads
- 39% have recently upgrade nozzles
- 30% recently upgraded irrigation software
- 28% upgraded irrigation controller, with 19% upgrading the master controller
- 22% reported injecting wetting agents into the water
- 21% installed a new pump, with 13% installing a new pump station
- 20% added more heads, while 7% removed heads
- 12% added new lateral or irrigation main lines
- 4% indicated they had a water management plan in place

Opportunities for Reducing Water Use

- Only 13% are using ET to schedule irrigation amounts
- Only 14% are monitoring soil moisture and using to schedule irrigation
- Only 5% have conducted an irrigation audit
- Only 14% are using rain shut off switches

Dear:

In 2005, the Golf Course Superintendents Association of America conducted a national survey of golf course water use. That survey uncovered some impressive facts: golf course water use accounts for about 0.5% of the total annual water use in the US, and represents only 1.5% of all agricultural irrigation water use. While the survey was able to summarize the data for the North Central region (which included Wisconsin), it is difficult to draw conclusions about Wisconsin golf course water use data from a region that also includes Nebraska, a substantially drier state. In addition, the survey response rate in Wisconsin was relatively low and therefore, the responses may not be representative of the actual golf course water use in the state.

Recently, even historically water-rich states have begun to scrutinize water use. Wisconsin is no exception and the adoption of the Great Lakes Compact and the 2003 Wisconsin Act 310 serve as examples. It is likely that water use regulations will become more stringent in the foreseeable future. For these reasons, I felt it necessary to conduct this survey of water use on Wisconsin golf courses. I sincerely value your time, and would not send this comprehensive survey if I felt it was not critical to *ensuring that future regulations are science-based, effective, and realistic from an economic and management perspective.*

All survey responses will be kept anonymous, and I will not have access to any of the returned surveys before identifying information is removed. To encourage you to fill out this survey, all respondents will have a chance at winning an Apple iPad2. I will be paying for this prize out of my pocket, not from taxpayer or other university funds. Please contact me by phone or email with questions or concerns (djsoldat@wisc.edu, 608-263-3631).

Sincerely,

Doug Soldat Assistant professor

- 1. In which Wisconsin county is your golf course located?
- 2. Is your golf course open to the public?
- 3. If you prefer not to indicate the county, please circle the appropriate region below



- 4. How many holes do you have at your course?
- 5. How many holes do you have the ability to report water useage?
- 6. Which of the following best describes the annual maintenance budget for your golf course?
- 7. Please approximate the total number of irrigated acres at your golf course



- 8. Has the irrigated acreage of your course increased, decreased, or stayed the same over the past 5 years (circle the answer in the question)?
- 9. If increased or decreased, please indicate by how much
- 10. Please fill out the table below to the best of your knowledge

Year	Water Use (Gallons)	Metered or Estimated
2010		
2009		
2008		
2007		

- 11. If your water use is metered, what type of meter do you use? If estimated, how do you estimate it?
- 12. What percentage of the total irrigation at your course occurs in the following months

March-April	
May-June	
July-Aug	
Sept-Oct	

13. Estimate often you run your irrigation system during a three week period in the summer with no rain. Please circle the most appropriate characterization for the areas listed below.

a.	Greens:	daily	2-4 times a week	weekly	never
b.	Fairways	: daily	2-4 times a week	weekly	never
c.	Tees:	daily	2-4 times a week	weekly	never
d.	Roughs:	daily	2-4 times a week	weekly	never

14. Please fill out the table below regarding the source(s) of your irrigation water

Water Source	Percentage of Total Irrigation	2010 Water Cost
Surface water (lake, river)		
Well		
Municipal water system		
Other (Specify)		

- 15. Which water conservation practices have been used at your golf course in the past five years? Circle all that apply.
 - a. Use of wetting agents on greens
 - b. Use of wetting agents on fairways

- c. Reduction of irrigated acres
- d. Use of handwatering
- e. Raised mowing heights
- f. Complete update of irrigation system
- g. Partial upgrade of irrigation system (nozzles, software, heads, etc)
- h. Water harvesting
- i. ET-based irrigation scheduling
- j. Use of soil moisture sensors or probes
- k. Root pruning
- I. Outside irrigation audit
- m. Internal irrigation audit
- n. Use of drought tolerant species or cultivars
- o. Automatic rain shut-off sensors
- p. Use of drip irrigation in landscape beds
- q. Use of drought tolerant landscape plants
- r. Other (specify)_____

IRRIGATION SYSTEM INFORMATION

16. What type of irrigation system does your golf course have?

- a. Fully-automated (central or remotely controlled)
- b. Semi-automated (satellite controls only)
- c. Manual system
- d. Other_____
- 17. If you've had an outside irrigation audit in the past five years what was the distribution uniformity (DU) of the following areas?
 - a. Fairways_____
 - b. Tees_____
 - c. Greens_____
 - d. Total_____

- 18. Which irrigation system updates have occurred on your golf course in the past five years?
 - a. New nozzles
 - b. New heads
 - c. More heads
 - d. Fewer heads
 - e. New controllers
 - f. New master controller
 - g. New software
 - h. New pump(s)
 - i. New pump station
 - j. New lateral and/or main lines
 - k. Other_____
- 19. Which of the following, if any, do you use with your irrigation system
 - a. Fertigation unit
 - b. Acid injection
 - c. Sulfur burner
 - d. Wetting agent injection
 - e. Gypsum injection
 - f. Biological control injection
 - g. Other_____
- 20. Does your golf course have a written drought management or water conservation plan?

APPENDIX 2: Article Published in The Grass Roots

WISCONSIN SOILS REPORT

Results from the UW-Madison 2010 Golf Course Irrigation Use Survey

By Dr. Doug Soldat, Department of Soil Science, University of Wisconsin - Madison

In 2005, the GCSAA conducted a national survey of golf course water use. The survey found that golf facilities account for 0.5% of all water withdrawn in the US, and only 1.5% of all water used for irrigation. In general, the survey found most golf course superintendents were utilizing technology and scientific information to make decisions about how to irrigate. One of the key conclusions was that golf courses must continue to be proactive in their water conservation practices to achieve environmental and economic sustainability.

While the GCSAA survey (which can be found on the Environmental Institute for Golf web page), was eye-opening, it painted in broad strokes and grouped results from Wisconsin with ten other states, including Nebraska and Missouri which seem pretty different than Wisconsin to me from a climate perspective. So last year, I sent a letter and survey to 491 golf courses in Wisconsin to characterize the typical water use. We received 102 responses for a response rate of 21%, which was slightly disappointing. On the other hand, the GC-SAA survey was returned at a rate of only 15%. The primary concern with a low re-

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turn rate is the potential for sampling bias – which is the idea that the group returning the survey is fundamentally different (i.e. more conscientious about water use) than the group that did not return the survey. However, a growing body of survey research (e.g. Holbrook et al., 2007) suggests that response rates of 20% often yield statistically similar results to surveys with high response rates (>50%).

The following are some of the highlights from the Wisconsin Water Use Survey.

General Findings

The average maintenance budget was \$370,000 per 18 holes (which ranged from \$20,000 (believe it or not) to \$1.4 million).
The average total irrigated acreage was 65 acres. 70% of courses had kept the same irrigated acreage over the last five years, with 15% increasing the acreage, and 15% decreasing it.

• The average amount of irrigation applied was 12.6 inches per year from 2007-2010.

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Water Conservation Practices in Place



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Hamilton, Dennis..608-295-2494

WISCONSIN SOILS REPORT

It seems that there are many water conservation practices already in place on Wisconsin golf courses, including: continual updating of irrigation systems and components, wetting agent use on greens and fairways, use of handwatering. But, what about the total amount of water used? Is 12.6 inches of water (the average amount of water applied by our golf courses per year) an excessive amount? While it's hard to know for sure, we can do a simple calculation of irrigation efficiency. I will define irrigation efficiency as summer water deficit divided by irrigation applied. The water deficit is the amount of evapotranspiration during that season minus the effective rainfall. Effective rainfall is simply the amount of rain divided by two. This is a pretty gross assumption that accounts for the fact that about half of the rain that falls during the year either drains to the groundwater or runs off before entering the soil. If you get a nice light rain, chances are all of the rain will enter the soil and remain available for plant uptake, but during a five inch rainstorm very little of that rain will be made available to the plants. So the textbooks have concluded that it's dividing the rainfall by two is as good an approximation of effective rainfall as any for this region.

Let's take a look at the irrigation efficiency of Wisconsin golf courses in 2008. We will define the irrigation season as May 1 through Sept 30. During that period we had 18.4 inches of rain. We divide that number by two to get 9.2 inches of effective rainfall. The evapotranspiration during that same period was 25.3 inches. We will assume a crop coefficient of 0.8, which brings the total ET down to 20.2 inches. So 20.2 inches of ET (or plant water use) minus the 9.2 inches of effective precipitation equals 11 inches of water deficit (basically the irrigation requirement of the turf). In 2008, Wisconsin golf courses reported using an average of 13 inches of irrigation. So the estimated statewide irrigation efficiency was 11 inches of water required divided by the 13 inches that were applied which equals 85% efficient. I am impressed!

Similarly, the statewide irrigation efficiency in 2009 was 87%, and in 2010 it was 82%. However, in 2007, the irrigation efficiency was only 48%. That year we had 26 inches of rain, but still applied 14 inches of irrigation. What happened? Many may remember that we had (in Madison at least) 17 inches of rainfall over a 24 day period. The majority of those 17 inches did not become plant available, therefore making our assumption that half of all rainfall will be available for use. When we exclude that 24 day period, the irrigation efficiency for the rest of the year jumps up to 89%.







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So overall, I think an 80 to 90% irrigation statewide efficiency is outstanding! There is not much room for improvement. But it's never a good idea to rest on your laurels, and the survey also revealed many opportunities for improvement. The calculation for irrigation efficiency takes into account the evapotranspiration and the available moisture in the soil (effective rainfall), but less than 15% of the superintendents were using the two outstanding tools to manage their water use. While collectively, superintendents seems to be doing a good job at intuitively getting the irrigation right, using a water budget approach which utilizes soil moisture monitoring and estimates of daily ET can make water management less intuitive and more scientific. It will also be easier to train your assistants to manage the irrigation this way.

Another opportunity for improvement is in irrigation system auditing. Only 5% of you admitted to having conducted an irrigation audit. While I am not necessarily a proponent of traditional catchcan style irrigation auditing, I think using a soil moisture meter to conduct a soil moisture uniformity audit is a very important task for maintaining consistent moisture on the course. For a detailed explanation on this process and its merits, check out my article in the September 2011 issue of the Grass Roots on irrigation distribution uniformity. I am also planning a workshop on soil moisture monitoring and irrigation auditing during the afternoon session at WTA Field Day on July 31st. Hope to see you there!

References:

Holbrook, A., J. Krosnick, and A. Pfent. 2007. The causes and consequences of response rate in surveys by the news media and government contractor survey research firms. In Advances in Telephone Survey Methodology. Eds. J.M. Lepkowki, et al. New York: Wiley.

Coming Events!

Monday June 25th WGCSA Tournament, Oshkosh CC, Oshkosh

Tuesday July 31st Summer Field Day at OJ Noer Center, Verona

August 20th Joint Meeting w/NGLGCSA, Lake Arrowhead Golf Club, Nekoosa

Monday September 17th Wee One Fundraiser, Pine Hills CC, Sheboygan

Fri Oct 5th and Sat Oct 6th Couples Weekend, Edgewood GC, Big Bend

October 1, WTA Fundraiser, Ozaukee Country Club, Mequon

Tuesday & Wednesday December 4th and 5th, Golf Turf Symposium, American Club, Kohler

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