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Abstract

Reclaimed water is proving to be a beneficial source of irrigation water for golf courses around the world. To gain a better perspective of issues associated with reclaimed water use, 487 golf course superintendents in Texas were surveyed. Of those, 150 surveys were returned, and 40 respondents indicated they were using reclaimed water at their facility. Costs and availability were the biggest impediments to reclaimed water use and the most commonly cited problems were salinity, algae growth, and clogged irrigation heads. Commonly cited benefits included a reliable water source, conservation of fresh water, and cost.

A follow-on project investigated the impact of golf course fertilizer applications on water quality in Spring Lake on the Texas State campus. The study showed no statistically significant correlation between fertilizer applications and measured dissolved oxygen concentrations in the lake.

A preliminary assessment of best practices was developed to outline environmentally sustainable practices for golf course superintendants. The manual also includes an overview of the Texas State University golf course and examines the course's practices and their effects on the surrounding environment.

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Introduction

Population and economic growth is placing increasing demands on the fresh water supply in Texas. Industries such as golf courses which can supplement their fresh water usage with lower quality recycled water have an economic incentive to do so. In this project, Texas golf courses were surveyed to gauge the adoption, uses, and challenges of using recycled water for irrigation. Such uses dovetail with campaigns of major golf organizations such as the United States Golf Association and the Golf Course Superintendents Association of America to incorporate green practices into course maintenance.

Water is a valuable resource which becomes more precious as demand for fresh water increases. With increasing urban populations and diminishing sources of fresh, potable water, management practices must adapt to the new pressures on water resources. Texas is at a unique time in our water management practices. We have the ability to be proactive in our water management strategies to better conserve and protect our water resources before demand outpaces availability. Wastewater reclamation and reuse are strategies used to mitigate the impacts of increased demand on fresh water resources. Potable water must meet high quality standards, while other uses of water can be conducted at lower qualities. Irrigation of turfgrasses on golf courses with treated wastewater effluent can reduce the demand on municipal water resources serving the need of water conservation, but this has "both advantages and disadvantages related to regulatory, agronomic, economic, and operational issues" (Huck, Carrow, and Duncan 2000, 15). Through this research those regulatory, agronomic, economic, and operational issues were discussed and analyzed in the context of Texas golf courses.

The golf industry has a reputation for using excessive water, pesticides, herbicides and fertilizers and for being a large producer of non-point source pollution while contaminating the environment and water sources (Knox 2009). The golf course industry faces many challenges involving the care of golf course grounds. Knowing how to manage the course will ultimately affect the quality of air, water, natural vegetation, wildlife, and most importantly, potential water source contamination.

Objectives

This study had two objectives:

Objective 1: The first objective was to conduct a survey of golf course superintendents in Texas to determine their level of adoption of recycled water. The survey also asked questions concerning barriers to adoption and perceived benefits or problems of using recycled water for golf course irrigation. The purpose of this research was to analyze the inherent benefits and potential problems associated with wastewater reused to irrigate golf courses. A recycled water use survey was prepared and sent to United States Golf Association (USGA) member courses in Texas to evaluate the spatial distribution of golf courses utilizing reclaimed water in Texas. This research analyzed the regulatory and management issues and considerations identified by Texas golf course superintendents for beneficial use of reclaimed water.

Objective 2: The second objective was to determine if there was a link between fertilization and water quality at the Texas State Golf Course and the surrounding Spring Lake, the headwaters of the San Marcos River. Through careful examination of golf course practices, a list of best management practices were developed to provide golf course superintendants with the insight to become environmental stewards while consequently improving golf course profitability and public image.

Methodology

Objective 1: For the recycled water use survey a 33 item questionnaire was constructed. Questions were both open-ended and fixed response to determine facility characteristics, use of recycled water, problems and benefits of its use. Clubs that responded in the negative to their use of recycled water were asked if they had plans to incorporate it in the future and what were the barriers keeping them from adoption. Surveys were mailed to the golf course superintendents of 487 United States Golf Association (USGA) member clubs in Texas. The survey package included letters of endorsement from the USGA and stamped self-addressed envelopes to return the survey. A response rate of 31% was achieved with 150 clubs returning their surveys. Survey answers were extracted, encoded, and analyzed using standard statistical and spreadsheet software.

A GIS-based display which aggregates the response data by Texas Water Coordinating Board Regional Water Planning Area (TWCB-RWPA) was developed.

Objective 2: For the water quality study data on date and type of fertilizer used were obtained from the Texas State University Golf Course. Water quality data, specifically dissolved oxygen was obtained from routine monitoring records maintained at the Texas State University River Systems Institute. A correlation analysis was performed using standard statistical software with dissolved oxygen and lag in days since the application of fertilizer. A separate correlation analysis was performed using month as a controlling factor to see if there was an interaction effect of fertilizer application at different times of the year.

Results

Objective 1: Complete results from the study are contained in Dixon and Ray (2008) (Appendix G1) and a Master of Applied Geography Directed Research Project Report (Ray 2007) (Appendix G2). Findings include:

- Average monthly use of recycled water is 23.7 acre feet of water per course.
- Primary playing surfaces (greens, fairways, roughs, and tees) are the course areas most often irrigated with recycled water.
- Almost half (48%) of the respondents do not pay for their recycled water, but among those who do the median annually water price is $50,000.
- Most commonly cited problems of recycled water use include salinity, algae growth, and clogged irrigation heads.
- Most commonly cited barriers to recycled water adoption include lack of supply and cost of retrofitting existing irrigation systems.
- Many of these findings are similar to a study conducted in Florida by Cisar et al (2006).
- The GIS display of results aggregated by TWDP-RWPA is on-line at http://geosites.evans.txstate.edu/Irrigation

Objective 2: The correlation analysis was conducted on 20 measurements covering the years 2004 – 2009 which had coincident fertilizer application and dissolved oxygen (DO) measurements. Complete results from the study are contained in Appendix G3. Findings include:

- The mean lag (number of days between fertilizer application and DO measurement was 12.1 days with a standard deviation of 4.8 days.
- The shortest lag was 2 days while the longest lag was 18 days.
- The mean value of DO was 6.5 with a standard deviation of 0.8.

- The lowest DO recorded was 5.2 while the highest was 8.1.
- The Pearson Correlation Coefficient between lag and DO (r= -0.012, P= 0.959) was neither statistically nor practically significant.
- To remove the effect of month of the year, a partial correlation coefficient controlling for month of the year was also computed.
- The resulting coefficient (r= -0.030, P= 0.898) was also not significant

Implications

Objective 1: The GIS-based display will allow users to access survey data aggregated by Water Planning Area. This allows users to see which areas have incorporated this technology and to what extent. Greatest adoption appears to be in the Central Texas corridor from Georgetown to San Antonio with a secondary adoption region in the Houston area. Areas of the state especially lacking in adoption include the Panhandle and North Central (DFW) areas.

Objective 2: Results of the water quality study indicate that Texas State University Golf Course is not a significant source of non-point source pollution in Spring Lake. This can be attributed to careful management practices in application of fertilizers as well as a management decision to only fertilizer the greens and teeing grounds of the course.

Recommendations

Objective 1: Particular attention should be paid to the Panhandle and North Texas areas of the state if programs to encourage recycled water use are to be designed. At a minimum all new courses should perform a cost/benefit analysis of the use of recycled water, as early installation of irrigation systems reduces initial adoption infrastructure costs.

Objective 2: Golf courses in environmentally sensitive areas should act as environmental stewards and utilize best management practices. By increasing environmentally sustainable practices, golf courses may protect wildlife and improve water quality while decreasing irrigation expenditures and increasing profitability.

Appendices

G1. Copy of Dixon and Ray 2008 as published in Applied Turfgrass Science.

G2. Copy of Daniel J. Ray, “Reclaimed Water Use for Irrigation on Texas Golf Courses.” Unpublished Master of Applied Geography Directed Research Project Report. Texas State University, October 2007.

G3. Copy of Stacy Bray, “Preliminary Assessment: Evaluation of Best Management Practices for Environmentally Sensitive Golf Courses” Unpublished

References

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