

2018

# Center for Water Efficient Landscaping

ANNUAL REPORT | JUNE 2018

*UTAH STATE UNIVERSITY*



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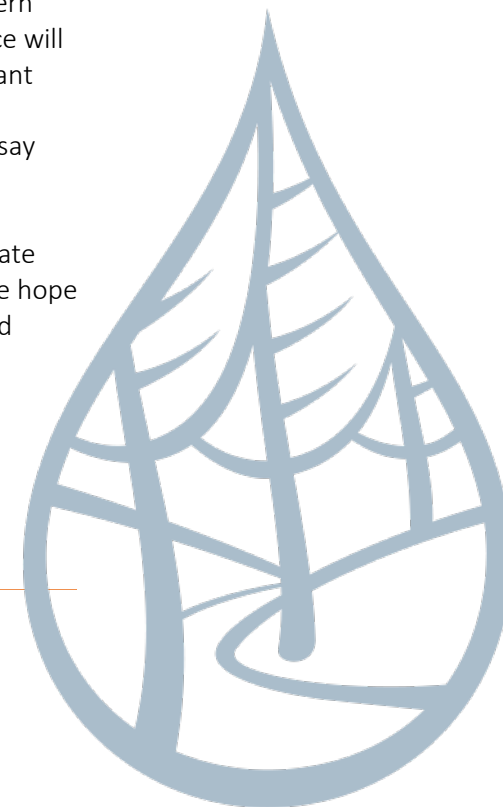


## MESSAGE FROM THE DIRECTOR

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The mission of the Center for Water Efficient Landscaping (CWEL) is “to sustain the quality of life enjoyed from landscaping while conserving water.” We are passionate about water conservation and the important role it plays in the management of Utah’s water. We are equally as passionate about the importance of landscaping and the many benefits it adds to our lifestyles. Aligning these two goals is challenging, complex, and (quite frankly) a lot of fun. Their alignment is one of many paradoxes within the world of western water policy where effectively managing this precious resource will take all the wisdom we can muster. Fortunately, the Land-Grant model permits us to bring research, Extension, and teaching programs to bear on this unique problem. I think I can safely say the faculty, staff, and students of CWEL are thrilled with the challenge and opportunities given them and appreciate the confidence shown in us by the Utah State Legislature, Utah State University, and most importantly, our many collaborators. We hope you enjoy reviewing our accomplishments of the past year and encourage your comments and suggestions.

*Larry A. Rupp*, Director  
Center for Water Efficient Landscaping  
Utah State University



# WHO WE ARE

## FACULTY

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### **DR. LARRY RUPP**

Director, Center for Water-Efficient Landscaping  
Professor Ornamental Horticulture, Extension Specialist  
*Department of Plant, Soils and Climate*  
*College of Agriculture and Applied Sciences*

Dr. Rupp works on the development of plants native to the intermountain region for use in water conserving landscapes.



### **DR. KELLY KOPP**

Professor/Extension Water Conservation, Turfgrass Specialist  
*Department of Plant, Soils and Climate*  
*College of Agriculture and Applied Sciences*

Dr. Kopp's research aims to improve the efficiency of landscape irrigation with projects that include plant water use efficiency evaluations, appropriate irrigation system design, and smart water application technologies.



### **DR. JOANNA ENDTER-WADA**

Professor of Natural Resource Policy and Social Science  
*Department of Environment & Society*  
*Quinney College of Natural Resources*

Dr. Endter-Wada researches urban landscape water use and conservation, and the human dimensions of drought and climate change with a focus on conceptualizing linkages between humans and biophysical aspects of ecosystems.



### **DR. YOUNG SUN**

Assistant Professor Landscape Horticulture  
*Department of Plant, Soils and Climate*  
*College of Agriculture and Applied Sciences*

Dr. Sun is working on landscape horticulture with an emphasis on understanding whole-plant responses to natural or managed water stress in urban landscapes.



### **DR. PAUL JOHNSON**

Professor of Turfgrass Science  
*Department of Plant, Soils and Climate*  
*College of Agriculture and Applied Sciences*

Dr. Johnson develops bluegrass species with increased drought and salt tolerance for better adaptation to Intermountain West environments.



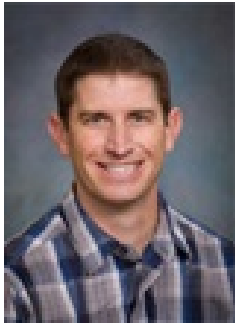
### **CANDACE SCHAIBLE, MS**

Professional Practice Extension Assistant Professor  
*Iron County Extension*

Ms. Schaible is an Extension Associate Professor in Iron County, Utah. With a focus on horticulture, she works to educate homeowners on best practices for water conservation in the landscape.

## STAFF

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### **PAUL HARRIS**

Research Technician, *Center for Water Efficient Landscaping*

Paul's professional interests include furthering research in turfgrass drought tolerance and promoting landscape water conservation. Paul is also pursuing Master's degree in Plant Science.



### **MICHAEL KILCREASE**

Research Technician, *USU Botanical Center & Center for Water Efficient Landscaping*

Michael is a Research Technician based at the USU Botanical Center in Kaysville. He assists with a variety of research projects for CWEL at that location.



### **ADREA WHEATON, MPSH**

Program Coordinator, *Center for Water Efficient Landscaping*

With a background in landscape architecture and horticulture, Adrea's interests include promoting landscape water conservation through smart plant selection.



### **DIANA WUENSHELL, MS**

Research Associate, *Department of Environment and Society*

Diana is the Projects Manager with the WaterMAPS™ Initiative of CWEL and has contributed to research focusing on water conservation behavior.

## RESEARCH GRADUATE STUDENTS

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**PAIGE BOYLE**

**Graduate Student, PhD Ecology**

**Undergraduate Degree:** Environmental, Soil & Water Science, University of Arkansas

**Master's Degree:** Horticulture, University of Arizona

**Dissertation Project:** Evaluation of Ecosystem Services in Golf Course Out-of-Play Areas Newly Transitioned to Native and Adapted Species



**KYLIE LAWSON**

**Graduate Student, MS Plant Science**

**Undergraduate Degree:** Plant Science, Utah State University

**Thesis Project:** Selecting and Grafting Single-leaf Pinyon Pine



**SHANE EVANS**

**Graduate Student, MS Plant Science**

**Undergraduate Degree:** BS Environmental Science, Brigham Young University

**Thesis Project:** Comparison of Irrigation Smart Controllers to Determine Water Efficiency



**IVY THOMSON**

**Graduate Student, PhD Human Dimensions**

**Undergraduate Degree:** Interdisciplinary, Utah State University

**Master's Degree:** Masters of Professional Studies in Horticulture, Utah State University

**Dissertation Project:** Water Conservation in Urban Landscapes: Influence through municipal landscaping ordinances and institutional water policy



**PAUL HARRIS**

**Graduate Student, MS Plant Science**

**Undergraduate Degree:** Horticulture, emphasis in Turfgrass Management, Utah State University

**Thesis Project:** Salinity Tolerance in Kentucky Bluegrass Hybrids

## MASTER'S OF PROFESSIONAL STUDIES IN HORTICULTURE (MPSH) STUDENTS

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**KIMBERLY EDEN**

**Undergraduate Degree:** English, Brigham Young University

**Capstone Project:** Kimberly is working on an education and outreach project to educate guests of Ashton Gardens at Thanksgiving Point about their new waterwise shade garden.



**JACOB HENDRICKSON**

**Undergraduate Degree:** Landscape Architecture, Utah State University

**Capstone Project:** Jacob created a Bioswale Fact Sheet and Bioswale Plant List for the Wasatch Front to help homeowners and landscape professionals manage storm water and reduce runoff from landscapes.



**KATHRYN JOHNSON**

**Undergraduate Degree:** Residential Landscape Design & Construction, Utah State University

**Capstone Project:** Kathryn is looking at tree water use and how to ensure tree survival when transitioning traditional landscapes to low-water landscapes.



**TREVOR KIMBALL**

**Undergraduate Degree:** Landscape Architecture, Utah State University

**Capstone Project:** Trevor worked with Perennial Favorites wholesale nursery in Layton, Utah to create perennial trial beds.



**JAY WARNICK**

**Undergraduate Degree:** Ornamental Horticulture, Utah State University

**Capstone Project:** Jay has worked in the athletic turfgrass industry for over twenty years. As the new landscape manager for the Salt Lake City LDS temple grounds and is looking to create a capstone project focused on management techniques for low-water landscapes.

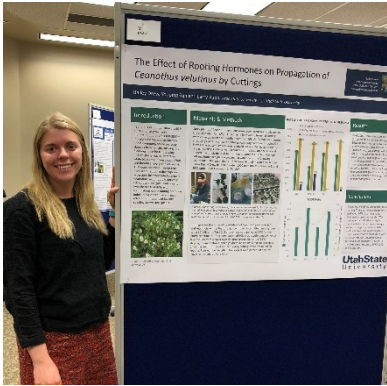


**GILBERT YOUNG**

**Undergraduate Degree:** Plant Science, Utah State University

**Capstone Project:** Gilbert works for USU Facilities and manages the Innovation Campus landscape. His capstone project is redesigning and installing a new native landscape north of the Big Blue parking terrace.

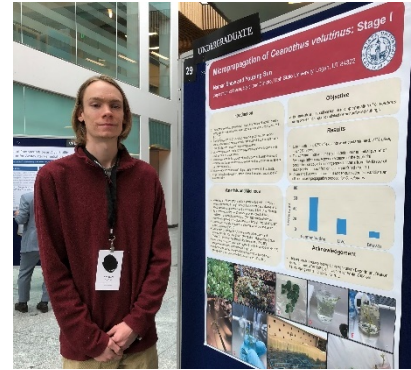
## UNDERGRADUATE RESEARCHERS



### BAILEY DREW

**Undergraduate Research Project:** The Effect of Rooting Hormones on *Ceanothus velutinus* by Cuttings

**Faculty Advisors:**  
**Drs. Youping Sun & Larry Rupp** – Department of Plants, Soils & Climate



### NATHAN SNOW

**Undergraduate Research Project:** Micropropagation of *Ceanothus velutinus*: Stage 1

**Faculty Advisors:**  
**Drs. Youping Sun, John Carmen & Larry Rupp** – Department of Plants, Soils & Climate



### ALYSSA PALMER

**Undergraduate Research Project:** Salinity Tolerance of Ornamental Grasses & Grass-Like Plants

**Faculty Advisor:**  
**Dr. Youping Sun** – Department of Plants, Soils & Climate



# WHAT WE DO



## RESEARCH

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Currently, it is estimated that approximately 50-65% of Utah's culinary water is used for landscape irrigation. Research has demonstrated that the amount of water applied to landscapes could be reduced substantially without affecting landscape quality or consumer lifestyles. Water use could be reduced even further if alternative landscape designs and management programs were practiced.

CWEL's specific goals currently include research on water requirements of trees and turfgrass, effects of short-term drought on landscapes, development and use of drought tolerant grasses and landscape plants, characterization of community-wide landscape water demand and use patterns, and development of water conservation policy.



# IMPLEMENTING WATER CONSERVATION STRATEGIES IN EAGLE MOUNTAIN CITY, UTAH

## PROJECT INFO

### PRINCIPAL INVESTIGATORS/COLLABORATORS (USU)

- Dr. Joanna Endter-Wada** – Professor, Natural Resource Policy and Social Science (PI)
- Dr. Kelly Kopp** – Professor, Water Conservation and Turfgrass Science Specialist (co-PI)
- Dr. Larry Rupp** – Professor, Landscape Horticulture Specialist (co-PI)
- Dr. Youping Sun** – Assistant Professor, Landscape Horticulture
- David Anderson** – Professional Practice Associate Professor
- David Bell** – Professor, Landscape Architecture Specialist
- Diana T. Wuenschell** – Research Associate, CWEL
- Adrea Wheaton** – Program Coordinator, CWEL
- Ivy Harvey Thomson** – Ph.D. Student, CWEL
- Logan Oates** – Master’s Student, Landscape Architecture and Environmental Planning
- Chris Garrard** – Programmer/Analyst, Remote Sensing & GIS Lab
- Ellie McGinty** – GIS Specialist, Remote Sensing GIS Lab
- Chris McGinty** – Assistant Director, Remote Sensing & GIS Lab

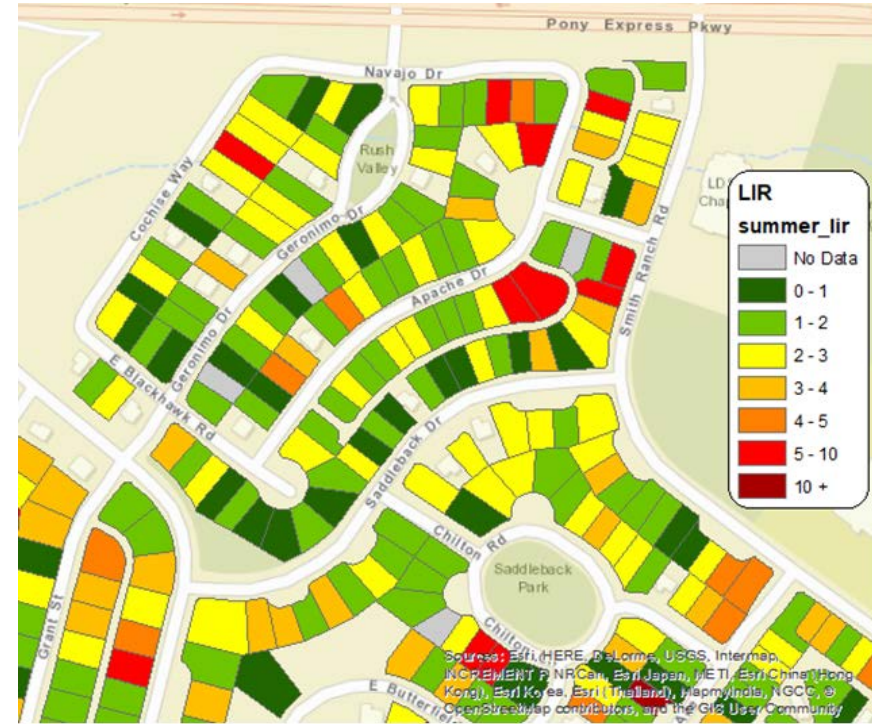
### CO-INVESTIGATORS/COOPERATORS (EAGLE MOUNTAIN CITY)

- Tom Westmoreland** – Mayor
- Ifo Pili** – City Administrator
- Evan Berrett** – Management Analyst, Eagle Mountain-USU Project Manager
- Brad Hickman** – Director, Parks and Recreation
- Lori Jolley** – Accountant, Utility Billing

LOCATION: **Eagle Mountain City, Utah**

## PROJECT OBJECTIVES

We are assisting Eagle Mountain City with water conservation through customized application of several Extension programs and public outreach efforts including WaterMAPS™ analyses, delivery of Water Checks, Landscape



Planning and Design for public spaces, and information provision to citizens. Eagle Mountain City is one of the fastest growing communities in Utah. The city is striving to become a Utah model for effective community-wide water conservation efforts and is wisely seeking documentation of program efficacy by establishing a baseline of current water use prior to program implementation. This project provides an excellent opportunity for USU Extension to work with Eagle Mountain City to develop a municipal case study of documented practices that will benefit water conservation outreach efforts throughout the state.

## PROJECT SUMMARY

**WaterMAPS™ baseline analyses** has been conducted to determine how efficiently the citizens of the community are using water on their landscapes. The analysis found that 57% of single-family residential locations have a

substantial capacity to conserve water. These locations are distributed throughout the city and no single neighborhood appears to be wholly less efficient than another. Every neighborhood has the potential to increase their efficiency. WaterMAPS™ software, developed at USU, integrates various databases (property boundaries, aerial imagery of landscape features, water use data, and real-time weather data) to produce parcel-specific landscape irrigation ratios (LIRs) based on water use as compared to estimated landscape water need. The LIRs indicate which landscapes are being overwatered and, thus, where the highest capacity to conserve exists. Results can be spatially and temporally displayed and analyzed.

**USU's Water Check program** completed 24 irrigation system evaluations of city properties; e.g. city parks, sports fields etc. Mayor Pengra and Eagle Mountain City are early adopters of a city-wide water conservation philosophy and strategy. The Mayor felt that it was essential for the city to demonstrate this commitment to its citizens before they were asked to conserve water. The Water Check program promotes water use efficiency on existing landscapes. USU interns provided professional evaluations of city irrigation systems. The services included an evaluation of the irrigation system design and maintenance, catch cup tests to determine the system's distribution uniformity and precipitation rate, a soil feel test to determine soil type, a recommended watering schedule and conservation recommendations for the irrigation system, plants, and soil.

**Landscape Planning and Design.** Logan Oates, a Masters of Landscape Architecture student from USU accepted an assistantship and developed a design for a low-water landscape for the area surrounding the city hall and the police department. The design was completed November 2017 and this landscape will be the focus of an educational program through its concomitant role as a demonstration garden.

**Information Design for Citizens.** A custom series of Extension flyers were developed for the city. The city is located in a unique micro-climate and residents have had a difficult time selecting plant material for their landscapes that will survive the city's harsh growing conditions. The series identifies the "Top 10 Low-Water" trees, shrubs, perennials, and ornamental grasses with



**MOCK BEARBERRY  
MANZANITA** ☀️ 🌧️ 💧

*Arctostaphylos x coloradensis*  
Woody, evergreen groundcover with urn-shaped, white flowers that produce small red berries.  
Zones: 5-8 H x W: 10-24" x 36-60"



**'POWIS CASTLE'  
ARTEMISIA** ☀️

*Artemisia x 'Powis Castle'*  
Pleasing mounded shape with silvery gray foliage that is also fragrant. Sub-shrub that can be cut back to 1/3 to rejuvenate growth.  
Zones 4-10 H x W: 36" x 30"



**CREeping OREGON GRAPE** ☀️ 🌧️ 💧  
*Berberis (Mahonia) repens*  
Holly-shaped evergreen leaves and fragrant yellow flowers. Zones: 4-7 H x W: 12-18" x 36"

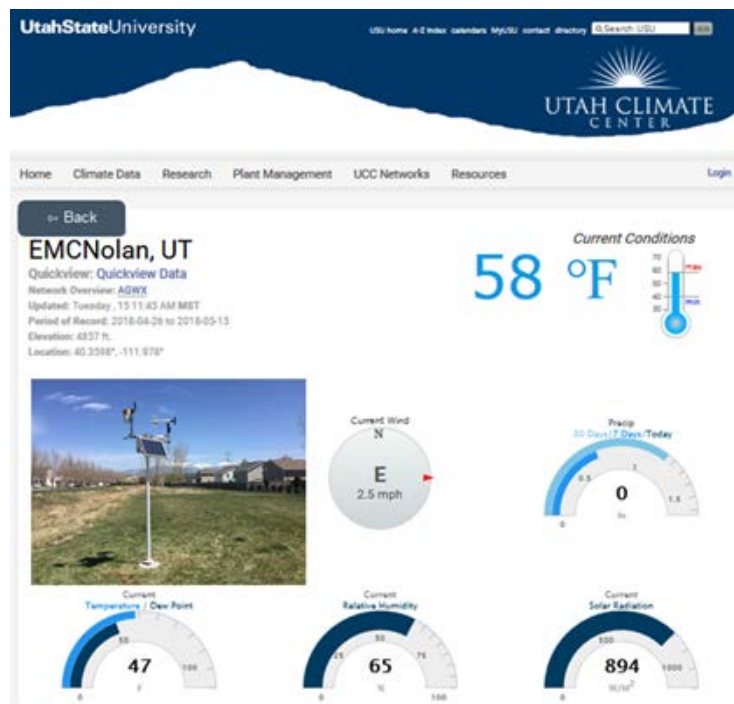


**BLUE MIST SPIREA** ☀️ 💧  
*Caryopteris x clandonensis*  
Mounded shrub covered in blue flowers late summer. Zones: 5-9 H x W: 2-4' x 2-4'



**FERNBUSH** ☀️ 🌧️ 💧  
*Chamaebatiaria millefolium*  
Finely divided foliage and showy white flowers.  
Zones: 4-8 H x W 3-6' x 3-6'

characteristics well-suited for the area. New infrastructure, current technology, and accurate data are all vital to a city's water conservation efforts, but will fall short of their potential without appropriate educational programming such as localized plant lists to promote water conservation.



**Weather Stations.** The CWEL team has collaborated with the Utah Climate Center to cost share and obtain additional financial resources from USU Research and Graduate Studies to install and maintain two weather stations in Eagle Mountain City. These weather stations will be maintained as part of the Utah Climate Center network of public weather stations in Utah and will fill a critical data gap. Eagle Mountain City is the largest geographic city in the state of Utah encompassing 53 square miles located in the Cedar Valley west of Utah Lake. The city has significant observable climatic differences between the “city center” and “ranches” areas within the city. Data from these official network weather stations will support research being conducted by CWEL as well as the Utah Climate Center, assist the city with assessing and promoting efficiency in landscape water use. These state of the art weather stations will provide citizens and businesses with local weather data for use with irrigation smart controllers, and make available new opportunities for delivering

educational programs related to weather, climate, and water use efficiency to local schools and community groups.

## PROJECT STATUS

This project has received funding for Phase II, which will run through 2019. The next phase of the project will include:

- Conducting a comparative WaterMAPS™ analyses of Eagle Mountain City and an older more established city,
- Delivering Water Check irrigation system evaluations to city residents during 2018 and 2019 irrigation seasons,
- Reviewing and analyzing landscape ordinances and policies for urban water conservation.

## RELATED PUBLICATIONS

- Wheaton, A., Rupp, L., & Caron, M. (2018).** 10 Low-Water Trees Ideal for Water-Efficient Landscapes in Eagle Mountain, Utah. [https://digitalcommons.usu.edu/extension\\_curall/1856](https://digitalcommons.usu.edu/extension_curall/1856)
- Wheaton, A., Rupp, L., & Caron, M. (2018).** 10 Low-Water Ornamental Grasses Ideal for Water-Efficient Landscapes in Eagle Mountain, Utah. [https://digitalcommons.usu.edu/extension\\_curall/1855](https://digitalcommons.usu.edu/extension_curall/1855)
- Wheaton, A., Rupp, L., & Caron, M. (2018).** Low-Water Perennials Ideal for Water-Efficient Landscapes in Eagle Mountain, Utah. All Current Publications. Paper 1853. [https://digitalcommons.usu.edu/extension\\_curall/1853](https://digitalcommons.usu.edu/extension_curall/1853)
- Wheaton, A., Rupp, L., & Caron, M. (2018).** 10 Low-Water Shrubs Ideal for Water-Efficient Landscapes in Eagle Mountain, Utah. [https://digitalcommons.usu.edu/extension\\_curall/1854](https://digitalcommons.usu.edu/extension_curall/1854)
- Wheaton, A., Rupp, L., & Caron, M. (2018).** Landscape Plants for Eagle Mountain, Utah. [https://digitalcommons.usu.edu/extension\\_curall/1857](https://digitalcommons.usu.edu/extension_curall/1857)

# IDENTIFYING AND MEETING SALT LAKE CITY'S LANDSCAPE WATER CONSERVATION POTENTIAL

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## PROJECT INFO

### PRINCIPAL INVESTIGATORS/COOPERATORS (USU)

**Dr. Joanna Endter-Wada** – Professor, Natural Resource Policy and Social Science

**Dr. Kelly Kopp** – Professor, Water Conservation and Turfgrass Science Specialist (co-PI)

**Dr. Larry Rupp** – Professor, Landscape Horticulture Specialist (co-PI)

**Diana T. Wuenschell** – Research Associate, WaterMAPS™ and Urban Water Conservation Research

**Adrea Wheaton** – Program Coordinator, CWEL

**Chris Garrard** – Programmer/Analyst, Remote Sensing & GIS Lab

**Ellie McGinty** – GIS Specialist, Remote Sensing & GIS Lab

### CO-INVESTIGATORS/COOPERATORS (SLC)

**Stephanie Duer** – SLC Water Conservation Program Manager

## PROJECT OBJECTIVES

SLCDPU began a formal Water Conservation Program in 2001 when annual demand was 109,967 acre feet. The Water Conservation Program serves as a critical avenue for engaging participation and dedication of water customers in the adoption of water conservation measures. SLCDPU has led customers to a sustained water use reduction of more than 20 percent since 2001. In 2015, SLCDPU's annual water demand was 86,038 acre feet. However, the city is convinced and determined that more can be done to accommodate growth-related water demands and supply impacts associated with climate change. This challenge raises important questions that the proposed project is designed to answer. How much more water applied to landscapes can SLCDPU expect to save, that is, how much water conservation potential exists within its service area and how does the city capture that savings?

## PROJECT SUMMARY

As in most western cities, urban landscape irrigation constitutes a large proportion of municipal water use in the SLCDPU service area, and gaining efficiencies in that element of end use is the new focus of urban conservation efforts. Does conservation in an “average” water year look the same as conservation during a drought? Where does SLCDPU have capacity to conserve water (geographically at particular locations; temporally at certain times of the irrigation season)? What tools could be most effective with any given group of water users to eliminate waste, increase efficiency, and reduce use? The answers to these questions will enable SLCDPU to prioritize delivery of future water conservation programs, and help the community to be adaptive and responsive in its relationship with water in order to create a more sustainable water supply now and for the future. However, we do not know how much water is actually being wasted on existing landscapes. Analysis of city meter data can provide clues as to watering practices, but the question remains: How much irrigation water currently being applied is not necessary to support urban landscapes?

Application of USU Water Management Analysis and Planning Software (WaterMAPS™) addresses this specific information need. WaterMAPS™ is a custom software application that has been developed by an interdisciplinary team of USU researchers for the purpose of promoting urban landscape water conservation (visit [watermaps.usu.edu](http://watermaps.usu.edu)). WaterMAPS™ integrates water meter data with property records, weather data, and landscape classifications into one database, then enables different time-step calculations of site-specific Landscape Irrigation Ratios (LIRs) that compare landscape water use to landscape water need. In this project, several different innovations will be implemented in the application of WaterMAPS™ to help SLCDPU meet the challenge of refining and focusing city water conservation programs in the future.

## PROJECT STATUS

This is a new project just underway.

# LANDSCAPE WATER USE ANALYTICS FOR INSTITUTIONAL AND CORPORATE PROPERTIES

## PROJECT INFO

### PRINCIPAL INVESTIGATORS/COOPERATORS

**Dr. Joanna Endter-Wada** – Professor, Natural Resource Policy and Social Science (PI)

**Dr. Larry Rupp** – Professor - Landscape Horticulture Specialist (co-PI)

**Chris Garrard** – Programmer/Analyst, Remote Sensing & GIS Lab

**Diana T. Wuenschell** – Research Associate, CWEL

**Chris McGinty** – Assistant Director, Remote Sensing & GIS Lab

**Ivy Harvey Thomson** – Ph.D. Student, CWEL

**Kathryn Johnson** – MPSH Student, CWEL

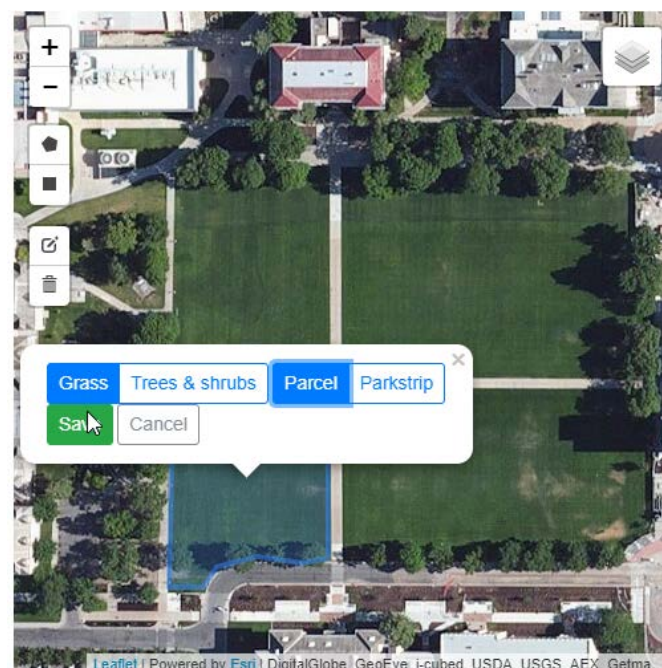
LOCATION: **Throughout the state of Utah**

## PROJECT OBJECTIVES

A specialized WaterMAPS™ web application is being developed that will enable large property owners to analyze and track landscape water use at its various facilities. As an assessment and monitoring tool, this web application will help guide the property manager's water conservation efforts and inform landscape replacement and operations decisions. The WaterMAPS™ web application is being designed for direct use by institutional or corporate entities that own and/or manage multiple urban properties in dispersed locations.

## PROJECT SUMMARY

The innovation of this project is to extend the ability to use the software to individual entities who can supply their own landscape classification and water meter data needed to do the calculations. The project is geared to professional institutional and corporate property managers who generally have these data capabilities. We facilitate their use of WaterMAPS™, a leading-edge urban landscape water demand management software application, with a web-



based interface that contains a user mapping tool and integrates the additional needed data, such as GIS data for property locations and the new zip code-based ET weather data being developed by the Utah Climate Center. However, once extended with these more professionalized property managers, it would be quite feasible to make WaterMAPS™ accessible to individual users of all types via a supported web application and service. We are also identifying best management practices and developing interim guidelines for irrigation of established trees in newly constructed low-water landscapes, traditional landscapes, and existing traditional landscapes being transitioned to low-water plant material while retaining existing trees. Mature trees play a significant role in mitigating the urban heat island effect and protecting human health during heat waves.

## PROJECT STATUS

This project received funding for Phase II and will run through 2019.

# SALINITY TOLERANCE IN KENTUCKY BLUEGRASS HYBRIDS

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## PROJECT INFO

### PRINCIPAL INVESTIGATORS

**Dr. Paul Johnson** – Department of Plants, Soils & Climate/CWEL

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate/CWEL

**Dr. Shaun Bushman** – Forage & Range Research Lab, USU

### MASTER'S STUDENT

**Paul Harris** – Research Technician, CWEL

### LOCATION:

**Forage and Range Research Lab**, Logan Utah

## PROJECT OBJECTIVES

Test differences in salinity tolerance among parental and hybrid lines of Kentucky bluegrass.

## PROJECT SUMMARY

Population growth and extended droughts have stressed water supplies in the West. To cope, municipalities have turned to alternative water sources, such as reclaimed water, for landscape irrigation. These alternative sources generally have elevated salinity levels, which puts stress on landscape plants such as turfgrass. Kentucky bluegrass (*Poa pratensis*) is a widely used turfgrass because of its adaptability, dark color, durability and soft texture. However, Kentucky bluegrass is sensitive to salinity stress.

**Methods:** A total of 44 hybrid and parent plants developed by the USDA were grown in a silica sand media and irrigated with a salinity solution increasing to 6 dS m<sup>-1</sup> for a period of 8 weeks. Irrigation events occurred every-other-day and was delivered through an overhead automated boom irrigation system. Stress was quantified by measuring electrolyte leakage, a measure of general stress on the plant, and visual ratings of plant health and quality.



## PROJECT STATUS

To date there have been 3 runs of this experiment, with the 4<sup>th</sup> run currently underway. Results have varied from run to run but despite the differences, some hybrids have consistently demonstrated tolerance to saline conditions.

## PRESENTATIONS

**Harris, P.** (2017, Oct. 22-25). Salinity tolerance in Kentucky bluegrass hybrids. Presented at the Tri Society (ASA, CSSA, and CSA) Annual Conference, Tampa, Florida. (American Society of Agronomy, the Crop Science Society of America, and the Canadian Society of Agronomy)

# NATIONAL TURFGRASS EVALUATION PROGRAM (NTEP) VARIETY TRIALS

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate/CWEL

### CO-INVESTIGATORS/COOPERATORS

**Paul Harris** – Research Technician, CWEL

### LOCATION:

**Greenville Research Farm**, Logan Utah

## PROJECT OBJECTIVES

The National Turfgrass Evaluation Program (NTEP) is a national research program working with plant breeders and researchers to provide the turfgrass industry and consumers with objective evaluation of varieties across many locations in the US and Canada.

## PROJECT SUMMARY

At USU, we have cooperated with NTEP for more than 20 years to provide high quality data on species in northern Utah and the northern Intermountain West region. With that data, we help identify stress tolerant species and varieties for our region with an emphasis on acceptable quality under reduced irrigation levels. These data from Utah and elsewhere in the country are available at <http://ntep.org> The data we collect on these evaluation trials throughout the year include:

- Visual quality
- Color
- Spring greenup
- Density and uniformity



- Percent living cover (% survival)
- Percent disease infection

Currently, we are conducting the following trials:

- USGA/NTEP Water use and drought tolerance, cool-season species-2016.
- Perennial ryegrass—standard and drought test-2016
- Kentucky bluegrass—2017
- Tall fescue—2012
- Bentgrass putting green—standard and drought-2014
- Bentgrass fairway/tee drought—2014
- Cool-season low-input—2015
- Warm-season low input—2018 (in St. George, UT)
- Tall fescue test—2018 (to be planted in fall 2018)





In general, we can maintain acceptable turf with substantially reduced irrigation levels compared to those usually recommended, but recovery from wear and traffic is reduced under those conditions. For example, most information sources recommend that 80% of reference evapotranspiration (ET<sub>o</sub>) amounts be replaced at each irrigation for Kentucky bluegrass. Replacing 60% of ET<sub>o</sub>, a decrease of 25% in irrigation applied, can still provide acceptable turf in many Kentucky bluegrass varieties, but regrowth and the ability to tolerate traffic is reduced.

## PROJECT STATUS

Some top performing varieties for visual quality\* in trials more than 2 years old include:

- Tall fescue-2012: MET 1, Bullseye, Hover, Raptor III, 4th Millennium SRP, Amity, Faith, Fayette, Firewall, Avenger II, Catalyst, Diablo, Rebounder, Titanium 2LS, Traverse 2 SRP.
- Bentgrass putting green-2014: Kingdom, Nightlife, PST-ROPS, Armor, Pure Select, 777, Piranha, V-8.
- Bentgrass fairway/tee-2014: None recommended.
- Cool-season low input-2015: Tall fescue entries maintained green color longer than many other grasses without any supplemental irrigation. Western yarrow (Yaak) provided green color longer than any other entries.

*\* those listed are varieties near the top of the average ratings but do not include all varieties that performed within the same statistical group.*

# IMPROVEMENT OF BLUEGRASS AND OTHER NATIVE AND ADAPTED SPECIES

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Joe Robins** – Research Geneticist, USDA

**Dr. Shaun Bushman** – Research Geneticist, USDA

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Paul Harris** – Research Technician, CWEL

### LOCATION:

**USDA Forage & Range Research Laboratory**, Logan Utah

## PROJECT SUMMARY

CWEL cooperates extensively with scientists at the USDA Forage & Range Research Laboratory (FRRL) located on the Utah State University campus. Their lab has a long history of collecting, studying and developing rangeland grasses for the cool-arid West. In the 2000's, cooperation between USU and the FRRL started in earnest with wheatgrasses adapted to low maintenance turf conditions—improving quality characteristics of well adapted grass species. That work has continued along with research and development of *Poa*, or bluegrasses. This latter project takes the opposite approach of improving stress tolerant characteristics of a grass that has excellent turfgrass use adaptation.

## PROJECT OBJECTIVES

The main objectives of both approaches are to identify and develop plant materials with good turfgrass quality and salt and drought tolerance. At the same time, we are gaining a better understanding of these genetically complex species to improve breeding progress.



Work led by Dr. Joe Robins, Research Geneticist, is developing thickspike and crested wheatgrasses with a higher density of rhizomes and acceptable turfgrass quality. He is also identifying perennial ryegrass accessions with greater drought tolerance.

Dr. Shaun Bushman, Research Geneticist, is leading work focusing on Kentucky bluegrass with several objectives: (1) identifying salt tolerant Kentucky bluegrass germplasm; (2) finding gene markers associated with salt tolerance; (3) finding drought tolerant Kentucky bluegrass germplasm that maintains more green color with less irrigation; (4) characterizing genomes within Kentucky bluegrass to improve plant selection; and (5) sequencing genomes of Kentucky bluegrass and hard fescue.

## PROJECT STATUS

Bluegrass lines with improved salt and drought tolerance are being evaluated for seed yield characteristics by growers in Washington.

# TURFGRASS WATER CONSERVATION ALLIANCE (TWCA) TRIALS

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Paul Harris** – Research Technician, CWEL

### LOCATION

**Greenville Research Farm**, Logan Utah

## PROJECT BACKGROUND

The Turfgrass Water Conservation Alliance (TWCA) was founded in 2009 by three grass seed production and marketing companies to provide a framework for evaluating low water use turfgrass species and varieties.

Partially inspired by the EPA's WaterSense Program, TWCA has established protocols for acute and chronic drought stresses on individual varieties using digital image analysis (DIA) to measure the exact amount of living plant material during various stages of water deprivation.

In the case of acute drought testing, irrigation is stopped, and plots are allowed to decline until all varieties exhibit less than 25% green cover. At that point, recovery is initiated with the application of 2 inches of water. Imagery and irrigation continue until the plots reach 100% green cover.

This project evaluated 27 Kentucky bluegrass varieties and 30 tall fescue varieties as detailed below.



## PROJECT OBJECTIVES

- Evaluate ET based drought tolerance of experimental and control varieties of Kentucky bluegrass and tall fescue under acute drought stress.
- Develop dry down curves for the tested varieties based on cumulative ET loss.
- Develop green up curves for the tested varieties based on the number of days to recovery after irrigation is applied.

## >>> TWCA TALL FESCUE TRIAL

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This portion of the projects is evaluating 30 varieties of tall fescue including 7 named varieties and 23 experimental varieties.

### PROJECT STATUS

**Project Period:** 2017-2018

This project is ongoing and will be completed in 2018. Of the named varieties tested thus far, the rankings for maintaining an acceptable level of quality without irrigation for the longest period of time were:

- (1) Aquavita (2) Falcon IV (3) SixPoint
- (4) 5Dart (5) 2nd Millenium (6) Shenandoah Elite

## >>> TWCA KENTUCKY BLUEGRASS TRIAL

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This portion of the project evaluated 27 Kentucky bluegrass varieties including 5 named varieties and 22 experimental varieties.

### PROJECT STATUS

**Project Period:** 2015-2017

This project was completed in October 2017. Of the named varieties tested, the rankings for maintaining an acceptable level of quality without irrigation for the longest period of time were:

- (1) Bedazzled (2) Mallard (3) Diva (4) Midnight (5) Geronimo

### SELECTED PRESENTATIONS

**Kopp, K.** (2018, January 29). New turf varieties for low water. Presented at the Utah Nursery and Landscape Association Annual Conference, Salt Lake City, UT.



# A-LIST KENTUCKY BLUEGRASS TRIAL

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Plants, Soils & Climate

**Paul Harris** – Research Technician, CWEL

LOCATION: **Greenville Research Farm**, Logan Utah

## PROJECT BACKGROUND

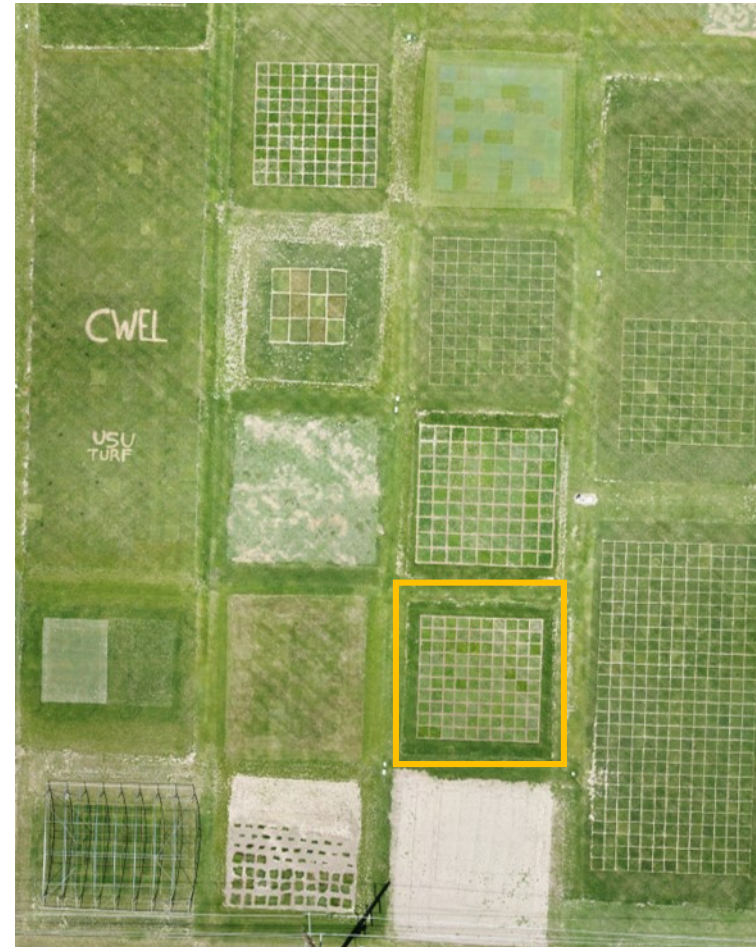
The Alliance for Low Input Sustainable Turf (A-LIST) is a national non-profit organization that seeks to aid turfgrass managers and grass growers by providing holistic guidelines that account for all factors in sustainable plant growth.

A-LIST members are comprised of universities and industry companies that test, identify, and promote grass varieties that combine high turf quality and low-input performance; such as reduced water, chemical, and fertilizer. Information is developed on certified, high quality turf that is verified via transparent protocols and independently tested at leading regional universities, including USU.

This project is evaluating 23 varieties of Kentucky bluegrass including 11 named varieties and 12 experimental varieties.

## PROJECT OBJECTIVES

- Evaluate ET based drought tolerance of experimental and control varieties of Kentucky bluegrass under acute drought stress.
- Develop recovery curves for the tested varieties based on the number of days to recovery after irrigation is applied.



## PROJECT STATUS

This project was established in 2017 and data collection has begun in 2018.

## SELECTED PRESENTATIONS

**Kopp, K.** (2018, January 29). New turf varieties for low water. Presented at the Utah Nursery and Landscape Association Annual Conference, Salt Lake City, UT.

# JACKLIN® SEED KENTUCKY BLUEGRASS TRIAL

## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Paul Harris** – Research Technician, CWEL

LOCATION: **Greenville Research Farm**, Logan Utah

## PROJECT BACKGROUND

The J.R. Simplot Company is a vertically integrated seed production, farming, fertilizer manufacturing, frozen-food processing, and food brands and distribution company. Jacklin® Seed is a leader in turfgrass research, breeding, and production. The company offers a full product line of turfgrass varieties including Kentucky bluegrass, perennial ryegrass, creeping bentgrass, tall and fine fescues, and other specialty grasses.

This project is evaluating 25 experimental varieties of Kentucky bluegrass.

## PROJECT OBJECTIVES

- Evaluate ET based drought tolerance of experimental and control varieties of Kentucky bluegrass under acute drought stress.
- Develop dry down curves for the tested varieties based on cumulative ET loss.
- Develop green up curves for the tested varieties based on the number of days to recovery after irrigation is applied.

## PROJECT STATUS

This project was established in 2017, and data collection has begun in 2018.



## SELECTED PRESENTATIONS

**Kopp, K.** (2018, January 29). New turf varieties for low water. Presented at the Utah Nursery and Landscape Association Annual Conference, Salt Lake City, UT.

# EVALUATION OF ECOSYSTEM SERVICES IN GOLF COURSE OUT-OF-PLAY AREAS NEWLY TRANSITIONED TO NATIVE AND ADAPTED SPECIES

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Paige Boyle** – PhD student

LOCATION: **Salt Lake City municipal golf courses**, Salt Lake City, Utah

## PROJECT OBJECTIVES

To 1) determine native and adapted turfgrass and forb species mixes suitable for out-of-play golf course systems in the Intermountain West and 2) to assess the ecosystem services provided by golf course out-of-play turf systems before and after transitioning to native/adapted species.

## PROJECT STATUS

Native and adapted turfgrass and forb species to be studied will be determined in spring/summer 2018. Research plots will be established at the Utah State University (Greenville Research Farm, North Logan, UT) for preliminary screening for mix compatibility and suitability for the region. Golf courses (3-5) of interest in the Intermountain West will be selected and contacted in summer 2018. Baseline measurements of ecosystem services will be conducted in the first year of the study, before and during transition to native/adapted species. Subsequent measurements of ecosystem services will be conducted after establishment of new species is complete.



# APPLIED DROUGHT RESEARCH ON SALT LAKE CITY MUNICIPAL GOLF COURSES

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Dr. Shaun Bushman** – Research Geneticist, United States Department of Agriculture-Forage and Range Research Laboratory

### LOCATION:

**Salt Lake City municipal golf courses**, Salt Lake City, Utah

## PROJECT BACKGROUND

As part of the Drought Plan Update process, Salt Lake City Department of Public Utilities Water Conservation Program initiated a collaborative effort with Salt Lake City Golf Division. The purpose was to discuss issues pertaining to potential water shortages and to devise strategies to minimize or mitigate negative impacts as a result of drought-driven changes in water supply. Working with the Water Conservation Manager, SLC Golf developed, course-specific drought plans. These plans articulate impacts on playability and site conditions in the event of hypothetical water use reductions.

Working with USU and United States Department of Agriculture-Forage and Range Research Laboratory personnel, it was determined that field-based research would provide the Golf Division with the information necessary to select and implement programs that will optimize the desired outcomes of reduced water use and improved site efficiency while maintaining course playability.



## PROJECT OBJECTIVES

- Evaluate drought-tolerant turfgrass species and varieties in rough and out-of-bounds areas.
- Reduce irrigation on fairways and roughs where grass must still be mowed.
- Establish demonstration areas of lower water use turfgrass varieties in highly visible areas of the courses.
- As drought watering restrictions are implemented, determine the effectiveness of soil surfactant/wetting agent products for maintaining soil moisture and turfgrass health through the growing season, and.
- Monitor the effectiveness of the Maximum H2O system for maintaining turfgrass health and playability through the growing season.

## PROJECT STATUS

This project is beginning in 2018 and will continue through 2019.



# DOCUMENTING WATER USE FOR TURFGRASSES IN THE UNITED STATES

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Paul Harris** – Research Technician, CWEL

LOCATION: **Greenville Research Farm**, Logan Utah

## PROJECT BACKGROUND

Turfgrass surface area in the U.S. has been estimated to be three times greater than any other irrigated crop, potentially requiring nearly 1000 L water daily and models of irrigation requirements have been used to estimate the potential use of water by turfgrasses in discrete situations. The actual amount of water use by turf areas is unknown and complex to understand. Locally available sources of sod were evaluated in six locations (Utah, California, Texas, Tennessee, Minnesota, and Connecticut) across the U.S., representing a diversity of climates and species, as well as high and low level fertility management. Evapotranspiration (ET) rates were estimated at each location and compared against the actual amount of water used.

At USU, Kentucky bluegrass, tall fescue and fine fescue sod was established and evaluated during 2016 and 2017 and was maintained with either high or low levels of fertility. Once sod was established, irrigation was withheld until green coverage was less than 50%. Once plots reached green coverage of less than 50%, irrigation for recovery was applied until plots exceeded 50% green cover. The process continued through the 2016 and 2017 growing seasons.



## PROJECT OBJECTIVES

To document the amount of water required to maintain 50% green cover of turfgrasses commonly used as lawn grasses in key climates across the U.S. under high and low levels of fertility.

## PROJECT STATUS

- Irrigation requirements often differed among grasses at each location, though relative requirements depended on the climate as well as species.
- In Utah, the amount of irrigation required to maintain 50% green cover for the species evaluated was least for tall fescue, regardless of fertility treatment, and most for fine fescue sod receiving low fertility management.
- Kentucky bluegrass results were mixed across years, although Kentucky bluegrass receiving lower fertility treatments required more irrigation than that receiving higher fertility treatments.

# LOW-INPUT TURFGRASS TRANSITION-FINE FESCUE

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department Head and Professor, Department of Plants, Soils & Climate

**Dr. Shaun Bushman** – Research Geneticist, United States Department of Agriculture-Forage and Range Research Laboratory

LOCATION: **Utah State University Campus**, Logan Utah

## PROJECT BACKGROUND

This outreach project is being performed cooperatively by CWEL in conjunction with a national research project to develop fine leaf fescue turfgrass for use as a low maintenance turfgrass alternative. The project seeks to follow several campus locations across the country as the landscapes transition from traditional turfgrass to low-input fine fescue turfgrass.

## PROJECT OBJECTIVES

- To understand how different campus members evaluate the opportunities and barriers for low-input turfgrass in their efforts for more sustainable land management.
- To evaluate the use of low-input turfgrass for meeting environmental, economic, and social objectives.

## PROJECT STATUS

- The USU-CWEL transition/demonstration area (adjacent to the Agricultural Sciences building) was planted with improved fine fescue varieties in the fall of 2017.



- The project will continue for two more years with signage in place for passersby to learn more about the project and provide input and feedback.

# SELECTION AND PROPAGATION OF NATIVE PLANTS FOR LOW-WATER LANDSCAPING

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Larry Rupp**

### CO-INVESTIGATORS/COOPERATORS

**Dr. Youping Sun** –Plants, Soils & Climate

**Richard Anderson** –USU Botanical Center

**Jerry Goodspeed** – USU Botanical Center

**JayDee Gunnell** – Cache County Extension

**Dr. Brent Black** – Plants, Soils & Climate

**Tiffany Maughan** – Plants, Soils & Climate

**Dr. Stephen Love** – University of Idaho

**Jim Klett** – Colorado State University

**William Varga** – Perennial Favorites Nursery

**Johnnie Bobb** – Shoshone Nation

**Lance Brown** – USDA–FS Toiyabe National Forest

### LOCATION:

**Utah Agricultural Experiment Station Research Greenhouse and Greenville Farm, Logan, Utah**

**Utah State University Botanical Center, Kaysville UT**

## PROJECT OBJECTIVE

To select superior woody plants with characteristics amenable to attractive, functional, low-water landscaping; determine appropriate means of propagation and production; evaluate landscape performance; and introduce into the landscape industry.

## PROJECT SUMMARY

The nature of woody, native plants is such that any project must be considered on a scale of years. Currently, this project has selected a number of native



plants that have been evaluated in depth. Several of these have developed to the point of being considered for release, including bigtooth maple ('Alice' and five other selections), littleleaf mountain mahogany ('Hoodoo' and 'DoubleDown' selections), creeping Oregon grape ('Semi-Gloss', 'Matte', and 'Angel' selections), and mountain lover ('Teton' and 'City Creek' selections). Additional research is currently being done with a number of plants, however selections for further development have not been made. These plants include prostrate ceanothus, snowbrush ceanothus, huckleberry oak, pinyon pine, curlleaf mountain mahogany, white rabbitbrush, Gambel oak, ninebark, serviceberry, sagebrush, greenleaf manzanita, and Rocky Mountain maple.

## PROJECT STATUS

In addition to selection of elite accessions, this research is also exploring propagation of various species, production in nurseries, and performance in the landscape. Recent research has illustrated the importance of establishing stock plants in a controlled environment improves propagation success. For example, 'Hoodoo' littleleaf mountain mahogany from the field has less than 5% success as a rooted cutting, while greenhouse-grown plants approach 70% success. Current research is examining the impact of exotic sugar maple rootstocks on iron chlorosis in bigtooth maple and the effect of irrigation and native soil inoculum on longevity of a buffaloberry hybrid in the landscape.

## SELECTED PRESENTATIONS

**Rupp, L.A.** (2017, various dates). Plant propagation. Presented at Master Gardener courses in Iron, Kane, Washington, Summit, and Wasatch counties, UT.

**Rupp, L.A.** (2018, Feb. 26-28). The Qualified Water Efficient Landscaper program. Extension Annual Conference. Logan, UT.

**Rupp, L.A.** (2017, May 9). Extension landscape horticulture programming. Presented at the USU Southern Region Extension Meeting. Nephi, UT.

**Rupp, L.A.** (2017, May 24). Introduction of 'DoubleDown' littleleaf mountain mahogany as a potential bonsai plant. Presented at the Salt Lake City Bonsai Club, Salt Lake City, UT.

**Rupp, L.A.** (2017, July 19). Woody plant propagation. Idaho Ext. In-Service Training. Salmon, ID.

**Rupp, L.A. and R. Anderson.** (2017, Sept. 19). Developing native plants as alternative landscape plants for low-water landscaping. Am. Soc. Hort. Sci. Annual Conf. Waikaloa, HI.

**Rupp, L.A.** (2017, Jan. 29-Feb. 2). Native woody plant cultivars and sustainable urban landscaping. Soc. Range Mgt. Annual Conf. St. George, UT.

## RELATED PUBLICATIONS

**Maughan, T., B. Black, L.A. Rupp, and T. Yost.** (2018). Propagation techniques for *Sambucus cerulea* (Blue Elderberry). Native Plants Journal (accepted).

**Muntz, H., L. Rupp.** (2018). Landscaping in dry shade - 15 great landscape plants for dry shady areas.

[https://digitalcommons.usu.edu/extension\\_curall/1844](https://digitalcommons.usu.edu/extension_curall/1844)

**Rupp, L.A., R.M. Anderson, J. Klett, S.L. Love, J. Goodspeed, and J. Gunnell.** Developing native and adapted plants for low-water landscaping. HortTechnology (accepted).

# SELECTING AND GRAFTING SINGLE-LEAF PINYON PINE (*PINUS MONOPHYLLA*)

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Larry Rupp**

### CO-INVESTIGATORS/COOPERATORS

**Kylie Lawson** – Graduate Research Assistant, Department of Plants, Soils & Climate

**Teryl Roper** – Plants, Soils & Climate

**Mike Kuhns** – Department of Wildlife Resources

### LOCATIONS:

**Utah Agricultural Experiment Station Research Greenhouse and Greenville Farm, Logan, Utah**

**Austin, NV; Hamlin Valley, UT; Eureka, UT; Raft River Mountains, UT**

## PROJECT OBJECTIVE

Single-leaf Pinyon Pine (*Pinus monophylla*) is a xeric tree native to the Great Basin. This species produces large, soft-shelled pine nuts that are in great demand. Current production relies on harvesting nuts from wild trees. The selection and propagation of superior nut producing trees should increase production in both orchards and marginal wildlands. The goal of this research is to identify wild, high-yield trees and then determine the most effective method of clonal propagation.

## PROJECT SUMMARY

During April and August 2017, scions of *P. monophylla* were grafted onto mature, wild grown *P. edulis* rootstock in Kaysville, UT to determine if grafting could be used to convert low producing trees on marginal lands to superior accessions. These trials compared scion type and graft type, tying methods, and aftercare. Scions were either terminal buds with current season's



needles, or just buds. The buds only treatment involved removing all the needles from the bud wood and dipping the bud in wax (April) or grafting seal (August) to prevent desiccation. Graft types included terminal bark grafts, side-wedge grafts and wedge grafts. Aftercare included tying with grafting rubbers, wrapping with Parafilm, and sealing with grafting seal. Grafts with needles were sealed in clear plastic and then covered with opaque white plastic to reduce heat. For each rootstock tree, three scion sources were randomly selected, and applied using the four graft types. Preliminary results indicated that April grafts were more successful (27.5% survival) than August grafts (5%). In addition, grafts with needles were more successful (16%) than buds only (5%) or wedge grafts (6%).



In a separate experiment to establish a stock orchard, superior producing trees were selected from productive stands near Austin, NV; Hamlin Valley, UT; Eureka, UT; and the Raft River Mountains, UT. Six superior trees were selected from each stand based on a visual assessment of cones. Six shoots per tree were collected for counting cone abscission scars, indicators of cone production, and collecting bud wood for grafting. The three most productive trees in each stand were selected as scions. Scions with both buds and needles were grafted to *P. edulis* seedling rootstocks using either side-wedge or side-veneer grafts. The grafts were placed under 1 mm plastic and Remay in a cold frame for 6 weeks, then Remay only for one week before uncovering. Currently, 90% of the grafts are healthy and growing, with side-wedge grafts being more advanced than the side veneer grafts.

A third grafting experiment was completed in April 2018 at the Blue Creek Experiment Farm. This trial compared side-wedge and side-veneer grafts, and the effect of leaving or removing the tree apex.

## PRESENTATIONS

**Lawson, K.** (2018, Mar. 19). Selecting and grafting single-leaf Pinyon pine (*Pinus monophylla*) for pine nut production. Presented at the Research Showcase for the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

# RESPONSES OF ORNAMENTAL GRASS AND GRASS-LIKE PLANTS TO SALINE WATER IRRIGATION

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Youping Sun** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Alyssa Palmer** – Undergraduate Researcher

LOCATION: **Research Greenhouse**, Utah State University, Logan, UT

## PROJECT OBJECTIVE

To evaluate the responses of ornamental grasses to saline water irrigation and select the salt tolerant ornamental grasses for landscape use.

## PROJECT SUMMARY

Ornamental grasses are popular in Utah's urban landscapes and the Intermountain West. An estimated \$158 million worth of ornamental grasses are sold annually in U.S. Alternative water sources are becoming important resources for landscape irrigation. These water sources are known to carry relatively high levels of salts, which negatively affect plant growth and development. Therefore, understanding the salinity tolerance of different ornamental grasses can be beneficial for preventing salt damage to ornamental plants while maintaining appealing landscapes. The purpose of this experiment was to evaluate the responses of five ornamental grass species and two ornamental grass-like species to saline irrigation water in a research greenhouse.

## PROJECT STATUS

This experiment is completed, and the manuscript is under preparation for HortTechnology.



## PRESENTATIONS

**Palmer, A.** (2018, Mar. 19). Salinity tolerance of seven ornamental grasses and grass-like species. Presented at the Research Showcase for the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

**Palmer, A.** (2018, Mar. 1) Salinity tolerance of seven ornamental grasses and grass-like species. Presented at the Intermountain Sustainability Summit, Weber State University, Ogden, UT.

# RELATIVE SALT TOLERANCE OF *SPIRAEA JAPONICA* CULTIVARS

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## PROJECT INFO

PRINCIPAL INVESTIGATOR

**Dr. Youping Sun** – Department of Plants, Soils & Climate

LOCATION: **Research Greenhouse, Utah State University, Logan, UT**

## PROJECT OBJECTIVE

To evaluate the responses of *Spiraea japonica* cultivars to saline irrigation water and select the salt tolerant *Spiraea* for landscape use.

## PROJECT SUMMARY

*Spiraea* is a genus in *Rosaceae* with about 80-100 species of shrubs. They are native to the temperate northern hemisphere with great diversity in eastern Asia. Many species in *Spiraea* are widely used as ornamental plants in temperate climates, particularly for their showy clusters of dense flowers. In the United States, an estimated \$29 million *Spiraea* are sold annually for garden and landscape uses, making them the fourth best-selling deciduous shrubs (U.S. Department of Agriculture, 2018). There are numerous named hybrids and cultivars that are selected from natural populations and bred in gardens. For example, *Spiraea japonica* and *Spiraea × nipponica* are commonly used in Utah landscapes and the Intermountain West. The fact that many *Spiraea* species and cultivars with diversified salt tolerance are planted in gardens and landscapes warrants further research. This project will investigate the relative salinity tolerance of different *Spiraea japonica* cultivars.

## PROJECT STATUS

*Spiraea japonica* plants donated from Spring Meadow Nursery are under evaluation in a research greenhouse.





# HOW DO LANDSCAPE PLANTS RESPOND TO GOVERNOR'S WATER CONSERVATION GOAL OF 25% REDUCTION BY 2025?

## PROJECT INFO

### PRINCIPAL INVESTIGATORS

**Dr. Youping Sun** – Department of Plants, Soils & Climate

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

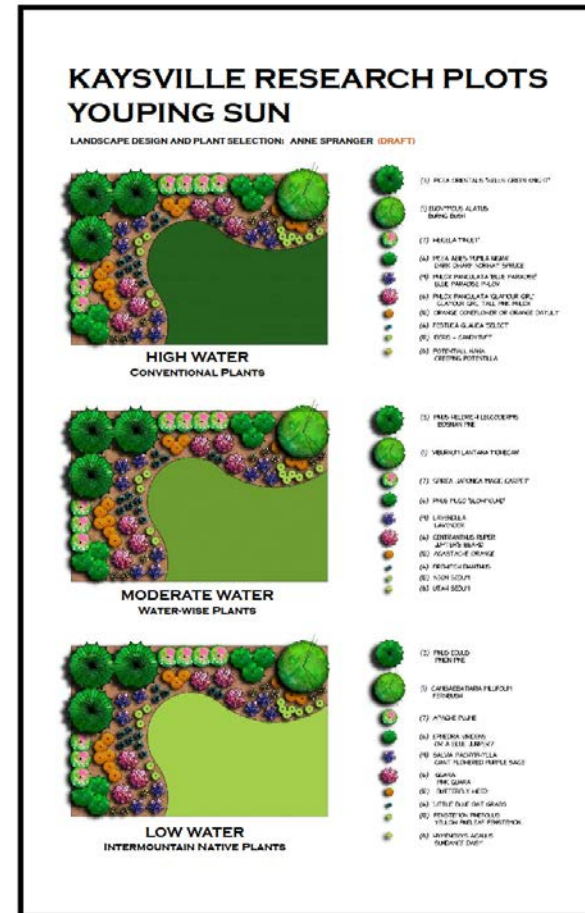
LOCATION: **Kaysville Research Farm, Utah State University, Kaysville, UT**

## PROJECT OBJECTIVE

To characterize the water use of different plant types (woody, herbaceous perennial, and turf) and water use categorizations (mesic, mixed and xeric) in designed landscapes under water-limited conditions to define the minimum water needs for water-efficient landscapes.

## PROJECT SUMMARY

Climate and human driven changes in water quantity and quality could result in more agricultural and urban landscape irrigation restrictions, a segment of water use that utilizes 82% of freshwater resources in Utah. Water conservation is becoming critically important in Utah and the Intermountain West, one of the driest and fastest growing regions in the United States. Governor Gary Herbert has set a statewide goal to use 25% less water per person by 2025 from 2000 levels. Although Utahns are willing to significantly reduce water use, they do not want limited water supplies to diminish their ability to maintain aesthetically appealing landscapes. There is an urgent need for empirical data to distinguish water use of different plant types and water use categorizations under water-limiting conditions. This research will be conducted in designed landscapes comprised of three presumptive water use characterizations— mesic, mixed and xeric—and plant materials of three different types—woody, herbaceous perennial, and turf. The water use of different plant types and water use categorizations at the first two years of establishment will be characterized under well-watered conditions.



Subsequently, their water use will be measured under increasingly water-limited conditions to define the minimum water needs for water-efficient landscape.

## STATUS

This project is in the preparation phase. Current tasks include developing plant lists and preparing the site for planting.

# MICROPROPAGATION OF UTAH NATIVE PLANTS

## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Youping Sun** – Department of Plants, Soils & Climate  
**Dr. Larry Rupp** – Department of Plants, Soils & Climate  
**Dr. John Carman** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Nathan Snow** – Undergraduate Researcher

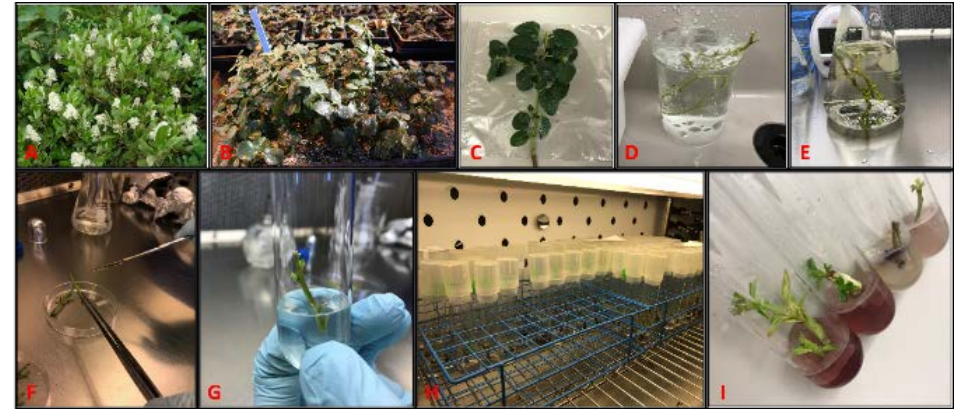
LOCATION: **AGRS Building, Utah State University**, Logan, UT

## PROJECT OBJECTIVE

To develop efficient mass propagation protocols for Utah native plants.

## PROJECT SUMMARY

Native plants are of keen interest to green industry. They are adapted to harsh conditions of arid and semiarid environments and are resistant to insects and fungi prevalent in their home regions. For these reasons, native plants are excellent candidates for water efficient landscaping. Promoting the use of native plants for low water use landscapes is vital for water conservation and environmental stewardship. Unfortunately, information on how to propagate enough plants for field evaluation and nursery production is still limited. Micropropagation is the growth of plant organs or tissues in sterile growth medium where the environment as well as nutrient and hormone levels are tightly controlled. Micropropagation, is useful for propagating plants that are difficult or slow to propagate with other approaches. Micropropagation consists of four stages; stage I: establishment of aseptic culture, stage II: shoot multiplication, stage III: root formation, and stage IV: acclimatization. This project is to develop micropropagation protocols for selected Utah native plant species.



## STATUS

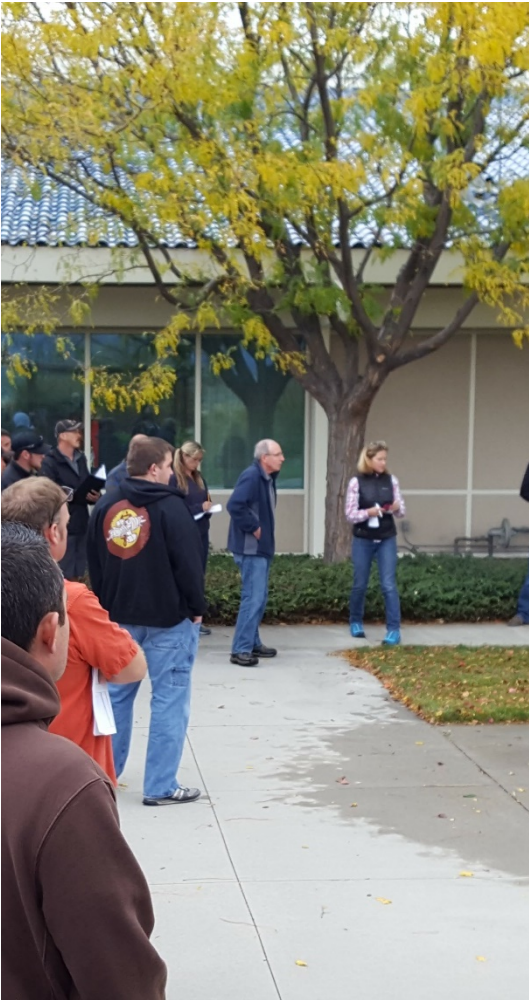
Nine Utah native plant species/cultivars were tested in stage I to establish aseptic culture with nodal segments as explants. *Ceanothus velutinus* (Snowbrush Ceanothus), *Arctostaphylos patula* (Greenleaf Manzanita), and *Shepherdia × utahensis* 'Torrey Compact' (Silver Buffaloberry) were established with less contaminations. *Ceanothus velutinus* is still under culture with different plant growth hormones to promote shoot proliferation. More tissue cultures will be initiated to establish efficient mass propagation protocols for Utah native plants with significance for the green industry.

## PRESENTATIONS

**Snow, N.** (2018, Mar. 1). Micropropagation of *Ceanothus velutinus*: stage I. Presented at Showcase at the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

**Snow, N.** (2018, Apr. 12). Micropropagation of *Ceanothus velutinus*: stage I." Presented at USU's 2018 Student Research Symposium, Utah State University, Logan, UT.

# WHAT WE DO



## OUTREACH & EDUCATION

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Out-reach and education programs from CWEL are geared to provide expertise and information to state-wide Extension offices, the green industry, water purveyors/institutions, and the general public.



# TURF FIELD DAY

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## PROJECT INFO

### PRESENTERS

- Dr. Paul Johnson** – Plants, Soils & Climate
- Dr. Kelly Kopp** – Department of Plants, Soils & Climate
- Dr. Larry Rupp** – Plants, Soils & Climate
- Paul Harris** – Research Technician, CWEL
- Dr. Shaun Bushman** – Forage & Range Research Lab, USU
- Dr. Joe Robins** – Research Geneticist, USDA
- Dr. Ricardo Ramirez** – Biology Department

### COLLABORATORS

- Dr. Youping Sun** – Plants, Soils & Climate
- Adrea Wheaton** – Program Coordinator, CWEL
- Diana Wuenschell** – Research Associate, CWEL

LOCATION: **Greenville Research Farm**, Logan Utah

## PROJECT OBJECTIVE

The CWEL group hosted 2018 Field Day at the Greenville Farm on June 21<sup>st</sup>, 2018. This field day focused on turfgrass related research and outreach activities including variety trials, irrigation controller evaluations, turf water-use research, studies on insect biology and control, on-going breeding work with bluegrasses and wheatgrasses, and more. Presenters include our CWEL group plus collaborators at the USDA Forage & Range Research Laboratory and the Department of Biology.

## IMPACT

Over 50 attendees from the turfgrass and landscape industries attended our field day. Our field day is one of the best attended research field day events hosted at USU.



# TURF GRASS INTEGRATED PEST MANAGEMENT ADVISORY

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## PROJECT INFO

### PRINCIPAL INVESTIGATORS

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate/CWEL

### CO-INVESTIGATORS/COOPERATORS

**Dr. Paul Johnson** – Department of Plants, Soils & Climate/CWEL

**Ryan Davis** – USU Arthropod Diagnostician and School IPM Associate

**Dr. Ricardo Ramirez** – Extension Entomology Specialist

**Dr. Claudia Nieschwitz** – Associate Professor and USU Extension Plant Pathology Specialist

**Dr. Diane Alston** – Professor and USU Extension Entomology Specialist

**Marion Murray** – IPM Project Leader

## PROJECT BACKGROUND

In 2008, the first Turfgrass IPM Advisory was published and distributed to a listserv of 210 members. The advisory is published quarterly (corresponding to season) and serves two purposes. Subscribers receive alerts on turfgrass insect and disease pests that are active in the state and where they are located. Subscribers also receive information on general turfgrass management practices and their timing. New USU Extension fact sheets are also highlighted. As of May 2018, the listserv has grown to 7091 subscribers.

## PROJECT OBJECTIVES

- Alert turfgrass managers in the state regarding active turfgrass insect pests and diseases.
- Provide science-based recommendations for managing turfgrass insect pests and diseases in the state.
- Provide recommendations on routine turfgrass management practices and their timing.



## PROJECT STATUS

**Project Period:** 2008-present

The USU Extension Turfgrass IPM Advisory has been extremely well-received as evidenced by the continued growth of listserv subscriptions. Subscribers have responded with appreciation and additional questions, allowing ongoing communications and education on the topics that are addressed. The cooperative nature of the effort has also facilitated communication and collaboration among USU Extension faculty both on campus and off campus.



## Turfgrass IPM Advisory

Quarterly Turfgrass Pest Update, USU Turfgrass Extension Vol. 11(1), Spring 2018

### Turfgrass Integrated Pest Management

An integrative approach to the management of turfgrass insect pests, diseases and weeds is most effective. Prevention is the best strategy!

#### What to Watch For

As temperatures warm, residual damage from snow mold disease may become apparent. Insect pests are also increasing their activity.

### Pest Alert: Armyworms

Armyworms have recently been identified in Cache, Salt Lake, and Utah Counties.

Armyworms are immature moths that feed on turfgrass leaves and stems. These caterpillars often feed and migrate in large groups, skeletonizing turfgrass leaves or chewing off young leaves just above the ground, causing widespread damage of irregular brown patches.

#### Armyworm Description and Life Cycle

In Utah, the most common species of armyworm damaging turfgrasses is the true armyworm, *Psuedaleia unipuncta*. The larvae of the true armyworm are yellow or grey with black stripes and sometimes the body can have a pink tint (Fig. 1). Adults are reddish-brown in color and have a wingspan of 38 mm (Fig. 2). Each wing has a distinct white dot in the center. True armyworms can have more than five generations per year, but the climate in northern Utah likely restricts this insect to two to three generations per year. Mated females can lay thousands of eggs, where sticky egg masses are laid on various parts of turfgrass blades. Eggs hatch into larvae that feed for 3 - 4 weeks until



Figure 1. True armyworm larva (Photo credit: Frank Peairs, Colorado State University, [bugwood.org](http://bugwood.org)).

they reach about 35 mm in length. Larvae will pupate within the soil and emerge as adults in 2 - 3 weeks. The entire life cycle takes about 60 days.

#### Scouting and Thresholds

Scouting for the presence of armyworm larvae is recommended if you notice nocturnal moths flying over turfgrass or you suspect general thinning of

### RECENT TURFGRASS IPM ADVISORIES

Kopp, K. (Ed.). (2018, Spring). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 11 \(1\)](#).

Kopp, K. (Ed.). (2018, Winter). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(4\)](#).

Kopp, K. (Ed.). (2017, Fall). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(3\)](#).

Kopp, K. (Ed.). (2017, Summer). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(2\)](#).

# WATER CHECK PROGRAM

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## PROJECT INFO

### PRINCIPAL INVESTIGATOR

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

### CO-INVESTIGATORS/COOPERATORS

**Dr. Joanna Endter-Wada** – Professor, Environment and Society

**Diana Wuenschell** – Research Associate, CWEL

**Candace Schaible** – Extension Assistant Professor, Iron County

**Helen Muntz** – Extension Assistant Professor, Morgan and Weber Counties

**Jaydee Gunnell** – Extension Associate Professor, Cache County

## PROJECT BACKGROUND

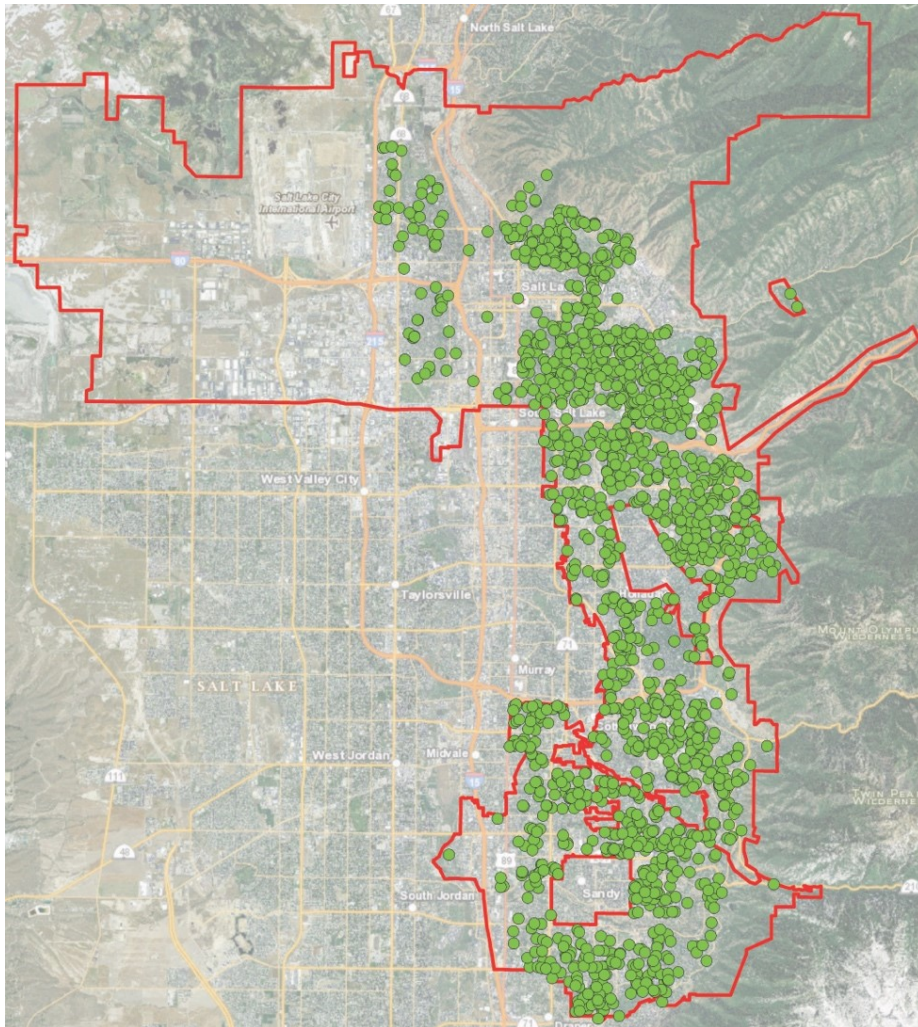
The Water Check Program began in 1999 as a cooperative effort between USU Extension and water providers in the Salt Lake Valley. Over the many years since, the program has been adopted by other USU County Extension offices, water conservancy districts, providers and utilities.

The Program sends pairs of trained employees to properties to evaluate the irrigation system and landscape, identifying flaws that contribute to decreased irrigation efficiency. The program is offered free of charge to participants who request the service. They receive a customized irrigation schedule based on catch cup results and a list of conservation recommendations based on an evaluation of the landscape. Participants are also able to ask questions and receive additional information on relevant topics of their choice.

## PROJECT OBJECTIVES

- Provide educational support and practical guidance to homeowners and landscape managers on ornamental landscape irrigation.
- Provide a positive means of interaction between water providers and homeowners and landscape managers.
- Decrease landscape irrigation water use.





## SELECTED PRESENTATIONS

**Kopp, K.** (2018, January 22). Metropolitan Water District of Salt Lake and Sandy Water Check program update. Presented to Metropolitan Water District of Salt Lake and Sandy Board of Directors, Salt Lake City, UT.

**Kopp, K.** (2017, Nov. 8). Irrigation system maintenance: enhancing homeowner skills. Presented at the Annual Conference of the American Water Resources Association, Portland, OR.

## PROJECT STATUS

PROJECT PERIOD: 1999-present

To date, over 14,000 residential and 500 commercial and institutional properties have received Water Checks. Program evaluation is performed on an ongoing basis, with more detailed analyses performed for Salt Lake City due to the city's provision of water billing data. Key findings for Salt Lake City include:

- 2013 Water Check participants reduced water use by 7900 gallons per month (47,000 gallons over season).
- 2015 Water Check participants reduced water use by 3000 gallons per month (18,000 gallons over season).



# QUALIFIED WATER EFFICIENT LANDSCAPER PROGRAM

## PROJECT INFO

### COLLABORATORS

**Dr. Kelly Kopp** – Department of Plants, Soils & Climate

**Dr. Larry Rupp** – Department of Plants, Soils & Climate

**Candace Schaible** – Extension Assistant Professor, Iron County

## PROJECT OBJECTIVES

- Provide an affordable, proactive, local approach to reducing landscape water demand.
- Provide landscape professionals with knowledge in water efficient and sustainable landscape practices, including water management and preservation of other valuable resources.

## PROJECT BACKGROUND

The Qualified Water Efficient Landscaper program was launched by the Sonoma County, CA Water Agency in 2007, with the goal of reducing landscape water demand through a professional landscaper certification program. The program has since been adopted by over 20 Professional Certifying Organizations (PCOs) throughout the US and is recognized as an Environmental Protection Agency (EPA) WaterSense labeled professional certification program for irrigation system audits. In 2009, Utah State University became a QWEL adopting organization as well as an EPA WaterSense partner and WaterSense PCO. In order to reach a broader audience, USU partnered with Jordan Valley & Washington County Water Conservancy Districts to launch the statewide program in 2012. With the support of USU, water districts throughout the state host the training program and rely on USU faculty and local experts to teach the material.



## SELECTED PRESENTATIONS

**Pollard C., J. Vierola, C. Schaible.** (2017, Oct. 5). QWEL: Tales from two adopting organizations. Presented in partnership with Sonoma County Water Agency & San Diego County Water Authority at the Water Smart Innovations Conference in Las Vegas, NV.

**Rupp, L.A.** (2018, Feb. 26-28). The Qualified Water Efficient Landscaper program. Extension Annual Conference. Logan, UT.

## PROJECT STATUS

PROJECT PERIOD: 2012-present

To date, over 300 landscape professionals have been certified through the QWEL training program. Three trainings were offered in 2017.

## 'WATER WELL WITH CWEL' WEBINAR SERIES

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### PROJECT INFO

#### ORGANIZERS

**Candace Schaible** – Extension Assistant Professor, Iron County  
**Adrea Wheaton** – Program Coordinator, CWEL

#### COLLABORATORS

**Dr. Joanna Endter-Wada** – Professor, Natural Resource Policy and Social Science  
**Dr. Kelly Kopp** – Professor, Water Conservation and Turfgrass Science Specialist  
**Dr. Larry Rupp** – Professor, Landscape Horticulture Specialist  
**Dr. Paul Johnson** – Professor, Turfgrass Science  
**Dr. Youping Sun** – Assistant Professor, Landscape Horticulture  
**Diana T. Wuenschell** – Research Associate, CWEL

### PROJECT OBJECTIVES

- Engage with professionals throughout the country to provide an easy and affordable way to connect professionals, practitioners and academics with research and on-the-ground lessons learned.
- Provide a forum for water conservation professionals in a variety of professions to earn continuing education units (CEU's) while learning about landscape water conservation.

### PROJECT BACKGROUND

Webinars are a way to reach a substantial audience that may not be able to spend time or money on travel to conferences. The 'Water Well with CWEL' webinar series aims to create a forum for dialog between researchers and outreach professionals.

### PROJECT STATUS

The 'Water Well with CWEL' webinar series started in January, 2018 and is broadcast monthly every second Tuesday at 2 pm MST. The following



webinars have been broadcast with a total of 195 registrants, 133 participants and 225 post-webinar video views on CWEL's YouTube channel. The audience is growing each month and we hope to expand our reach with upcoming webinars that are geared towards turfgrass and irrigation specialists.

- **Using Interactive Web-based Tools to Increase Outreach Efforts-** *Katie Masucci, Water Education Coordinator for City of Plano, Texas (January 2018)*
- **Smart Controller Pilot: Don't Set it & Forget it-** *Tim York, Aurora Water Conservation District (February 2018)*
- **State of the State: Water Conservation Programs and Resources in the State of Utah-** *Faye Rutishauser and Josh Palmer, Utah Division of Water Resources (March 2018)*
- **Wild West Tale: Debunking the Myth That Conservation Increases Rates-** *Candice Rupprecht, Tucson Water (April 2018)*
- **Update on the Outdoor Water Use Research Initiative of the Alliance for Water Efficiency-** *Peter Mayer, Water DM (May 2018)*

# COMBINATIONS FOR CONSERVATION

## PROJECT INFO

### EDITORS

**Dr. Larry Rupp** – Professor, Landscape Horticulture Specialist  
**Adrea Wheaton** – Program Coordinator, CWEL

### COLLABORATORS

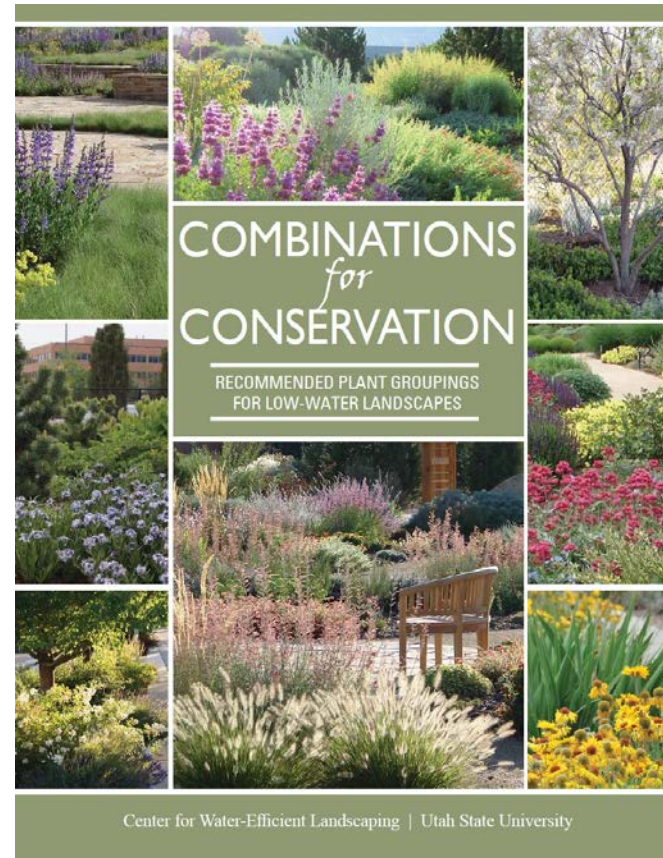
**David Anderson** – Professional Practice Associate Professor  
**Dr. Paul Johnson** – Professor, Turfgrass Science  
**Dr. Roger Kjelgren** – Professor (formerly USU)  
**Dr. Kelly Kopp** – Professor, Water Conservation and Turfgrass Science Specialist  
**Anne Spranger** – Senior Lecturer, Department of Plants, Soils and Climate  
**William A. Varga** – Professor Emeritus, Department of Plants, Soils and Climate

## PROJECT OBJECTIVES

- Give homeowners and designers the confidence to create beautiful, low-water landscapes by showing them examples of plant combinations that have been successful in low-water gardens throughout the Intermountain West.
- Provide tips and suggestions for water conservation on a residential landscape scale.

## PROJECT STATUS

Combinations for Conservation was published through Extension in January of 2017. The book is sold through the online Extension store and at Extension offices throughout the state. Over 650 copies of the book have been sold and plans to update and issue a second printing are under development.



## PRESENTATIONS

**Wheaton, A., B. Varga.** (2018, Mar. 24). Combinations for Conservation. Presented at Central Utah Gardens, Orem, UT.

**Wheaton, A., B. Varga.** (2018, Apr. 21). Combinations for Conservation. Presented at USU Homestead Expo, Conservation Garden Park, West Jordan, UT.

**Wheaton, A., B. Varga.** (2018, May 4). Combinations for Conservation. Presented at Armchair Gardening Series, Bridgerland Audubon Society, Logan, UT.

# MASTER OF PROFESSIONAL STUDIES IN HORTICULTURE ONLINE DEGREE

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## PROGRAM BACKGROUND

Using landscape water efficiently is a multi-faceted issue involving an understanding of plant science, irrigation technologies, human behaviors, and landscape design, all set within the political and economic contexts of communities challenged to meet the water demands of growing populations. The purpose of the Master of Professional Studies in Horticulture (MPSH) degree is to provide horticulturists with the knowledge and skills needed to promote landscape water conservation effectively.

## PROGRAM OBJECTIVES

Prepare graduates for careers as highly qualified water conservation specialists through a curriculum grounded in horticulture, water policy, turfgrass science and irrigation.

## PROGRAM STATUS

Utah State University is the only university offering a professional master's degree that focuses on urban landscape water conservation. The MPSH degree includes a specialization in Water Efficient Landscaping and has been offered through Utah State University since 2001, with 32 graduates to date. In 2016, we began offering the MPSH as an online degree. Currently there are five students enrolled in the program, four are online students and one is on-campus. Our first completely online student graduated in May of 2018.



# PRESENTATIONS

**Endter-Wada, J., I. Thomson, and C. Carney.** (2018, May 17). Water Conservation Motivations and Societal Outcomes. Presented at the Utah Water Conservation Forum, West Jordan, UT.

**Endter-Wada, J., C. Carney, I. Thomson, D. Wuenschell, L. Welsh.** (2017, Nov. 6-9). Role of water demand management infrastructure: tapping new potential and assessing tradeoffs. Presented at the American Water Resources Association Annual Meeting, Portland, OR.

**Endter-Wada, J., D. Rice, D. Wuenschell and C. Garrard.** (2017, Oct. 3-6). Metering non-potable water: 5-year study of urban irrigation efficiency.” Presented at the Water Smart Innovations Conference and Exposition, Las Vegas, NV.

**Harris, P.** (2017, Oct. 22-25). Salinity tolerance in Kentucky bluegrass hybrids. Presented at the Tri Society (ASA, CSSA, and CSA) Annual Conference, Tampa, Florida.

**Kopp, K.** (2018, January 22). Metropolitan Water District of Salt Lake and Sandy Water Check program update. Presented to Metropolitan Water District of Salt Lake and Sandy Board of Directors, Salt Lake City, UT.

**Kopp, K.** (2017, Nov. 8). Irrigation system maintenance: enhancing homeowner skills. Presented at the Annual Conference of the American Water Resources Association, Portland, OR.

**Kopp, K.** (2018, January 29). New turf varieties for low water. Presented at the Utah Nursery and Landscape Association Annual Conference, Salt Lake City, UT.

**Lawson, K.** (2018, Mar. 19). Selecting and grafting single-leaf Pinyon pine (*Pinus monophylla*) for pine nut production. Presented at the Research Showcase for the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

**Palmer, A.** (2018, Mar. 19). Salinity tolerance of seven ornamental grasses and grass-like species. Presented at the Research Showcase for the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

**Palmer, A.** (2018, Mar. 1) Salinity tolerance of seven ornamental grasses and grass-like species. Presented at the Intermountain Sustainability Summit, Weber State University, Ogden, UT.

**Pollard C., J. Vierola, C. Schaible.** (2017, Oct. 5). QWEL: Tales from two adopting organizations. Presented in partnership with Sonoma County Water Agency & San Diego County Water Authority at the Water Smart Innovations Conference in Las Vegas, NV.

**Rupp, L.A.** (2017, various dates). Plant propagation. Presented at Master Gardener courses in Iron, Kane, Washington, Summit, and Wasatch counties, UT.

**Rupp, L.A.** (2018, Feb. 26-28). The Qualified Water Efficient Landscaper program. Extension Annual Conference. Logan, UT.

**Rupp, L.A.** (2017, May 9). Extension landscape horticulture programming. Presented at the USU Southern Region Extension Meeting. Nephi, UT.

**Rupp, L.A.** (2017, May 24). Introduction of ‘DoubleDown’ littleleaf mountain mahogany as a potential bonsai plant. Presented at the Salt Lake City Bonsai Club, Salt Lake City, UT.

**Rupp, L.A.** (2017, July 19). Woody plant propagation. Idaho Ext. In-Service Training. Salmon, ID.

**Rupp, L.A. and R. Anderson.** (2017, Sept. 19). Developing native plants as alternative landscape plants for low-water landscaping. Am. Soc. Hort. Sci. Annual Conf. Waikaloa, HI.

**Rupp, L.A.** (2017, Jan. 29-Feb. 2). Native woody plant cultivars and sustainable urban landscaping. Soc. Range Mgt. Annual Conf. St. George, UT.

**Snow, N.** (2018, Mar. 1). Micropropagation of *Ceanothus velutinus*: stage I. Presented at Showcase at the Department of Plants, Soils and Climate, Utah State University, Logan, UT.

**Snow, N.** (2018, Apr. 12). Micropropagation of *Ceanothus velutinus*: stage I.” Presented at USU's 2018 Student Research Symposium, Utah State University, Logan, UT.

**Wheaton, A., B. Varga.** (2018, Mar. 24). Combinations for Conservation.  
Presented at Central Utah Gardens, Orem, UT.

**Wheaton, A., B. Varga.** (2018, Apr. 21). Combinations for Conservation.  
Presented at USU Homestead Expo, Conservation Garden Park, West Jordan,  
UT.

**Wheaton, A., B. Varga.** (2018, May 4). Combinations for Conservation.  
Presented at Armchair Gardening Series, Bridgerland Audubon Society, Logan,  
UT.

# PUBLICATIONS

## PEER-REVIEWED JOURNAL ARTICLES

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**Avolio, M. L., Pataki, D. E., Trammell, T. L., & Endter-Wada, J.** (2018). Biodiverse cities: the nursery industry, homeowners, and neighborhood differences drive urban tree composition. *Ecological Monographs*, 88(2), 259-276.

**Chen, L., Sun, Y., Niu, G., Liu, Q., & Altland, J.** (2017). Relative Salt Tolerance of Eight Japanese Barberry Cultivars. *HortScience*, 52(12), 1810-1815.

**Flint, C. G., Dai, X., Jackson-Smith, D., Endter-Wada, J., Yeo, S. K., Hale, R., & Dolan, M. K.** (2017). Social and geographic contexts of water concerns in Utah. *Society & Natural Resources*, 30(8), 885-902.

**Kopp, K., Kjelogren, R., Urzagaste, P., & Dai, X.** (2017). Physiological and Quality Responses of Turfgrass and Ornamental Plants to Weather-Based Irrigation Control. *International Turfgrass Society Research Journal*, 13(1), 537-546.

**Liu, Q., Sun, Y., Niu, G., Altland, J., Chen, L., & Jiang, L.** (2017). Morphological and Physiological Responses of Ten Ornamental Taxa to Saline Water Irrigation. *HortScience*, 52(12), 1816-1822.

**Li, E., Li, S., & Endter-Wada, J.** (2017). Water-smart growth planning: linking water and land in the arid urbanizing American West. *Journal of environmental planning and management*, 60(6), 1056-1072.

**Maughan, T., B. Black, L.A. Rupp, and T. Yost.** (2018). Propagation techniques for *Sambucus cerulea* (Blue Elderberry). *Native Plants Journal* (accepted).

**Niu, G., Sun, Y., & Masabni, J. G.** (2018). Impact of Low and Moderate Salinity Water on Plant Performance of Leafy Vegetables in a Recirculating NFT System. *Horticulturae*, 4(1), 6.

**Rupp, L.A., R.M. Anderson, J. Klett, S.L. Love, J. Goodspeed, and J. Gunnell.** Developing native and adapted plants for low-water landscaping. *HortTechnology* (accepted).

**Staub, J. E., Robbins, M. D., Larson, S. R., & Johnson, P. G.** (2017). USDA-ARS Multicolored Ornamental Festuca Grass Cultivars "Freedom Fire" 'Francy', 'Vida', 'Heidi', and 'Kim' for Low-input Applications in Semiarid Environments. *HortScience*, 52(6), 925-931.

**Sun, Y., Niu, G., Perez, C., Pemberton, H. B., & Altland, J.** (2018). Responses of Marigold Cultivars to Saline Water Irrigation. *HortTechnology*, 28(2), 166-171.

**Sun, Y., Niu, G., Ganjegunte, G., & Wu, Y.** (2018). Salt Tolerance of Six Switchgrass Cultivars. *Agriculture*, 8(5), 66.

**Tong, T., Shao, L., Peng, Z., & Sun, Y.** (2018). *Osmanthus fragrans* 'Cai Ye Gui', a Variegated Cultivar. *HortScience*, 53(5), 729-731.

**Van Dyke, A., & Johnson, P. G.** (2017). Cultural, Organic, and Biological Methods for Snow Mold Control on Putting Greens in the Intermountain West. *Crop, Forage & Turfgrass Management*, 3(1).

**Welsh, L. W., & Endter-Wada, J.** (2017). Piping water from rural counties to fuel growth in Las Vegas, Nevada: Water transfer risks in the arid USA West. *Water Alternatives*, 10(2), 420.

**Welsh, L. W., & Endter-Wada, J.** (2017). Policy debates over the Southern Nevada Water Authority groundwater development project: Beneficial uses of water in a desert. *Journal of the Southwest*, 59(1), 302-337.

## EXTENSION FACT SHEETS

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**Beddes, T., Caron, M., Barnhill, J., & Kopp, K.** (2017). Suppression and Control of Field Bindweed-(Perennial Morning Glory) in Residential Areas.

[https://digitalcommons.usu.edu/extension\\_curall/1784](https://digitalcommons.usu.edu/extension_curall/1784)

**Kopp, K. (Ed.)**. (2018, Spring). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 11 \(1\)](#).

**Kopp, K. (Ed.)**. (2018, Winter). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(4\)](#).

**Kopp, K. (Ed.)**. (2017, Fall). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(3\)](#).

**Kopp, K. (Ed.)**. (2017, Summer). USU Extension Turfgrass IPM Advisory. Utah State University. [Vol 10 \(2\)](#).

**Muntz, H., L. Rupp.** (2018). Landscaping in dry shade - 15 great landscape plants for dry shady areas.

[https://digitalcommons.usu.edu/extension\\_curall/1844](https://digitalcommons.usu.edu/extension_curall/1844)

**Wheaton, A., Rupp, L., & Caron, M.** (2018). 10 Low-water trees ideal for water-efficient landscapes in Eagle Mountain, Utah.

[https://digitalcommons.usu.edu/extension\\_curall/1856](https://digitalcommons.usu.edu/extension_curall/1856)

**Wheaton, A., Rupp, L., & Caron, M.** (2018). 10 Low-water ornamental grasses ideal for water-efficient landscapes in Eagle Mountain, Utah.

[https://digitalcommons.usu.edu/extension\\_curall/1855](https://digitalcommons.usu.edu/extension_curall/1855)

**Wheaton, A., Rupp, L., & Caron, M.** (2018). Low-water perennials ideal for water-efficient landscapes in Eagle Mountain, Utah.

[https://digitalcommons.usu.edu/extension\\_curall/1853](https://digitalcommons.usu.edu/extension_curall/1853)

**Wheaton, A., Rupp, L., & Caron, M.** (2018). 10 Low-water shrubs ideal for water-efficient landscapes in Eagle Mountain, Utah.

[https://digitalcommons.usu.edu/extension\\_curall/1854](https://digitalcommons.usu.edu/extension_curall/1854)

**Wheaton, A., Rupp, L., & Caron, M.** (2018). Landscape plants for Eagle Mountain, Utah. [https://digitalcommons.usu.edu/extension\\_curall/1857](https://digitalcommons.usu.edu/extension_curall/1857)

## DISSERTATIONS/THESES

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**Schaible, C. J. (2018)**. Assessing Homeowners' Lawn Management Practices and Preferred Sources of Educational Information. (Master's Thesis) Utah State University, 2017.