Conserving Water Without Reducing Quality of Life

Kelly Kopp & Joanna Endter-Wada (presenters) with Paul Johnson, Roger Kjelgren, & Larry Rupp
Created to conduct research on effective irrigation techniques, landscape water demand analysis, low-water use landscaping, and plant water needs.

Disseminates information to water purveyors, the Utah green industry, local USU Extension offices, and the public to support public education in water-efficient landscaping.
+Personnel

- Kelly Kopp
- Roger Kjelgren
- Larry Rupp
- Joanna Endter-Wada
- Paul Johnson
Presentation Overview

- **Policy Dimensions and Context:** Water management challenges & conservation opportunities in Utah

- **CWEL Contributions:**
  - **Management Tools:** WaterMAPS™
  - **Interdisciplinary Research:**
    - Landscape Plant Materials
    - Irrigation Technologies
    - Human Water Use Behaviors
  - **Public Information:** Extension Programs
Policy Dimensions & Context: Water Management
Challenges & Opportunities
Water Management Strategies

Conservation  Optimization

Sequencing

Prioritization

Repair
Replace
Redesign

R³ Existing Infrastructure

Synergies

New Supplies

Water and Financial Efficiencies
+ **Urban Water Conservation**  
**Why it Matters**

- Rapidly growing percentage of Utah’s total water use
- Location – requires large physical transfers of water from outlying rural and natural areas
- It is less flexible than agricultural water use in times of shortage (can’t “fallow a subdivision”)
- Water use expectations and behaviors are being established in the urbanization process
- Physical conversion of moving water from ag. to urban use has long-term implications for future water demand:
  - water delivery and metering infrastructure
  - urban design and initial investments in landscaping
  - situational constraints on efficiency
“Conservation is critical to minimize risk and build financial resilience” (thinking long term)

- Allows utilities to cut operation and maintenance costs
- Helps defer expensive supply expansion projects (avoided costs)
- Helps reduce total demand, shave peak use, provide revenue stability

“...credit rating agencies have recognized conservation as a best practice in water utility policy... [and] necessary to deal with long-term risks associated with supply shortages and high costs of capital”

Source: C.E. Boyle, January 2014
Conservation Assessment

**Conservation successes**

- Water use reductions
- Awareness raised & people responsive to drought
- Voluntary conservation programs implemented
- Uniform building code has had big effect indoors
- “Low-hanging fruit”

**“Untapped” potential**

- *Outdoor water use efficiency*
- More widespread and durable reductions through changes in habits and norms
- Greater use of markets and mandates (e.g. rates, codes)
- Finding outdoor equivalent of the building code
- Needs greater investment
Supply-side management & investments

Demand-side management & investments
CWEL Contributions to Water Demand Management and Science
Management Tools: WaterMAPS™

Software application to analyze and manage urban landscape water use

"Tools to Help Put Water Conservation on the Map"
Basic Approach: defining appropriateness of urban landscape irrigation relative to plant water needs
Basic Approach: **Identifying Capacity to Conserve**

**Landscape Irrigation Ratio (LIR)**

\[
\text{LIR} = \frac{\text{Landscape Water Use }_{\text{estimated}}}{\text{Landscape Water Need }_{\text{estimated}}}
\]

- **LIR less than 1** = Efficient
- **Between 1 and 2** = Acceptable
- **Between 2 and 3** = Inefficient
- **Greater than 3** = Excessive

**Landscape Water Use** _estimated_
[gallons extracted from municipal or water provider meter/billing data]

**Landscape Water Need** _estimated_
[calculated from landscaped area (derived from classification of airborne remotely-sensed multispectral imagery) and local evapotranspiration (ETo) modified by relevant landscape correction factors for turf vs. trees and shrubs]

(per unit of landscaped area)
Seasonal LIR Calculations

- **Time Period:** 4/1 - 10/31, 2013
- **Locations analyzed:** 1369
- **Mean LIR:** 2.01

Quantifies Conservation Potential
Weber Basin Project

If you don’t meter water, you can’t manage it.

Issue in many ag-to-urban transition areas

Example: Weber Basin Water Conservancy District

WBWCD meter installation project for pressurized secondary irrigation systems
Meters Used

Elster, Smart meter

Evo Q4

Badger, E-Series

Sensus Ipearl

Meter Valve Assembly

WBWCD METER TRANSITION:

- Approximately 16,500 direct retail connections
- Approximately 50,000-60,000 total secondary connections in the district’s service area
Analysis using hourly data

- People generally do not water during the middle of the day
- People who overwater do so at night
- Caution about only using “visual cues” to enforce waste restrictions
Analysis of seasonal patterns

Can be used to better design water policies and deliver conservation programming

<table>
<thead>
<tr>
<th>Month</th>
<th>LIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>May</td>
<td>1.41</td>
</tr>
<tr>
<td>June</td>
<td>1.48</td>
</tr>
<tr>
<td>July</td>
<td>2.81</td>
</tr>
<tr>
<td>Aug</td>
<td>2.13</td>
</tr>
<tr>
<td>Sept</td>
<td>1.84</td>
</tr>
<tr>
<td>Oct</td>
<td>1.93</td>
</tr>
</tbody>
</table>
Made possible by investments in new sources of data
Increasing irrigation system efficiency increases conservation potential.

2012 average LIR = 1.26
(average savings = 56,583 gal)
2013 average LIR = 1.06
(average savings = 11,780 gal)

2012 average LIR = 1.89
(average savings = 129,703 gal)
2013 average LIR = 1.59
(average savings = 75,973 gal)

2012 average LIR = 2.52
(average savings = 166,213 gal)
2013 average LIR = 2.12
(average savings = 108,069 gal)
Interdisciplinary Research
Turfgrass Research

- Salt tolerant and drought tolerant lines of Kentucky bluegrass were crossed and progeny planted in small turf plots this fall.

- Currently evaluating collections of *Poa*, *Festuca*, *Agrostis*, and *Puccinellia* from Kyrgyzstan, Mongolia, and Russia for drought tolerance characteristics.
Dormant Kentucky Bluegrass
Recovering Perennial Ryegrass
Collecting Seed in Russia
Turfgrass Research Summary

- Perennial ryegrass tolerates extended drought, but needs periodic irrigation to survive.

- Kentucky bluegrass tolerates extended dormancy without irrigation. Some difference in rate of dry-down and recovery, but most recover completely.

- Tall fescue retains some green cover throughout most of summer in deep soil. May not survive if root system is restricted.
Ornamental Horticulture Research

Locating exceptional plants and determining how to propagate them.

Bigtooth maple (found by Chad Reid, Parowan Canyon).
Bigtooth Maple Propagation by Layering

- Girdling and rooting hormone
- Mounded with pine shavings
- Sprinkler irrigated twice daily
Layering of other woody plants

Rabbit Brush (*Ericameria albicaulis*)

Mountain Mahogany (*Cercocarpus intricatus*)

Chokecherry (*Prunus virginiana*)
Ornamentals & Dendrochronology

- Water management
  - Quantifying water use of woody plants
  - Tree rings for climate reconstruction

- Native plants
  - Roundleaf buffalo berry (*Shepherdia rotundifolia*) hybrid
  - Lacy buckwheat (*Eriogonum corymbosum*) cultivar development
Comparing three maples, Bigtooth (Native, hot dry), Sugar (East, hot humid) and Bigleaf (West, cool dry).
Sweetgum water use rate, as fraction of ET_0 in three climates: Utah, Texas, Florida.

- Rate of water use highest in humid Florida.
- Rate of water use lower in arid Utah and Texas as trees reduce transpiration in response to drier air.
Tree Rings for Climate Reconstruction

- Relate tree ring width to past precipitation, river flow, temperature.
- Juniper and Douglas Fir
Across the western US, annual growth is limited by moisture availability

- a dry year leads to a narrow growth ring
- a wet year leads to a wide growth ring
Naomi Peak Douglas-Fir Tree Ring Index (~700 yrs)

Correlation, 1-yr lag, 3 pt run

1922-1960

\[ y = 0.0281x + 0.7887 \]

\[ R^2 = 0.4801 \]
Native Plants: *Shepherdia* Hybrid

Understand *Shepherdia* *rotundifolia* adaptation.

Hybrid with *S. argentea* more able to tolerate landscape conditions.
Native Plants: *Eriogonum corymbosum*

- Identifying lines of lacy buckwheat with attractive flower color.
- Tolerant of landscape conditions.
Turf and Ornamental Research

Comparison of water use of landscapes (Mesic, Mixed and Xeric) differing only in plant materials utilized.

Simulation of landscape water and nitrogen transport in the landscapes.

Simulation of different landscape management scenarios and their effects on water and nitrogen transport in the Salt Lake Valley.
Birds-Eye View of Landscapes

Well

Mesic

Xeric

Mixed
Plant canopy cover was a better predictor of overall landscape water use than water use classification.
- Low risk
  <10 kg N/ha
- Medium risk
  10-25 Kg N/ha
- High risk
  25-40 kg N/ha
- Extremely high risk
  >40 kg N/ha
- **Low risk**
  
  \(<10 \text{ kg N/ha}\)

- **Medium risk**
  
  \(10-25 \text{ Kg N/ha}\)

- **High risk**
  
  \(25-40 \text{ kg N/ha}\)

- **Extremely high risk**
  
  \(>40 \text{ kg N/ha}\)
Summary Findings

- Plant canopy cover—rather than water use classification—was the controlling factor in woody plant and perennial water use.

- Over irrigation was the main contributing factor to NO$_3$-N leaching, and NO$_3$-N leaching increased as irrigation increased.

- Improved irrigation and fertilization management may reduce turf NO$_3$-N leaching significantly, and result in lower NO$_3$-N leaching risk areas in urban areas of the Salt Lake Valley.
Turf and Ornamental Research

- Do different climate-based irrigation controller technologies achieve landscape water conservation without negatively impacting landscape quality?
- Quantify the amount of water saved in turfgrass and ornamental area using different controllers.
- Determine the level of drought stress in turfgrass and ornamental plant for the different treatments.
- Evaluate plant quality and growth on the plants under different treatments.
Plants

- Turfgrass (*Poa pratensis* blend)
- ‘Little Giant’ Arborvitae (*Thuja occidentalis*)
- ‘Koreana’ Boxwood (*Buxus microphylla*)
- Dwarf Burning Bush ‘Compactus’ (*Euonymus alatus*)
- Paeonia Hybrid (*Paeonia lactiflora*)
- ‘May Nights’ Salvia (*Salvia nemorosa*)
- Stella D’oro Daylilly (*Hemerocallis lilioasphodelus*)
- Blue Oat Grass (*Helictotrichon sempervirens*)
Controllers

Rainbird

Hunter

WeatherMatic

“Control” (Hunter)

“Control” is programmed according to recommended schedules.
Conclusions

- In 2011, WeatherMatic® controller had the best performance.
- In 2012, all climate-based controllers had similar performance and all used less water than the standard controller.
Public Information: Extension Programs
Center for Water-Efficient Landscaping

The Center for Water Efficient Landscaping (CWEL) is a research and outreach center designed to improve efficient use of water for landscape irrigation. The mission of CWEL is to promote water conservation through environmentally, socially, and economically sound landscape management practices.

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

Research into efficient irrigation, water-wise plant materials, proper turf management, and social behaviors regarding conservation are just a few research interests CWEL is pursuing. Extension and outreach programs are geared to providing expertise and information to state-wide Extension offices, the green industry, water purveyors/institutions, and the general public.

cwel.usu.edu
Outreach Materials

Turfgrass Cultural Practices and Insect Pest Management

Do You Know?
- Good cultural practices and prevention of stress are critical to keeping turfgrass healthy and problem-free.
- Good turfgrass management is dependent on optimal timing of cultural and pest control treatments.
- There are four main insect pest groups that attack turfgrass in Utah.

Mowing
At a rate, regular mowing height should be 2 to 3 in. to promote root growth and stress tolerance of turfgrasses. Mow regularly to avoid removing more than 1/30 of the desired leaf length at any one time. Clippings should be recycled back into the lawn as a source of nutrients and organic matter. Consider rotating turfgrass areas to remove residual clippings and encourage upright growth of the leaves after a long winter under snow cover.

Fertilization
Nitrogen is the primary concern in turfgrass fertilization. In the spring sowing, apply 1 pound of slow-release nitrogen fertilizer per 1000 ft² of lawn area. This will help the grass recover from winter stress and damage. It will also be especially helpful for areas that have suffered damage due to diseases such as pink and gray snow mold. In a slow-release form, nitrogen fertilizer will provide a consistent source of nutrients as the growing season begins. Apply a second pound of slow-release nitrogen fertilizer per 1000 ft² of lawn area in late spring to early summer. This will allow the grass to enter into the warm season growth.

Cultural Practices to Prevent Turf Insect Problems
Refer to Fig. 1 for optimal timing of turf cultural practices.

<table>
<thead>
<tr>
<th>Cultural Practices</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Age</td>
<td>Out</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aeration/Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Age</td>
<td>Out</td>
</tr>
<tr>
<td>Fertilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeding/Transplant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Turfgrass cultural practices and timing of application for northern and southern Utah.

Insect and Disease Activity and Information

Necrotic Ring Spot

Favorable Conditions: cool (60-65°F) and moist conditions, may be compounded by drought and compaction.

Necrotic ring spot (NRS) primarily infects Kentucky bluegrass, though it may also be seen in annual bluegrass and tall fescue. The disease damages the roots and crowns of the grass plants and the first symptoms are small, light green patches of turf that get larger over time. Frequently the turf will survive the infection and re-grow in the center of the patches, giving them a ring-like ("frog eye") appearance.

Cultural Practices
Maintain the highest mowing height possible and follow recommended irrigation practices to prevent drought stress. Core aeration once annually to reduce thatch and avoid over application of N fertilizers.

Resistant Turfgrass Varieties

- "Awards".

Fungicide Options
- Azoxystrobin + Propiconazole (Benomyl MAXX, Propiconazole Pro, Fortome Liquid Systemic fungicide), and azoxystrobin + propiconazole (Headway).
Propagating Bigtooth Maple

Melody R. Richards, Graduate Student, and Larry A. Rupp, Extension Landscape Horticulture Specialist

Propagating Native Utah Plants

Native plants are playing an increasing role in sustainable landscapes that use fewer resources such as water and fertilizer. Unfortunately, many native plants are not available in the nursery trade, or if they are available they may only be found as seedling plants grown for the reclamation industry. Such plants are high quality and have a valuable role in the reclamation of disturbed sites such as fire-damaged areas. But, these plants by design are

extension.usu.edu
Horticulture

March 2011

Drought Tolerance
A Database of Irrigation Requirements for Woody Plants of Northern Utah

Compiled by Samuel Cook and Larry A. Rupp
Plants, Soils, and Climate Department, Utah State University
Logan, Utah

Acknowledgments
The database lists all the known references on water use by woody plants adapted to northern Utah.

<table>
<thead>
<tr>
<th>#</th>
<th>Species</th>
<th>USDA Native Distribution</th>
<th>USDA Water Use (RRI)</th>
<th>Natural History of this Plant</th>
<th>Drought Tolerance</th>
<th>Review of previous use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abies concolor</td>
<td>Seldom Native to Utah</td>
<td>3 4</td>
<td>30-36 months, 39-75 years</td>
<td>Likely</td>
<td>Review of previous use</td>
</tr>
<tr>
<td>2</td>
<td>Abies balsamea</td>
<td>Seldom Native to Utah</td>
<td>3 5</td>
<td>30-36 months</td>
<td>Likely</td>
<td>Review of previous use</td>
</tr>
<tr>
<td>3</td>
<td>Abies lasiocarpa</td>
<td>Native to Utah</td>
<td>3 4</td>
<td>30-36 months</td>
<td>Likely</td>
<td>Review of previous use</td>
</tr>
<tr>
<td>4</td>
<td>Picea engelmannii</td>
<td>Native to Utah</td>
<td>3 4</td>
<td>30-36 months</td>
<td>Likely</td>
<td>Review of previous use</td>
</tr>
<tr>
<td>5</td>
<td>Populus tremuloides</td>
<td>Native to Utah</td>
<td>3 4</td>
<td>30-36 months</td>
<td>Likely</td>
<td>Review of previous use</td>
</tr>
</tbody>
</table>
COMBINATIONS FOR CONSERVATION

RECOMMENDED PLANT GROUPINGS FOR LOW-WATER LANDSCAPES
COMBINATIONS FOR CONSERVATION

It has been said that in an urban environment, the constructed landscapes found throughout the community become the environment. As such, they are as critical to our quality of life as any natural environment. They are also critical to the quality of environmental factors such as clean water, reduced heat island effects, food for pollinators, our mental well-being and more. For many years the landscapes created in the communities of the Intermountain West were artificially supported by copious amounts of irrigation water. These landscapes have been welcome retreats from the native cold desert we call home, and as long as we have had plenty of cheap water they have been easy to justify.

The combination of increased population throughout the state and potentially deepening drought cycles, coupled with a finite water supply are making us re-examine water use by Utah landscapes. Since these landscapes use roughly 65% of our treated drinking water, they are the obvious first choice for conservation. There is nothing wrong with that, as long as we realize the key to landscape water conservation is not to eliminate landscaping, but to do it more wisely so that we retain the quality of life desired while reducing excessive water use.

The purpose of this guide is to provide options for landscape plantings that are functional, attractive, and desirable; yet are also water-wise. The approach is different than many guides. Rather than focus on individual plants and what they require from and add to a landscape, this guide focuses on small groupings of plants that together are greater than the sum of the parts. It is somewhat analogous to developing a wardrobe. While it is entirely possible to purchase separate items of clothing and then mix and match them to get the desired result, it is probably easier and more effective to buy all the components of an ensemble together so that the shoes, socks, belt, shirt, and coat all work together in an attractive and functional combination. As a result, rather than recommending that a single plant be added to a landscape, the guide recommends groups of three-four plants that fit together well and accomplish the desired purpose.

The groupings or combinations in this guide are not based on any strict criteria beyond the goal of being water-wise. This has resulted in broad spectrum of combinations based on a wide range of criteria.

ECONOMIC COMBINATIONS

In nature, there are combinations of plants that are synergistic and well as competitive. Synergistic plants perform better together than either could individually. An extreme example would be Indian paintbrush and sagebrush. The paintbrush is semi-parasitic and depends on its association with the sage for nutrients. In turn, at least from a landscape perspective, the paintbrush adds a welcome splash of color to the gray sage. Ecological combinations are based on what we find in nature with the assumption that if they naturally group together and do well, then that would carry over to the landscape. So plants common to an ecological niche, such as a desert climate with full sun and minimal precipitation would be grouped separately from those native to a stream bank in the bottom of a shaded canyon. Such groupings should also reduce the situation where one plant out-competes its neighbors and eventually overshadows them entirely.

AESTHETIC CONSIDERATIONS

Some combinations in the guide are based simply on the fact that they look good together. Virtually everyone has been in a situation where they have seen a particular combination of plants that is striking for its beauty. Whether based on color, texture, size, or a combination of all traits, the common thread is that together they look good. This is not to say that these combinations won’t work ecologically. It is just that some of the plants may not be natives or normally found together in nature, even though they have the same requirements for growth.

FUNCTIONALITY IN A COMMON NICHE

One of the challenges of landscape design is fitting plants to the varied micro-climates found in a landscape. Every home has a sunny southern exposure and a shady northern one. They may also have steep slopes, poor soils, partial shade, or other characteristics. Some of the groupings in this guide are based on their fit to such micro-climates. For example, a micro-climate may be characterized as being shady and dry. Selection of a group of plants that fit such an environment insures that they will all prosper rather than compete for space and resources.

Within each combination, the guide also explains the characteristics and needs of the individual plants. Further, in the back of the guide is a list of potential substitutes in the event that a particular plant is unavai-

able. But, again the focus is not on the individual, but rather the group as a whole. The guide will also provide incidental information about the group such as how much water does it really need? Is it attractive to pollinators? How hardy are the plants?

While the guide provides information on a number of combinations, designing plant use for an entire landscape is beyond its scope. This does not mean that the reader could not group various combinations together to develop effective results, and in fact such groupings can be a very effective way to expand this information to the larger landscape. But, the focus of the guide remains on simple combinations that can be effective in the landscape. To return to the wardrobe analogy, we are not trying to develop the attire for an entire wedding party, we just want to make sure that the guest in the corner has slacks, shirt, and a jacket that fit and match.

Lastly, this guide is designed to help the home gardener go beyond adding a single plant to a landscape, or a number of single plants, to adding a wisely chosen group of 2-3 plants that will complete a segment of the landscape. Most of all, it is designed to promote landscapes that conserve water while conserving our quality of life.
KENTUCKY BLUE GRASS IN THE LOW WATER LANDSCAPE

Kentucky blue grass is often vilified as a water hog, but it is often over watered and requires much less water than it generally receives. While Kentucky blue grass does require more water than other turf types, it doesn’t need much more. Reducing amount of turf to a practical amount and watering it efficiently would drastically cut back on the amount of water used in the landscape. Plus, if you need to really conserve water in the summer, you can tolerate extended periods of no or little irrigation. It will go brown, but it’s not dead.

You don’t have to completely get rid of your lawn to conserve water in the western landscape. Simply, reduce the amount of lawn and water it efficiently. The planting bed that is watered separately from the lawn area. The turf grass will need to be watered more frequently than the planting beds, but water it when the soil dries out. With deep, infrequent watering the roots will be more developed and better adapted to drought. The Bosnian pine provides a dark green backdrop for the fall blooming blue spirea, and the succulent pink sedum. The lawn in this design is minimal, but it draws the eye into the planting.

PLANTING AND CARE

Hydroponics is an important concept when using plants with differing water requirements.
Slow the Flow Water Check Program

On average, program participants save 25,570 gallons of water annually, reducing the amount of water applied to landscapes by 8%.
<table>
<thead>
<tr>
<th></th>
<th>Salt Lake City Public Utilities</th>
<th>Sandy City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average annual savings</td>
<td><strong>64</strong></td>
<td><strong>111</strong></td>
</tr>
<tr>
<td>(in thousands of gallons)</td>
<td><strong>1,141,384</strong></td>
<td><strong>773,365</strong></td>
</tr>
<tr>
<td>Cumulative savings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(in thousands of gallons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative $ saved per</td>
<td></td>
<td></td>
</tr>
<tr>
<td>household</td>
<td>$729.27</td>
<td>$2,153.67</td>
</tr>
<tr>
<td>Total cumulative $ saved</td>
<td><strong>$1,700,662.26</strong></td>
<td><strong>$1,871,542.38</strong></td>
</tr>
</tbody>
</table>
+ Thanks very much....

joanna.endter-wada@usu.edu  kelly.kopp@usu.edu  @kopptweets