Don't Let Water Restrictions Strike You Out

Bryan Hopkins, Professor, Brigham Young University

Kelly Kopp, Professor and Extension Specialist, Utah State University

EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY

Water Scarcity in the U.S. (Lake Mead)

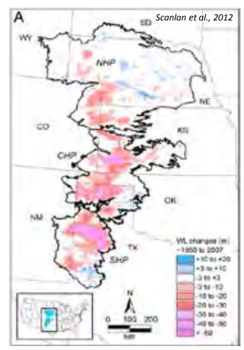
EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY

Today's Talk

- Background
- Restriction examples
- Management approaches
- Strategies for success

EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY

Water Scarcity in the U.S. (Ogallala Aquifer)



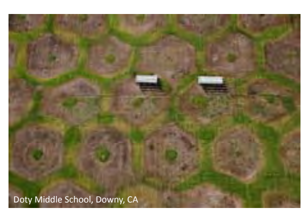
EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY

Background

- 7 billion gallons of water per day for landscape irrigation in US (USEPA)
- Varies greatly depending on location and season
- Greatest in the west and southwest
  - Highly urbanized
  - Growing quickly
- Periodic droughts occur across the U.S.

EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY

Water Scarcity in the U.S. (California)

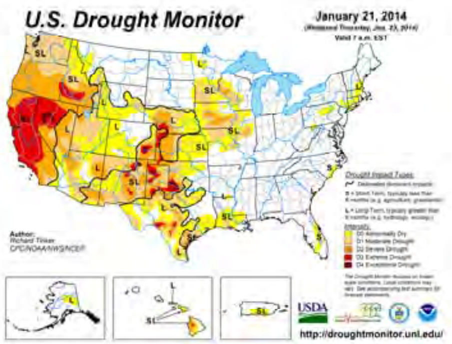


Doty Middle School, Downy, CA

Bogdanovich Recreation Center, San Pedro, CA

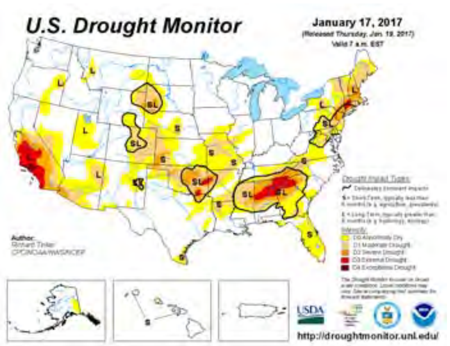
https://www.bloomberg.com/distribution/blog/2015-09-10/high-socal/

EXTENSION UtahStateUniversity | BRIGHAM YOUNG UNIVERSITY



Water Restrictions-3 Examples

- Salt Lake City, UT
- San Antonio, TX
- Southwest Florida



Salt Lake City, UT

- Mild Stage (5-14% reduction)
- Moderate Stage (15-24% reduction)
- Severe Stage (25-34% reduction)
- Critical Stage (35% or more reduction)

Water Scarcity in the U.S. (Colorado)

- Population growth
- Economic development
- Aquifer depletion
- Drought/Climate change

Anticipated Population Growth	Additional Water Needed (AF)	Total Irrigated Acres in Basin	Estimated Loss of Irrigated Acres
+ 65%	409,700	1,000,500	179,500

Colorado population growth effects on water demand

Salt Lake City-Run Properties

- 20% reduction collectively, NOT entire property, not even same site, but as a cumulative volume of water
- Recognized different water requirements for different turfs and uses
- As restrictions became tighter, restrictions extended to other sports fields, could prioritize fields as needed
- Some fields had to address poor irrigation design issues
- Golf courses were very proactive, went out and turned off rough and naturalized areas by hand, managed manually
- “Golf did a phenomenal job!”

Salt Lake City

- Playability of actual playing surfaces was maintained
- Turf areas not devoted to field pl received less water
- Schools, universities had same directives
- Very effective, very positive
- Messaging across utility, parks, sports had to be consistent


Herman Franks Park, Salt Lake City, UT

SAWS Athletic Field Variance Requests

- Basic plan guidelines
  - One irrigation day per week
  - Multiple fields get one day per week, per field
  - Large field irrigation can be split over days
- Advanced plan guidelines
  - Soccer and football, 3 days per week
  - Softball and baseball, 2 days per week
  - Additional days upon review
  - Irrigation audit required to establish precipitation rate

SAWS Interpretation

- Basic-you're assigned a day
- Advanced
  - What is the precipitation rate?
  - How many fields are you irrigating?
  - What irrigation schedule do you want?
  - ½" per week allowable (based on TAMU recs.)
- "Most field managers, aside from really large school districts, don't know much about irrigation."
  - Opportunity for education
- SAWS recognizes personnel issues
  - Coaches and ADs, for example, may override the district's variance, who's controlling the controller

San Antonio Water System (San Antonio, TX)

- Year round
- Stage 1-660' (mean sea level)
- Stage 2-650'
- Stage 3-640'
- Stage 4-supply can't meet demand
- Sports fields may request variances

Southwest Florida Water Management District

- Time of day
- Address
- 2 day per week limit at all times, 3 day in certain counties
- Consideration of new landscapes
- Reclaimed water
- Variance options

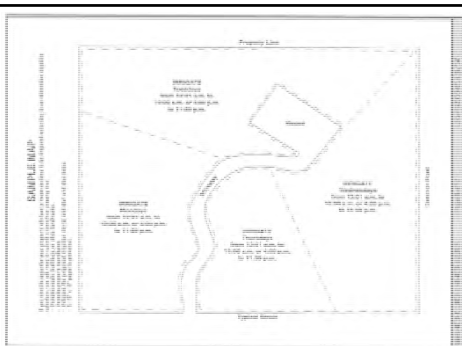
Southwest Florida Water Management District

- Variance
  - Describe water source and use, including athletic fields, ball fields, golf
  - Describe reason for request, i.e. smart control in place, large property
  - Option for alternative to restrictions, i.e. change times or days
  - Must include plans for additional conservation/efficiency
  - Must include sample maps such as….

Relative Stress Tolerance of Turfgrasses

Warm-season grasses (most → least)
- Bermudagrass
- Buffalograss
- Zoysiagrass
- Centipedegrass
- St. Augustine grass
- Paspalums

Cool-season grasses (most → least)
- Wheatgrasses
- Tall fescue
- Fine fescue
- Bluegrasses
- Ryegrasses



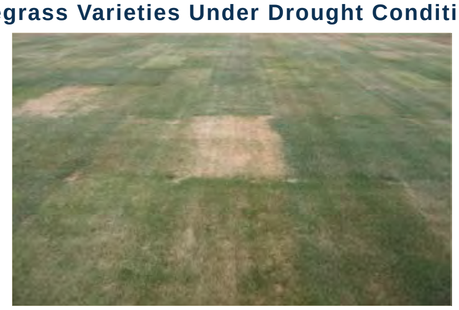
National Evaluation Programs

- National Turfgrass Evaluation Program (NTEP.org)
- Turfgrass Water Conservation Alliance (TGWCA.org)
- Alliance for Low-Input, Sustainable Turfgrass (A-LIST)

Management Approaches

- *Turfgrass selection*
- Soil amendments
- Irrigation efficiency and technology
- Stress management

Bluegrass Varieties Under Drought Conditions



Turfgrass Water Conservation Alliance

- Formed in 2010 by direct competitors in the turfgrass seed industry
- Developed a science-based approach to water conservation
- Qualifies turfgrasses that demonstrate statistically significant water savings potential over conventional varieties of the same species
- Relies on peer review of objective data to make qualifications
- Educates and reaches out to industry, government, and end users

EXTENSION
UtahStateUniversity

Screening Methods

Chronic drought stress

- Decreased irrigation
- Watered weekly (%ET)
- Digital image analysis quantifies % green cover
  - ✓ 2 x per week for 90 days
  - ✓ Immediately before watering, and 2 days after

Acute drought stress

- No irrigation
- Irrigation shut off until top performer reaches 25% green cover
- Then 1"/week
- Digital image analysis quantifies recovery rates

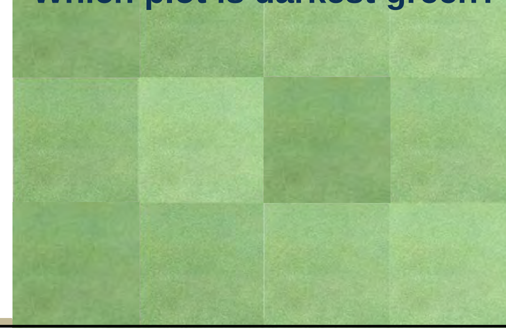
EXTENSION
UtahStateUniversity

Goals of Drought Evaluations

- Screen a wide range of species and cultivars for response to acute and chronic drought stress
- Identify superior drought-tolerant cultivars within each turfgrass species
- Investigate mechanisms associated with drought tolerance of superior cultivars
- "Brand" superior cultivars

EXTENSION
UtahStateUniversity

Which plot is darkest green?

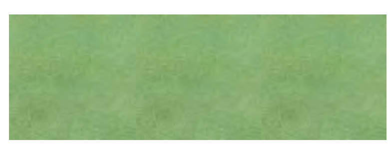


TWCA Qualification Process

- 2 years minimum of data to justify entry into the TWCA trialing program
- 2 years minimum of TWCA trialing completed
  - ✓Objective data collection
  - ✓Two types of drought imposed
  - ✓Peer review of results
- Finish in top 2-5% in drought performance
- Maintain acceptable level of quality
- Comprise a minimum of 60% in blends or mixtures

EXTENSION
UtahStateUniversity

Which plot is darkest green?

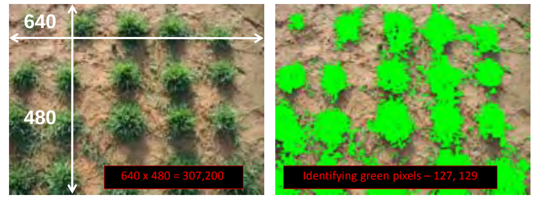


Digital Image Analysis allows measurement of leaf firing as a function of green cover

50 Days With No Water

Mallard – 38% Green Cover   Geronimo – 2% Green Cover

DIA Images are Analyzed with Software



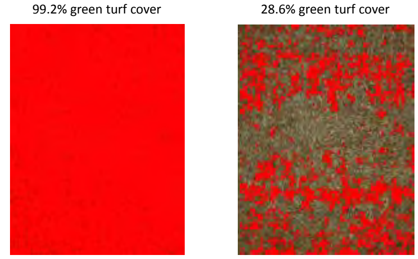
% Green Cover = [127,129 / 307,200] × 100 = 41.3%

Digital Image Analysis-DIA

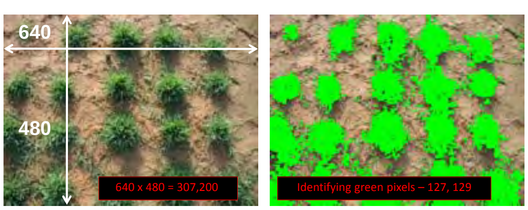
- Light box is used to collect images
- Box contains uniform, standardized light source
- Digital camera on top

What is the % Green Cover?

99.2% green turf cover   28.6% green turf cover



DIA Images are Analyzed with Software



% Green Cover = [No. of Green Pixels / Total No. of Pixels] × 100

Management Approaches

- Turfgrass selection
- *Soil amendments*
- Irrigation efficiency and technology
- Stress management

Water and Fertility Interaction

---------- 60% ET ----------- ---------- 100% ET -----------

Four Replications (RCBD)

Low N Opt.N Exc.N Low N Opt.N Exc.N

Irrigation Treatments
- 100% ET
- 60% ET

Nitrogen Treatments
- Low
- Optimum
- Excessive

EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

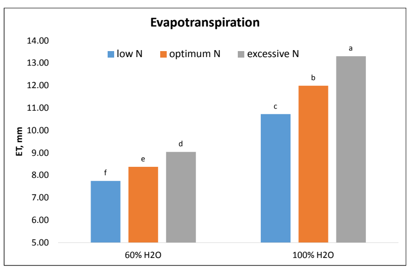
Utah Case Study

- Kentucky bluegrass
- Common irrigation practices (USU)
  - Daily irrigation with automatic sprinkler system
  - Irrigation volumes two or more times what is required
- Common fertilizer application
  - 6 lb-N/1000 ft^2
  - 2 lb-P_2O_5/1000 ft^2
  - 3 lb-K_2O/1000 ft^2
  - Plus S and micronutrients

EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

- For both irrigation levels, increasing nitrogen rates increased evapotranspiration
- Nitrogen management can be employed for water conservation



EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

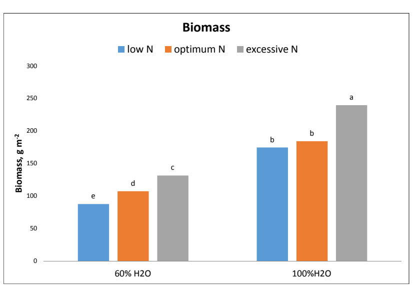
Soil Amendments and Mowing BMPs

- Data shows that each of the following practices are known to impact water use efficiency due to root depth/efficiency and/or shoot biomass production.

EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

Combined management of water and fertilizer can also reduce mowing frequency.



EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

Soil Amendments and Mowing BMPs

- Appropriate mowing frequency and height
  - Raised mowing height from less than to greater than 2 inches
  - Avoiding scalping (cutting off more than 35-40% of the shoot)
- Appropriate fertilization based on soil tests and sound science
  - Cut N rate in half—using PCU (2/3) and ammonium sulfate (1/3)
  - Stopped applying other nutrients based on soil test (retest every 3-5 years)

EXTENSION UtahStateUniversity

BRIGHAM YOUNG UNIVERSITY

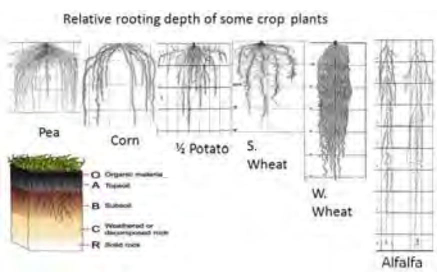
Soil Amendments and Mowing BMPs

- Develop deeper roots
  - Cut nitrogen rate
  - Ample fall nutrition (especially nitrogen) when root growth is most prolific
  - Intentional water stress in spring two times
  - Deeper and less frequent irrigation
    - Deeper = monitoring root depth and irrigating enough to move water to this depth
    - Began by stretching time between irrigations at about 3 days in summer to eventually (two years later) to 5 day intervals

Turfgrass Rooting Changes Over Growing Season

http://thelawncodenver.homestead.com/Grass_Growth_Chart.jpg

Root Depth and Architecture of Different Plants

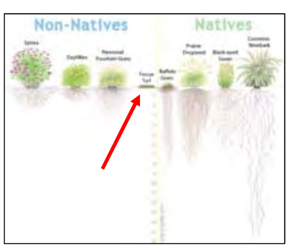


(Weaver, 1926)

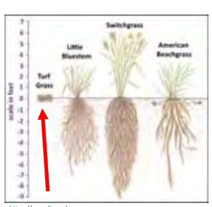
Management Approaches

- Turfgrass selection
- Soil amendments
- *Irrigation efficiency and technology*
- Stress management

Mowed Turfgrass Roots are More Shallow



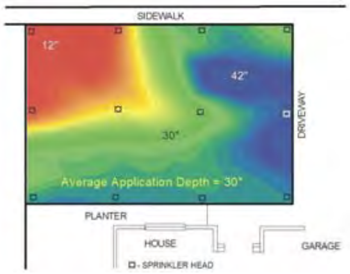
http://www.marc.org/Environment/Water-Resources/images/roots_diagram.aspx



https://s-media-cache-ak0.pinimg.com/564x/d5/c2/35/d5c235bc35a4a533a2a864ab0f33ab11.jpg

Distribution Uniformity (DU)

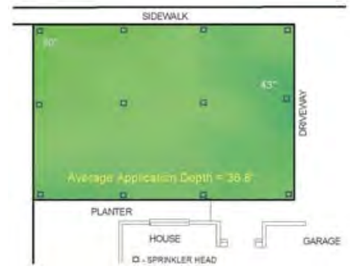
- DU represents irrigation system efficiency, 100% if water were applied *completely* evenly over an irrigated area
- For example, if DU is 50%, some areas may receive twice as much water as other areas to compensate



DU=50%, Ave. Depth=30", Min. Depth=12", Max. Depth=42"

WATER-EFFICIENT

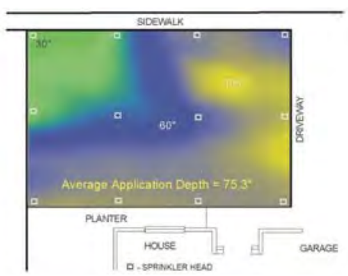
EXTENSION.USU.EDU EXTENSION UtahStateUniversity



DU=85%, Ave. Depth=37", Min. Depth=30", Max. Depth=43"

WATER-EFFICIENT

EXTENSION.USU.EDU EXTENSION UtahStateUniversity



DU=50%, Ave. Depth=75", Min. Depth=30", Max. Depth=105"

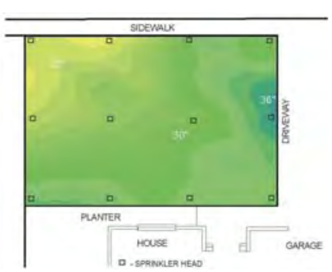
WATER-EFFICIENT

EXTENSION.USU.EDU EXTENSION UtahStateUniversity

Climate-Based Controller Study

- Overall objective
  - Evaluate potential water savings using climate-based irrigation controllers AND landscape plant health and quality
- Specific objectives
  - *Quantify the amount of water applied to turfgrass and ornamental irrigation zones*
  - Assess drought stress in turfgrass and ornamental plant zones
  - Evaluate plant quality and growth

EXTENSION UtahStateUniversity



DU=85%, Ave. Depth=30", Min. Depth=25", Max. Depth=36"

WATER-EFFICIENT

EXTENSION.USU.EDU EXTENSION UtahStateUniversity

Treatments

	Control (CTRL)	(WTM)	(RBR)	(HTR)
Weather data source	N/A	On-Site temperature and rain sensor and solar radiation estimated based on date and location.	Public and private weather stations data managed by centralized computer server	On-Site Temp, solar, and rain sensors
Irrigation Scheduling	Base irrigation scheduling required	Base irrigation scheduling required	Fully automatic schedule	Base irrigation scheduling required
ET_o Data		Modified Hargreaves	Penman-Monteith	Modified Penman-Monteith

EXTENSION UtahStateUniversity

Cumulative Water Application

Treatments		N	Median (mm)	25%	75%	Group
2011	CTRL	10	265	120	406	A
	HTR	10	178	80	258	BC
	RBR	10	208	96	282	AB
	WTM	10	153	66	214	C

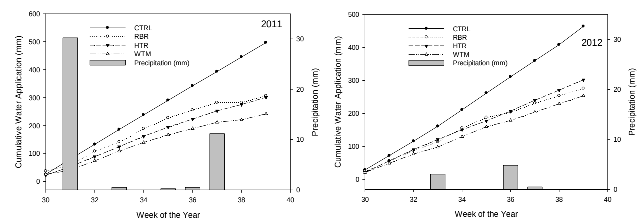
Treatments		N	Median (mm)	25%	75%	Group
2012	CTRL	10	237	105	372	A
	HTR	10	164	82	248	AB
	RBR	10	172	80	237	BC
	WTM	10	145	70	210	C

EXTENSION
UtahStateUniversity

Methods

EXTENSION
UtahStateUniversity

Precipitation and Cumulative Water Application

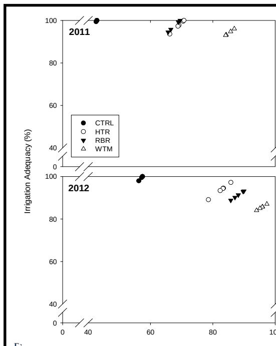


EXTENSION
UtahStateUniversity

Methods

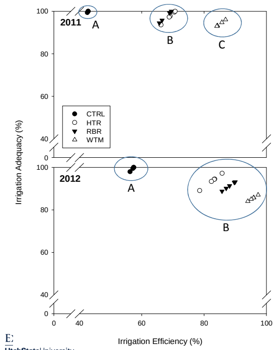
- Measurements/observations
  - Weather conditions
  - Water application
    - DLJ Water Meter
  - Distribution uniformity
    - Catch cups
  - Irrigation adequacy
  - Irrigation efficiency

EXTENSION
UtahStateUniversity



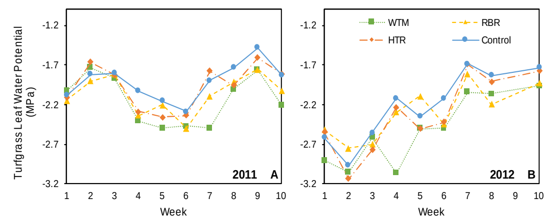
Evaluating Controller Performance-Relating Adequacy and Efficiency

UtahStateUniversity



Evaluating Controller Performance-Relating Adequacy and Efficiency

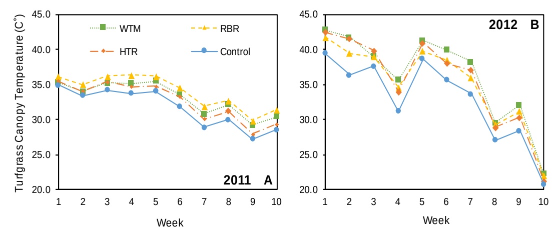
Turfgrass Water Potential



Key Water Application Findings

- Average water savings compared to Control
  - Hunter® (37%), Rainbird® (40%) and WeatherMatic® (48%).
- All controllers adjusted irrigation application in response to weather conditions.
- Irrigation efficiency values for all climate-based controllers were significantly higher than control treatment.
- In 2011, WeatherMatic® controller had the best performance.
- In 2012, all climate-based controllers had similar performance.

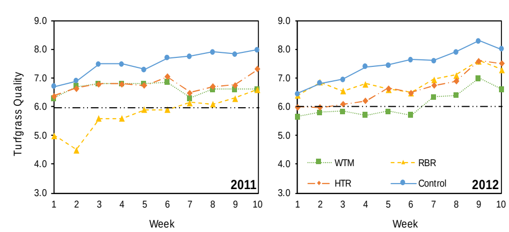
Turfgrass Leaf Temperature



This Project….

- Overall objective
  - Evaluate potential water savings using climate-based irrigation controllers AND landscape plant health and quality
- Specific objectives
  - Quantify the amount of water applied to turfgrass and ornamental irrigation zones
  - *Assess drought stress in turfgrass and ornamental plant zones*
  - *Evaluate plant quality and growth*

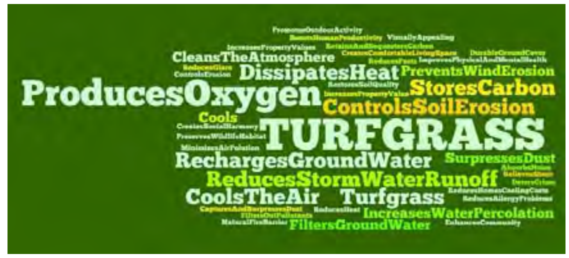
Turfgrass Quality



Key Findings

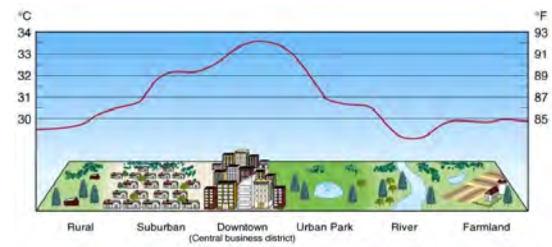
- Hunter®, Rainbird® and WeatherMatic® controllers reduced water use of landscapes under Intermountain West weather conditions.
- The sole installation of a climate-based controller doesn't guarantee water savings, correct programming is required.
- Evaluation of plant health and quality is recommended for overall controllers performance assessment.
- End user evaluation based on cost, adaptability, installation, and programming should be included in the analysis of these controllers.

Describing Turfgrass Benefits



Turfgrass Producers International, 2015

Establishing Relationships



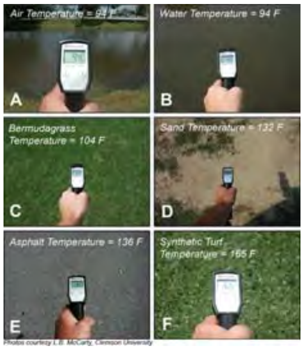
Source: USEPA

Safety, Safety, Safety

- 75% grass cover
- No bare spots
- Well-drained, with no standing water
- Uniform height, color and density
- Strong root system
- No weeds, burrs
- No ruts or trenches
- Communication between maintenance staff and users

Surface Temperature Comparisons

Surface Type	Max. daytime surface temperature	Min. nocturnal surface temperature
Green, growing bermudagrass	88° F (31° C)	75° F (24° C)
Dry bare soil	102° F (39° C)	79° F (26° C)
Brown, summer-dormant bermudagrass	126° F (52° C)	81° F (27° C)
Synthetic turf	158° F (70° C)	84° F (29° C)



Photos courtesy L.B. McCarty, Clemson University

Green Space Access Correlations to Health

- Positive link between lower disease prevalence and more green space
- Strongest link was for anxiety disorders and depression
- Stronger link for children and for people with lower socio-economic status
- Prevalence rate of 15 of 24 disease clusters was lower in environments that had more green space

Maas, et al. 2009. *Morbidity is related to a green living environment. J. Epidemiological Community Health*. Published Online 15 October 2009.

EXTENSION UtahStateUniversity
BRIGHAM YOUNG UNIVERSITY

Table 14.3 Annual net carbon sequestration rate per yard

Parameter	Trees	Shrubs	Lawns
Minimum scenario C sequestered (kg)	6.8-11.8 (9.3)	0.4-2.4 (1.4)	31.4-164.0 (97.7)
Percent C in each category	8.6	1.3	90.1
Maximum scenario C sequestered (kg)	20.4-35.4 (27.9)	1.2-8.4 (4.8)	43.3-250.4 (146.9)
Percent C in each category	15.5	2.7	81.8

R. Lal and B. Augustin (eds.) *Carbon Sequestration in Urban Ecosystems*, 2012

Salt Lake City Experience

- City prioritized community and public areas such as sports fields
- Playability of actual playing surfaces was a priority
- Turf areas not devoted to field play weren't maintained in the same way
- Messaging across the utility, parks, sports had to be consistent
- "Very effective, very positive."


Herman Franks Park, Salt Lake City, UT

EXTENSION UtahStateUniversity
BRIGHAM YOUNG UNIVERSITY

Just Considering Home Lawns

There are approximately 80 million single family detached homes in the U.S.

Therefore, the total national carbon sequestration from turfgrass ranges from 2.5-20 billion kg, or between 5 and 40 billion lbs. (NGA 2004; Augustin 2007)

EXTENSION UtahStateUniversity
BRIGHAM YOUNG UNIVERSITY

Thank you….

Questions?

bryan_hopkins@byu.edu
kelly.kopp@usu.edu

EXTENSION UtahStateUniversity
BRIGHAM YOUNG UNIVERSITY