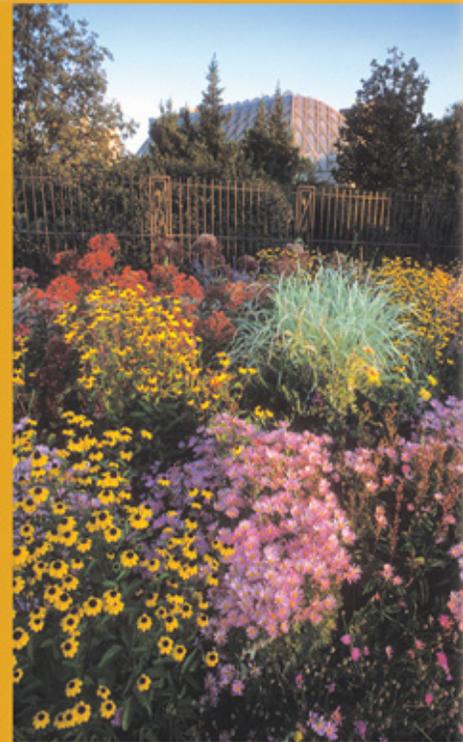


Sustainable Practices at Denver Botanic Gardens

June 27, 2007

Sarada Krishnan



Denver Botanic Gardens



Scientific & Cultural
Facilities District

Making It Possible.



Sustainability

Sustainability or Sustainable Development:

Development that “meets the needs of the present without compromising the ability of future generations to meet their own needs”

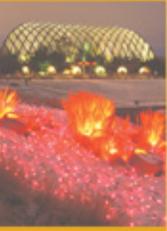
- Resource conservation
- Biodiversity conservation





Characteristics of Colorado's Climate

- Large swings in temperature
- Large day to night temperature changes
- Hot summers in the plains, often relieved by afternoon thundestorms
- Mountain region almost always cool
- Low humidity, favoring rapid evaporation
- Thin atmosphere and hence high solar radiation
- Average annual precipitation statewide is 17 inches (ranges from 7 inches to over 60 inches)



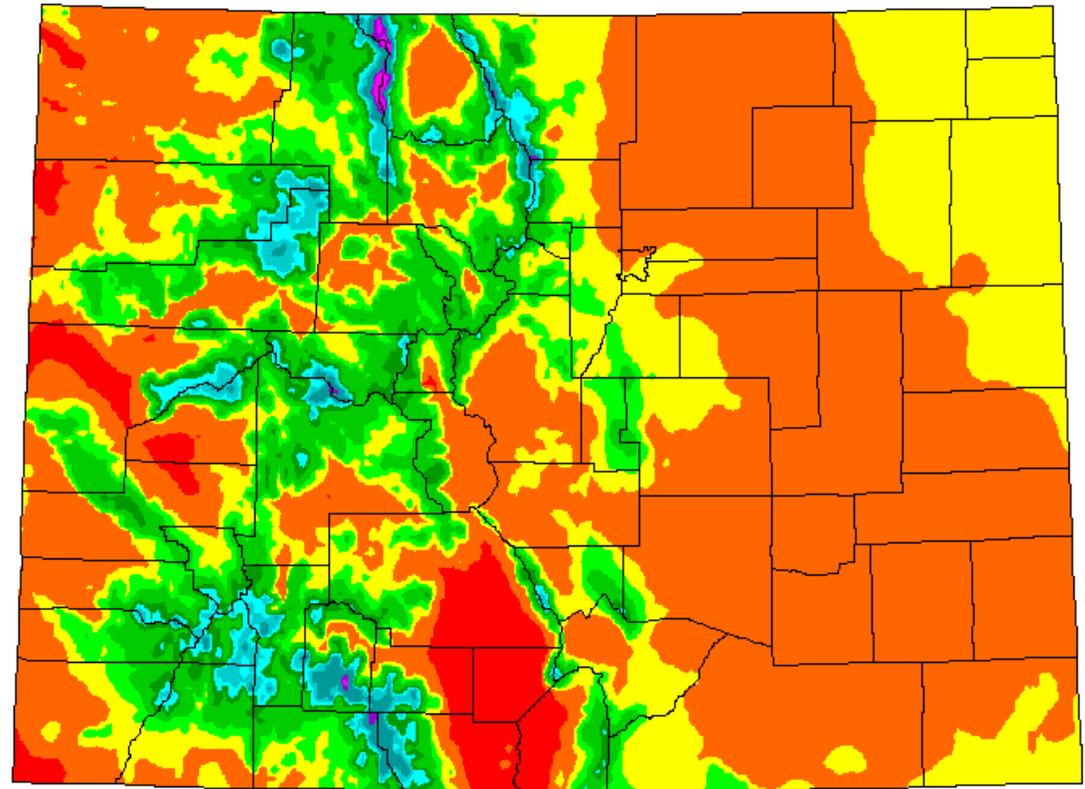
How Colorado Gets Its Water

Average Annual Precipitation Colorado



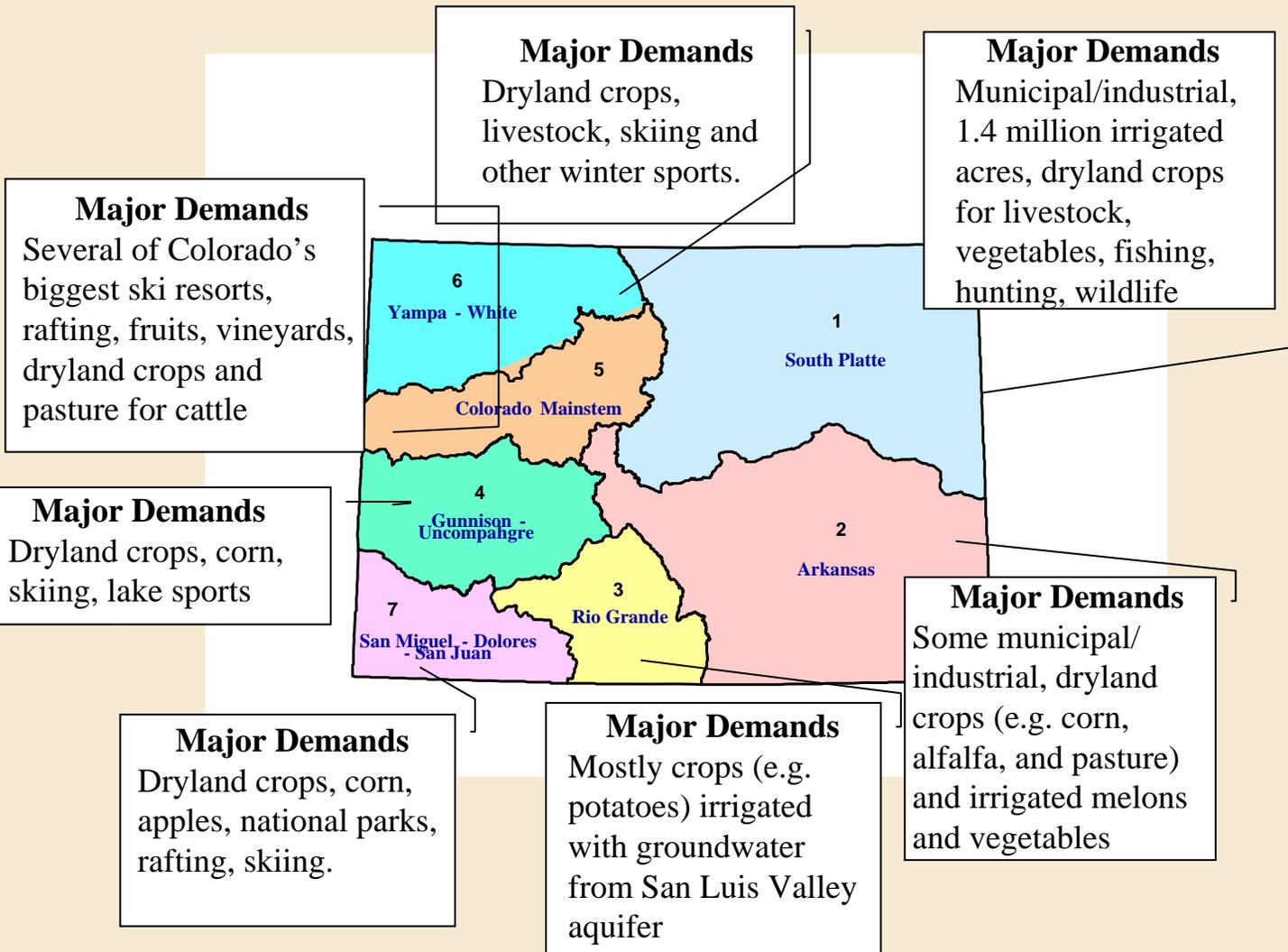
Period: 1961-1990

This map is a plot of 1961-1990 annual average precipitation contours from NOAA Cooperative stations and (where appropriate) USDA-NRCS SNOTEL stations. Christopher Daly used the PRISM model to generate the gridded estimates from which this map was derived; the modeled grid was approximately 4x4 km latitude/longitude, and was resampled to 2x2 km using a Gaussian filter. Mapping was performed by Jenny Weisburg. Funding was provided by USDA-NRCS National Water and Climate Center.



12/8/97

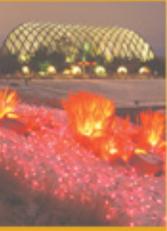
Colorado's Water Demands: How and When We Use Water

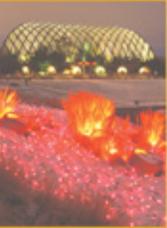




Colorado's Eastern Plains

- Summer daily maximum temperatures are often 95°F or above
- Winter temperature extremes are from zero to -10°F to -15°F
- Annual precipitation – 11 – 18 inches
- Multi-year drought is common to the area
- Significant drought periods include the decade-long drought of the 1930s, the severe drought of the mid 1950s and 1970s and the recent intense widespread drought of the early 2000s.





Drought of 2002

- Beginnings in autumn of 1999 – very dry
- Winter 1999/2000 - below average snow accumulation and above average temperatures
- Spring/summer 2000 – very dry
- Spring 2001 – relatively normal precipitation
- Summer 2001 – hotter than average temperatures, high evaporation rates, continued depletion of soil moisture and surface water supplies

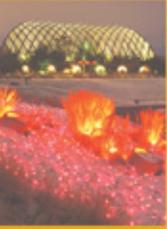
This set the stage for “The drought of 2002”



Drought of 2002

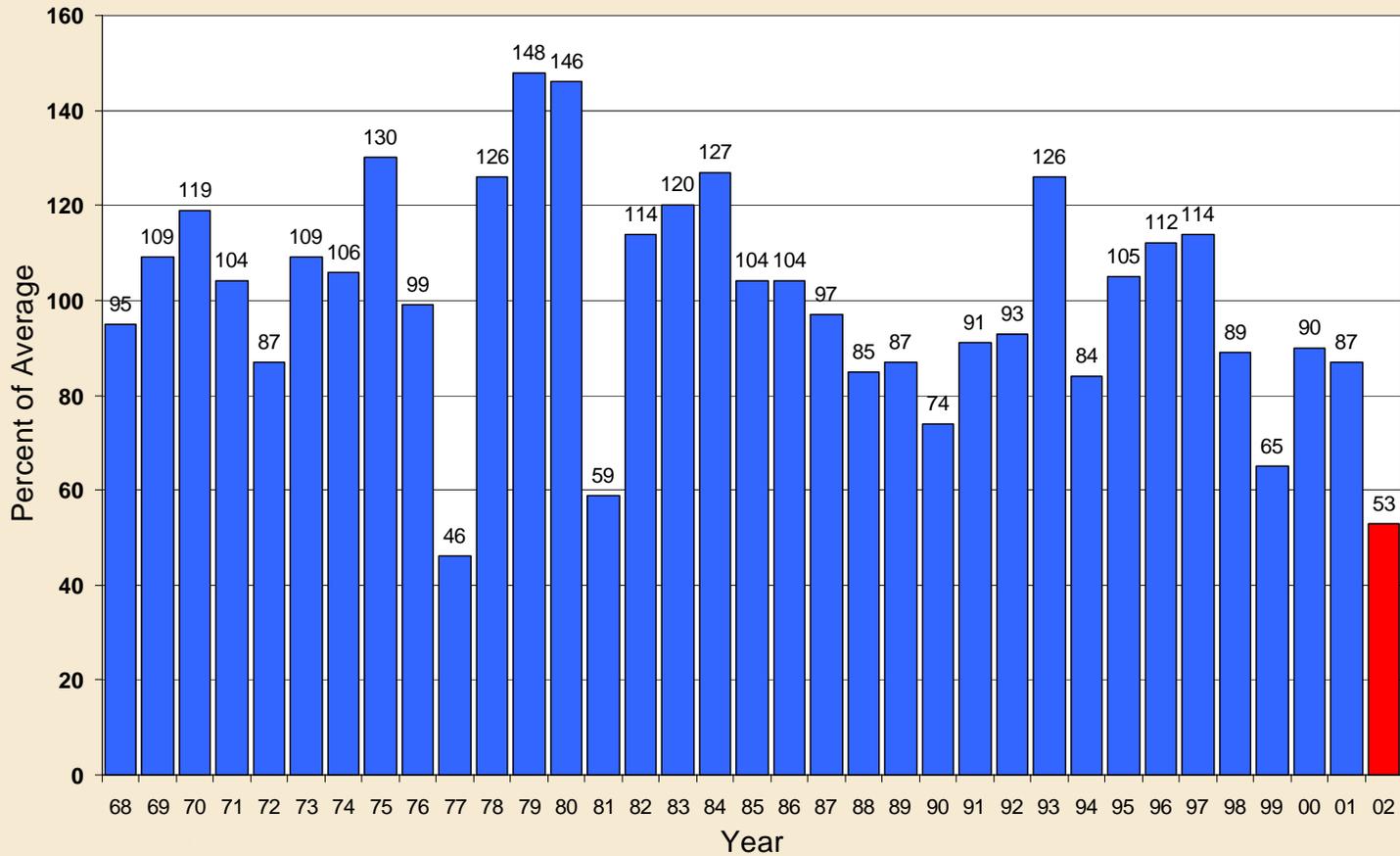
- January – below average precipitation in the mountains
- February – very little precipitation
- March – statewide snowpack 53% of average
- April – almost no precipitation, record high temperatures, rapid snowmelt, high fire danger





Drought of 2002

APRIL 1 SNOWPACK COLORADO STATEWIDE





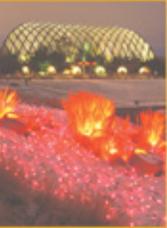
Drought of 2002

May also failed us

- Only one significant storm
- High evaporation rates
- Severe drought
- Strict water conservation regulations
- Forest fires



Steamboat Springs Fire



Drought of 2002

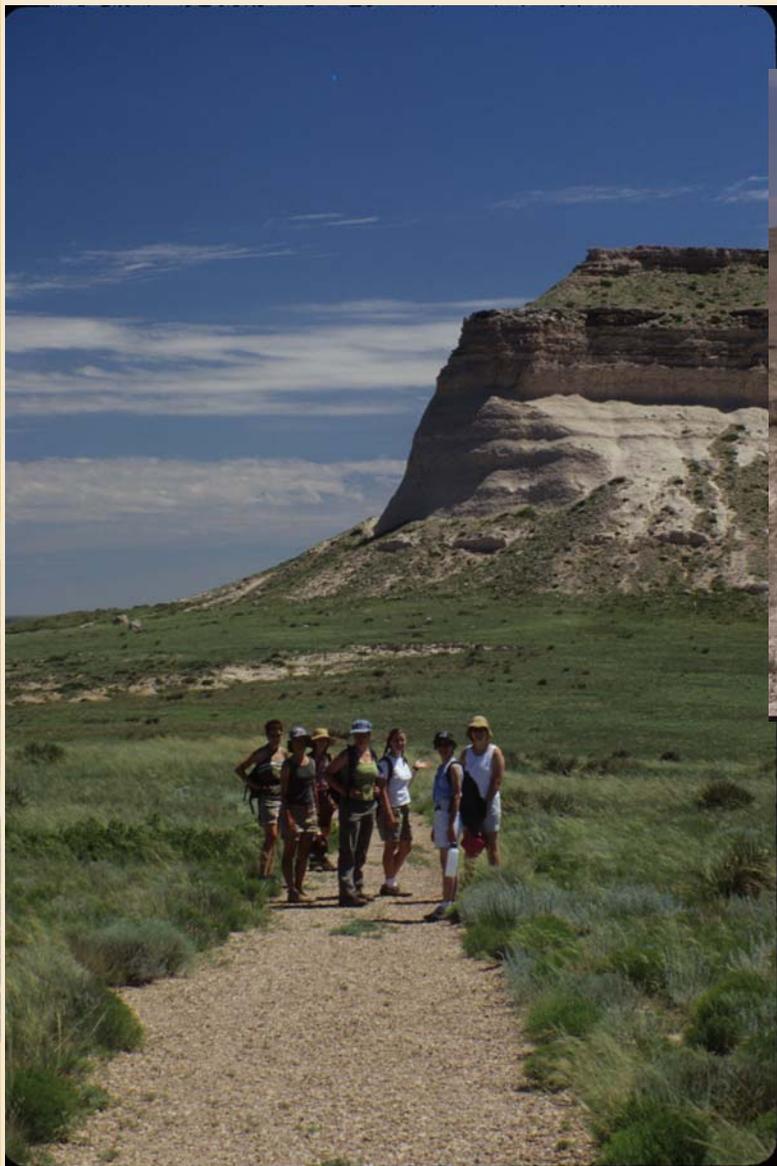
June 2002

- Intense heat
- Extreme low streamflows
- Rapidly depleted reservoirs
- RH often dropped to $<10\%$
- Severe agricultural impacts
- Urban water restrictions
- Most severe fires of the season



**Hayman Fire
Largest in Recent History**

Drought of 2002

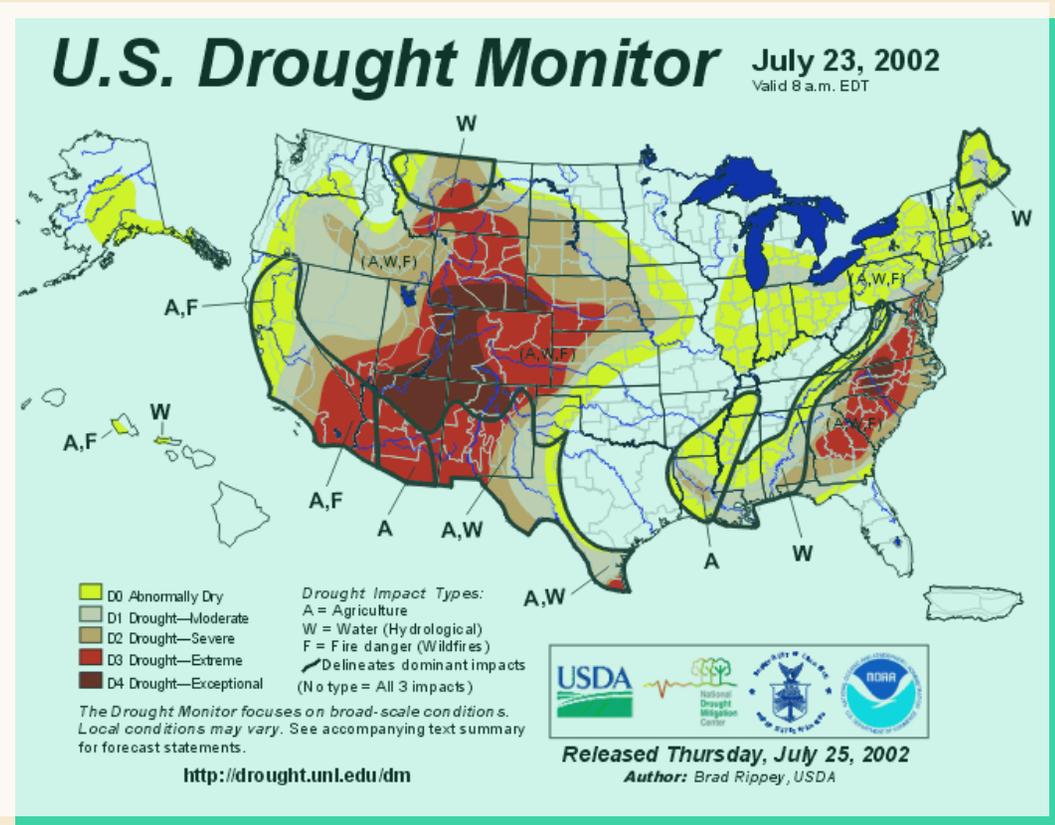


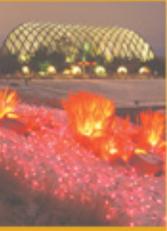
Pawnee Buttes Grasslands

June 27, 1999 & 2002

Drought of 2002

- By late July 2002, Colorado near epicenter of extensive regional drought
- Nearly every part of the state experiencing drought





Drought of 2002

- August - precipitation was below average
- September - above average rainfall.
Temperatures were still warmer than average, but with the cooler air of fall, frequent showers and a few soaking rains, grasses actually began to green up a bit.
- The worst of the 2002 drought was at last behind us.

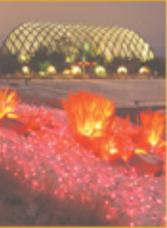


Drought in Colorado

Historic Analysis of Wet and Dry Periods

Fraction of Colorado Dry for 24 Months			
Dates	Dry	Wet	Duration
1893-1905	X		12 years
1905-1931		X	26 years
1931-1941	X		10 years
1941-1951		X	10 years
1951-1957	X		6 years
1957-1959		X	2 years
1963-1965	X		2 years
1965-1975		X	10 years
1975-1978	X		3 years
1979-1999		X	20 years
1999-2002	X		4 years





Drought Impact on Gardeners

- Water restrictions
- No watering between 9:00 AM and 6:00 PM
- Only 15 minutes per zone
- 2x per week / 1x per week
- Citation for those not following restrictions
- Many homeowners stopped gardening



Drought Response by DBG

Water-Smart

Gardening™

Committee formed

- Develop consistent message
- Determine methods of communicating to the community





Drought Response by DBG

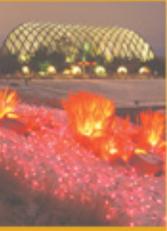
Key components of messaging and communications were determined as:

- The primary terminology to be used is Water-Smart Gardening™ rather than drought.
- Communication process - 5 key elements:
 - I - Inspiration
 - D - Demonstration
 - E - Education - Water-Smart Gardening™ symposium was launched in collaboration with Denver Water
 - A - Alliances (Collaboration)
 - S - Success through Innovation
- A list of Water-Smart Gardening™ Tips was designed to ensure a consistent message within DBG and to promote that message.



Drought Response by DBG

- Garden changes started in 2000 – many gardens were changed from high to medium, low or no water use
- Change in gardening habits





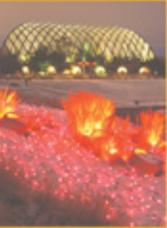
Drought Response by DBG

- Reduced water use
– reduced from 14 million gallons per year to 9 million gallons
- Reduction in containers and innovative use of plant material





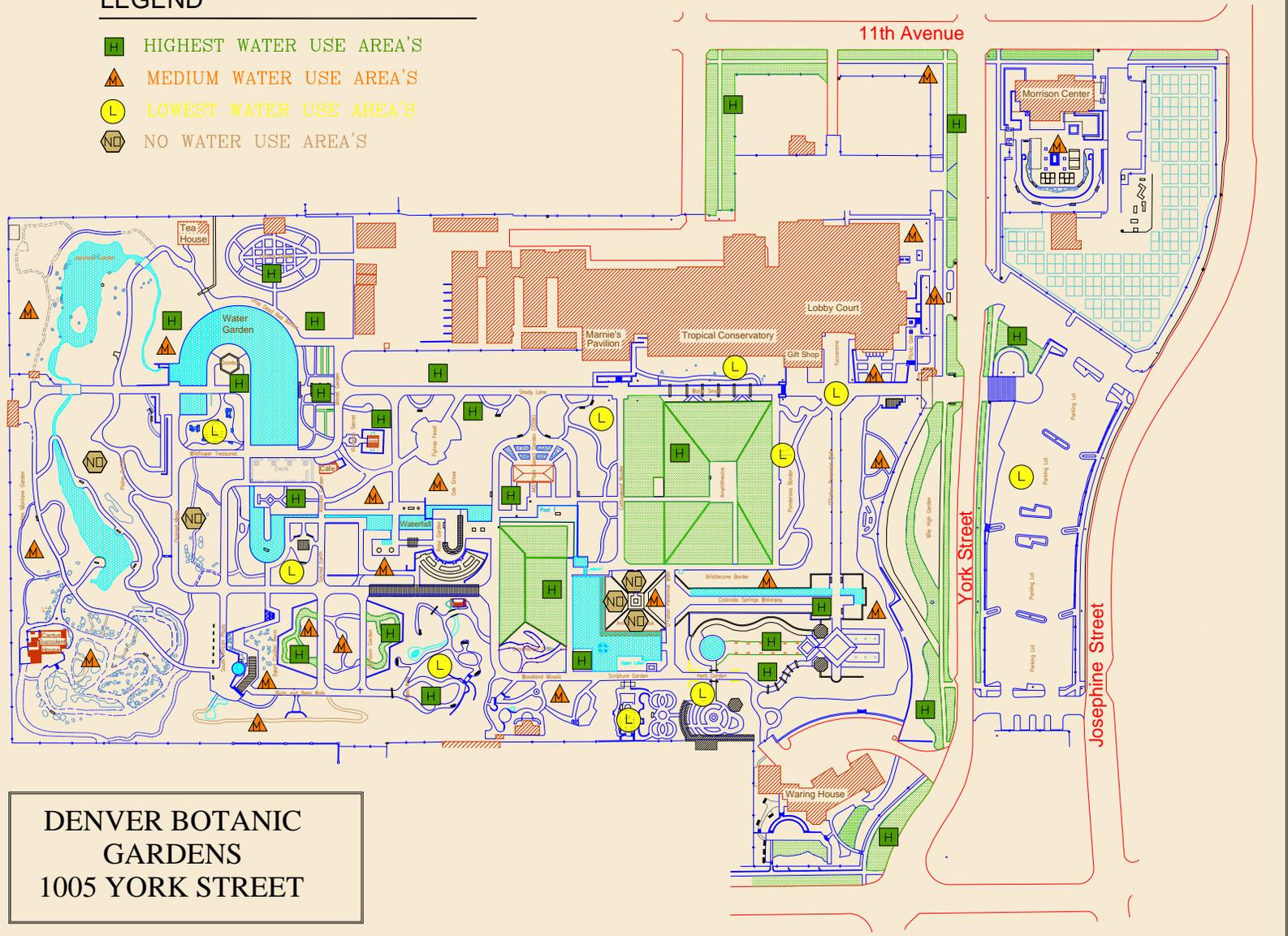
Drought Response by DBG



Garden Water Usage

LEGEND

- HIGHEST WATER USE AREA'S
- ▲ MEDIUM WATER USE AREA'S
- L LOWEST WATER USE AREA'S
- ◻ ND NO WATER USE AREA'S



DENVER BOTANIC
GARDENS
1005 YORK STREET





Garden Changes

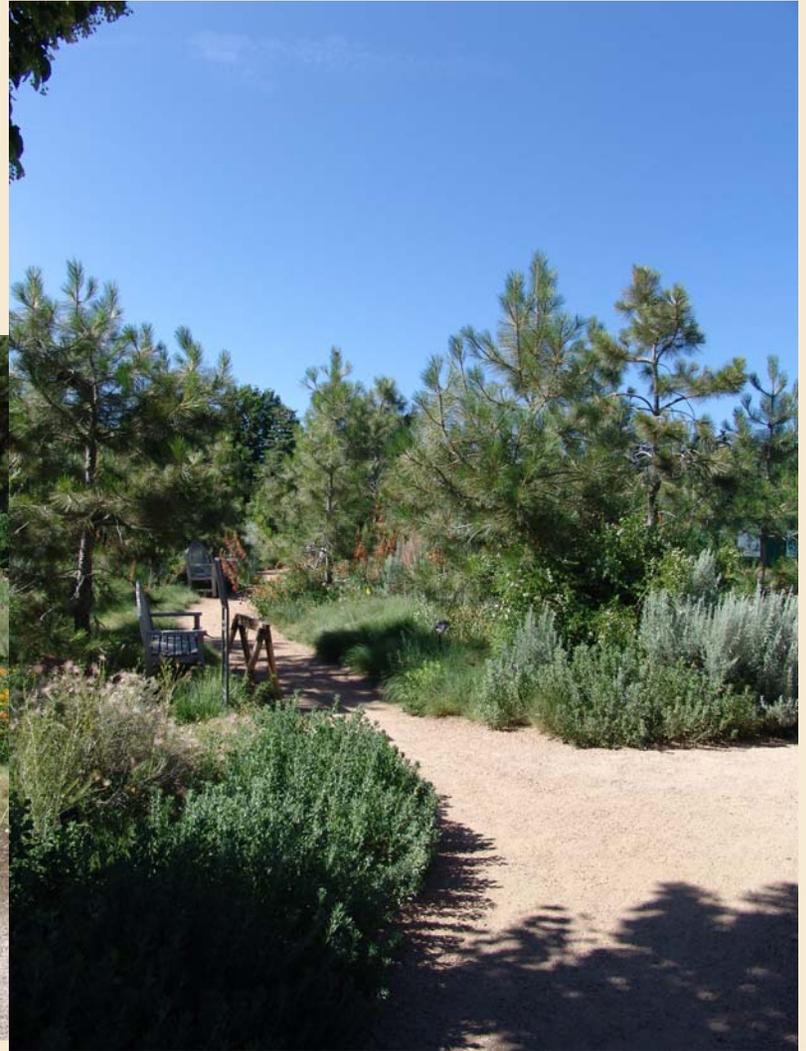
Anna's Overlook
– High to No
water





Garden Changes

Ponderosa and
Cottonwood Borders
– High to Low





Garden Changes

Bristlecone Border –
High to Medium





Garden Changes

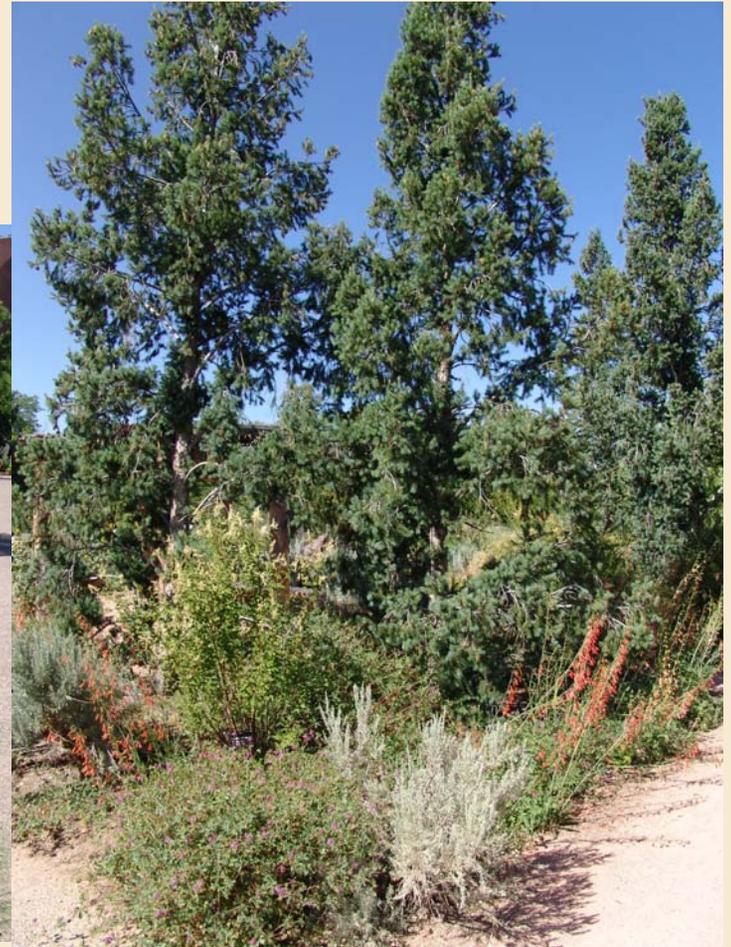
Plant Asia (Steppe area)
– High to Low





Garden Changes

Sacred Earth – High to
Low





Garden Changes

Wildflower Treasures – High to Low





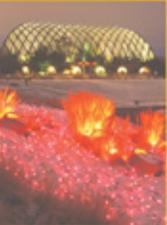
Garden Changes

Yuccarama – Medium to low





Sustainability – Biodiversity Conservation Mt. Goliath



• DBG's satellite
Alpine Rock
Garden

• A sub-peak of Mt.
Evans, located at
12,216 ft. above
sea level





Mt. Goliath

- 1960's – Walter Pesman Trail built





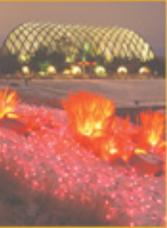
Mt. Goliath

2003

- Dos Chappell Nature Center
- Expansion of Alpine Rock Garden
- Interpretation



Mt. Goliath – Dos Chappell Nature Center





Mt. Goliath – Garden construction

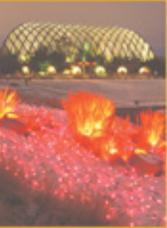


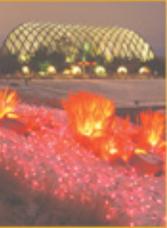


Mt. Goliath – Garden construction



Mt. Goliath – Dos Chappell Nature Center & Garden





Mt. Goliath

Alpine Plant communities present in this location:

- Dry meadow
- Wet meadow
- Krummholz
- Fellfield
- Bristlecone pine forest
- Crevice, Talus and Scree slopes



Mt. Goliath – Dry Meadow





Mt. Goliath – Wet Meadow



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Mt. Goliath – Krummholz





Mt. Goliath - Fellfield





Mt. Goliath – Bristlecone Pine Forest



Mt. Goliath – Crevice, Talus, Scree Slopes



Thank You!

