



# Revised 2010 Colorado Drought Mitigation and Response Plan

September 14<sup>th</sup>, 2010

CWCB Board Meeting, Grand Junction



# Presentation Outline

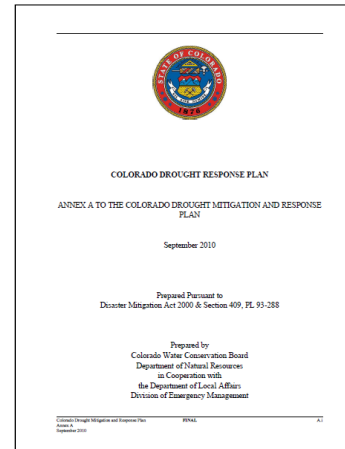
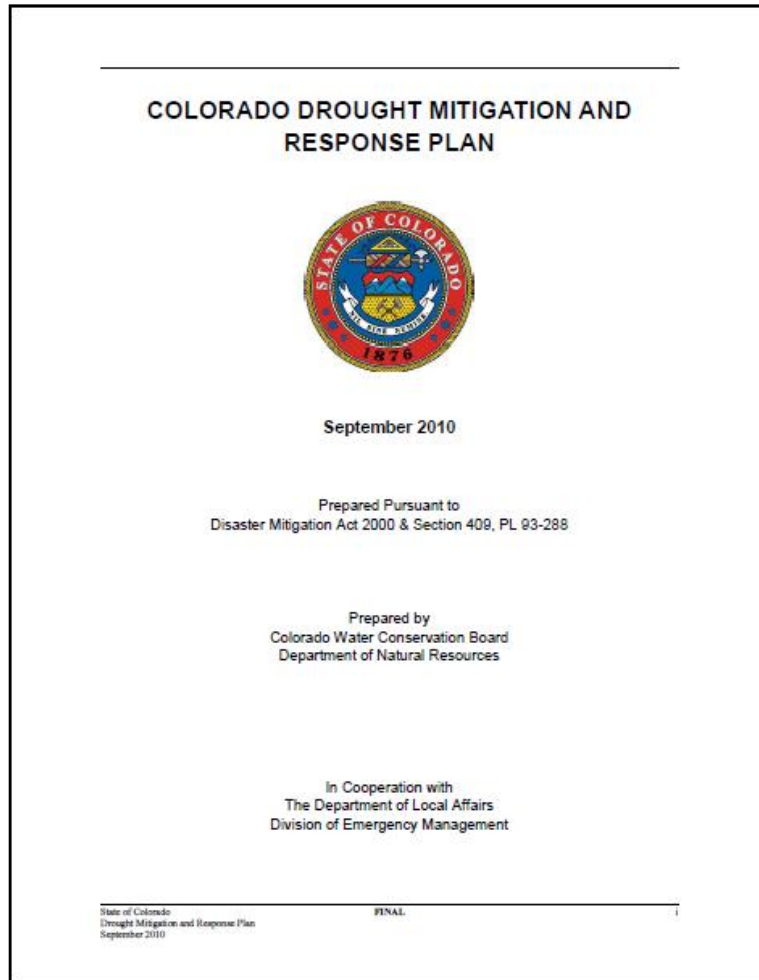


- Plan orientation
- Main Plan Document
- Annex A: Response Plan
- Annex B: Vulnerability Assessment
- Annex D: Drought Monitoring Indices
- Drought planning resources

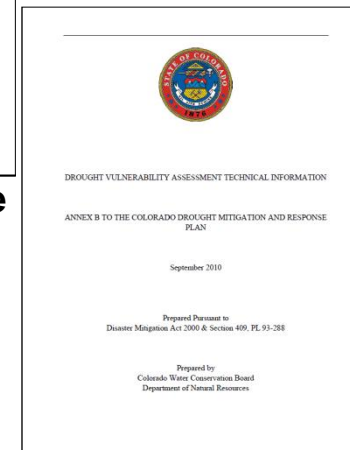




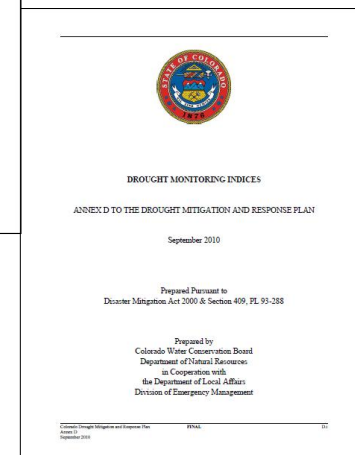
## Drought Mitigation and Response Plan



## Drought Response Plan



## Vulnerability Assessment



## Drought Monitoring Indices

# Plan Elements



## Drought Mitigation and Response Plan

Main base document outlining the State's drought mitigation and response strategies. This document also contains key finding from the appendices and annexes described below.

### Annex A: Drought Response Plan

All of the drought response elements have been consolidated into this annex.

### Annex B: Drought Vulnerability Assessment

An enhanced drought vulnerability assessment approach that highlights drought exposure and adaptive capacity for sectors and state assets, county-by-county within Colorado.

- |   |                         |
|---|-------------------------|
| ▪Drought Vulnerability Assessment Technical Information | ▪Energy                 |
| ▪State Assets   | ▪Environmental          |
| ▪Agriculture  | ▪Municipal & Industrial |
|   | ▪Recreation             |
|   | ▪Socioeconomic          |

## Annex B: Climate Change Implications

A high level analysis of possible implications of climate change for drought in Colorado based on previous studies and enhanced analysis of the Colorado River Water Availability Study results.

## Annex E: Drought Monitoring Indices

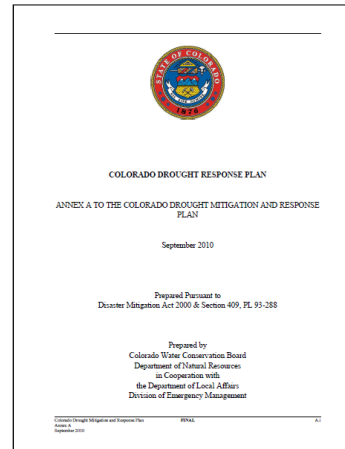
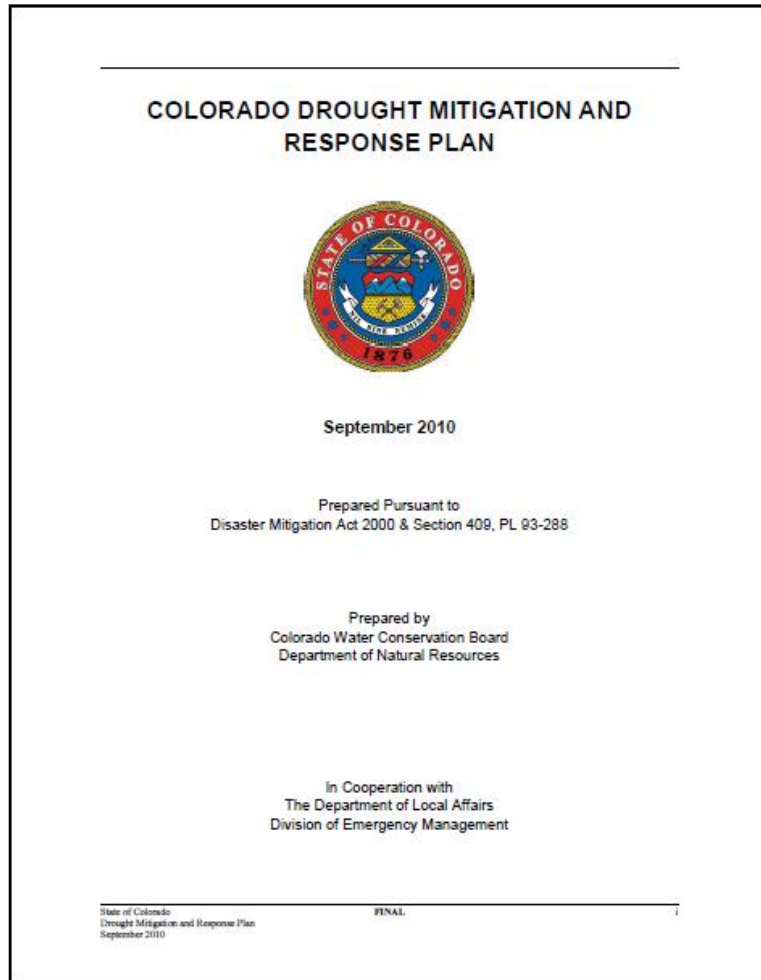
An evaluation and integration of drought monitoring indices and their role and use in Colorado's Drought Mitigation and Response Plan.

## Appendices (A-E)

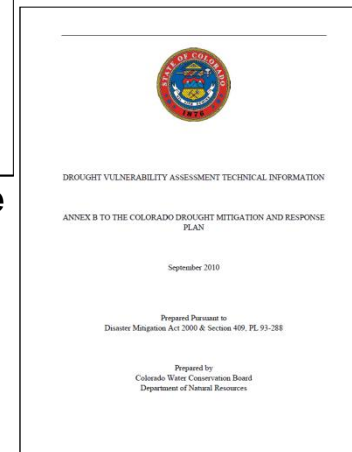
- Drought Mitigation and Response Planning Committee
- Actions Taken to Reduce Drought Impacts in Previous Droughts
- Drought Mitigation Capabilities Summary
- References
- Definitions and Acronyms



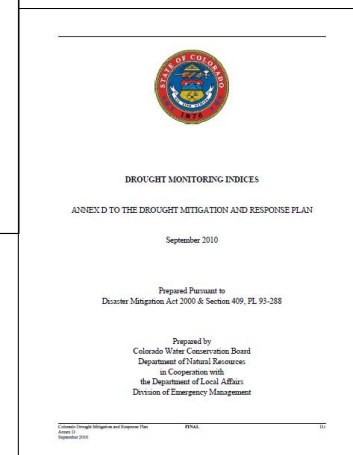
## Drought Mitigation and Response Plan



## Drought Response Plan



## Vulnerability Assessment



## Drought Monitoring Indices



# Benefits of the Newly Revised Drought Plan



- Reduced Losses (economic, social, physical, etc..)
- Efficient, Coordinated Government
- Reduced Liability
- Reduced State and Local Expenditures
- Includes Continued Eligibility for Mitigation Funding
- Increased Collaboration



# Drought Mitigation and Response Plan Goals



1. Improve Water Availability Monitoring and Drought Impact Assessment
2. Increase Public Awareness and Education
3. Support Substitute Water Supply Plans and Leasing Options to Augment Water Supply
4. Coordinate and Provide Technical Assistance for State, Local, and Watershed Planning Efforts
5. Reduce Water Demand/Encourage Conservation
6. Reduce Drought Impacts to Colorado's Economy, People, State Assets, and Environment.
7. Develop Intergovernmental and Interagency Stakeholder Coordination
8. Evaluate Potential Impacts from Climate Change





# Key Changes in the 2010 Plan Revision



## Planning Process

- Extensive planning effort documented
- Multi-agency outreach and coordination
- More clearly defined and revised plan maintenance process

## Vulnerability Assessment

- Revised with latest climate science
- Developed drought vulnerability methodology
- Includes EMAP consequence analysis
- Updated drought indices



# Key Changes in the 2010 Plan Revision



## Coordination of Local Mitigation Planning

- Information revised with changes and assistance provided in past 3 years

## Mitigation Strategy

- Goals re-assessed and revised to reflect current priorities
- Mitigation Action table expanded and organized by goal
- Actions revised and prioritized
- New actions developed
- Comprehensive capability assessment review
- Funding sources revised



# Key Changes in the 2010 Plan Revision



## Drought Response Plan Annex

- Response elements from 2002 plan consolidated in Annex.
- NIMS compliant response and recovery plan format
- Streamlined response framework
- Consolidated Impact Task Force framework



# Mitigation Action Strategy



- Sample actions include:
  - Collect climatologic data at mid & lower elevations to fill existing gaps in the data collection network
  - Integrate and correlate the State Drought Mitigation Plan with other statewide planning efforts
  - Develop a state-wide drought messaging campaign
  - Require drought planning by Colorado municipalities, water providers and large agricultural producers
  - Construction of water storage facilities on State Trust Land
  - Integrate results, tools and methods from the 2010 vulnerability assessment to improve local hazard mitigation plans
  - Evaluate the relationship/interaction between both drought and water conservation on water quality of streams as well as health related consequences
  - Continue to pursue improved climate data to inform the planning process



## Drought Mitigation and Response Plan

### COLORADO DROUGHT MITIGATION AND RESPONSE PLAN



September 2010

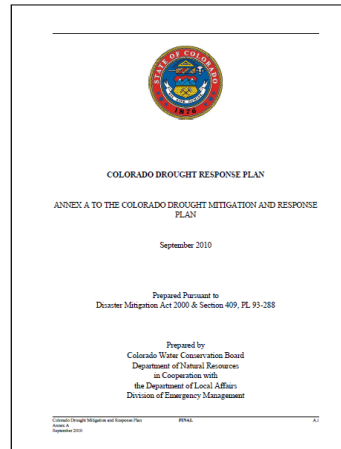
Prepared Pursuant to  
Disaster Mitigation Act 2000 & Section 409, PL 93-288

Prepared by  
Colorado Water Conservation Board  
Department of Natural Resources

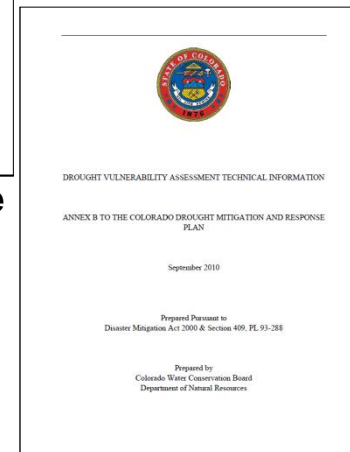
In Cooperation with  
The Department of Local Affairs  
Division of Emergency Management

State of Colorado  
Drought Mitigation and Response Plan  
September 2010

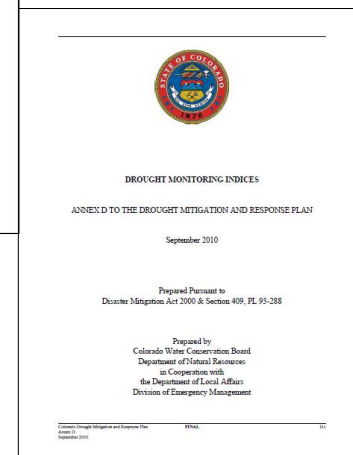
FINAL



### Drought Response Plan



### Vulnerability Assessment



### Drought Monitoring Indices

# Response Element Key Updates



- Aligned with modern emergency planning guidelines
- Impact Task Force structure evaluated modified
- Response framework evaluated, modernized and streamlined
- Roles and responsibilities of state agencies updated
- Roles and responsibilities of Impact Task Forces updated and clarified

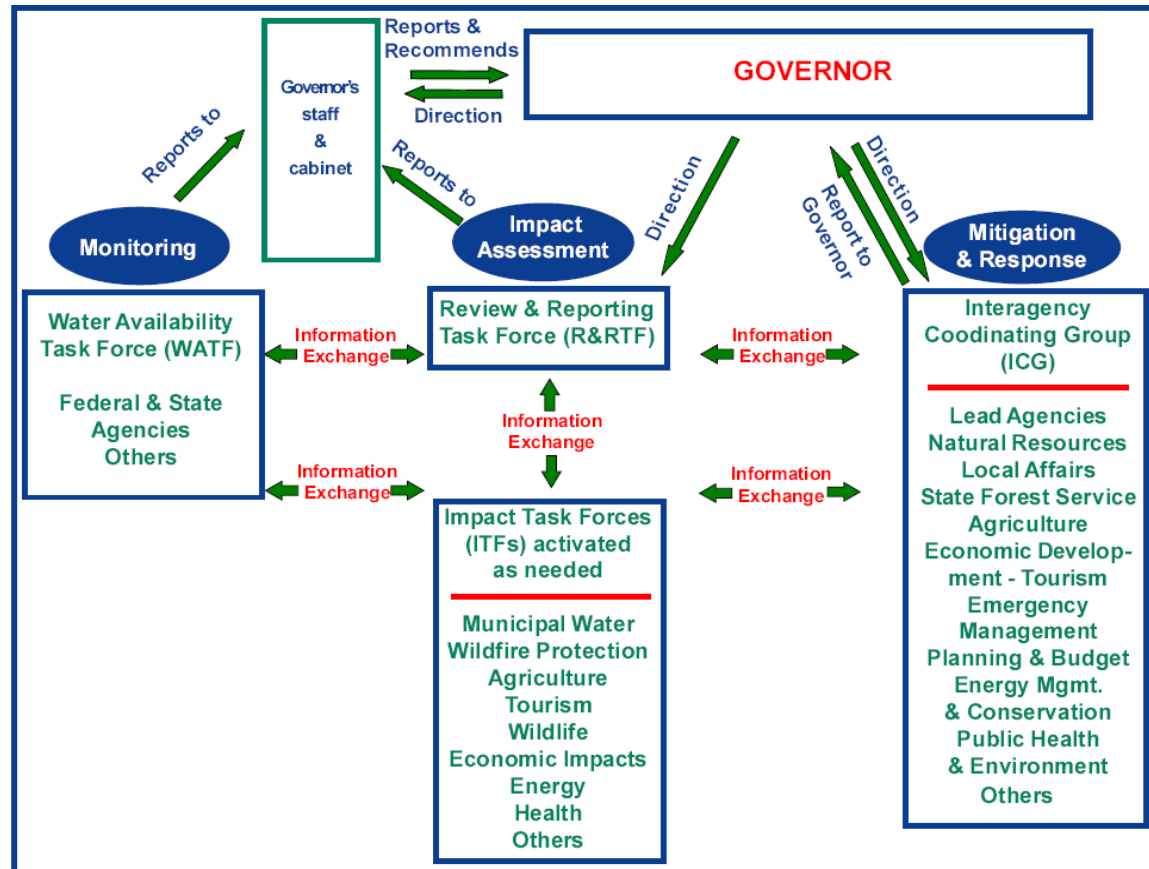




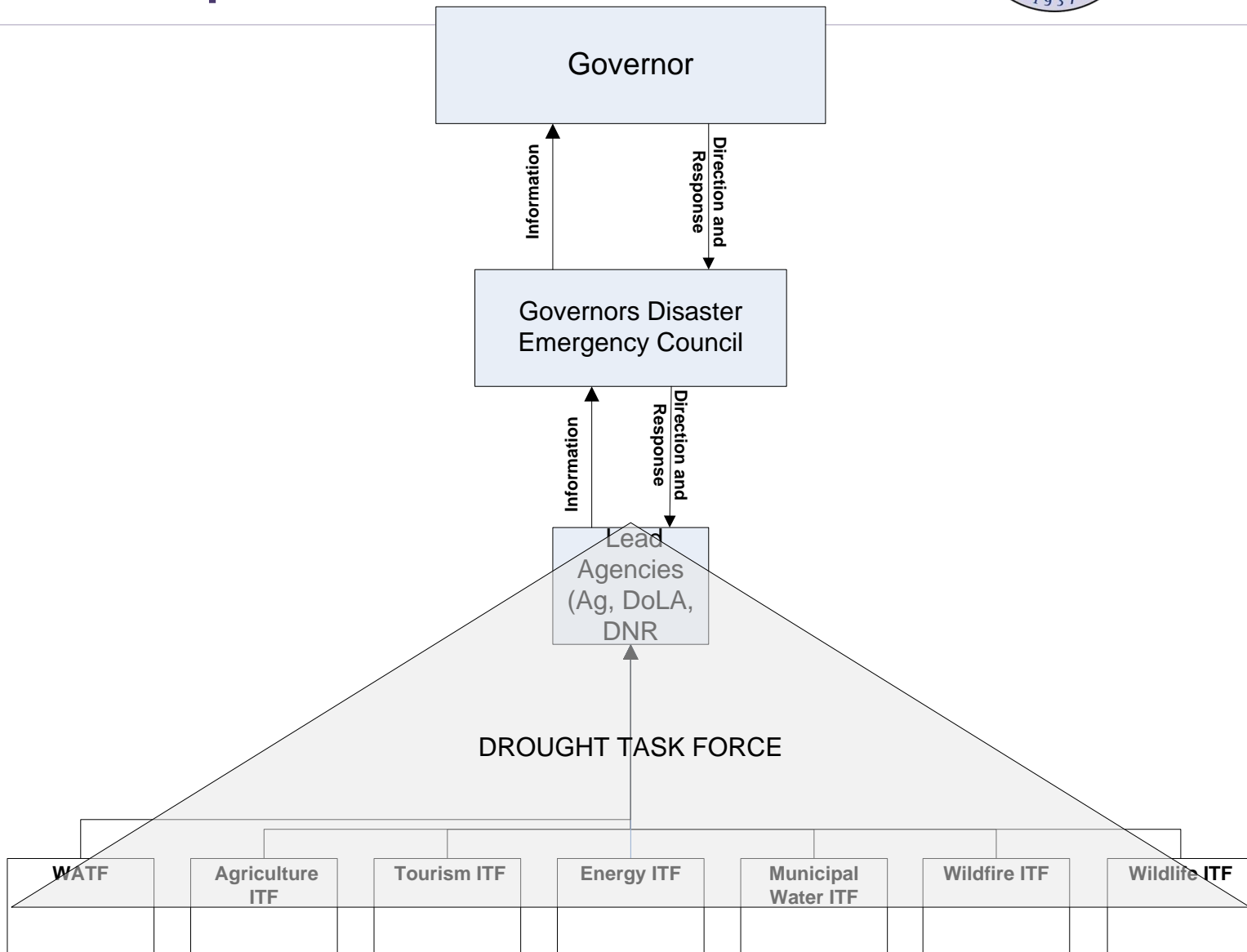
# Previous Response Framework



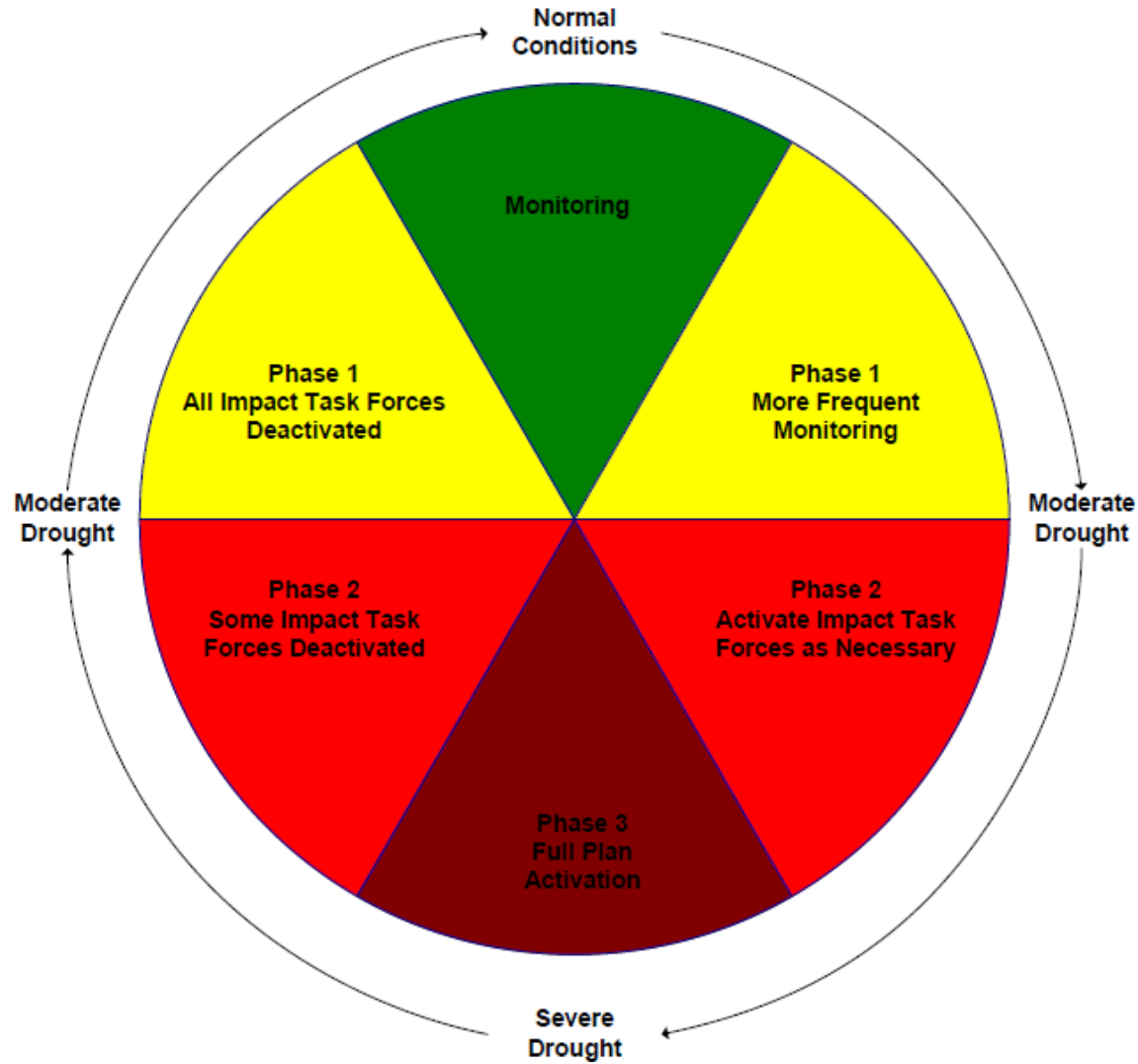
- WATF
- Agriculture ITF
- Tourism ITF
- Economic ITF
- Energy ITF
- Health ITF
- Municipal Water ITF
- Wildfire ITF
- Wildlife ITF



# Revised Response Framework



# Revised Plan Implementation Cycle



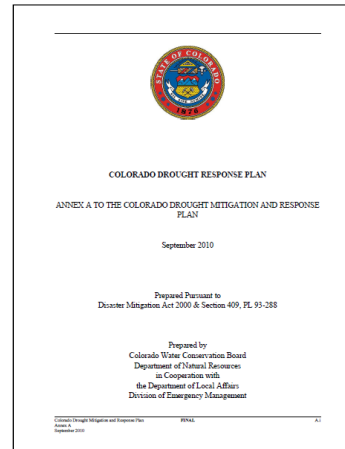
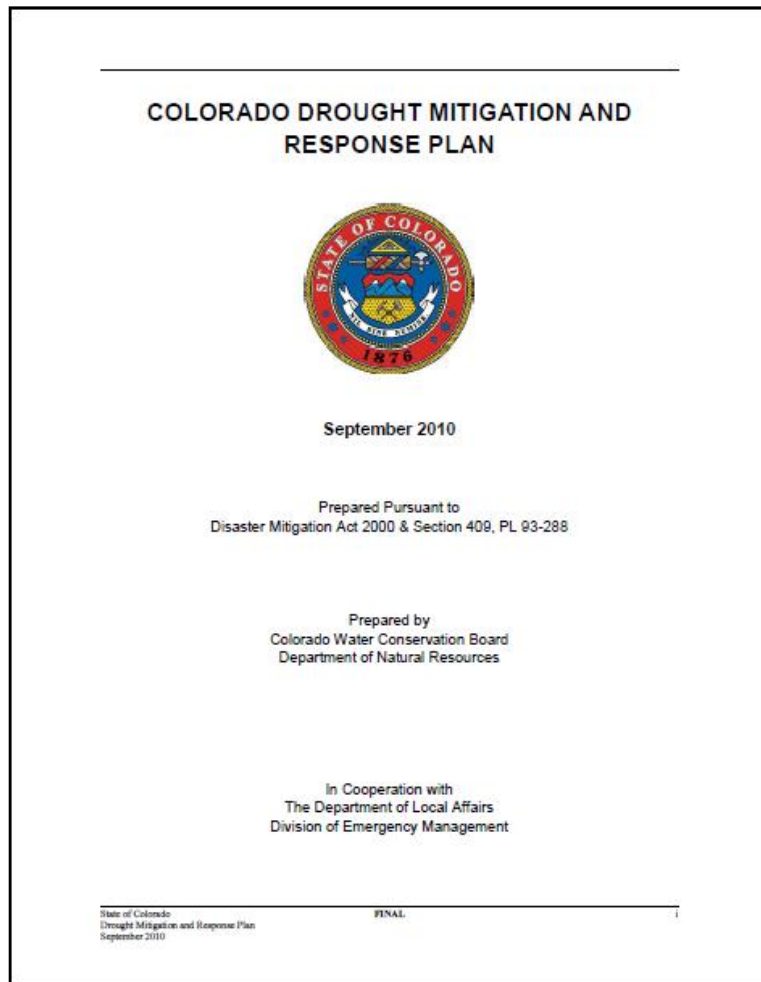
# Revised Drought Response Summary Action Table



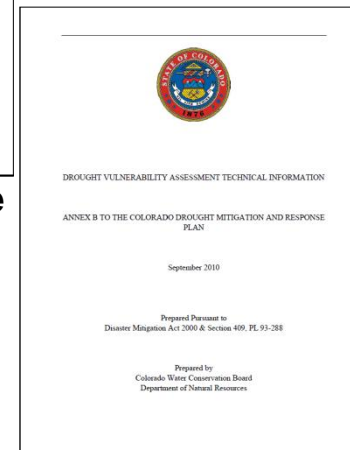
Severity Indicators and Impacts	Drought Phase and Response Summary	Actions to be Considered
<ul style="list-style-type: none"> <li>-0.5 to positive SPI (six month)</li> <li>D0 Abnormally Dry</li> <li>CMPDI or SWSI: -1.0 to -1.9</li> <li>SPI: -0.5 to -0.7</li> </ul>	Normal Conditions Regular Monitoring	<ul style="list-style-type: none"> <li>CWCB/WATF monitors situation on monthly basis.</li> <li>Data reviewed for drought emergence and summarized in Governor's Drought Situation Report.</li> <li>Implement long term mitigation actions</li> <li>ITF chairs meet twice yearly</li> </ul>
<ul style="list-style-type: none"> <li>-0.6 to -1.0 SPI (six month)</li> <li>D1 Moderate Drought</li> <li>CMPDI or SWSI: -2.0 to -2.9</li> <li>SPI: -0.8 to -1.2</li> </ul>	<b>Phase 1</b> More close monitoring of conditions for persisting or rapidly worsening drought; Official drought not yet declared	<ul style="list-style-type: none"> <li>ITF chairs alerted of potential for activation, monitoring of potential impacts</li> <li>Assess need for formal ITF and DTF activation</li> <li>DTF Lead Agencies (CDA/DoLA/DNR) notified of need for potential activation</li> </ul>
<ul style="list-style-type: none"> <li>Less than -1.0 SPI (six month)</li> <li>D2 Severe Drought</li> <li>CMPDI or SWSI: -3.0 to -3.9</li> <li>SPI: -1.3 to -1.5</li> </ul>	<b>Phase 2</b> Drought Task Force and Impact Task Forces are activated; Potential Drought Emergency declared	<ul style="list-style-type: none"> <li>Governor's Memorandum activates the Drought Task Force and necessary Impact Task Forces.</li> <li>Department of Agriculture initiates Secretarial Disaster Designation process if appropriate</li> <li>ITF's make an initial damage or impact assessment.</li> <li>ITF's recommend opportunities for mitigation to minimize or limit potential impacts</li> <li>Relevant state agencies undertake response and incident mitigation actions with their normal programs with available resources</li> </ul>
<ul style="list-style-type: none"> <li>Less than -1.0 to -1.99 SPI (six month)</li> <li>D3 Extreme Drought to</li> <li>D4 Exceptional Drought</li> <li>CMPDSI or SWSI: -3.0 to -5 or less</li> <li>SPI: -1.3 to -2.0 or less</li> </ul>	<b>Phase 3</b> Drought Emergency is declared by Proclamation of the Governor.	<ul style="list-style-type: none"> <li>Governor's Proclamation of drought emergency.</li> <li>Governor's Proclamation activates the GDEC</li> <li>Activated ITFs continue to assess, report, and recommend response measures and incident mitigation.</li> <li>Unmet needs are reported to the DTF Chairs.</li> <li>The GDEC assembles the data to advise the Governor with recommendations to support a request for a Presidential Drought Declaration.</li> <li>Governor requests a Presidential Declaration.</li> </ul>



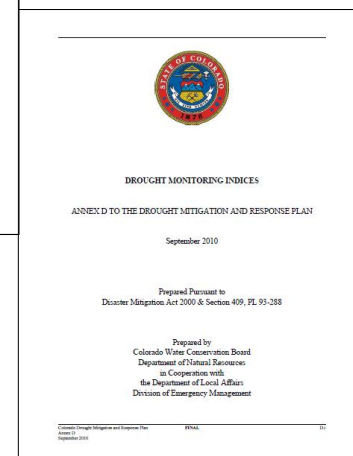
## Drought Mitigation and Response Plan



## Drought Response Plan



## Vulnerability Assessment



## Drought Monitoring Indices

# Definitions



**Risk Assessment:** The process of identifying the likelihood and consequences of an event to provide the basis for informed planning decisions on a course of action (FEMA 1992)

**Drought Risk** =

**Hazard**

x

**VULNERABILITY**

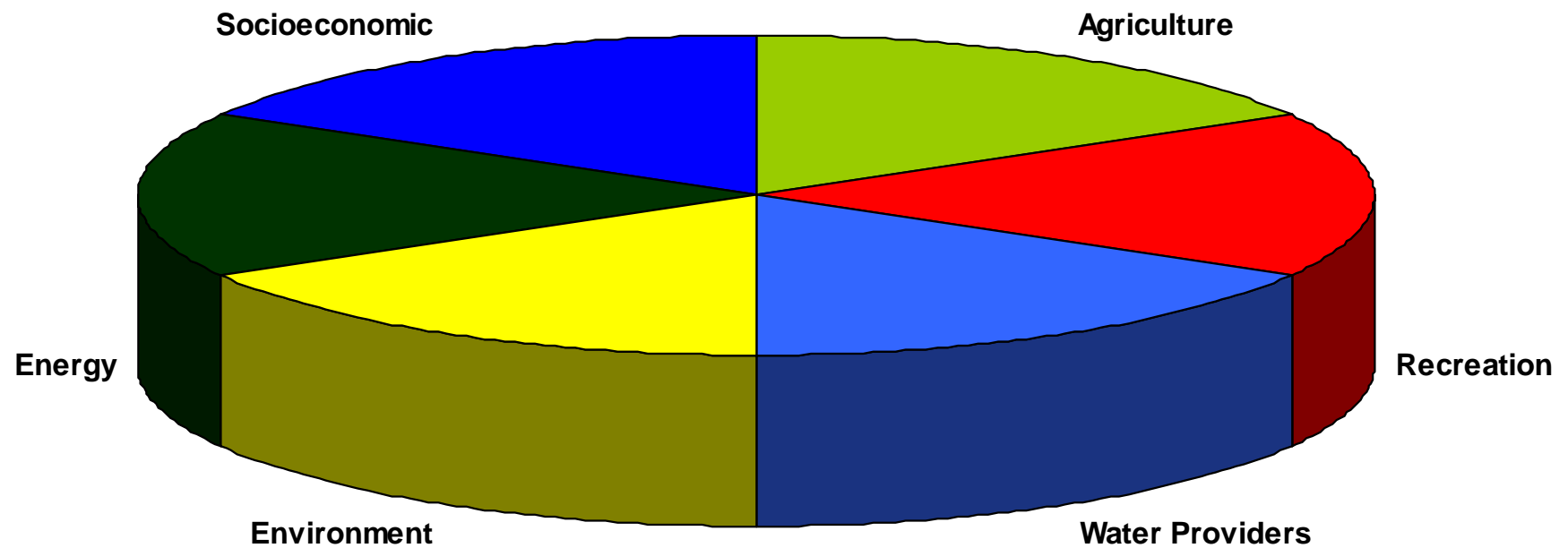
**Drought Hazard:** a period of abnormally dry weather sufficiently prolonged for the lack of water to cause serious hydrologic imbalance in the affected area."

**Vulnerability:** The susceptibility to injury or damage from hazards." (Godschalk 1991, 132)





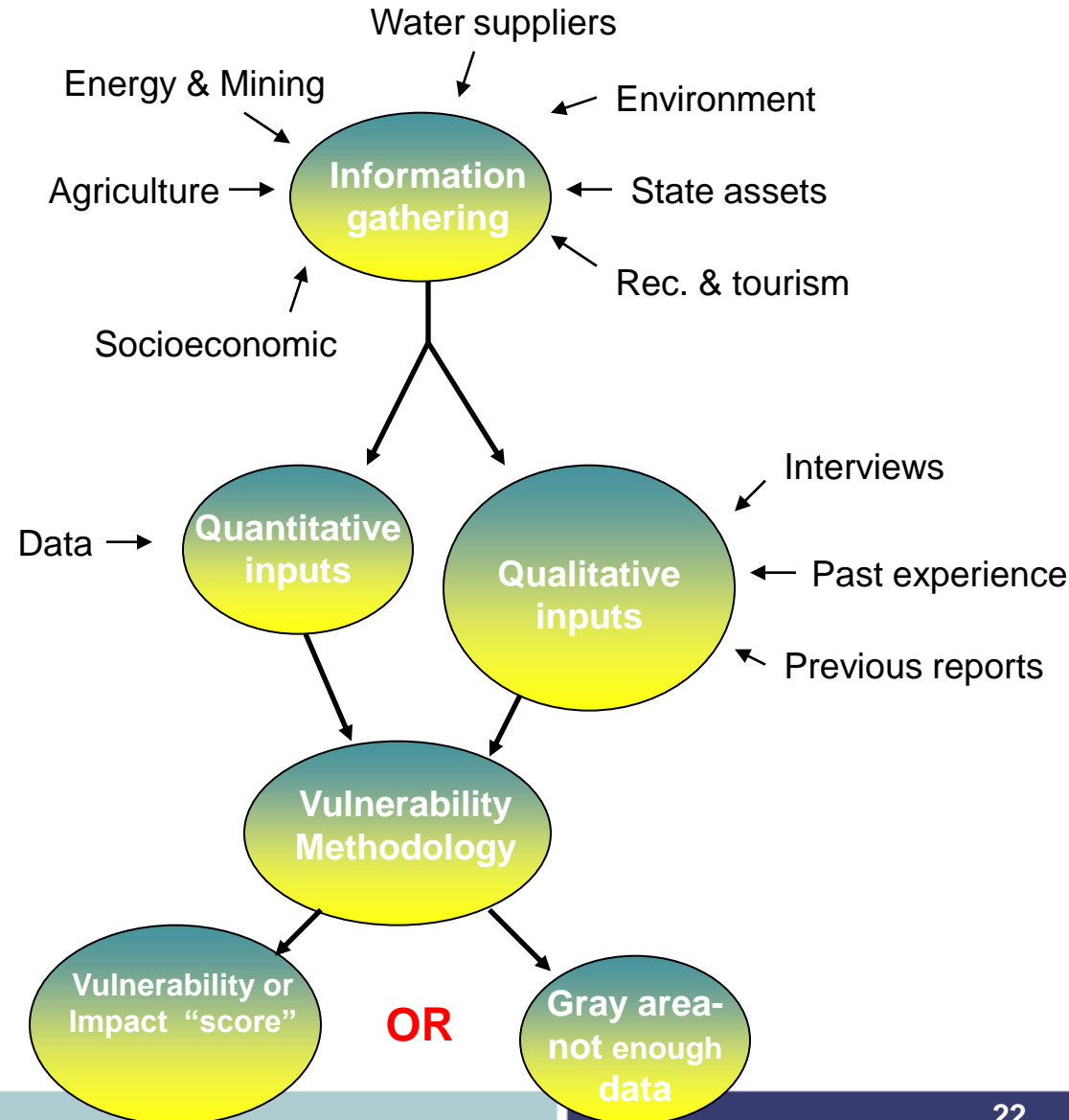
# Integrated System



# Methodological Framework



- Research sectors, publications, previous drought studies
- Quantitative data
  - What we have
  - What we need
- Qualitative
  - Interviews
  - Past experiences
  - Specific knowledge of the area
- Methodology
- Vulnerability “score” OR framework for future data collection



# State Assets: Key Findings



- Subsectors
  - Structures
  - Recreational revenue
  - Land Board revenue
  - Aquatic habitat
  - Protected areas
- State owned buildings are vulnerable to wildfires and loss of landscaping
- Critical infrastructure can be damaged by low water levels and debris flows
- State agencies dealing with the environment may have increased management requirements and decreased revenue
- Impacts to protected areas and species can be severe, including those with instream flows



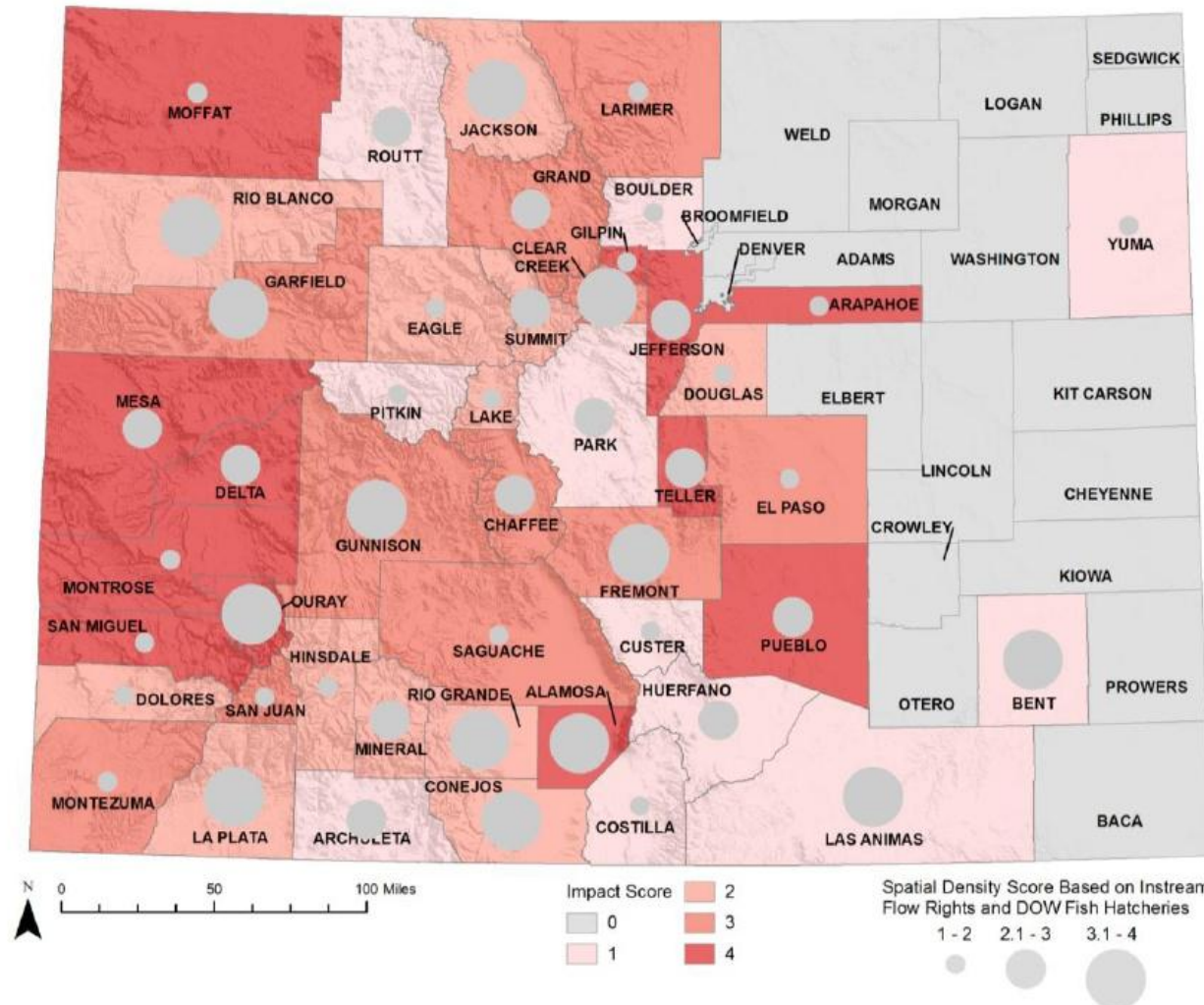
# State Assets: Key Recommendations



- Increased drought awareness in planning by all state agencies
- Every agency should be aware of their specific vulnerabilities and have response policies in place
- Media coordination plans should be developed before drought occurs
- Increased monitoring to aid future vulnerability assessments.



# Aquatic Habitat Inventory and Impact Scores



# Agriculture: Key Findings



- Subsectors
  - Crops
  - Livestock
  - Green Industry.
- Key drought vulnerabilities for crops include crop loss from lack of precipitation or insufficient irrigation, and possible damage to crops due to reduced quality of irrigation water.
- The livestock sub-sector focuses on impacts to grazing cattle, which can be vulnerable to drought due to limited forage availability.
- The green industry is vulnerable to municipal water restrictions as well as water-availability reductions that could cause plant loss.





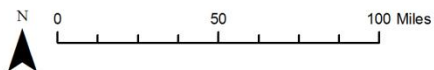
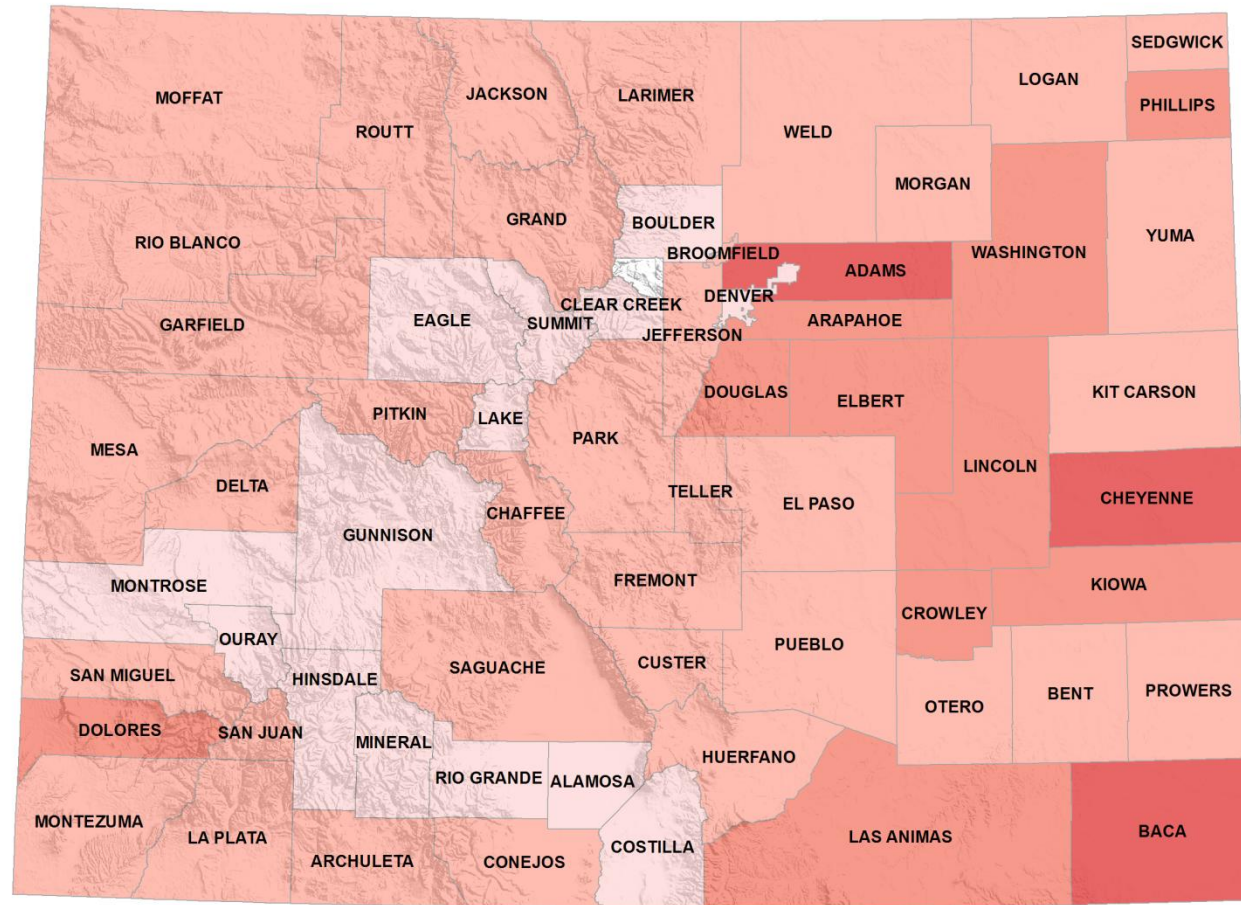
# Agriculture: Key Recommendations



- Crop diversification and advanced planning for drought scenarios.
- Best management practices developed by the green industry might have applications for irrigated crop producers, and a formal set of best management practices could be developed for dryland farmers.
- Crop specific vulnerability assessments.
- Additional data collection on the green industry.



# Overall Agriculture Vulnerability Scores



Vulnerability Score



# Environment: Key Findings



- Colorado's natural environment is diverse and drought vulnerabilities are expected to vary spatially based on ecology and current precipitation regimes.
- In the 2002 drought significant impacts to fish populations were noted.
- Increased wildfires and beetle infestation are common secondary drought impacts.
- Monitoring resources are limited and comprehensive impact information even for the most recent drought is not available.



# Environment: Key Recommendations

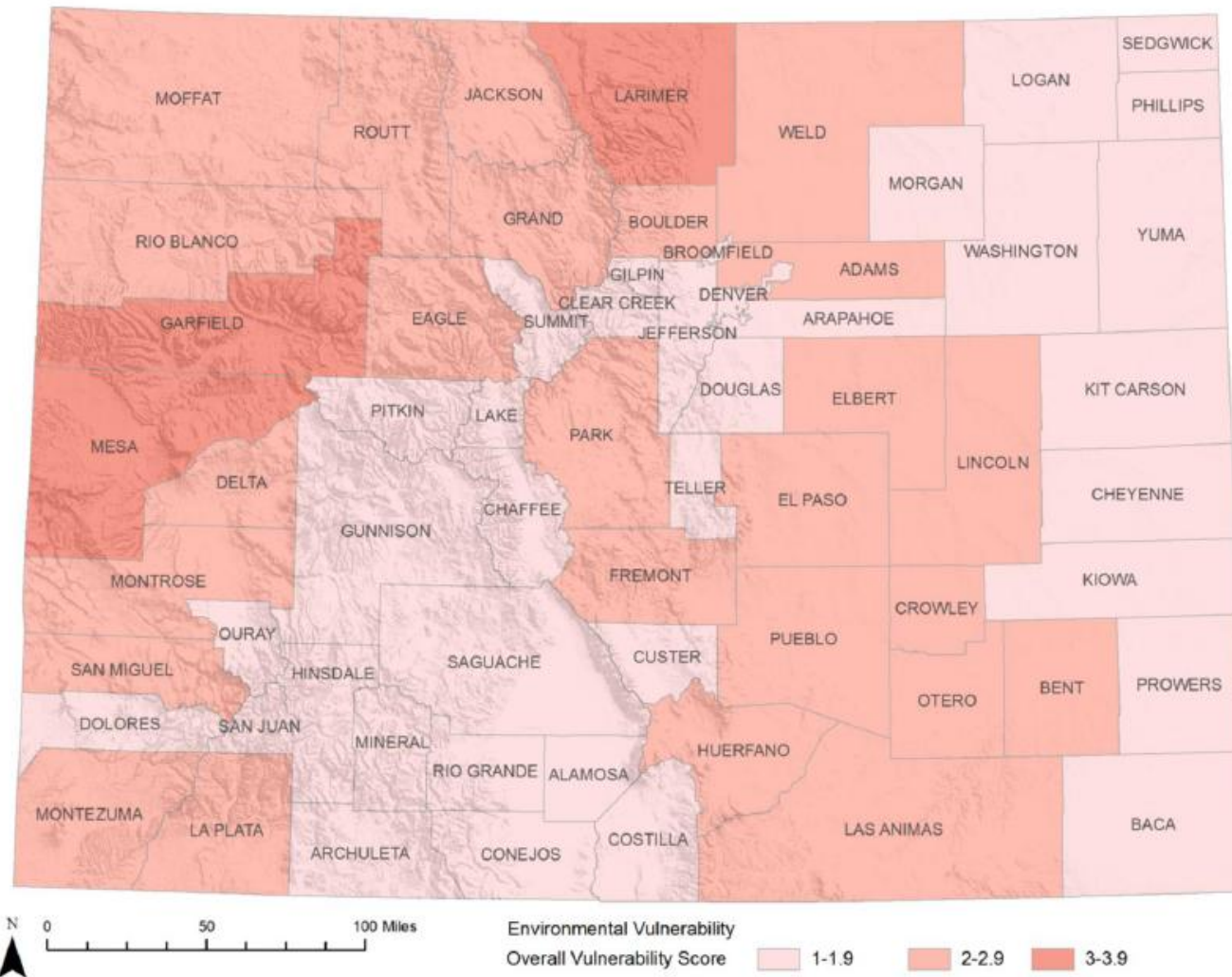


- Identification of critical areas and additional monitoring.
- Cross agency collaboration on monitoring efforts.
- Additional analysis of previous studies conducted in the Colorado.
- Future work should, where possible build on the foundation of previous studies that have been conducted.
- As additional data becomes available the drought vulnerability metrics used in this analysis should be update.





# Overall Environmental Vulnerability Scores



# M&I: Key Findings

- Drought vulnerability depends on the reliability of a water supply system during a drought and the ability to effectively respond.
- Vulnerability is can vary greatly based on the following categories:
  - Water supply
  - Water distribution
  - Water demand
  - Adaptive capacity
- A quantitative vulnerability assessment would require consideration of the uniqueness of each M&I provider and was beyond the scope of this study.
- A qualitative assessment of M&I vulnerability at regional basin-wide level was found to be appropriate for this study.



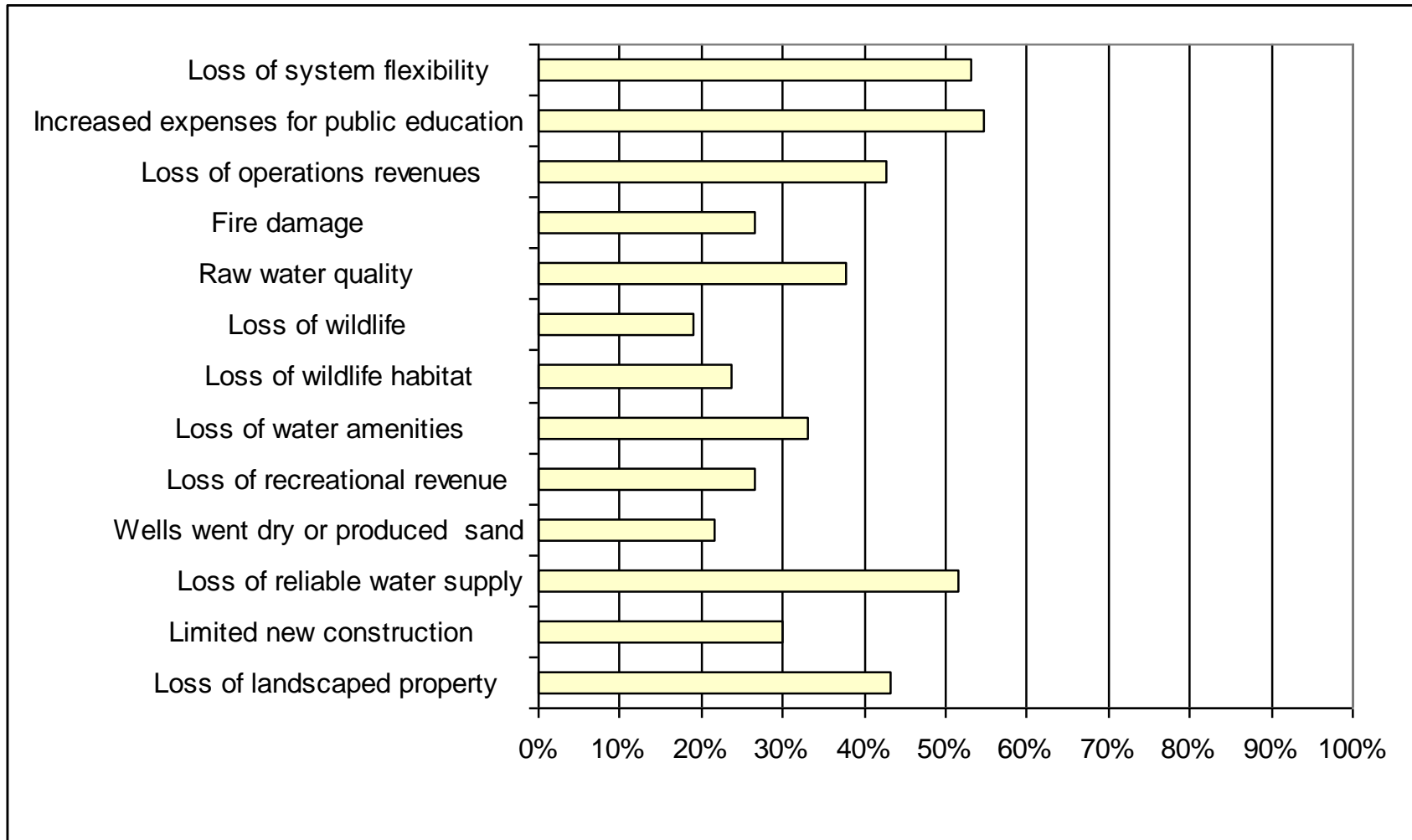


# M&I: Key Recommendations

- Encourage local policy that enforces the development or acquisition of reliable water supplies for growing communities.
- Develop state policy requiring/encouraging M&I providers to develop drought plans.
- Continue to provide technical and financial assistance to M&I providers.
- Incorporate a review of river administration and historical call data in future M&I drought vulnerability studies
- Develop a database(s) that records individual M&I providers' historical drought impacts, and mitigation and planned response actions.



# 2001 Drought Impacts from 2004 DWSA Survey Results



# Recreation: Key Findings



- Subsectors
  - Skiing
  - Wildlife Viewing
  - Hunting/fishing/camping
  - Golfing
  - Boating
  - Rafting
- Higher operating costs for the ski industry and decreased visitation.
- Animals may move away from traditional viewing/hunting areas due to lack of water, loss of vegetative cover, and/or heat.
- Fishing areas can be impacted by lower reservoir and lake levels, decreased stream flow, and fish decline.



# Recreation: Key Findings

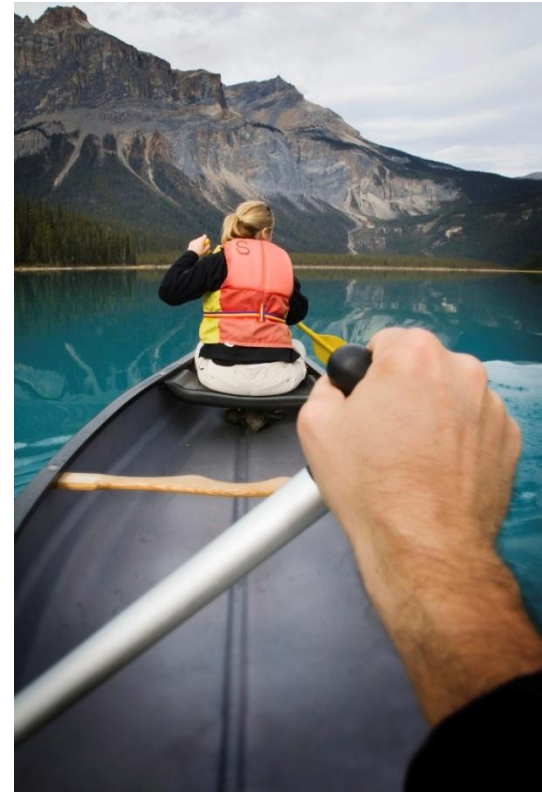


- Forced closure of campsites and surrounding forest due to risk of wildfires and/or hazard trees.
- Golf courses are impacted if municipalities impose watering restrictions or if water rights become out of priority due to low stream flows.
- Lower reservoir and lake levels can render boat ramps unusable; and lower water levels can deter potential boaters.
- Rafting companies can be impacted as a result of low flows and negative public perception.



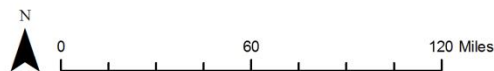
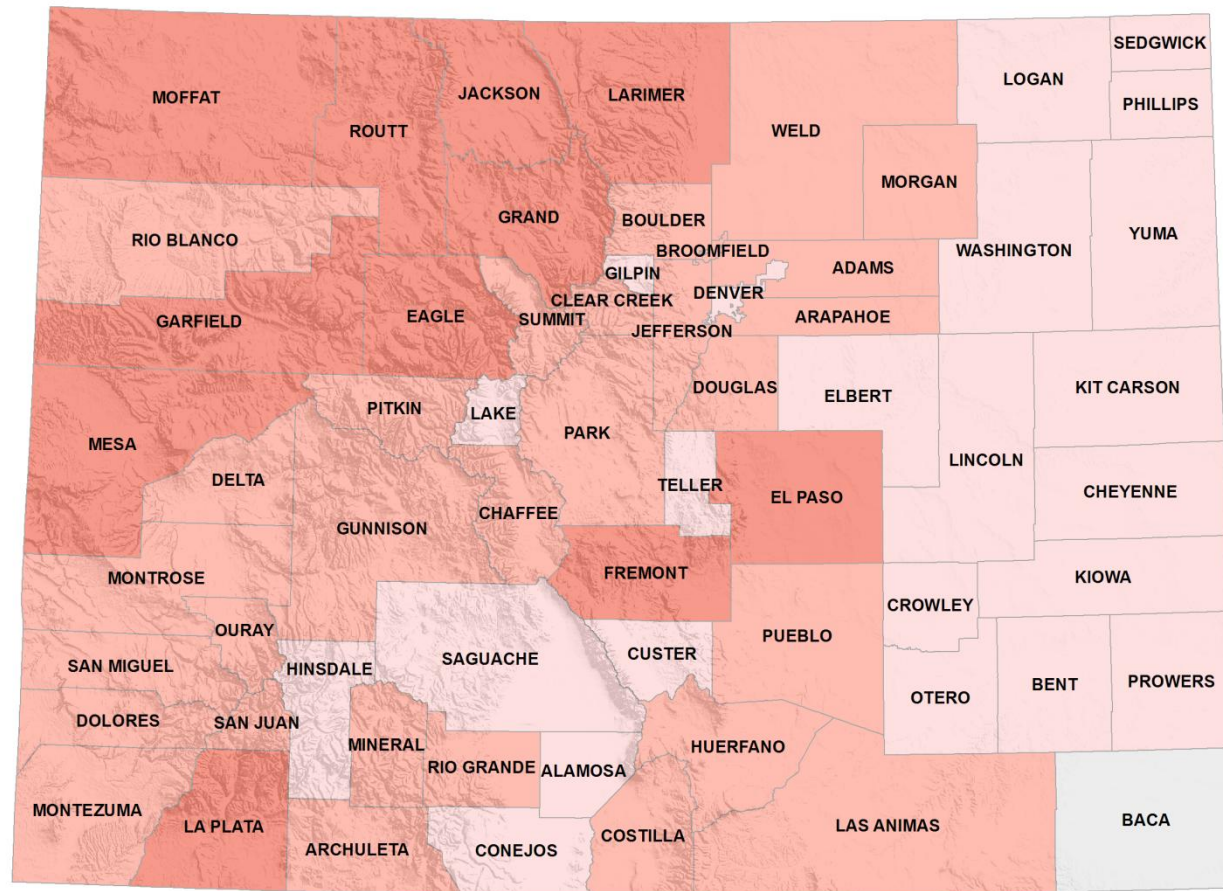
# Recreation Key Recommendations

- Public perception is a primary concern among all recreation sub-sectors. Public relations plans and strategies can help mitigate or prevent negative public perception during drought.
- Adjusting the seasonality and variety of offerings increase the adaptive capacity of recreation companies.
- Diversification and communication with the public, media, and local governments was found to be the most widely-repeated strategy for adapting to drought conditions.

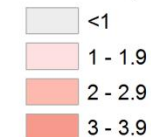




# Overall Recreation and Tourism Vulnerability Scores



Vulnerability Score



# Socioeconomic: Key Findings



- Subsectors
  - Secondary economic impacts
  - Mental health impacts
  - Public health concerns
- The economic reliance of some counties on particularly drought vulnerable industries (agriculture, recreation) increases the vulnerability of the county as a whole.
- Counties identified as having a mental health manpower shortage will have a difficult time responding to the increased mental health issues that can occur during drought.
- Drought induced public health issues can include; impaired drinking water quality, increased incidence of mosquito born illness and respiratory complications resulting from impaired air quality.





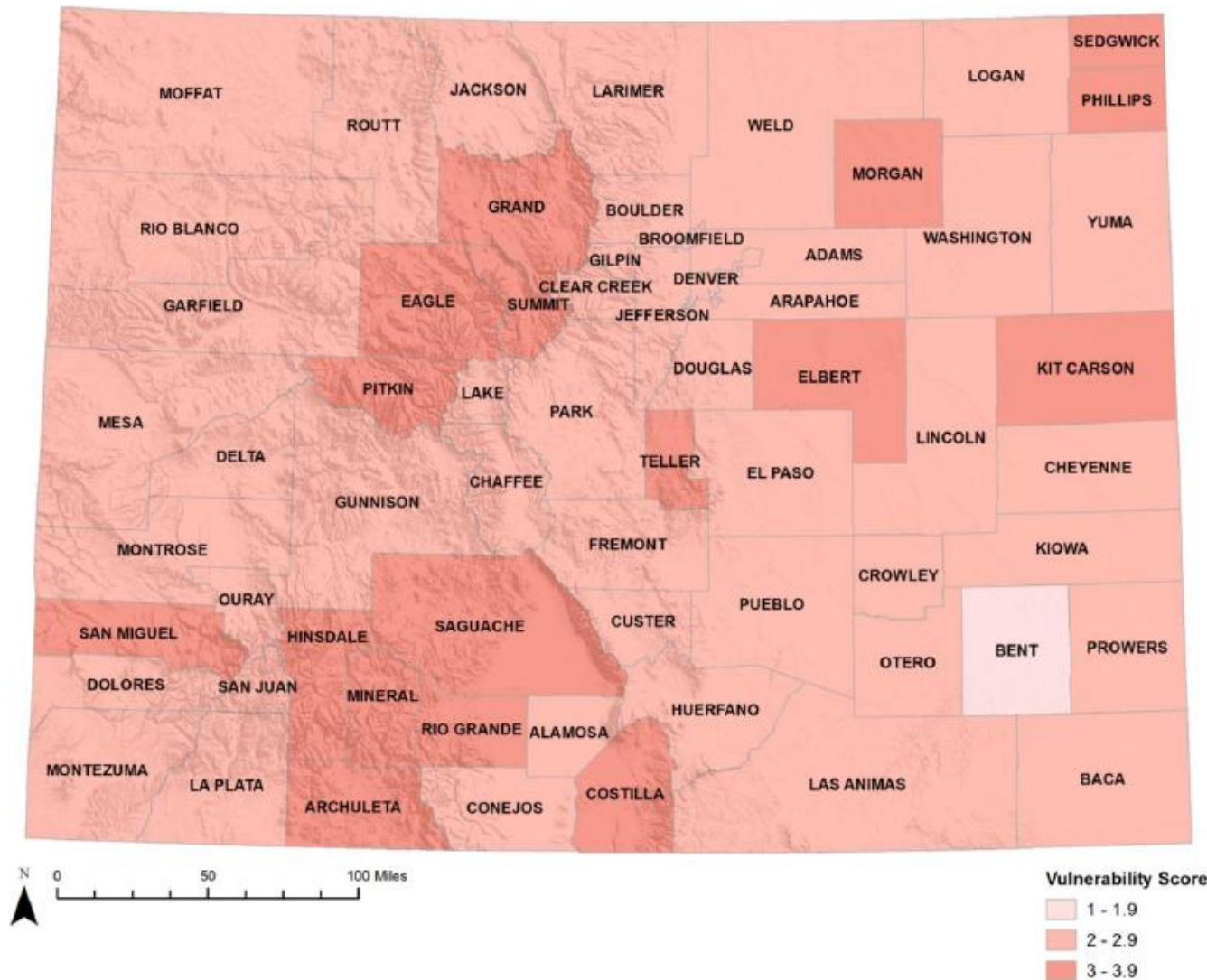
# Socioeconomic: Key Recommendations



- Economic diversification
- Cooperative alliances and community planning
- Statewide agencies should increase their understanding of societal impacts of drought and focus on collaborative opportunities to mitigate drought impacts.
- Significant data gathering and additional monitoring is required to spatially characterize social vulnerability.

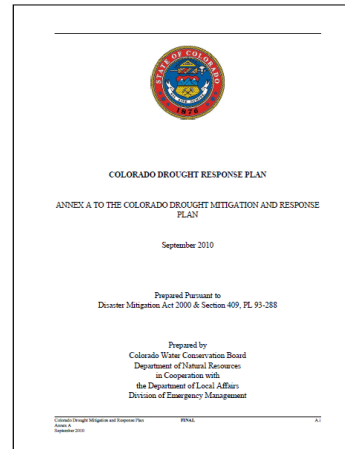
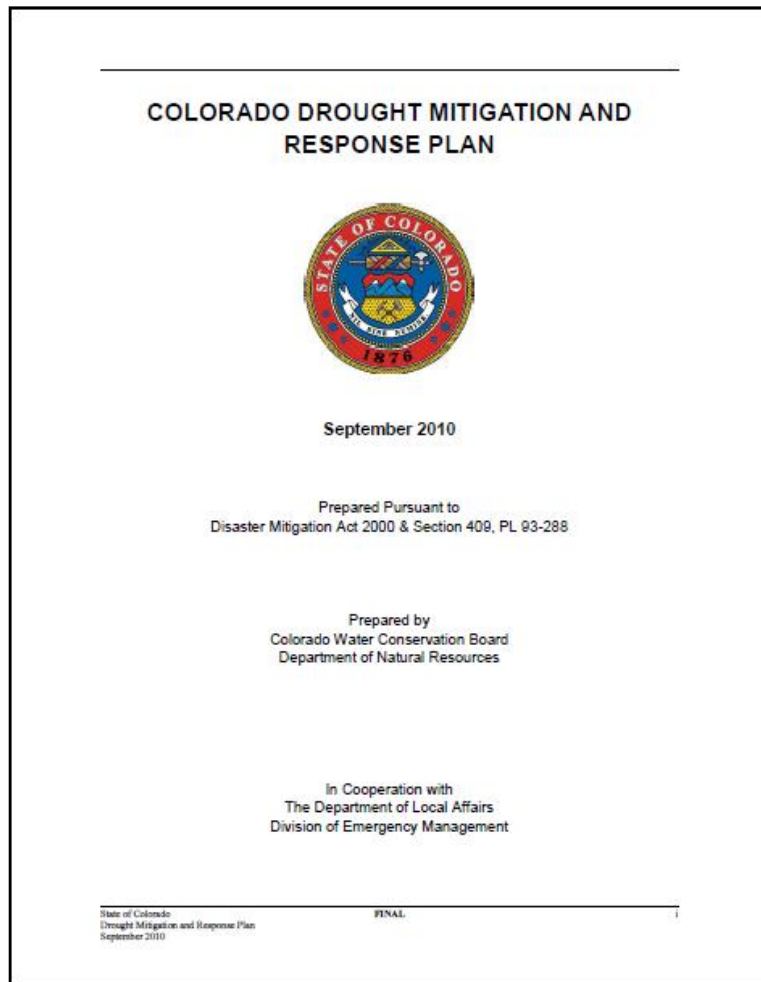


# Overall Socioeconomic Vulnerability Scores

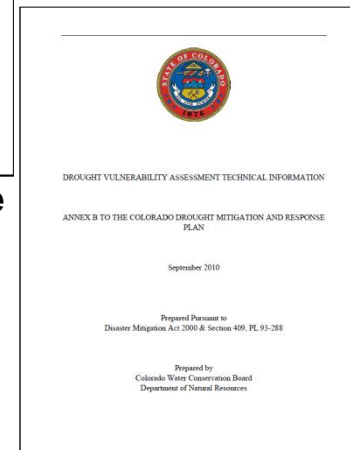




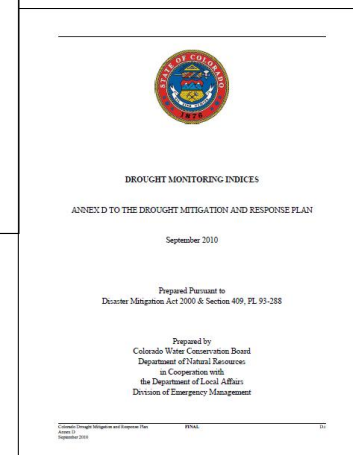
## Drought Mitigation and Response Plan



## Drought Response Plan



## Vulnerability Assessment



## Drought Monitoring Indices

# Drought Monitoring Indices



- Drought Indicators historically used for activation and deactivation of the Colorado Drought Response Plan:
  - Surface Water Supply Index (SWSI)
  - Palmer Drought Severity Index (PDSI)
  - Standardized Precipitation Index (SPI)
- Goals of this work
  - Modernize the SWSI index for Colorado
  - Analyze the effectiveness of the Colorado Modified Palmer Drought Index (CMPDI)



# Drought Indices Findings – SPI & CMPDI



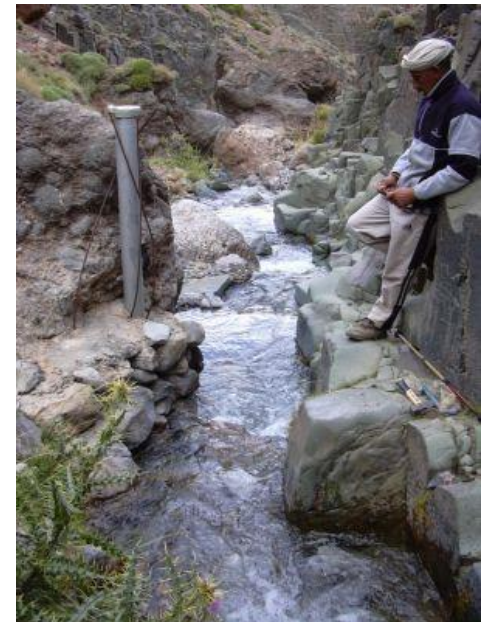
- 9 and 12 month SPI often behave similarly to the CMPDI.
- The CMPDI is sometimes the best leading indicator of impacts, but does not respond well to fairly rapid changes in hydrologic conditions.
- The 24 and 48 month SPIs provide excellent diagnostic documentation (after the fact) on the frequency, severity and areal extent of droughts that have occurred.
- The 3-9 month SPI values provide predictive skills of future (next 1-9 month) drought impacts.
- The significance of the SPI indices is highly seasonal





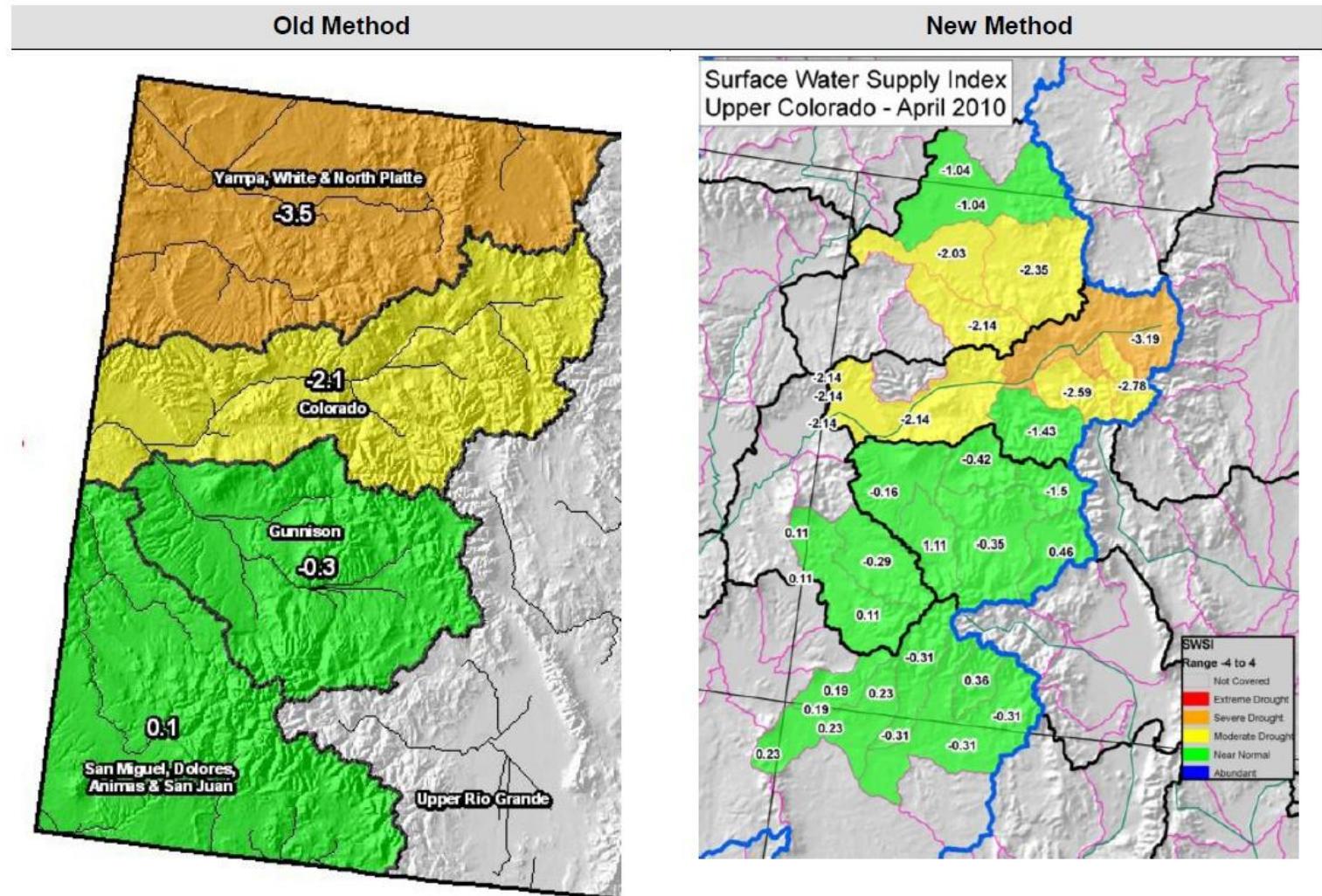
# Drought Indices Findings – Surface Water Supply Index (SWSI)

- Worked with Natural Resources Conservation Service (NRCS) & Colorado Climate Center
- Increasing the spatial resolution of SWSI analysis increases the number of watersheds from 7 to 30
- Revised SWSI technique provides a more stable month to month transition and eliminate some of the erratic shifts sometimes produced by current SWSI





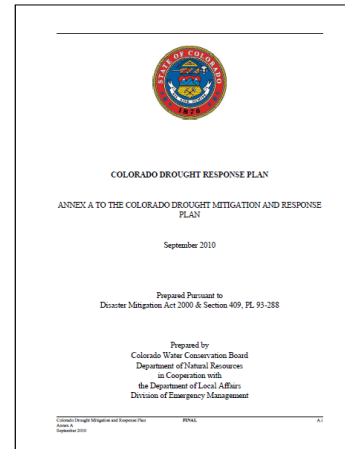
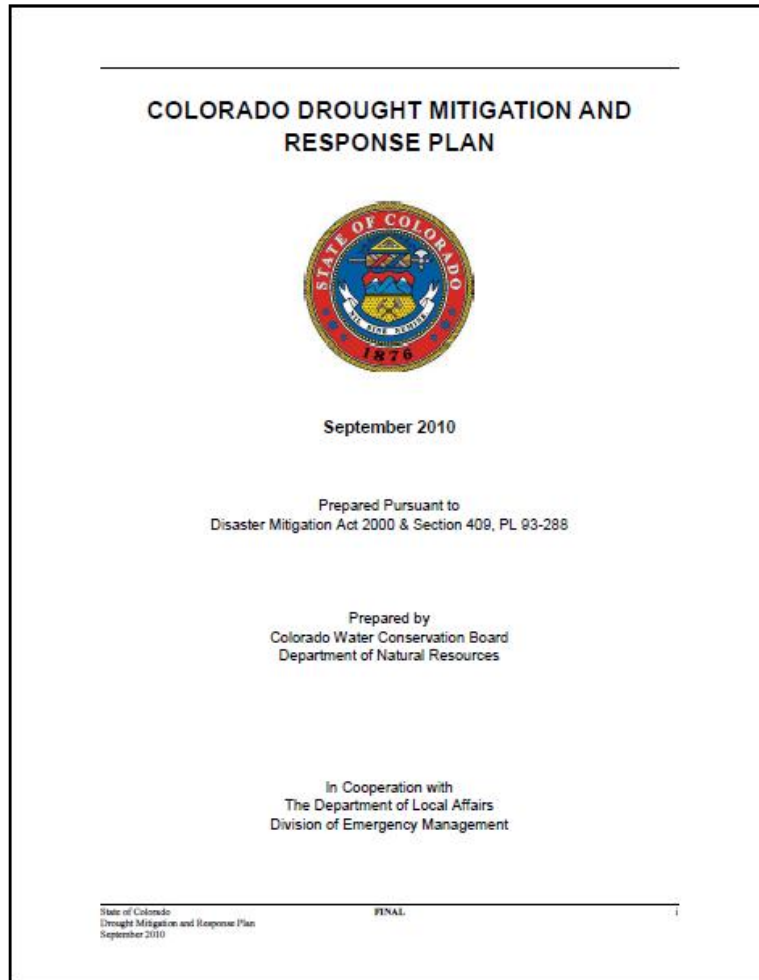
# Comparison of Old and New Surface Water Supply Index – April 2010



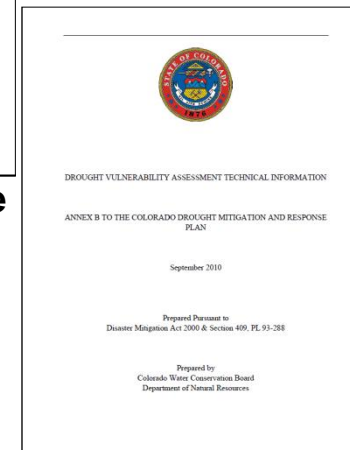
Source: USDA – Natural Resources Conservation Service



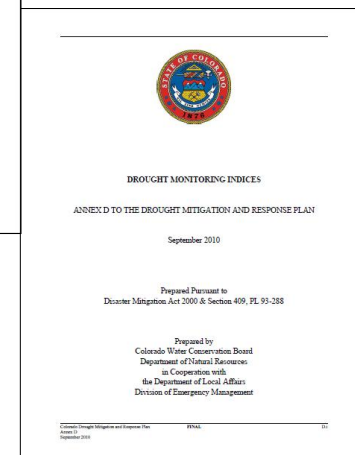
## Drought Mitigation and Response Plan



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## Drought Monitoring Indices

# Technical Assistance: Resources & Tools Development



## Drought Planning Toolbox

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The CWCB is developing the Drought Planning Toolbox to help water providers in their efforts to develop drought mitigation and response plans. The areas covered by the toolbox include drought information and data, as well as a comprehensive suite of planning resources and tools for local municipal water providers.

The Drought Planning Toolbox will be available in early fall 2010.

### Drought Status and Monitoring

Includes the status of current drought conditions and forecasts, drought monitoring data and resources, drought indices, links to other drought research centers and historical drought data.

### Contacts and Resources

Includes contact information for local, regional and state drought-related experts, as well as links to financial resources for drought response assistance.

### Drought Planning Resources

Provides step-by-step guidance for developing a local drought mitigation and response plan, including sample plans for reference.

### Public Information

Provides educational information designed specifically for the general public and includes drought and conservation definitions, frequently asked questions and drought-related news.



### Additional Information

- [Water Conservation](#)
- [What Is Drought?](#)
- [Local Drought Planning](#)
- [State Drought Planning](#)





## Questions?

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