

Making the Drought Monitor: Putting the Pieces Together

**Brian Fuchs, Climatologist
National Drought Mitigation Center
University of Nebraska-Lincoln**

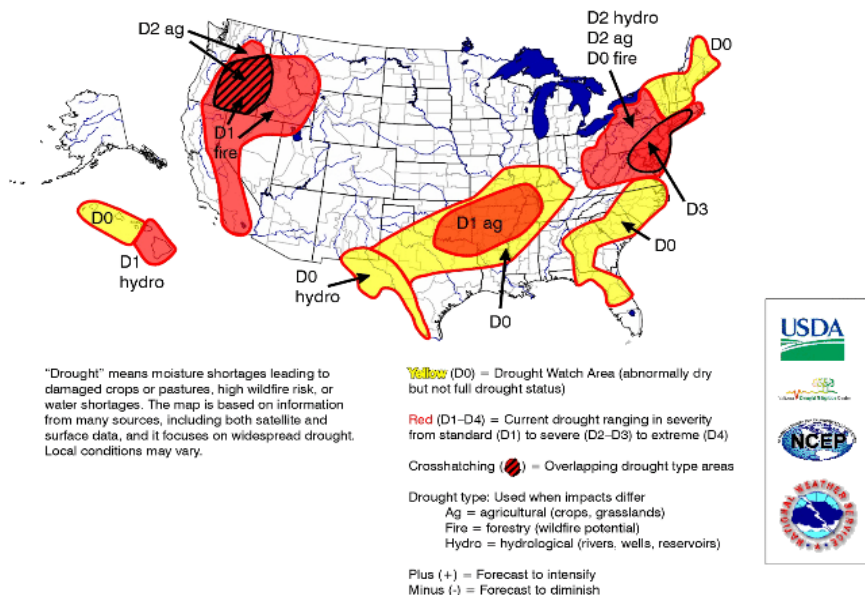
**Colorado River Commission of Nevada,
December 5, 2008 Las Vegas, NV**

The U.S. Drought Monitor

Since 1999, NOAA (CPC and NCDC), USDA, and the NDMC have produced a weekly composite drought map -- the U.S. Drought Monitor -- with input from numerous federal and non-federal partners

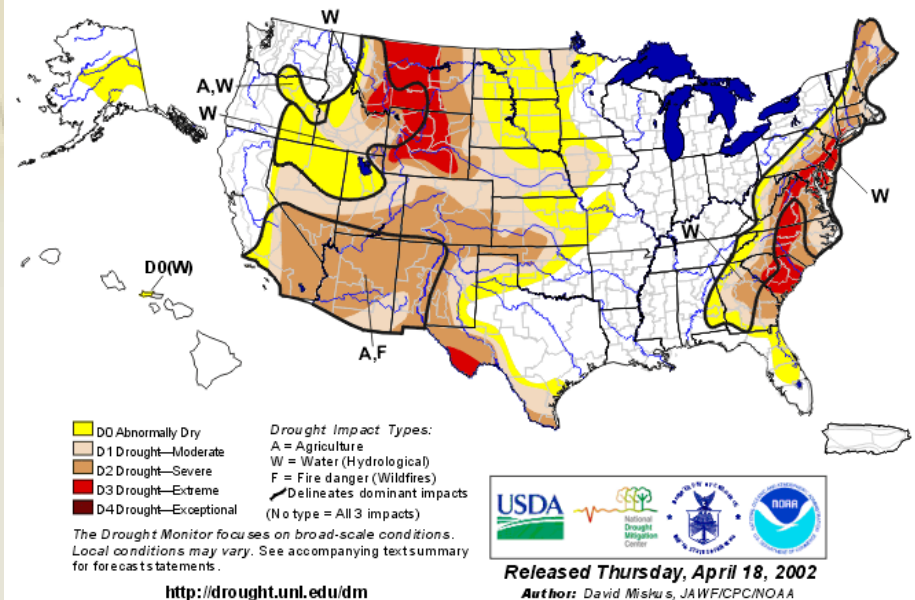
August 3, 1999

Experimental U.S. Drought Monitor



U.S. Drought Monitor April 16, 2002

Valid 8 a.m. EDT



The Drought Monitor Concept

- A **partnership** between the NDMC, USDA and NOAA's CPC, NCDC, and RCC's **(authors)**
- Incorporate relevant information and products from all entities (and levels of government) dealing with drought (RCC's, SC's, federal/state agencies, etc.) **(experts)**
- The **Drought Monitor** is **updated weekly** and provides a general up-to-date summary of current drought conditions across the 50 states, Puerto Rico and the Pacific possessions

The Drought Monitor Concept

- A consolidation of indices and indicators into one comprehensive national drought map
- Trying to capture these characteristics:
 - the drought's magnitude (duration + intensity)
 - spatial extent
 - probability of occurrence
 - Impacts
- Rates drought intensity by **Percentile Rankings**

Original Objectives

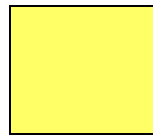


- “Fujita-like” scale
- **NOT** a forecast!
- **NOT** a drought declaration!
- Identify impacts (A, H)
- Assessment of current conditions
- Incorporate local expert input
- Be as objective as possible



U.S. Drought Monitor Map

Drought Intensity Categories



D0 **Abnormally Dry** (30%tile)



D1 Drought – **Moderate** (20%tile)



D2 Drought – **Severe** (10%tile)



D3 Drought – **Extreme** (5%tile)



D4 Drought – **Exceptional** (2%tile)

Key Variables For Monitoring Drought



- climate data
- soil moisture
- stream flow
- ground water
- reservoir and lake levels
- snow pack
- short, medium, and long range forecasts
- vegetation health/stress and fire danger

U.S. Drought Monitor

Integrates Key Drought Indicators:

- Palmer Drought Index
- SPI
- KBDI
- Modeled Soil Moisture
- 7-Day Avg. Streamflow
- Precipitation Anomalies

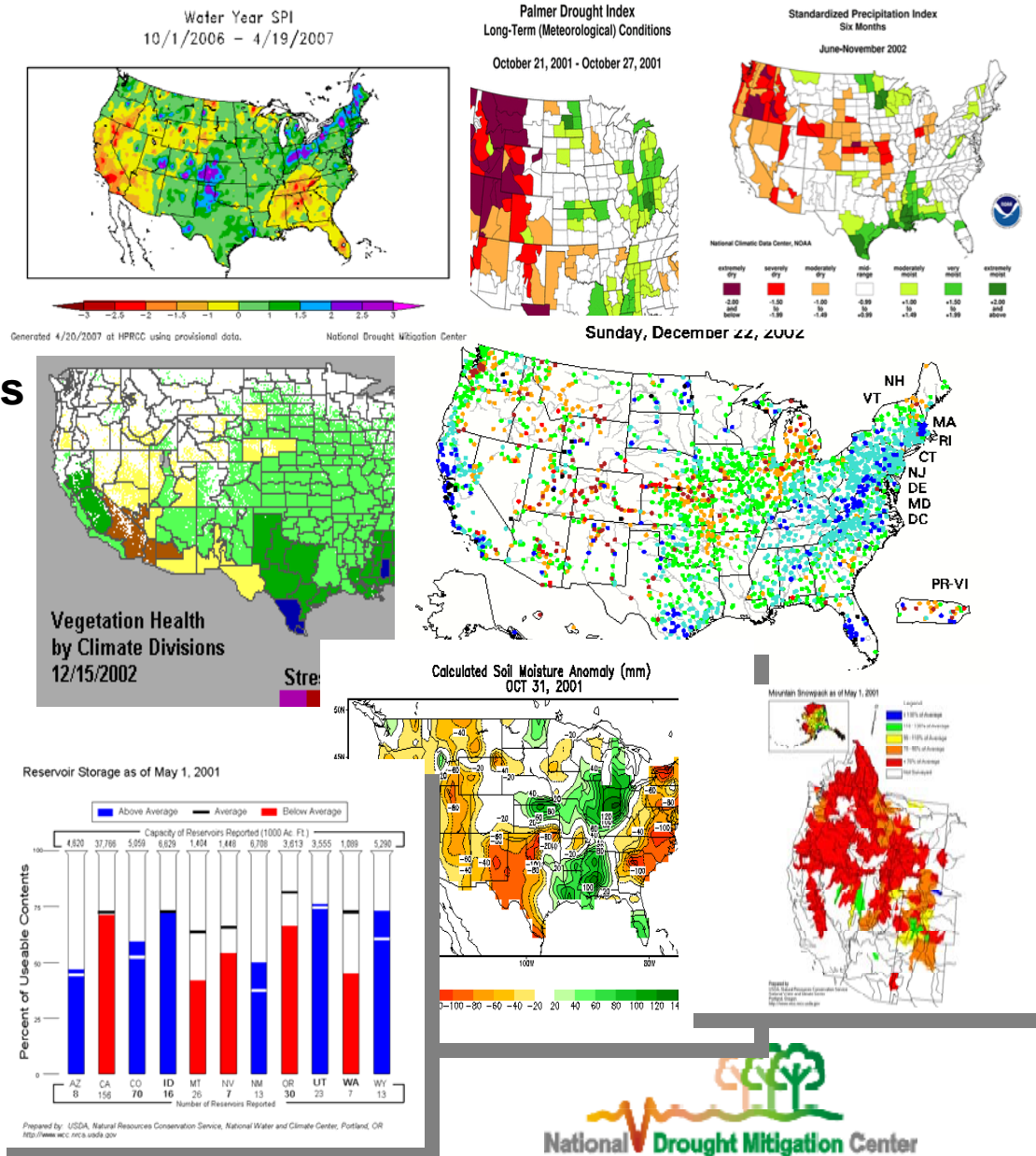
Growing Season:

- Crop Moisture Index
- Sat. Veg. Health Index
- Soil Moisture
- Mesonet data

In The West:

- SWSI
- Reservoir levels
- Snowpack
- Streamflow

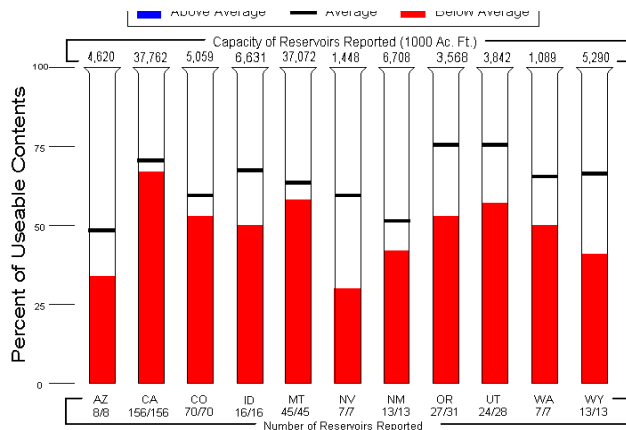
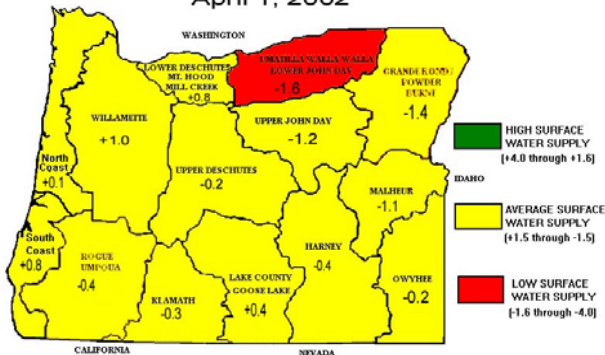
Created in ArcGIS



SURFACE WATER SUPPLY INDEX

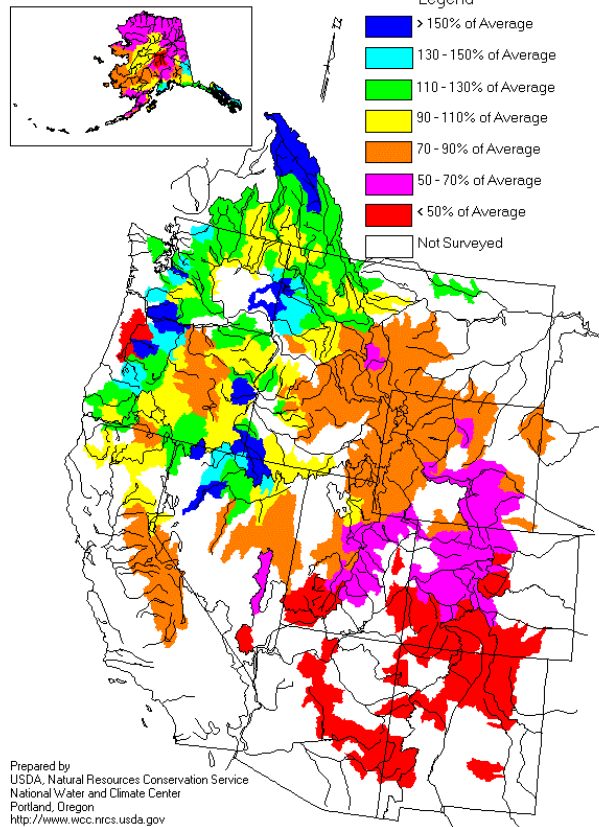
(SWSI)

April 1, 2002



Prepared by: USDA, Natural Resources Conservation Service, National Water and
http://www.wcc.nrcs.usda.gov

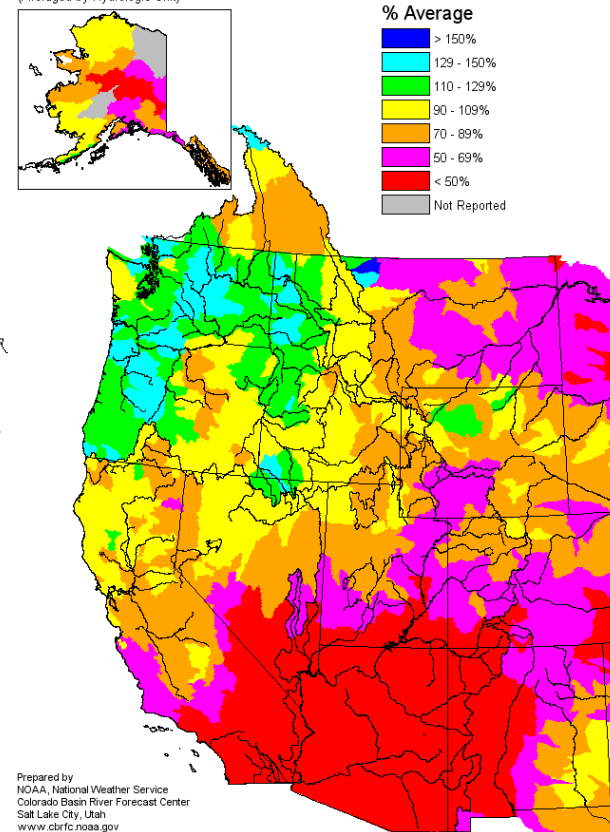
Mountain Snowpack as of April 1, 2002



Prepared by
USDA, Natural Resources Conservation Service
National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov

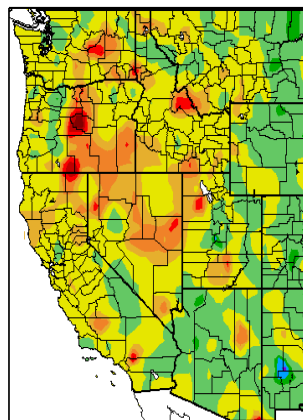
Seasonal Precipitation, October 2001 - March 2002

(Averaged by Hydrologic Unit)



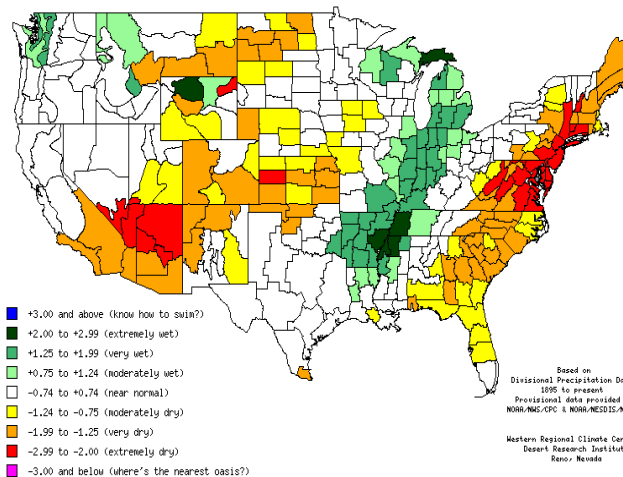
Prepared by
NOAA, National Weather Service
Colorado Basin River Forecast Center
Salt Lake City, Utah
www.cbrfc.noaa.gov

12 Month SPI 12/2/2007 - 12/1/2008



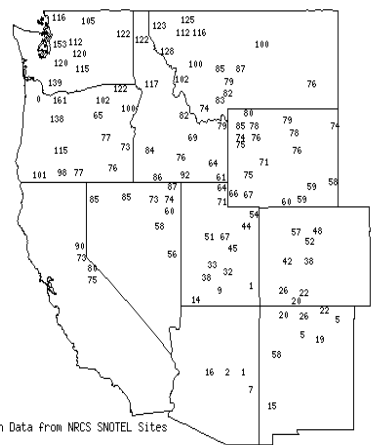
Generated 12/2/2008 at HPRCC using provisional data.

6-month Standardized Precipitation Index through the end of March 2002



Based on
Divisional Precipitation Data
1995 to present
Provisional data provided by
NOAA/NWS/CPC & NOAA/NESDIS/NCDC
Western Regional Climate Center
Desert Research Institute
Reno, Nevada

Basin Average Snow Water Content. (% of Average.)



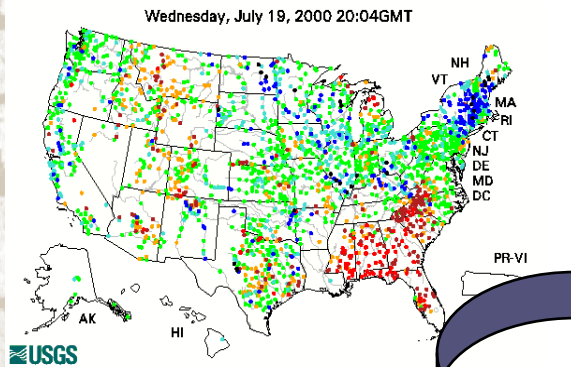
Based on
Rain Data from NRCS SNOTEL Sites
National Water and Climate Center
Desert Research Institute
Reno, Nevada

Western Regional
Climate Center
Desert Research
Institute

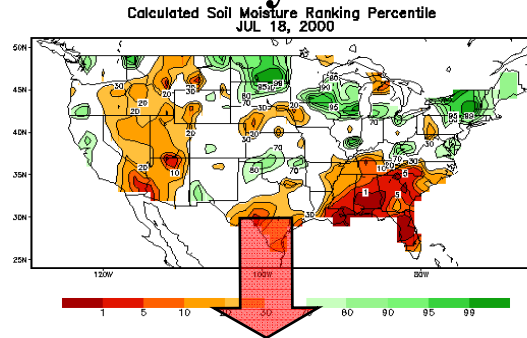
Indices for "The West"

Principal Drought Monitor Inputs

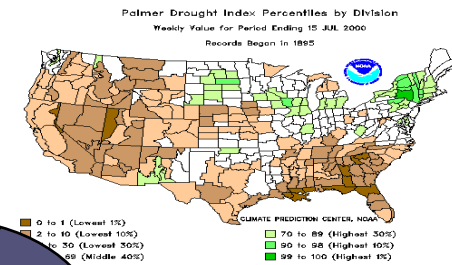
USGS Streamflow



CPC Daily Soil Model

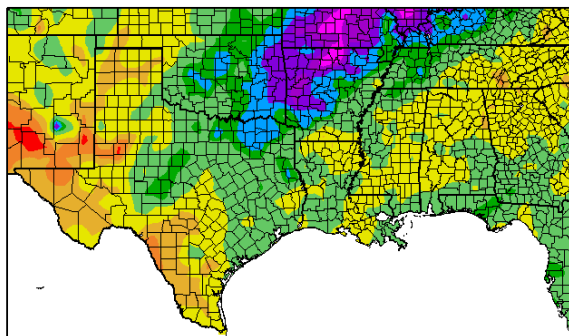


Palmer Drought Index

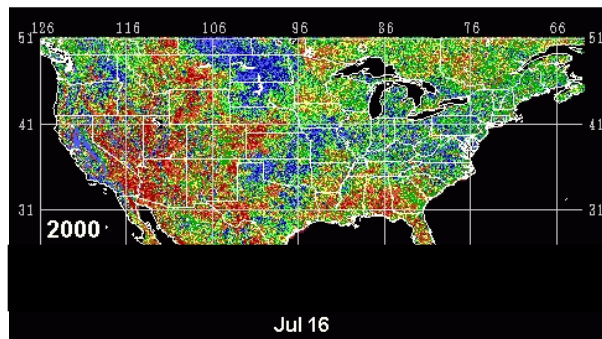
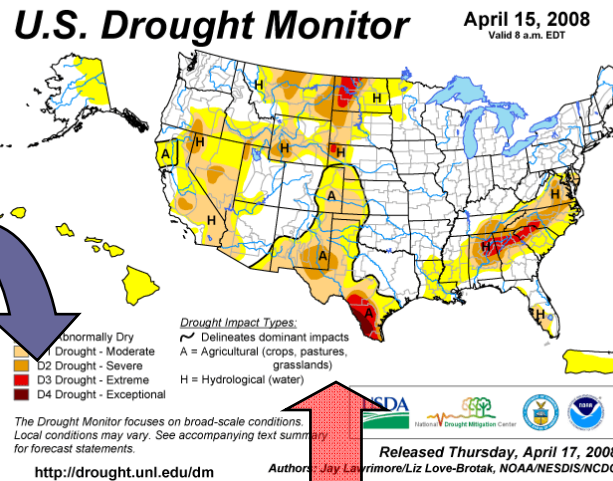


SPI Drought Index

90 Day SPI
1/16/2008 - 4/14/2008

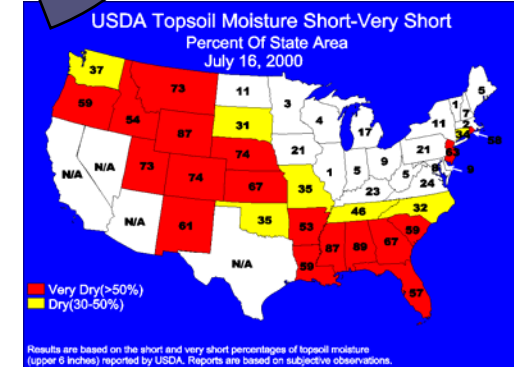


Generated 4/15/2008 at HPRCC using provisional data. National Drought Mitigation Center



Satellite Veg Health

USDA Soil Ratings



National Drought Mitigation Center

Monitor Development (Period starts 12Z last Tuesday)

Monday (5 Days available)

- ✓ Draft map sent to local experts

Tuesday (6 Days available)

- ✓ Local expert feedback
- ✓ Draft map sent to local experts
- ✓ Draft text sent to local experts

Wednesday (7 Days available; ending 12Z yesterday)

- ✓ Local expert feedback
- ✓ Draft map(s) sent to local experts
- ✓ Draft text(s) sent to local experts (Outlook)
- ✓ Final map and text sent to secured ftp server

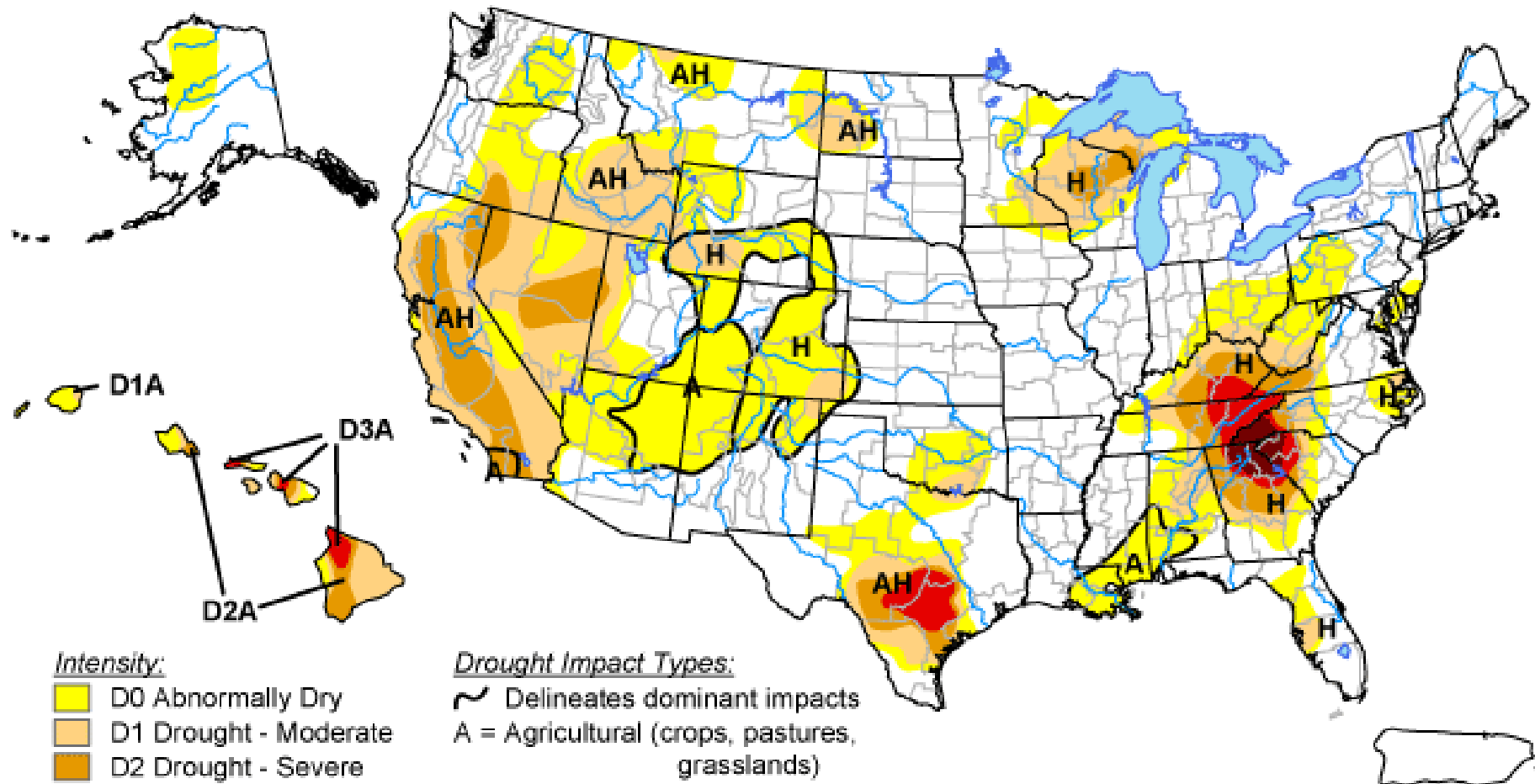
Thursday

- ✓ Final map & text released on NDMC Website

U.S. Drought Monitor

November 25, 2008

Valid 8 a.m. EST



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

- Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

<http://drought.unl.edu/dm>

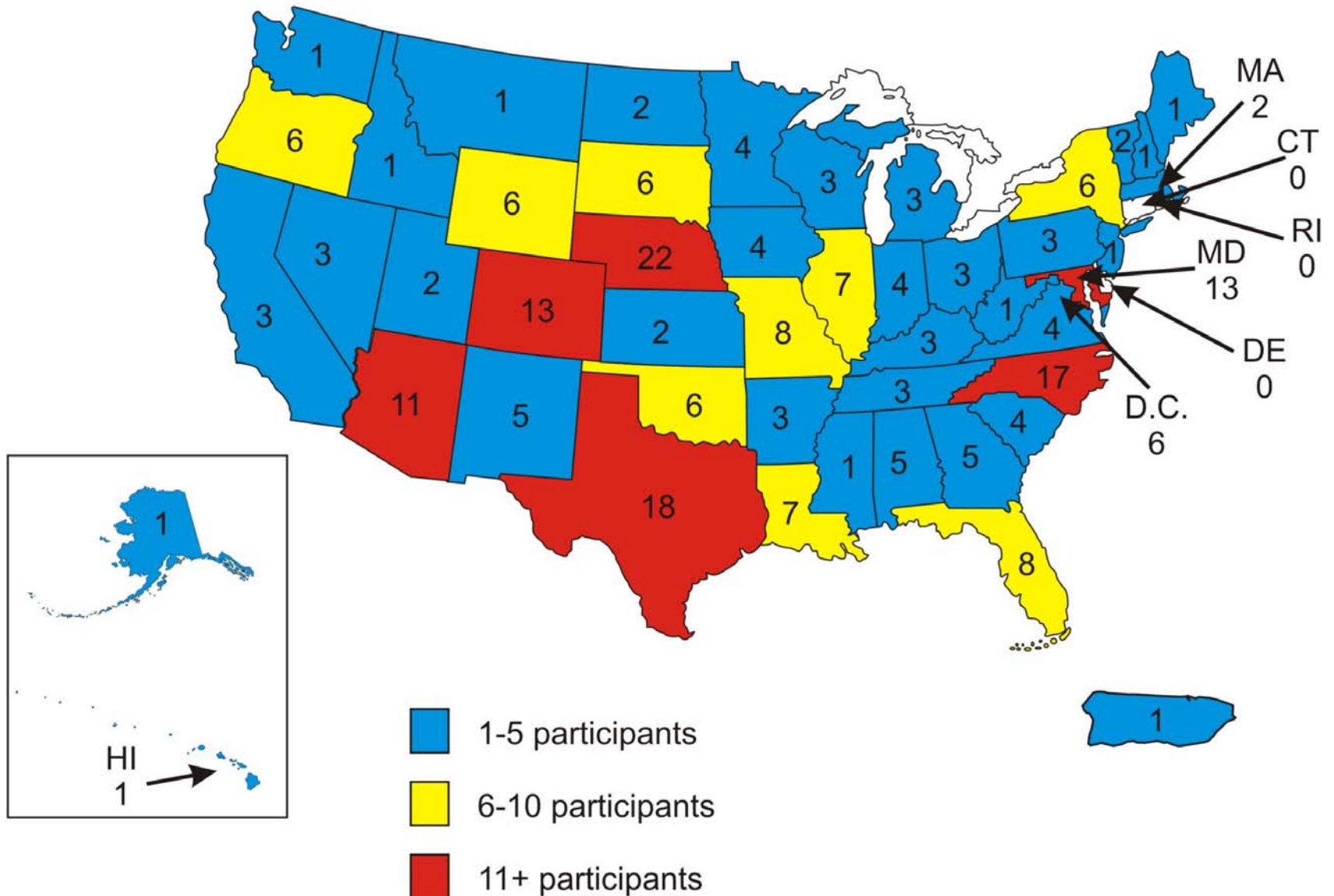


Released Wednesday, November 26, 2008

Author: Brad Rippey, U.S. Department of Agriculture

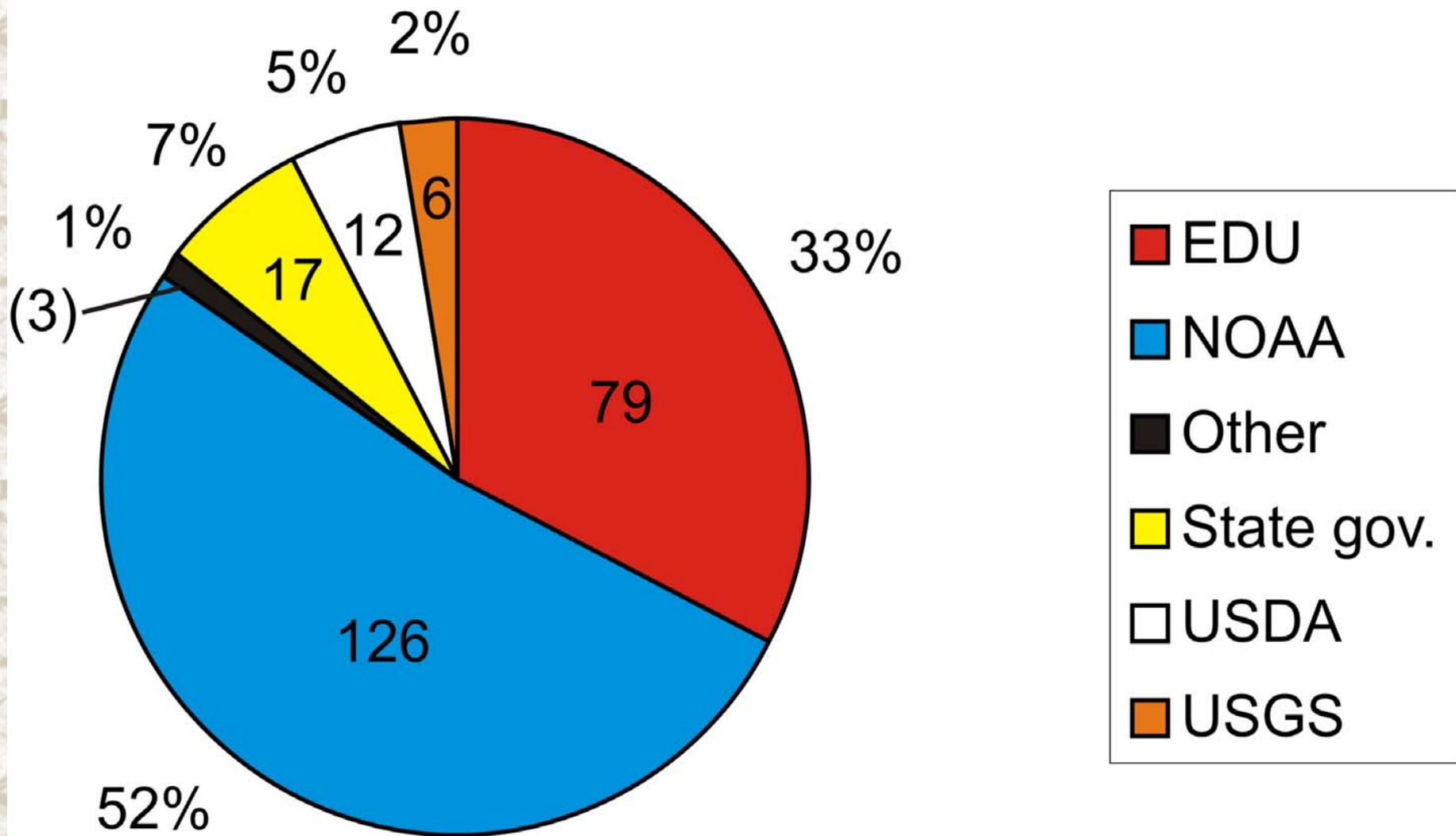
USDM Listserve Subscribers

(as of June 3, 2008)



USDM Listserve Subscribers

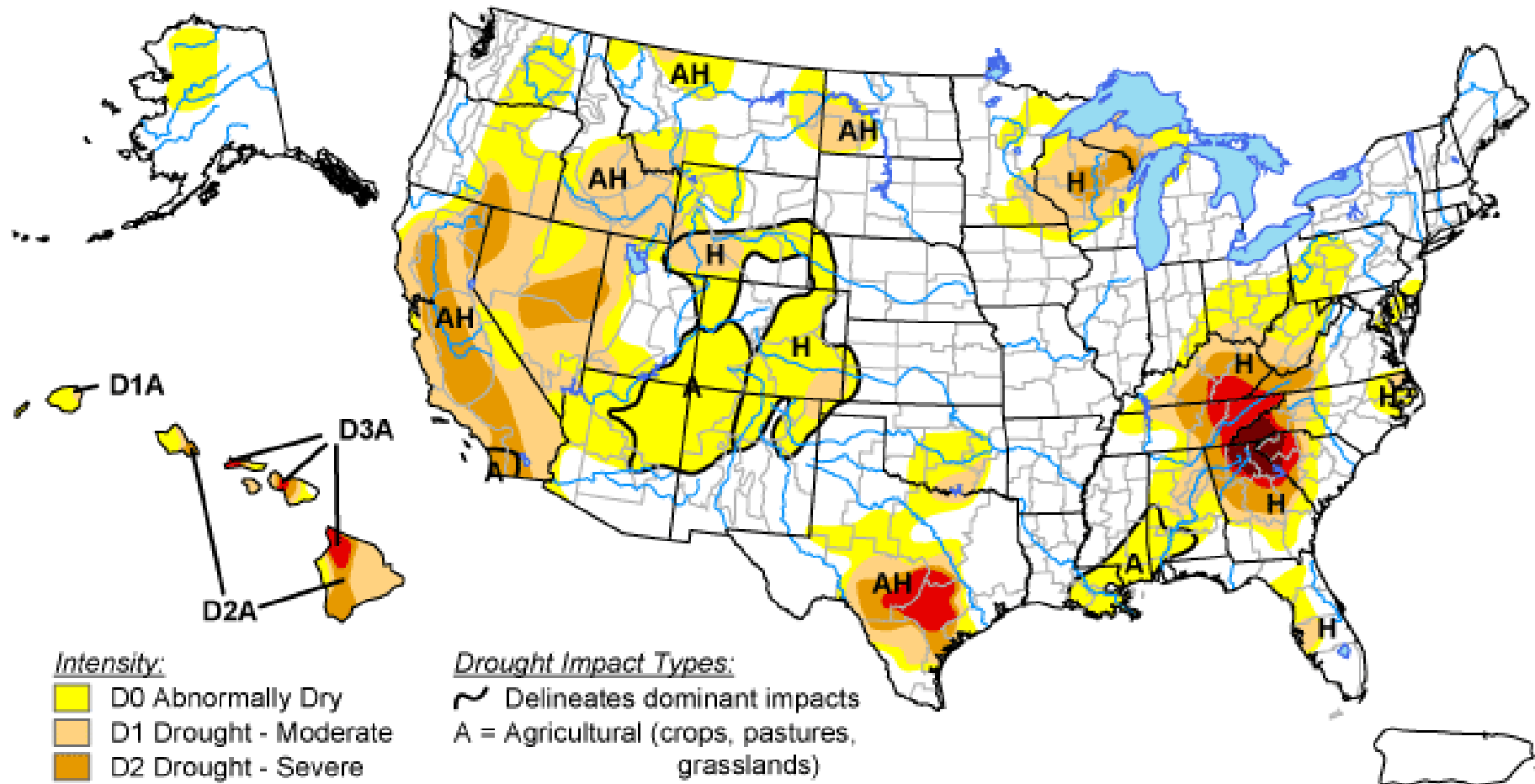
(as of June 3, 2008)



U.S. Drought Monitor

November 25, 2008

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<http://drought.unl.edu/dm>



Released Wednesday, November 26, 2008

Author: Brad Rippey, U.S. Department of Agriculture

U.S. Drought Monitor

West

November 25, 2008

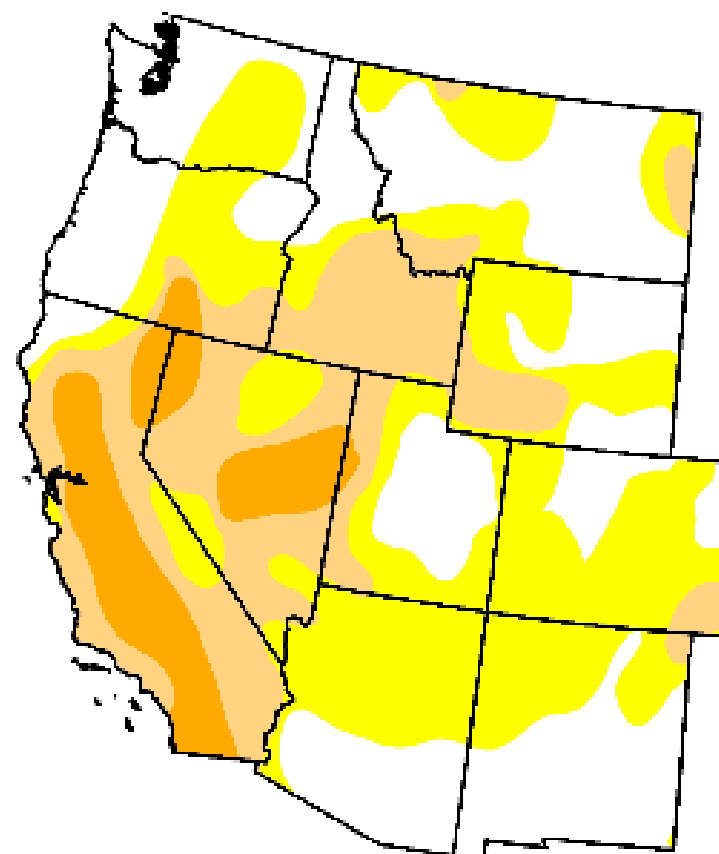
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	36.0	64.0	29.3	8.6	0.0	0.0
Last Week (11/18/2008 map)	36.0	64.0	29.3	8.6	0.0	0.0
3 Months Ago (09/02/2008 map)	34.2	65.8	31.1	10.1	0.2	0.0
Start of Calendar Year (01/01/2008 map)	26.3	73.7	54.7	33.1	2.7	0.0
Start of Water Year (10/07/2008 map)	41.3	58.7	28.6	10.4	0.1	0.0
One Year Ago (11/27/2007 map)	25.4	74.6	58.4	38.1	7.9	0.0

Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

<http://drought.unl.edu/dm>



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Author: Brad Rippey, U.S. Department of Agriculture

U.S. Drought Monitor

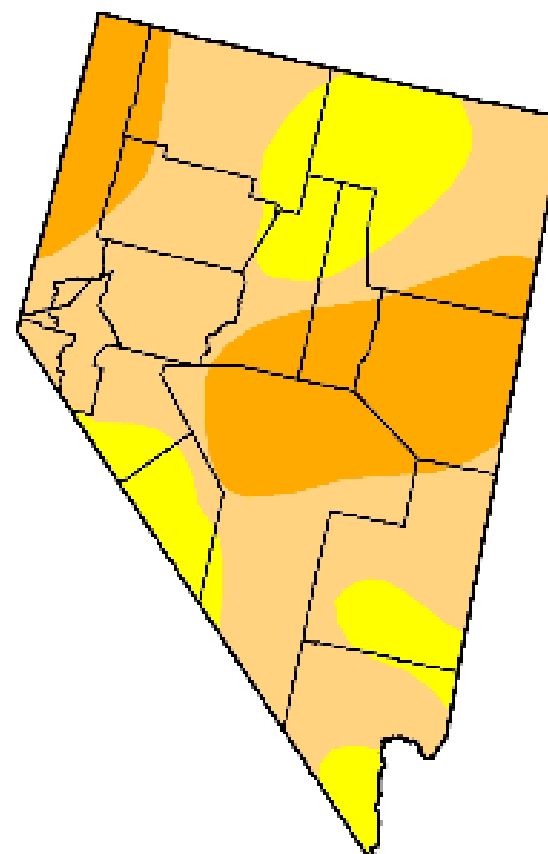
Nevada

November 25, 2008

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.0	100.0	79.0	26.8	0.0	0.0
Last Week (11/18/2008 map)	0.0	100.0	79.0	26.8	0.0	0.0
3 Months Ago (09/02/2008 map)	0.0	100.0	77.9	20.7	0.0	0.0
Start of Calendar Year (01/01/2008 map)	0.0	100.0	100.0	86.1	8.5	0.0
Start of Water Year (10/07/2008 map)	0.0	100.0	74.8	20.8	0.0	0.0
One Year Ago (11/27/2007 map)	0.0	100.0	100.0	89.6	8.9	0.0



Intensity:

 D0 Abnormally Dry	 D3 Drought - Extreme
 D1 Drought - Moderate	 D4 Drought - Exceptional
 D2 Drought - Severe	

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<http://drought.unl.edu/dm>



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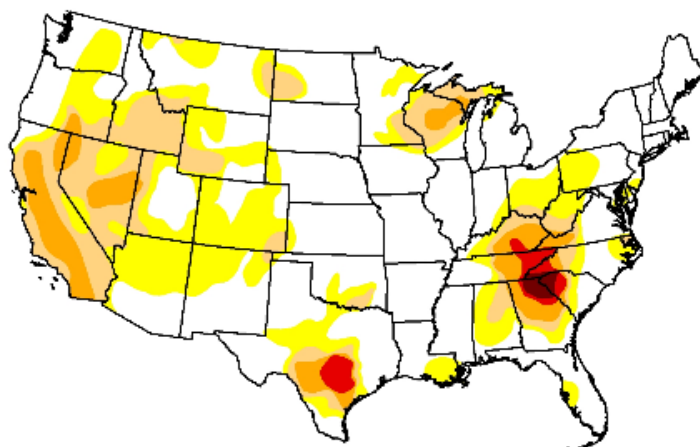
Maps Tables 1999 Archive GIS Data

Select an area and click the 'Update' button to view the archive.

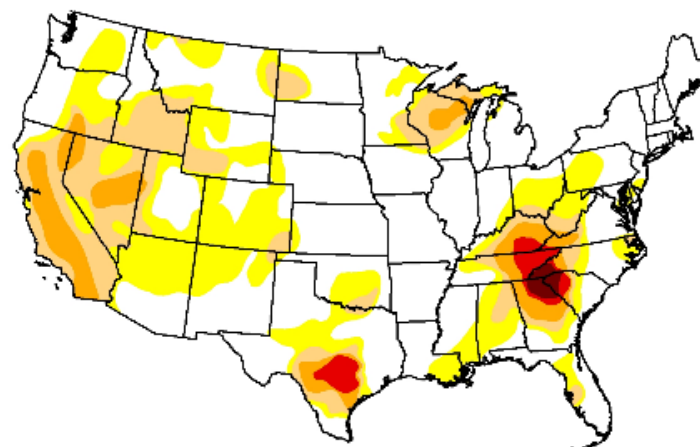
☒ Contiguous United States ☐ Region ☐ State

Drought Severity

☐ D0 Abnormally Dry ☐ D1 Drought - Moderate ☐ D2 Drought - Severe ☐ D3 Drought - Extreme ☐ D4 Drought - Exceptional



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Read the [summary](#)



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☐ Contiguous United States ☒ Region ☐ State

West

Alabama

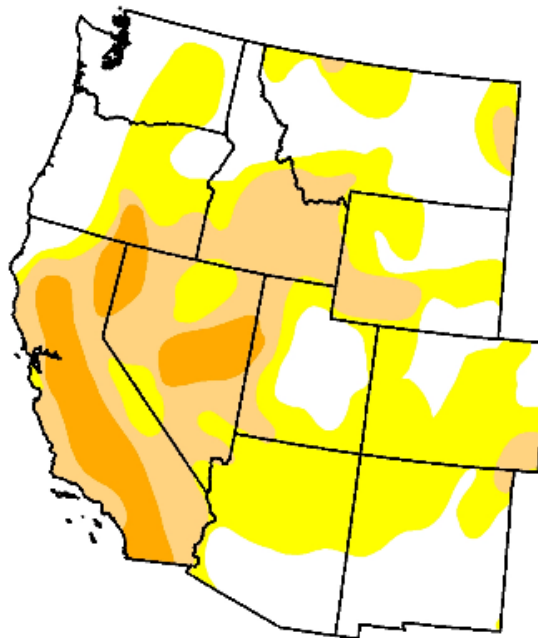
Update

Drought Severity

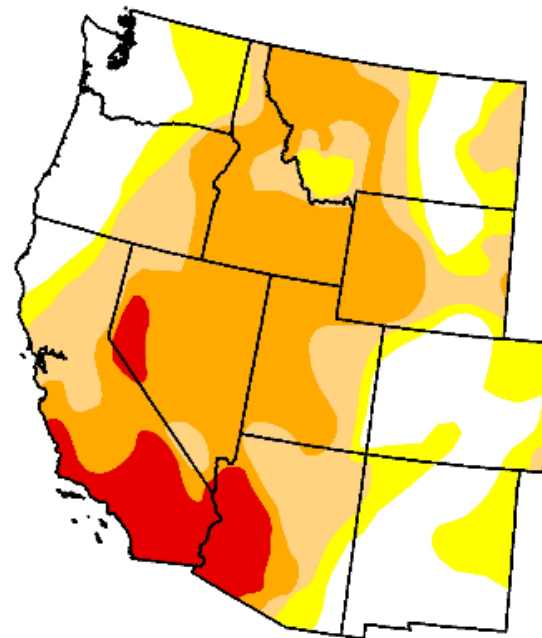
D0 Abnormally Dry D1 Drought - Moderate D2 Drought - Severe D3 Drought - Extreme D4 Drought - Exceptional

November 25, 2008

November 27, 2007



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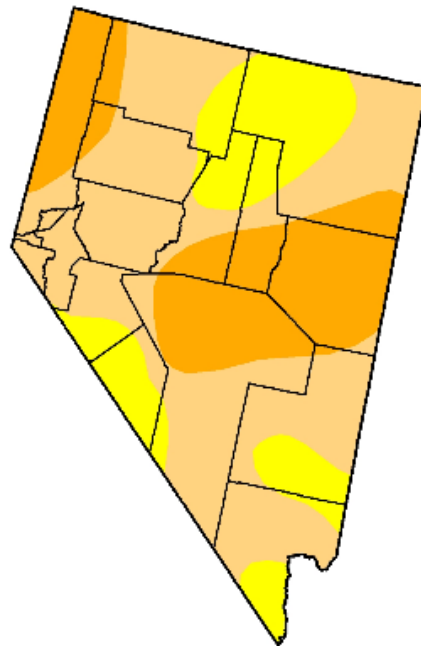
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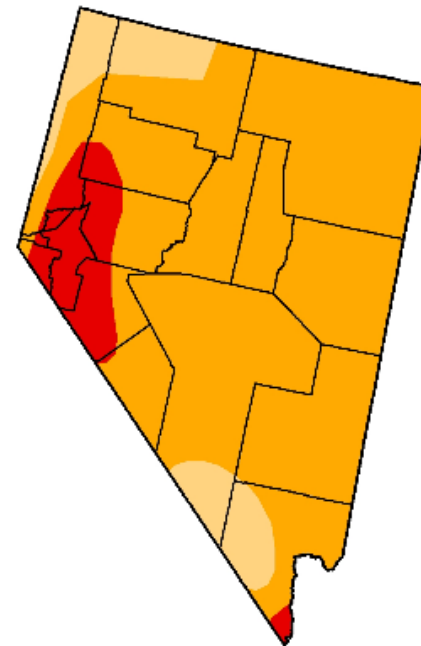
☐ Contiguous United States ☐ Region ☒ State

Drought Severity

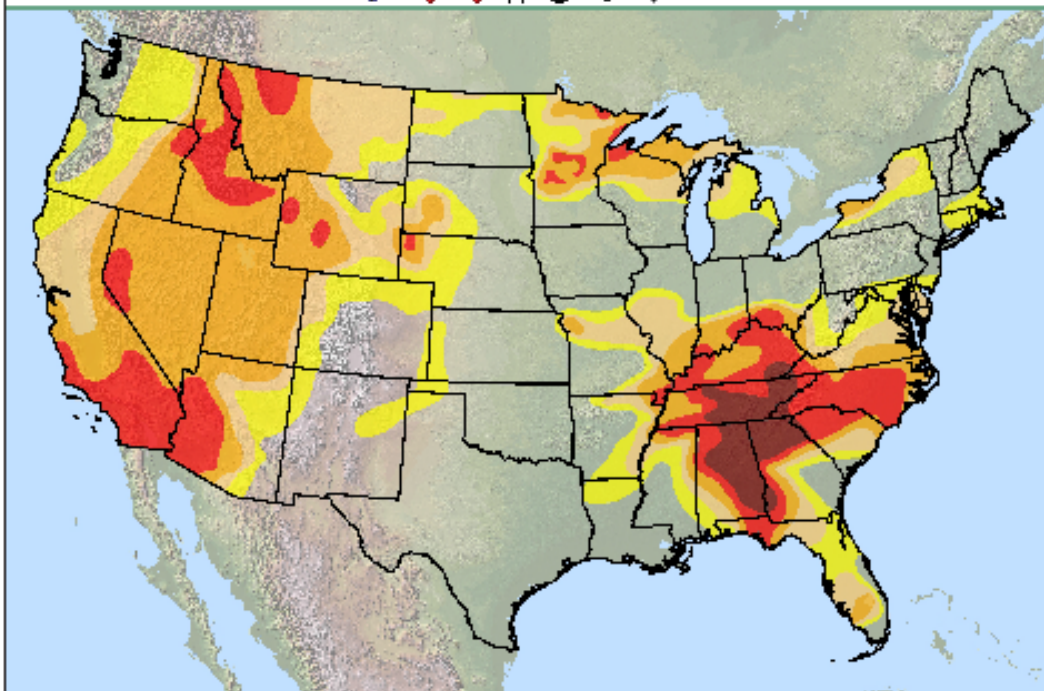
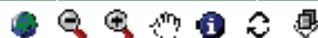
☐ D0 Abnormally Dry ☐ D1 Drought - Moderate ☐ D2 Drought - Severe ☐ D3 Drought - Extreme ☐ D4 Drought - Exceptional



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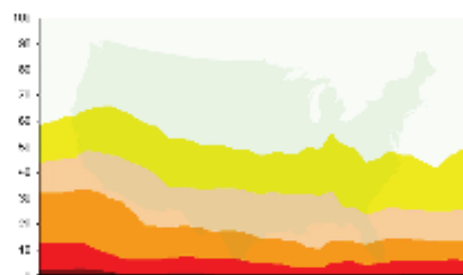
☒ Continental United States

☐ Alaska

☐ Hawaii

☐ Puerto Rico

Drought Conditions: 2007



Date	Monitoring	D0	D1	D2	D3	D4
Sept 18, 2007	41.4	58.5	43.7	52.08	1.25	0.31
Sept 11, 2007	40.4	56.59	44.45	52.1	1.25	0.35
Sept 4, 2007	38.48	51.82	47.47	52.33	12.17	2.4
Aug 28, 2007	30.77	51.86	47.21	50	12.01	2.77
Aug 21, 2007	35.76	54.69	47.24	50.79	12.5	2.07
Aug 14, 2007	35.79	55.21	46.17	52.85	1.01	0.39
Aug 7, 2007	33.84	55.17	46.19	50.01	8.29	1.52
July 31, 2007	35.55	54.05	45.1	50.75	6.78	0.65
July 24, 2007	37.73	52.57	43.24	51.83	6.31	0.4
July 17, 2007	38.15	51.25	47.1	49.21	6.11	1.1
July 10, 2007	41.05	51.13	49.49	49.4	6.03	0.51
July 3, 2007	46.77	51.83	51.54	48.52	7.09	0.77
June 26, 2007	46.43	51.58	54.24	48.08	7.36	0.95
June 19, 2007	57.47	51.66	54.17	49.03	7.65	0
June 12, 2007	59.43	51.57	53.43	48.39	6.91	0.15

Legend

Visible

Drought Monitor

- ☒ D0
- ☒ D1
- ☒ D2
- ☒ D3
- ☒ D4

Date

September 18, 2007

Transparency

60%

ACIS Stations

Climate Layers

- ☐ Standardized Precipitation Index
- ☐ Palmer Drought Severity Index
- ☐ ACIS Precipitation/Temperature Overlay
- ☐ NWS Hybrid Radar/Gauge Precipitation Analysis

Boundaries

- ☐ Rivers
- ☐ Hydrologic Units (HUCs)
- ☐ Congressional Districts
- ☐ Climate Divisions
- ☐ Counties
- ☐ Cities
- ☐ Roads
- ☐ County Warning Areas
- ☐ States

Drought Monitor

About the
Drought Monitor

Impacts

Animations

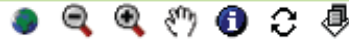
Current

Forecasts

Search the Archives

Submit Feedback

NIDIS



?

Legend

Visible

☐ Drought Monitor

☐ D0

☐ D1

☐ D2

☐ D3

☐ D4

Date

December 19, 2006

Transparency

40%

☐ ACIS Stations

☐ Climate Layers

☐ Standardized Precipitation Index

☐ Palmer Drought Severity Index

Select

☐ Boundaries

☐ Rivers

☐ Hydrologic Units (HUCs)

☐ Congressional Districts

☐ Climate Divisions

☐ Counties

☐ Cities

☐ Roads

☐ County Warning Areas

☐ States

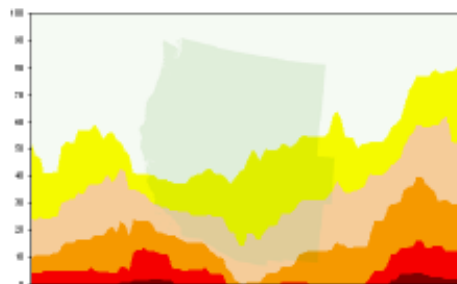
Continental United States

Alaska

Hawaii

Puerto Rico

Drought Conditions: 2005-2006



Date	Nothing	D0	D1	D2	D3	D4
December 19, 2006	46.51	51.50	24.20	9.95	3.96	0.00
December 12, 2006	52.36	47.66	23.69	10.57	4.07	0.00
December 5, 2006	53.45	46.55	24.45	10.71	4.07	0.00
November 28, 2006	58.90	41.10	23.94	10.84	4.76	0.00
November 21, 2006	59.12	40.88	23.80	10.59	4.76	0.00
November 14, 2006	58.82	41.18	24.89	11.60	4.76	0.00
November 7, 2006	58.82	41.18	24.89	11.60	4.76	0.00
October 31, 2006	49.71	50.29	29.64	13.66	4.84	0.00
October 24, 2006	47.57	52.13	30.18	15.21	4.84	0.00
October 17, 2006	47.57	52.13	31.57	15.21	4.84	0.00
October 10, 2006	47.95	52.05	31.57	15.21	4.83	0.00
October 3, 2006	43.46	56.54	32.63	16.86	6.24	0.00
September 26, 2006	43.42	56.58	32.86	16.39	4.86	0.00
September 19, 2006	43.38	56.62	35.50	16.34	4.86	0.00
September 12, 2006	43.13	56.87	36.92	16.63	6.61	0.00

Drought Monitor

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Impacts

Animations

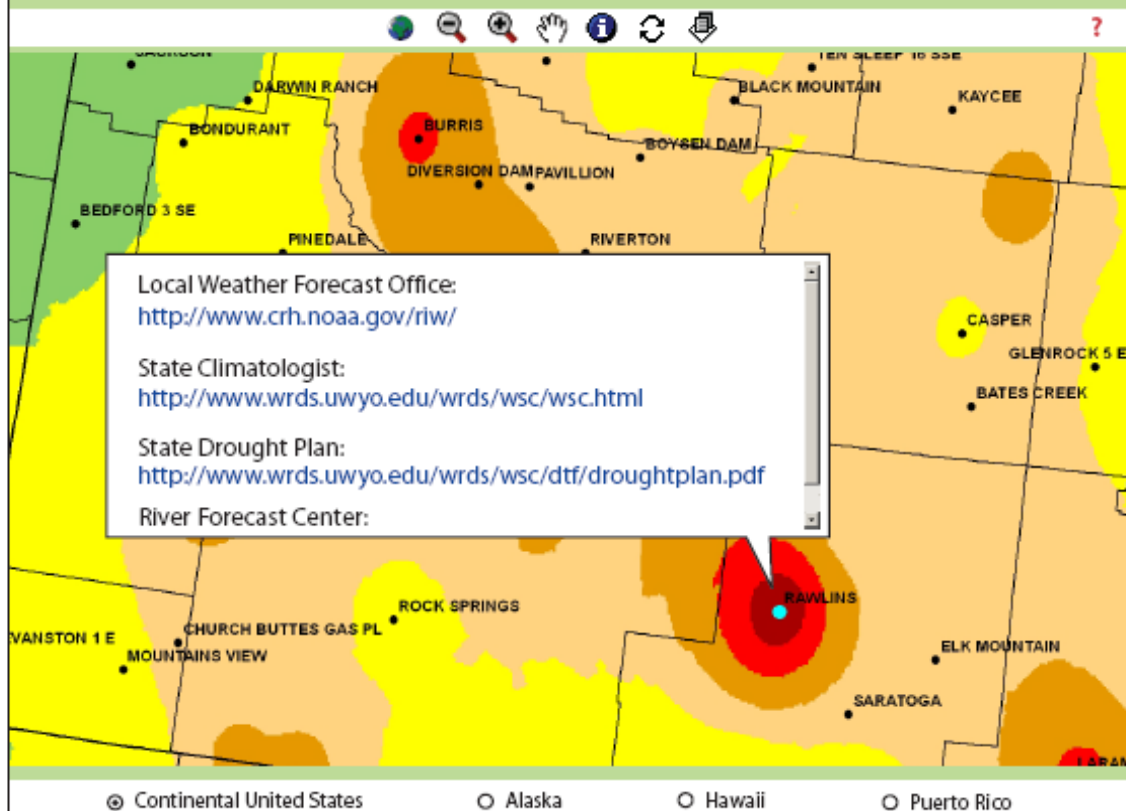
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NIDIS



Legend

Visible

[+] ☐ Drought Monitor

[-] ☒ ACIS Stations

• Station Name

[-] ☒ Climate Layers

☒ Standardized Precipitation Index

< -3

-3 to -2.5

-2.5 to -2

-2 to -1.5

-1.5 to -1

-1 to 0

0 to 1

1 to 1.5

1.5 to 2

2 to 2.5

2.5 to 3

> 3

☐ Palmer Drought Severity Index

Select

[-] ☒ Boundaries

☐ Rivers

☐ Hydrologic Units (HUCs)

☐ Congressional Districts

☐ Climate Divisions

☒ Counties

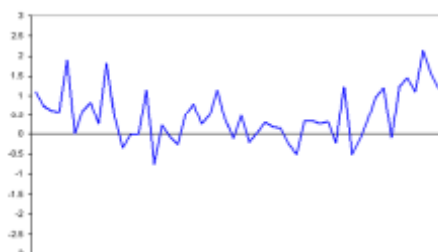
☐ Cities

☐ Roads

☐ County Warning Areas

☒ States

SPI for Rawlins, 2006



Annual Precipitation

Year	Precipitation (in)	Departure from Normal	Rank (1 = driest)
2006	6.5	-2.55	2
2005	7.97	-1.08	11
2004	9.34	0.29	66
2003	9.88	0.83	70
2002	8.13	-0.92	25
2001	8.67	-0.38	45
2000	10.56	1.51	78

Drought Impacts for Rawlins, Wyoming

Environmental Impact 12-15-2006

Rawlins, Wyoming—Forty-five bighorn sheep that were destined for the Seminole Mountains northeast of Rawlins won't be delivered there to due sustained drought conditions. [read more...](#)

Use of the DM in Decision Making

- USDA Dried Milk Program 2002-03
- USDA CRP Release hot spot trigger
- Numerous states use as a drought trigger (Governor's declarations)
- 2006 USDA Livestock Assistance
- 2006 IRS (tax deferral on livestock losses)

The Standard Precipitation Index (SPI)

Overview: The SPI is an index based on the probability of precipitation for any time scale.

Who uses it: Many drought planners appreciate the SPI's versatility.

Pros: The SPI can be computed for different time scales, can provide early warning of drought and help assess drought severity, and is less complex than the Palmer.

Cons: Values based on preliminary data may change.

Developed by: T.B. McKee, N.J. Doesken, and J. Kleist,
Colorado State University, 1993.

SPI Methodology

- The SPI was designed to quantify the precipitation deficit for multiple time scales
- These time scales reflect the impact of drought on the availability of the different water resources
- Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect the longer-term precipitation anomalies
- For these reasons, McKee et al. (1993) originally calculated the SPI for 3-, 6-, 12-, 24-, and 48-month time scales.

SPI Methodology

- The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero (Edwards and McKee, 1997)
- Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation
- Because the SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can also be monitored using the SPI.

NDMC SPI Products

- Updated daily for several time frames using near real time data from the ACIS data stream from the Regional Climate Centers
- SPI map is generated by using Grid Analysis and Display System (GrADS). The discrete station SPI data are interpolated using a Cressman objective analysis. The grid resolution is 0.4 degrees

SPI data used in the U.S. Drought Monitor

- D0 Abnormally Dry: SPI value of -0.5 to -0.7
- D1 Moderate Drought: -0.8 to -1.2
- D2 Sever Drought: -1.3 to -1.5
- D3 Extreme Drought: -1.6 to -1.9
- D4 Exceptional Drought: -2.0 or less

■ [NDMC Daily Gridded SPI Product](#)

NDMC Drought Impact Reporter

- The **National Drought Mitigation Center** developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Drought impacts are inherently hard to quantify, therefore there has not been a comprehensive and consistent methodology for quantifying drought impacts and economic losses in the United States.
- The Drought Impact Reporter is intended to be the initial step in creating a comprehensive database. The principal goal of the Drought Impact Reporter is to collect, quantify, and map reported drought impacts for the United States and provide access to the reports through interactive search tools.

NDMC Drought Impact Reporter

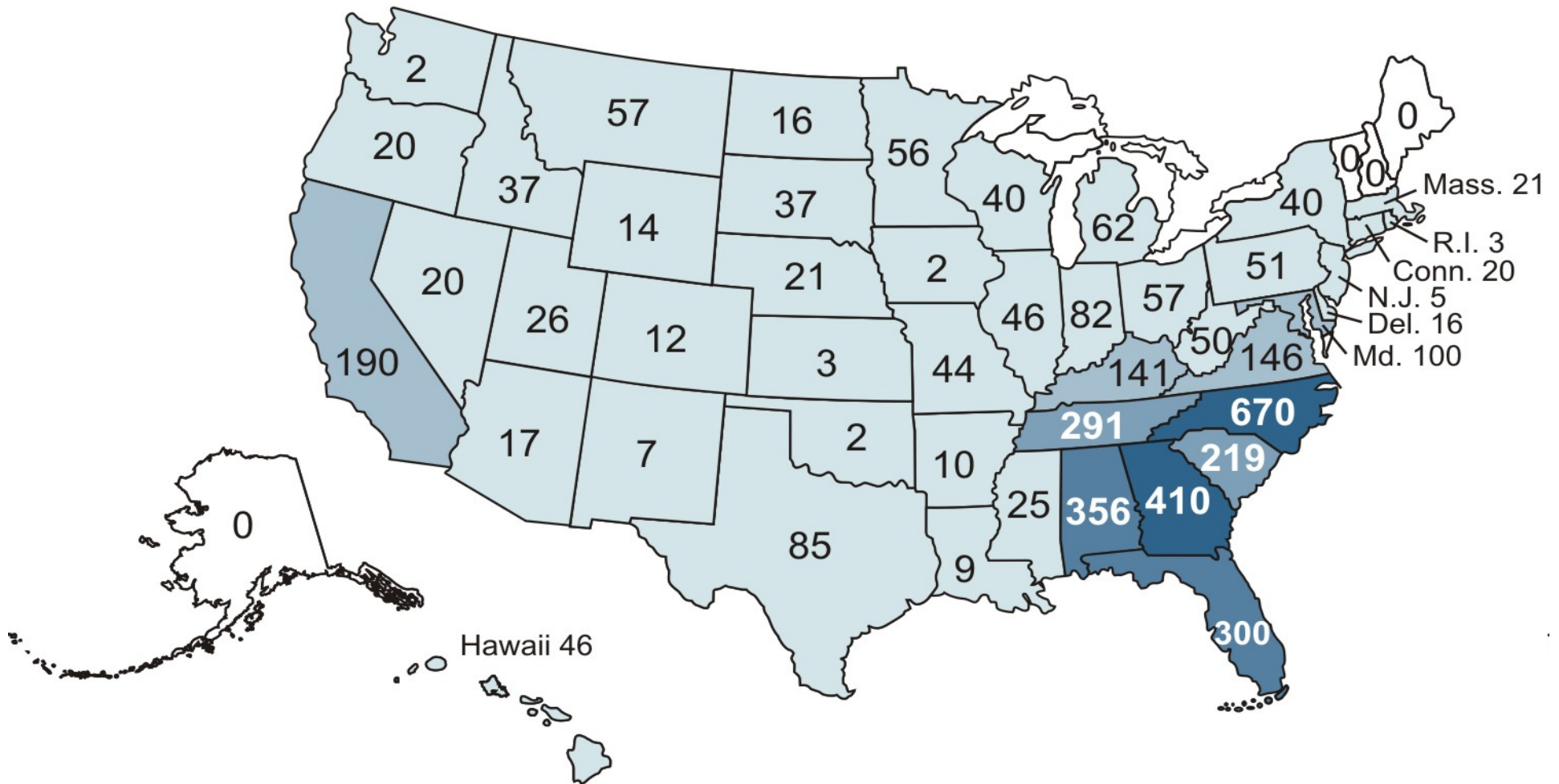
- The DIR came on-line in July 2005
- Since then we've logged more than 9,600 impacts, mostly in real-time but a few historic.
 - 90% from media reports
 - 10% from government and / or the general public
- Uses drought impacts submitted by the public as well as media reports from more than 5,000 media sources
- Moving to a new GIS interface in early 2009

NDMC Drought Impact Reporter

- From 1/1/2006 through 10/15/2008 there were 7,096 unique impacts added
- 89% of these were from media reports, the rest from the public or government reports
- 31% of these were categorized as water/energy related
- 19% of these were categorized as ag related

Reported Drought Impacts

May 1, 2007–April 30, 2008



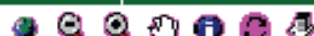
0 1–99 100–199 200–299 300–399 > 400

Source: National Drought Mitigation Center, University of Nebraska–Lincoln

First 10 of 32



Next 10 >>



Legend

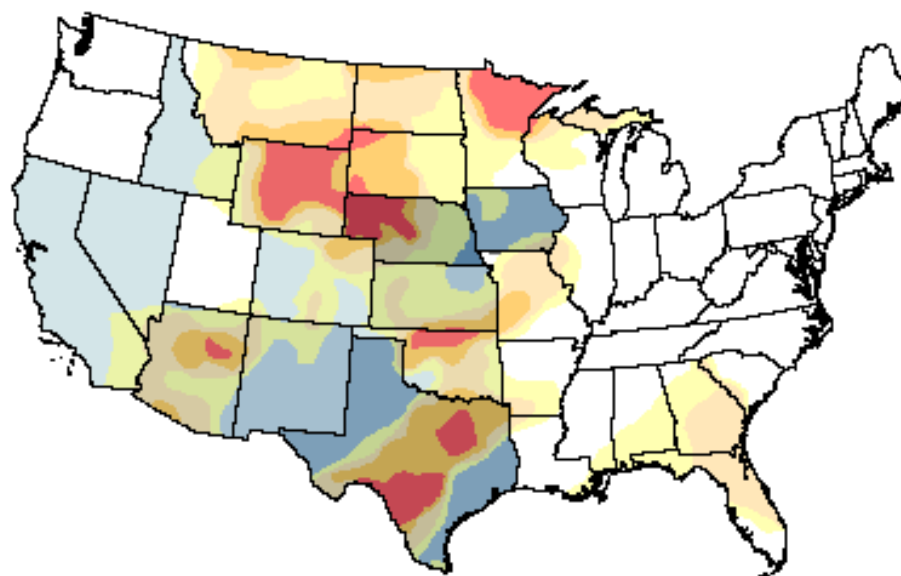
Continental US Impacts

11-21-06 – 11-21-06

- 2 Society & Public Health
- 5 Agriculture \$
- 5 Disaster Declarations & Aid \$
- 3 Energy
- 8 Water Supply & Quality
- 2 Wildfire
- 1 Plants & Wildlife
- 4 Other Business & Industry \$
- 2 Tourism & Recreation

USDA extends emergency grazing on CRP acres in 30 states

● Disaster Declarations & Aid
Agriculture Secretary Mike Johanns has lengthened the time allowed for emergency livestock grazing on land in the Conservation Reserve Program (CRP) in 30 states for farmers and livestock owners who were affected by drought. The deadline is usually September 30... [more](#)



☒ Continental United States

☐ Alaska

☐ Hawaii

Date








starting on

Nov 21 2006

ending on

Nov 21 2006

Search

-  Zoom to the full extent of the selected geographical area
-  Zoom out
-  Zoom in
-  Pan
-  Display summary impact or report information
-  Refresh the map
-  Print map

Visible

☐ Number of Categories

☐ 0 Categories

☐ 1 Categories

☐ 2 Categories

☐ 3 Categories

☐ 4 Categories

☐ 5+ Categories

☐ Categories

☐ Media Reports

☐ Condition Reports

☐ Drought Monitor

☐ D0

☐ D1

☐ D2

☐ D3

☐ D4

Date

Nov 2 2006

☐ Select Boundaries

☐ Hydrologic Units (HUCs)

☐ Counties

☐ Congressional Districts

☐ States

First 10 of 16



Next 10 >>

Wyoming

6-1-2007 to 6-16-2007

- 6 Wildfire
- 3 Agriculture \$
- 5 Water Supply & Quality
- 1 Plants & Wildlife
- 1 Tourism

State considering park rule changes

6-1-2007

- Wildfire

Cheyenne, WY—The Wyoming Department of State Parks and Cultural Resources proposes banning the possession of any fireworks in state parks and historic places... [more](#)

Northeast drought persists, despite rain

6-11-2007

- Water Supply & Quality

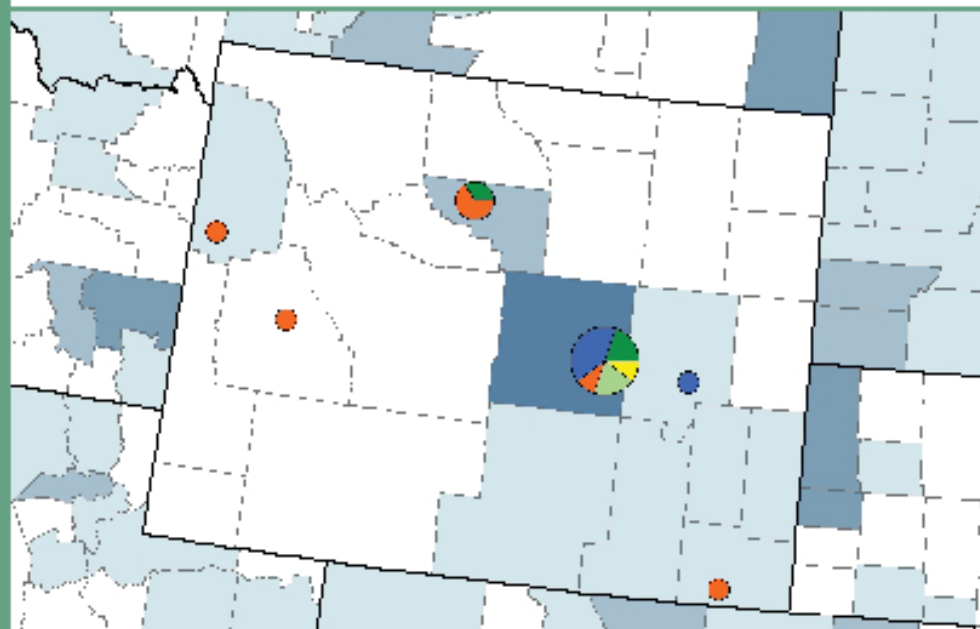
Casper, WY—Drought still persists in Northeast Wyoming, despite heavy rains last week. Keyhole Reservoir remains at 37 percent of its average level after local flooding of streams, creeks and basements... [more](#)

Drought affecting sugarbeet acreage

6-2-2007

- Agriculture

Worland, WY—The number of



Continental United States

Alaska

Hawaii

Date

starting on June 1 2007

ending on June 16 2007

Search

- Zoom to the full extent of the selected geographical area
- Zoom out
- Zoom in
- Pan
- Display summary impact or report information
- Refresh the map
- Print map

Legend







- Visible
- [-] Number of Categories
 - ☐ 0 Categories
 - ☐ 1 Categories
 - ☐ 2 Categories
 - ☐ 3 Categories
 - ☐ 4 Categories
 - ☐ 5+ Categories
- [+] Categories
- [-] Media Reports
 - ☐ Society & Public Health
 - ☐ Agriculture
 - ☐ Disaster Declarations & Aid
 - ☐ Energy
 - ☐ Water Supply & Quality
 - ☐ Wildfire
 - ☐ Plants & Wildlife
 - ☐ Other Business & Industry
 - ☐ Tourism & Recreation
 - ☐ General Awareness
- [+] Condition Reports
- [+] Drought Monitor
- [+] Boundaries

Impact Categories

Current

Map Options











Impact Categories:

<input checked="" type="checkbox"/>  Agriculture	<input checked="" type="checkbox"/>  Fire
<input checked="" type="checkbox"/>  Water/Energy	<input checked="" type="checkbox"/>  Social
<input checked="" type="checkbox"/>  Environment	<input checked="" type="checkbox"/>  Other

Source:

Time Period:

Planned

- [+] ☐ Media Reports
- ☐  Society & Public Health
 - ☐  Agriculture
 - ☐  Disaster Declarations & Aid
 - ☐  Energy
 - ☐  Water Supply & Quality
 - ☐  Wildfire
 - ☐  Plants & Wildlife
 - ☐  Other Business & Industry
 - ☐  Tourism & Recreation
 - ☐  General Awareness

NDMC Drought Impact Reporter

- Allows the public to have a voice in the process of making the weekly United States Drought Monitor
- <http://droughtreporter.unl.edu>

National Drought Mitigation Center

University of Nebraska–Lincoln



The National Drought Mitigation Center (NDMC) helps people and institutions develop and implement measures to reduce societal vulnerability to drought. The NDMC, based at the University of Nebraska–Lincoln, stresses preparation and risk management rather than crisis management.

What is Drought?

An overview of drought • Climographs • Historical Palmer Drought index maps and graphs • Drought and El Niño • The Dust Bowl

Planning for Drought

How (and why) to plan for drought • The 10-Step Planning Process • Directory of drought planning contacts

Monitoring Drought

How to select monitoring tools • The SPI, the U.S. Drought Monitor, and links to tools elsewhere on the web

Understanding Your Risk

Understanding drought's impacts • Drought Impacts in the United States • Drought impacts around the world

Mitigating Drought

Putting a drought plan together • Existing drought plans and studies • Drought mitigation tools/initiatives • Water conservation

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for Kids*

For Media

*Other
Drought-related
Sites*

*U.S.
Drought
Monitor*

*NDMC's
Drought Impact
Reporter*

Thank you!

Please visit us at:
<http://drought.unl.edu/>

Please contact me at:
bfuchs2@unl.edu



DROUGHT MONITOR

A hand in a blue shirt cuff is pinning a map of the United States to a wall. The map is made of a material that cracks and peels, symbolizing drought. The background is a textured, brownish wall.

drought monitor

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current conditions

archive

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