Funding provided by NOAA
Sectoral Applications Research Project

MONITORING DROUGHT

Basic Climatology

Oklahoma Climatological Survey

DEFINING DROUGHT

First off, just what is drought?

- Define a tornado
- Define a severe thunderstorm
- Define a hurricane
- Define a volcanic eruption
- When did it begin? Where was it? How bad was it? When did it end? Can you point to one on a map or radar display?
- *Okay, do the same for drought*

First off, just what is drought?

- Precipitation deficits?
- Soil moisture?
- Streamflow?
- Plants wilting?
- Wildfire?
- Famine?
- Other?

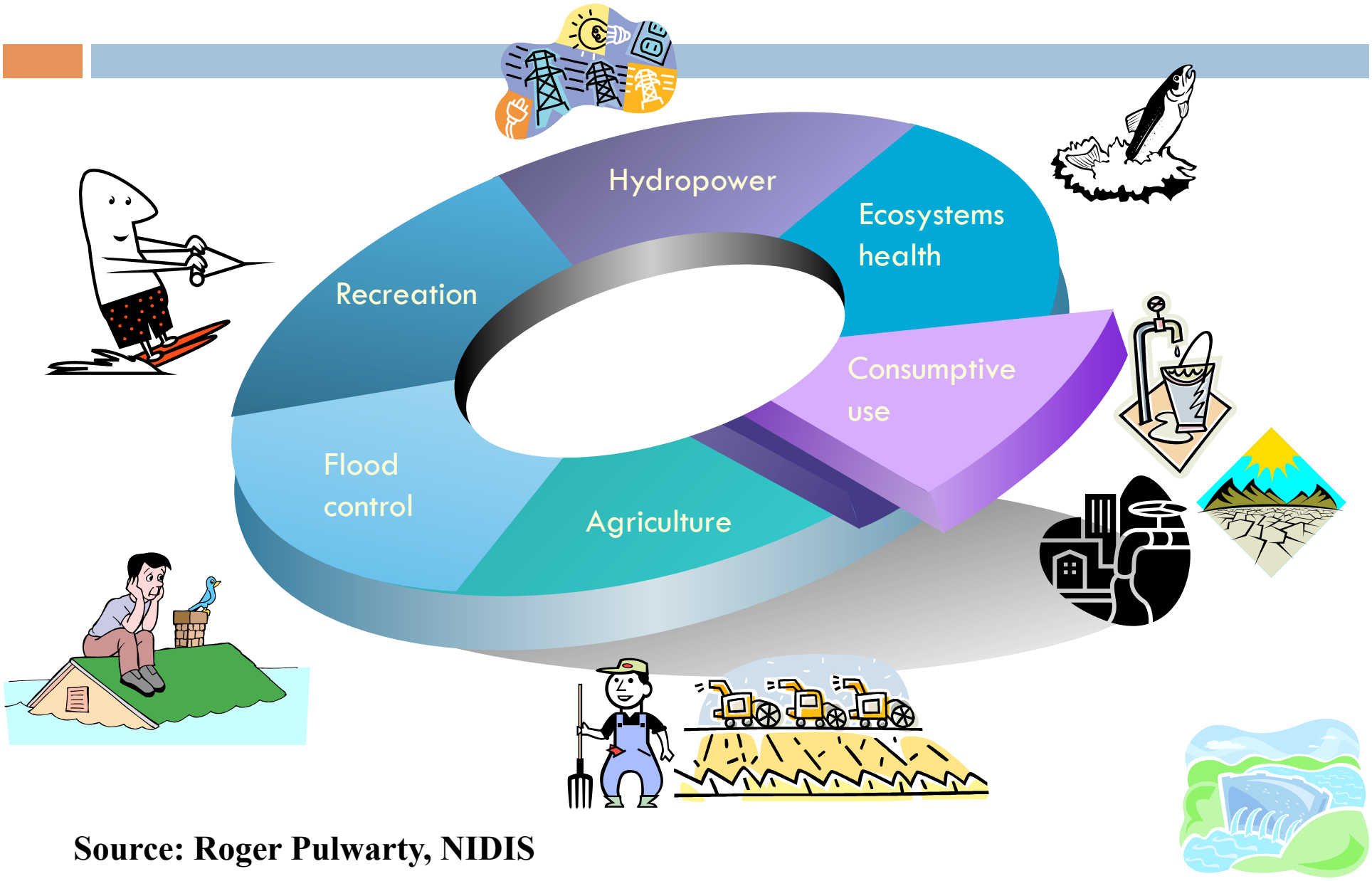
Drought defined by its impacts

- Meteorological Drought – departures from "normal" precipitation
- Agricultural Drought – soil / groundwater deficits that affect vegetation
- Hydrologic Drought – deficiency of water in watersheds, rivers; often lags agriculture impacts
- Socio-Economic Drought – shortage of some item (water, food, fish, natural values) that affects the balance of supply and demand

What is drought?

- Drought is the condition that occurs when ***water resources are insufficient to meet water needs.***
- … *in other words* …
- ***Drought is a social phenomenon.***
  - It's what it does to people that counts!
  - We read about droughts in the Sahel, but not the Sahara. *Why?* Because people live in the Sahel.

Multiple competing values, Multiple competing objectives



Source: Roger Pulwarty, NIDIS

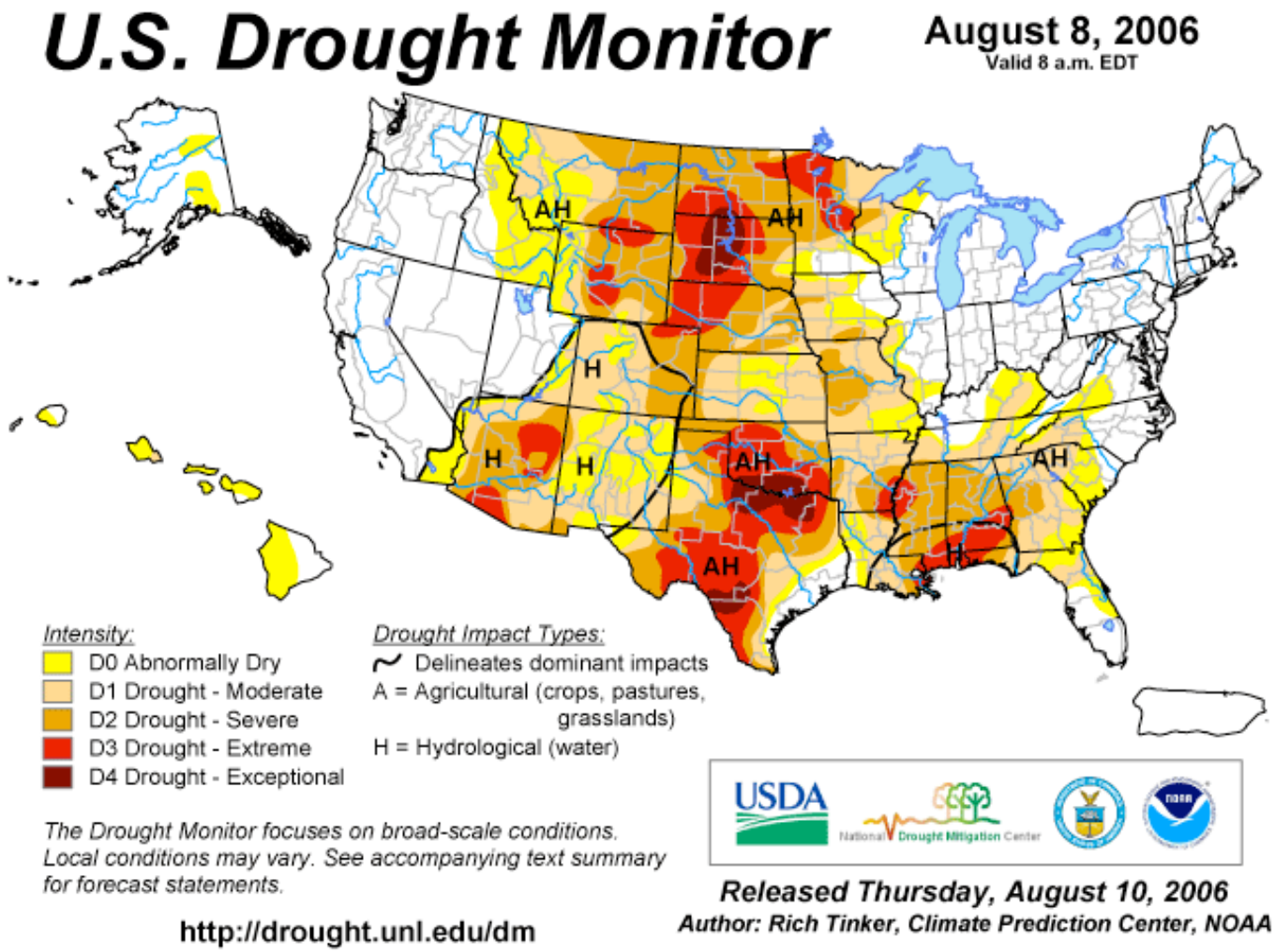
What is Drought?

- ***Drought is a multi-faceted issue and requires a multi-faceted assessment.***
  - Does a doctor take your temp, check a chart and say "based on your temp, you are moderately-to-severely sick"?
  - Instead, she uses the results of several patient-appropriate and symptom-appropriate tests. *i*.e., *well-chosen indicators in concert with each other.*
  - A responsible drought decision-maker (and those who supply her data) should take the same approach.

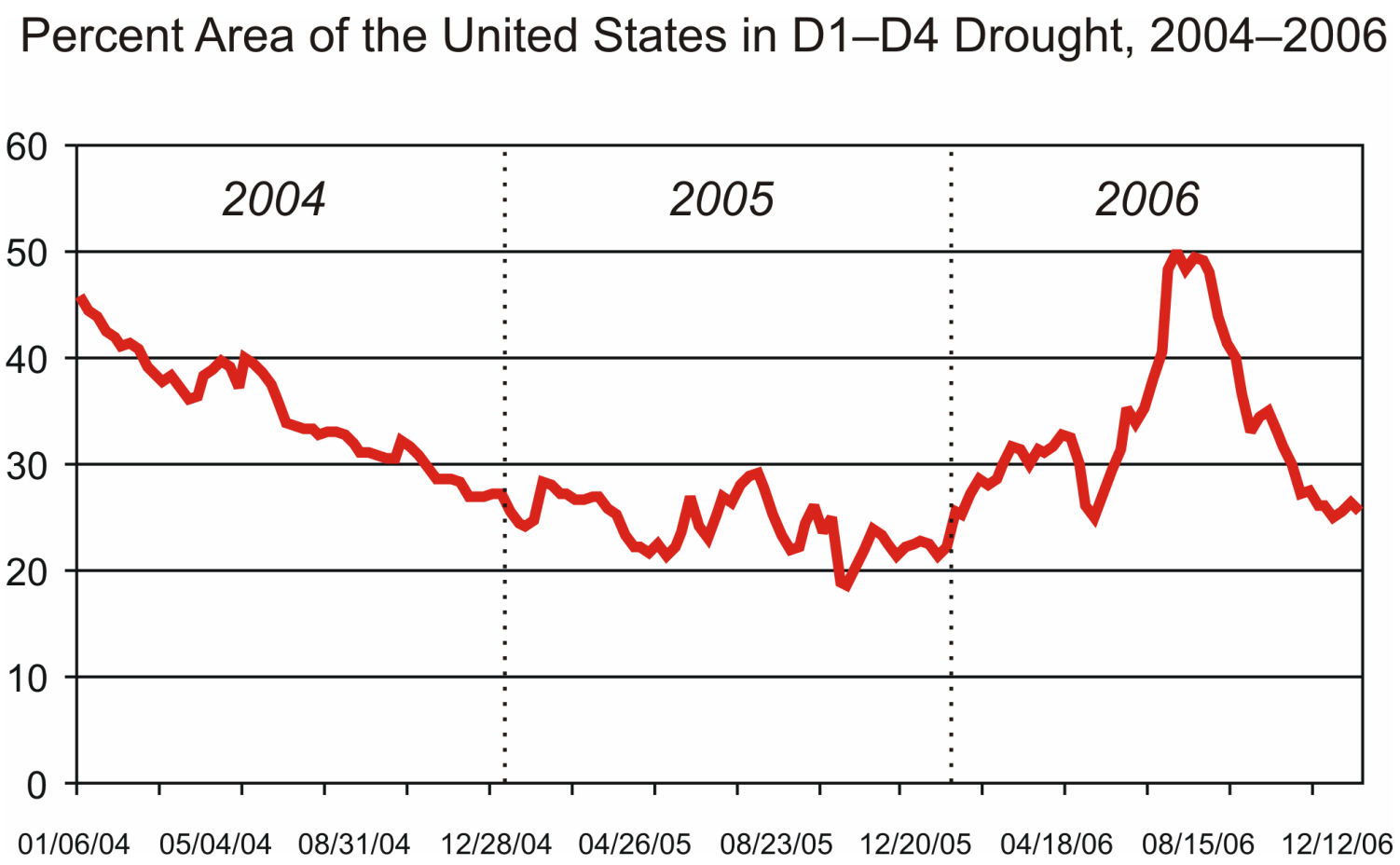
Why Monitor Drought Impacts?

- Drought is one of the **most costly** U.S. natural disasters
  - Estimated annual losses at **$6-8 billion** (1995)
  - **1988: $39 billion ($68B in 2007 $)**
  - **2002, 2003, 2004, 2005, 2006, 2007: ???**
  - Europe, 2003: **US$13B**
  - Canada, 2001-02: **US$5.7B**
- USDA/Risk Management Agency, 2006: US $1.71B indemnities
- Congress has appropriated approximately **$30 billion** in drought relief since 1988

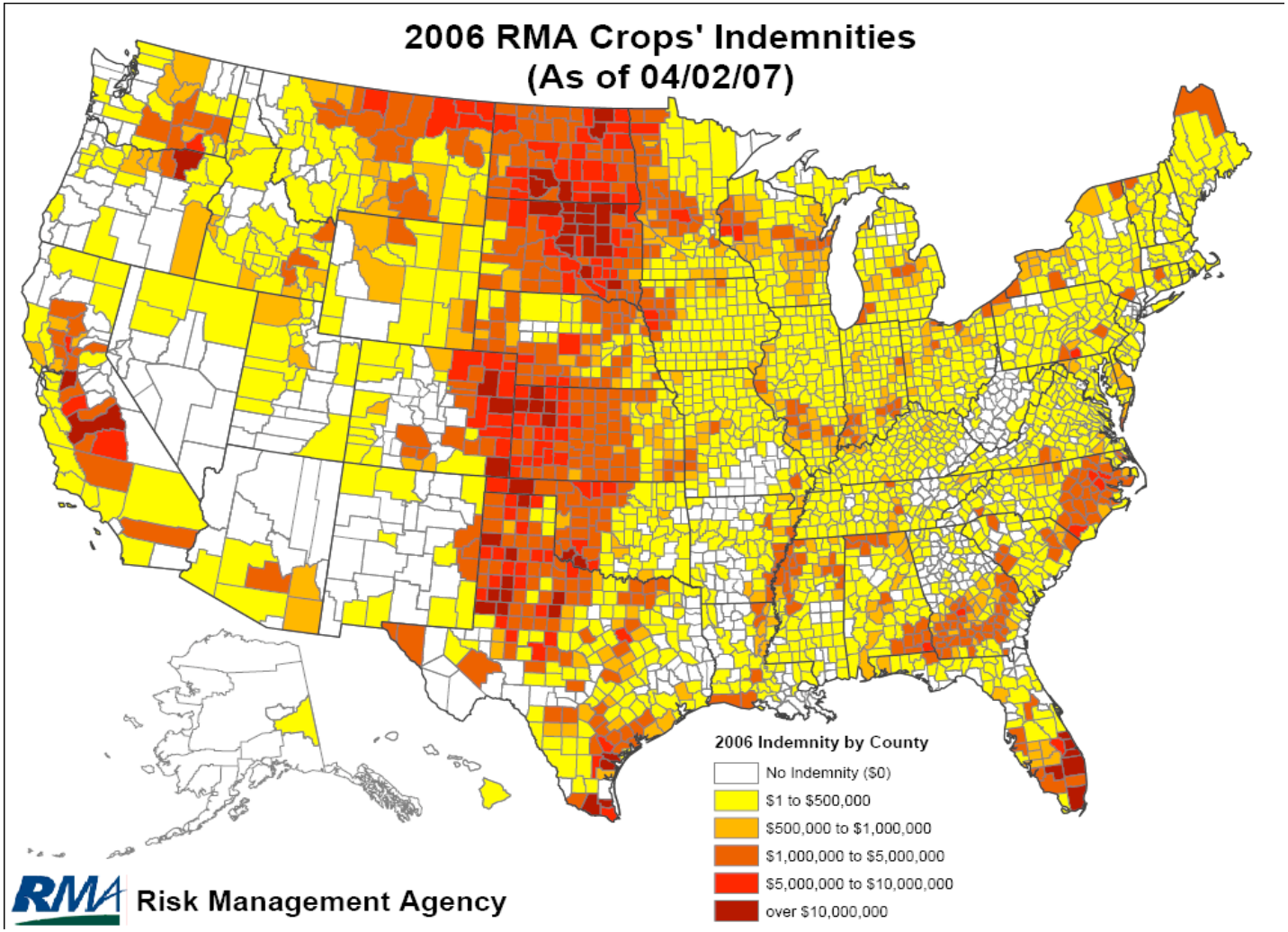
Approximate Peak of 2006 Drought



50% of US in Drought



Economic Impacts of Drought

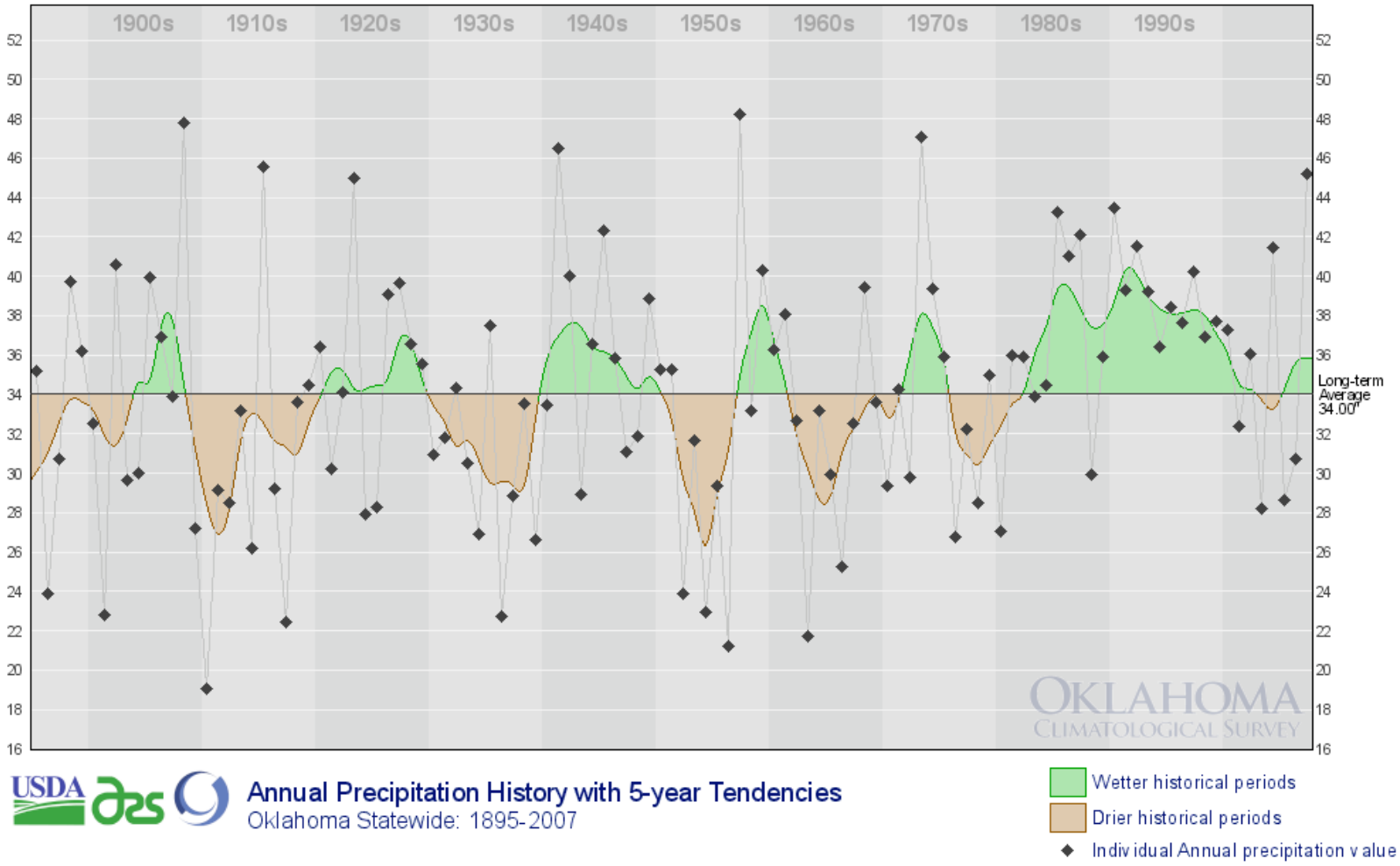


DROUGHT INDICATORS

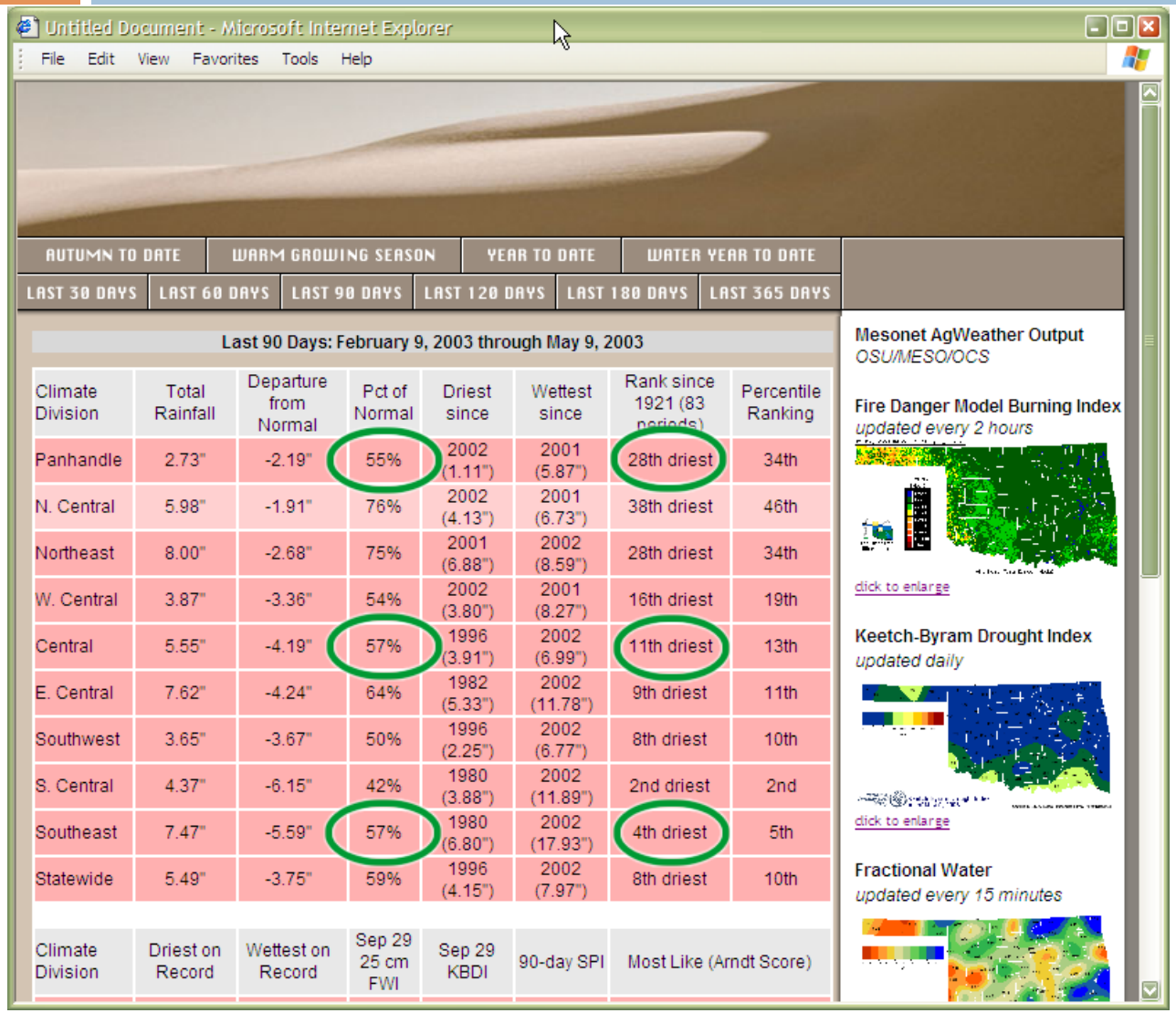
Precipitation Departures

- Precipitation the key indicator for vegetation growth, water resources
  - Temperature effects also important, but precipitation dominates
- Measured virtually everywhere
- Easy to calculate
- Can be done for points or over areas (such as a state or climate division)

Droughts are a part of Oklahoma



Lies, Darn Lies and Statistics



Climate Division	Total Rainfall	Departure from Normal	Pct of Normal	Driest since	Wettest since	Rank since 1921 (83 periods)	Percentile Ranking
Panhandle	2.73"	-2.19"	55%	2002 (1.11")	2001 (5.87")	28th driest	34th
N. Central	5.98"	-1.91"	76%	2002 (4.13")	2001 (6.73")	38th driest	46th
Northeast	8.00"	-2.68"	75%	2001 (6.88")	2002 (8.59")	28th driest	34th
W. Central	3.87"	-3.36"	54%	2002 (3.80")	2001 (8.27")	16th driest	19th
Central	5.55"	-4.19"	57%	1996 (3.91")	2002 (6.99")	11th driest	13th
E. Central	7.62"	-4.24"	64%	1982 (5.33")	2002 (11.78")	9th driest	11th
Southwest	3.65"	-3.67"	50%	1996 (2.25")	2002 (6.77")	8th driest	10th
S. Central	4.37"	-6.15"	42%	1980 (3.88")	2002 (11.89")	2nd driest	2nd
Southeast	7.47"	-5.59"	57%	1980 (6.80")	2002 (17.93")	4th driest	5th
Statewide	5.49"	-3.75"	59%	1996 (4.15")	2002 (7.97")	8th driest	10th

Climate Division	Driest on Record	Wettest on Record	Sep 29 25 cm FWI	Sep 29 KBDI	90-day SPI	Most Like (Arndt Score)

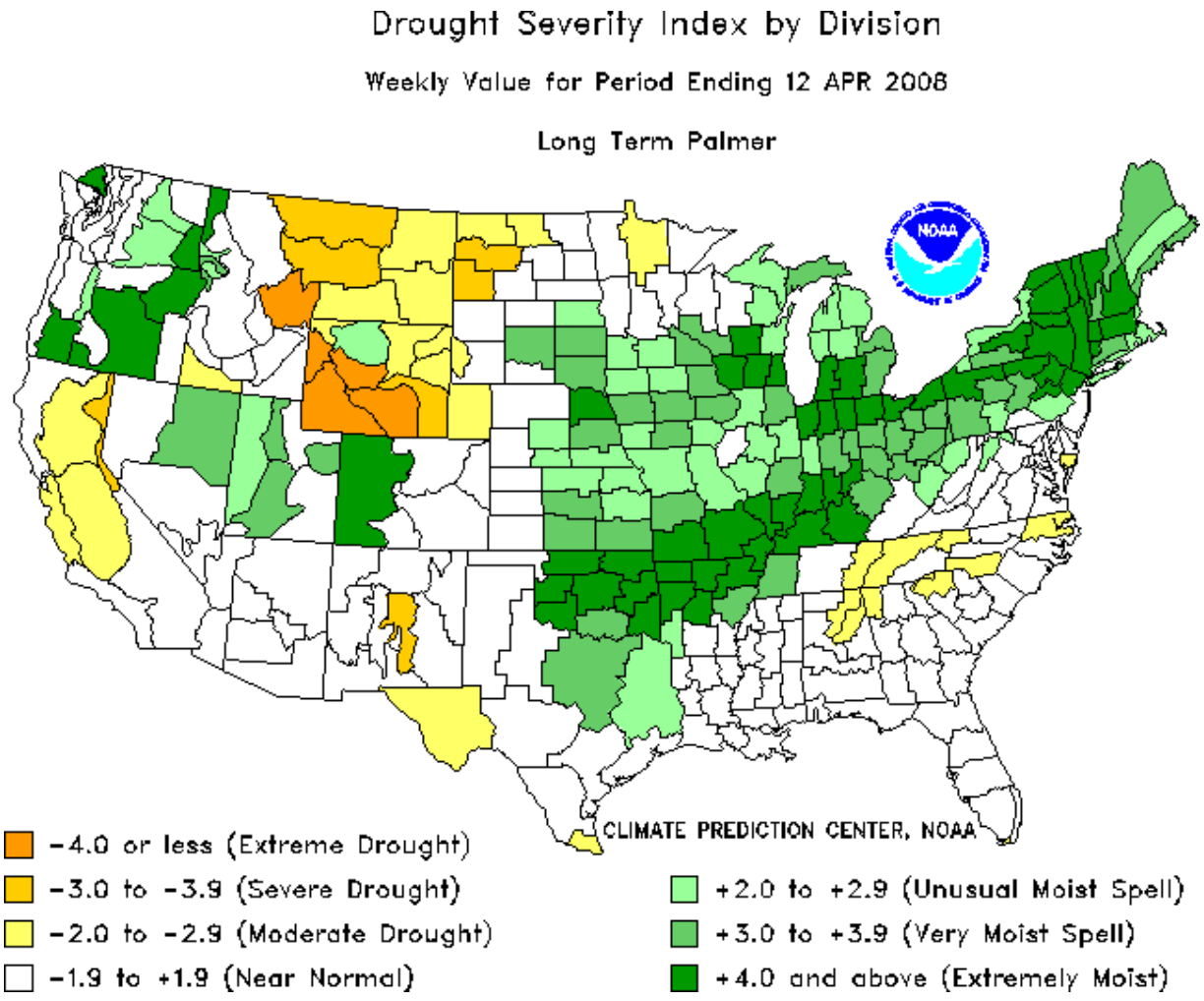
Often, the raw statistics do not reveal the complete picture!

55% vs. **57**% vs. **57**% doesn't necessarily mean they're all in the same situation!

Palmer Drought Severity Index (PDSI)

- Developed in 1965 (first widely used soil moisture model)
- Uses temperature and precipitation departures to determine dryness
- Ranges from -4 (extreme drought) to +4 (extreme wet)
- Standardized to local climate
  - Based on departures from local climate normals
- Good for measuring long-term drought in relatively uniform regions
  - Not good for short-term drought / rapid changes
  - Not good for variable terrain (i.e., mountains)
- May lag emerging drought conditions by several months

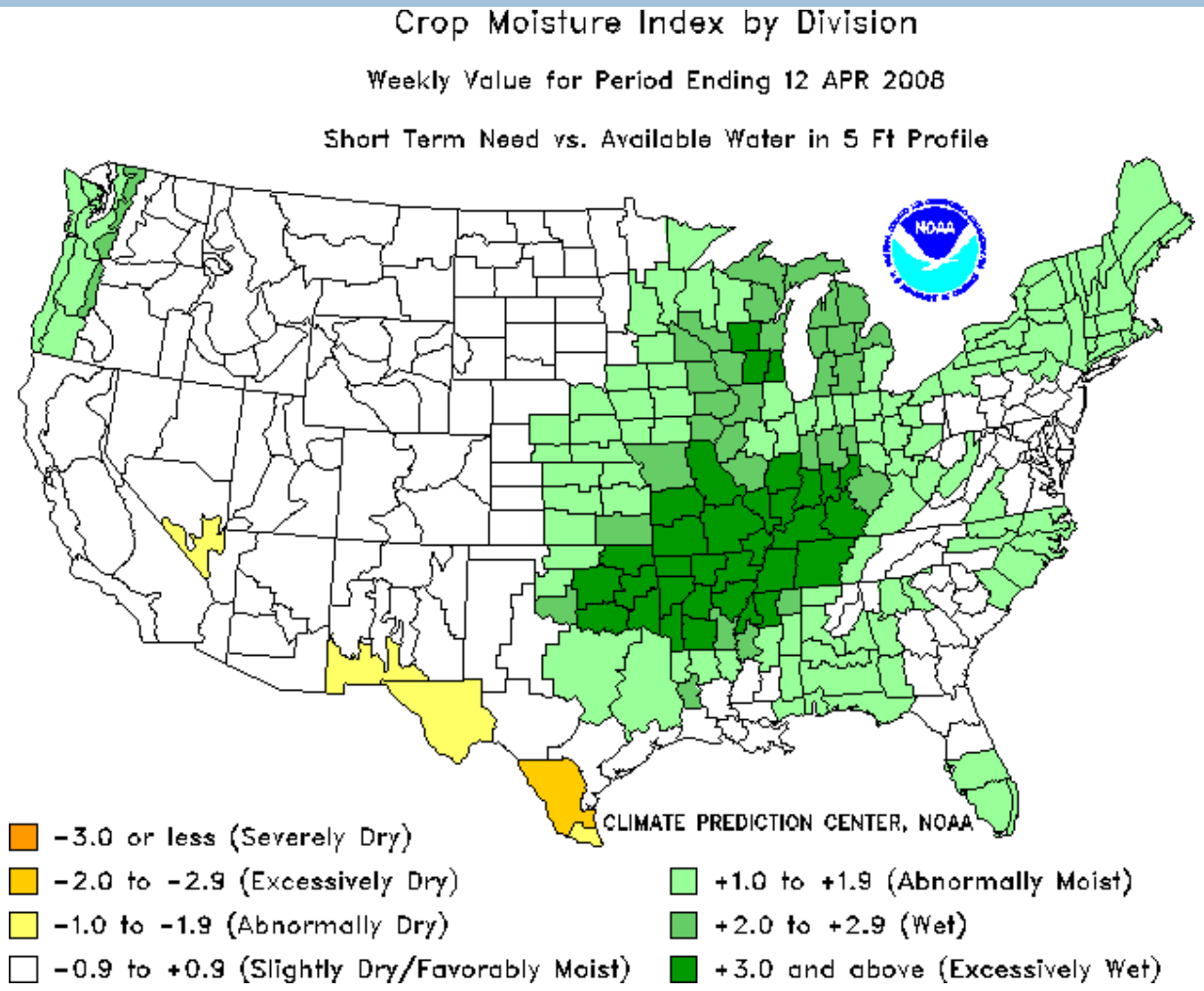
Palmer Drought Severity Index (PDSI)



Crop Moisture Index (CMI)

- Developed in 1968
- Geared for agricultural drought
- Uses same categories as PDSI
- Responds more rapidly than PDSI
  - Short-term dryness or wetness
- Starts and ends growing season at near zero
  - Not good for long-term assessments
- May overestimate recovery resulting from short-term rainfall

Crop Moisture Index (CMI)

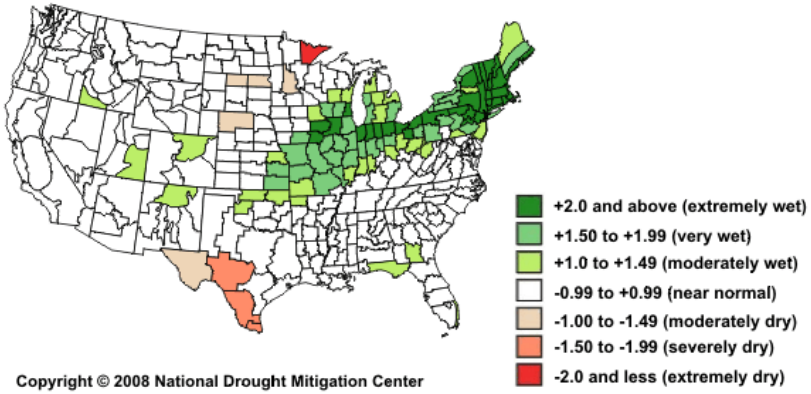


Standardized Precipitation Index (SPI)

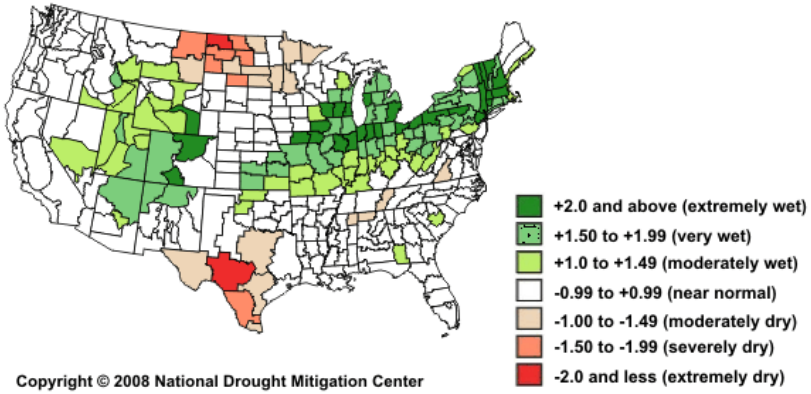
- Developed in 1990s
- Can be produced for a variety of time periods, depicting both short-term and long-term conditions
- Based on precipitation over an accumulation period compared to the station's historical distribution
  - Statistical "unusualness" of a period
- PDSI uses a water-balance model to estimate evaporation based on temperature
- Values of -2 or less are extremely dry; +2 and greater are extremely wet

Standardized Precipitation Index (SPI)

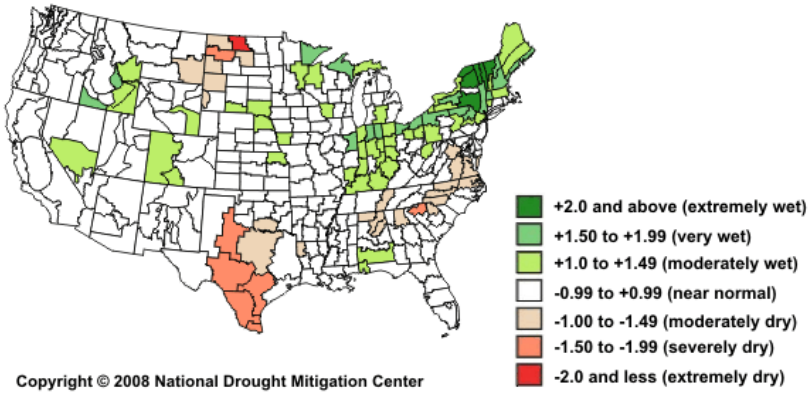
1-month SPI through the end of February 2008



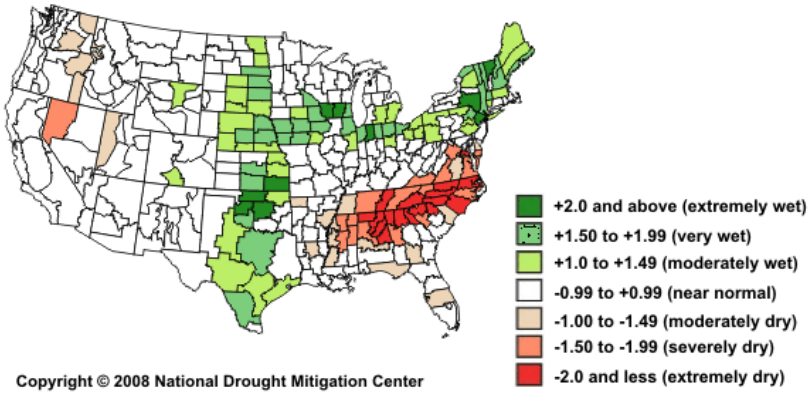
3-month SPI through the end of February 2008



6-month SPI through the end of February 2008



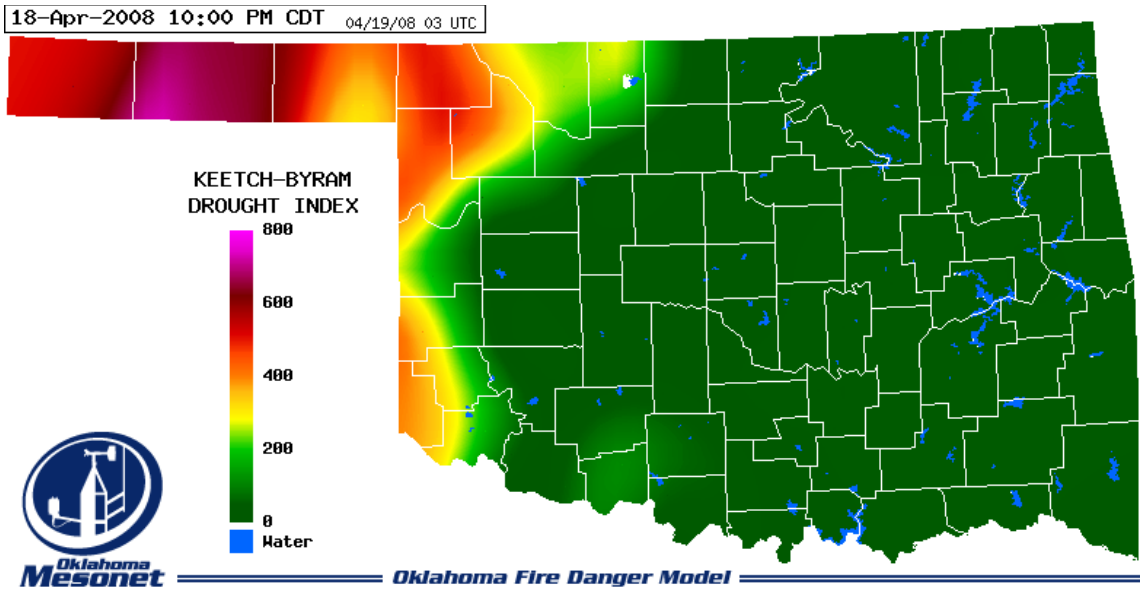
12-month SPI through the end of February 2008



Keetch-Byram Drought Index (KBDI)

- Estimates dryness of soil and dead vegetation
- Ranges from 0 (saturated soil) to 800 (dry soil)
- Based on combination of recent precipitation and estimated evaporation
  - Soil may dry because of extended periods without precipitation or by high temperatures / strong winds
- Developed for fire management purposes, but also a good short-term drought indicator

Keetch-Byram Drought Index (KBDI)



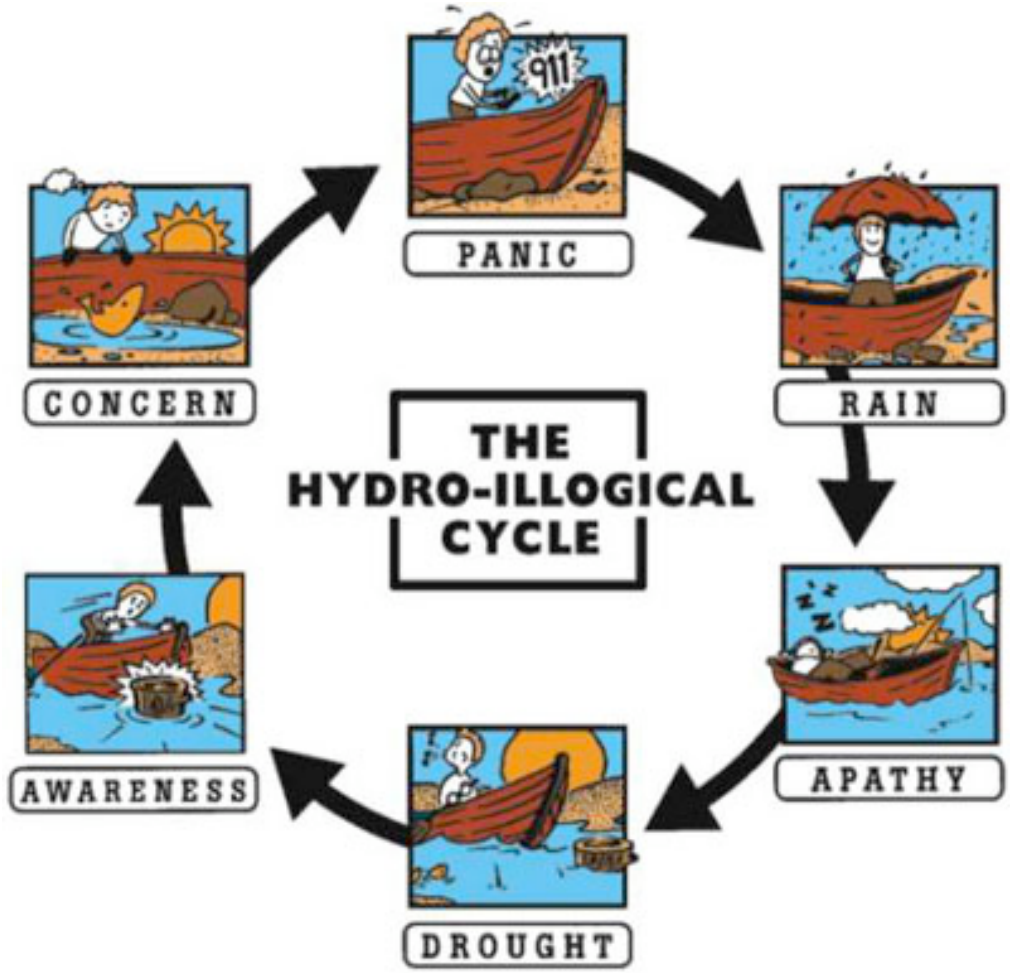
KBDI Value	Interpretation
0-200	No Drought-Slight Drought. Fuels and ground are quite moist.
200-400	Moderate Drought. Dry vegetation begins to contribute to fire.
400-600	Severe Drought. Escaped fire is difficult to control.
600-800	Extreme Drought. Fire suppression is a major problem.

Other Drought Tools

- Evaporation models
  - Often the missing link in drought understanding
  - Direct measurement difficult and disappearing (pan evap)
  - ET models are getting more sophisticated
- Soil Moisture
  - Integrates precipitation deficits over time
  - Lagging indicator but strongly related to impacts
  - Valuable for assessing recovery

DROUGHT MONITORING

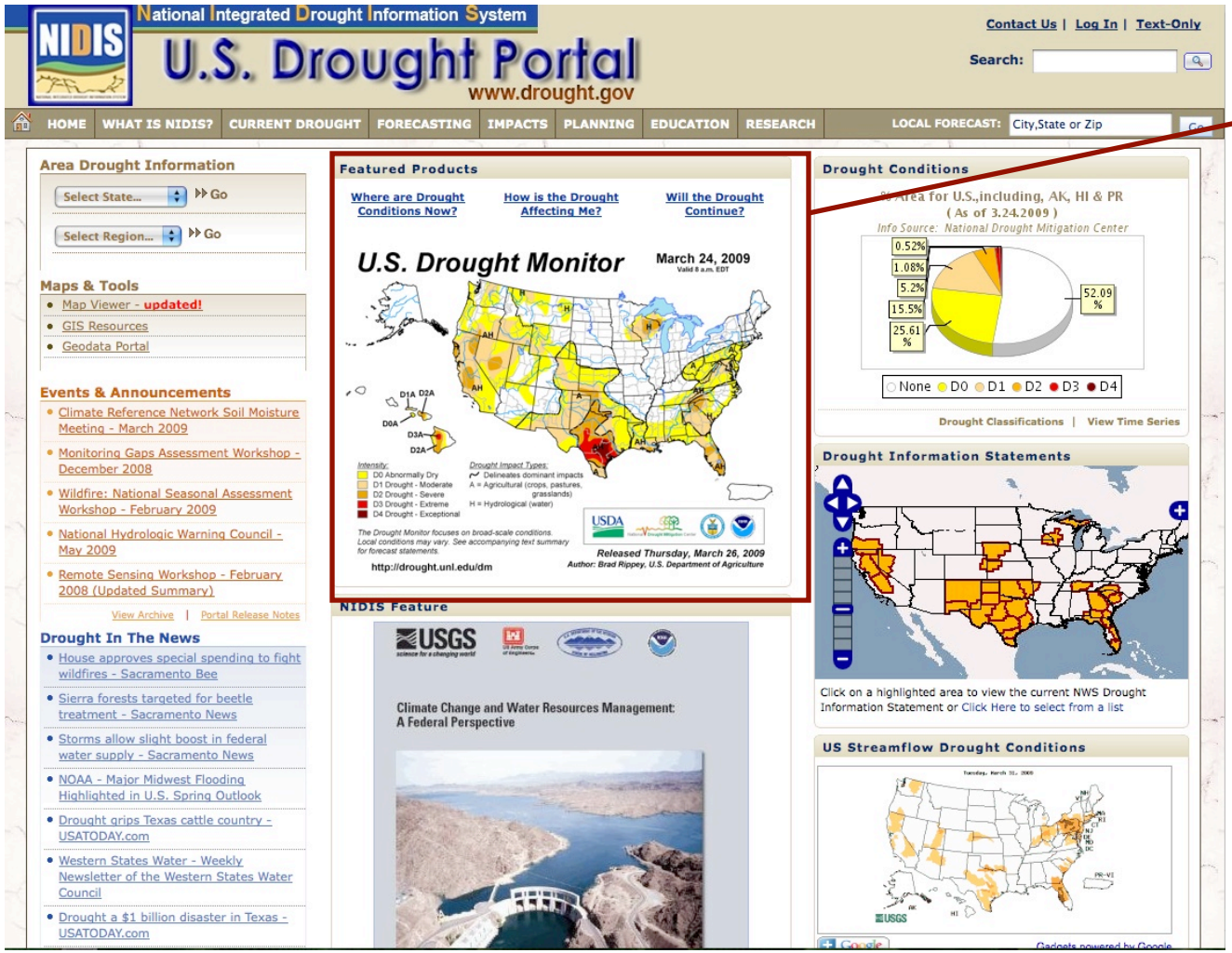
The “normal” reaction to drought



Source: Don Wilhite, National Drought Mitigation Center

NIDIS Drought Portal

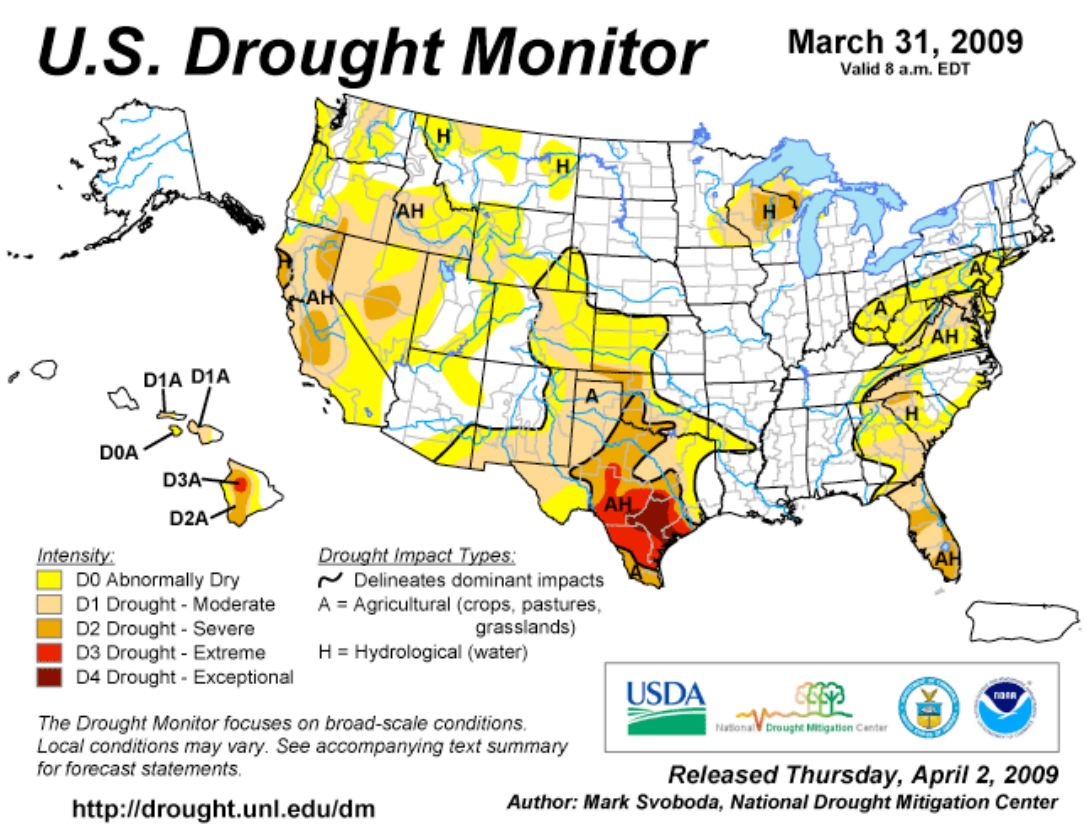
http://www.drought.gov



Drought Monitor
Drought Impact Reporter
Drought Outlook

NIDIS Drought Portal

U.S. Drought Monitor



D0 – Abnormally Dry
- Heads Up!

D1 Drought – Moderate
- Some localized impacts

D2 Drought – Severe
- Losses likely, water restrictions

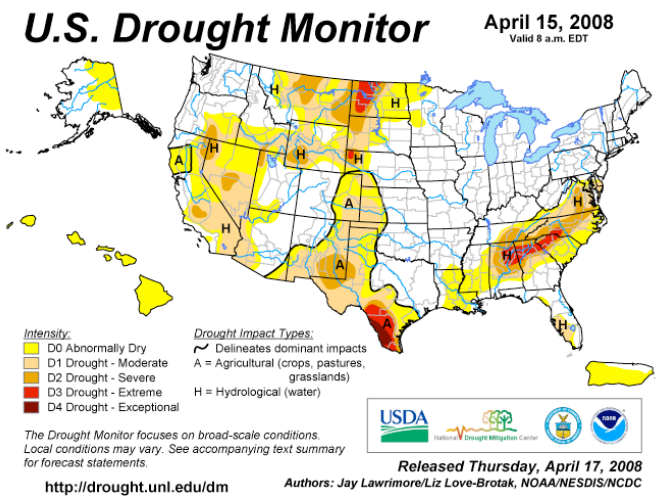
D3 Drought – Extreme
-Widespread & severe losses, water shortages

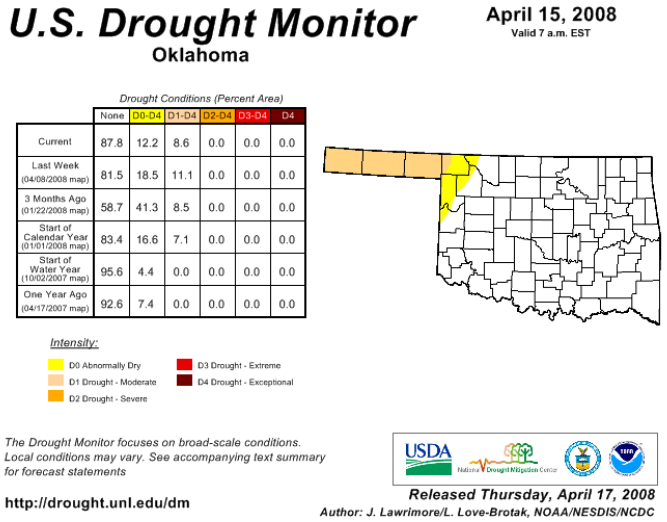
D4 Drought – Exceptional
- Dust Bowl

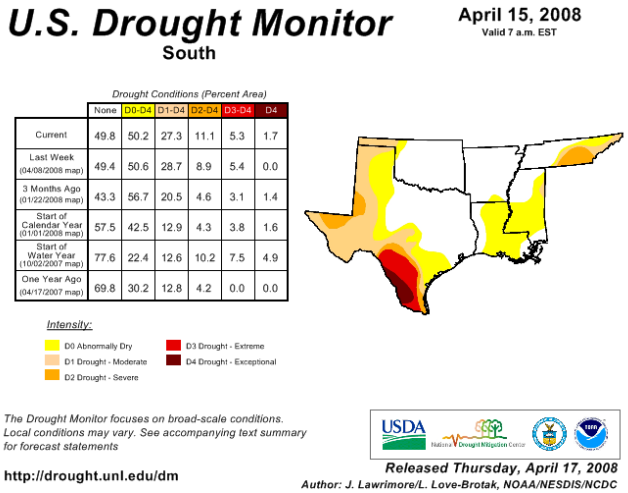
The Drought Monitor Concept

- A consolidation of indicators into one comprehensive national drought map
- Trying to capture these characteristics:
  - the drought's magnitude (duration + intensity)
  - spatial extent (how widespread)
  - how often similar conditions occur
  - Impacts
- Rates drought intensity by **percentile ranks**
- An assessment – not a forecast, not a declaration

From National to Local…







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

Who Makes the Drought Monitor?

- A ***partnership*** between the National Drought Mitigation Center, USDA and NOAA's Climate Prediction Center and National Climatic Data Center ***(authors)***
- Incorporate relevant information and products from all entities (and levels of government) dealing with drought (Regional Climate Centers, State Climatologists, 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

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(s) 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

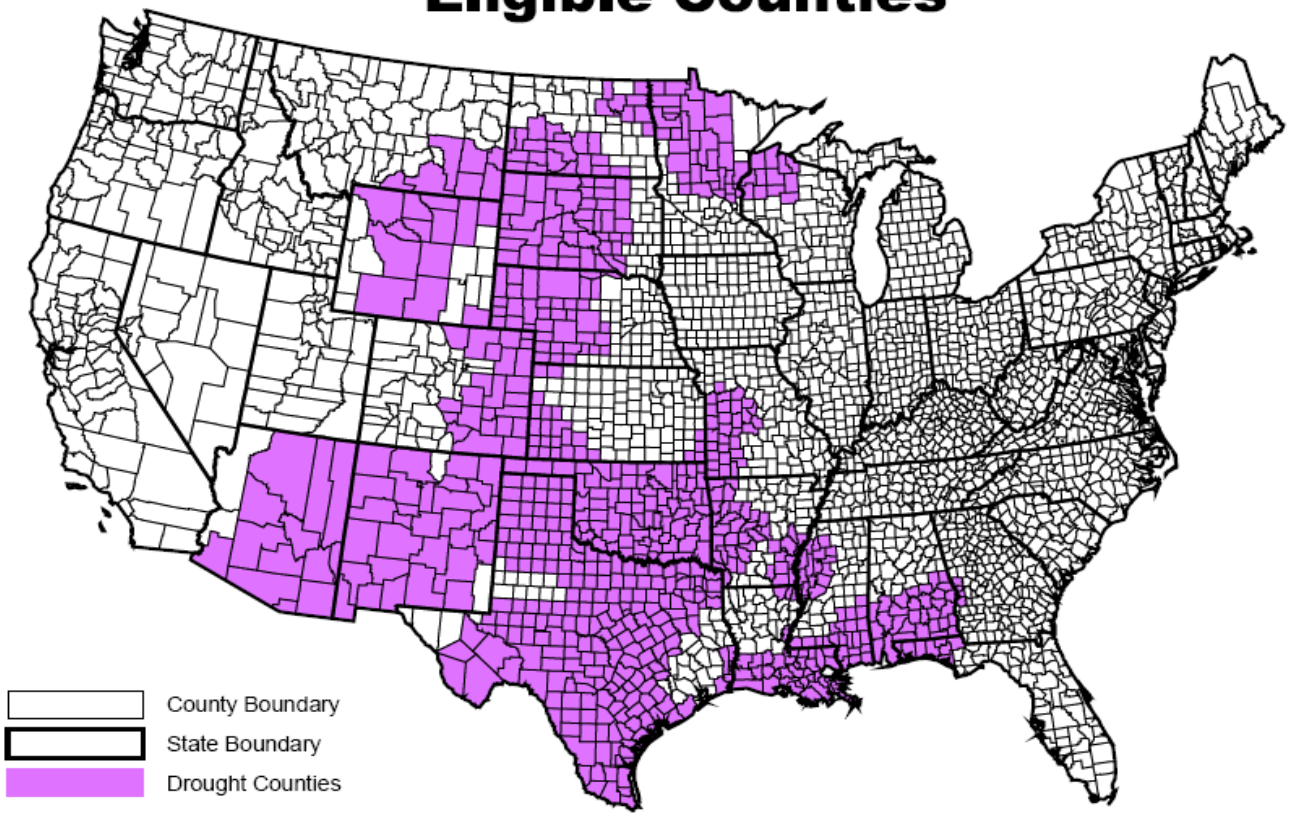
- ✓Final map & text released on NDMC Website

Why Does This Matter?

Use of the DM in Decision-Making

- USDA Conservation Reserve Program Release hot spot trigger (D2)
- USDA Dried Milk Program 2002-03
- Numerous states use as a drought trigger (Governor's declarations)
- 2006 USDA Livestock Assistance (D3)
- 2006 IRS (tax deferral on livestock losses)

Livestock Assistance Grant Program
Eligible Counties



The purple area represents counties that were at level D3 or D4 at anytime from March 7th, 2006 through August 31st, 2006.

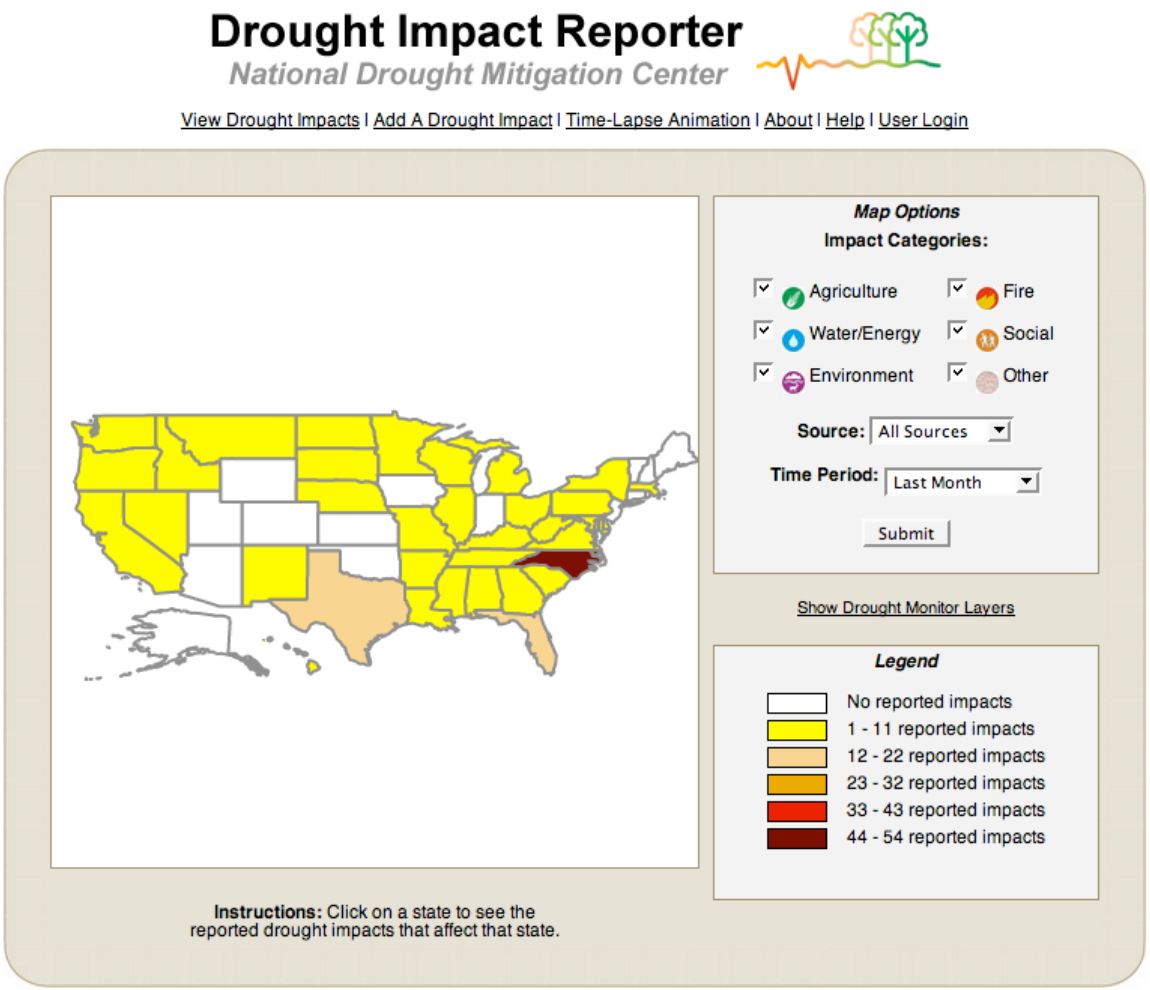
Drought Data Source:
The Drought Monitor
National Drought Mitigation Center
Lincoln, NE

USDA

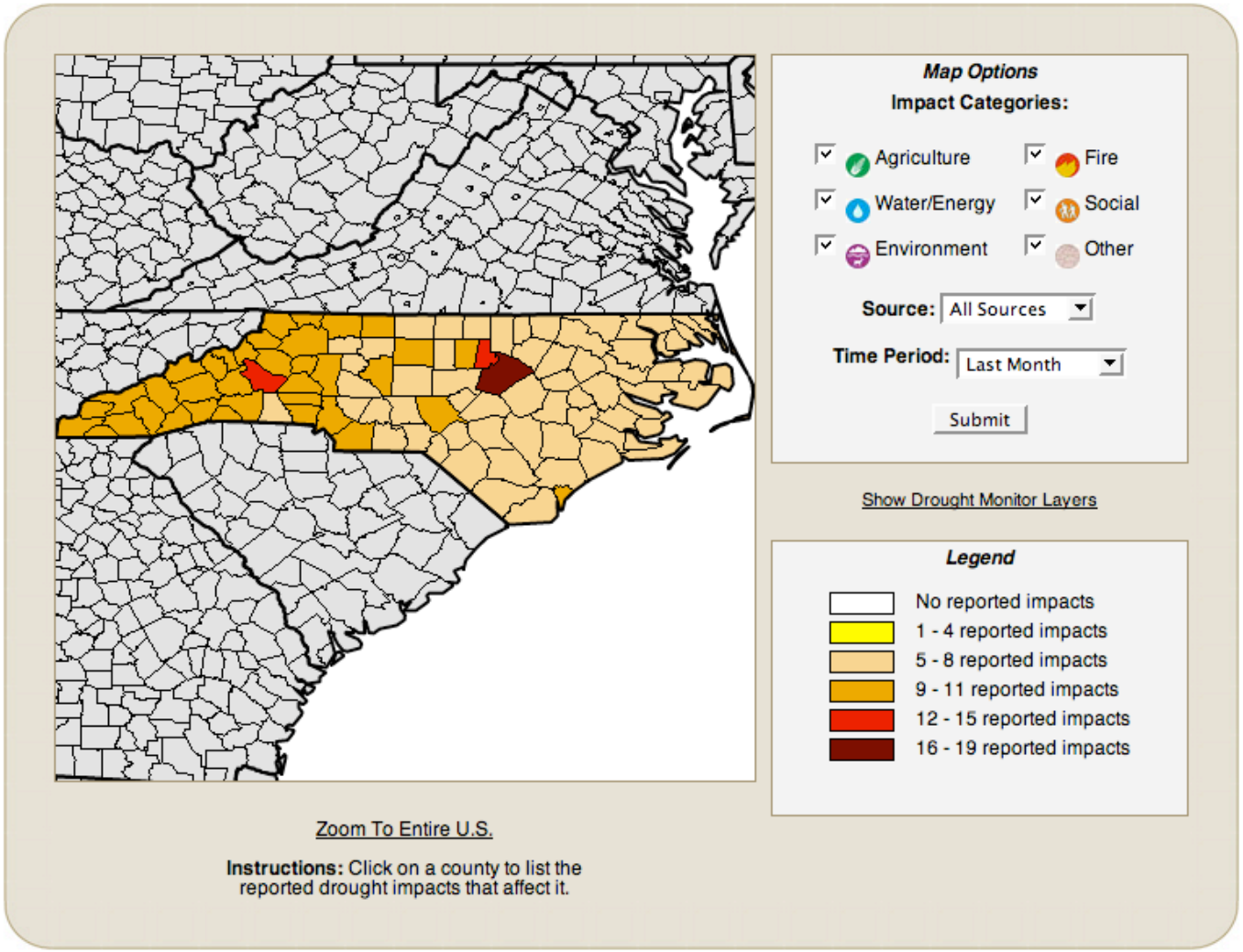
August 31st, 2006
Farm Service Agency

NIDIS Drought Portal

Drought Impact Reporter



Drought Impact Reporter



What can you find in the Drought Impact Reporter?

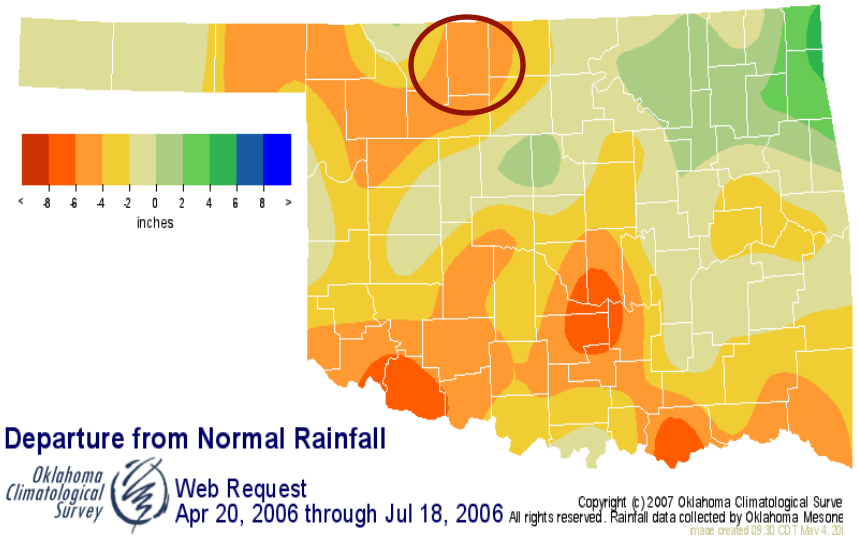
- Individual and media reports of drought "events"
- Color-coded maps to show counties, states reporting many impacts
- Number of reports does not necessarily indicate severity
  - Could have many reports from an organized community
  - Could have few (or zero) reports from sparse areas
  - Local "chatter" doesn't make it into the DIR unless somebody submits it

The Importance of Reporting

A rancher submitted the following report: In Alfalfa County in NW Oklahoma for the month of June I recorded 1.3 inch of rainfall west of Manchester. Wells are running dry and we are drilling new wells. Most all farm ponds are dry and many streams are dry. Water is hauled to livestock from Manchester. We had two very short cuttings of alfalfa hay at 10 percent of average yield. There will not be a 3rd cutting in many fields. The 4th of July we received .35 inch rain. The Palmer Drought Index is off track once again. The extreme drought leads much farther east than is shown on their map clear into Grant County. Kansas is receiving beneficial rains. As close as 15 miles north and east 2 inches of rain was recorded in Anthony, Kansas, and east of Anthony. I would feed my cattle hay, if I had it or could afford to buy it. - "Jack the Toad"

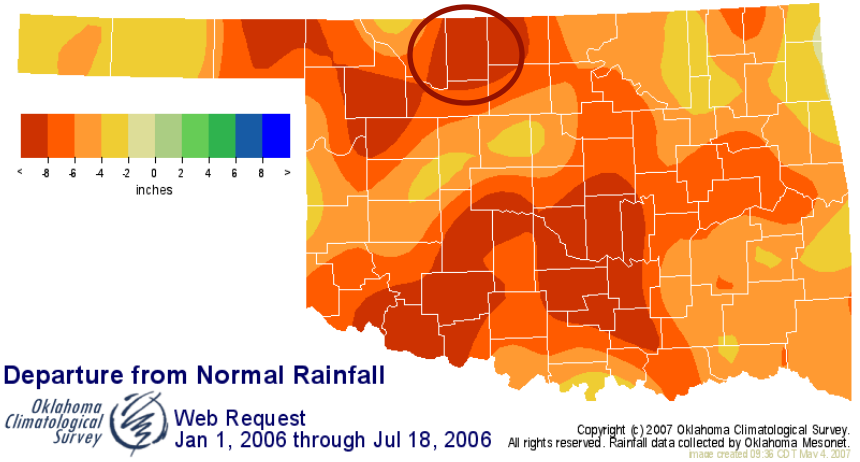
…but nothing particularly unusual in Alfalfa County compared to neighbors at first glance

The Indicators Told Different Stories



But the long-term revealed underlying problems

The short-term didn't look so bad



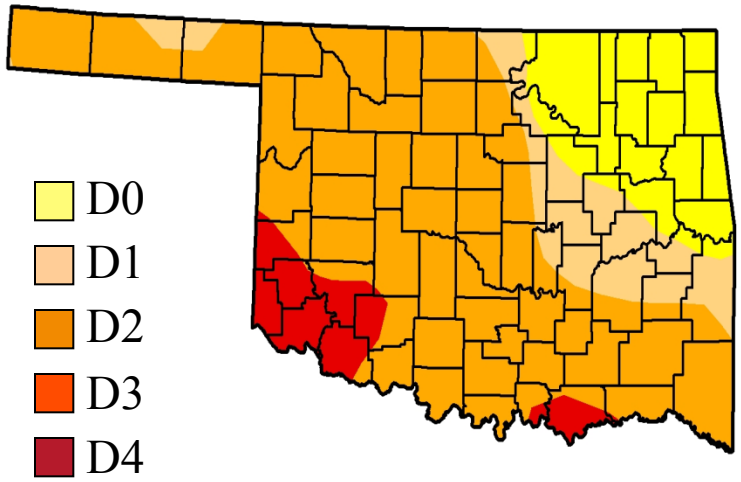
Set off Discussion

I often don't do such large, drastic changes but the last couple of weeks have made me think **we need to step this up** - that our precip-based indicators just aren't keeping up with impacts.

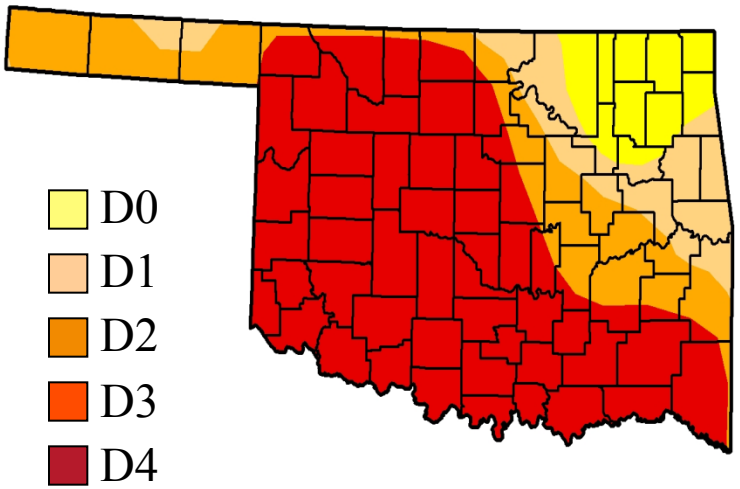
It shows a rapidly deteriorating conditions pretty much statewide. With more 100s on the way, any moisture that's left in the soil is getting sucked out quickly. **I'm giving up on rainfall as an indicator of drought** - it just doesn't last long enough now to make a difference.

And the most telling indicator of all - there are fewer campaign signs around this year even though we have some very contested races. It's tough to put those in the ground (especially the big signs).

We Listened!



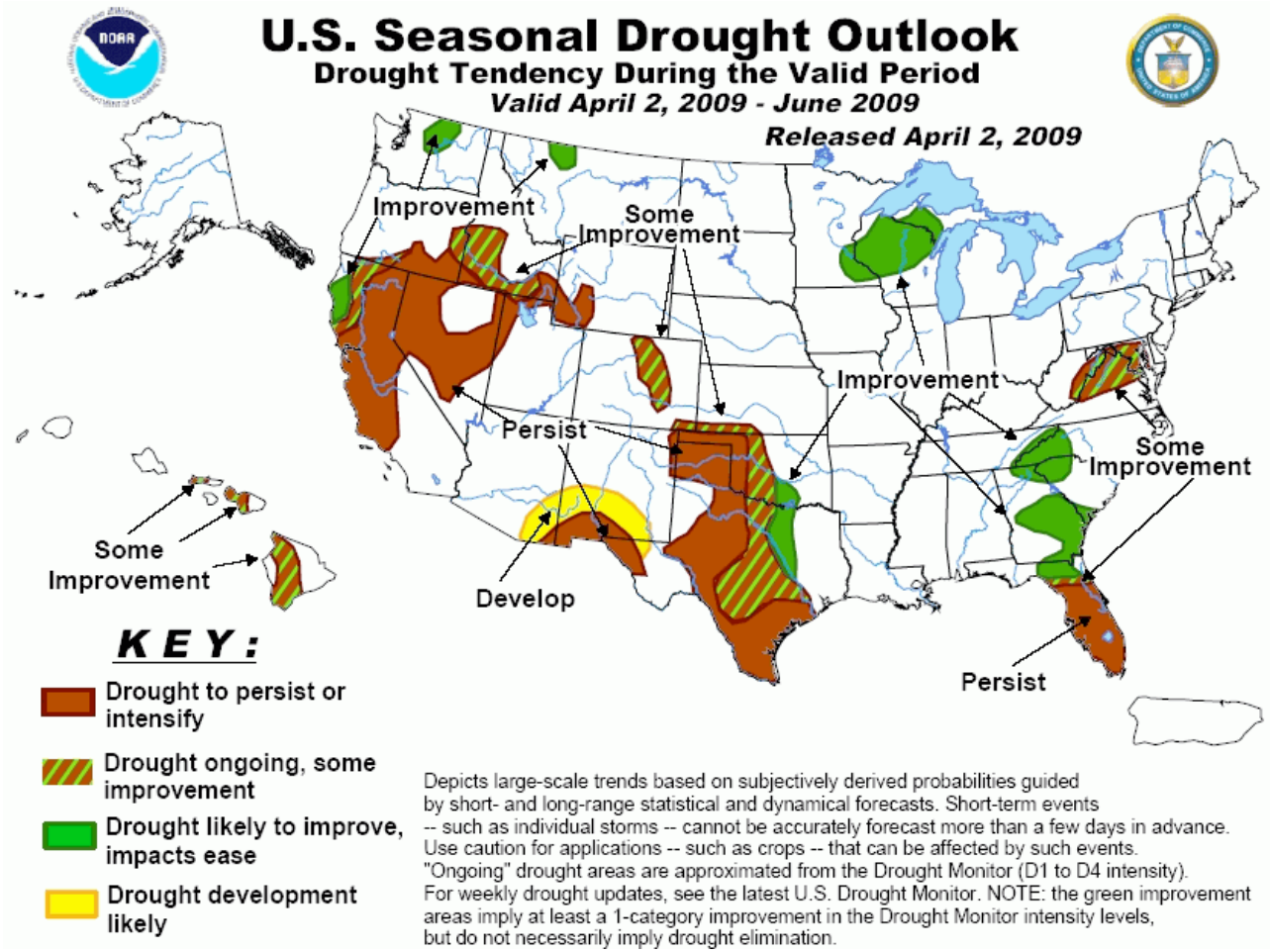
July 18, 2006



July 25, 2006

NIDIS Drought Portal

Drought Outlook

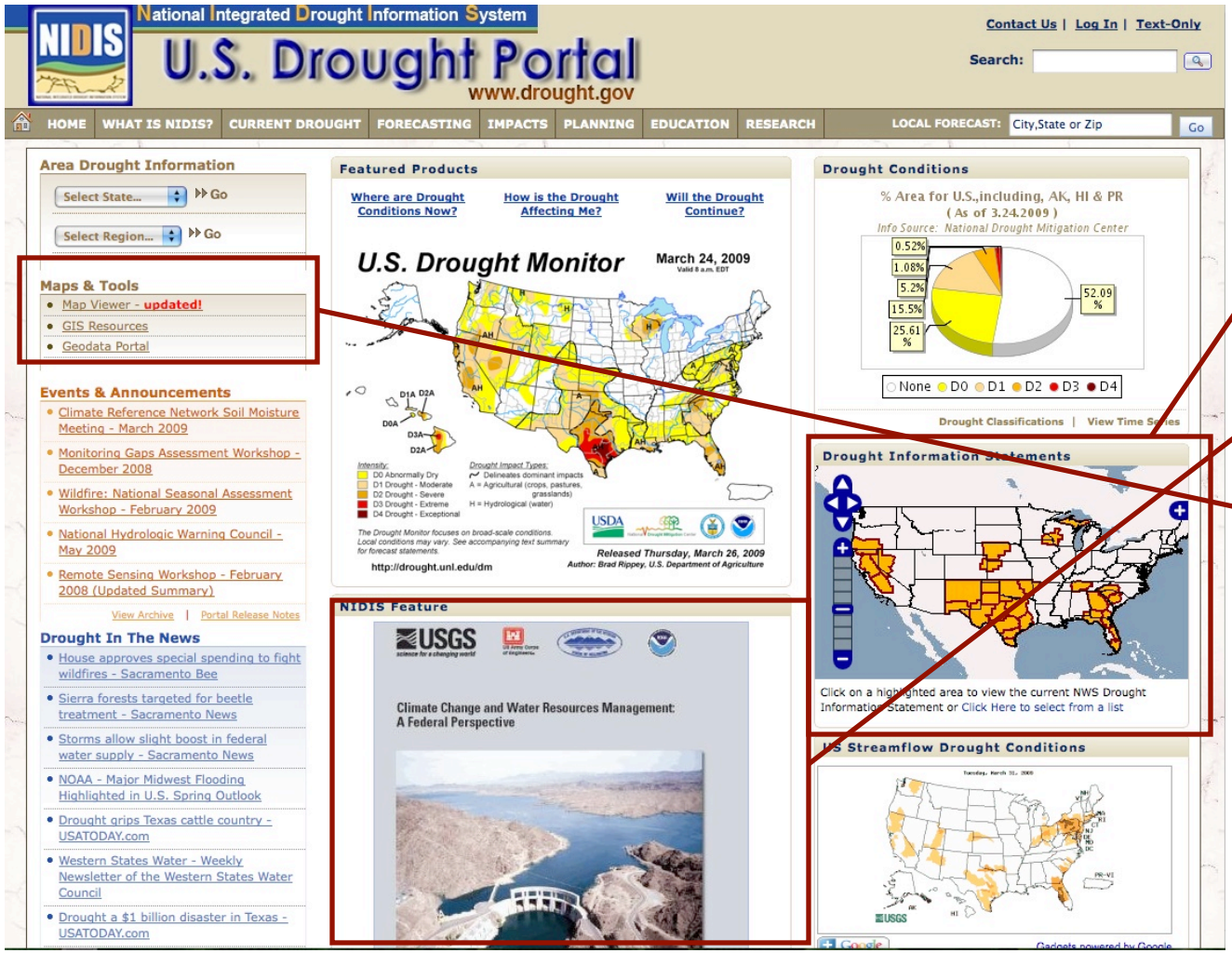


What Does the Drought Outlook Tell Us?

- Shows expected changes from current Drought Monitor (D1-D4)
  - Essentially a 3-month forecast
- Large-scale trends
  - Seasonal forecasts usually lack skill on small scales
  - Does not forecast impacts of a single event
- Subjective, based on models
- Forecasted development based on areas already depicted as abnormally dry (D0)
- Improvement may just be one category
  - Not necessarily elimination of drought

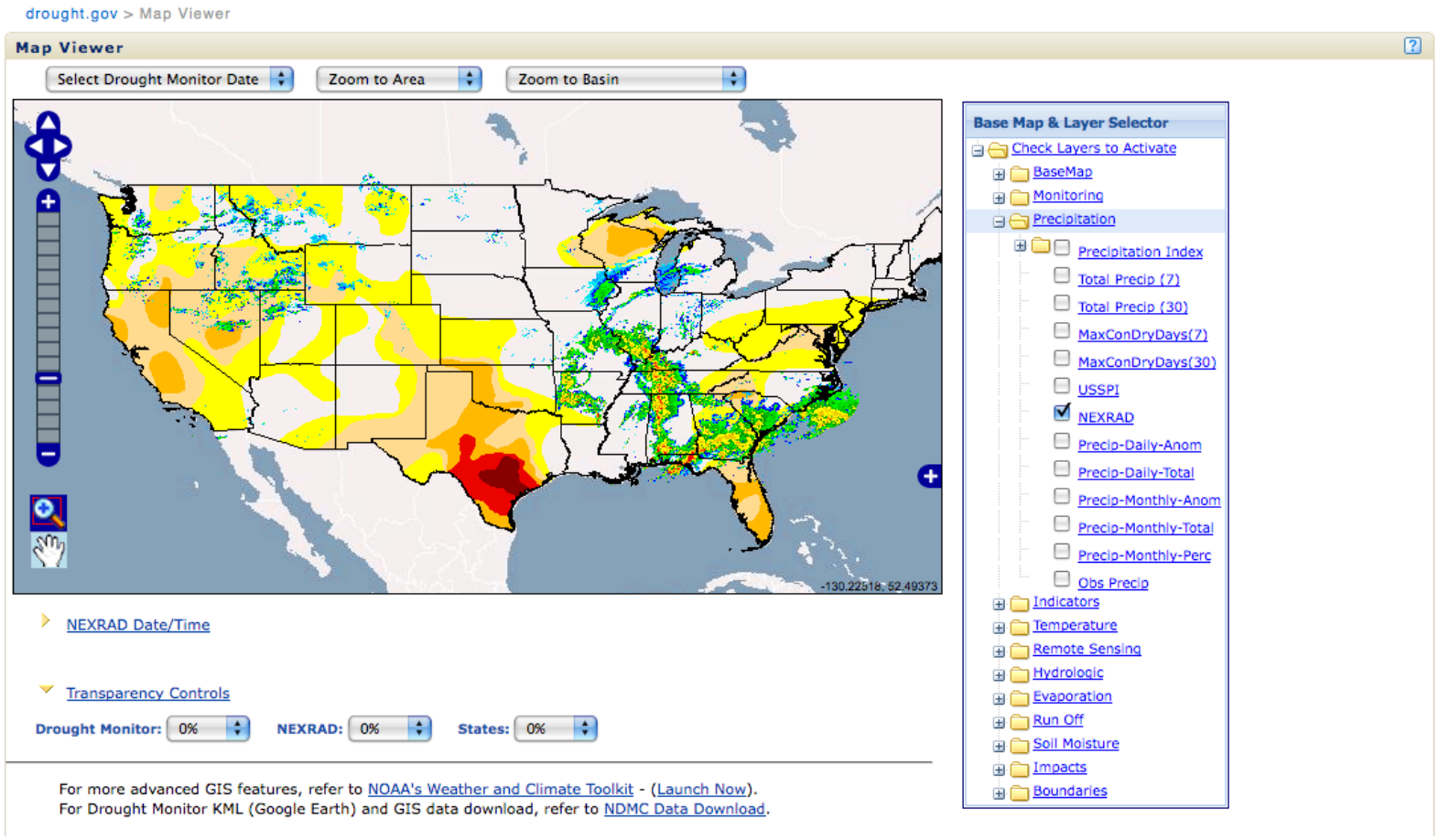
NIDIS Drought Portal

http://www.drought.gov



NIDS Drought Portal

Map Viewer



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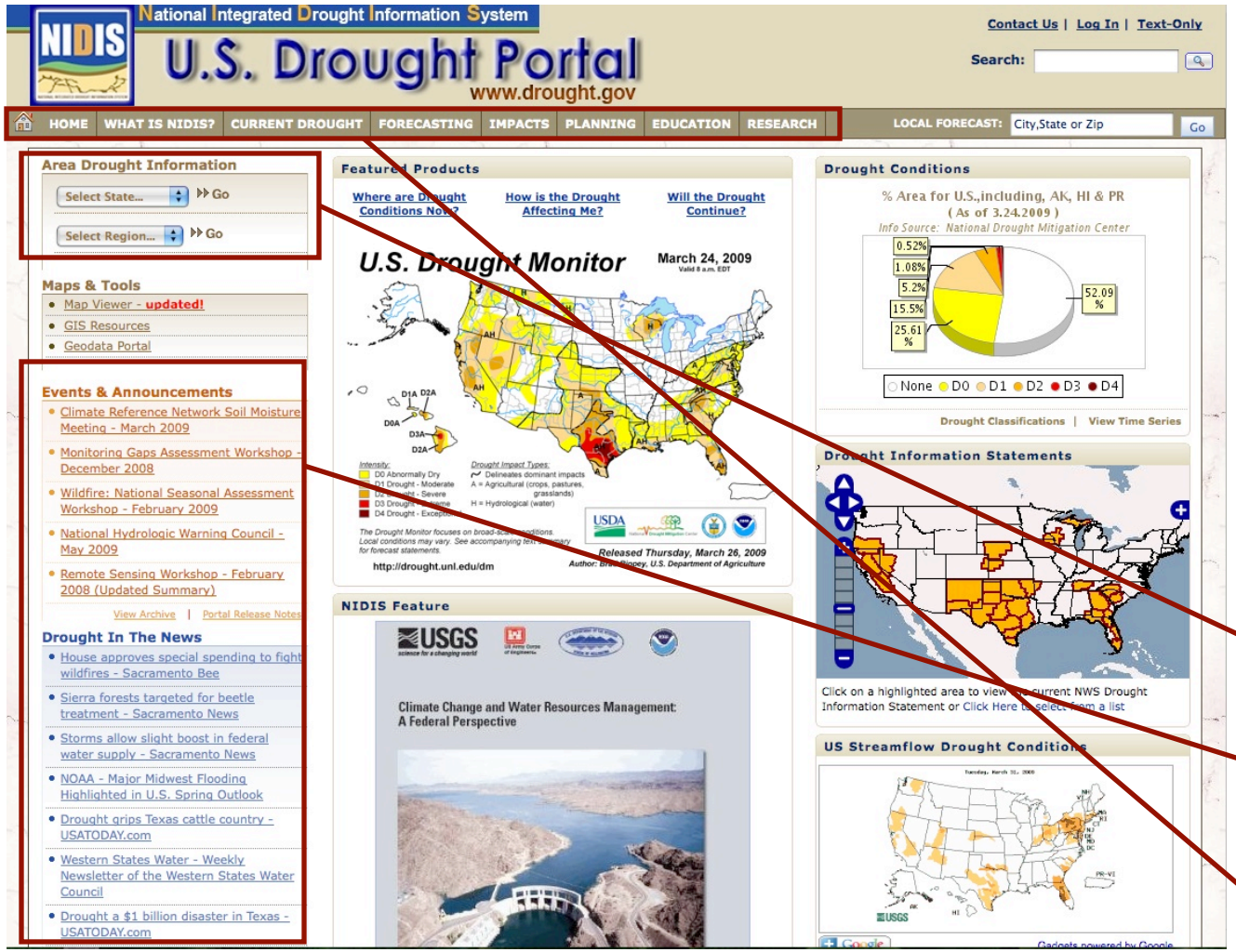


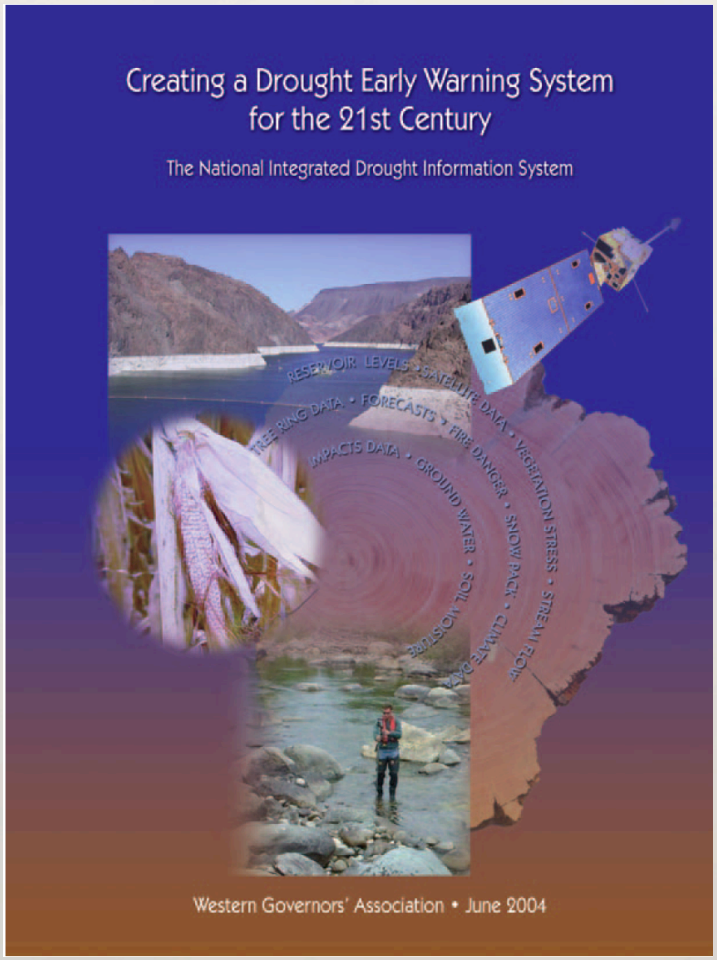
What about Oklahoma?

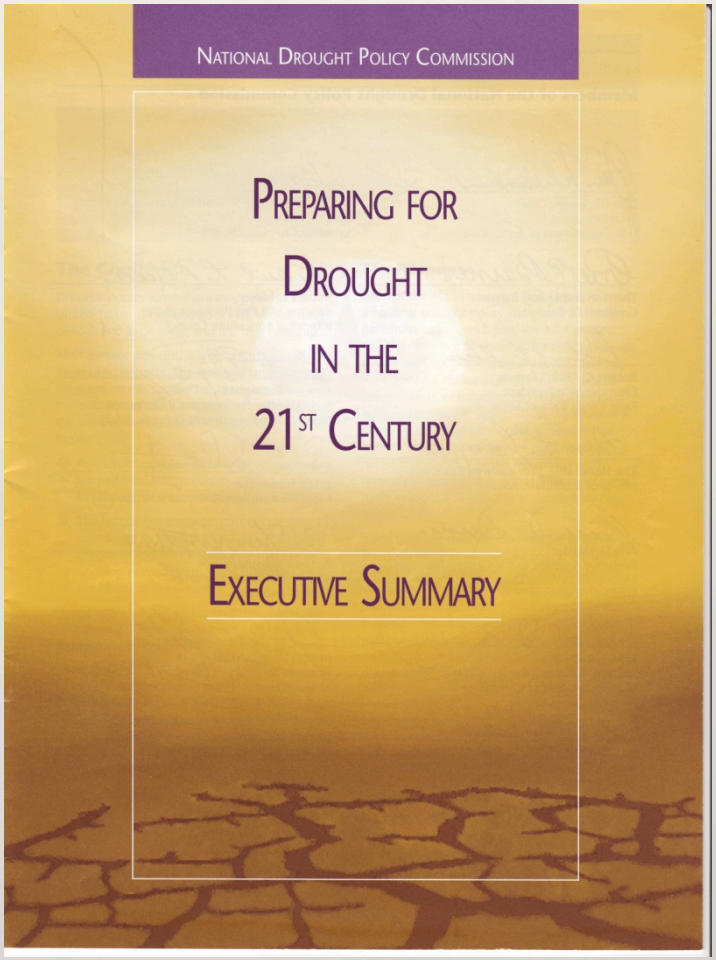
Tell me more!

I really, really want to know details

NIDIS

The Future of Drought?





NIDIS VISION and GOALS

"A dynamic and accessible drought information system that provides users with the ability to determine the potential impacts of drought and the associated risks they bring, and the decision support tools needed to better prepare for and mitigate the effects of drought."

Public Law 109-430 (Signed by the President December 2006)

NIDIS Objectives

Creating a drought early warning ***information*** system

- ***Coordinating*** *national drought monitoring and forecasting systems*
- *Providing an* ***interactive drought information clearinghouse*** *and delivery system for products and services—including an internet portal and standardized products (databases, forecasts, Geographic Information Systems (GIS), maps, etc)*
- *Designing mechanisms for* ***improving and incorporating*** *information to support coordinated preparedness and planning*

Drought Information: NIDIS Early Warning (sub)Systems

- *Monitoring and forecasting subsystem*

  National, regional and local levels

- *Risk assessment sub-system*

  Enable disaster management authorities to generate risk and impact scenarios, trigger and tools development

- *Preparedness sub-system*

  Outline and inform and coordinate actions required to reduce the loss and damage expected from an impending event and for post-event planning

NIDIS Pilot Projects

The National Integrated Drought Information System (NIDIS) envisions several pilot projects, once of which will be Oklahoma/Missouri (2010 or later)

Goals of the Pilots:

✧*Facilitate development of a drought coordinator network*

✧*Coordinate collaborative development of critical indicators and triggers*

✧*Help secure funding, develop evaluation criteria, and conduct post-drought assessments*

✧*Drought exercises or drought simulations for risk scenarios and generation of alternative options*

✧*Facilitate the improvement of organizational networks*

NIDIS Pilots
Upper Colorado River Basin

Water management issues in a region with growing demand

Arid region with long-term climate change threats

Multi-year droughts recent occurrences (ongoing)

First Pilot, launched in 2008

- Federal Planning Meeting - NIDIS Pilot for the Colorado River Basin, Salt Lake City UT, **May 2008**
- Scoping Workshop for the Upper Colorado River Basin NIDIS Pilot, Boulder CO, **October 2008**

NIDIS Pilots
Southeast U.S.

Institutional issues governing water management across state boundaries

Southeast US Drought Workshop (Peachtree City, GA, April 2008)

✧Overview of Federal Drought Products

✧Overview of State Plans and Triggers: What Works & What is Needed

✧Coastal and Estuarine Issues and Drought

✧Current Long Range Forecast from NOAA

Status: Fall 2009 scoping workshop

NIDIS Pilots
Oklahoma / Missouri

Transition area between semi-arid (west) to abundant precipitation (east)

Rain-fed agriculture, aquifers, small reservoirs

Technology transfer issues

Surveys being conducted of drought management & communication

- How do they manage drought?
- What are their sources of information?
- How do they convey that information

Phase I – interviews of participants on drought management teams (partially completed)

Phase II – surveys of local water, agriculture, and emergency officials (Fall 2009)

NIDIS Pilots
Montana / Northern Plains

Tourism and Recreation

Farming and Ranching in a semi-arid area

Dependent upon rainfall, snowfall

Short-term rapid-onset drought

Trans-boundary issues (Canada)

Status: Pending

NIDIS Pilots
Chesapeake Bay

Densely-populated urban environment

Multiple environmental stressors

Low water storage capacity

Water quality issues

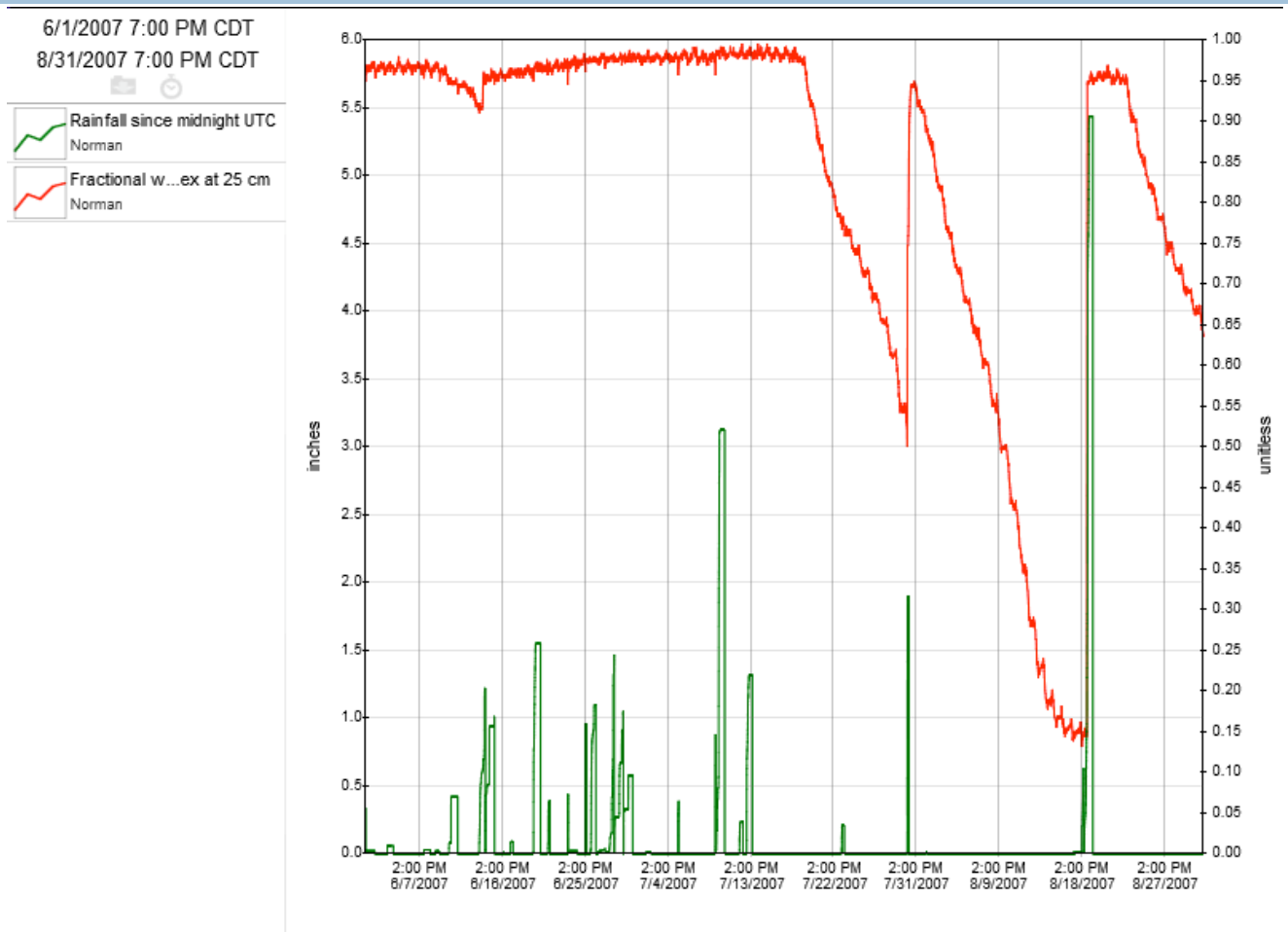
Focus on instream flows

Status: Pending

SOME CLOSING THOUGHTS

Even the wet years have dry-downs

Soil Moisture (10”) & rainfall for Norman, OK; June-Aug 2007



Are Drought Designations Purely Objective?