Using ArcGIS 10 to Estimate the U.S. Population Affected by Drought

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Overview

- What is the U.S. Drought Monitor
- Mapping Process
- Need for Population Statistics
- Population Calculation Process
- Caveats and Future Considerations

U.S. DROUGHT MONITOR BACKGROUND

What is the U.S. Drought Monitor?

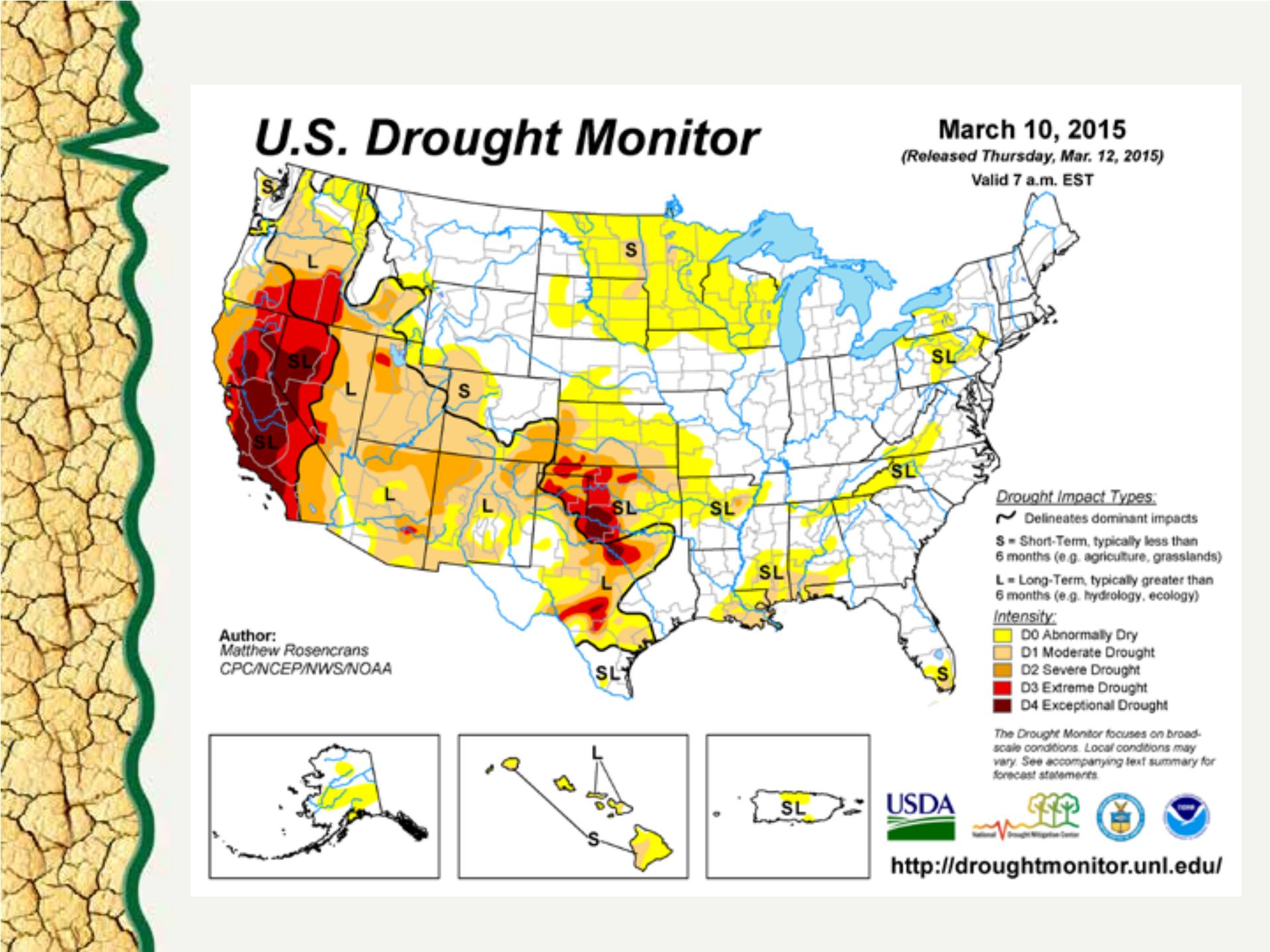
- Map depicting current drought conditions across the U.S.
- Produced on a weekly basis
- Five categories
  - D0 – Abnormally Dry
  - D1 – Moderate Drought
  - D2 – Severe Drought
  - D3 – Extreme Drought
  - D4 – Exceptional Drought

What is the U.S. Drought Monitor?

- Compiled by one author each week
- Authors examine inputs
  - Information provided from local experts
  - Drought indices
- Released at 8:30 A.M. Eastern Time each Thursday
- http://droughtmonitor.unl.edu/

What is the U.S. Drought Monitor?

- Viewed by millions of people each year
  - 6.7 million page views in 2014
  - 1.4 million unique site visitors in 2014
- Incorporated into federal aid programs and state drought plans


U.S. Drought Monitor
March 10, 2015
(Released Thursday, Mar. 12, 2015)
Valid 7 a.m. EST
Author:
Matthew Rosencrans
CPC/NCEP/NWS/NOAA
Drought Impact Types:
Delineates dominant impacts
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)
Intensity:
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.
USDA
http://droughtmonitor.unl.edu/

USDM MAPPING PROCESS

USDM Mapping Process

- Maps are produced each week using a combination of Python and ArcGIS 10
- Process was created and implemented in 2013
  - Replaced a process using VB.NET
- Much simpler to run and keep up to date

USDM Mapping Process

- Over 2600 maps produced weekly
- 5 types of areas mapped
  - Continental U.S.
  - Total U.S.
  - States
  - Predefined Regions (usually a combination of states)
  - 2-digit Hydrologic Units

USDM Mapping Process

- Statistics calculated for 15 types of areas
  - Continental U.S.
  - Total U.S.
  - States
  - Predefined Regions
  - Counties
  - 2,4,6,8-digit Hydrologic Units
  - Climate Divisions
  - FEMA Regions
  - NWS Regions and Weather Forecast Offices
  - River Forecast Center Regions
  - USACE districts and divisions

USDM Mapping Process

- Statistics originally consisted of:
  - Area in drought
  - Percent of area in drought
- Added population statistics in mid-2014

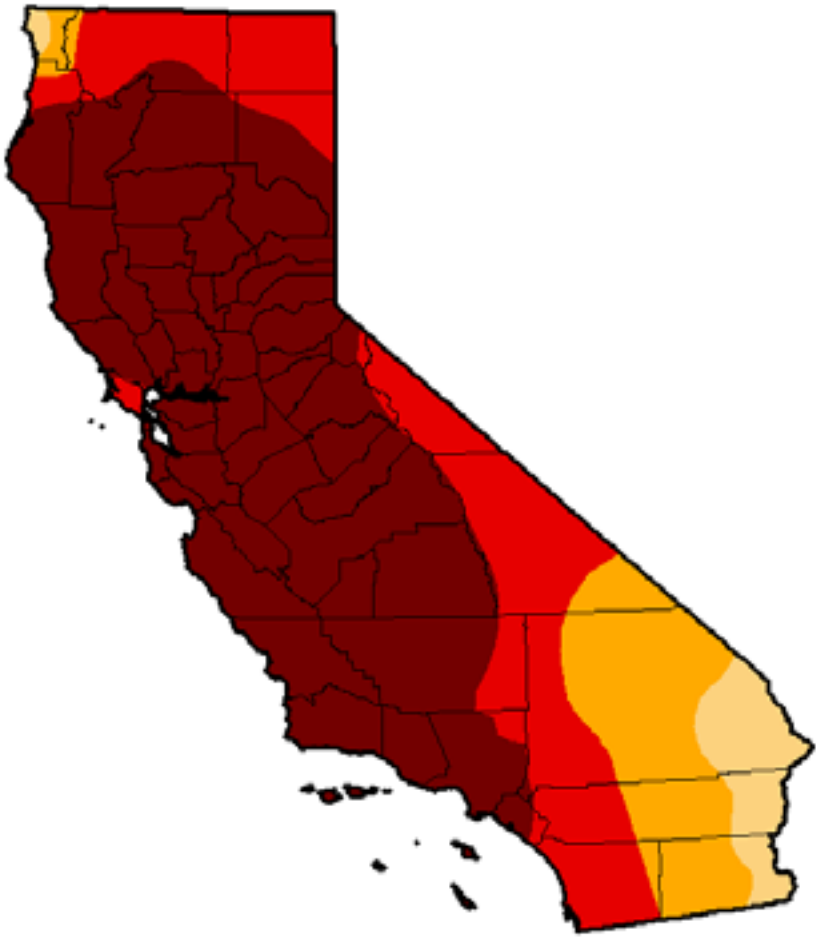
NEED FOR POPULATION STATISTICS

Need for Population Statistics

- Multiple severe droughts in highly populated areas
  - Texas
  - California

U.S. Drought Monitor

California



September 30, 2014

(Released Thursday, Oct. 2, 2014)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	95.04	81.92	58.41
Last Week 9/23/2014	0.00	100.00	100.00	95.34	81.92	58.41
3 Months Ago 7/1/2014	0.00	100.00	100.00	100.00	78.97	36.46
Start of Calendar Year 12/31/2013	2.61	97.39	94.25	87.53	27.59	0.00
Start of Water Year 10/1/2013	2.63	97.37	95.95	84.12	11.36	0.00
One Year Ago 10/1/2013	2.63	97.37	95.95	84.12	11.36	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
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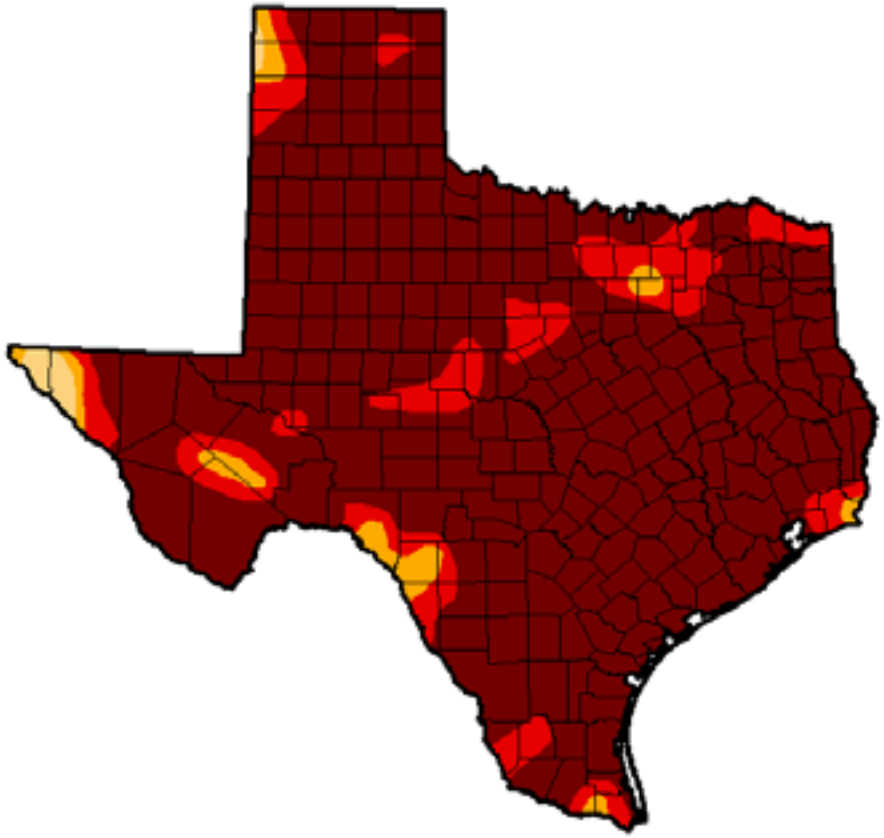
Author:
Richard Heim
NCDC/NOAA

http://droughtmonitor.unl.edu/

U.S. Drought Monitor
Texas



September 27, 2011
(Released Thursday, Sep. 29, 2011)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	99.16	96.65	85.75
Last Week 9/20/2011	0.00	100.00	100.00	99.03	96.10	85.43
3 Months Ago 6/28/2011	2.68	97.32	95.71	94.52	90.62	72.32
Start of Calendar Year 1/4/2011	13.55	86.45	66.68	36.30	13.04	0.00
Start of Water Year 9/28/2010	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago 9/28/2010	75.57	24.43	2.43	0.99	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
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Author:
Michael Brewer
NCDC/NOAA

http://droughtmonitor.unl.edu/

Need for Population Statistics

- Frequently requested by media sources
  - Questions are always being asked about how many people are being directly affected by drought
- Gives the public a better idea of the scope of the drought

CALCULATION PROCESS

Calculation Process

- How to determine population of an area?
  - Start with fairly small areas
  - Boundaries need to be reasonable static
  - Cover the entire U.S.

Calculation Process

- Counties seemed the best choice
- Why counties?
  - Fairly small in size
  - Boundaries are relatively static
  - Can be aggregated to larger units (states, regions, etc.)

Calculation Process

- County population data obtained from 2010 U.S. Census
- Population values stored in shapefile
  - Population and area of each county
  - Population and area of larger areas
    - States
    - Regions

Calculation Process

- Population density determined
  - Area of each county is calculated in square miles
  - Population divided by area of county
- Area of each county in each USDM category calculated
- Density multiplied by area in each USDM category
  - Provides number of people in each USDM category for each county

Calculation Process

- For larger areas, population numbers are aggregated
  - County -> State -> Regional -> National
- Population percentage values are determined for all areas
  - Divide affected population by total population of area
- Values are initially calculated inside of a shapefile and then exported to a data table inside of a geodatabase

Calculation Process

- Final numbers imported into a SQL database
- Numbers disseminated to maps, spreadsheets, website, etc.

Calculation Process

- How is this done?
  - Python scripts used for the entire process
- Why scripts?
  - Difficult to do manually in a timely manner
  - Script can be automated to run at a certain time of the week
  - Results are consistent and repeatable

Calculation Process

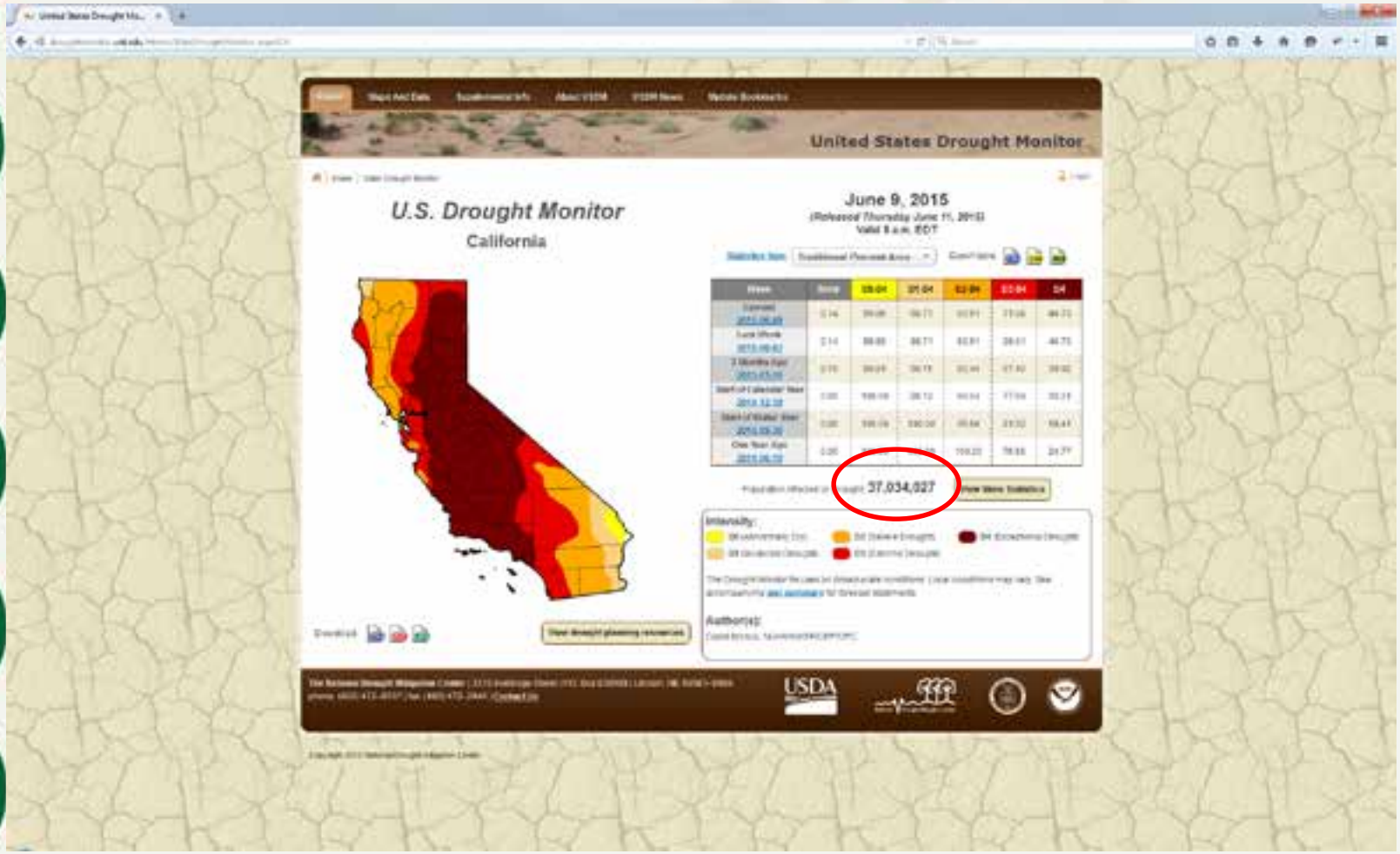
- Why python?
  - Much simpler to program than other options such as a standalone application
  - Arcpy provides all of the necessary functionality
  - Mapping process already uses python
    - Easier to integrate

RESULTS

Results

- Numbers displayed in multiple locations on the USDM website

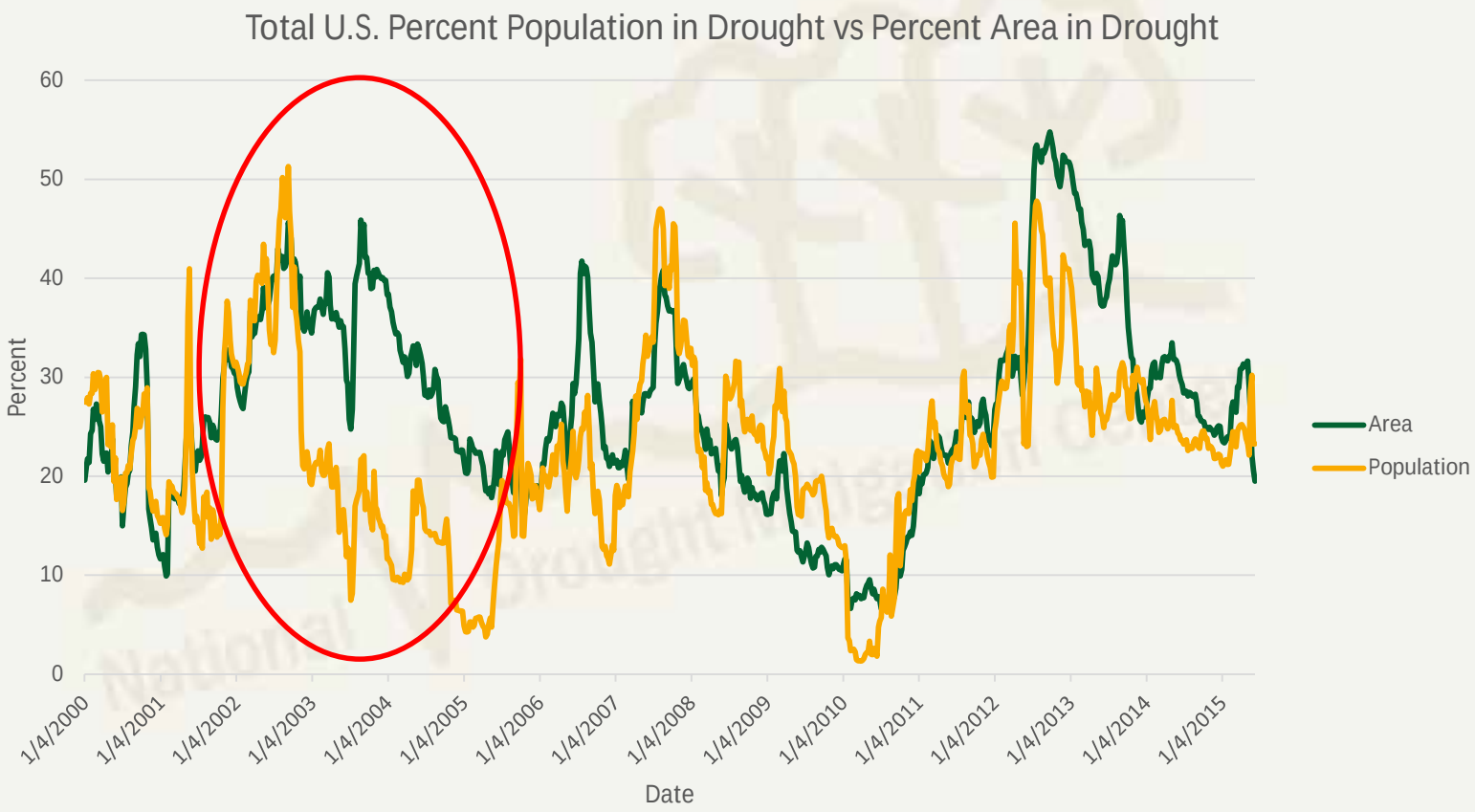
Results


United States Drought Monitor
U.S. Drought Monitor
California
June 9, 2015
37,034,027
Intensity:
Author(s):
USDA

Results

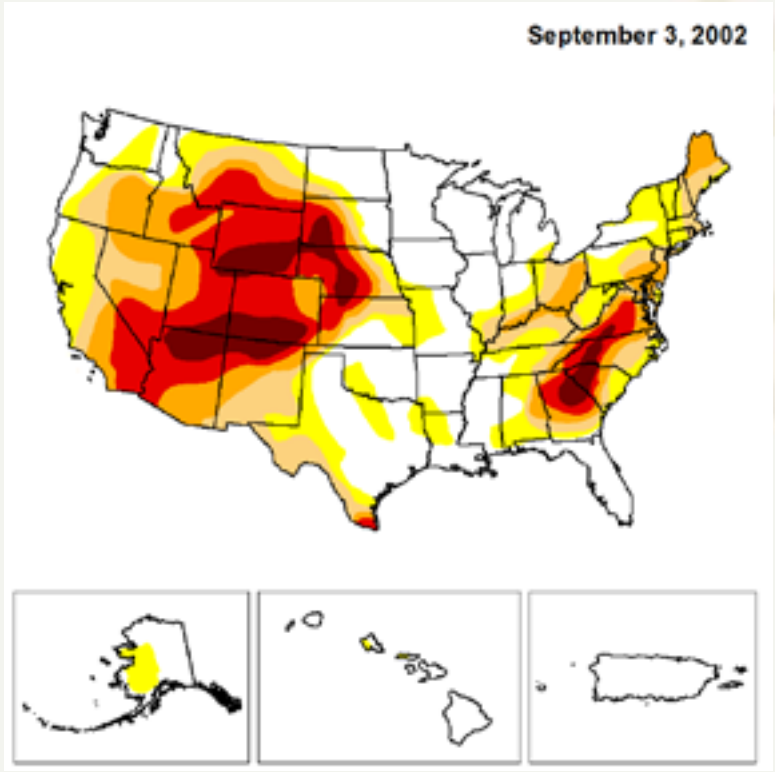
- Interesting trends appeared when looking at the population estimates
  - Area in drought increased while affected population declined in some cases
  - Not evident by looking at the spatial coverage alone

Results

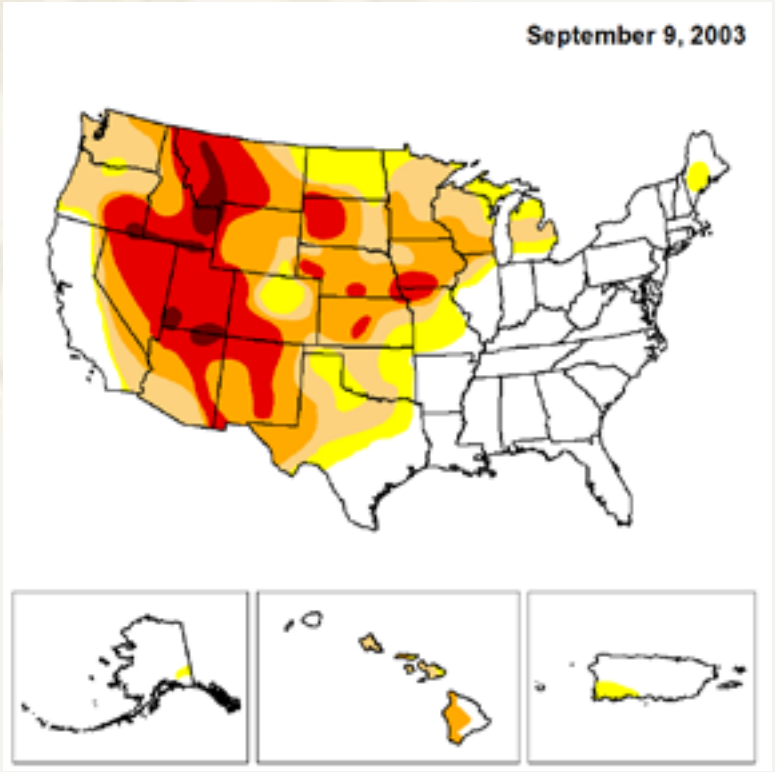

Total U.S. Percent Population in Drought vs Percent Area in Drought
Percent
60
50
40
30
20
10
0
1/4/2000
1/4/2001
1/4/2002
1/4/2003
1/4/2004
1/4/2005
1/4/2006
1/4/2007
1/4/2008
1/4/2009
1/4/2010
1/4/2011
1/4/2012
1/4/2013
1/4/2014
1/4/2015
Date
Area
Population

Results

Greater population



Greater area



CAVEATS AND FUTURE CONSIDERATIONS

Caveats and Future Considerations

- Process can only provide a population estimate
  - Population is not evenly distributed across counties or any other area
  - Process becomes much more complicated to start with areas smaller than counties (i.e. urban areas)

Caveats and Future Considerations

- USDM boundaries are considered “fuzzy”
  - Not a sharp cutoff between areas of each type of drought
  - More of a transitional zone

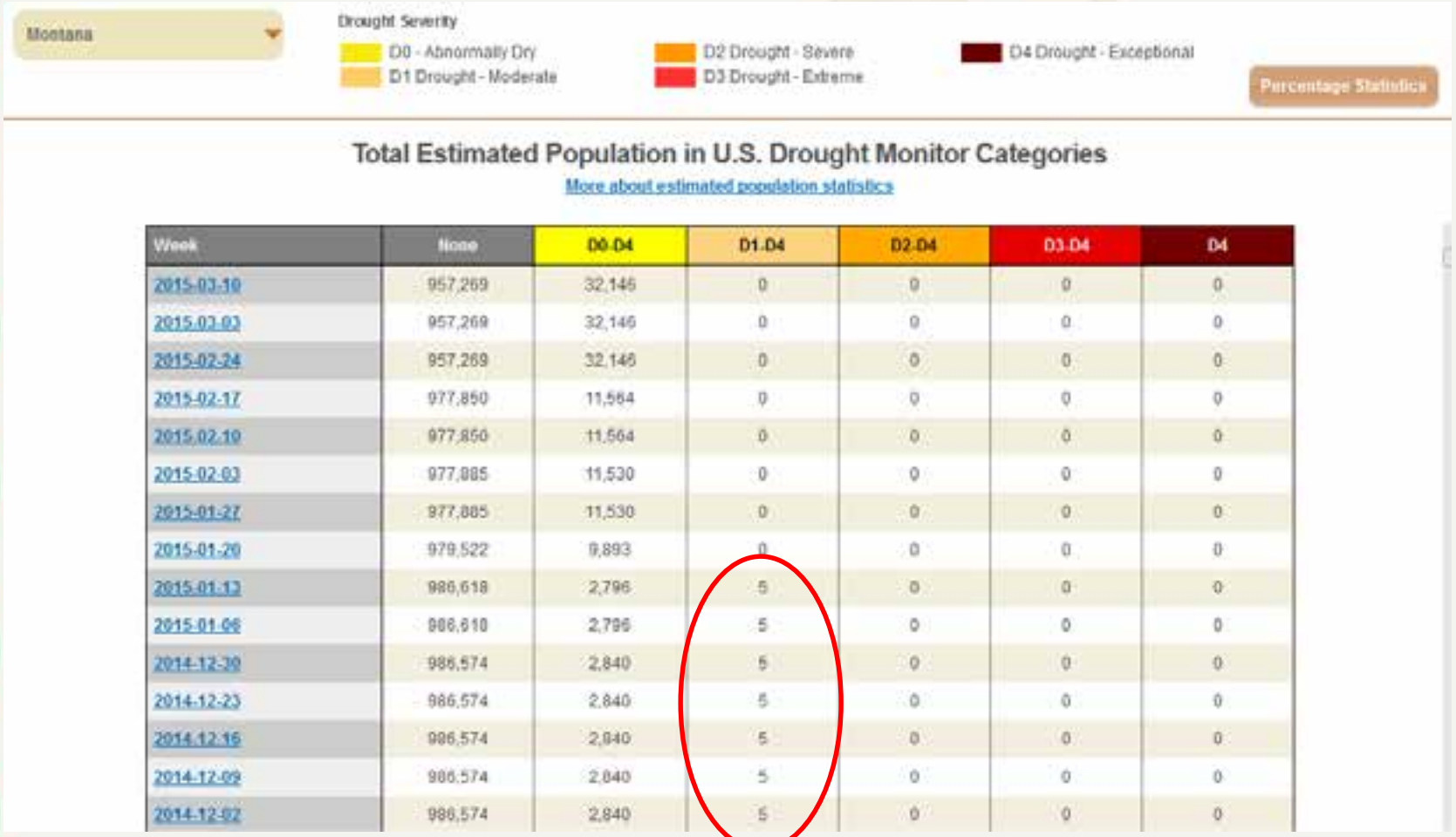
Caveats and Future Considerations

- Due to the complex nature of drought, people are affected outside of the primary drought area
  - i.e. higher food prices at grocery stores

Caveats and Future Considerations

- Occasional situations where numbers don’t make sense
  - Remember, just using as a rough estimate

Caveats and Future Considerations



Total Estimated Population in U.S. Drought Monitor Categories

More about estimated population statistics

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
2015-03-10	957,269	32,146	0	0	0	0
2015-03-03	957,269	32,146	0	0	0	0
2015-02-24	957,269	32,146	0	0	0	0
2015-02-17	977,850	11,564	0	0	0	0
2015-02-10	977,850	11,564	0	0	0	0
2015-02-03	977,885	11,530	0	0	0	0
2015-01-27	977,885	11,530	0	0	0	0
2015-01-20	979,522	9,893	0	0	0	0
2015-01-13	986,618	2,796	5	0	0	0
2015-01-06	986,618	2,796	5	0	0	0
2014-12-30	986,574	2,840	5	0	0	0
2014-12-23	986,574	2,840	5	0	0	0
2014-12-16	986,574	2,840	5	0	0	0
2014-12-09	986,574	2,840	5	0	0	0
2014-12-02	986,574	2,840	5	0	0	0

Caveats and Future Considerations

- Population values based on 2010 census
  - How do we handle data after 2020, 2030, etc?
  - Do we collect data in between the censuses?

Caveats and Future Considerations

- Investigate population estimation for areas not based on counties
  - i.e. Watersheds
  - Would need to determine a method to get initial population figures

Caveats and Future Considerations

- Improve the calculation process
  - Implement multiprocessing to increase speed

Caveats and Future Considerations

- Apply this methodology to other products
  - Currently duplicating the process for the North American Drought Monitor
- Apply this process to data other than population
  - Crop production
  - Livestock production

Questions?

- Contact information:

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