

Measuring beyond precipitation. How is your Forest responding to drought?

Peter Goble, Colorado Climate Center – Assistant State Climatologist

CoCoRaHS Weather Talk Webinar

September 26th, 2024



ATMOSPHERIC SCIENCE
COLORADO STATE UNIVERSITY



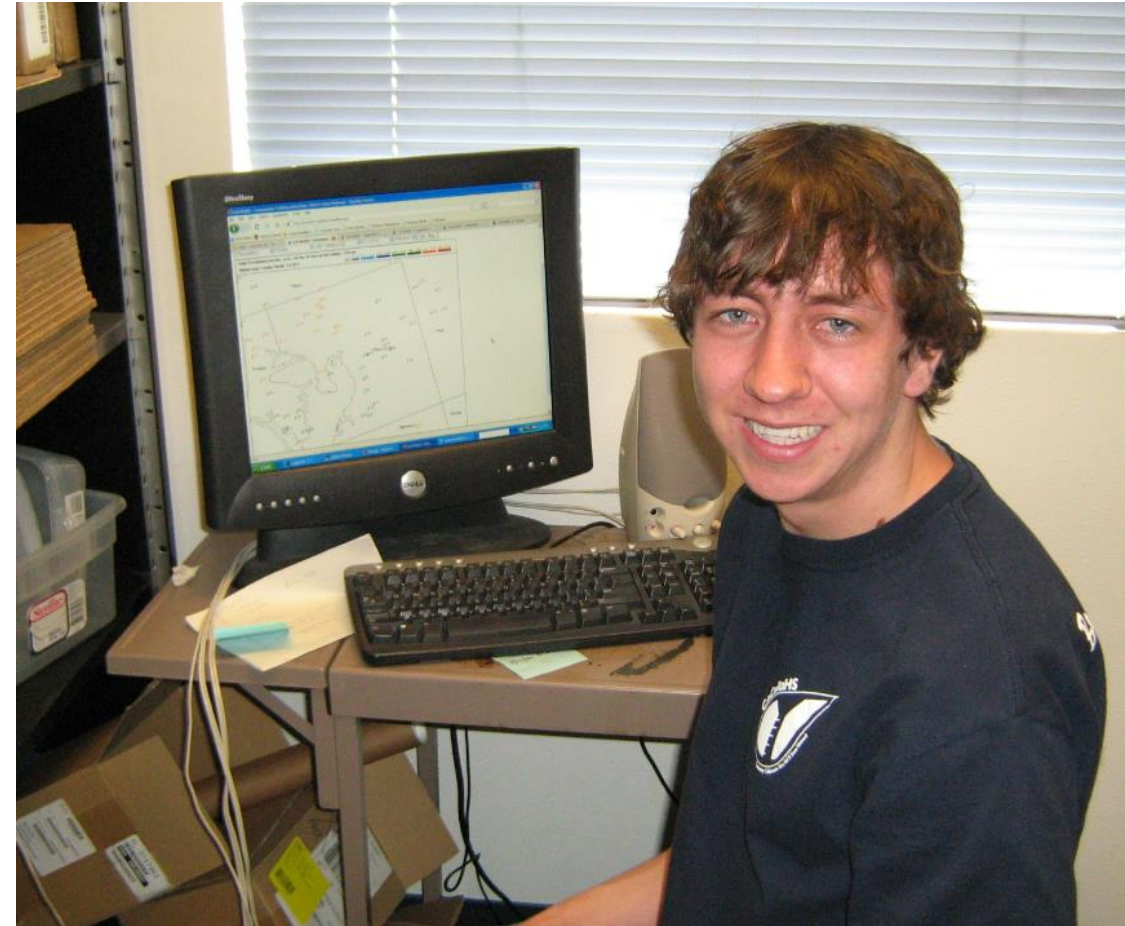
About Me

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- MS in Atmospheric Science from Colorado State University in 2016
- Became a CoCoRaHS intern in 2011
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About Me

- I'm an avid outdoorsman, which was one of the largest reasons I became interested in weather
- I love our Colorado Mountains, and the mountain meteorology that goes with it
- I've competed in a couple marathons and trail races, and I've climbed over 20 of Colorado's 14,000ft peaks

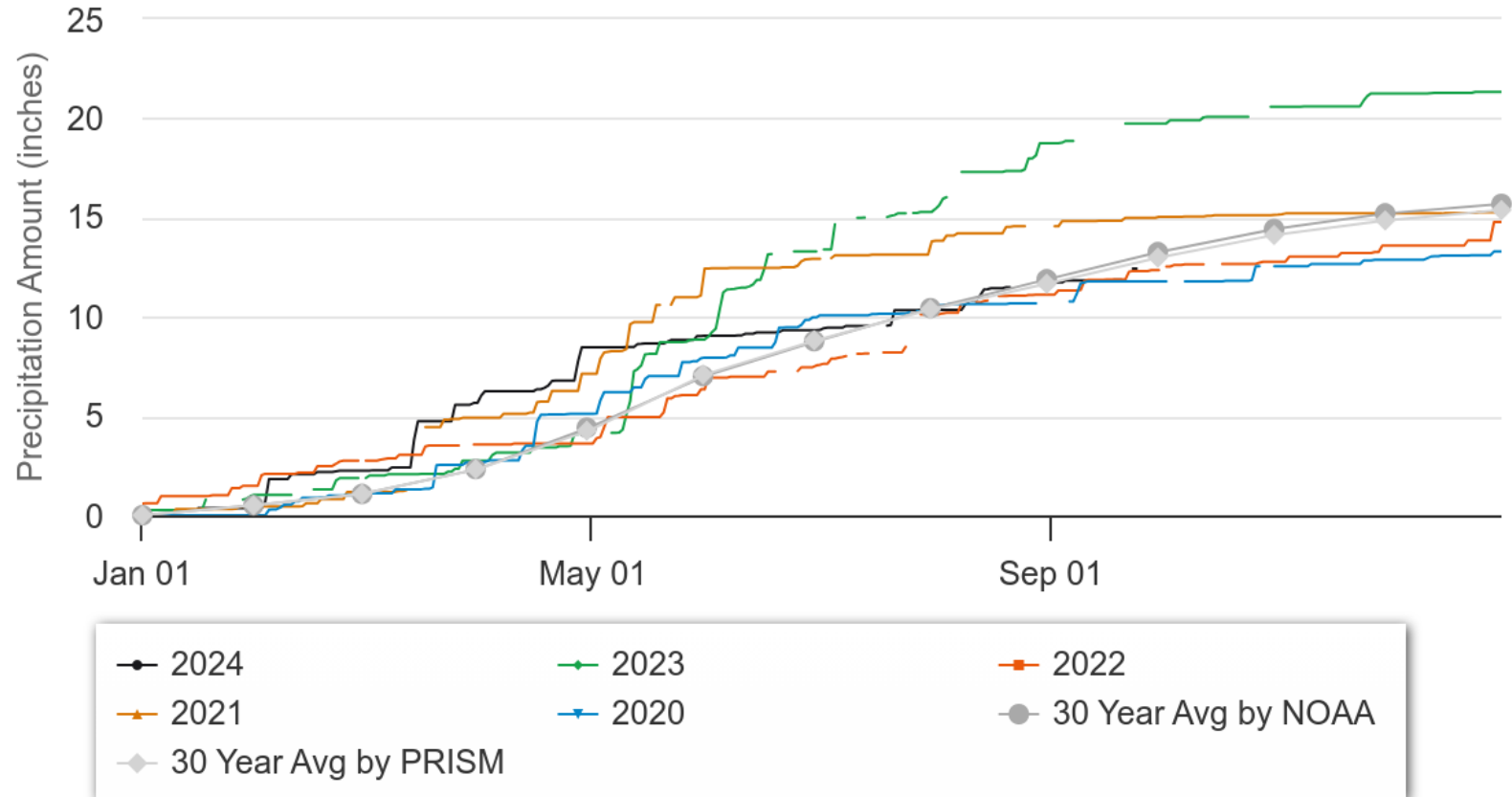


My CoCoRaHS Station

- Opened my current station in June of 2019
- I love being a CoCoRaHS observer
- I do use multi-day accumulations sometimes, but I do my absolute best not to miss
- Somebody needs to keep me honest with Condition Monitoring

Year-Over-Year Accumulated Precipitation Jan 1st to Dec 31st

Station: CO-LR-1200: Berthoud 2.5 N



Today's Agenda

- Why Monitor Forests?
- How do we monitor Forest conditions?
- Understanding the United States Drought Monitor
- Understanding climate change in Colorado
- Surveying the US Forest Service
- A call for forest monitors
- Progress: 2021 and 2022
- Related projects/Where we go from here



Why Monitor Forests?

- Most of the water we use in the United States originates as precipitation that falls in a forest
- Forests are beautiful, an important source of human recreation, and therefore important to maintain
- Source of natural resources, such as timber and biodiversity
- Long-term changes and natural variations in climate (such as drought) may necessitate different Forest management strategies



This Project

- Dreamed up at a National Soil Moisture Workshop in Manhattan, Kansas in conjunction with the US Forest Service Office of Sustainability and Climate
- Agreement that we struggle to monitor changes in forested environments both on a year-to-year basis, and over time
- The US Forest Service needs more information about how ecological conditions are changing in order to make decisions to adapt to droughts and to climate change
- What can CoCoRaHS offer to this equation?



Monitoring Forest Conditions: Temperature and Precipitation

- Monitoring Networks: COOP, SNOTEL, RAWS, CoCoRaHS
- Satellite and Radar monitoring
- We would love to have more observations at high elevations in our Rocky Mountain forests
- Radar can be problematic due to beam blockage

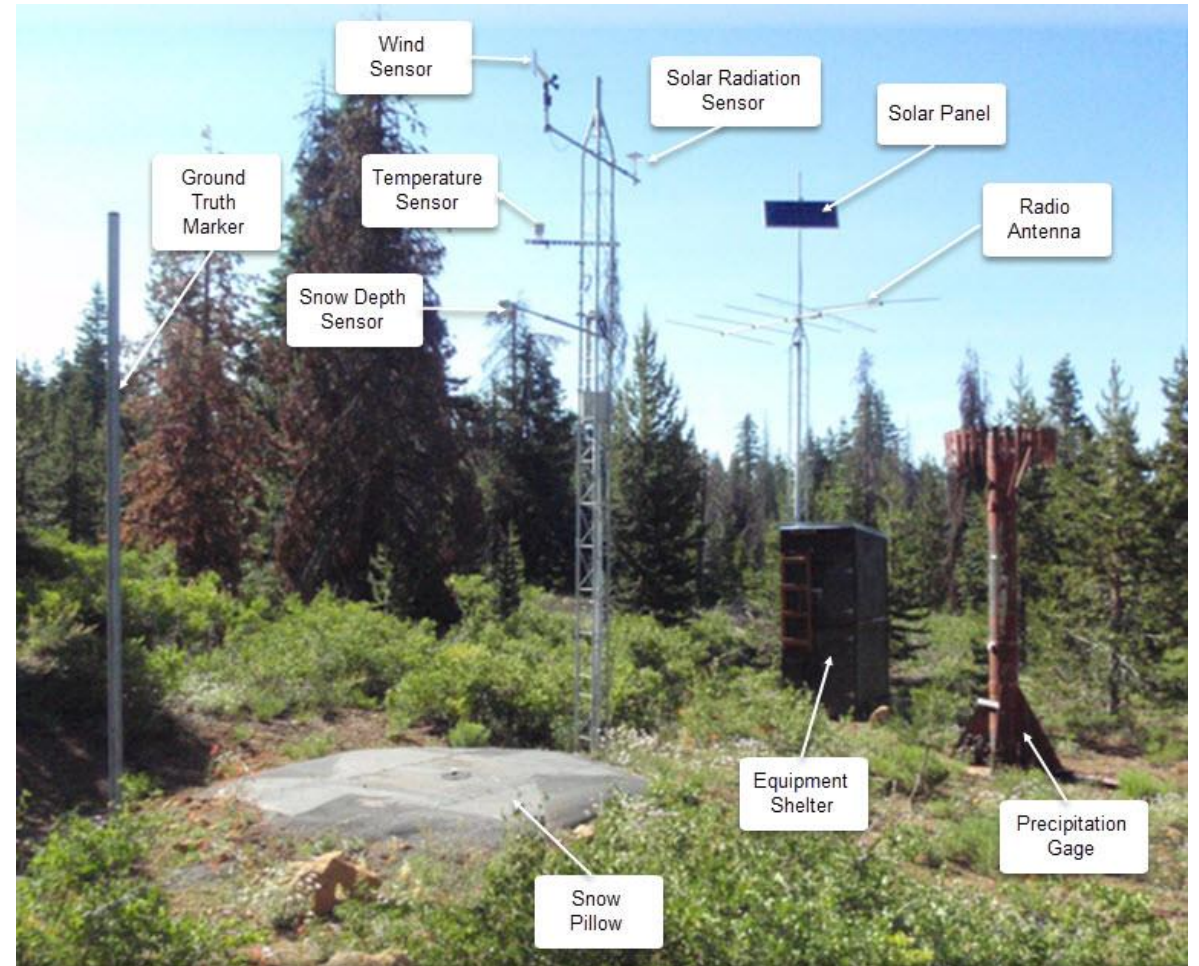


Photo of Colorado Black Canyon Remote Automate Weather Station

Monitoring Forest Conditions: Snow

- Snow courses
- Snowpack Telemetry Network
- Monitors Snow Water Equivalent just like in CoCoRaHS
- These numbers are used to make crucial water supply forecasts

Photo of SNOTEL site from:
<https://www.nrcs.usda.gov/wps/portal/wcc/home/aboutUs/monitoringPrograms/automatedSnowMonitoring/>



Monitoring Forest Conditions: Streamflow

- Much of the water we use for drinking, farming, and even industrial uses originates as precipitation in forests
- The US Geological Survey measures the streamflow from these watersheds using streamgages
- These are also crucial for understanding weather and water in Colorado Forests

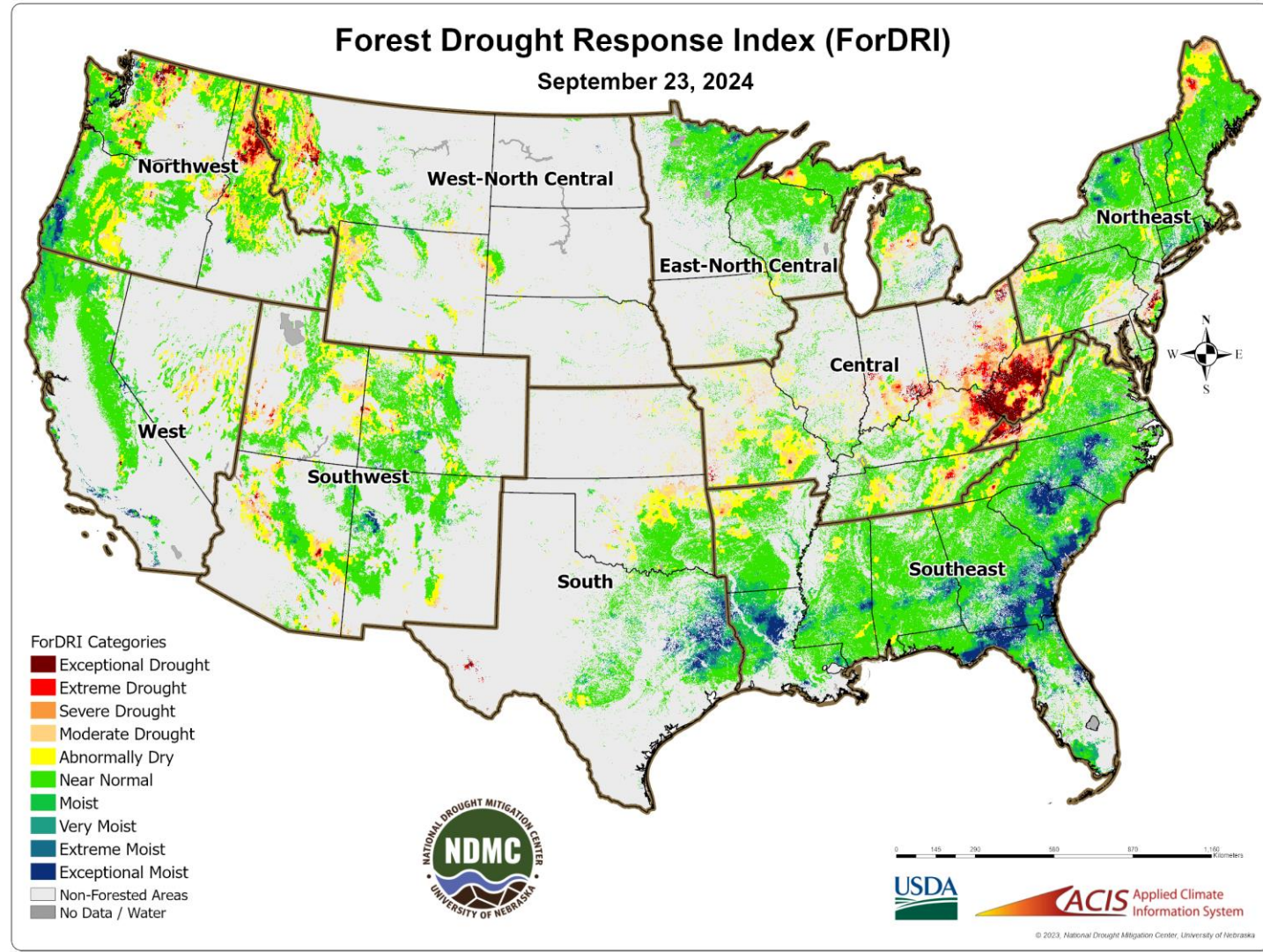


Photo Credit: Will Elliott – US Geological Survey



Monitoring Forest Conditions: Vegetative Health

- Forest Drought Response Index
- We can use satellite-derived measures of vegetative health to help gauge the exposure of vegetation to drought and/or increasing aridity with climate change
- Works based on how effectively vegetation is absorbing near infrared radiation



What is Missing?

- Soil moisture – available at a few sites, and with numerical models, but still largely an unknown
- Consistent monitoring of vegetation condition – Much like we do with condition monitoring: How does what you are seeing compare to a normal year? What is different?
- Variation in tree health (early/late bloom, early/late senescence)
- Variation in fauna activity

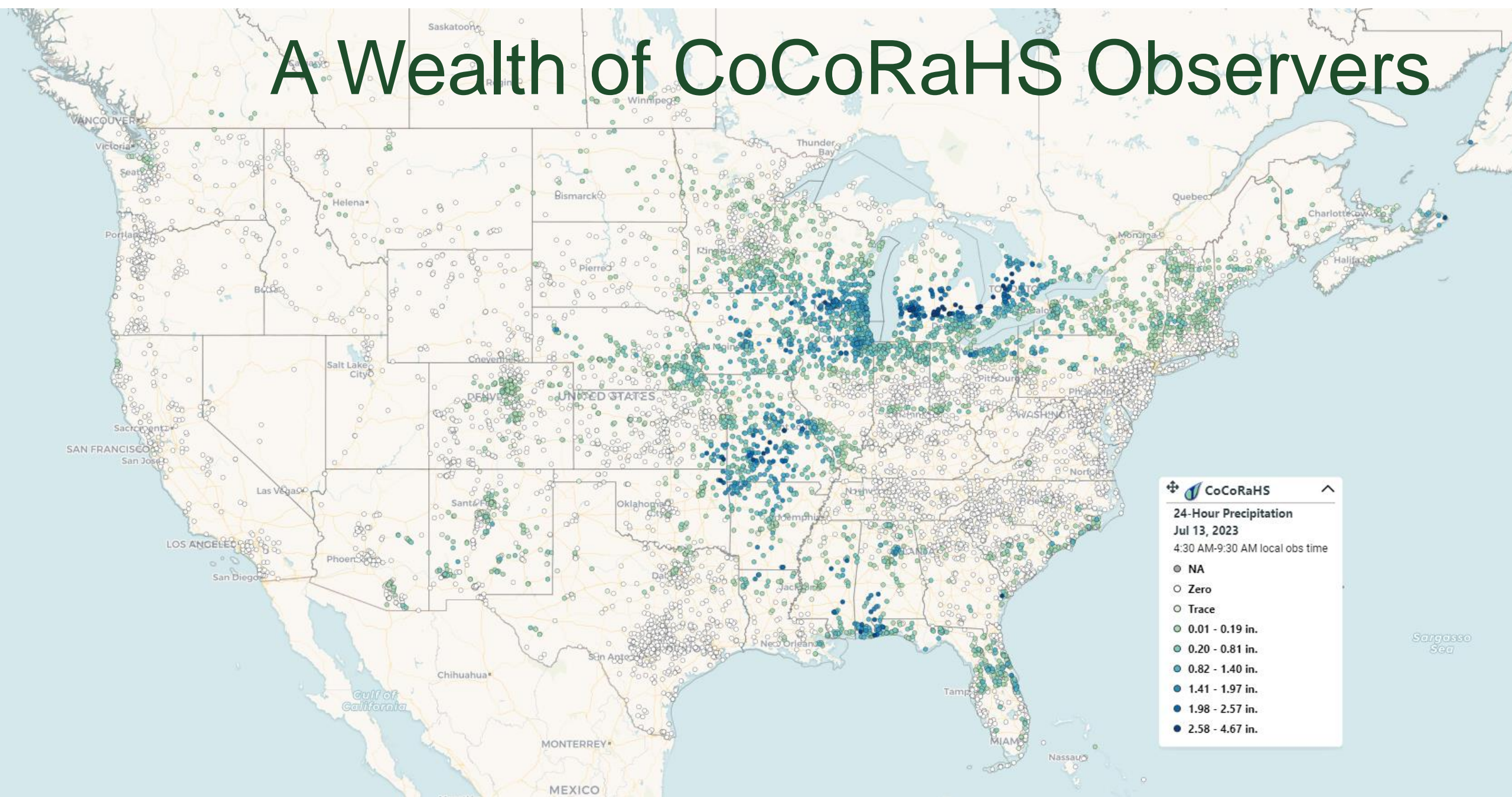


Monitoring Forest Conditions: US and State Forest Service

- The United State Forest Service and Colorado State Forest Service do participate in a multitude of land management projects, and do pay attention to
- These data are not always cataloged or archived, which can make understanding changes and variations in forest health more difficult to understand



A Wealth of CoCoRaHS Observers

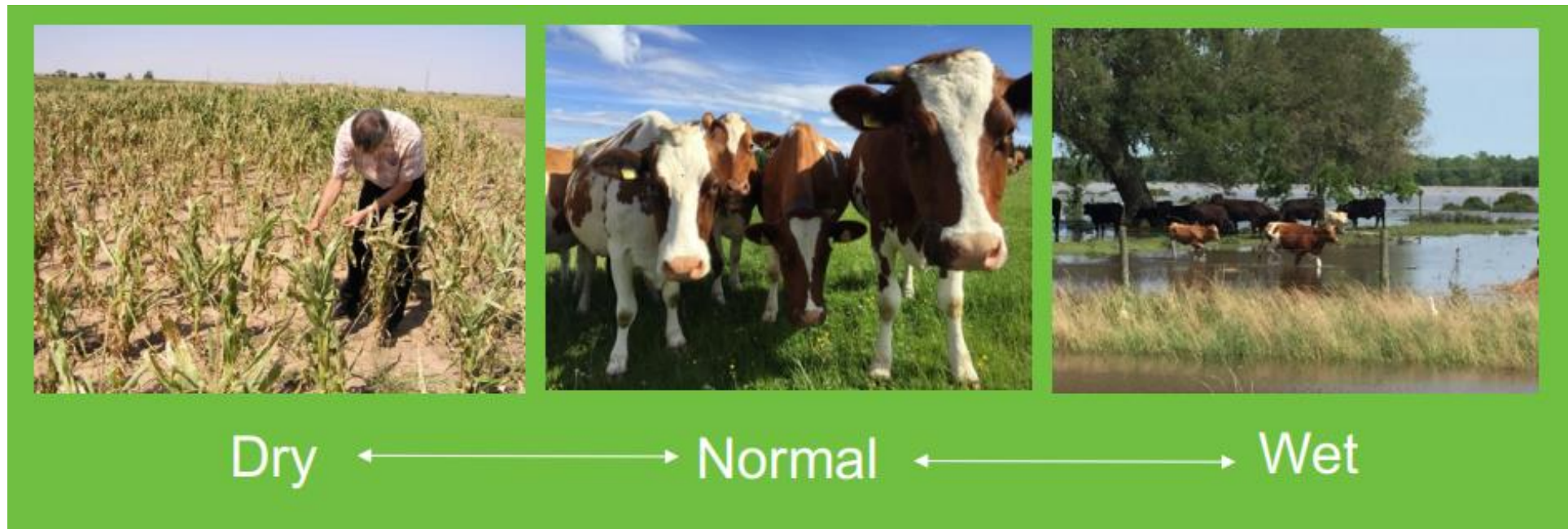


Condition Monitoring

An anecdotal once/week (ideally) appraisal of whether conditions are wetter or drier than normal given the time of year

Impact reports are key: local experts are able to tell more complete, meaningful stories about how weather and climate conditions have impacted the landscape than we can get from weather data alone

Started with funding from National Integrated Drought Information System (NIDIS)



Ordway 3.5 W

Station Number	CO-CR-18 (48 CM Reports in prior 12 months)
Report	Still no big rains, but almost daily. Pea sized hail July 4th, pea sized to golf ball sized Saturday. Roof and tree damage. One cracked window. Humidity like OK. Grasshoppers are thinning a little. Blister beetles have arrived - they'll work on the hoppers. Deer in the pastures and coyotes in the distance. Many different birds. Happy to see a pair of oriels outside the front door. River and creeks still running full. Seeing grasses that haven't been here in years.
Condition	Mildly Wet
Date	Mon Jul 10 2023
Summary Data	CoCoRaHS summary data by week for this station.

Condition Monitoring Report Form

Submit Data Reset

Station Number : CO-LR-1200

Station Name : Berthoud 2.5 N

Condition monitoring reports are submitted on a regular (weekly, biweekly, monthly) basis to share information about the effects of local precipitation on the environment and society. By submitting reports on a regular basis, you create a baseline to see change through time, such as seasonal differences or changes caused by more or less precipitation. Please refer to the [Condition Monitoring training slide show](#) for more information.

* indicates required field

Report Date *

7/13/2023

Condition Scale Bar [More information on the scale bar](#)

Severely Dry	Moderately Dry	Mildly Dry	Near Normal	Mildly Wet	Moderately Wet	Severely Wet
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Description

Please provide a description of how dry, normal or wet conditions are affecting you, your livelihood, your activities, etc. *

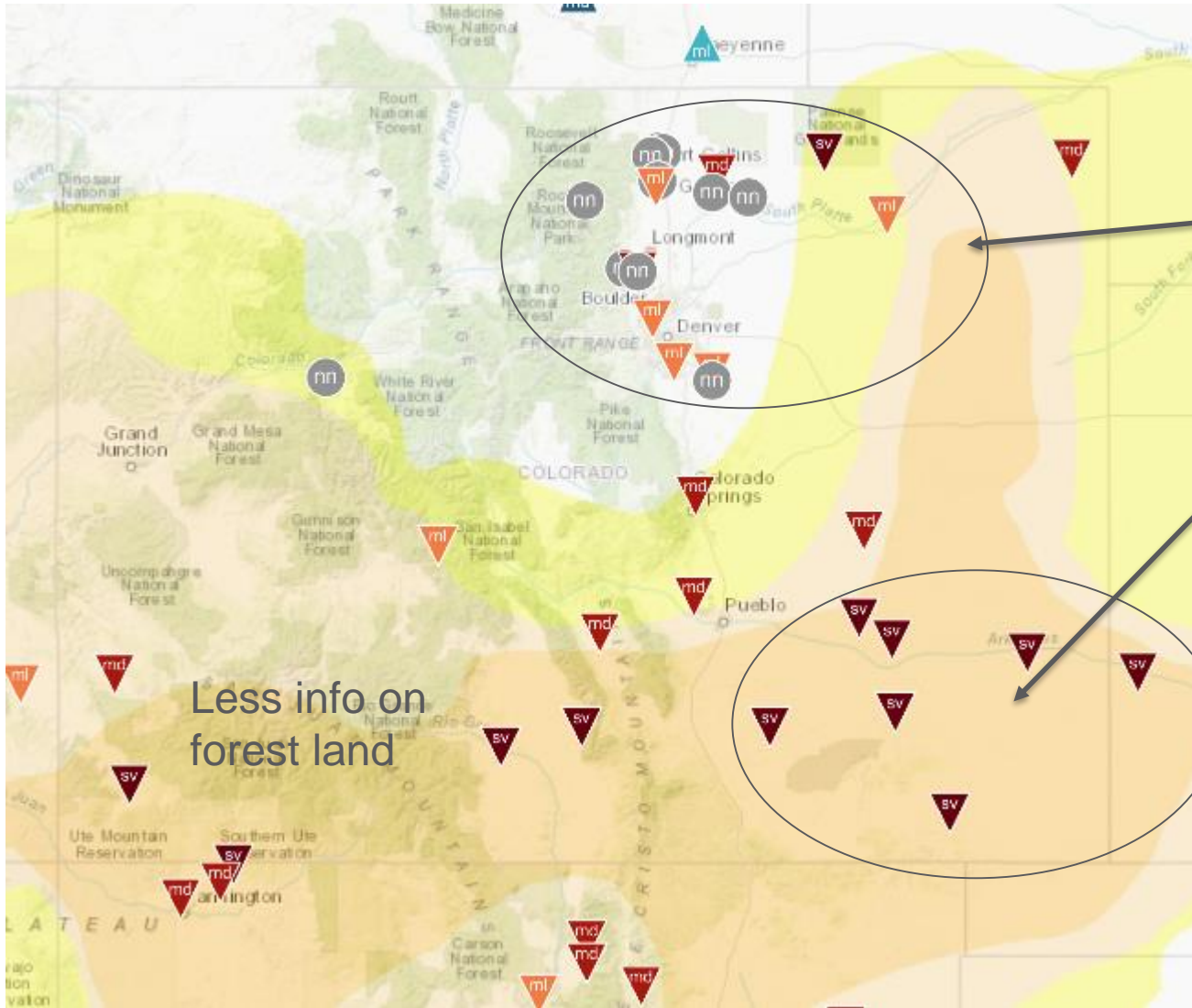
Report Categories

Please check at least one report category. If you check a category, please provide supporting information in the description. [More information on condition monitoring categories.](#)

- General Awareness
- Agriculture
- Business & Industry
- Energy
- Fire
- Plants & Wildlife
- Relief, Response & Restrictions
- Society & Public Health
- Tourism & Recreation
- Water Supply & Quality

Submit Data Reset





We receive great information from agricultural areas and suburban areas during dry times

Syracuse 7.2 WSW

Station Number	KS-HM-5
Report	Another week and no moisture. It is getting worse by the day now with the warmer temperatures. Cattle sales are picking up do to drought. Spring crops aren't being planted and the winter wheat is going backward. Pastures tried to green 3 to 4 weeks ago but look like winter now. This is another 2012-2013 type drought. It's getting ugly now. More hot, dry, windy and dusty conditions in the forecast this week.
Condition	Severely Dry
Date	Mon May 04 2020
Summary Data	CoCoRaHS summary data by week for this station.



U.S. Drought Monitor

September 17, 2024
(Released Thursday, Sep. 19, 2024)

Valid 8 a.m. EDT

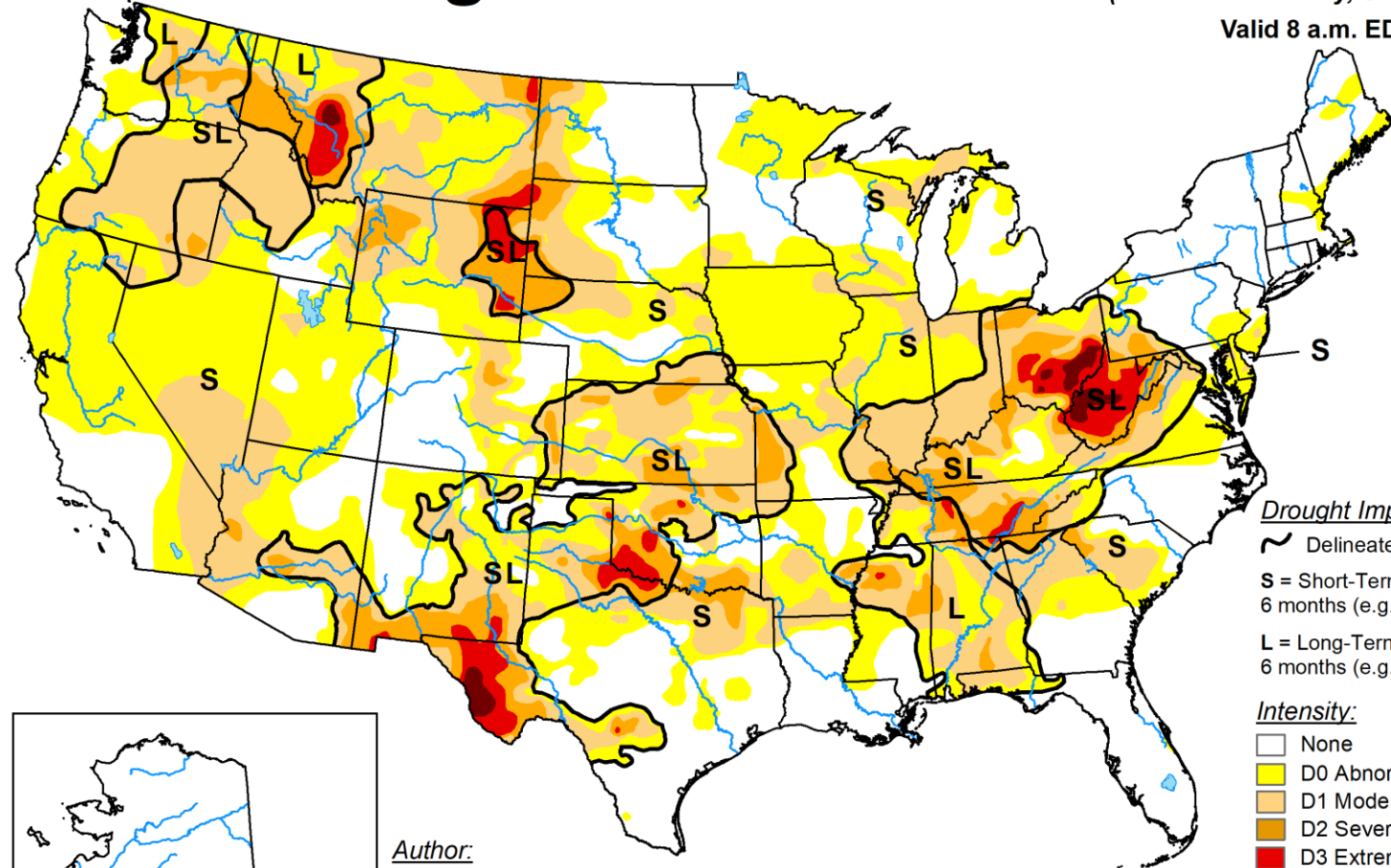
US Drought Monitor

A weekly expert-based appraisal of drought conditions across US states and territories

Based on many different drought indicators (including condition monitoring)

Tied to federal disaster relief programs (e.g. livestock forage program)

Always needs more drought impacts data

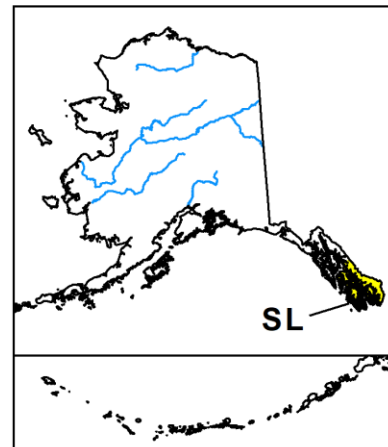


Drought Impact Types:

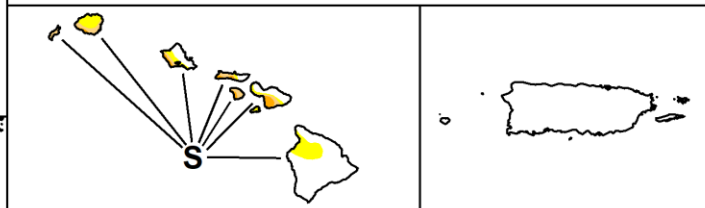
- ~ Delineates dominant impacts
- S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought



Author:
Brad Rippey
U.S. Department of Agriculture



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to <https://droughtmonitor.unl.edu/About.aspx>



droughtmonitor.unl.edu



Temperature and Precipitation Trends in Colorado

We are able to track important meteorological and hydrological variables in forests across Colorado. This is how we can confidently make statements about warming temperatures and a changing water cycle, but what are these changes doing for the plants, animals, and soils?

Climate variable/event	Recent trend	Projected future change	Confidence in change
Average Temperature	Warmer	Warmer	<i>Very high</i>
Annual Precipitation	Lower	Uncertain	<i>Low</i>

Climate variable/event	Recent trend	Projected future change	Confidence in change
Spring Snowpack	Lower	Lower	<i>Medium</i>
Runoff Timing	Earlier	Earlier	<i>High</i>
Annual Streamflow	Lower	Lower	<i>Medium</i>
Summer Soil Moisture	Lower	Lower	<i>High</i>
Evaporative Demand	Higher	Higher	<i>Very High</i>

Tables from climatechange.colostate.edu



Motivation

- Conditions on Forests are underrepresented by CoCoRaHS Condition Monitoring, but we care a great deal about how forests are changing on short and long timescales
- A database of forest condition impacts would be of value to management communities monitoring climate change, drought, floods, phenology, and other natural hazards impacting forests
- Additional monitoring reports can help Forest managers with their monitoring goals



Forest Needs

- Our team conducted a survey of Federal and State Forest Service personnel
- This survey was used to determine what data collection needs Forests specialists had, and if CoCoRaHS could help
- Let's review some results:



Forest Needs

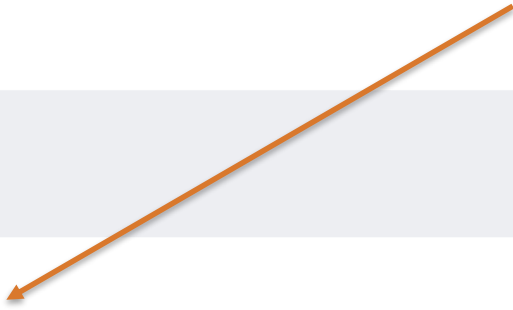
Q: What are your biggest management challenges related to drought, climate change, or changing environmental conditions?

Answers	Count	Percentage
Increased forest/vegetation drought stress	29	80.56%
Reduced forest regeneration	10	27.78%
Increasing tree mortality	28	77.78%
Increasing fire	22	61.11%
Increasing invasive species	24	66.67%
Changes in plant growth or phenology	12	33.33%
Increased flooding	6	16.67%
Extreme weather events	11	30.56%
Changing patterns of seasonal human use	23	63.89%
Damaged or lost infrastructure	6	16.67%
Other	8	22.22%



What Weather and Climate Data Sources Do You Use?

Seeing that the US Drought Monitor is widely-used was an interesting finding. CoCoRaHS Condition Monitoring and this project were born out of our efforts to make the Drought Monitor better



Answers	Count	Percentage
National Drought Monitor	26	72.22%
meteorological stations	23	63.89%
remotely-sensed data	13	36.11%
local weather reports	19	52.78%
stream gauges	21	58.33%
personal observations	22	61.11%
Other	7	19.44%



Forests Are Not Consistently Storing Data Like this

- We asked how survey respondents were storing data relating to shifts in environmental conditions

- Responses:

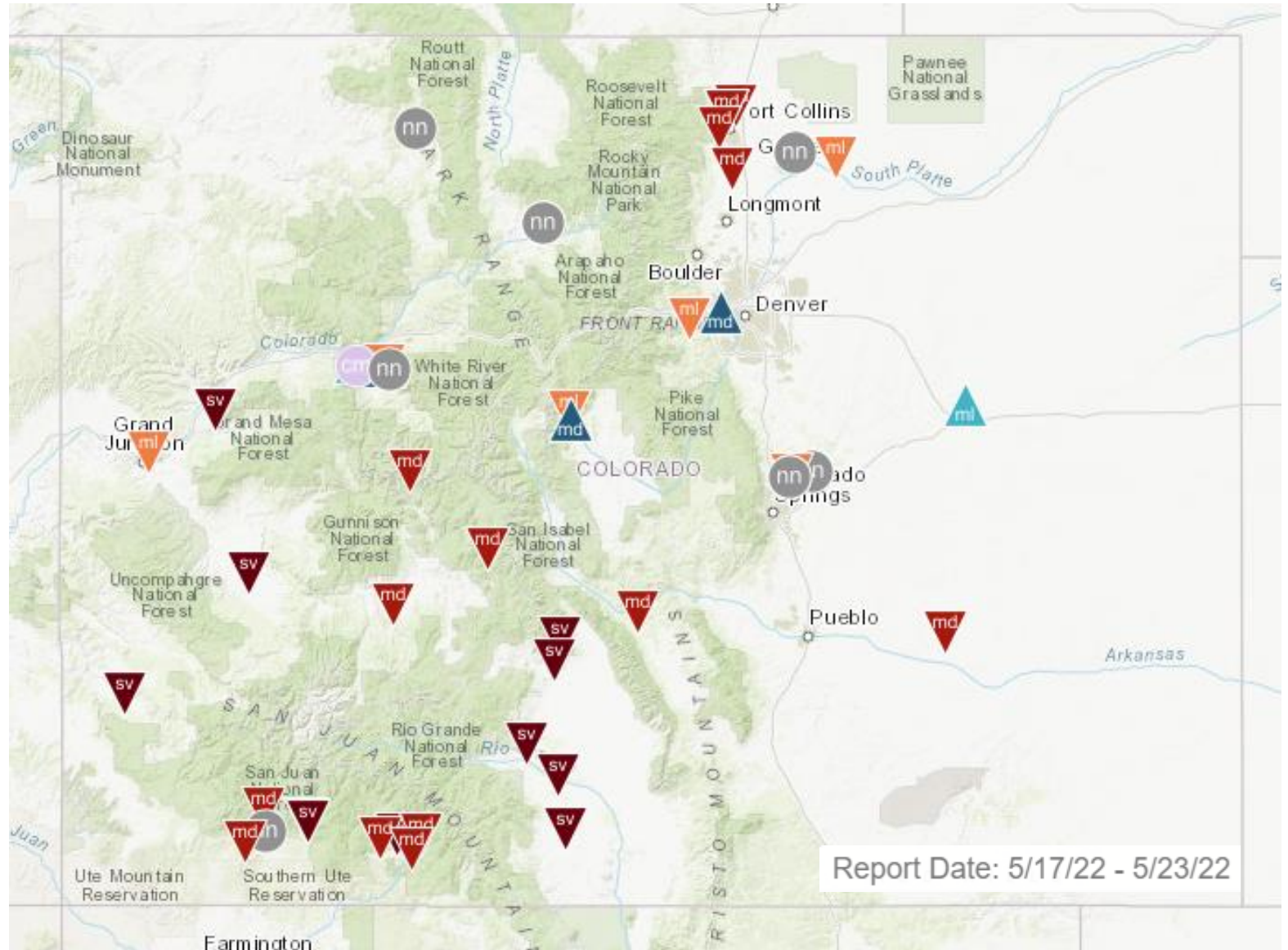
Don't know.	3
We store data locally, in Dropbox and a large part of our data will become publicly available once the EPA decides to release it	1
We keep the raw data, but no one is tracking extreme events or shifts.	1
We don't have a data manager. Can you help us with that?	1
we do not store this data	1



Progress

In 2021 and 2022 the Colorado Climate Center worked with the National Integrated Drought Information System to increase the number of CoCoRaHS condition monitoring participation in forested areas

These efforts included working with the US and Colorado State Forest Service to sign up Forest Service employees, working with CoCoRaHS coordinators to sign up new volunteers, and email reminders and “thank you’s” to observers who did file Condition Monitoring reports



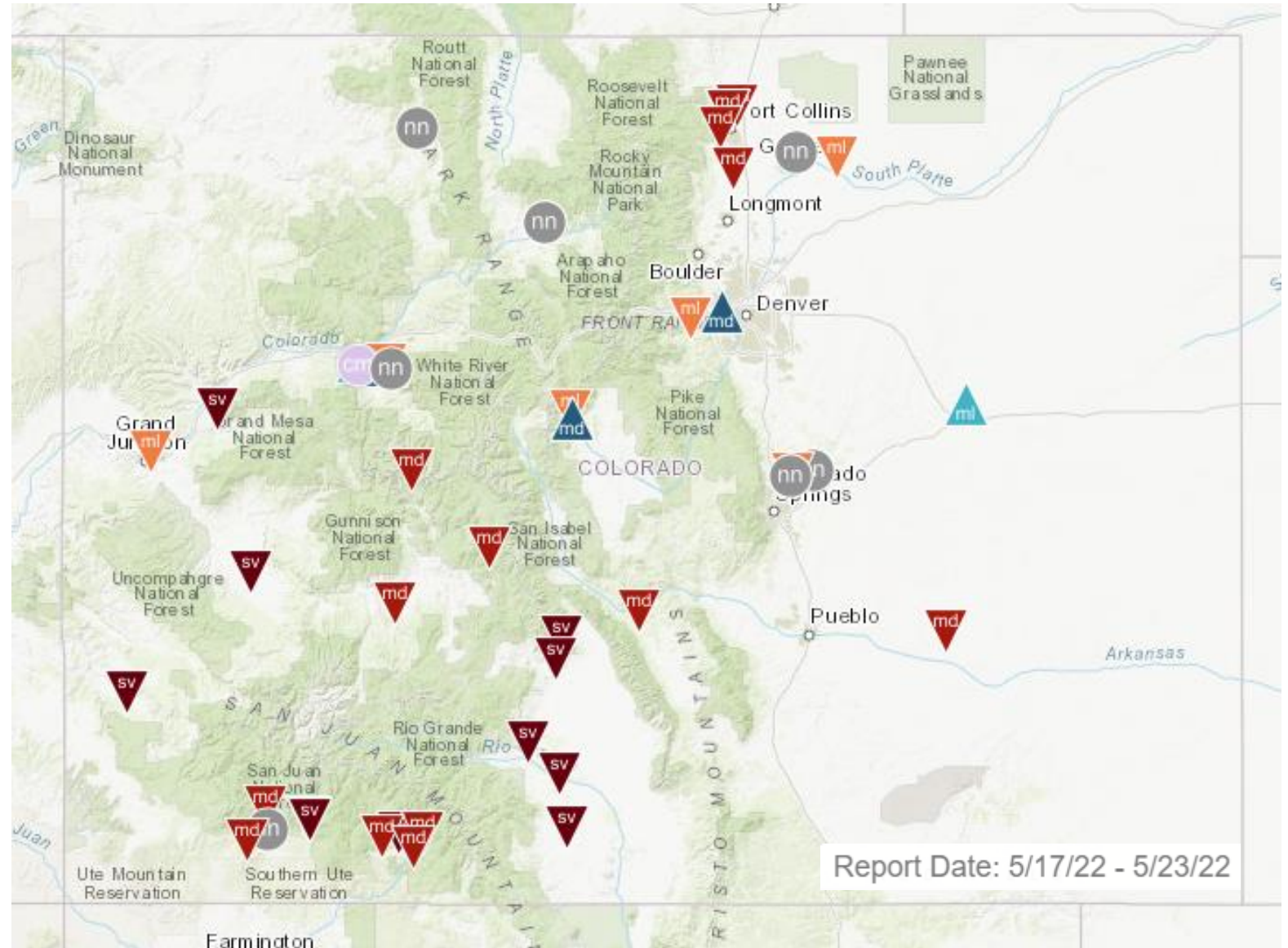
Progress

We made strides collecting Condition Monitoring Reports in Forests last summer, especially the San Juan Forest.

Recruiting and advertising increased May-September reporting 346 in 2021 to 610 in 2022 statewide.

Archuleta County and La Plata County were particularly successful (3 -> 39 reports and 16 -> 52 reports respectively)

With the help of the State Forest Service we could do so much more!



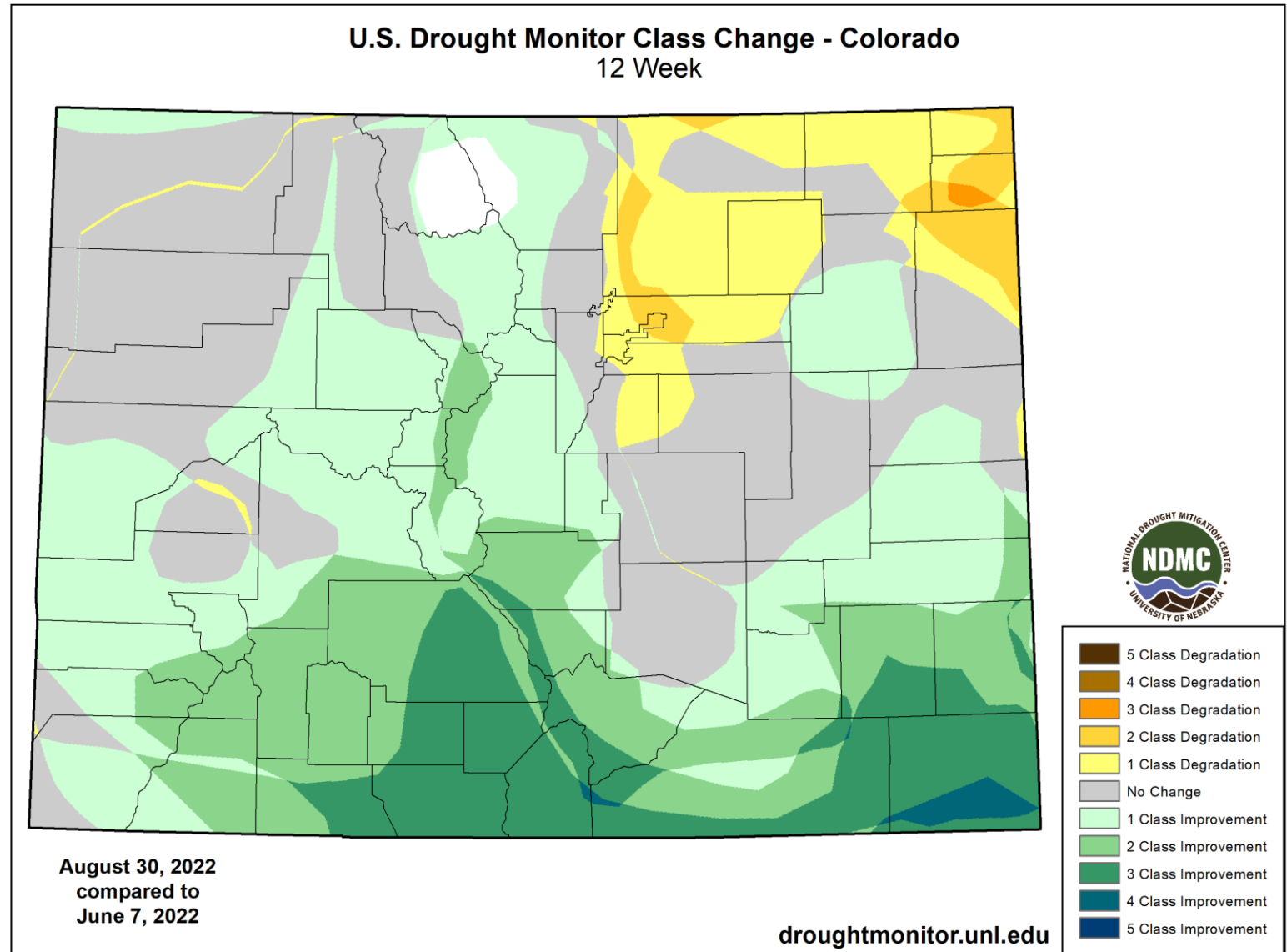
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billy barr

- High elevation CoCoRaHS observer near Gothic, Colorado
- Keeps meticulous and extensive notes about vegetation and wildlife at his cabin
- One of our best Condition Monitoring observers in the 2021/2022 forest monitoring program



Photo credit: 5280 Magazine



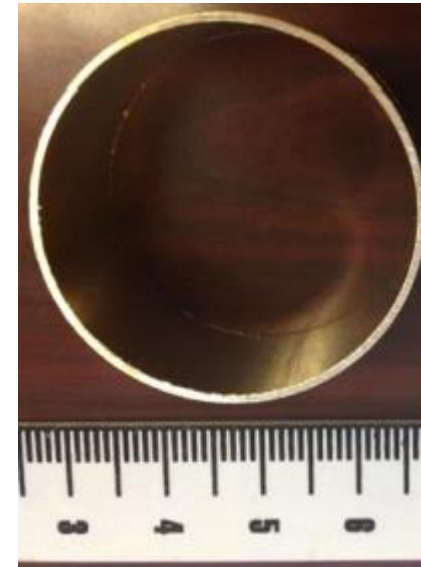
Challenges

- Forests are sparsely populated, so reaching the right observers is difficult
- Adding any additional protocols to the plates of Forest Service workers is met with friction and red tape
- Forest Service employees are very mobile. They are rarely in the same part of the forest routinely (there are exceptions)
- CoCoRaHS reporting is tied to the location of a rain gauge
- Consistent reporting is key to fully addressing the challenges outlined above, and fostering consistent Condition Monitoring observers has been difficult. If you are doing this, you are important!
- How can we make this more fun?



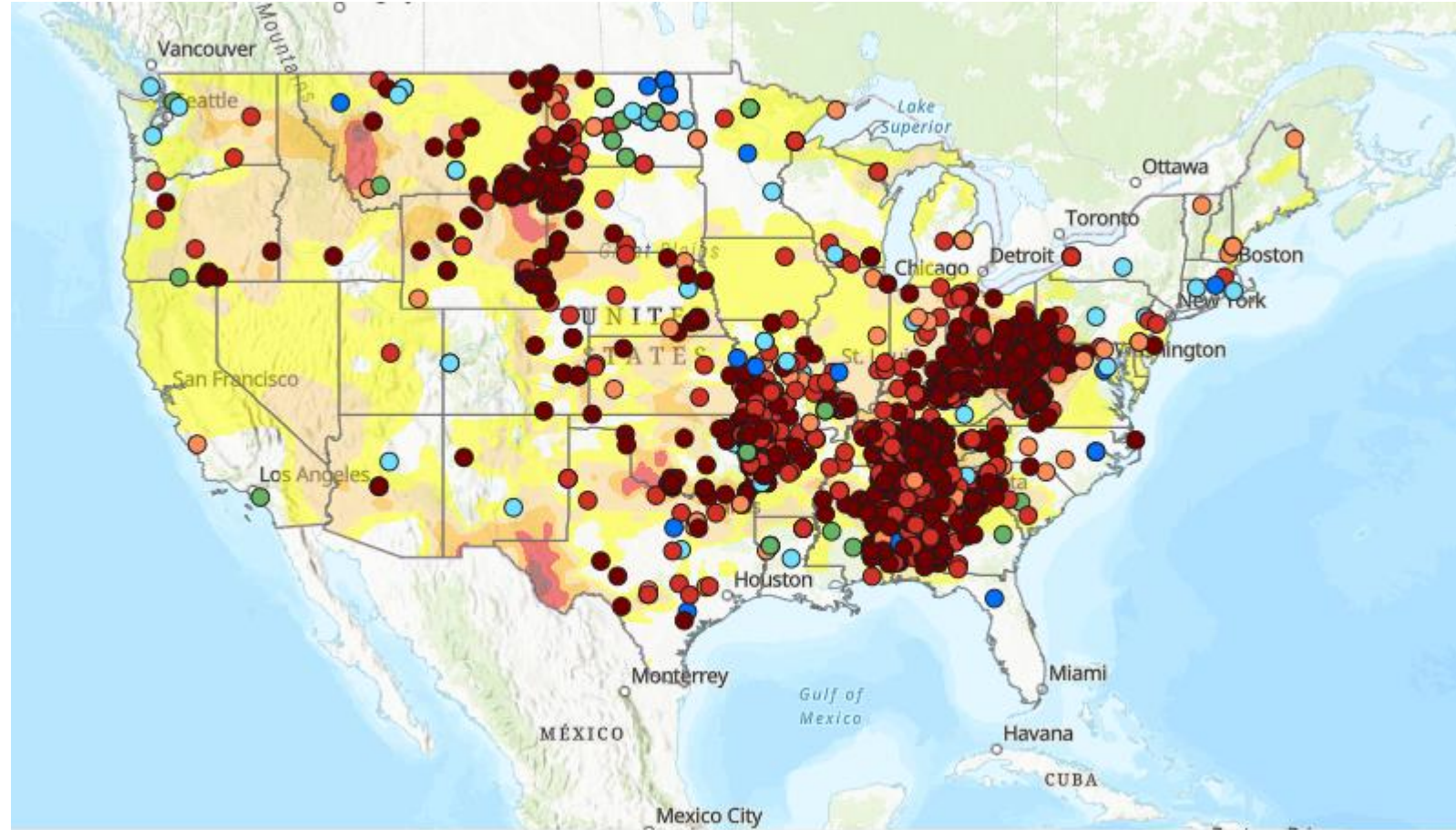
Related Projects: CoCoRaHS Soil Moisture

- Soil moisture conditions were underreported to capture the 2012 central United States drought
- CoCoRaHS observers asked to take gravimetric soil moisture measurements
- CoCoRaHS has always been a manual measurement organization
- Soil moisture was a step too far
- Fewer than 50 participants from over 20,000 active observers



Related Projects: Other Options (CMOR Drought Reports)

- Similar program run by National Drought Mitigation Center
- Advantages: Photo upload, not tied to a specific point. Foresters could go somewhere once and submit a report without creating a station
- Disadvantages: Routinely monitored sites tied to a station ID become more valuable with every observation



Future Work

- Yampa River Basin monitoring
- Colorado State Forest Service projects
- Work with other Forests
- Understanding the needs of other regions (e.g. wildfire vs flooding concerns)



Photo credit: Purdue University - <https://ag.purdue.edu/departments/extension/ppp/resources/ppp-publications/ppp-098.html>



Thanks for your time!

Questions, comments?

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