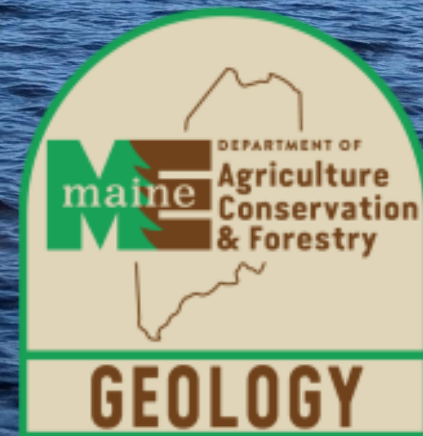


Impacts of Maine's Drought Conditions on Lake Storage and Water Quality

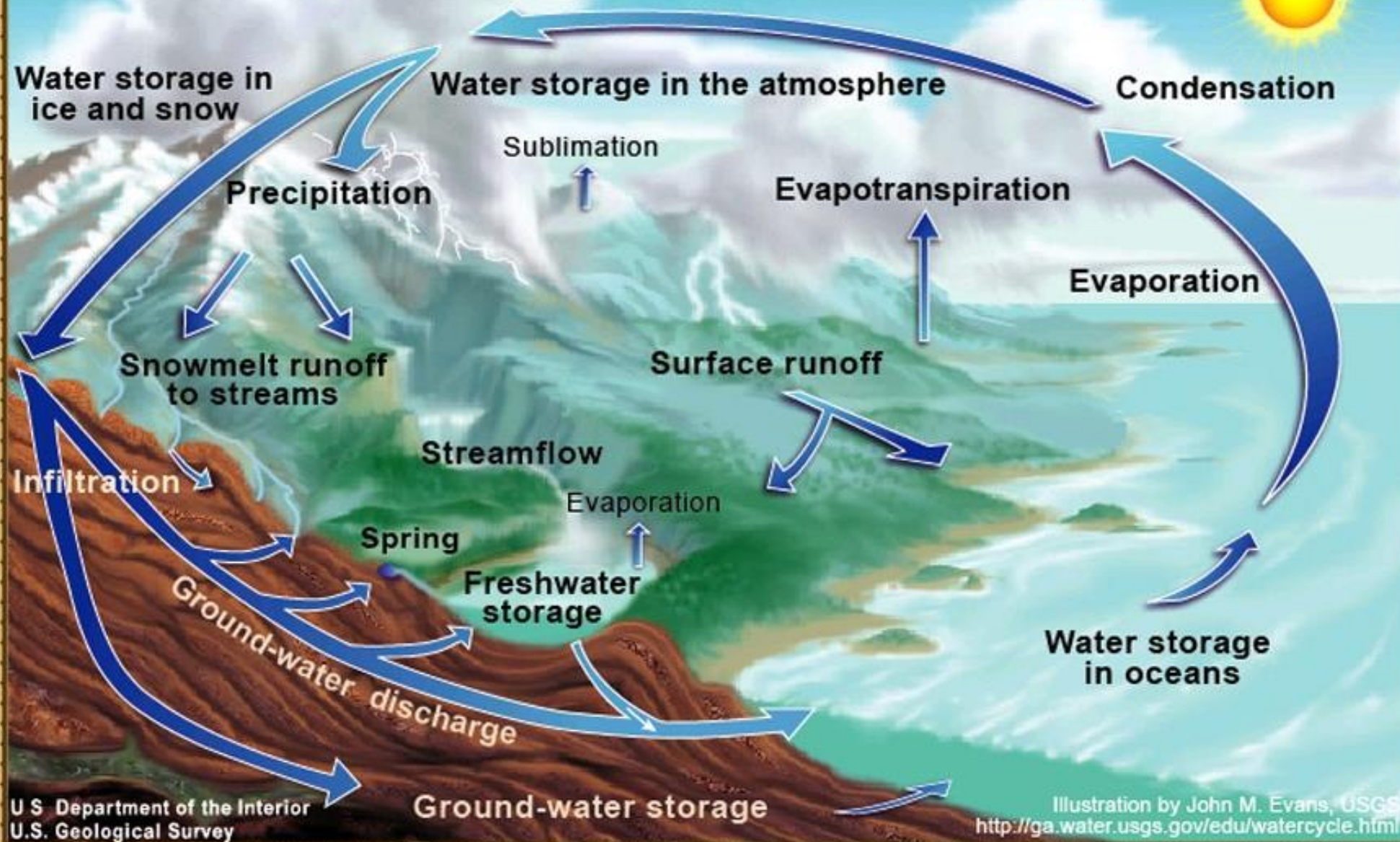
Mary Szatkowski
Hydrogeologist, Maine Geological Survey



Outline

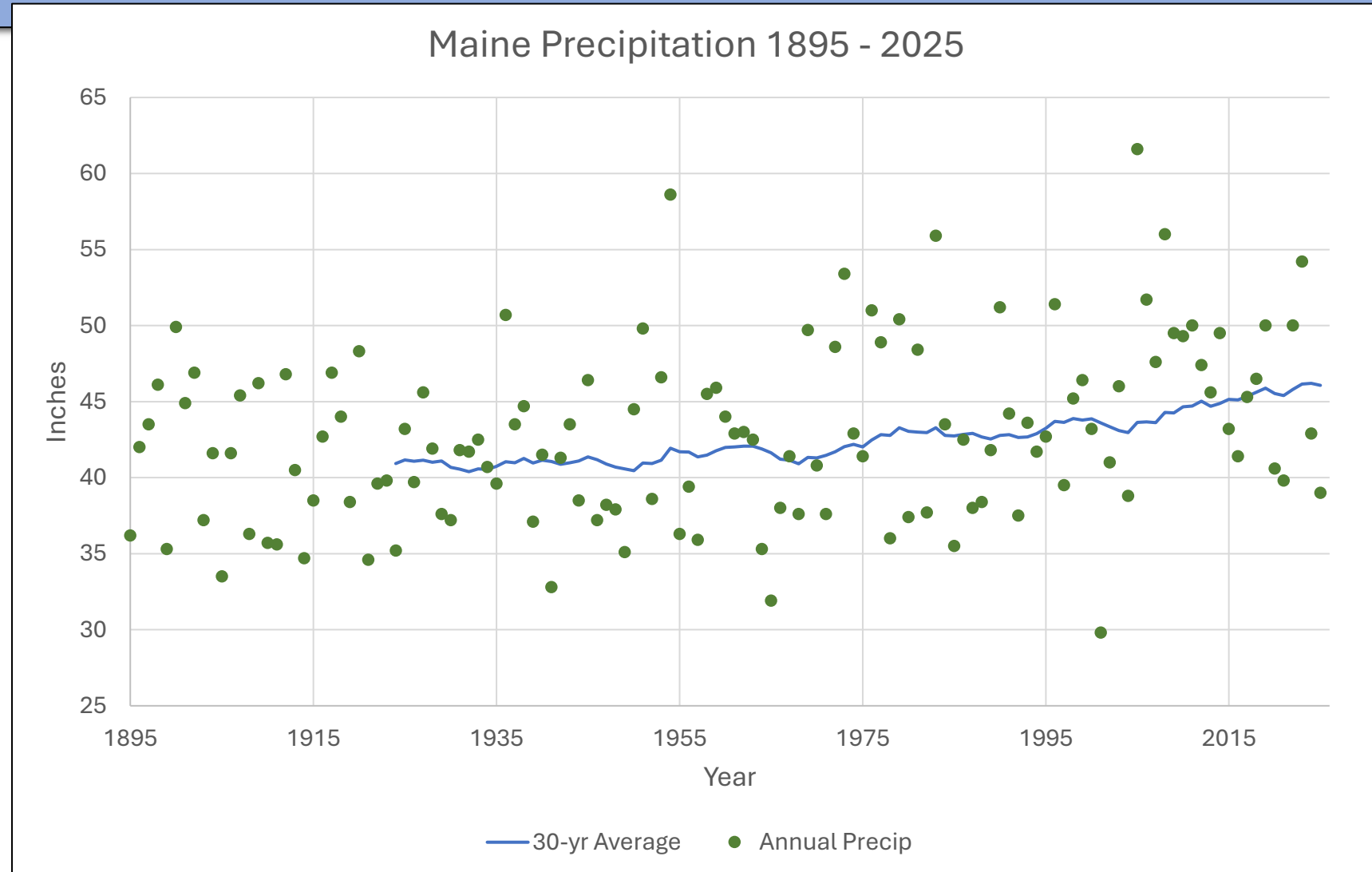
- Intro to Maine's hydrology
- Drought
 - Definitions, monitoring, and 2024-2026 conditions
- Drought impacts to lakes
 - Water storage, water quality

The Water Cycle



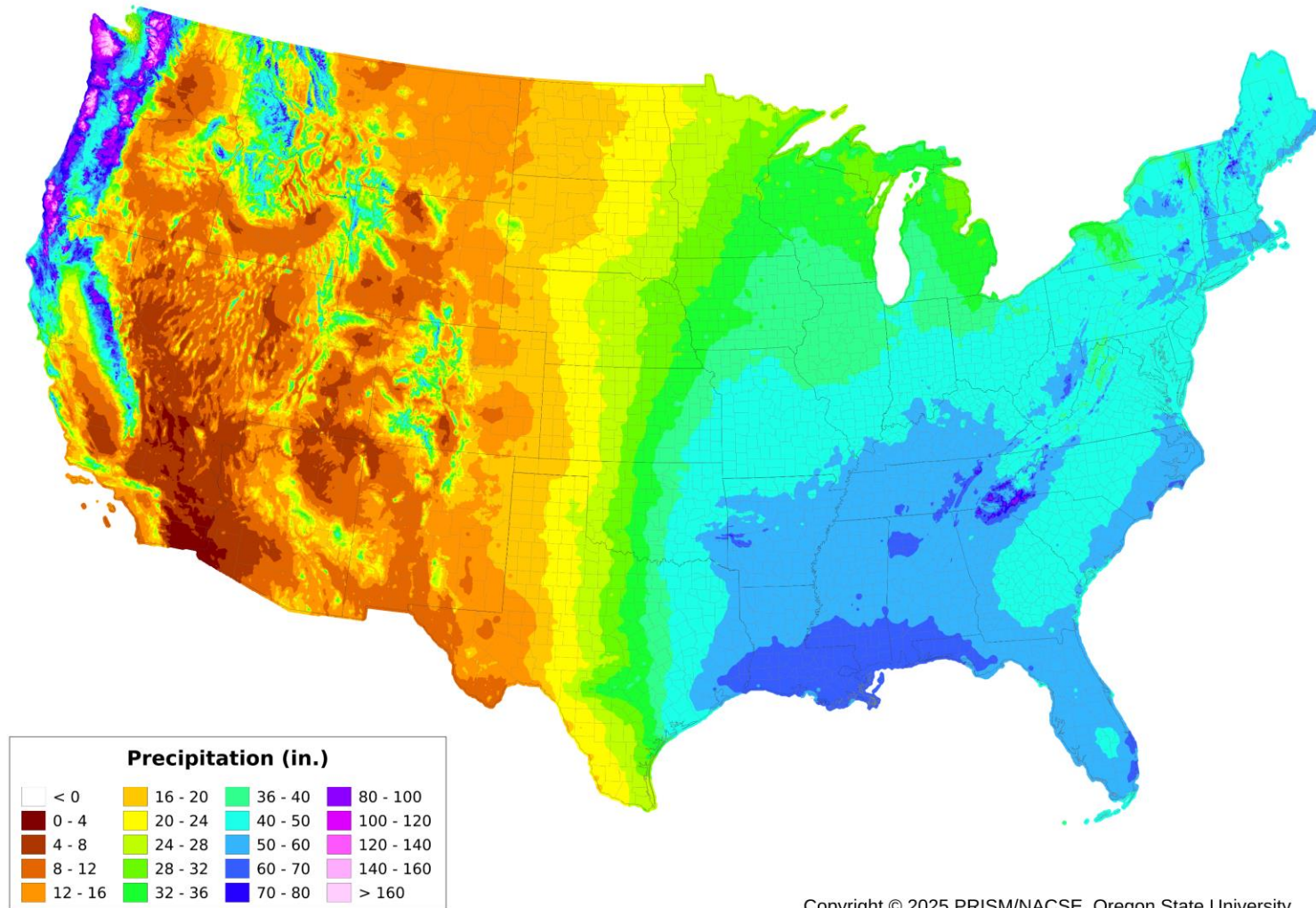
Precipitation

- Rain, snow, everything in between
- 30-yr average has increased from 41" to 46" in the last century
- 2025 rainfall was 39"



30-yr Normal Precipitation: Annual

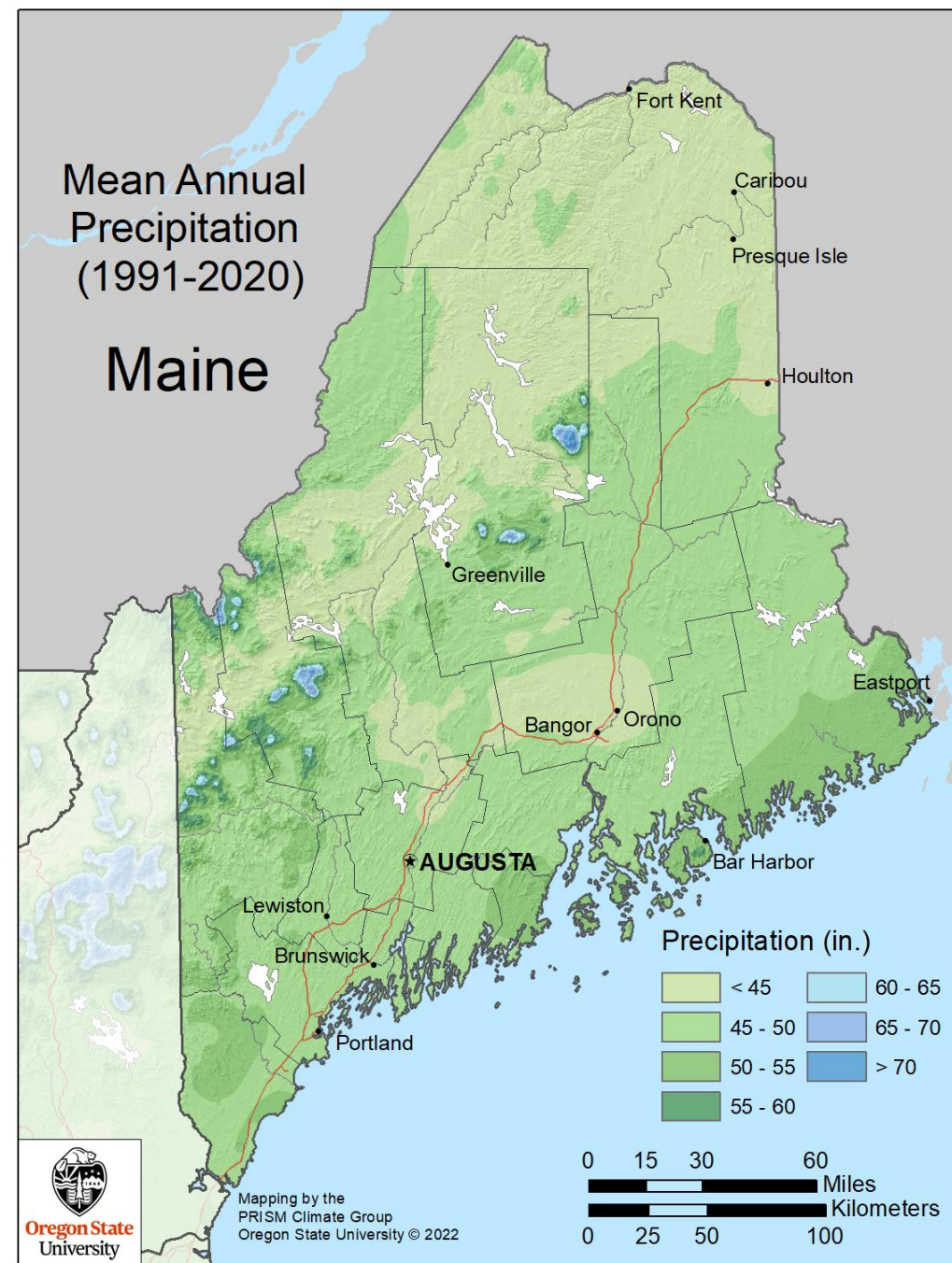
Period: 1991 - 2020



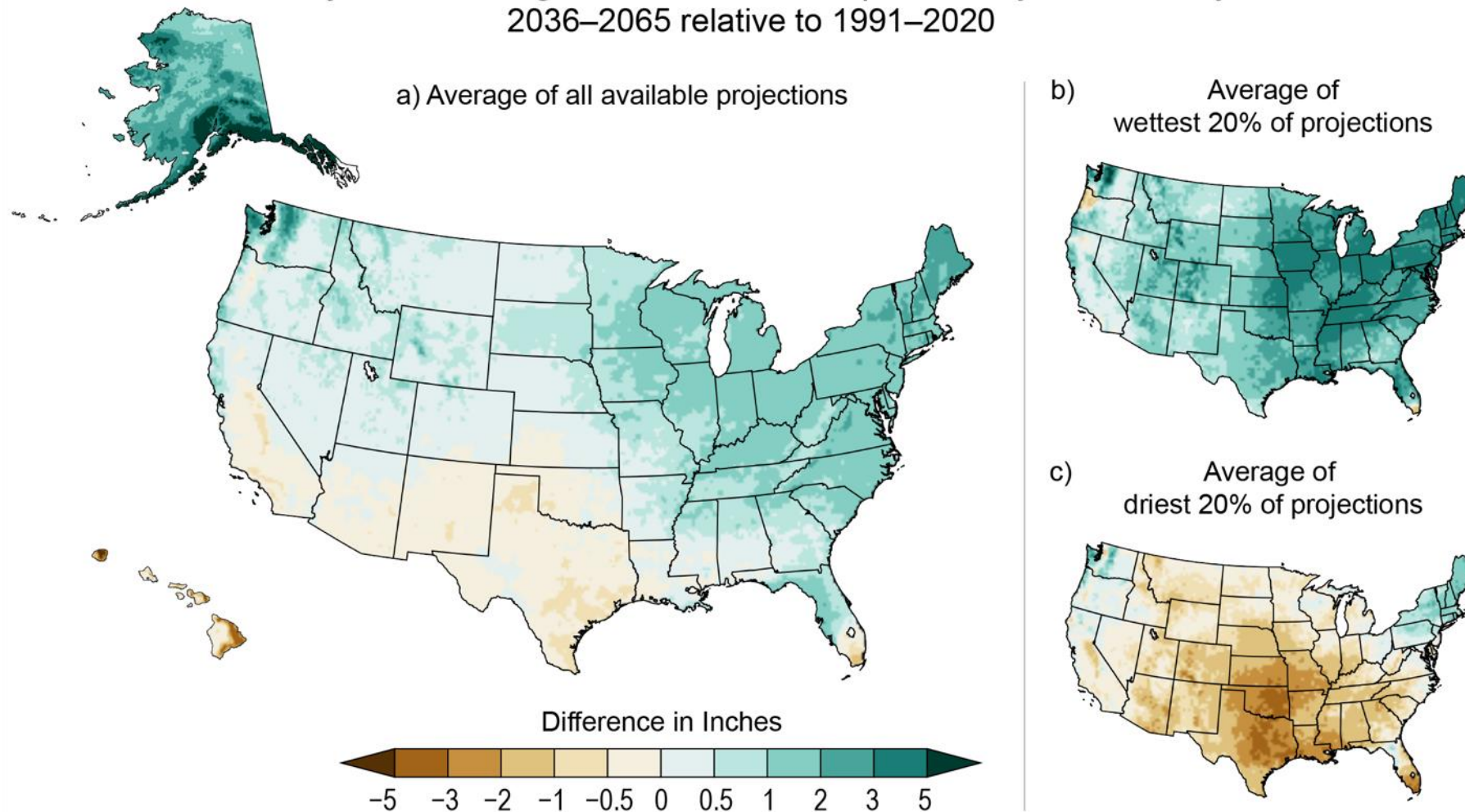
Copyright © 2025 PRISM/NACSE, Oregon State University

Mean Annual Precipitation (1991-2020)

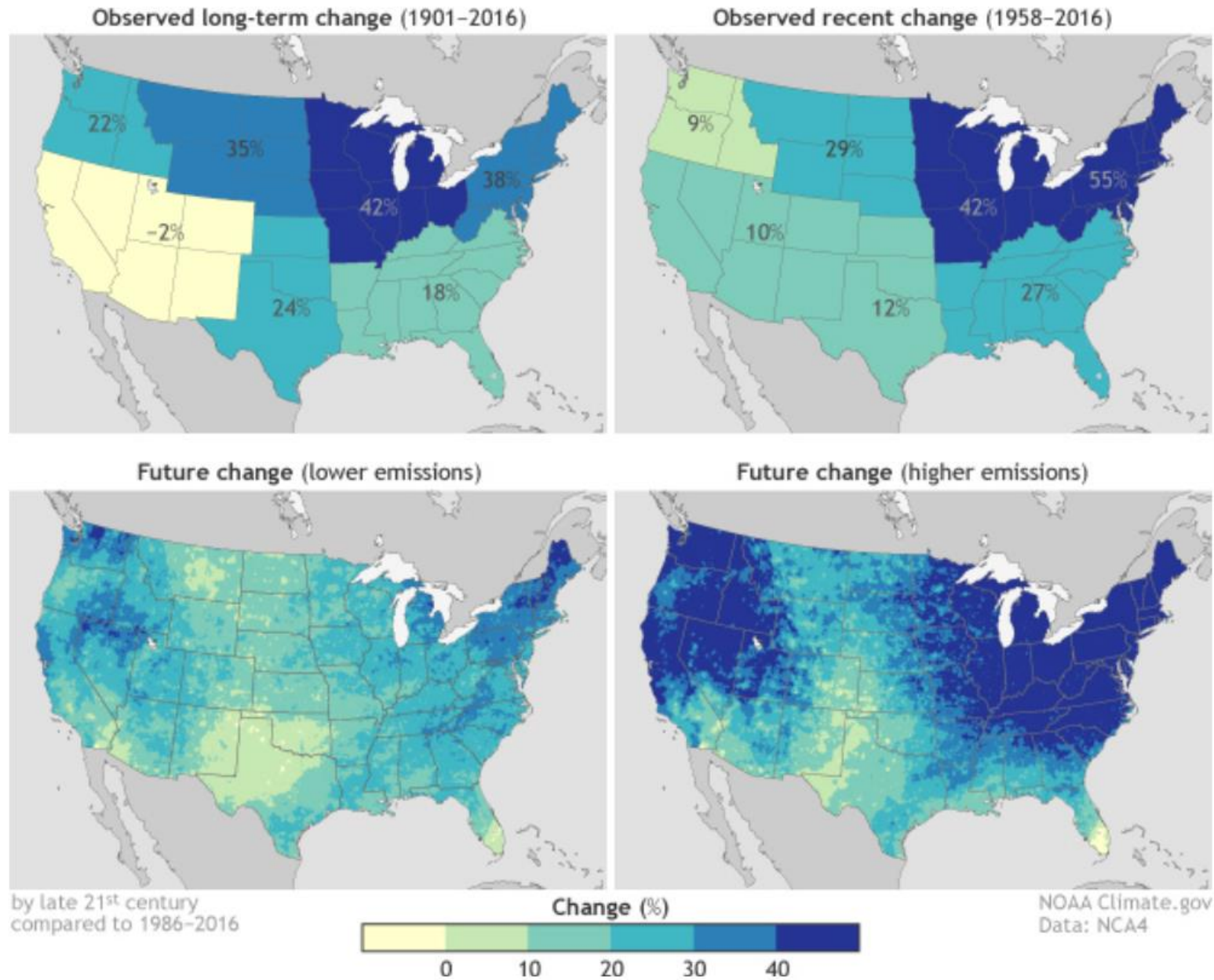
Maine



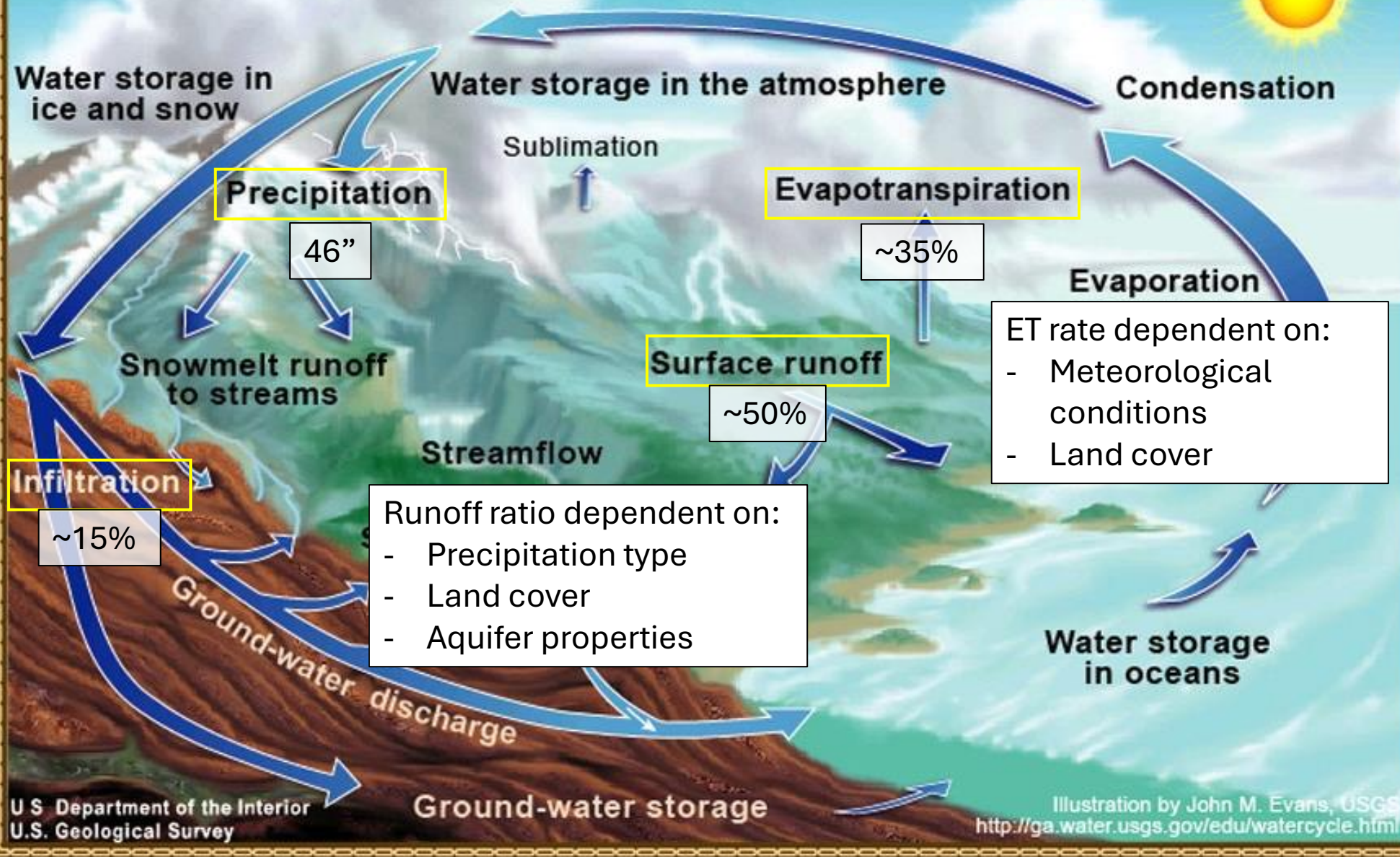
Projected Changes in Annual Precipitation by Midcentury 2036–2065 relative to 1991–2020



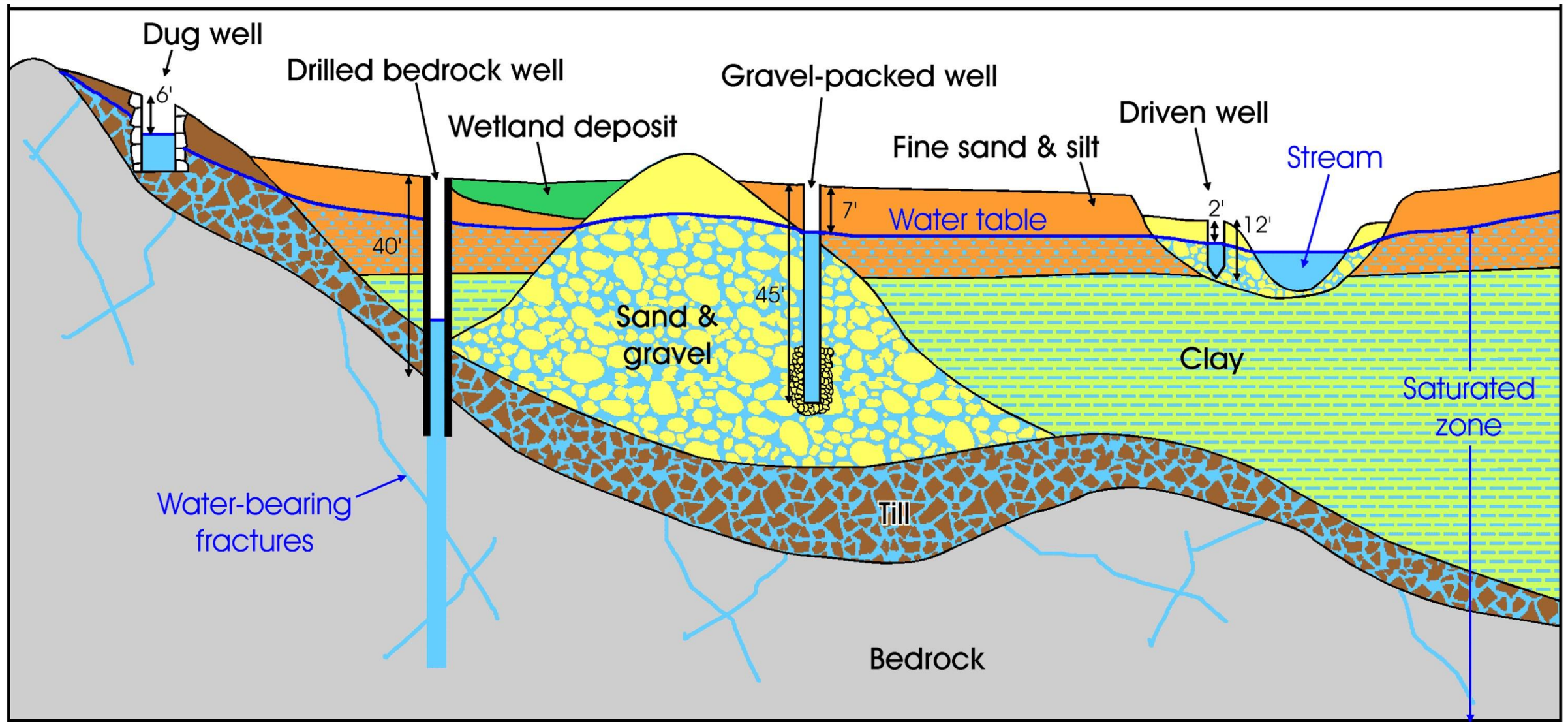
Change in very heavy precipitation events



The Water Cycle



Infiltration - Maine's Groundwater Aquifers



Bedrock Aquifer

- Metamorphic and igneous bedrock
- Water flows through discrete, thin fractures
- Density and interconnectivity of fractures variable and unpredictable
- Infiltration 2-5%

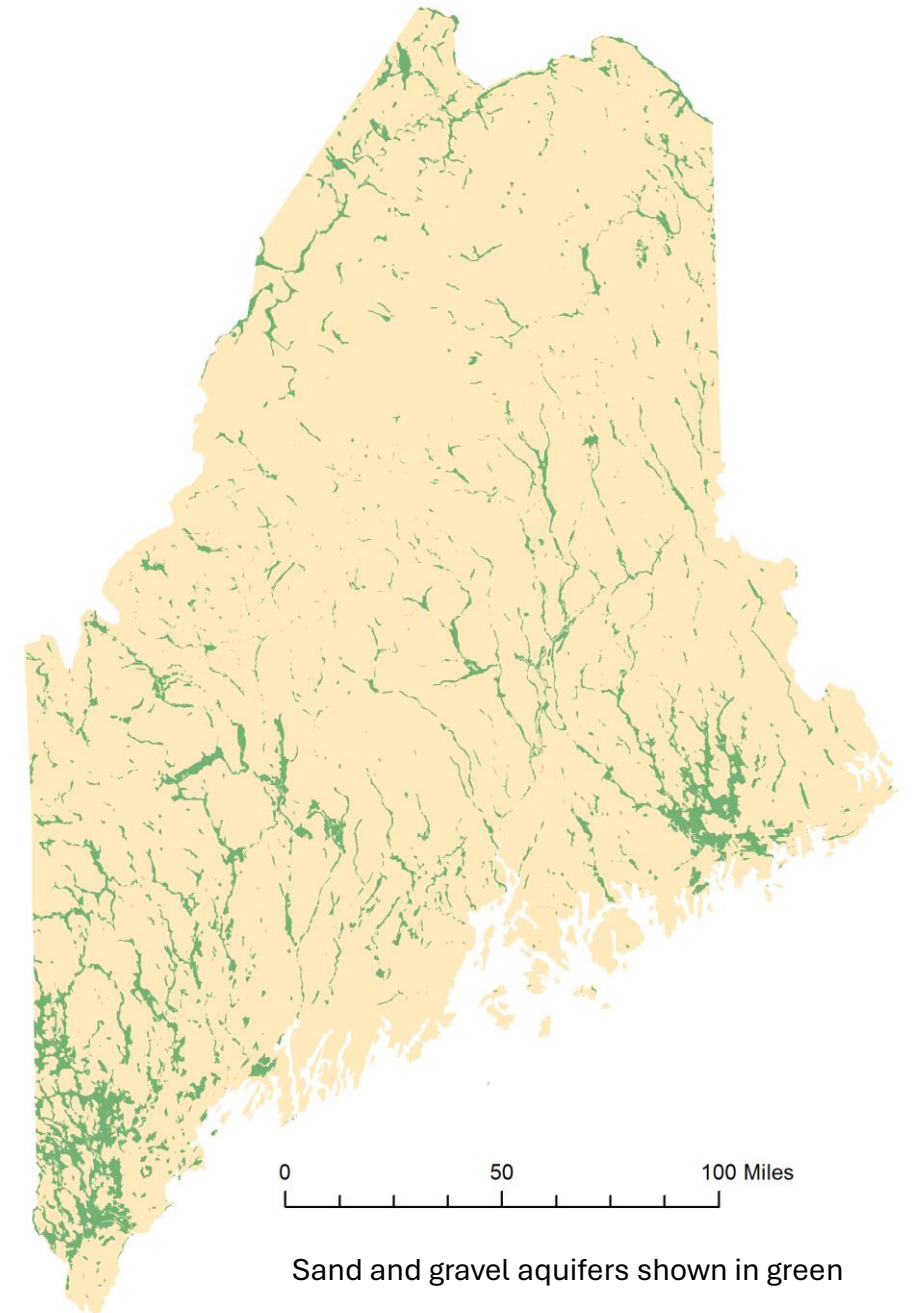


Surficial Aquifers

- Sediment (sand, gravel, silt)
- Water flows in spaces between grains
- Sand and gravel deposits are the best resources for high-yield wells, but their distribution is limited.

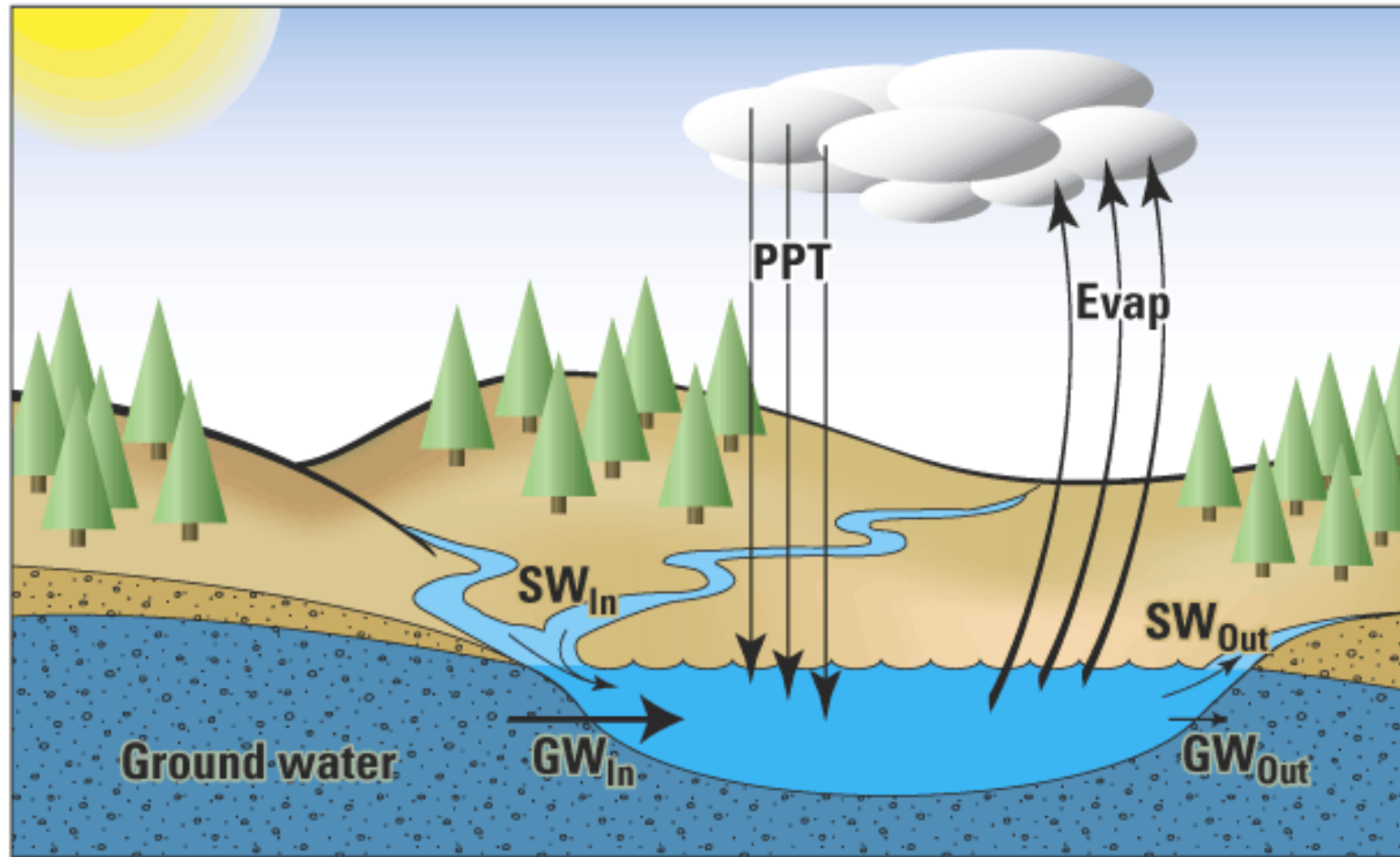


Sinuous glacial ridge (esker)
of sand and gravel.



Sand and gravel aquifers shown in green

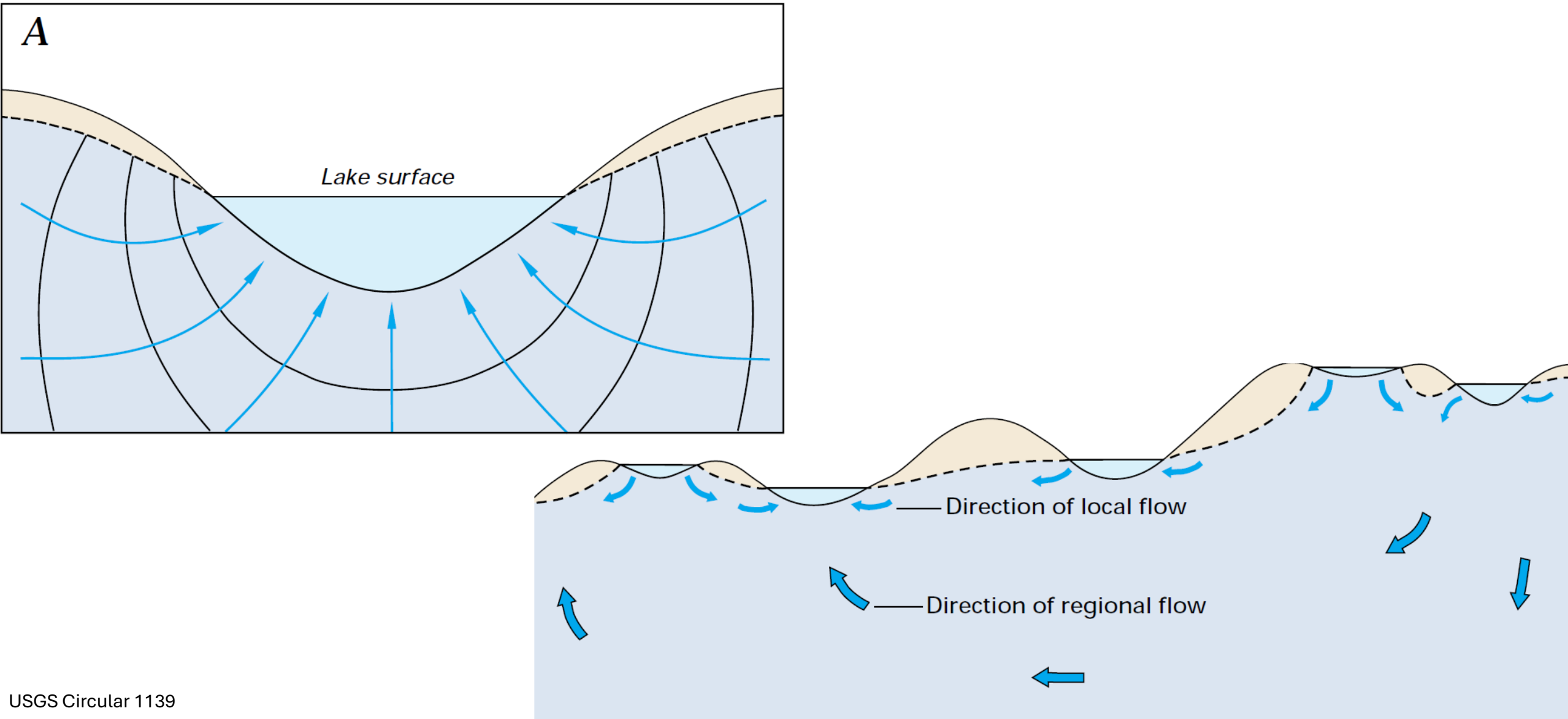
Lake Water Budgets



EXPLANATION

Evap	Evaporation
GW _{In}	Ground-water inflow
GW _{Out}	Ground-water outflow
PPT	Precipitation
SW _{In}	Surface-water inflow
SW _{Out}	Surface-water outflow

Water Table Near Lakes



Drought: What is it?

- Meteorological drought: Lack of rain, high temperatures, low humidity
- Agricultural drought: Lack of soil moisture
 - Wilting plants, reduced crop growth and yield
 - Increase in fire danger
- Shorter-term hydrological drought: Low flow in streams, rivers, and lakes
 - Loss of irrigation sources, stressed public water supplies
 - Higher water temperatures
 - Stranding of fish and invertebrates
- Longer-term hydrological drought: Low groundwater levels
 - Drying wells
 - Drying springs and groundwater-dependent wetlands

U.S. Drought Monitor



Drought.gov
National Integrated Drought Information System

- Combination of quantitative data, local observations, and experts' judgment
- Data includes meteorological conditions, soil moisture, streamflow, groundwater levels
- Maps updated weekly

Abnormally
Dry

Category	Impact
D0	Crop growth is stunted; planting is delayed
	Fire danger is elevated; spring fire season starts early
	Lawns brown early; gardens begin to wilt
	Surface water levels decline
D1	Irrigation use increases; hay and grain yields are lower than normal
	Honey production declines
	Wildfires and ground fires increase
	Trees and landscaping are stressed; fish are stressed
D2	Voluntary water conservation is requested; reservoir and lake levels are below normal capacity
	Specialty crops are impacted in both yield and fruit size
	Producers begin feeding cattle; hay prices are high
	Warnings are issued on outdoor burns; air quality is poor
	Golf courses conserve water
	Trees are brittle and susceptible to insects
	Fish kills occur; wildlife move to farms for food
	Water quality is poor; groundwater is declining; irrigation ponds are dry; outdoor water restrictions are implemented
D3	Crop loss is widespread; Christmas tree farms are stressed; dairy farmers are struggling financially
	Well drillers and bulk water haulers see increased business
	Water recreation and hunting are modified; wildlife disease outbreak is observed
	Extremely reduced flow to ceased flow of water is observed; river temperatures are warm; wells are running dry; people are digging more and deeper wells

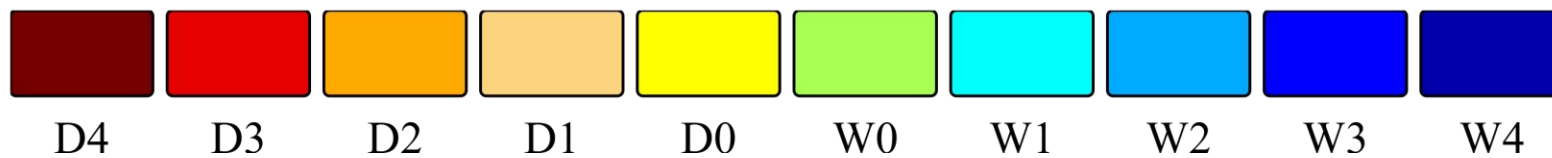
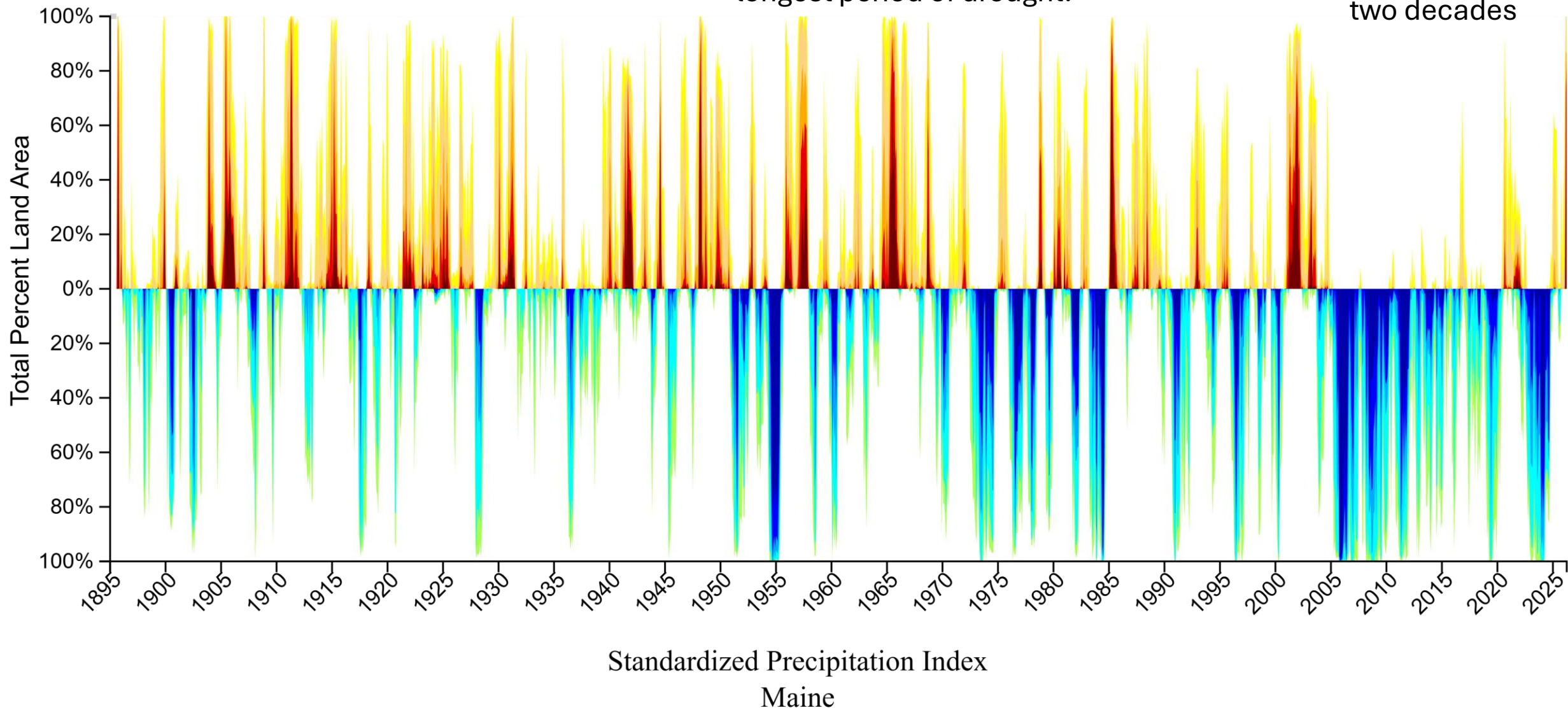
Moderate
Drought

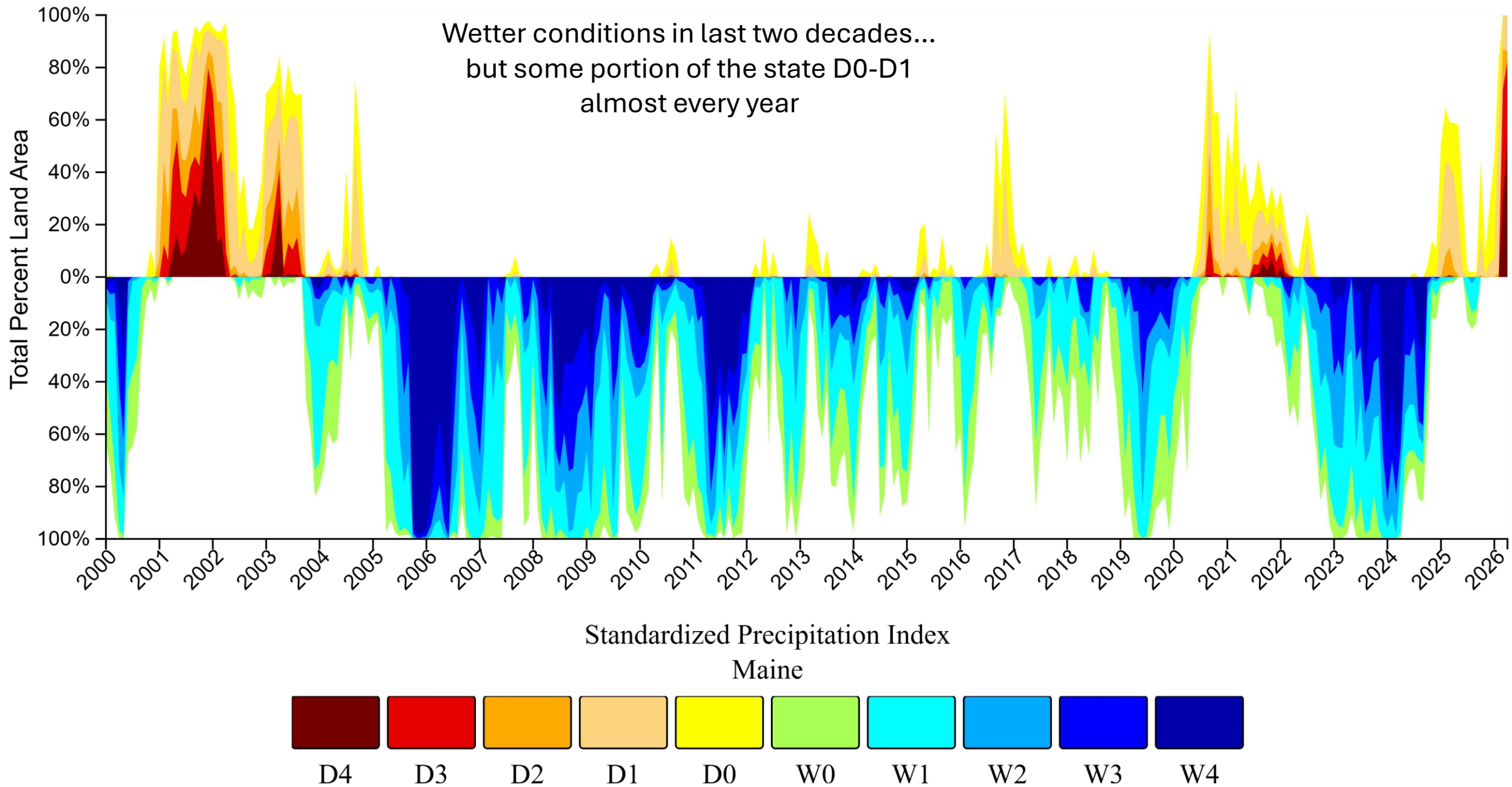
Severe
Drought

Extreme
Drought

1963-1969
longest period of drought.

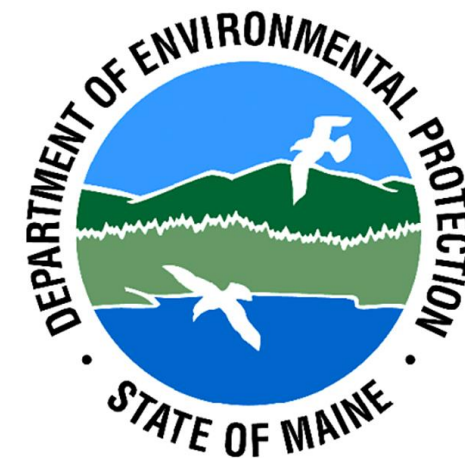
Wetter conditions in last
two decades





Maine Drought Task Force

Collaborative monitoring, assessment, response



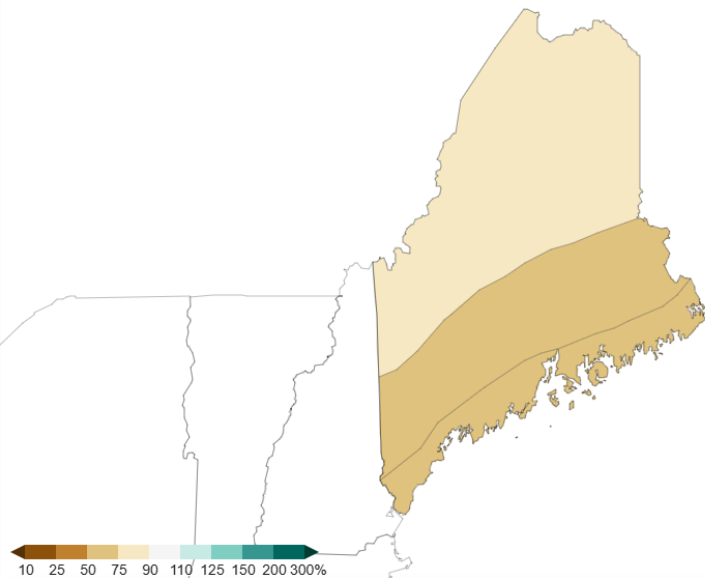
and more!

2024-2026 Drought Conditions

- Fall 2024, below average precipitation led to 92 % of Maine in Moderate Drought by December.

Divisional Precipitation Percent of Average (1901-2000)

September - December 2024

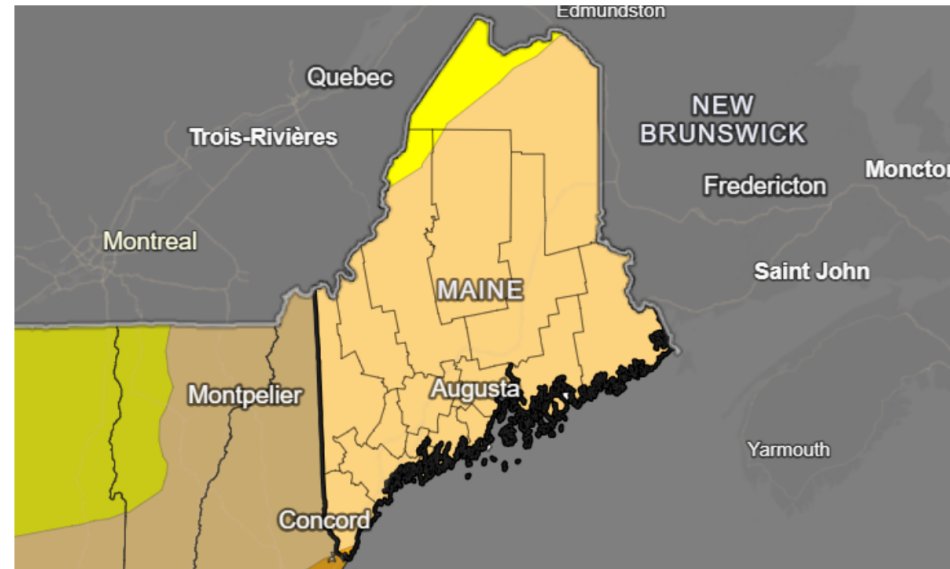


Maine
Precip: 10.87" Average: 14.81" Departure: -3.94" % of Avg: 73.4% Rank: 12th Lowest



U.S. Drought Monitor

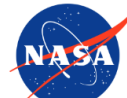
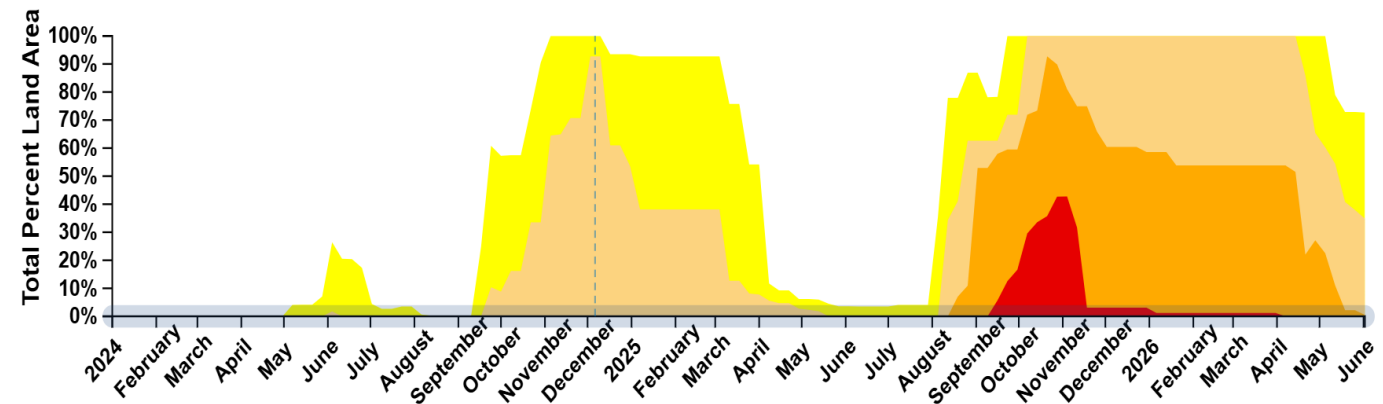
December 10, 2024



USDM values for Maine

D0	Abnormally Dry	7.3%
D1	Moderate Drought	92.5%
D2	Severe Drought	0.1%
D3	Extreme Drought	0.0%
D4	Exceptional Drought	0.00%

Total Area in Drought **92.60%**

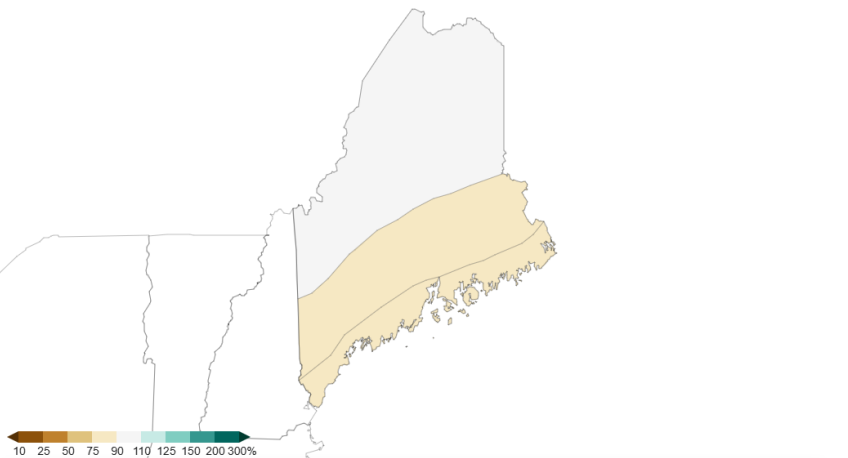


Drought.gov

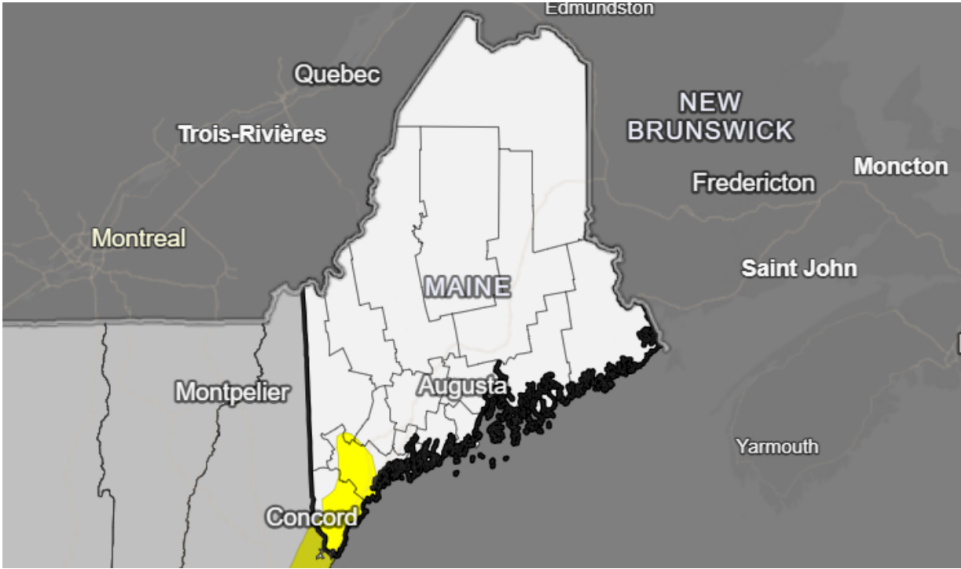
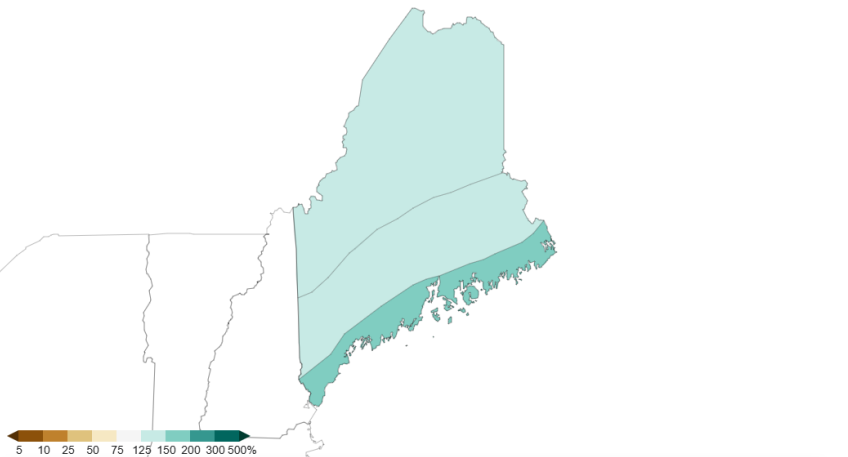
2024-2026 Drought Conditions

U.S. Drought Monitor July 08, 2025

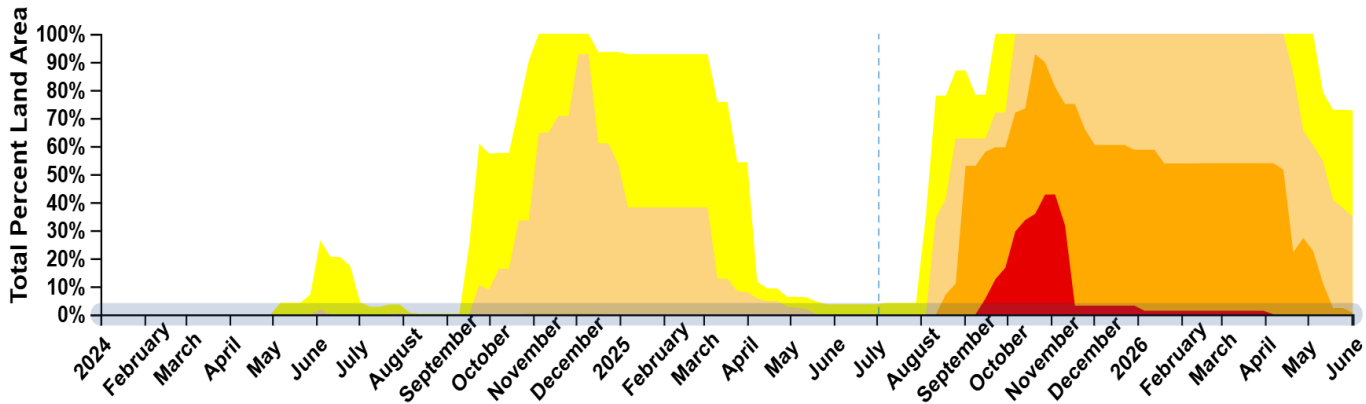
Divisional Precipitation Percent of Average (1901-2000) January - March 2025



Divisional Precipitation Percent of Average (1901-2000) April - May 2025



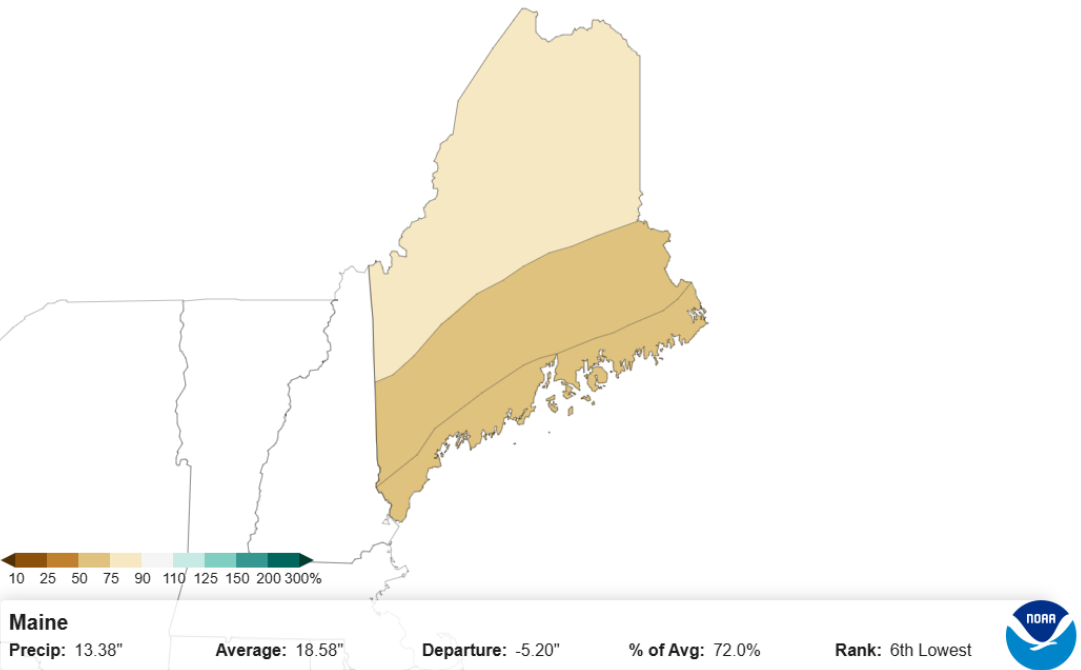
USDM values for Maine		
D0	Abnormally Dry	4.1%
D1	Moderate Drought	0.0%
D2	Severe Drought	0.0%
D3	Extreme Drought	0.0%
D4	Exceptional Drought	0.00%
Total Area in Drought		0.00%



2024-2026 Drought Conditions

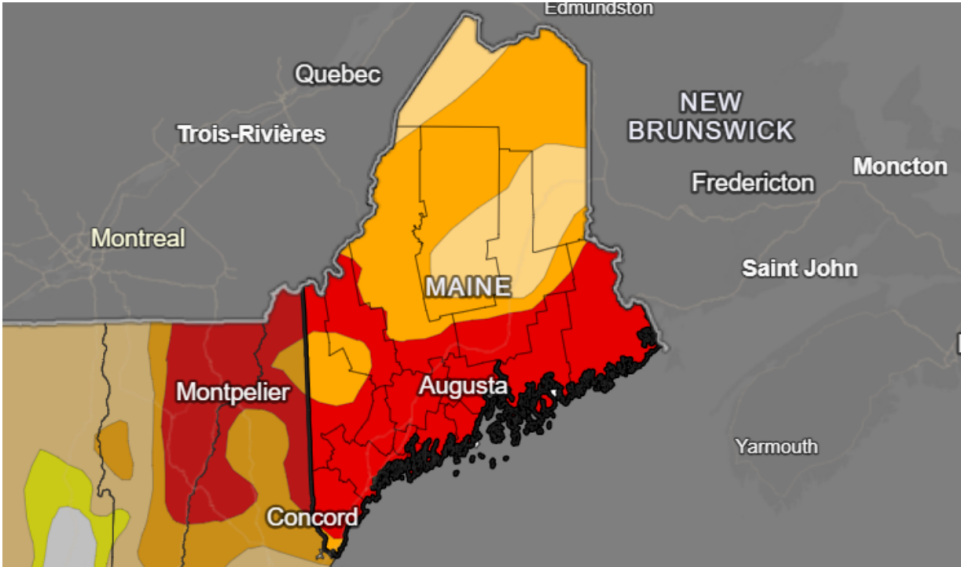
Flash drought – Rapid intensification of drought conditions due to the combination of below-normal precipitation and high temperatures

Divisional Precipitation Percent of Average (1901-2000) July - November 2025

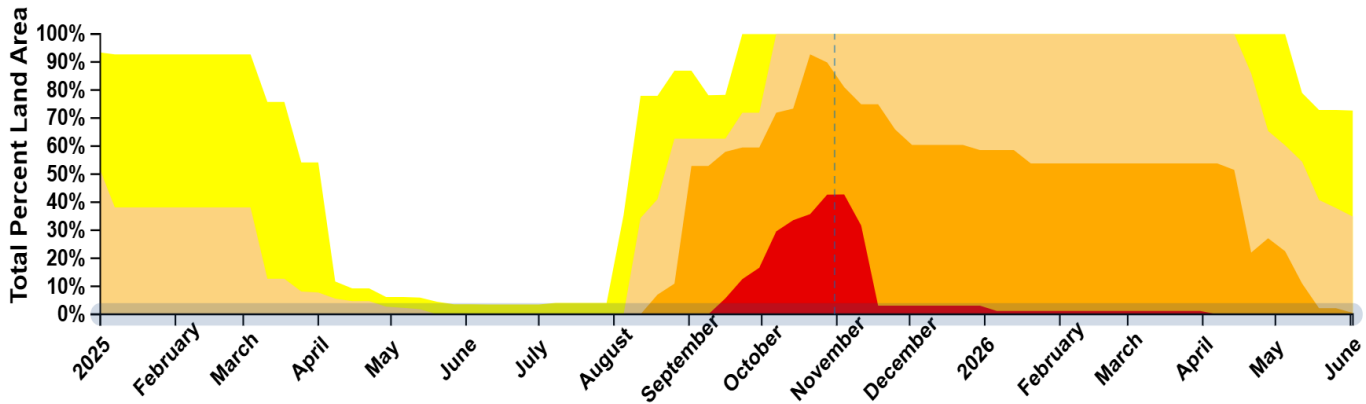


U.S. Drought Monitor

November 04, 2025

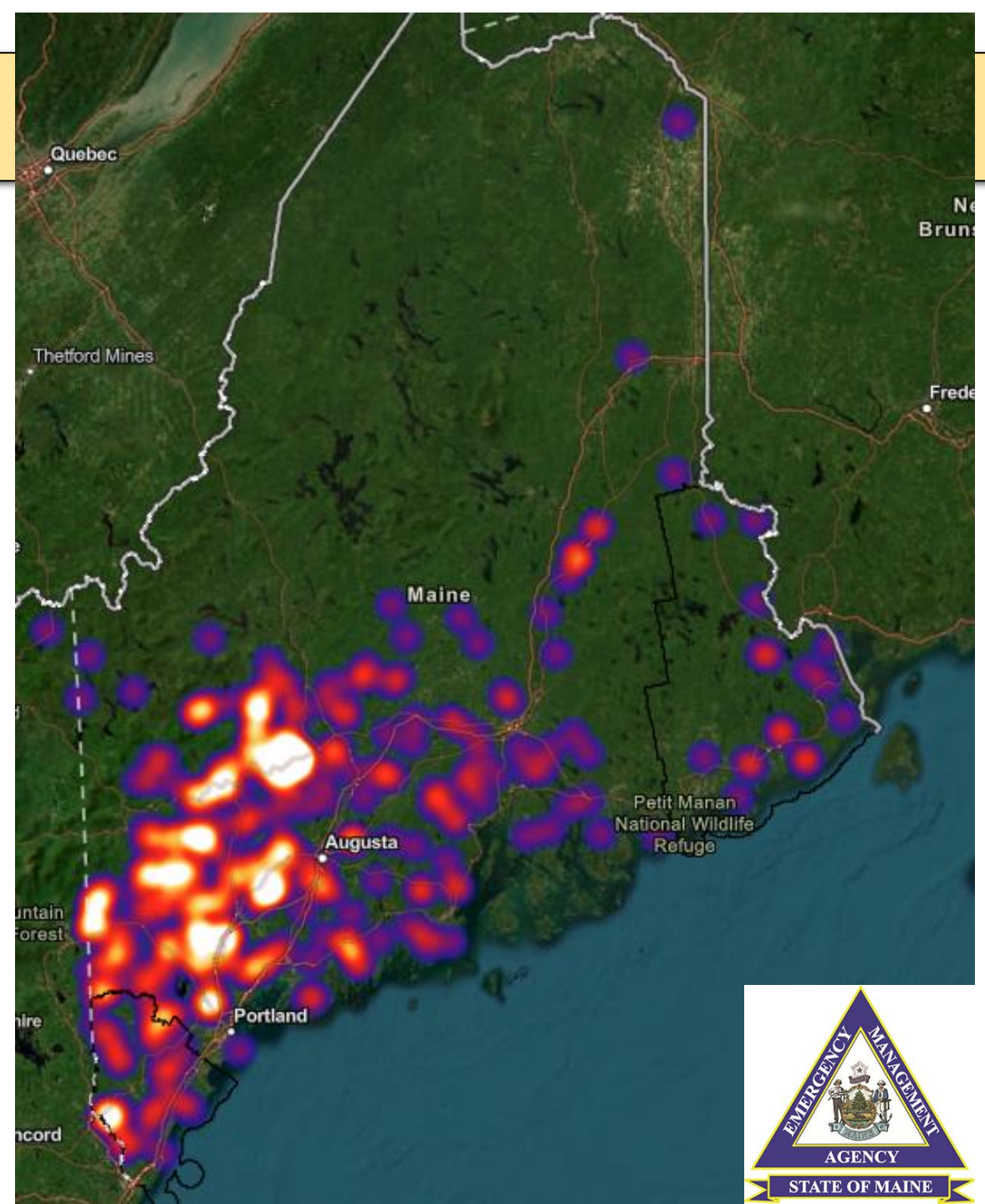


USDM values for Maine		
D0	Abnormally Dry	0.0%
D1	Moderate Drought	19.0%
D2	Severe Drought	38.3%
D3	Extreme Drought	42.7%
D4	Exceptional Drought	0.00%
Total Area in Drought		100.00%



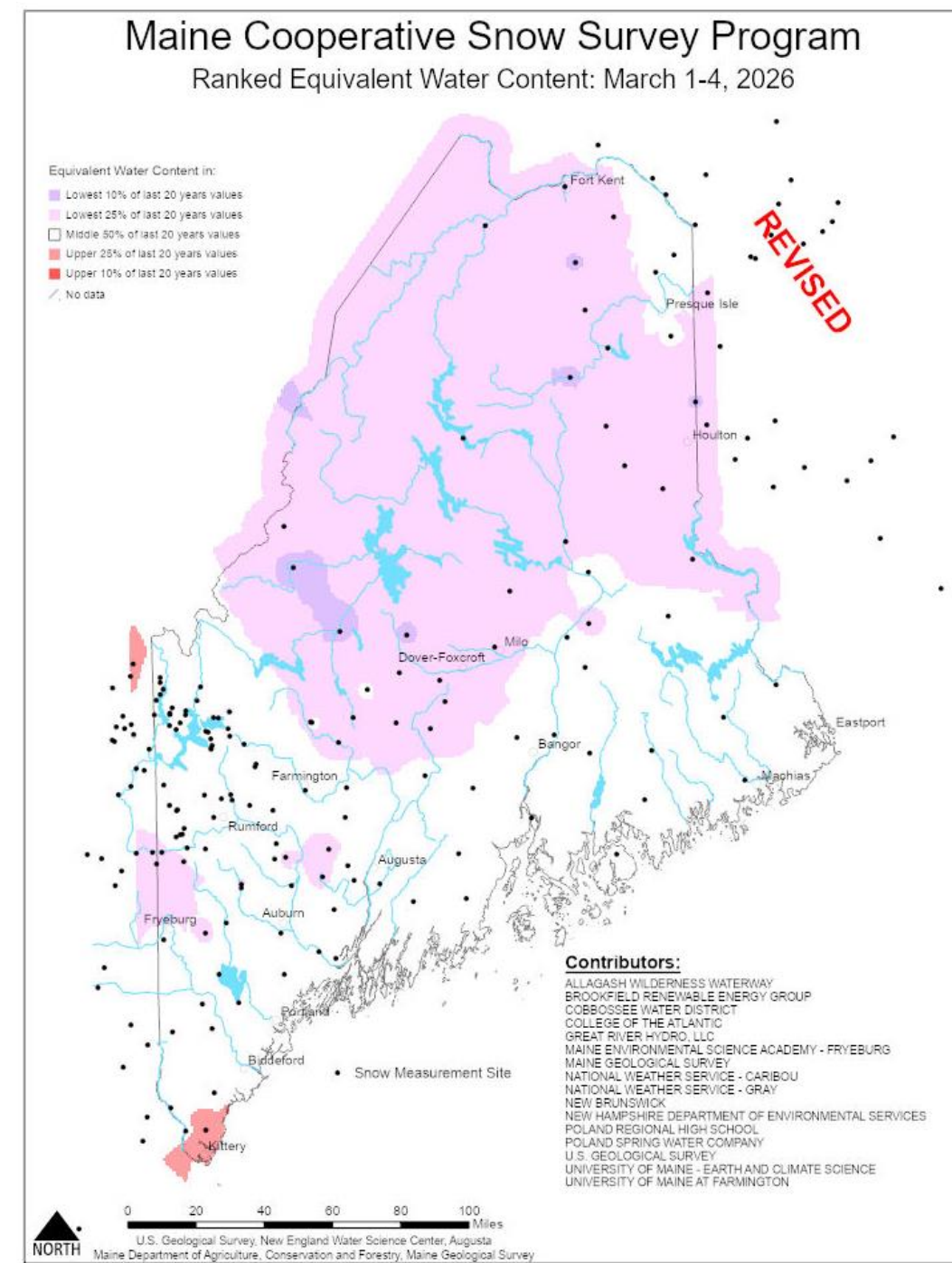
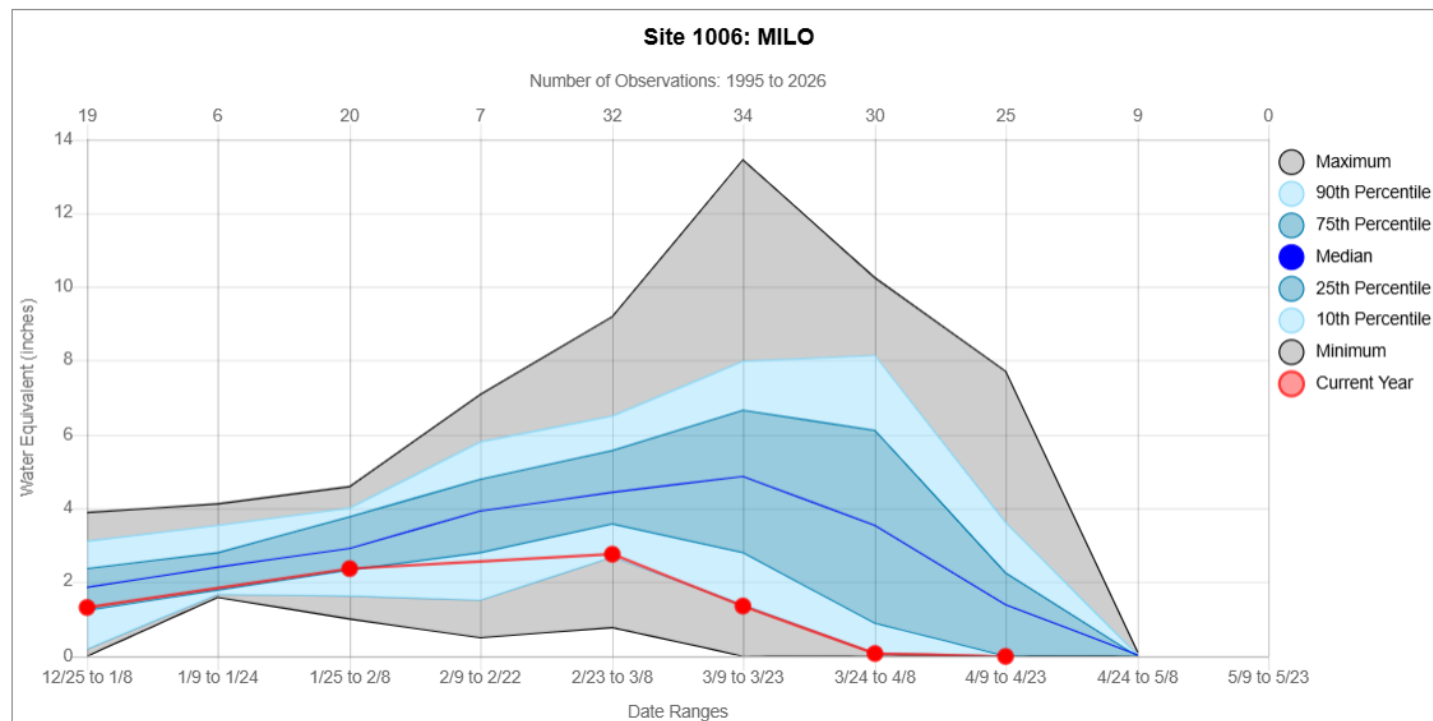
2025 Drought Impacts

- Hydroelectric operators working against minimum surface water conditions
- Record setting low groundwater levels, even compared to early 2000's drought
- 551 dry wells reported via MEMA voluntary dry well survey
- Wildfires. August had >200, compared to the usual ~40. Wildfire danger persisted late into fall.
- Agriculture losses. Blueberry and dairy industry specifically impacted. USDA declared natural disaster.
- Tourism losses due to fall foliage impacts.



2024-2026 Drought Conditions

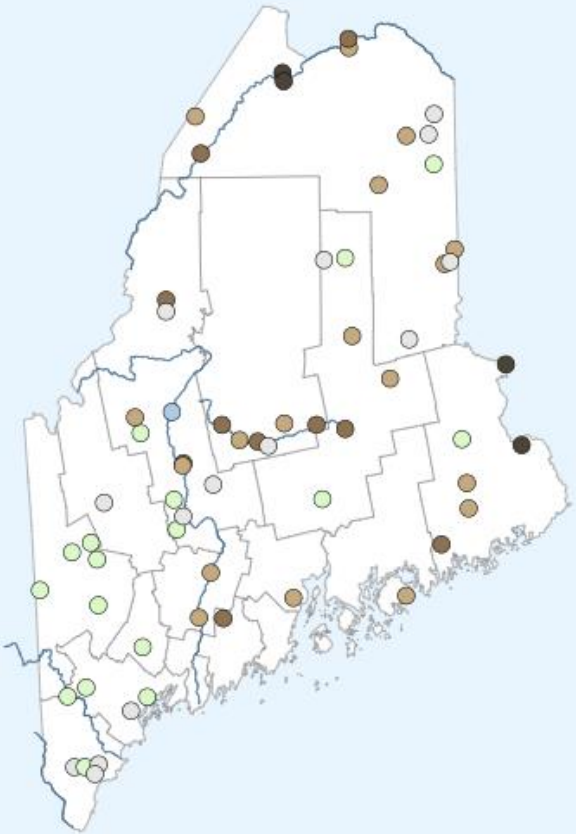
- With seasonal decrease in evapotranspiration, drought conditions stabilized in the winter of 2026



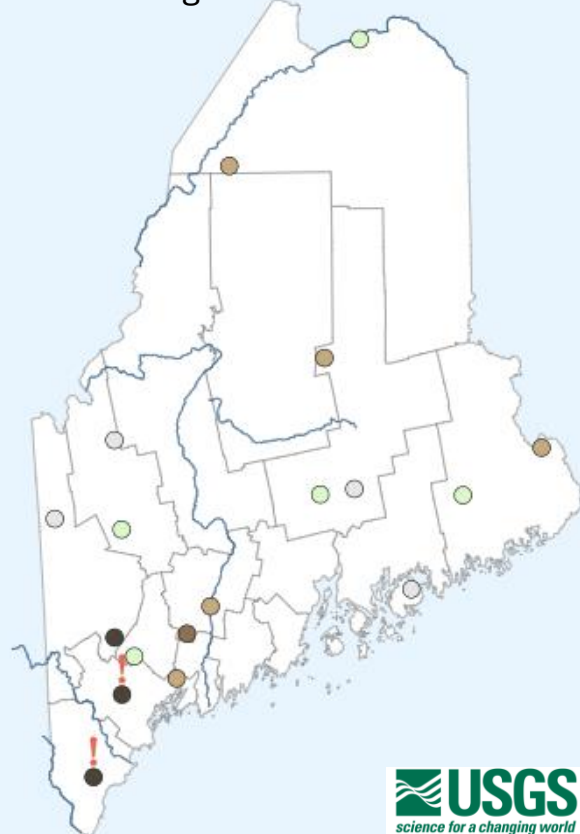
Current Drought Conditions

- Spring snowmelt and rain have improved the drought conditions.

Statewide streamflow conditions

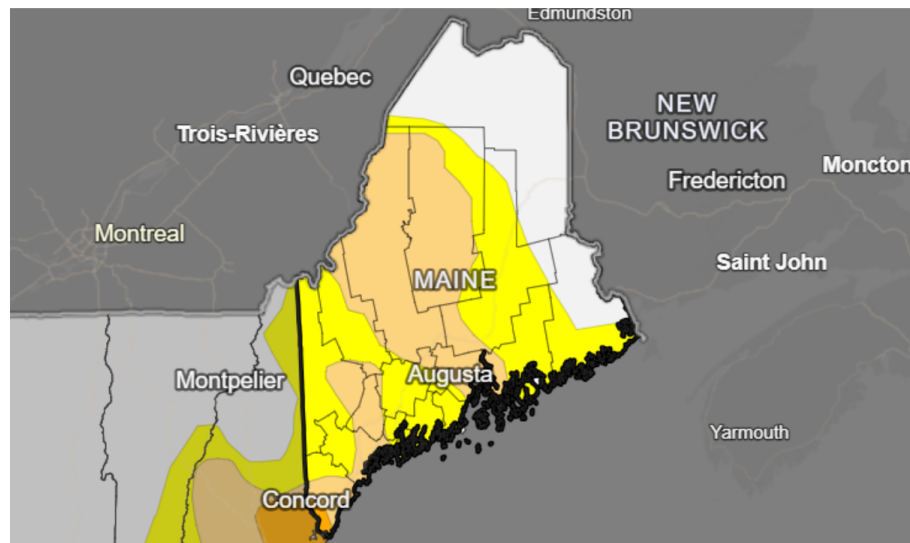


Statewide groundwater conditions



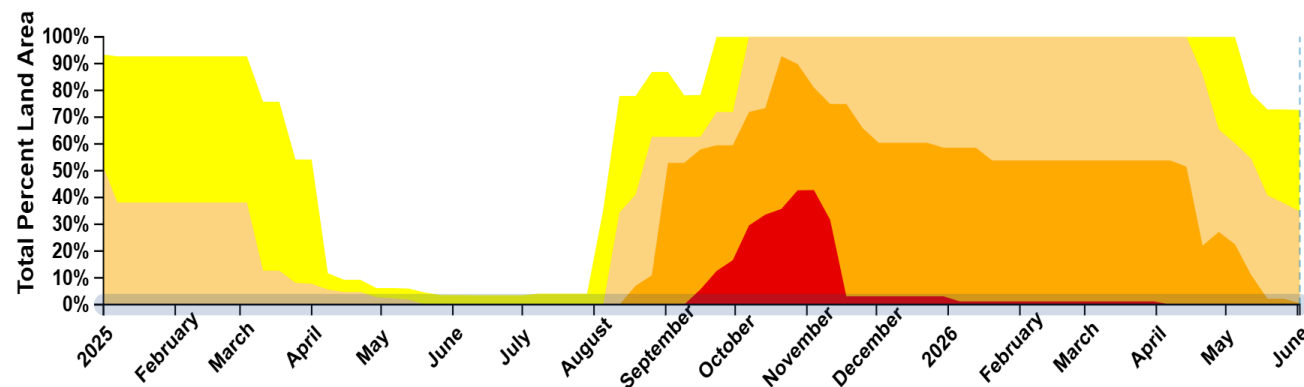
U.S. Drought Monitor

June 02, 2026



USDM values for Maine

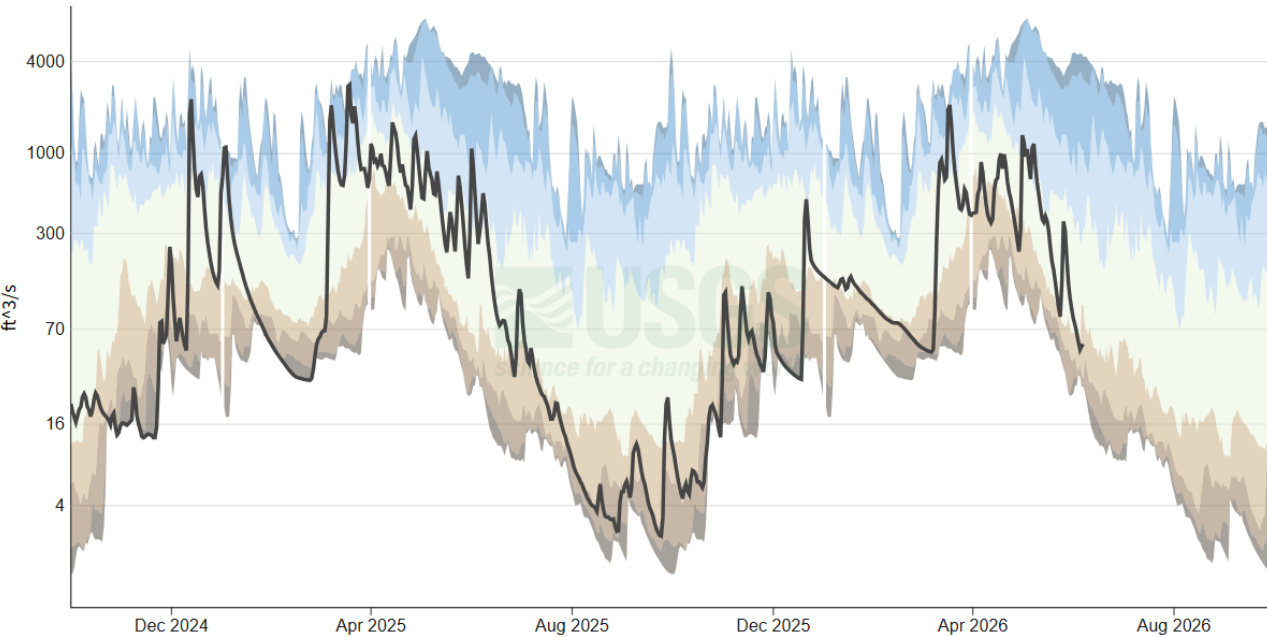
D0	Abnormally Dry	37.9%
D1	Moderate Drought	34.3%
D2	Severe Drought	0.5%
D3	Extreme Drought	0.0%
D4	Exceptional Drought	0.00%
Total Area in Drought		34.80%



2024-2026 Streamflow Conditions

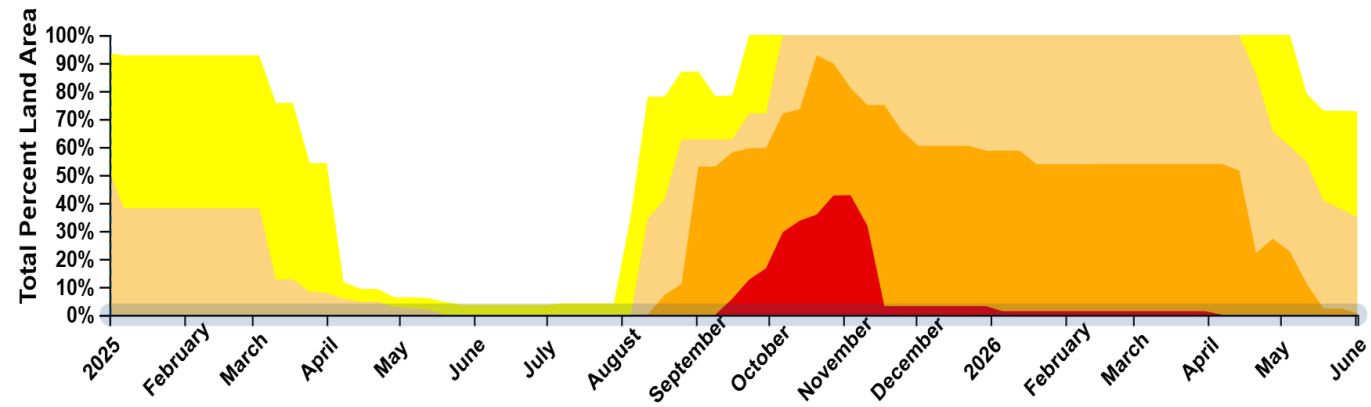
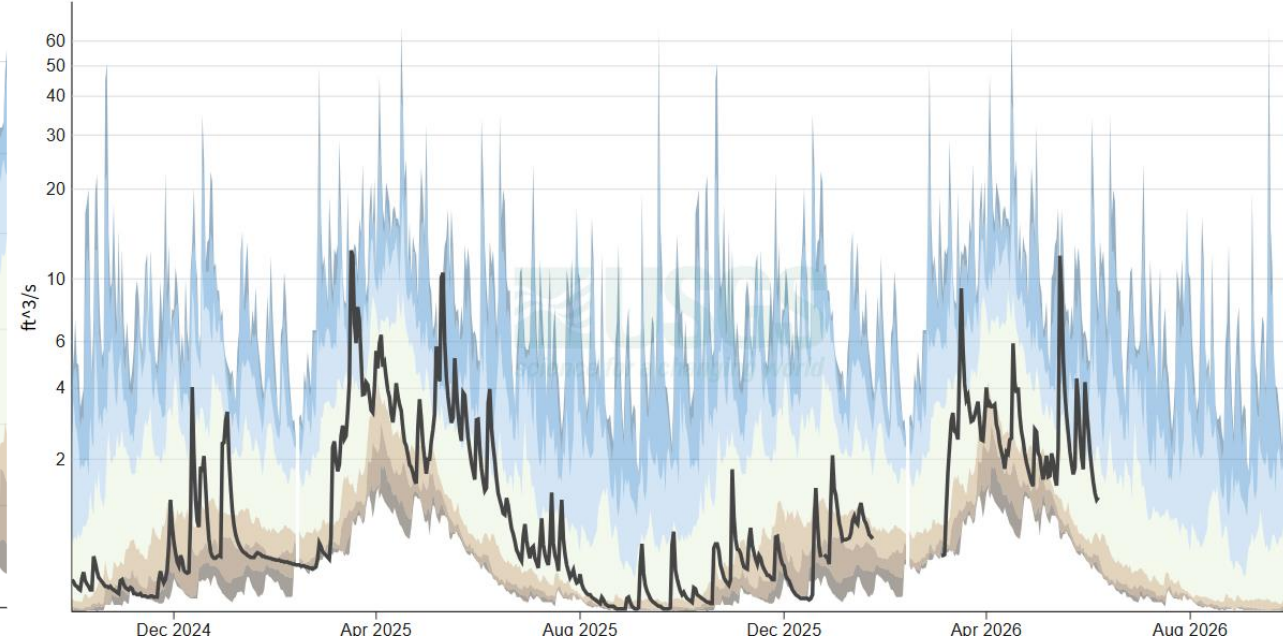
Kenduskeag Stream near Bangor, Maine - USGS-01037000

October 1, 2024 - September 30, 2026
Discharge, cubic feet per second



Stony Brook at East Sebago, Maine - USGS-01063310

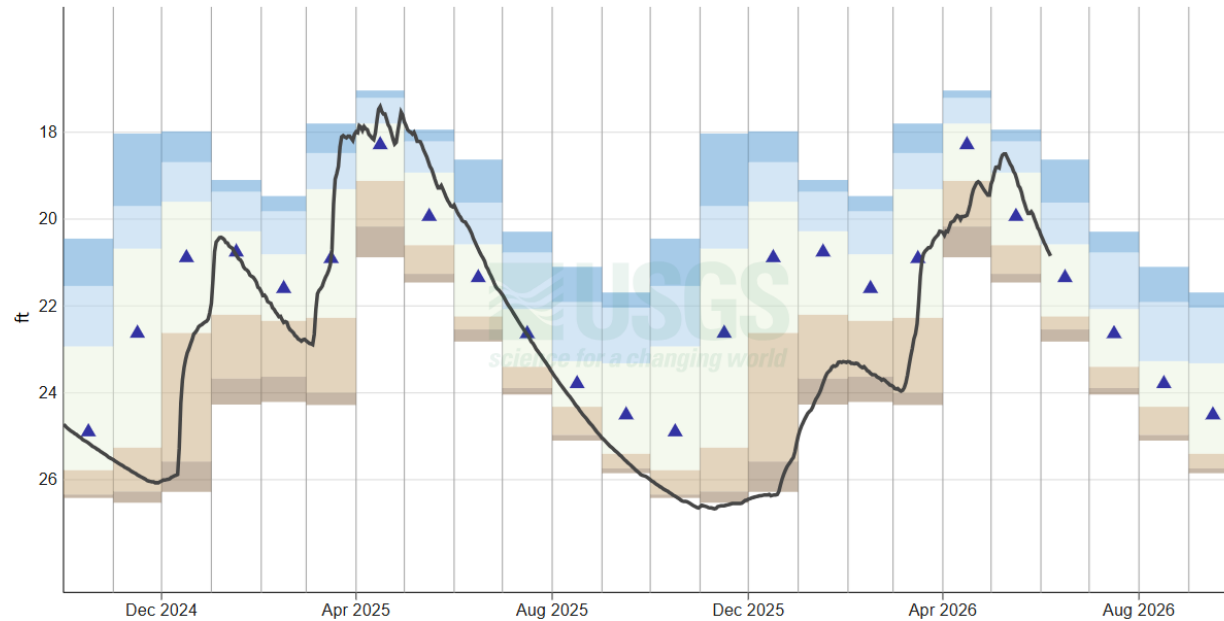
October 1, 2024 - September 30, 2026
Discharge, cubic feet per second



2024-2026 Groundwater Conditions

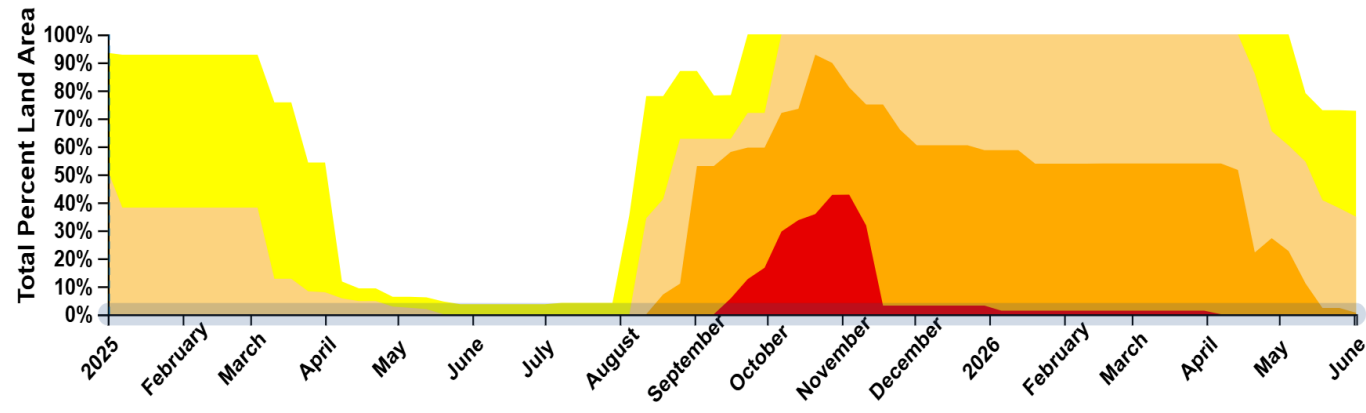
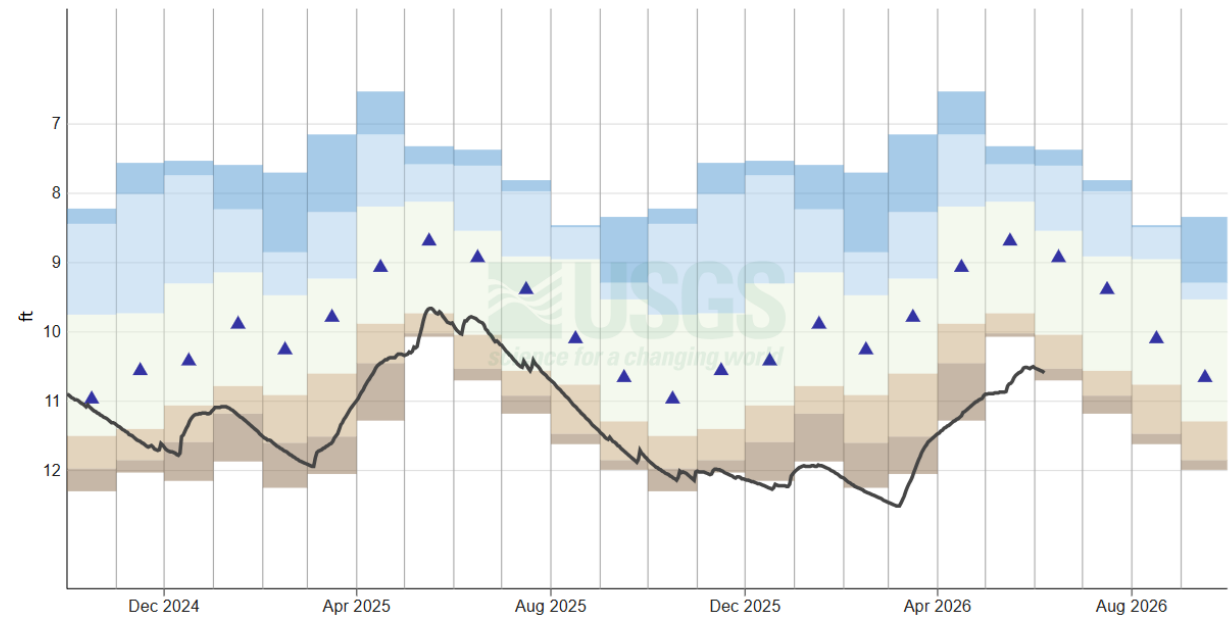
ME-PEW456 Kenduskeag, Maine - USGS-445319068560101

October 1, 2024 - September 30, 2026
Depth to water level, feet below land surface



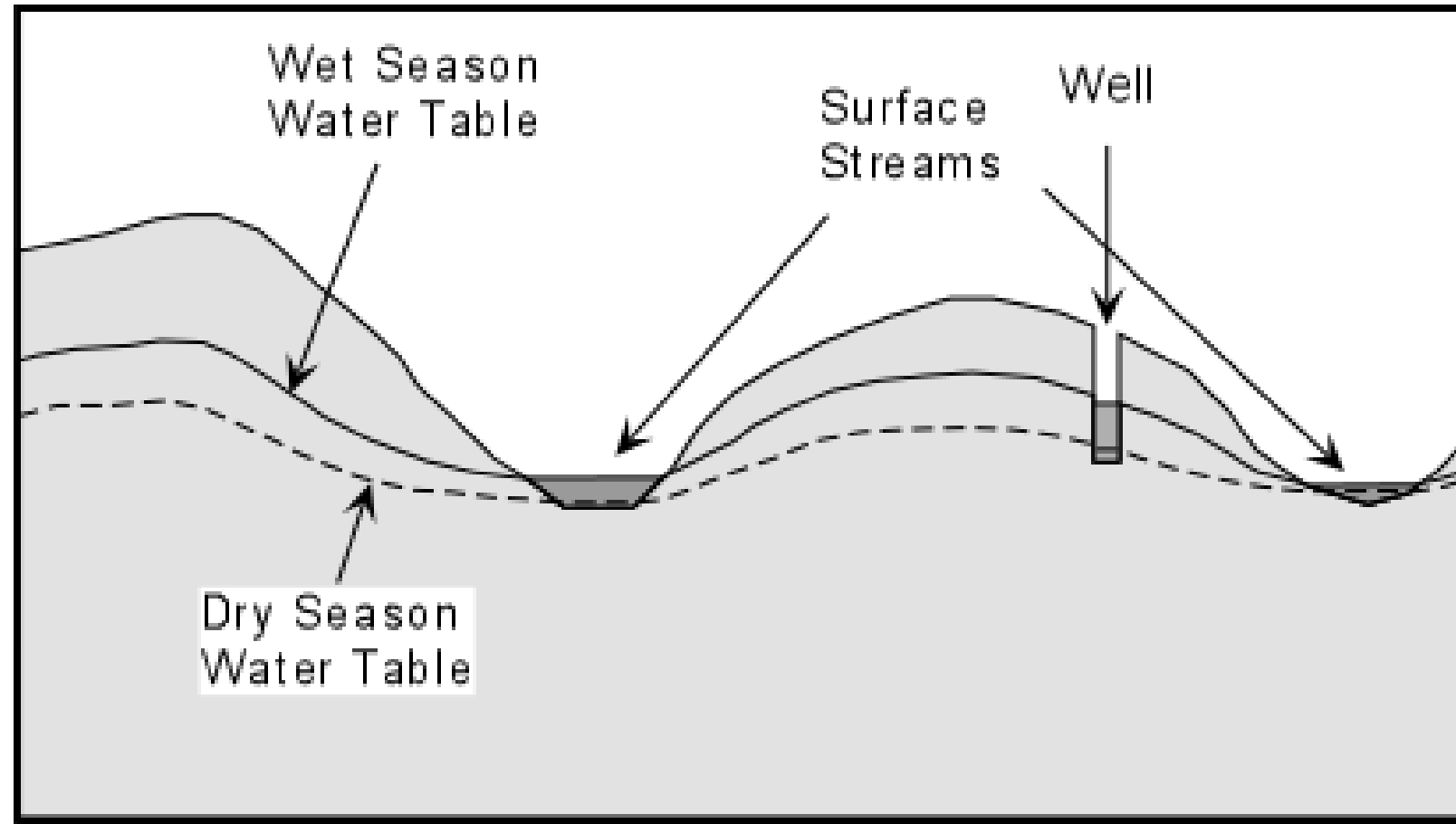
ME-CW 2026 North Windham, Maine - USGS-434955070261401

October 1, 2024 - September 30, 2026
Depth to water level, feet below land surface



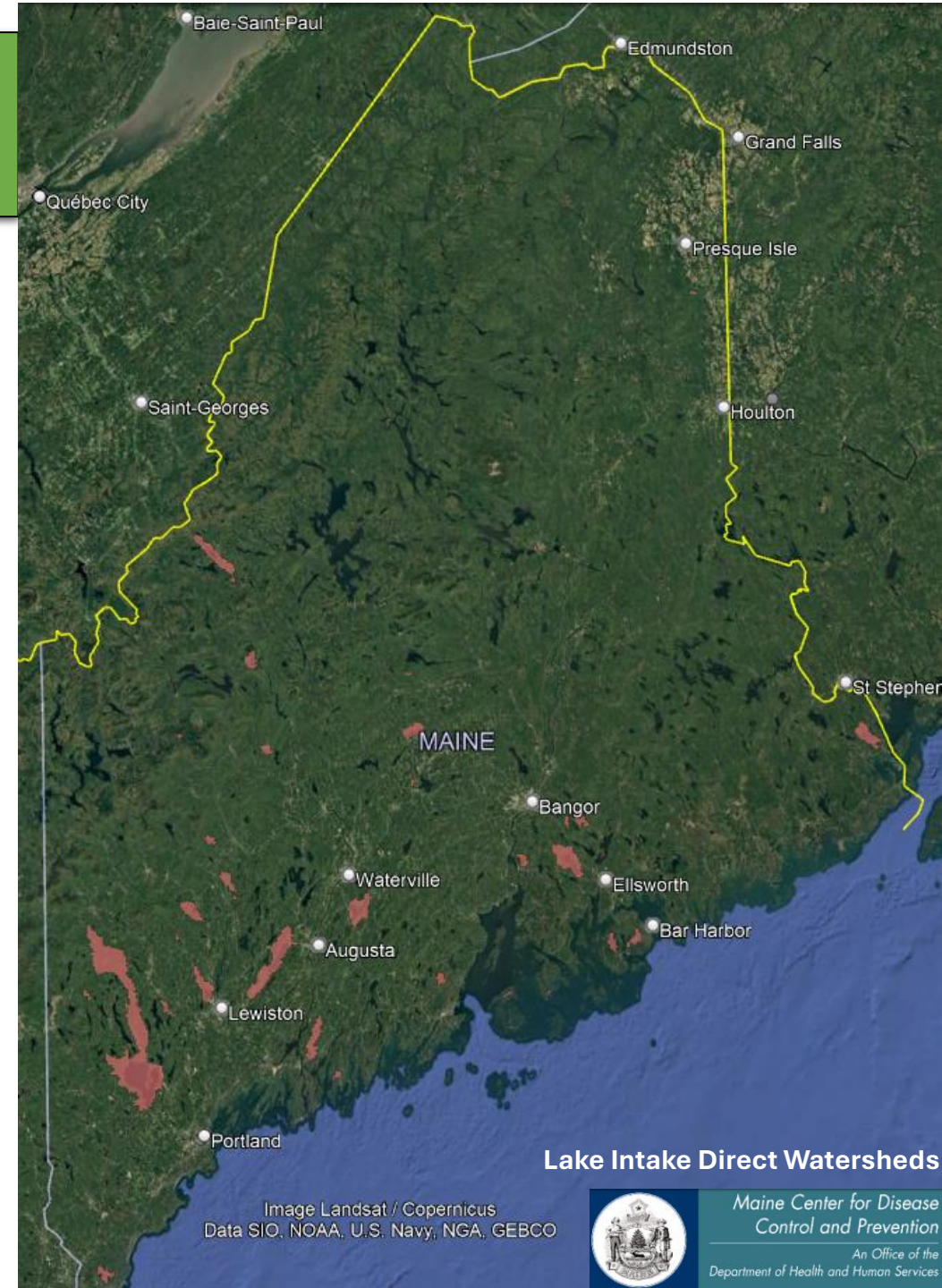
Drought Impacts on Lakes – Water Volume

- Inflow decreases, lake levels lower, outflow decreases
- Residence time increases
- Shallower lakes more subject to internal mixing
- Minimum stream levels needed to support aquatic habitat and hydraulic connectivity



Lake Water Withdrawals

- Of 59 surface water systems, 47 source from lakes
- Statewide public water utility usage is ~31 BG annually, with ~23BG from surface water systems
- Domestic supply accounts for 12.7 BG, estimating 9.5 BG from surface bodies.
- In drought, human withdrawals maintain or even increase.
- PUC and DEP regulate and monitor withdrawals, with cooperation from water districts. Does this remove all burden from end-user?



Lake Intake Direct Watersheds

Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO



Maine Center for Disease
Control and Prevention

An Office of the
Department of Health and Human Services

Drought Impacts on Lake Water Quality

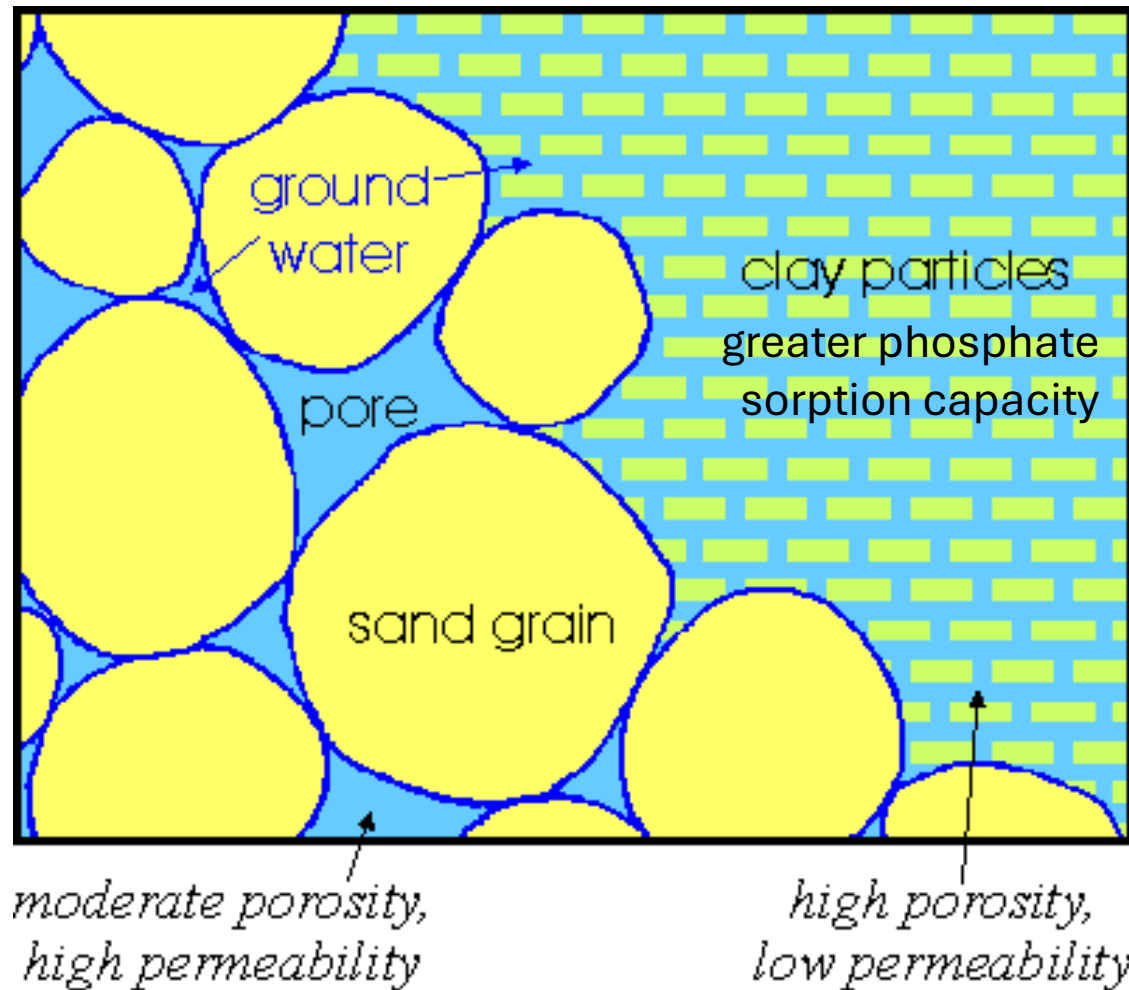
Impacts vary with specific lake, watershed, and drought characteristics. In general:

- Increased salinity from reduced dilution
- Increased water temperature from increased RT and air T
- Increased algal production and reduced DO
- Increased turbidity from reduced flushing, increased production, and resuspension
 - Reduced turbidity and nutrients in rivers/streams
 - In some cases, turbidity rise reduced sun penetration such that inhibited algal blooms

Drought Impacts on Lake Water Quality

- Point-source pollution associated with deteriorated WQ due to reduced dilution
- Non-point-source-pollution
 - Decreased mobilization during dry period
 - Increased mobilization of accumulated pollutants in flushing event after dry period
- Increased erosion in flushing event after dry period
 - Buffer vegetation damaged or killed
 - Less upland vegetation
 - Bare, compacted soils increase runoff ratio

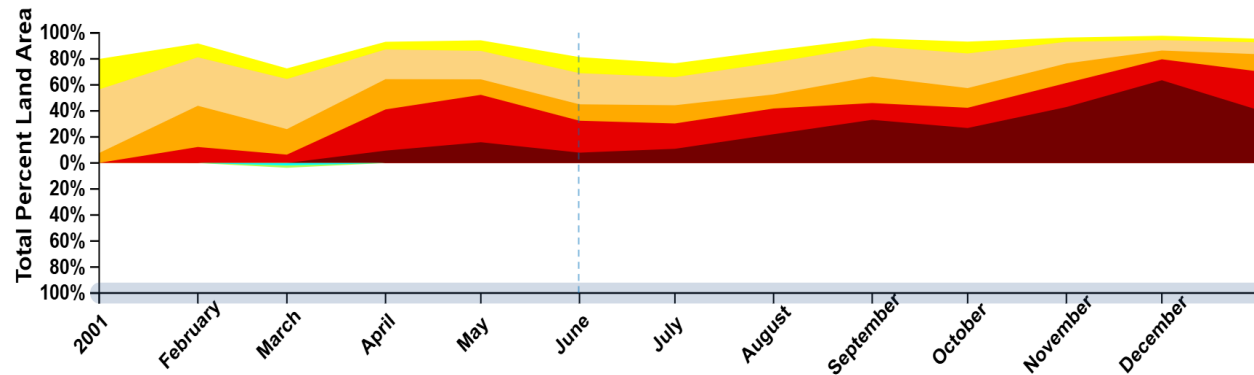
Flushing of Phosphorus from Soils



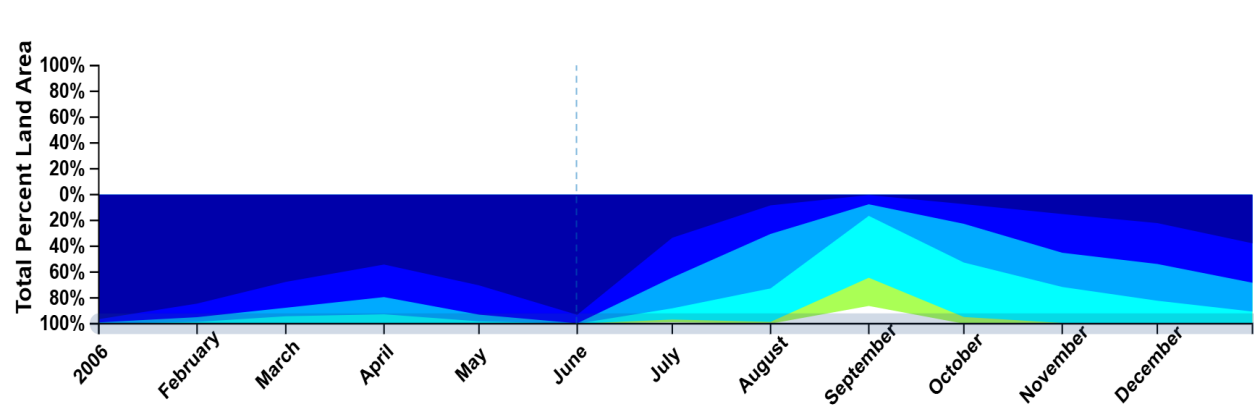
- Phosphorus sorbed onto sediment grains as well as dissolved in groundwater
- Drying of soils alters soil mineral crystal structure and reduces capacity for adsorption
- Upon rewetting, a greater amount of P is released compared to soils that did not dry out
- If soil is fully eroded, both dissolved and sorbed P enter surface water

Water Quality Comparison: China Lake

2001 Drought Conditions



2006 Wet Conditions



China Lake	May-Sept 2001	May-Sept 2006
Total Phosphorus (mg/L)	39.4	27.5
Temperature (C)	14.0	15.8
DO (mg/L)	4.4	5.0
pH	7.16	7.00
Conductivity (uS)	82.2	60.2
Alkalinity (mg/L)	16.7	19.8

Data from Lake Stewards of Maine

Questions?

