NWS Form E-5 (04-2006) (PRES. BY NWS Instruction 10-924)	U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NATIONAL WEATHER SERVICE	HYDROLOGIC SERVICE AREA (HSA)
MONTHLY REPORT OF HYDROLOGIC CONDITIONS		**WFO Caribou, Maine**
		REPORT FOR: MONTH YEAR **December 2022**
TO: Hydrologic Information Center, W/OS31 NOAA's National Weather Service 1325 East West Highway Silver Spring, MD 20910-3283		SIGNATURE **James Sinko - Meteorologist** **Hydrology Program Manager**
		DATE **January 14, 2023**

When no flooding occurs, include miscellaneous river conditions below the small box, such as significant rises, record low stages, ice conditions, snow cover, droughts, and hydrologic products issued (NWS Instruction 10-924).

☐ An X inside this box indicates that no flooding occurred within this hydrologic service area.

December 2022

December 2022 was much warmer than average across the area compared to the 1991-2020 climate normals. This was a result of the monthly average of the North Atlantic Oscillation (NAO) pattern monthly mean of -0.15 standard deviation, while the Pacific North American (PNA) pattern at -0.66 standard deviation. This typically results in higher 500mb heights over the Eastern United States and typically zonal flow. This is depicted below in the reanalysis of the monthly anomaly of the 500mb Geopotential Heights and the mean heights. We saw heights were slightly higher on average for the month depicted in the anomalies. Overall the Jet Stream was mostly zonal with a few arctic air intrusions taking place but wasn't enough to skew the overall well above normal temperatures.

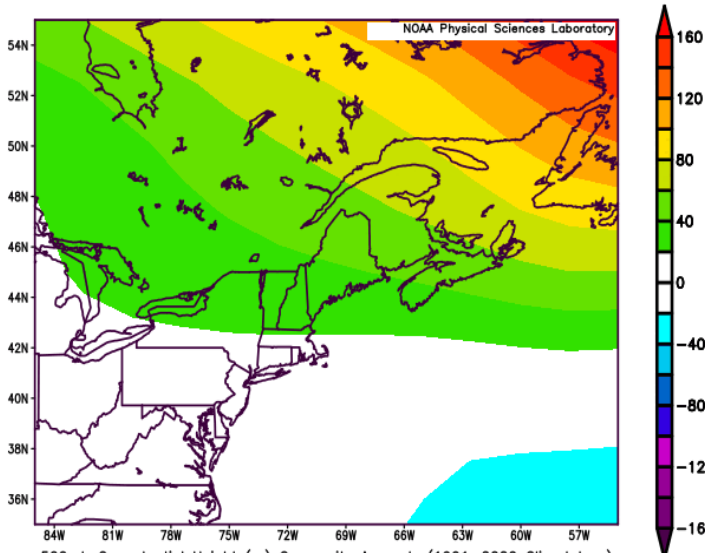


Figure 1: 500mb Geopotential Height (m) Anomalies *(1991-2020 Climo)* December 2022

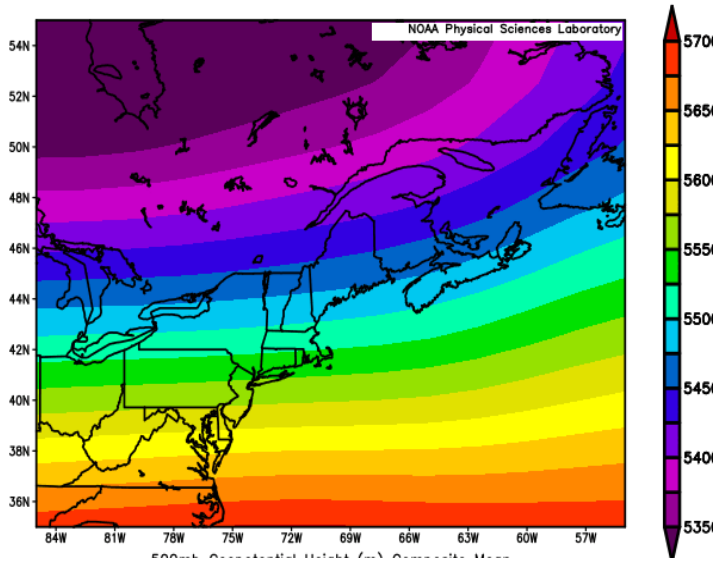


Figure 2: 500mb Geopotential Height (m) Composite Mean December 2022

Source: NOAA Physical Sciences Laboratory

Temperatures across the region as a whole averaged about 5.0 to 6.5 degrees above the 1991-2020 climate normals. Caribou monthly average temperature for December 2022 was 26.4F which was 3rd warmest on record with records dating back to 1939. In Houlton, the average temperature was 27.5F which was also 3rd warmest on record with their records dating back to 1948. Millinocket, featured an average monthly temperature of 28.5F which was the 4th warmest on record with records dating back to 1902. Lastly, Bangor's December 2022 average monthly temperature was 30.9F which was also 4th warmest on record with records dating back to 1925. Repeated warm spells was the overall theme of the month broken only by relatively short periods of near to somewhat below average temperatures. No extremely warm days occurred, but Northern locations had some days where high temps reached into the 40s with Central and Downeast locations occasionally reaching highs into the lower to mid 50s, including record high temps on the last two days of the month. There were few arctic air masses that entered the region with little zero and sub-zero low temperatures this month. In fact, the low monthly temperature of zero at Caribou recorded on the 28th was the 4th latest first zero occurrence there.

Town/City	*Avg Monthly Temperature (°F)*	*Normal Monthly Temperature (°F)*	*Departure from Normal (°F)*
Frenchville	25.0	19.3	+5.7
Fort Kent	23.0	17.0	+6.0
Caribou	26.3	19.9	+6.4
Houlton	27.5	20.9	+6.6
Millinocket	28.4	23.0	+5.4
Greenville	27.0	21.5	+5.5
Bangor	30.9	25.9	+5.0
Robbinston*	31.3	26.9	+4.4
Topsfield*	27.1	23.2	+3.9

**Topsfield Records date back to 2000, *Robbinston Records date back to 1994*

Precipitation for the month ranged from about 95 to 125 percent of average across the region with the majority of it falling as rainfall even across the north. Significant rainfall events on the 3rd and 7th completely liquidated early snowpacks from November over this portion of the region. Another heavy rainfall event on the 23rd resulted in minor flooding over southwest portions of the event falling after and melting much of the heavy snowfall less than a week prior. **Snowfall** across the region was relatively light, only 50 to 75 percent of average due to few storm systems this month taking a favorable track for snowfall. By far and away, the most important and long duration event began late on the 16th over the southwest and finished late on the 19th over the northeast. Inland from the coast over the south and west, this event featured heavy snow banding resulting in snow totals upwards to 20 inches over some central and western locations and ended on the 18th. Coastal Downeast locations had much reduced snowfall due to mixing or even periods of all rain during this event. Over the northeast, the event began on the afternoon of the 17th and continued into the evening of the 19th with light steady snowfall that still managed to accumulate over a foot at most locations. Blocking over northeast Canada, which was slowly breaking down, was the reason for the slow northeast progression of this storm. **Snow depth** was mostly below average for the month as a whole with the average of 1.5 inches at Bangor and 4 inches at Caribou about 35 percent below 1991-2020 average values of 2.5 and 6.5 inches, respectively. Maximum snow depths of 9 inches at Bangor on the 19th and 13 inches at Caribou did not last many days afterwards due to thawing temps and rainfall.

Precipitation Totals for Select Locations with all units in inches

Location	*Total Precip*	*Normal Precip*	*Departure from Normal*	*% of Normal*	*Snowfall*	*Normal Snowfall*	*Departure from Normal*	*Greatest Snow Depth*	*Monthly Average Snow Depth*
Frenchville	2.45	2.27	+0.18	107.9%					
Fort Kent	4.51	3.38	+1.13	133.4%	13.0	22.3	-9.3	12	4.5
Caribou	4.53	3.60	+0.93	125.8%	19.7	25.2	-5.5	13	4.1
Houlton	3.03	3.37	-0.34	89.9%					
Millinocket*	3.19	3.45	-0.26	92.5%	12.5			9	2.3
Greenville	4.59	4.33	+0.26	106%					
Bangor	4.09	3.72	+0.37	109.9%	10.3	14.7	-4.4	9	1.4
Robbinston*	6.29	6.27	+0.02	100.3%	7.2	19.3	-12.1	3	0.7
Topsfield*	7.45	5.20	+2.25	143.3%	18.9	24.3	-5.4	16	4.5

**Millinocket snowfall measured at CoOp site, not the ASOS site. Departure data is not available.*
**Topsfield Records date back to 2000, *Robbinston Records date back to 1994*

Streamflows coming out of the month of November 2022 were running in several locations above normal in the Aroostook, Penobscot and Piscataquis river basins. Across the Headwaters of the St. John we began to see ice impacts on the river gage data but the rivers were running Much Below Normal with lack of precipitation in these locations. In addition the St. Croix basin was running Much Below Normal for the beginning of December. Streamflows began to increase across the area in response to melting snowpack and several rainfall events across the area. Several days later in the month featured record daily discharge readings for numerous USGS gages across the entire area. The monthly averages ended up being nearly all above the 90th percentile which is Much Above Normal discharge. On the Allagash River at Allagash it was reported to be a monthly record discharge in the 90 years of record for this point. The eastern St. John River flows ended the month generally Above Normal in the 76-90th percentile with the Fish River generally at Normal flows. We saw significant improvement in the St. Croix basin as rivers turned to Normal and some sites reported Above Normal. As flow became significantly high we began to see ice jams on the Penobscot and Aroostook River. See the ice section below for more details.

Pic 1: Penobscot River, Howland, ME *(Courtesy: Penobscot Co EMA)*

Pic 2: Water Rescue, Howland, ME *(Courtesy: Penobscot Co Sheriff's Office)*

Pic 3: Merrill Brook Flooding, Howland, ME *(Courtesy: Penobscot Co EMA)*

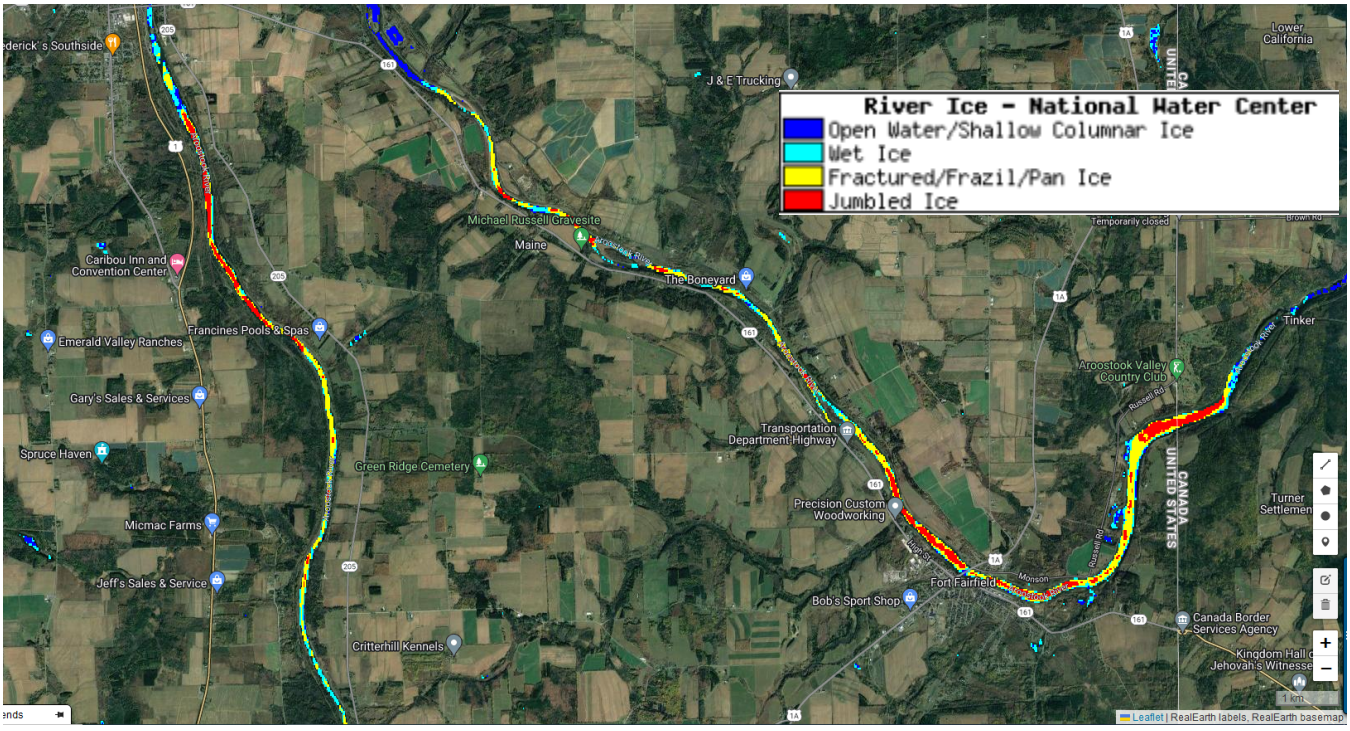
Pic 4: Gardner Ln Flooding, Howland, ME *(Courtesy: Penobscot Co EMA)*

Ice: Started the month with frazil ice on much of the northern & central rivers across the area. We saw significant development of frazil to form thicker into pancake and sheet ice across the area mainly on the St. John & Aroostook Rivers but did see development on the Mattawamkeag along with sections of the Penobscot River. This ice developed into thicknesses varying from 4-6" with isolated thicknesses up to 10" especially on the Aroostook River between Caribou & Tinker Dam in New Brunswick. Several thermal and mechanical breakups took place resulting in significant movement of ice across the area. An Ice Jam developed with significant hummocked ice on the Penobscot River on December 27th that was located above the Howland Dam stretching back 2-3 miles upstream. This hummocked ice (Pic 1) resulted in flow constriction on the top of the water flow that caused backwater issues. We had significant runoff on the Merril Brook but due to the ice caused it to leave its banks (Pic 3). This caused flooding of Gardner Lane cutting off 10 residents on a residential island between the Penobscot and Merrill Brook (Pic 4). By December 29th the water began to rise and threaten Mattamiscontis Road north of Howland heading towards Chester in the area of Gordon Brook as backwater issues developed. On the morning of December 30th a resident in a pickup truck attempted to cross the flooded Gardner Lane bridge (Pic 2) but was overtaken by the floodwaters and required a water rescue from Howland Fire Department. Thankfully, no one was harmed due to the floodwaters… Several days a few residents were unable to return home and the flooding continued into the night of December 31st.

A significant Ice Jam was developing along the Aroostook River at the end of the month due to significant hummocked ice that extended from Tinker Dam in New Brunswick upstream approximately 10-12 river miles to the confluence of the Little Madawaska River in Caribou. This hummocked ice was the result of 2 mechanical breakups during the month that added deeper jumbled ice to the river that combined with well above normal flow was causing water to rise upstream.

Pic 5: Aroostook River, Fort Fairfield, ME *(Courtesy: James Sinko)*

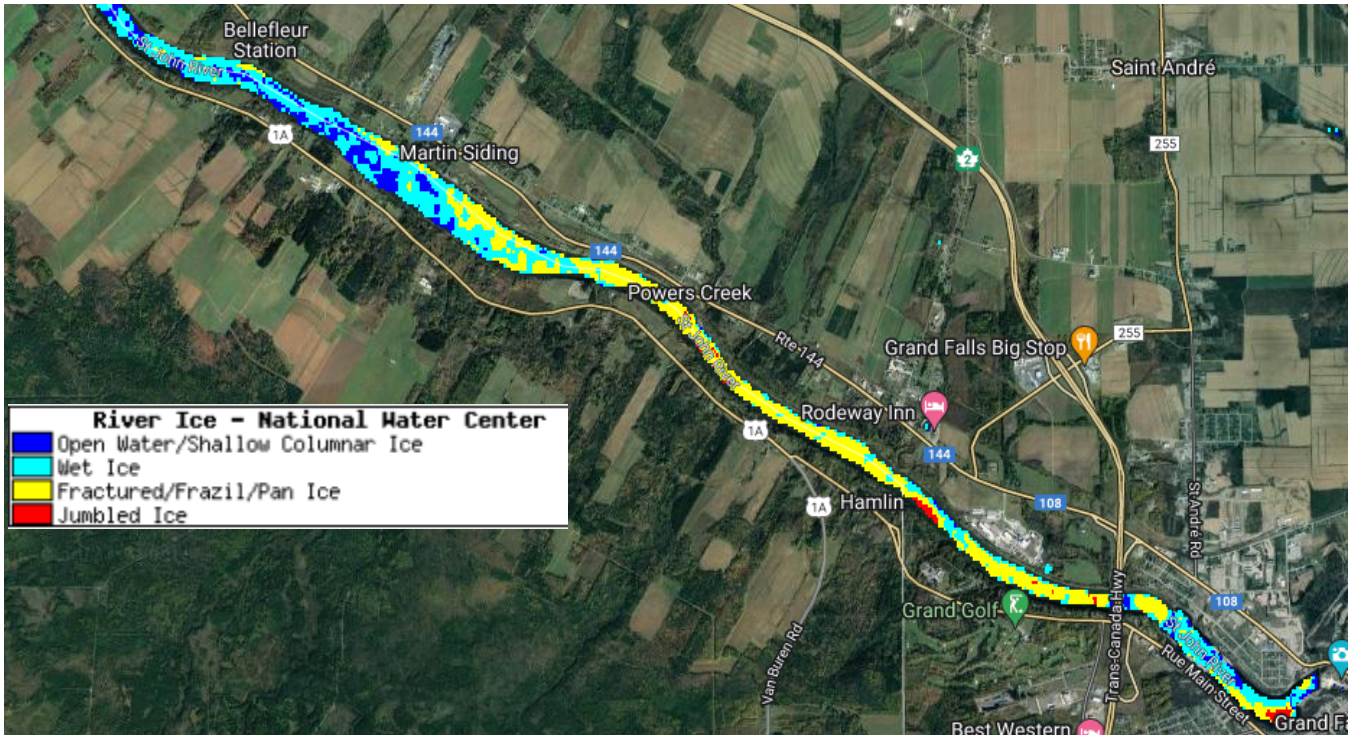
Pic 6: Aroostook River, Fort Fairfield, ME *(Courtesy: James Sinko)*



Pic 7: SARRIS December 29th Analysis of Aroostook River from Sentinel-1 Satellite

Lastly, another Jam developed by late December due to significant hummocked ice conditions between Hamlin and stretched a couple miles upstream along the New Brunswick border. A Hamlin resident

reported via social media that ice was hummocked and was jamming up. This was confirmed by the December 29th SARRIS image as seen below.



Pic 8: SARRIS December 29th Analysis of Aroostook River from Sentinel-1 Satellite

Groundwater: Although the ground had frozen between 1-4" depth by the end of the month we still saw significant rainfall across the area combined with snowmelt adding more water to the ground. In fact for the month of December we saw a record groundwater level for the Calais site which is 23 years of record. The monthly median was -0.46ft which was a departure from the monthly median of -1.30 feet. The USGS gages at Hadley Lakes, Kenduskeag and Millinocket were all Above Normal seeing significant departures from monthly median values. Clayton Lakes reported normal conditions for December while Fort Kent reported Much Above Normal compared to its 45 years of record. Fort Kent saw a monthly median depth of 5.83ft which was a departure from the monthly median of -3.97 feet.

In regards to **Drought** monitoring, the entire month of December featured No Drought conditions.

Read below for specific details & maps of Streamflows, Groundwater Levels, Non-Routine Hydrologic Products issued by WFO Caribou and Drought conditions.

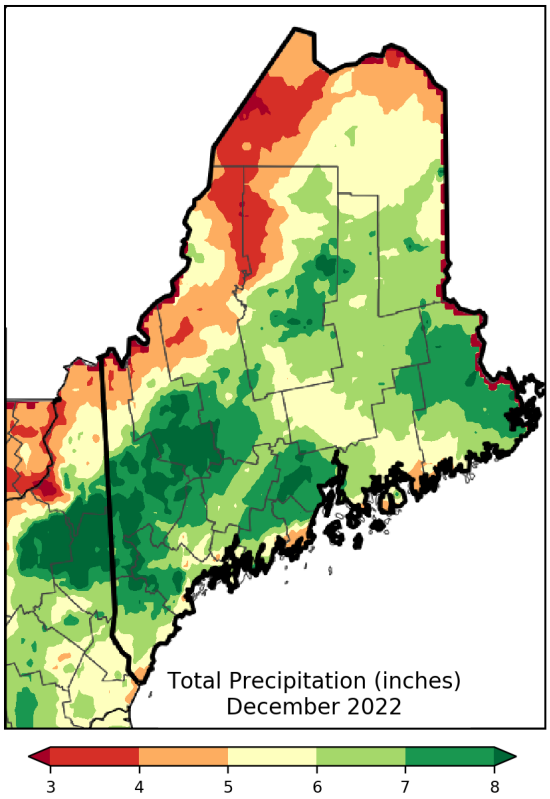


Figure 3: Monthly Precipitation Totals for December 2022

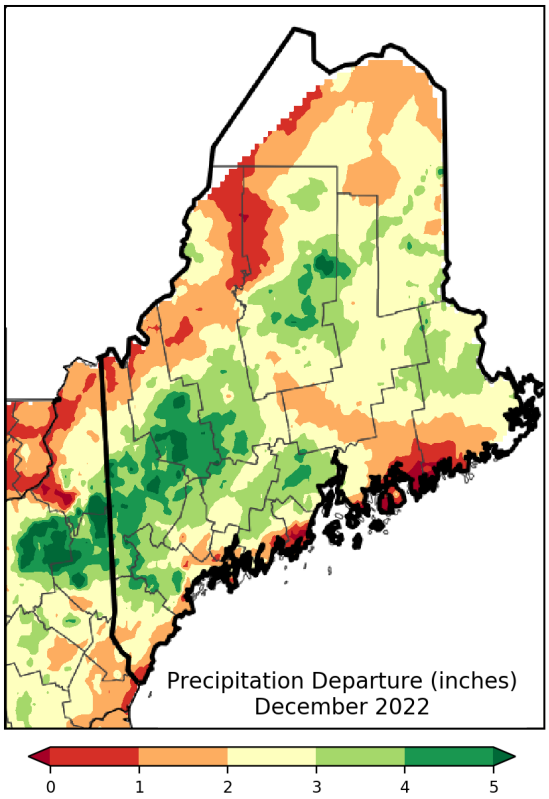


Figure 4: Monthly Precipitation Departures from Normal for December

Source: Northeast Regional Climate Center

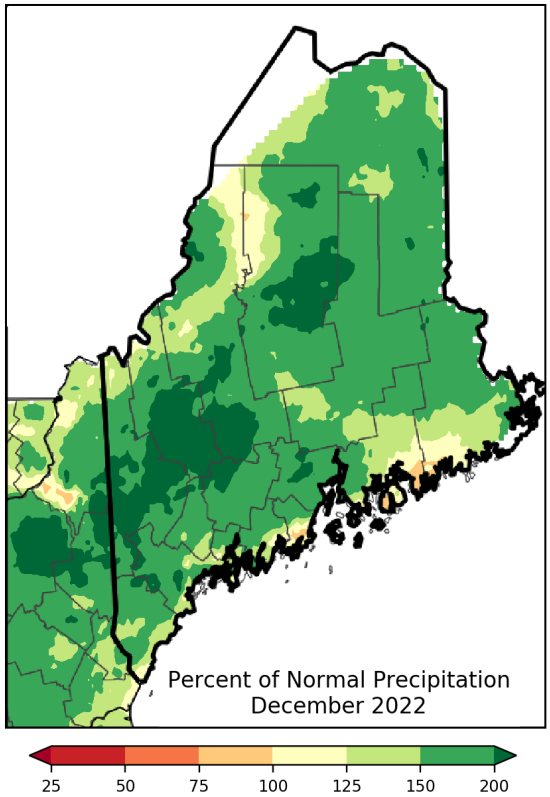


Figure 5: Percent of Normal Precipitation December 2022

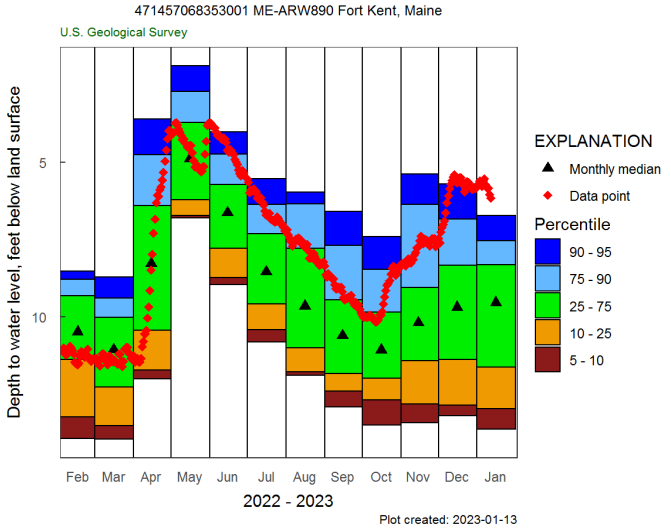
Source: Northeast Regional Climate Center

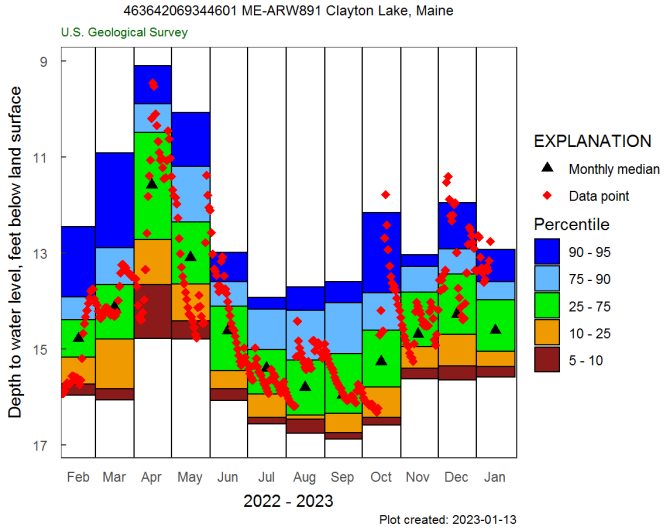
December Streamflows for Rivers

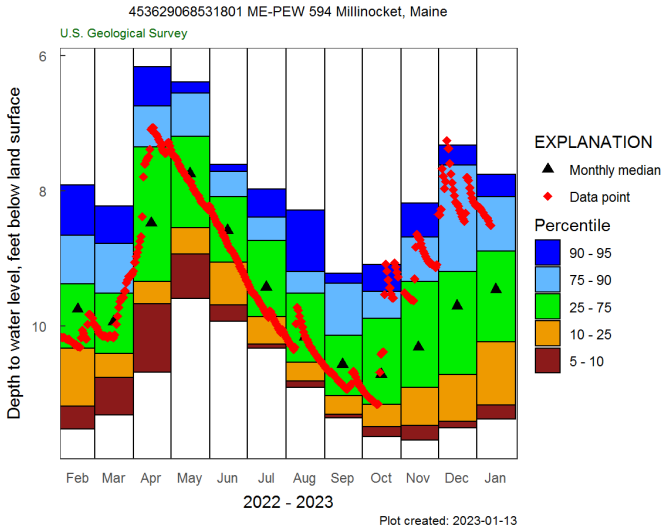
River	Monthly Mean Flow (cfs)	% Normal (mean)	Percentile Class	Drainage (mi^2)	Years of Record
Big Black River near Depot Mtn	1517.20	NA	**Ice Affected**	171	38
St. John River at Nine Mile Bridge	13900.00	N/A	**Ice Affected**	1341	71
Allagash River near Allagash	4673.16	370.47%	High	1478	90
St. John River at Dickey	23466.67	NA	**Ice Affected**	2680	75
St. John River at Fort Kent	7644.11	124.48%	Above Normal	5929	95
Fish River near Fort Kent	1487.25	122.32%	Normal	873	92
Aroostook River near Masardis	4718.46	NA	**Ice Affected**	892	64
Aroostook River at Washburn	6960.91	334.10%	Much Above Normal	1654	91
St. Croix River at Vanceboro	765.39	126.99%	Above Normal	413	94
St. Croix River at Baring	3091.42	103.08%	Normal	1374	63
Grand Lake Stream at Grand Lake Stream	361.22	136.57%	Above Normal	228.3	94
Narraguagus River at Cherryfield	1368.23	197.78%	Much Above Normal	227	73
East Branch Penobscot River at Grindstone	4432.94	261.98%	Much Above Normal	837	100
Mattawamkeag near Mattawamkeag	6114.84	209.60%	Much Above Normal	1418	87
Piscataquis River near Dover-Foxcroft	1562.71	263.31%	Much Above Normal	298	119
Sebec River at Sebec	1460.71	240.79%	Much Above Normal	326	67
Piscataquis River at Medford	5286.15	210.15%	Much Above Normal	1162	90
Penobscot River at West Enfield	27854.84	241.07%	Much Above Normal	6422	119

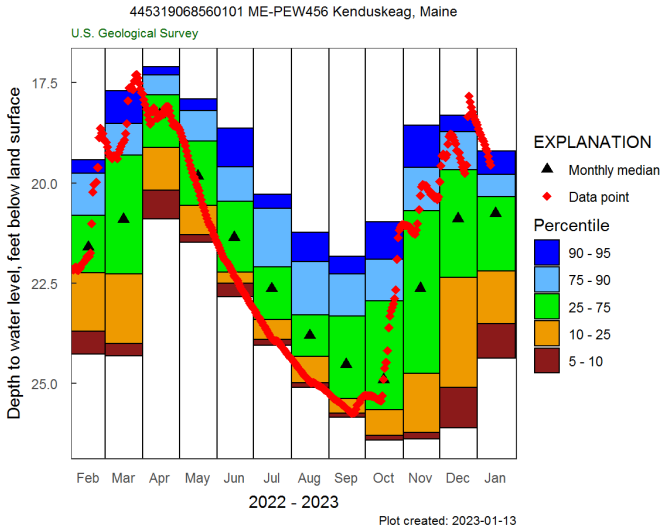
December Groundwater Levels

Station	Percentile Class	Years of Record
Hadley Lakes	Above Normal	37
Kenduskeag	Above Normal	44
Calais	High	23
Millinocket	Above Normal	29
Clayton Lake	Normal	44
Fort Kent	Much Above Normal	45









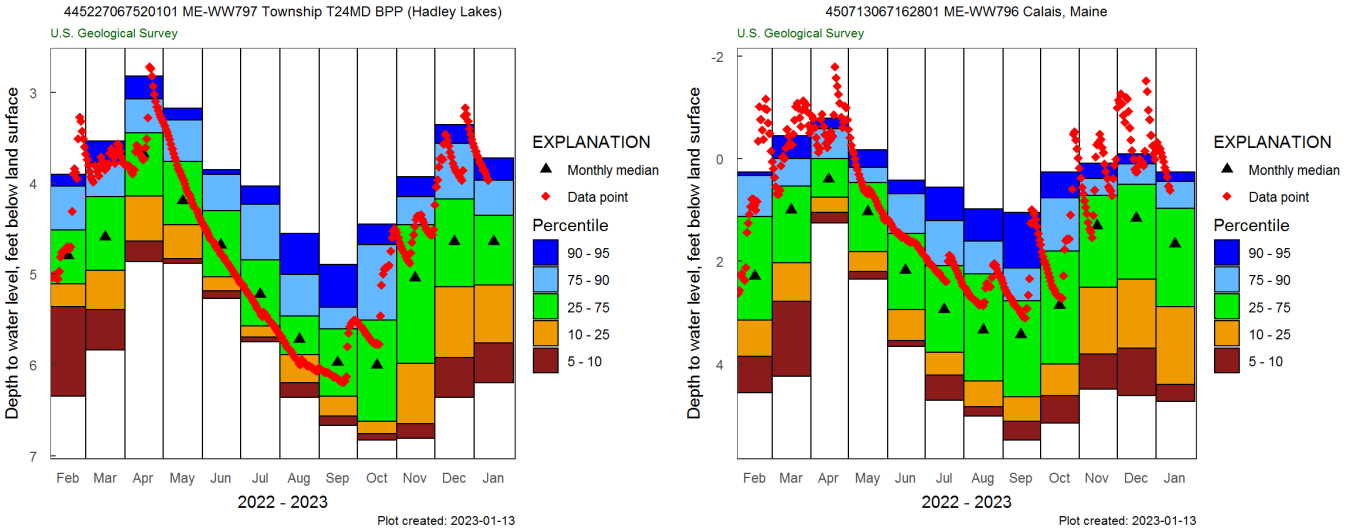


Figure 6-11: Groundwater Level Yearly Plots to Current
Source: United States Geological Survey

Flow or Water Level	Percentile Range	Explanation
Low	0^{th}	The monthly mean streamflow or median water level during this month is the lowest ever recorded during the period of record for this site.
Much below normal	0^{th} to 10^{th}	The monthly mean streamflow or median water level during this month is less than the 10^{th} percentile when compared to all of the months during the period of record for this site.
Below normal	10^{th} to 25^{th}	The monthly mean streamflow or median water level during this month is between the 10^{th} and 25^{th} percentiles when compared to all of the months during the period of record for this site.
Normal	25^{th} to 75^{th}	The monthly mean streamflow or median water level during this month is between the 25^{th} and 75^{th} percentiles when compared to all of the months during the period of record for this site.
Above normal	75^{th} to 90^{th}	The monthly mean streamflow or median water level during this month is between the 75^{th} and 90^{th} percentiles when compared to all of the months during the period of record for this site.
Much above normal	90^{th} to 100^{th}	The monthly mean streamflow or median water level during this month is greater than the 90^{th} percentile when compared to all of the months during the period of record for this site.
High	100^{th}	The monthly mean streamflow or median water level during this month is the highest ever recorded during the period of record for this site.

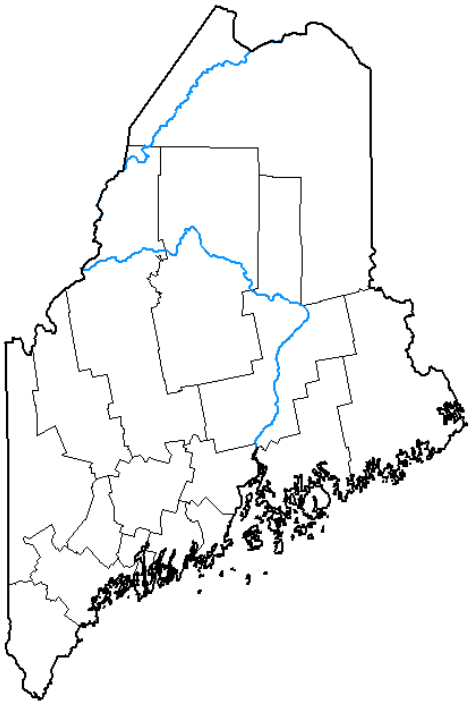
Non-Routine Hydrologic Products
December 2022
WFO Caribou, ME

Product	How Many Issued	Reason for Issuance
Flood Advisory	2	Ice Jam
Flood Advisory	2	Excessive Rainfall
Flood Warning	2	Areal Flooding (Heavy Rain + Snowmelt)
Flood Warning	1	Penobscot River @ Bangor
Flood Watch	1	Heavy Rain + Snowmelt

Drought Conditions for December 2022

U.S. Drought Monitor

Maine



December 6, 2022

(Released Thursday, Dec. 8, 2022)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week *11-29-2022*	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago *09-06-2022*	51.35	48.65	9.15	3.42	0.00	0.00
Start of Calendar Year *01-04-2022*	72.42	27.58	11.82	5.32	0.00	0.00
Start of Water Year *09-27-2022*	88.92	11.08	3.23	0.00	0.00	0.00
One Year Ago *12-07-2021*	72.42	27.58	11.82	5.32	0.00	0.00

Intensity:

- None
- 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. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
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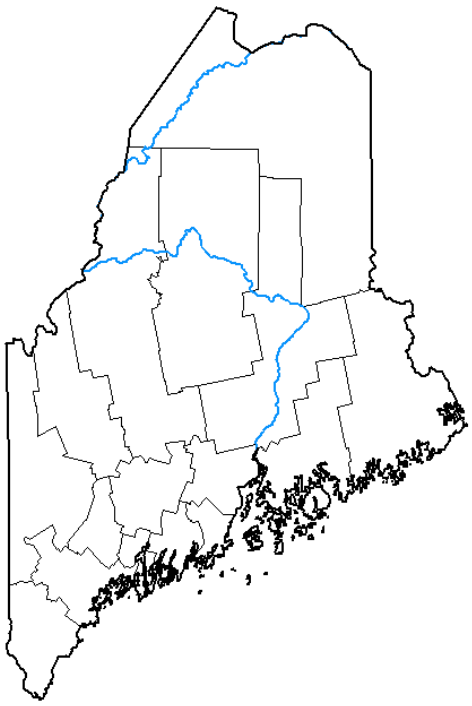
Western Regional Climate Center

droughtmonitor.unl.edu

U.S. Drought Monitor

Maine



December 27, 2022

(Released Thursday, Dec. 29, 2022)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	100.00	0.00	0.00	0.00	0.00	0.00
Last Week 12-20-2022	100.00	0.00	0.00	0.00	0.00	0.00
3 Months Ago 09-27-2022	88.92	11.08	3.23	0.00	0.00	0.00
Start of Calendar Year 01-04-2022	72.42	27.58	11.82	5.32	0.00	0.00
Start of Water Year 09-27-2022	88.92	11.08	3.23	0.00	0.00	0.00
One Year Ago 12-28-2021	72.42	27.58	11.82	5.32	0.00	0.00

Intensity:

- None
- 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. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Richard Heim

NCEI/NOAA

droughtmonitor.unl.edu

Drought Classification (Cumulative Percent Area %)

Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4	DSCI
12/6/2022	100.00	0.00	0.00	0.00	0.00	0.00	0
12/27/2022	100.00	0.00	0.00	0.00	0.00	0.00	0
Change	0.00	0.00	0.00	0.00	0.00	0.00	0

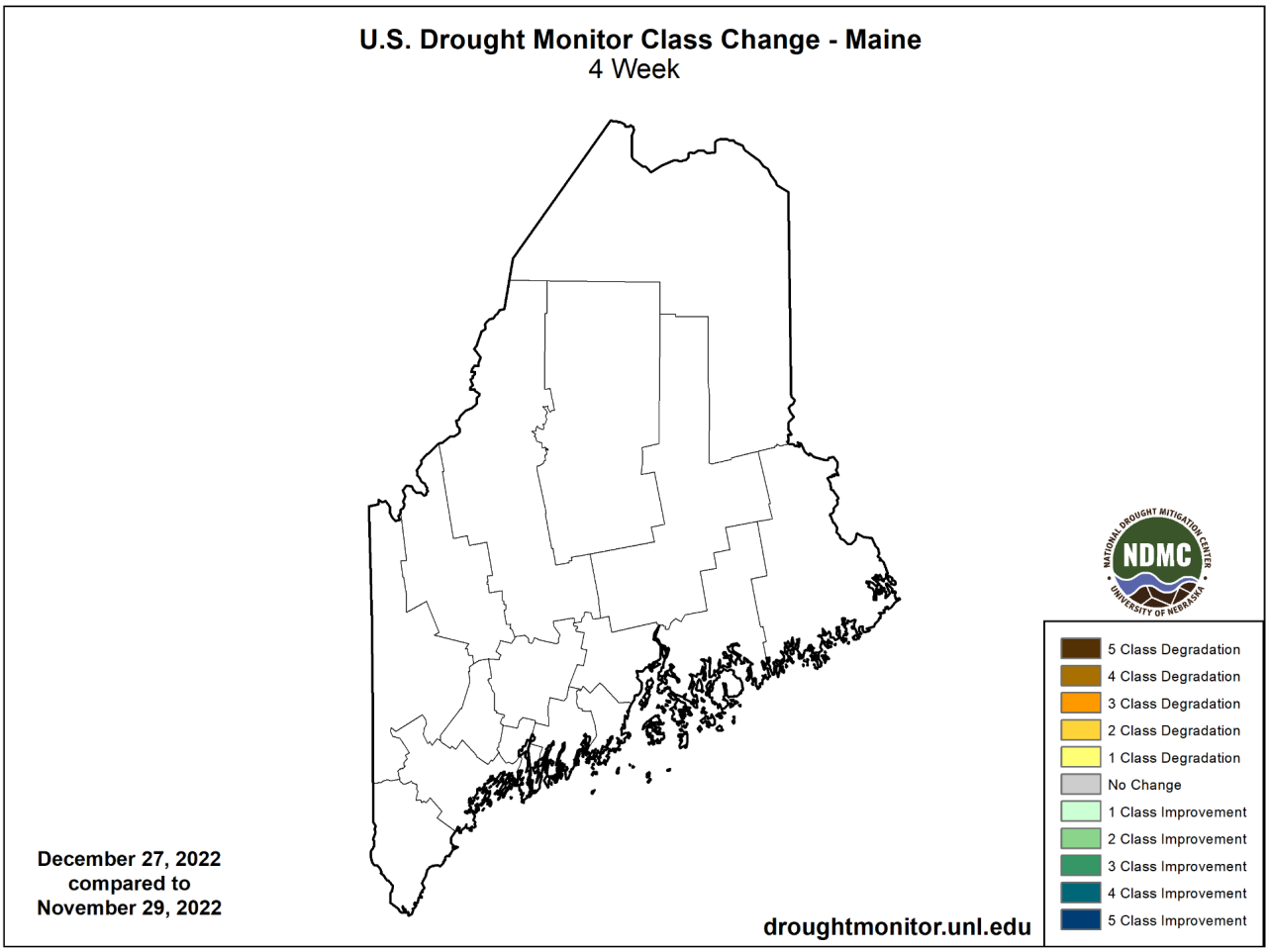


Figure 12-14: U.S. Drought Monitor Drought Classification & Statistics for November
Source: U.S. Drought Monitor