Kaibab National Forest Climate Report: October 2022 - September 2023

Highlights

- The Current Average 12-month (October-September) Standardized Precipitation Index (SPI) for Kaibab National Forest is **1.21** (Moderately Wet).
- Average October-September precipitation was 24.33 inches, which was 5.99 inches different from the long-term average. This value ranks 12th out of 129 years in total precipitation (Rank 1 is the wettest year).
- Average October-September temperature was 48.3 degrees F, which was -1 degrees F different from the long-term average. This value ranks 98th out of 129 years in average temperature (Rank 1 is the warmest year).
- The 1-month outlook for October predicts a 33-40% chance of wetter-than-average precipitation and a 33-40% chance of warmer-than-average temperatures. The 3-month seasonal outlook for October-December predicts equal chances of above, below or normal precipitation and a 33-40% chance of warmer-than-average temperatures. (More information at NOAA Climate Prediction Center, https://www.cpc.ncep.noaa.gov/)

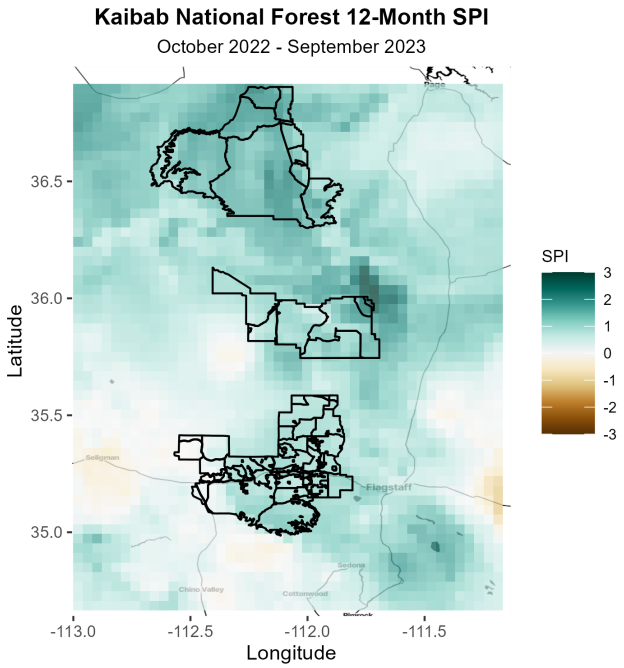

Figure 1: 2023 Water Year SPI Values for the Kaibab National Forest (September 2023 12-Mo. SPI)

Table 1: KNF District-level Climate Metrics

District	Minimum SPI	Mean SPI	Maximum SPI	Total Precip [in.]	Anomaly [in.]
Tusayan	0.38	1.18	2.37	19.85	4.44
Williams	-0.07	0.86	1.39	24.96	4.47
North Kaibab	0.86	1.58	2.22	26.04	8.04

Note:

2023 Water Year (12-month; October - September) SPI and climate statistics for districts within the Kaibab National Forest are calculated based on the average of all PRISM grid cells lying within a district boundary.

Seasonal Drought Index Summaries

The Maps in *Figure 2* depict SPI values at the end of each season for districts in the Kaibab National Forest (KNF). Seasonal definitions for the KNF are as follows: **Winter (Oct - Feb); Spring (Mar - May); Summer (Jun - Sep); Fall (-)**. *Figure 3* shows seasonal drought progression within each district. Seasonal mean SPI values and precipitation totals are shown in *Table 2*. *Figure 4* depicts monthly progression of forest-wide 12-month SPI. Mean values are calculated by averaging all grid cells lying within a district or forest boundary. SPI and precipitation values were acquired via PRISM Gridded Climate Dataset.

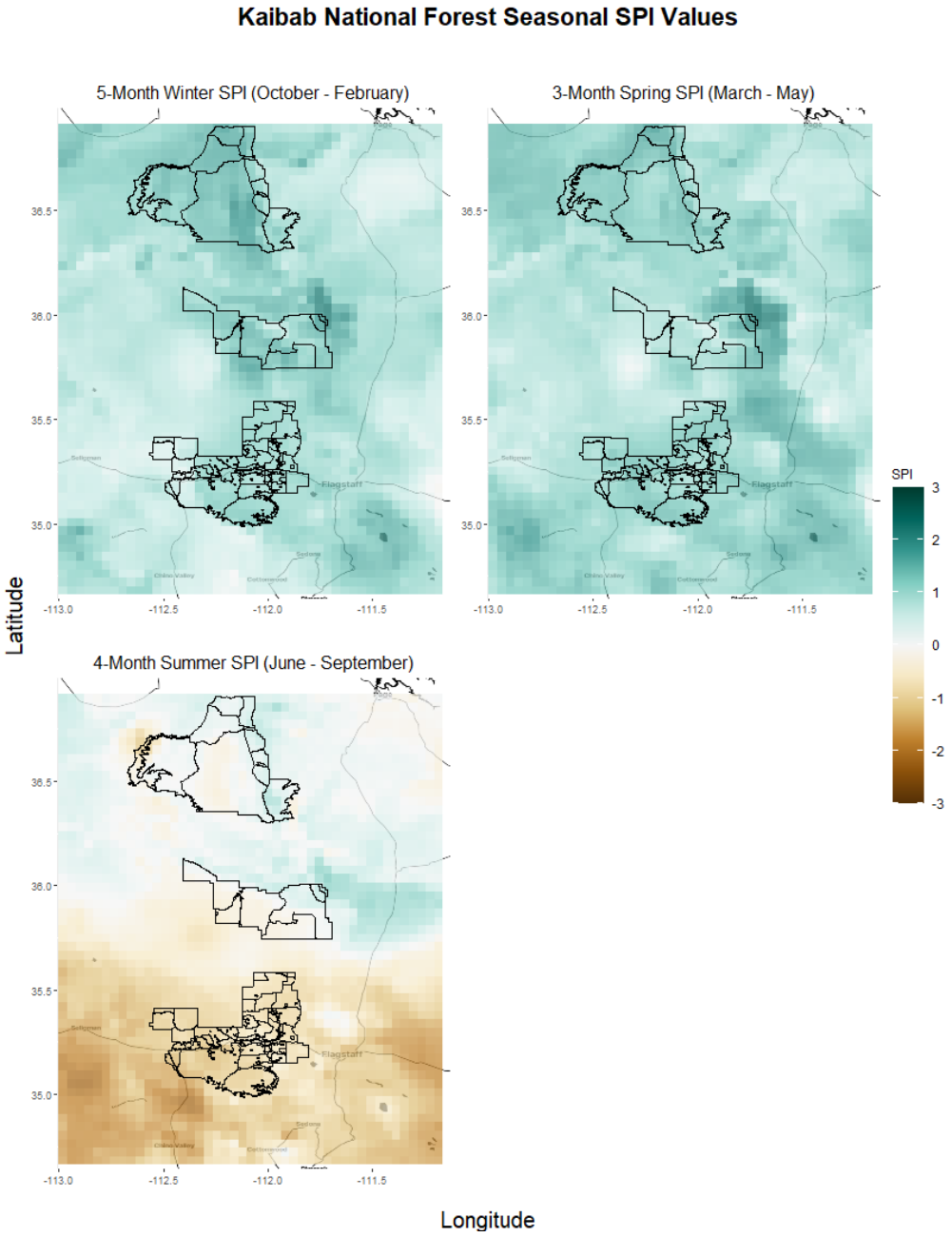

Figure 2: Seasonal SPI Maps for the Kaibab National Forest for the 2023 water year (Oct - Sept)

Seasonal Drought Index Summaries (cont.)

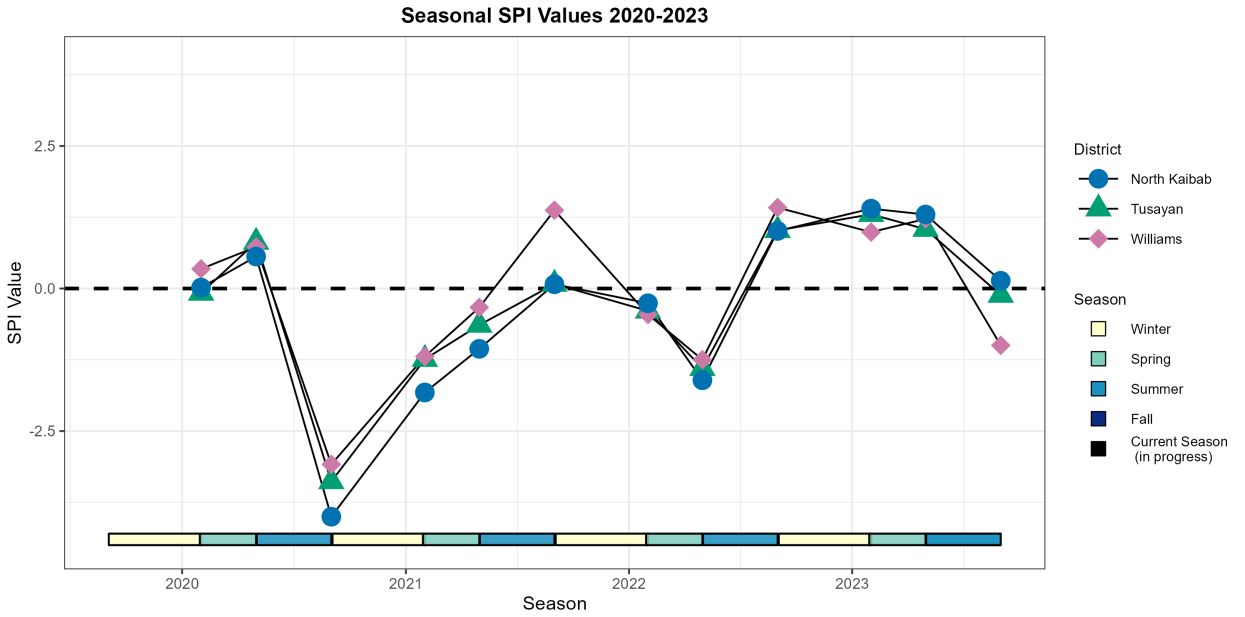

Figure 3: Progression of seasonal SPI values for districts within the Kaibab National Forest (2020-2023).

Table 2: KNF District-level Seasonal Difference Metrics from Previous Year

District	Winter SPI	Spring SPI	Summer SPI	Fall SPI	12-Month SPI	Winter Precip [in.]	Spring Precip [in.]	Summer Precip [in.]	Fall Precip [in.]	12-Month Precip [in.]	Precip Anom [in.]
Tusayan	1.30	1.04	-0.09	NA	1.18	9.30	4.59	5.96	NA	19.85	4.47
Williams	0.99	1.22	-0.94	NA	0.86	12.96	6.65	5.35	NA	24.96	4.5
North Kaibab	1.40	1.30	0.07	NA	1.58	13.21	7.37	5.46	NA	26.04	8.06

Note:

2023 Water year (October - September) and seasonal climate statistics for districts within the Kaibab National Forest. Seasonal SPI values depict the SPI value of the final month within each season, calculated at a timescale of the number of months within that season.

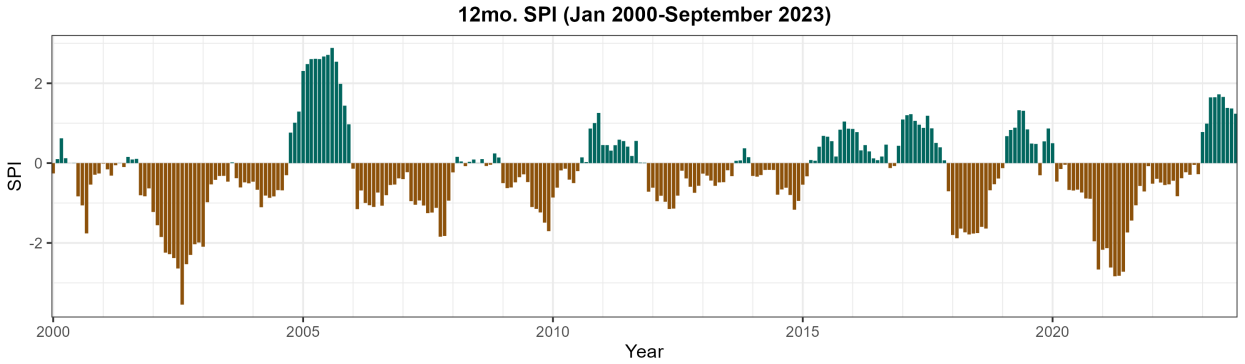

Figure 4: 12mo. SPI for the Kaibab National Forest (2000-2023)

Forage Production Estimates

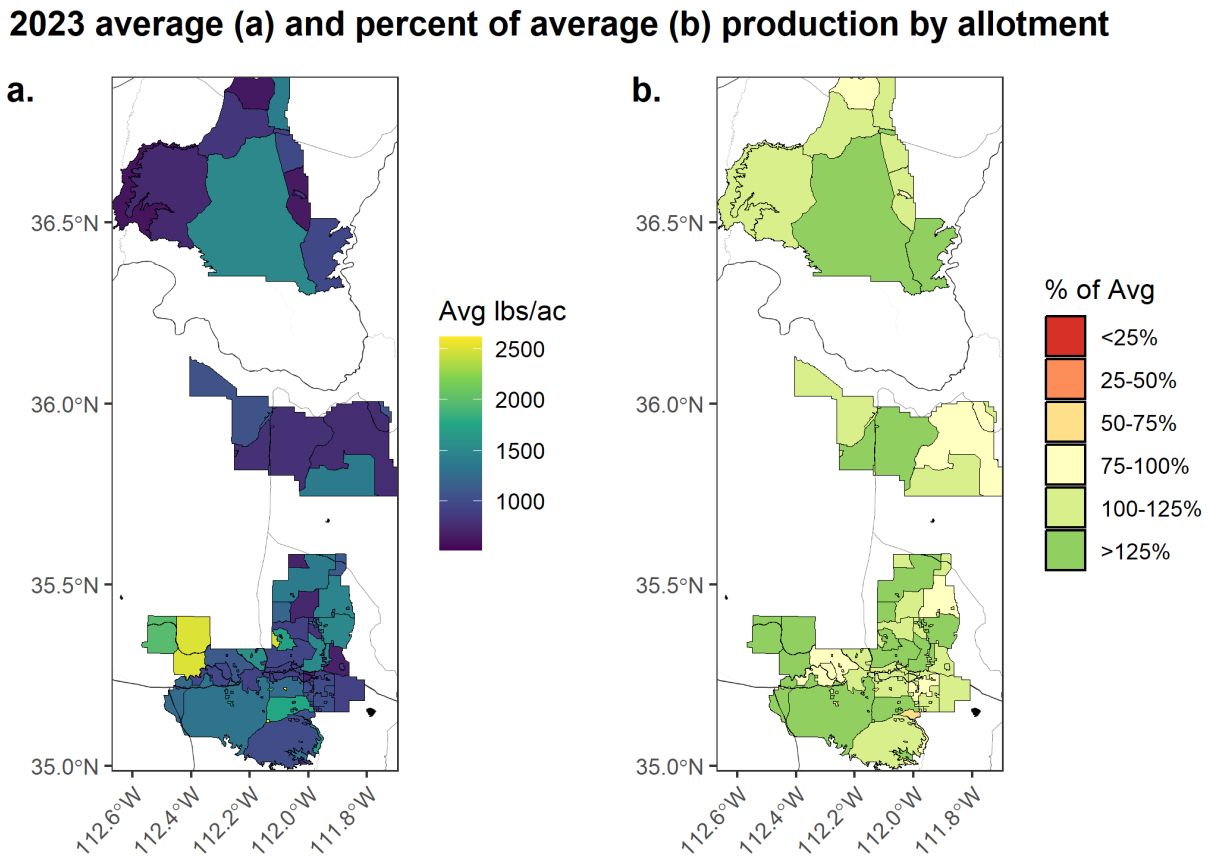

Figure 5: Remote sensing based forage production estimates

The maps above depict the average and percent of long-term average for each allotment. The coverage of production data varies for each allotment with heavily forested areas having limited data. Production estimates are based on remote sensing information and provided by the USFS Rangeland Production Monitoring Service (RPMS, more information on this product can be found at this link: https://www.fs.usda.gov/rmrs/projects/development-rangeland-production-monitoring-service-could-improve-rangeland-management)

Station Climate Summaries

Summaries from climate stations with relatively long periods of record, minimal missing data (<10% of days), and within and near the Kaibab National Forest are presented in the following tables (5 and 6) as reference locations. These stations are a select subset of stations that contribute to the gridded climate maps. Red circles on map indicate locations of NOAA Global Historical Climate Network stations while blue asterisks are USDA-NRCS SNOTEL (Snow Telemetry) station locations.

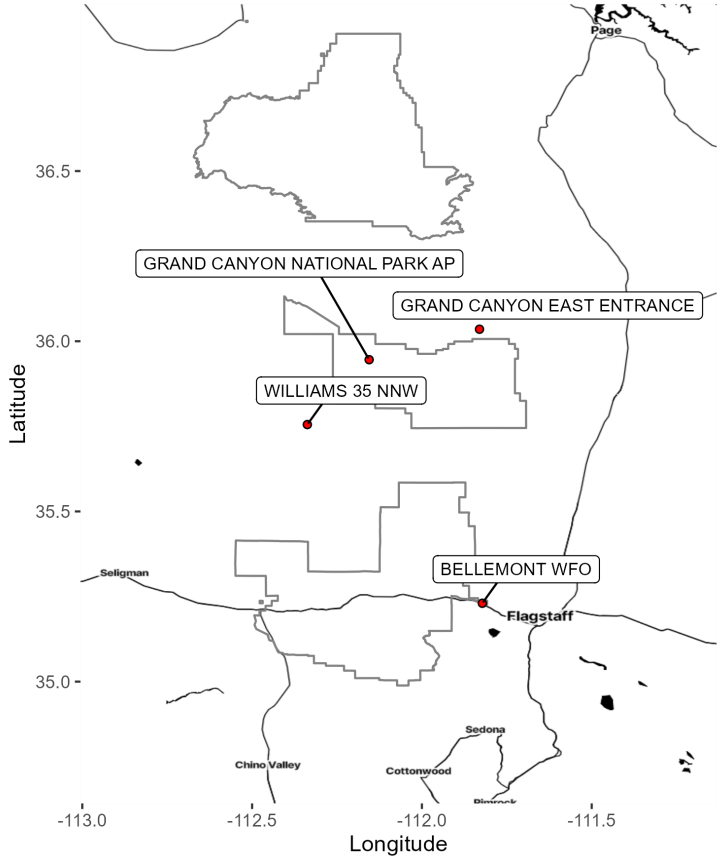

Figure 6: NOAA and SNOTEL Station Locations within and near KNF.

Table 3: NOAA Climate Station Observations (2022-10-01 to 2023-09-30)

Station	Elev (ft)	POR	Total Precip (in)	Precip Anom (in)	Days with Precip	Total Snow (in)	Avg Temp (F)	Temp Anom (F)	Freeze Days
BELLEMONT WFO	7152	2000-2023	27.78	8.32	95	179.0	42.9	-1.63	229
WILLIAMS 35 NNW	5990	2009-2023	12.28	0.91	75	0.0	50.0	-2.25	163
GRAND CANYON EAST ENTRANCE	7480	2012-2023	24.28	9.18	93	140.8	48.2	-2.12	150
GRAND CANYON NATIONAL PARK AP	6540	1999-2023	17.11	4.05	84	0.0	45.4	-1.35	210

Note:

October-September 2023 summary statistics of select NOAA stations accessed through RCC-ACIS within and near the Kaibab National Forest

Table 4: USDA NRCS SNOTEL Station Observations (2022-10-01 to 2023-09-30)

Station	Elev (ft)	POR	Max SWE (in)	Max SWE Anom (in)	Total Precip (in)	Precip Anom (in)
WHITE HORSE LAKE	7201	1970-2023	13.9	8.17	35.00	11.82
FRY	7238	1978-2023	21.8	13.66	35.98	10.23
CHALENDER	7034	2009-2023	11.1	7.36	28.10	9.87

Note:

October-September 2023 summary statistics of select USDA NRCS Snow Telemetry (SNOTEL) stations within and near the Kaibab National Forest

Soil Moisture Estimates

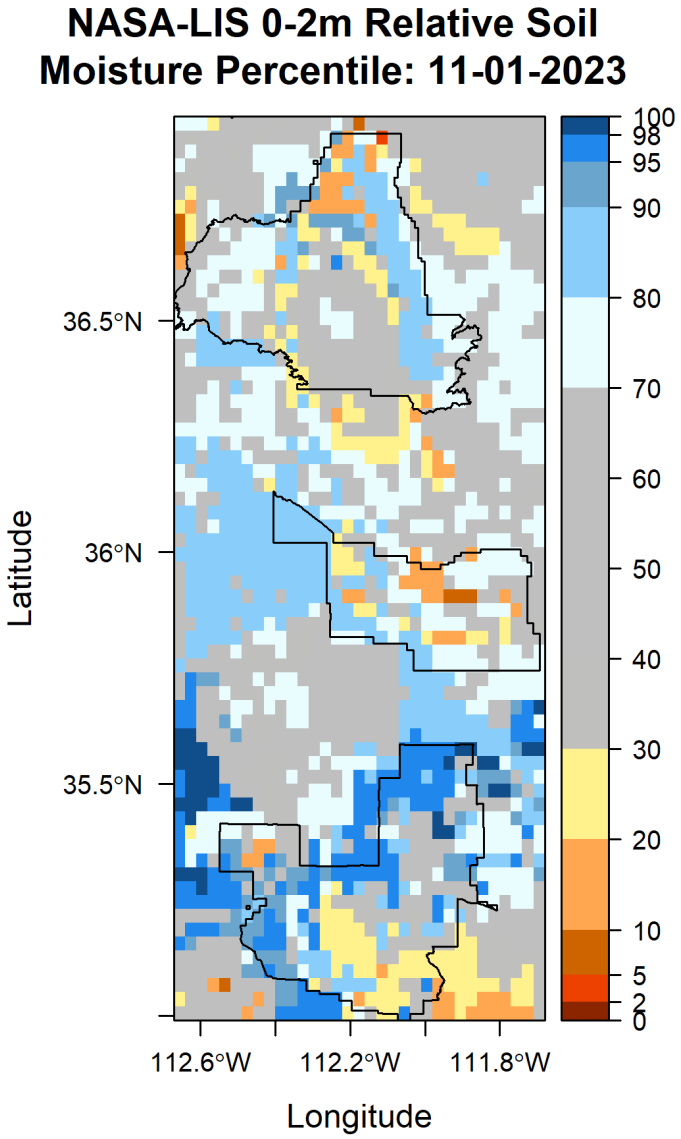

Figure 7: Integrated surface to 2 meter deep relative soil moisture estimate

Modeled soil moisture estimates are provided by the NASA Short-term Prediction Research and Transition Center. This program uses a land surface model to integrate surface weather conditions (e.g. precipitation, temperature, wind…) with surface and soil properties like vegetation cover, soil depth and type to track and make near real-time estimates of soil moisture on a 3km by 3km grid. This map displays how unusually wet or dry the relative soil moisture (based on local soil properties) is for the integrated amount from the surface to 2 meters deep. The values shown are the percentile rank of soil moisture values relative to a long-term distribution of values for this time of year. Values above the 70th percentile depict unusually wet conditions for this date, while values below the 30th-tile are unusually dry. (more information at https://weather.ndc.nasa.gov/sport/modeling/lis.html).

Mechanics Behind the Standardized Precipitation Index (SPI)

The SPI is a meteorological drought index which use monthly precipitation sums to calculate a time series of z-score values. The SPI uses z-score values to represent the number of standard deviations a monthly precipitation total is from the long-term mean. The sign (positive or negative) of a z-score value represents if the monthly total precipitation is above (+, water surplus) or below (-, water deficit) the long-term mean for *all other instances of that month on record*. Furthermore, the size of the z-score value represents the frequency of drought conditions (Table . Smaller SPI values (i.e. falling near zero) represent more frequent drought events while larger SPI values (positive or negative) are less frequent drought events.

Table 5: SPI Drought Categories

SPI Value	SPI Category
≥ 2	Extremely Wet
1.5 to 1.99	Very Wet
1 to 1.49	Moderately Wet
-0.99 to 0.99	Near Average
-1 to -1.49	Moderately Dry
-1.5 to -1.99	Very Dry
$\leq$ -2	Extremely Dry

Note:

Table adapted from https://drought.unl.edu/Monitoring/SPI/MapInterpretation.aspx

An important feature of the SPI is the ability to be calculated at a variety of monthly timescales. This flexibility allows the SPI to evaluate drought conditions for different time periods. For example, a 3-month SPI calculation compares total precipitation from the 3 months with all other instances of those same 3 months on record. Land managers can assess SPI values of different timescales to interpret short and long-term drought conditions on their land.

About the data used in this report

- PRISM Climate: The gridded climate data used in mapping and forest and district level summaries is provided by the PRISM (Parameter elevation Regression on Independent Slopes Model) statistical mapping system. This system uses a weighted regression scheme to interpolate station data while accounting complexities like topography and rain shadows. The PRISM mapping system relies on a high density of stations to account for small variations in temperature and precipitation. Use caution in interpreting fine-scale patterns (or lack thereof) in regions with low station density. More information on PRISM can be found at https://prism.oregonstate.edu/ and https://climatedataguide.ucar.edu/climate-data/prism-high-resolution-spatial-climate-data-united-states-maxmin-temp-dewpoint.
- Climate Stations: Station-level data used in this report consist of NOAA Global Historical Climatology Network(NOAA-GHCN) stations and USDA NRCS Snow Telemetry sites which include Cooperative Observer sites, Airports, and CoCoRAHS volunteer observations and also USDA NRCS Snow Telemetry(SNOTEL) sites. NOAA-GHCN stations consist of Cooperative Observer sites, Airports, and CoCoRAHS volunteer precipitation observations. SNOTEL sites are automated stations located in key snow monitoring locations, often in forested locations. NOAA-GHCN data were accessed through the Regional Climate Center-Applied Climate Information System(RCC-ACIS) and SNOTEL data were downloaded using the 'snotelr' package.

Past reports can be found at: https://cals.arizona.edu/climate/reports/KNF/

Contact information

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https://cals.arizona.edu/climate

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Appendix A: Allotment Climate Statistics

North Kaibab Ranger District

SPI and climate statistics for allotments within the North Kaibab Ranger District of the Kaibab National Forest are shown below.

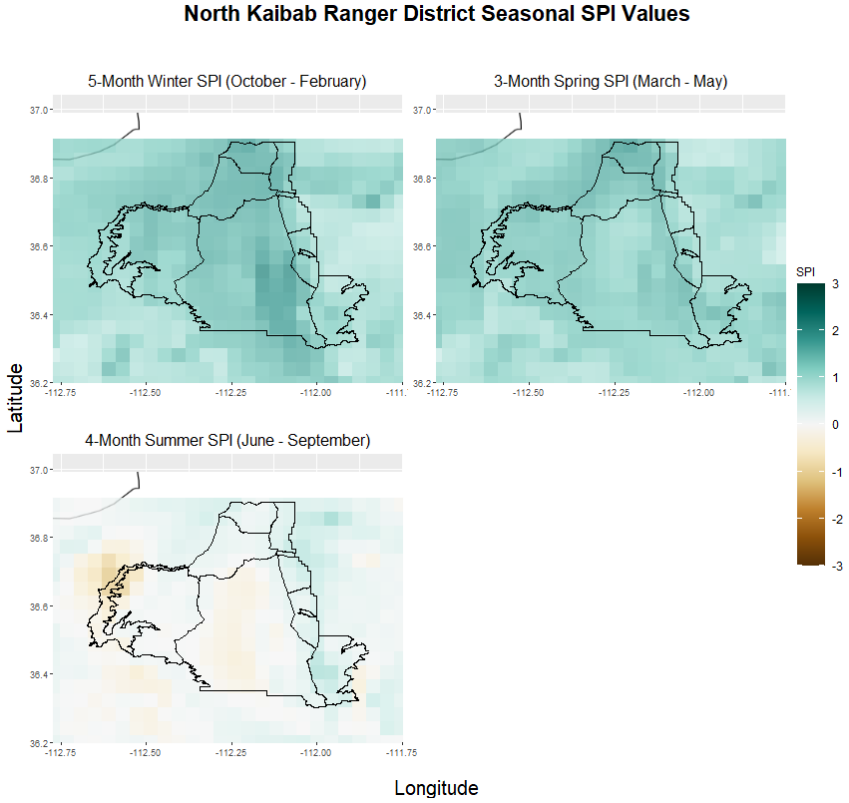

Figure 8: Seasonal SPI values for allotments within the North Kaibab Ranger District.

Table 6: Seasonal Allotment Climate Statistics for the North Kaibab Ranger District

District	Winter SPI	Spring SPI	Summer SPI	Fall SPI	12-Month SPI	Winter Precip [in.]	Spring Precip [in.]	Summer Precip [in.]	Fall Precip [in.]	12-Month Precip [in.]	Precip Anom [in.]
House Rock	1.16	1.07	0.43	NA	1.39	7.91	4.33	4.85	NA	17.10	4.57
Ryan	1.55	1.41	0.15	NA	1.77	12.00	7.28	5.72	NA	25.00	8.01
Central Winter	1.32	1.34	-0.02	NA	1.52	10.40	5.83	4.53	NA	20.76	5.99
Kanab Creek	1.13	1.23	-0.39	NA	1.16	7.32	3.93	2.83	NA	14.08	3.34
Burro	1.48	1.33	0.47	NA	1.78	9.62	5.43	5.46	NA	20.51	6.62
Central Summer	1.52	1.27	-0.04	NA	1.65	18.26	10.06	6.48	NA	34.80	11.16
Kane	1.12	1.13	0.40	NA	1.36	8.00	4.20	4.72	NA	16.92	4.54
Willis Canyon	1.60	1.61	0.27	NA	1.97	11.10	6.57	5.17	NA	22.84	7.98

Note:

2023 Water year (October - September) and seasonal climate statistics for allotments within the North Kaibab Ranger District. Seasonal monthly definitions are as follows: Winter (Oct-Feb); Spring (Mar-May); Summer (Jun-Sep); Fall (NA). All data acquired via PRISM.

Tusayan Ranger District

SPI and climate statistics for allotments within the Tusayan Ranger District of the Kaibab National Forest are shown below.

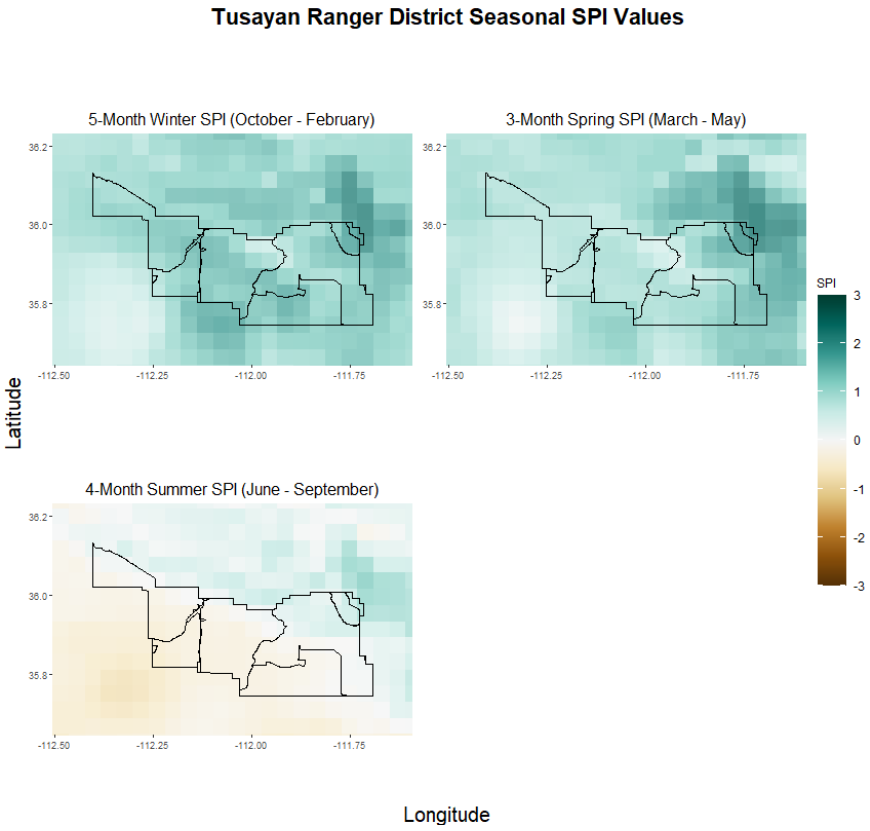

Figure 9: Seasonal SPI values for allotments within the Tusayan Ranger District.

Table 7: Seasonal Allotment Climate Statistics for the Tusayan Ranger District

District	Winter SPI	Spring SPI	Summer SPI	Fall SPI	12-Month SPI	Winter Precip [in.]	Spring Precip [in.]	Summer Precip [in.]	Fall Precip [in.]	12-Month Precip [in.]	Precip Anom [in.]
Rain Tank	1.27	0.86	-0.16	NA	0.99	8.37	4.02	5.63	NA	18.03	3.58
Anita	1.26	0.86	-0.26	NA	0.96	9.37	4.51	5.84	NA	19.72	3.75
Cameron	1.34	1.27	0.17	NA	1.46	9.48	4.94	6.18	NA	20.61	5.53
Moqui	1.34	1.09	-0.19	NA	1.22	9.71	4.59	6.10	NA	20.41	4.63

Note:

2023 Water year (October - September) and seasonal climate statistics for allotments within the Tusayan Ranger District. Seasonal monthly definitions are as follows: Winter (Oct-Feb); Spring (Mar-May); Summer (Jun-Sep); Fall (NA). All data acquired via PRISM.

Williams Ranger District

SPI and climate statistics for allotments within the Williams Ranger District of the Kaibab National Forest are shown below.

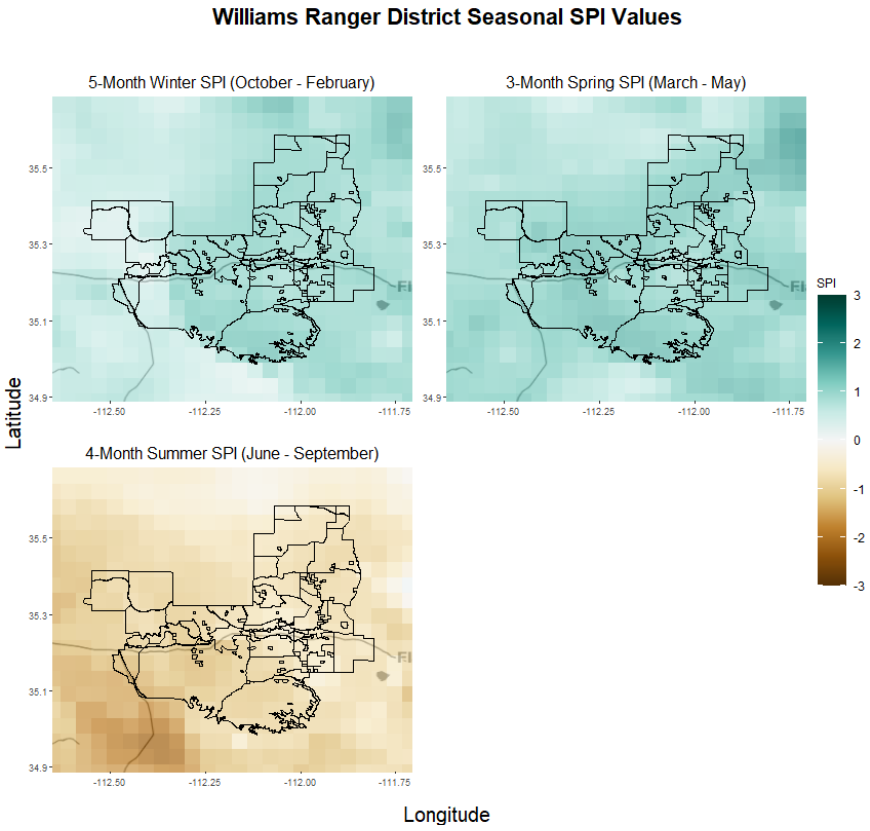

Figure 10: Seasonal SPI values for allotments within the Williams Ranger District.

Table 8: Seasonal Allotment Climate Statistics for the Williams Ranger District

District	Winter SPI	Spring SPI	Summer SPI	Fall SPI	12-Month SPI	Winter Precip [in.]	Spring Precip [in.]	Summer Precip [in.]	Fall Precip [in.]	12-Month Precip [in.]	Precip Anom [in.]
Smoot Lake	1.11	1.14	-0.74	NA	0.94	12.00	5.68	5.70	NA	23.37	4.23
Government Prairie	1.08	1.23	-0.82	NA	1.02	13.99	7.26	5.93	NA	27.18	5.28
Pomeroy	1.07	1.14	-0.66	NA	1.08	15.96	7.91	5.83	NA	29.70	6.47
Squaw Mountain	1.11	1.33	-0.87	NA	1.03	13.34	6.69	5.85	NA	25.87	5.05
Juan Tank	1.09	1.35	-1.01	NA	0.96	12.64	6.44	5.28	NA	24.37	4.49
Partridge Creek	0.39	1.02	-1.05	NA	-0.02	6.03	3.81	4.29	NA	14.13	-0.33
Homestead	1.16	1.30	-0.66	NA	1.15	13.64	6.62	6.16	NA	26.42	5.68
Ebert	1.09	0.86	-0.53	NA	0.84	10.37	4.50	5.72	NA	20.59	3.35
Seven C Bar	1.12	1.35	-1.31	NA	0.98	14.09	7.23	4.60	NA	25.92	5.01
Cowboy Tank	1.15	1.28	-0.78	NA	1.08	13.26	6.51	5.86	NA	25.63	5.24

District	Winter SPI	Spring SPI	Summer SPI	Fall SPI	12-Month SPI	Winter Precip [in.]	Spring Precip [in.]	Summer Precip [in.]	Fall Precip [in.]	12-Month Precip [in.]	Precip Anom [in.]
Dog Knobs	1.14	1.31	-0.85	NA	1.01	12.58	6.30	5.59	NA	24.47	4.73
Spitz Hill	1.03	1.06	-0.84	NA	0.9	14.71	7.20	6.06	NA	27.97	4.9
Corva	1.13	1.46	-1.15	NA	1.01	12.63	6.68	4.94	NA	24.25	4.72
Big Springs	1.05	1.11	-0.94	NA	0.98	16.34	8.03	5.30	NA	29.67	5.97
Bellemont	0.99	1.11	-0.66	NA	0.95	14.12	7.14	5.97	NA	27.24	5.1
Twin Tanks	1.10	1.27	-0.80	NA	1.04	13.85	6.81	5.99	NA	26.65	5.26
Elk Springs	1.06	1.23	-0.88	NA	0.97	14.45	7.20	6.05	NA	27.70	5.14
Davenport Lake	1.10	1.27	-0.77	NA	1.02	13.83	6.77	5.99	NA	26.59	5.24
Garland Prairie	1.03	1.19	-0.62	NA	1.05	14.89	7.66	6.08	NA	28.63	5.97
Irishman Dam	0.56	1.08	-1.25	NA	0.08	6.43	3.81	3.64	NA	13.88	0.02
Tule	1.22	1.32	-0.99	NA	1.22	16.52	8.37	5.22	NA	30.11	7.35
Moritz Lake	1.06	1.28	-0.92	NA	0.96	14.12	7.24	5.99	NA	27.35	5.03
Chalender	0.96	1.04	-0.80	NA	0.85	14.44	7.06	5.76	NA	27.25	4.6
Sitgreaves	1.08	1.16	-0.68	NA	1.02	14.49	6.91	6.30	NA	27.70	5.43
Government Mountain	1.05	1.20	-0.89	NA	0.95	14.43	7.33	6.13	NA	27.89	5.06
Double A	0.56	1.22	-0.97	NA	0.33	7.99	4.85	4.93	NA	17.77	1.09
Pine Creek	1.12	1.29	-0.81	NA	1.01	12.89	6.29	5.77	NA	24.94	4.78

Note:

2023 Water year (October - September) and seasonal climate statistics for allotments within the Williams Ranger District. Seasonal monthly definitions are as follows: Winter (Oct-Feb); Spring (Mar-May); Summer (Jun-Sep); Fall (NA). All data acquired via PRISM.