Going with the Flow Update

An update and comparative analysis of five years of Water Sentinels flow data collection of the Upper Verde River

Rachel Shultis
Intern for Science-Practice Integration
Grand Canyon Chapter of the Sierra Club
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Water Sentinels' Above Verde Springs Discharge Measurement Site

Figure 1. Above Verde Springs.
Photo Credit: Rachel Shultis

As determined in the 2013 "Going with the Flow Report," the Above Verde Springs measurement site at mile 2.1 that begins just downstream of Stillman Lake and at the mouth of the Granite Creek River remains essentially dry. Although there are times when some water flow can be gaged, it often involves digging a channel or measuring just one small area of movement. Measurements from 2012 to 2017 continue the 2006-2011 pattern where flow measurements were less than 1.0 cubic feet per second (cfs); however, there was one measurement in January 2017 of 1.9 cfs. In 2013, most measurements were less than 0.2 cfs. Data from 2012 to 2017 demonstrate flow measurements of 0.17 cfs on average with most measurements falling below 0.1 or at 0.0.

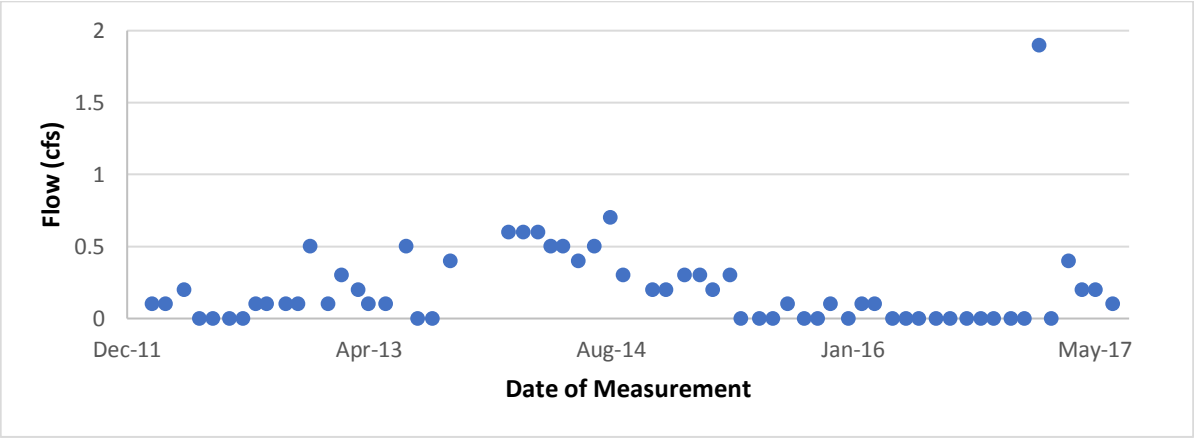

Chart 1. Flow Rate Data: Above Verde Springs Site

Base Flow at the SRP Campbell Ranch Low-Flow Gage

The Salt River Project (SRP) installed a low-flow gage at river mile 3.2 that logs and records river flow in cfs every 15 minutes. These data are important because of the gage's close proximity to Verde Springs, which is the primary source of baseflow for the river.

Figure 2. Campbell Ranch Low-Flow Gage.
Photo Credit: Gary Beverly

Water Sentinels obtained daily mean flow data from the SRP archives for years 2012-2017. These data were then calculated into monthly average cfs where sufficient data were available [*See* Appendix A].

The majority of the monthly mean flow of the Upper Verde River from January 2012 to December 2017 ranged between 14 and 16 cfs, a decrease in both the size of the range and the measurements themselves from the 2005-2011 flow data range of 17 to 20 cfs.**Error! Bookmark not defined.** In these sets of data specifically, it appears as measurements decrease, they also move closer together. Although this pattern of clustering as measurements decrease is not accurate in considering the long-term record from mid-1963 to 2018, it is an interesting observation in these most recent data sets.

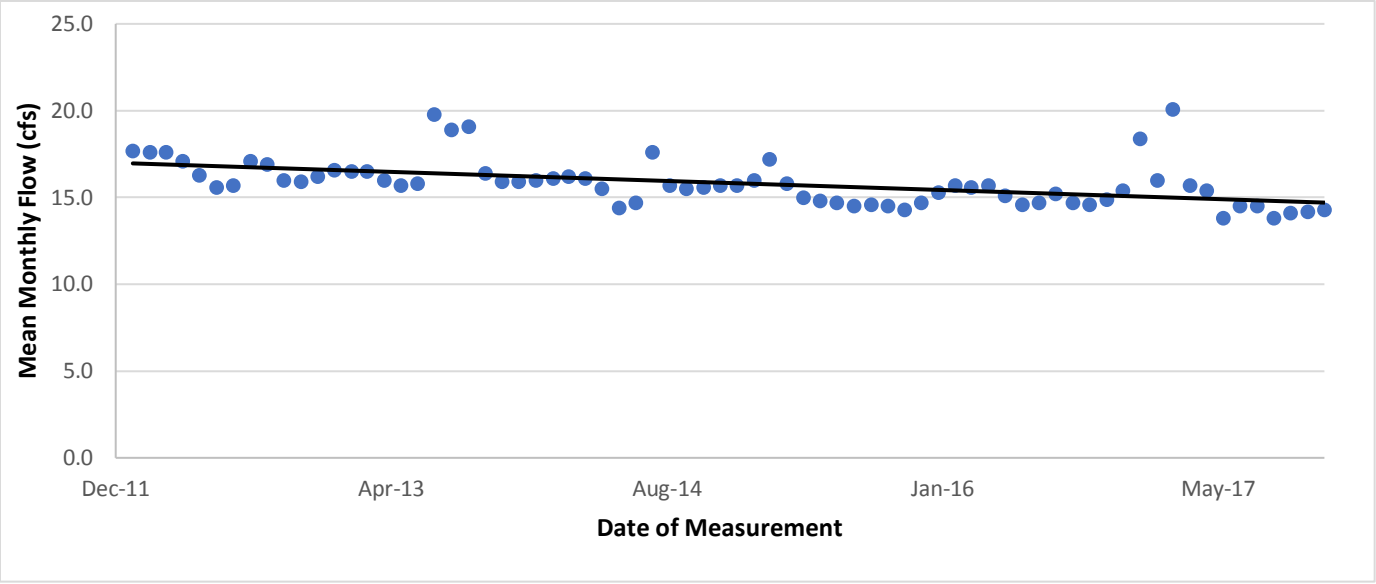

Chart 2. Monthly Mean Flow 2012-2017 – SRP Campbell Ranch Gage

The main body of data from the time of the gage's installation in 2005 through 2017 demonstrates a well-defined decline in mean monthly flow through time, from approximately 21 cfs to 14 cfs. Data points that lie above the main trend represent runoff from both winter and summer storms.

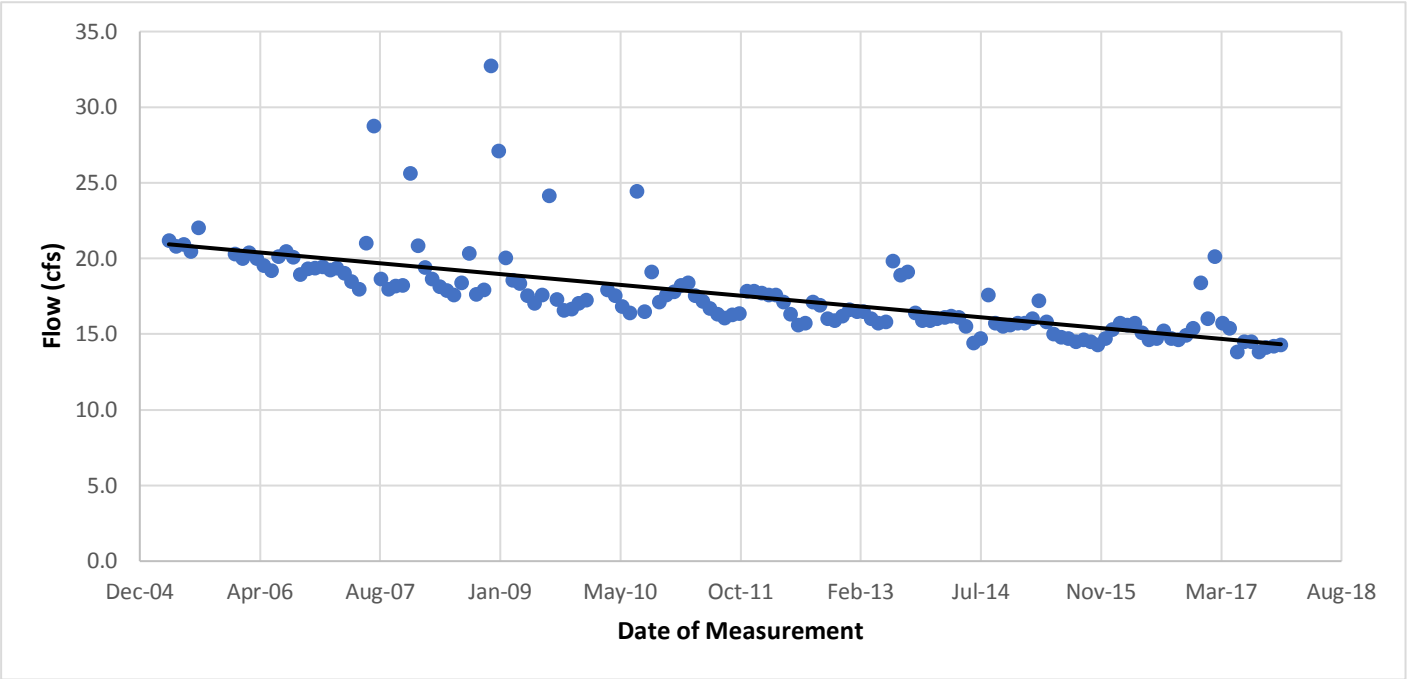

Chart 3. Monthly Mean Flow 2005-2017 – SRP Campbell Ranch Gage

Although scattered outliers exist, they become scarcer in the data over time and represent seasonal changes in the river flow due to monsoon season, snowmelt runoff, and winter storms. A clear decline in flow over a 12-year period indicates that the groundwater discharges at Verde Springs are gradually decreasing.

Comparison of the data from the SRP Campbell Ranch streamgage with the daily data for the same time period from the U.S. Geological Survey (USGS) Paulden streamgage demonstrates that the Verde River, from its headwaters through at least the first eight river miles to the Paulden gage, is a gaining reach.

USGS Stream Gage near Paulden

Approximately six river miles below the Campbell Ranch gage and 10 miles below the Sullivan Dam lies the USGS Paulden gage (09503700), which collects streamflow measurements every 15 minutes. The Water Sentinels obtained monthly mean flows from the USGS National Water Information System Web Interface to determine monthly average flows at the USGS Paulden gage between 2012 and 2017.[1]

Table 1. Monthly Means at Paulden Gage, cfs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	23.1	23.1	25.9	24.1	22.9	20	19.5	22.3	23.1	22.9	23.3	23.5
2013	24.5	24.7	21.8	19.1	19.5	18.2	60.8	29	29.6	21	21.2	20.5
2014	21.9	22.5	21.1	20.9	19.5	17.9	20	27.4	20.5	19.7	21.7	23.1
2015	23.4	24.7	34.5	19.9	18.5	17.2	17.4	17.4	18	18.5	19.2	19.9
2016	20.2	20.8	21.3	20.4	19.8	18.5	18.4	20.9	19.8	20.4	20.8	21.7
2017	34	38.5	72.7	21.2	20.2	19.6	19.3	19.8	18.3	18.9	19.0	19.3

Green and yellow highlighted values together demonstrate cfs below 22. Yellow demonstrate cfs below 20.

The Sierra Club (2013) report stated that between 1964 and 2003, monthly mean flows under 22 cfs occurred less than ten percent of the time.[2] From 2007 to 2012, monthly mean flows were less than 22 cfs thirty-seven percent of the time.[2] Just five years later, 2013-2017 data indicate that seventy-eight percent of the time the river is flowing below 22 cfs. This five-year span demonstrates a more than 100 percent reduction of streamflows to less than 22 cfs and a shift in the majority from 20-25 cfs in 2007-2011 to 17-22 cfs in 2012-2017. Should this pattern continue, all monthly mean river flow would be reduced to below 22 cfs by 2019. However, this reduction may be slowed by winter precipitation, snowmelt, and monsoon activity.

[1] Retrieved from National Water Information System web interface at: https://nwis.waterdata.usgs.gov/nwis/annual/?referred_module=sw&site_no=09503700&por_09503700_5684=19813,00060,5684,1963,2018&start_dt=1990&end_dt=2017&year_type=W&format=html_table&date_format=YYYY-MM-DD&rdb_compression=file&submitted_form=parameter_selection_list

[2] The Sierra Club. (2013). *Going with the flow*. Grand Canyon Chapter. Pawlowski, S.

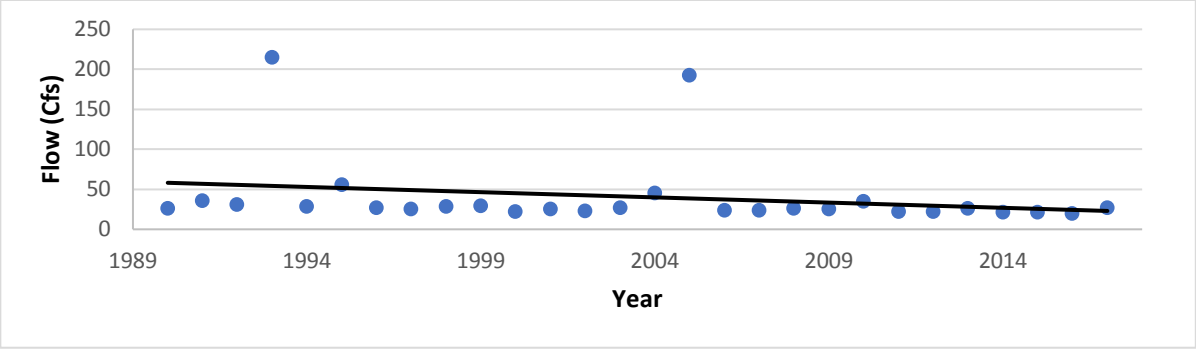

Chart 4. USGS Paulden Gage Annual Mean Flow

Monthly mean discharge values of historic lows below 20 cfs were recorded a total of 10 times from the 1963-2011 record.[3] Over the 2012-2017 period, monthly mean flows drop to values less than 20 cfs 27 times for a combined total of 35 percent of all measurements at or below 20 cfs *[See footnote for a list of dates]*.[4] From 2007-2011, just 0.08 percent of all measurements made up this same percentage.[3] Averages remain higher in February and March as expected due to winter precipitation and snowmelt, though there are many instances where averages fall below the historic average flow of 25 cfs in these months. Nine out of twelve months experienced historic lows in 2015, indicating this may have been a particularly dry year. The pervasive nature of these lows may mark a shift from 20 cfs as a historic low to representative of a new normal.

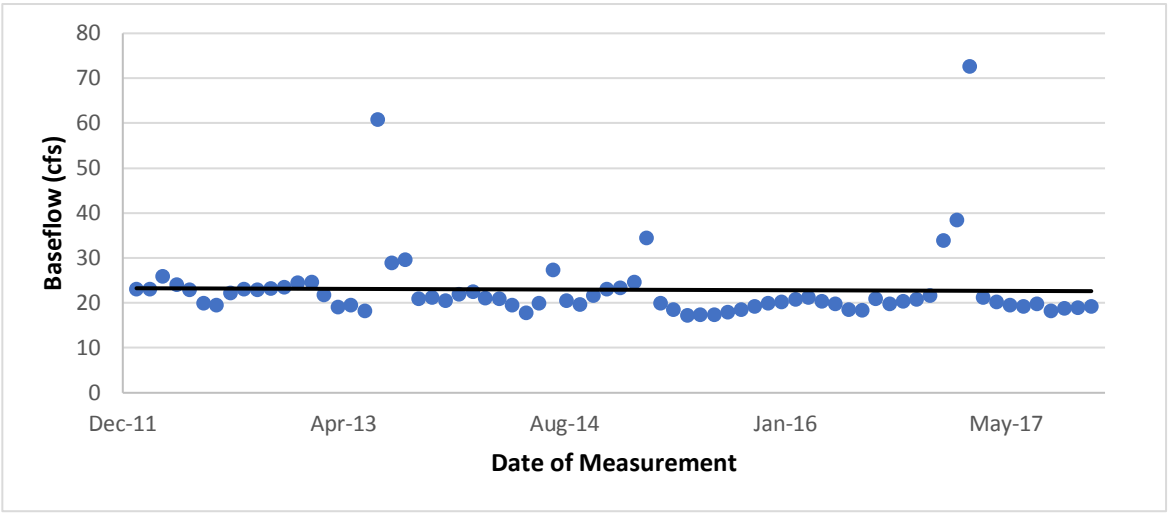

Chart 5. Monthly Mean Flow 2012-2017 – USGS Paulden Gage

The graphed values below represent the average of seven days or more of continuous lowest streamflow at the Paulden gage in each calendar year [*See* Appendix C]. This is used to estimate the rate of groundwater contribution to the stream in the summer months. Baseflow measurements in the winter are a bit higher, about a couple of cfs, because evapotranspiration is at a minimum in the winter.

[3] The Sierra Club. (2013). *Going with the flow*. Grand Canyon Chapter. Pawlowski, S.

[4] July 2012, April 2013-June 2013, May 2014, June 2014, October 2014, April 2015-December 2015, May 2016-July 2016, September 2016, June 2017-December 2017

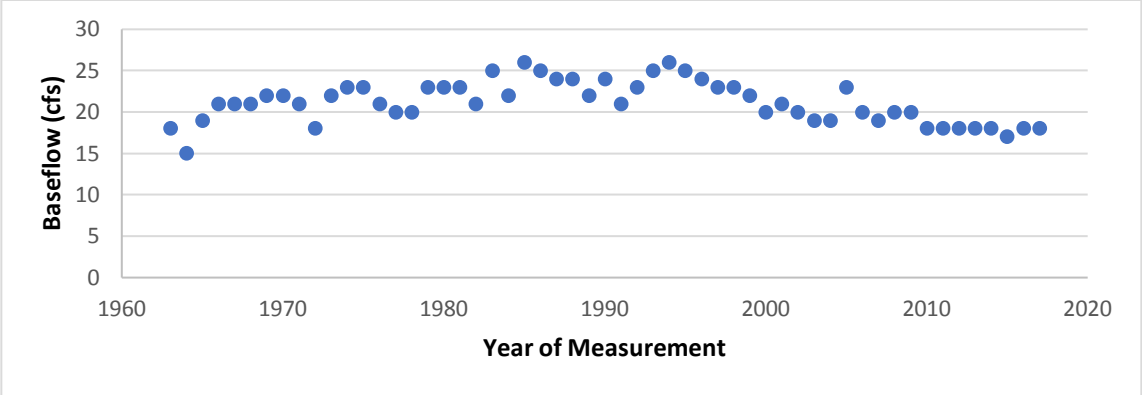

Chart 6. USGS Paulden Gage Annual 7-Day or More Mean Low-flow 1964-2017

Fifty-four full years, 1964-2017, of record at the Paulden streamgage show a substantial decline in monthly mean flows and annual discharge beginning in 2000. The average summer baseflow for the entire data set is 21 cfs. The average for 2000-2017 is 19 cfs. From 2010 through 2017 the average is 18 cfs. These changes likely represent some combination of the effect of regional climate change and long-term groundwater pumping in the Big Chino and Williamson Valleys and in the Prescott Active Management Area (AMA).

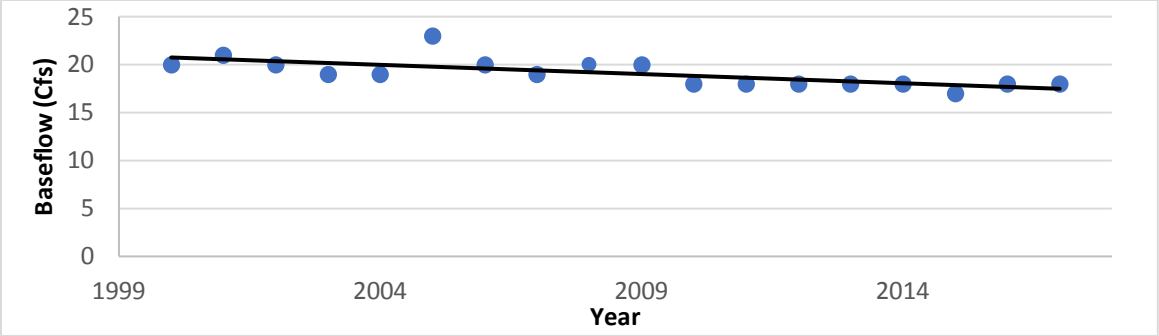

Chart 7. USGS Paulden Gage Annual 7-Day or More Mean Low-flow 2000-2017

These graphs exemplify an evident decline in baseflow. Most, if not all, monthly mean flows greater than 60 cfs represent Pacific Ocean storms that skew the average annual discharge. Discounting average annual discharge for all years that have one or more months greater than 60 cfs results in average annual discharge ranges from 25 to 30 cfs from 1964 through 1999 and from 20 to 24 cfs from 2000 through 2017. That is a significant change, and it correlates well with the current drought. This may or may not be a manifestation of long-term climate change, but it clearly represents a prolonged—essentially two-decade—drought that is ongoing. It may reflect as well, a gradual decrease owing to the long-term effect of groundwater pumping in both the Big Chino Valley and the Prescott Active Management Area. It appears that the Upper Verde near Paulden is indeed, "going with the flow."

Water Sentinels' Bear Siding Discharge Measurement Site

Free-flowing and wild with little evidence of human impact is Bear Siding, located at river mile 19.4, approximately 9.4 miles downstream of the USGS Paulden gage. The Water Sentinels monitored flow here from February 2007 through October 2009, beginning again in February 2013 to collect more data on the losing reach of river between the USGS Paulden gage and Perkinsville.

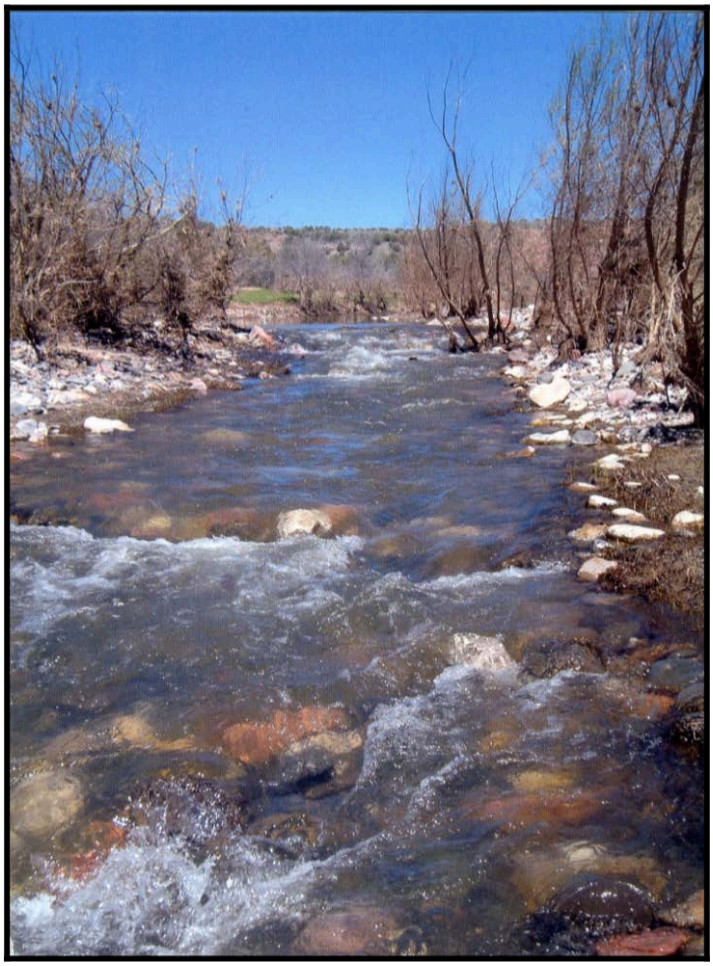

Figure 4. Verde River at Bear Siding in Winter.
Photo Credit: Tom Slaback

Monthly Measurements from 2013-2017 remain relatively consistent with 2007-2009 data. Monthly streamflow measurements appear relatively constant, with the majority of measurements ranging from 13-17 cfs. This is a decrease in range from 2007-2009 data where the majority of measurements were between 10 and 20 cfs.[5] Discharge ranged from a minimum of 11.5 cfs to a maximum of 70.2 in February 2017.

[5] The Sierra Club. (2013). *Going with the flow*. Grand Canyon Chapter. Pawlowski, S.

Table 2. Monthly Measurements at Bear Siding, cfs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013		19.5	17.6	16.5	14.8	13.0	30.3	18.0	16.8	18.0	21.9	17.8
2014	20.2	14.3	19.2	17.3	14.9	14.0	14.7	21.3	17.8	15.1	14.5	16.4
2015	16.7	14.1	19.0	15.4	17.3	15.4	12.9	15.6	14.7	14.0	16.0	16.0
2016	17.2	16.4	16.4	14.4	14.2	14.8	15.5	17.2	16.2	18.2	18.4	N/A
2017	50.5	70.2	18.9	18.4	14.0	11.5	22.5	14.1	14.7	15.9	17.5	17.2

Green highlighted values demonstrate cfs 17-20. Yellow demonstrate cfs between 13-17.

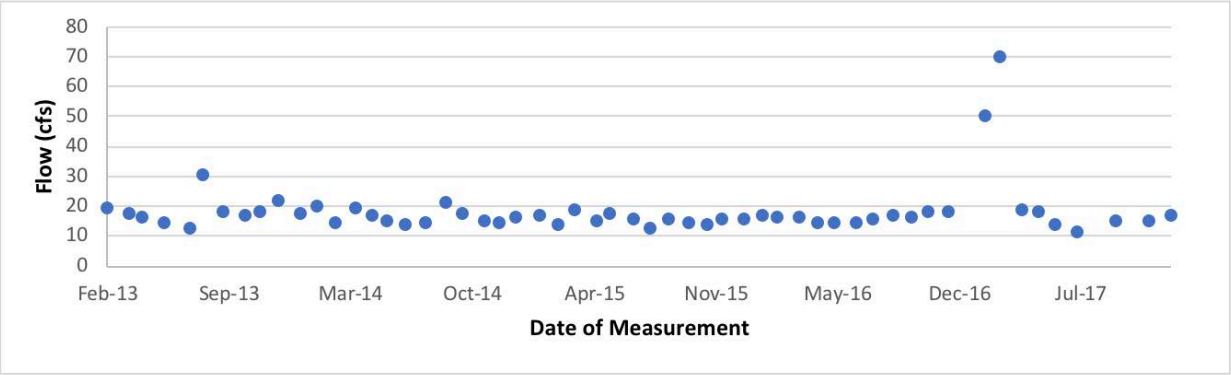

Chart 8. Flow Rate Data 2013-2017 - Bear Siding Site

It is interesting to note that the lower end of the majority has increased from 10 to 13 cfs while the upper range has decreased, demonstrating a shift toward a smaller range over time. Streamflow measurements at Bear Siding are much lower than those at the Paulden gage, indicating this site is on a losing stretch of river. This decrease in flow supports the idea that this losing reach of the Upper Verde between Paulden and Perkinsville is in danger of becoming intermittent. Evapotranspiration contributes to a small part of the downstream loss, but infiltration of streamflow to the groundwater is likely much more significant. Combined effects of climate change and continuing and increasing pumping of groundwater in the Prescott AMA and Big Chino Valley likely threaten the river from the headwater springs through Perkinsville.

Monthly Water Sentinels' Perkinsville Discharge Measurement Site

This flow measurement site is the most downstream measured by the Water Sentinels at river mile 24.

Figure 5. Perkinsville Measurement Site.
Photo Credit: Rachel Shultis

Perkinsville monthly measurements demonstrate a trend of decreasing flow. More than 50 percent of all flow measurements fall between the range of 8-13 cfs, making this the majority for 2012-2017 data. This is a decrease from the 2011-2012 range of 9-15 cfs.[6]

Table 3. Monthly Means at Perkinsville.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	14.4	14.7	12.2	11.4	8.1	8.1	11.0	54.9	11.1	13.7	13.5	17.0
2013	14.3	14.2	13.4	12.4	11.0	7.9	14.4	12.5	12.7	14.2	17.4	15.3
2014	13.4	15.6	16.9	14.2	10.0	9.4	10.2	12.2	21.0	14.0	14.4	15.4
2015	15.1	16.0	16.0	12.2	11.9	10.2	8.8	12.8	10.7	13.1	14.7	15.6
2016	15.6	15.1	12.3	12.9	10.9	11.5	11.6	13.1	13.2	13.3	13.9	59.5
2017	45.8	61.8	15.4	14.1	10.5	7.9	24.7	11.4	10.3	12.5	13.2	14.9

Yellow highlighted values demonstrate cfs at or below 13. Green and yellow demonstrate cfs at or below 14.

In 2007, the majority of monthly measurements ranged from 16-21. Ten years later, data indicate a drastic reduction in the range, now between 8-14 cfs. However, although the range demonstrates a dramatic shift from 2007-2017, the 2012-2017 majority of 8-13 cfs is not a substantial shift from the 2011-2012 majority flow determined to be between 9-15 cfs.[6] This indicates a relative slowing of loss of flow as measurements move closer together, clustering at 10 cfs. Flow measurements for the months of

[6] The Sierra Club. (2013). *Going with the flow*. Grand Canyon Chapter. Pawlowski, S.

May and June from 2012-2017 range only from 7.9-11.9 cfs, again supporting a continual shift toward smaller ranges as measurements near 0 cfs.

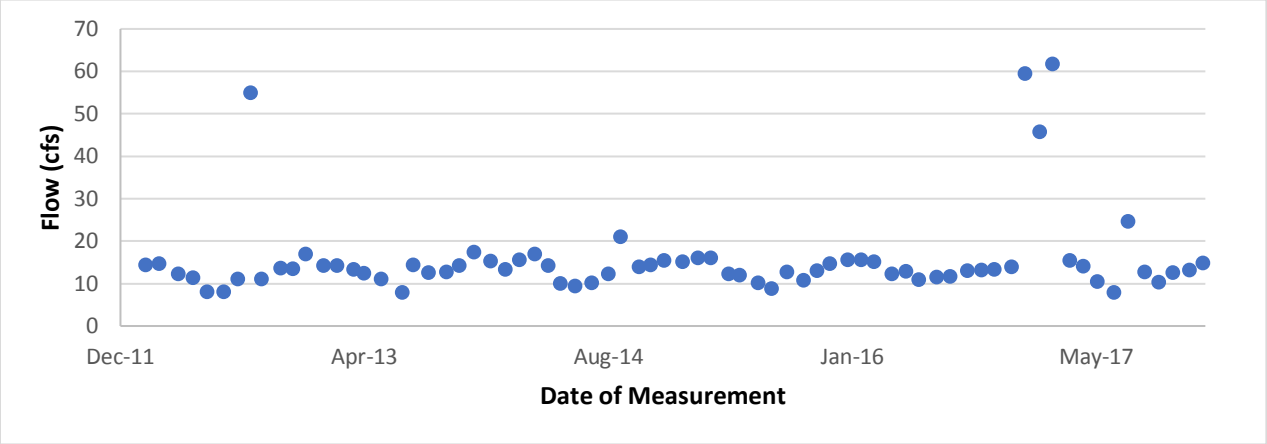

Chart 9. Flow Rate Data 2012-2017 – Perkinsville Site.

The graph above indicates the range in flow measurements is slowly decreasing, moving closer to 10 as an average where measurements have less flexibility as the size of the range itself is decreasing. Drastic highs and lows are more sparing in the 2012-2016 data; this trend of reduction in range of flow measurements or cfs clustering is also apparent in measurements taken at Campbell Ranch and Bear Siding. This identical trend in several sets of data demonstrates a streamflow that is steadily decreasing with smaller decreases over time as the majority of measurements move closer to 0.

The 2013 report estimated that the river was losing about 1 cfs per year.[7] Measurements from 2012-2017 demonstrate a slower rate of change; however, it is apparent that streamflow is decreasing at the Perkinsville gage. Where many monthly measurements were once in and around 20 cfs, 2012-2016 data reflect a mild rate of change where measurements are becoming closer together and have reached 20 only once in September, which is historically a month of increased river flow due to monsoon activity. However, 2017 measurements feature a much greater range of data where streamflow reaches highs of approximately 60 cfs and drops to a new low of 7 cfs in September. This extreme variation may be due to increased precipitation in 2017.

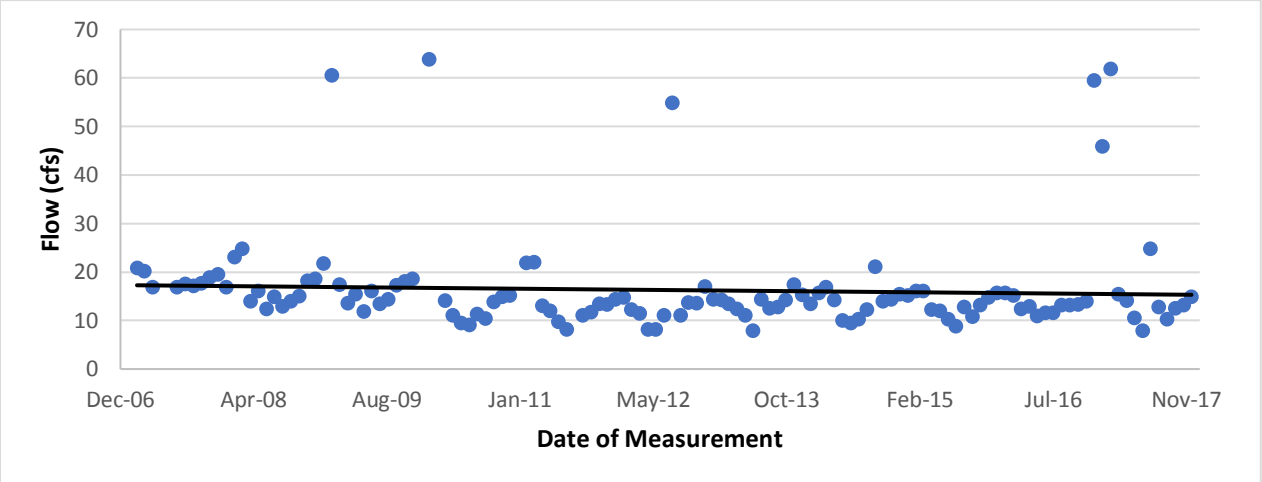

Chart 10. Flow Rate Data 2007-2017 – Perkinsville Site.

[7] The Sierra Club. (2013). *Going with the flow*. Grand Canyon Chapter. Pawlowski, S.

The 10-year graph above including mean streamflow from 2007-2017 maintains a downward slope where flow continues to reach new historic lows. Where lows were once historic at 9 cfs, measurements of 8 and 9 have become increasingly commonplace and concern arises with a new low of 7 cfs. All of the lowest measurements were taken in the summer months. This is relevant because this is generally the time baseflow conditions arise, as streamflow is least influenced by precipitation. These low values provide critical information about the combined impact of drought and groundwater pumping on the river. Furthermore, these values indicate a rate of change of 2 cfs over five years, reinforcing the idea that the river is steadily decreasing, although the rate of decrease is becoming less severe as flow measurements move closer to 0.

There is a losing reach of river between Perkinsville and the Paulden gage, located approximately 14 miles upstream. Loss is demonstrated by the difference in the majority of the flow measurements, as well as by the progressive decrease in minimum values from Paulden to Bear Siding to Perkinsville. Perkinsville flow measurements fall between 8 and 13 cfs, while in Paulden, the majority of flows range from 17 to 22 cfs, describing a loss of 9-15 cfs between locations as pictured below. Paulden lows reach 17 cfs and decline through the losing reach to 7 cfs in Perkinsville. As flow decreases at the Paulden Gage, repercussions in the form of decreased flow at Perkinsville are apparent.

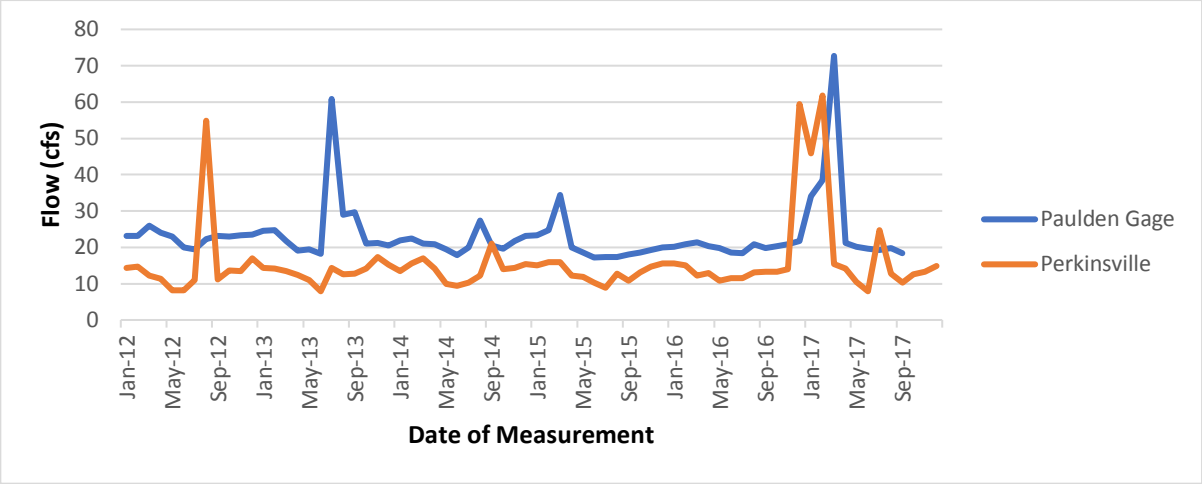

Chart 11. Paulden Average Monthly Flow and Perkinsville Monthly Flow.

Another potential source of streamflow loss for the Upper Verde River comes from an irrigation ditch located an estimated one-third of a mile upstream from the Perkinsville measurement site. Water is diverted from the river into the irrigation ditch, which eventually joins with the Verde again below the Perkinsville measurement site. Flow measurements taken in the ditch give information about the streamflow that is added back to the river below the upper 26 miles of interest [*See* Appendix B]. However, it is not clear how much streamflow is diverted upstream. Measurements from the point of diversion into the ditch could be used to determine if this irrigation ditch is a significant factor in diminishing streamflow.

With new historic lows being reached in Perkinsville, trends of clustered flow measurements and cfs ranges greatly decreased as they move closer to 0, and once historic lows becoming the new norm in Paulden, it is evident the Upper Verde is indeed "going with the flow." The 2013 report predicted the Upper Verde had approximately 10 cfs in baseflow to lose before intermittency began in the summer.

Five years later, baseflow has decreased and the Upper Verde now has approximately 8 cfs of baseflow to lose before becoming intermittent in dry summer months.

Appendix A. SRP Campbell Ranch Low-flow Gage Data

Month	Monthly Average (cfs)	Notes
04/2005	21.1633	
05/2005	20.7932	
06/2005	20.9144	
07/2005	20.4644	
08/2005	22.0208	
09/2005		High flows, loss of data
10/2005		High flows, loss of data
11/2005		High flows, loss of data
12/2005		High flows, loss of data
01/2006	20.2700	High flows, loss of data
02/2006	19.9770	
03/2006	20.3676	
04/2006	19.9700	
05/2006	19.5104	
06/2006	19.1910	
07/2006	20.1200	
08/2006	20.4630	
09/2006	20.0580	
10/2006	18.9470	
11/2006	19.3010	Float tap came off of encoder shaft
12/2006	19.3390	
01/2007	19.4270	
02/2007	19.2478	
03/2007	19.3550	
04/2007	19.0095	
05/2007	18.4710	
06/2007	17.9544	
07/2007	20.9950	
08/2007	28.7540	
09/2007	18.6270	
10/2007	17.9775	
11/2007	18.1600	
12/2007	18.1965	
01/2008	25.6296	
02/2008	20.8328	
03/2008	19.4168	
04/2008	18.6310	
05/2008	18.1445	
06/2008	17.8932	
07/2008	17.5696	

Month	Monthly Average (cfs)	Notes
08/2008	18.3686	
09/2008	20.3467	
10/2008	17.6344	
11/2008	17.9231	
12/2008	32.7342	High flows, loss of data
01/2009	27.0945	High flows, loss of data
02/2009	20.0517	
03/2009	18.5645	
04/2009	18.3289	
05/2009	17.5229	
06/2009	17.0276	
07/2009	17.5984	
08/2009	24.1481	
09/2009	17.2783	
10/2009	16.5824	
11/2009	16.6510	
12/2009	17.0484	
01/2010	17.2310	High flows, loss of data
02/2010		High flows, loss of data
03/2010		High flows, loss of data
04/2010	17.9357	High flows, loss of data
05/2010	17.5340	
06/2010	16.8281	
07/2010	16.4047	
08/2010	24.4513	Missing data due to power outage
09/2010	16.4652	
10/2010	19.0895	
11/2010	17.1149	
12/2010	17.5682	
01/2011	17.8068	
02/2011	18.1930	
03/2011	18.3789	
04/2011	17.5357	
05/2011	17.1451	
06/2011	16.6985	
07/2011	16.2988	
08/2011	16.0743	
09/2011	16.2820	
10/2011	16.3588	
11/2011	17.8407	
12/2011	17.8180	

Month	Monthly Average	Notes
1/2012	17.7	
2/2012	17.6	
3/2012	17.6	
4/2012	17.1	
5/2012	16.3	
6/2012	15.6	
7/2012	15.7	
8/2012	17.1	
9/2012	16.9	
10/2012	16.0	
11/2012	15.9	
12/2012	16.2	
1/2013	16.6	
2/2013	16.5	
3/2013	16.5	
4/2013	16.0	
5/2013	15.7	
6/2013	15.8	
7/2013	19.8	High flows, loss of data
8/2013	18.9	High flows, loss of data
9/2013	19.1	High flows, loss of data
10/2013	16.4	
11/2013	15.9	
12/2013	15.9	
1/2014	16.0	
2/2014	16.1	
3/2014	16.2	
4/2014	16.1	
5/2014	15.5	
6/2014	14.4	
7/2014	14.7	

Month	Monthly Average	Notes
8/2014	17.6	High flows, loss of data
9/2014	15.7	
10/2014	15.5	
11/2014	15.6	
12/2014	15.7	
1/2015	15.7	
2/2015	16.0	
3/2015	17.2	High flows, loss of data
4/2015	15.8	
5/2015	15.0	
6/2015	14.8	
7/2015	14.7	
8/2015	14.5	
9/2015	14.6	
10/2015	14.5	
11/2015	14.3	
12/2015	14.7	
1/2016	15.3	
2/2016	15.7	
3/2016	15.6	
4/2016	15.7	
5/2016	15.1	
6/2016	14.6	
7/2016	14.7	
8/2016	15.2	
9/2016	14.7	
10/2016	14.6	
11/2016	14.9	
12/2016	15.4	
1/2017	18.4	High flows, loss of data
2/2017	16.0	High flows, loss of data
3/2017	20.1	High flows, loss of data

Month	Monthly Average	Notes
4/2017	15.7	
5/2017	15.4	
6/2017	13.8	
7/2017	14.5	
8/2017	14.5	
9/2017	13.8	
10/2017	14.1	
11/2017	14.2	
12/2017	14.3	

Notes on Appendix A: Monthly averages were not always possible to calculate due to flows exceeding 100 cfs or the streamgage being out of service. Yellow highlighted values signify averages calculated from an incomplete dataset, followed by an explanation of why data was missing in the adjacent column. Blank fields are included for information purposes and represent months without data. The reader is cautioned that the Water Sentinels calculations of monthly average values without data reflecting higher flows greater than 100 cfs in a month are biased. Data highlighted in yellow are qualified because the monthly average value is less than it otherwise would be if accurate higher flow data were included in the calculation of the monthly average.

Appendix B. Water Sentinels Discharge Measurements for All Sites

Date	Flow (cfs)		
	Above Verde Springs	Bear Siding	Perkinsville
1/22/12	0.1	N/A	14.4
2/18/12	0.1	N/A	14.7
3/28/12	0.2	N/A	12.2
4/28/12	0.0	N/A	11.4
5/26/12	0.0	N/A	8.1
6/30/12	0.0	N/A	8.1
7/28/12	0.0	N/A	11.0
8/23/12	0.1	N/A	54.9
9/15/12	0.1	N/A	11.1
10/24/12	0.1	N/A	13.7
11/18/12	0.1	N/A	13.5
12/14/12	0.5	N/A	17.0
1/20/13	0.1	N/A	14.3
2/16/13	0.3	19.5	14.2
3/23/13	0.2	17.6	13.4
4/13/13	0.1	16.5	12.4
5/18/13	0.1	14.8	11.0
6/30/13	0.5	13.0	7.9
7/23/13	0.0	30.3	14.4
8/23/13	0.0	18.0	12.5
9/29/13	0.4	16.8	12.7
10/25/13		18.0	14.2
11/24/13		21.9	17.4
12/28/13		17.8	15.3
1/27/14	0.6	20.2	13.4
2/26/14	0.6	14.3	15.6
3/29/14	0.6	19.2	16.9
4/25/14	0.5	17.3	14.2
5/20/14	0.5	14.9	10.0
6/20/14	0.4	14.0	9.4
7/23/14	0.5	14.7	10.2

Date	Flow (cfs)		
	Above Verde Springs	Bear Siding	Perkinsville
8/26/14	0.7	21.3	12.2
9/21/14	0.3	17.8	21.0
10/28/14		15.1	14.0
11/21/14	0.2	14.5	14.4
12/19/14	0.2	16.4	15.4
1/26/15	0.3	16.7	15.1
2/26/15	0.3	14.1	16.0
3/25/15	0.2	19.0	16.0
4/30/15	0.3	15.4	12.2
5/22/15	0.0	17.3	11.9
6/30/15	0.0	15.4	10.2
7/27/15	0.0	12.9	8.8
8/27/15	0.1	15.6	12.8
9/30/15	0.0	14.7	10.8
10/28/15	0.0	14.0	13.1
11/23/15	0.1	16.0	14.7
12/30/15	0.0	16.0	15.6
1/27/16	0.1	17.2	15.6
2/22/16	0.1	16.4	15.1
3/30/16	0.0	16.4	12.3
4/27/16	0.0	14.4	12.9
5/24/16	0.0	14.2	10.9
6/29/16	0.0	14.8	11.5
7/27/16	0.0	15.5	11.6
8/31/16	0.0	17.2	13.1
9/29/16	0.0	16.2	13.2
10/26/16	0.0	18.2	13.3
11/30/16	0.0	18.4	13.9
12/28/16	0.0		59.5
1/27/17	1.9	50.5	45.8
2/22/17	0.0	70.2	61.8

Date	Flow		
	Above Verde Springs	Bear Siding	Perkinsville
3/29/17	0.4	18.9	15.4
4/26/17	0.2	18.4	14.1
5/24/17	0.2	14.0	10.5
6/28/17	0.1	11.5	7.9
7/26/17		22.5	24.7
8/30/17		14.1	11.4
9/27/17		14.7	10.3
10/26/17		15.9	12.5
11/29/17		17.5	13.2
12/27/17		17.2	14.9

Date	Perkinsville Ditch Flow (cfs) Measurements
1/22/12	<0.1
2/18/12	<0.1
3/28/12	2.4
4/28/12	1.7
5/26/12	0.6
6/30/12	1.0
7/28/12	0.1
8/23/12	1.9
9/15/12	0.7
5/18/13	0.9
6/30/13	1.3
7/23/13	2.2
8/23/13	0.8
9/29/13	1.1
10/25/13	0.8
4/30/15	3.5
5/22/15	1.4
6/30/15	2.6
7/27/15	2.3
8/27/15	1.7
9/30/15	2.4
10/28/15	1.4
3/30/16	2.9
4/27/16	1.7

5/24/16	1.0
6/29/16	1.4
7/27/16	1.1
8/31/16	0.9
9/29/16	1.3
10/26/16	1.4
11/30/16	1.4
12/28/16	1.0
5/24/17	1.4
6/28/17	1.6
7/26/17	2.5
8/30/17	1.3
9/27/17	1.3
11/29/17	0.2
12/27/17	0.3

Notes on Appendix B: Blank fields are included for information purposes and represent months without data due to either too high or too low flows to measure. Perkinsville ditch flow measurements demonstrate an approximation of how much water is being added to the Verde downstream where the ditch and river join together.

Appendix C. Annual Baseflow Values Calculated from 7 or More Low-flow Measurements

Year	7-Day or More Average Low-flow (cfs)	Month(s) Recorded
1963	18	Jul, Aug; record begins July 17, 1963
1964	15	18 in March, 15 in May, 19 in June, 22 in July, 20 in Nov
1965	19	19 in Oct, 20 in Sept and Oct
1966	21	Aug
1967	21	Jun and Oct
1968	21	Jul
1969	22	Jun, Jul, Sept, Oct
1970	22	Jan, Jul, Oct
1971	21	Jun, Jul, Sept
1972	18	18 in March, 20 in Jul
1973	22	Sep
1974	23	Feb, May, Jun, Jul, Oct
1975	23	Oct
1976	21	Jan-Feb, Jun, Jul, Sep
1977	20	Jul
1978	20	Sep-Oct
1979	23	Sep-Oct
1980	23	Sep-Oct
1981	23	Aug
1982	21	Sep
1983	25	Jan, Jun, Jul, Aug, Sep
1984	22	Sep
1985	26	Jun, Jul, Aug. Sep, Oct
1986	25	May, Jun, Jul
1987	24	Aug
1988	24	Jul
1989	22	Jul
1990	24	Jun
1991	21	Jul
1992	23	Jan,Nov
1993	25	May

1994	26	Jun,Jul,Sep,Oct
1995	25	Jul, Aug,Sep
1996	24	Aug,Sep
1997	23	Jun,Jul
1998	23	Jun-Jul
1999	22	Jun-Jul
2000	20	Jun,Jul,Aug,Sep
2001	21	Jun-Jul
2002	20	Jun,Jul,Aug,Sep
2003	19	Jul,Aug
2004	19	Jul
2005	23	Oct
2006	20	Jun
2007	19	Jul
2008	20	Jun
2009	20	Jul,Aug
2010	18	Jul
2011	18	Aug,Sep
2012	18	Jun-Jul
2013	18	May, Jun
2014	18	Jun,Jul
2015	17	
2016	18	
2017	18	
1963-2017	21	Average of all years
2000-2017	19	Average of 2000-2017
2010-2017	18	Average of 2010-2017