Analysis of 2023 Trail Usage Patterns along the Great Allegheny Passage

Final Report to the Great Allegheny Passage Conservancy
March 27, 2024

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Acknowledgments

This research would not be possible without the hard work and generous support of number of people and organizations.

First, I would like to recognize Doug Riegner of the Great Allegheny Passage Conservancy for his heroic efforts in maintaining and collecting data from the TRAFx counters along the Great Allegheny Passage, as well as organizing volunteers for the manual counts, which is a substantial and critical task. I would also like to thank the volunteers who generously contributed their time – many on several occasions -- to conduct the manual counts.

In addition, I would like to acknowledge the support of the Fayette, Somerset, and Westmoreland Counties' Tourism Grants, which help to fund this research project.

Executive Summary

- The Great Allegheny Passage is well used. I estimate the total number of visits to be in the range of 773,871 to 877,054 in 2023, with a mid-range estimate of 822,238.

- Volunteers identified "thru-riders" when conducting their synchronized counts. Based on this data, I estimate a total of 131,732 thru-riders on the GAP in 2023.

- This year's report is the eighth report since 2015, when the TRAFx locations and synchronized count protocol changed substantially. Trail use estimates have varied year-to-year since 2015, but the overall trend is an increase in trail use of approximately 2% per year.

Summary of Methodology

This report estimates trail use patterns along the Great Allegheny Passage (GAP), from Cumberland to Pittsburgh. These estimates are based on two primary data sources. The first is information gathered from TRAFx counters, infrared counters that track trail use at fixed locations along the trail. The second is information gathered from synchronized manual counts conducted at TRAFx counter locations. These counts occurred on seven dates in 2023: May 9 (Tue), May 31 (Wed), June 24 (Sat), July 17 (Mon), August 20 (Sun), September 15 (Fri), and October 5 (Thu). In each case, counts were conducted over a two-hour period (10-noon, 11-1, noon-2, or 1-3 pm).

I have conducted similar GAP trail use reports in previous years (2010–2013 and 2015–2022). The 2010-13 reports also relied heavily on information gathered from TRAFx counters and synchronized manual counts, but significant changes in data collection occurred in 2015. To start, three TRAFx counters were added, and several existing counters were relocated. In addition, the method for conducting synchronized counts changed substantially in 2015. Previously, synchronized counts were conducted close to trailhead locations, but the synchronized counts were moved to the TRAFx counter locations starting in 2015. As a result of different data collection methods, trail count numbers for 2015 and later years are not directly comparable to those of previous years.

I use the following methodology to estimate trail use along the GAP. First, I report raw TRAFx counts by location and month for March through December (Table 2). Next, I adjust these raw counts to account for the fact that the TRAFx counters typically under-count the actual number of people passing by the counters. I use the 2023 synchronized counts to derive a Count-to-Pass Factor (CP Factor) for each location (Tables 3 and 5). I then apply these CP Factors to derive adjusted TRAFx counts (Table 6) and use these adjusted TRAFx counts to derive low-, middle-, and high-range estimates of total trail use along the GAP.

TRAFx Data

In 2023, TRAFx counters collected data at 12 locations along the Great Allegheny Passage. Table 1 provides information on these counters and the data that they gathered.

Table 1: Summary of TRAFx Count Data (2023)

Location	Counter milepost	# Usable Count Days	First Date	Last Date
Cumberland	1.5	274	1-Mar	29-Nov
Frostburg	16.5	274	1-Mar	29-Nov
Deal	22.5	209	1-Mar	25-Sep
Garrett	34.5	272	1-Mar	29-Nov
Rockwood	45.5	267	1-Mar	22-Nov
Ohiopyle	69.0	225	19-Apr	30-Nov
Connellsville	85.0	275	1-Mar	30-Nov
Perryopolis	102.0	275	1-Mar	30-Nov
West Newton	111.5	178	6-Jun	30-Nov
Dravo Cemetery	122.0	275	1-Mar	30-Nov
Rankin Bridge	138.0	275	1-Mar	30-Nov
Hot Metal Bridge	146.5	275	1-Mar	30-Nov

In 2023, the TRAFx counters provided a total of 3,074 usable count days, an average of 256 per counter location.

Below, I provide some explanatory notes related to Table 1.

- I use March 1 as the standard start date and November 30 as the standard end date for the counters. In reality, five sites began registering data on February 28 and six sites recorded data through December 1. I do not feel comfortable making trail use estimates for February and December based on one day of data at selected sites, so I have disregarded the data from February 28 and December 1.
- The West Newton counter registered data beginning on February 28; however, it clearly under-reported counts early in the season. We replaced this counter on June 6. Immediately, counts increased to "normal" levels. For this reason, I report West Newton data starting on June 6.
- The trail near Ohiopyle was under construction through mid-April. For this reason, the Ohiopyle counter did not begin reporting data until April 19.
- The Deal counts dropped dramatically on September 26. On September 25, Deal registered a count of 46. On September 26, the count was 0. In fact, the Deal count was 0 in 55 of the 65 days from September 26 through November 29. For this reason, I do not use counter data for Deal after September 25.

Table 2 displays counts by month (March-December) at the 12 TRAFx counter locations, with slight modifications for days in which a counter registers no data, a count of 0, or a count that is unreasonably high or low, indicating a possible malfunctioning of equipment.[1] For each counter, I calculate an average weekday and weekend count for each month.[2] On days in which a counter has missing or unreliable data, I insert the average count for that location and month.[3]

Because we have few December 2023 counts (just one day for 6 locations and none for the other locations), I estimate December counts in Table 2 based on 2022 data. Specifically, I calculate the ratio of the December 2022 count to the total 2022 count from March through November for each location. I then multiply this ratio by the total 2023 count from March through November to estimate the December 2023 count for each location. Below is the calculation for Cumberland. All other calculations are similar.

- Cumberland December 2022 count: **1,261**
- Cumberland March thru November 2022 count: **56,210**
- Ratio of December 2022 to March thru November 2022: **0.0224** = (1,261)/(56,210)
- Cumberland March thru November 2023 count: **55,933**
- Estimated Cumberland December 2023 count: **1,255** = (55,933) x (0.0224)

Three locations experienced lengthy periods with no usable TrafX data: West Newton (March 1 – June 5), Ohiopyle (March 1 – April 18), and Deal (September 26 – November 29). I estimate counts for these locations with regression equations that relate counts at these locations to counts at a neighboring counter (Dravo Cemetery for West Newton, Connellsville for Ohiopyle, and Garrett for Deal). I do this separately for weekday and weekend counts. The resulting regression equations are as follows.

[1] Despite frequent testing, the TRAFx counters can return bad data due to moisture, spider webs, insect infestations, vandalism, battery failure, or a sweatshirt hanging over the lens.

[2] I define "weekday" as Monday through Friday and "weekend" as Saturday and Sunday. I also count holidays as "weekend" days, even if they occur during the week. In 2023, I counted the following holidays as weekend days: Memorial Day, Labor Day, July 4th (a Tuesday in 2023), Thanksgiving day, and the day after Thanksgiving.

[3] Specifically, I discarded 2 days of TrafX counts from Garrett because they were unreasonably high (647 on Thursday, May 11 and 255 on Friday, May 12). I suspect that there was some unusual activity at the counter on those days.

- West Newton weekdays = 0.863 x (Dravo Cemetery count) + 9.364 ($R^2 = 0.5748$)
- West Newton weekends = 0.755 x (Dravo Cemetery count) + 19.172 ($R^2 = 0.5631$)
    - Regression equations were derived from West Newton and Dravo Cemetery data from a baseline period of June 6 – November 30.
- Ohiopyle weekdays = 1.146 x (Connellsville count) – 3.927 ($R^2 = 0.6366$)
- Ohiopyle weekends = 0.656 x (Connellsville count) + 10.446 ($R^2 = 0.2938$)
    - Regression equations were derived from Ohiopyle and Connellsville data from a baseline period of October 12 – November 30. We are estimating 49 days of data at the beginning of the 2023 season (March 1 – April 18; the baseline period represents the 49 days at the end of the 2023 season.
- Deal weekdays = 0.433 x (Garrett count) + 4.921 ($R^2 = 0.2990$)
- Deal weekdays = 0.417 x (Garrett count) + 4.743 ($R^2 = 0.4807$)
    - Regression equations were derived from Deal and Garrett data from a baseline April 1 – September 25.

Finally, it is worth noting that the counters are intentionally located away from the trailheads, sometimes as far as two miles away, in order to reduce the number of walkers included in the count. With these caveats in mind, Table 2 summarizes the raw TRAFx counts for each location by month.

Synchronized Counts

Volunteers conducted synchronized counts on seven dates in 2023: May 9 (Tue), May 31 (Wed), June 24 (Sat), July 17 (Mon), August 20 (Sun), September 15 (Fri), and October 5 (Thu). In each case, counts were conducted over a two-hour period (10-noon, 11-1, noon-2, or 1-3 pm).

Given 12 locations and 7 synchronized count dates, a full set of data would include 84 synchronized count observations. In fact, we have 76 observations. Below is a summary of the missing synchronized counts.

- Deal (Oct 5): A manual count was conducted, but there is no corresponding TrafX count. Recall that I disregarded Deal TrafX counts after September 25 because the counter was recording unreasonably low counts.
- Garrett (Sep 15): The volunteer did not show.
- Perryopolis (July 17 and September 15): The volunteer did not show on these days.
- West Newton (May 9 and May 31): Manual counts were conducted on these days, but there is no corresponding TrafX count. Recall that the West Newton counter was not working properly until June 6.
- Rankin Bridge (May 9 and June 24): The volunteer did not show on these days.

Table 3 summarizes the Synchronized Count and TRAFx count at each counter for each count day. The last column calculates the overall Count-to-Pass Factor (CP Factor) for each location. The CP Factor equals the manual count divided by the TRAFx count.

Table 2: Raw TRAFx Counts by Location and Month (2023)

Location	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cumberland	2,879	5,062	8,271	7,518	7,802	6,776	6,805	7,539	3,281	1,255	57,188
Frostburg	932	2,584	3,953	3,594	3,567	3,305	3,773	3,638	1,678	611	27,635
Deal	103	468	1,504	1,454	423	824	1,015	750	275	152	6,968
Garrett	245	762	2,003	2,711	2,100	1,872	2,122	1,398	305	304	13,822
Rockwood	208	971	2,447	2,936	2,381	2,352	2,704	1,873	434	366	16,672
Ohiopyle	542	1,582	4,125	4,730	4,742	3,918	3,449	2,855	394	551	26,889
Connellsville	567	1,592	2,351	1,773	1,056	1,324	2,072	1,901	756	297	13,689
Perryopolis	798	1,634	2,785	2,678	2,075	2,040	1,983	1,014	275	334	15,616
West Newton	1,198	2,580	4,956	4,001	2,507	4,051	4,490	2,578	1,460	604	28,426
Dravo Cemetery	1,007	2,693	5,606	5,122	3,826	3,957	4,227	2,998	1,490	407	31,333
Rankin Bridge	3,910	7,502	11,162	10,520	8,519	8,284	8,821	6,370	3,712	1,498	70,298
Hot Metal Bridge	6,197	9,420	12,657	12,744	13,460	13,318	12,725	7,305	5,033	5,592	98,451
Total	18,586	36,851	61,820	59,781	52,458	52,021	54,186	40,219	19,093	11,971	406,987

Table 3: Synchronized Trail Counts (2023)

	9-May-23		31-May-23		24-Jun-23		17-Jul-23		20-Aug-23		15-Sep-23		5-Oct-23		Total		
Location	Man	TrafX	Man	TrafX	Man	TrafX	Man	TrafX	Man	TrafX	Man	TrafX	Man	TrafX	Man	TrafX	CP
Cumberland	29	49	27	27	56	31	30	39	23	21	42	47	72	92	279	306	0.912
Frostburg	27	13	61	47	53	33	35	21	49	41	55	44	53	38	333	237	1.405
Deal	14	10	53	17	34	4	38	3	77	16	35	12			251	62	4.048
Garrett	4	5	19	6	18	10	27	15	56	26			41	7	165	69	2.391
Rockwood	13	4	25	20	47	41	22	13	34	27	39	33	41	27	221	165	1.339
Ohiopyle	15	12	48	26	98	62	60	37	142	72	80	42	84	41	527	292	1.805
Connellsville	27	12	31	6	42	27	27	9	69	19	80	42	99	27	375	142	2.641
Perryopolis	19	16	33	21	47	24			70	35			111	88	280	184	1.522
West Newton					76	23	89	6	141	74	83	43	97	28	486	174	2.793
Boston	21	9	57	39	57	22	56	25	113	62	60	31	79	33	443	221	2.005
Rankin Bridge			116	99			61	40	171	106	76	67	118	101	542	413	1.312
Hot Metal Bridge	61	58	108	97	143	76	84	57	276	199	114	98	91	41	877	626	1.401
Total	**230**	**188**	**578**	**405**	**671**	**353**	**529**	**265**	**1,221**	**698**	**664**	**459**	**886**	**523**	**4,779**	**2,891**	**1.653**

Count-to-Pass (CP) Factors

By their nature, the TRAFx counters do not count trail users perfectly. For example, when cyclists ride side-by-side, follow close behind one another, or travel in a group, TRAFx counters tend to undercount the number of riders, because they do not have enough time to reset themselves between cyclists. Thus, the accuracy of a TRAFx counter declines when trail use is heavy.

To gauge the accuracy of each TRAFx counter, volunteers have conducted manual counts at the TRAFx counters for many years. These manual counts can be compared to the counts registered by the TRAFx counters during the same time period. I use this data to calculate a Count-to-Pass (CP) Factor by dividing the manual count by the TRAFx count and then use the CP Factors to derive adjusted TRAFx counts at each location. Table 4 exhibits this data for 2010-2023.[4]

Table 4: Historic CP Factors (2010-2023)

Year	Manual	TrafX	CP
2010	2,564	1,524	1.682
2011	1,821	1,000	1.821
2012	882	468	1.885
2013	1,123	633	1.774
2014	NA	NA	NA
2015	2,345	1,324	1.771
2016	5,858	3,107	1.885
2017	3,169	1,593	1.989
2018	3,405	1,270	2.681
2019	4,893	2,538	1.928
2020	4,093	1,780	2.299
2021	3,554	1,336	2.660
2022	4,552	2,368	1.922
2023	4,779	2,891	1.653
Total	43,038	21,832	1.971

[4] No manual counts were conducted in 2014.

Table 5 lists the CP Factors by location for 2023. These factors range from 0.912 at Cumberland[5] to 4.048 at Deal.

Table 5: CP Factors by Location (2023)

Location	Manual	TrafX	2023 CP Factor
Cumberland	279	306	0.912
Frostburg	333	237	1.405
Deal	251	62	4.048
Garrett	165	69	2.391
Rockwood	221	165	1.339
Ohiopyle	527	292	1.805
Connellsville	375	142	2.641
Perryopolis	280	184	1.522
West Newton	486	174	2.793
Dravo Cemetery	443	221	2.005
Rankin Bridge	542	413	1.312
Hot Metal Bridge	877	626	1.401
Total	4,779	2,891	1.653

Adjusted TRAFx Counts

As mentioned previously, the TRAFx counters tend to undercount trail users, particularly when cyclists ride side-by-side or in groups. For this reason, it is appropriate to apply CP Factors to the raw TRAFx counts to obtain a more accurate estimate of actual trail use.

Table 6 lists the adjusted TRAFx counts by location and month after applying the CP Factors. For the months of March through December, each count listed in Table 6 equals the corresponding count in Table 2 multiplied by the CP Factor for each location. For example, Cumberland's CP Factor is 0.912, and its raw count for March (listed in Table 2) is 2,879. Thus, the adjusted count for Cumberland in March in Table 6 is 2,625 (= 0.912 x 2,879). The other counts listed for March through December in Table 6 are calculated in a similar manner.

Staff from the Great Allegheny Passage Conservancy remove the TRAFx counters each winter to prevent damage from freeze-thaw cycles and, therefore, they do not operate during the months of January and February. I estimate trail use for these months by assuming total trail use at all locations is 1,200. This is the same assumption that I have made for several years in this report. I then allocate the trail use at each location according to the patterns observed during the March-December period. For example, during the months of March through December, Cumberland accounted for 8.0% of total trail use. So for January and February, I estimate trail use at Cumberland as 8.0% of 1,200, which is 97. I do a similar calculation for all 12 locations.

Table 6 reports total adjusted trail use in 2023 as 657,791. This represents a 8.9% decrease compared to 2022, when total adjusted trail use was 722,378.

[5] A CP Factor less than one indicates that the TraFx count exceeds the manual count. This rarely happens; however, it has happened two consecutive years (2022 and 2023) Cumberland. We are looking into why this may be happening.

Table 6: Adjusted Monthly TRAFx Counts (2023)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Cumberland	95	95	2,625	4,615	7,541	6,855	7,114	6,178	6,205	6,874	2,992	1,144	**52,333**
Frostburg	71	71	1,310	3,631	5,554	5,050	5,012	4,644	5,301	5,112	2,357	858	**38,971**
Deal	52	52	417	1,895	6,089	5,886	1,712	3,335	4,108	3,036	1,115	614	**28,311**
Garrett	61	61	586	1,822	4,791	6,483	5,022	4,478	5,074	3,343	729	727	**33,175**
Rockwood	41	41	279	1,301	3,277	3,932	3,189	3,150	3,622	2,509	581	490	**22,412**
Ohiopyle	89	89	978	2,856	7,445	8,537	8,558	7,072	6,225	5,153	712	994	**48,706**
Connellsville	66	66	1,497	4,204	6,209	4,682	2,789	3,496	5,472	5,020	1,996	785	**36,283**
Perryopolis	44	44	1,214	2,487	4,238	4,075	3,158	3,104	3,018	1,543	418	509	**23,851**
West Newton	145	145	3,347	7,208	13,842	11,176	7,002	11,314	12,541	7,201	4,078	1,687	**79,687**
Dravo Cemetery	115	115	2,019	5,398	11,237	10,267	7,669	7,932	8,473	6,010	2,987	816	**63,037**
Rankin Bridge	169	169	5,131	9,845	14,648	13,806	11,180	10,871	11,576	8,360	4,871	1,966	**92,593**
Hot Metal Bridge	253	253	8,682	13,197	17,732	17,854	18,857	18,658	17,827	10,234	7,051	7,834	**138,431**
Total	**1,200**	**1,200**	**28,084**	**58,458**	**102,604**	**98,603**	**81,262**	**84,233**	**89,442**	**64,393**	**29,888**	**18,425**	**657,791**

Interpreting the Adjusted TRAFx Counts

The adjusted TRAFx counts in Table 6 are derived by multiplying the raw TRAFx counts by the CP Factor for each location. As such, the adjusted TRAFx counts are a best estimate of the number of times a trail user passes a TRAFx counter. Moreover, the adjusted TRAFx counts at any location also represents a reasonable estimate of trail usage by those who enter at the trailhead closest to that counter.

Consider, for example, Ohiopyle. The TRAFx counter is located a couple miles down the trail toward Confluence. A rider traveling from Ohiopyle to Confluence and back will pass the counter twice, and the adjusted TRAFx count would, on average, double-count this trail user. But other trail users at Ohiopyle will go the opposite direction, toward Connellsville. These trail users will not pass the TRAFx counter at Ohiopyle. Some might be counted by the Connellsville counter, but some will not be counted by any TRAFx counter. In addition, most walkers who enter at Ohiopyle will not pass a TRAFx counter, even if they walk toward Confluence. As a result, we must balance those trail users who will double-counted with those who are not counted at all. It seems reasonable to assume that these two groups are roughly equal. If this is the case, then the adjusted TRAFx count provides a good estimate of trail usage at Ohiopyle.

Given the data available, I view the last column of Table 6 as the best estimate of 2023 trail use at each of the trailheads listed. These estimates will be better for some locations than others depending on how far the TRAFx counter is from the trailhead and the proportion of trail users who go in the direction toward the counter. These two factors vary between trailheads, so the estimates in Table 6 likely overestimate trail use at some trailheads and underestimate at others.

Total Trail Use Estimate

The bottom row of Table 6 estimates that trail users passed by the 12 TRAFx counter locations a total of 657,791 times. As I have argued above, this number is a reasonable estimate of the number of trail usage by those who enter the trail at the trailheads closest to the TRAFx counters. But these 12 locations are not the only places where users may enter the trail. As such, this number likely *underestimates* total trail use.

The locations of the TRAFx counters were chosen to capture as many as possible while minimizing the occurrence of trail users passing multiple counters on a single trip. I will assume as a midpoint estimate that 80% of trail visits begin at the trailheads closest to the TRAFx counters, with a range of 75% to 85%.[6] Put another way, I estimate that somewhere between 15% and 25% of trail visits begin at a trailhead other than the 12 trailhead locations where TRAFx counters are located.

If we assume the midpoint estimate of 80%, then the resulting mid-range estimate of total trail use is 822,238 = (657,791 ÷ 0.80). The low-range and high-range estimates are 773,378 = (657,791 ÷ 0.85) and 877,054 = (657,791 ÷ 0.75), respectively. I estimate that trail use along the GAP decreased by 8.9% between 2022 and 2023.

[6] These estimates are based on input provided by the Great Allegheny Passage Conservancy.

Thru-Riders

The GAP offers the opportunity for cyclists to take lengthy, multi-day trips. Starting in 2018, the form that volunteers use to tally synchronized manual counts has included a section to mark "thru-riders." The Great Allegheny Passage Conservancy asked volunteers to use their judgment to determine whether a passing cyclist was on an extended ride, and provided examples, such as a cyclist riding with a substantial pack, one with two loaded panniers, or one carrying camping gear might be a thru-rider. Some volunteers take initiative to ask cyclists as they pass by.

Table 7 summarizes the number of riders identified as a thru-rider during manual counts for the years 2018-2023 and calculates a percentage of thru-riders relative to the total number of trail users. The data is broken down by weekday manual counts (Mon-Fri) versus weekend manual counts (Sat and Sun).

Table 7: Thru Riders Compared to All Users, Weekday and Weekend (2018-2023) Calculated by Volunteer Judgment

	Weekday			Weekend		
Year	Thru	Total	% Thru	Thru	Total	% Thru
2018	121	783	15.5%	334	2,622	12.7%
2019	162	831	19.5%	208	4,064	5.1%
2020	351	2,918	12.0%	166	1,437	11.6%
2021	848	3,779	22.4%	NA	NA	NA
2022	539	2,235	24.1%	210	2,317	9.1%
2023	701	2,887	24.3%	253	1,892	13.4%
Total	**2,722**	**13,433**	**20.3%**	**1,171**	**12,332**	**9.5%**

The data in Table 7 show that the percentage of thru riders is approximately twice as large during the week as compared to the weekend. This makes intuitive sense. By definition, thru-riders have set aside several days for their long trek. In contrast, day riders would more likely use the trail before work, after work, or on the weekend. Thus, it is reasonable to assume that weekday manual counts conducted in the middle of the day would count a higher percentage of thru riders than weekend counts.

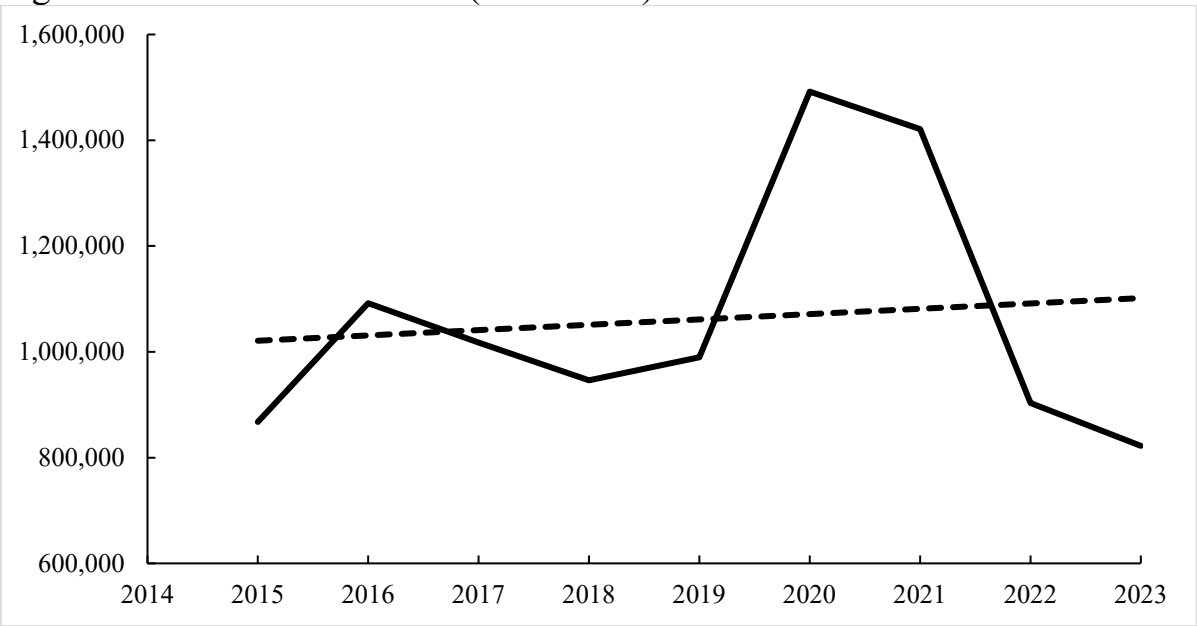
The mid-range estimate of total trail use is 822,238 for 2023. The raw TRAFx count data indicates that 60.6% of trail use occurs during the week compared to 39.4% on the weekend. This implies that the total trail use in 2023 breaks down to 498,288 during the week and 323,950 on the weekend. Applying the average thru rider percentages (2018–2023) from Table 7 (20.3% weekday and 9.5% weekend) yields an estimate of 100,971 weekday thru riders and weekend 30,761 thru riders, for a total estimate of 131,732 thru riders in 2023.

Historical Perspective

This year's report is the eighth report since 2015, when the TRAFx locations and synchronized count protocol changed substantially.

Figure 1 shows the mid-range total trail use estimates for 2015-2023 along with a linear trendline. Clearly, trail use estimates have varied considerably year-to-year. Some of the fluctuation is likely due to fluctuations in the quality of data generated by the TRAFx counters, and some is likely due to true year-to-year fluctuations caused by factors such as the weather. The dramatic increase in trail use in 2020 and 2021 undoubtedly reflects the impact of the COVID-19 pandemic, when people increasingly engaged in outdoor recreational activities. Overall, the linear trendline shows an increase in trail use of approximately 2% per year from 2015-2023.

Figure 1: Total GAP Trail Use (2015-2023)



Year	Total Trail Use
2015	867,719
2016	1,091,706
2017	1,017,662
2018	946,284
2019	989,455
2020	1,491,963
2021	1,421,963
2022	902,973
2023	822,238