

US 85 / ND 200 Spot Speed Studies

Final Report

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BACKGROUND

NDDOT requested the Advanced Traffic Analysis Center (ATAC) to conduct before-and-after spot speed studies at three locations along US 85/ND 200. The three locations are:

1. Site 1
US 85/ND 200 east of Arnegard
RP 147.5
Posted Speed Limit 65mph
2. Site 2
US 85/ND 200 through Arnegard
RP 149.5
Posted Speed Limit 45mph
3. Site 3
US 85/ND 200 south of Alexander
RP 157.2
Posted Speed Limit 65mph

One study was conducted at each of the locations with both northbound/westbound and southbound/eastbound directions of travel observed. Two years later, another study was conducted in the same manner.

METHODOLOGY

For these spot speed studies, the Operating Speed Method, generally known as the 85th percentile speed method, was used. In addition to the 85th percentile speed, the following parameters were calculated:

- Mean speed
Average speed of vehicles observed.
- Mode speed
Most frequently observed speed.
- Median speed
50th percentile speed.
- Minimum speed
Speed of the slowest observed vehicle.
- Maximum speed
Speed of the fastest observed vehicle.
- Pace
Window of 10 mph range encompassing highest number of observed vehicles.
- Vehicles in pace
Percent of observed vehicles driving at speeds within pace.
- Total speeding
Total percent of vehicles speeding.
- Speeding 5 & over
Percent of vehicles speeding 5 mph and over the posted speed limit.
- Speeding 10 & over
Percent of vehicles speeding 10 mph and over the posted speed limit.
- Standard deviation
Measure of spread or dispersion of observed speeds.

- Sample size
Total number of vehicles observed in the given direction per site.

Assuming a standard deviation of 5.3 mph, the minimum sample size requirement at these locations was found to be 187. The dates and times of observation are listed in Table 1. Note that because of rapidly decreasing/increasing instantaneous speeds or otherwise non-free-flow conditions, some vehicles were intentionally left out from the observations, including:

- Emergency vehicles in pursuit or responding to emergency situations
- Vehicles deliberately driving slower (indicated by actively flashing beacons)
- Turning vehicles including vehicles in two way turn lane
- Vehicles entering the roadway from a complete stop close to the study location(s) including all vehicles turning into or out of fueling station/Bakken base camp.

Table 1. Observation dates and times for spot speed studies.

Location	Data	Date	Direction	Time
Site 1	Before	August 7, 2019	Northbound	2:00 p.m. – 6:00 p.m.
			Southbound	2:00 p.m. – 5:30 p.m.
	After	August 10, 2021	Northbound	9:30 a.m. – 12:00 p.m.
			Southbound	9:30 a.m. – 12:00 p.m.
Site 2	Before	August 6, 2019	Northbound	2:00 p.m. – 6:00 p.m.
			Southbound	2:00 p.m. – 6:00 p.m.
	After	August 11, 2021	Northbound	9:00 a.m. – 12:00 p.m.
			Southbound	9:00 a.m. – 12:00 p.m.
Site 3	Before	August 6, 2019	Northbound	9:45 a.m. – 12:45 p.m.
			Southbound	9:45 a.m. – 12:45 p.m.
	After	August 10, 2021	Northbound	12:30 p.m. – 3:00 p.m.
			Southbound	12:30 p.m. – 3:00 p.m.

Table 2. Summary of spot speed study results.

<div> <div>Location</div> <div>Parameter</div> </div>	1. NB US 85/WB ND 200 RP 147.5				2. NB US 85/WB ND 200 RP 149.5				3. NB US 85/WB ND 200 RP 149.5			
	NB/WB		SB/EB		NB/WB		SB/EB		NB/WB		SB/EB	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Posted (mph)	65	65	65	65	45	45	45	45	65	65	65	65
85 th Percentile (mph)	69	68	70	68	52	49	51	48	71	68	71	69
Standard Deviation (mph)	7.9	3.9	3.9	3.7	4.0	3.9	4.8	3.4	4.0	3.6	7.2	4.3
Mean (mph)	66	64	66	65	48	46	48	45	68	65	68	65
Mode (mph)	68	66	66	66	48	45	64	44	69	66	64	64
Median (mph)	66	64	66	65	47	45	47	44	68	65	67	65
Minimum (mph)	45	54	50*	51	37	37	39	34	52	53	54	52
Maximum (mph)	83	75	77	73*	62*	61	73	54	79*	75	80*	80
Pace (mph)	61-71	61-71	62-72	60-70	44-54	41-51	42-52	40-50	64-74	60-70	62-72	61-71
In Pace (%)	79	82	82	85	83	84	80	85	79	85	78	78
Total Speeding (%)	60	40	63	49	73	54	72	36	77	48	70	50
Speeding 5 & Over (%)	10	4	12	5	25	12	20	5	22	4	22	9
Speeding 10 & Over (%)	<1	0	2	0	3	2	5	0	3	0	5	0
Sample Size	229	217	252	233	223	202	227	211	230	250	237	249

* Multiple (2-4) observations at this speed

BEFORE SAFETY CORRIDOR IMPLEMENTATION

A summary of the results is presented in Table 2. Based on the before data, the observations/results are:

- On an average, the 85th percentile speed during the before studies was found to be approximately 5-6 mph over the posted speed limit.
- A very large percentage of motorists were observed to be traveling within the respective paces at each of the locations.
- The percentage of motorists speeding declined very sharply approaching the speeds of 5mph over the posted limit.
- The standard deviation at Site 1 in the NB US 85/WB ND 200 and Site 3 in the SB US 85/EB ND 200 directions of travel were found to be higher than expected.
- The highest occurrences of motorists speeding at or more than 10 mph over the speed limit were observed in the SB US 85/EB ND 200 direction at Sites 2 and 3.

AFTER SAFETY CORRIDOR IMPLEMENTATION

From the completed Table 2, the following is observed between 2019 and 2021:

- Mean speed had an average decrease of 2-3 mph.
- Pace had an average decrease of 2 mph.
- Less deviation was present in 2021. This is reflected in both a reduced standard deviation and a greater in pace percentage.
- Speeding percentage was reduced by 23% on average.

STATISTICAL TEST

To determine the significance of our results, we must compare values from our before and after studies using a normal approximation test. This test will ensure that there is less than a 5% chance of our results falsely appearing as if the problem is solved. We will use the following equations and data from our studies to complete this test:

$$z_d = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{s_y}$$

$$s_y = \sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}$$

Where:

z_d

= standard normal distribution equivalent to the observed difference in sample speeds

\bar{x}_1 = mean speed of the before sample, mph

\bar{x}_2 = mean speed of the after sample, mph

s_y = pooled standard deviation of the distribution of sample mean differences

s_1 = standard deviation of the before sample, mph

s_2 = standard deviation of the after sample, mph

N_1 = sample size of the before study, vehicles

N_2 = sample size of the after study, vehicles

Table 3. Statistical Data for Site 1, WB

Site 1, WB	Before Results (1)	After Results (2)
\bar{x}	66	65
s	7.9	3.7
N	229	217

Table 4. Statistical Data for Site 1, EB

Site 1, EB	Before Results (1)	After Results (2)
\bar{x}	66	64
s	3.9	3.9
N	252	233

Table 5. Statistical Data for Site 1, WB

Site 2, WB	Before Results (1)	After Results (2)
\bar{x}	48	45
s	4.0	3.4
N	223	202

Table 6. Statistical Data for Site 1, EB

Site 2, EB	Before Results (1)	After Results (2)
\bar{x}	48	46
s	4.8	3.9
N	227	211

Table 7. Statistical Data for Site 1, WB

Site 3, WB	Before Results (1)	After Results (2)
\bar{x}	68	65
s	4.0	4.3
N	230	250

Table 8. Statistical Data for Site 1, EB

Site 3, EB	Before Results (1)	After Results (2)
\bar{x}	68	65
s	7.2	3.6
N	237	249

We will use Site 1, WB calculations as an example of how we arrived at our results regarding the normal approximation test.

$$\begin{aligned}
 s_y &= \sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}} \\
 s_y &= \sqrt{\frac{7.9^2}{229} + \frac{3.7^2}{217}} \\
 s_y &= 0.5793 \\
 z_d &= \frac{(\bar{x}_1 - \bar{x}_2) - 0}{s_y} \\
 z_d &= \frac{(66 - 65) - 0}{0.5793} \\
 z_d &= 1.7261
 \end{aligned}$$

To have a confidence that exceeds 95%, we must have a z_d value that is greater than 1.645.

$$1.7261 \geq z_{\min} 1.645$$

We conclude from this statement that the reduction in average speed after changes were made is **significant**.

To find the “true” mean of the distribution of the after sample, we use the equation:

$$\mu = \bar{x}_2 \pm 1.96E$$

Where:

$$E = \frac{s_2}{\sqrt{N_2}}$$

$$E = \frac{3.7}{\sqrt{217}}$$

$$E = 0.2512$$

Plugging this E value into our “true” mean equation:

$$\mu = 54 \pm 1.96(0.2512)$$

This gives us a range of $64.5077 \leq \mu \leq 65.4923$

Table 9. Normal Approximation Results

US 85 Calculations							
Site	Dir	Sy	Zd	Significant?	E	Mean Lower	Mean Upper
1	WB	0.579327	1.726139	Yes	0.251172	64.5077	65.4923
	EB	0.354452	5.642515	Yes	0.255497	63.49922	64.50078
2	WB	0.359133	8.353448	Yes	0.239223	44.53112	45.46888
	EB	0.416633	4.800387	Yes	0.268487	45.47377	46.52623
3	WB	0.378847	7.918759	Yes	0.271956	64.46697	65.53303
	EB	0.520368	5.765156	Yes	0.228141	64.55284	65.44716

The table above shows that all data is statistically significant.

APPENDIX

Figure 1. 2019 Frequency Distribution of Site 1, WB

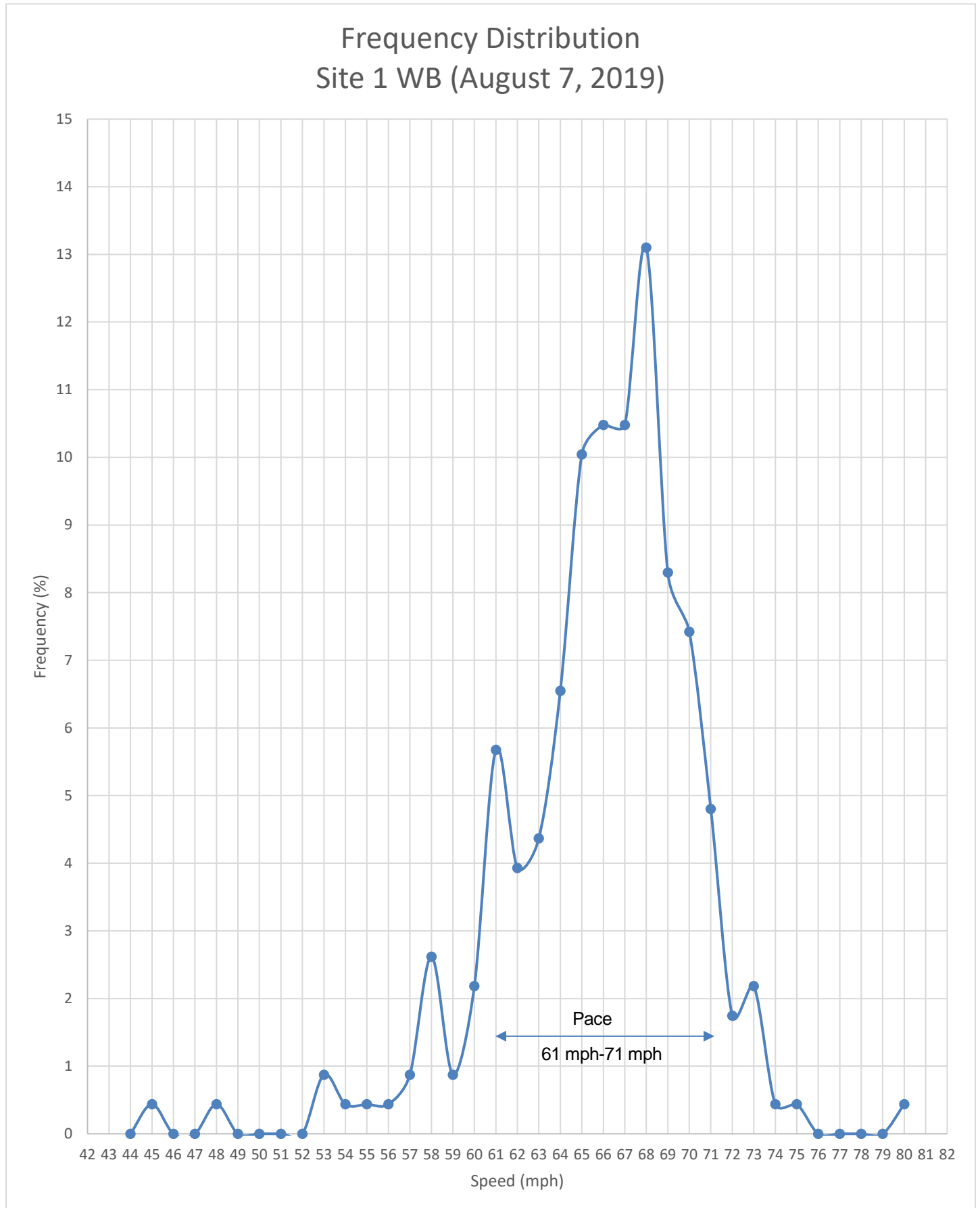


Figure 2. 2021 Frequency Distribution of Site 1, WB

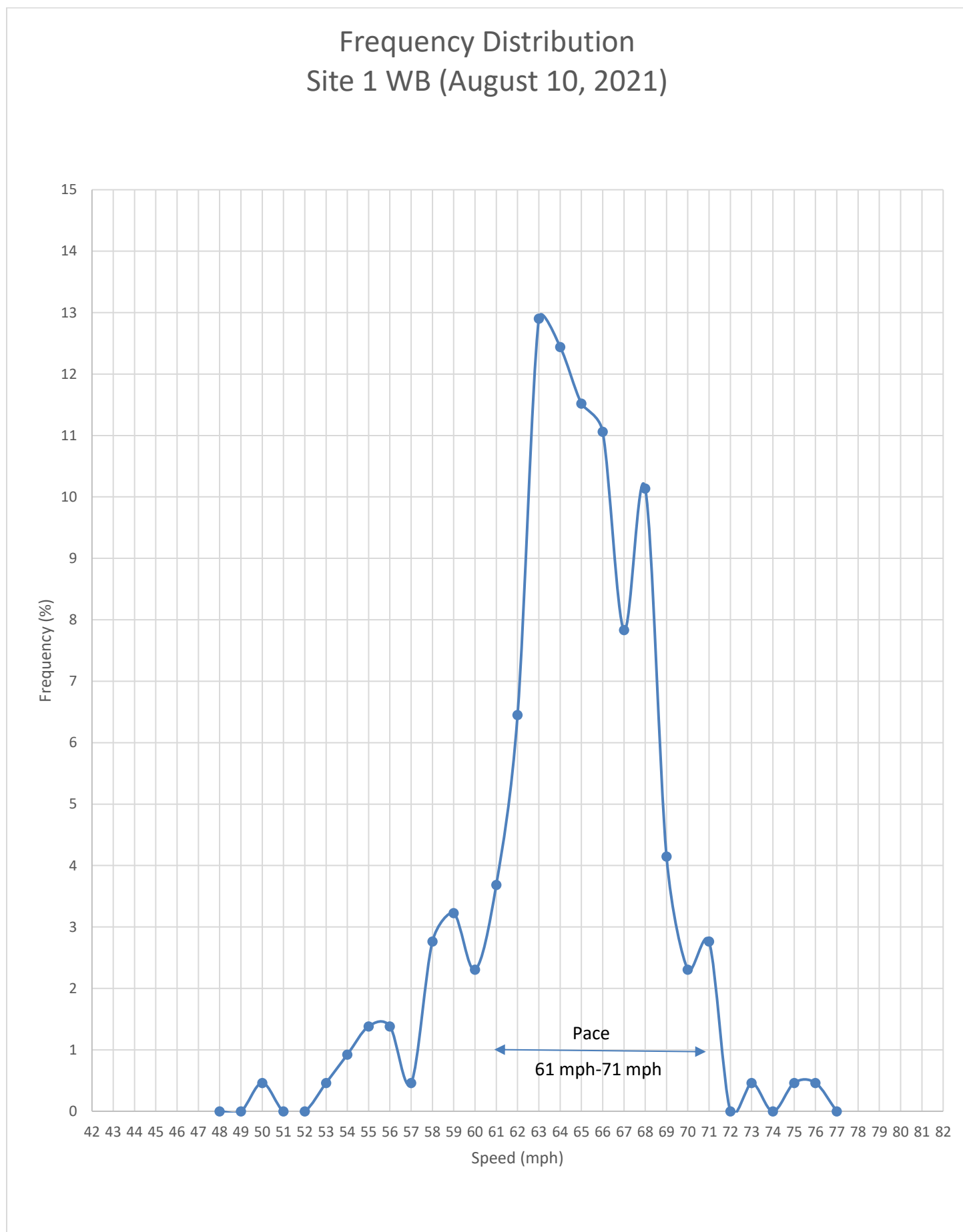


Figure 3. 2019 Frequency Distribution of Site 1, EB

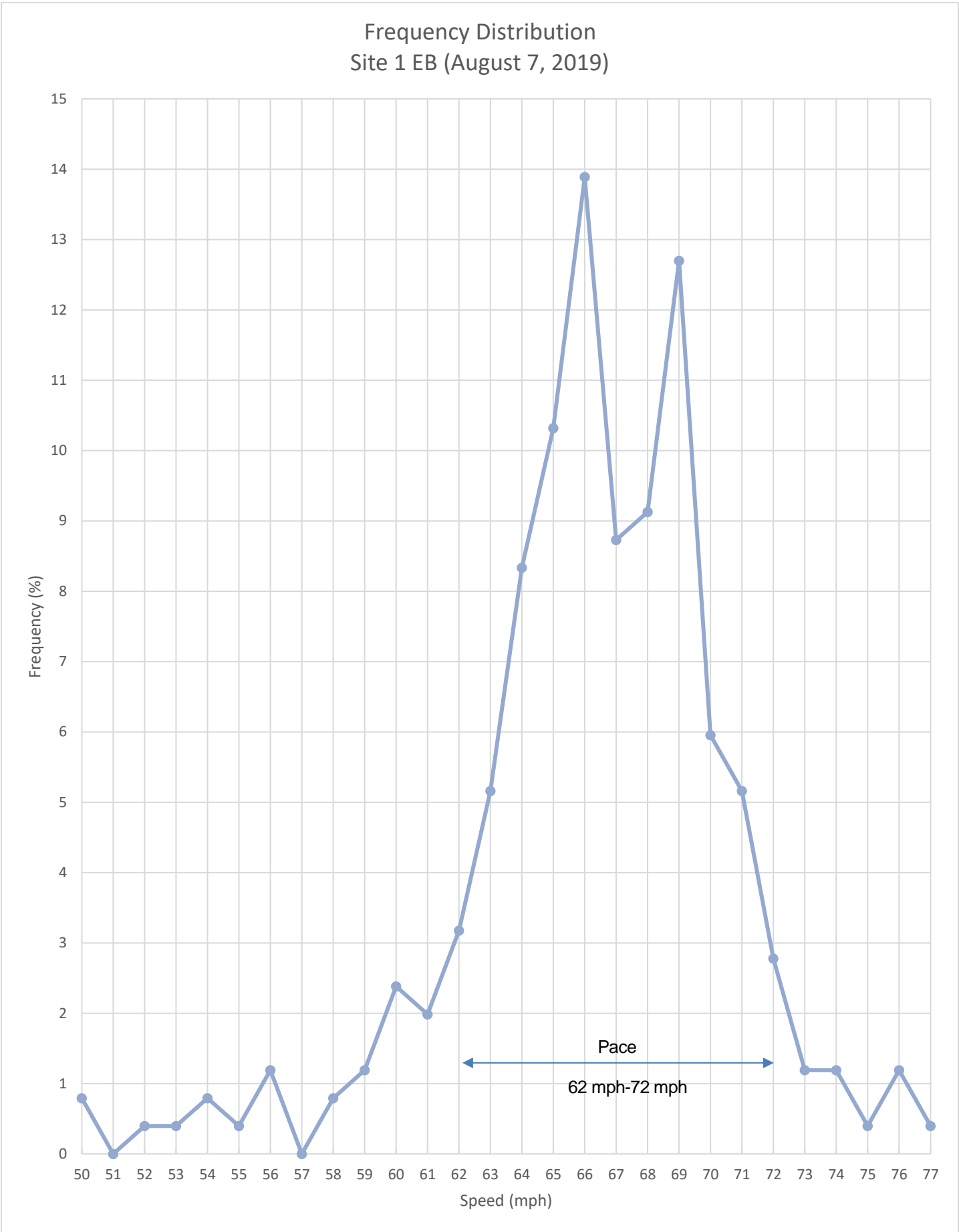


Figure 4. 2021 Frequency Distribution of Site 1, EB

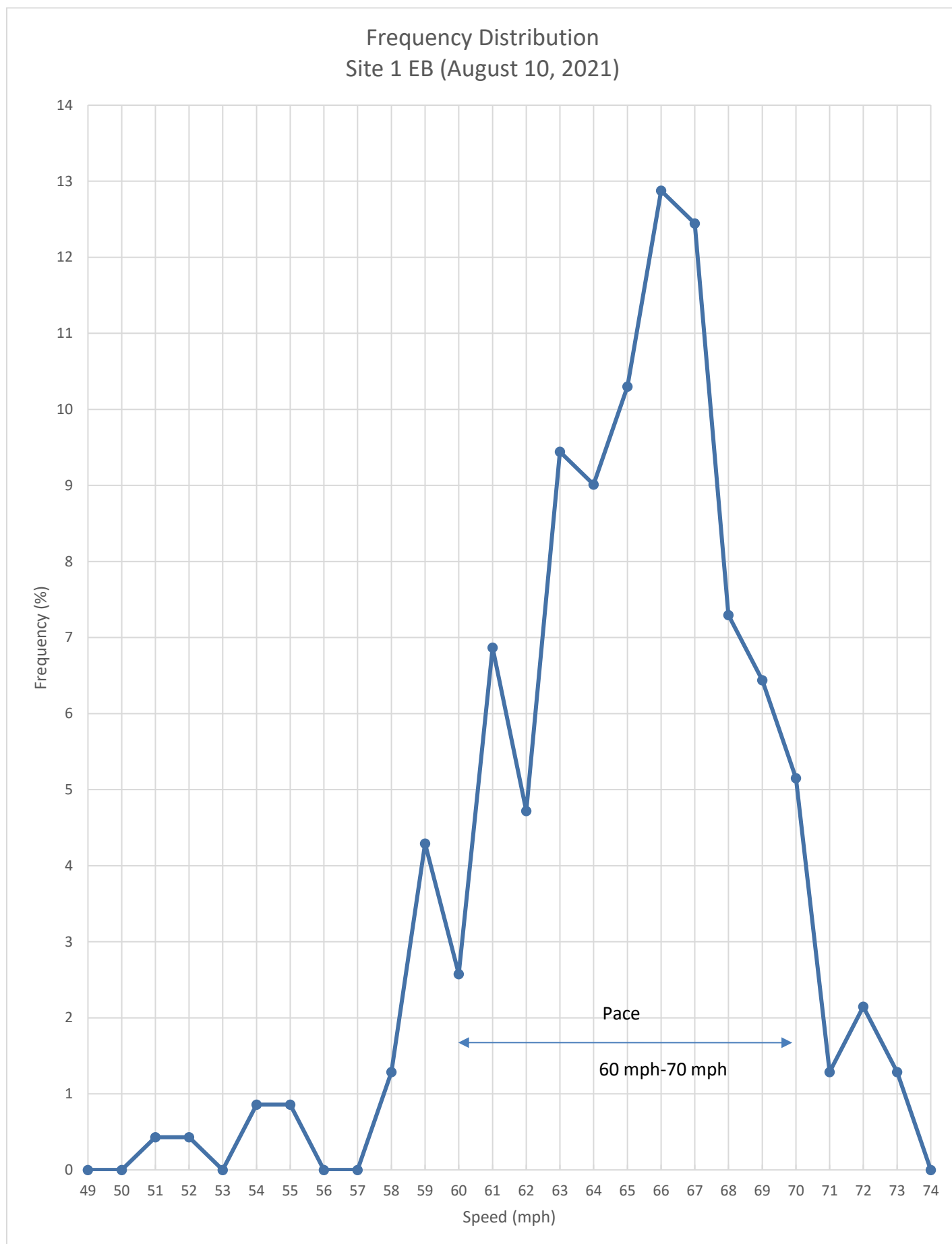


Figure 5. 2019 Frequency Distribution of Site 2, WB

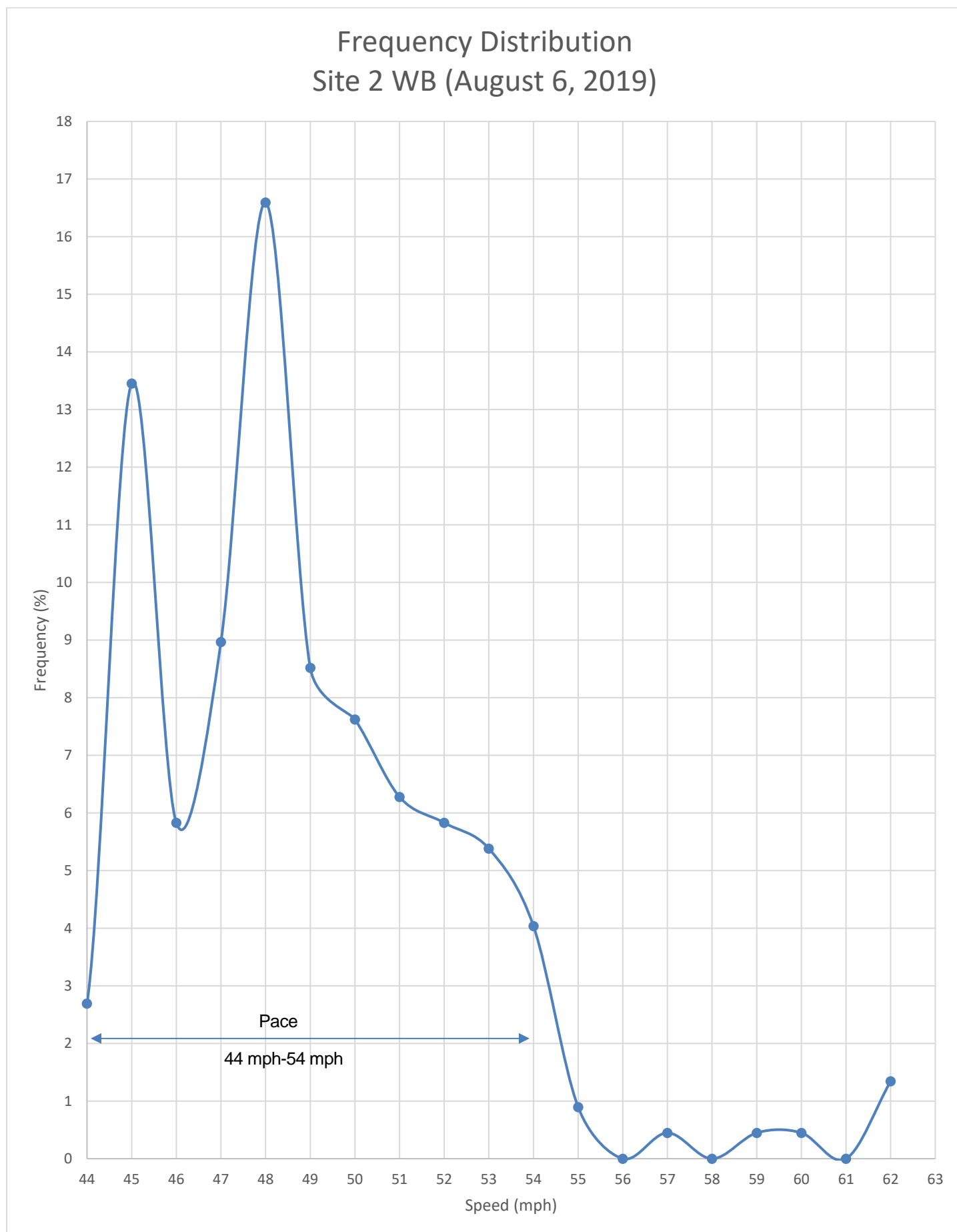


Figure 6. 2021 Frequency Distribution of Site 2, WB

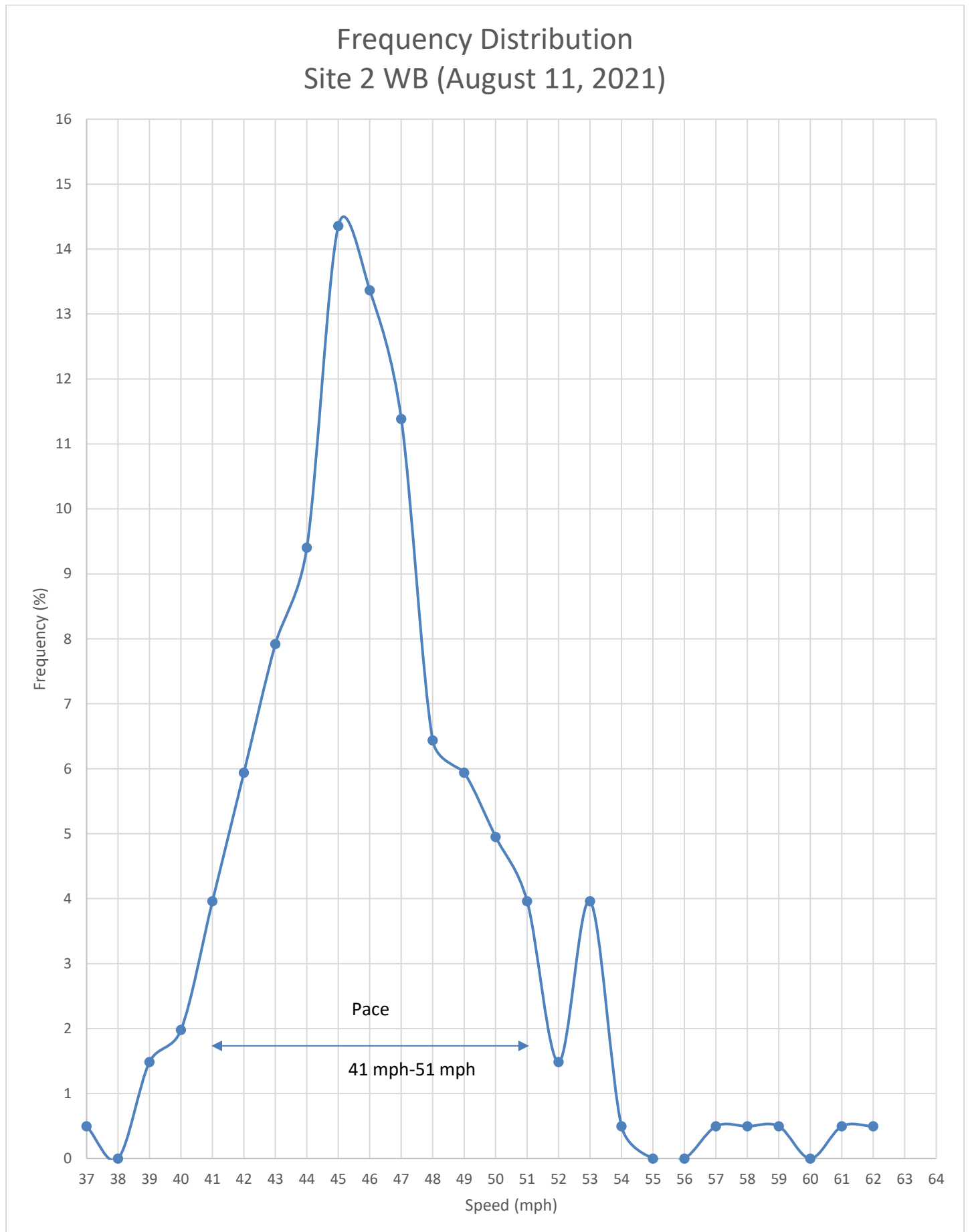


Figure 7. 2019 Frequency Distribution of Site 2, EB

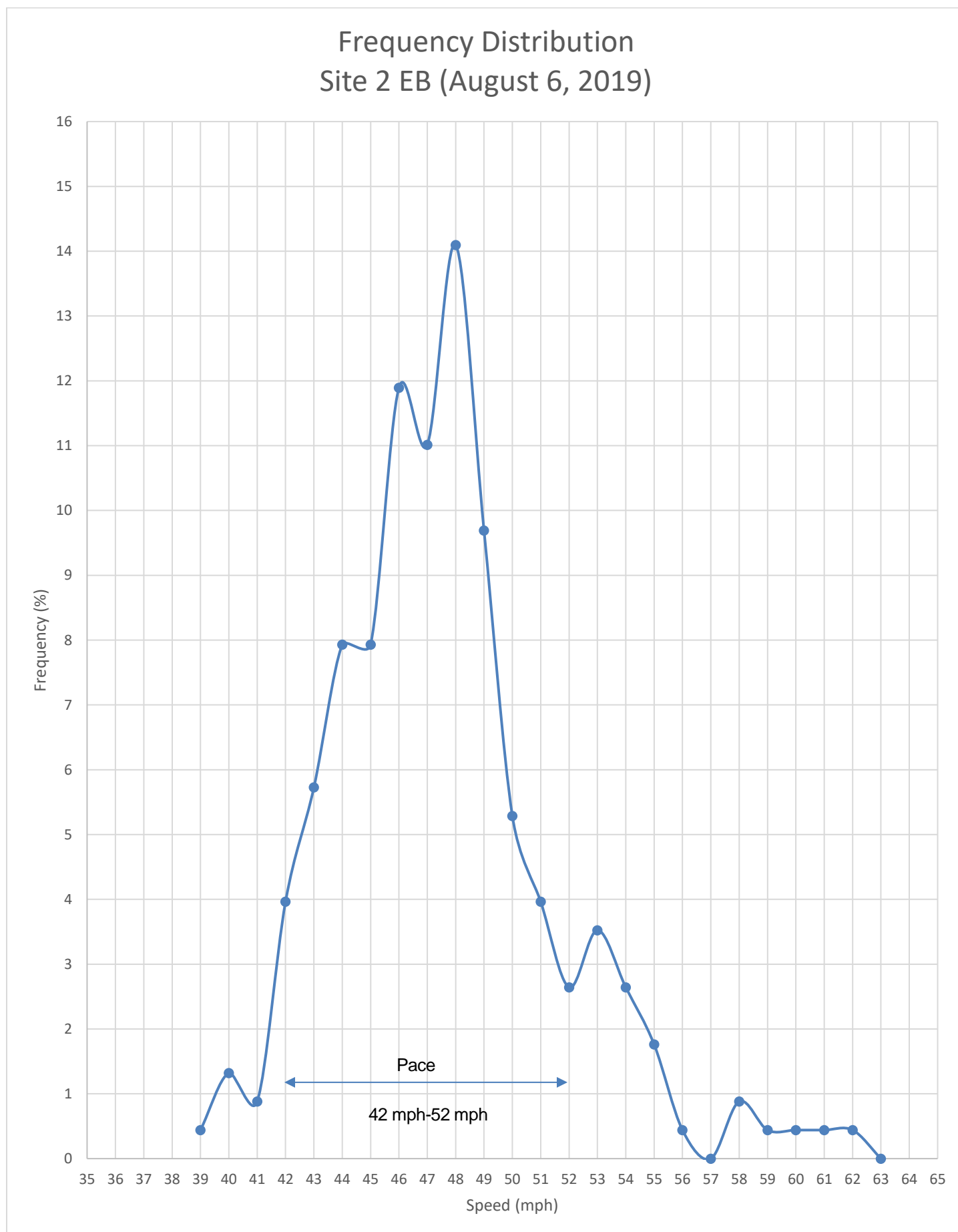


Figure 8. 2021 Frequency Distribution of Site 2, EB

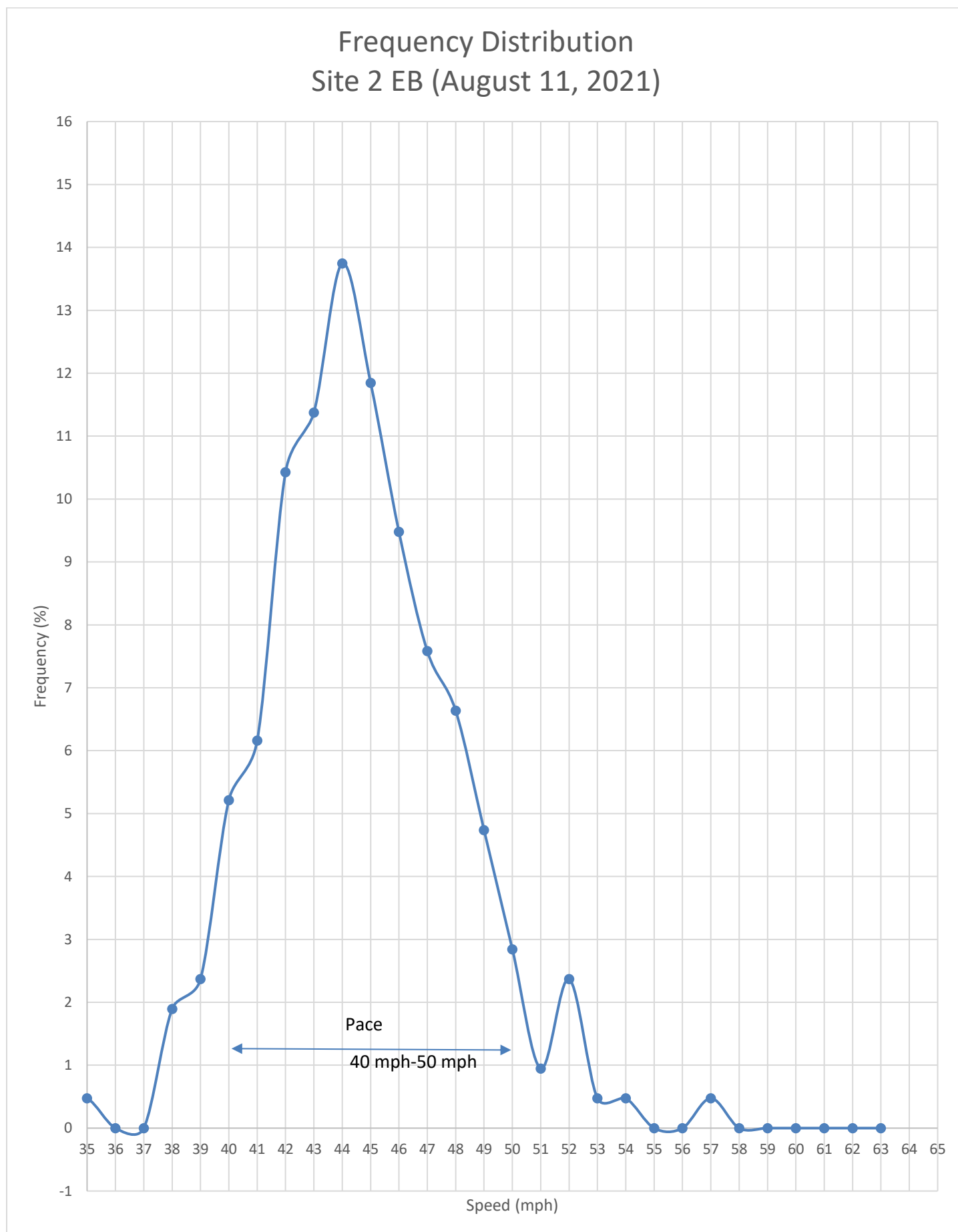


Figure 9. 2019 Frequency Distribution of Site 3, WB

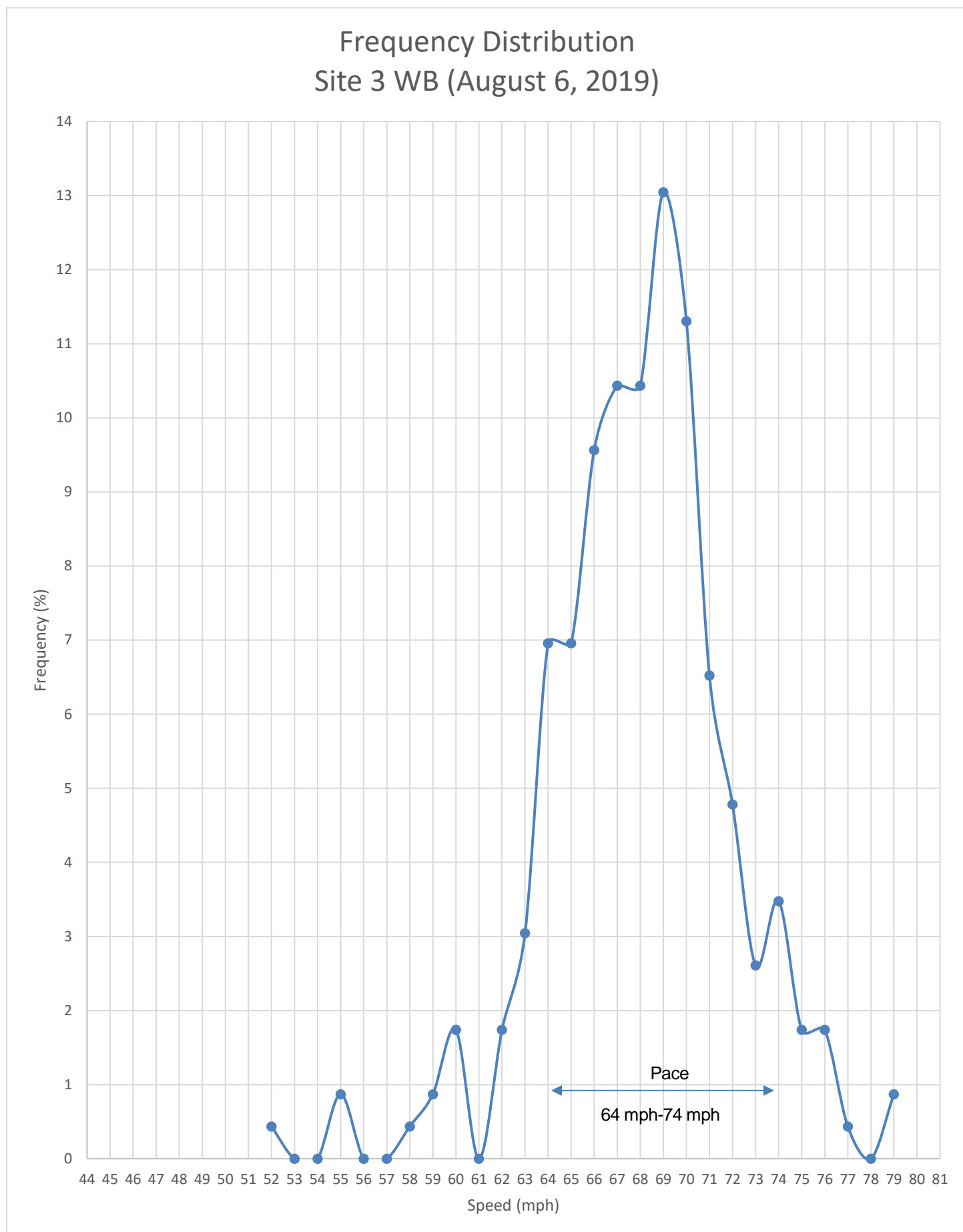


Figure 10. 2021 Frequency Distribution of Site 3, WB

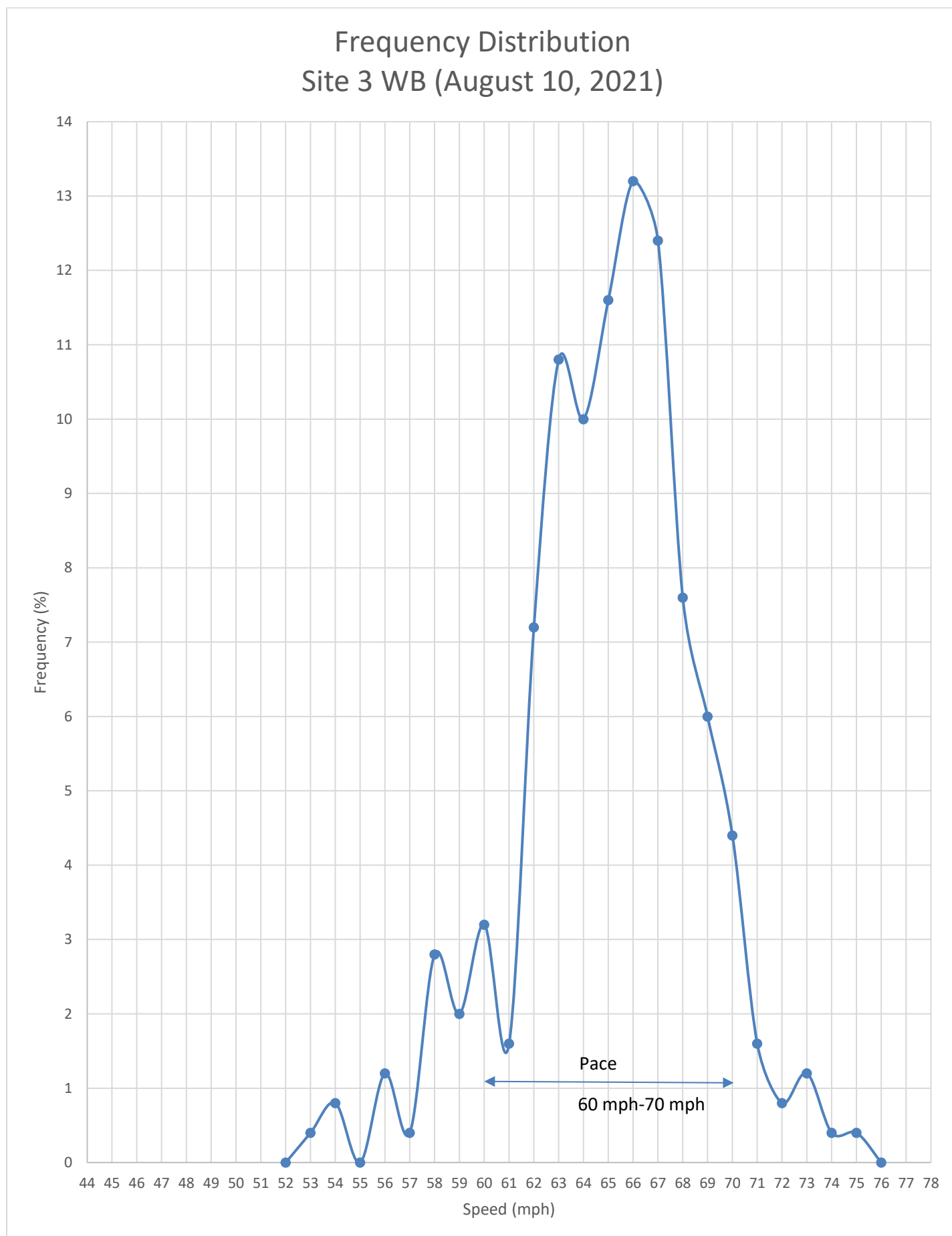


Figure 11. 2019 Frequency Distribution of Site 3, EB

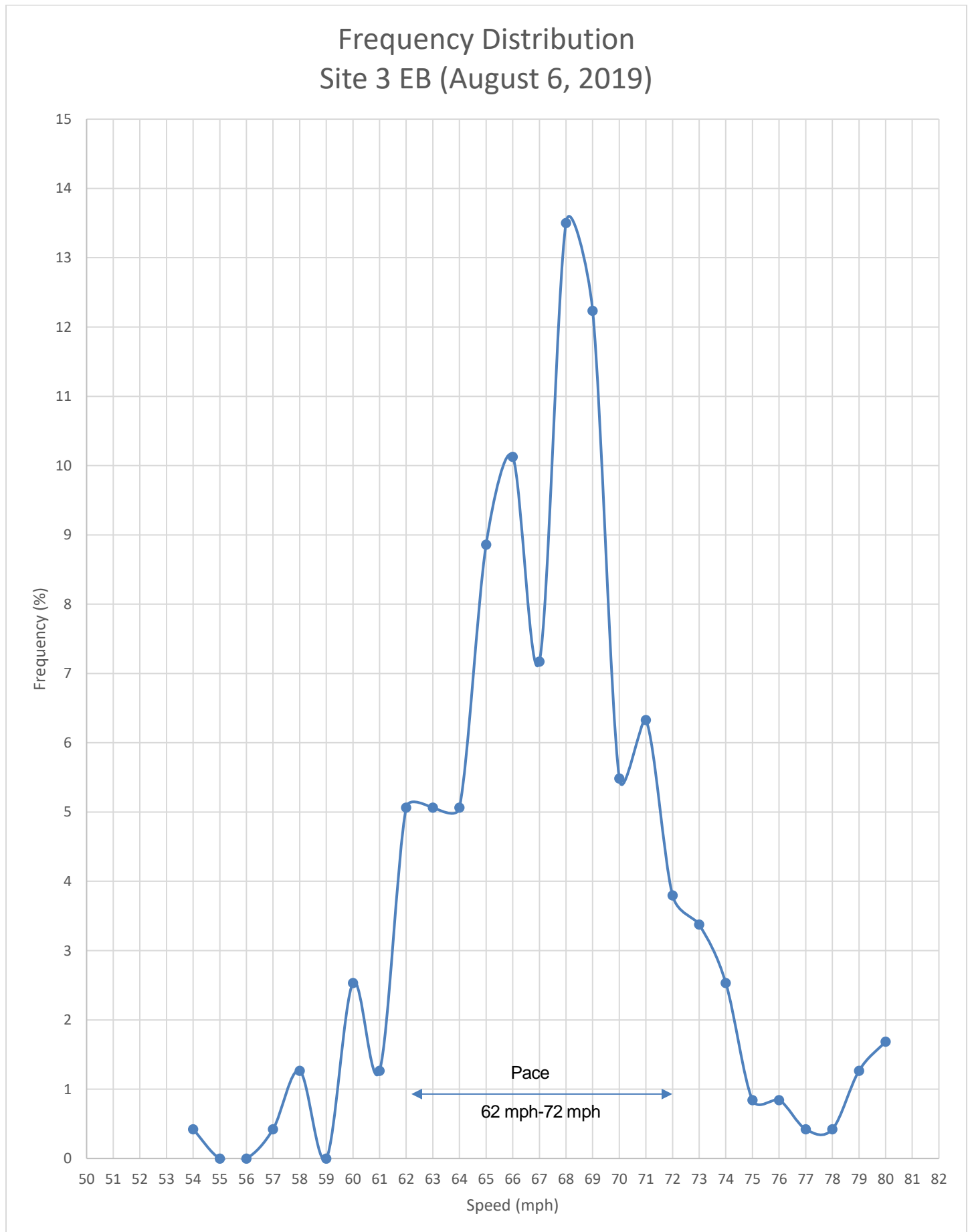


Figure 12. 2021 Frequency Distribution of Site 3, EB

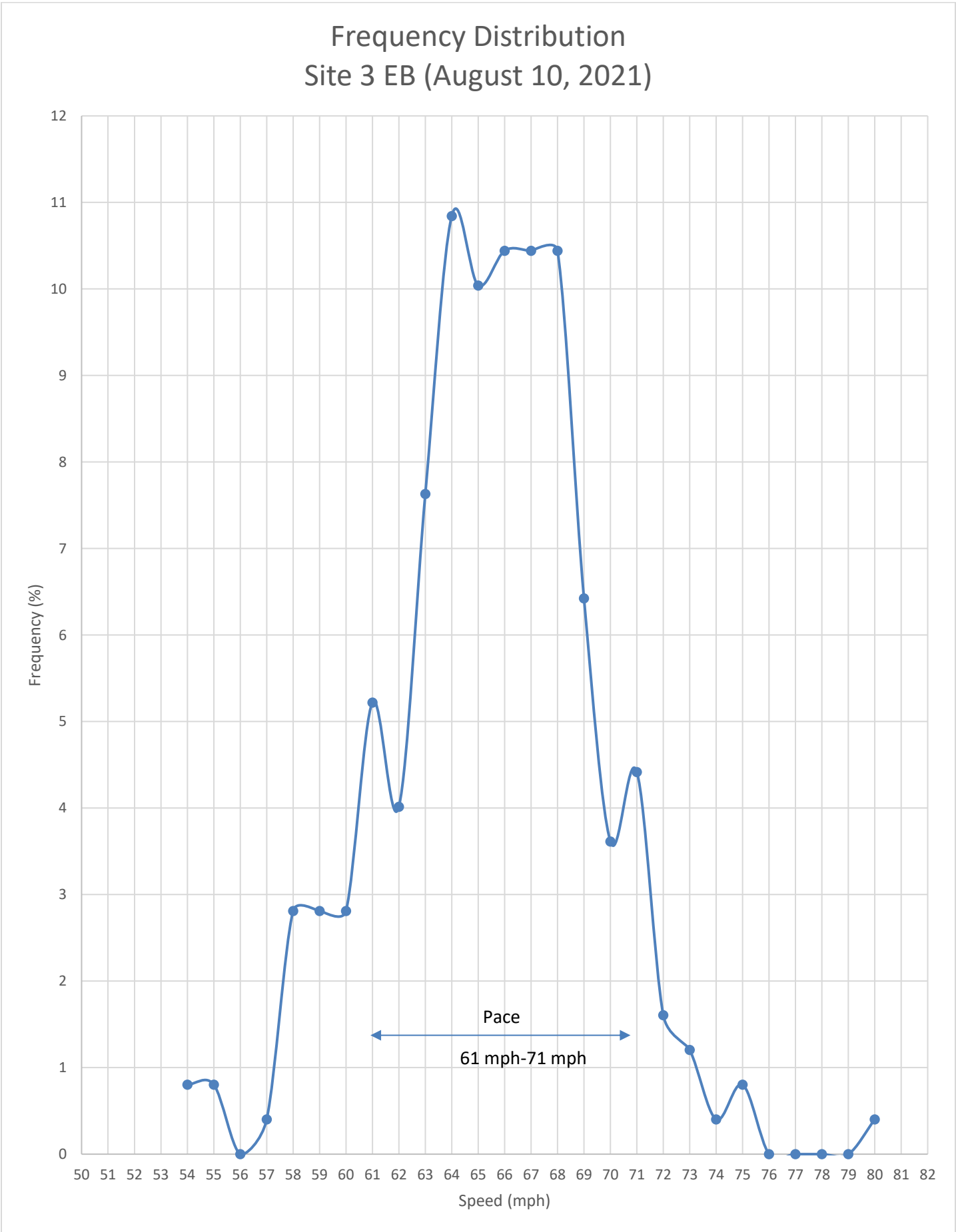


Figure 13. 2019 Cumulative Frequency Distribution of Site 1, WB

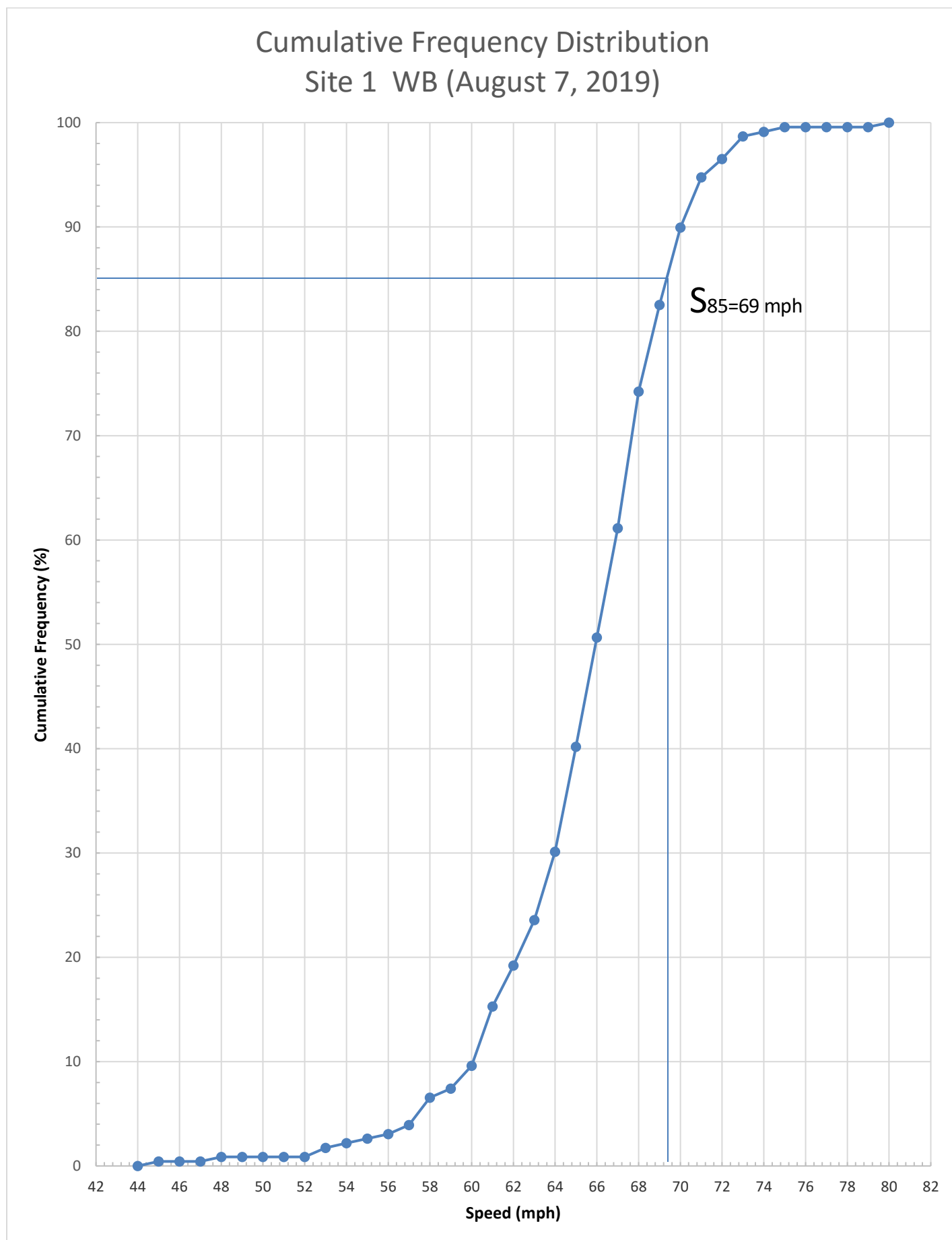


Figure 14. 2021 Cumulative Frequency Distribution of Site 1, WB

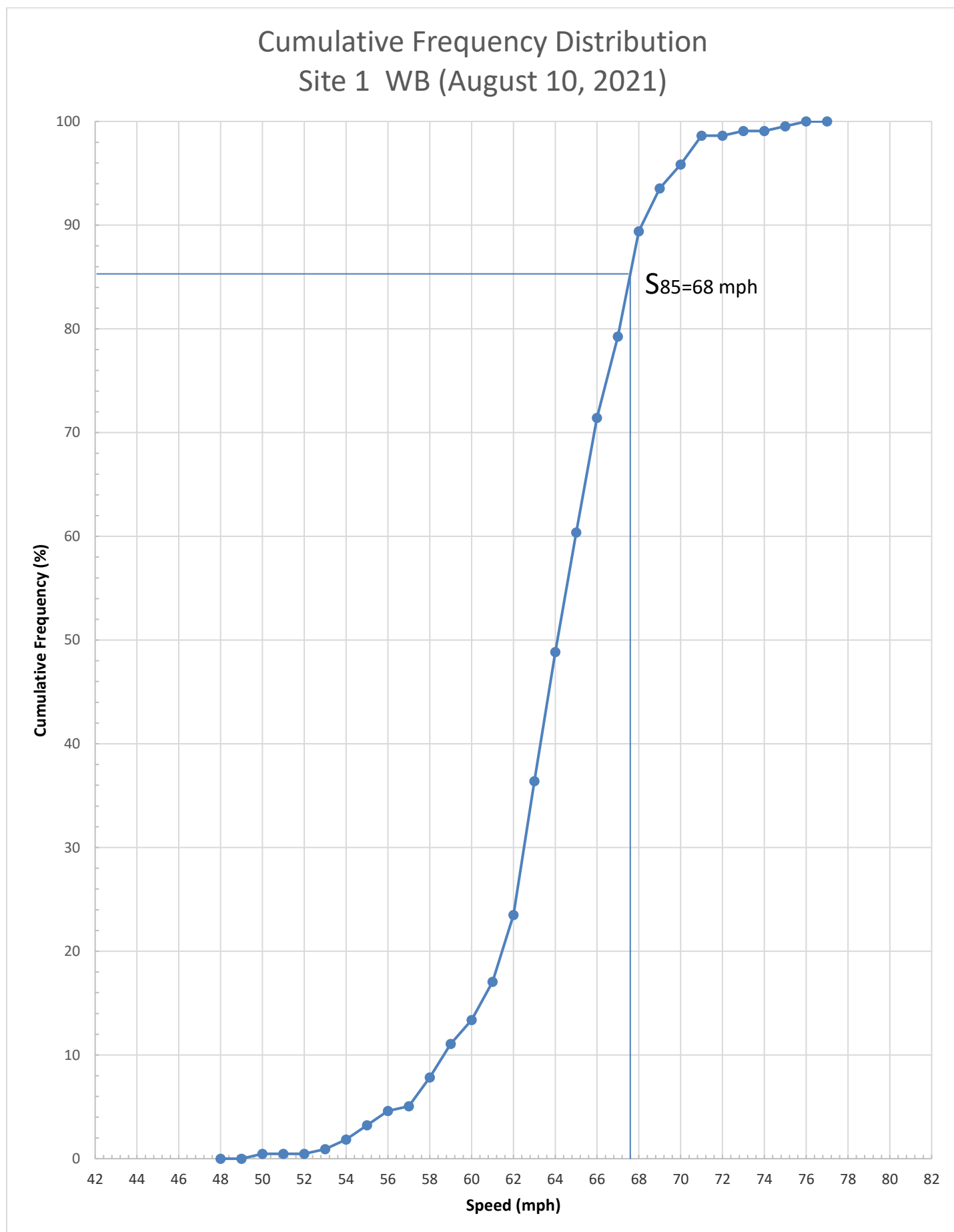


Figure 15. 2019 Cumulative Frequency Distribution of Site 1, EB

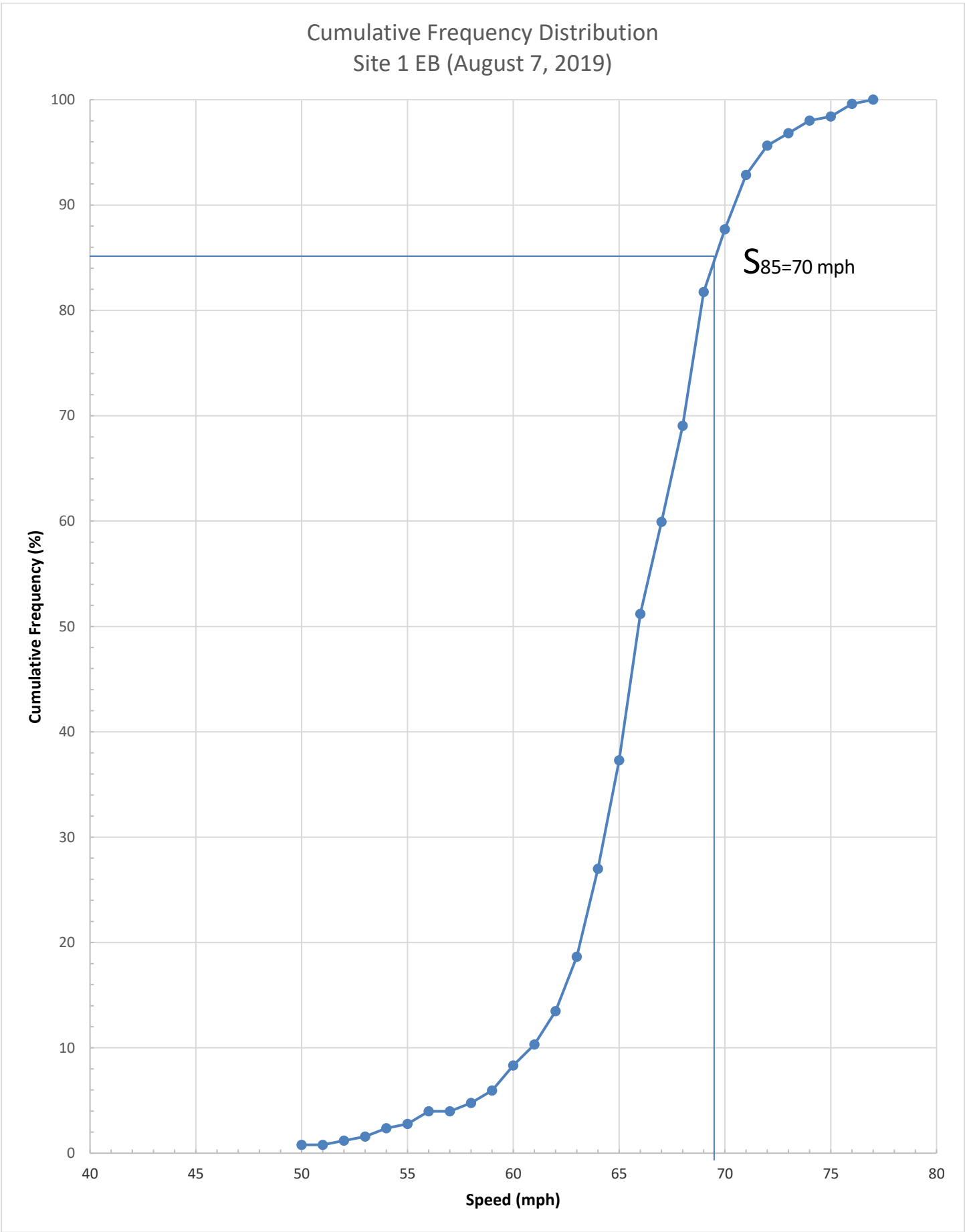


Figure 16. 2021 Cumulative Frequency Distribution of Site 1, EB

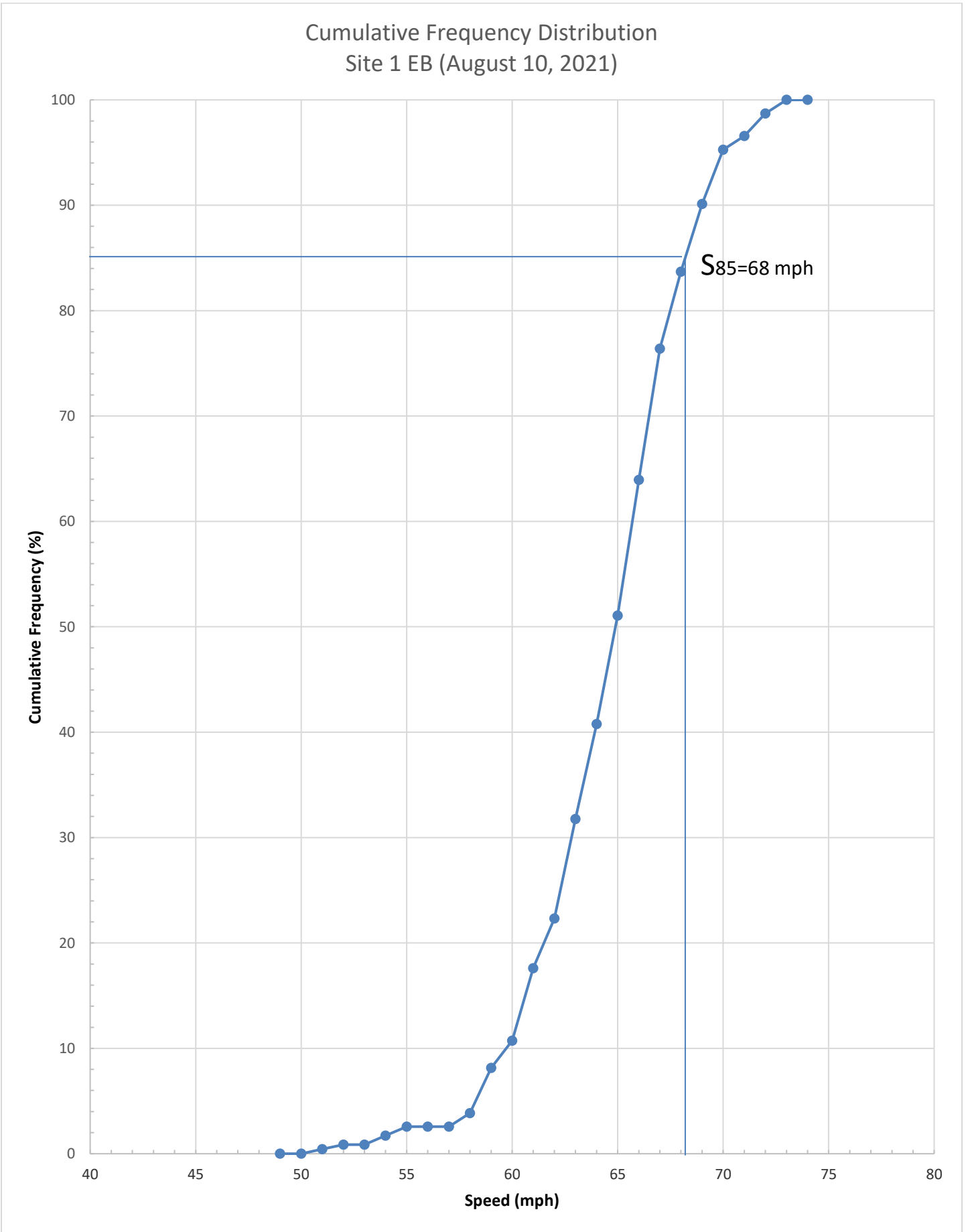


Figure 17. 2019 Cumulative Frequency Distribution of Site 2, WB

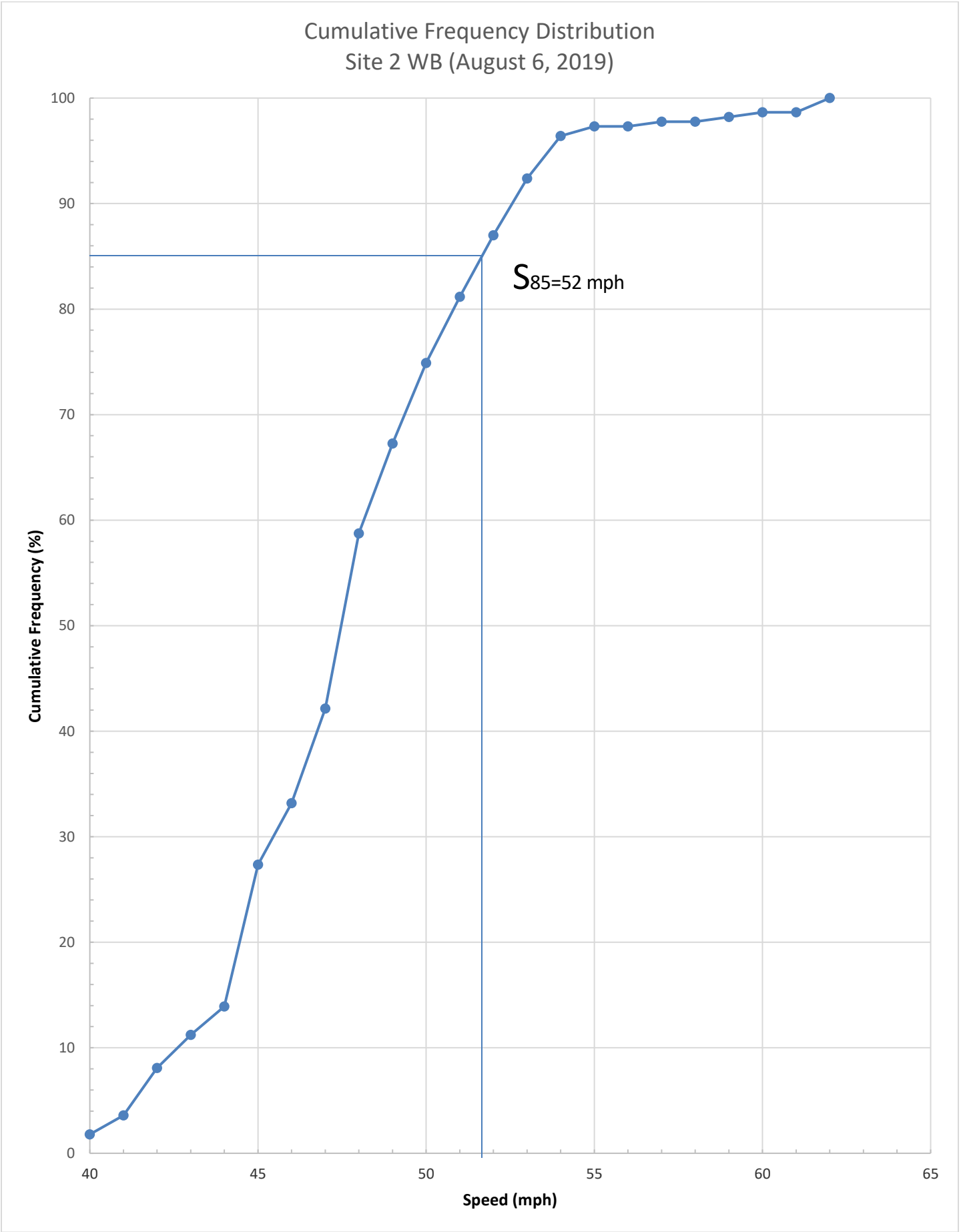


Figure 18. 2021 Cumulative Frequency Distribution of Site 2, WB

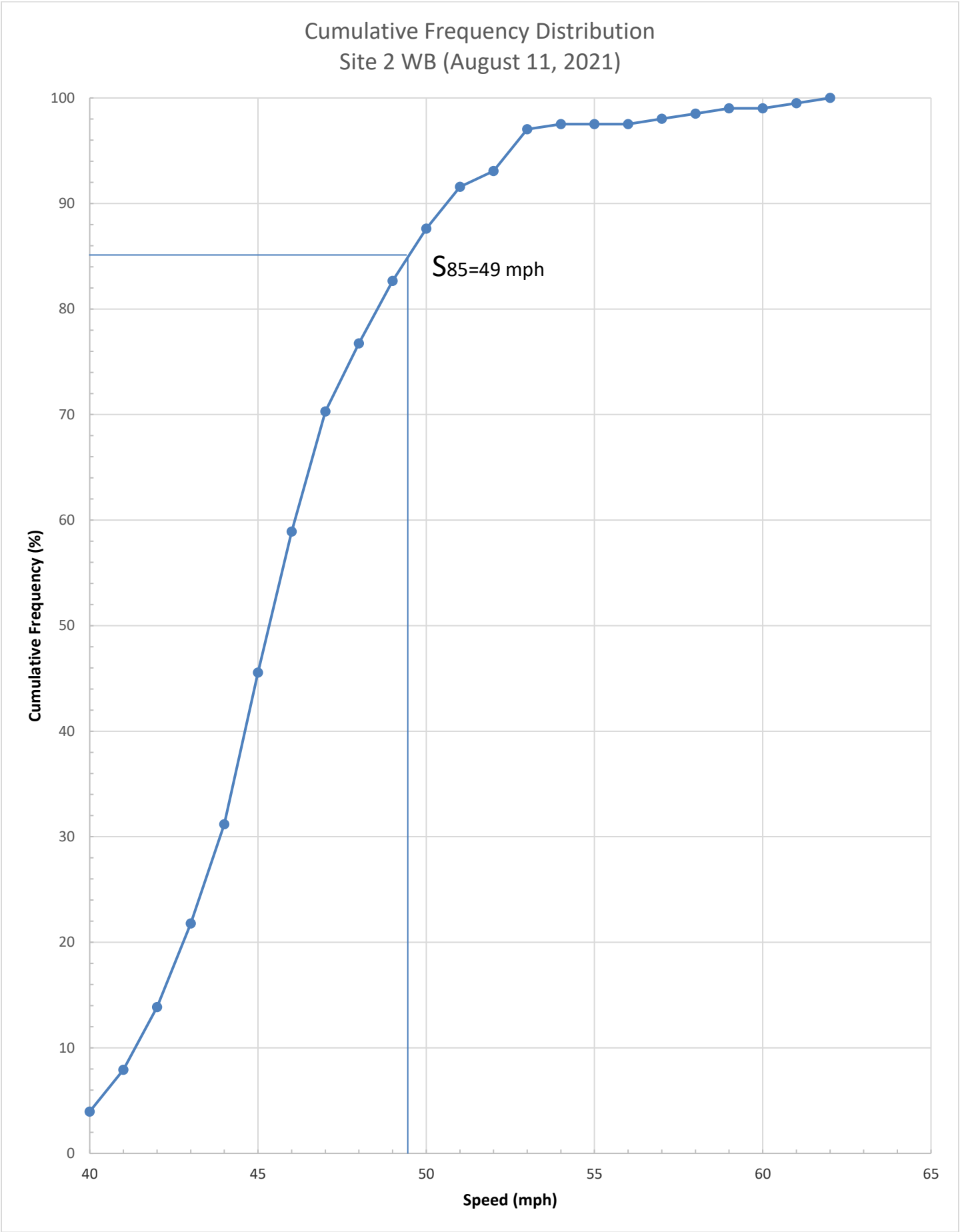


Figure 19. 2019 Cumulative Frequency Distribution of Site 2, EB

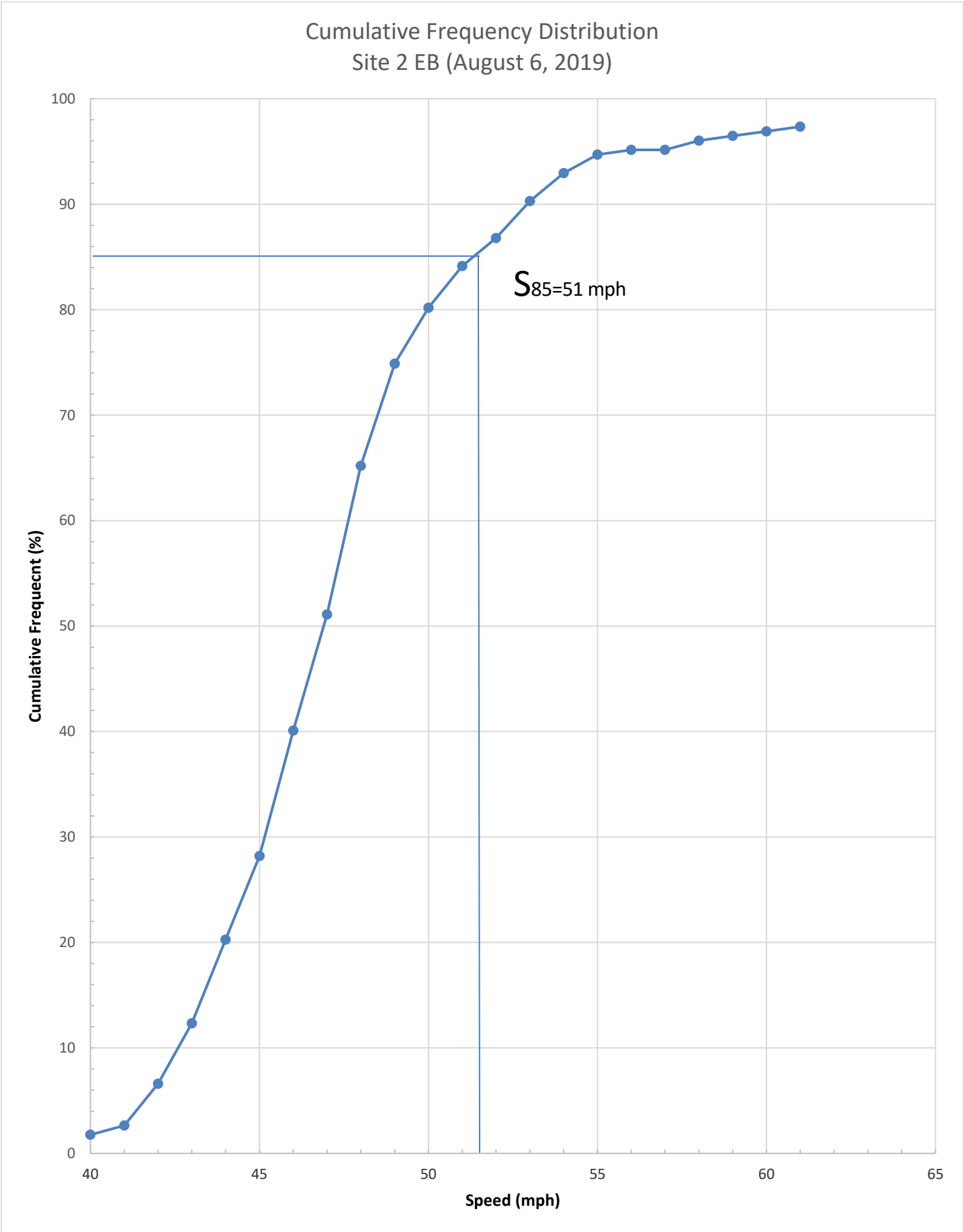


Figure 20. 2021 Cumulative Frequency Distribution of Site 2, EB

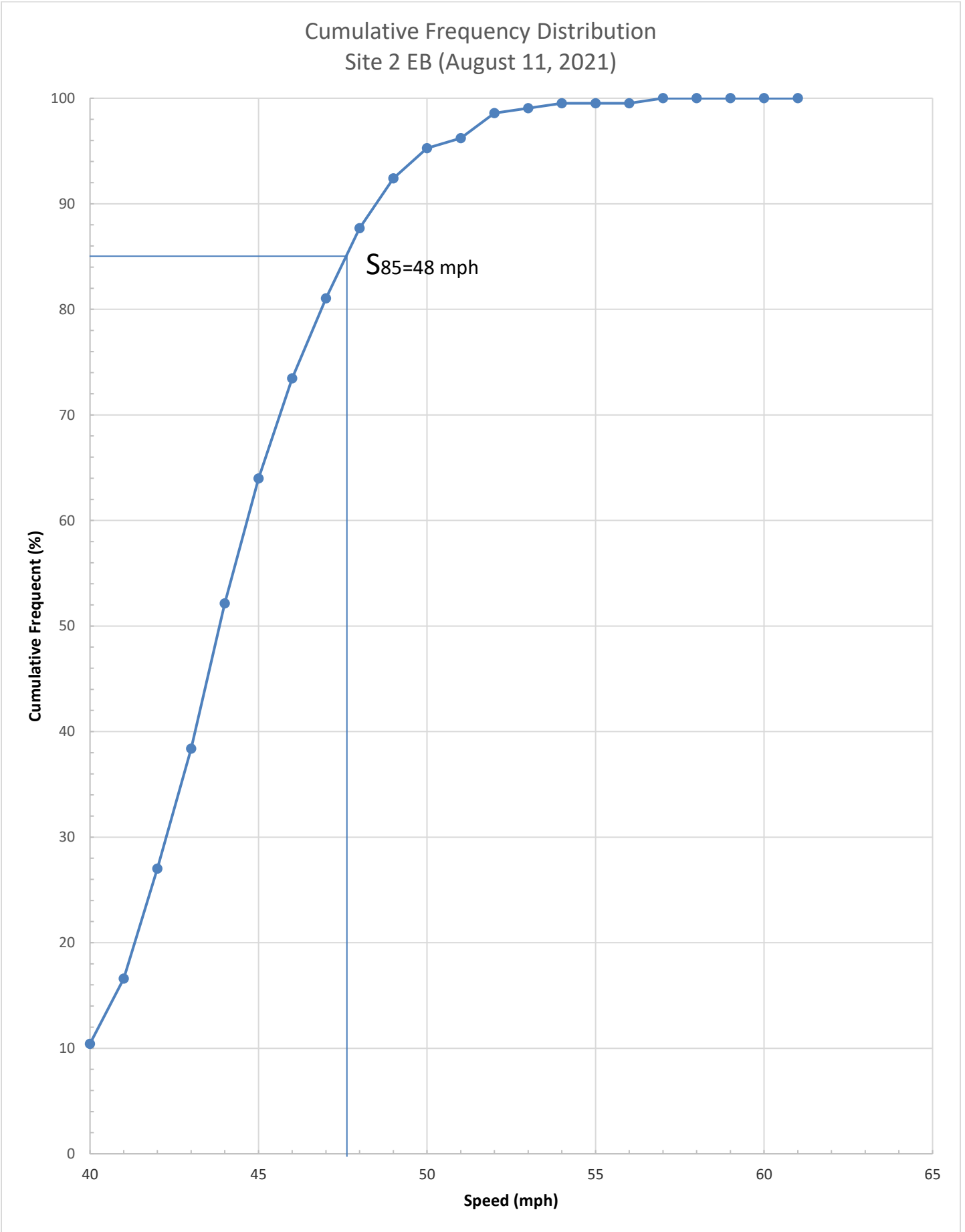


Figure 21. 2019 Cumulative Frequency Distribution of Site 3, WB

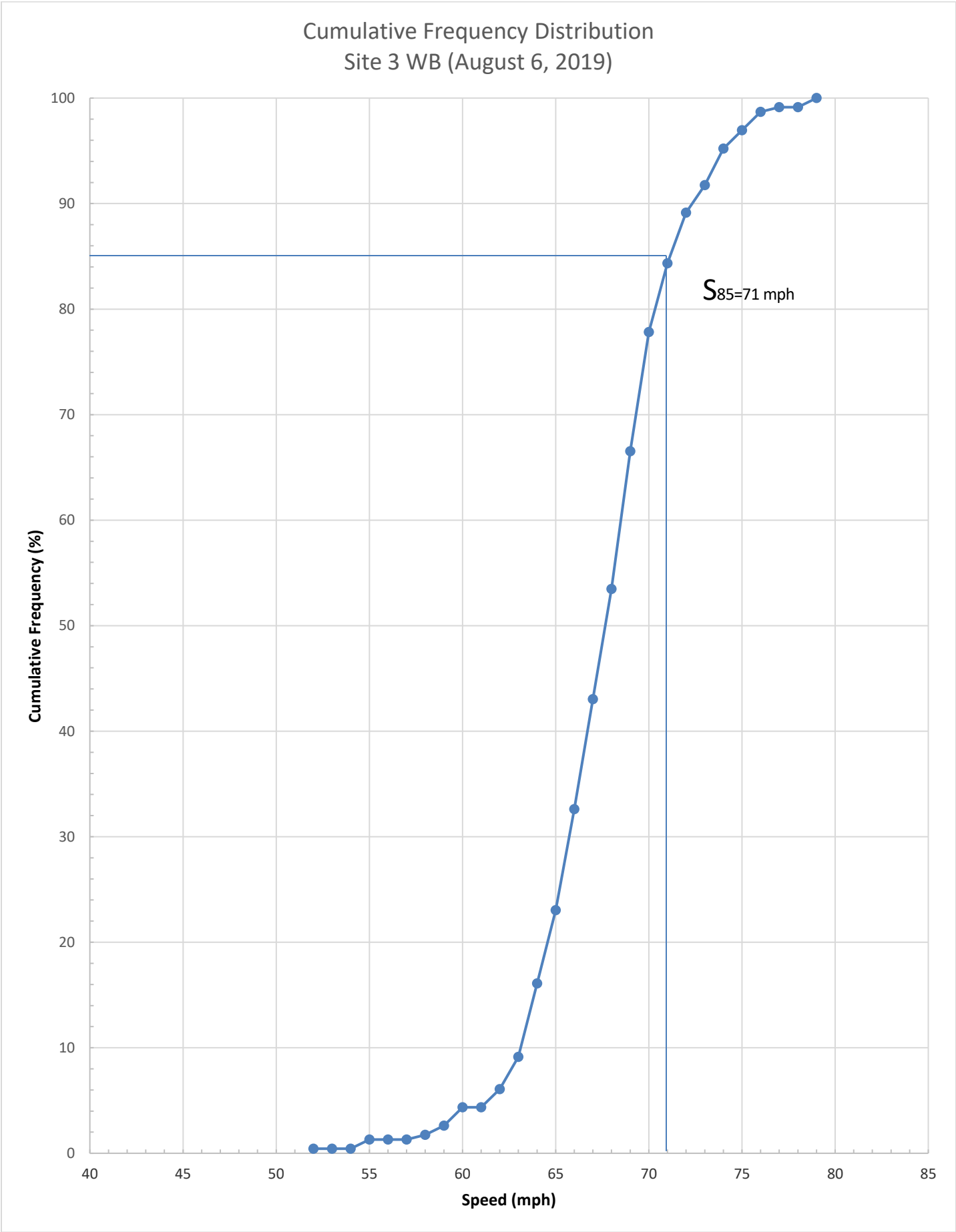


Figure 22. 2021 Cumulative Frequency Distribution of Site 3, WB

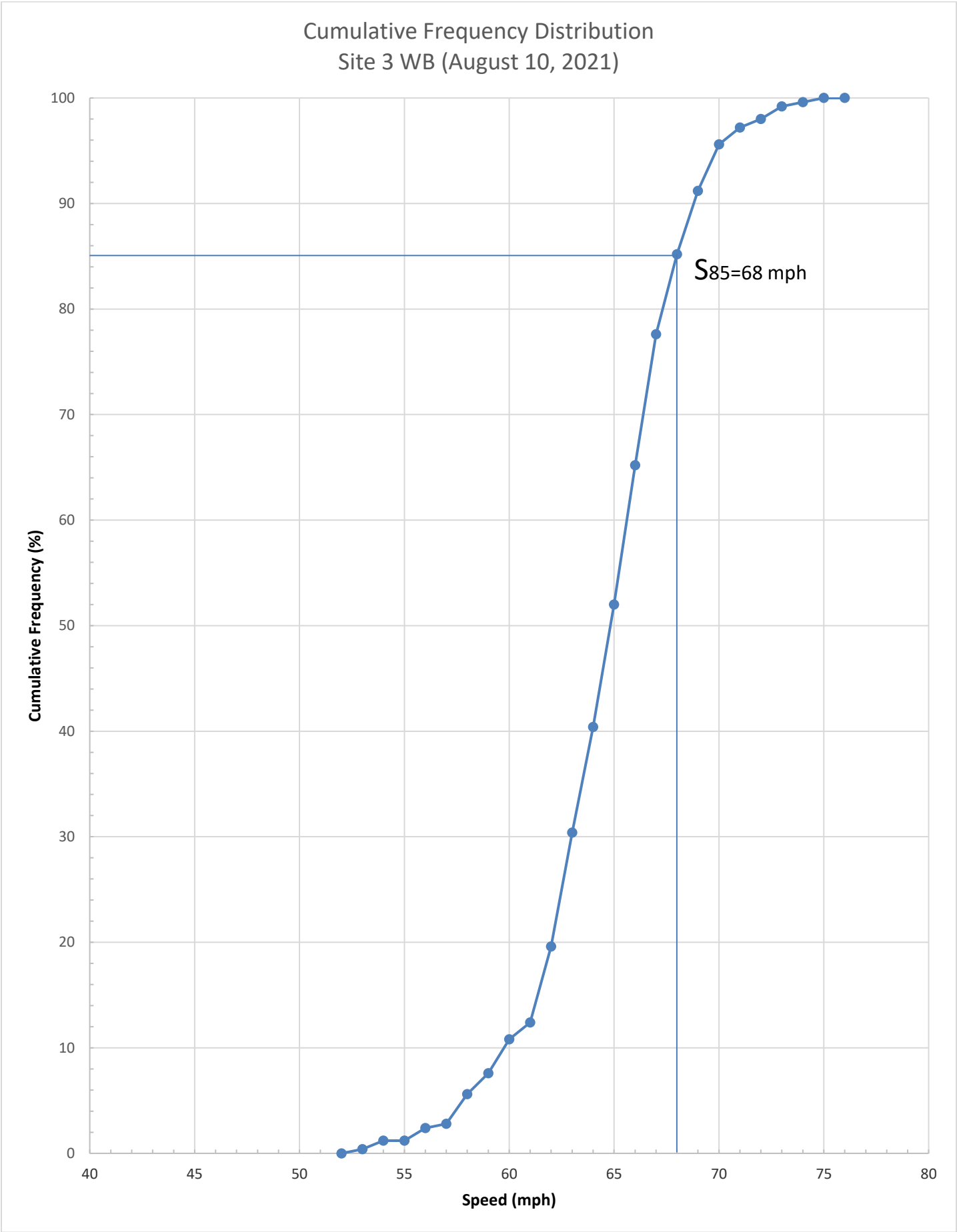


Figure 23. 2019 Cumulative Frequency Distribution of Site 3, EB

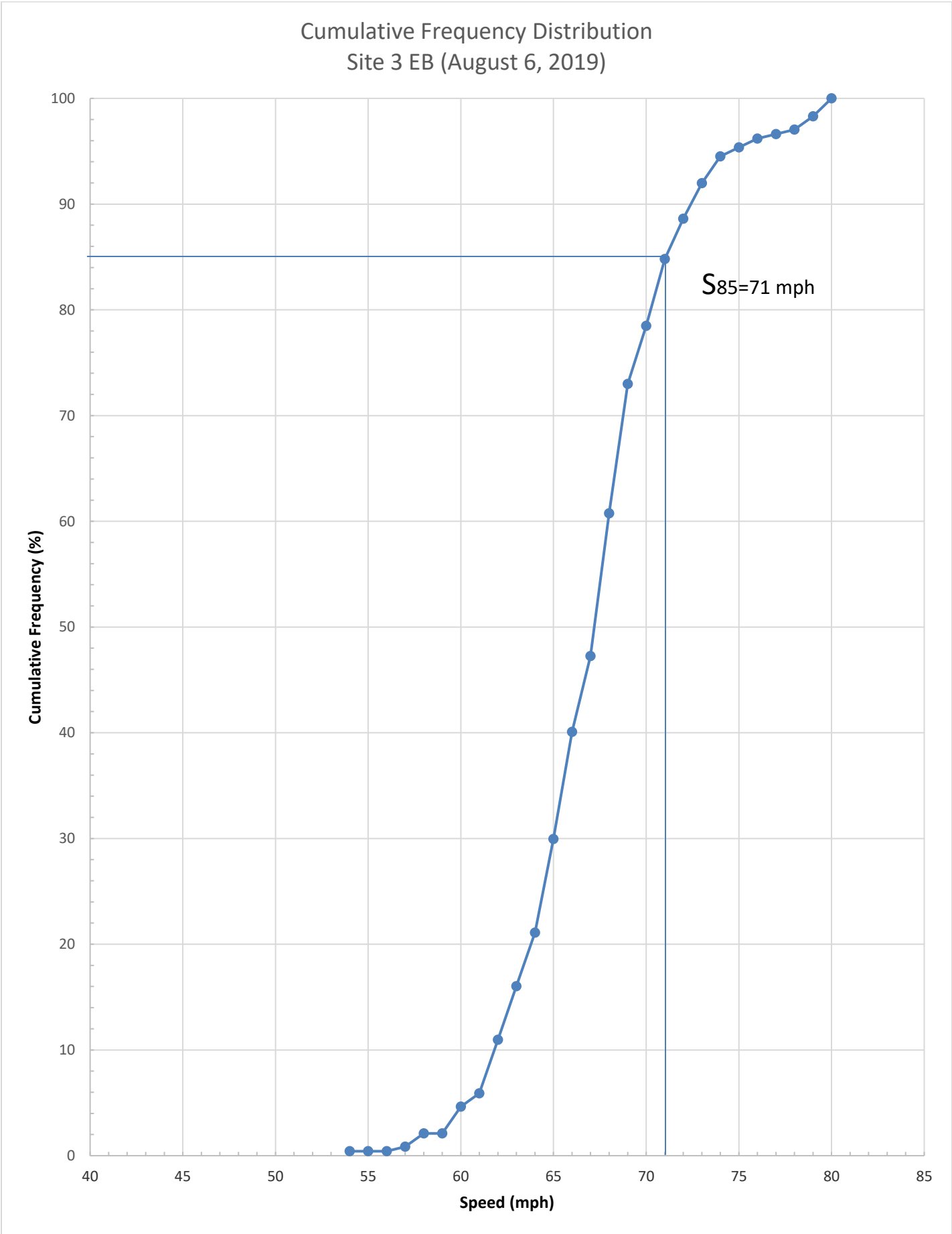


Figure 24. 2021 Cumulative Frequency Distribution of Site 3, EB

