Understanding the Dynamics of Social Encounters in NYC Public Spaces Using Human Mobility Data

Directed BY Takahiro Yabe, Graham Dove
Advised BY Vaidehi Raipat
PRESENTED BY Yin Wang, Zheyan Chen, Ruixin Gan

Capstone Progress Presentation

Background

Background

Extreme Heat in NYC

Due to New York City's dense population and the corresponding rise in greenhouse gas emissions, the city is expected to experience more frequent, prolonged, and intense heat waves. These extreme temperatures pose an increasing threat to the health of residents. Prolonged exposure to high temperatures can lead to dehydration, heat exhaustion, heatstroke, and even fatalities.

Impact of Extreme Heat on Urban Parks

Extreme heat challenges park usability, equity, and infrastructure planning, affecting visitor behavior and thermal comfort.

Research Focus

Analyzing demographic patterns and crowd distribution to understand how visitor behavior varies with temperature. Providing actionable insights for optimizing park design, resource allocation, and thermal comfort.

Literature Review

Literature Review

1. Visitation Patterns

H: Visitation **decreases during hot days** but increases during cooler evenings.

Lit: Song et al. (2024) – Dallas parks, hourly mobility data.

2. Demographic Patterns

H: **Vulnerable populations visit parks more** on hotter days.

Lit: Lo et al. (2022) – Hong Kong, surveys on socioeconomics and heat.
Song et al. (2024) – Dallas parks, mobility data.

3. Crowd Distribution

H: Visitors concentrate **near shaded areas or water features** during heat.

Lit: Wilkins et al. (2021): U.S. national parks, geotagged Flickr photos.
Sun et al. (2024): Atlanta, 84 parks, seasonal facility usage.
Song & Wei (2024): Atlanta, 103 parks, facilities mitigating heat impacts.
Huang et al. (2022): China, 27 monitoring points in one park.

NYC Based

H: Visitation **decreases during hot days** but increases during cooler evenings.
Lit: Marquet et al. (2019) – NYC, SOPARC observation data in 20 parks:
Evening hours (6 PM–7 PM) and weekends showed peak visitation, particularly in playgrounds and swings during summer

H: **Vulnerable populations visit parks more** on hotter days.
Lit: Marquet et al. (2019) – NYC, SOPARC observation data:
Latino and African American children got higher activity levels during hot summer days
Lit: Wei et al. (2023) – NYC, SafeGraph mobility data:
Parks in low-income neighborhoods saw higher summer visitation rates, with greater reliance on local parks.

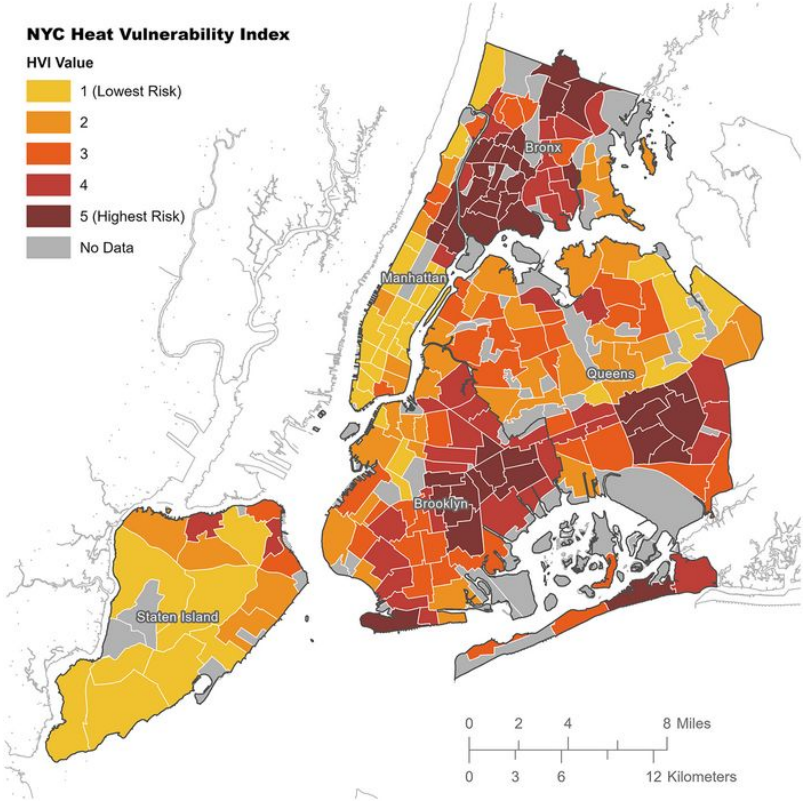
H: Visitors concentrate **near shaded areas or water features** during heat.
Lit: Marquet et al. (2019) – NYC, SOPARC observation data:
Playgrounds and swings were the most used facilities during summer, with shaded areas and water features attracting more visitors during hot days

Research Question

Research Question

How do visitor behaviors, such as park usage patterns, time of visit, and distance traveled, ……vary between hot days, average-temperature days, and cooler days during the summer season?

- **Visitation:**
  - How does park visitation (visitors count) differ between extremely hot and normal temperature days or hours during the summer?
- **Demographic Patterns:**
  - Do demographic characteristics (e.g., age, family groups) of visitors differ on hotter days versus cooler ones?
- **Crowd Distribution:**
  - How is visitor density distributed across the park under different weather conditions (e.g., near shaded areas, open lawns, or water features)?



Methodology

Methodology

Time range: June 1 to August 31, 2024

Data source:

- Weather data, including temperature and relative humidity
  - Source: NOAA (National Oceanic and Atmospheric Administration), Weather Underground
- Number of visitors to different POIs in the park
  - Source: Placer.ai
- Demographic characteristics, such as age and family groups
  - Source: United States Census Bureau
- Events held in the park
  - Source: NYC Parks
- New York City's heat prevention policy
  - Source: NYCEM (New York City Emergency Management)

Methodology

1. **Heat Index Calculation:**

   An estimate of how hot it feels when air temperature and humidity are combined.

   National Weather Service Weather Prediction Center-Heat Index Equation

The Heat Index Equation

The computation of the heat index is a refinement of a result obtained by multiple regression analysis carried out by Lans P. Rothfusz and described in a 1990 National Weather Service (NWS) Technical Attachment (SR 90-23). The regression equation of Rothfusz is

HI = -42.379 + 2.04901523*T + 10.14333127*RH - .22475541*T*RH - .00683783*T*T - .05481717*RH*RH + .00122874*T*T*RH + .00085282*T*RH*RH - .00000199*T*T*RH*RH

where **T** is temperature in degrees F and **RH** is relative humidity in percent. **HI** is the heat index expressed as an apparent temperature in degrees F. If the **RH** is less than 13% and the temperature is between 80 and 112 degrees F, then the following adjustment is subtracted from **HI**:

ADJUSTMENT = [(13-RH)/4]*SQRT{[17-ABS(T-95.)]/17}

where **ABS** and **SQRT** are the absolute value and square root functions, respectively. On the other hand, if the **RH** is greater than 85% and the temperature is between 80 and 87 degrees F, then the following adjustment is added to **HI**:

ADJUSTMENT = [(RH-85)/10] * [(87-T)/5]

The Rothfusz regression is not appropriate when conditions of temperature and humidity warrant a heat index value below about 80 degrees F. In those cases, a simpler formula is applied to calculate values consistent with Steadman's results:

HI = 0.5 * {T + 61.0 + [(T-68.0)*1.2] + (RH*0.094)}

In practice, the simple formula is computed first and the result averaged with the temperature. If this heat index value is 80 degrees F or higher, the full regression equation along with any adjustment as described above is applied.

The Rothfusz regression is not valid for extreme temperature and relative humidity conditions beyond the range of data considered by Steadman.

Methodology

Heat Advisory:

New York City opens cooling centers when the Heat Index is forecasted to be:

95°F or higher for two consecutive days, or **100°F or higher at any time**.

Heat Index Chart

The 'Heat Index' is a measure of how hot weather "feels" to the body. This table uses relative humidity and air temperature to produce the "apparent temperature" or the temperature the body "feels". These values are for shady locations only. Exposure to full sunshine can increase heat index values by up to 15°F. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous as the wind adds heat to the body.

Temperature & Relative Humidity

Classification	Heat Index/Apparent Temperature	General Affect on People in High Risk Groups
Extremely Hot	≥130°F	Heat/Sunstroke HIGHLY LIKELY with continued exposure
Very Hot	105°F - 129°F	Sunstroke, heat cramps, or heat exhaustion LIKELY, and heatstroke POSSIBLE with prolonged exposure and/or physical activity
Hot	90°F - 104°F	Sunstroke, heat cramps, or heat exhaustion POSSIBLE with prolonged exposure and/or physical activity
Very Warm	80°F - 89°F	Fatigue POSSIBLE with prolonged exposure and/or physical activity

Relative Humidity (%)

Temperature (F)	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100
126	113	116	119	123	126	130	134	138	142	147	151	156	161	166	171	177	182																																
124	112	114	117	120	123	127	130	134	138	142	146	151	155	160	165	170	175	180																															
122	110	113	115	118	121	124	127	130	134	138	141	145	150	154	158	163	168	173	178	183																													
120	109	111	113	116	118	121	124	127	130	133	137	140	144	148	152	156	161	165	170	175	180																												
118	107	109	111	113	116	118	121	123	126	129	132	135	139	142	146	150	154	158	162	167	171	176	181																										
116	106	108	109	111	113	115	117	120	122	125	128	131	134	137	140	144	148	151	155	159	164	168	172	177	182																								
114	105	106	107	109	111	112	114	117	119	121	124	126	129	132	135	138	141	145	148	152	156	160	164	168	173	177	182																						
112	103	104	105	107	108	110	112	113	115	117	120	122	124	127	130	133	136	139	142	145	149	152	156	160	164	168	172	177	181																				
110	101	102	103	104	106	107	109	110	112	114	116	118	120	122	125	127	130	133	136	139	142	145	149	152	156	159	163	167	171	175	180																		
108	99	100	101	102	103	105	106	107	109	110	112	114	116	118	120	122	125	127	130	132	135	138	141	144	148	151	155	158	162	166	170	174	178	182															
106	97	98	99	100	101	102	103	105	106	107	109	110	112	114	116	118	120	122	124	127	129	132	135	137	140	143	146	150	153	157	160	164	168	172	176	180													
104	96	96	97	98	99	100	101	102	103	104	105	107	108	110	111	113	115	117	119	121	123	126	128	131	133	136	139	142	145	148	151	154	158	161	165	169	173	176	181										
102	94	95	95	96	97	98	98	99	100	101	102	103	105	106	107	109	110	112	114	116	118	120	122	124	127	129	132	134	137	140	143	146	149	152	155	158	162	165	169	173	177	180							
100	92	93	93	94	95	96	96	97	97	98	99	100	101	102	104	105	106	108	109	111	113	114	116	118	120	123	125	127	129	132	135	137	140	143	146	149	152	155	158	162	165	168	172	176	179	183			
98	91	91	92	92	93	93	94	94	95	96	96	97	98	99	100	101	102	104	105	106	108	109	111	113	115	116	118	120	123	125	127	129	132	134	137	140	142	145	148	151	154	157	160	164	167	170	174	177	181
96	89	89	90	90	91	91	92	92	93	93	94	94	95	96	97	98	99	100	101	102	103	105	106	108	109	111	113	114	116	118	120	122	124	126	129	131	133	136	138	141	144	146	149	152	155	158	161	164	168
94	87	88	88	89	89	90	90	90	91	91	92	92	93	94	94	95	96	97	98	99	100	102	103	104	106	107	109	110	112	114	115	117	119	121	123	125	127	129	132	134	136	139	141	144	147	149	152	155
92	86	86	86	87	87	88	88	88	88	89	89	89	90	90	91	92	92	93	94	95	96	96	98	99	100	101	102	103	105	106	108	109	111	112	114	116	117	119	121	123	125	127	129	131	133	136	138	140	143
90	84	85	85	85	86	86	86	86	86	87	87	87	88	88	88	89	89	90	91	91	92	93	94	95	96	96	98	99	100	101	102	103	105	106	107	109	110	112	113	115	117	118	120	122	124	126	128	130	132
88	83	83	83	84	84	84	84	84	85	85	85	85	85	86	86	86	87	87	88	88	89	90	90	91	92	93	93	94	95	96	97	98	99	100	101	103	104	105	106	108	109	110	112	113	115	116	118	120	121
86	81	82	82	82	82	83	83	83	83	83	83	83	84	84	84	84	85	85	85	86	86	87	87	88	88	89	90	90	91	92	93	93	94	95	96	97	98	99	100	101	102	103	104	105	107	108	109	110	112
84	80	80	80	81	81	81	81	81	81	81	82	82	82	82	82	82	83	83	83	84	84	84	85	85	86	86	86	87	88	88	89	89	90	90	91	92	93	93	94	95	96	96	97	98	99	100	101	102	104
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78	76	76	76	76	76	76	76	76	77	77	77	77	77	77	77	77	77	77	77	78	78	78	78	78	78	78	78	78	78	78	79	79	79	79	79	79	80	80	80	80	80	80	80	81	81	81	81	81	81
76	73	74	74	74	74	74	74	74	74	74	74	75	75	75	75	75	75	75	75	75	75	75	76	76	76	76	76	76	76	76	76	76	77	77	77	77	77	77	77	77	77	77	78	78	78	78	78	78	78

www.weather.gov/jetstream/hi

NOAA-Heat Index

Methodology

2. **Classify Summer Days:**
   - Use daily heat index from **June 1 to August 31, 2024**, to categorize days into:
     - Extreme Hot Days: Heat index≥ 100°F or ≥ 95°F for two consecutive days. (NYCEM)
     - Hot Days: 100°F> Heat index≥ 90°F
     - Average-Temperature Days: 90°F> Heat index≥ 80°F
     - Cooler Days: Heat index< 80°F

Methodology

Cooler Days	Average Temperature Days
11	22
Hot Days	**Extreme Hot Days**
19	40

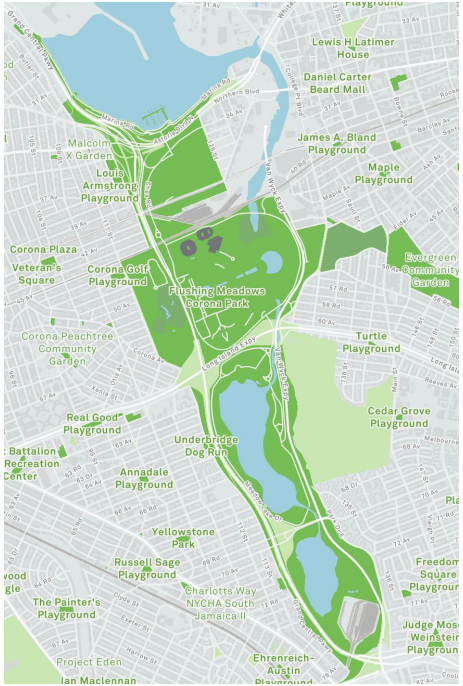
Date	Humidity	Temperat	HI	Category
2024/6/1	42	85	84.70022	Average-Temperature Days
2024/6/2	59	83	85.69469	Average-Temperature Days
2024/6/3	62	86	91.8309	Hot Days
2024/6/4	88	81	88.41041	Average-Temperature Days
2024/6/5	87	81	88.07966	Average-Temperature Days
2024/6/6	94	83	96.87487	Hot Days
2024/6/7	87	85	100.161	Extreme Hot Days
2024/6/8	54	79	80.25083	Average-Temperature Days
2024/6/9	61	76	77.98664	Cooler Days
2024/6/10	63	76	77.93361	Cooler Days
2024/6/11	67	76	77.79161	Cooler Days
2024/6/12	73	78	80.11657	Average-Temperature Days
2024/6/13	81	85	97.25923	Hot Days
2024/6/14	78	87	101.8031	Extreme Hot Days
2024/6/15	79	82	88.53967	Average-Temperature Days
2024/6/16	73	76	77.48879	Cooler Days
2024/6/17	84	84	95.53879	Hot Days
2024/6/18	68	86	94.21336	Hot Days
2024/6/19	69	89	102.3878	Extreme Hot Days
2024/6/20	64	94	113.5139	Extreme Hot Days
2024/6/21	73	97	133.9105	Extreme Hot Days
2024/6/22	84	94	133.9655	Extreme Hot Days
2024/6/23	90	95	145.8031	Extreme Hot Days
2024/6/24	72	81	84.96747	Average-Temperature Days
2024/6/25	55	91	99.16402	Hot Days
2024/6/26	76	93	121.1112	Extreme Hot Days
2024/6/27	87	86	103.6063	Extreme Hot Days
2024/6/28	50	78	79.23508	Cooler Days
2024/6/29	90	81	89.07916	Average-Temperature Days
2024/6/30	91	88	113.88	Extreme Hot Days
2024/7/1	65	79	81.0473	Average-Temperature Days
2024/7/2	55	83	84.85145	Average-Temperature Days
2024/7/3	70	83	88.38612	Average-Temperature Days
2024/7/4	85	86	102.4523	Extreme Hot Days
2024/7/5	87	90	119.0876	Extreme Hot Days
2024/7/6	91	92	131.7527	Extreme Hot Days
2024/7/7	85	91	121.6407	Extreme Hot Days
2024/7/8	87	92	127.8483	Extreme Hot Days
2024/7/9	91	88	113.88	Extreme Hot Days
2024/7/10	79	89	108.9924	Extreme Hot Days
2024/7/11	87	90	119.0876	Extreme Hot Days
2024/7/12	84	86	101.9068	Extreme Hot Days
2024/7/13	93	87	111.2224	Extreme Hot Days

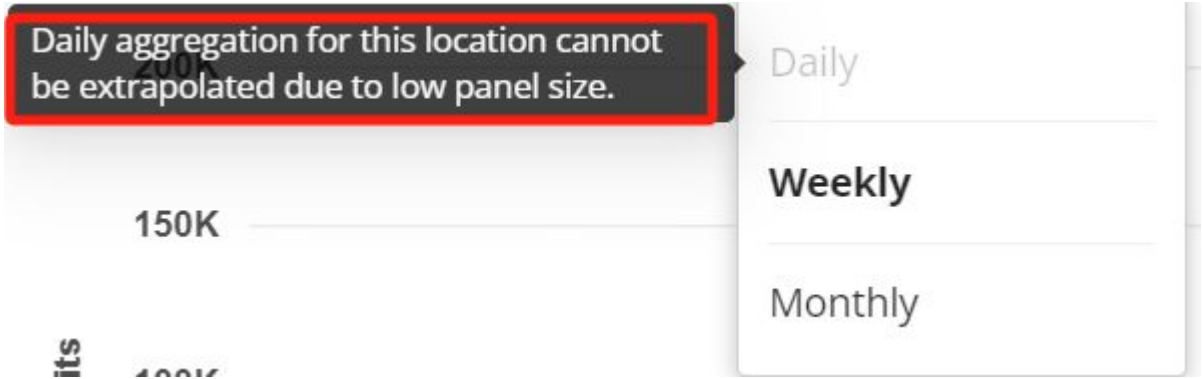
Methodology

3. Park Zones

○ Flushing Meadow Park

Park	Name	Type	Status	api-id	Daily Visits
Flushing Meadow Park	Water Front Zone_FM	Custom	E	675a40dafbd70689d03d527e	N/A
	Queens Zoo	Public	S	cb292b9ee536029ceb419d26	T
	Athletic Zone_1_FM	Custom	E	675dd223cc2b352ce072470d	N/A
	Plaza Zone_FM	Custom	E	675dcffb20f1a7ea6c01a7f0	T
	Athletic Zone_2_FM	Custom	E	675dd48b6a6325d3757a33ab	T
	Athletic Zone_3_FM	Custom	E	675dd6b8068e2e655701a7ef	N/A
	Recreation Zone_FM	Custom	S	675a0c78e36291a0a32b69c0	T
	Trail Zone_FM	Custom	S	6759f7165165cab09c060239	N/A

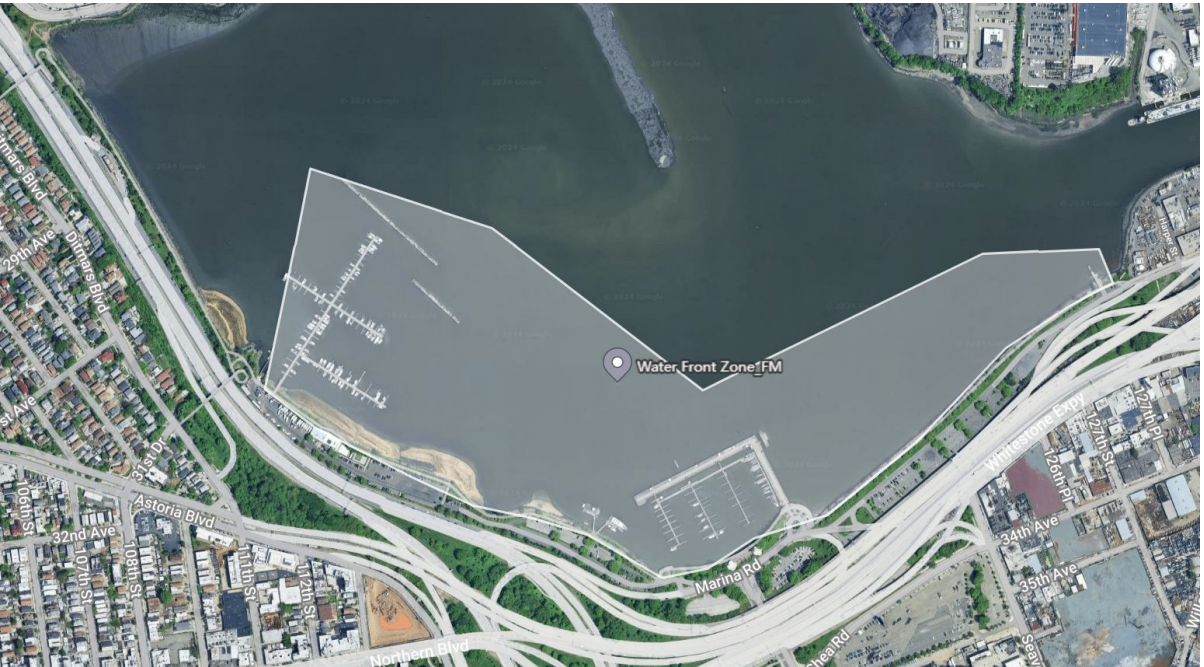


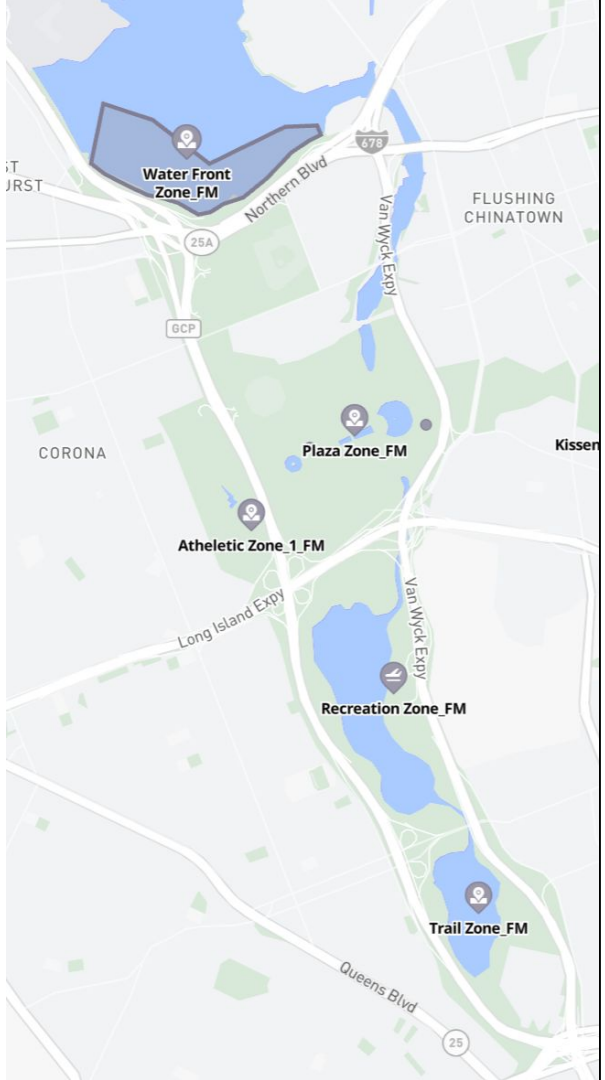

Daily aggregation for this location cannot be extrapolated due to low panel size.
Daily
Weekly
Monthly
150K

Water Front Zone_FM
Flushing Bay Promenade, New York City, NY 11368
Year to Date
Visits Trend
Property:
Metric:
Visits
Aggregation:
Weekly
Annual Summary:
12K
10K
8K
6K
4K
2K
0
Visits
Mon, January 15 - Sun, January 21, 2024
Water Front Zone_FM / Flushing ...
512
Jan 01
May 06
May 27
Jun 17
Jul 08
Jul 29
Aug 19
Sep 09
Sep 30
Oct 21
Nov 11
Dec 02

WaterFront Zone

Water Front Zone_FM	Custom	E	675a40dafbd70689d03d527e	N/A





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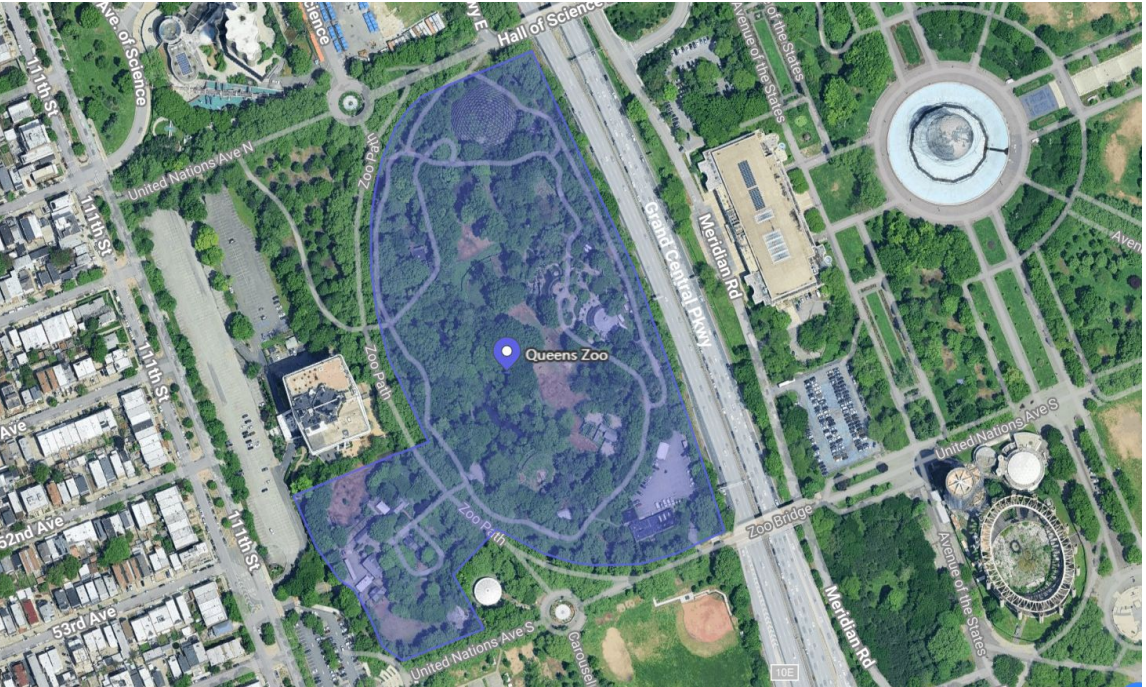
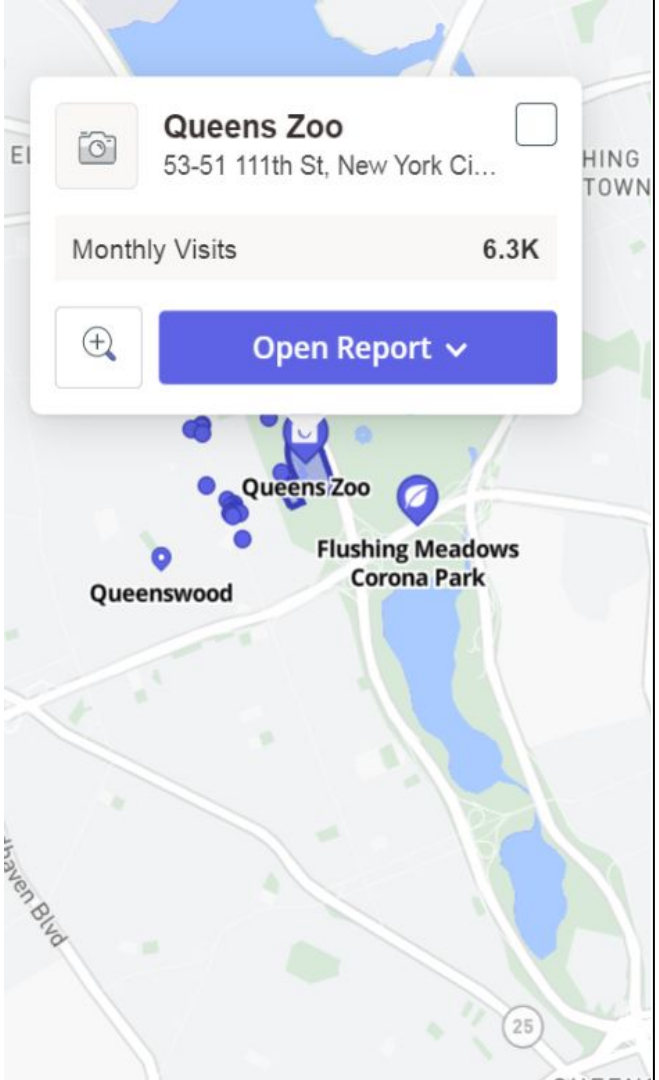
Queens Zoo

Queens Zoo	Public	S	cb292b9ee536029ceb419d26	T

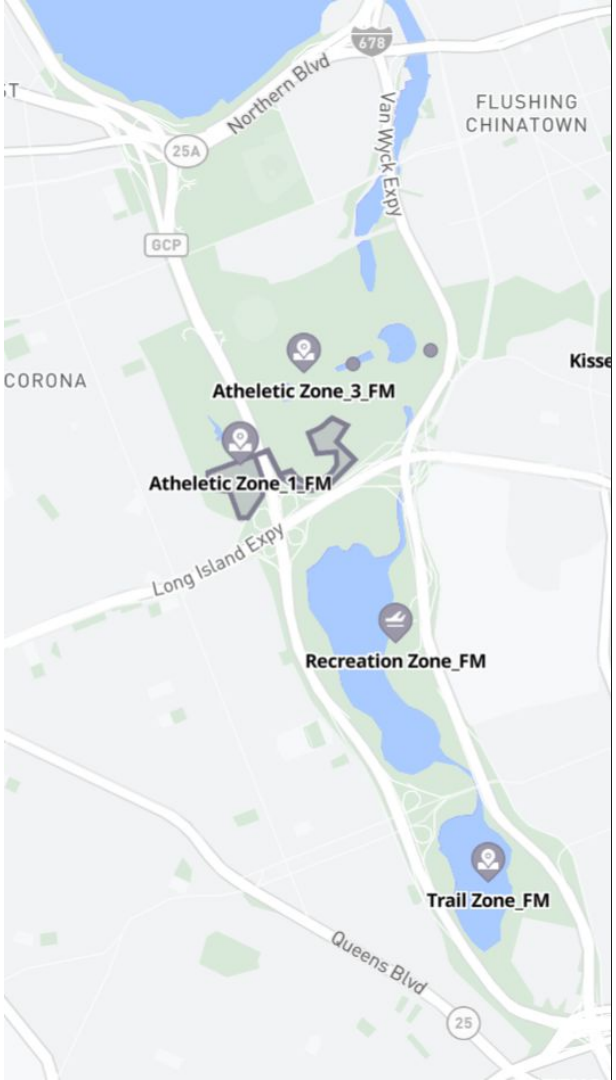




Capstone Progress Presentation

Athletic Zone 1

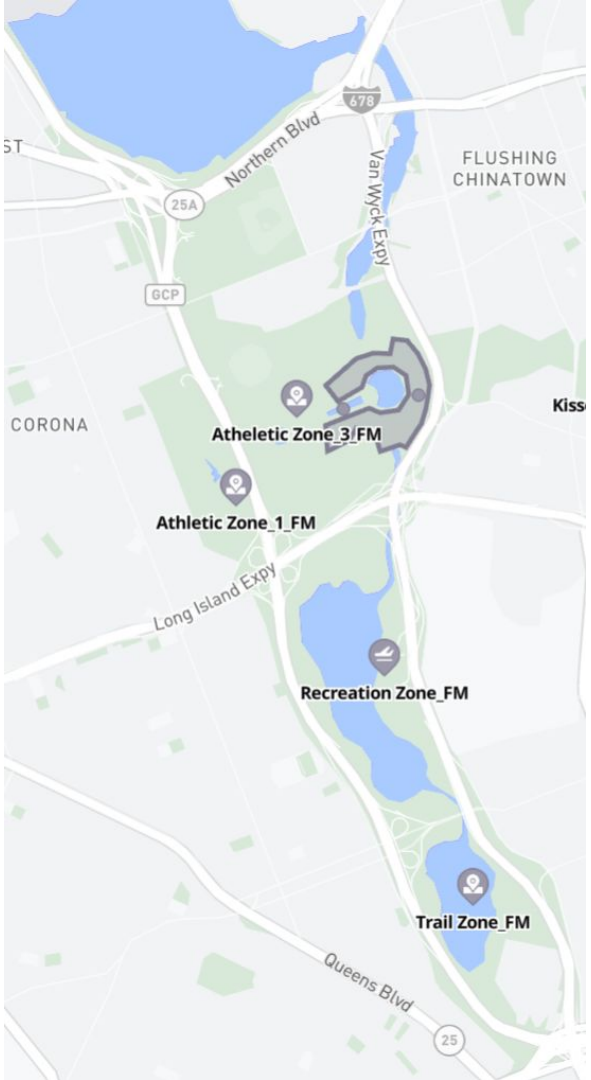
Athletic Zone_1_FM	Custom	E	675dd223cc2b352ce072470d	N/A



Capstone Progress Presentation

Athletic Zone 2

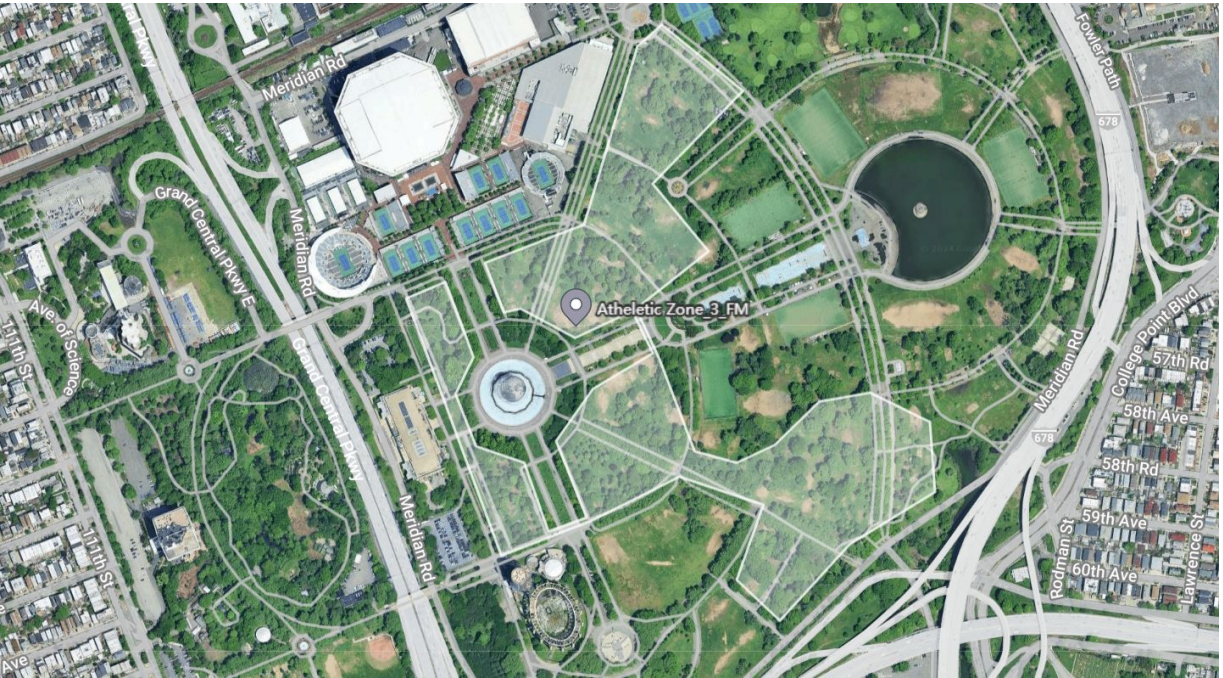
Athletic Zone_2_FM	Custom	E	675dd48b6a6325d3757a33ab	T

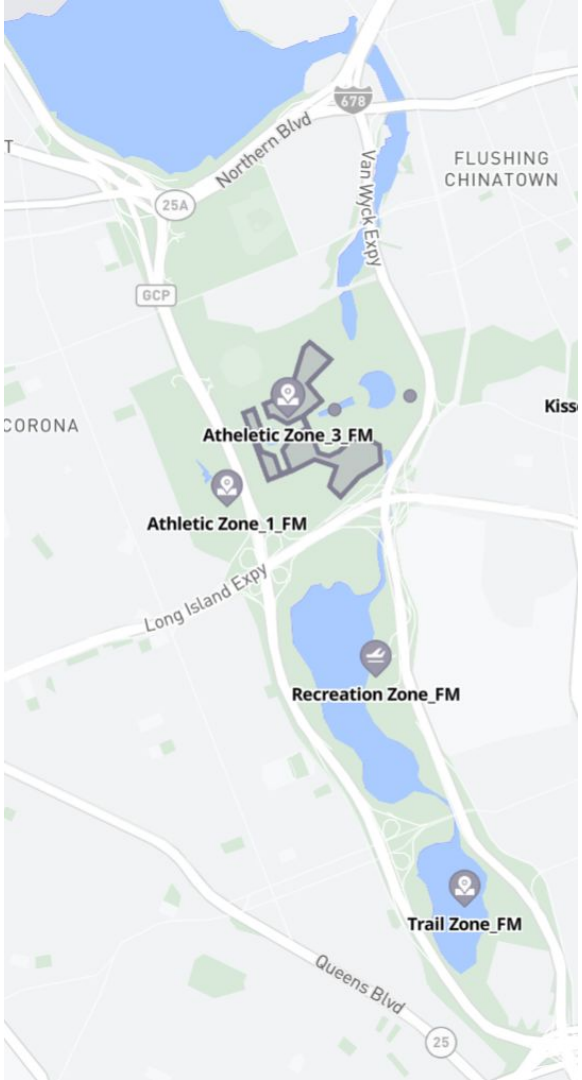


Capstone Progress Presentation

Athletic Zone 3

Athletic Zone_3_FM	Custom	E	675dd6b8068e2e655701a7ef	N/A





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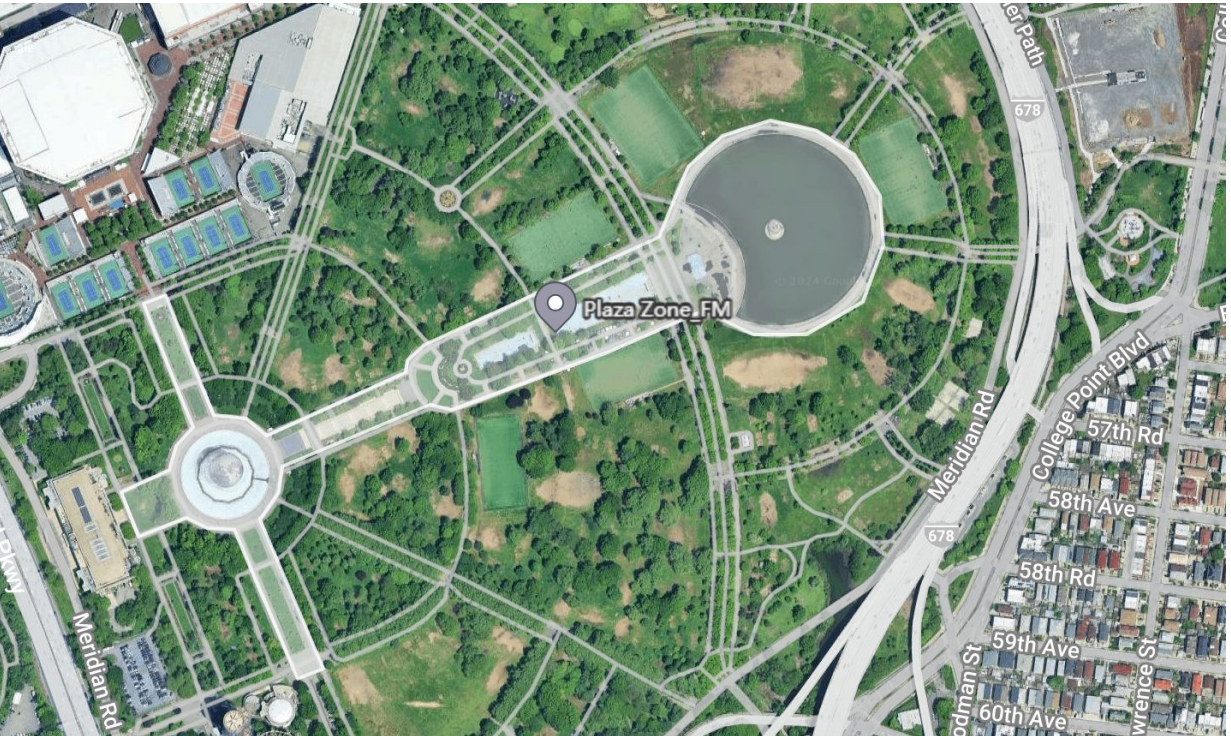
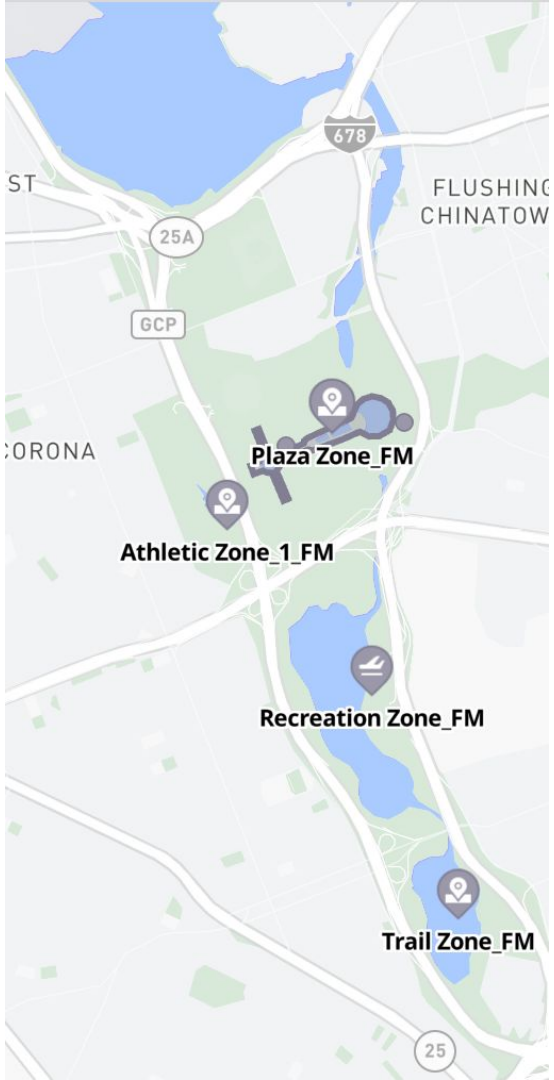
Athletic Zone 3

Plaza Zone_FM	Custom	E	675dcffb20f1a7ea6c01a7f0	T





Recreation Zone

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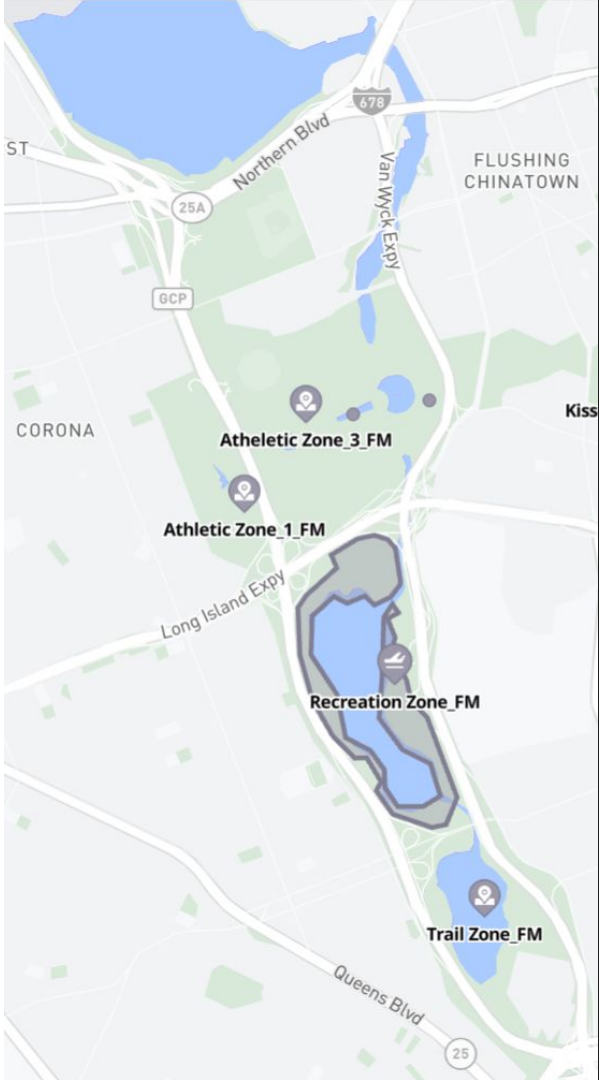
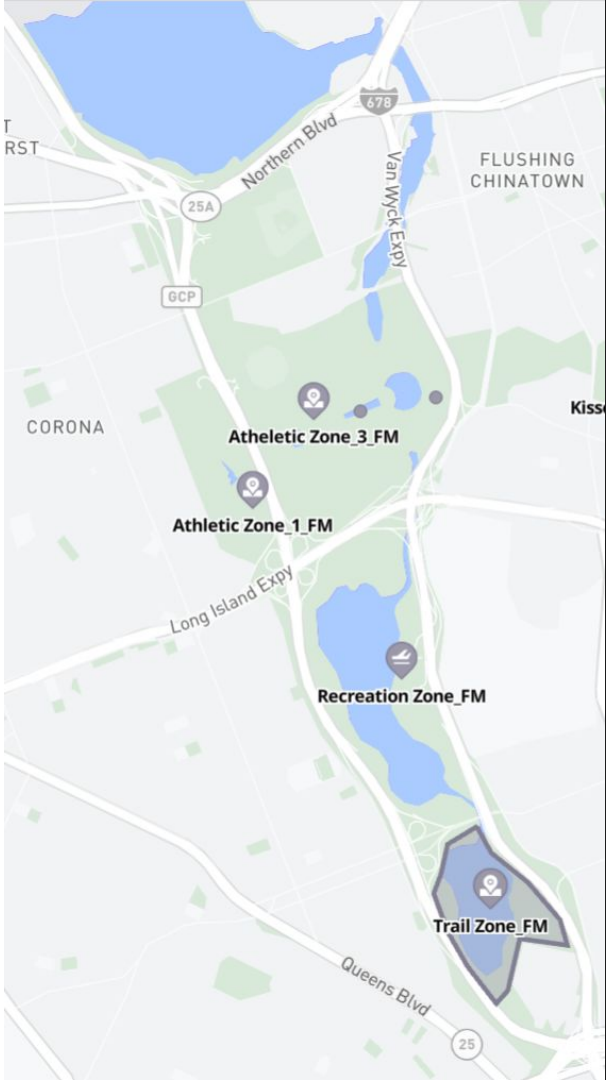


Trail Zone

Trail Zone_FM	Custom	S	6759f7165165cab09c060239	N/A



Capstone Progress Presentation

Methodology

- **Kissena Corridor Park**

Methodology

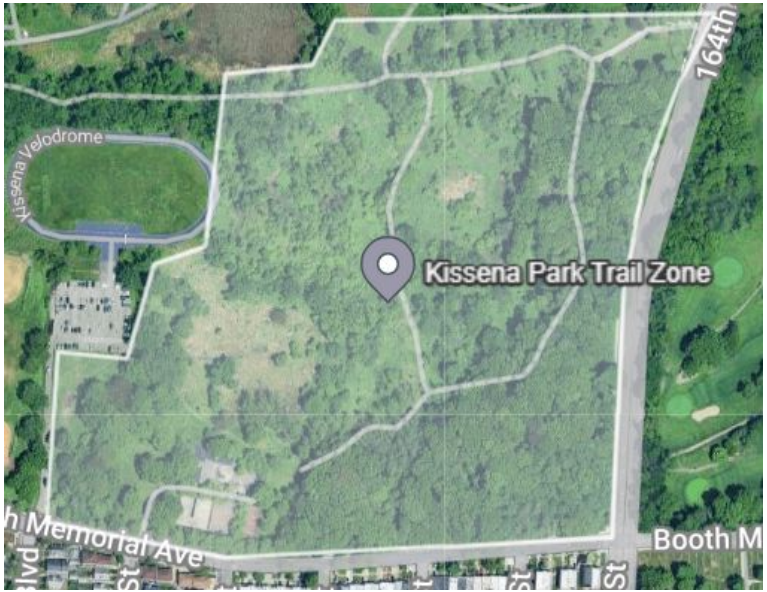
- **Kissena Corridor Park**

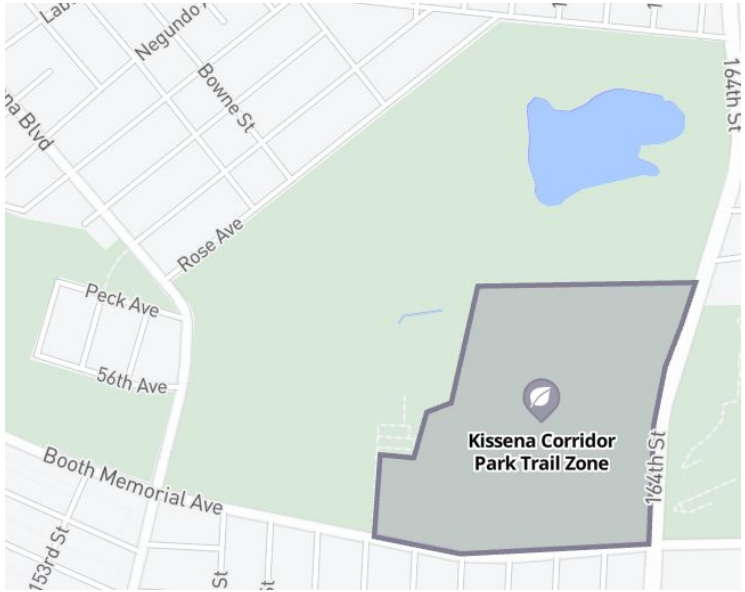
Park Zone_1	Custom	Mixed	67563a9f7057dc759126c472	T

Methodology

- **Kissena Corridor Park**

Trail Zone	Custom	S	6759ed6c5dc7cda029d65235	N/A

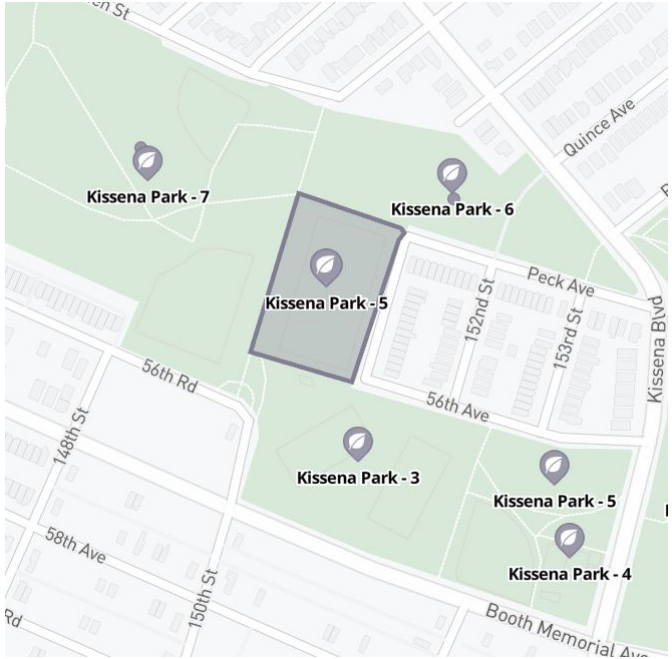




Methodology

- **Kissena Corridor Park**

Tennis Court	Custom	E	6756411029e861c5b46c4091	N/A

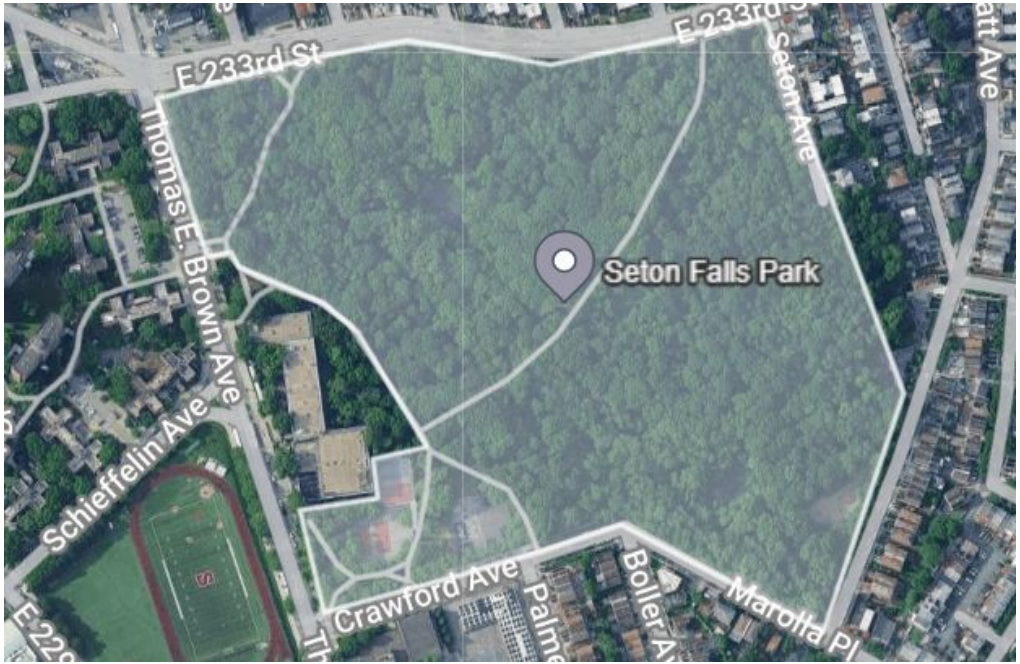


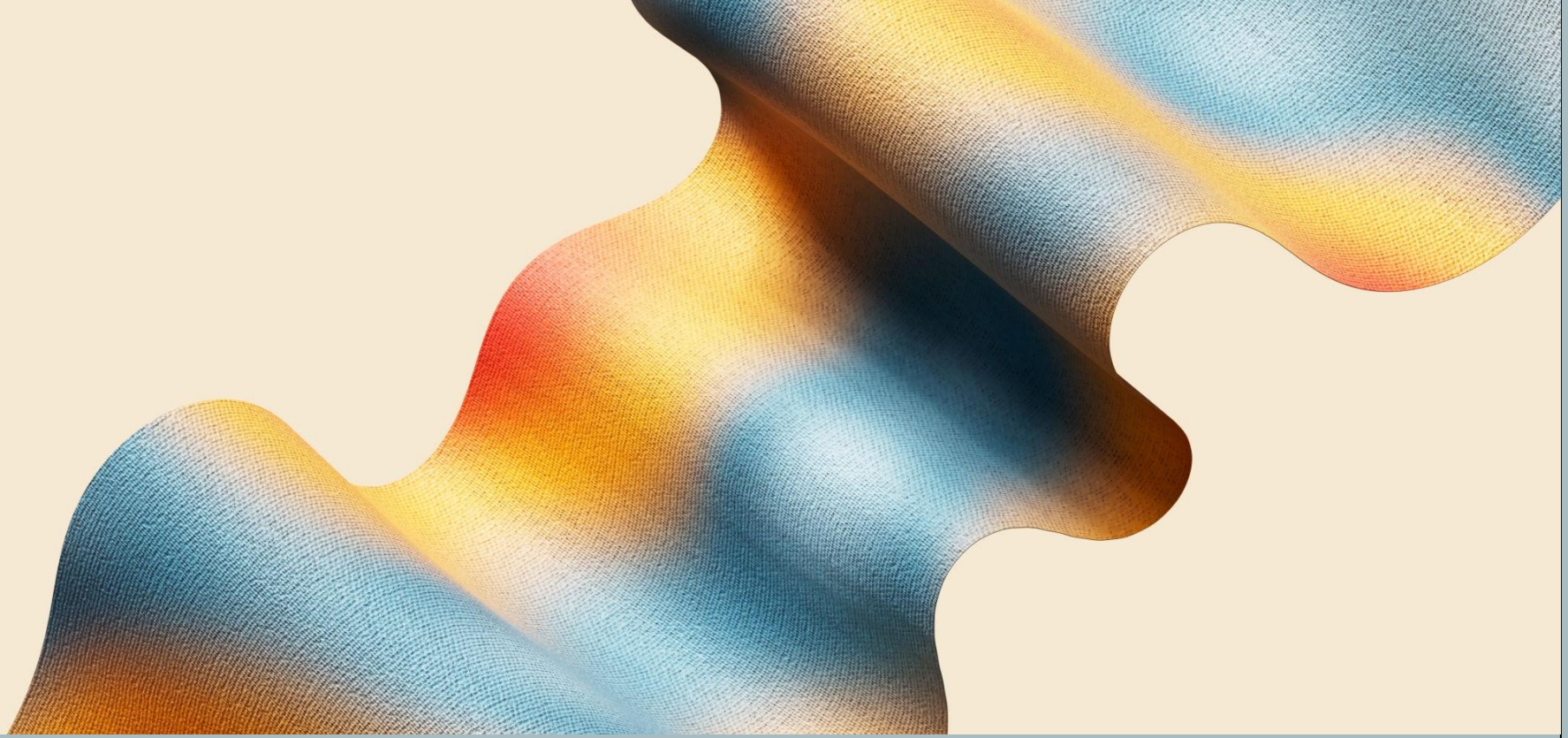
Methodology

- **Seton Falls Park**

Methodology

Park	Custom	S	675a0dafcec90d4bec8221cd	N/A





Next Step

Next Step

1. **Extract Visitor Data:**
   - Visitor statistics
   - Hourly visitor mobility data
   - Correlate visitation patterns with classified summer days
2. **Overlay Event Data:**
   - Incorporate NYC Parks
   - Identify potential event-day anomalies in visitation patterns.
3. **Analyze Behavioral Patterns:**
   - Visitation: Compare daily and hourly park visitation trends across different temperature categories.
   - Demographics: Using mobility and ACS data, examine demographic-specific patterns.
   - Crowd Distribution: Analyze visitor density across different park zones.

Appendix

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Thank You