**Motivation**
Climate change is increasing the frequency and intensity of extreme heat worldwide. Heat-related illnesses may result in organ damage, permanent disability, or death. In the United States, extreme heat events are leading causes of weather-related deaths. Thus, there is a need to investigate the relationship between heat and human health so communities can better prepare for extreme heat events.

**Methodology**
EMS data were only available for 2018. Therefore, only data between May–September 2018, which was when extreme heat events were most likely to occur, were used for analysis.

**Identifying Extreme Heat Days**
Any day that met at least one of the following criteria was considered an extreme heat day:
- Heat wave: The high temperature was at least 90°F
- Heat advisory: The heat index reached 95°F or greater
- Heat advisory, category 1: The heat index reached 100°F or greater
- Heat advisory, category 2: The heat index reached 105°F or greater
- Extreme heat: The high temperature exceeded 105°F

**Identifying “Hotspot” Zip Codes**
Using Microsoft Excel, the number of EMS incidents on each nonextreme heat day (n = 136) and extreme heat day (n = 17) was counted for each unique zip code. One-sided, two-sample t-tests (df = 16) were used to identify zip codes where the average number of EMS incidents was significantly higher (p < 0.05) on extreme heat days compared to nonextreme heat days. Such “hotspot” zip codes were distinguished using a Boolean true value. Additionally, the average percent change in EMS incidents on extreme heat days relative to nonextreme heat days was computed for each zip code. Any zip codes with zero EMS incidents, on average, were not reported EMS incident data. EMS incident statistics were joined to the zip code boundaries spatial dataset to map “hotspots” and investigate spatial patterns.

**Investigating Spatial Patterns**
The zonal histogram tool in the land cover raster (clipped to NYC zip codes) was used to determine the percentage of total land that each land cover type accounted for in “hotspot” versus “non-hotspot” zip codes. The sum test was used to count the number of GI points in each “hotspot” and “non-hotspot” zip code. From there, the number of GI points was divided by the zip code area. A one-sided Wilcoxon rank-sum test was conducted using R to assess whether the density of GI was lower in “hotspots” compared to “non-hotspots.” Lastly, a 1-mile buffer was created around each patient care center. Nursing homes were excluded because these facilities only provide care to individuals currently admitted in the facility. Using the “near” tool, the distance between the boundary of each “hotspot” and “non-hotspot” zip code and the nearest patient care center was computed. A one-sided Wilcoxon rank-sum test was conducted using R to assess whether the distance to the nearest patient care center was greater for “hotspots” compared to “non-hotspots.”

**Results**
Between May 1–September 30, 2018, 17 extreme heat days (136 nonextreme heat days) occurred. On average, more zip codes experienced an increase in EMS incidents on extreme heat days compared to nonextreme heat days. The average density of GI was lower in “hotspots” compared to “non-hotspots” (p = 0.0965). Additionally, the data did not provide sufficient evidence to suggest that the number of EMS incidents was significantly higher in “hotspots” compared to “non-hotspots” (p = 0.29). The data also did not provide sufficient evidence to suggest that the median distance to the nearest patient care center was higher for “hotspots” compared to “non-hotspots” (p = 0.9995). Some “hotspot” zip codes were partially more than 1 mile away from a patient care center; 11 of the 43 unique “hotspot” zip codes were entirely more than 1 mile away from a patient care center (“high-risk” hotspots).

**Conclusions**
The GIS analysis demonstrates how morbidity data can be used to gain spatial insight about the impact of heat on human health and help cities better prepare for extreme heat events. Because dark, built surfaces enhance the urban heat island effect, elevated temperatures in highly built regions, which increase morbidity risk, may explain the higher proportion of built land cover in “hotspots” compared to “non-hotspots.” This may suggest that incorporating natural land cover can reduce heat morbidity. GI is one strategy that incorporates more natural land cover. Although the data did not support the hypothesis that “hotspots” had less GI than “non-hotspots,” there may have been confounding factors, such as byways that limited construction in certain zip codes. The data also did not support the hypothesis that “hotspots” were further from a patient care center than “non-hotspots.” Patient care centers more often provide health services after heat morbidity has occurred. Therefore, far distance to a patient care center is likely not a risk factor of heat morbidity. Instead, far distance more likely influences the severity of existing heat morbidities. Thus, NYC should consider changing health personnel in “high-risk” hotspots on extreme heat days to ensure that care is timely provided to individuals experiencing heat morbidity.

Next steps include assessing if “hotspots” differ on weekday versus weekend extreme heat days and if the location of “hotspots” is correlated with demographic variables that vary spatially. Similar analysis may be conducted in the future to assess differences between “hotspots” and “non-hotspots” for other factors that may affect heat vulnerability.

**Land Cover Trends**

**Green Infrastructure Trends**

**Proximity to Patient Care Centers**