

Time Series Investigations

```
## — Attaching core tidyverse packages ————— tidyverse 2.0.0 —
## ✓ dplyr    1.1.4    ✓ readr    2.1.5
## ✓forcats   1.0.0    ✓ stringr  1.5.1
## ✓ ggplot2   3.5.1    ✓ tibble   3.2.1
## ✓ lubridate 1.9.3    ✓ tidyrr   1.3.1
## ✓ purrr    1.0.2

## — Conflicts ————— tidyverse_conflicts() —
## ✘ dplyr::filter() masks stats::filter()
## ✘ dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors
##
## Attaching package: 'janitor'
##
##
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```
## Warning: package 'sf' was built under R version 4.4.2
```

```
## Linking to GEOS 3.12.2, GDAL 3.9.3, PROJ 9.4.1; sf_use_s2() is TRUE
```

```
## Warning: package 'sp' was built under R version 4.4.2
```

```
## Warning: package 'raster' was built under R version 4.4.2
```

```
##
## Attaching package: 'raster'
##
## The following object is masked from 'package:dplyr':
##
##     select
```

```
## Warning: package 'geojsonR' was built under R version 4.4.2
```

```
##
## Attaching package: 'glue'
##
## The following object is masked from 'package:raster':
##
##     trim
```

```

## Warning: package 'lwgeom' was built under R version 4.4.2

## Linking to liblwgeom 3.0.0beta1 r16016, GEOS 3.13.0, PROJ 9.5.1

## Warning in fun(libname, pkgname): GEOS versions differ: lwgeom has 3.13.0 sf
## has 3.12.2

## Warning in fun(libname, pkgname): PROJ versions differ: lwgeom has 9.5.1 sf has
## 9.4.1

## 
## Attaching package: 'lwgeom'
##
## The following object is masked from 'package:sf':
## 
##     st_perimeter

## Reading layer `hex_merged_w_stats' from data source
##   `C:\Users\hbaue\OneDrive - The University of Chicago\Documents\GitHub\pre_1965\data\mst\hex
## _merged_w_stats.gpkg'
##   using driver `GPKG'
## Simple feature collection with 110014 features and 53 fields
## Geometry type: POLYGON
## Dimension:      XY
## Bounding box:  xmin: -87.94612 ymin: 41.63934 xmax: -87.51956 ymax: 42.02957
## Geodetic CRS:  WGS 84

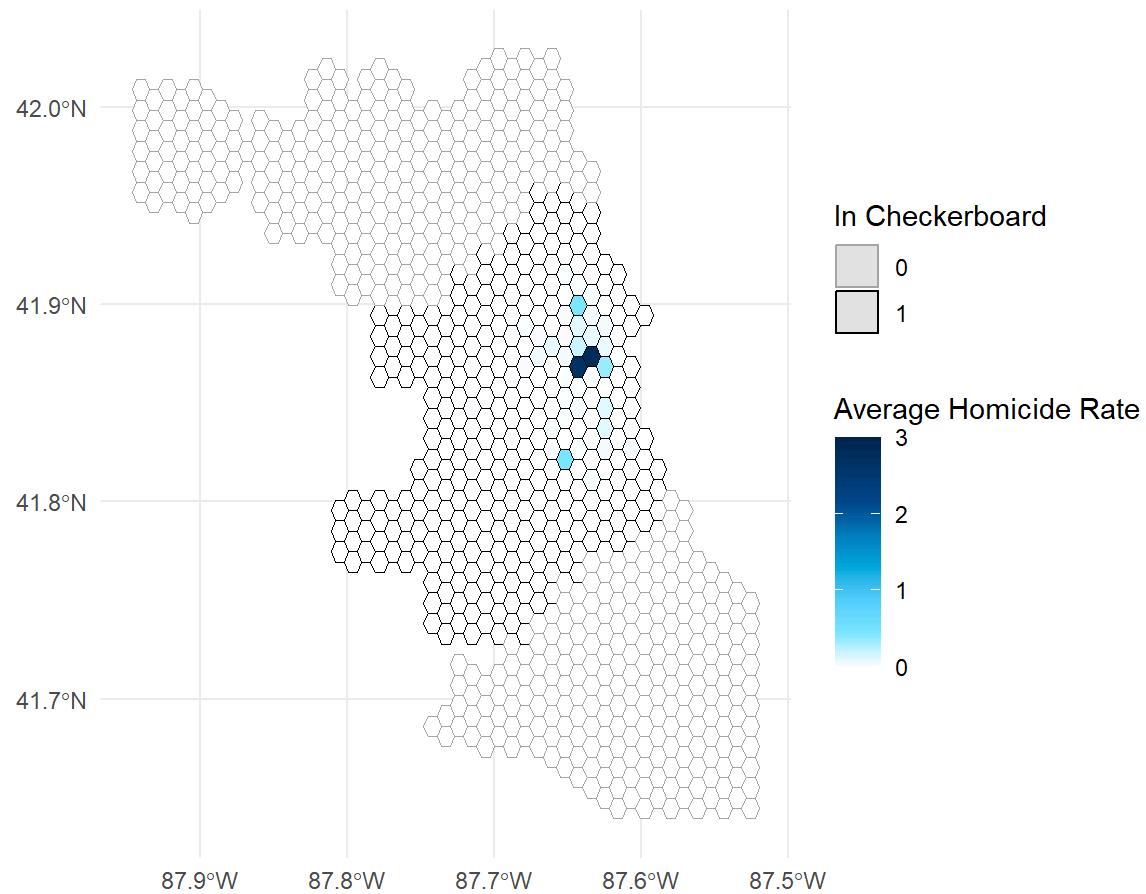
```

Estimation of Black Residency in 1939 and 1948

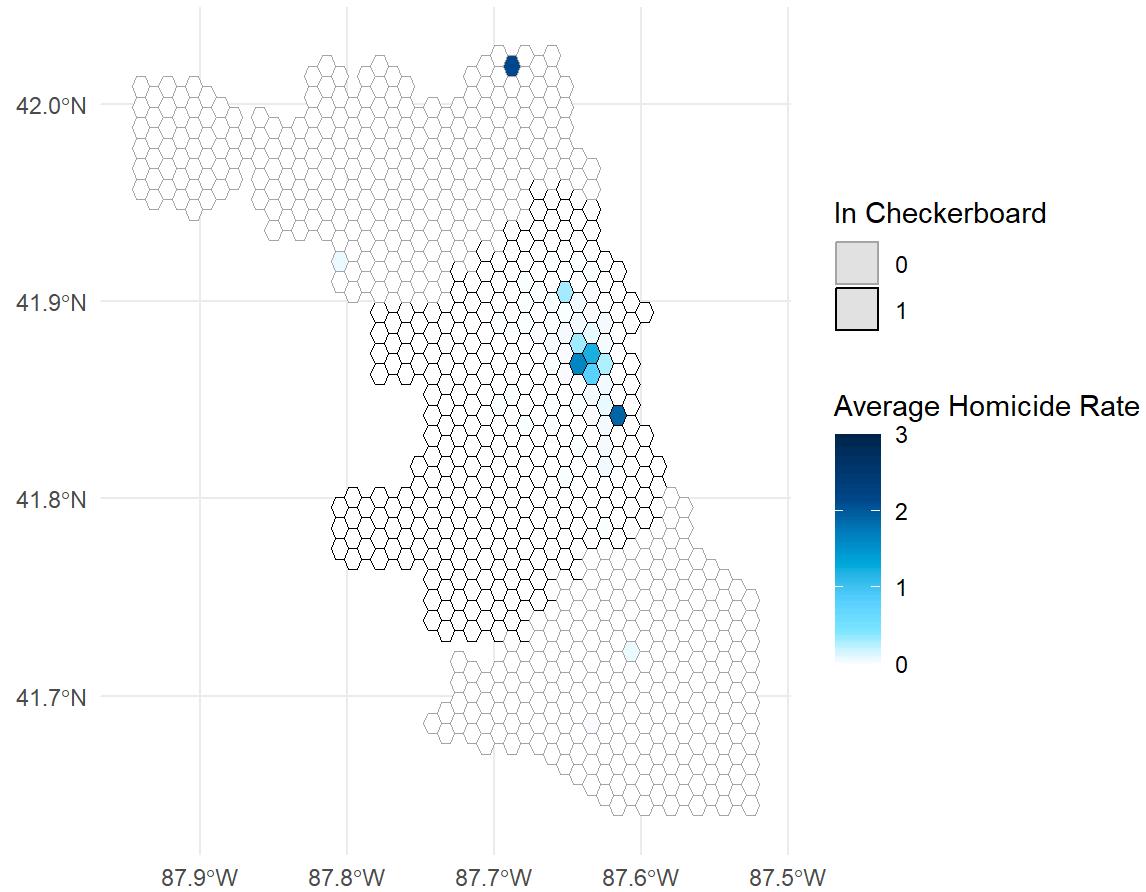
Plot of Homicide Rate Over Time

q_99_rt <dbl>	q_999_rt <dbl>	q_99_ct <dbl>	q_999_ct <dbl>	max <dbl>
0.2448831	4.554109	40	61	79
1 row				

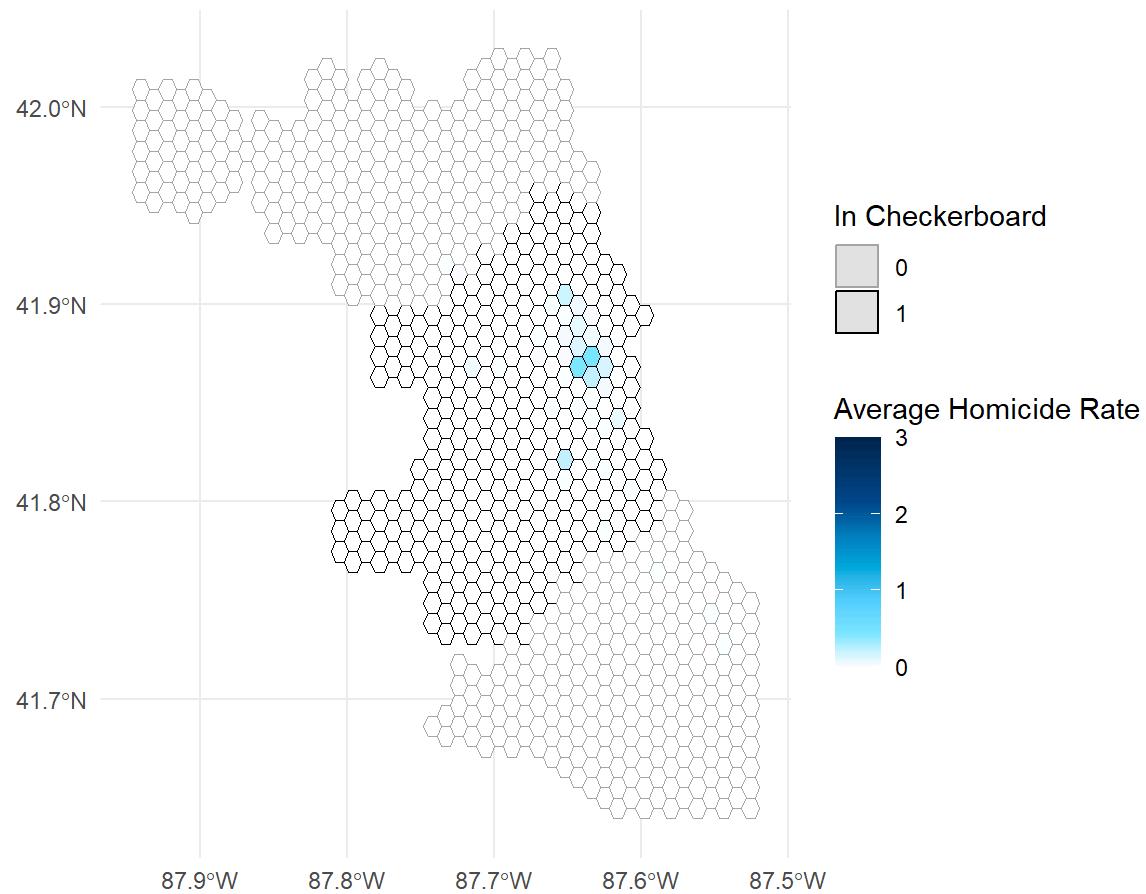
Homicide Rate 1876-1880



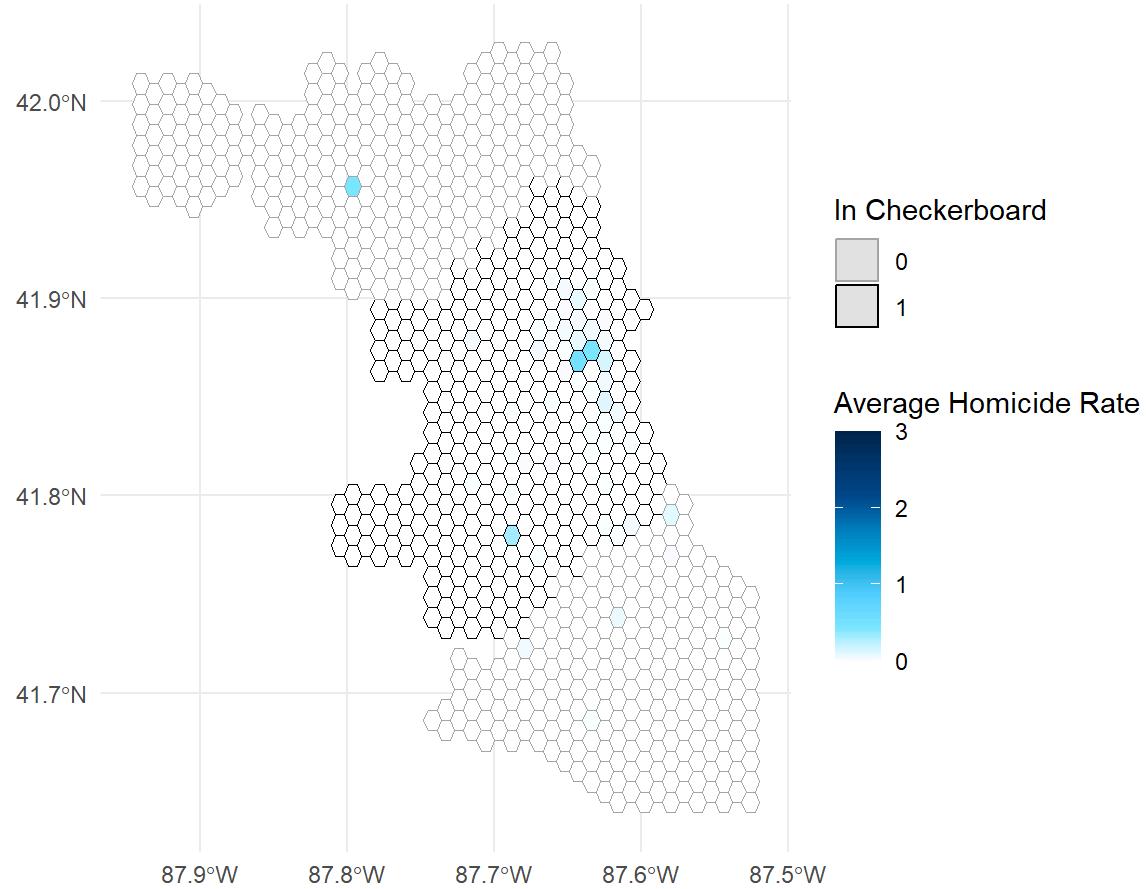
Homicide Rate 1881-1885



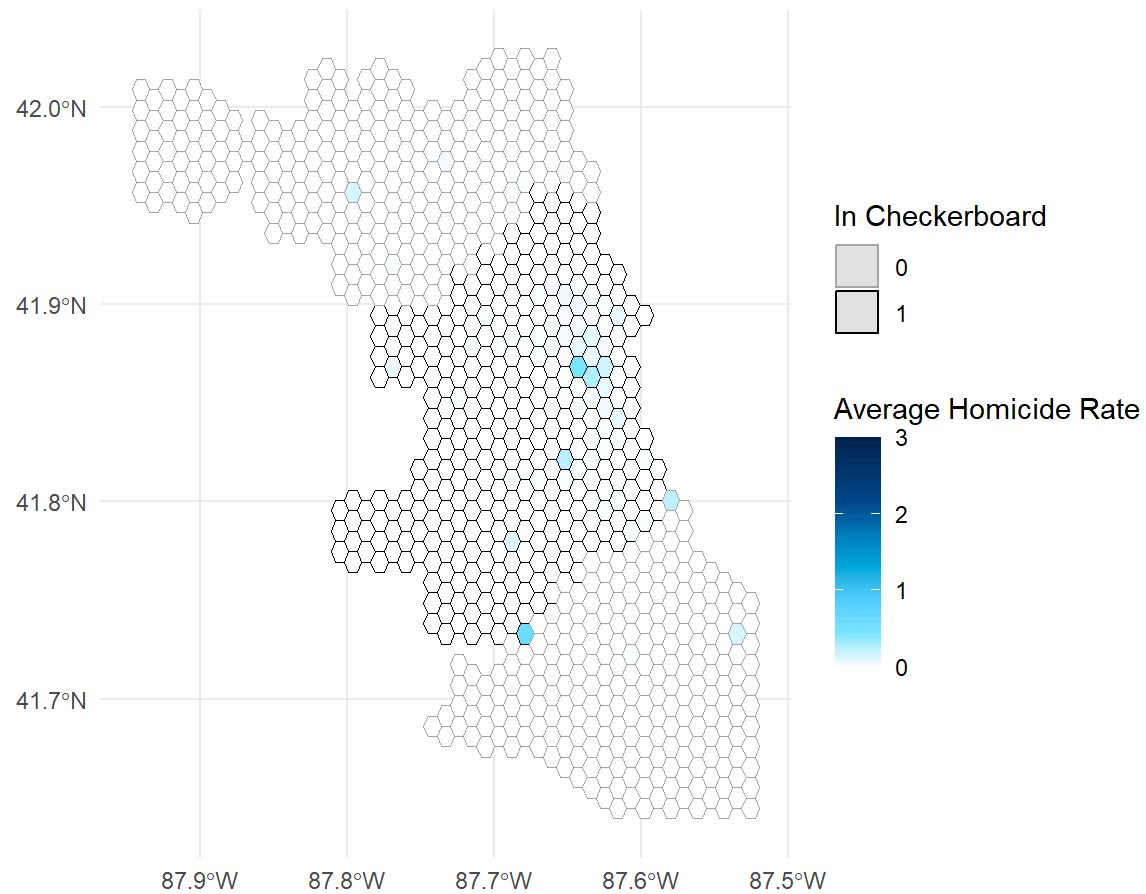
Homicide Rate 1886-1890



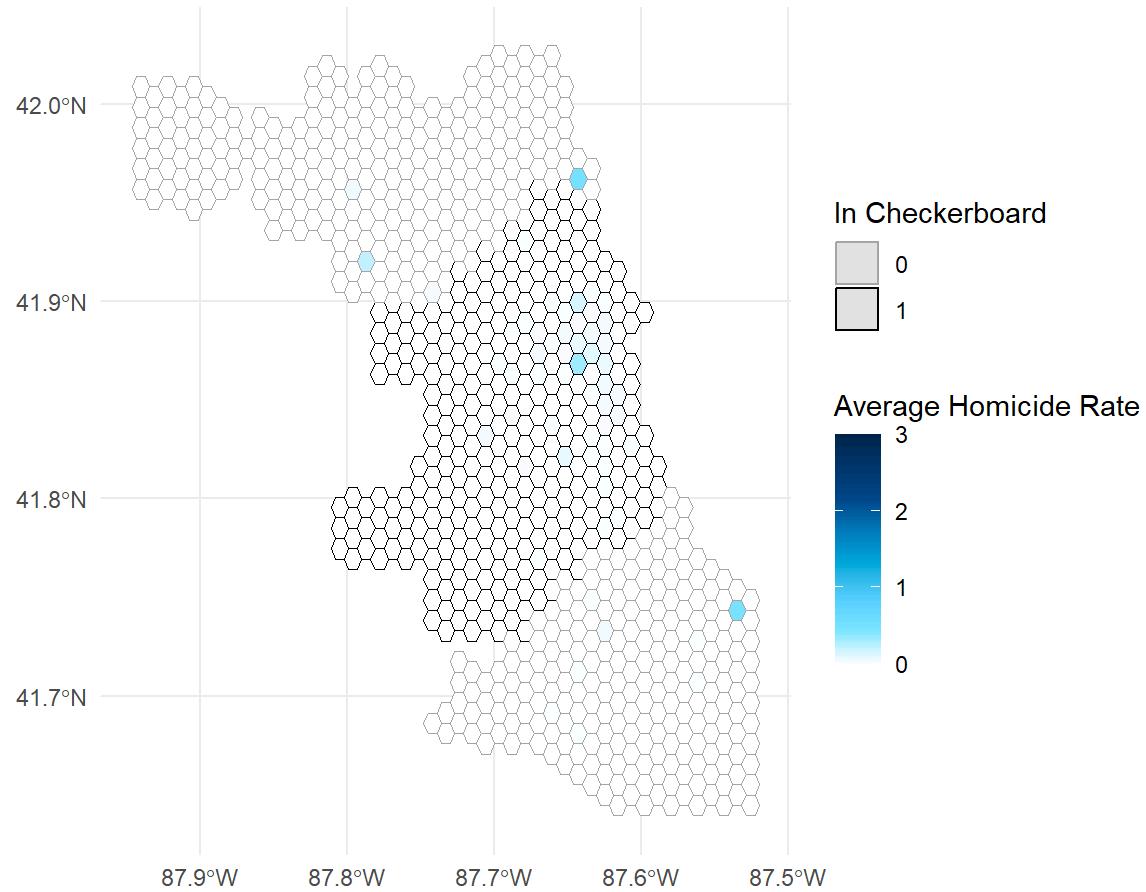
Homicide Rate 1891-1895



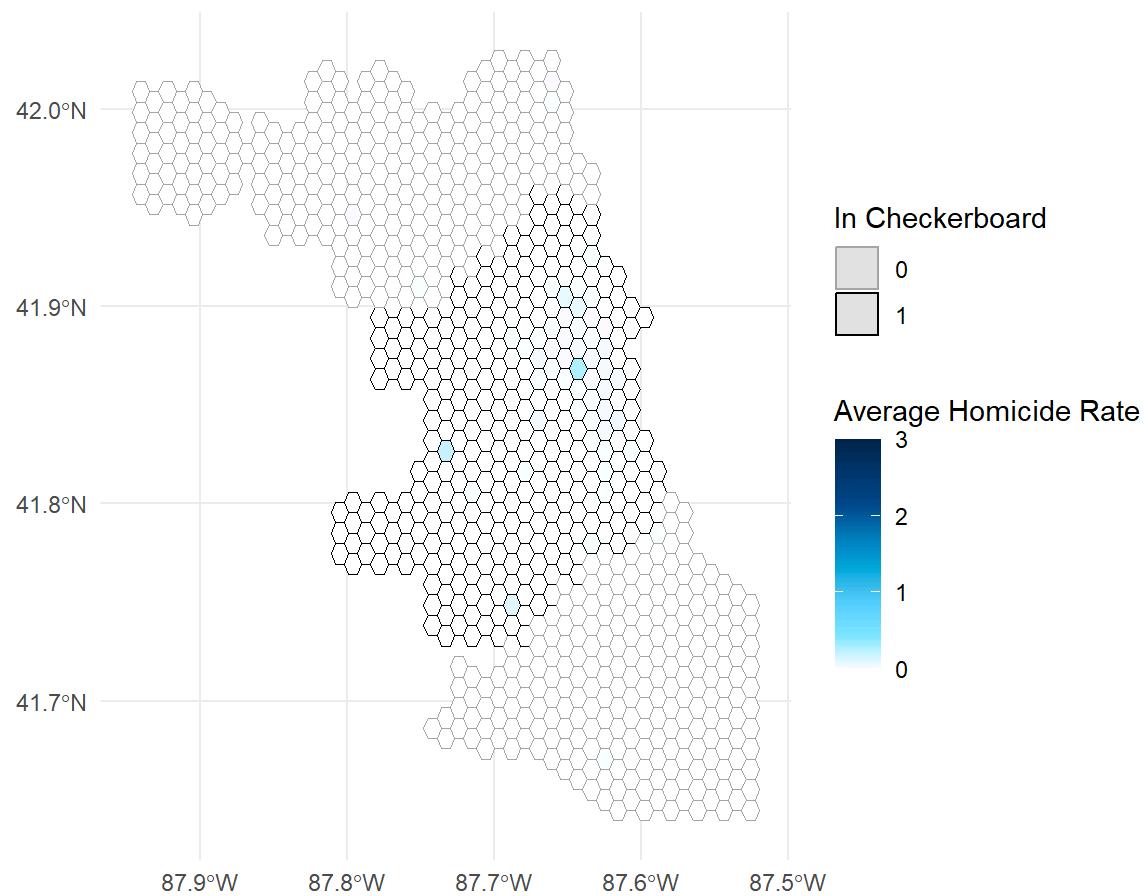
Homicide Rate 1896-1900



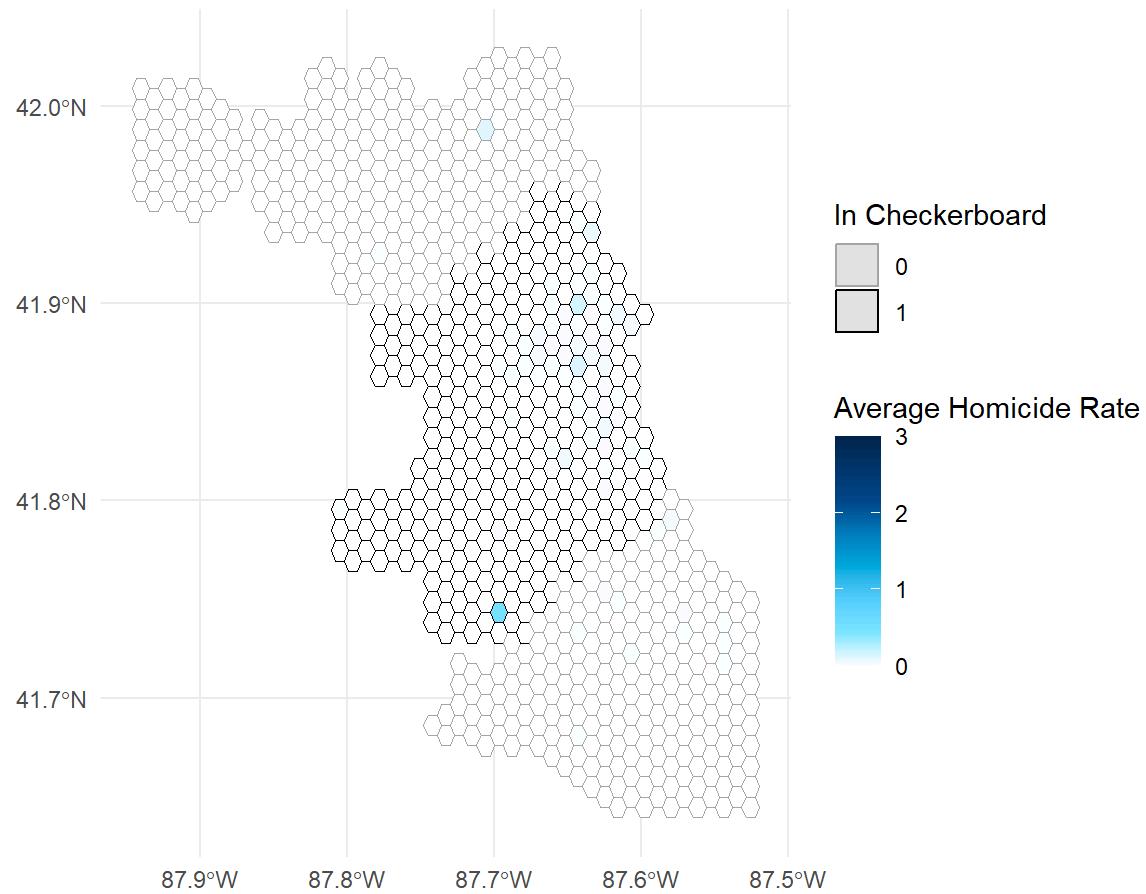
Homicide Rate 1901-1905



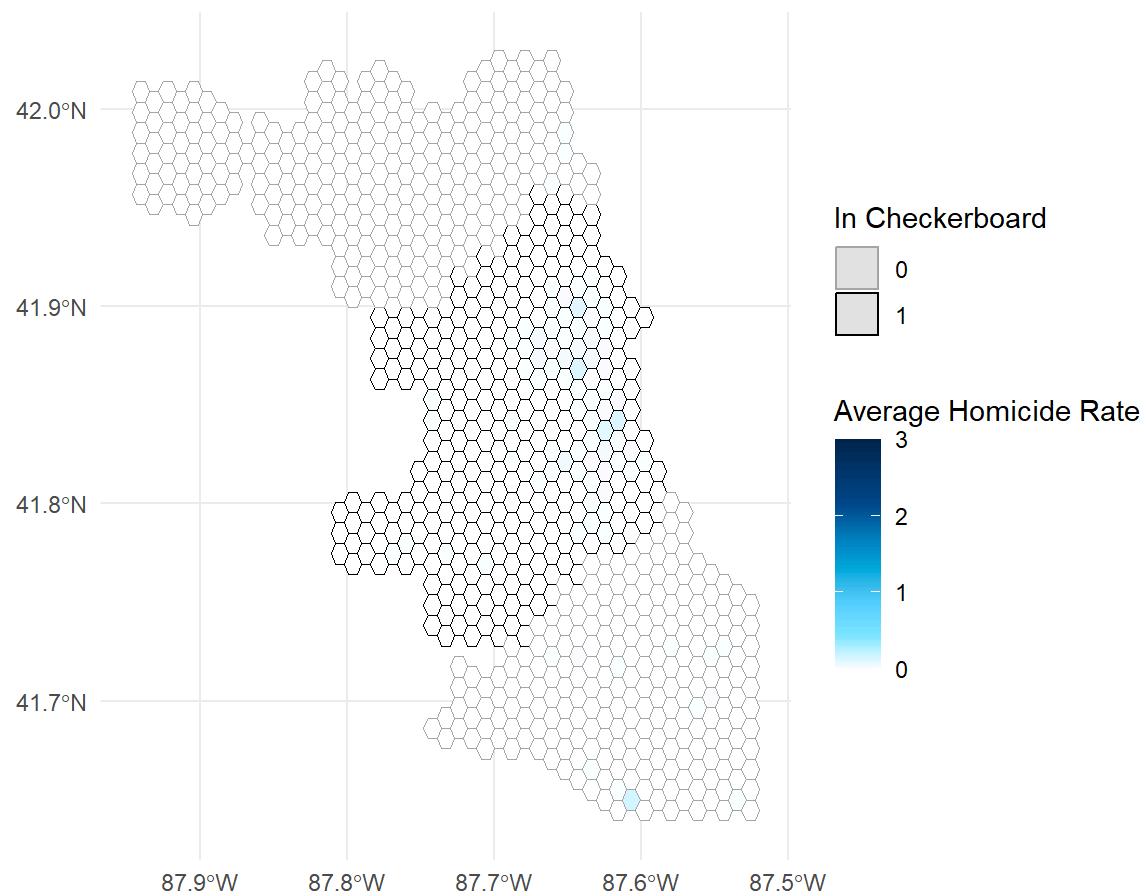
Homicide Rate 1906-1910



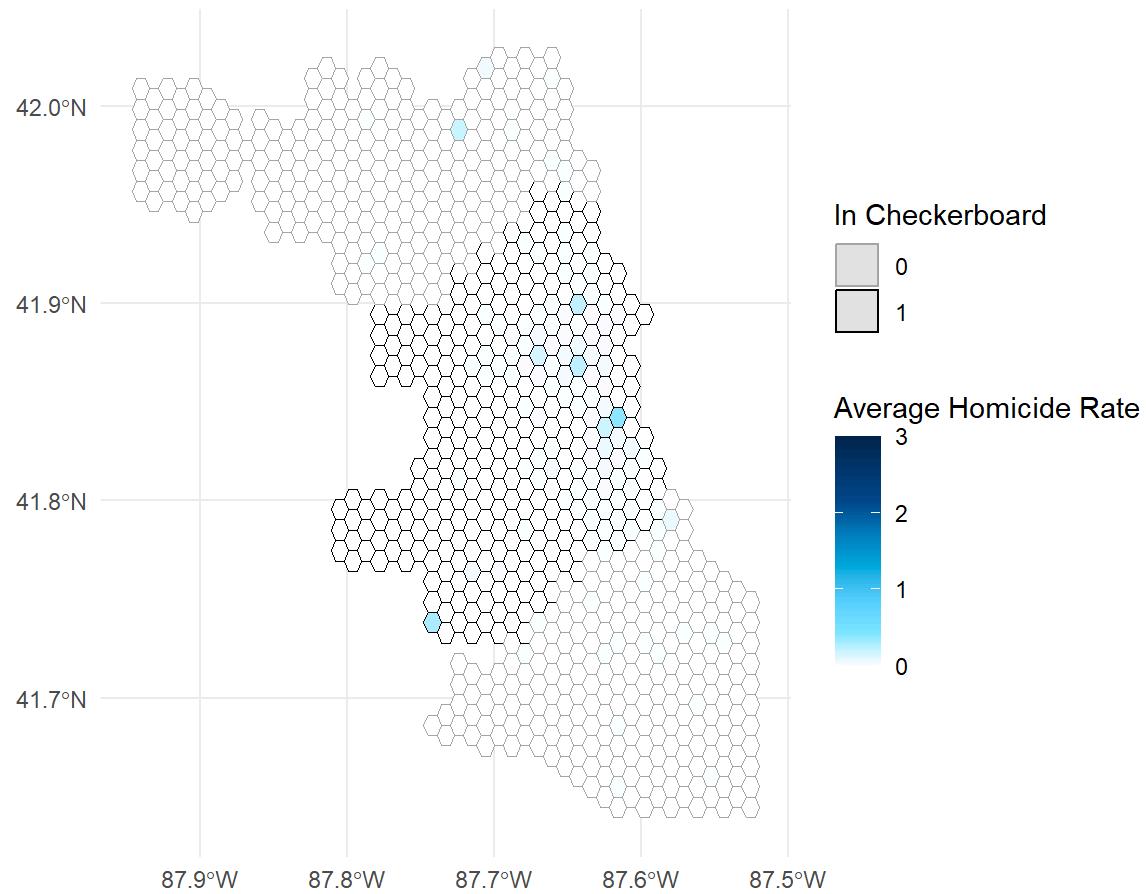
Homicide Rate 1911-1915



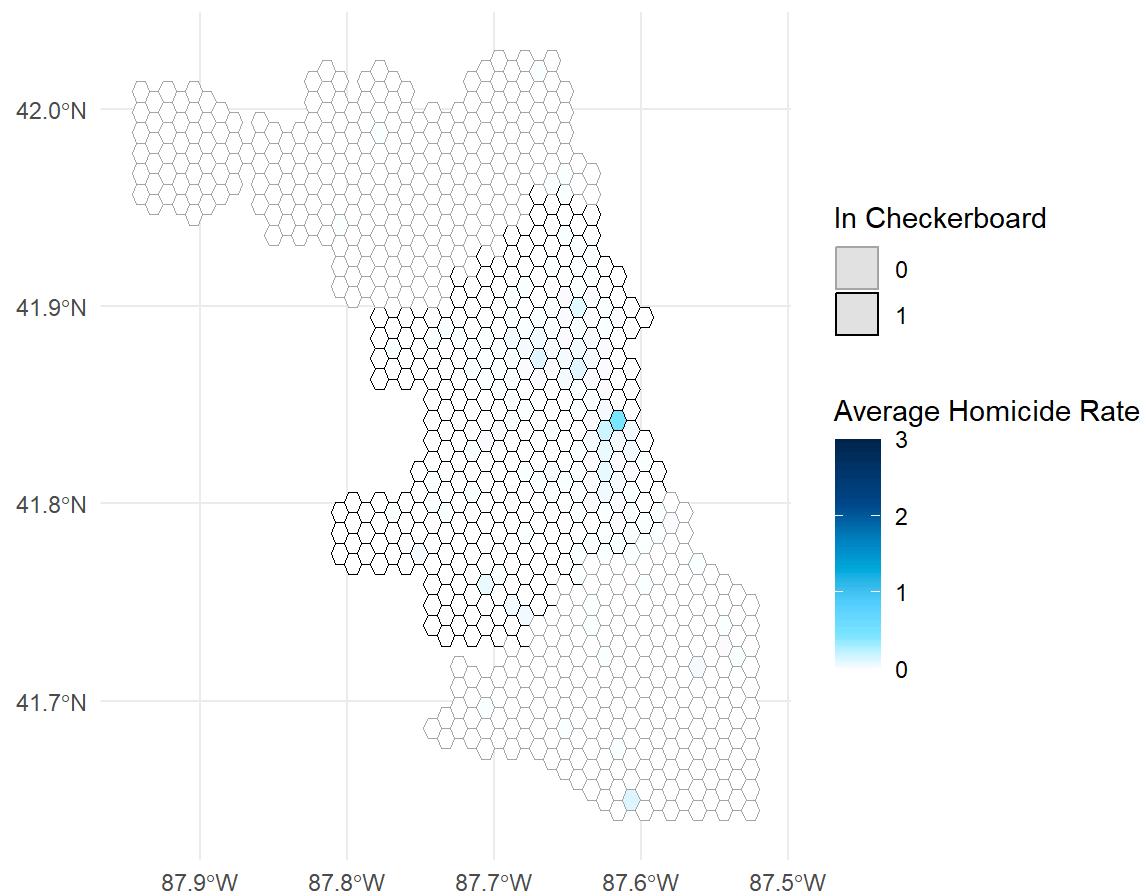
Homicide Rate 1916-1920



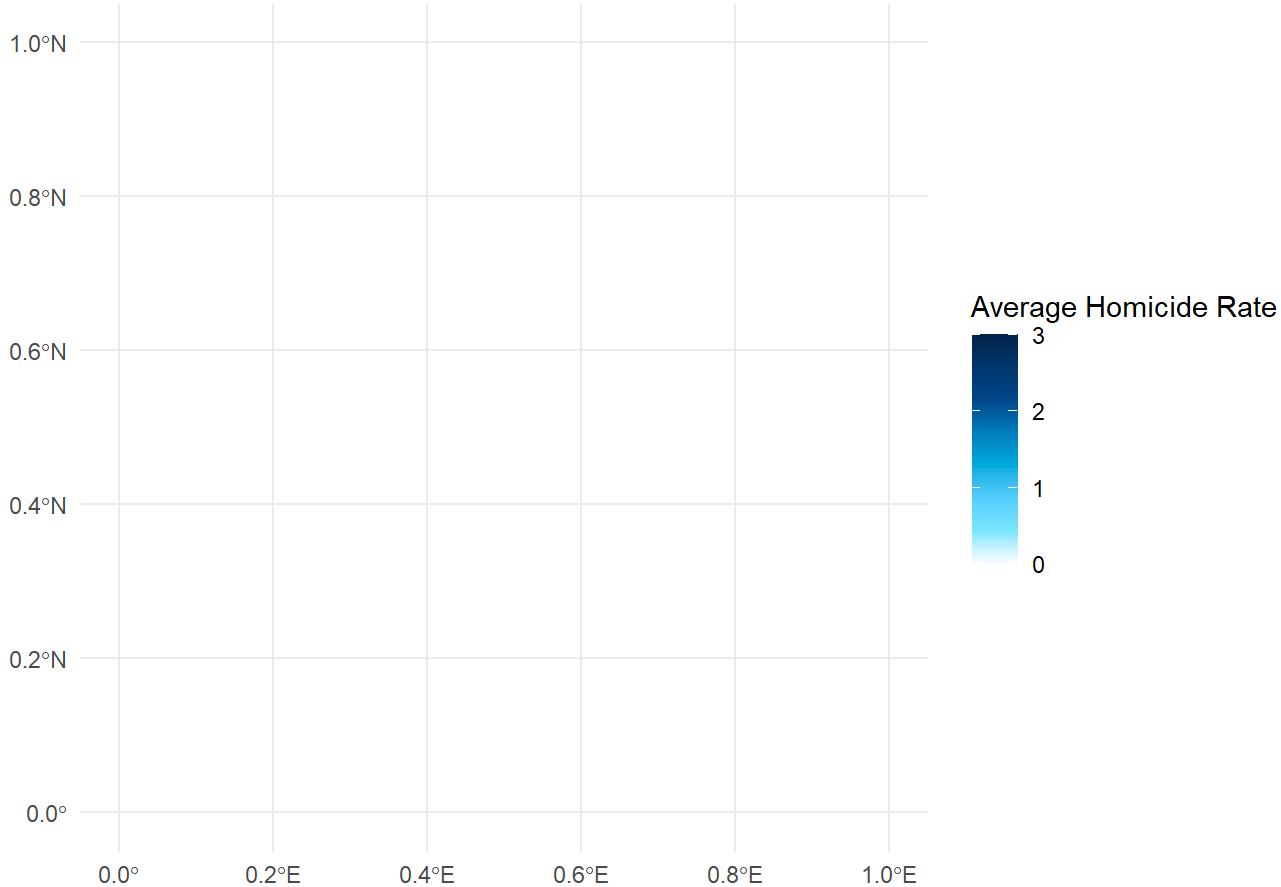
Homicide Rate 1921-1925



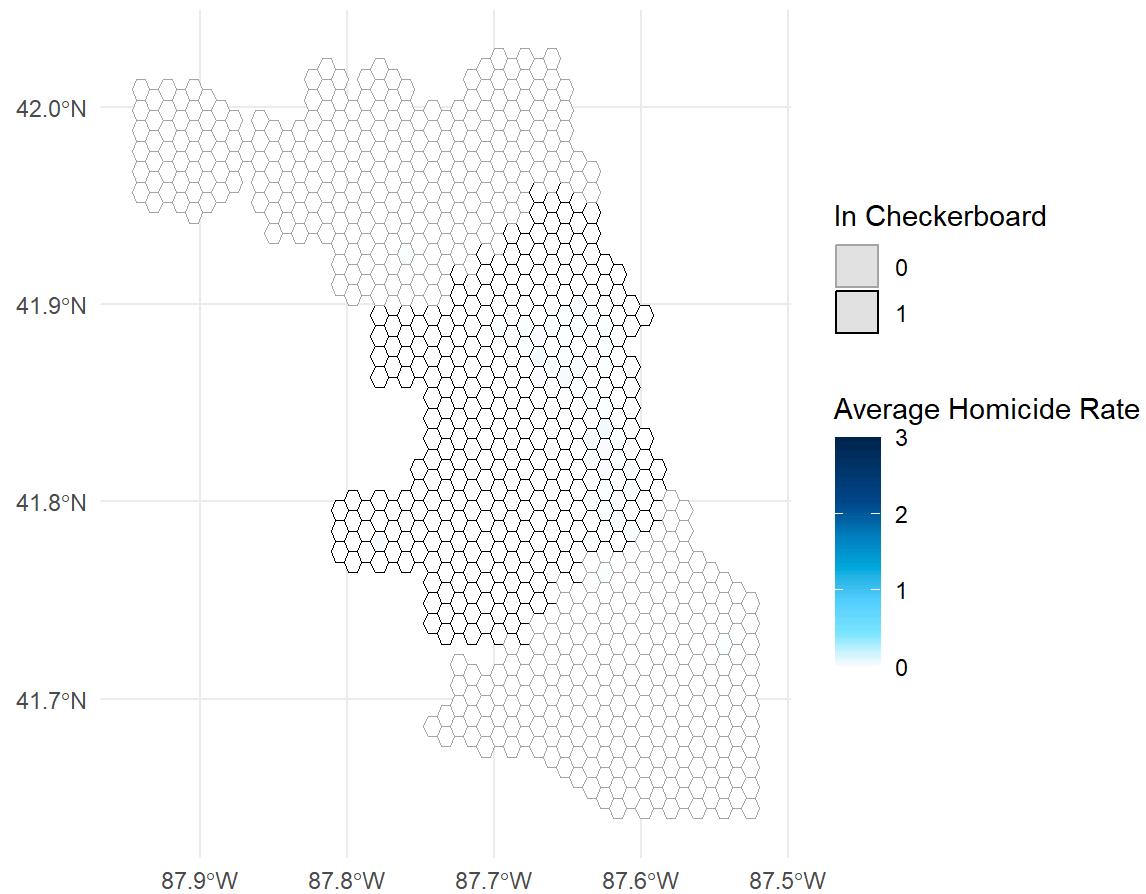
Homicide Rate 1926-1930



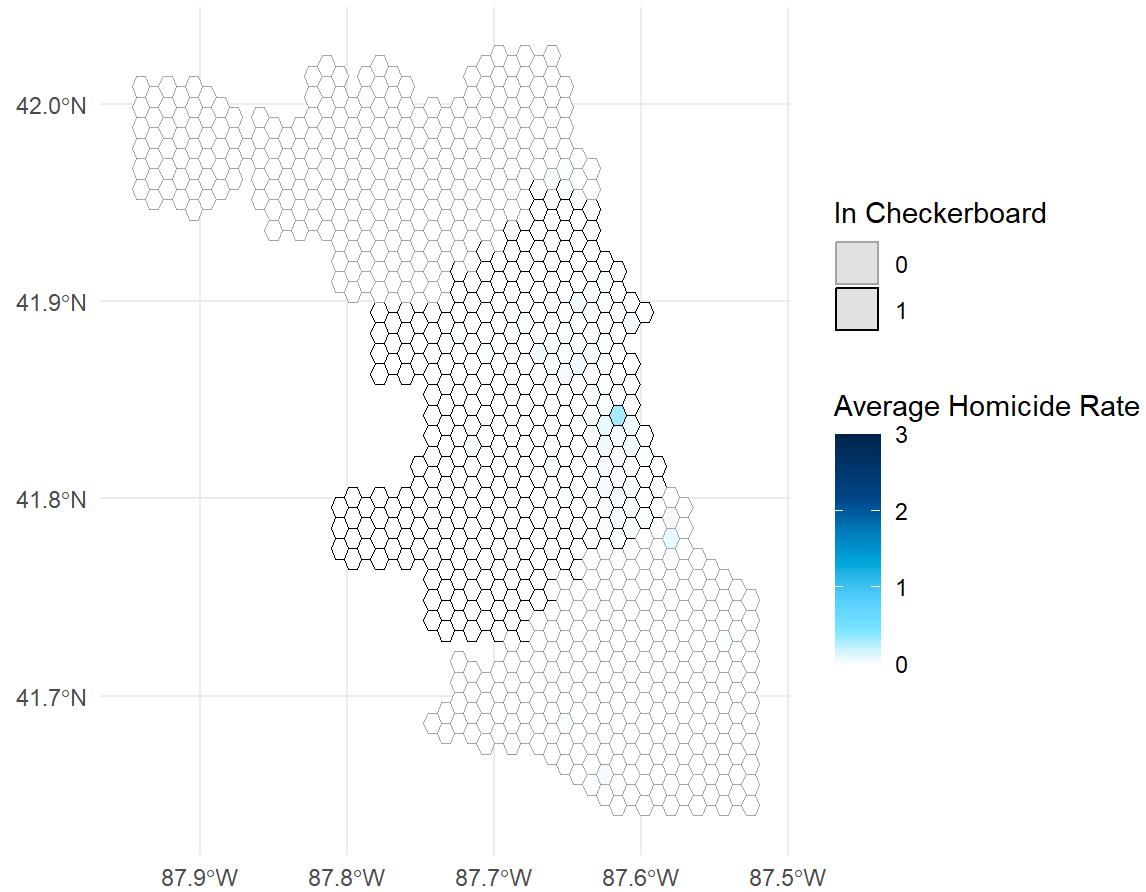
Homicide Rate 1931-1935



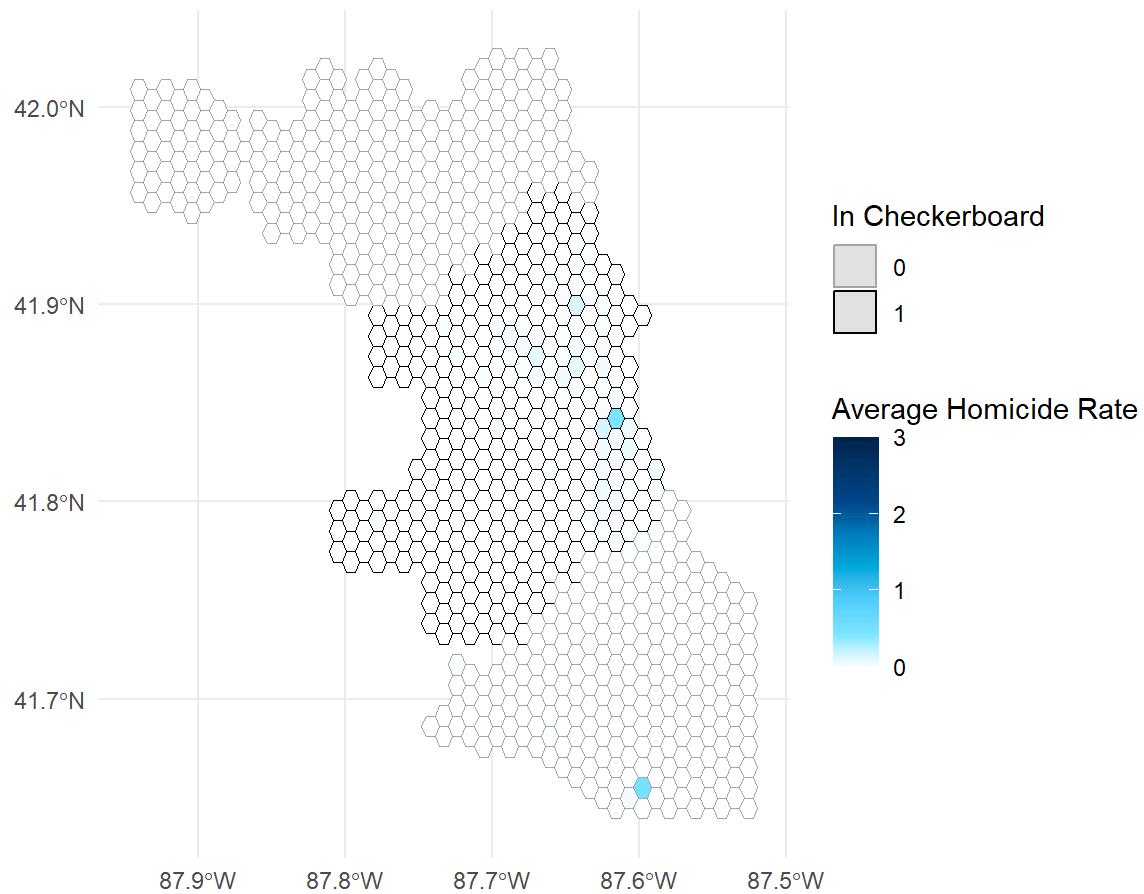
Homicide Rate 1936-1940



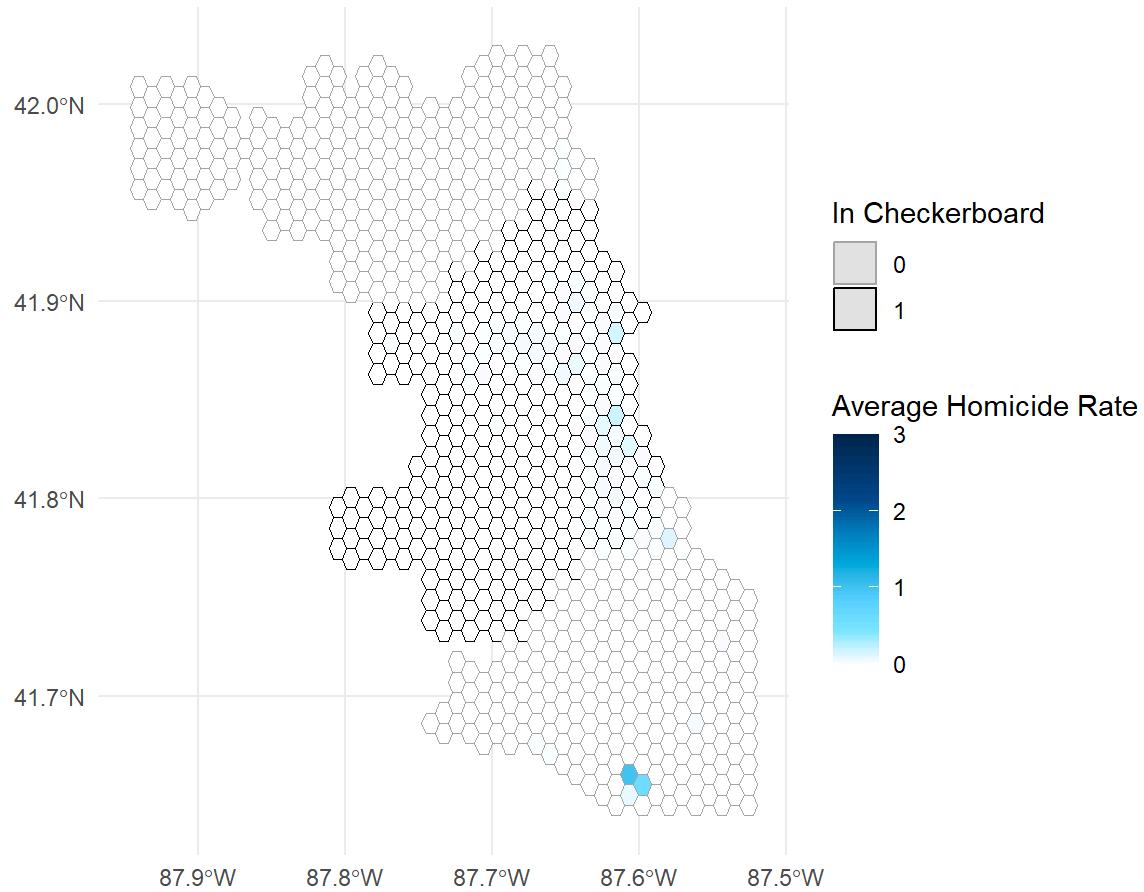
Homicide Rate 1941-1945



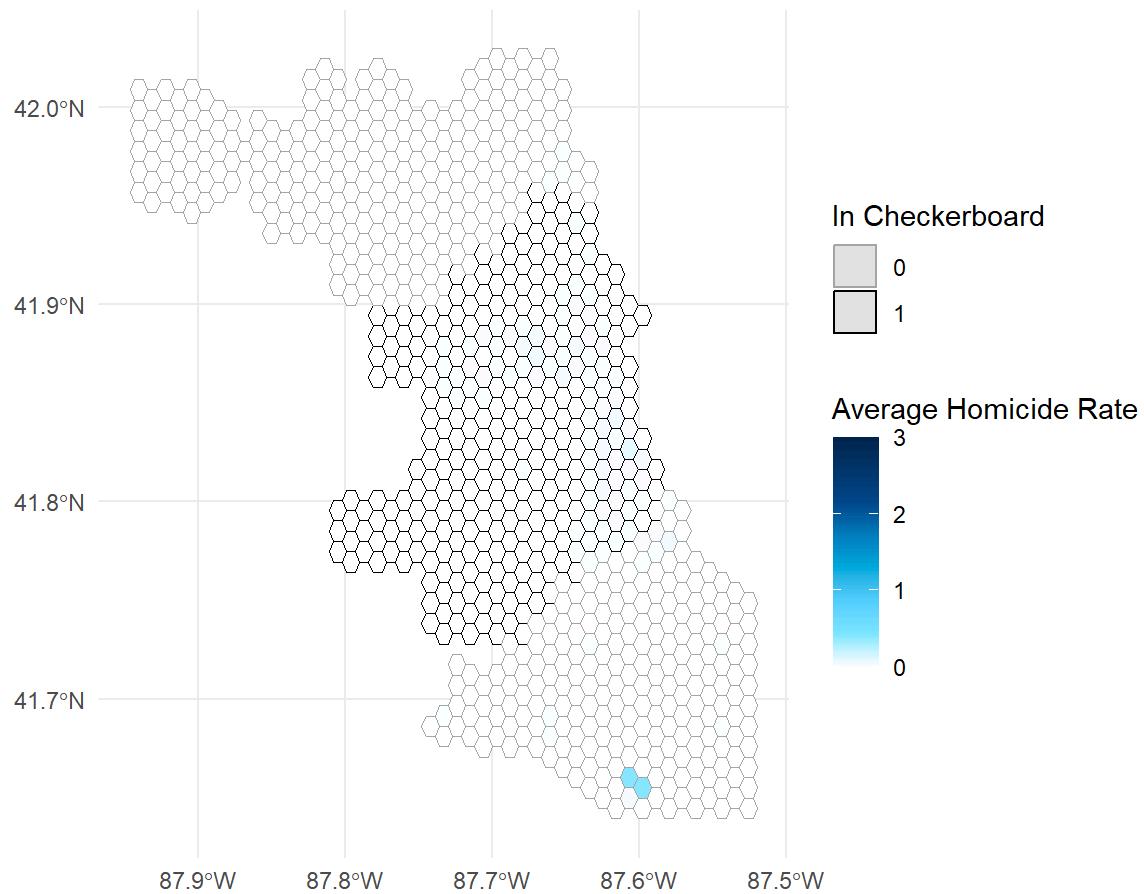
Homicide Rate 1946-1950



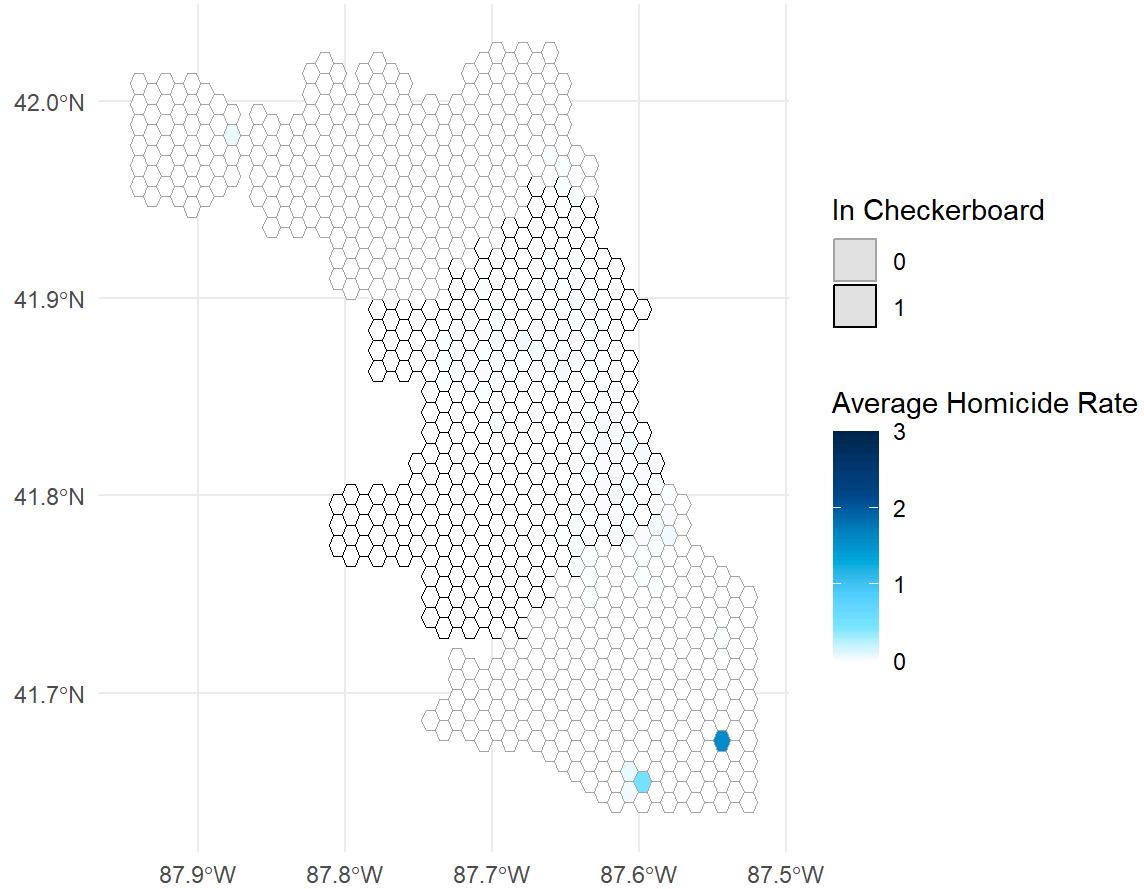
Homicide Rate 1951-1955



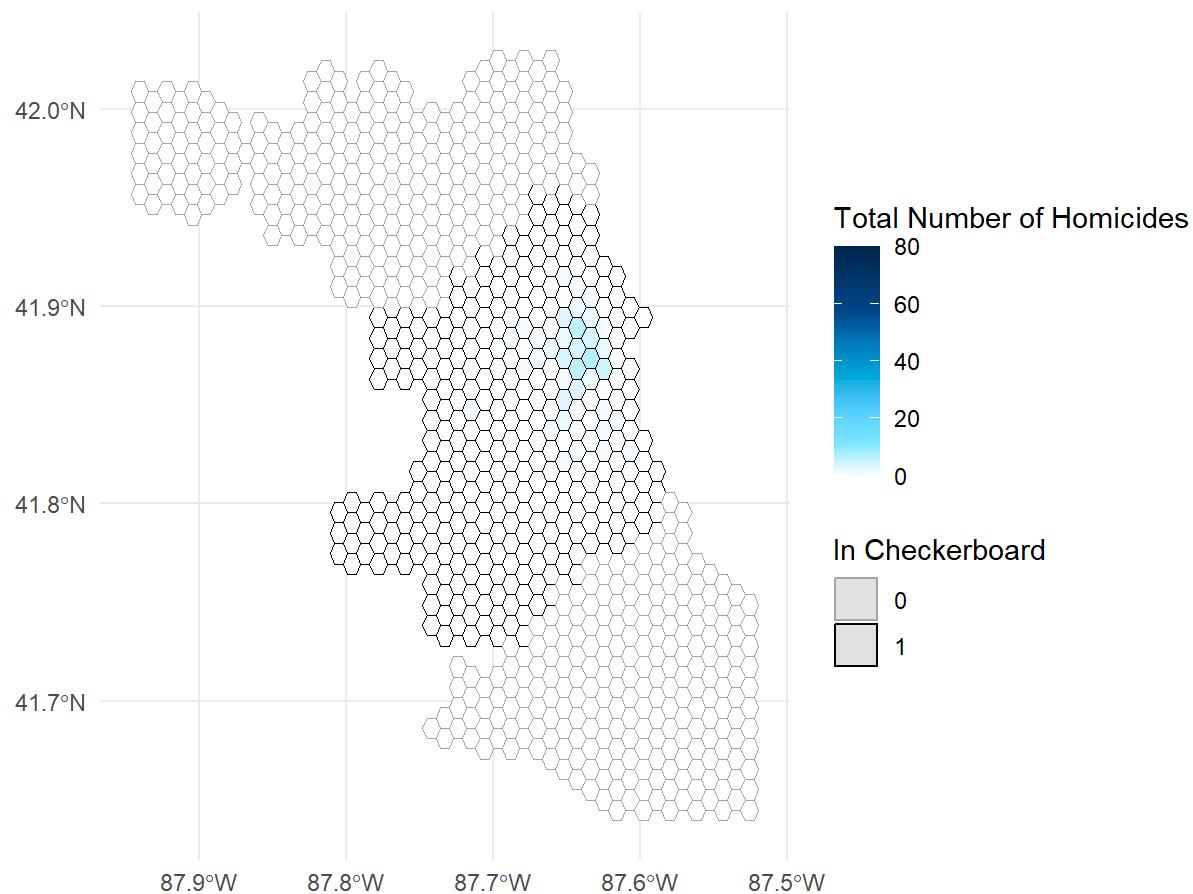
Homicide Rate 1956-1960



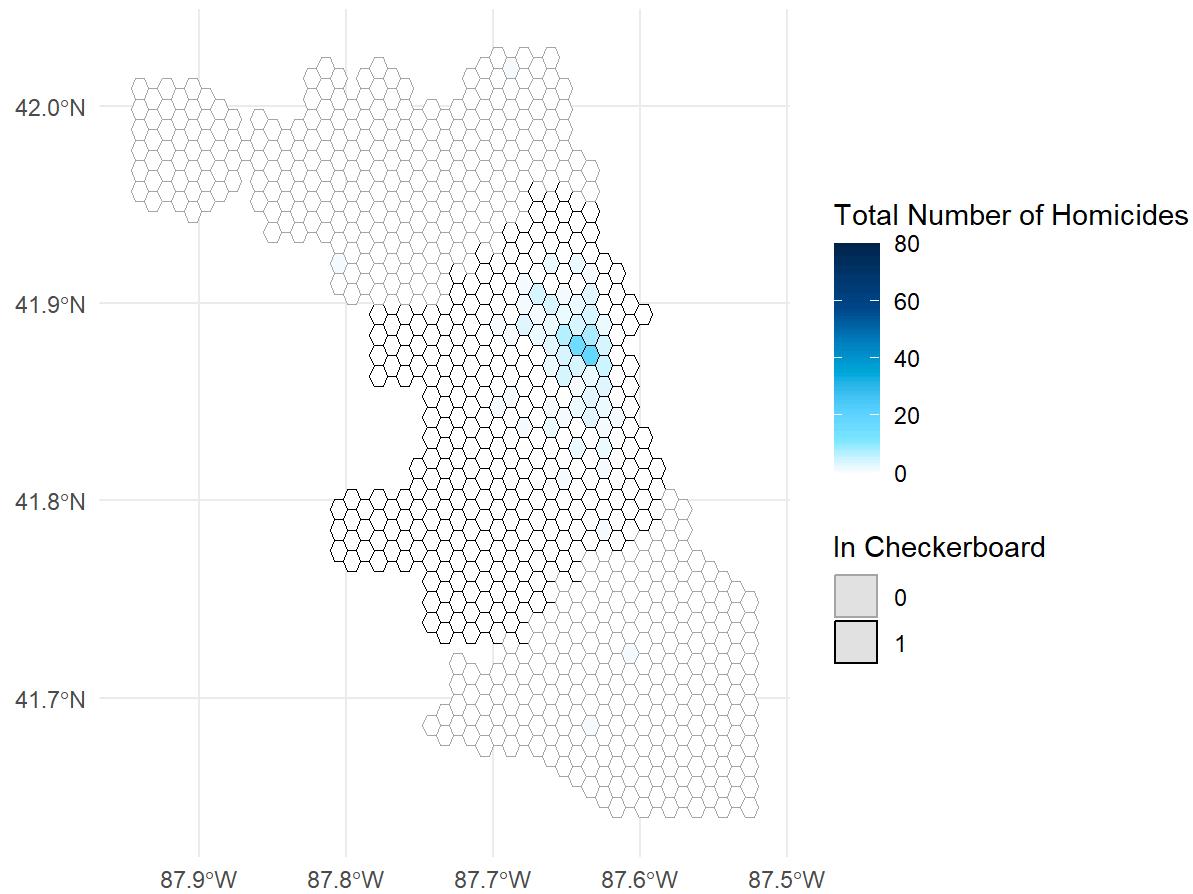
Homicide Rate 1961-1965



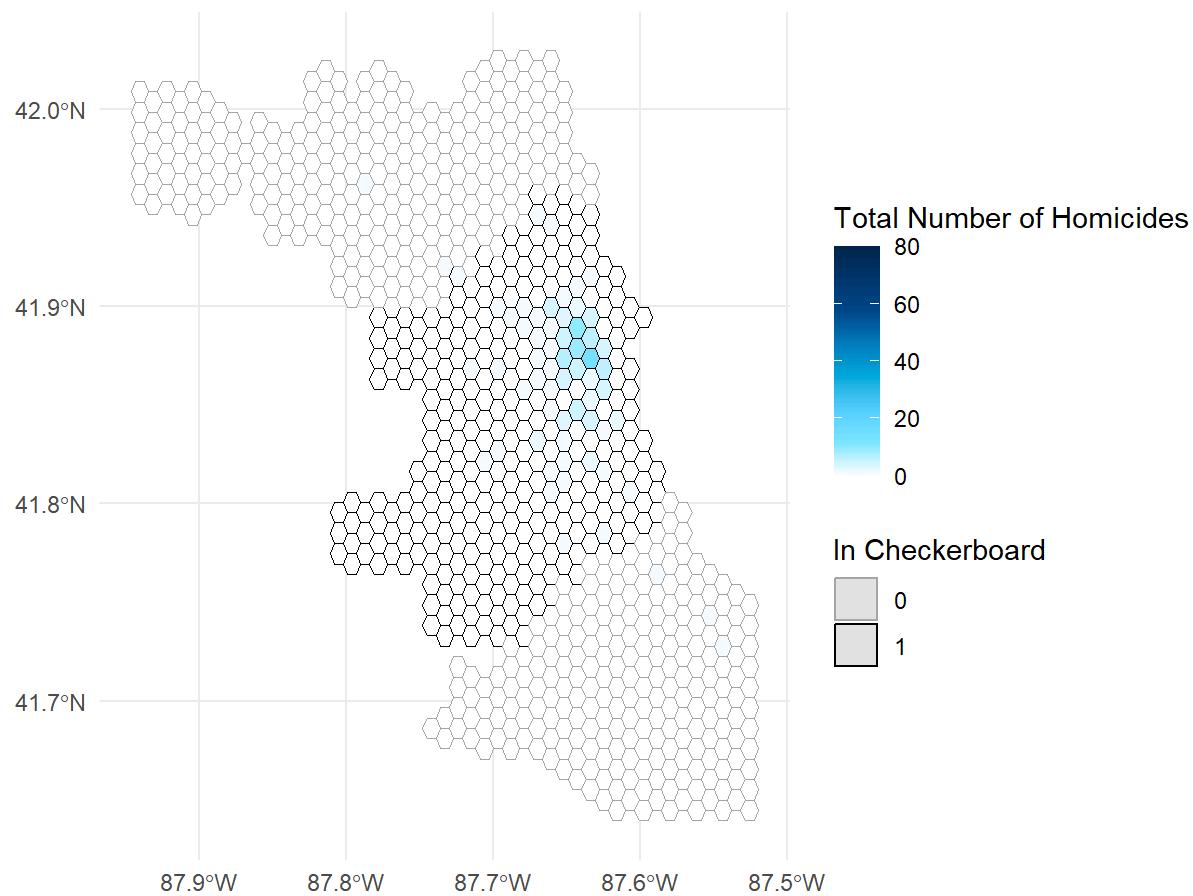
Number of Homicides 1876-1880



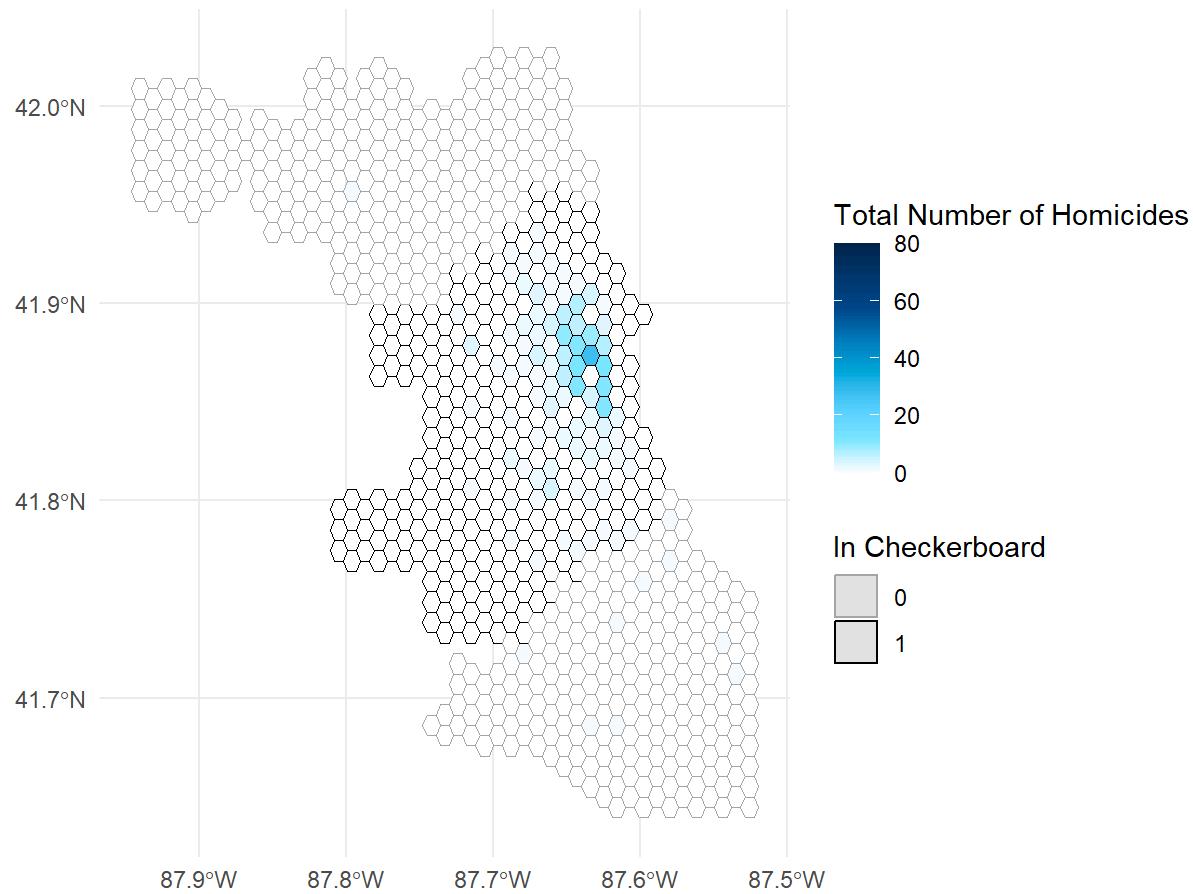
Number of Homicides 1881-1885



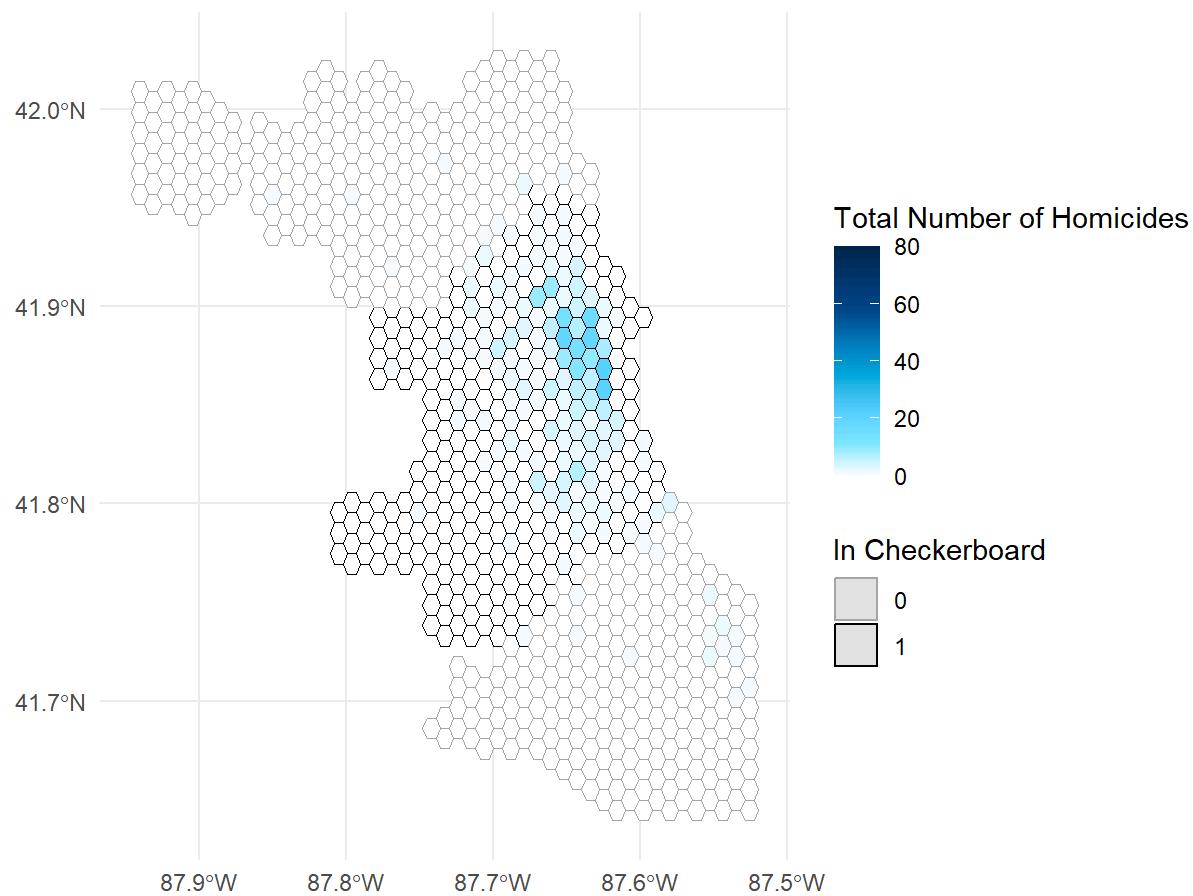
Number of Homicides 1886-1890



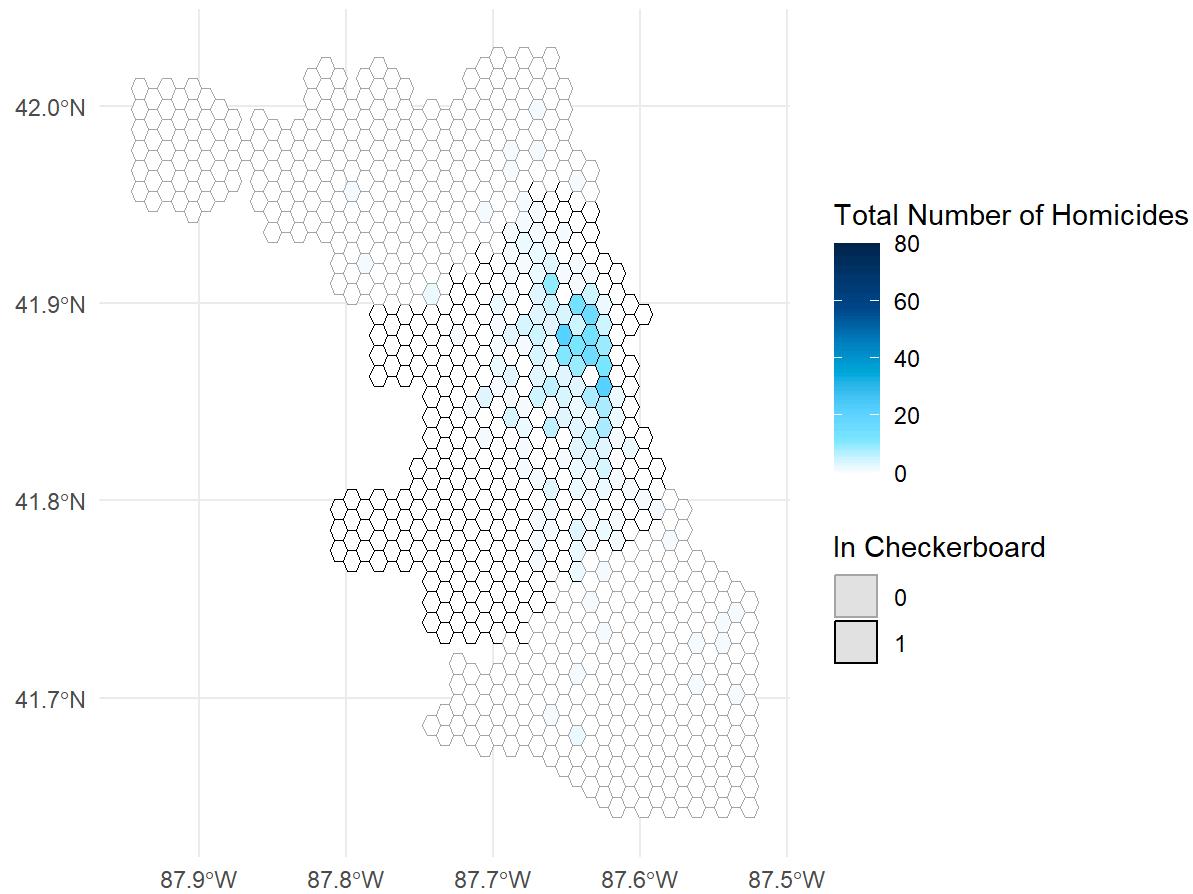
Number of Homicides 1891-1895



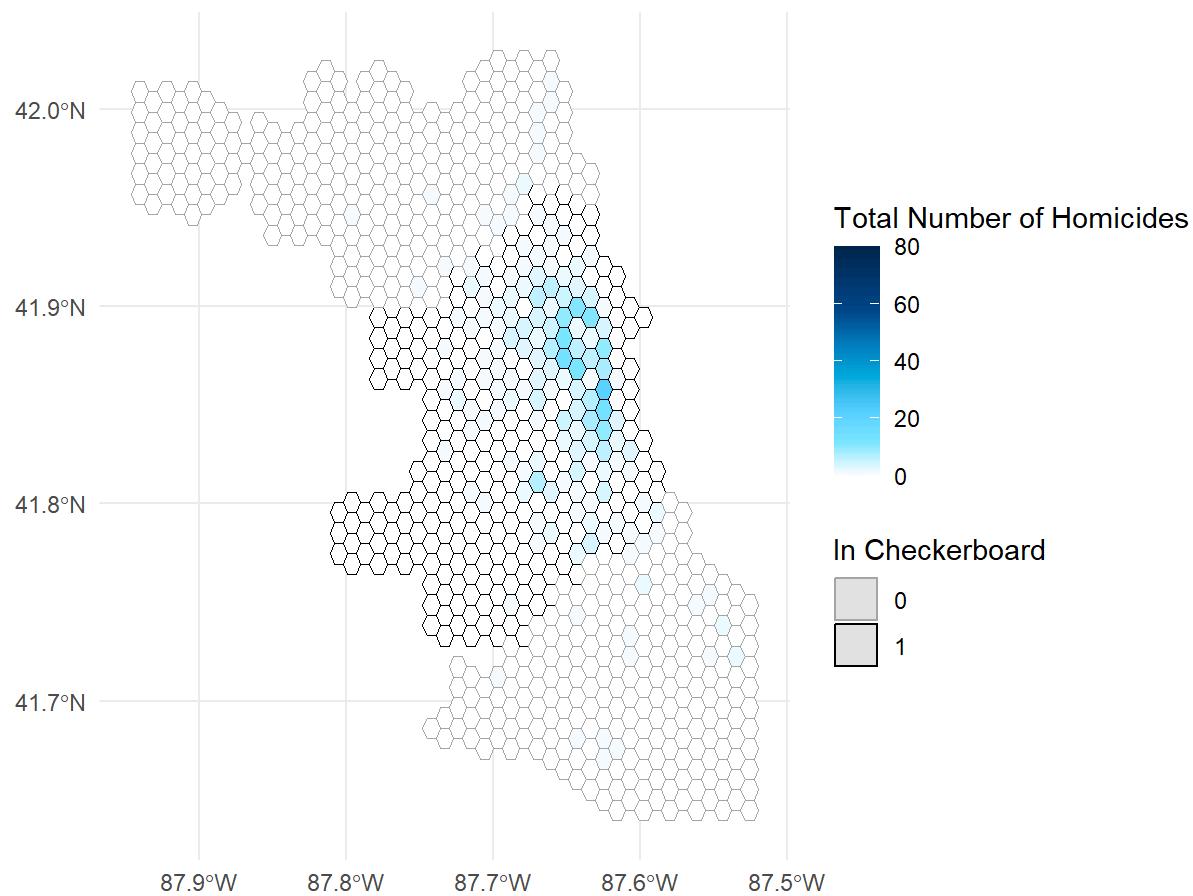
Number of Homicides 1896-1900



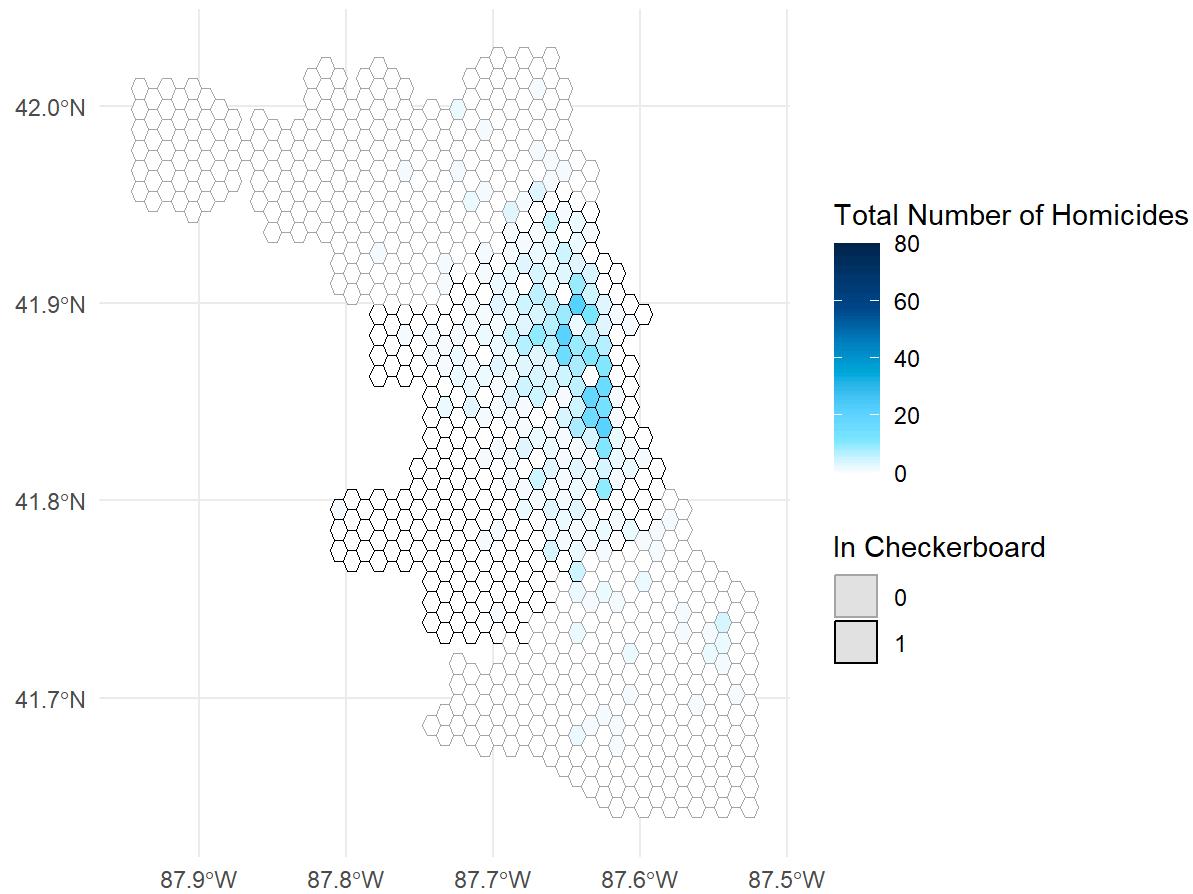
Number of Homicides 1901-1905



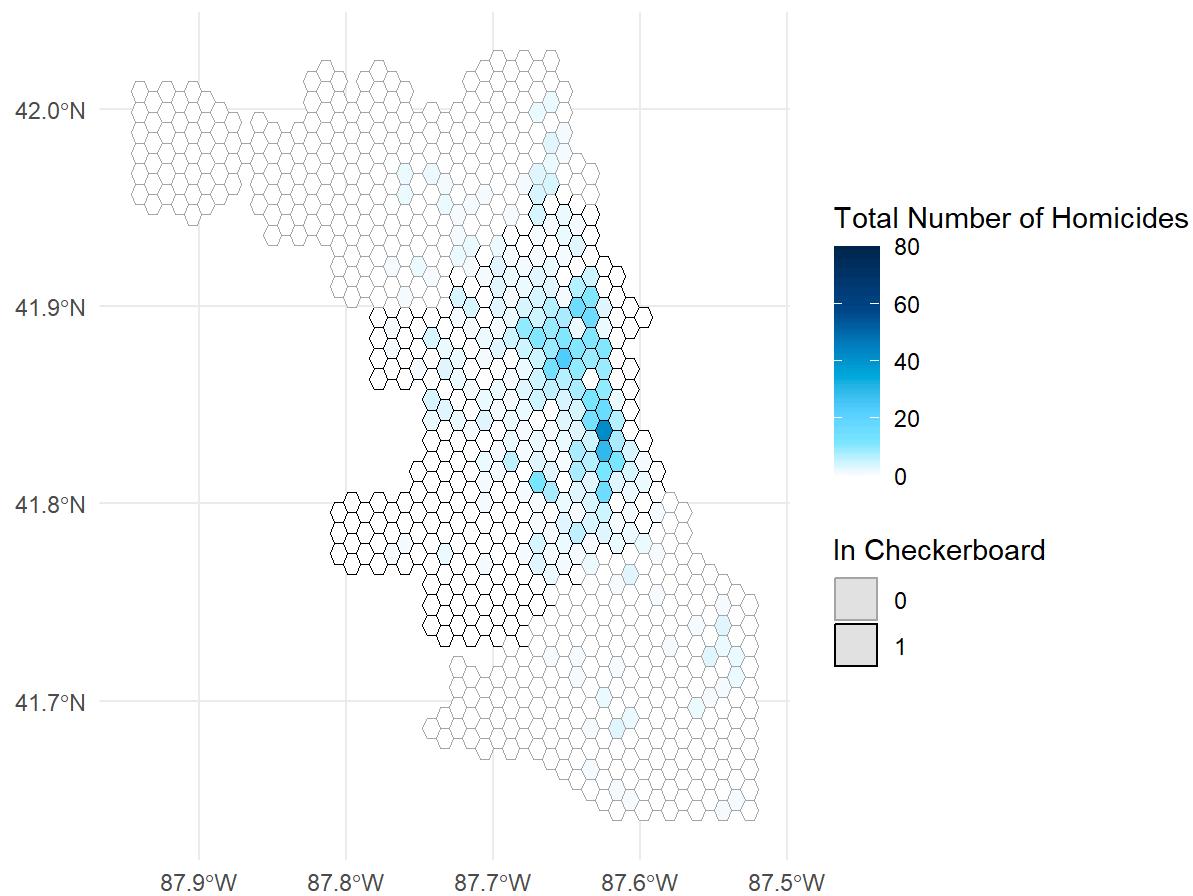
Number of Homicides 1906-1910



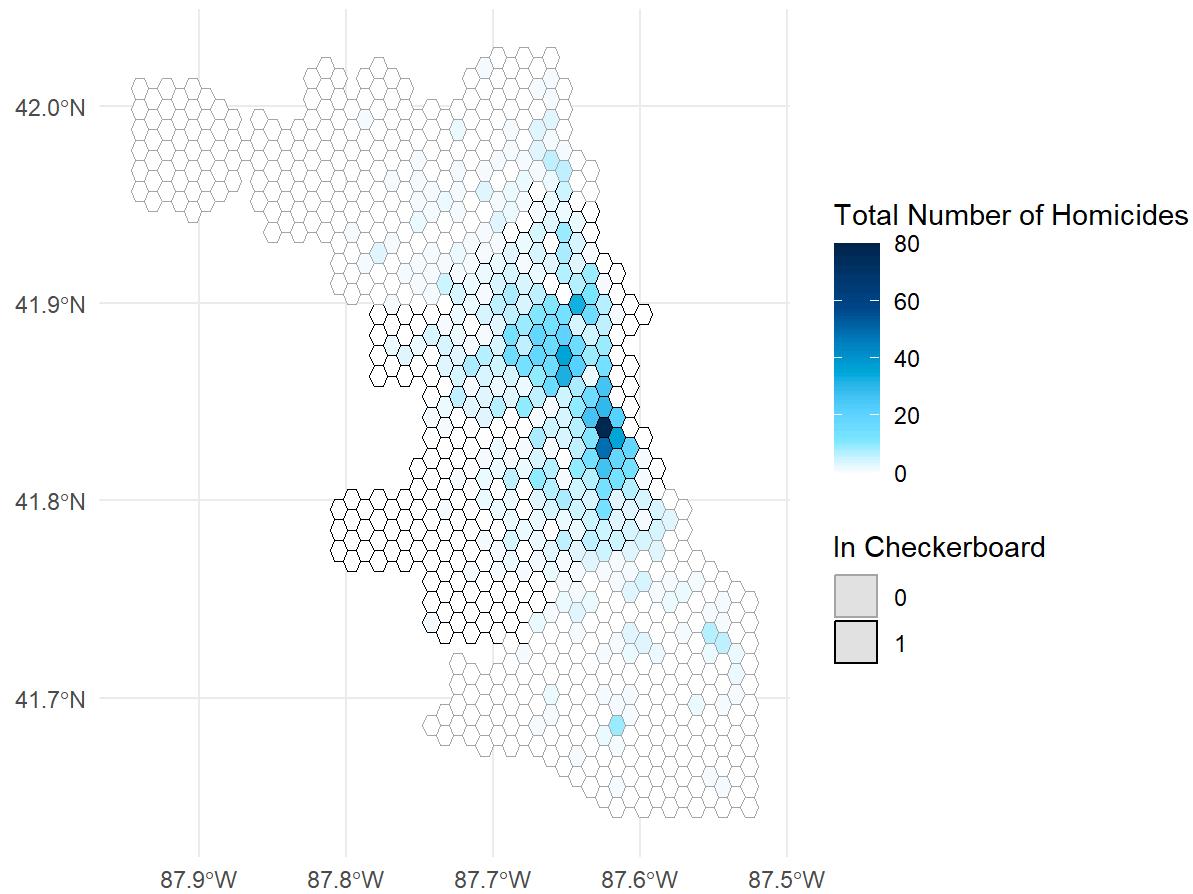
Number of Homicides 1911-1915



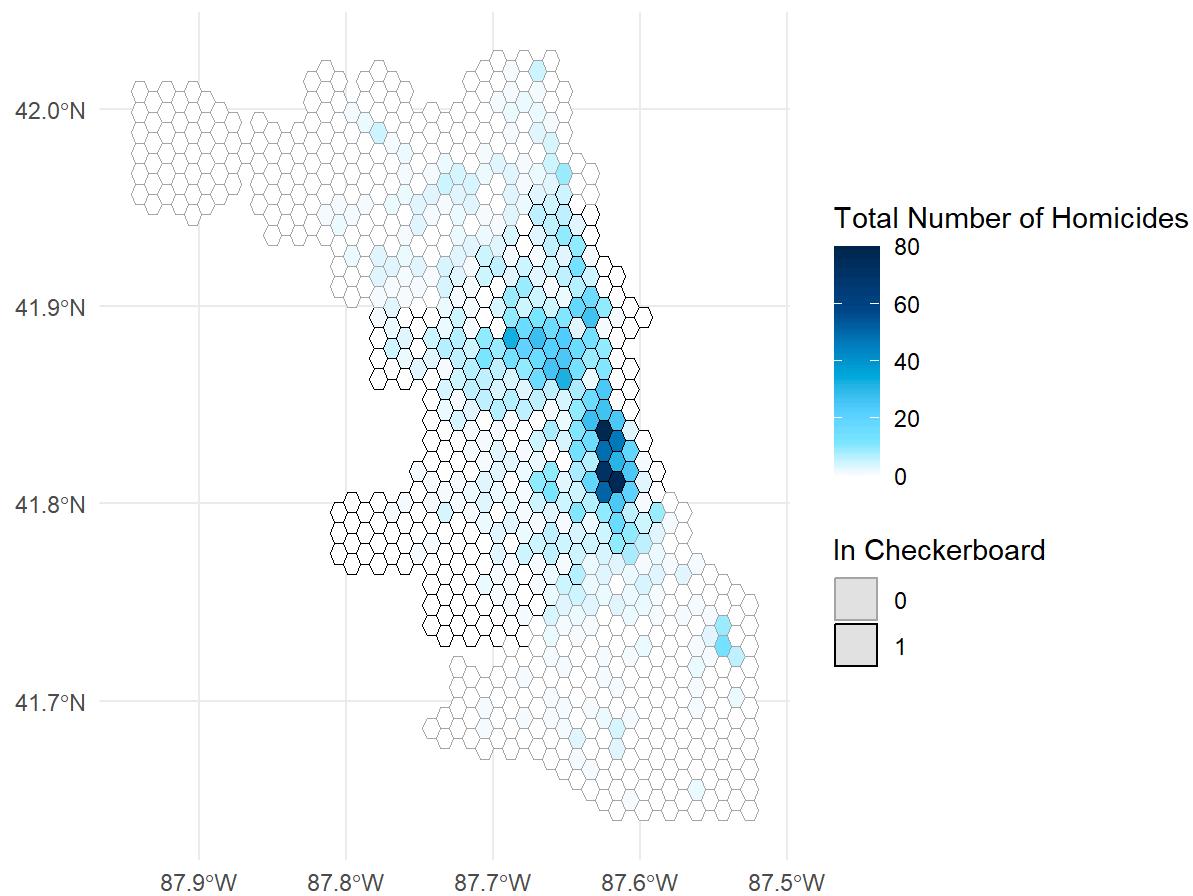
Number of Homicides 1916-1920



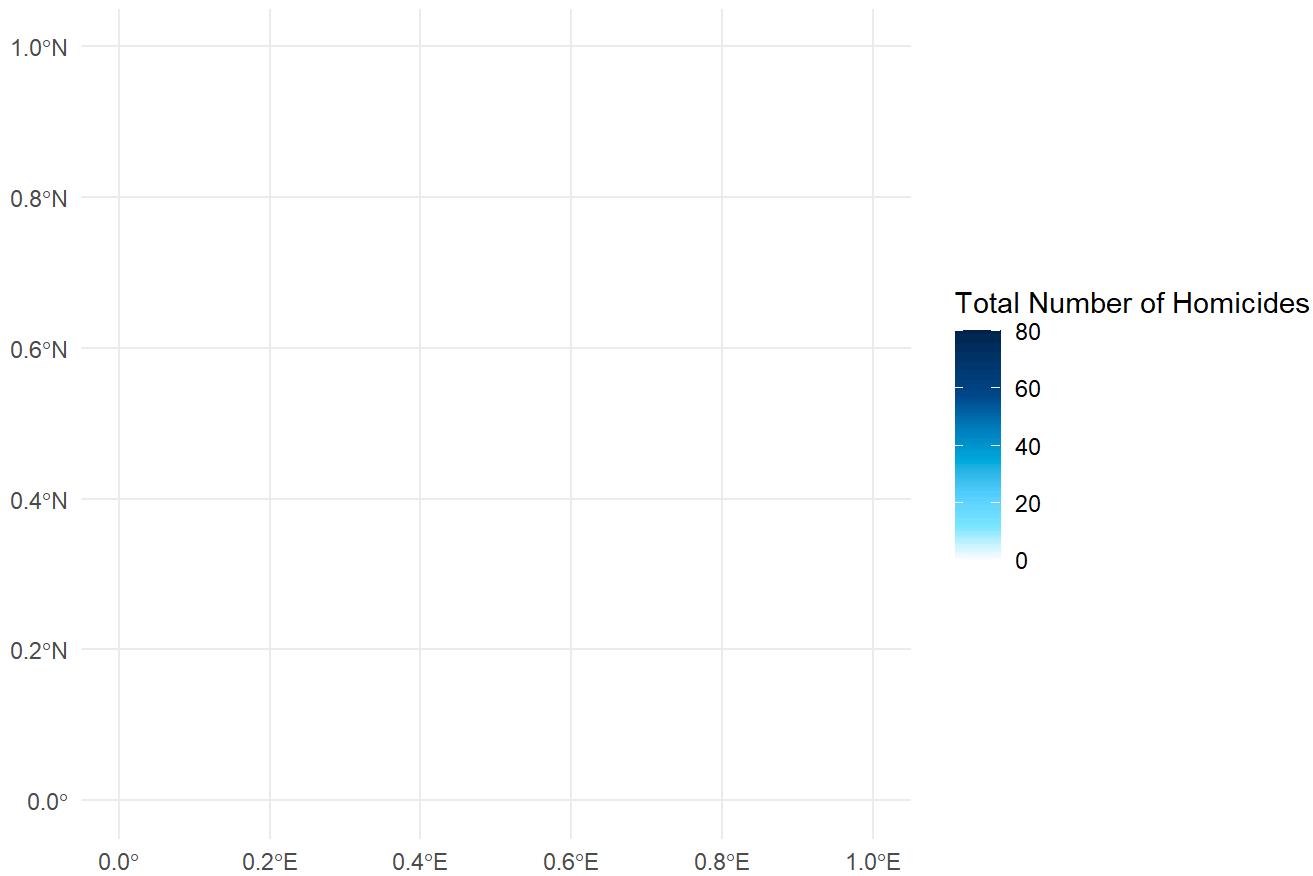
Number of Homicides 1921-1925



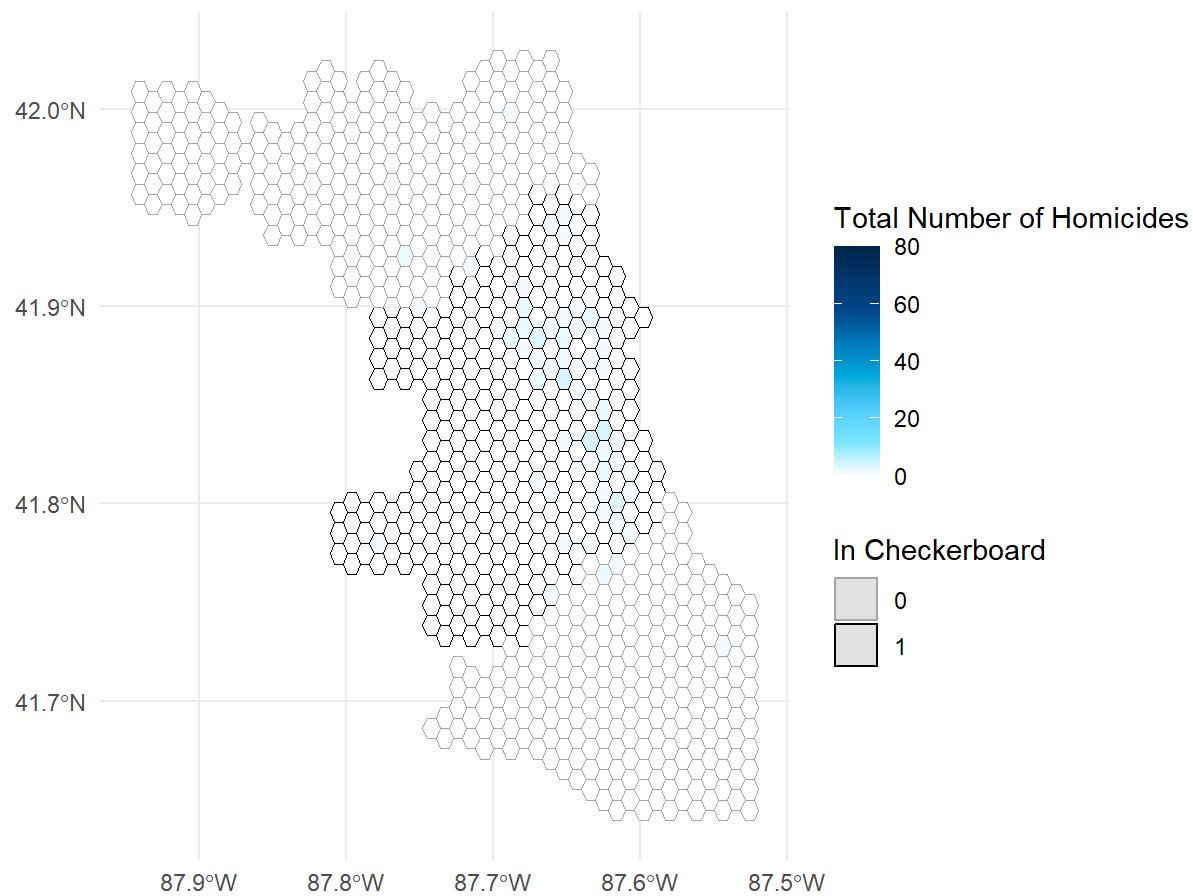
Number of Homicides 1926-1930



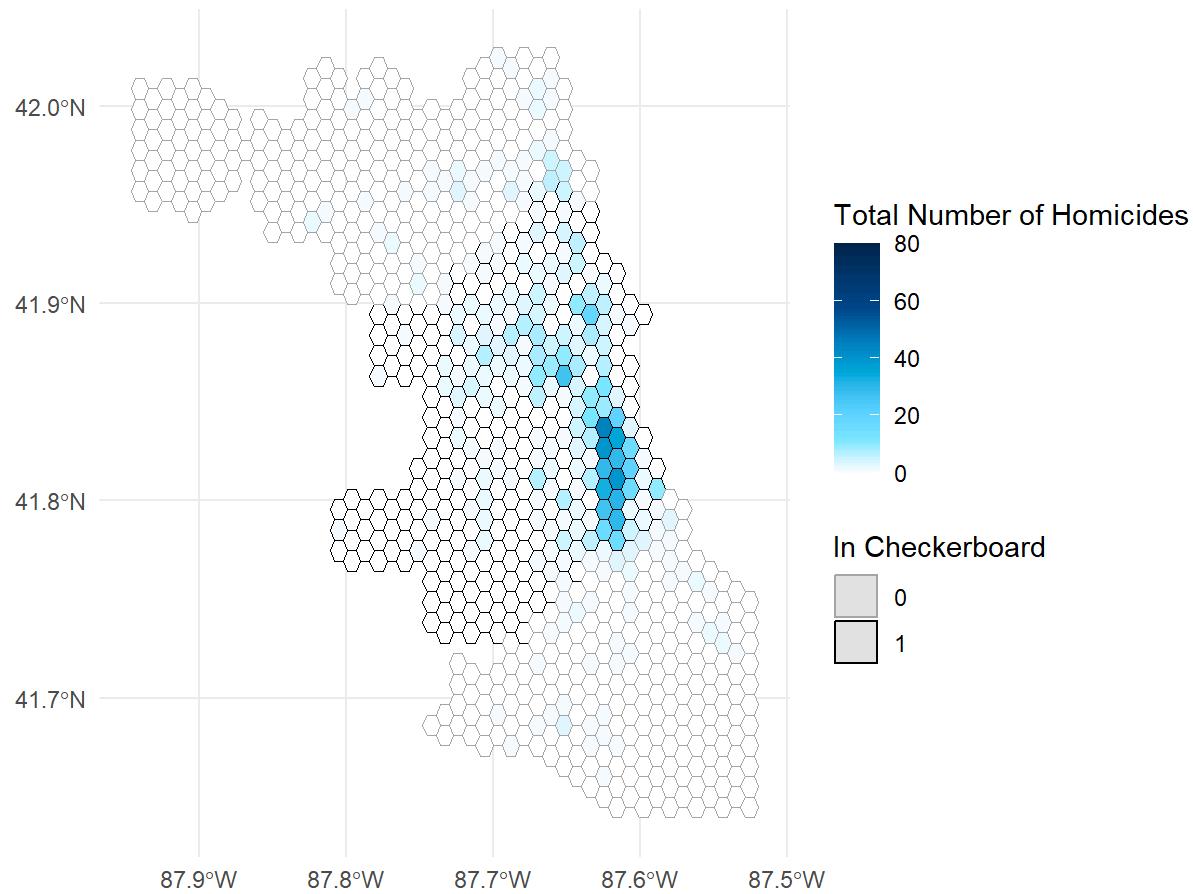
Number of Homicides 1931-1935



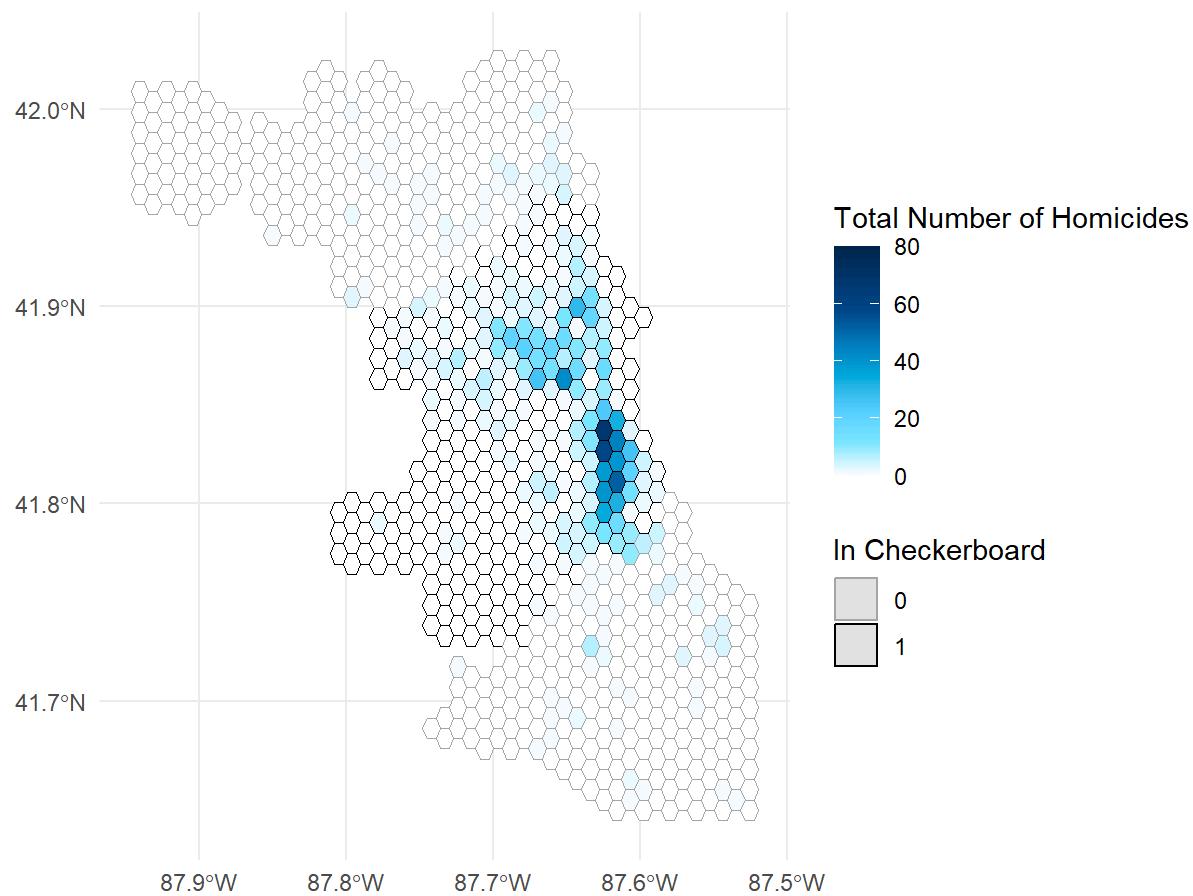
Number of Homicides 1936-1940



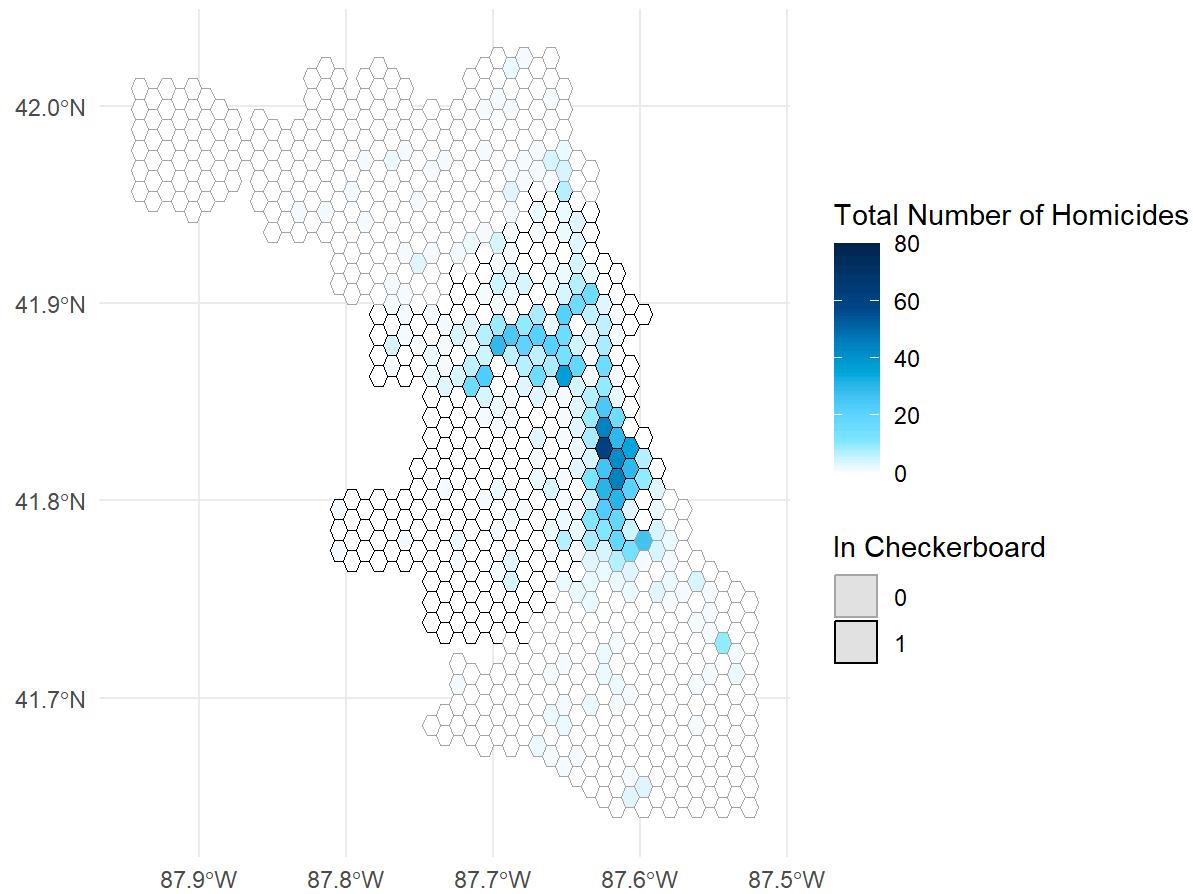
Number of Homicides 1941-1945



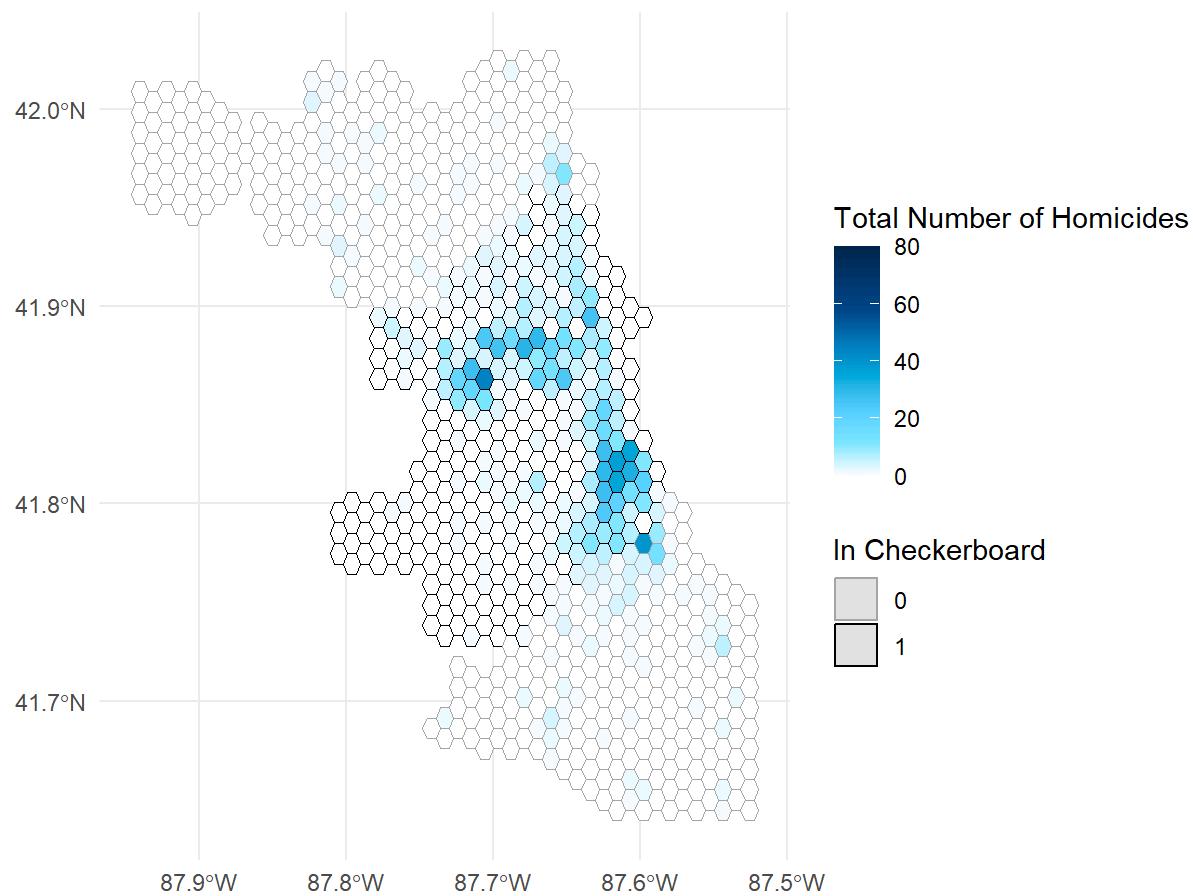
Number of Homicides 1946-1950



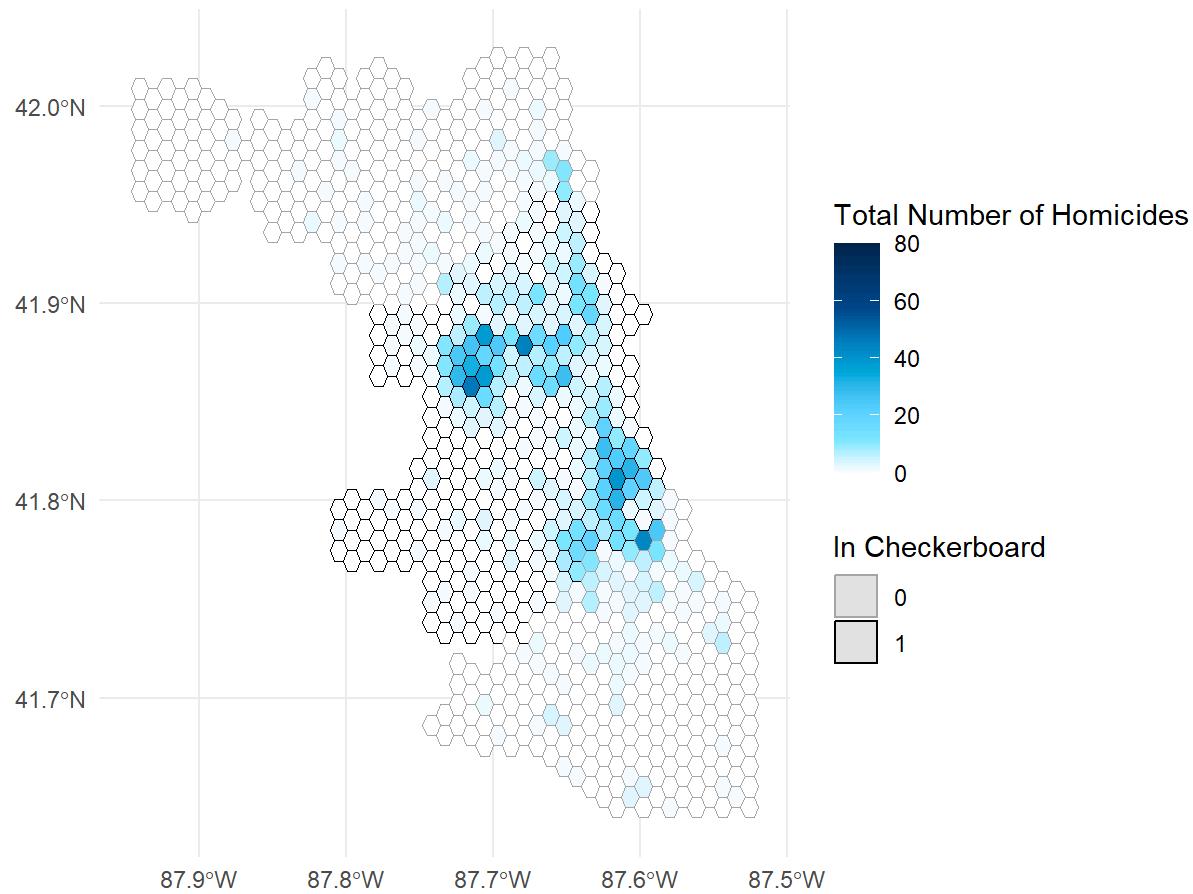
Number of Homicides 1951-1955



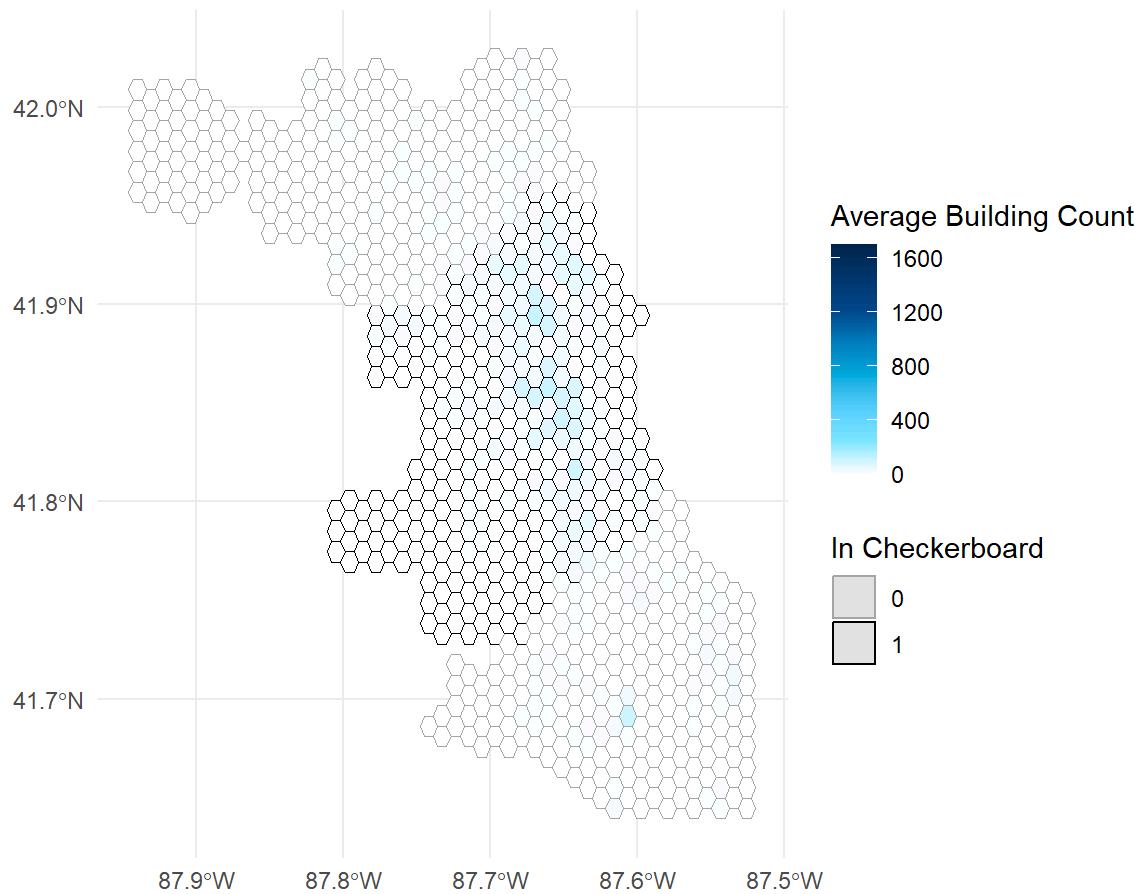
Number of Homicides 1956-1960



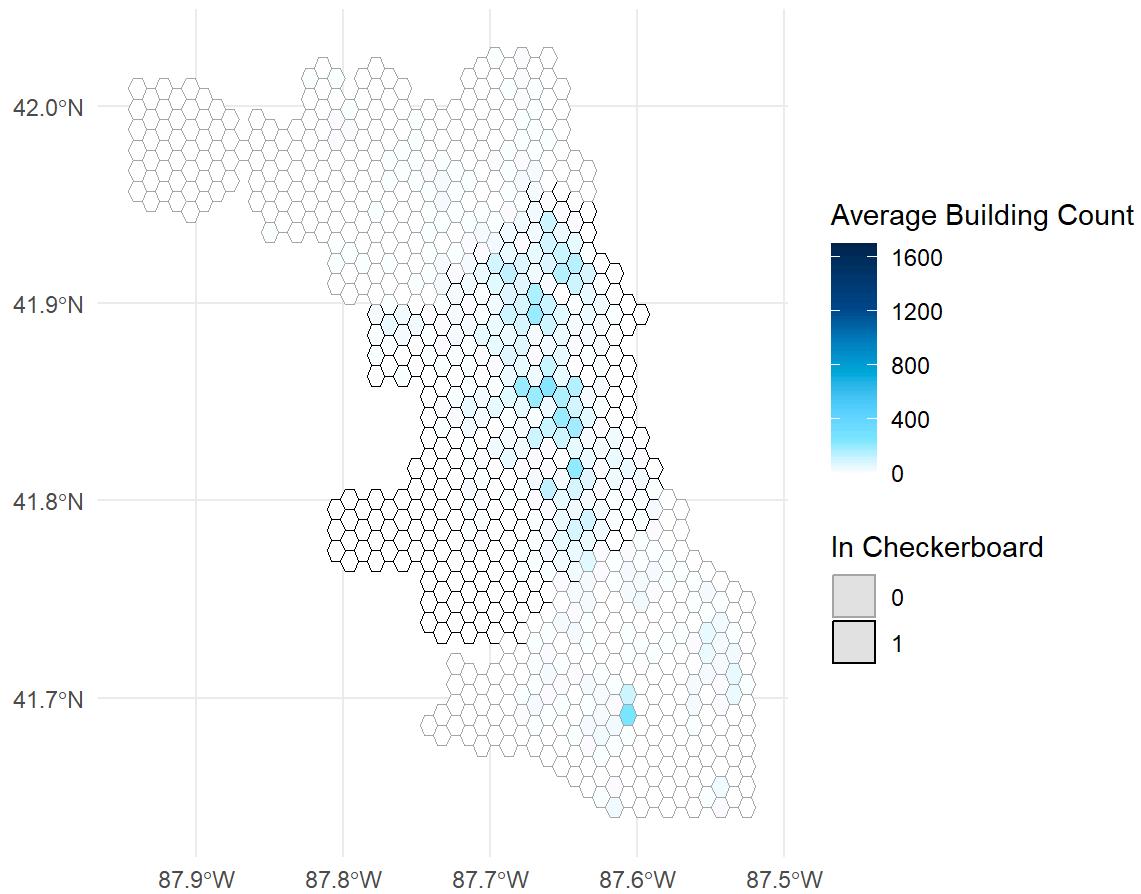
Number of Homicides 1961-1965



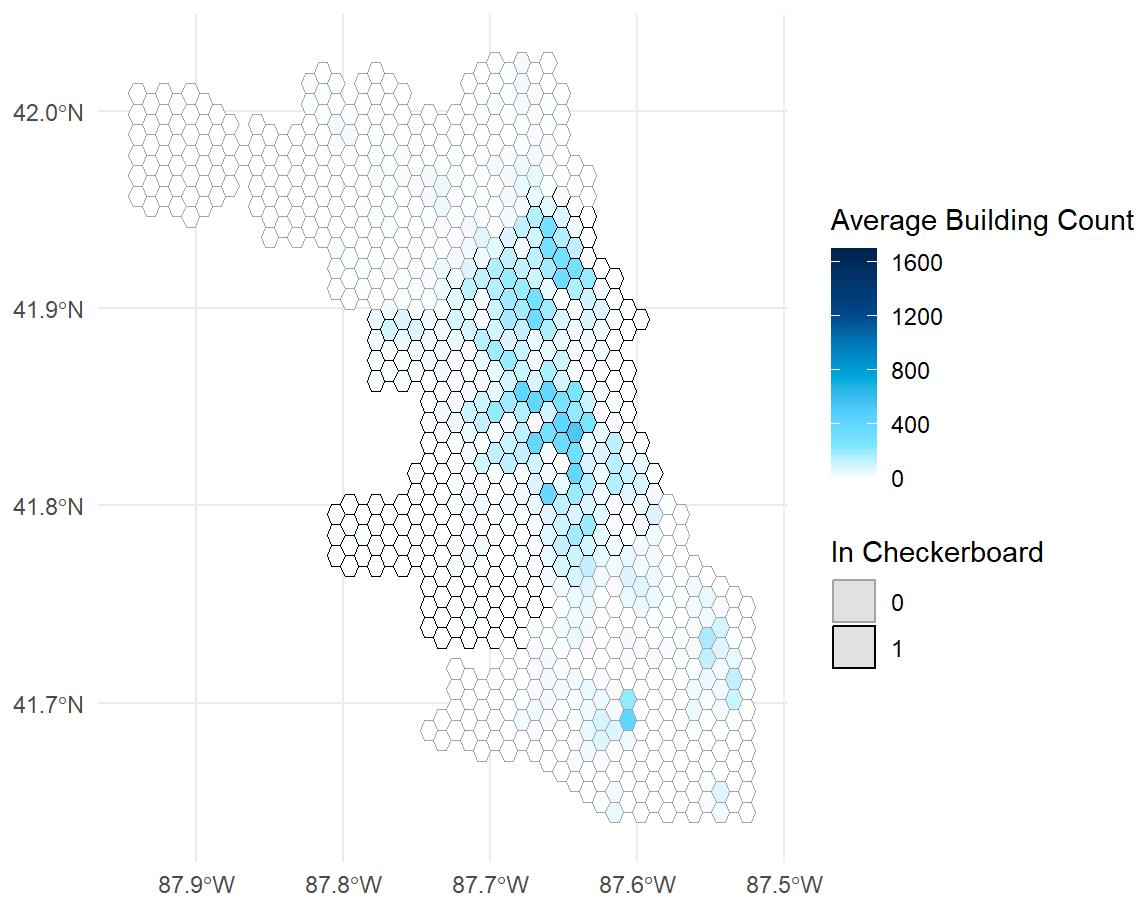
Building Count 1876-1880



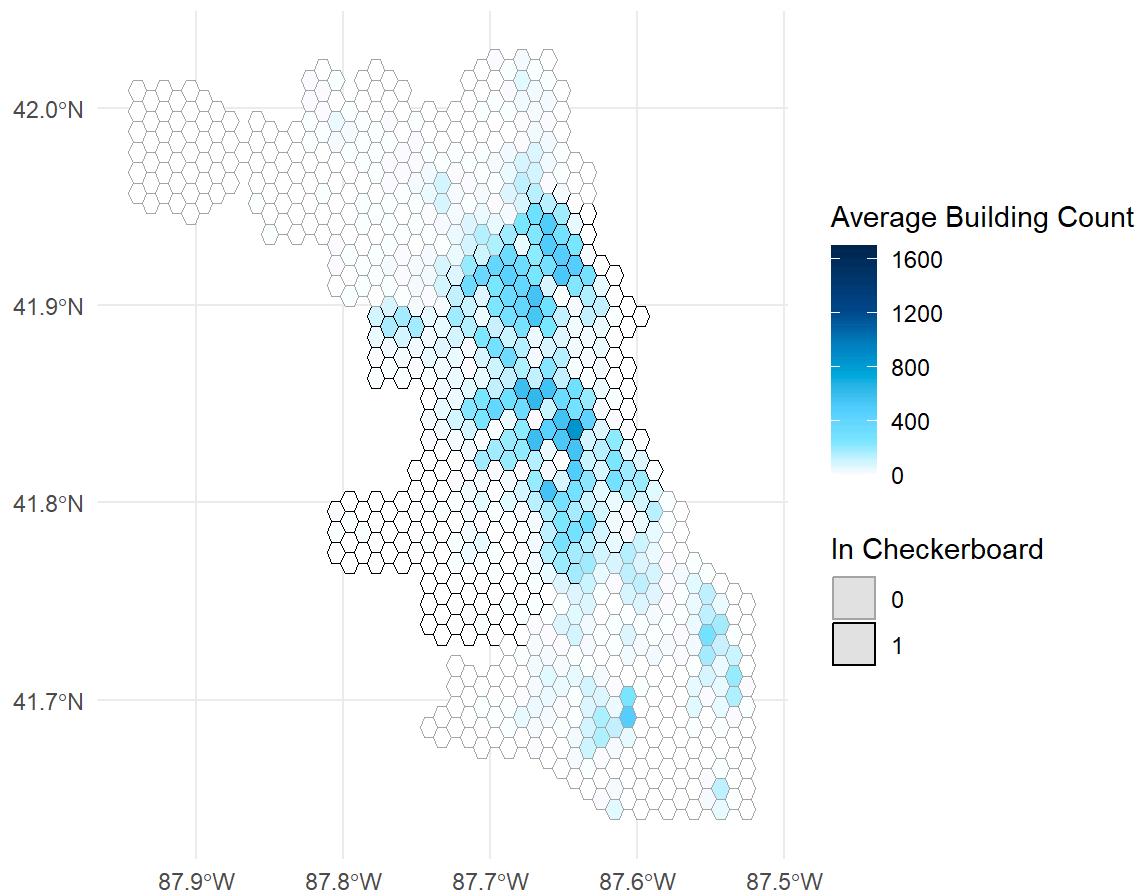
Building Count 1881-1885



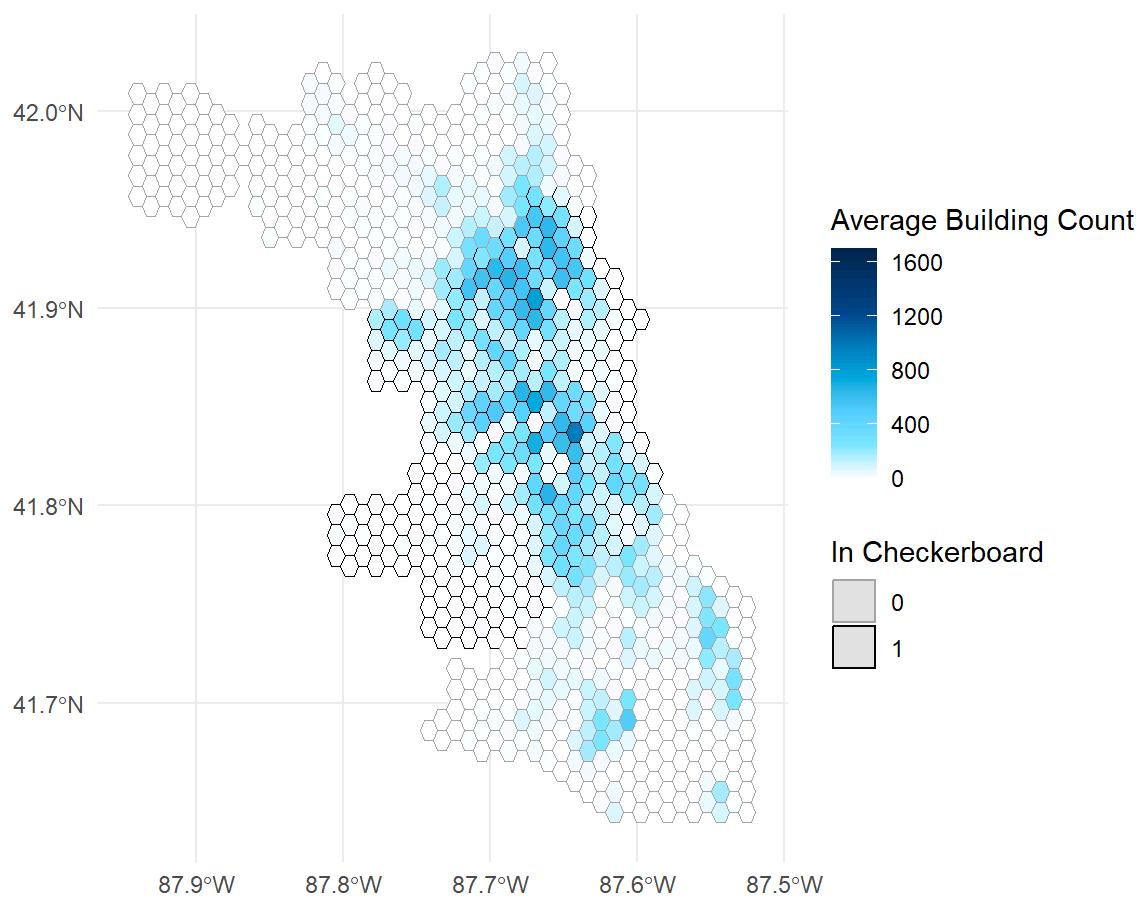
Building Count 1886-1890



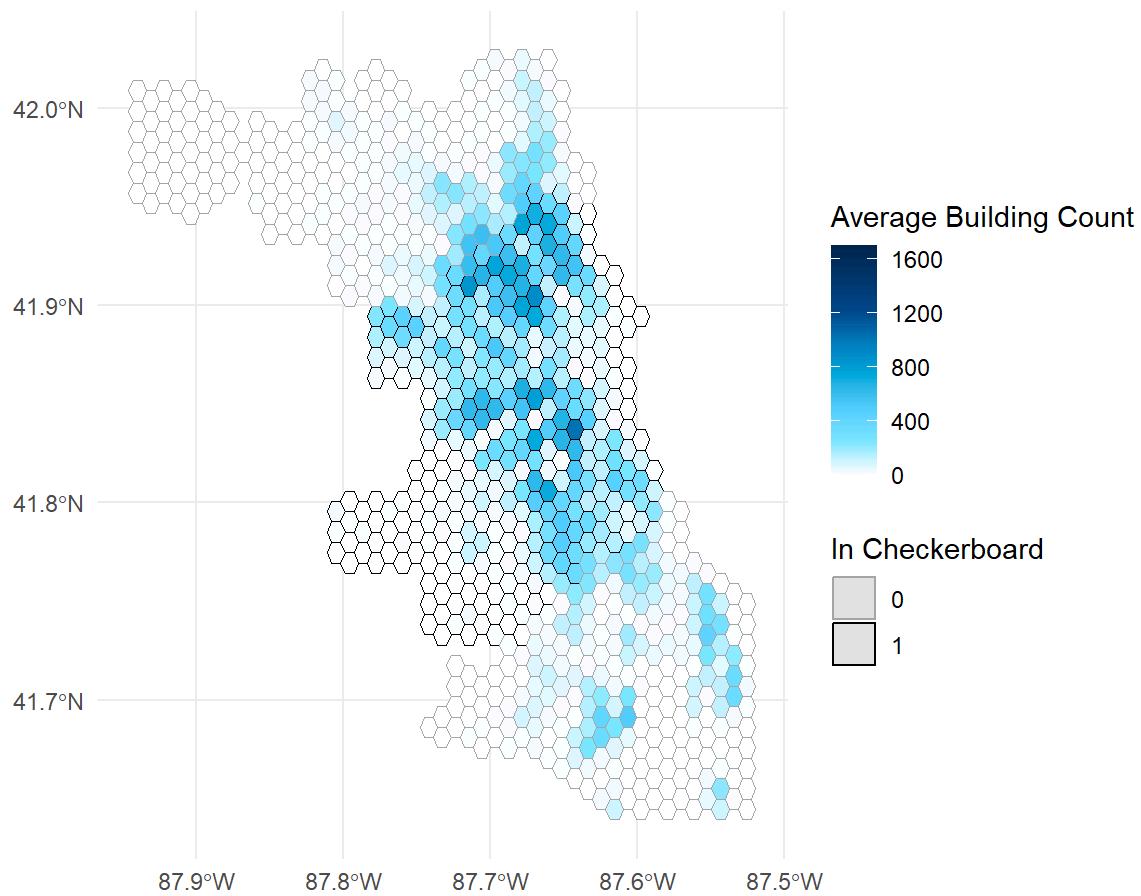
Building Count 1891-1895



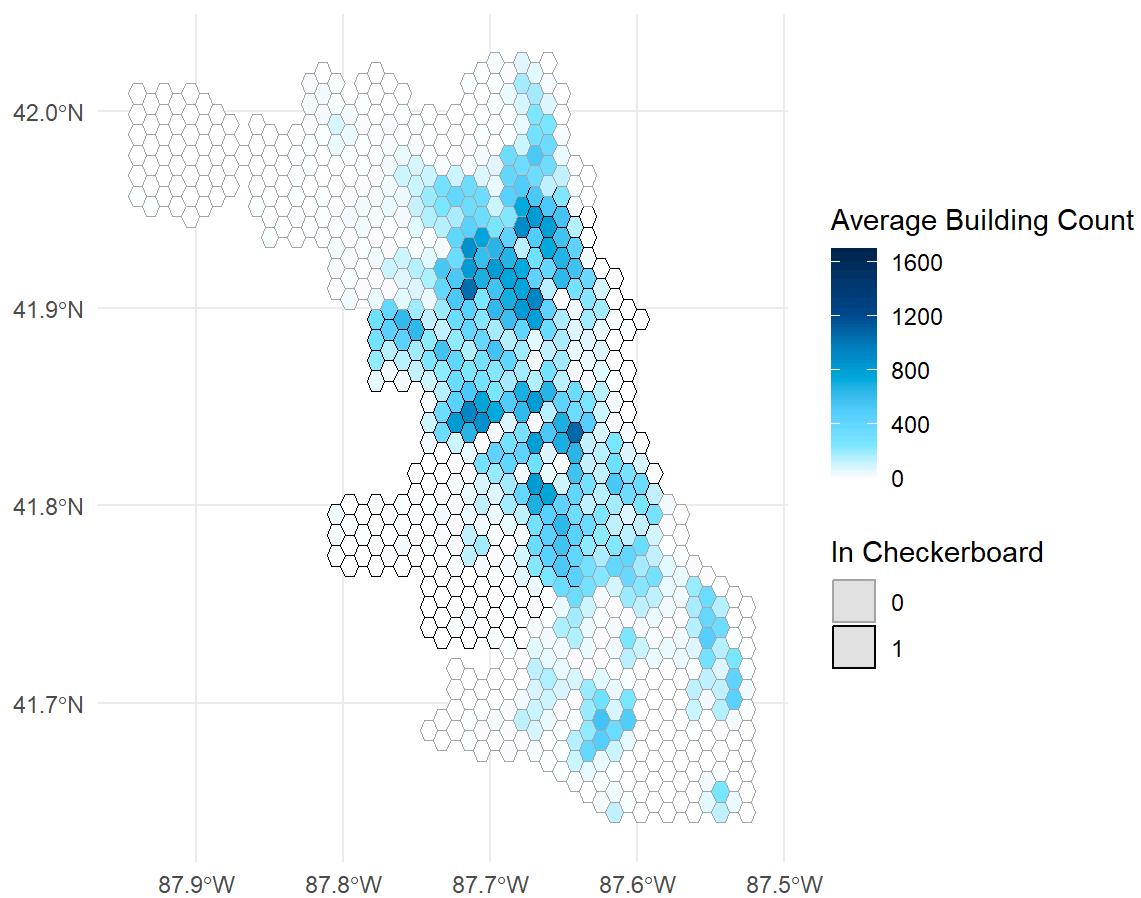
Building Count 1896-1900



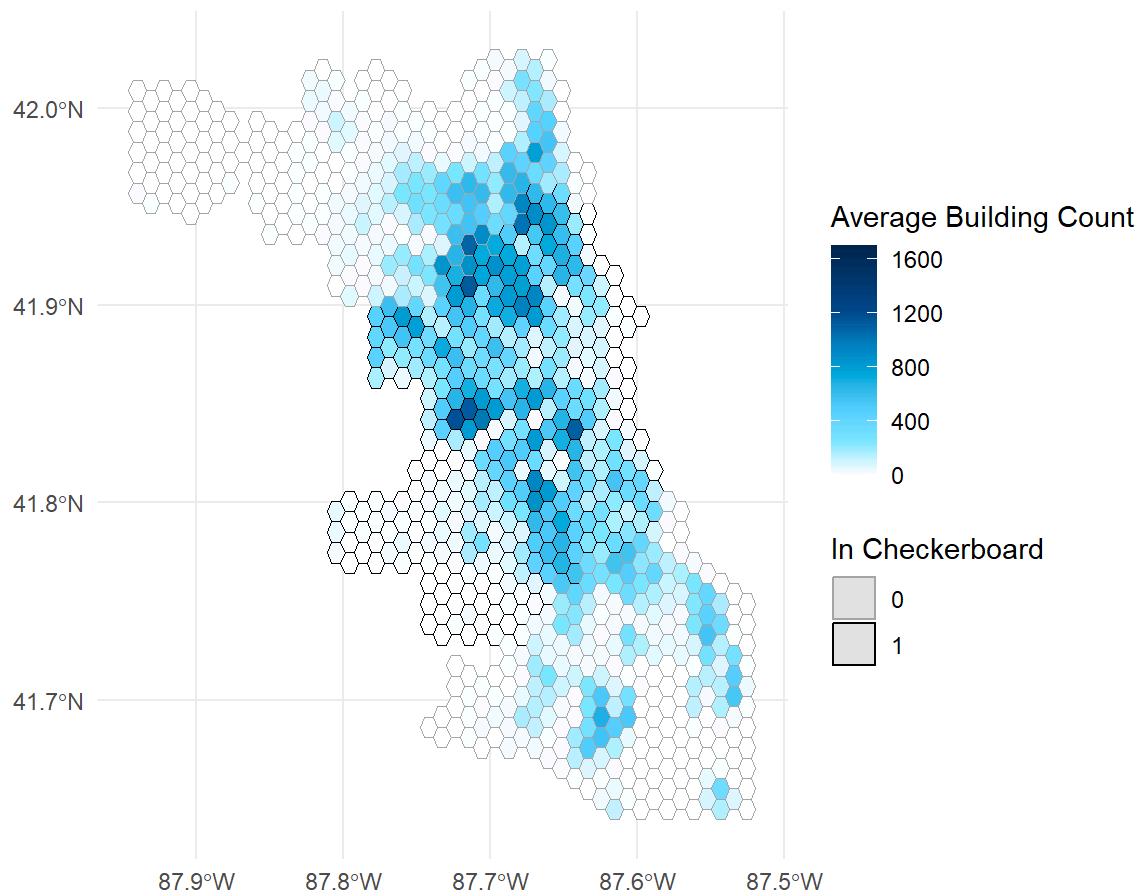
Building Count 1901-1905



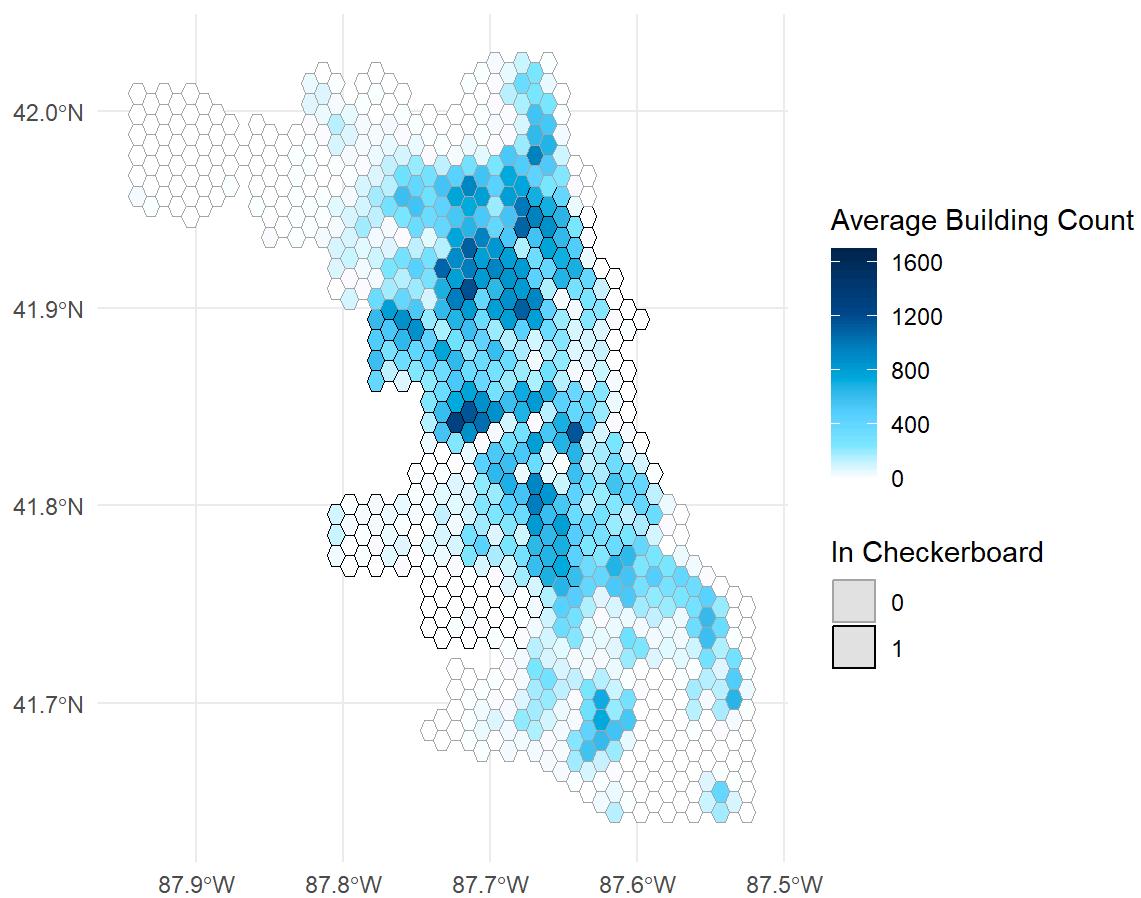
Building Count 1906-1910



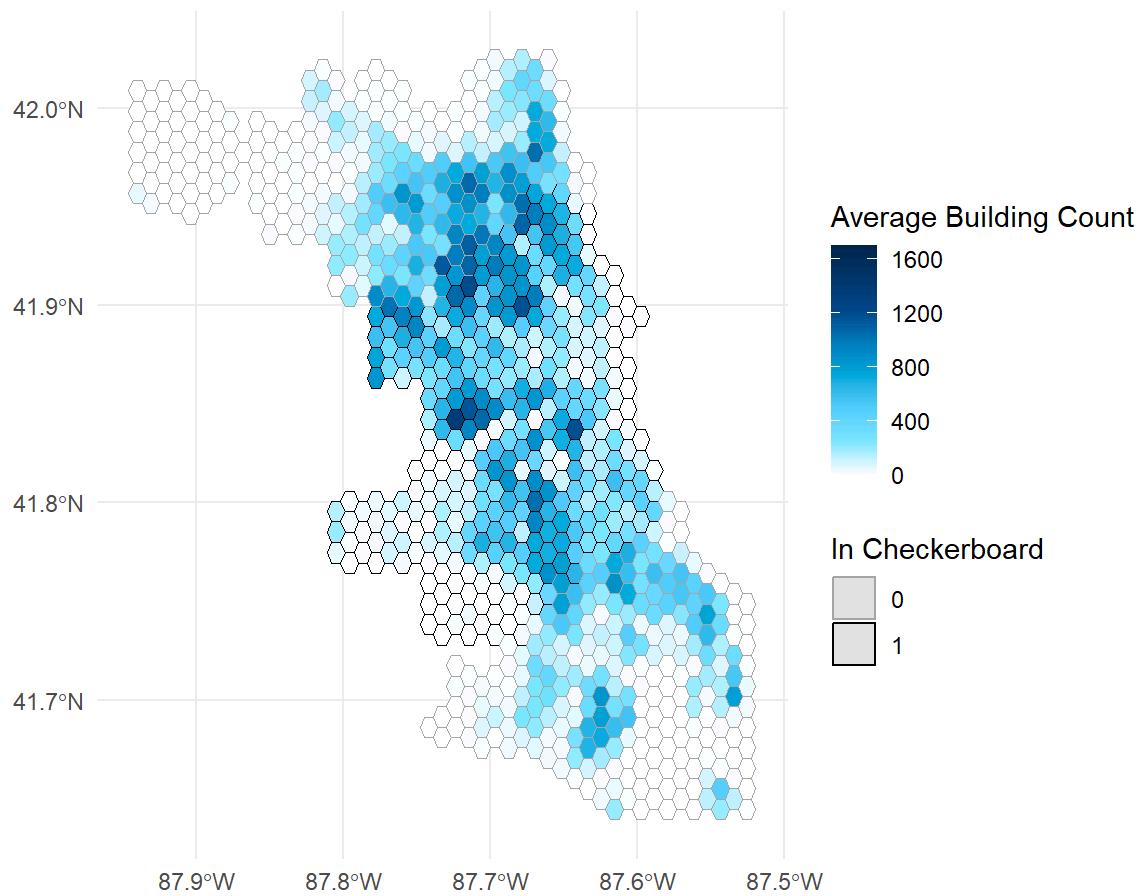
Building Count 1911-1915



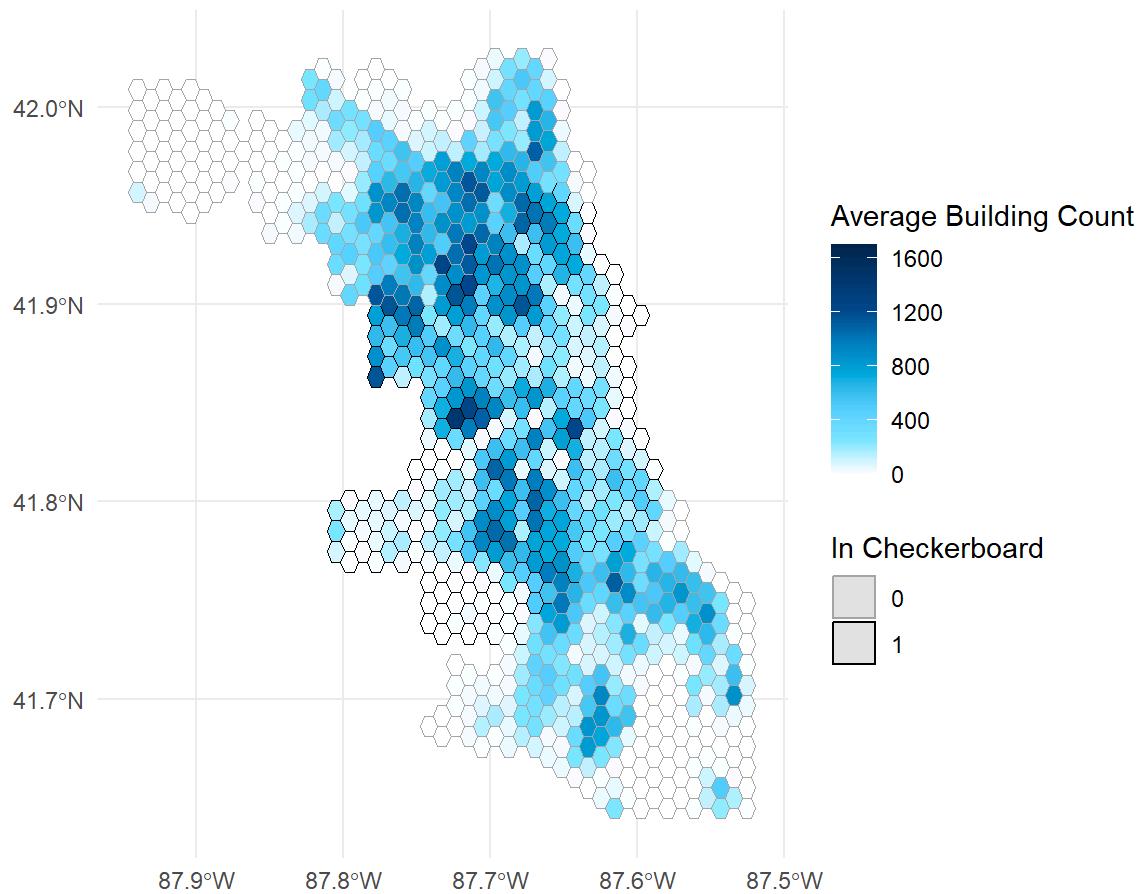
Building Count 1916-1920



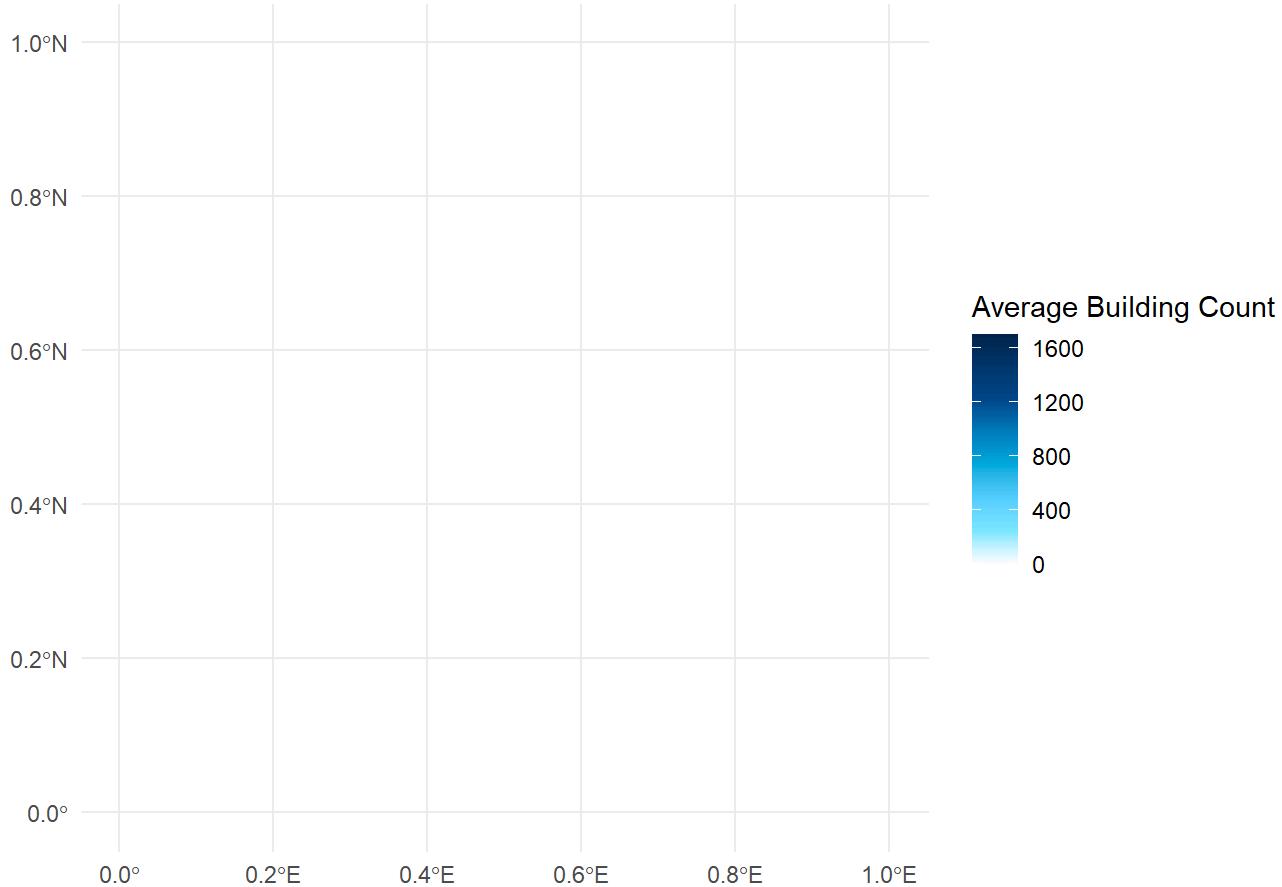
Building Count 1921-1925



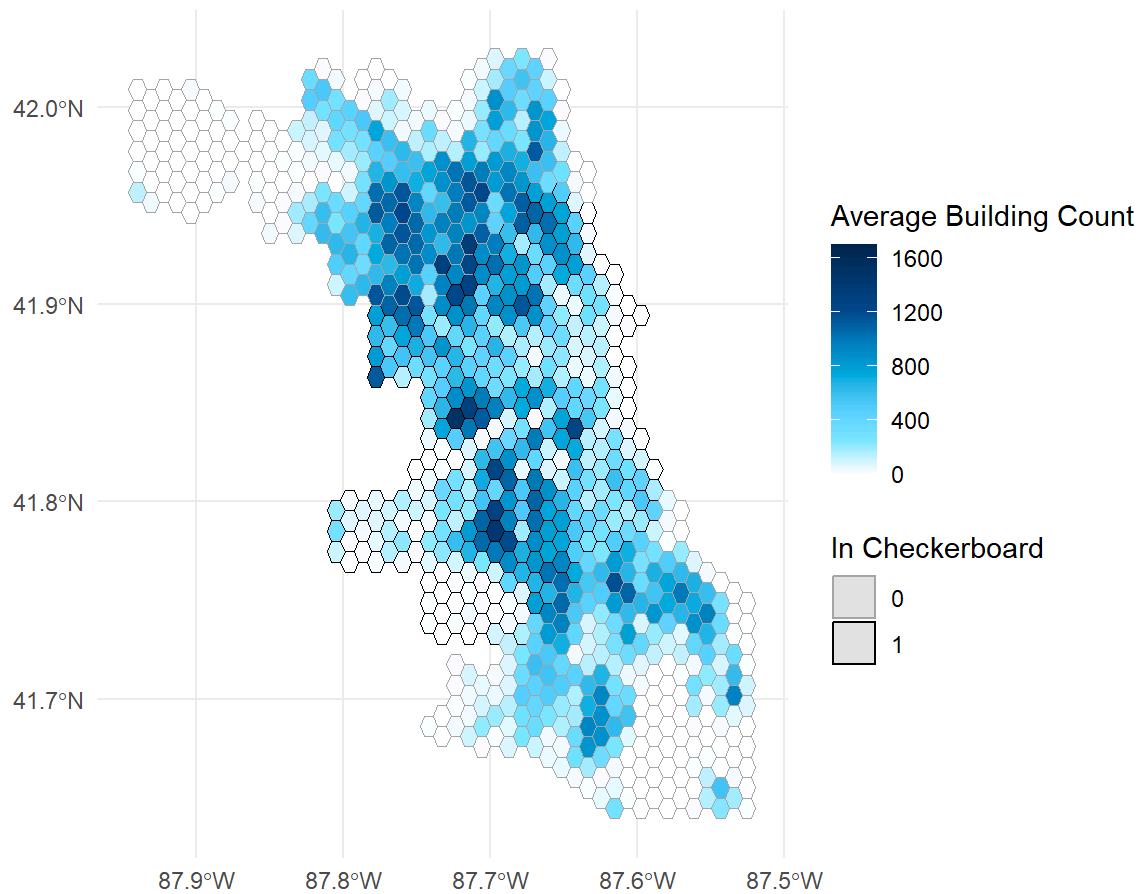
Building Count 1926-1930



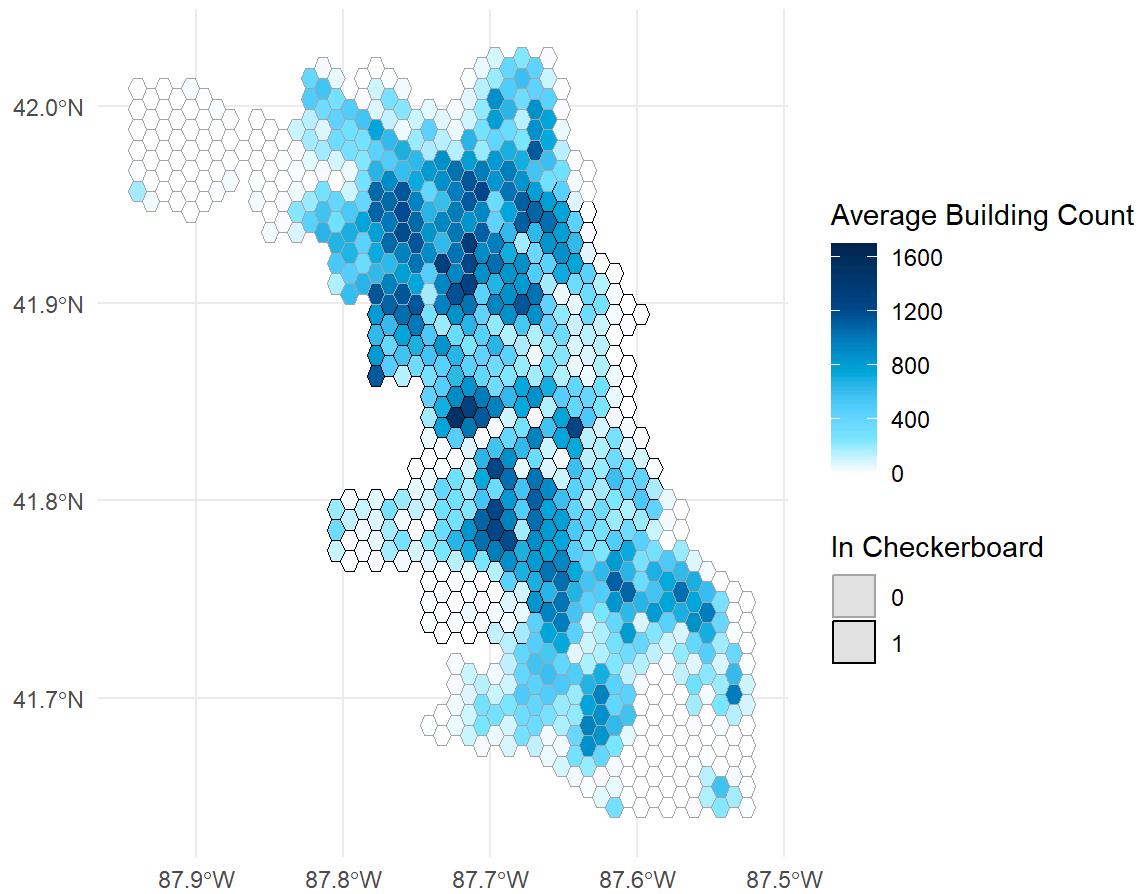
Building Count 1931-1935



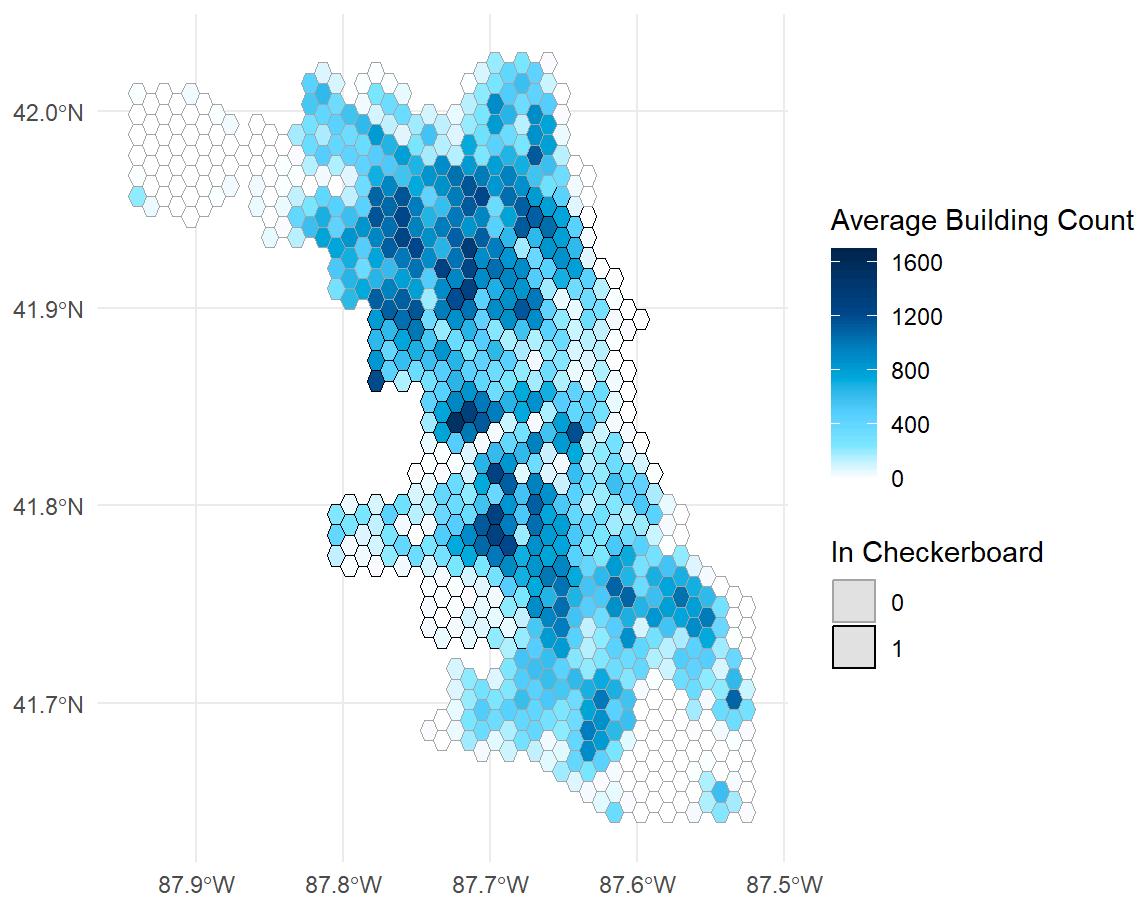
Building Count 1936-1940



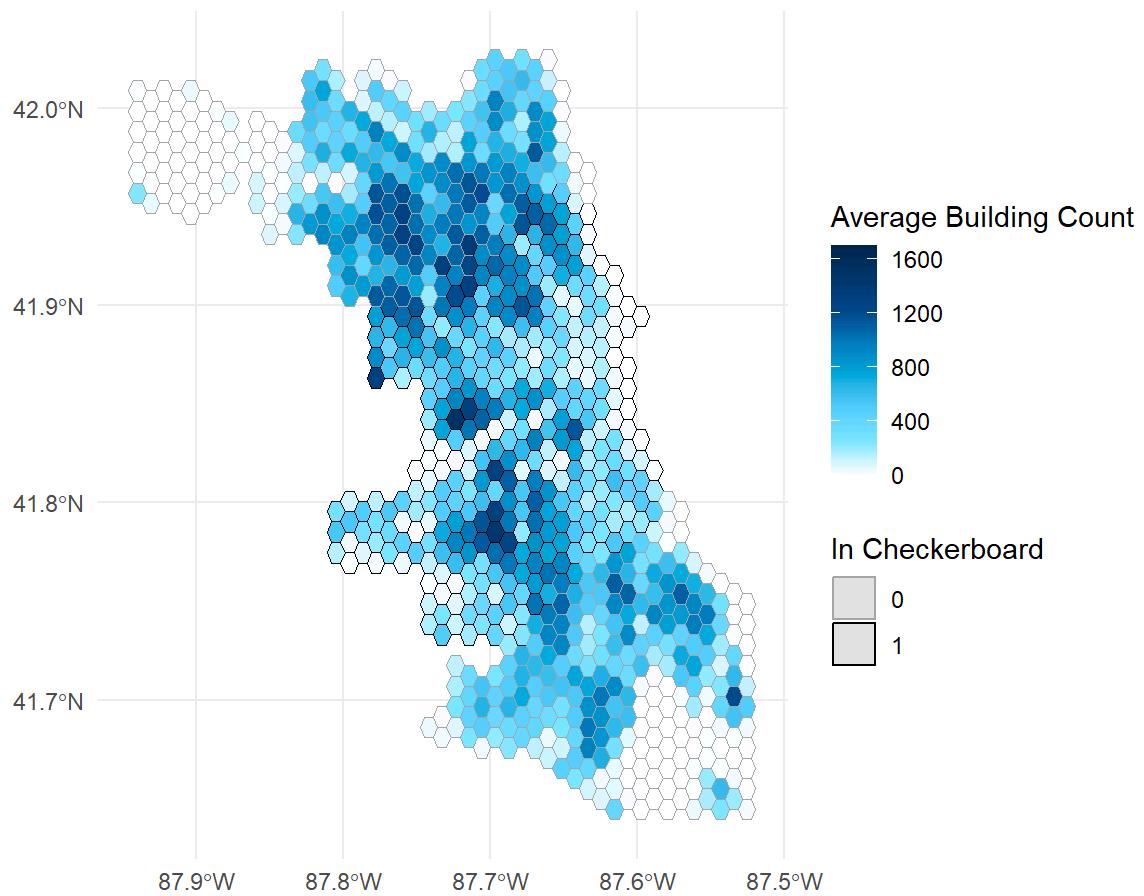
Building Count 1941-1945



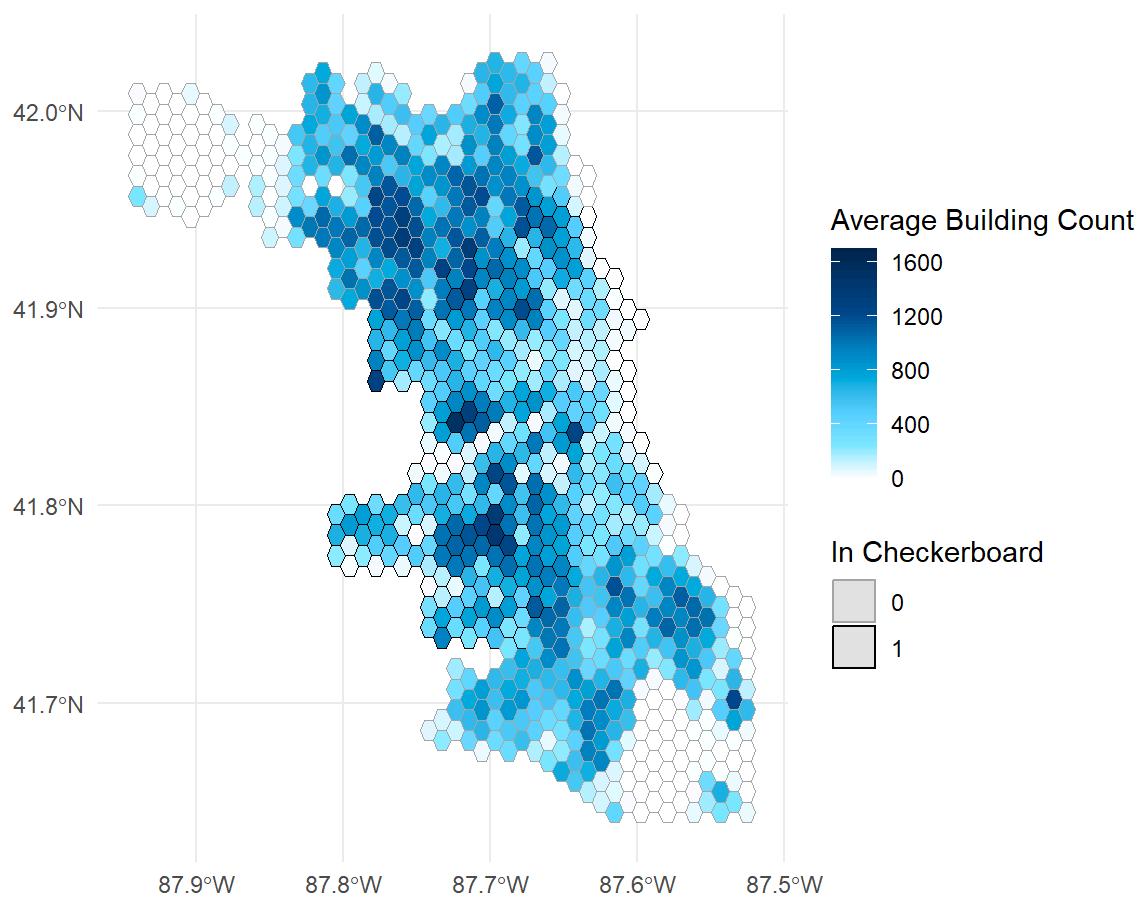
Building Count 1946-1950



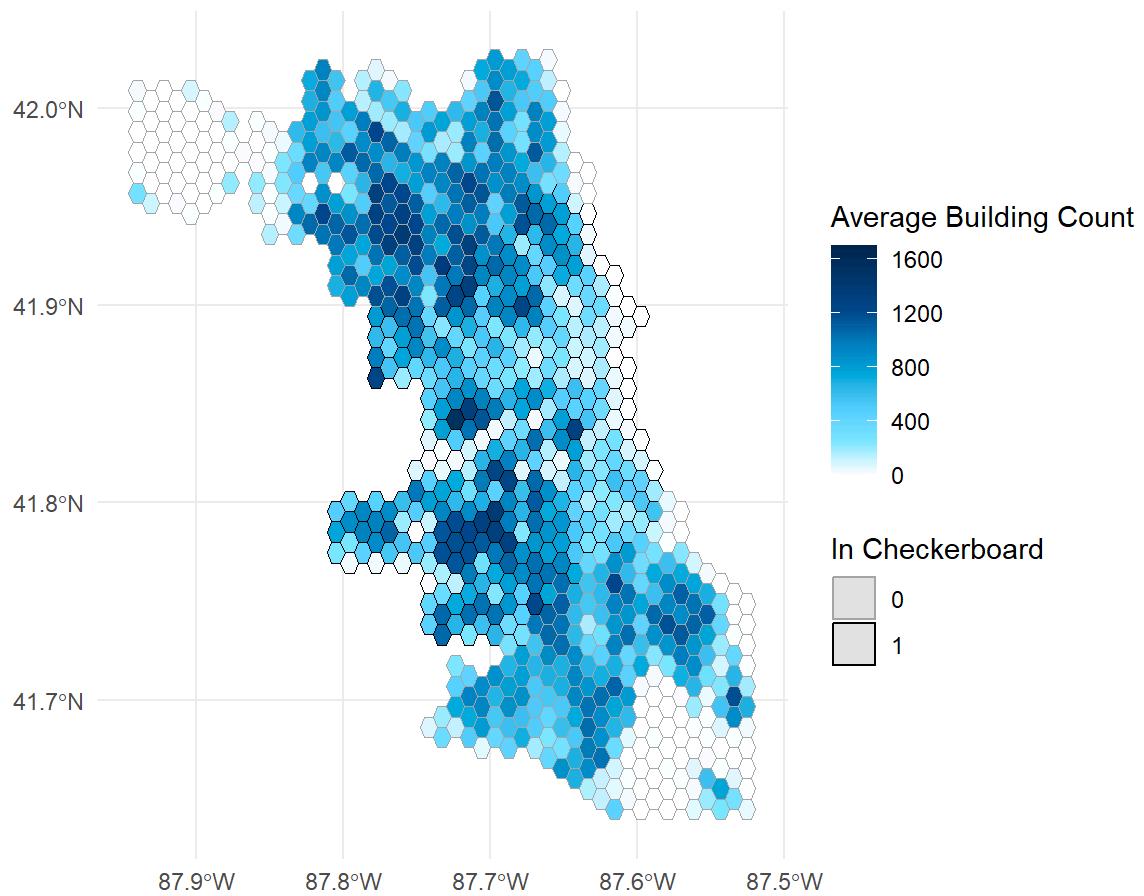
Building Count 1951-1955



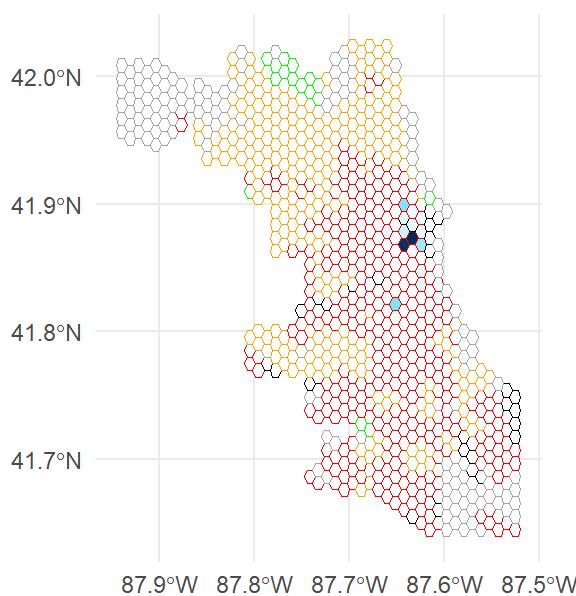
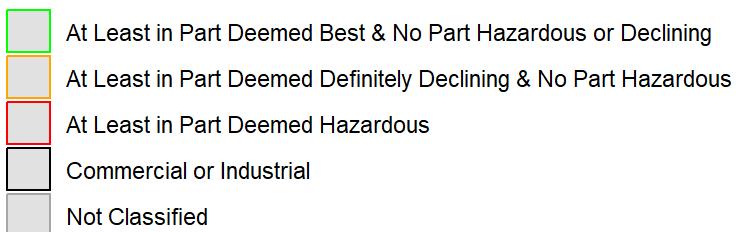
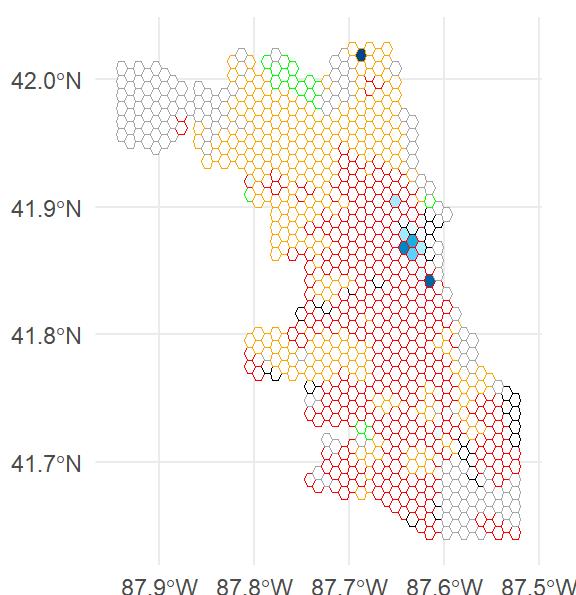
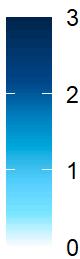
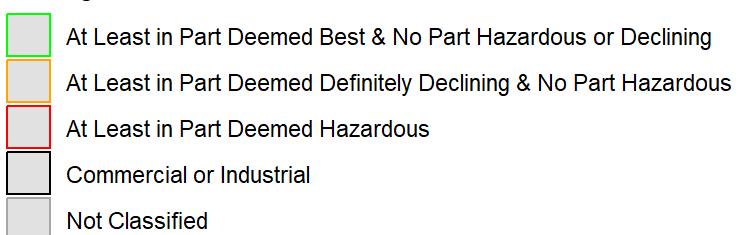
Building Count 1956-1960

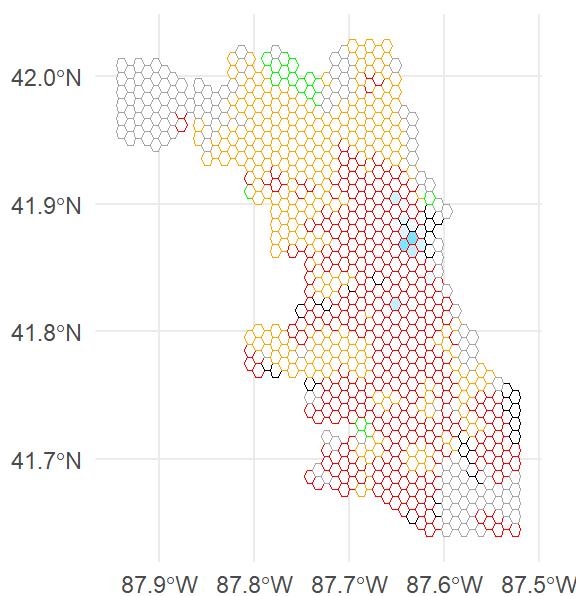
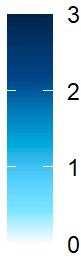
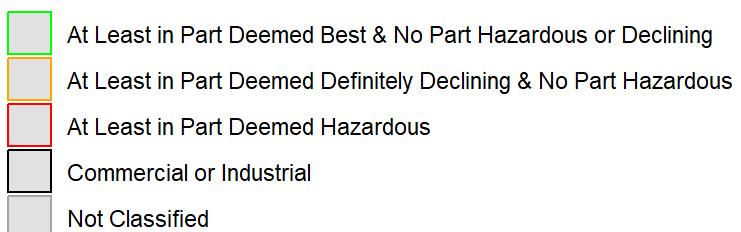
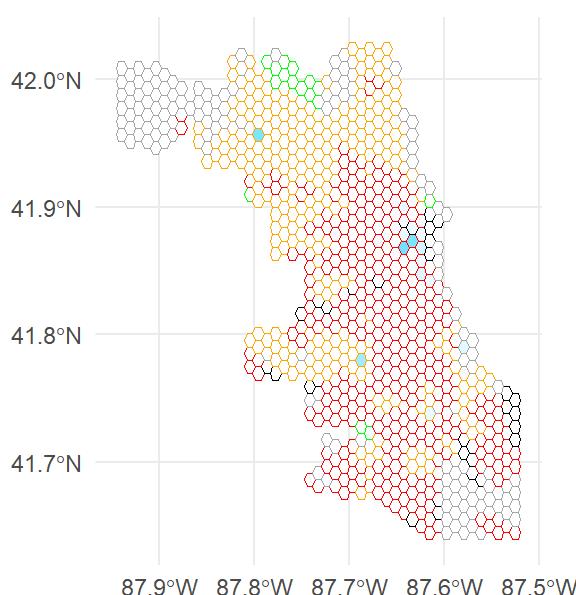
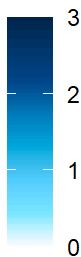
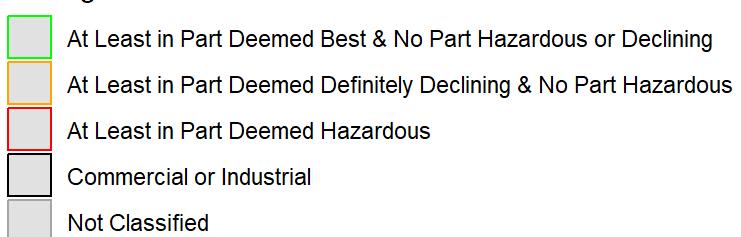


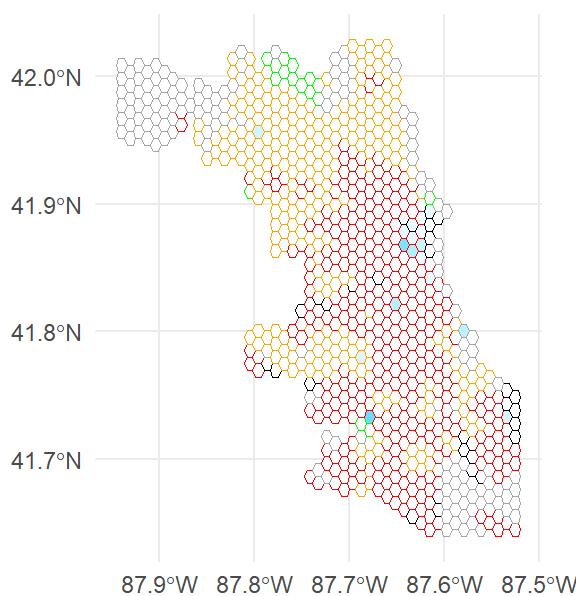
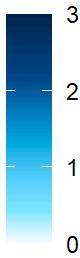
Building Count 1961-1965



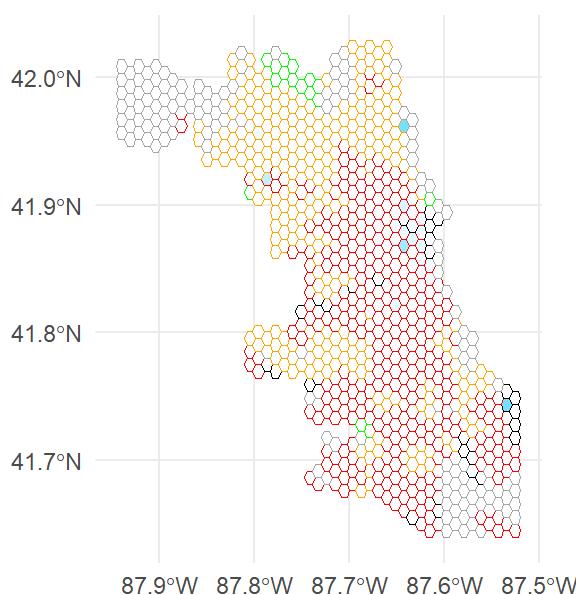
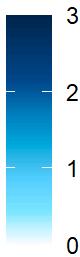
Zoning as of 1935/40

Homicide Rate 1876-1880**Average Homicide Rate****Zoning ca. 1935-40****Homicide Rate 1881-1885****Average Homicide Rate****Zoning ca. 1935-40**

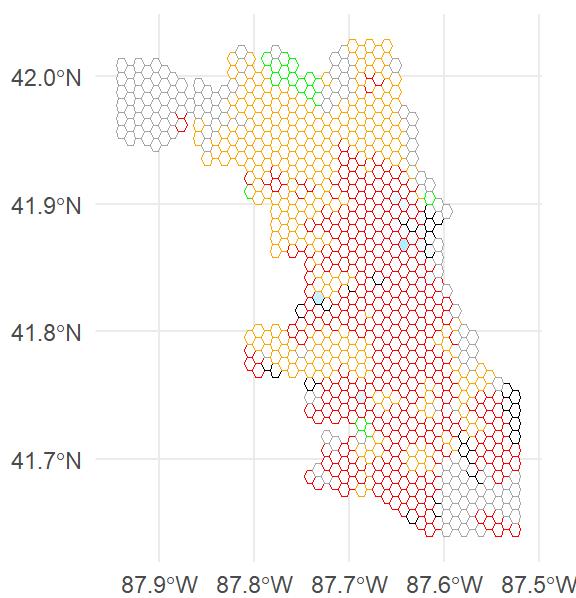
Homicide Rate 1886-1890**Average Homicide Rate****Zoning ca. 1935-40****Homicide Rate 1891-1895****Average Homicide Rate****Zoning ca. 1935-40**

Homicide Rate 1896-1900**Average Homicide Rate****Zoning ca. 1935-40**

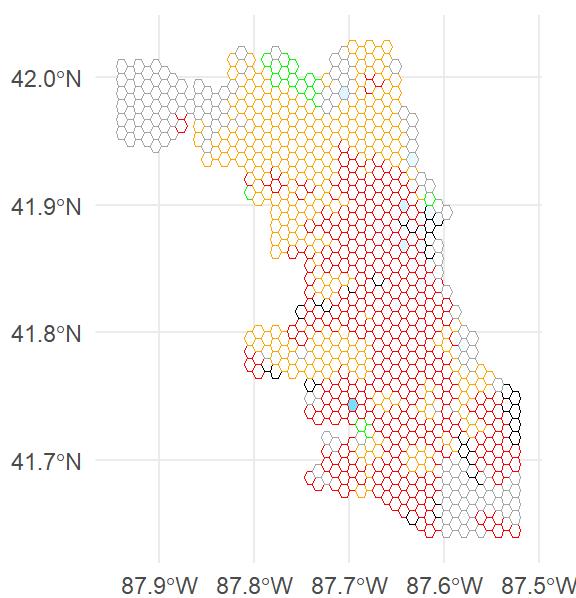
- █ At Least in Part Deemed Best & No Part Hazardous or Declining
- █ At Least in Part Deemed Definitely Declining & No Part Hazardous
- █ At Least in Part Deemed Hazardous
- █ Commercial or Industrial
- █ Not Classified

Homicide Rate 1901-1905**Average Homicide Rate****Zoning ca. 1935-40**

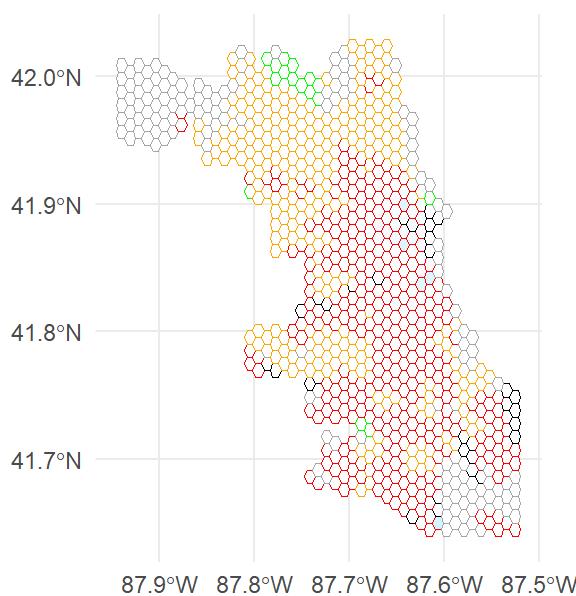
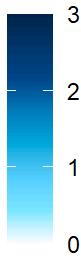
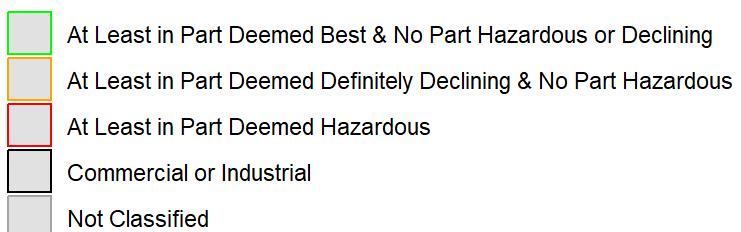
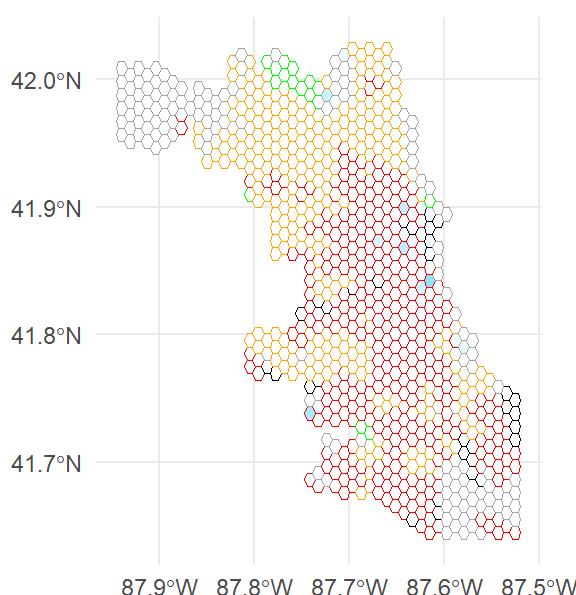
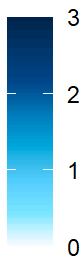
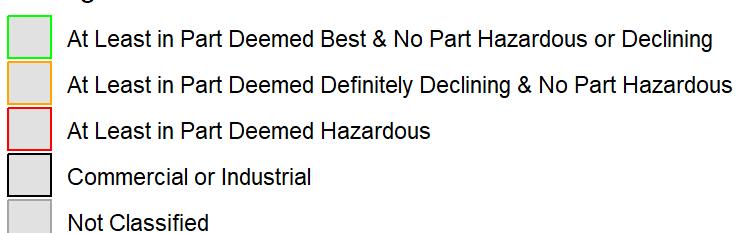
- █ At Least in Part Deemed Best & No Part Hazardous or Declining
- █ At Least in Part Deemed Definitely Declining & No Part Hazardous
- █ At Least in Part Deemed Hazardous
- █ Commercial or Industrial
- █ Not Classified

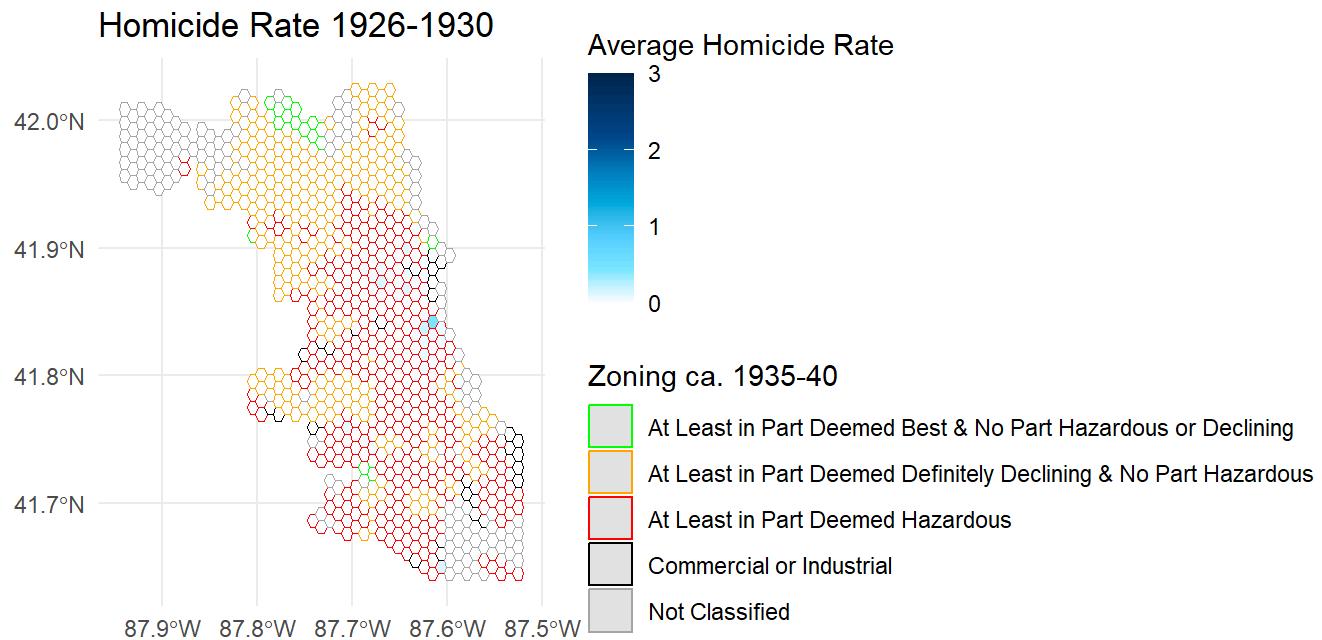
Homicide Rate 1906-1910**Zoning ca. 1935-40**

- [Green] At Least in Part Deemed Best & No Part Hazardous or Declining
- [Orange] At Least in Part Deemed Definitely Declining & No Part Hazardous
- [Red] At Least in Part Deemed Hazardous
- [Grey] Commercial or Industrial
- [Light Grey] Not Classified

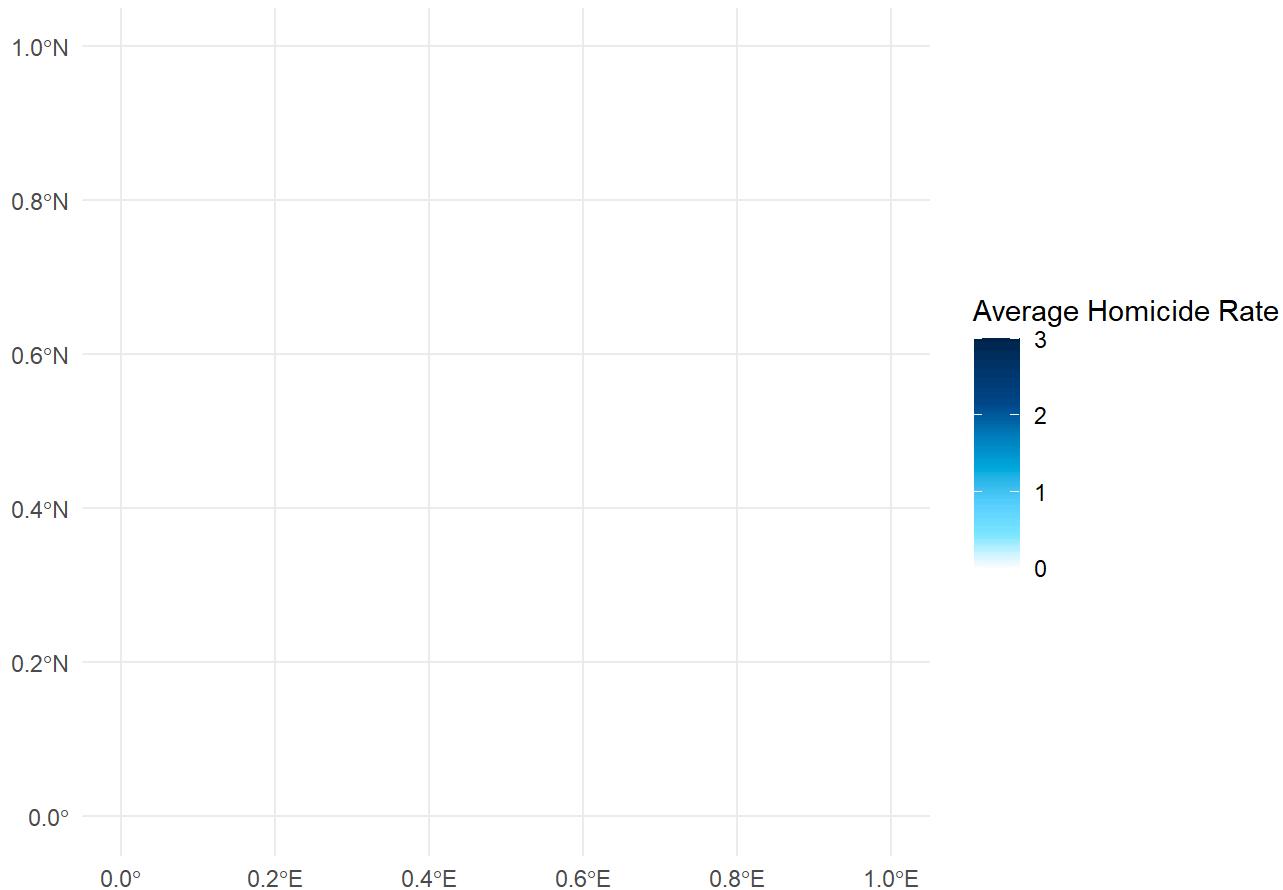
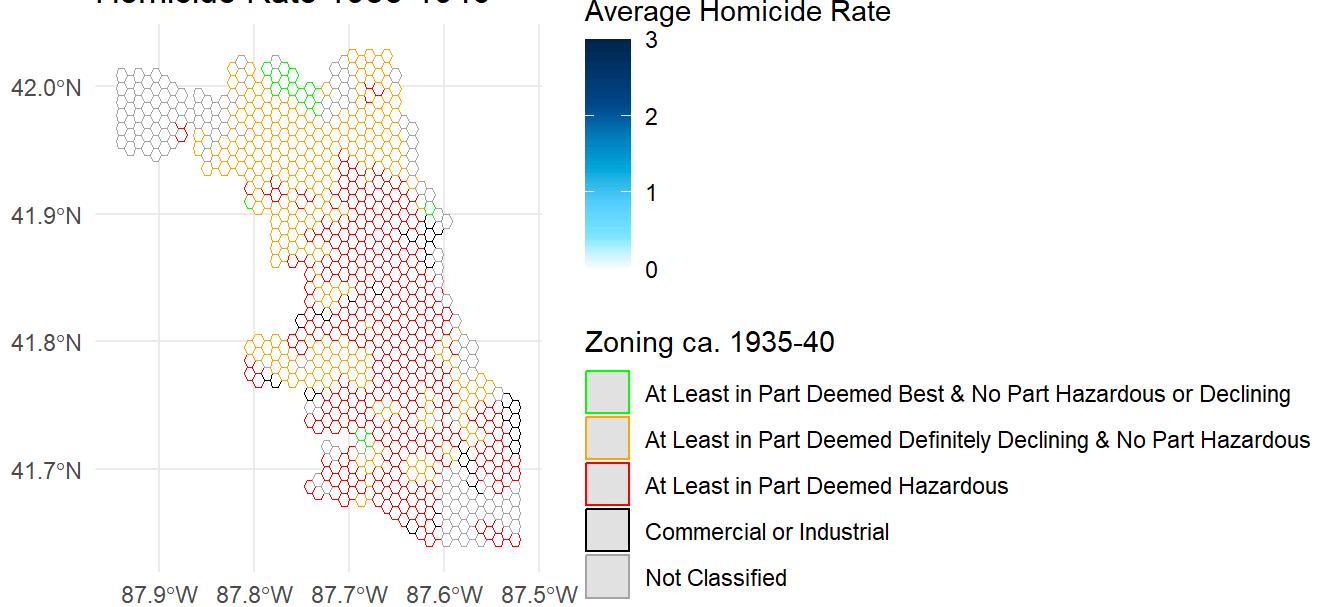
Homicide Rate 1911-1915**Zoning ca. 1935-40**

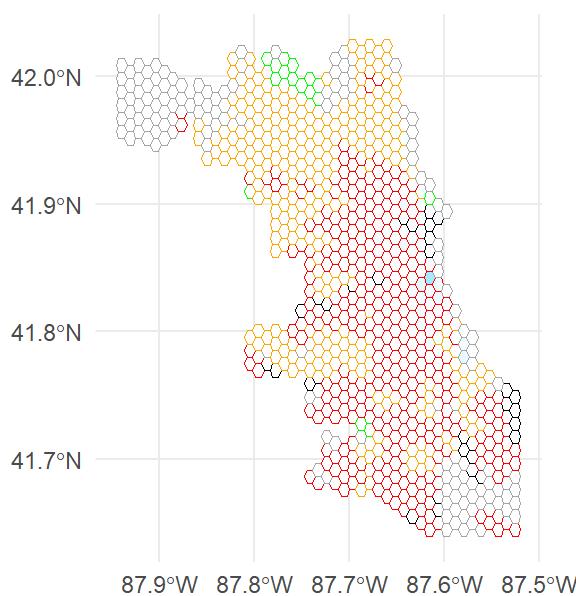
- [Green] At Least in Part Deemed Best & No Part Hazardous or Declining
- [Orange] At Least in Part Deemed Definitely Declining & No Part Hazardous
- [Red] At Least in Part Deemed Hazardous
- [Grey] Commercial or Industrial
- [Light Grey] Not Classified

Homicide Rate 1916-1920**Average Homicide Rate****Zoning ca. 1935-40****Homicide Rate 1921-1925****Average Homicide Rate****Zoning ca. 1935-40**

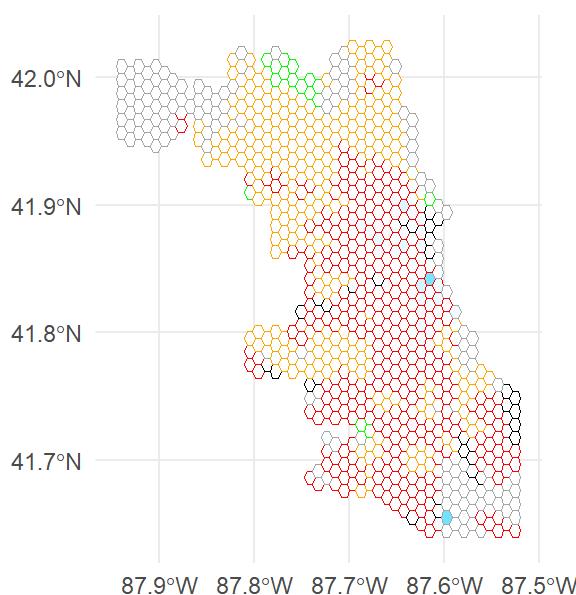


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## data's colour values.
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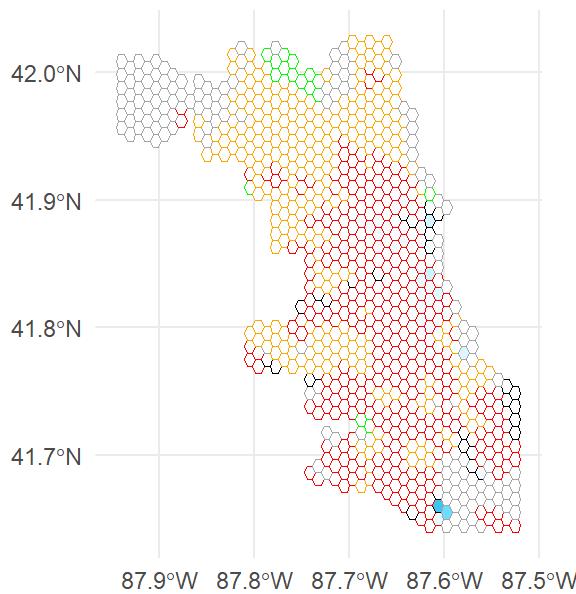
Homicide Rate 1931-1935**Homicide Rate 1936-1940**

Homicide Rate 1941-1945**Zoning ca. 1935-40**

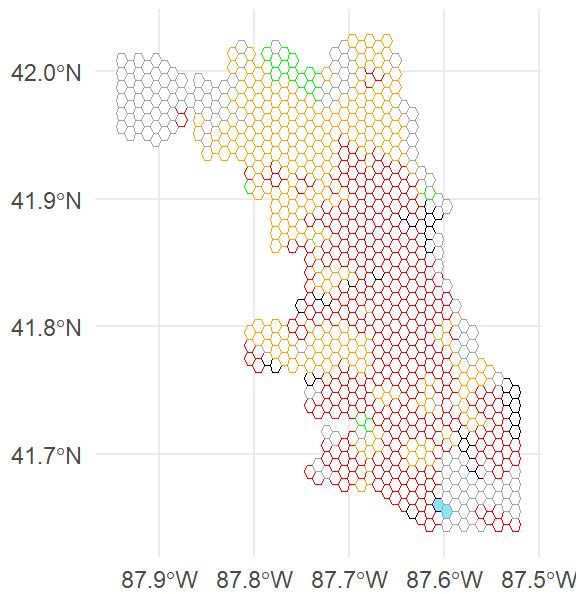
- █ At Least in Part Deemed Best & No Part Hazardous or Declining
- █ At Least in Part Deemed Definitely Declining & No Part Hazardous
- █ At Least in Part Deemed Hazardous
- █ Commercial or Industrial
- █ Not Classified

Homicide Rate 1946-1950**Zoning ca. 1935-40**

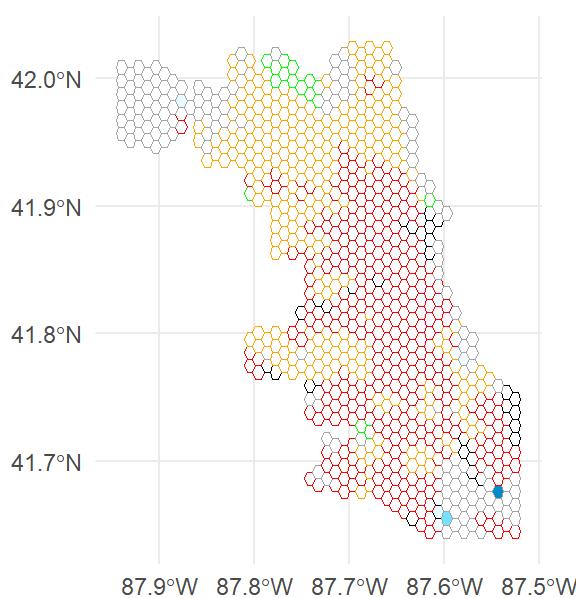
- █ At Least in Part Deemed Best & No Part Hazardous or Declining
- █ At Least in Part Deemed Definitely Declining & No Part Hazardous
- █ At Least in Part Deemed Hazardous
- █ Commercial or Industrial
- █ Not Classified

Homicide Rate 1951-1955**Zoning ca. 1935-40**

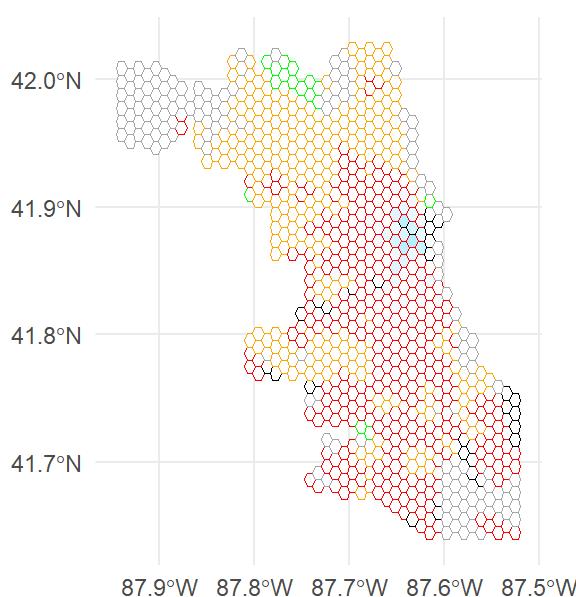
- At Least in Part Deemed Best & No Part Hazardous or Declining
- At Least in Part Deemed Definitely Declining & No Part Hazardous
- At Least in Part Deemed Hazardous
- Commercial or Industrial
- Not Classified

Homicide Rate 1956-1960**Zoning ca. 1935-40**

- At Least in Part Deemed Best & No Part Hazardous or Declining
- At Least in Part Deemed Definitely Declining & No Part Hazardous
- At Least in Part Deemed Hazardous
- Commercial or Industrial
- Not Classified

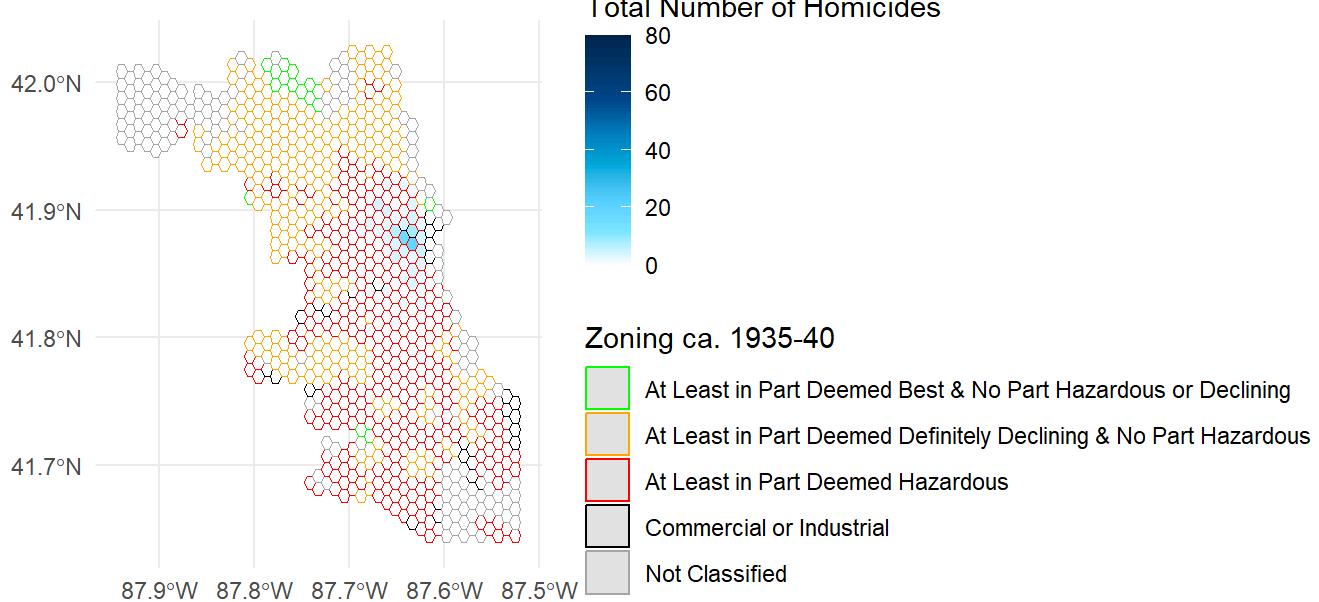
Homicide Rate 1961-1965**Zoning ca. 1935-40**

- [Green] At Least in Part Deemed Best & No Part Hazardous or Declining
- [Orange] At Least in Part Deemed Definitely Declining & No Part Hazardous
- [Red] At Least in Part Deemed Hazardous
- [Grey] Commercial or Industrial
- [Light Grey] Not Classified

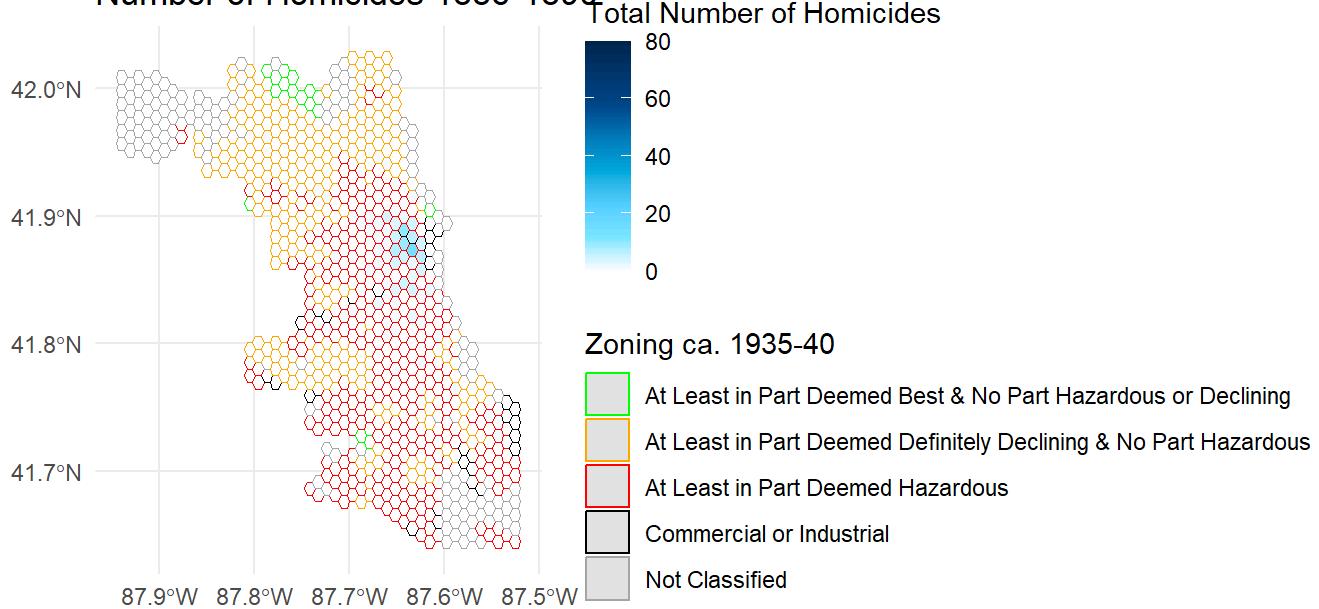
Number of Homicides 1876-1880**Zoning ca. 1935-40**

- [Green] At Least in Part Deemed Best & No Part Hazardous or Declining
- [Orange] At Least in Part Deemed Definitely Declining & No Part Hazardous
- [Red] At Least in Part Deemed Hazardous
- [Grey] Commercial or Industrial
- [Light Grey] Not Classified

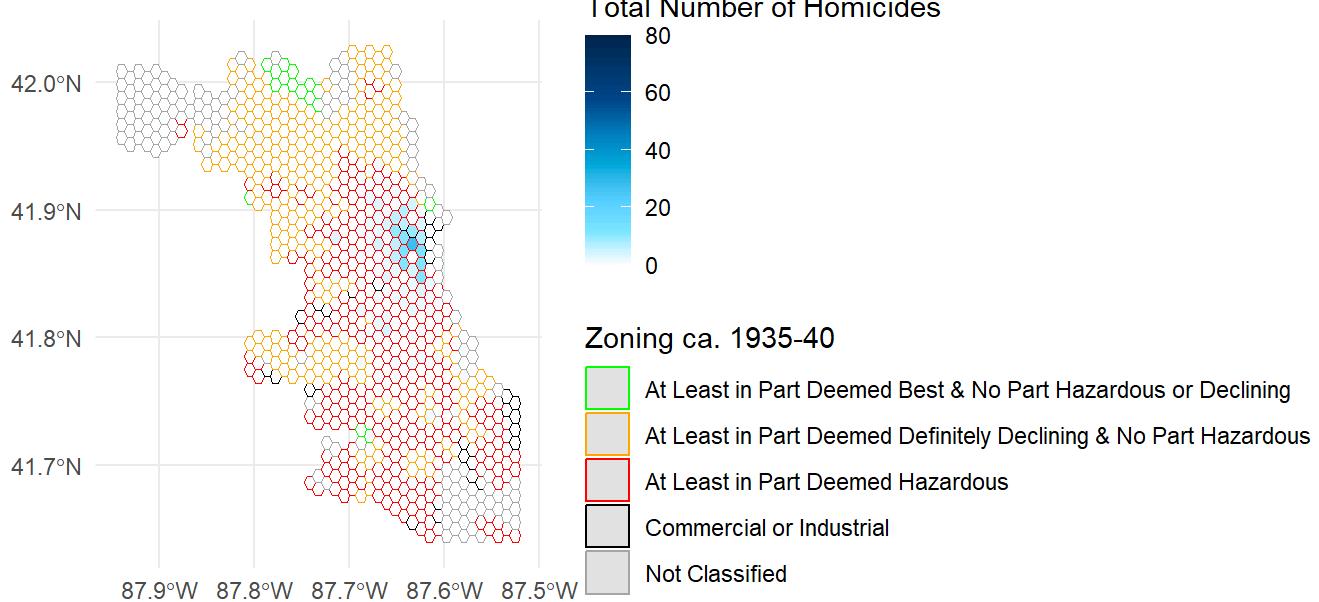
Number of Homicides 1881-1885



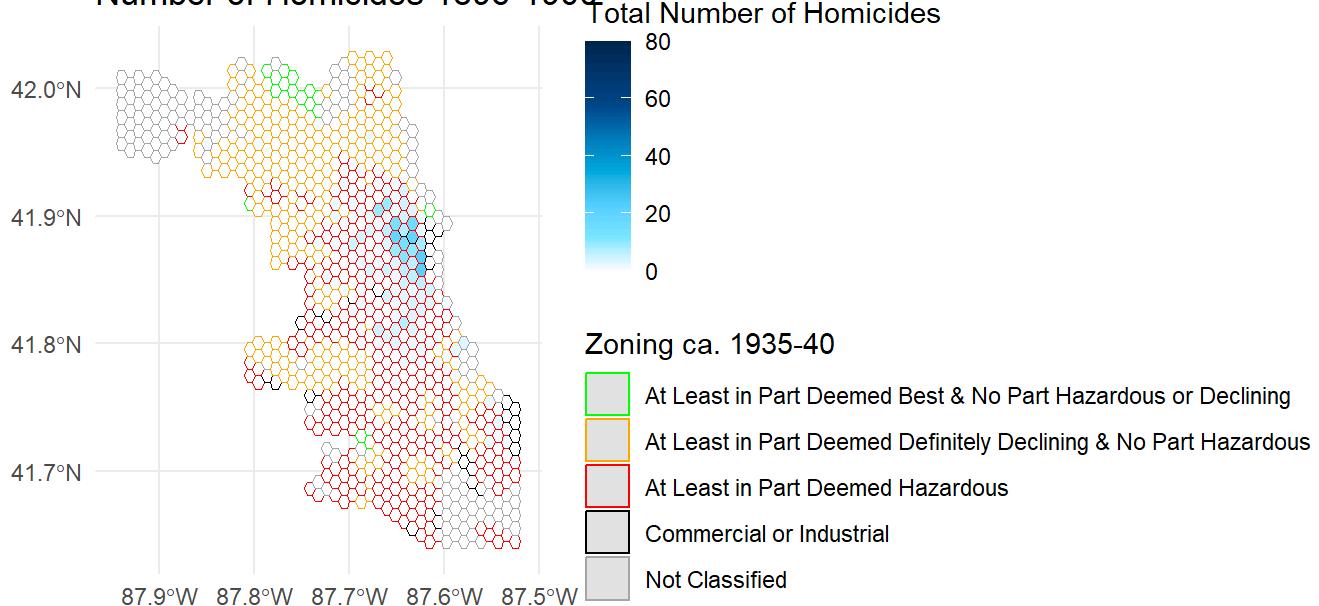
Number of Homicides 1886-1890



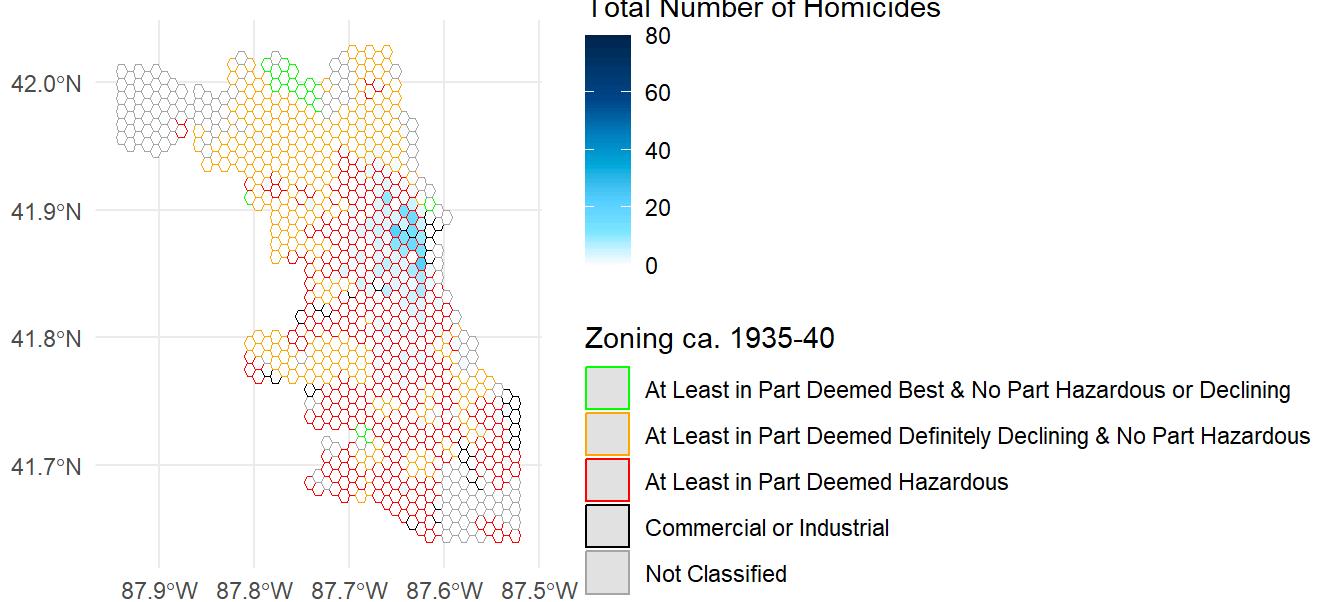
Number of Homicides 1891-1895



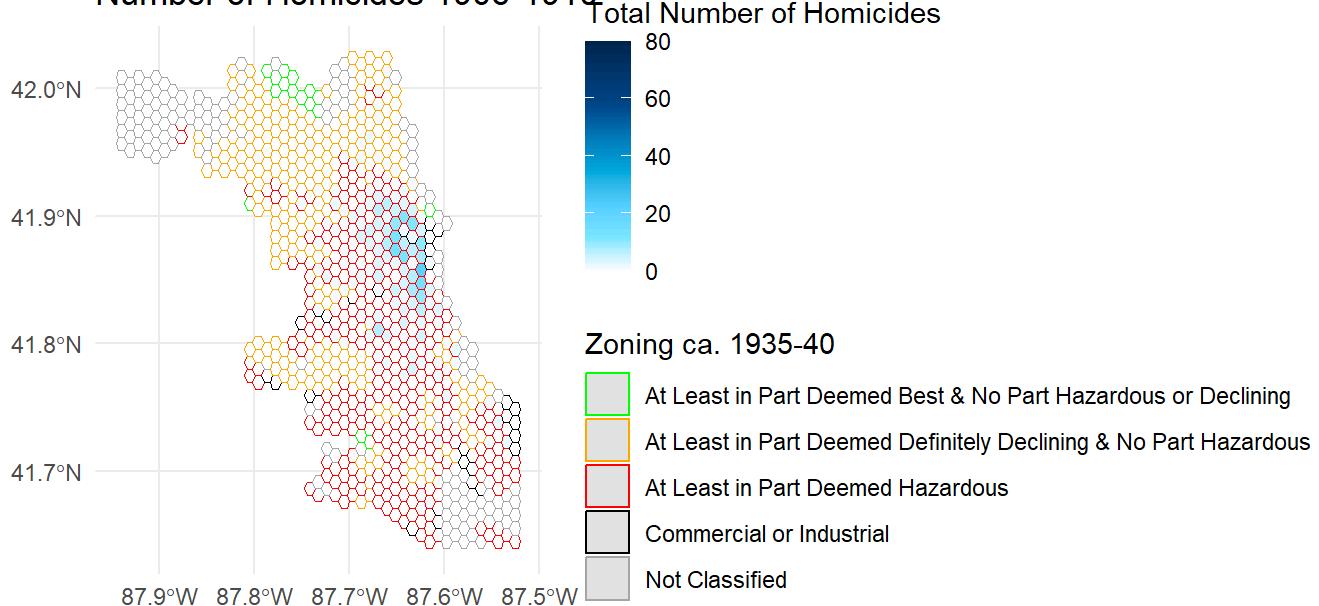
Number of Homicides 1896-1900



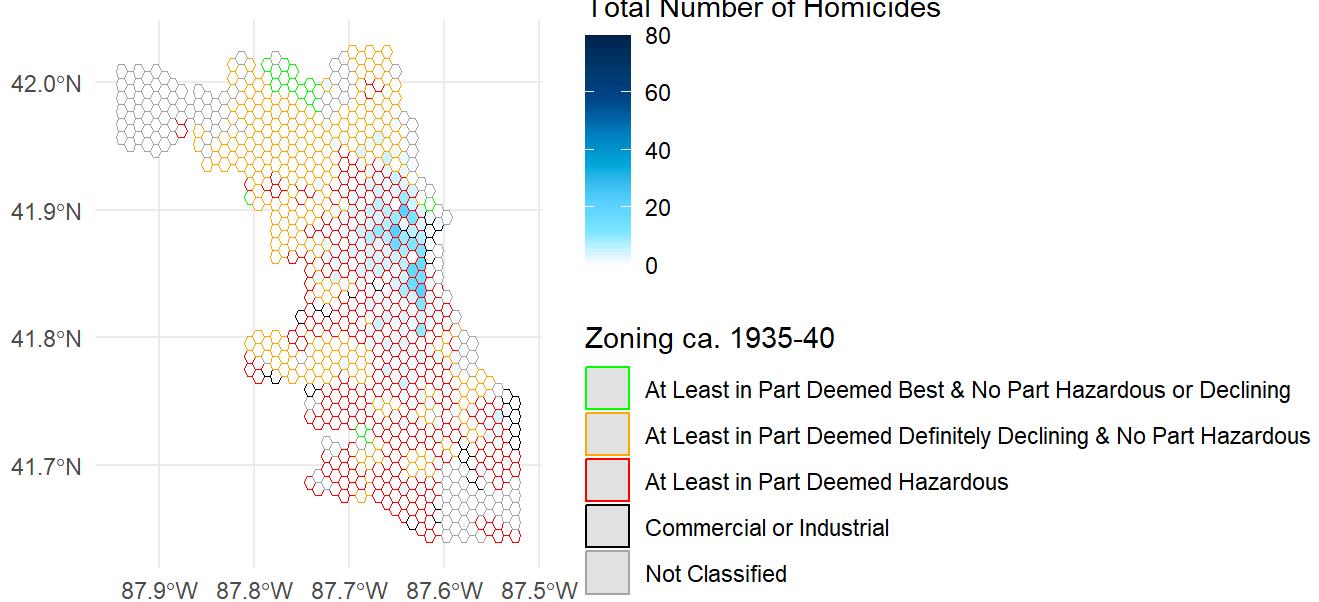
Number of Homicides 1901-1905



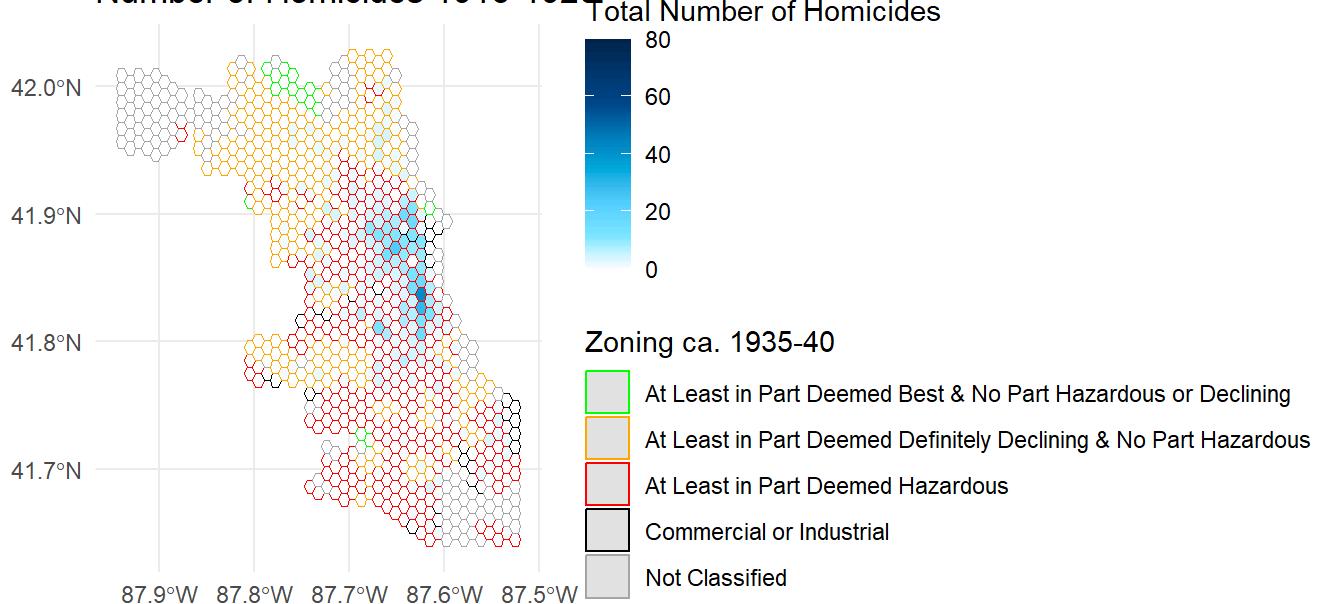
Number of Homicides 1906-1910



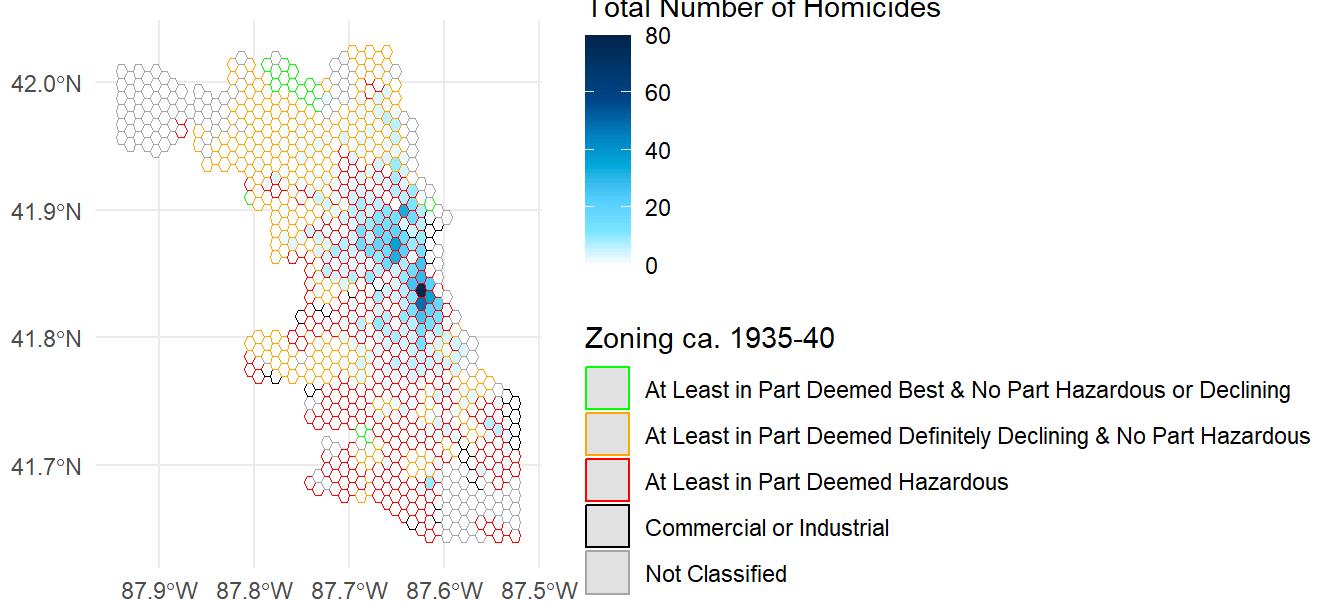
Number of Homicides 1911-1915



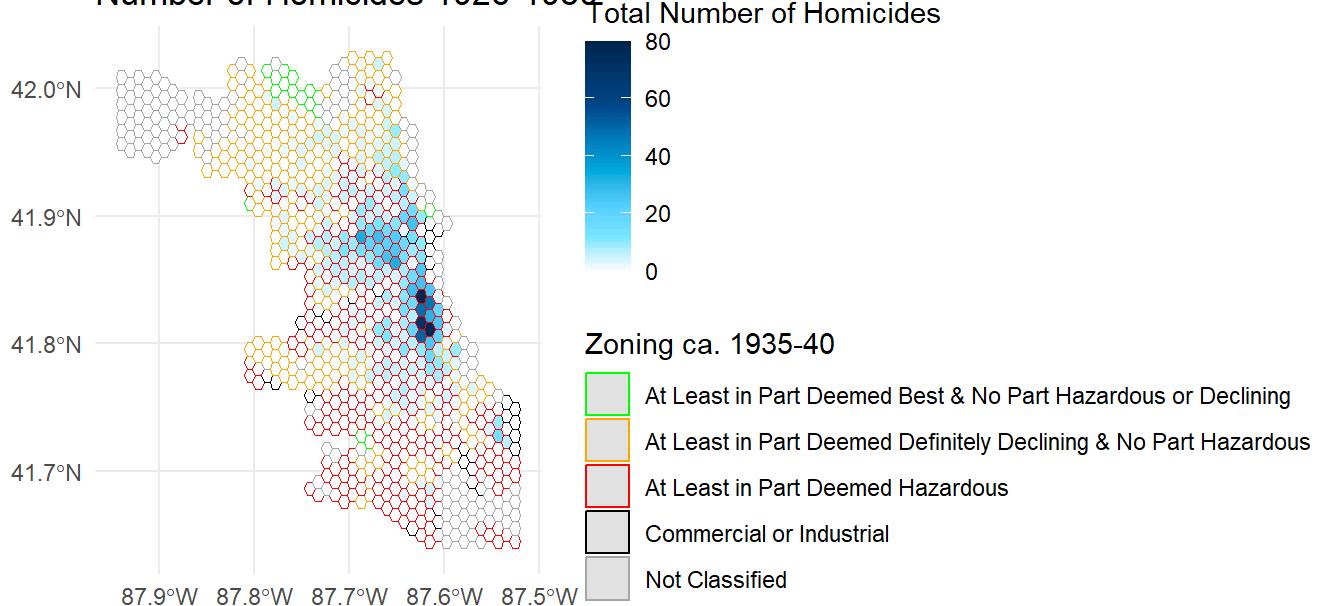
Number of Homicides 1916-1920



Number of Homicides 1921-1925

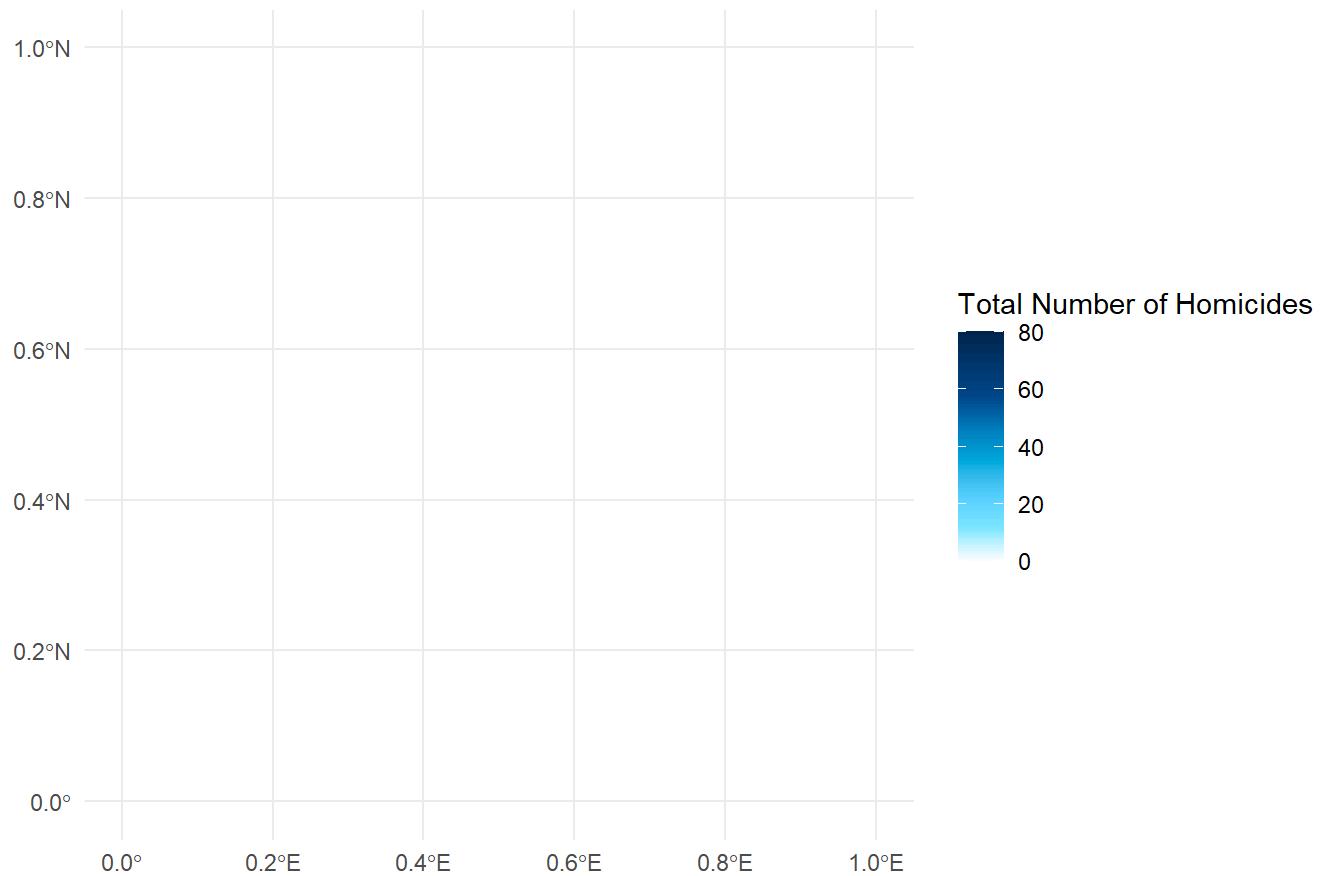


Number of Homicides 1926-1930

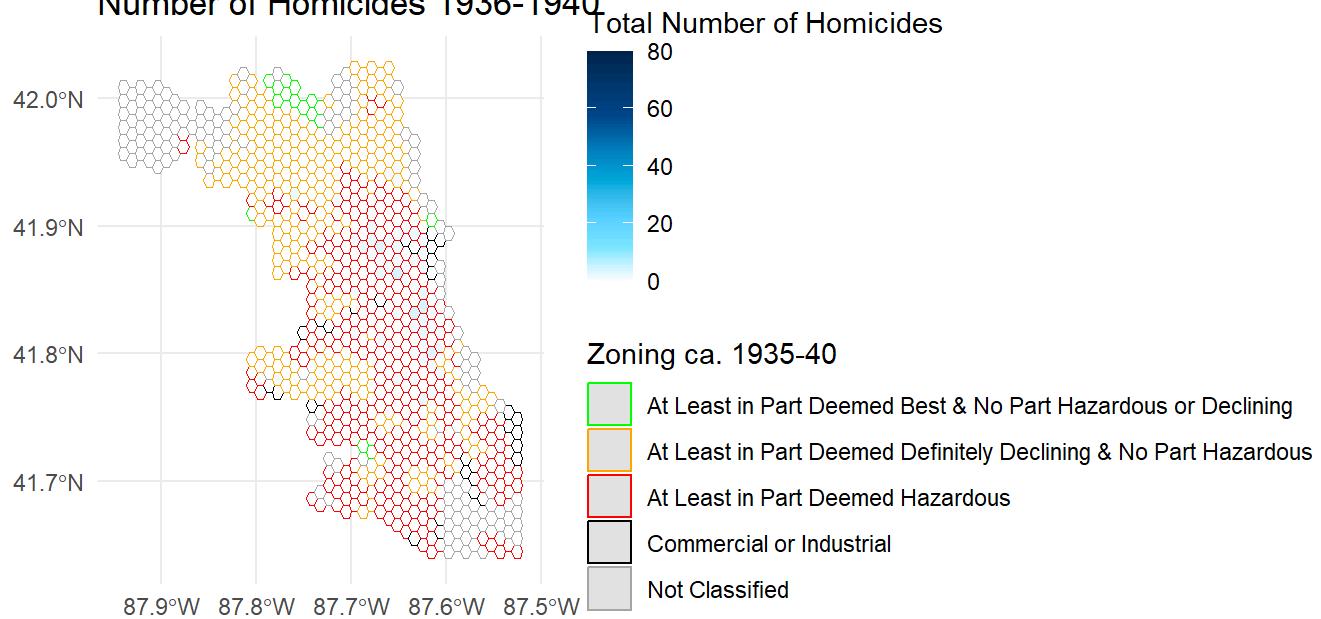


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## Warning: No shared levels found between `names(values)` of the manual scale and the
## data's colour values.
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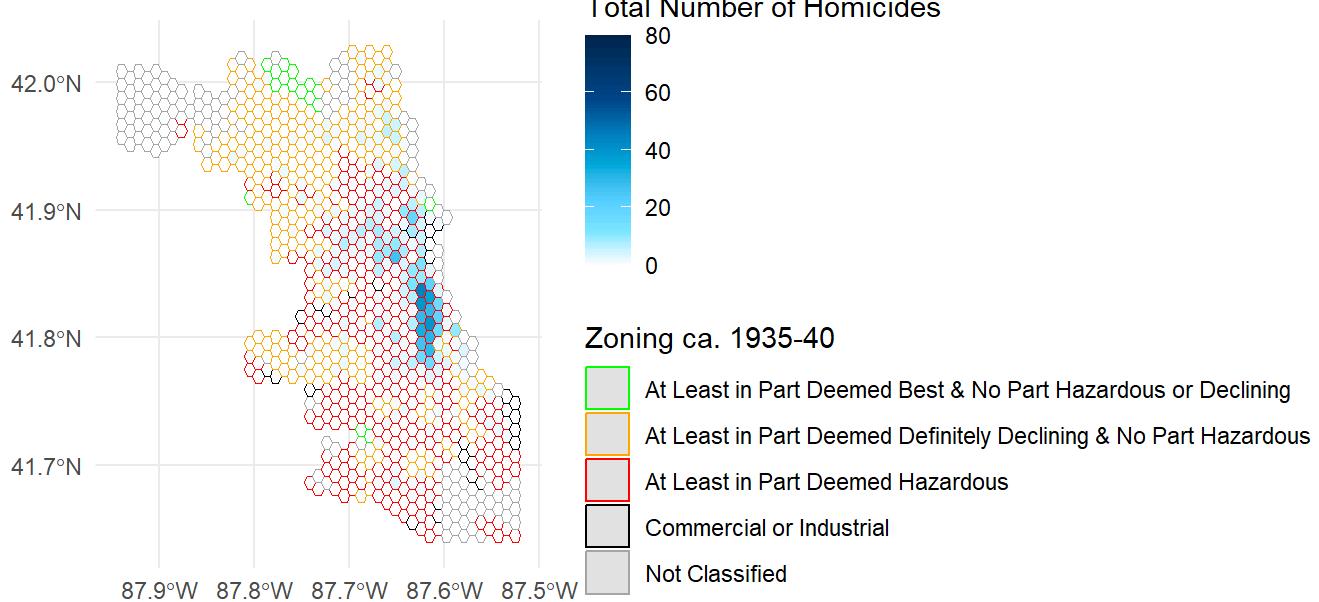
Number of Homicides 1931-1935



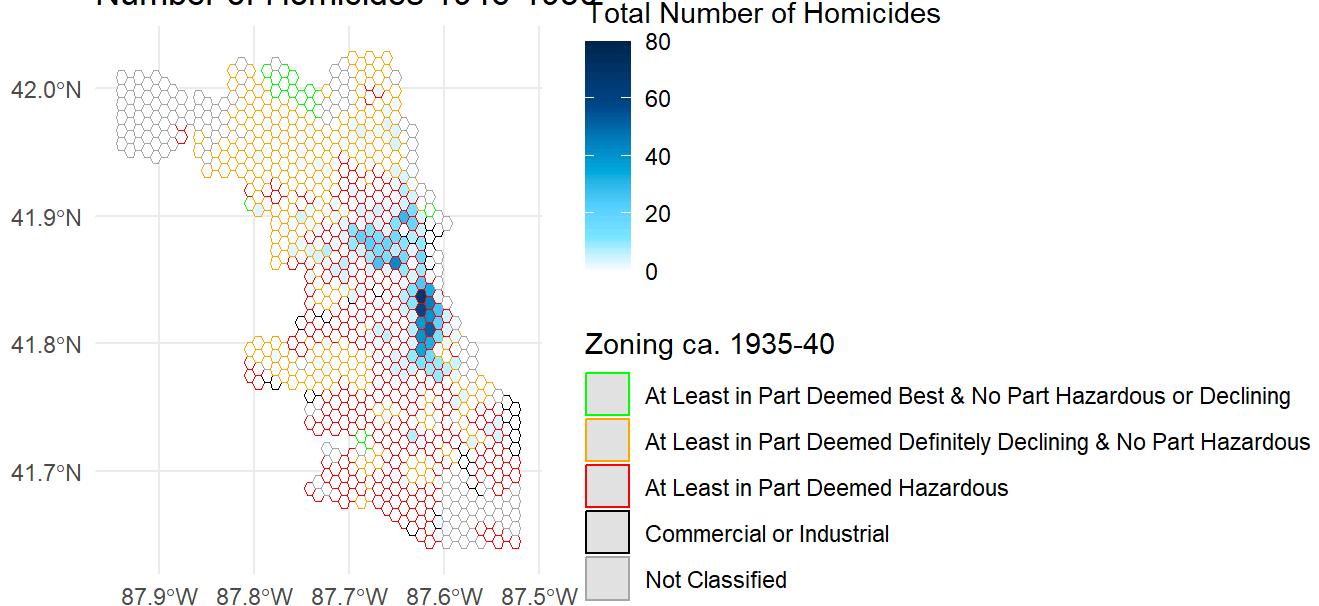
Number of Homicides 1936-1940



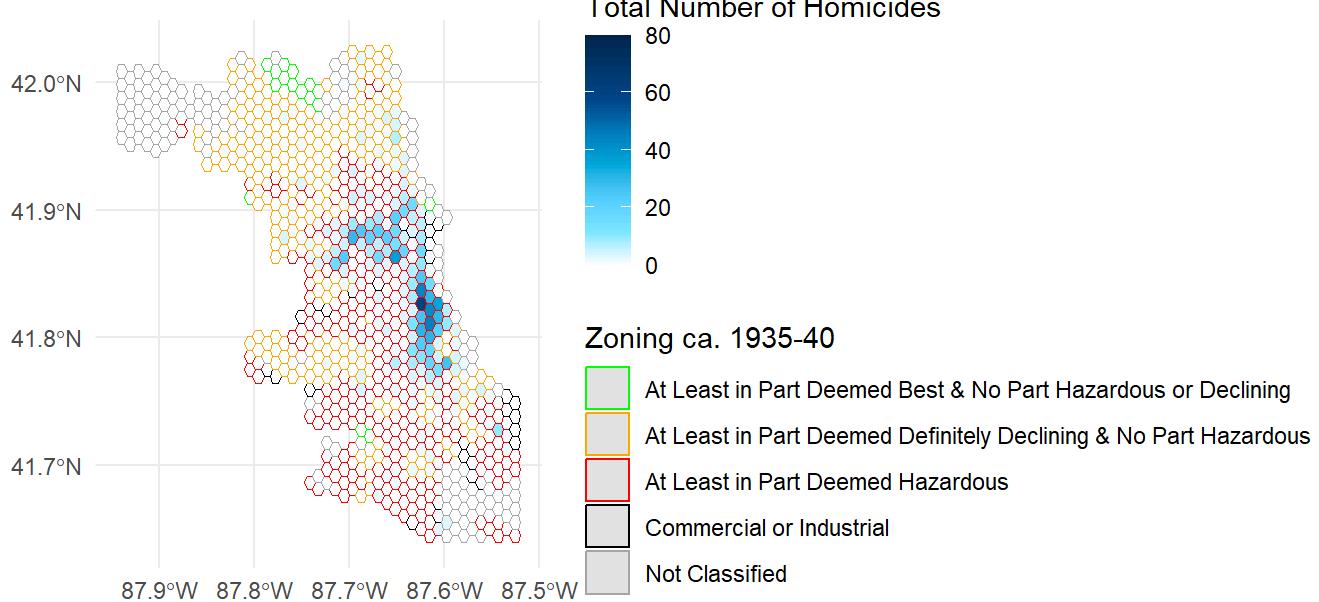
Number of Homicides 1941-1945



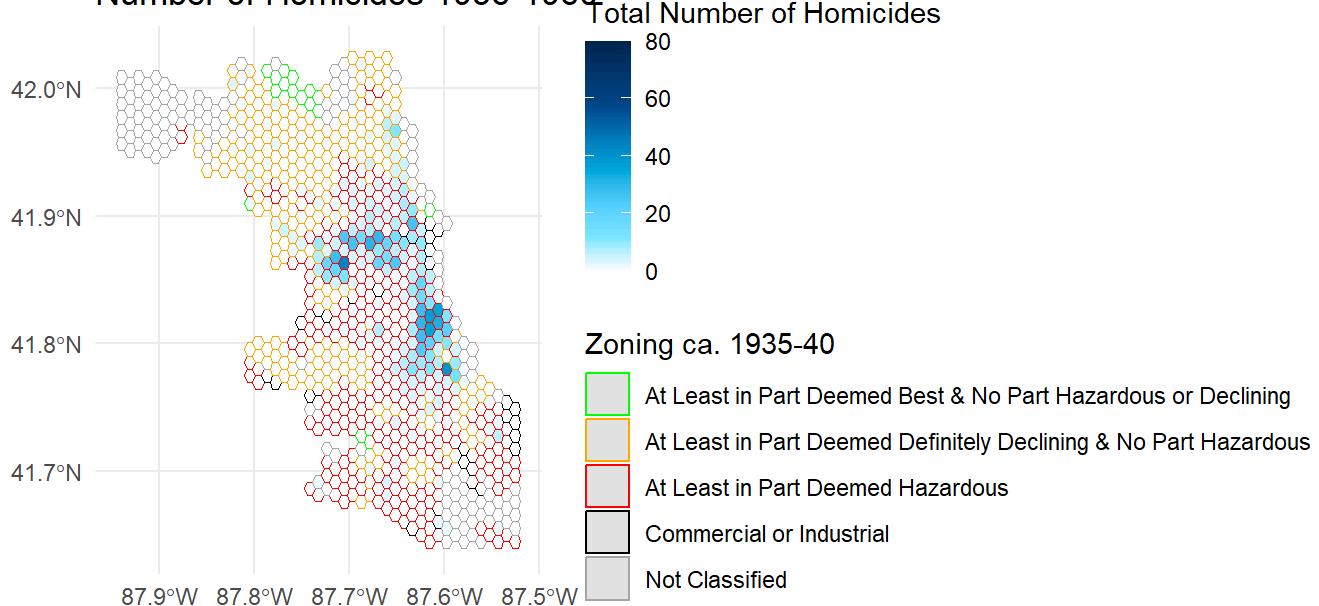
Number of Homicides 1946-1950

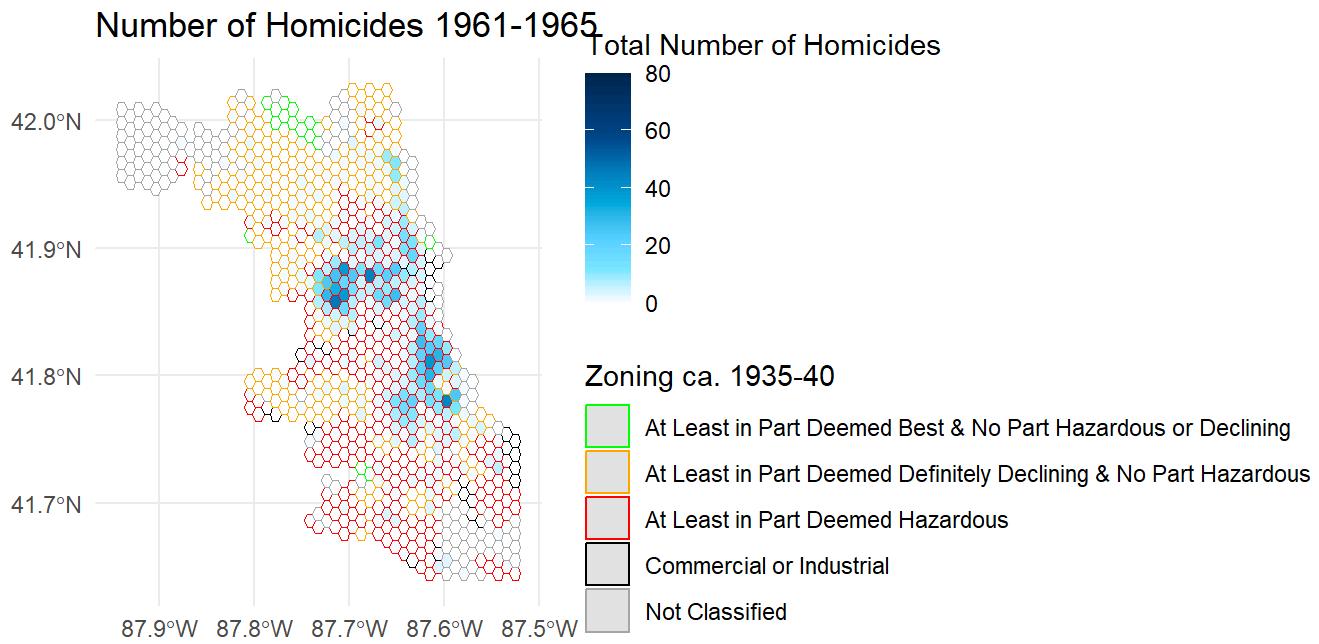


Number of Homicides 1951-1955



Number of Homicides 1956-1960





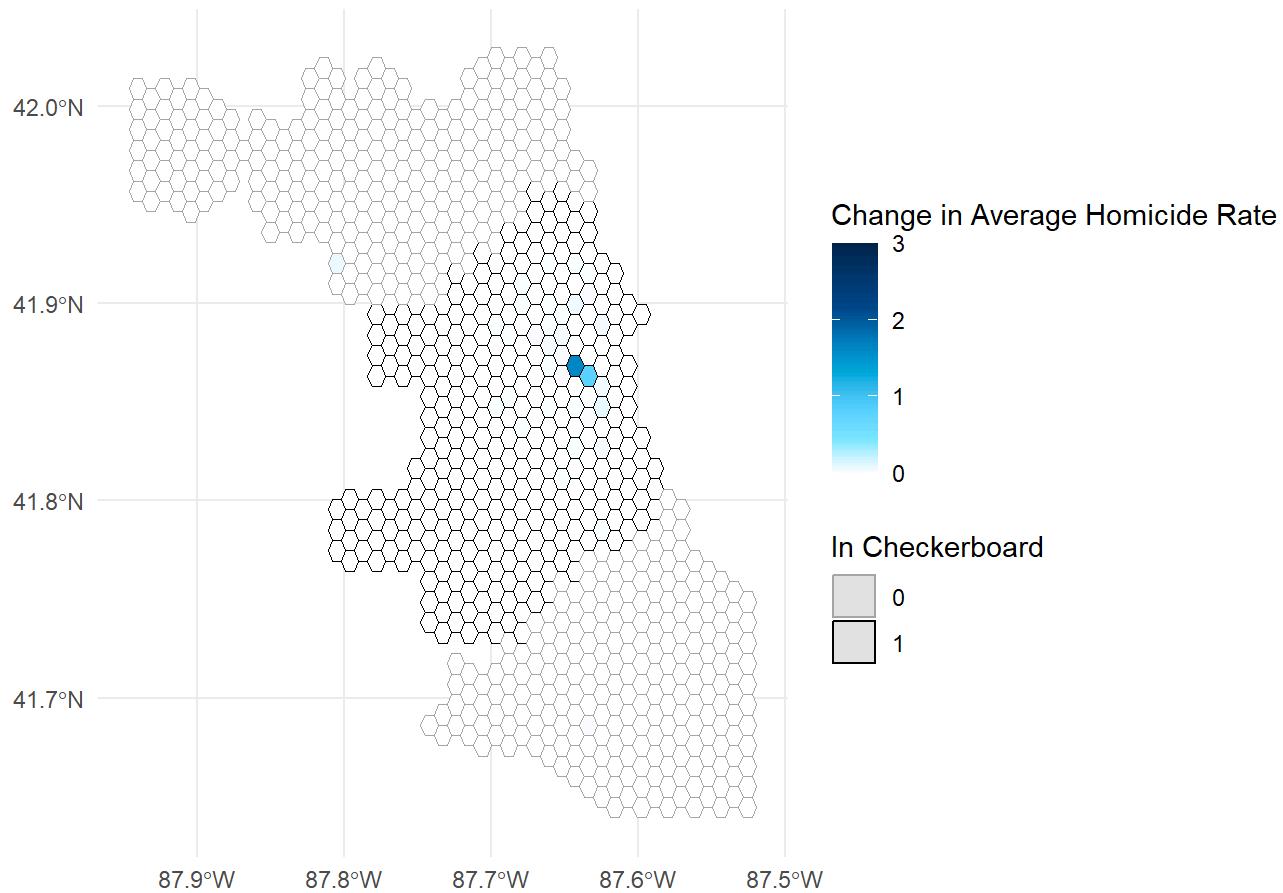
Preliminary Identification of Changes

Calculate the change of total homicides over 5 year periods, the change of average homicides over 5 year periods, and the change of average homicide rate over 5 year periods.

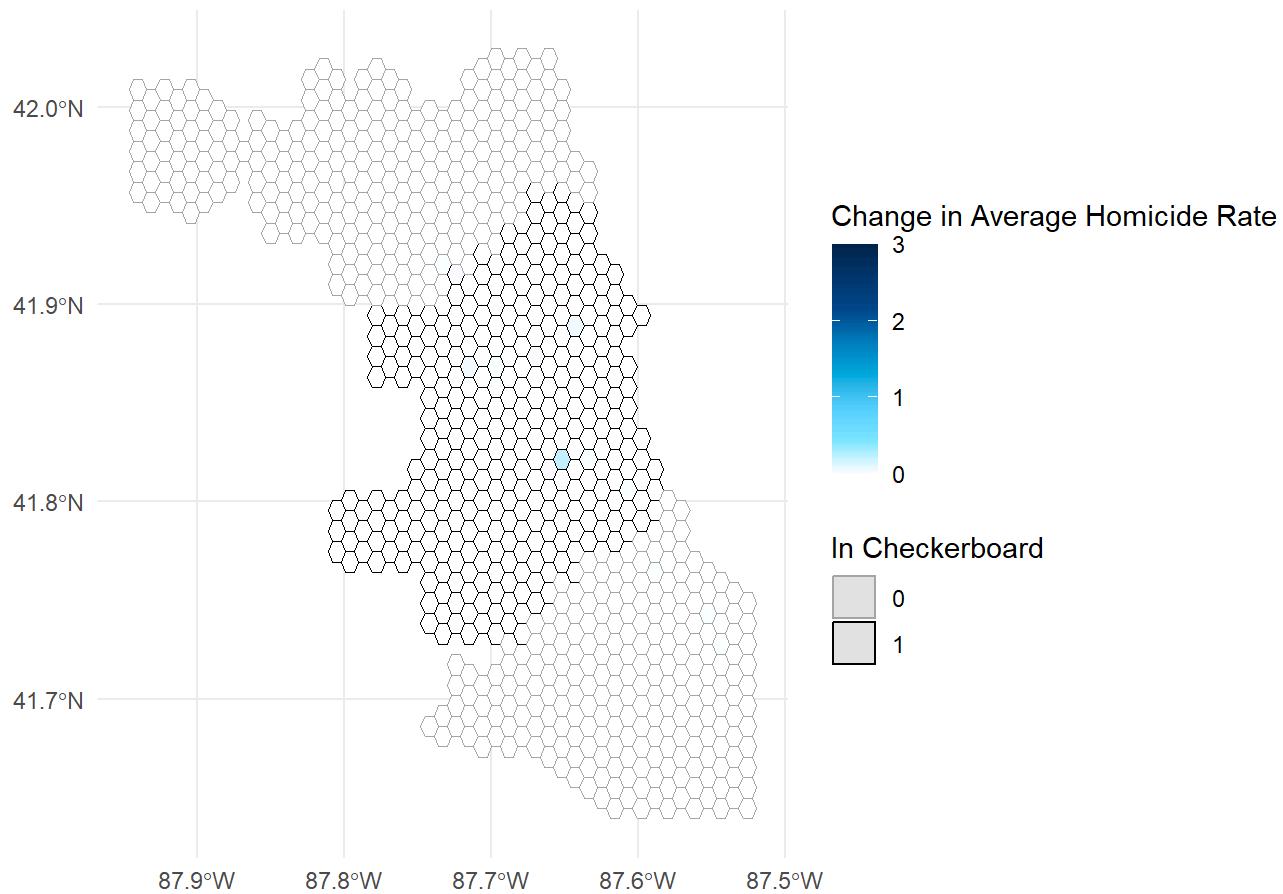
Define Notable Decline or Rise as change in the upper 10 percent of declines or rises within year.

Changes Over Time

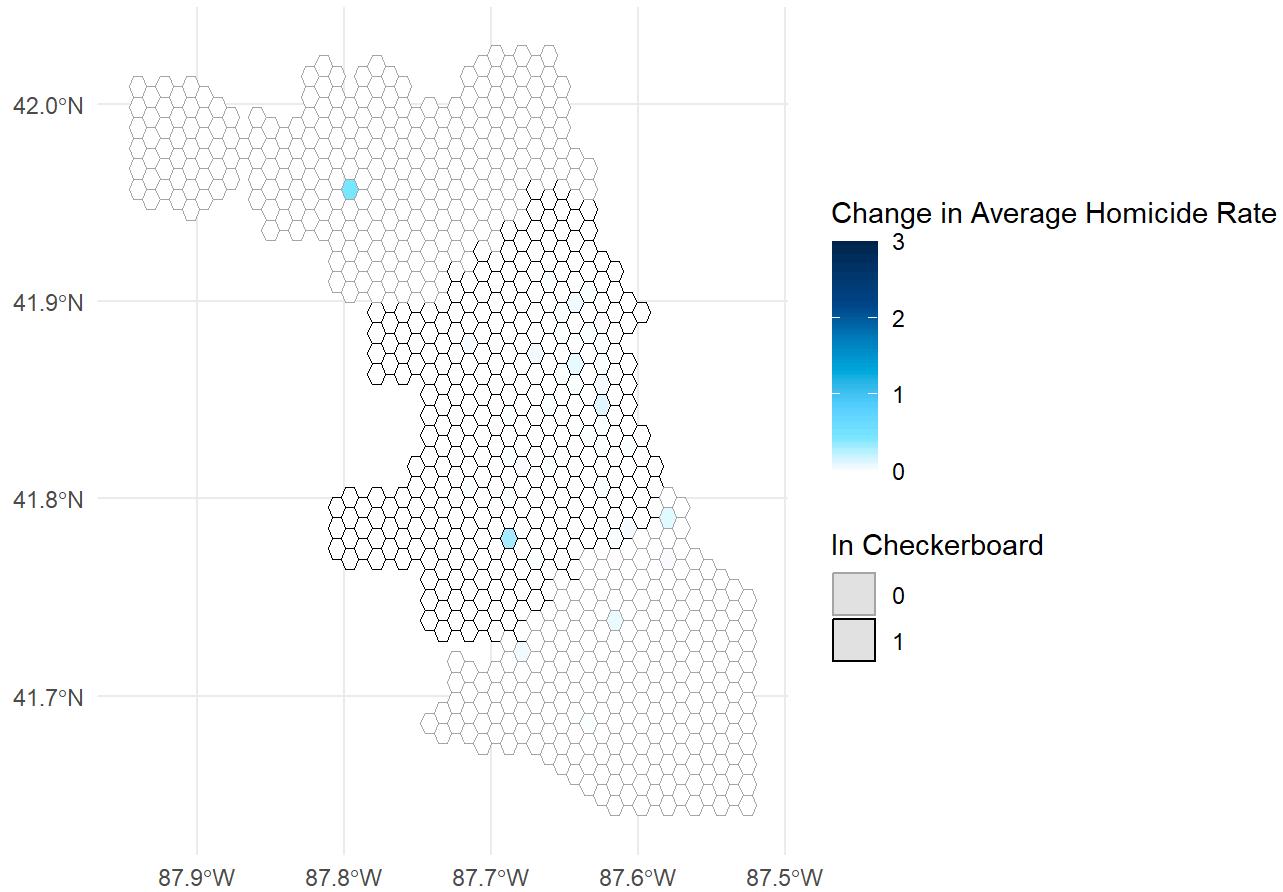
Change in Homicide Rate Between 1876-1880 and 1881-1885



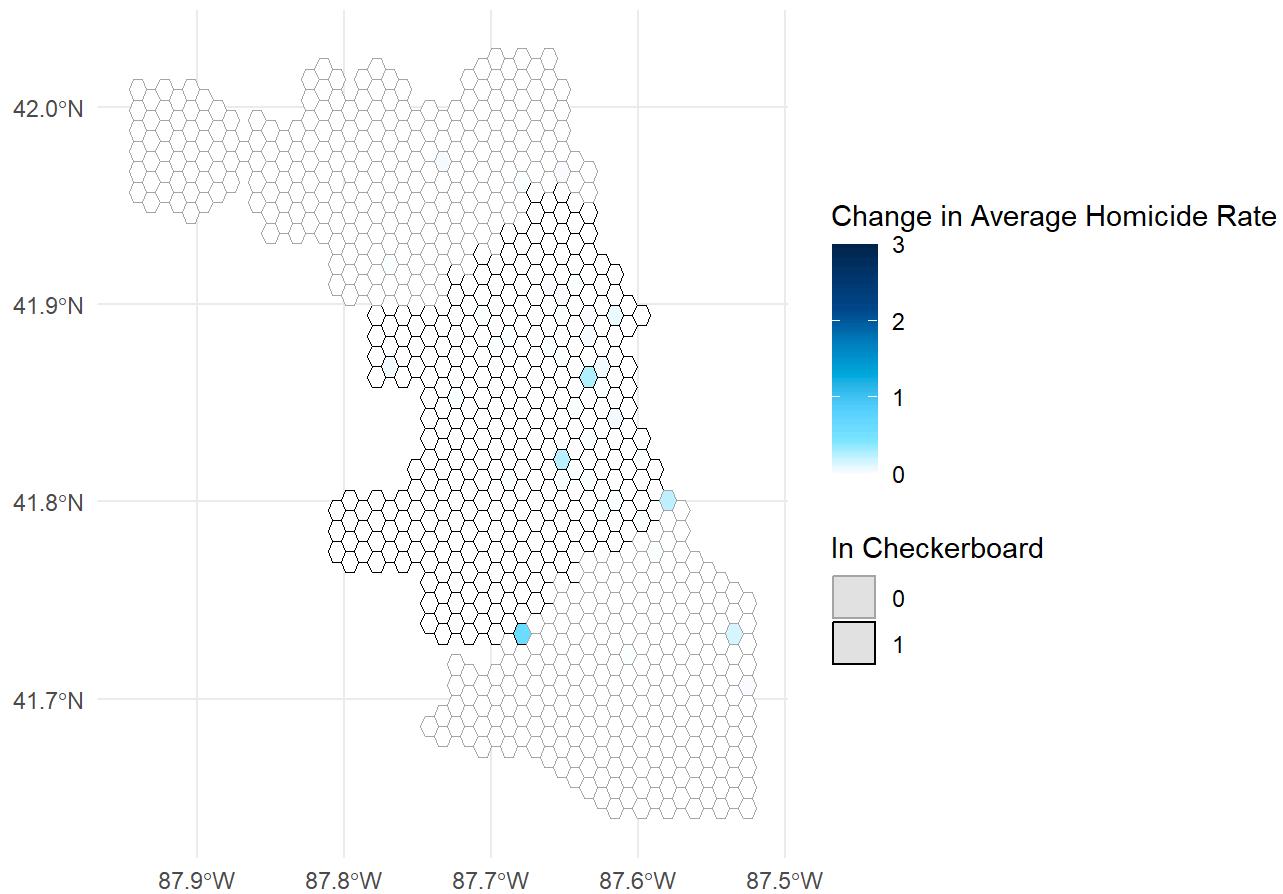
Change in Homicide Rate Between 1881-1885 and 1886-1890



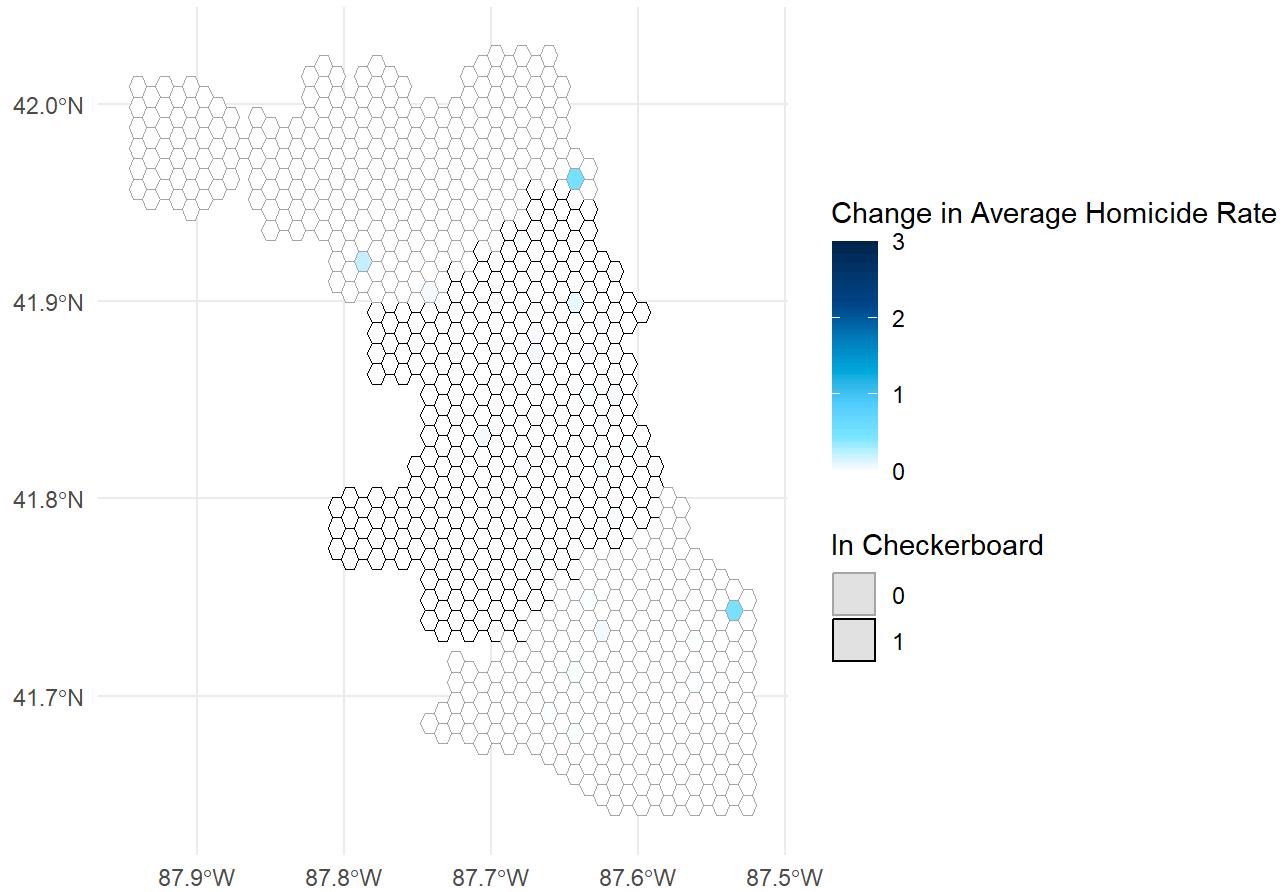
Change in Homicide Rate Between 1886-1890 and 1891-1895



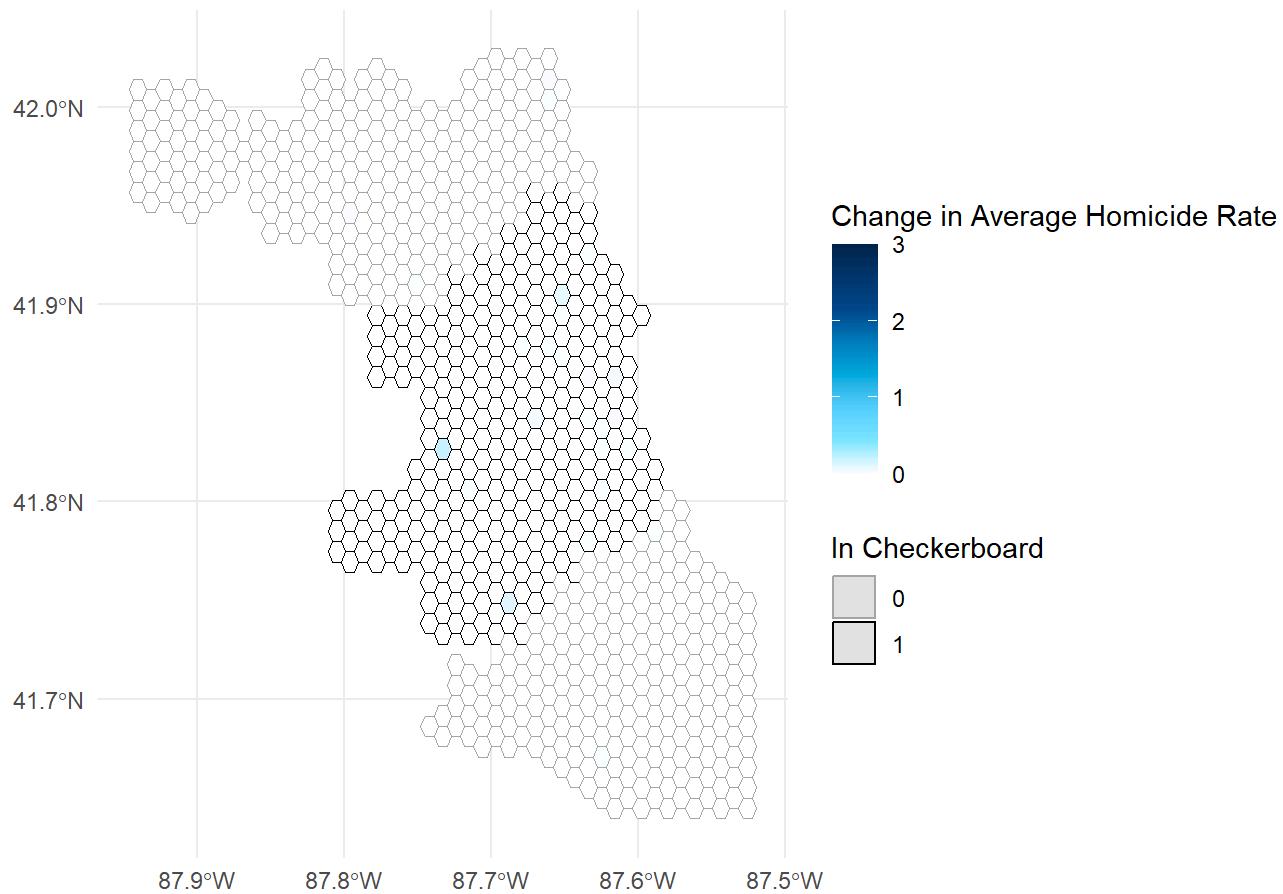
Change in Homicide Rate Between 1891-1895 and 1896-1900



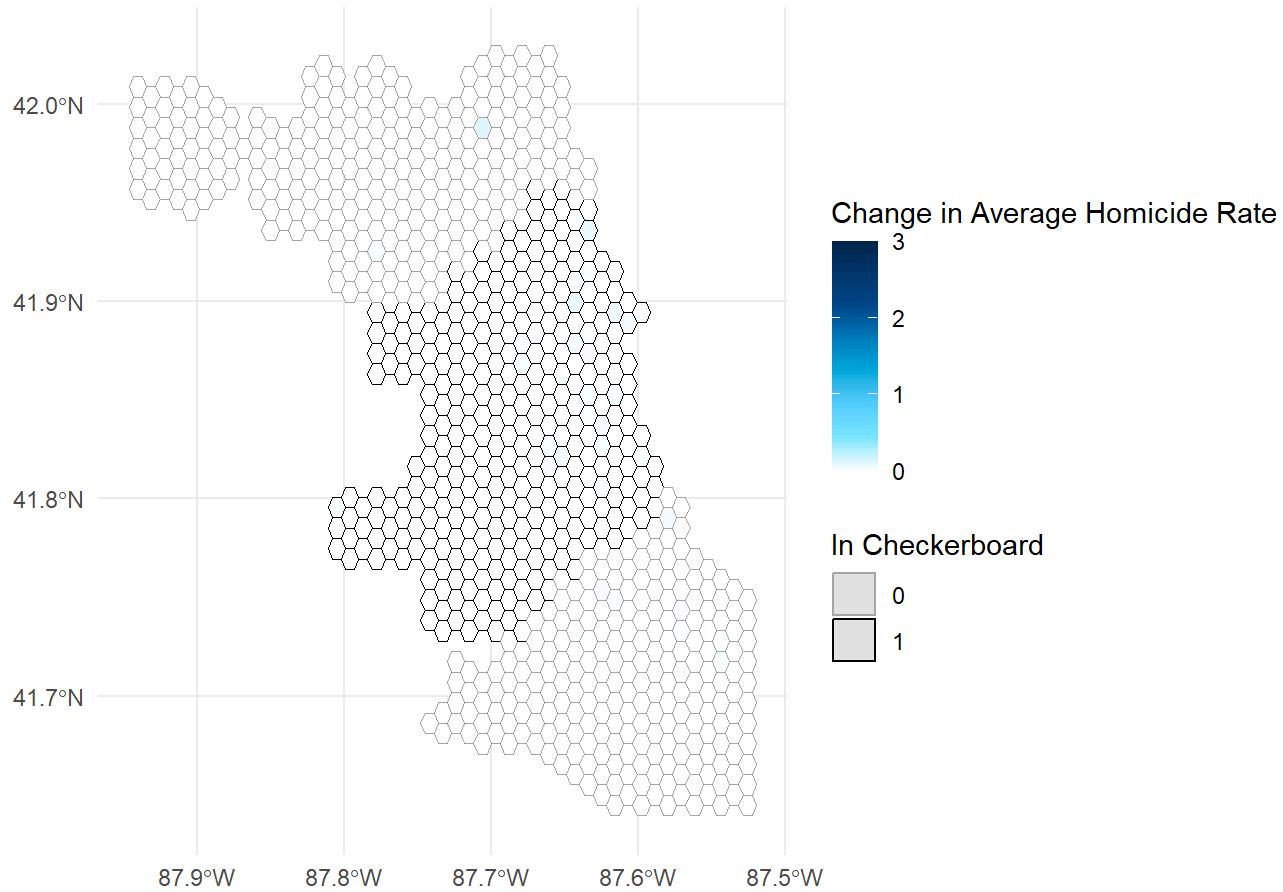
Change in Homicide Rate Between 1896-1900 and 1901-1905



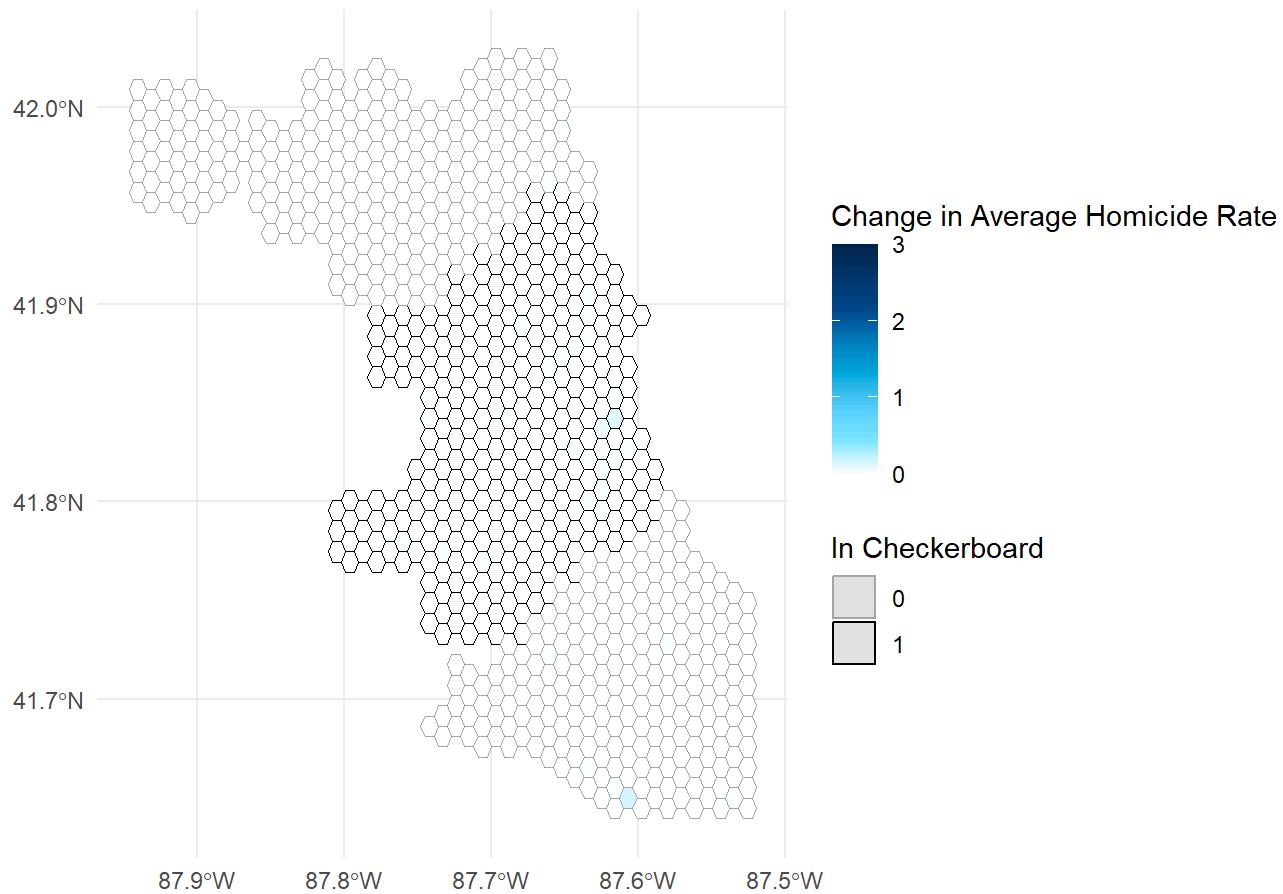
Change in Homicide Rate Between 1901-1905 and 1906-1910



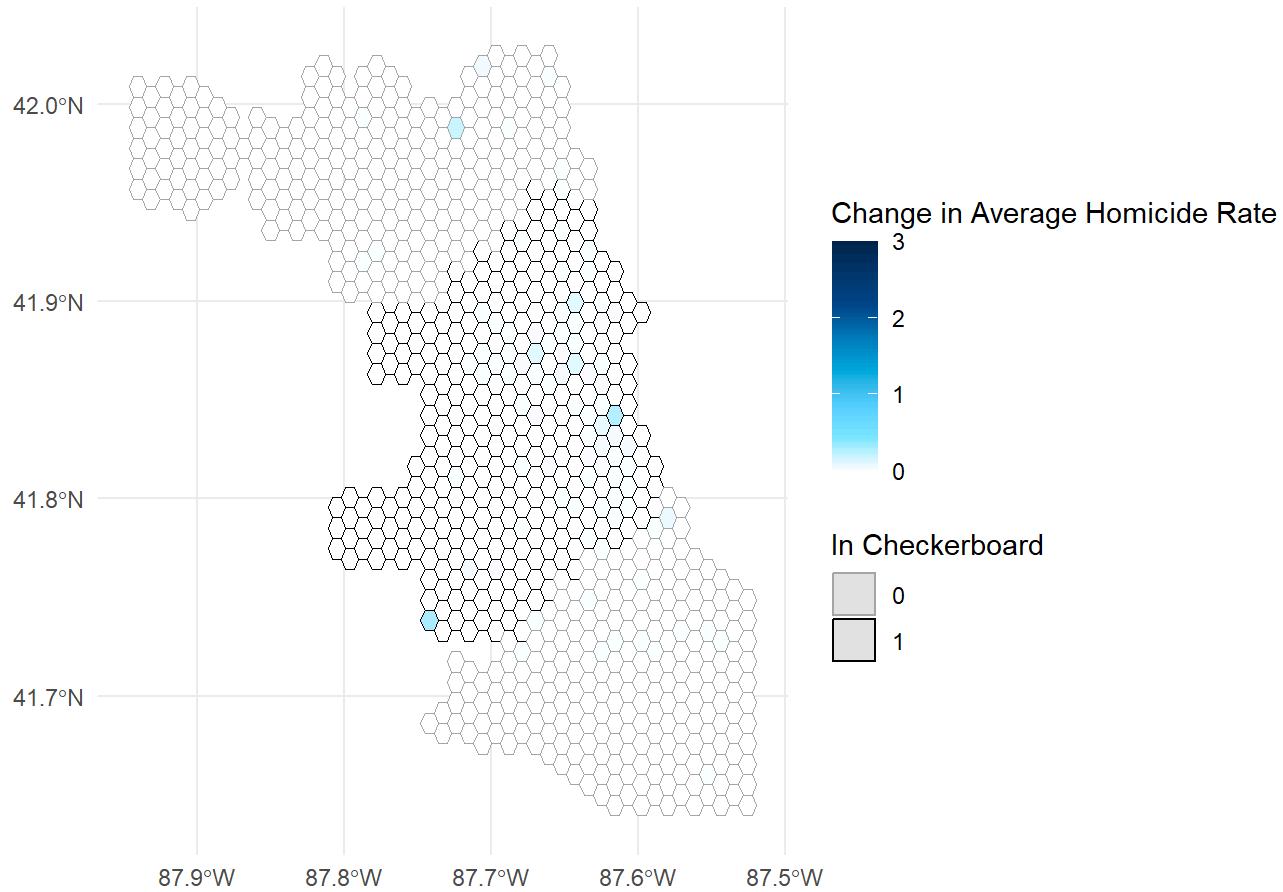
Change in Homicide Rate Between 1906-1910 and 1911-1915



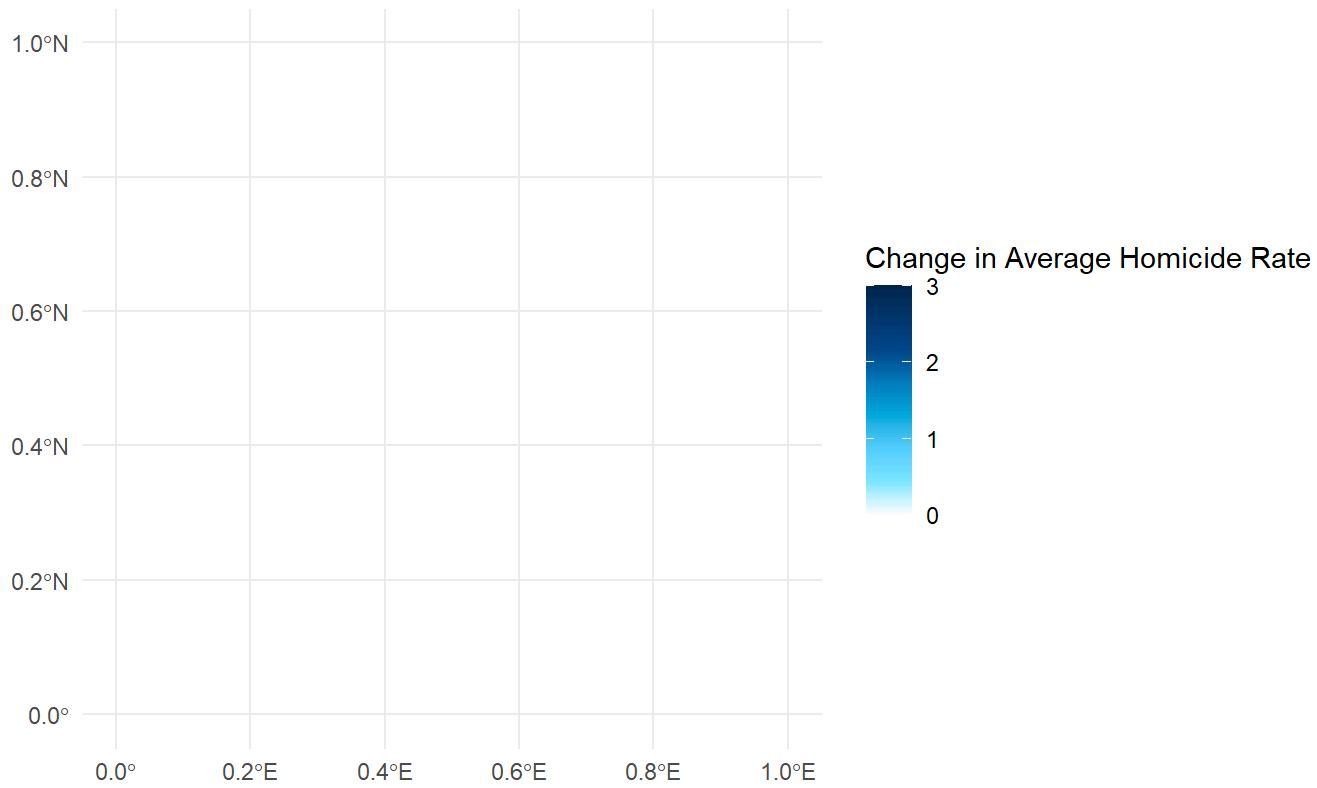
Change in Homicide Rate Between 1911-1915 and 1916-1920



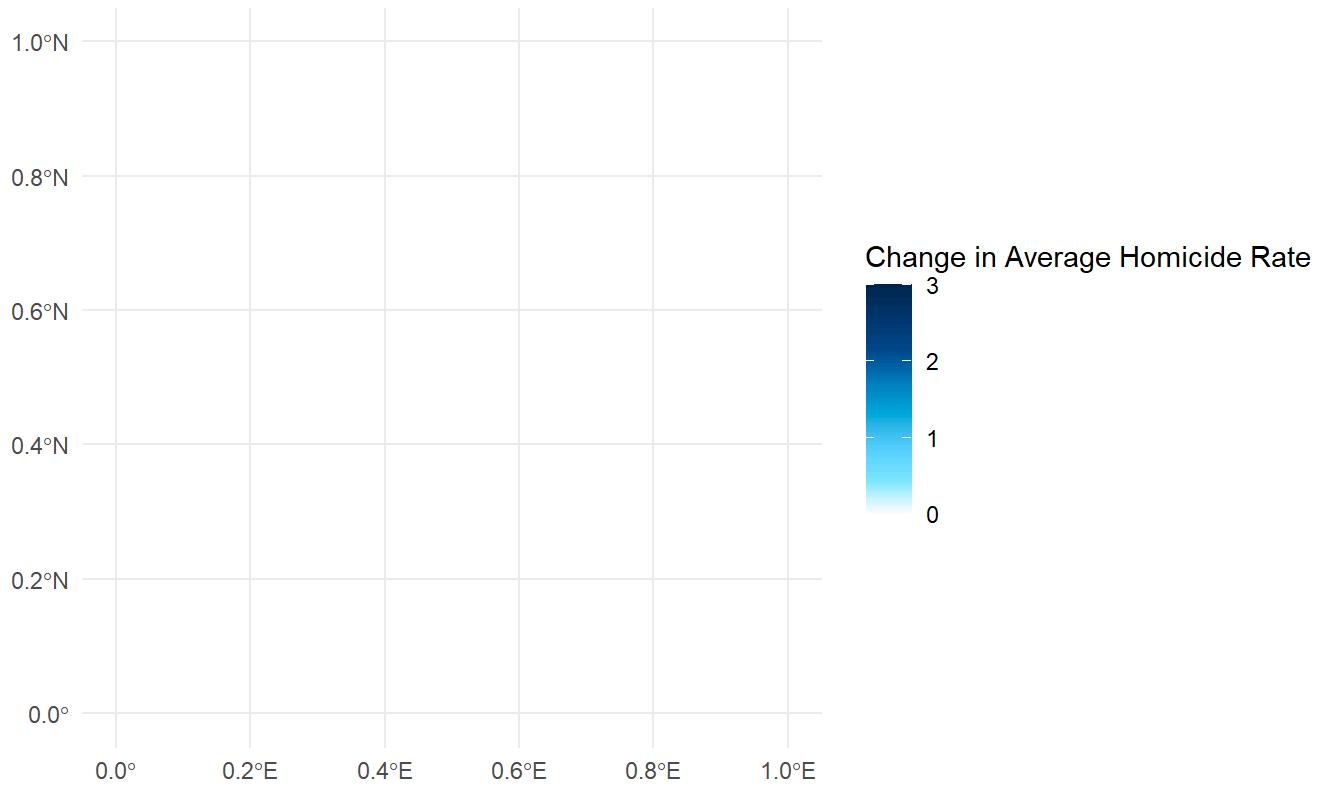
Change in Homicide Rate Between 1916-1920 and 1921-1925



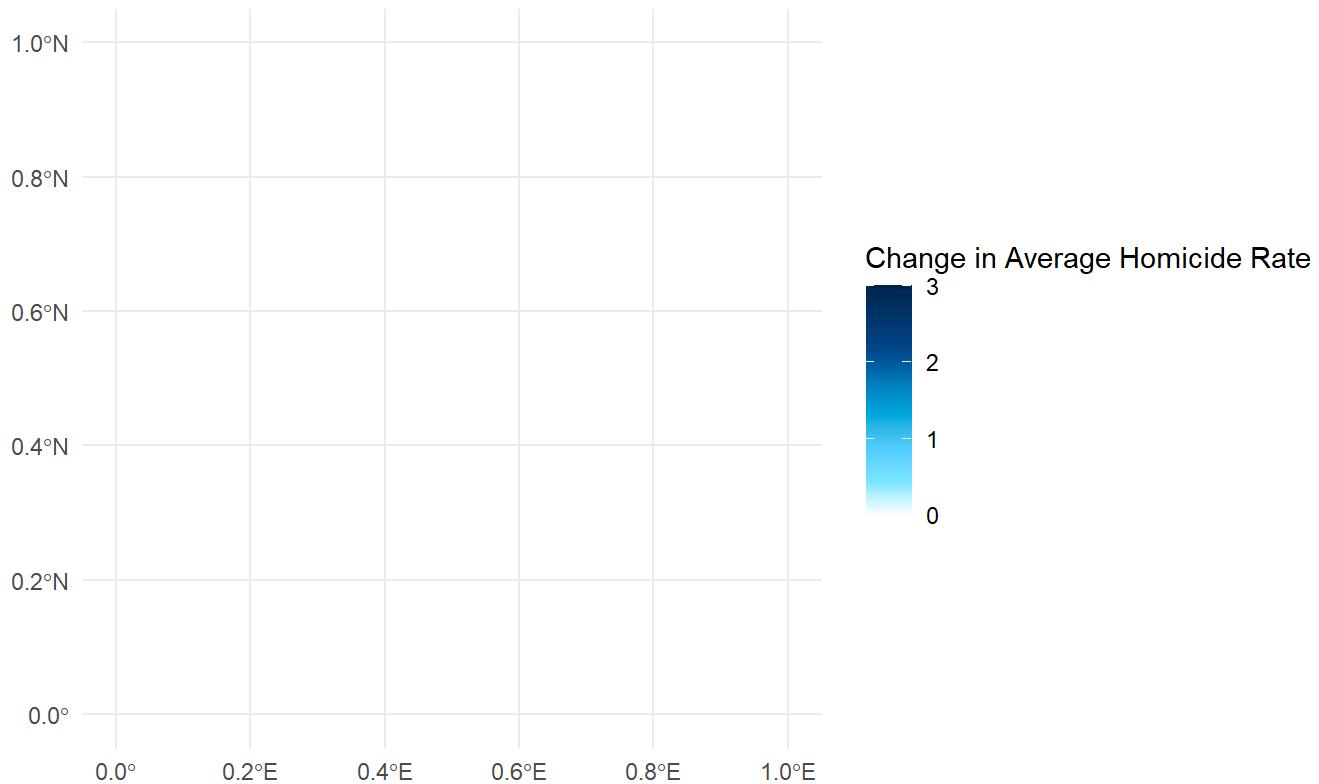
Change in Homicide Rate Between 1921-1925 and 1926-1930



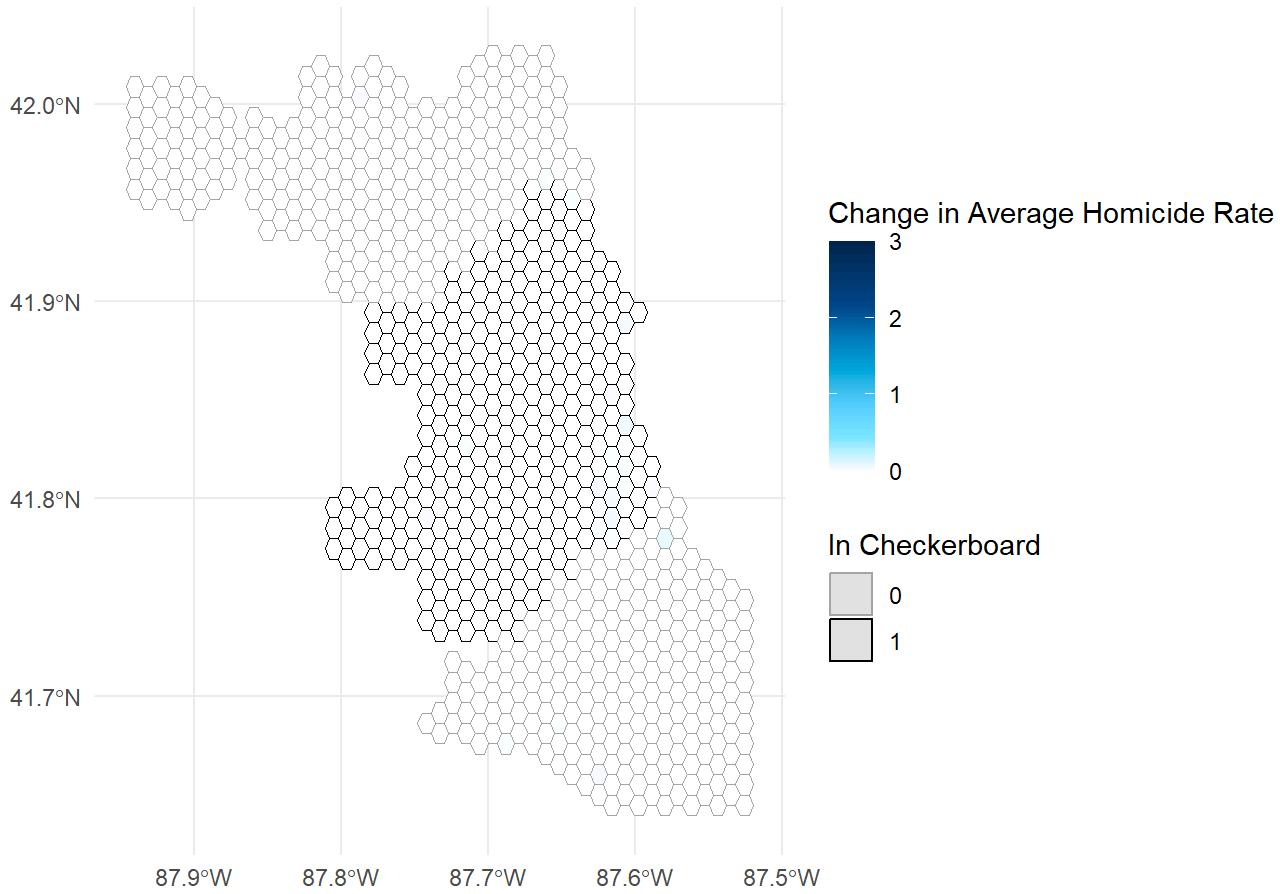
Change in Homicide Rate Between 1926-1930 and 1931-1935



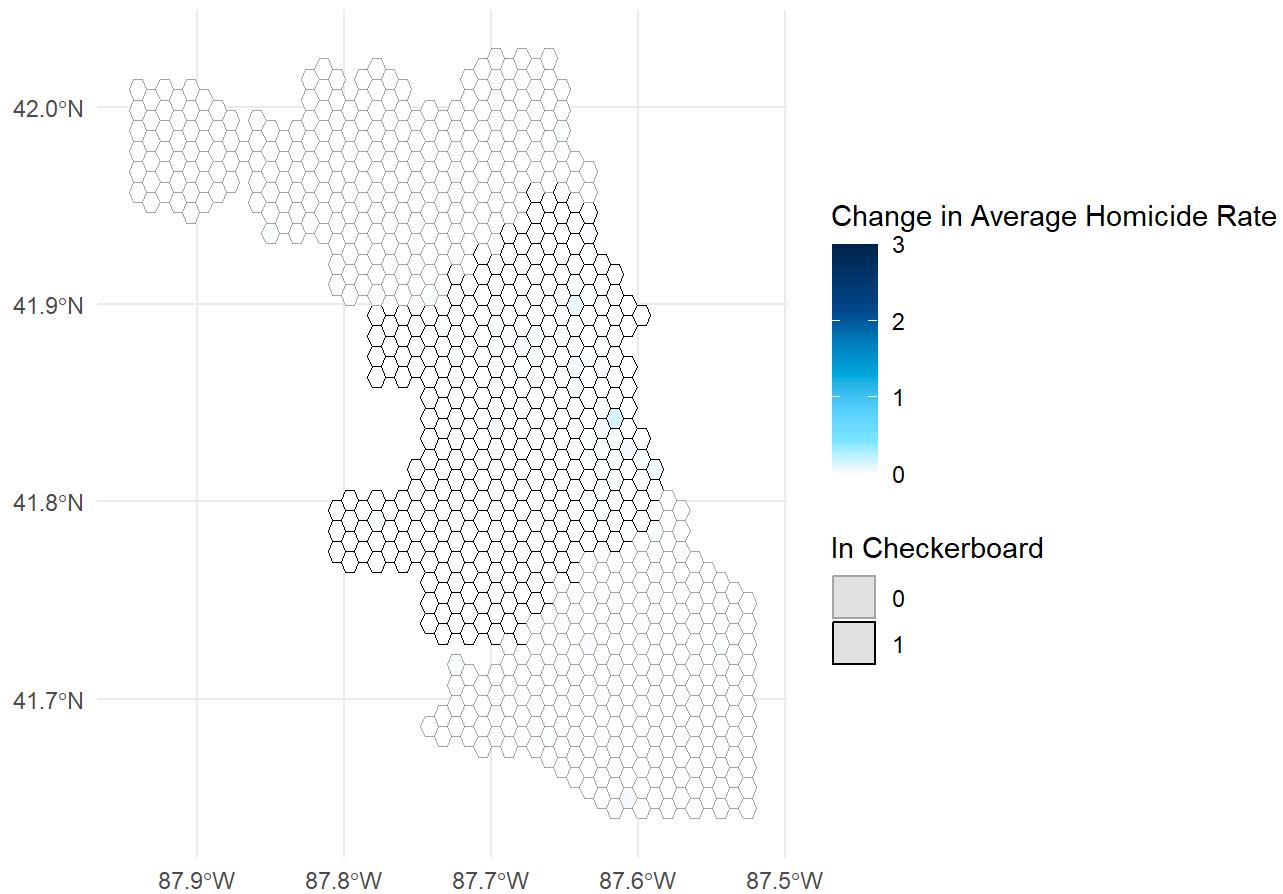
Change in Homicide Rate Between 1931-1935 and 1936-1940



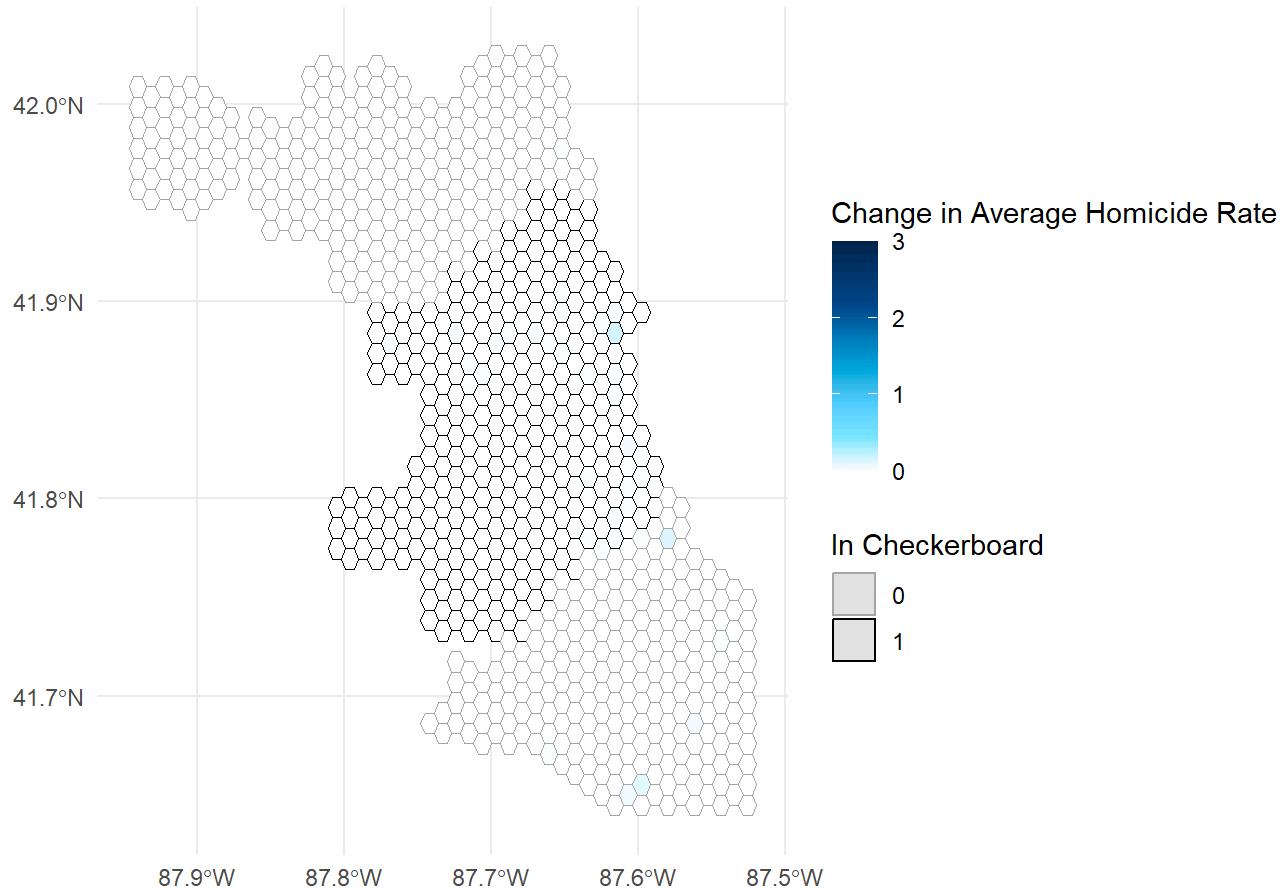
Change in Homicide Rate Between 1936-1940 and 1941-1945



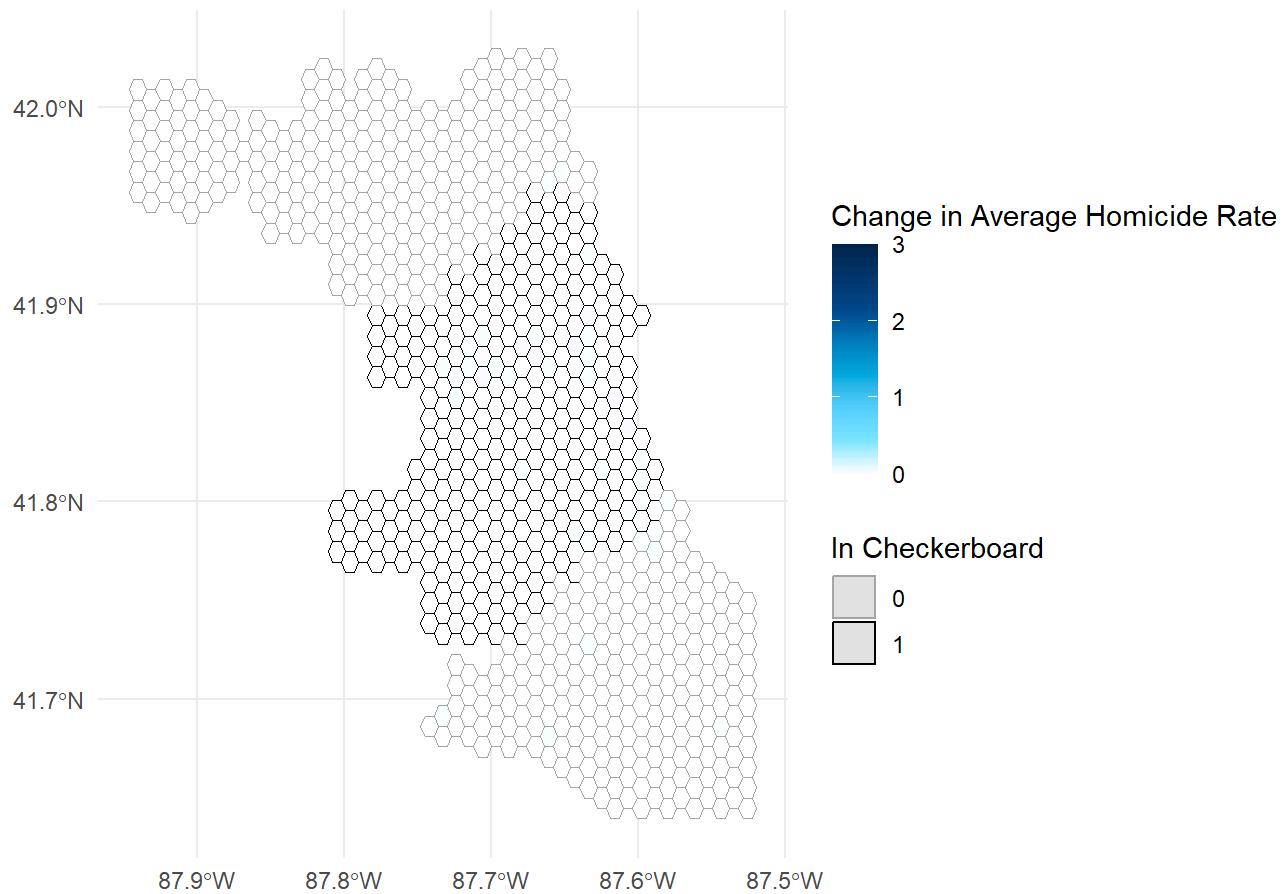
Change in Homicide Rate Between 1941-1945 and 1946-1950



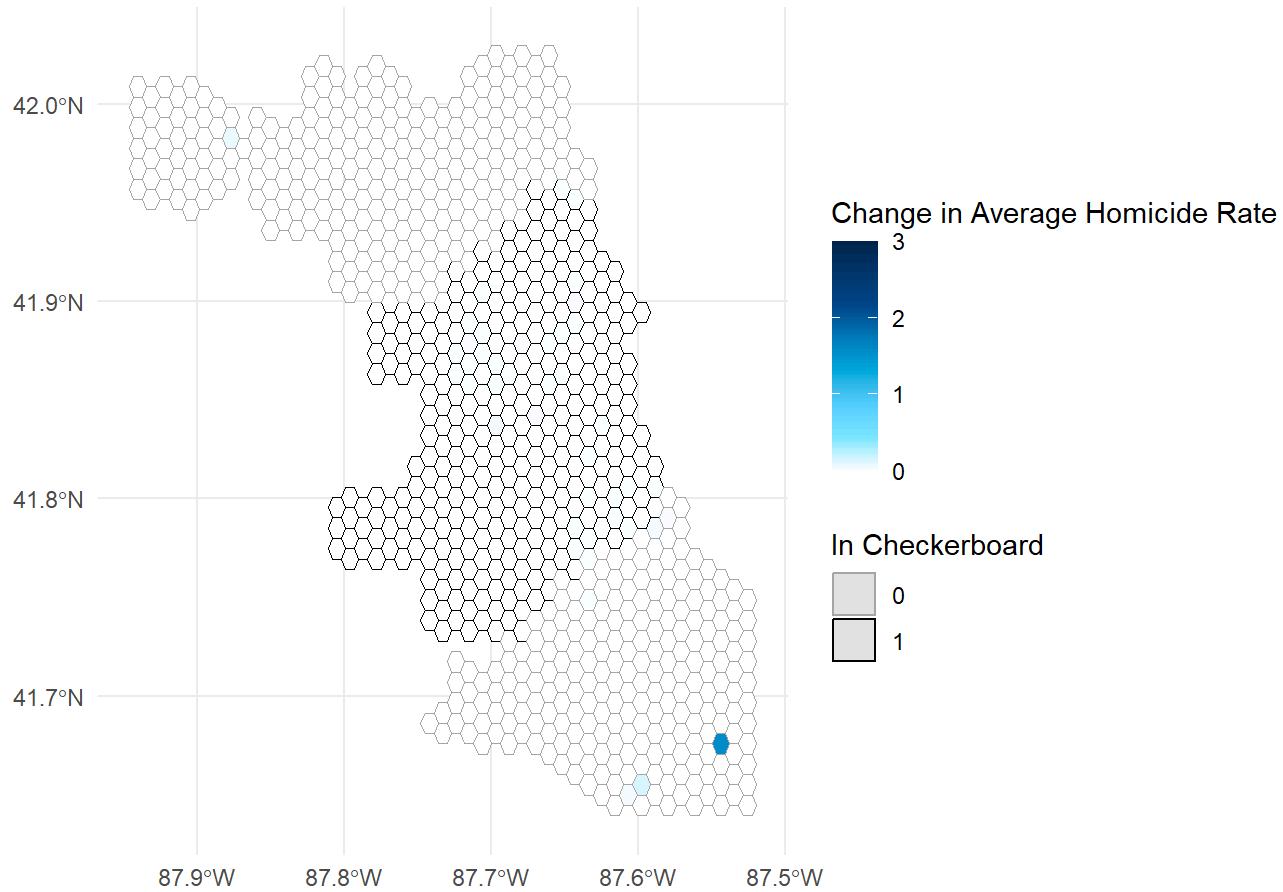
Change in Homicide Rate Between 1946-1950 and 1951-1955



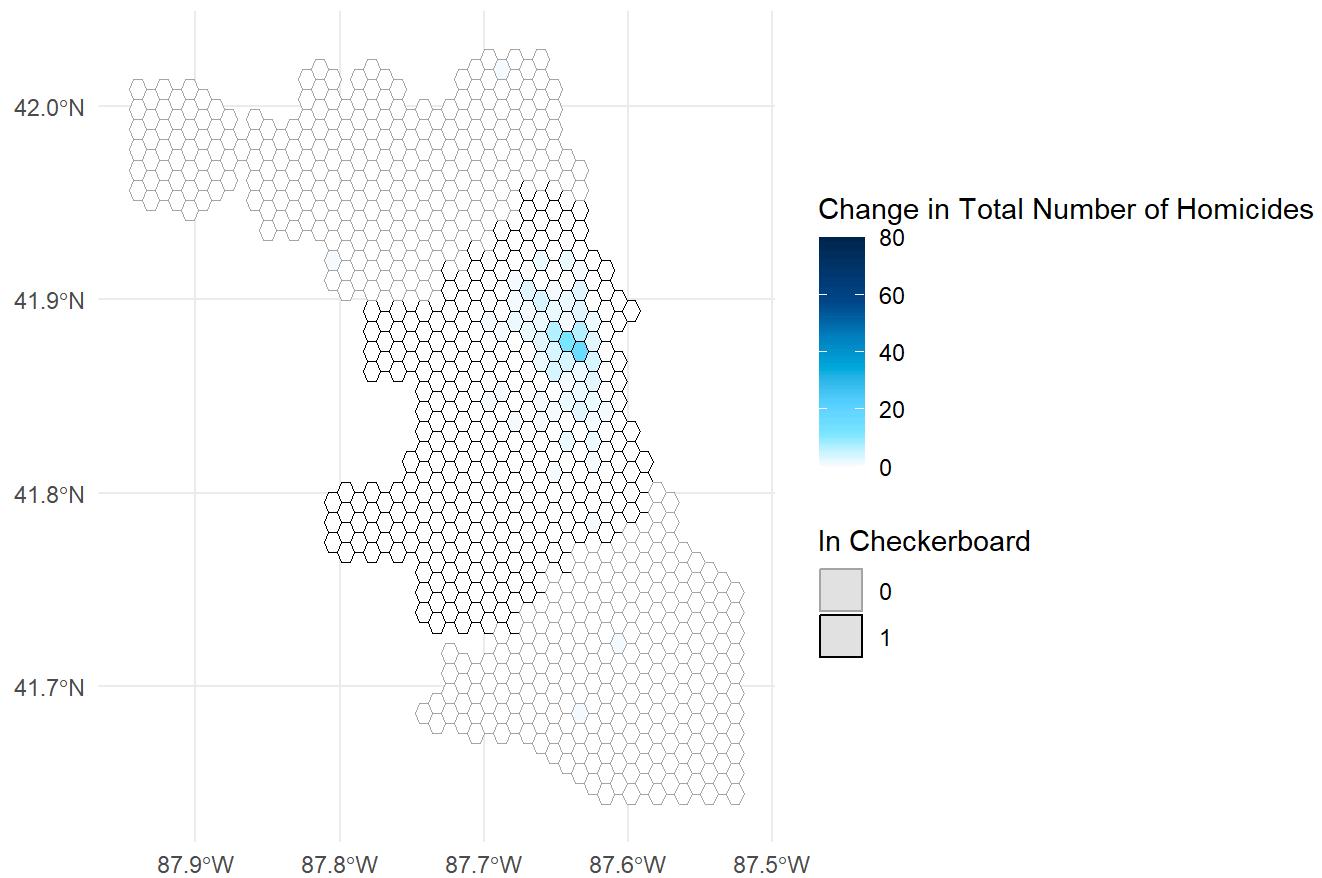
Change in Homicide Rate Between 1951-1955 and 1956-1960



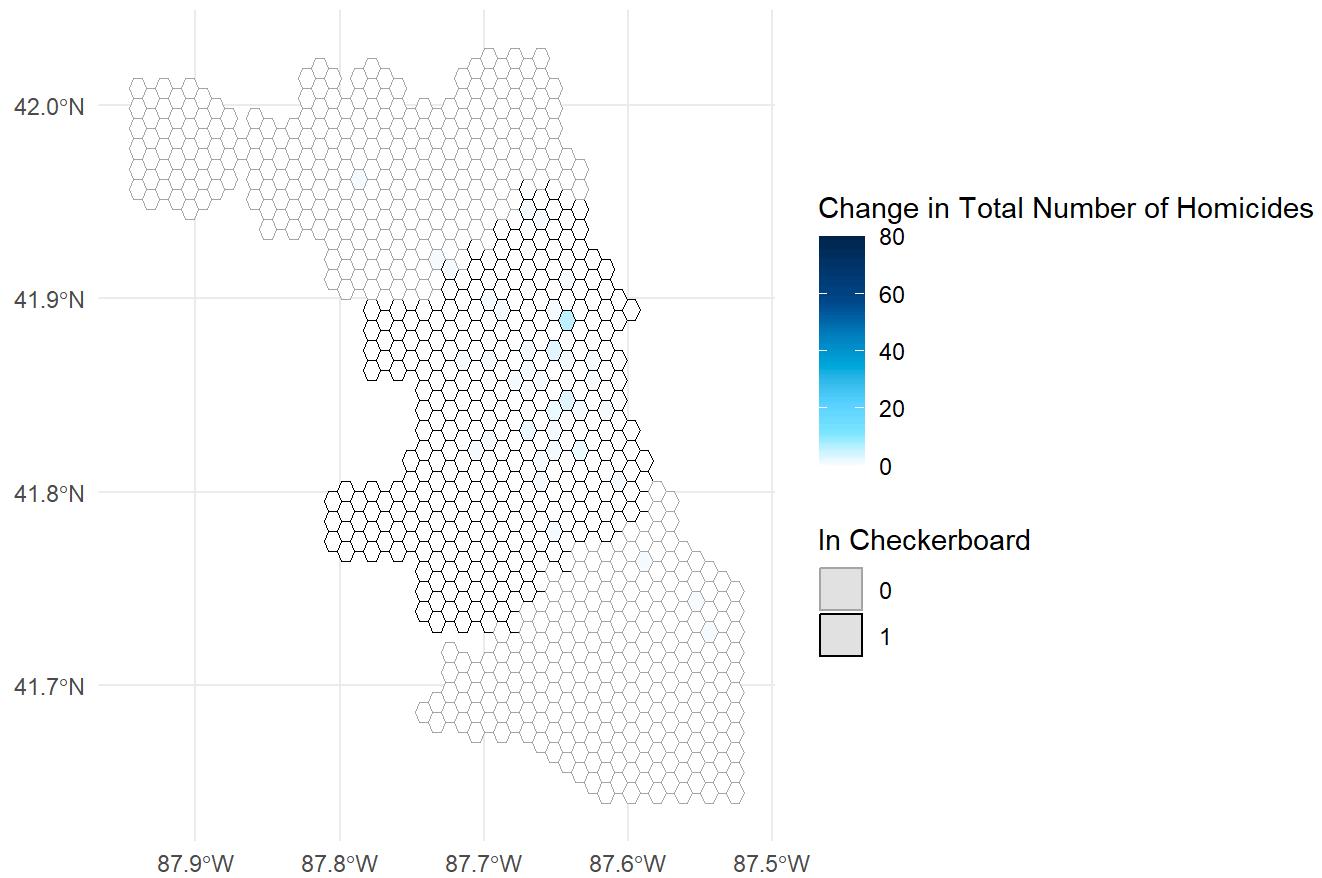
Change in Homicide Rate Between 1956-1960 and 1961-1965



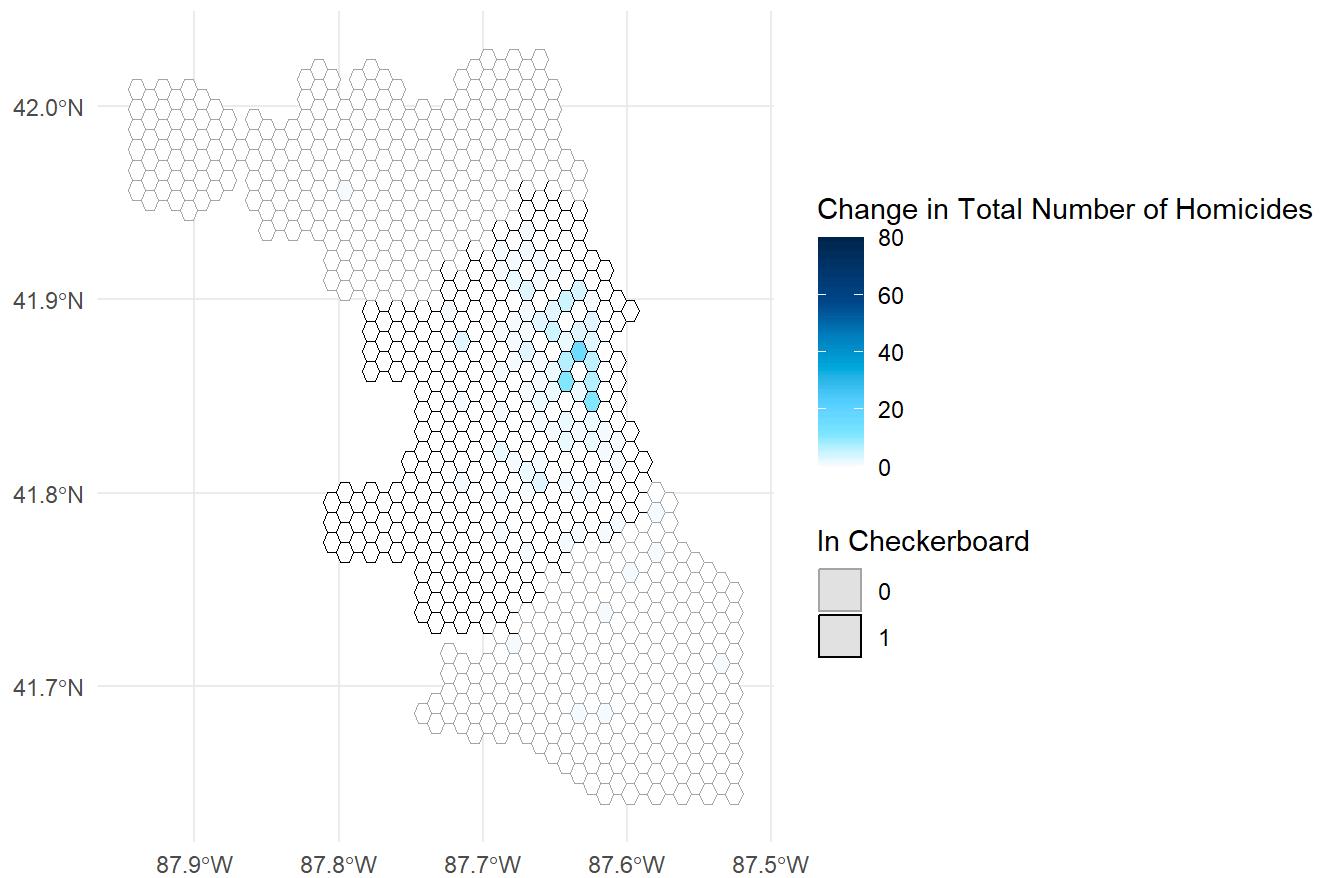
Change in Total Number of Homicides Between 1876-1880 and 1881-1885



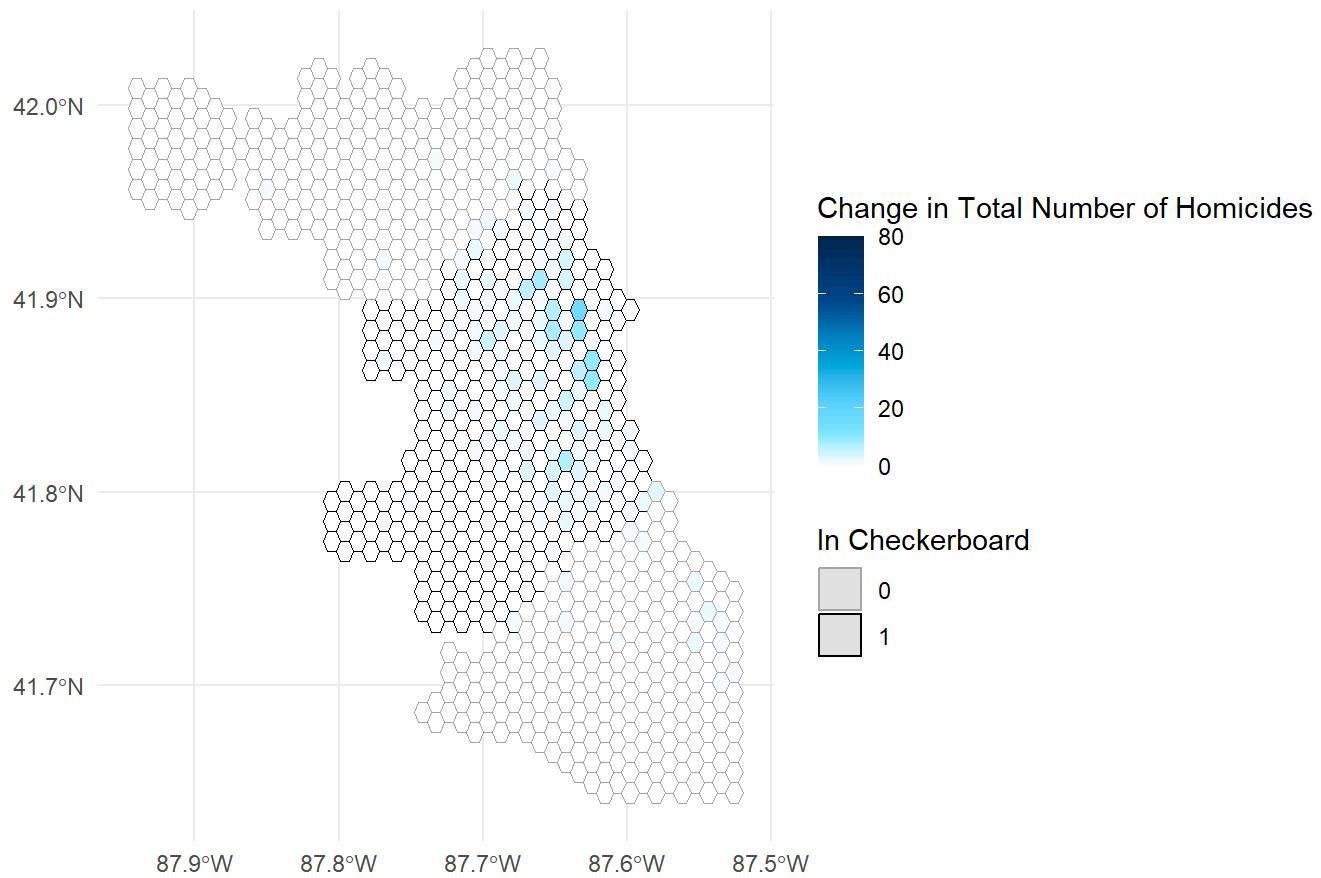
Change in Total Number of Homicides Between 1881-1885 and 1886-1890



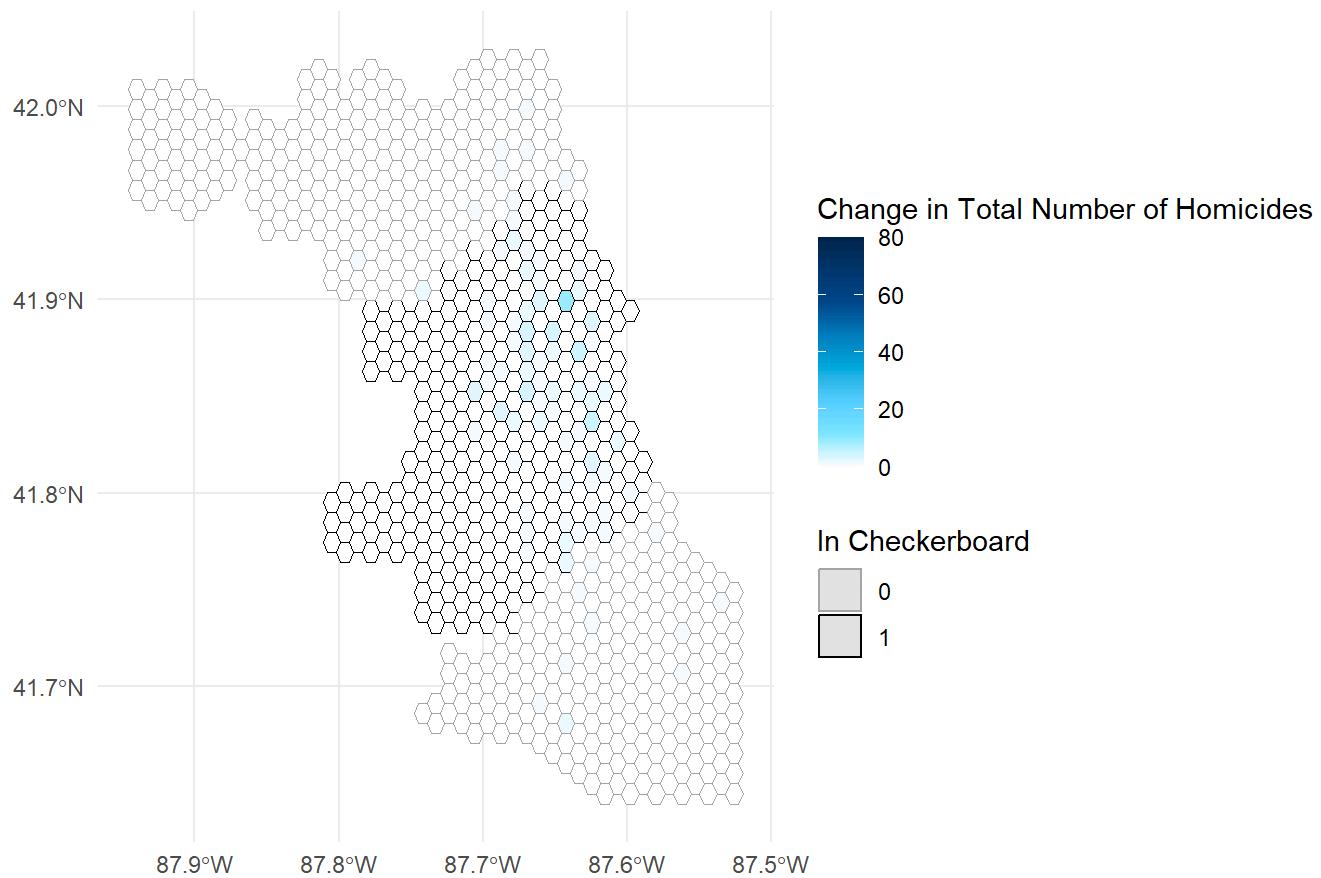
Change in Total Number of Homicides Between 1886-1890 and 1891-1895



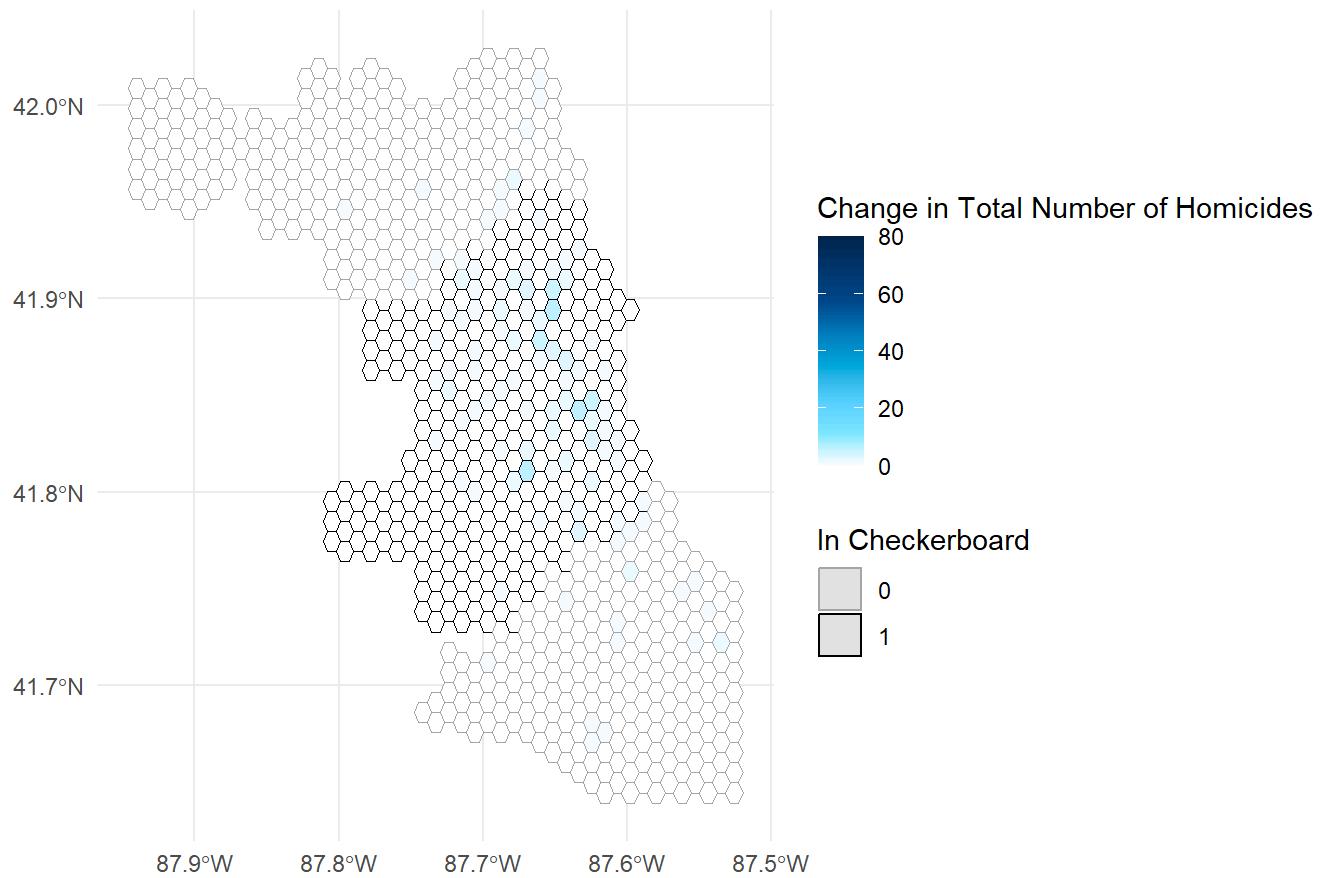
Change in Total Number of Homicides Between 1891-1895 and 1896-1900



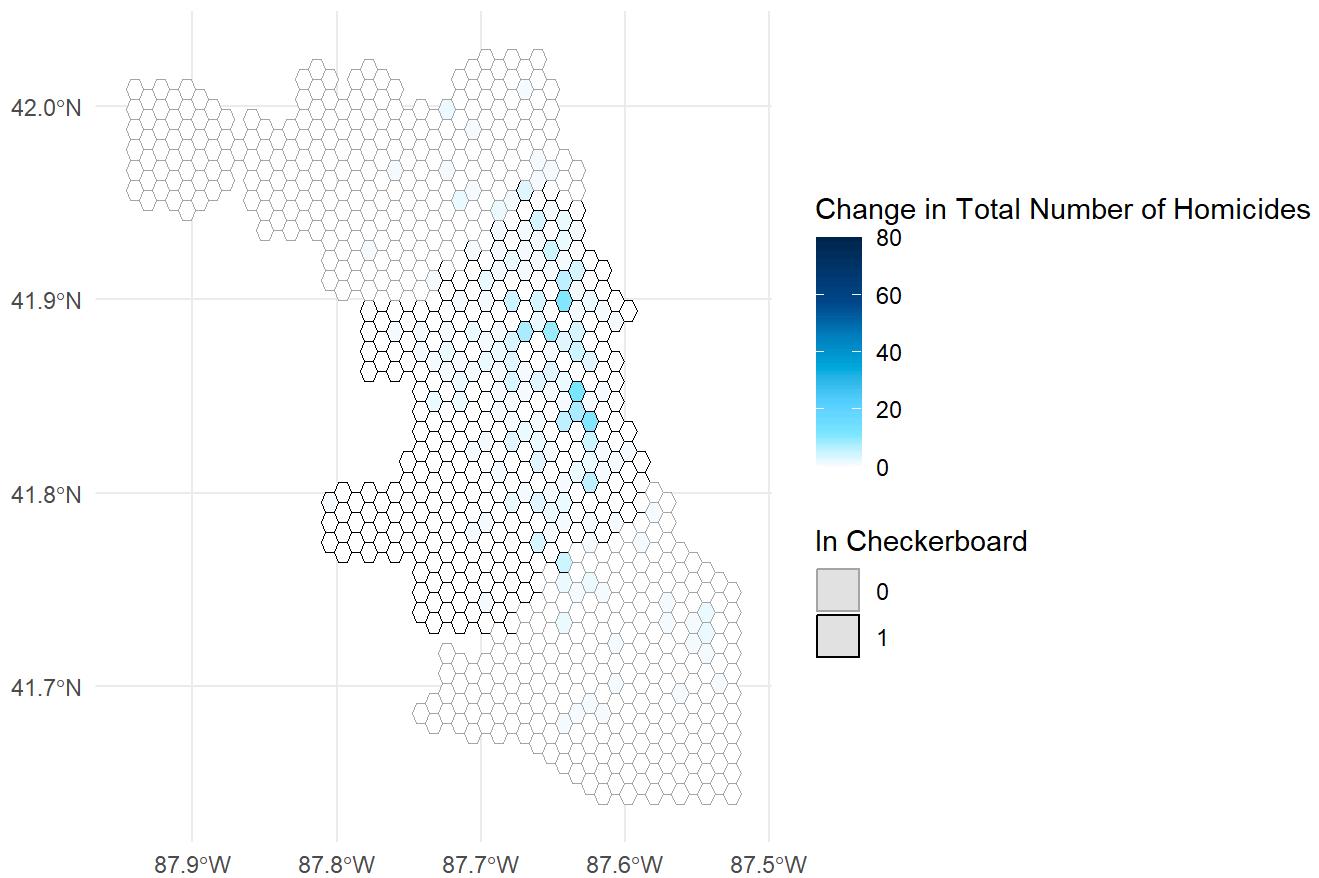
Change in Total Number of Homicides Between 1896-1900 and 1901-1905



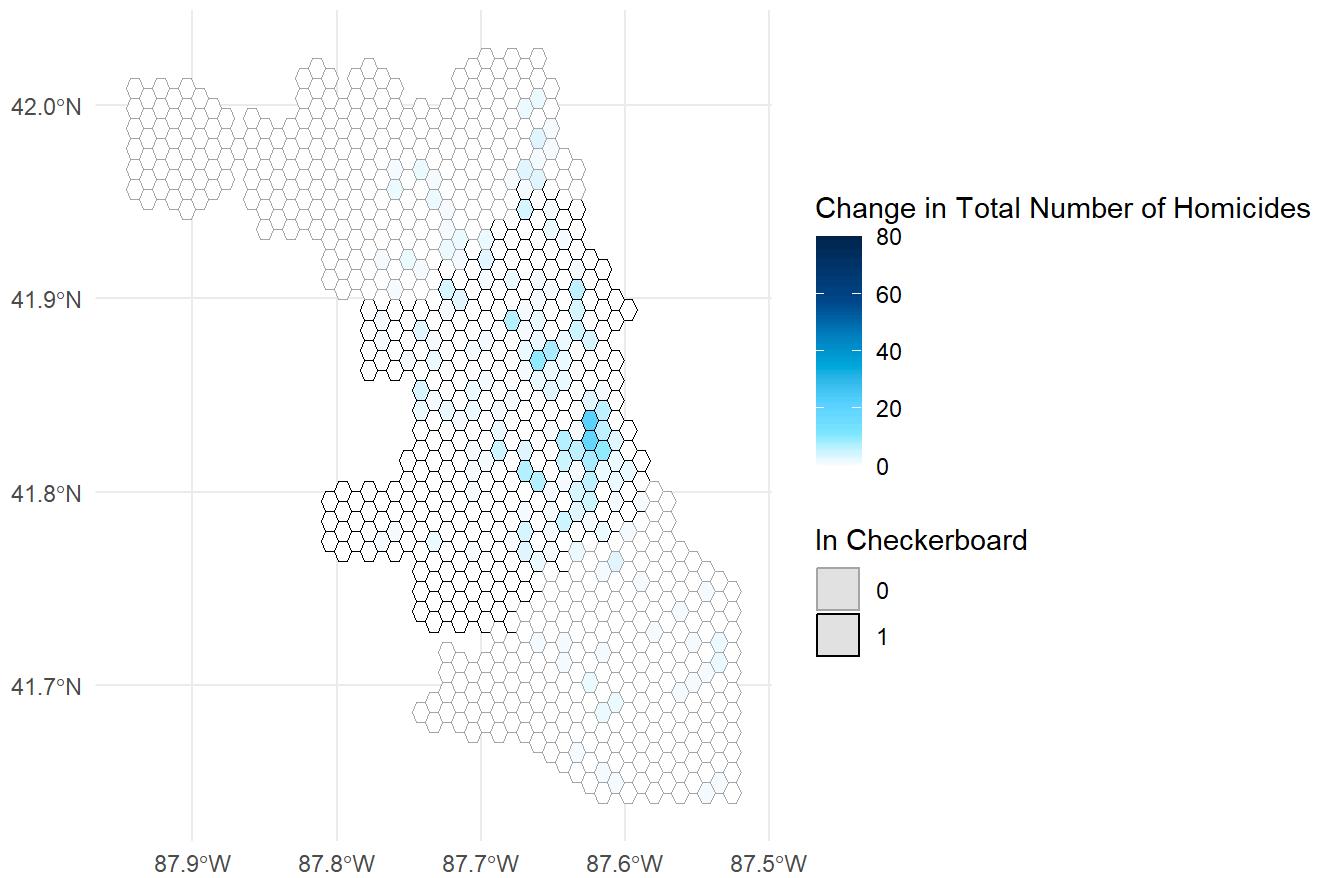
Change in Total Number of Homicides Between 1901-1905 and 1906-1910



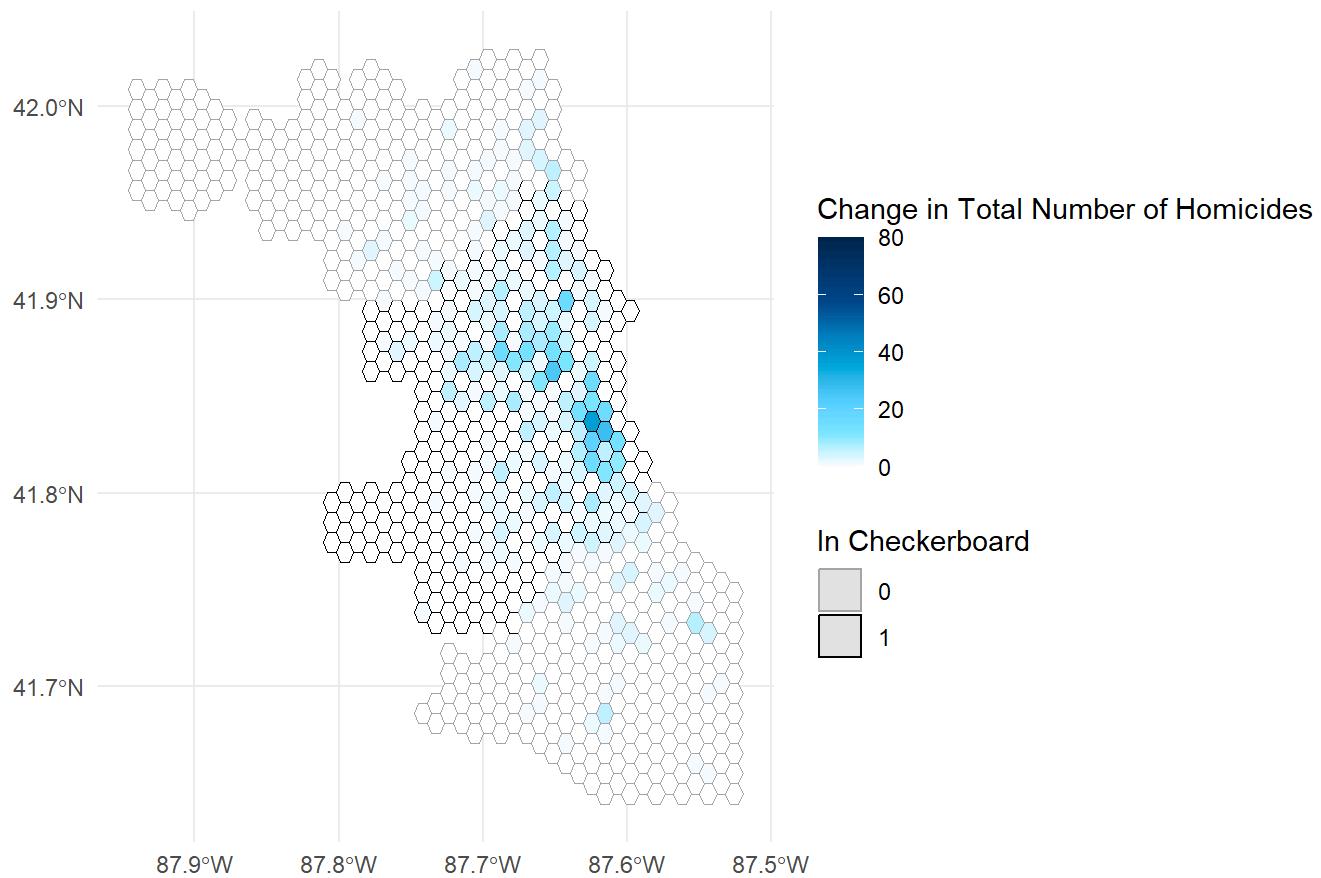
Change in Total Number of Homicides Between 1906-1910 and 1911-1915



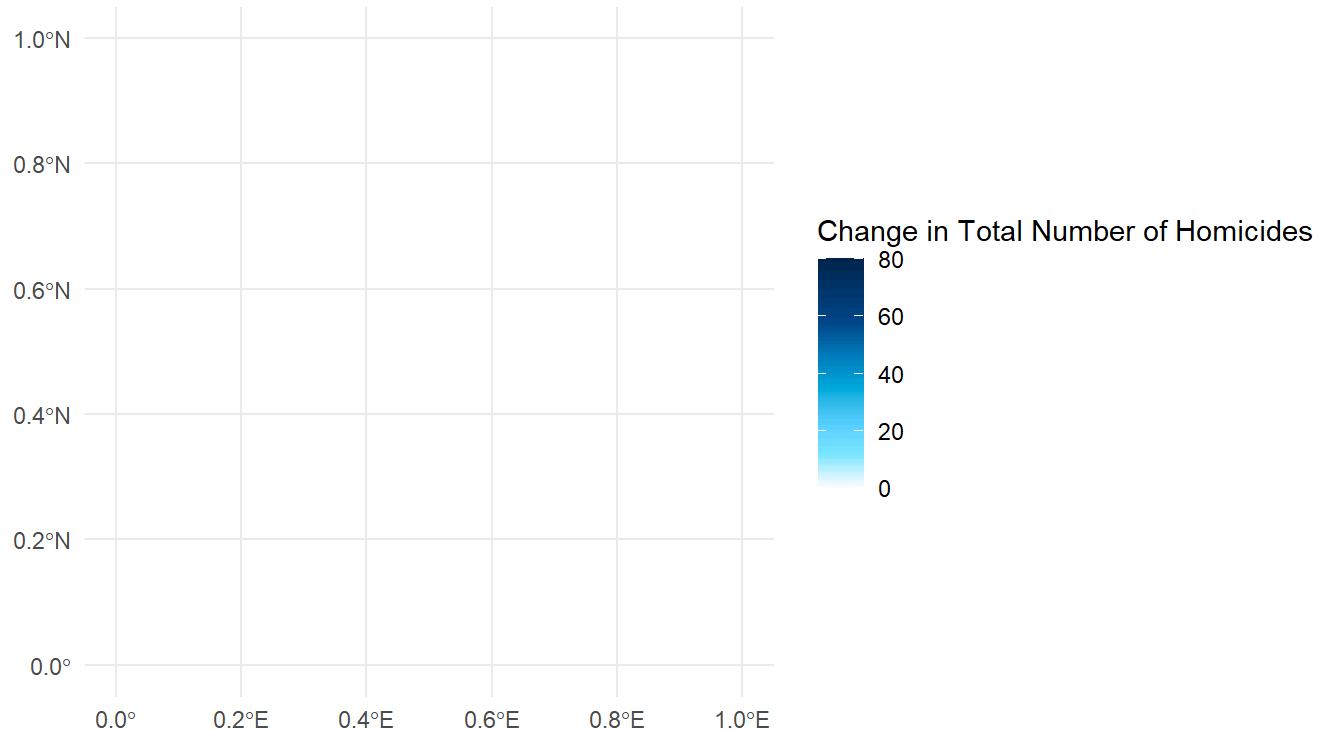
Change in Total Number of Homicides Between 1911-1915 and 1916-1920



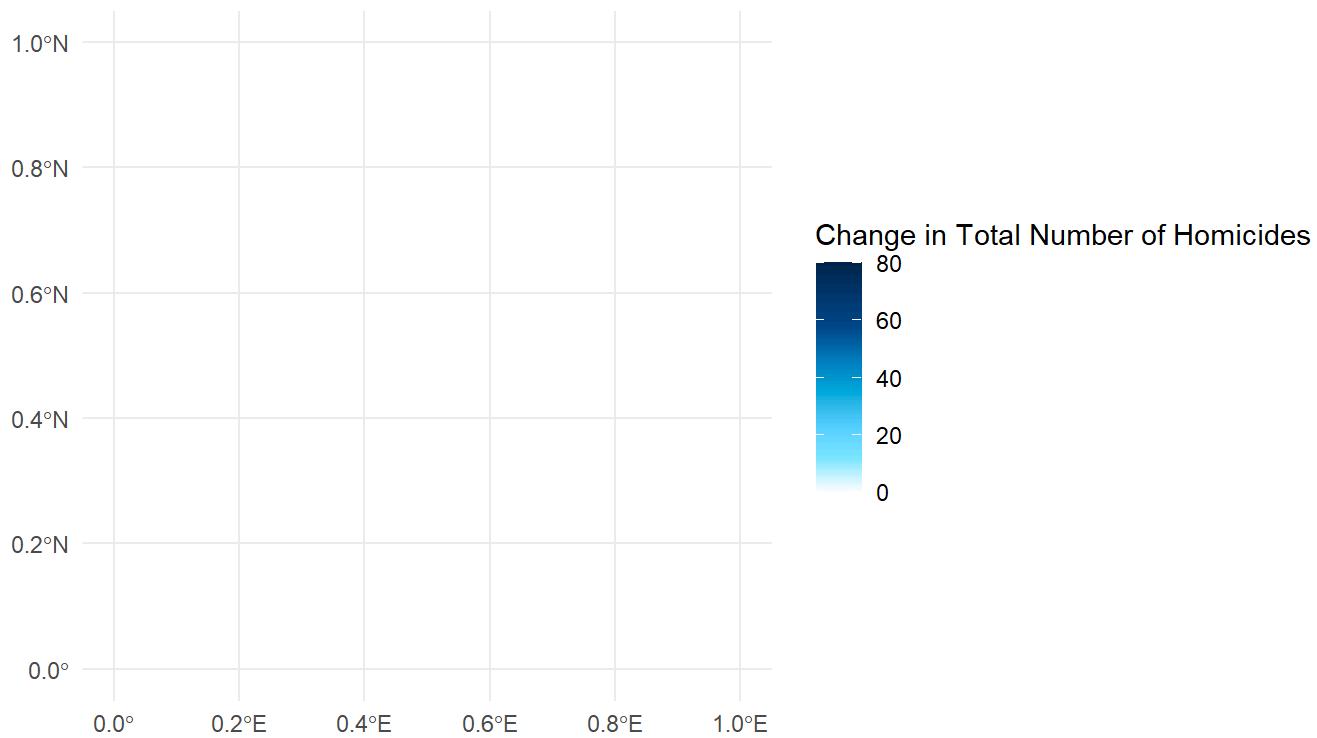
Change in Total Number of Homicides Between 1916-1920 and 1921-1925



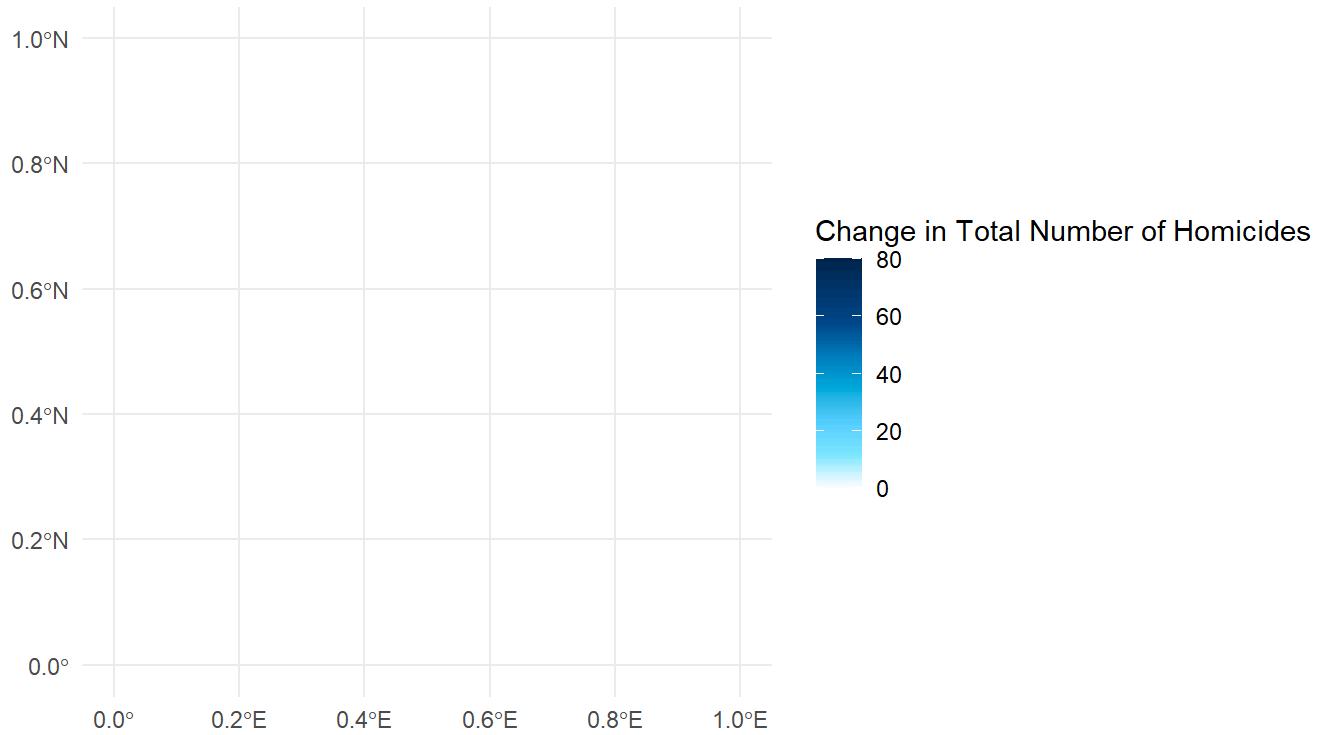
Change in Total Number of Homicides Between 1921-1925 and 1926-1930



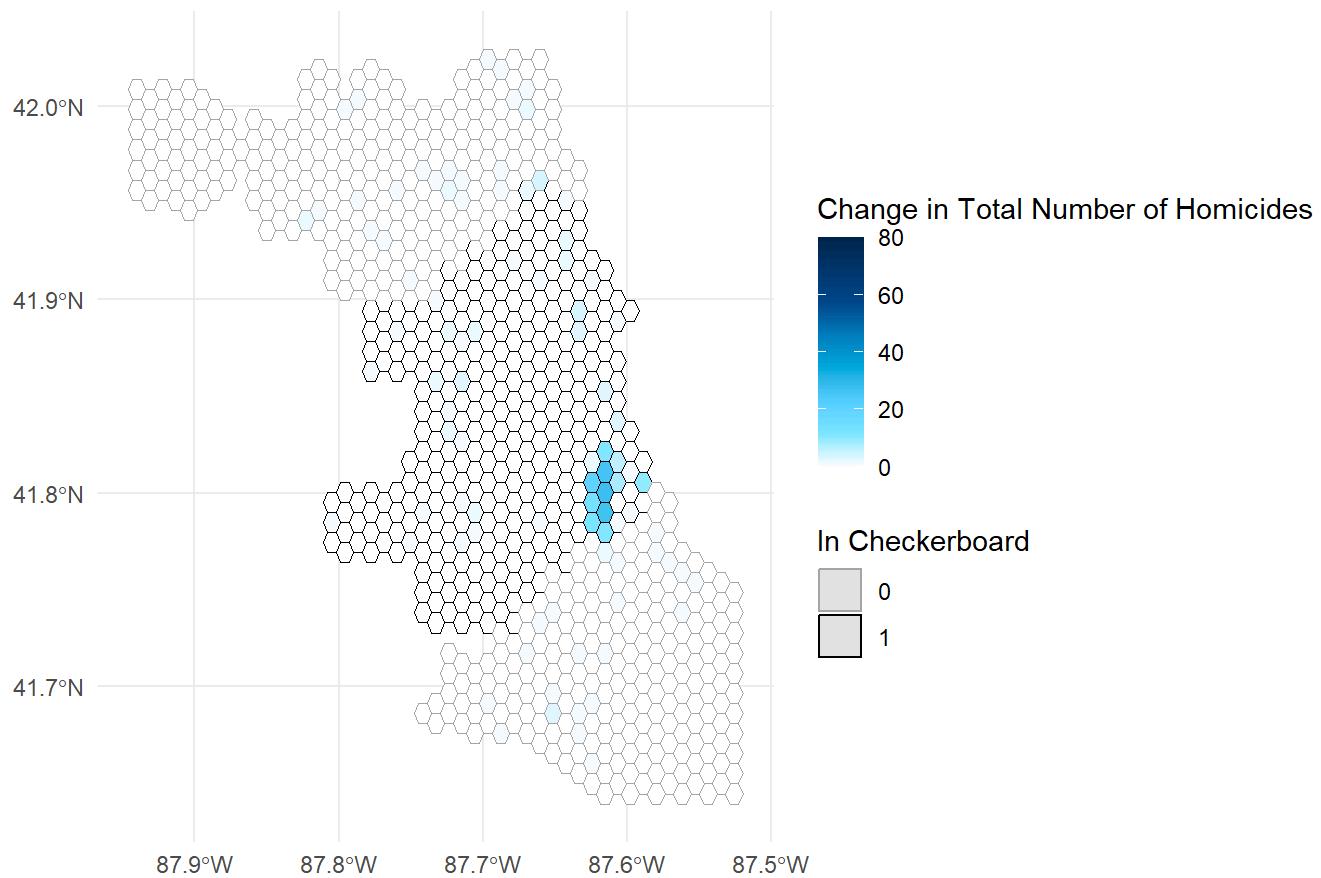
Change in Total Number of Homicides Between 1926-1930 and 1931-1935



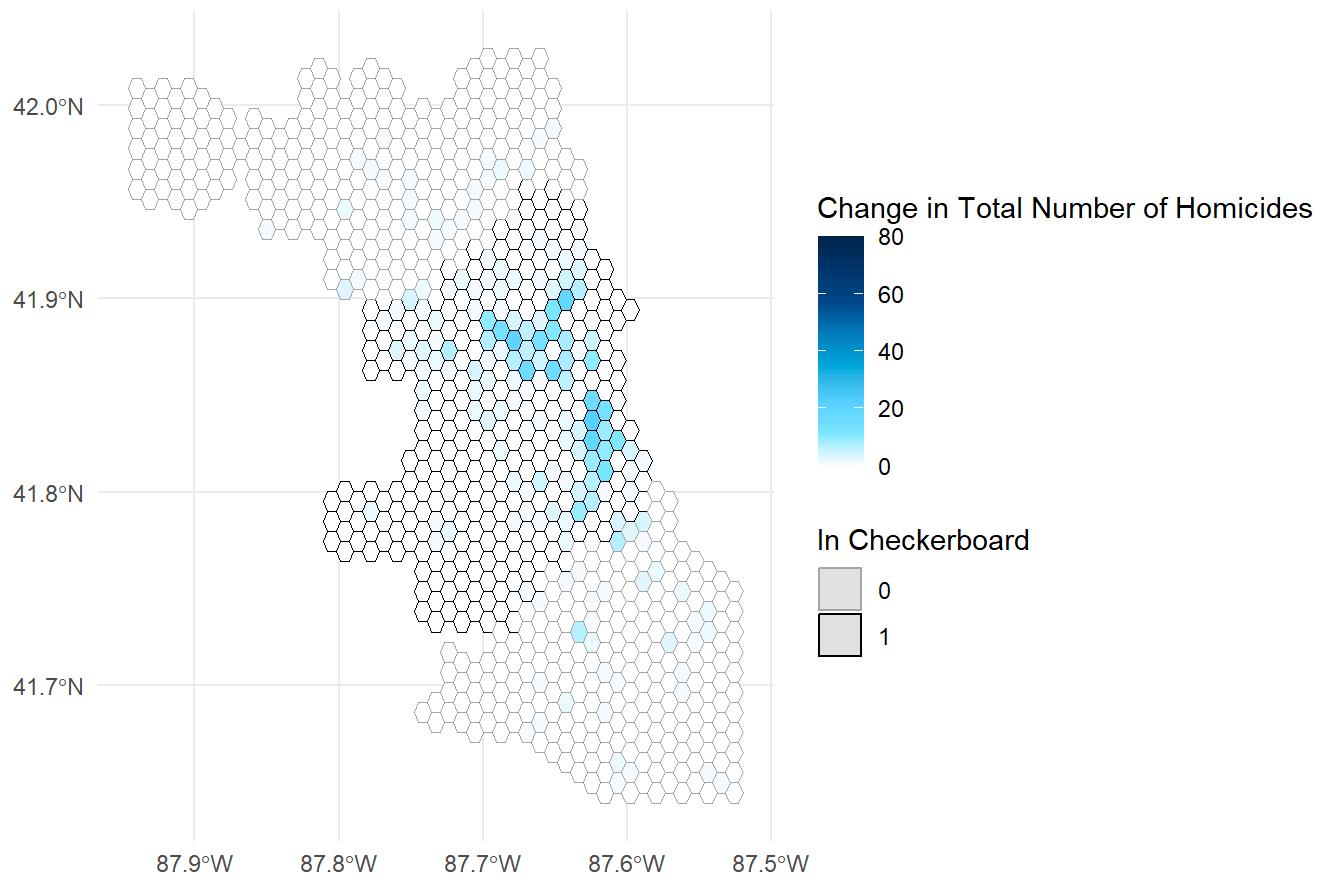
Change in Total Number of Homicides Between 1931-1935 and 1936-1940



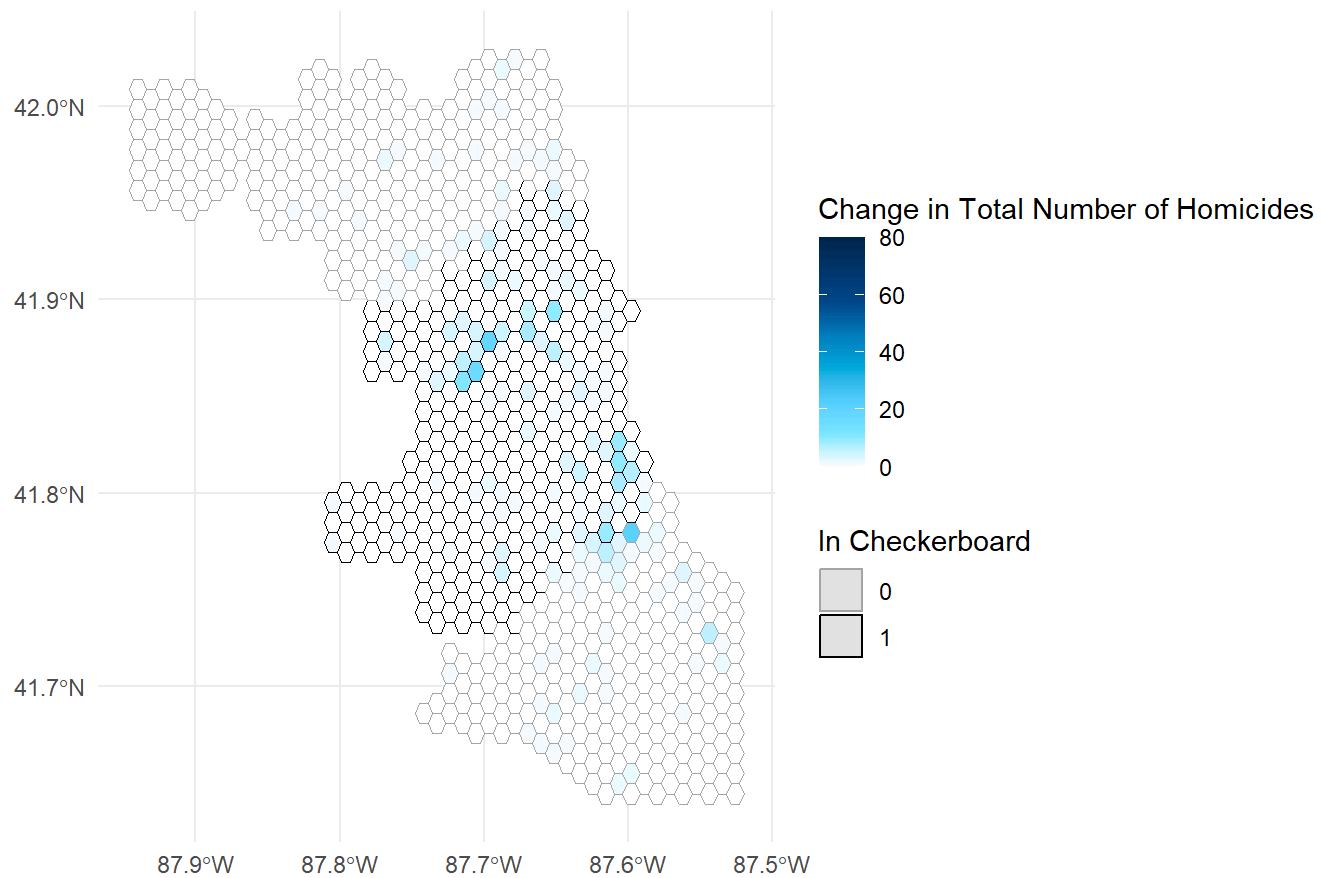
Change in Total Number of Homicides Between 1936-1940 and 1941-1945



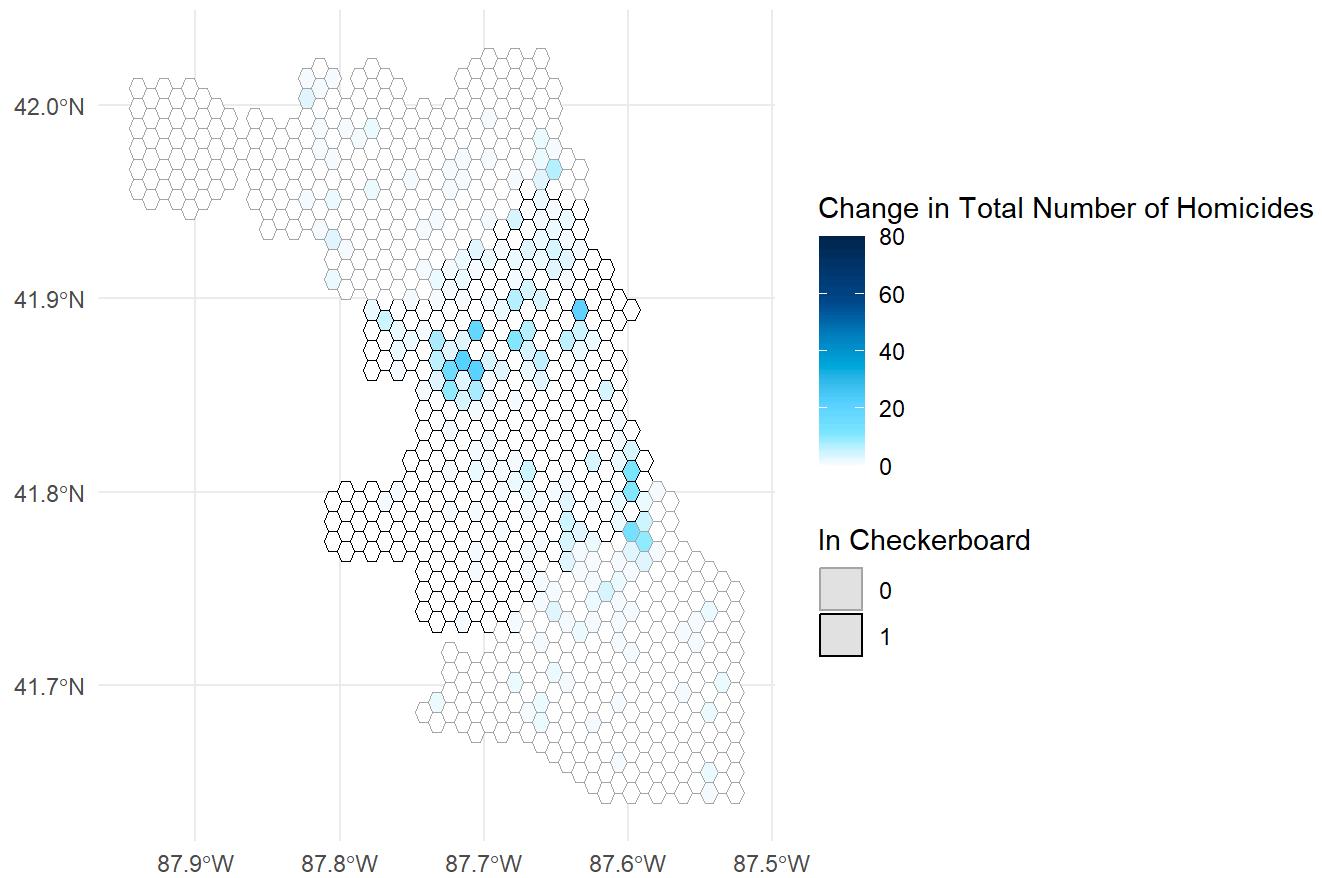
Change in Total Number of Homicides Between 1941-1945 and 1946-1950



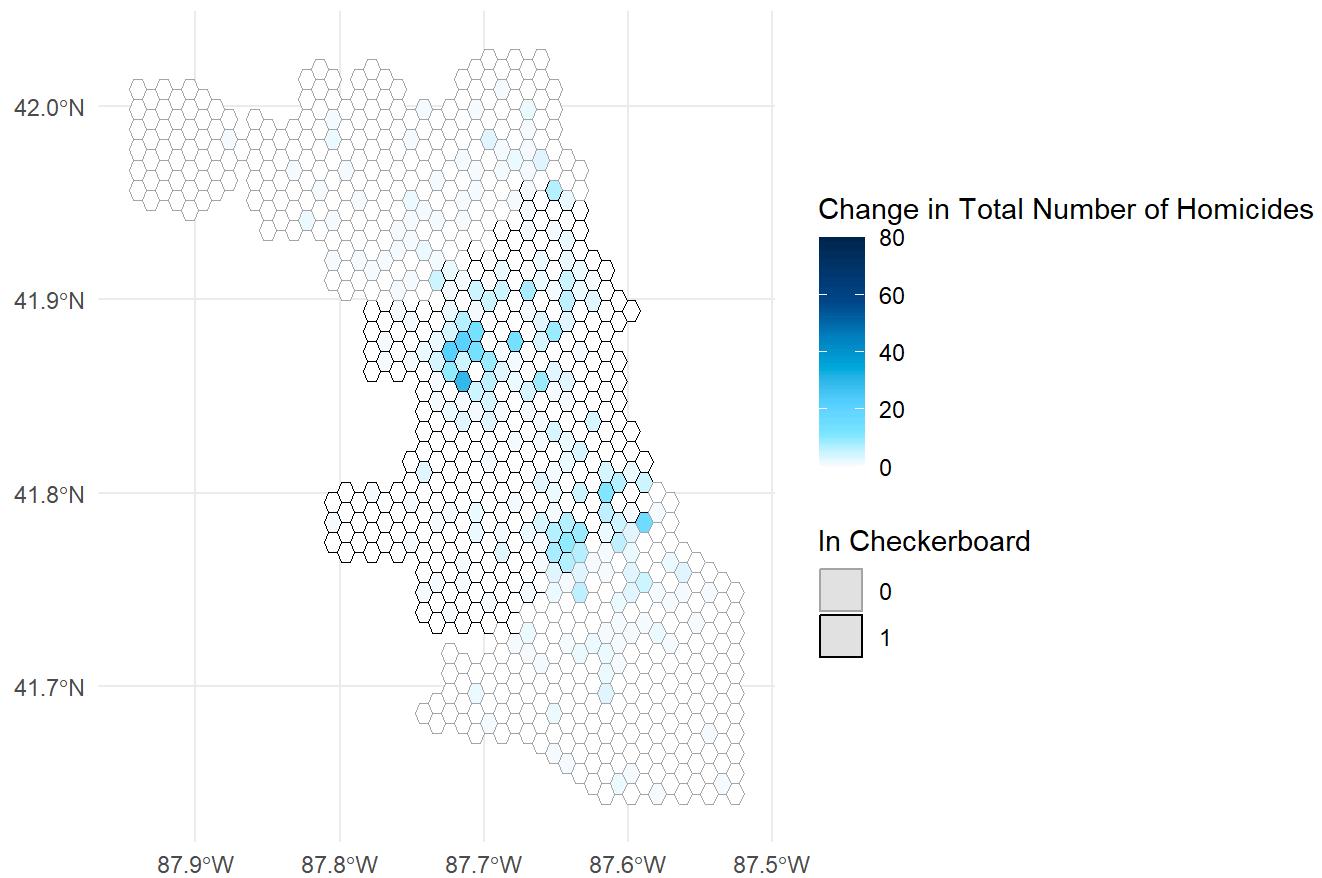
Change in Total Number of Homicides Between 1946-1950 and 1951-1955



Change in Total Number of Homicides Between 1951-1955 and 1956-1960



Change in Total Number of Homicides Between 1956-1960 and 1961-1965



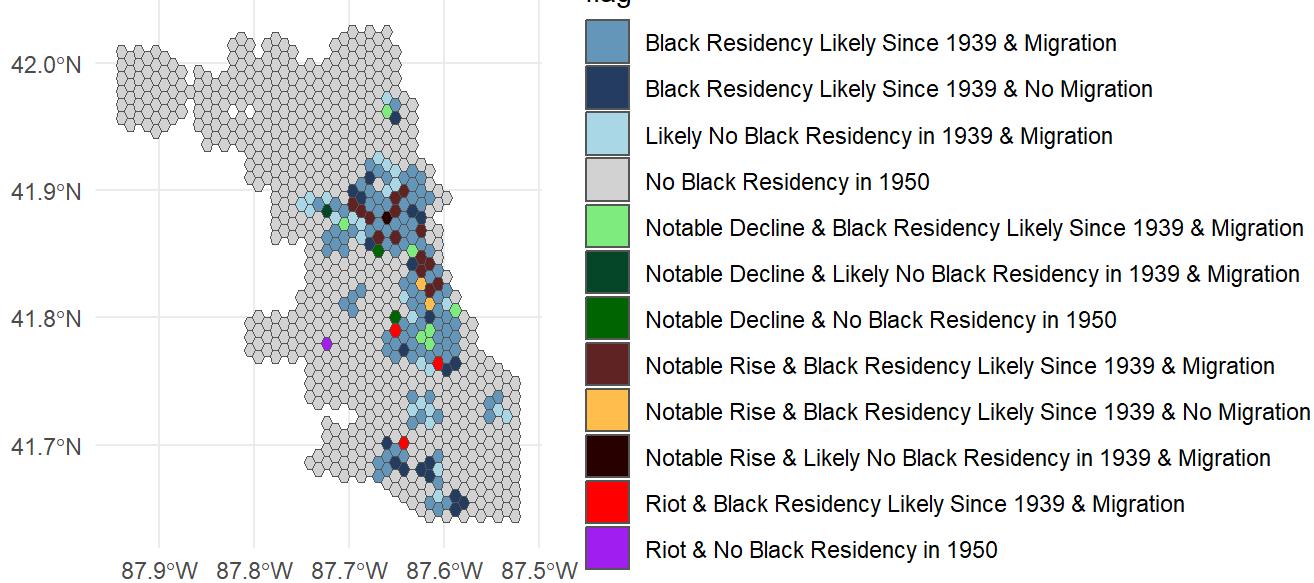
Notable Changes (Upper 10% of Rises or Declines in

a Given Year)

1950s - 1960s

Change in Total Number of Homicides Between 1941-1945 and 1946-1950

Intersection with Black Residency as of 1939 and 1950 & Riot in 1946-1950
flag



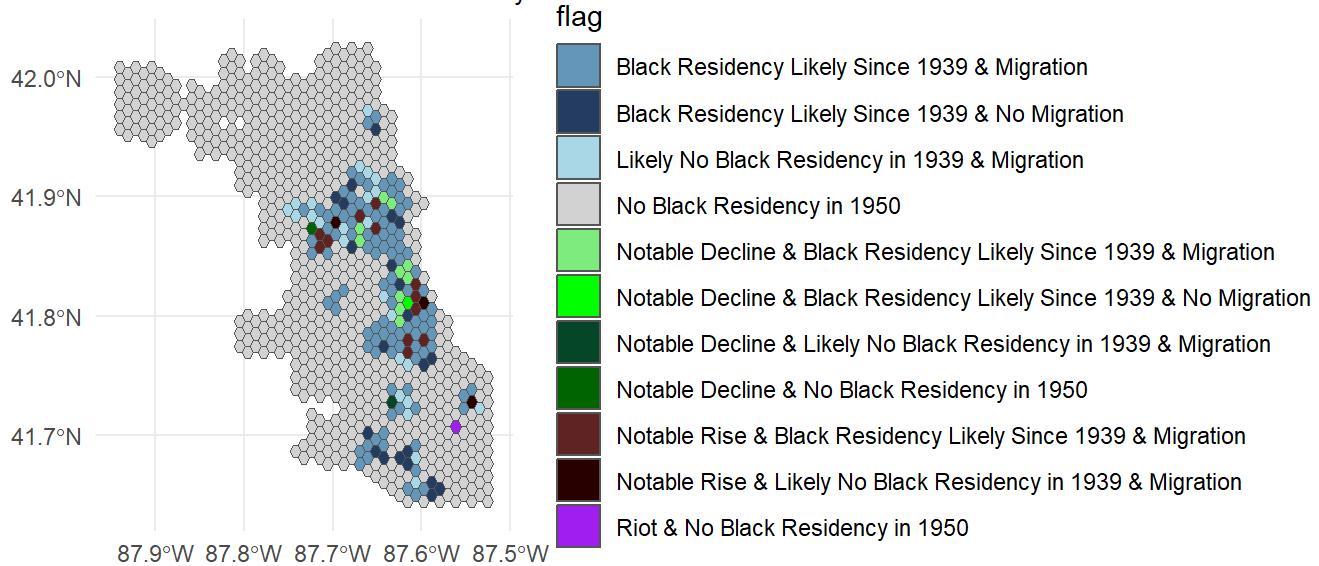
flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	98
Black Residency Likely Since 1939 & No Migration	21
Likely No Black Residency in 1939 & Migration	27
No Black Residency in 1950	644
Notable Decline & Black Residency Likely Since 1939 & Migration	7
Notable Decline & Likely No Black Residency in 1939 & Migration	1
Notable Decline & No Black Residency in 1950	2
Notable Rise & Black Residency Likely Since 1939 & Migration	14
Notable Rise & Black Residency Likely Since 1939 & No Migration	2
Notable Rise & Likely No Black Residency in 1939 & Migration	1

1-10 of 12 rows

Previous 1 2 Next

Change in Total Number of Homicides Between 1946-1950 and 1951-1955

Intersection with Black Residency as of 1939 and 1950 & Riot in 1951-1955



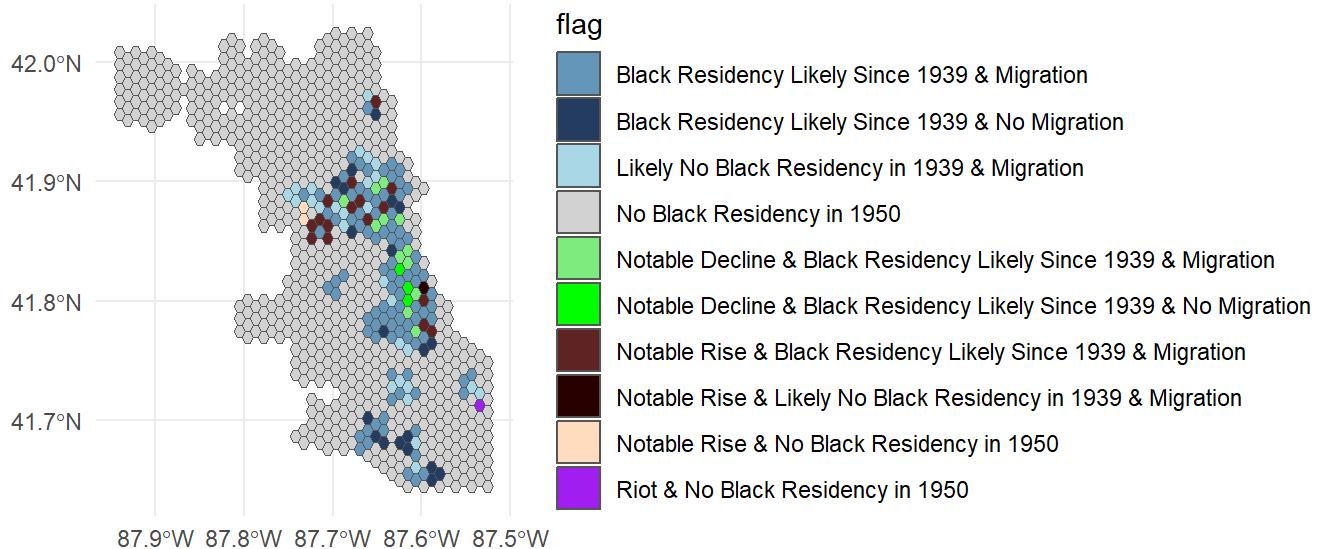
flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	100
Black Residency Likely Since 1939 & No Migration	22
Likely No Black Residency in 1939 & Migration	25
No Black Residency in 1950	645
Notable Decline & Black Residency Likely Since 1939 & Migration	10
Notable Decline & Black Residency Likely Since 1939 & No Migration	1
Notable Decline & Likely No Black Residency in 1939 & Migration	1
Notable Decline & No Black Residency in 1950	1
Notable Rise & Black Residency Likely Since 1939 & Migration	12
Notable Rise & Likely No Black Residency in 1939 & Migration	3

1-10 of 11 rows

Previous 1 2 Next

Change in Total Number of Homicides Between 1951-1955 and 1956-1960

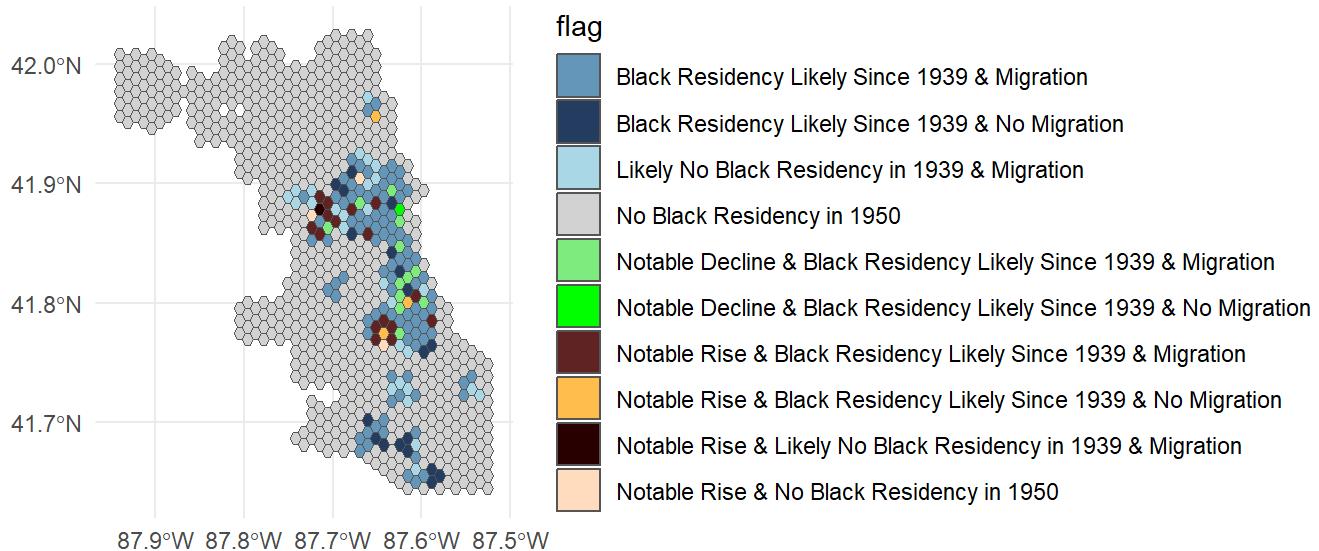
Intersection with Black Residency as of 1939 and 1950 & Riot in 1956-1960



flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	94
Black Residency Likely Since 1939 & No Migration	20
Likely No Black Residency in 1939 & Migration	28
No Black Residency in 1950	644
Notable Decline & Black Residency Likely Since 1939 & Migration	12
Notable Decline & Black Residency Likely Since 1939 & No Migration	3
Notable Rise & Black Residency Likely Since 1939 & Migration	16
Notable Rise & Likely No Black Residency in 1939 & Migration	1
Notable Rise & No Black Residency in 1950	2
Riot & No Black Residency in 1950	1
1-10 of 10 rows	

Change in Total Number of Homicides Between 1956-1960 and 1961-1965

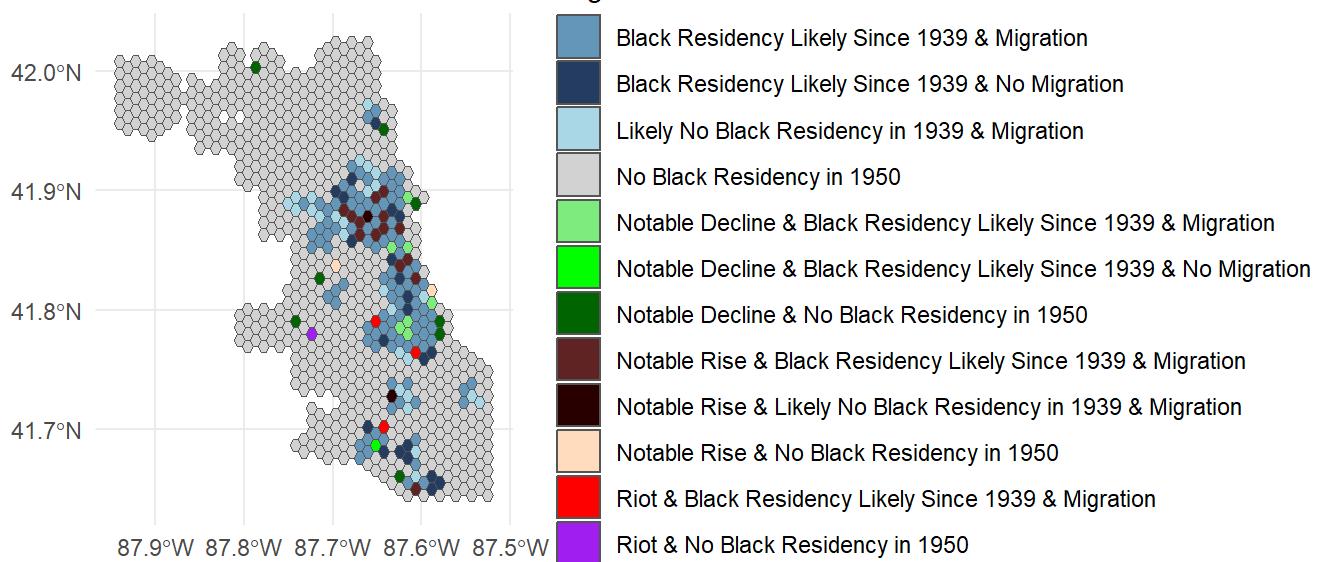
Intersection with Black Residency as of 1939 and 1950 & Riot in 1961-1965



flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	94
Black Residency Likely Since 1939 & No Migration	19
Likely No Black Residency in 1939 & Migration	28
No Black Residency in 1950	644
Notable Decline & Black Residency Likely Since 1939 & Migration	12
Notable Decline & Black Residency Likely Since 1939 & No Migration	1
Notable Rise & Black Residency Likely Since 1939 & Migration	16
Notable Rise & Black Residency Likely Since 1939 & No Migration	3
Notable Rise & Likely No Black Residency in 1939 & Migration	1
Notable Rise & No Black Residency in 1950	3
1-10 of 10 rows	

Change in Average Homicide Rate Between 1941-1945 and 1946-1950

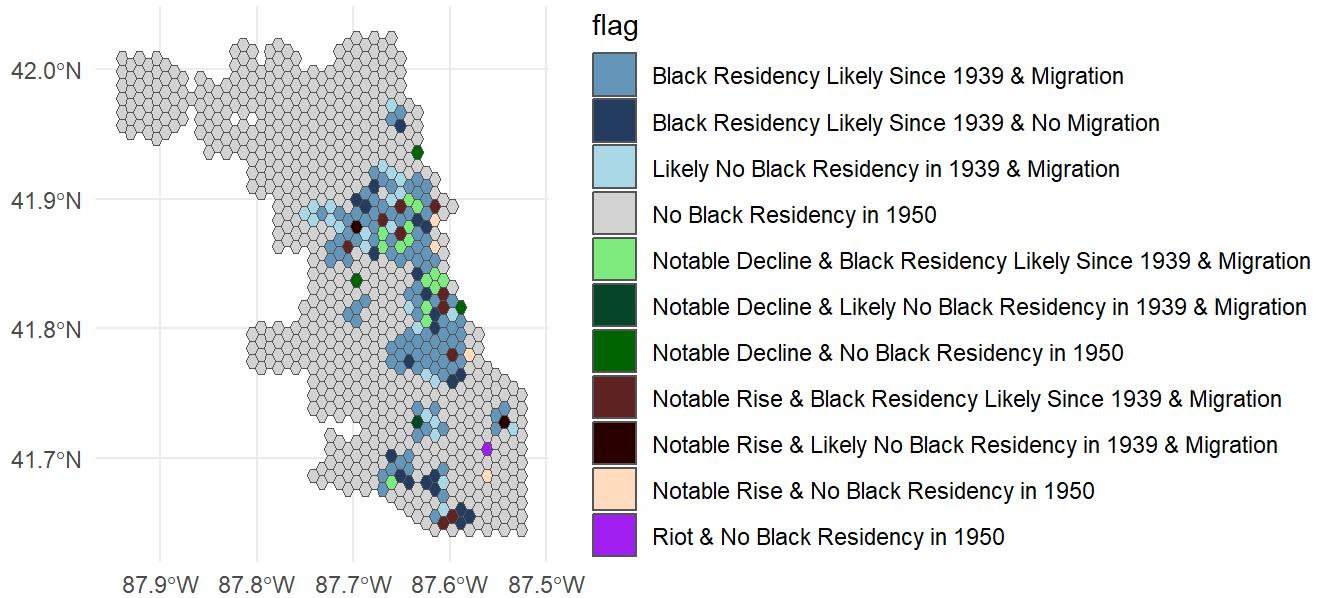
Intersection with Black Residency as of 1939 and 1950 & Riot in 1946-1950



flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	98
Black Residency Likely Since 1939 & No Migration	22
Likely No Black Residency in 1939 & Migration	27
No Black Residency in 1950	636
Notable Decline & Black Residency Likely Since 1939 & Migration	7
Notable Decline & Black Residency Likely Since 1939 & No Migration	1
Notable Decline & No Black Residency in 1950	8
Notable Rise & Black Residency Likely Since 1939 & Migration	14
Notable Rise & Likely No Black Residency in 1939 & Migration	2
Notable Rise & No Black Residency in 1950	2
1-10 of 12 rows	Previous 1 2 Next

Change in Average Homicide Rate Between 1946-1950 and 1951-1955

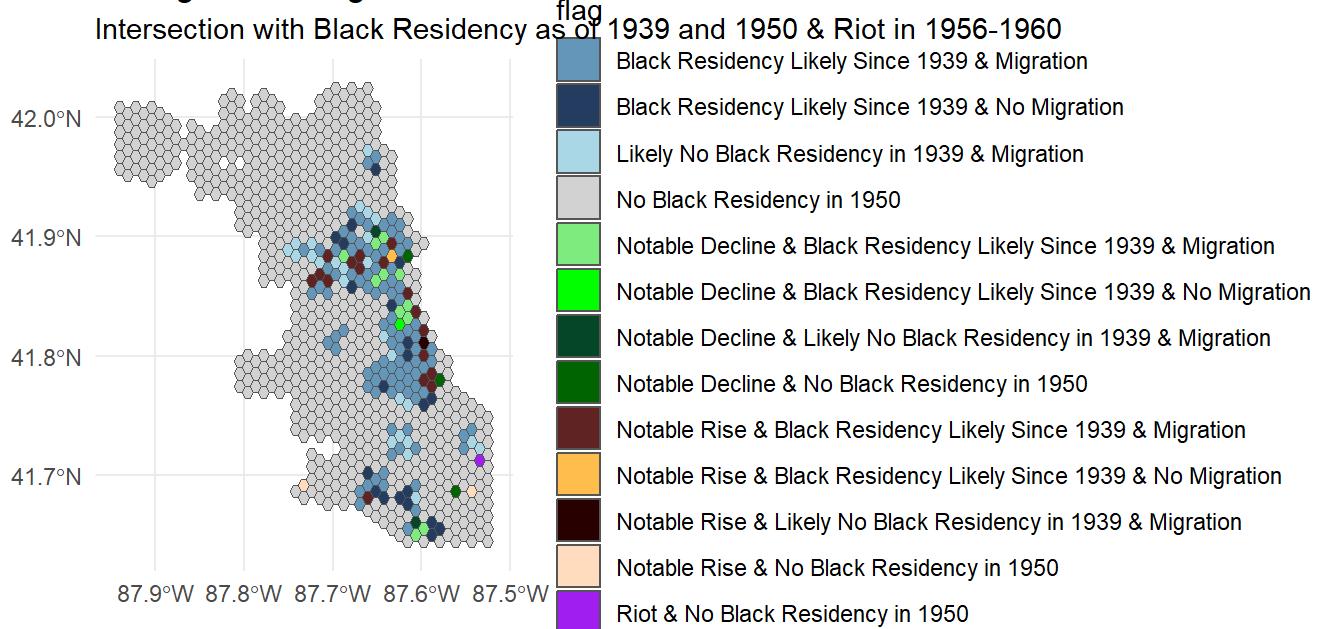
Intersection with Black Residency as of 1939 and 1950 & Riot in 1951-1955



flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	98
Black Residency Likely Since 1939 & No Migration	23
Likely No Black Residency in 1939 & Migration	26
No Black Residency in 1950	639
Notable Decline & Black Residency Likely Since 1939 & Migration	14
Notable Decline & Likely No Black Residency in 1939 & Migration	1
Notable Decline & No Black Residency in 1950	3
Notable Rise & Black Residency Likely Since 1939 & Migration	10
Notable Rise & Likely No Black Residency in 1939 & Migration	2
Notable Rise & No Black Residency in 1950	4
1-10 of 11 rows	Previous 1 2 Next

Change in Average Homicide Rate Between 1951-1955 and 1956-1960

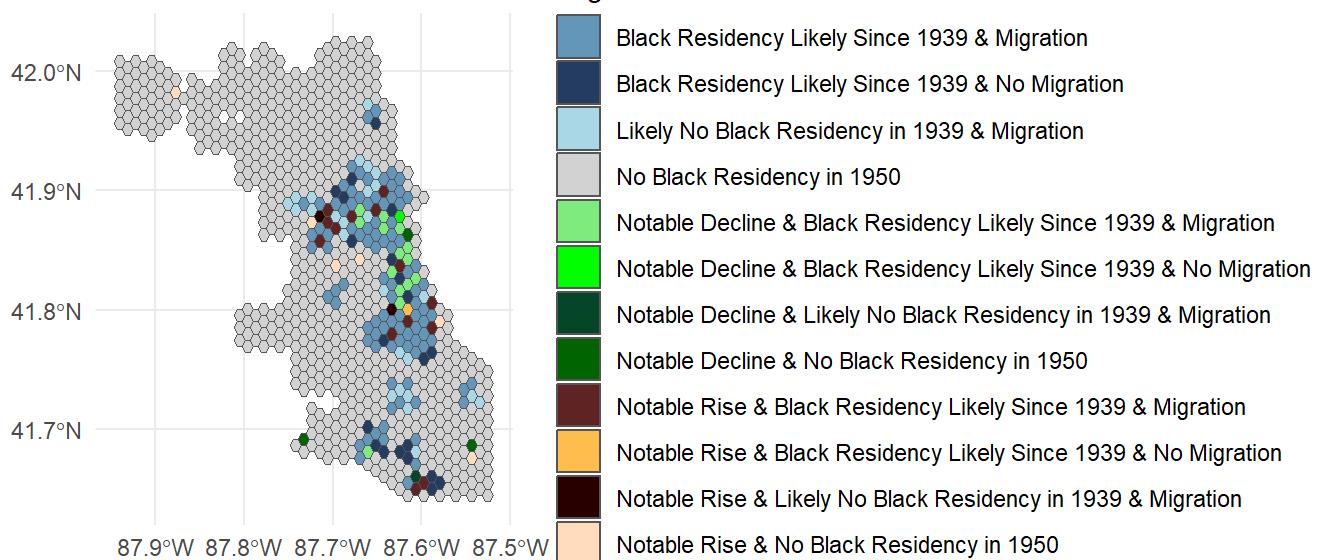
Intersection with Black Residency as of 1939 and 1950 & Riot in 1956-1960



flag	count
	<int>
Black Residency Likely Since 1939 & Migration	94
Black Residency Likely Since 1939 & No Migration	21
Likely No Black Residency in 1939 & Migration	26
No Black Residency in 1950	641
Notable Decline & Black Residency Likely Since 1939 & Migration	11
Notable Decline & Black Residency Likely Since 1939 & No Migration	1
Notable Decline & Likely No Black Residency in 1939 & Migration	2
Notable Decline & No Black Residency in 1950	3
Notable Rise & Black Residency Likely Since 1939 & Migration	17
Notable Rise & Black Residency Likely Since 1939 & No Migration	1
1-10 of 13 rows	Previous 1 2 Next

Change in Average Homicide Rate Between 1956-1960 and 1961-1965

Intersection with Black Residency as of 1939 and 1950 & Riot in 1961-1965



flag	count
<chr>	<int>
Black Residency Likely Since 1939 & Migration	94
Black Residency Likely Since 1939 & No Migration	21
Likely No Black Residency in 1939 & Migration	26
No Black Residency in 1950	638
Notable Decline & Black Residency Likely Since 1939 & Migration	14
Notable Decline & Black Residency Likely Since 1939 & No Migration	1
Notable Decline & Likely No Black Residency in 1939 & Migration	1
Notable Decline & No Black Residency in 1950	3
Notable Rise & Black Residency Likely Since 1939 & Migration	14
Notable Rise & Black Residency Likely Since 1939 & No Migration	1

1-10 of 12 rows

Previous 1 2 Next

Investigate Change in Black Residency 1939 - 1848 - 1950 and Zoning

Investigate Riot Years

Correlations

Rough Correlation Check

```
## [1] "year_riot"
## [1] "in_check"
## [1] "still_desi"
## [1] "def_decl"
## [1] "hazardous"
## [1] "industrial"
## [1] "best"
## [1] "commercial"
## [1] "bk_res_1"
## [1] "bk_res_2"
## [1] "bk_res_3"
## [1] "bk_res_4_1"
## [1] "bk_res_4_2"
## [1] "bk_res_4_3"
## [1] "bk_res_5_1"
## [1] "bk_res_5_2"
## [1] "bk_res_5_3"
```

variable	correlation
<chr>	<dbl>
bk_res_3	0.442651169
bk_res_2	0.428992340
bk_res_1	0.375319476
hazardous	0.338379788
year_riot	-0.308124038
bk_res_4_1	0.275515510
in_check	0.250655271
bk_res_5_1	0.217996860
bk_res_4_3	0.206394033
bk_res_4_2	0.166640608
1-10 of 17 rows	Previous 1 2 Next

Testing

Testing Black Residency Values

We see polygons where the percentage of 1% concentration is lower than 10% or 90%. There are very few instances where the difference is large (more than 10 percentage points difference in area mapped), and most occur in the south of Chicago where the maps were a) most distorted and b) the least amount of development matches the present state.

It may be best to use the 90% value rather than the 10% or 1% value in these instances. This is further corroborated by the original maps. The areas plotted below where the difference is highest appear to be of fairly equal size in all three maps.

```
test <- df %>%
  filter(year == 1950) %>%
  filter(bk_res_3 < bk_res_2 | bk_res_2 < bk_res_1 | bk_res_3 < bk_res_1) %>%
  dplyr::select(GRID_ID, bk_res_1, bk_res_2, bk_res_3) %>%
  mutate(diff_1_2 = bk_res_1 - bk_res_2,
        diff_1_3 = bk_res_1 - bk_res_3,
        diff_2_3 = bk_res_2 - bk_res_3) %>%
  pivot_longer(cols = contains("diff")) %>%
  filter(value > 0.1)

test
```

GRID_ID	bk_res_1	bk_res_2	bk_res_3	geom	name	value
<chr>	<dbl>	<dbl>	<dbl>	<s_POLYGO>	<chr>	<dbl>
1 AN-37	0.160145309	0.0000000	0.0000000	<s_POLYGO>	diff_1_2	0.1601453
2 AN-37	0.160145309	0.0000000	0.0000000	<s_POLYGO>	diff_1_3	0.1601453
3 AM-36	0.754519198	0.3691229	0.4169604	<s_POLYGO>	diff_1_2	0.3853963
4 AM-36	0.754519198	0.3691229	0.4169604	<s_POLYGO>	diff_1_3	0.3375588
5 AN-36	0.253805682	0.0000000	0.0000000	<s_POLYGO>	diff_1_2	0.2538057
6 AN-36	0.253805682	0.0000000	0.0000000	<s_POLYGO>	diff_1_3	0.2538057
7 AL-20	0.631251601	0.8766355	0.7593507	<s_POLYGO>	diff_2_3	0.1172848
8 AM-20	0.004161947	0.4012354	0.2760095	<s_POLYGO>	diff_2_3	0.1252259

8 rows

```
ggplot(data = test ) +
  geom_sf(aes(fill = GRID_ID)) +
  coord_sf(
    xlim = c(-87.94011, -87.52398), # Approximate Longitude bounds of Chicago
    ylim = c(41.64454, 42.02304)    # Approximate Latitude bounds of Chicago
  )
```

