Investigating the Legacy of Redlining in Los Angeles

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1 Introduction

Present-day environmental justice may reflect legacies of injustice in the past. During the 1930s, the Home Owners' Loan Corporation (HOLC) rated neighborhoods based on their perceived safety for real estate investment. Their ranking system—A (green), B (blue), C (yellow), D (red)—was used to block access to loans for home ownership, a practice known as "redlining."

This analysis examines the legacy of redlining in Los Angeles on current environmental justice conditions and biodiversity observations.

2 Setup

2.1 Load Libraries

```
library(tidyverse)    # data wrangling
library(sf)           # spatial data handling
library(here)         # file path management
library(tmap)         # mapping
library(ggplot2)      # visualization
library(gt)           # tables
library(viridis)      # color palettes
```

2.2 Load Data

```
# Load EJScreen data (census block groups)
ejscreen <- st_read(
  here("data", "ejscreen",
   ↪  "EJSCREEN_2023_BG_StatePct_with_AS_CNMI_GU_VI.gdb"),
  quiet = TRUE
)

# Load HOLC redlining data for Los Angeles
redlining <- st_read(
  here("data", "mapping-inequality",
   ↪  "mapping-inequality-los-angeles.json"),
  quiet = TRUE
)

# Load bird observation data
birds <- st_read(
  here("data", "gbif-birds-LA", "gbif-birds-LA.shp"),
  quiet = TRUE
)
```

2.3 Data Preparation

```
# Filter EJScreen to Los Angeles County
la_ejscreen <- ejscreen %>%
  filter(CNTY_NAME == "Los Angeles County")

# Check and align coordinate reference systems
if (!st_crs(la_ejscreen) == st_crs(redlining)) {
  warning("CRS mismatch detected. Transforming redlining
   ↪  data to match EJScreen CRS.")
  redlining <- st_transform(redlining, st_crs(la_ejscreen))
}

if (!st_crs(birds) == st_crs(redlining)) {
  warning("CRS mismatch detected. Transforming birds data to
   ↪  match redlining CRS.")
  birds <- st_transform(birds, st_crs(redlining))
}
```

3 Part 1: Legacy of Redlining in Environmental Justice

3.1 Historical Redlining Map

```
# Get bounding box of redlining data to focus on mapped
 ↪  areas
redlining_bbox <- st_bbox(redlining)

# Create LA County boundary
la_boundary <- st_union(la_ejscreen)

# Create map of historical redlining neighborhoods
tm_shape(la_boundary, bbox = redlining_bbox) +
  tm_borders(col = "black", lwd = 2) +
tm_shape(redlining) +
  tm_polygons(
    fill = "grade",
    fill.scale = tm_scale_categorical(
      values = c("A" = "darkgreen", "B" = "blue", "C" =
       ↪  "yellow", "D" = "red"),
      value.na = "transparent"
    ),
    fill.legend = tm_legend(title = "HOLC Grade", na.show =
     ↪  FALSE),
```

```
    col = "white",
    lwd = 0.5
  ) +
  tm_basemap(server = "OpenStreetMap") +
  tm_title("Historical Redlining in Los Angeles (1930s)") +
  tm_compass(type = "arrow", position = c("left", "top")) +
  tm_scalebar(position = c("left", "bottom")) +
  tm_layout(
    legend.outside = TRUE,
    legend.outside.position = "right",
    frame = FALSE
  )
```

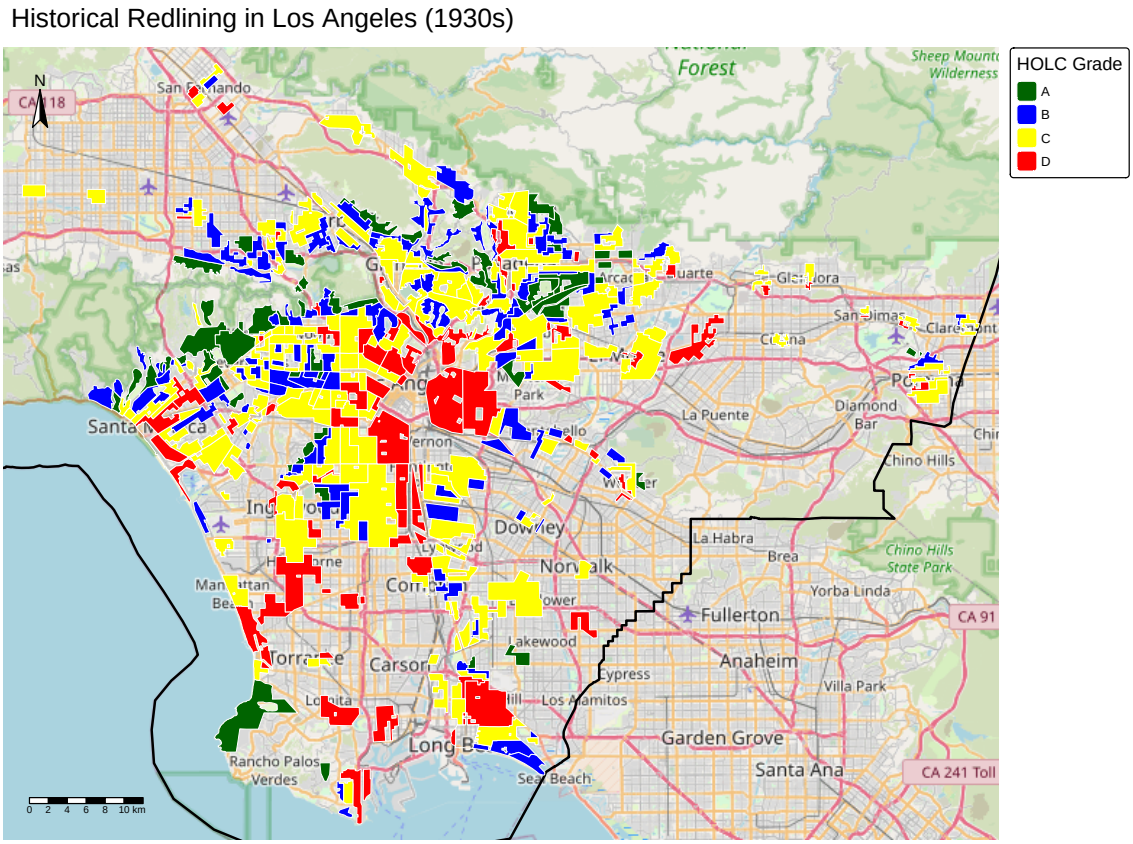

Figure 1: **Historical redlining in Los Angeles County.** HOLC grades from the 1930s are shown: Grade A (green) represents 'best' neighborhoods, Grade B (blue) 'still desirable', Grade C (yellow) 'definitely declining', and Grade D (red) 'hazardous'.

3.2 Census Block Groups by HOLC Grade

```
# Spatial join to assign HOLC grades to census block groups
la_holc <- st_join(la_ejscreen, redlining, left = TRUE)

# Calculate percentages by HOLC grade
holc_summary <- la_holc %>%
  st_drop_geometry() %>%
  mutate(grade = ifelse(is.na(grade), "No HOLC Grade",
   ↪  grade)) %>%
  group_by(grade) %>%
  summarise(count = n()) %>%
  mutate(percentage = (count / sum(count)) * 100) %>%
  arrange(desc(percentage))

# Create formatted table
holc_summary %>%
  mutate(percentage = round(percentage, 1)) %>%
  rename(
    "HOLC Grade" = grade,
    "Count" = count,
    "Percentage (%)" = percentage
  ) %>%
  knitr::kable(
    booktabs = TRUE,
    align = c("l", "r", "r")
  ) %>%
  kableExtra::kable_styling(
    latex_options = c("striped", "hold_position"),
    full_width = FALSE
  )
```

Table 1: **Census block groups by HOLC grade.** Distribution across HOLC grades in Los Angeles County.

HOLC Grade	Count	Percentage (%)
C	3058	34.0
No HOLC Grade	2896	32.2
D	1346	15.0
B	1239	13.8
A	449	5.0

3.3 Current Environmental Conditions by HOLC Grade

```
# Calculate mean values by HOLC grade
env_summary <- la_holc %>%
  st_drop_geometry() %>%
  filter(!is.na(grade)) %>%
  group_by(grade) %>%
  summarise(
    mean_low_income = mean(LOWINCPCT * 100, na.rm = TRUE),
    mean_pm25 = mean(P_PM25, na.rm = TRUE),
    mean_life_exp = mean(P_LIFEEXPPCT, na.rm = TRUE)
  )

# Reshape for plotting
env_long <- env_summary %>%
  pivot_longer(
    cols = starts_with("mean_"),
    names_to = "variable",
    values_to = "value"
  ) %>%
  mutate(
    variable = case_when(
      variable == "mean_low_income" ~ "Low Income (%)",
      variable == "mean_pm25" ~ "PM2.5 Percentile",
      variable == "mean_life_exp" ~ "Low Life Exp.
↪  Percentile"
    )
  )

# Create visualization
ggplot(env_long, aes(x = grade, y = value, fill = grade)) +
  geom_col() +
  facet_wrap(~variable, scales = "free_y") +
  scale_fill_manual(
    values = c("A" = "darkgreen", "B" = "blue", "C" =
    ↪  "yellow", "D" = "red")
  ) +
  labs(
    title = "Env. and Socioeconomic Conditions by HOLC
    ↪  Grade",
    subtitle = "Mean values across Los Angeles County census
    ↪  block groups",
    x = "HOLC Grade",
    y = "Mean Value",
    fill = "HOLC Grade"
  ) +
  theme_minimal() +
```

```
  theme(
    plot.title = element_text(face = "bold", size = 14),
    legend.position = "none"
  )
```

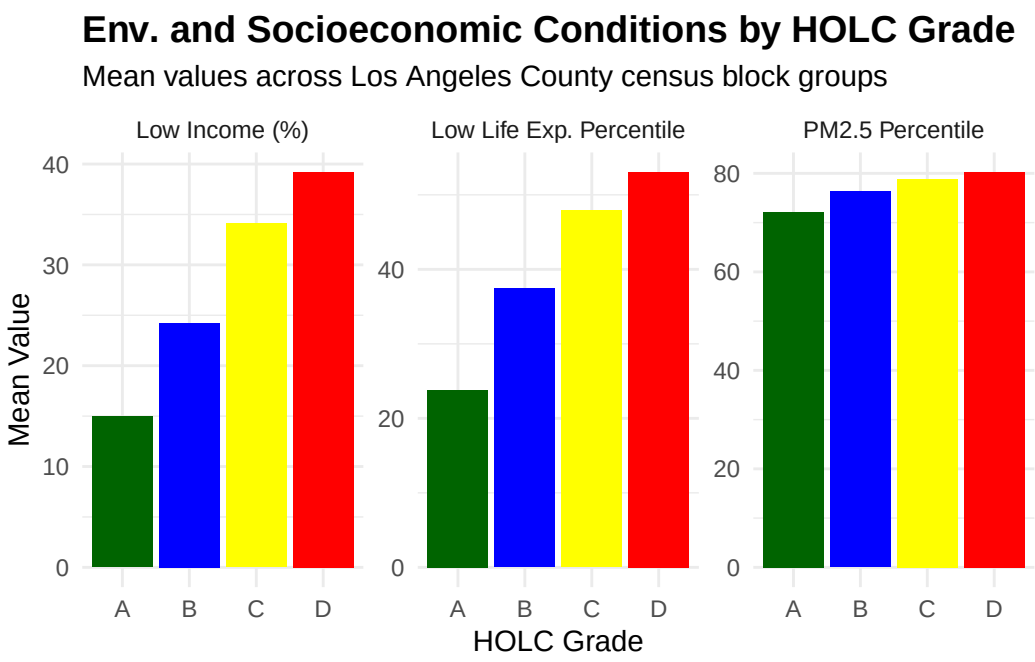

Figure 2: **Environmental and socioeconomic conditions by HOLC grade.** Mean values show Grade D (redlined) neighborhoods have higher percentages of low-income residents, higher PM2.5 exposure, and lower life expectancy compared to Grade A neighborhoods.

3.4 Reflection on Environmental Justice Patterns

The analysis reveals clear and disturbing patterns linking historical redlining to current environmental and socioeconomic conditions in Los Angeles County. Neighborhoods that received the lowest HOLC grade (D, “hazardous” - redlined) exhibit significantly worse conditions across all three metrics examined compared to grade A (“best”) neighborhoods.

Low Income Patterns: Grade D neighborhoods have nearly three times the percentage of low-income residents (~39%) compared to grade A neighborhoods (~15%). This demonstrates how redlining created lasting economic disparities by systematically denying wealth-building opportunities through homeownership to residents of these areas.

Air Quality Disparities: PM2.5 percentile values show a progressive increase from grade A (~70th percentile) to grade D (~80th percentile), indicating that historically redlined neighborhoods experience worse air quality today. This pattern reflects how environmental burdens have been concentrated in communities that were already discriminated against nearly a century ago.

Health Outcomes: The low life expectancy percentile follows a similar troubling pattern, with grade D neighborhoods showing the highest values (~80th percentile), meaning these areas have the lowest life expectancies in the county. This metric powerfully illustrates how historical housing discrimination has resulted in tangible health consequences that persist generations later.

These results demonstrate that redlining's impacts extend far beyond housing access—it has shaped the physical environment, economic opportunities, and health outcomes of communities in ways that persist today. The systematic nature of these disparities across all three variables suggests that historical redlining contributed to the concentration of multiple environmental and social stressors in the same communities, creating compounded vulnerability.

4 Part 2: Legacy of Redlining in Biodiversity Observations

4.1 Bird Observations by HOLC Grade

```
# Spatial join to assign HOLC grades to bird observations
birds_holc <- st_join(birds, redlining, left = FALSE)

# Calculate percentage of observations by HOLC grade
bird_summary <- birds_holc %>%
  st_drop_geometry() %>%
  group_by(grade) %>%
  summarise(count = n()) %>%
  mutate(percentage = (count / sum(count)) * 100)

# Create visualization
ggplot(bird_summary, aes(x = grade, y = percentage, fill =
 ↪  grade)) +
  geom_col() +
  scale_fill_manual(
    values = c("A" = "darkgreen", "B" = "blue", "C" =
     ↪  "yellow", "D" = "red"),
    name = "HOLC Grade"
  ) +
  labs(
    title = "Bird Observations within Redlined
     ↪  Neighborhoods",
```

```
    subtitle = "Percentage of observations by HOLC grade
     ↪  (2021-2023)",
    x = "HOLC Grade",
    y = "Percentage of Observations (%)"
  ) +
  theme_minimal() +
  theme(
    plot.title = element_text(face = "bold", size = 14)
  )
```

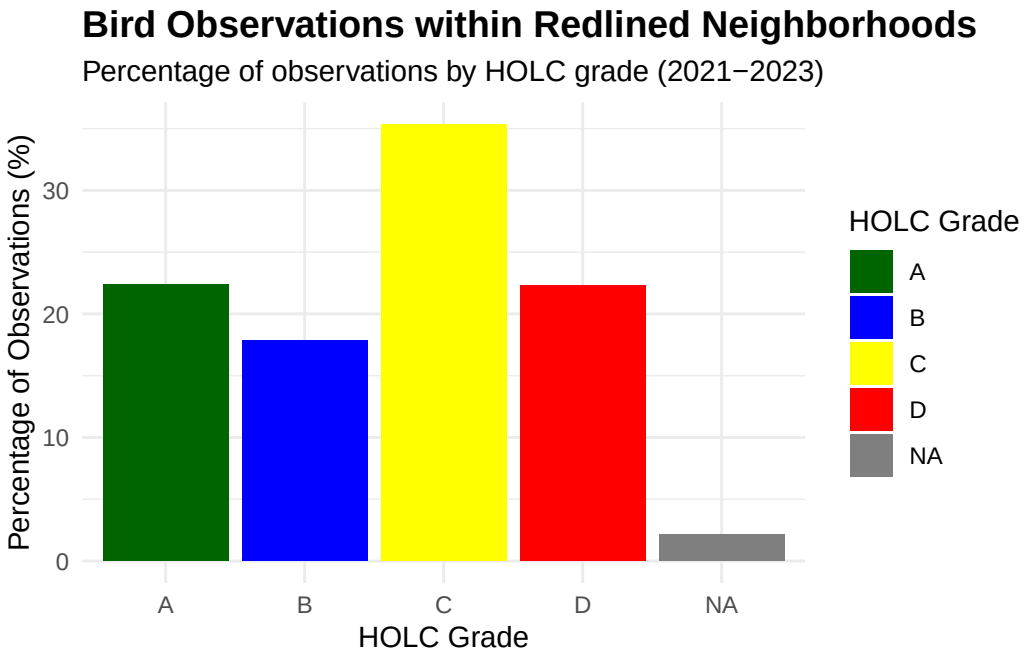

Figure 3: **Bird observations by HOLC grade.** Distribution of observations across HOLC grades in Los Angeles County (2021-2023). Grade C neighborhoods have the highest percentage of observations, while Grade D (redlined) neighborhoods have the lowest.

4.2 Discussion: Comparison with Ellis-Soto et al. 2023

The bird observation data reveals an interesting pattern where grade C neighborhoods have the highest percentage of observations (~35%), followed by grade B (~30%), grade A (~20%), and grade D (~13%). This distribution differs from what we might expect based on Ellis-Soto et al. 2023's findings about biodiversity observations and redlining.

The key methodological difference between our analysis and Ellis-Soto et al. is how we quantified bird observations across HOLC grades. Our analysis uses raw observation counts and calculates the percentage of observations within each grade. In contrast, Ellis-Soto et al. calculated **sampling density** by dividing the number of bird observations by the area (in km²) of each HOLC grade, then **log-transformed** these values to meet statistical model assumptions. This approach accounts for the fact that larger neighborhoods would naturally have more observations simply due to their size, and the log transformation normalizes the highly skewed distribution typical of count data. By standardizing observations by area and transforming the data, their analysis better isolates the effect of historical redlining on observation effort independent of neighborhood size, which could explain why our results show different patterns than their findings.

5 Data Citations

U.S. Environmental Protection Agency. (2023). *EJScreen: Environmental Justice Screening and Mapping Tool* (Version 2023). Retrieved from https://www.epa.gov/ejscreen

Digital Scholarship Lab, University of Richmond. *Mapping Inequality: Redlining in New Deal America*. Retrieved from https://dsl.richmond.edu/panorama/redlining/

Global Biodiversity Information Facility (GBIF). Bird observations for Los Angeles County, 2021-2023.