bikelaneusage_weather

November 17, 2024

1 Introduction: Bike Lane Usage in Vancouver

The city of Vancouver has been actively increasing the number of bike lanes by reducing car lanes on major roads in the last few years to reduce vehicle congestion and enhance cyclist safety. However, the reactions to bike lanes within the city have been mixed. Vancouver is a city that is nicknamed "raincouver" by its residents and like most major cities on west coast of North America, it has been developed around cars. In another words, the population density is low and it is dispersed. Furthermore, due to high housing and rent prices, people have been forced to move further away from the city and are required to commute longer distances and public transit expansion in Vancouver has been minimal. For a city like Vancouver with such conditions is reducing vehicle lanes to increase bike lanes effective? This project aims to explore how weather conditions affect bike lane usage and to build a model to predict bike lane usage based on weather data.

1.1 Executive Summary

Using a Generalized Additive Model (GAM), we aimed to assess the effectiveness of expanding bike lanes in a city known for its high precipitation levels. The analysis revealed that temperature and precipitation significantly impact cycling patterns, with bike usage decreasing notably during rainy and snowy periods. Given that Vancouver experiences rainfall for a considerable portion of the year (40-44% since 2021), this study raises questions about the year-round effectiveness of dedicating vehicle lanes to bike lanes. Additionally, the analysis indicated that higher temperatures drive increased bike usage on Saturdays more than on weekdays, suggesting that bike lanes may be less effective during weekday rush hours. Further investigation into complementary transportation options, such as public transit integration, is recommended to support a balanced approach to urban transportation planning.

1.2 Objectives:

1. Analyze bike lane usage and its relationship with different weather conditions.
2. Develop a predictive modeling for bike lane usage.

1.3 Methodology:

1.3.1 Data Collection:

1. Obtain the bike lane usage data for 2021 and 2022 from the city of Vancouver.
    - https://vancouver.ca/files/cov/bike-volume-2021-2024.xlsx
    - According to the City of Vancouver, the bike lane volume is presented as daily two-way totals.

- It is counted at specific location of the bike lane with automated bike counters.
- Due to possible errors (Sensitivity, Occlusion, Bypass) a constant value correction factor has been applied to the counts by the City of Vancouver.

2. Acquire the weather data for Vancouver in the same periods from Environment Canada.
   - https://climate.weather.gc.ca/climate_data/daily_data_e.html?StationID=51442

1.3.2 Data Preparation:

1. Clean and preprocess the bike lane usage and weather data.
2. Aggregate the bike lane usage data on a daily, monthly, yearly basis to facilitate analysis.
3. Perform necessary transformations to align data for meaningful comparisons.

1.3.3 Exploratory Data Analysis (EDA):

1. Conduct EDA on the bike lane usage and weather data to identify patterns and trends.
2. Analyze the correlation between bike lane usage and rainfall.

1.3.4 Predictive Modeling

1. Develop a model that can be used to predict bike lane usage based on weather data.

1.4 Potential Limitations:

1. Public transit usage data and traffic data in Vancouver is not readily available. It will not be possible to see if vehicle traffic or public transit usage have changed based on weather conditions.
2. Missing data from the automated counters occur within the raw data set due to vandalism or equipment failure. (City of Vancouver)

1.5 Data Preparation

1.5.1 Read in Data Files

[46]:
```python
# read in bike usage data
import pandas as pd
import altair as alt
import numpy as np
import warnings
from IPython.display import display, Image
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from pygam import LinearGAM, s, f
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error
import matplotlib.pyplot as plt

# hide warnings
warnings.filterwarnings('ignore')

excel_file_path = 'data/bike-volume-2021-2024.xlsx'
```

```
sheet_name = 'City of Vancouver Bike Data'
bike_usage = pd.read_excel(excel_file_path, sheet_name=sheet_name,␣
 ↪engine='openpyxl')
```

[47]:
```
bike_usage.head()
```

[47]:
```
                     Location                                   Direction  \
0  1815 Cornwall - Northside  1815 Cornwall - Northside Cyclist Westbound
1  1815 Cornwall - Northside  1815 Cornwall - Northside Cyclist Eastbound
2  1815 Cornwall - Northside  1815 Cornwall - Northside Cyclist Westbound
3  1815 Cornwall - Northside  1815 Cornwall - Northside Cyclist Eastbound
4  1815 Cornwall - Northside  1815 Cornwall - Northside Cyclist Westbound

   CorrectionFactor  PercentPassing20%  PercentPassing10%       date  \
0          1.106145                0.7                0.6 2021-01-01
1          1.106145                0.7                0.6 2021-01-01
2          1.106145                0.7                0.6 2021-01-02
3          1.106145                0.7                0.6 2021-01-02
4          1.106145                0.7                0.6 2021-01-03

       Volume
0   91.810056
1    3.318436
2   57.519553
3    4.424581
4  315.251397
```

[48]:
```
# read in weather data
weather_2021 = pd.read_csv('data/en_climate_daily_BC_1108395_2021_P1D.csv')
weather_2022 = pd.read_csv('data/en_climate_daily_BC_1108395_2022_P1D.csv')
weather_2023 = pd.read_csv('data/en_climate_daily_BC_1108395_2023_P1D.csv')
weather_2024 = pd.read_csv('data/en_climate_daily_BC_1108395_2024_P1D.csv')
```

[49]:
```
# combine weather 2021 and 2022
weather = pd.concat([weather_2021, weather_2022, weather_2023, weather_2024],␣
 ↪axis=0)
weather.head()
```

[49]:
```
   Longitude (x)  Latitude (y)      Station Name  Climate ID   Date/Time  \
0        -123.18         49.19  VANCOUVER INTL A     1108395  2021-01-01
1        -123.18         49.19  VANCOUVER INTL A     1108395  2021-01-02
2        -123.18         49.19  VANCOUVER INTL A     1108395  2021-01-03
3        -123.18         49.19  VANCOUVER INTL A     1108395  2021-01-04
4        -123.18         49.19  VANCOUVER INTL A     1108395  2021-01-05

   Year  Month  Day  Data Quality  Max Temp (°C)  … Total Snow (cm)  \
0  2021      1    1           NaN           10.1  …             0.0
```

```
1  2021       1     2            NaN            8.8  …             0.0
2  2021       1     3            NaN            9.3  …             0.0
3  2021       1     4            NaN            7.7  …             0.0
4  2021       1     5            NaN            7.6  …             0.0

   Total Snow Flag Total Precip (mm)  Total Precip Flag Snow on Grnd (cm)  \
0              NaN              17.6                NaN               NaN
1              NaN              12.7                NaN               NaN
2              NaN               6.4                NaN               NaN
3              NaN              18.1                NaN               NaN
4              NaN              29.5                NaN               NaN

   Snow on Grnd Flag Dir of Max Gust (10s deg)  Dir of Max Gust Flag  \
0                NaN                        9.0                  NaN
1                NaN                       15.0                  NaN
2                NaN                       14.0                  NaN
3                NaN                       10.0                  NaN
4                NaN                       11.0                  NaN

  Spd of Max Gust (km/h)  Spd of Max Gust Flag
0                   45.0                   NaN
1                   59.0                   NaN
2                   41.0                   NaN
3                   48.0                   NaN
4                   63.0                   NaN

[5 rows x 31 columns]
```

1.6 Data Cleaning

[50]:
```
# clean bike usage data
# filter on year, 2021 and 2022
# missing data. hard to tell difference between if missing or if no one used␣
↪the bike lanes

# check type for date. convert to date
type(bike_usage.date)
bike_usage['date'] = pd.to_datetime(bike_usage['date'])
bike_usage['Year'] = bike_usage['date'].dt.year
```

[51]:
```
# only select relevant columns. also has direction per bike lane, we do not␣
↪care about direction
# group by year, by date by bike lane

cols = ['Location', 'date', 'Volume']
bike_usage = bike_usage[cols]
```

```
# group by date, location and sum volume
bike_usage = bike_usage.groupby(['date', 'Location']).sum().reset_index()

# round volume, it is a float currently b/c of the correction factor that has
↪been applied bike_usage['Volume'] = bike_usage['Volume'].apply(np.ceil)
bike_usage['Volume'] = bike_usage['Volume'].apply(round)
bike_usage.head()
```

[51]:
```
         date                 Location  Volume
0  2021-01-01  1815 Cornwall - Northside      95
1  2021-01-01  1818 Cornwall - Southside      70
2  2021-01-01                1850 York     164
3  2021-01-01            486 East 37th      83
4  2021-01-01               821 Powell      63
```

1.6.1 Missing Data

- The bike lane data has several gaps, with missing values that the City of Vancouver attributes to factors such as automated counter errors, vandalism, or equipment failure. A correction factor was applied for consistent counter issues. However, most of the missing data points are consecutive and tend to appear either at the start or end of the timeline (where the x-axis represents dates). This pattern could indicate that the bike lane didn't exist at the beginning or was closed towards the end. In one instance—Dunsmuir at Beatty—there is a significant block of missing data in the middle of the timeline, which could potentially be due to construction or other interruptions, though the exact cause is not specified.
- Based on the visualization of the bike lane usage vs date, it seems like there is a clear cyclic pattern for all bikelanes.

Bike Lane Data

[52]:
```
# first need to pivot data so that each bike lane is a column
bike_usage_missing = bike_usage.pivot(index='date', columns='Location',
↪values='Volume').reset_index()
bike_usage_missing.head()
```

[52]:
```
Location        date  1815 Cornwall - Northside  1818 Cornwall - Southside  \
0         2021-01-01                       95.0                       70.0
1         2021-01-02                       62.0                       43.0
2         2021-01-03                      330.0                      201.0
3         2021-01-04                      161.0                      120.0
4         2021-01-05                      105.0                       89.0

Location  1850 York  486 East 37th  821 Powell  885 Dunsmuir  \
0             164.0           83.0        63.0         158.0
1             123.0           79.0        75.0         166.0
2             572.0          235.0       232.0         386.0
3             387.0          245.0       183.0         646.0
4             401.0          209.0       135.0         564.0
```

```
Location  Alex Fraser Bridge East  Alex Fraser Bridge West  \
0                             4.0                      4.0
1                             4.0                      2.0
2                            15.0                     13.0
3                            13.0                     11.0
4                             8.0                     12.0

Location  Burrard at Cornwall - Eastside - Burrard Bridge  …  \
0                                                   247.0  …
1                                                   204.0  …
2                                                   937.0  …
3                                                   568.0  …
4                                                   492.0  …

Location  Seawall at Creekside Community Centre  Seawall at David Lam Park  \
0                                         302.0                      343.0
1                                         279.0                      277.0
2                                        1539.0                     1737.0
3                                         665.0                      659.0
4                                         399.0                      397.0

Location  Seawall at HMCS Discovery  Seawall at Harbour Green Park  \
0                             179.0                          143.0
1                              98.0                          136.0
2                             880.0                          686.0
3                             186.0                          251.0
4                              80.0                          152.0

Location  Seawall at Lumbermen's Arch  Seawall at Morton Park  \
0                                 NaN                    29.0
1                                 NaN                    24.0
2                                 NaN                    40.0
3                                 NaN                    20.0
4                                 NaN                    26.0

Location  Seawall at Second Beach Pool  Stephens at Point Grey  \
0                                164.0                    76.0
1                                 92.0                    43.0
2                                891.0                   310.0
3                                178.0                   135.0
4                                 78.0                   108.0

Location  Union at Hawks  Vanness at Brant
0                  313.0               0.0
1                  299.0               0.0
2                 1040.0               0.0
```

```
3                  979.0              0.0
4                  947.0              0.0

[5 rows x 37 columns]
```

[53]:

```
# need to deal with missing data
# find out for each column how many have 0s or nas
zeros_count_perc = ((bike_usage_missing == 0).sum() + bike_usage_missing.isna().
 ↪sum())/len(bike_usage_missing)
print(zeros_count_perc)
```

```
Location
date                                                0.000000
1815 Cornwall - Northside                           0.000000
1818 Cornwall - Southside                           0.017673
1850 York                                           0.000000
486 East 37th                                       0.000000
821 Powell                                          0.035346
885 Dunsmuir                                        0.350515
Alex Fraser Bridge East                             0.877025
Alex Fraser Bridge West                             0.874816
Burrard at Cornwall - Eastside - Burrard Bridge     0.167894
Burrard at Cornwall - Westside - Burrard Bridge     0.206186
Cambie Bridge - Eastside                            0.211340
Canada Line Bridge at West Kent                     0.253314
Central Valley Greenway at Victoria                 0.547865
Comox at Thurlow                                    0.000000
Dunsmuir Viaduct at Main                            0.326951
Dunsmuir at Beatty                                  0.508100
East 10th at Clark                                  0.352725
Fleming at East 57th                                0.509573
Helmcken at Burrard                                 0.508100
Hornby at Robson                                    0.720913
Lions Gate Bridge at Spirit Trail - Eastside        0.276141
Lions Gate Bridge at Spirit Trail - Westside        0.000000
Point Grey at Alma                                  0.377761
Point Grey at Stephens                              0.332842
Point Grey at Volunteer Park                        0.597202
Richards at Dunsmuir                                0.686303
Seawall at Creekside Community Centre               0.000000
Seawall at David Lam Park                           0.000000
Seawall at HMCS Discovery                           0.143594
Seawall at Harbour Green Park                       0.000000
Seawall at Lumbermen's Arch                         0.365243
Seawall at Morton Park                              0.970545
Seawall at Second Beach Pool                        0.525773
Stephens at Point Grey                              0.002209
Union at Hawks                                      0.051546
```

```
Vanness at Brant                                    1.000000
dtype: float64
```

[54]:
```python
# check for consecutive zeros per bike lane
# if consecutive zeros, then we can assume that the bike lane was not used for␣
↪specific reasons or it wasn't recorded

def consecutive_zeros(df):
    consecutive_zero_lanes = {}

    for col in df.columns:
        count = 0
        max_count = 0

        for i in range(len(df)):
            if df[col].iloc[i] == 0 or pd.isna(df[col].iloc[i]) or df[col].
↪iloc[i] == '':
                count += 1
            else:
                max_count = max(count, max_count)
                count = 0

        # for when column ends with 0s
        max_count = max(count, max_count)

        consecutive_zero_lanes[col] = max_count
        # create a dictionary with the bike lane and the number of consecutive␣
↪zeros

    result_df = pd.DataFrame(list(consecutive_zero_lanes.items()),␣
↪columns=['Lane', 'Max Consecutive Zeros'])


    return result_df

consecutive_zero_lanes = consecutive_zeros(bike_usage_missing)
print(consecutive_zero_lanes)
```

```
                                         Lane  Max Consecutive Zeros
0                                        date                      0
1                      1815 Cornwall - Northside                      0
2                      1818 Cornwall - Southside                     24
3                                   1850 York                      0
4                              486 East 37th                      0
5                                 821 Powell                     46
6                               885 Dunsmuir                    476
7                       Alex Fraser Bridge East                   1190
8                       Alex Fraser Bridge West                   1002
```

```
9   Burrard at Cornwall - Eastside - Burrard Bridge                      186
10  Burrard at Cornwall - Westside - Burrard Bridge                      186
11                       Cambie Bridge - Eastside                         99
12                Canada Line Bridge at West Kent                        344
13            Central Valley Greenway at Victoria                        337
14                              Comox at Thurlow                          0
15                       Dunsmuir Viaduct at Main                        444
16                            Dunsmuir at Beatty                         447
17                            East 10th at Clark                         478
18                          Fleming at East 57th                         398
19                           Helmcken at Burrard                         361
20                              Hornby at Robson                         921
21     Lions Gate Bridge at Spirit Trail - Eastside                      310
22     Lions Gate Bridge at Spirit Trail - Westside                        0
23                            Point Grey at Alma                         477
24                        Point Grey at Stephens                         446
25                  Point Grey at Volunteer Park                         811
26                          Richards at Dunsmuir                         811
27           Seawall at Creekside Community Centre                         0
28                      Seawall at David Lam Park                          0
29                      Seawall at HMCS Discovery                        163
30                   Seawall at Harbour Green Park                         0
31                     Seawall at Lumbermen's Arch                       463
32                        Seawall at Morton Park                        1318
33                   Seawall at Second Beach Pool                        472
34                        Stephens at Point Grey                           1
35                              Union at Hawks                            70
36                              Vanness at Brant                        1358
```

[55]:

```
alt.data_transformers.disable_max_rows()

# Create a line chart with independent y-axis for each facet
chart = alt.Chart(bike_usage).mark_line(point=True).encode(
    x='date:T',
    y='Volume:Q',
    color='Location:N'
).properties(
    width=400,
    height=250
).facet(
    facet='Location:N',
    columns=3  # Number of columns in the grid
).resolve_scale(
    y='independent'  # Allow y-axis to be independent for each chart
)

chart
```

[55]: alt.FacetChart(…)

Removing Outliers/Missing Data

- Remove any zeros that show up consecutively 5 times or more.
- Remove Bike lanes that has significant amount of missing data. (70% or greater)
- Remove outliers
  e.g. Richards at Dunsumuir.

Remove Bike lanes with 70% or more data missing

[56]:
```
# use zeros_count_perc to determine which bike lanes to drop
# drop bike lanes that have more than 70% zeros

bike_usage_lanes_dropped = bike_usage_missing.
 ↪drop(columns=zeros_count_perc[zeros_count_perc > 0.7].index)
bike_usage_lanes_dropped.columns
```

[56]:
```
Index(['date', '1815 Cornwall - Northside', '1818 Cornwall - Southside',
       '1850 York', '486 East 37th', '821 Powell', '885 Dunsmuir',
       'Burrard at Cornwall - Eastside - Burrard Bridge',
       'Burrard at Cornwall - Westside - Burrard Bridge',
       'Cambie Bridge - Eastside', 'Canada Line Bridge at West Kent',
       'Central Valley Greenway at Victoria', 'Comox at Thurlow',
       'Dunsmuir Viaduct at Main', 'Dunsmuir at Beatty', 'East 10th at Clark',
       'Fleming at East 57th', 'Helmcken at Burrard',
       'Lions Gate Bridge at Spirit Trail - Eastside',
       'Lions Gate Bridge at Spirit Trail - Westside', 'Point Grey at Alma',
       'Point Grey at Stephens', 'Point Grey at Volunteer Park',
       'Richards at Dunsmuir', 'Seawall at Creekside Community Centre',
       'Seawall at David Lam Park', 'Seawall at HMCS Discovery',
       'Seawall at Harbour Green Park', 'Seawall at Lumbermen's Arch',
       'Seawall at Second Beach Pool', 'Stephens at Point Grey',
       'Union at Hawks'],
      dtype='object', name='Location')
```

Replace outliers with nan for each bike lane We are removing outliers as there may be event spikes. There are many cycling events in Vancouver and it would distort the data.

[57]:
```
# for each bikelane calculate outliers and replace with nan

def replace_outliers(df):
    for col in df.columns:
        Q1 = df[col].quantile(0.25)
        Q3 = df[col].quantile(0.75)
        IQR = Q3 - Q1
        lower_bound = Q1 - 1.5 * IQR
        upper_bound = Q3 + 1.5 * IQR
```

```
        df[col] = df[col].apply(lambda x: np.nan if x < lower_bound or x >␣
↪upper_bound else x)

    return df

bike_usage_no_outliers = replace_outliers(bike_usage_lanes_dropped)
```

[58]:
```
# pivot bike_usage_no_outliers
bike_usage_no_outliers_check = bike_usage_no_outliers.melt(id_vars='date',␣
↪var_name='Location', value_name='Volume')
```

Replace consecutive zeros with nan

[59]:
```
bike_usage_no_outliers_consecutive_zeros = bike_usage_no_outliers.copy()

for col in bike_usage_no_outliers_consecutive_zeros.columns:
    count = 0
    for i in range(len(bike_usage_no_outliers_consecutive_zeros)):
        if (bike_usage_no_outliers_consecutive_zeros[col].iloc[i] == 0 or
            pd.isna(bike_usage_no_outliers_consecutive_zeros[col].iloc[i]) or
            bike_usage_no_outliers_consecutive_zeros[col].iloc[i] == ''):
            count += 1
        else:
            if count > 3:
                bike_usage_no_outliers_consecutive_zeros[col].iloc[i-count:i] =␣
↪np.nan
            count = 0

    # Check end of column for remaining sequence
    if count > 3:
        bike_usage_no_outliers_consecutive_zeros[col].
↪iloc[len(bike_usage_no_outliers_consecutive_zeros) - count:] = np.nan
```

Weather Data

- Columns with 70% or more missing data have been removed.
- The following columns 'Longitude (x)', 'Latitude (y)', 'Station Name', 'Dir of Max Gust (10s deg)', 'Dir of Max Gust Flag', 'Spd of Max Gust (km/h)', 'Spd of Max Gust Flag' have also been removed as it will not be used or because it also has high % of missing data.
- Rows with any missing data have also been removed in the rest of the columns.
  - Majority of the rows were future dates for which data does not exist yet.
  - 34 rows of missing data were also removed as they cannot be used in the model.

[60]:
```
# missing data for weather
weather.isna().sum()/len(weather)
```

[60]:
```
Longitude (x)                 0.000000
Latitude (y)                  0.000000
```

```
Station Name                    0.000000
Climate ID                      0.000000
Date/Time                       0.000000
Year                            0.000000
Month                           0.000000
Day                             0.000000
Data Quality                    1.000000
Max Temp (°C)                   0.069815
Max Temp Flag                   0.977413
Min Temp (°C)                   0.069815
Min Temp Flag                   0.977413
Mean Temp (°C)                  0.069815
Mean Temp Flag                  0.977413
Heat Deg Days (°C)              0.069815
Heat Deg Days Flag              0.977413
Cool Deg Days (°C)              0.069815
Cool Deg Days Flag              0.977413
Total Rain (mm)                 0.052019
Total Rain Flag                 0.929500
Total Snow (cm)                 0.048597
Total Snow Flag                 0.988364
Total Precip (mm)               0.052019
Total Precip Flag               0.924709
Snow on Grnd (cm)               0.963723
Snow on Grnd Flag               0.984942
Dir of Max Gust (10s deg)       0.432580
Dir of Max Gust Flag            0.624230
Spd of Max Gust (km/h)          0.432580
Spd of Max Gust Flag            0.614648
dtype: float64
```

[61]:
```
# select weather columns that will be used
# drop columns that have more than 70% missing data

weather = weather.drop(columns=weather.columns[weather.isna().sum()/
 ↪len(weather) > 0.7])
```

[62]:
```
# select columns of interest
weather_dropcols = ['Longitude (x)', 'Latitude (y)', 'Station Name', 'Dir of␣
 ↪Max Gust (10s deg)', 'Dir of Max Gust Flag',
       'Spd of Max Gust (km/h)', 'Spd of Max Gust Flag'] # we are dropping gust␣
 ↪b/c it's missing a lot of data

weather = weather.drop(columns=weather_dropcols)
```

[63]:
```
# check rows with missing data
weather[weather.isna().any(axis=1)]
```

```
# weather data actually includes future data - data doesn't exist yet.
# drop any rows after 2024-10-24
weather = weather[weather['Date/Time'] <= '2024-10-24']

# check how many rows missing data
weather.isna().sum()
```

[63]:
```
Climate ID              0
Date/Time               0
Year                    0
Month                   0
Day                     0
Max Temp (°C)          34
Min Temp (°C)          34
Mean Temp (°C)         34
Heat Deg Days (°C)     34
Cool Deg Days (°C)     34
Total Rain (mm)         8
Total Snow (cm)         3
Total Precip (mm)       8
dtype: int64
```

[64]:
```
# there are very few rows with missing data. we can drop those rows
weather = weather.dropna()
```

1.7 Data Joining

Join bike lane data and weather data. bike_usage_no_outliers_consecutive_zeros, weather

[65]:
```
weather['Date/Time'] = pd.to_datetime(weather['Date/Time'])
# join the data
bike_weather = pd.merge(bike_usage_no_outliers_consecutive_zeros, weather,␣
 ↪how='left',
                        left_on='date', right_on='Date/Time')
bike_weather.head()
```

[65]:
```
        date  1815 Cornwall - Northside  1818 Cornwall - Southside  1850 York  \
0 2021-01-01                       95.0                       70.0      164.0
1 2021-01-02                       62.0                       43.0      123.0
2 2021-01-03                      330.0                      201.0      572.0
3 2021-01-04                      161.0                      120.0      387.0
4 2021-01-05                      105.0                       89.0      401.0

   486 East 37th  821 Powell  885 Dunsmuir  \
0           83.0        63.0         158.0
1           79.0        75.0         166.0
2          235.0       232.0         386.0
```

```
3          245.0       183.0          646.0
4          209.0       135.0          564.0

   Burrard at Cornwall - Eastside - Burrard Bridge  \
0                                            247.0
1                                            204.0
2                                            937.0
3                                            568.0
4                                            492.0

   Burrard at Cornwall - Westside - Burrard Bridge  Cambie Bridge - Eastside  \
0                                            285.0                     107.0
1                                            214.0                     139.0
2                                           1015.0                     280.0
3                                            638.0                     342.0
4                                            513.0                     298.0

   …  Month  Day  Max Temp (°C)  Min Temp (°C)  Mean Temp (°C)  \
0  …    1.0  1.0           10.1            6.9             8.5
1  …    1.0  2.0            8.8            6.9             7.9
2  …    1.0  3.0            9.3            2.3             5.8
3  …    1.0  4.0            7.7            3.8             5.8
4  …    1.0  5.0            7.6            2.8             5.2

   Heat Deg Days (°C)  Cool Deg Days (°C)  Total Rain (mm)  Total Snow (cm)  \
0                 9.5                 0.0             17.6              0.0
1                10.1                 0.0             12.7              0.0
2                12.2                 0.0              6.4              0.0
3                12.2                 0.0             18.1              0.0
4                12.8                 0.0             29.5              0.0

   Total Precip (mm)
0               17.6
1               12.7
2                6.4
3               18.1
4               29.5

[5 rows x 45 columns]
```

[66]:
```python
# drop rows with missing Climate ID
bike_weather = bike_weather.dropna(subset=['Climate ID'])
```

[67]:
```python
# create a list of bikelanes
bikelanes = ['1815 Cornwall - Northside', '1818 Cornwall - Southside',
       '1850 York', '486 East 37th', '821 Powell', '885 Dunsmuir',
       'Burrard at Cornwall - Eastside - Burrard Bridge',
```

```python
       'Burrard at Cornwall - Westside - Burrard Bridge',
       'Cambie Bridge - Eastside', 'Canada Line Bridge at West Kent',
       'Central Valley Greenway at Victoria', 'Comox at Thurlow',
       'Dunsmuir Viaduct at Main', 'Dunsmuir at Beatty', 'East 10th at Clark',
       'Fleming at East 57th', 'Helmcken at Burrard',
       'Lions Gate Bridge at Spirit Trail - Eastside',
       'Lions Gate Bridge at Spirit Trail - Westside', 'Point Grey at Alma',
       'Point Grey at Stephens', 'Point Grey at Volunteer Park',
       'Richards at Dunsmuir', 'Seawall at Creekside Community Centre',
       'Seawall at David Lam Park', 'Seawall at HMCS Discovery',
       'Seawall at Harbour Green Park', "Seawall at Lumbermen's Arch",
       'Seawall at Second Beach Pool', 'Stephens at Point Grey',
       'Union at Hawks']
# fix the data so that each row is date + bike lane
id_vars = [col for col in bike_weather.columns.tolist()
               if col not in bikelanes]

bike_weather_melt = pd.melt(bike_weather, id_vars=id_vars,
                            var_name = 'bikelane', value_name='num_usage')

# create a year/month column
bike_weather_melt['year/month'] = bike_weather_melt['Year'].astype(int).
 ↪astype(str) + '/' + bike_weather_melt['Month'].astype(int).astype(str).str.
 ↪zfill(2)
bike_weather_melt['year/month'] = pd.to_datetime(bike_weather_melt['year/
 ↪month'], format='%Y/%m').dt.strftime('%Y/%m')
bike_weather_melt.head()
```

[67]:

```
         date  Climate ID  Date/Time    Year  Month  Day  Max Temp (°C)  \
0 2021-01-01   1108395.0 2021-01-01  2021.0    1.0  1.0           10.1
1 2021-01-02   1108395.0 2021-01-02  2021.0    1.0  2.0            8.8
2 2021-01-03   1108395.0 2021-01-03  2021.0    1.0  3.0            9.3
3 2021-01-04   1108395.0 2021-01-04  2021.0    1.0  4.0            7.7
4 2021-01-05   1108395.0 2021-01-05  2021.0    1.0  5.0            7.6

   Min Temp (°C)  Mean Temp (°C)  Heat Deg Days (°C)  Cool Deg Days (°C)  \
0            6.9             8.5                 9.5                 0.0
1            6.9             7.9                10.1                 0.0
2            2.3             5.8                12.2                 0.0
3            3.8             5.8                12.2                 0.0
4            2.8             5.2                12.8                 0.0

   Total Rain (mm)  Total Snow (cm)  Total Precip (mm)  \
0             17.6              0.0               17.6
1             12.7              0.0               12.7
2              6.4              0.0                6.4
3             18.1              0.0               18.1
```

```
4          29.5          0.0          29.5

                   bikelane  num_usage year/month
0  1815 Cornwall - Northside       95.0    2021/01
1  1815 Cornwall - Northside       62.0    2021/01
2  1815 Cornwall - Northside      330.0    2021/01
3  1815 Cornwall - Northside      161.0    2021/01
4  1815 Cornwall - Northside      105.0    2021/01
```

1.8 Add Day of Week to data

[68]:
```python
# add day of week to bike_weather_melt
bike_weather_melt['day_of_week'] = bike_weather_melt['date'].dt.day_name()
```

1.9 Exploratory Data Analysis

1.9.1 Bike lane usage by month per bike lane

- For each bike lane, we can see a spike in users in July and a decline in the fall/winter months through October to April.
- We can also see that the bikelanes along the Seawall are most popular. It makes sense given that it is a tourist attraction and a scenic ride completely separated from cars. However, it's also important to note that the Seawall is not a commuting route. It goes around Stanley Park, English Bay, Yaletwon, Granville Island and Kitsilano Beach.

[69]:
```python
# plot the data
alt.Chart(bike_weather_melt).mark_line().encode(
    x='year/month:T',
    y='mean(num_usage):Q',
    color='bikelane:N'
).properties(
    width=1000,
    height=250
)
```

[69]: alt.Chart(…)

[70]:
```python
selection=alt.selection(type="multi", fields=["year/month"])
base =  alt.Chart(bike_weather_melt).properties(width=1000, height=250)

bike_usage_by_month = alt.Chart(bike_weather_melt).mark_bar().encode(
    y = "num_usage",
    x = 'year/month',
    color=alt.condition(selection, alt.value("orange"), alt.value("lightgrey"))
).add_selection(selection).properties(height=250, width=500)

usage_per_bike_lane = hist = bike_usage_by_month.mark_bar().encode(
    y = "num_usage",
```

```
    x = "bikelane"
).transform_filter(selection).properties(height=250, width=500)

bike_usage_by_month | usage_per_bike_lane
```

[70]: alt.HConcatChart(…)

1.9.2 Exploring weather data

- There is precipitation in Vancouver more than 40% of the year. 2024 is not yet done yet and November and December should have more rain.
- The temperature clearly gets lower between September and April.
- There is increase in total precipitaion during the same time period.

[71]:
```
# per year % of days with rain
weather['Rain Flag'] = weather['Total Precip (mm)'].apply(lambda x: 1 if x > 0␣
 ↪else 0)
rain_days = weather.groupby(['Year']).agg({'Rain Flag': 'mean'}).reset_index()
rain_days
```

[71]:

	Year	Rain Flag
0	2021	0.444444
1	2022	0.435393
2	2023	0.416901
3	2024	0.393617

[72]:
```
base =  alt.Chart(bike_weather_melt).properties(width=1000, height=250)
min_temp_chart = alt.Chart(bike_weather_melt).mark_line().encode(
    y = 'Min Temp (°C)',
    x = 'date',
    color=alt.condition(selection, alt.value("orange"), alt.value("lightgrey"))
).add_selection(selection).properties(height=250, width=500)

max_temp_chart = alt.Chart(bike_weather_melt).mark_line().encode(
    y = 'Max Temp (°C)',
    x = 'date',
    color=alt.condition(selection, alt.value("orange"), alt.value("lightgrey"))
).add_selection(selection).properties(height=250, width=500)

total_precipt_chart = alt.Chart(bike_weather_melt).mark_line().encode(
    y = 'Total Precip (mm)',
    x = 'date',
    color=alt.condition(selection, alt.value("orange"), alt.value("lightgrey"))
).add_selection(selection).properties(height=250, width=1000)


min_temp_chart | max_temp_chart
```

[72]: alt.HConcatChart(…)

```
[73]: total_precipt_chart
```

[73]: alt.Chart(…)

1.9.3 Correlation Matrix

```
[74]: # create a correlation matrix
bike_weather_melt_corr = bike_weather_melt.drop(columns=['date', 'Climate ID',␣
↪'Date/Time', 'Year', 'Month', 'Day','bikelane', 'year/month', 'day_of_week',␣
↪'day_of_week'])
# drop where num_usage is na
bike_weather_melt_corr = bike_weather_melt_corr.dropna(subset=['num_usage'])

bike_weather_melt_corr = bike_weather_melt_corr.corr()

# correlation matrix table
bike_weather_melt_corr
```

[74]:

```
                    Max Temp (°C)  Min Temp (°C)  Mean Temp (°C)  \
Max Temp (°C)            1.000000       0.911261        0.980870
Min Temp (°C)            0.911261       1.000000        0.973979
Mean Temp (°C)           0.980870       0.973979        1.000000
Heat Deg Days (°C)      -0.968943      -0.969570       -0.991397
Cool Deg Days (°C)       0.533016       0.480760        0.520207
Total Rain (mm)         -0.182502      -0.025838       -0.112594
Total Snow (cm)         -0.215686      -0.207602       -0.216970
Total Precip (mm)       -0.215765      -0.059563       -0.146863
num_usage                0.497210       0.390844        0.458228

                    Heat Deg Days (°C)  Cool Deg Days (°C)  Total Rain (mm)  \
Max Temp (°C)                -0.968943            0.533016        -0.182502
Min Temp (°C)                -0.969570            0.480760        -0.025838
Mean Temp (°C)               -0.991397            0.520207        -0.112594
Heat Deg Days (°C)            1.000000           -0.403944         0.100725
Cool Deg Days (°C)           -0.403944            1.000000        -0.129696
Total Rain (mm)               0.100725           -0.129696         1.000000
Total Snow (cm)               0.227252           -0.033602        -0.015944
Total Precip (mm)             0.136816           -0.133707         0.985783
num_usage                    -0.456958            0.220941        -0.270175

                    Total Snow (cm)  Total Precip (mm)  num_usage
Max Temp (°C)             -0.215686          -0.215765   0.497210
Min Temp (°C)             -0.207602          -0.059563   0.390844
Mean Temp (°C)            -0.216970          -0.146863   0.458228
Heat Deg Days (°C)         0.227252           0.136816  -0.456958
```

```
Cool Deg Days (°C)        -0.033602          -0.133707   0.220941
Total Rain (mm)           -0.015944           0.985783  -0.270175
Total Snow (cm)            1.000000           0.150580  -0.099076
Total Precip (mm)          0.150580           1.000000  -0.283224
num_usage                 -0.099076          -0.283224   1.000000
```

1.9.4 Scatter plot between weather data and bike lane usage

- The relationship between bike lane usage and total precipitation appears to follow an exponential decay pattern, while there seems to be an exponential relationship between mean temperature and bike lane usage. For Cool Deg Days, it is difficult to determine, what is the relationship between CDD and usage.
- Given strong correlation between some of the independent variables, going to do a PCA.

[75]:
```python
# Linked views
# Creating a selection:
selection = alt.selection(type="multi", fields=["bikelane"])

# Create a container for our two different views
base =  alt.Chart(bike_weather_melt).properties(width=400, height=400)

# Create our scatterplot
tp_bl_scatterplot = base.mark_circle().encode(
    x = 'Total Precip (mm)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)


mt_bl_scatterplot = base.mark_circle().encode(
    x = 'Mean Temp (°C)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)

ts_bl_scatterplot = base.mark_circle().encode(
    x = 'Total Snow (cm)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)

cd_bl_scatterplot = base.mark_circle().encode(
    x = 'Cool Deg Days (°C)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)
```

```
tp_bl_scatterplot | mt_bl_scatterplot
```

[75]: alt.HConcatChart(…)

[76]:
```
ts_bl_scatterplot | cd_bl_scatterplot
```

[76]: alt.HConcatChart(…)

[77]:
```
# to get a clear picture, take 5 bike lanes and plot them to see a clearer␣
↪picture
bike_weather_melt_sample = bike_weather_melt[bike_weather_melt['bikelane'].
↪isin(['1815 Cornwall - Northside', '1818 Cornwall - Southside',
       '1850 York', '486 East 37th', '821 Powell'])]

# Create a selection:
selection = alt.selection(type="multi", fields=["bikelane"])

# Create a container for our two different views
base =  alt.Chart(bike_weather_melt_sample).properties(width=400, height=400)

# Create our scatterplot
tp_bl_scatterplot = base.mark_circle().encode(
    x = 'Total Precip (mm)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)

mt_bl_scatterplot = base.mark_circle().encode(
    x = 'Mean Temp (°C)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)

ts_bl_scatterplot = base.mark_circle().encode(
    x = 'Total Snow (cm)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)

cd_bl_scatterplot = base.mark_circle().encode(
    x = 'Cool Deg Days (°C)',
    y = 'num_usage',
    color = alt.condition(selection, "bikelane", alt.value('lightgray'))
).add_selection(selection)


tp_bl_scatterplot |mt_bl_scatterplot |ts_bl_scatterplot |cd_bl_scatterplot
```

[77]: alt.HConcatChart(…)

1.9.5 Bike lane usage based on day of week

Bike lane usage seems to be highest on either Wednesday or Saturday.

[78]:
```
# bike lane usage based on day of week per bike lane
# cross tabulate day of week and bike lane usage per bike lane
bike_weather_melt_day_of_week = bike_weather_melt.dropna(subset=['num_usage'])

# get the mean of num_usage per day of week per bike lane
bike_weather_melt_day_of_week = bike_weather_melt_day_of_week.
↪groupby(['bikelane', 'day_of_week'])['num_usage'].mean().reset_index()

# sort by day of week
bike_weather_melt_day_of_week['day_of_week'] = pd.
↪Categorical(bike_weather_melt_day_of_week['day_of_week'],
                                                              ␣
↪categories=['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday',␣
↪'Saturday', 'Sunday'],
                                                              ordered=True)

bike_weather_melt_day_of_week = bike_weather_melt_day_of_week.
↪sort_values('day_of_week')

# create a matrix bar chart, get bar chart for each bike lane
alt.Chart(bike_weather_melt_day_of_week).mark_line().encode(
    x='day_of_week',
    y='num_usage',
    color='bikelane'
).properties(
    width=600,
    height=250
)
```

[78]: alt.Chart(…)

[79]:
```
# For each bikelane, find which day has the highest usage
bike_weather_melt_day_of_week_max = bike_weather_melt_day_of_week.
↪groupby('bikelane')['num_usage'].idxmax()
bike_weather_melt_day_of_week_max = bike_weather_melt_day_of_week.
↪loc[bike_weather_melt_day_of_week_max]

bike_weather_melt_day_of_week_max['day_of_week'].value_counts()
```

[79]:
```
day_of_week
Wednesday    15
```

```
Saturday     15
Thursday      1
Monday        0
Tuesday       0
Friday        0
Sunday        0
Name: count, dtype: int64
```

1.10 PCA Dimension Reduction

- The first 4 principal components capture 99% of the variance in the data
- For each of the component, select the variable that is linked closest
  - PC1 - Mean Temp (°C)
  - PC2 - Total Precip (mm)
  - PC 3 - Total Snow (cm)
  - PC 4 - Cool Deg Days (°C)
- Also Day of week will also be added given that it theoretically cannot be correlated with any of the weather data.

[80]:
```python
features = ['Max Temp (°C)', 'Min Temp (°C)', 'Mean Temp (°C)',
            'Heat Deg Days (°C)', 'Cool Deg Days (°C)',
            'Total Rain (mm)', 'Total Snow (cm)', 'Total Precip (mm)']
X = bike_weather_melt[features]
X_standardized = StandardScaler().fit_transform(X)

# Apply PCA
pca = PCA()
pca.fit(X_standardized)

# Explained variance by each component
explained_variance = pca.explained_variance_ratio_

# Loadings (correlation between original features and principal components)
loadings = pd.DataFrame(pca.components_.T, columns=[f'PC{i+1}' for i in␣
 ↪range(len(features))], index=features)

# Output results
print("Explained Variance Ratio by each Principal Component:")
print(explained_variance)
print("\nLoadings (Feature Contribution to Each Principal Component):")
print(loadings)
```

```
Explained Variance Ratio by each Principal Component:
[5.40197026e-01 2.41457768e-01 1.23735534e-01 8.50803675e-02
 9.49571261e-03 3.14572363e-05 2.13404242e-06 6.94192592e-34]

Loadings (Feature Contribution to Each Principal Component):
                          PC1       PC2       PC3       PC4       PC5  \
```

Max Temp (°C)	-0.470472	0.034130	0.031069	-0.084855	0.682006
Min Temp (°C)	-0.456402	0.153729	0.015370	-0.144175	-0.723531
Mean Temp (°C)	-0.474784	0.091432	0.024116	-0.115091	0.034045
Heat Deg Days (°C)	0.465092	-0.098867	0.025954	0.258574	-0.042625
Cool Deg Days (°C)	-0.285082	-0.006041	0.339277	0.886281	-0.040322
Total Rain (mm)	0.115791	0.694456	-0.079497	0.075168	0.057777
Total Snow (cm)	0.126290	0.008348	0.933584	-0.316477	0.004883
Total Precip (mm)	0.134146	0.688980	0.067347	0.024591	0.058371

	PC6	PC7	PC8
Max Temp (°C)	0.005108	0.551514	4.648144e-15
Min Temp (°C)	0.004042	0.472788	3.517133e-15
Mean Temp (°C)	-0.003986	-0.471804	-7.270617e-01
Heat Deg Days (°C)	0.004144	0.493861	-6.787108e-01
Cool Deg Days (°C)	-0.000821	-0.075698	1.035999e-01
Total Rain (mm)	0.699270	-0.006081	1.465602e-16
Total Snow (cm)	0.110538	-0.001131	-1.425351e-16
Total Precip (mm)	-0.706206	0.006147	-2.680464e-16

1.11 Model Building

Based on previous analysis we observed the following relationship between bike lane usage and weather data. Given the large differences in bike lane usage depending on the location, the model will be built per bike lane.

- Mean temperature: There appears to be a linear relationship between mean temperature and bike usage
- Total Rain: Bike lane usage shows an exponential decay with increasing rain, suggesting that as rain increases, usage drops off sharply.
- Total Snow: A similar but less pronounced exponential decay relationship is seen with snowfall, where bike lane usage decreases as snow levels rise, though the effect is not as strong as with precipitation.
- Cool Degree Days: Is a measurement of how hot the temperature is on a given day. The hotter it is, there seems to be a slight increase.
- Day of the Week: Bikelane usage changes based on the day of the week.

$$\text{Bike Usage} = \beta_0 + \beta_1 \cdot e^{\alpha \cdot \text{Mean Temp}} + \beta_2 \cdot e^{-\gamma \cdot \text{Total Rain}} + \beta_3 \cdot e^{-\delta \cdot \text{Total Snow}} + \beta_4 \cdot \text{Cool Deg Days} + \beta_5 \cdot (\text{Cool Deg Days})^2 + \sum_{i=1}^{6}$$

1.11.1 Summary

1. Model Performance: The models, for the most part, demonstrated reasonably high predictive accuracy across different bike lanes, with varying pseudo R-squared and mean squared error (MSE) values. This suggests that the models effectively capture key drivers of bike lane usage. However, there is a recurring tendency across the models to underestimate high-usage values in certain lanes, indicating that some factors influencing peak usage might be missing from the model.

2. Significant Predictors: Temperature and total precipitation consistently appeared as significant factors across all models. Higher mean temperatures were associated with increased bike usage, as expected, while precipitation (both rain and snow) generally had a dampening effect on usage. This aligns with intuitive patterns, as favorable weather tends to encourage cycling while inclement weather discourages it.

3. Other Predictors: Snow and Cool Degree Days display complex, nonlinear relationships with bike usage, likely benefiting from second, third, or even fourth-degree polynomial terms. Partial dependence plots reveal that bike usage decreases as snow and cooling days increase, but this effect is nonlinear, suggesting threshold levels where bike usage patterns shift significantly. Furthermore, the interaction term between Mean Temperature and Day of the Week indicates a significant positive effect on Saturdays, suggesting that higher temperatures may boost bike usage more on Saturdays than on weekdays.

4. Underestimation of High Usage: Despite the models' overall predictive strength, they often underestimate bike lane usage during high-traffic periods, particularly in certain lanes. This effect was most pronounced in tourist-heavy areas, such as the Seawall and lanes around Kitsilano Beach, as well as the Lions Gate Bridge at Spirit Trail. These lanes likely see elevated usage due to both local and tourist traffic, especially during peak seasons.

5. Model Improvements: Incorporating variables that capture commuting patterns, infrastructure quality, and neighborhood demographics may help explain usage variances in non-tourist lanes. Additionally, including variables that capture time-of-day effects could account for commuter traffic, and further data on lane quality or biking culture could help explain high usage in specific lanes.

[81]:
```
# drop all values where num_usage is na
bike_weather_melt = bike_weather_melt.dropna(subset=['num_usage'])
# create interaction term
bike_weather_melt['day_bike_interaction'] = bike_weather_melt['day_of_week'].
 ↪astype(str) + "_" + bike_weather_melt['bikelane'].astype(str)
```

[82]:
```
# create dummy variable for day of week and bikelane
bike_weather_melt['bikelane_original'] = bike_weather_melt['bikelane']
bike_weather_melt_dummies = pd.get_dummies(bike_weather_melt,␣
 ↪columns=['day_of_week', 'bikelane'], drop_first=True)
```

[83]:
```
# Define features (X) and target (y)
X = bike_weather_melt_dummies[['Mean Temp (°C)', 'Total Rain (mm)', 'Total Snow␣
 ↪(cm)', 'Cool Deg Days (°C)'] +
       [col for col in bike_weather_melt_dummies.columns if 'day_of_week' in␣
 ↪col]]
y = bike_weather_melt_dummies['num_usage']
```

[84]:
```
# Split the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

1.11.2 GAM Results

[85]:
```
# Dictionary to store evaluation results
lane_results = {}

# Loop over each bike lane
for lane in bike_weather_melt_dummies['bikelane_original'].unique():
    # Filter data for this specific bike lane
    lane_data =␣
↪bike_weather_melt_dummies[bike_weather_melt_dummies['bikelane_original'] ==␣
↪lane]

    # Define features and target
    X = lane_data[['Mean Temp (°C)', 'Total Rain (mm)', 'Total Snow (cm)',␣
↪'Cool Deg Days (°C)'] +
                  [col for col in lane_data.columns if 'day_of_week' in col]]
    y = lane_data['num_usage']

    # Create interaction terms between Mean Temp and each day of the week
    for day_col in [col for col in X.columns if 'day_of_week' in col]:
        X[f'MeanTemp_{day_col}'] = X['Mean Temp (°C)'] * X[day_col]

    # Split the data
    X_train, X_test, y_train, y_test = train_test_split(X.to_numpy(), y.
↪to_numpy(), test_size=0.2, random_state=42)

    # Define and fit the model for this lane with the manually added␣
↪interaction terms
    # Note: Adjust the number of fixed terms (f) to match the number of␣
↪day_of_week and interaction terms
    gam = LinearGAM(
        s(0) +                  # Smooth term for Mean Temp
        s(1) +                  # Smooth term for Total Rain (mm)
        s(2) +                  # Smooth term for Total Snow
        s(3) +                  # Smooth term for Cool Deg Days
        f(4) +                  # Fixed effects for day_of_week_Monday
        f(5) +                  # Fixed effects for day_of_week_Saturday
        f(6) +                  # Fixed effects for day_of_week_Sunday
        f(7) +                  # Fixed effects for day_of_week_Thursday
        f(8) +                  # Fixed effects for day_of_week_Tuesday
        f(9) +                  # Fixed effects for day_of_week_Wednesday
        s(10) +                 # Interaction term MeanTemp_day_of_week_Monday
        s(11) +                 # Interaction term MeanTemp_day_of_week_Saturday
        s(12) +                 # Interaction term MeanTemp_day_of_week_Sunday
        s(13) +                 # Interaction term MeanTemp_day_of_week_Thursday
        s(14) +                 # Interaction term MeanTemp_day_of_week_Tuesday
        s(15)                   # Interaction term MeanTemp_day_of_week_Wednesday
```

```
    )

    gam.gridsearch(X_train, y_train)  # Use gridsearch to find optimal␣
↪smoothness

    # Print summary for each model
    print(f"Summary for lane {lane}:")
    gam.summary()

    # Predict and evaluate
    y_pred = gam.predict(X_test)
    mse = mean_squared_error(y_test, y_pred)
    lane_results[lane] = mse  # Store MSE for this lane

    # Plot actual vs. predicted for this lane
    plt.figure(figsize=(5, 5))
    plt.scatter(y_test, y_pred, alpha=0.5, color='blue')
    plt.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()], 'r--',␣
↪linewidth=2)
    plt.xlabel("Actual Bike Usage")
    plt.ylabel("Predicted Bike Usage")
    plt.title(f"Actual vs Predicted Bike Usage for {lane}")
    plt.show()

    print(f"Mean Squared Error for {lane}: {mse}")
```

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:01
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane 1815 Cornwall - Northside:
LinearGAM
===============================================
==========================================================
Distribution:                       NormalDist Effective DoF:
33.6836
Link Function:                    IdentityLink Log Likelihood:
-11601.8808
Number of Samples:                        1052 AIC:
```

```
23273.1289
                                               AICc:
23275.5644
                                               GCV:
26072.2562
                                               Scale:
24574.0368
                                               Pseudo R-Squared:
0.7606
===============================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.9
1.11e-16     ***
s(1)                              [63.0957]            20           4.0
1.11e-16     ***
s(2)                              [63.0957]            20           2.3
8.56e-01
s(3)                              [63.0957]            20           1.7
4.15e-03     **
f(4)                              [63.0957]            2            0.9
3.58e-01
f(5)                              [63.0957]            2            0.9
2.78e-01
f(6)                              [63.0957]            2            0.9
6.90e-01
f(7)                              [63.0957]            2            0.9
6.80e-01
f(8)                              [63.0957]            2            0.9
7.45e-01
f(9)                              [63.0957]            2            0.8
4.87e-01
s(10)                             [63.0957]            20           2.1
4.05e-01
s(11)                             [63.0957]            20           2.2
1.68e-08     ***
s(12)                             [63.0957]            20           2.0
1.31e-01
s(13)                             [63.0957]            20           1.6
9.53e-01
s(14)                             [63.0957]            20           1.6
7.89e-01
s(15)                             [63.0957]            20           1.1
9.61e-01
intercept                                              1            0.0
```

```
4.53e-01
===============================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

WARNING: Fitting splines and a linear function to a feature introduces a model
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models or models with
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estimated, the p-values
         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

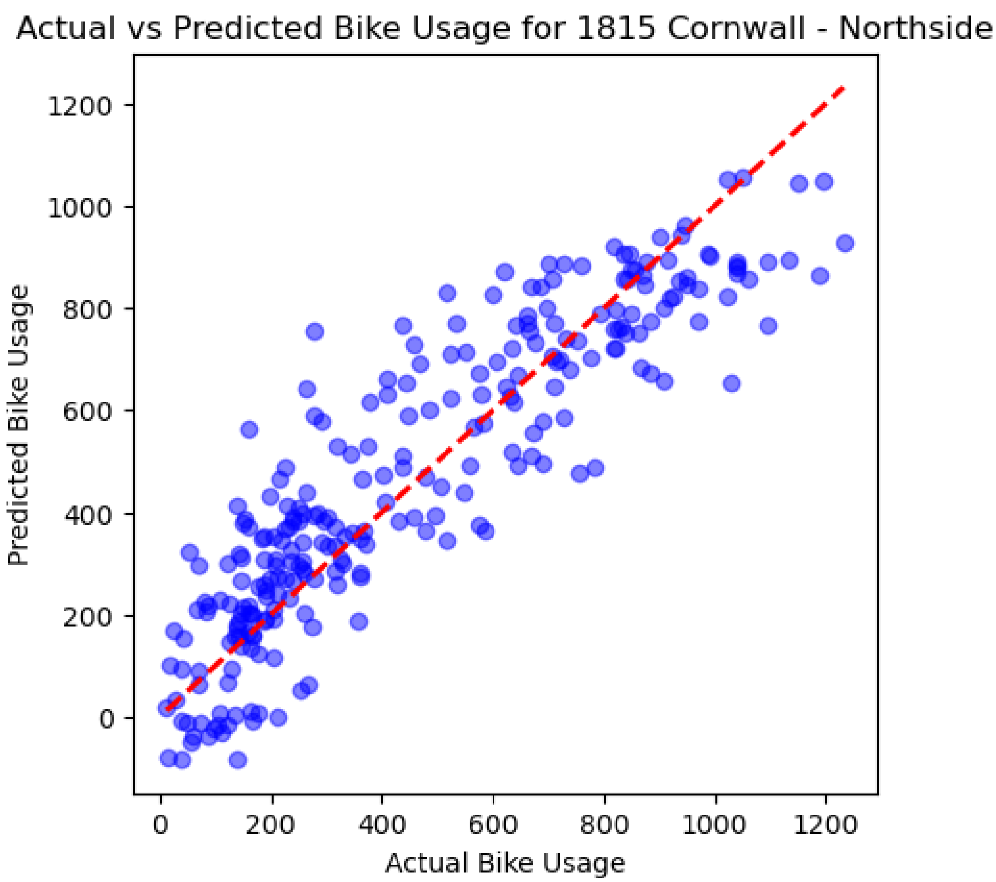


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for 1815 Cornwall - Northside: 20062.460673923226

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
```

```
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:01
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane 1818 Cornwall - Southside:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
34.6524
Link Function:                   IdentityLink Log Likelihood:
-10796.8646
Number of Samples:                       1036 AIC:
21665.0341
                                                AICc:
21667.6493
                                                GCV:
14251.3694
                                                Scale:
13395.9774
                                                Pseudo R-Squared:
0.7742
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.5
1.11e-16     ***
s(1)                              [63.0957]            20           3.9
1.11e-16     ***
s(2)                              [63.0957]            20           2.8
9.20e-01
s(3)                              [63.0957]            20           1.6
1.48e-04     ***
f(4)                              [63.0957]            2            0.9
7.47e-01
f(5)                              [63.0957]            2            0.9
5.50e-01
f(6)                              [63.0957]            2            0.9
```

```
9.59e-01
f(7)                                [63.0957]            2            0.9
5.85e-01
f(8)                                [63.0957]            2            0.9
7.21e-01
f(9)                                [63.0957]            2            0.8
4.44e-01
s(10)                               [63.0957]            20           2.1
6.08e-02     .
s(11)                               [63.0957]            20           2.5
2.57e-06     ***
s(12)                               [63.0957]            20           2.0
6.94e-01
s(13)                               [63.0957]            20           2.2
6.81e-01
s(14)                               [63.0957]            20           1.6
6.91e-01
s(15)                               [63.0957]            20           1.1
7.63e-01
intercept                                                1            0.0
5.43e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

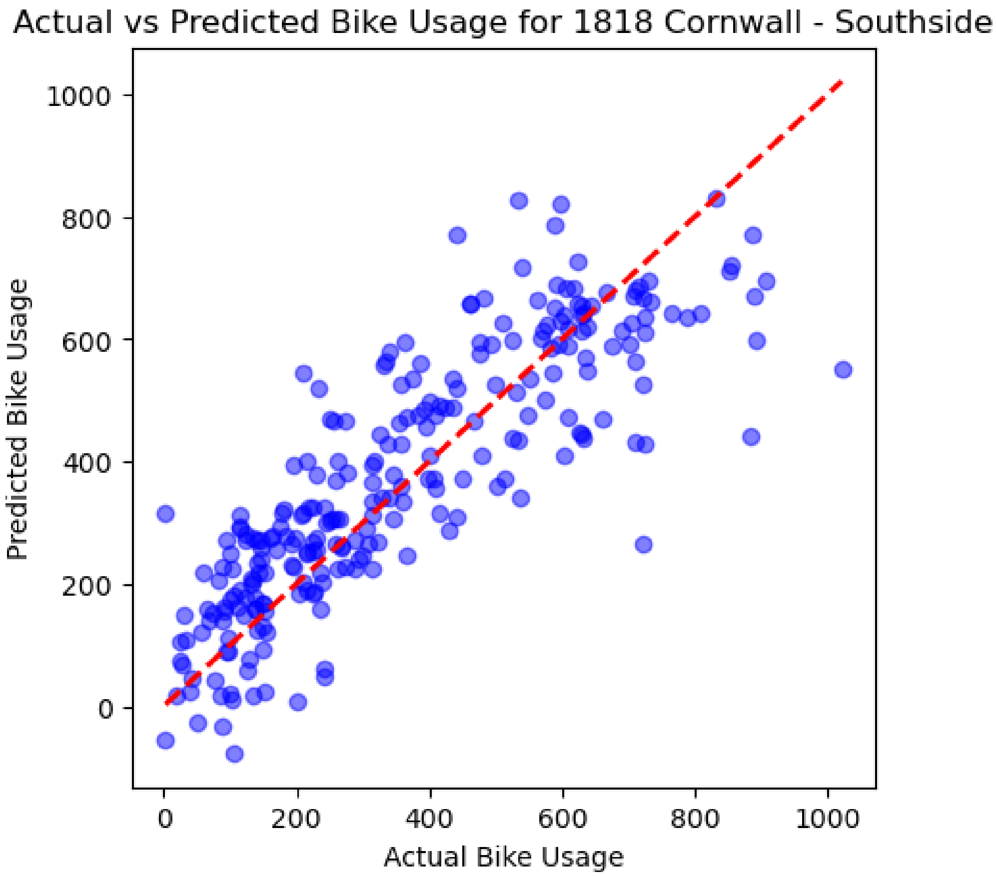


```
  0% (0 of 11) |                          | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for 1818 Cornwall - Southside: 15677.980908007425

  9% (1 of 11) |##                        | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############             | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |#########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane 1850 York:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
```

```
47.7284
Link Function:                        IdentityLink Log Likelihood:
-13140.9644
Number of Samples:                            1055 AIC:
26379.3857
                                                   AICc:
26384.2067
                                                   GCV:
111470.3642
                                                   Scale:
102431.2969
                                                   Pseudo R-Squared:
0.7934
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           11.9
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           4.1
7.10e-01
s(3)                              [15.8489]            20           2.3
1.28e-01
f(4)                              [15.8489]            2            0.9
7.03e-01
f(5)                              [15.8489]            2            0.9
9.05e-01
f(6)                              [15.8489]            2            0.9
2.70e-01
f(7)                              [15.8489]            2            0.9
8.74e-01
f(8)                              [15.8489]            2            1.0
7.86e-01
f(9)                              [15.8489]            2            0.9
6.65e-01
s(10)                             [15.8489]            20           4.2
2.89e-01
s(11)                             [15.8489]            20           2.9
3.42e-01
s(12)                             [15.8489]            20           3.0
6.23e-03     **
s(13)                             [15.8489]            20           3.6
4.79e-02     *
s(14)                             [15.8489]            20           2.7
```

```
7.18e-01
s(15)                              [15.8489]            20            2.0
1.69e-02     *
intercept                                               1             0.0
4.94e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

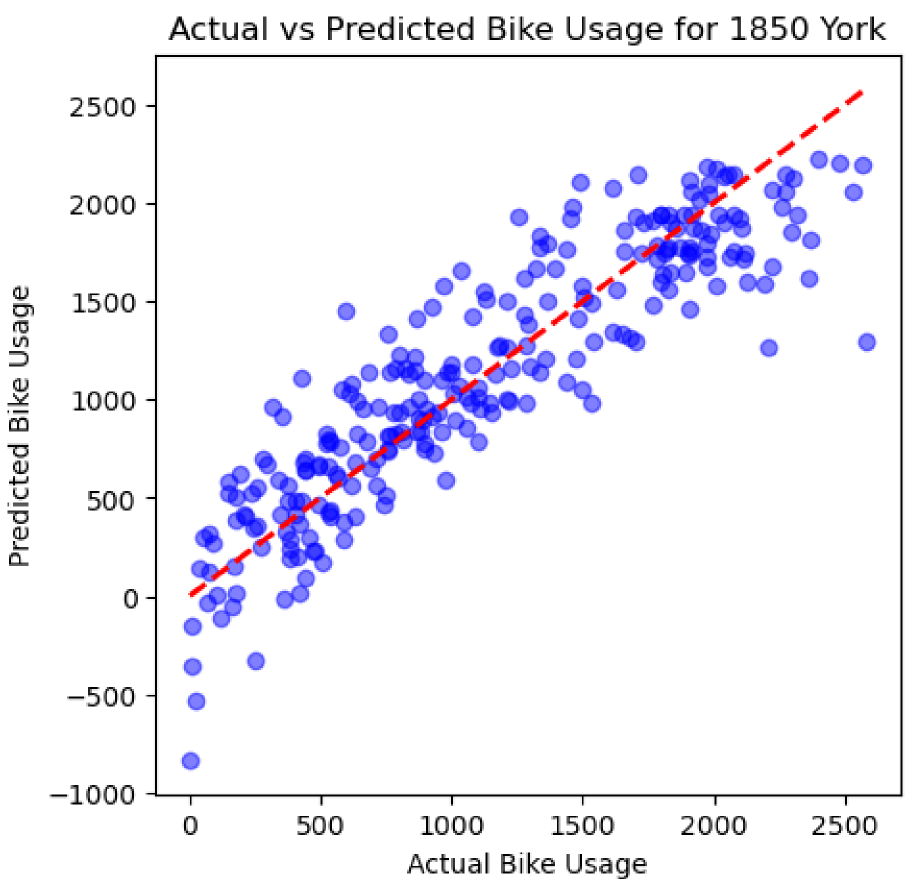

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for 1850 York: 89921.0591823779

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane 486 East 37th:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
47.7284
Link Function:                     IdentityLink Log Likelihood:
-11122.6107
Number of Samples:                         1055 AIC:
22342.6782
                                                AICc:
22347.4992
                                                GCV:
16454.5209
                                                Scale:
15120.2333
                                                Pseudo R-Squared:
0.7333
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           11.9
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           4.1
3.60e-01
s(3)                              [15.8489]            20           2.3
3.10e-01
f(4)                              [15.8489]            2            0.9
```

```
6.05e-01
f(5)                              [15.8489]            2            0.9
9.50e-01
f(6)                              [15.8489]            2            0.9
1.73e-01
f(7)                              [15.8489]            2            0.9
8.23e-01
f(8)                              [15.8489]            2            1.0
7.14e-01
f(9)                              [15.8489]            2            0.9
4.80e-01
s(10)                             [15.8489]            20           4.2
1.83e-01
s(11)                             [15.8489]            20           2.9
7.30e-01
s(12)                             [15.8489]            20           3.0
8.02e-04     ***
s(13)                             [15.8489]            20           3.6
9.86e-02     .
s(14)                             [15.8489]            20           2.7
9.61e-01
s(15)                             [15.8489]            20           2.0
6.79e-01
intercept                                              1            0.0
3.20e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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the null too readily.
```

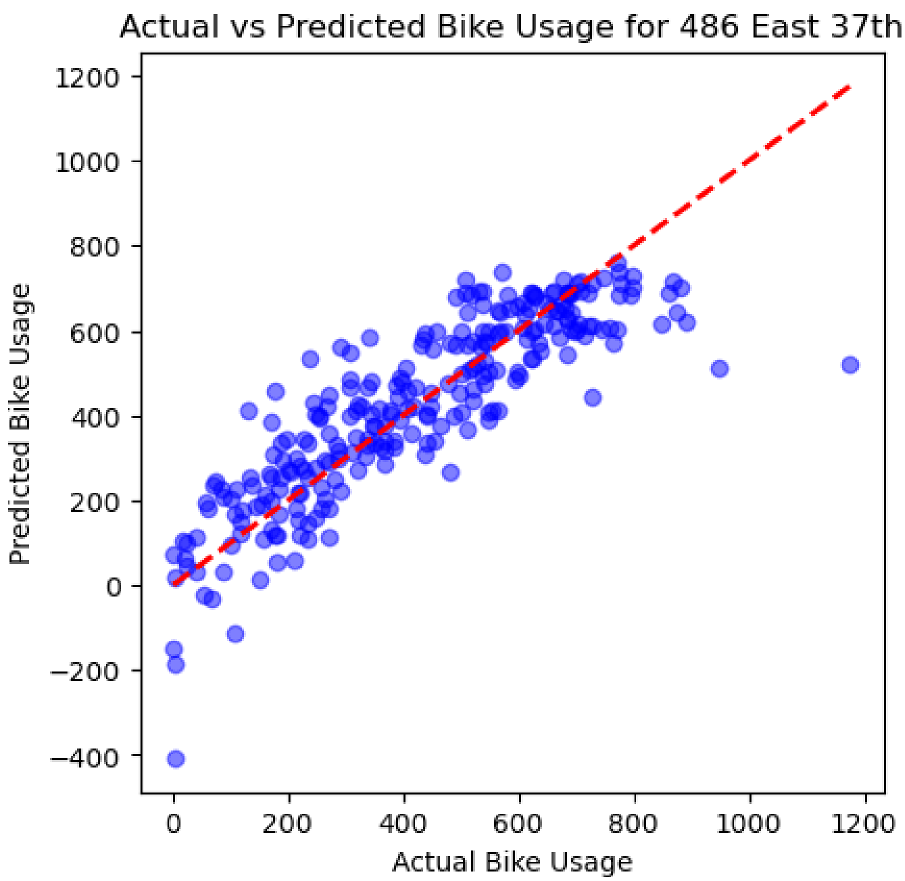


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for 486 East 37th: 13832.348967938296

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |######################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane 821 Powell:
LinearGAM
===============================================
==========================================================
Distribution:                         NormalDist Effective DoF:
```

```
47.1004
Link Function:                     IdentityLink Log Likelihood:
-10200.3451
Number of Samples:                         1020 AIC:
20496.8911
                                                AICc:
20501.7562
                                                GCV:
9582.8678
                                                Scale:
8789.7827
                                                Pseudo R-Squared:
0.797
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.1
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           3.3
4.81e-01
s(3)                              [15.8489]            20           2.9
4.58e-02     *
f(4)                              [15.8489]            2            0.9
7.55e-01
f(5)                              [15.8489]            2            0.9
7.38e-01
f(6)                              [15.8489]            2            1.0
4.20e-02     *
f(7)                              [15.8489]            2            0.9
4.60e-01
f(8)                              [15.8489]            2            0.9
1.04e-01
f(9)                              [15.8489]            2            0.9
8.38e-01
s(10)                             [15.8489]            20           3.5
3.00e-01
s(11)                             [15.8489]            20           3.3
3.89e-03     **
s(12)                             [15.8489]            20           3.1
9.30e-12     ***
s(13)                             [15.8489]            20           3.4
4.50e-01
s(14)                             [15.8489]            20           2.5
```

```
6.70e-01
s(15)                            [15.8489]            20           2.1
4.94e-02     *
intercept                                             1            0.0
7.83e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

WARNING: Fitting splines and a linear function to a feature introduces a model
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estimated, the p-values
         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

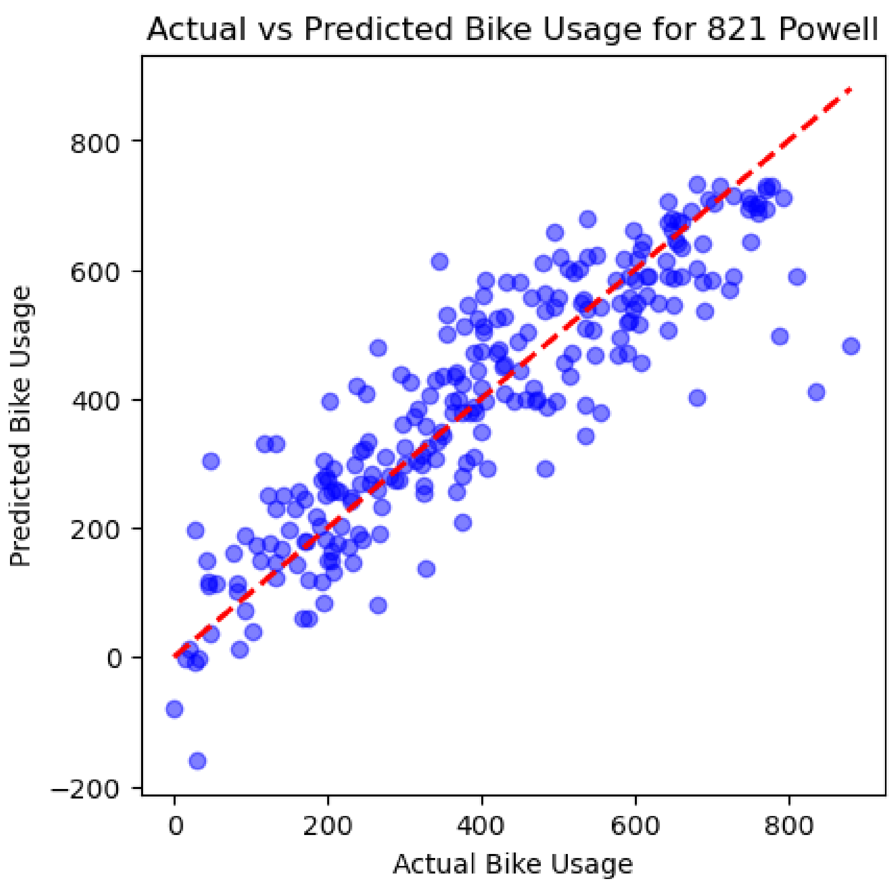

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for 821 Powell: 9458.880769895883

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane 885 Dunsmuir:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
43.6641
Link Function:                     IdentityLink Log Likelihood:
-7979.5073
Number of Samples:                          691 AIC:
16048.3427
                                                AICc:
16054.6636
                                                GCV:
46573.8545
                                                Scale:
41308.2396
                                                Pseudo R-Squared:
0.8654
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.1
1.11e-16     ***
s(1)                              [15.8489]            20           5.1
1.11e-16     ***
s(2)                              [15.8489]            20           4.2
1.49e-02     *
s(3)                              [15.8489]            20           2.9
4.95e-02     *
f(4)                              [15.8489]            2            0.9
```

```
2.16e-01
f(5)                              [15.8489]          2            0.9
8.23e-07     ***
f(6)                              [15.8489]          2            0.9
2.15e-06     ***
f(7)                              [15.8489]          2            0.9
1.71e-01
f(8)                              [15.8489]          2            0.9
3.93e-02     *
f(9)                              [15.8489]          2            0.9
1.09e-01
s(10)                             [15.8489]          20           2.7
1.22e-01
s(11)                             [15.8489]          20           2.7
6.55e-15     ***
s(12)                             [15.8489]          20           2.6
1.11e-16     ***
s(13)                             [15.8489]          20           2.4
1.32e-03     **
s(14)                             [15.8489]          20           2.1
3.50e-07     ***
s(15)                             [15.8489]          20           1.4
2.41e-04     ***
intercept                                            1            0.0
2.62e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

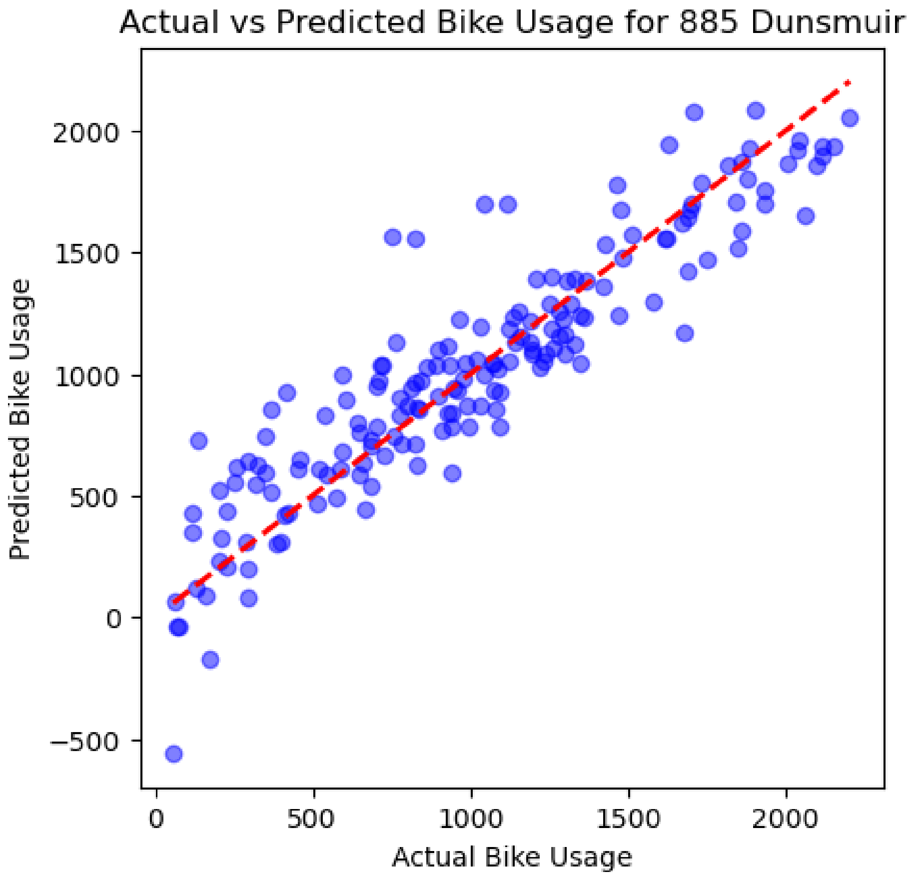


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for 885 Dunsmuir: 49212.5182340492
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Burrard at Cornwall - Eastside - Burrard Bridge:
LinearGAM
===============================================
======================================================
Distribution:                      NormalDist Effective DoF:
```

```
45.0913
Link Function:                     IdentityLink Log Likelihood:
-11671.705
Number of Samples:                          881 AIC:
23435.5925
                                                AICc:
23440.7981
                                                GCV:
249065.2322
                                                Scale:
226229.5078
                                                Pseudo R-Squared:
0.8022
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.3
1.11e-16     ***
s(1)                              [15.8489]            20           5.2
1.11e-16     ***
s(2)                              [15.8489]            20           3.1
5.72e-01
s(3)                              [15.8489]            20           3.0
9.57e-04     ***
f(4)                              [15.8489]            2            0.9
7.93e-01
f(5)                              [15.8489]            2            0.9
8.65e-01
f(6)                              [15.8489]            2            0.9
4.30e-01
f(7)                              [15.8489]            2            0.9
8.38e-01
f(8)                              [15.8489]            2            0.9
9.61e-01
f(9)                              [15.8489]            2            0.9
2.57e-01
s(10)                             [15.8489]            20           3.4
5.39e-01
s(11)                             [15.8489]            20           3.2
1.48e-04     ***
s(12)                             [15.8489]            20           3.1
1.29e-01
s(13)                             [15.8489]            20           2.4
9.12e-01
s(14)                             [15.8489]            20           2.3
```

```
1.23e-01
s(15)                               [15.8489]           20            1.6
1.65e-01
intercept                                               1             0.0
7.29e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

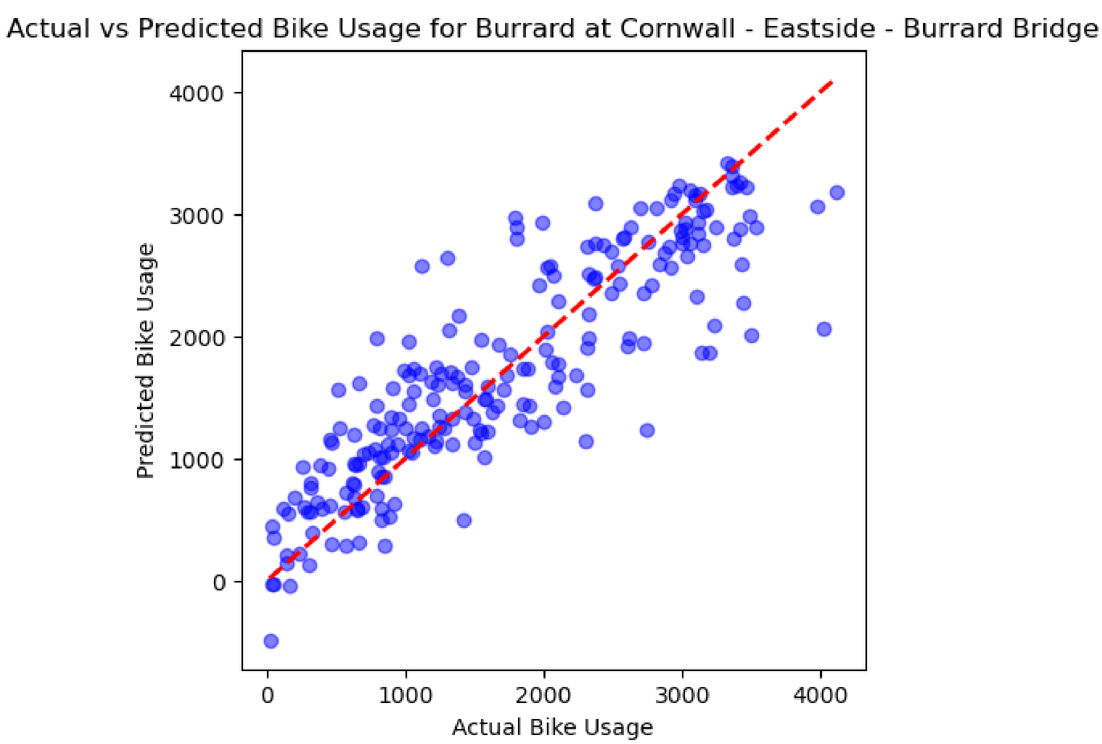


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Burrard at Cornwall - Eastside - Burrard Bridge:
259238.1967909589
```

```
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:01
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:01 Time:  0:00:01

Summary for lane Burrard at Cornwall - Westside - Burrard Bridge:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
45.468
Link Function:                     IdentityLink Log Likelihood:
-11132.6565
Number of Samples:                          840 AIC:
22358.249
                                                AICc:
22363.8153
                                                GCV:
251747.9669
                                                Scale:
227344.5509
                                                Pseudo R-Squared:
0.8183
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           11.7
1.11e-16     ***
s(1)                              [15.8489]            20           5.2
1.11e-16     ***
s(2)                              [15.8489]            20           3.6
6.17e-01
s(3)                              [15.8489]            20           2.2
8.24e-04     ***
f(4)                              [15.8489]            2            0.9
6.85e-01
f(5)                              [15.8489]            2            0.9
7.90e-01
```

```
f(6)                              [15.8489]           2             0.9
2.39e-01
f(7)                              [15.8489]           2             0.9
3.30e-01
f(8)                              [15.8489]           2             0.9
8.30e-01
f(9)                              [15.8489]           2             0.9
2.15e-01
s(10)                             [15.8489]           20            3.3
6.43e-01
s(11)                             [15.8489]           20            3.7
6.37e-03     **
s(12)                             [15.8489]           20            3.1
2.25e-01
s(13)                             [15.8489]           20            2.9
6.87e-01
s(14)                             [15.8489]           20            2.5
5.66e-01
s(15)                             [15.8489]           20            1.8
2.54e-01
intercept                                             1             0.0
5.32e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

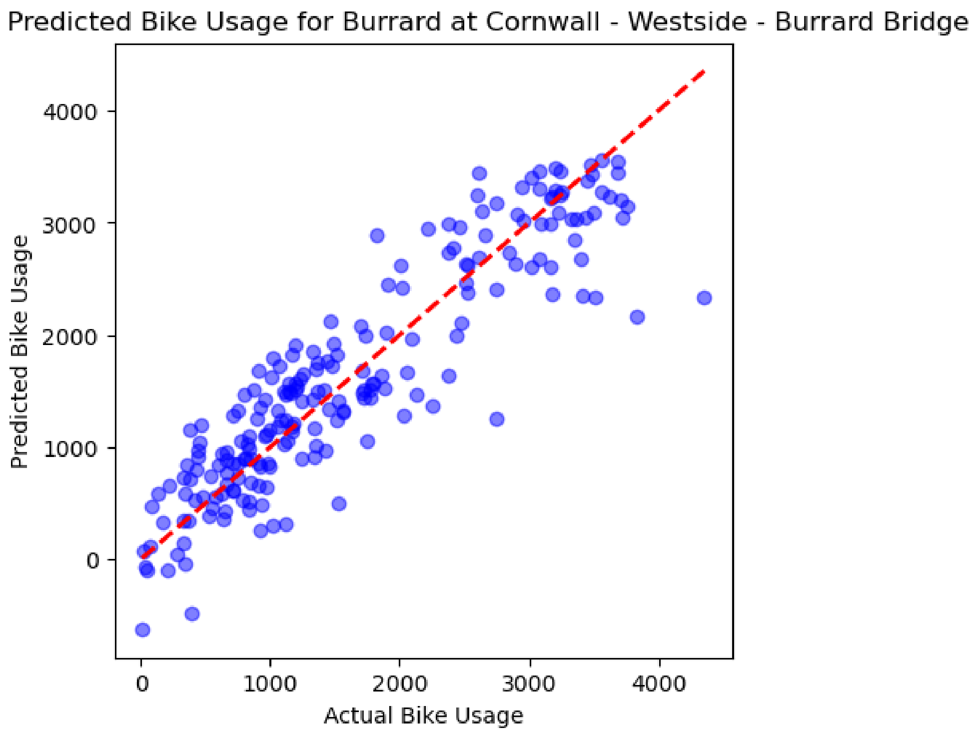


```
  0% (0 of 11) |                          | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Burrard at Cornwall - Westside - Burrard Bridge:
206461.65609922772

  9% (1 of 11) |##                        | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############             | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane Cambie Bridge - Eastside:
LinearGAM
===============================================
=========================================================
Distribution:                      NormalDist Effective DoF:
32.6478
Link Function:                   IdentityLink Log Likelihood:
-9667.8645
```

```
Number of Samples:                            838 AIC:
19403.0245
                                                  AICc:
19405.9269
                                                  GCV:
43928.3589
                                                  Scale:
40858.9184
                                                  Pseudo R-Squared:
0.695
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.4
1.11e-16     ***
s(1)                              [63.0957]            20           3.9
1.11e-16     ***
s(2)                              [63.0957]            20           2.5
1.54e-01
s(3)                              [63.0957]            20           2.0
1.99e-01
f(4)                              [63.0957]            2            0.9
9.33e-01
f(5)                              [63.0957]            2            0.9
5.63e-04     ***
f(6)                              [63.0957]            2            0.9
9.24e-04     ***
f(7)                              [63.0957]            2            0.9
8.78e-02     .
f(8)                              [63.0957]            2            0.9
1.58e-01
f(9)                              [63.0957]            2            0.8
3.80e-01
s(10)                             [63.0957]            20           2.1
2.68e-01
s(11)                             [63.0957]            20           2.0
2.41e-13     ***
s(12)                             [63.0957]            20           2.0
1.11e-16     ***
s(13)                             [63.0957]            20           1.4
2.47e-02     *
s(14)                             [63.0957]            20           1.3
3.02e-01
s(15)                             [63.0957]            20           0.9
1.49e-01
```

```
intercept                                                   1            0.0
4.18e-02     *
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

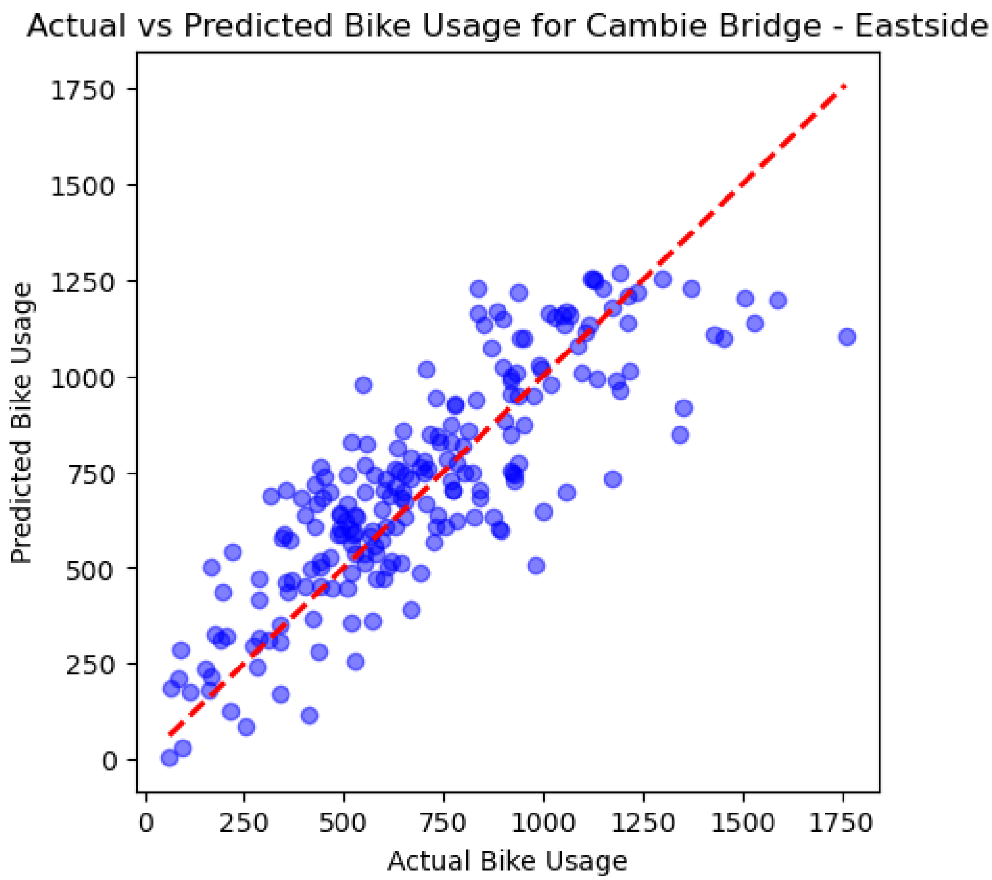


```
  0% (0 of 11) |                        | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Cambie Bridge - Eastside: 33091.23622016974
```

```
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Canada Line Bridge at West Kent:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
44.3281
Link Function:                     IdentityLink Log Likelihood:
-9170.7051
Number of Samples:                          789 AIC:
18432.0664
                                                AICc:
18437.7215
                                                GCV:
49526.9114
                                                Scale:
44544.8236
                                                Pseudo R-Squared:
0.7696
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.0
1.11e-16     ***
s(1)                              [15.8489]            20           5.1
1.11e-16     ***
s(2)                              [15.8489]            20           3.6
9.16e-01
s(3)                              [15.8489]            20           3.0
3.36e-03     **
f(4)                              [15.8489]            2            0.9
8.53e-01
f(5)                              [15.8489]            2            0.9
1.43e-02     *
```

```
f(6)                              [15.8489]            2             0.9
4.79e-01
f(7)                              [15.8489]            2             0.9
3.99e-01
f(8)                              [15.8489]            2             0.9
3.73e-01
f(9)                              [15.8489]            2             0.9
2.87e-01
s(10)                             [15.8489]            20            3.1
9.56e-01
s(11)                             [15.8489]            20            2.9
1.33e-13     ***
s(12)                             [15.8489]            20            2.8
8.21e-10     ***
s(13)                             [15.8489]            20            2.7
3.04e-01
s(14)                             [15.8489]            20            2.2
5.44e-01
s(15)                             [15.8489]            20            1.5
8.35e-01
intercept                                              1             0.0
2.43e-02     *
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

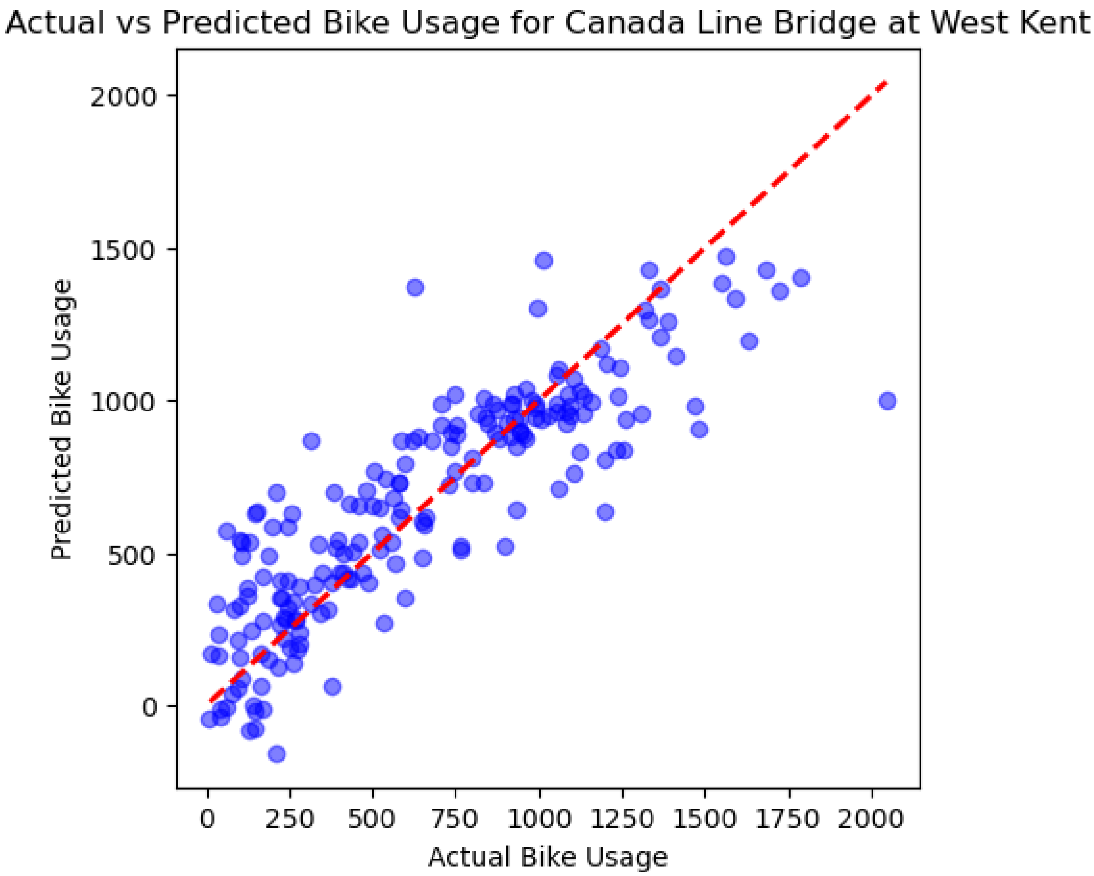


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Canada Line Bridge at West Kent: 51895.48680391936
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Central Valley Greenway at Victoria:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
21.5354
Link Function:                          IdentityLink Log Likelihood:
-6527.4218
Number of Samples:                               490 AIC:
13099.9145
                                                     AICc:
13102.1886
                                                     GCV:
264181.5435
                                                     Scale:
243367.594
                                                     Pseudo R-Squared:
0.5548
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [251.1886]           20           6.8
1.11e-16     ***
s(1)                              [251.1886]           20           2.7
1.11e-16     ***
s(2)                              [251.1886]           20           1.7
8.23e-01
s(3)                              [251.1886]           20           1.1
1.40e-03     **
f(4)                              [251.1886]           2            0.9
9.39e-01
f(5)                              [251.1886]           2            0.8
7.64e-01
f(6)                              [251.1886]           2            0.8
3.55e-01
f(7)                              [251.1886]           2            0.8
7.67e-01
f(8)                              [251.1886]           2            0.8
4.40e-01
f(9)                              [251.1886]           2            0.8
9.27e-01
s(10)                             [251.1886]           20           0.9
8.77e-01
s(11)                             [251.1886]           20           0.9
4.99e-01
s(12)                             [251.1886]           20           0.7
6.03e-02     .
s(13)                             [251.1886]           20           0.8
8.64e-02     .
s(14)                             [251.1886]           20           0.7
```

```
5.12e-01
s(15)                         [251.1886]          20            0.4
4.68e-02     *
intercept                                         1             0.0
4.26e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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         known smoothing parameters, but when smoothing parameters have been
estimated, the p-values
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the null too readily.
```

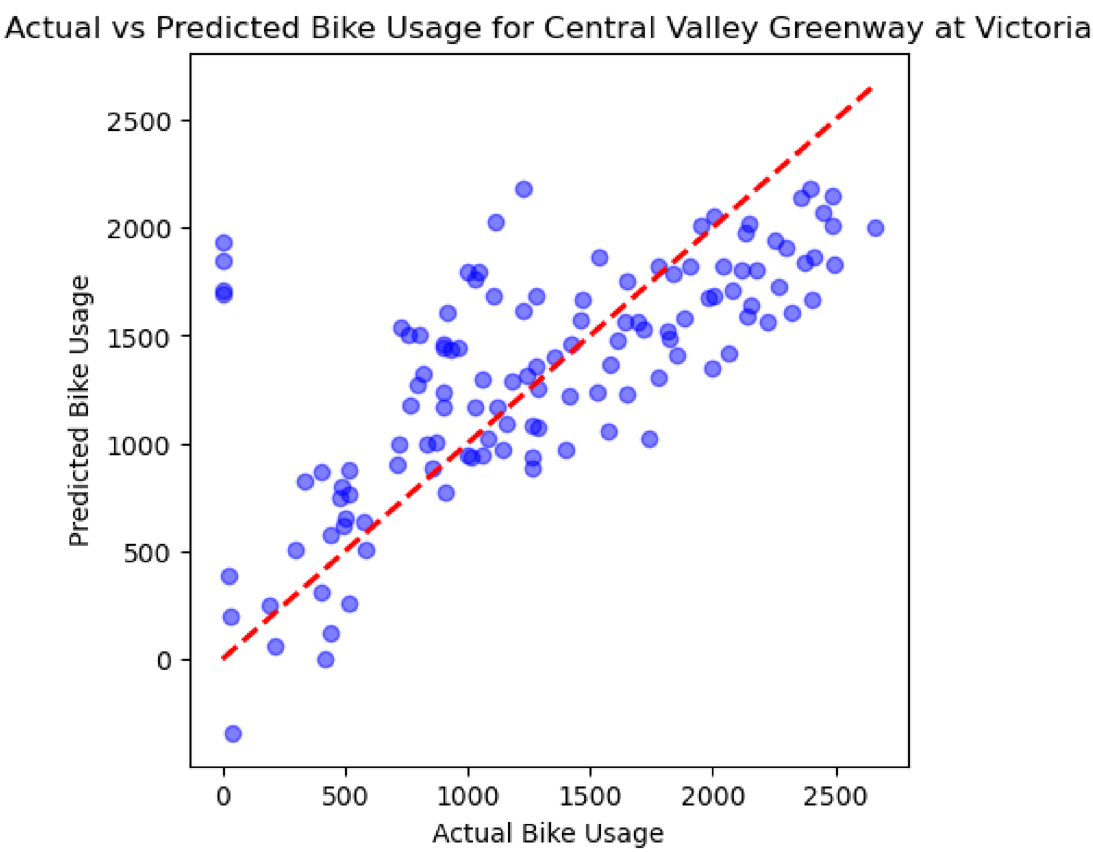


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
```

```
Mean Squared Error for Central Valley Greenway at Victoria: 260071.06070436985
  9% (1 of 11) |##                        | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############             | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Comox at Thurlow:
LinearGAM
===============================================
=========================================================
Distribution:                        NormalDist Effective DoF:
34.2502
Link Function:                     IdentityLink Log Likelihood:
-10642.8562
Number of Samples:                         1051 AIC:
21356.2127
                                                AICc:
21358.7312
                                                GCV:
10590.2128
                                                Scale:
9970.8646
                                                Pseudo R-Squared:
0.7454
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.7
1.11e-16     ***
s(1)                              [63.0957]            20           4.0
1.11e-16     ***
s(2)                              [63.0957]            20           2.3
8.72e-04     ***
s(3)                              [63.0957]            20           1.4
1.68e-01
f(4)                              [63.0957]            2            0.9
4.39e-01
f(5)                              [63.0957]            2            0.9
```

```
7.61e-03     **
f(6)                                [63.0957]          2            0.9
4.83e-01
f(7)                                [63.0957]          2            0.9
1.92e-01
f(8)                                [63.0957]          2            0.9
5.22e-01
f(9)                                [63.0957]          2            0.8
3.52e-01
s(10)                               [63.0957]          20           2.4
1.01e-04     ***
s(11)                               [63.0957]          20           2.5
1.17e-06     ***
s(12)                               [63.0957]          20           1.9
3.33e-16     ***
s(13)                               [63.0957]          20           1.8
2.19e-01
s(14)                               [63.0957]          20           1.7
6.54e-01
s(15)                               [63.0957]          20           1.4
2.38e-01
intercept                                              1            0.0
7.99e-02     .
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

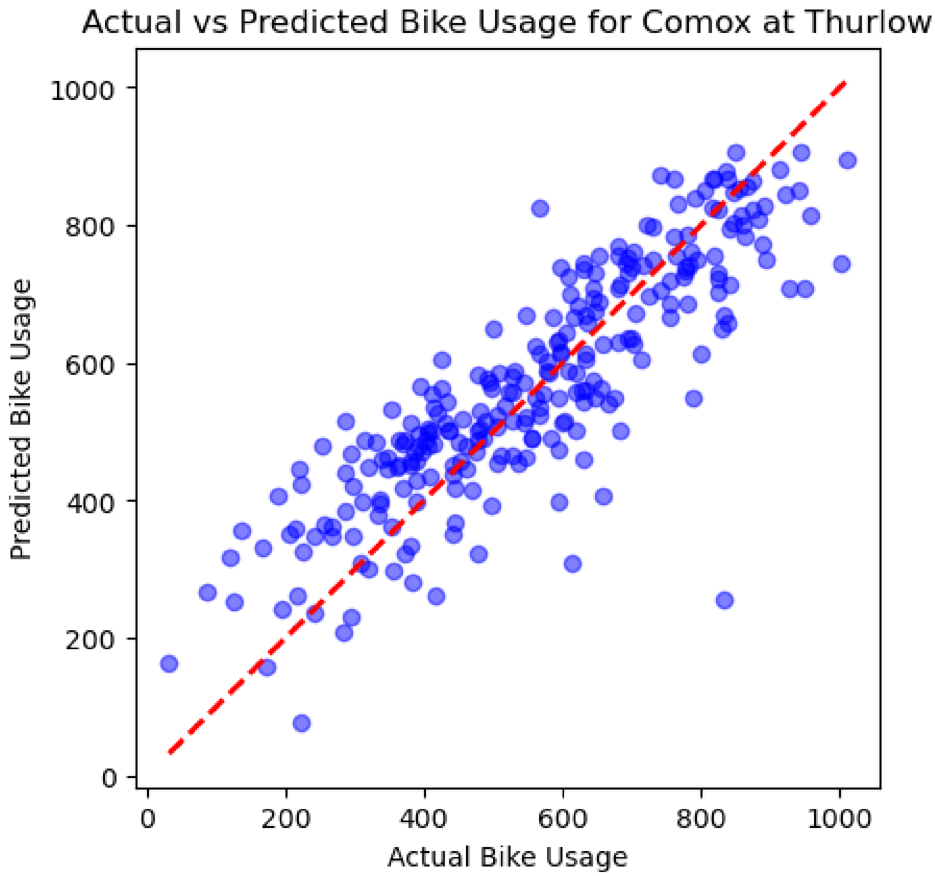


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Comox at Thurlow: 11103.789157697169

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Dunsmuir Viaduct at Main:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
```

```
43.135
Link Function:                             IdentityLink Log Likelihood:
-8344.8082
Number of Samples:                                  716 AIC:
16777.8864
                                                        AICc:
16783.8251
                                                        GCV:
51529.0302
                                                        Scale:
45973.0612
                                                        Pseudo R-Squared:
0.854
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.0
1.11e-16     ***
s(1)                              [15.8489]            20           5.1
1.11e-16     ***
s(2)                              [15.8489]            20           3.6
9.47e-03     **
s(3)                              [15.8489]            20           2.9
1.14e-01
f(4)                              [15.8489]            2            0.9
3.26e-01
f(5)                              [15.8489]            2            0.9
2.86e-05     ***
f(6)                              [15.8489]            2            0.9
1.58e-07     ***
f(7)                              [15.8489]            2            0.9
1.60e-01
f(8)                              [15.8489]            2            0.9
2.96e-01
f(9)                              [15.8489]            2            0.9
2.81e-01
s(10)                             [15.8489]            20           3.2
3.28e-01
s(11)                             [15.8489]            20           2.8
1.25e-14     ***
s(12)                             [15.8489]            20           2.6
1.11e-16     ***
s(13)                             [15.8489]            20           2.3
5.25e-04     ***
s(14)                             [15.8489]            20           1.8
```

```
7.19e-07     ***
s(15)                              [15.8489]            20            1.4
1.16e-05     ***
intercept                                               1             0.0
2.69e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

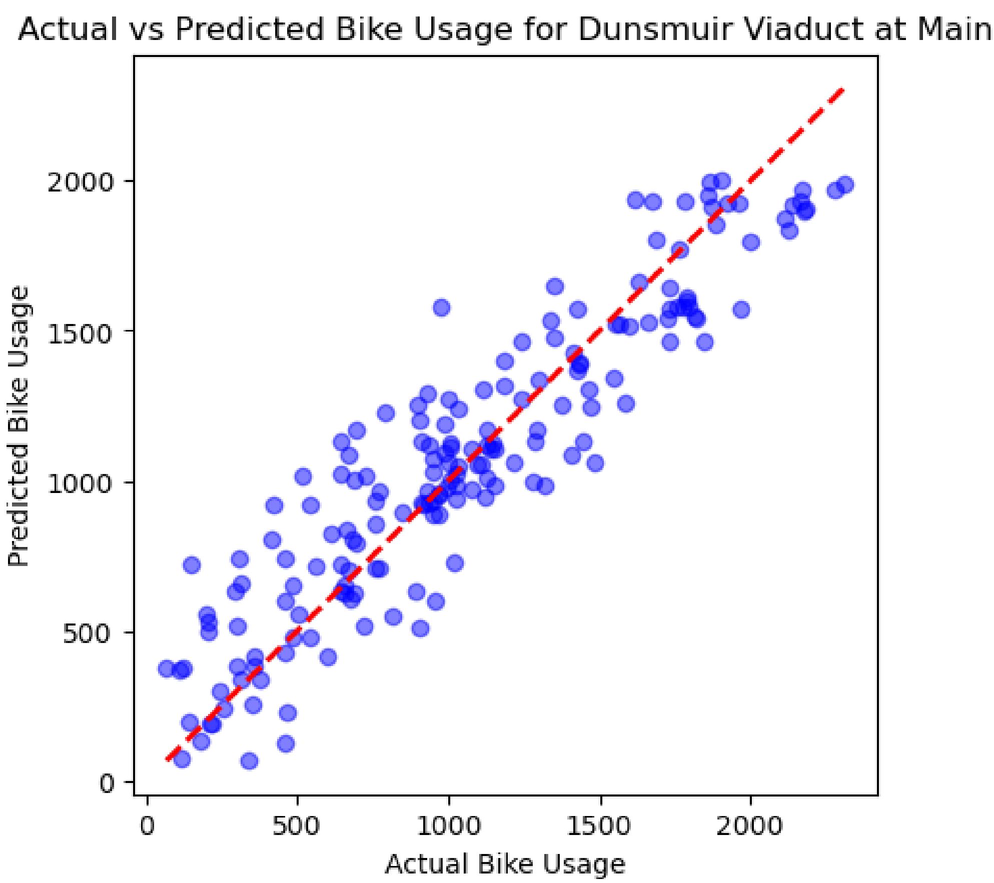

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Dunsmuir Viaduct at Main: 47750.56948435841
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Dunsmuir at Beatty:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
15.5934
Link Function:                     IdentityLink Log Likelihood:
-6260.0382
Number of Samples:                          463 AIC:
12553.2632
                                                AICc:
12554.5741
                                                GCV:
316158.2597
                                                Scale:
297051.4065
                                                Pseudo R-Squared:
0.5877
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [1000.]              20           5.1
1.11e-16     ***
s(1)                              [1000.]              20           2.0
1.11e-16     ***
s(2)                              [1000.]              20           1.3
9.13e-01
s(3)                              [1000.]              20           1.1
7.72e-01
f(4)                              [1000.]              2            0.7
```

```
3.83e-01
f(5)                              [1000.]              2            0.7
3.56e-02     *
f(6)                              [1000.]              2            0.7
1.53e-01
f(7)                              [1000.]              2            0.6
1.43e-01
f(8)                              [1000.]              2            0.6
9.83e-01
f(9)                              [1000.]              2            0.6
3.96e-01
s(10)                             [1000.]              20           0.5
9.75e-01
s(11)                             [1000.]              20           0.4
6.14e-05     ***
s(12)                             [1000.]              20           0.4
2.03e-09     ***
s(13)                             [1000.]              20           0.3
9.12e-01
s(14)                             [1000.]              20           0.2
9.26e-01
s(15)                             [1000.]              20           0.2
8.63e-01
intercept                                              1            0.0
1.36e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

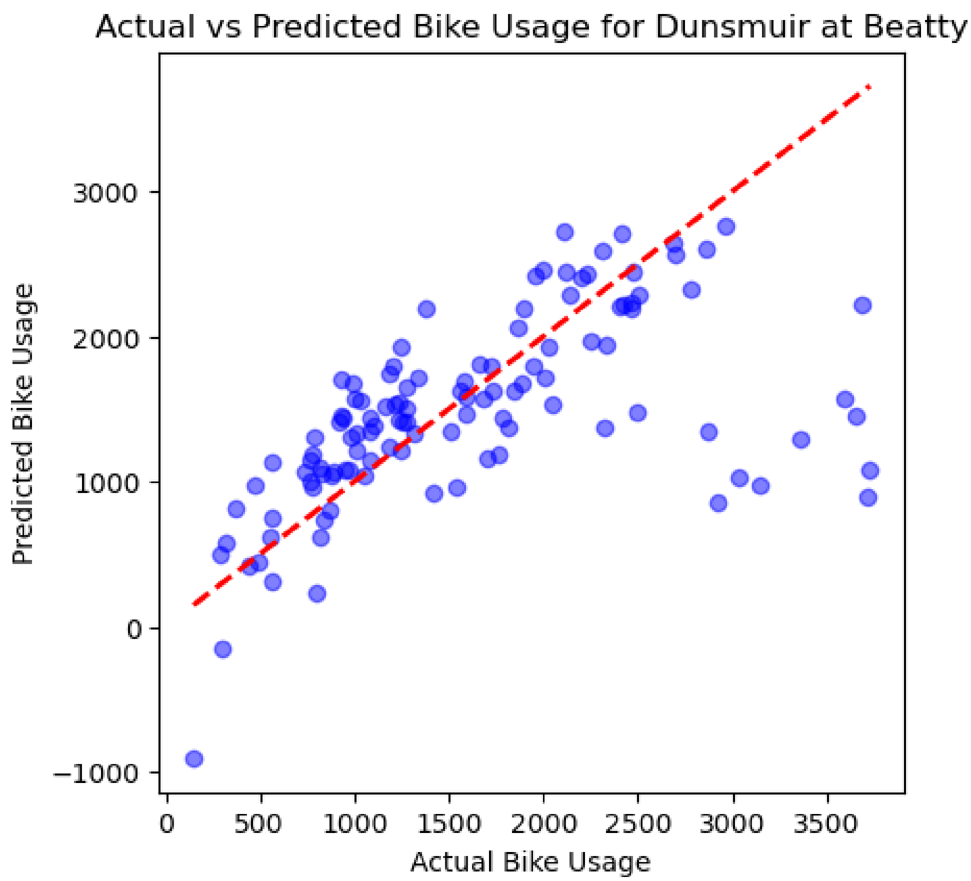


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Dunsmuir at Beatty: 527109.9577395204

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane East 10th at Clark:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
22.8937
Link Function:                          IdentityLink Log Likelihood:
-9063.1997
Number of Samples:                               684 AIC:
18174.1867
                                                     AICc:
18175.9916
                                                     GCV:
241178.2608
                                                     Scale:
226692.8517
                                                     Pseudo R-Squared:
0.5362
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [251.1886]           20           7.1
1.11e-16     ***
s(1)                              [251.1886]           20           2.7
1.11e-16     ***
s(2)                              [251.1886]           20           1.7
2.48e-01
s(3)                              [251.1886]           20           1.2
9.83e-03     **
f(4)                              [251.1886]           2            0.8
1.98e-01
f(5)                              [251.1886]           2            0.8
2.39e-01
f(6)                              [251.1886]           2            0.8
4.80e-02     *
f(7)                              [251.1886]           2            0.8
3.52e-01
f(8)                              [251.1886]           2            0.8
4.05e-01
f(9)                              [251.1886]           2            0.7
6.72e-01
s(10)                             [251.1886]           20           1.2
5.73e-01
s(11)                             [251.1886]           20           1.2
3.58e-01
s(12)                             [251.1886]           20           1.0
4.89e-02     *
s(13)                             [251.1886]           20           0.9
6.06e-03     **
s(14)                             [251.1886]           20           0.8
```

```
1.25e-01
s(15)                              [251.1886]           20            0.4
8.24e-01
intercept                                               1             0.0
3.50e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

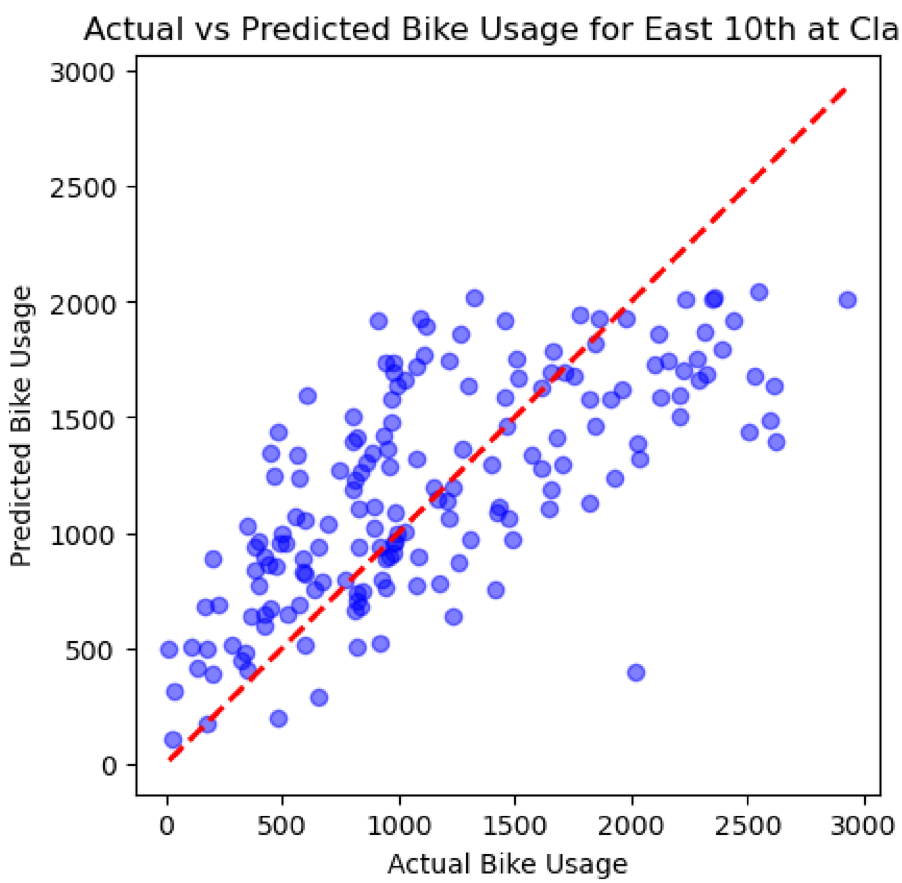

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for East 10th at Clark: 233144.1929463925

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Fleming at East 57th:
LinearGAM
===============================================
=========================================================
Distribution:                        NormalDist Effective DoF:
30.3154
Link Function:                     IdentityLink Log Likelihood:
-3593.7329
Number of Samples:                          517 AIC:
7250.0965
                                                AICc:
7254.2722
                                                GCV:
464.9582
                                                Scale:
416.1551
                                                Pseudo R-Squared:
0.8121
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.5
1.11e-16     ***
s(1)                              [63.0957]            20           3.6
1.11e-16     ***
s(2)                              [63.0957]            20           2.4
2.19e-01
s(3)                              [63.0957]            20           1.9
2.32e-02     *
f(4)                              [63.0957]            2            0.9
```

```
4.55e-01
f(5)                              [63.0957]            2             0.9
8.65e-02     .
f(6)                              [63.0957]            2             0.8
2.43e-02     *
f(7)                              [63.0957]            2             0.8
6.75e-01
f(8)                              [63.0957]            2             0.8
4.67e-01
f(9)                              [63.0957]            2             0.8
6.94e-01
s(10)                             [63.0957]            20            2.4
3.09e-01
s(11)                             [63.0957]            20            1.5
2.86e-10     ***
s(12)                             [63.0957]            20            1.3
2.62e-13     ***
s(13)                             [63.0957]            20            1.1
1.13e-02     *
s(14)                             [63.0957]            20            1.1
2.04e-03     **
s(15)                             [63.0957]            20            0.7
4.51e-02     *
intercept                                              1             0.0
1.57e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

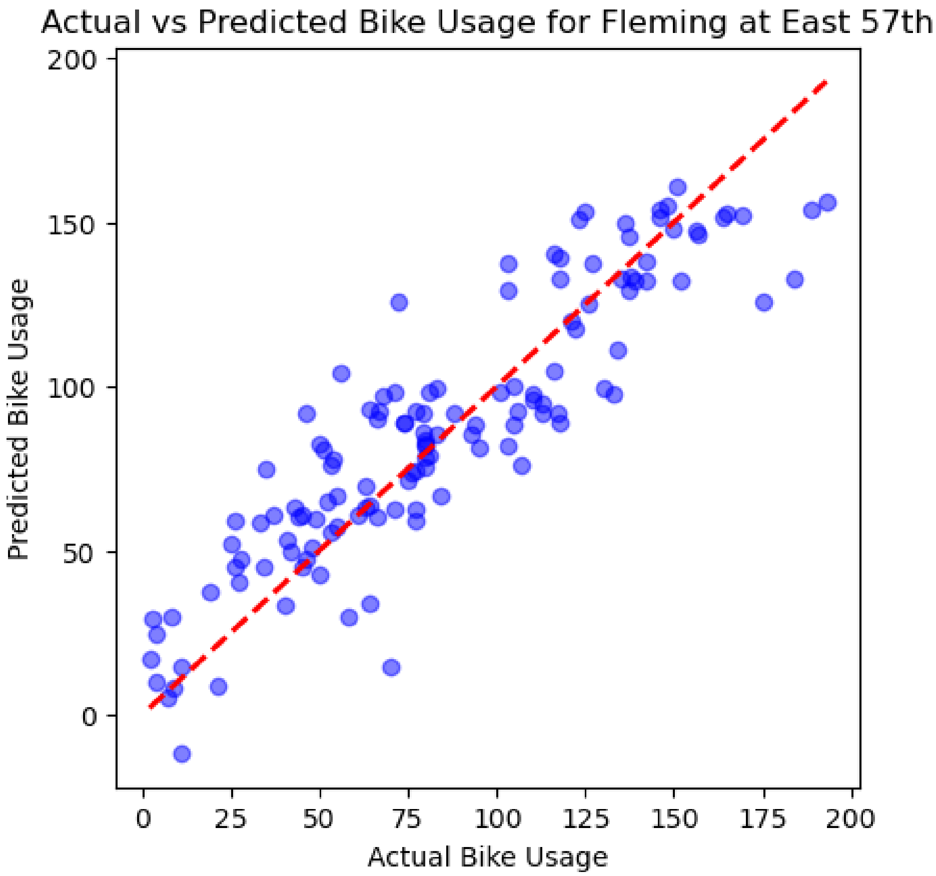


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Fleming at East 57th: 411.76568013383735
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:01
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Helmcken at Burrard:
LinearGAM
===============================================
=========================================================
Distribution:                      NormalDist Effective DoF:
```

```
22.1656
Link Function:                        IdentityLink Log Likelihood:
-5351.0393
Number of Samples:                             520 AIC:
10748.4098
                                                   AICc:
10750.6679
                                                   GCV:
12720.6548
                                                   Scale:
11748.4985
                                                   Pseudo R-Squared:
0.8182
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [251.1886]           20           7.2
1.11e-16     ***
s(1)                              [251.1886]           20           2.7
1.11e-16     ***
s(2)                              [251.1886]           20           1.4
4.49e-06     ***
s(3)                              [251.1886]           20           1.0
9.88e-01
f(4)                              [251.1886]           2            0.8
9.23e-01
f(5)                              [251.1886]           2            0.8
9.52e-03     **
f(6)                              [251.1886]           2            0.8
6.65e-03     **
f(7)                              [251.1886]           2            0.7
4.47e-01
f(8)                              [251.1886]           2            0.8
4.40e-01
f(9)                              [251.1886]           2            0.7
8.18e-01
s(10)                             [251.1886]           20           1.2
4.26e-01
s(11)                             [251.1886]           20           1.2
3.33e-16     ***
s(12)                             [251.1886]           20           0.9
1.11e-16     ***
s(13)                             [251.1886]           20           0.6
4.18e-01
s(14)                             [251.1886]           20           0.6
```

```
1.35e-01
s(15)                              [251.1886]          20           0.4
1.86e-01
intercept                                              1            0.0
4.02e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

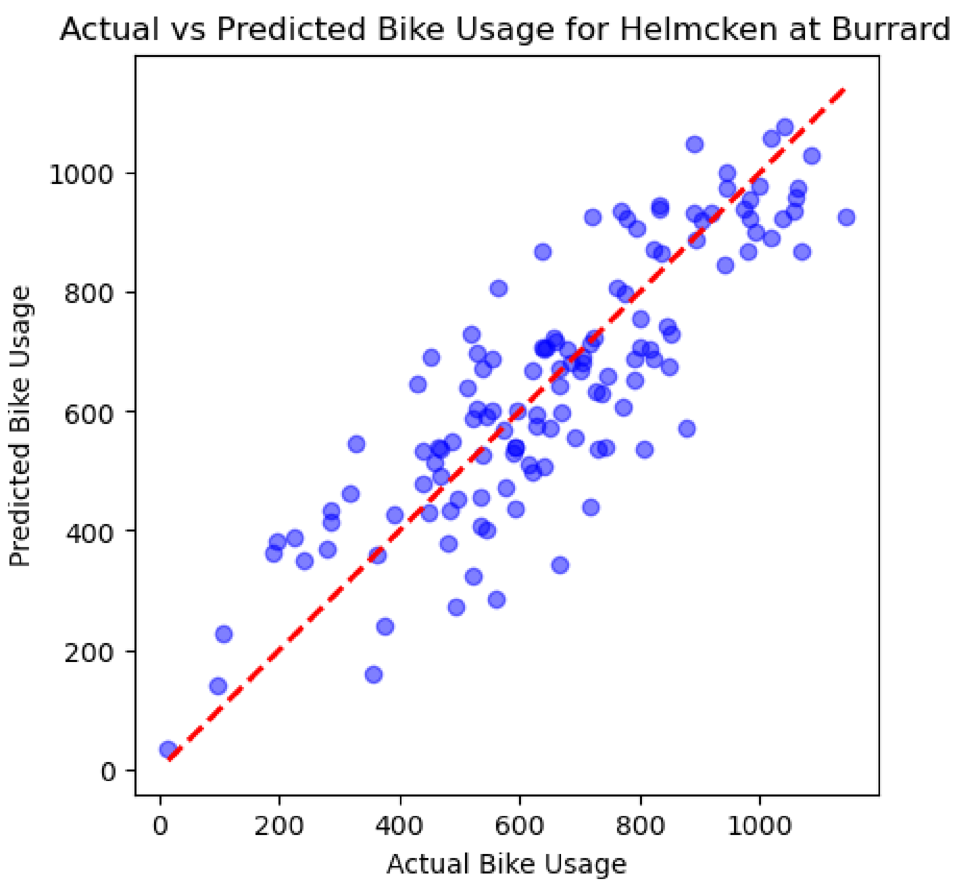

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Helmcken at Burrard: 15463.1295696251
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Lions Gate Bridge at Spirit Trail - Eastside:
LinearGAM
===============================================
=============================================================
Distribution:                        NormalDist Effective DoF:
32.7391
Link Function:                     IdentityLink Log Likelihood:
-8941.4194
Number of Samples:                          766 AIC:
17950.3168
                                                AICc:
17953.5224
                                                GCV:
50698.153
                                                Scale:
46813.2948
                                                Pseudo R-Squared:
0.757
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.2
1.11e-16     ***
s(1)                              [63.0957]            20           3.8
1.11e-16     ***
s(2)                              [63.0957]            20           3.0
9.33e-01
s(3)                              [63.0957]            20           1.7
2.68e-04     ***
f(4)                              [63.0957]            2            0.9
```

```
4.35e-01
f(5)                              [63.0957]            2            0.9
6.84e-01
f(6)                              [63.0957]            2            0.9
9.63e-01
f(7)                              [63.0957]            2            0.9
8.91e-01
f(8)                              [63.0957]            2            0.9
8.70e-01
f(9)                              [63.0957]            2            0.8
5.63e-01
s(10)                             [63.0957]            20           2.4
7.97e-01
s(11)                             [63.0957]            20           1.8
1.03e-09     ***
s(12)                             [63.0957]            20           1.5
8.86e-02     .
s(13)                             [63.0957]            20           1.9
6.84e-01
s(14)                             [63.0957]            20           1.3
6.19e-01
s(15)                             [63.0957]            20           0.9
5.62e-01
intercept                                              1            0.0
2.79e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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models or models with
         known smoothing parameters, but when smoothing parameters have been
estimated, the p-values
         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

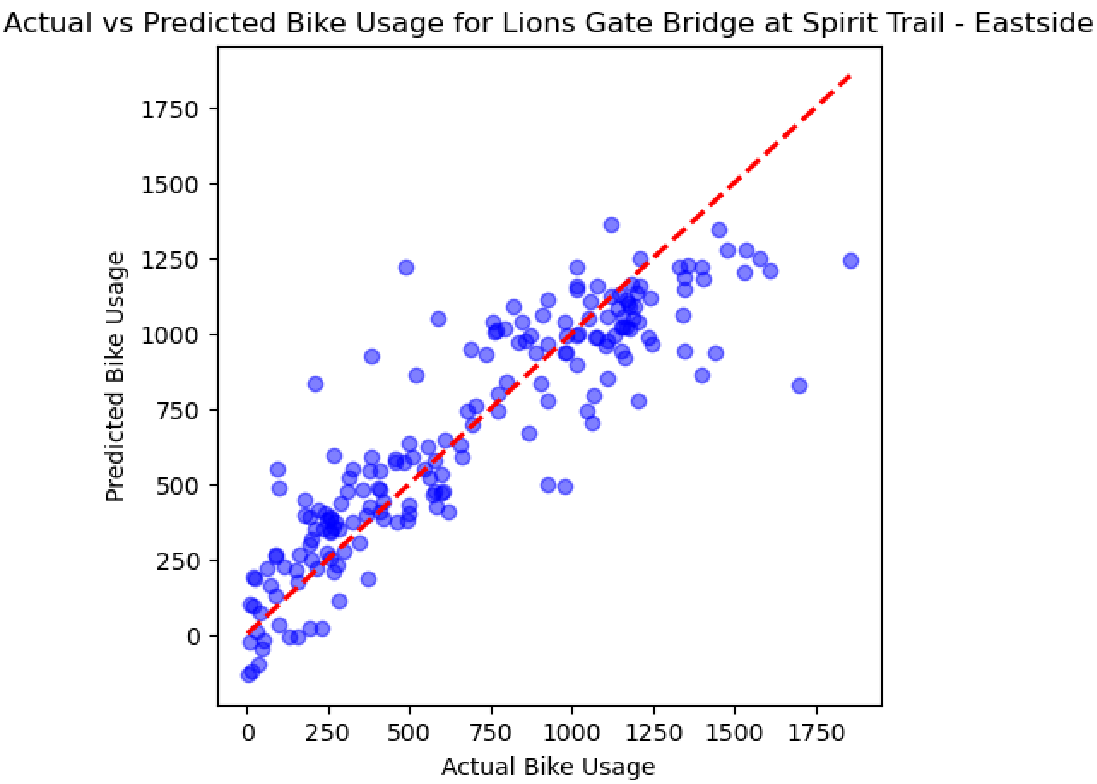


```
  0% (0 of 11) |                          | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Lions Gate Bridge at Spirit Trail - Eastside:
42823.89807446513

  9% (1 of 11) |##                        | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |##############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |################          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |#####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#######################  | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |#########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Lions Gate Bridge at Spirit Trail - Westside:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
47.3045
Link Function:                   IdentityLink Log Likelihood:
```

```
-12265.2732
Number of Samples:                         1052 AIC:
24627.1553
                                                AICc:
24631.9057
                                                GCV:
50216.064
                                                Scale:
46168.6257
                                                Pseudo R-Squared:
0.7639
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.1
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           3.8
7.00e-01
s(3)                              [15.8489]            20           2.4
4.29e-06     ***
f(4)                              [15.8489]            2            0.9
6.12e-01
f(5)                              [15.8489]            2            0.9
5.06e-01
f(6)                              [15.8489]            2            0.9
6.77e-01
f(7)                              [15.8489]            2            0.9
8.65e-01
f(8)                              [15.8489]            2            0.9
9.77e-01
f(9)                              [15.8489]            2            0.9
2.50e-01
s(10)                             [15.8489]            20           3.4
8.43e-01
s(11)                             [15.8489]            20           3.5
4.80e-10     ***
s(12)                             [15.8489]            20           3.3
2.36e-03     **
s(13)                             [15.8489]            20           3.1
9.33e-01
s(14)                             [15.8489]            20           2.9
8.43e-01
s(15)                             [15.8489]            20           1.9
```

```
8.54e-01
intercept                                                        1            0.0
5.03e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

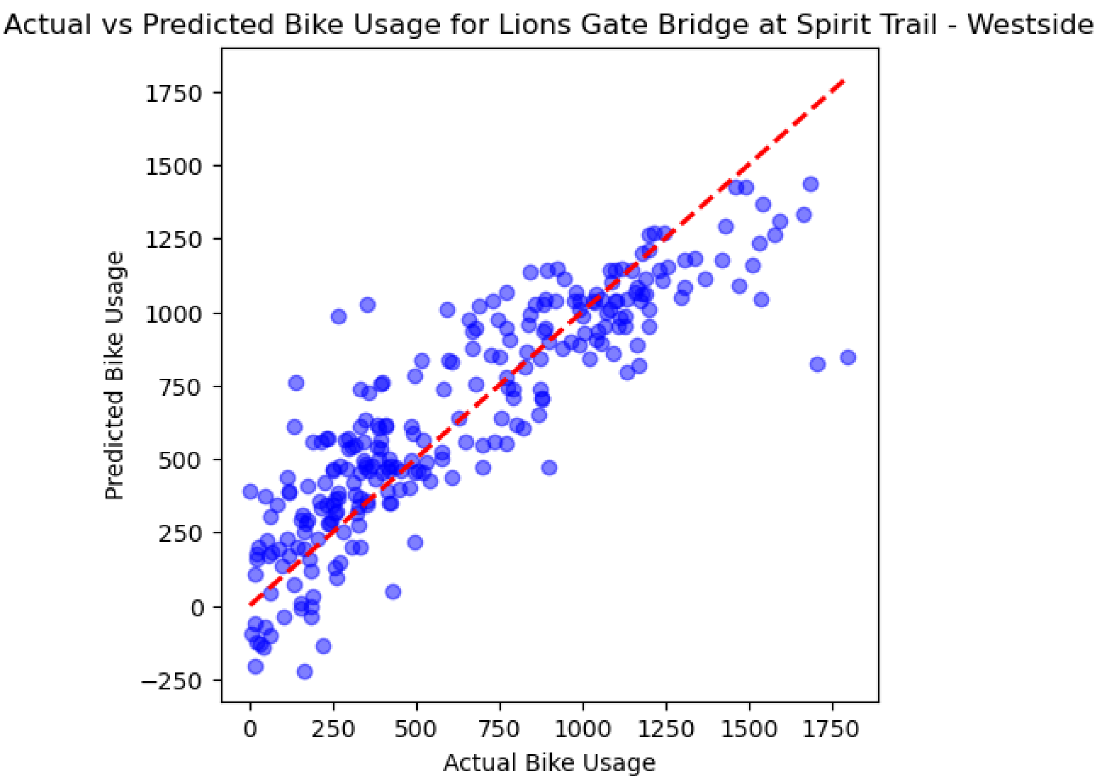


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Lions Gate Bridge at Spirit Trail - Westside:
44841.89382542534

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
```

```
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############             | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |#########################| Elapsed Time: 0:00:00 Time:  0:00:00
```

```
Summary for lane Point Grey at Alma:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
31.7052
Link Function:                     IdentityLink Log Likelihood:
-8926.2095
Number of Samples:                          652 AIC:
17917.8294
                                                AICc:
17921.3951
                                                GCV:
385667.1028
                                                Scale:
352063.1196
                                                Pseudo R-Squared:
0.7378
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.5
1.11e-16     ***
s(1)                              [63.0957]            20           3.7
1.11e-16     ***
s(2)                              [63.0957]            20           2.6
9.88e-01
s(3)                              [63.0957]            20           1.6
1.18e-01
f(4)                              [63.0957]            2            0.8
6.99e-01
f(5)                              [63.0957]            2            0.9
3.28e-01
f(6)                              [63.0957]            2            0.8
```

```
4.81e-01
f(7)                              [63.0957]            2            0.8
7.84e-01
f(8)                              [63.0957]            2            0.8
4.80e-01
f(9)                              [63.0957]            2            0.8
3.56e-01
s(10)                             [63.0957]            20           1.9
8.82e-01
s(11)                             [63.0957]            20           2.0
5.34e-07     ***
s(12)                             [63.0957]            20           1.7
2.27e-03     **
s(13)                             [63.0957]            20           1.5
7.08e-01
s(14)                             [63.0957]            20           1.4
8.42e-01
s(15)                             [63.0957]            20           0.9
9.75e-01
intercept                                              1            0.0
1.53e-02     *
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

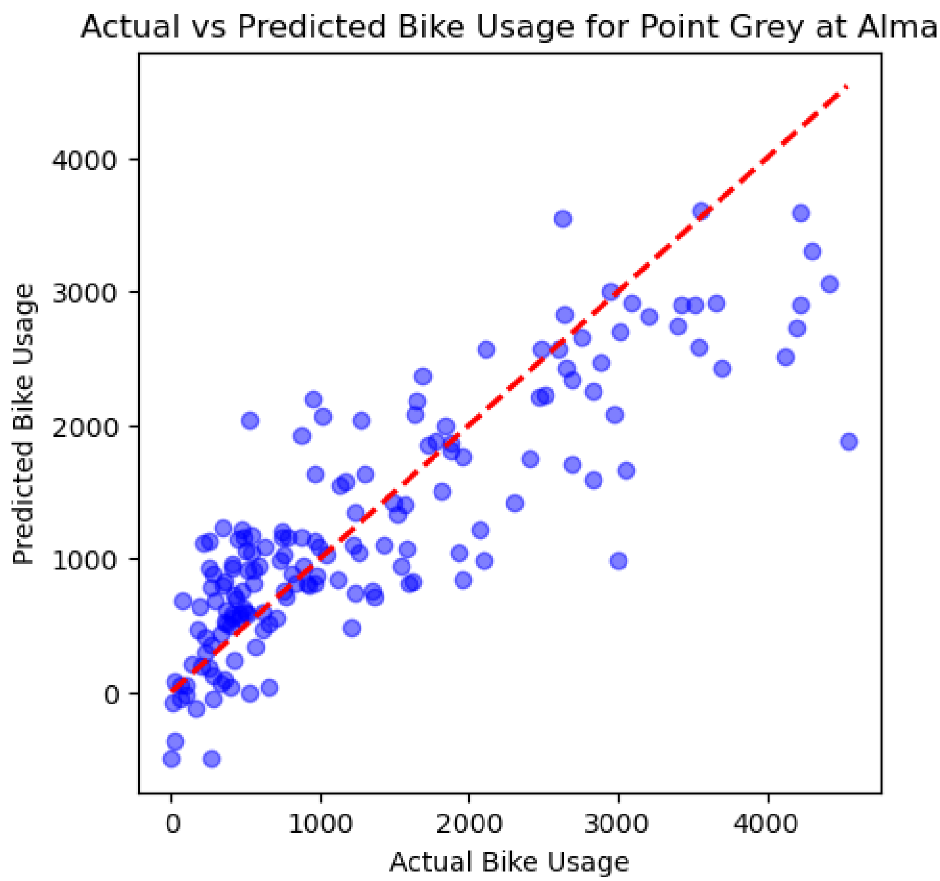


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Point Grey at Alma: 382277.382368473
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00
Summary for lane Point Grey at Stephens:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
31.6203
Link Function:                        IdentityLink Log Likelihood:
-8995.0569
Number of Samples:                             705 AIC:
18055.3544
                                                   AICc:
18058.6215
                                                   GCV:
150816.0151
                                                   Scale:
138691.0435
                                                   Pseudo R-Squared:
0.7026
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.5
1.11e-16     ***
s(1)                              [63.0957]            20           3.8
1.11e-16     ***
s(2)                              [63.0957]            20           2.3
9.75e-01
s(3)                              [63.0957]            20           2.1
1.84e-01
f(4)                              [63.0957]            2            0.8
6.23e-01
f(5)                              [63.0957]            2            0.9
7.62e-02     .
f(6)                              [63.0957]            2            0.9
8.39e-01
f(7)                              [63.0957]            2            0.8
7.95e-01
f(8)                              [63.0957]            2            0.9
4.09e-01
f(9)                              [63.0957]            2            0.8
3.18e-01
s(10)                             [63.0957]            20           1.8
9.14e-01
s(11)                             [63.0957]            20           1.8
1.55e-06     ***
s(12)                             [63.0957]            20           1.8
1.40e-02     *
s(13)                             [63.0957]            20           1.3
9.62e-01
s(14)                             [63.0957]            20           1.3
```

```
5.51e-01
s(15)                              [63.0957]           20            0.8
9.19e-01
intercept                                              1             0.0
1.57e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

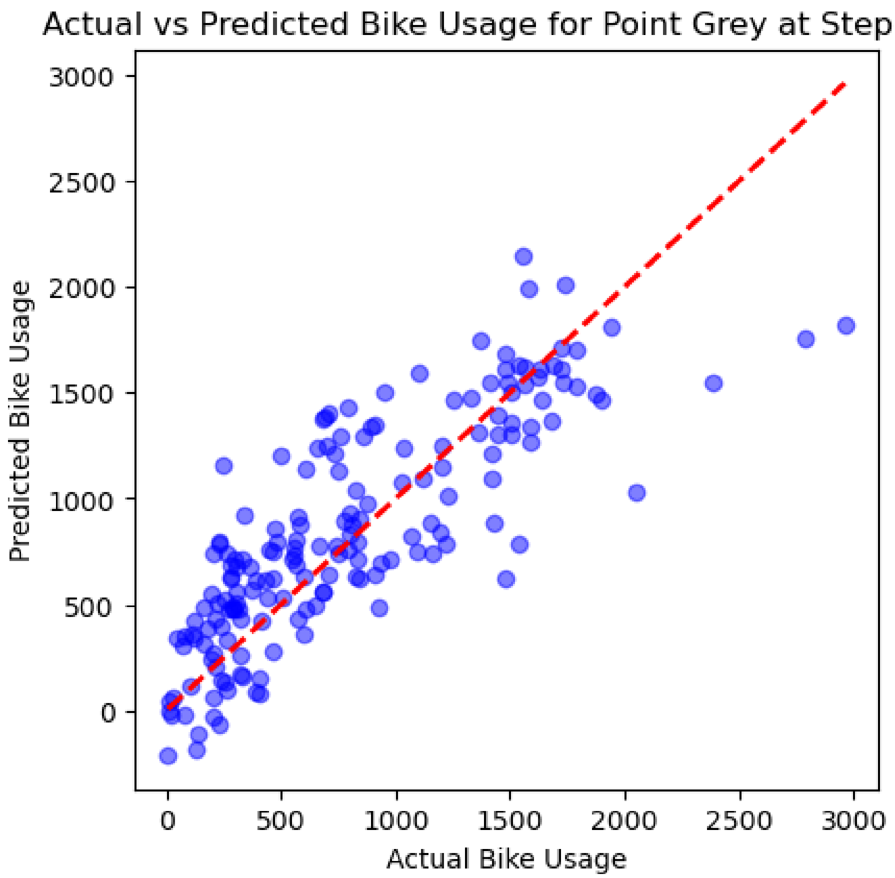

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Point Grey at Stephens: 116074.8285693996

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |######################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |#########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Point Grey at Volunteer Park:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
28.8965
Link Function:                     IdentityLink Log Likelihood:
-6129.2815
Number of Samples:                          426 AIC:
12318.3562
                                                AICc:
12323.0319
                                                GCV:
804814.5351
                                                Scale:
707183.8448
                                                Pseudo R-Squared:
0.7048
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.1
1.11e-16     ***
s(1)                              [63.0957]            20           3.7
1.11e-16     ***
s(2)                              [63.0957]            20           2.5
9.80e-01
s(3)                              [63.0957]            20           2.2
1.80e-01
f(4)                              [63.0957]            2            0.8
```

```
1.02e-01
f(5)                              [63.0957]            2            0.8
3.23e-01
f(6)                              [63.0957]            2            0.8
7.41e-01
f(7)                              [63.0957]            2            0.8
5.87e-01
f(8)                              [63.0957]            2            0.8
9.93e-01
f(9)                              [63.0957]            2            0.8
1.92e-01
s(10)                             [63.0957]            20           1.3
9.02e-01
s(11)                             [63.0957]            20           1.3
2.49e-03     **
s(12)                             [63.0957]            20           1.2
1.93e-03     **
s(13)                             [63.0957]            20           1.3
9.22e-01
s(14)                             [63.0957]            20           0.9
8.74e-01
s(15)                             [63.0957]            20           0.5
5.93e-01
intercept                                              1            0.0
3.76e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

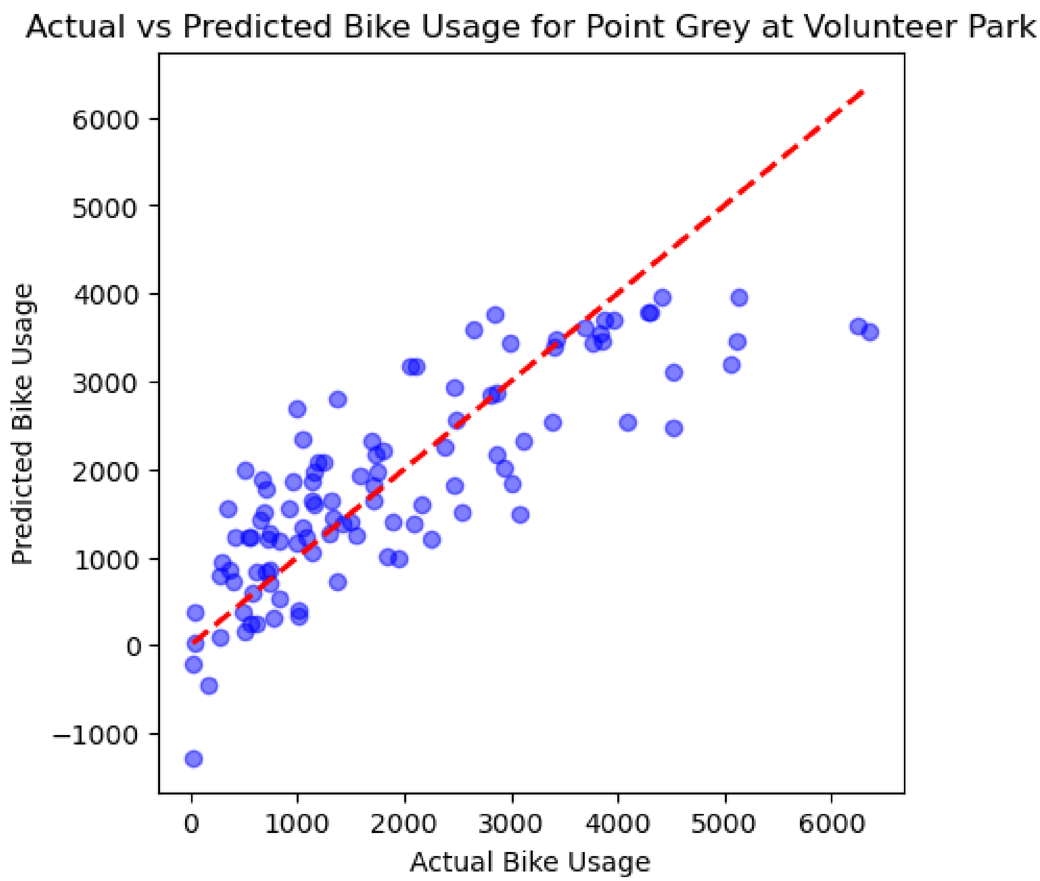


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Point Grey at Volunteer Park: 710180.2043148

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Richards at Dunsmuir:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
20.0228
Link Function:                      IdentityLink Log Likelihood:
-2663.5874
Number of Samples:                           310 AIC:
5369.2204
                                                 AICc:
5372.4358
                                                 GCV:
2430.4902
                                                 Scale:
2149.6525
                                                 Pseudo R-Squared:
0.7454
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [251.1886]           20           6.8
1.11e-16     ***
s(1)                              [251.1886]           20           2.6
1.11e-16     ***
s(2)                              [251.1886]           20           1.7
3.80e-02     *
s(3)                              [251.1886]           20           1.7
1.62e-03     **
f(4)                              [251.1886]           2            0.7
7.82e-01
f(5)                              [251.1886]           2            0.7
6.36e-03     **
f(6)                              [251.1886]           2            0.6
3.22e-02     *
f(7)                              [251.1886]           2            0.7
4.16e-01
f(8)                              [251.1886]           2            0.7
5.16e-01
f(9)                              [251.1886]           2            0.6
1.16e-01
s(10)                             [251.1886]           20           0.6
1.45e-02     *
s(11)                             [251.1886]           20           0.6
1.17e-05     ***
s(12)                             [251.1886]           20           0.6
4.67e-10     ***
s(13)                             [251.1886]           20           0.6
2.24e-01
s(14)                             [251.1886]           20           0.5
```

```
3.68e-01
s(15)                            [251.1886]           20            0.2
8.14e-01
intercept                                             1             0.0
9.30e-04     ***
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

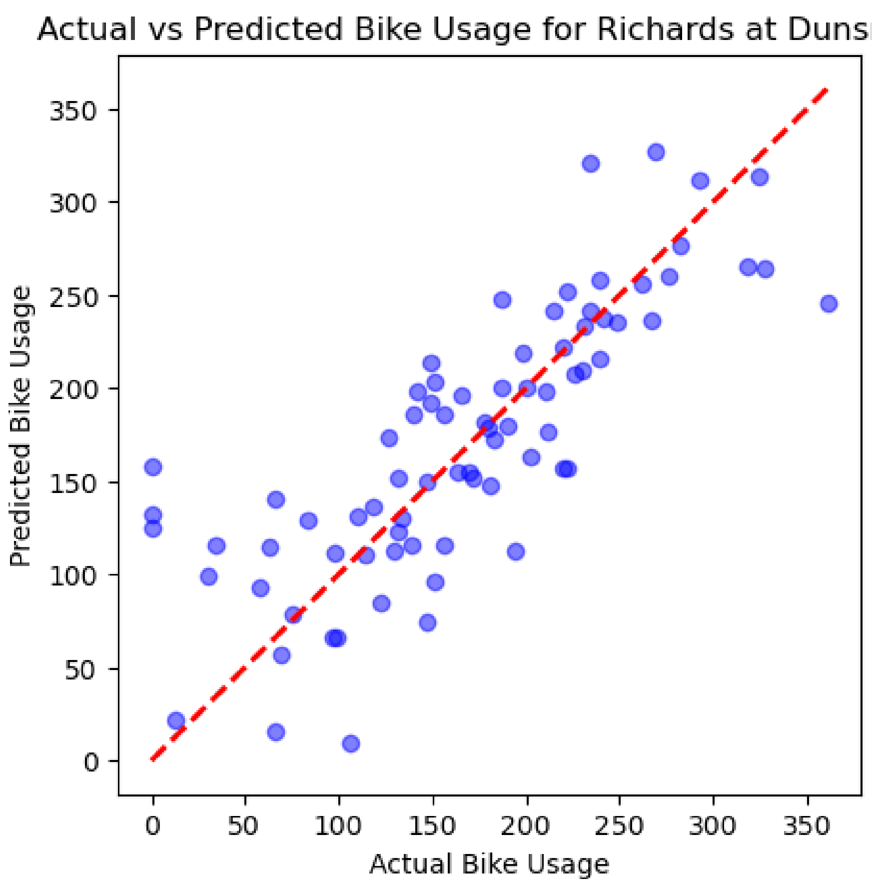

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Richards at Dunsmuir: 2400.0923363636707

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Seawall at Creekside Community Centre:
LinearGAM
===============================================
=============================================================
Distribution:                        NormalDist Effective DoF:
47.3214
Link Function:                     IdentityLink Log Likelihood:
-15010.4901
Number of Samples:                         1052 AIC:
30117.623
                                                AICc:
30122.3768
                                                GCV:
682592.5897
                                                Scale:
627555.7265
                                                Pseudo R-Squared:
0.7463
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.3
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           4.0
9.10e-01
s(3)                              [15.8489]            20           2.4
2.25e-04     ***
f(4)                              [15.8489]            2            0.9
```

```
5.01e-01
f(5)                              [15.8489]           2            0.9
3.15e-01
f(6)                              [15.8489]           2            0.9
7.79e-01
f(7)                              [15.8489]           2            1.0
7.10e-01
f(8)                              [15.8489]           2            0.9
5.95e-01
f(9)                              [15.8489]           2            0.9
2.08e-01
s(10)                             [15.8489]           20           3.1
3.79e-01
s(11)                             [15.8489]           20           3.3
2.16e-03     **
s(12)                             [15.8489]           20           3.6
2.02e-04     ***
s(13)                             [15.8489]           20           3.1
7.90e-01
s(14)                             [15.8489]           20           2.8
6.68e-01
s(15)                             [15.8489]           20           1.9
8.90e-01
intercept                                             1            0.0
9.76e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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         known smoothing parameters, but when smoothing parameters have been
estimated, the p-values
         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

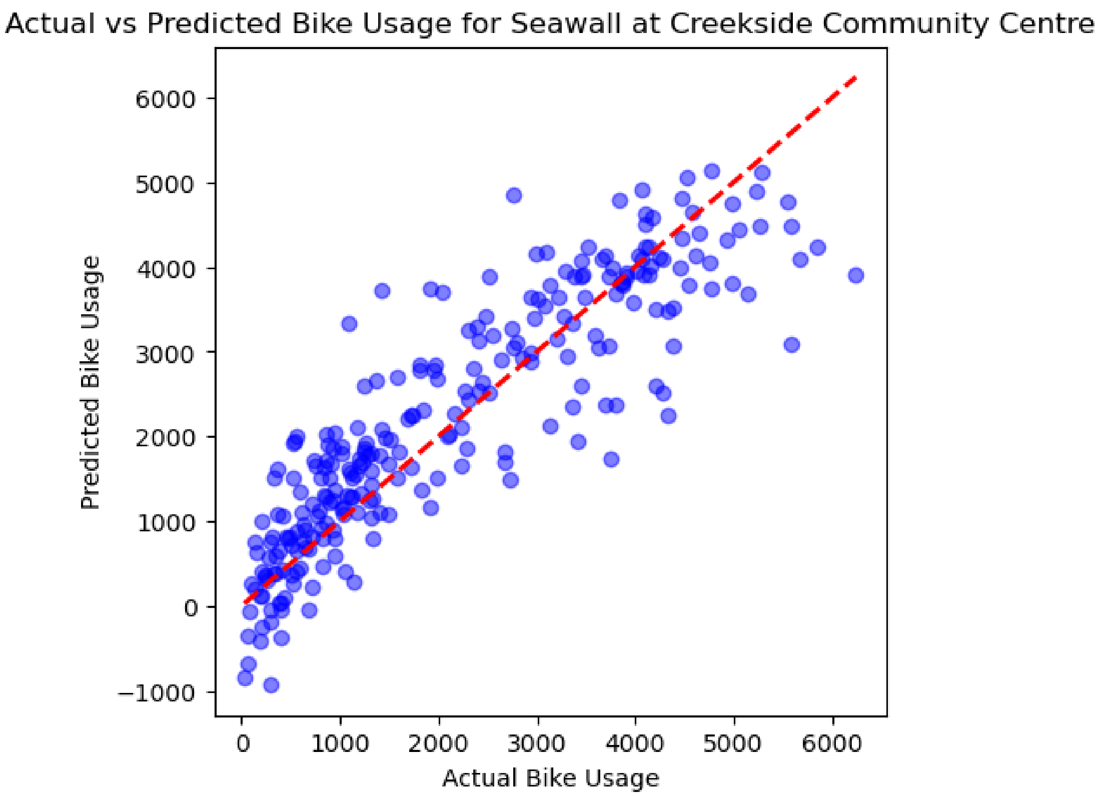


```
  0% (0 of 11) |                          | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Seawall at Creekside Community Centre: 550774.4519403967

  9% (1 of 11) |##                        | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                 | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############             | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################        | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane Seawall at David Lam Park:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
47.7284
Link Function:                     IdentityLink Log Likelihood:
```

```
-15428.4941
Number of Samples:                        1055 AIC:
30954.445
                                               AICc:
30959.266
                                               GCV:
974609.9454
                                               Scale:
895579.3889
                                               Pseudo R-Squared:
0.7605
===============================================================================
==========================
Feature Function                 Lambda               Rank         EDoF
P > x        Sig. Code
================================ ==================== ============ ============
============ ============
s(0)                             [15.8489]            20           11.9
1.11e-16     ***
s(1)                             [15.8489]            20           5.3
1.11e-16     ***
s(2)                             [15.8489]            20           4.1
8.42e-01
s(3)                             [15.8489]            20           2.3
3.59e-02     *
f(4)                             [15.8489]            2            0.9
1.37e-01
f(5)                             [15.8489]            2            0.9
2.46e-01
f(6)                             [15.8489]            2            0.9
6.47e-01
f(7)                             [15.8489]            2            0.9
4.06e-01
f(8)                             [15.8489]            2            1.0
2.20e-01
f(9)                             [15.8489]            2            0.9
1.57e-01
s(10)                            [15.8489]            20           4.2
2.27e-02     *
s(11)                            [15.8489]            20           2.9
4.78e-04     ***
s(12)                            [15.8489]            20           3.0
6.26e-04     ***
s(13)                            [15.8489]            20           3.6
9.16e-01
s(14)                            [15.8489]            20           2.7
6.68e-01
s(15)                            [15.8489]            20           2.0
```

```
5.33e-01
intercept                                                        1            0.0
8.72e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

WARNING: Fitting splines and a linear function to a feature introduces a model
identifiability problem
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         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

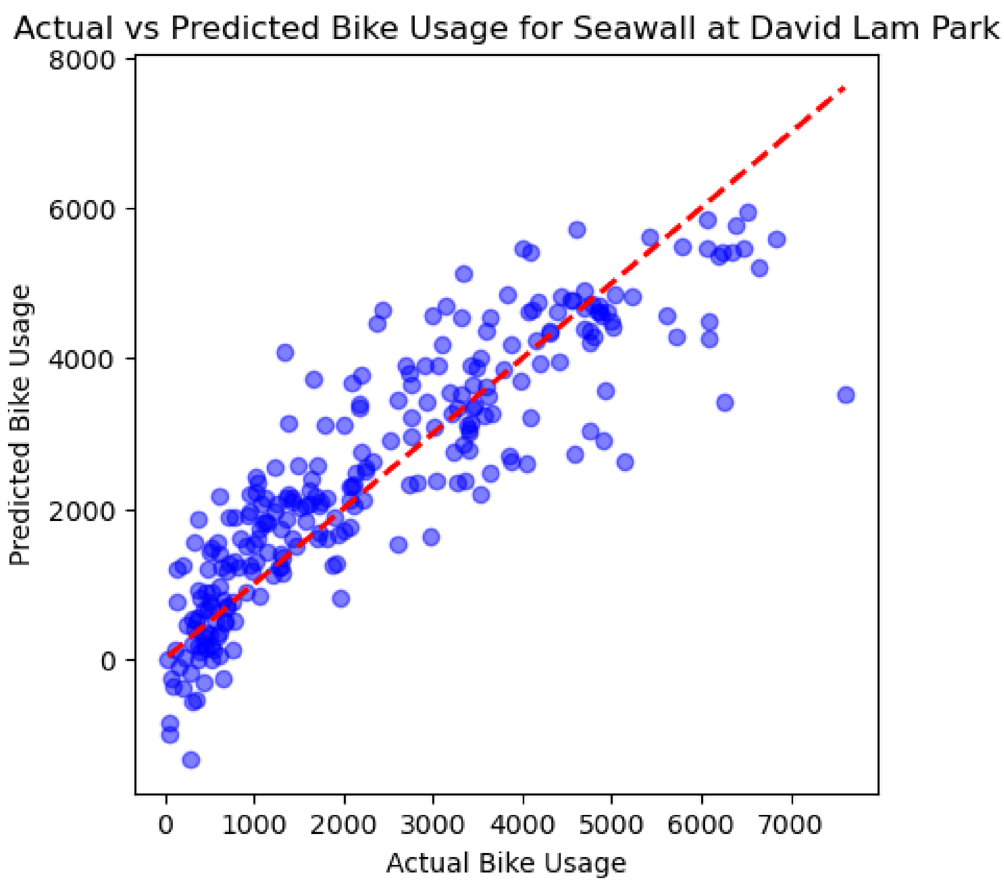


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
```

```
Mean Squared Error for Seawall at David Lam Park: 746465.8028795036
  9% (1 of 11) |##                      | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                    | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                  | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########               | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########             | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############           | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############         | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################      | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################    | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################  | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |#######################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Seawall at HMCS Discovery:
LinearGAM
===============================================
==========================================================
Distribution:                        NormalDist Effective DoF:
33.4866
Link Function:                     IdentityLink Log Likelihood:
-12676.0072
Number of Samples:                          888 AIC:
25420.9875
                                                AICc:
25423.8586
                                                GCV:
677308.2125
                                                Scale:
631493.8851
                                                Pseudo R-Squared:
0.7704
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.8
1.11e-16     ***
s(1)                              [63.0957]            20           3.8
1.11e-16     ***
s(2)                              [63.0957]            20           2.4
9.86e-01
s(3)                              [63.0957]            20           1.8
8.73e-04     ***
f(4)                              [63.0957]            2            0.9
5.21e-01
f(5)                              [63.0957]            2            0.9
```

```
1.34e-01
f(6)                                [63.0957]           2            0.9
5.47e-01
f(7)                                [63.0957]           2            0.9
6.56e-01
f(8)                                [63.0957]           2            0.9
7.62e-01
f(9)                                [63.0957]           2            0.8
1.75e-01
s(10)                               [63.0957]           20           2.2
8.60e-01
s(11)                               [63.0957]           20           2.2
5.54e-09     ***
s(12)                               [63.0957]           20           1.7
5.82e-06     ***
s(13)                               [63.0957]           20           1.8
8.55e-01
s(14)                               [63.0957]           20           1.5
7.80e-02     .
s(15)                               [63.0957]           20           0.9
1.47e-01
intercept                                               1            0.0
7.42e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

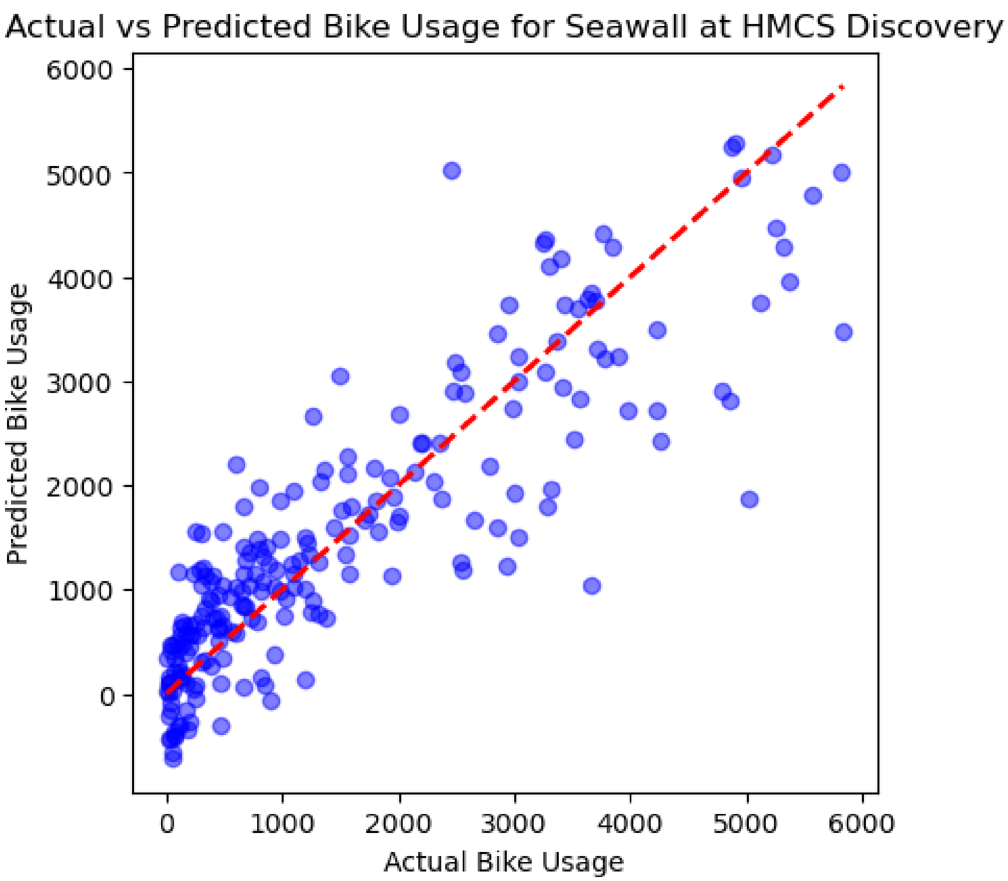


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
Mean Squared Error for Seawall at HMCS Discovery: 546480.8785508823
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00
Summary for lane Seawall at Harbour Green Park:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
47.7284
Link Function:                     IdentityLink Log Likelihood:
-13741.5876
Number of Samples:                         1055 AIC:
27580.632
                                                AICc:
27585.4529
                                                GCV:
196973.8808
                                                Scale:
181001.3828
                                                Pseudo R-Squared:
0.8324
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           11.9
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           4.1
9.63e-01
s(3)                              [15.8489]            20           2.3
1.35e-06     ***
f(4)                              [15.8489]            2            0.9
5.54e-01
f(5)                              [15.8489]            2            0.9
2.14e-01
f(6)                              [15.8489]            2            0.9
5.68e-01
f(7)                              [15.8489]            2            0.9
6.56e-01
f(8)                              [15.8489]            2            1.0
3.74e-01
f(9)                              [15.8489]            2            0.9
2.09e-01
s(10)                             [15.8489]            20           4.2
9.34e-04     ***
s(11)                             [15.8489]            20           2.9
4.47e-05     ***
s(12)                             [15.8489]            20           3.0
5.56e-03     **
s(13)                             [15.8489]            20           3.6
7.59e-01
s(14)                             [15.8489]            20           2.7
```

```
8.73e-01
s(15)                             [15.8489]           20            2.0
2.34e-01
intercept                                             1             0.0
4.42e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

WARNING: Fitting splines and a linear function to a feature introduces a model
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         are typically lower than they should be, meaning that the tests reject
the null too readily.
```

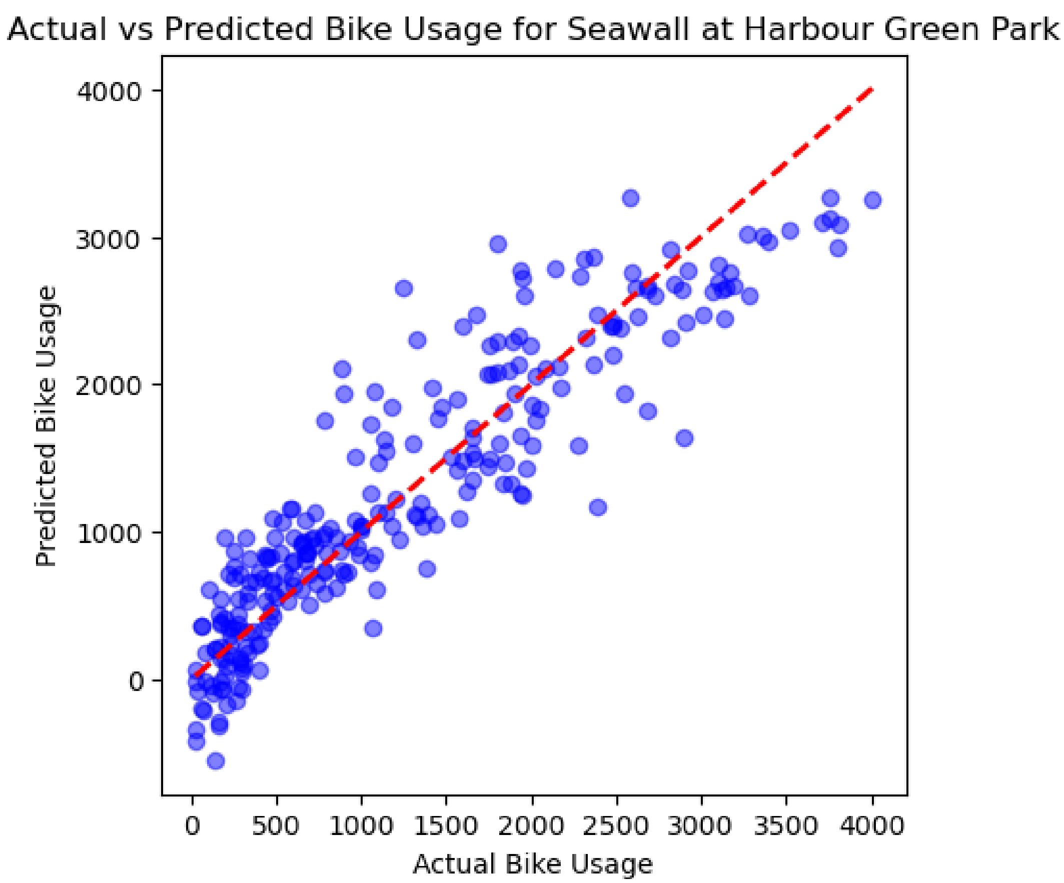

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Seawall at Harbour Green Park: 166010.83282012853

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Seawall at Lumbermen's Arch:
LinearGAM
===============================================
==========================================================
Distribution:                       NormalDist Effective DoF:
22.667
Link Function:                    IdentityLink Log Likelihood:
-9560.5415
Number of Samples:                         667 AIC:
19168.417
                                               AICc:
19170.2348
                                               GCV:
713275.7418
                                               Scale:
669780.9045
                                               Pseudo R-Squared:
0.787
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [251.1886]           20           7.0
1.11e-16     ***
s(1)                              [251.1886]           20           2.6
1.11e-16     ***
s(2)                              [251.1886]           20           1.7
9.90e-01
s(3)                              [251.1886]           20           1.2
1.69e-04     ***
f(4)                              [251.1886]           2            0.8
```

```
7.79e-01
f(5)                              [251.1886]          2            0.9
5.83e-01
f(6)                              [251.1886]          2            0.8
3.91e-01
f(7)                              [251.1886]          2            0.8
5.19e-01
f(8)                              [251.1886]          2            0.8
4.81e-01
f(9)                              [251.1886]          2            0.7
5.27e-01
s(10)                             [251.1886]          20           1.2
3.19e-01
s(11)                             [251.1886]          20           1.0
6.14e-12     ***
s(12)                             [251.1886]          20           1.0
1.91e-06     ***
s(13)                             [251.1886]          20           0.8
3.16e-01
s(14)                             [251.1886]          20           0.9
1.24e-02     *
s(15)                             [251.1886]          20           0.4
5.66e-03     **
intercept                                             1            0.0
9.88e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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```

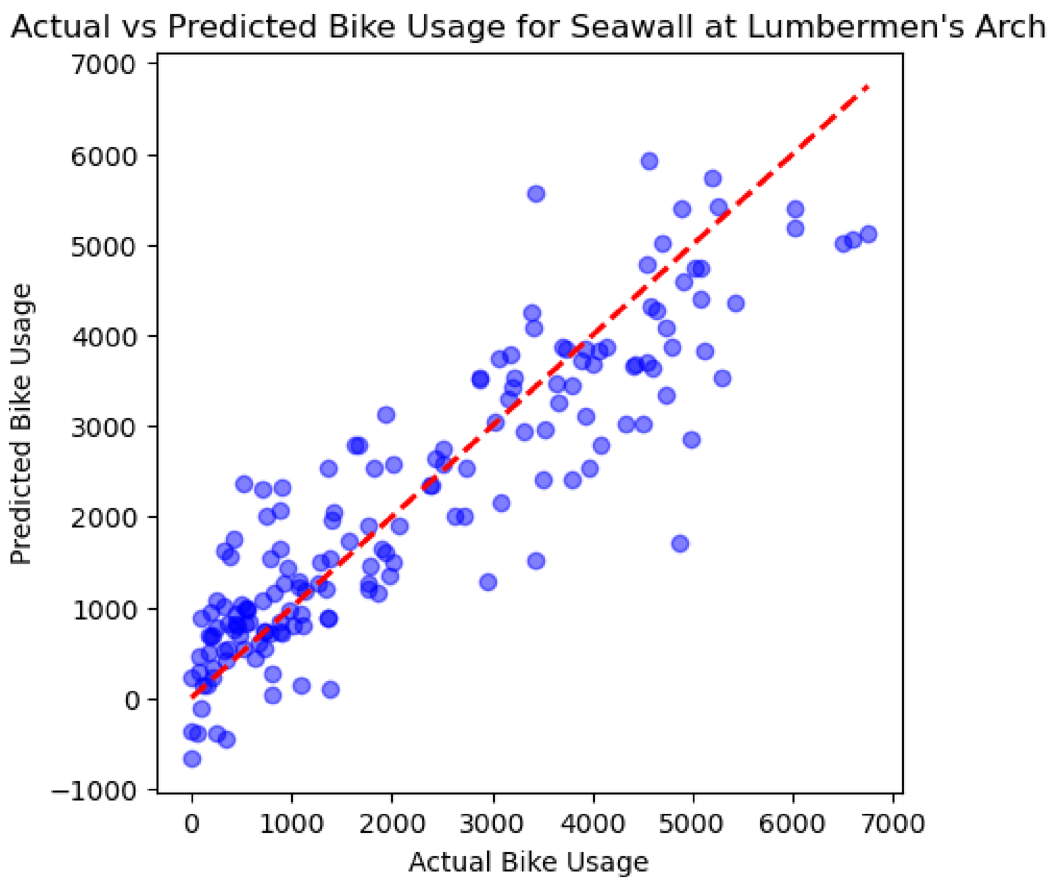


```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--
  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00

Mean Squared Error for Seawall at Lumbermen's Arch: 626890.6850404472

 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:  0:00:00

Summary for lane Seawall at Second Beach Pool:
LinearGAM
===============================================
==========================================================
Distribution:                      NormalDist Effective DoF:
```

```
29.9774
Link Function:                        IdentityLink Log Likelihood:
-6824.8733
Number of Samples:                             467 AIC:
13711.7013
                                                AICc:
13716.2554
                                                GCV:
1001828.5767
                                                Scale:
886778.6805
                                                Pseudo R-Squared:
0.7278
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [63.0957]            20           9.4
1.11e-16     ***
s(1)                              [63.0957]            20           3.7
1.11e-16     ***
s(2)                              [63.0957]            20           3.2
1.00e+00
s(3)                              [63.0957]            20           2.0
2.06e-01
f(4)                              [63.0957]            2            0.8
5.01e-01
f(5)                              [63.0957]            2            0.8
4.29e-01
f(6)                              [63.0957]            2            0.8
2.68e-01
f(7)                              [63.0957]            2            0.8
6.59e-01
f(8)                              [63.0957]            2            0.8
5.79e-01
f(9)                              [63.0957]            2            0.8
2.83e-01
s(10)                             [63.0957]            20           1.4
1.43e-01
s(11)                             [63.0957]            20           1.3
5.76e-04     ***
s(12)                             [63.0957]            20           1.1
1.86e-03     **
s(13)                             [63.0957]            20           1.1
2.47e-01
s(14)                             [63.0957]            20           1.2
```

```
9.50e-03     **
s(15)                              [63.0957]             20             0.7
2.03e-03     **
intercept                                                1              0.0
7.90e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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the null too readily.
```

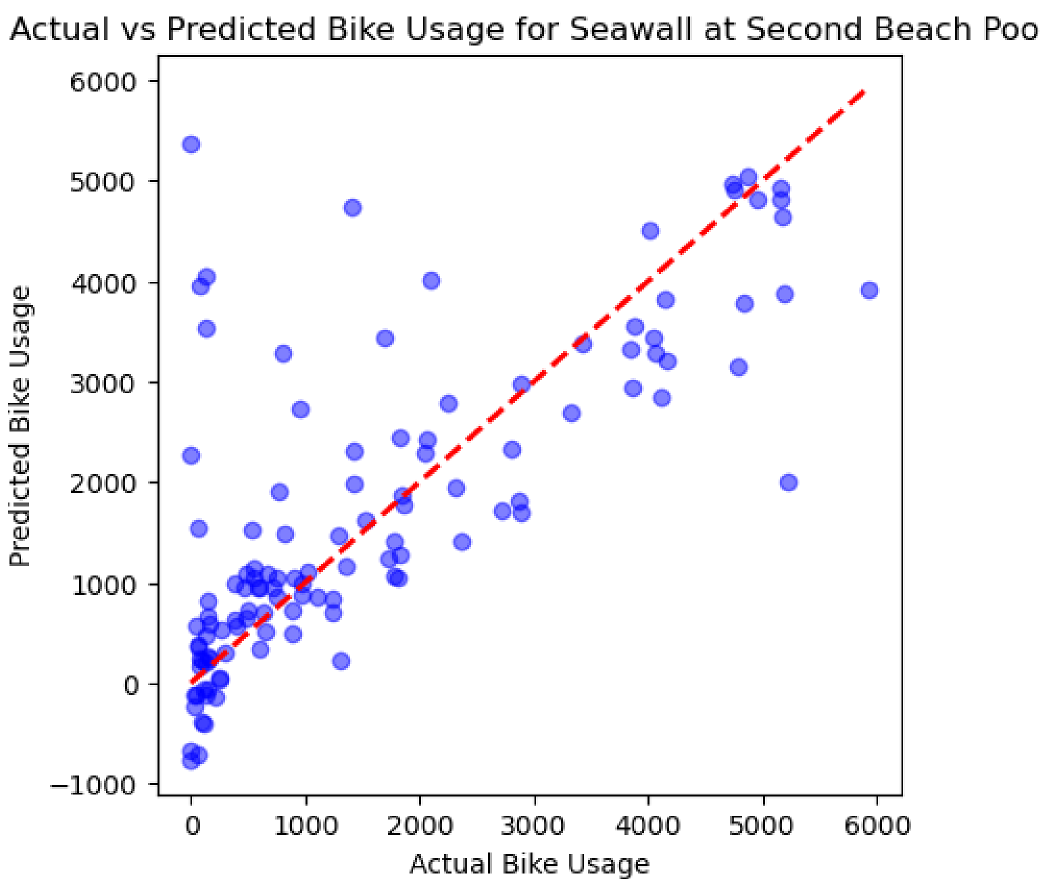

```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Seawall at Second Beach Pool: 1292979.5975843756

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |#####################   | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:01 Time:  0:00:01

Summary for lane Stephens at Point Grey:
LinearGAM
===============================================
=====================================================
Distribution:                        NormalDist Effective DoF:
47.5045
Link Function:                     IdentityLink Log Likelihood:
-12027.1016
Number of Samples:                         1054 AIC:
24151.2122
                                                AICc:
24155.9931
                                                GCV:
39190.8267
                                                Scale:
36024.7194
                                                Pseudo R-Squared:
0.7491
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.1
1.11e-16     ***
s(1)                              [15.8489]            20           5.3
1.11e-16     ***
s(2)                              [15.8489]            20           3.4
9.44e-01
s(3)                              [15.8489]            20           3.0
2.40e-01
f(4)                              [15.8489]            2            0.9
```

```
5.91e-01
f(5)                              [15.8489]           2            0.9
3.73e-01
f(6)                              [15.8489]           2            0.9
8.80e-01
f(7)                              [15.8489]           2            1.0
9.78e-01
f(8)                              [15.8489]           2            0.9
9.02e-01
f(9)                              [15.8489]           2            0.9
3.56e-01
s(10)                             [15.8489]           20           4.1
7.64e-01
s(11)                             [15.8489]           20           3.5
3.77e-02     *
s(12)                             [15.8489]           20           2.7
4.31e-01
s(13)                             [15.8489]           20           3.3
6.08e-01
s(14)                             [15.8489]           20           2.6
5.39e-01
s(15)                             [15.8489]           20           1.9
2.12e-01
intercept                                             1            0.0
7.76e-02     .
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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         are typically lower than they should be, meaning that the tests reject
the null too readily.
```
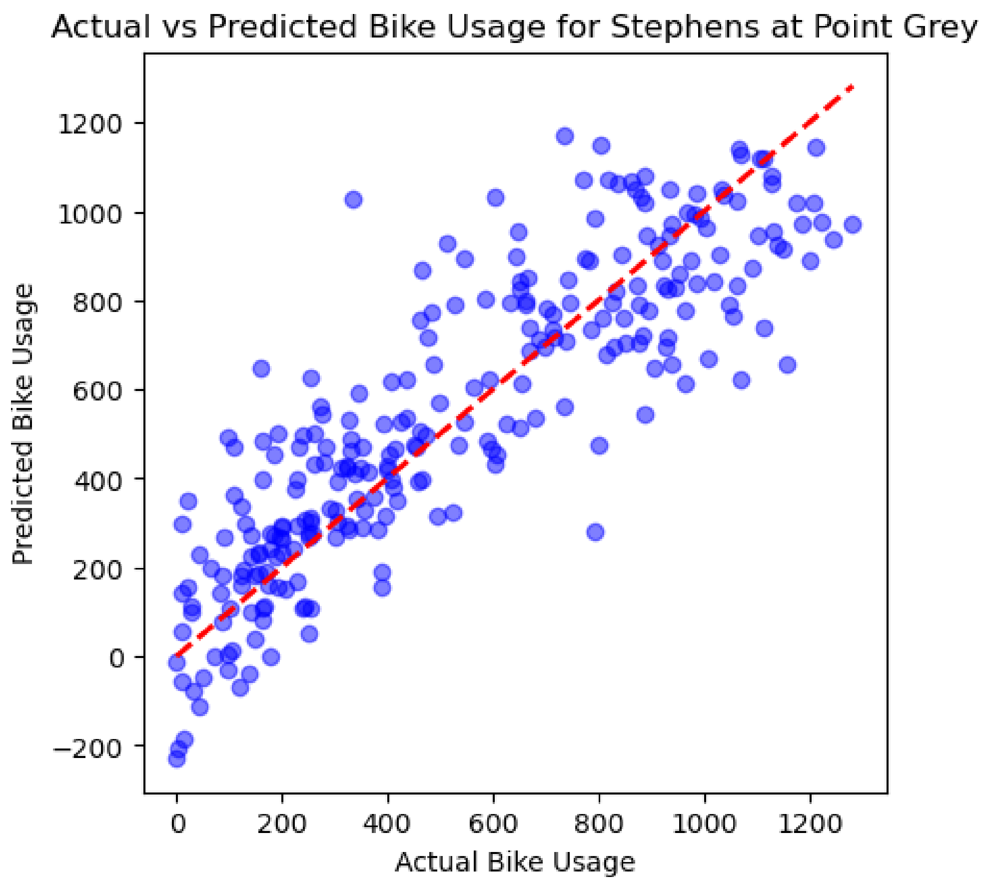
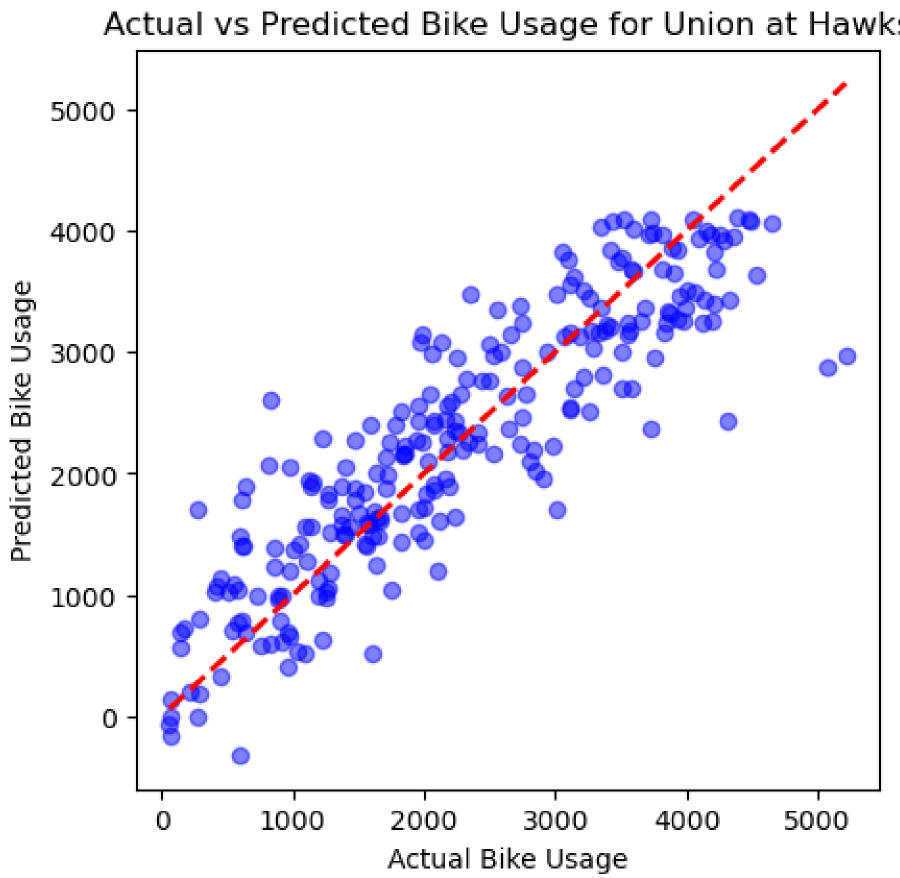




```
  0% (0 of 11) |                         | Elapsed Time: 0:00:00 ETA:  --:--:--

Mean Squared Error for Stephens at Point Grey: 32414.501885912014

  9% (1 of 11) |##                       | Elapsed Time: 0:00:00 ETA:   0:00:00
 18% (2 of 11) |####                     | Elapsed Time: 0:00:00 ETA:   0:00:00
 27% (3 of 11) |######                   | Elapsed Time: 0:00:00 ETA:   0:00:00
 36% (4 of 11) |#########                | Elapsed Time: 0:00:00 ETA:   0:00:00
 45% (5 of 11) |###########              | Elapsed Time: 0:00:00 ETA:   0:00:00
 54% (6 of 11) |#############            | Elapsed Time: 0:00:00 ETA:   0:00:00
 63% (7 of 11) |###############          | Elapsed Time: 0:00:00 ETA:   0:00:00
 72% (8 of 11) |##################       | Elapsed Time: 0:00:00 ETA:   0:00:00
 81% (9 of 11) |####################     | Elapsed Time: 0:00:00 ETA:   0:00:00
 90% (10 of 11) |######################  | Elapsed Time: 0:00:00 ETA:   0:00:00
100% (11 of 11) |########################| Elapsed Time: 0:00:00 Time:   0:00:00

Summary for lane Union at Hawks:
LinearGAM
===============================================
==========================================================
Distribution:                     NormalDist Effective DoF:
```

```
46.8961
Link Function:                            IdentityLink Log Likelihood:
-13503.368
Number of Samples:                                1000 AIC:
27102.5282
                                                       AICc:
27107.4529
                                                       GCV:
318766.6322
                                                       Scale:
291976.2639
                                                       Pseudo R-Squared:
0.8024
================================================================================
==========================
Feature Function                  Lambda               Rank         EDoF
P > x        Sig. Code
================================= ==================== ============ ============
============ ============
s(0)                              [15.8489]            20           12.3
1.11e-16     ***
s(1)                              [15.8489]            20           5.2
1.11e-16     ***
s(2)                              [15.8489]            20           3.9
2.20e-01
s(3)                              [15.8489]            20           2.8
2.17e-02     *
f(4)                              [15.8489]            2            0.9
7.85e-01
f(5)                              [15.8489]            2            0.9
9.01e-01
f(6)                              [15.8489]            2            0.9
1.65e-02     *
f(7)                              [15.8489]            2            0.9
6.72e-01
f(8)                              [15.8489]            2            0.9
5.65e-01
f(9)                              [15.8489]            2            0.9
8.98e-01
s(10)                             [15.8489]            20           3.2
4.45e-02     *
s(11)                             [15.8489]            20           3.5
1.04e-01
s(12)                             [15.8489]            20           3.3
7.84e-09     ***
s(13)                             [15.8489]            20           2.9
8.78e-02     .
s(14)                             [15.8489]            20           2.4
```

```
4.50e-01
s(15)                            [15.8489]            20            1.8
1.88e-02     *
intercept                                             1             0.0
4.01e-01
================================================================================
==========================
Significance codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

WARNING: Fitting splines and a linear function to a feature introduces a model
identifiability problem
         which can cause p-values to appear significant when they are not.

WARNING: p-values calculated in this manner behave correctly for un-penalized
models or models with
         known smoothing parameters, but when smoothing parameters have been
estimated, the p-values
         are typically lower than they should be, meaning that the tests reject
the null too readily.
```



```
Mean Squared Error for Union at Hawks: 329467.6360162588
```

1.12 Conclusion

The GAM analysis effectively highlighted the primary drivers of bike usage in Vancouver, revealing that warmer weather promotes cycling, whereas rain and snow significantly decrease it. With rainfall occurring 40-44% of the year, bike lane utilization is highly seasonal, raising questions about the year-round effectiveness of reducing vehicle lanes in favor of bike lanes. Additionally, the analysis suggests that higher temperatures have a more pronounced effect on bike usage on Saturdays compared to weekdays, which may further limit bike lane effectiveness during weekday rush hours. These findings suggest the need for further investigation into complementary transportation modes, such as public transit, and their integration with traffic patterns to develop a more balanced and resilient transportation strategy suited to Vancouver's climate.