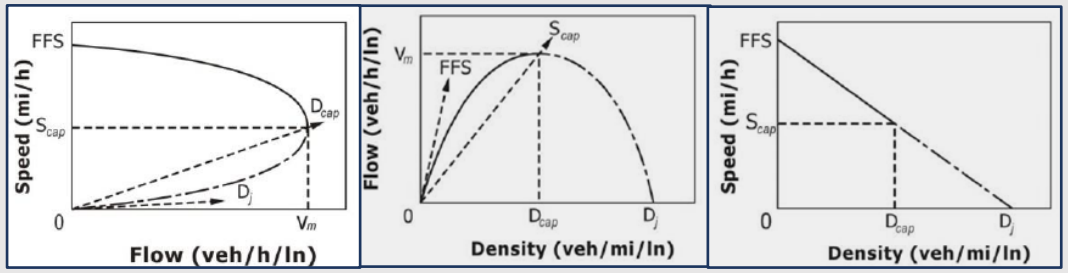
# Speed-Flow Analysis

2024-03-05

DAPR, TPAU, ODOT

Shen Qu

Oregon Department of Transportation



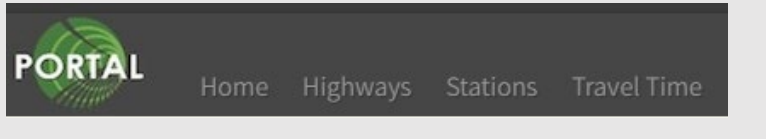
# Data

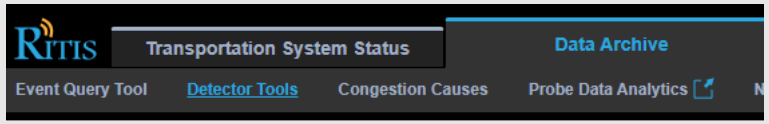
| ID | Timestamp | Volume | Speed | Occupancy |
|---|---|---|---|---|
| | | | | |

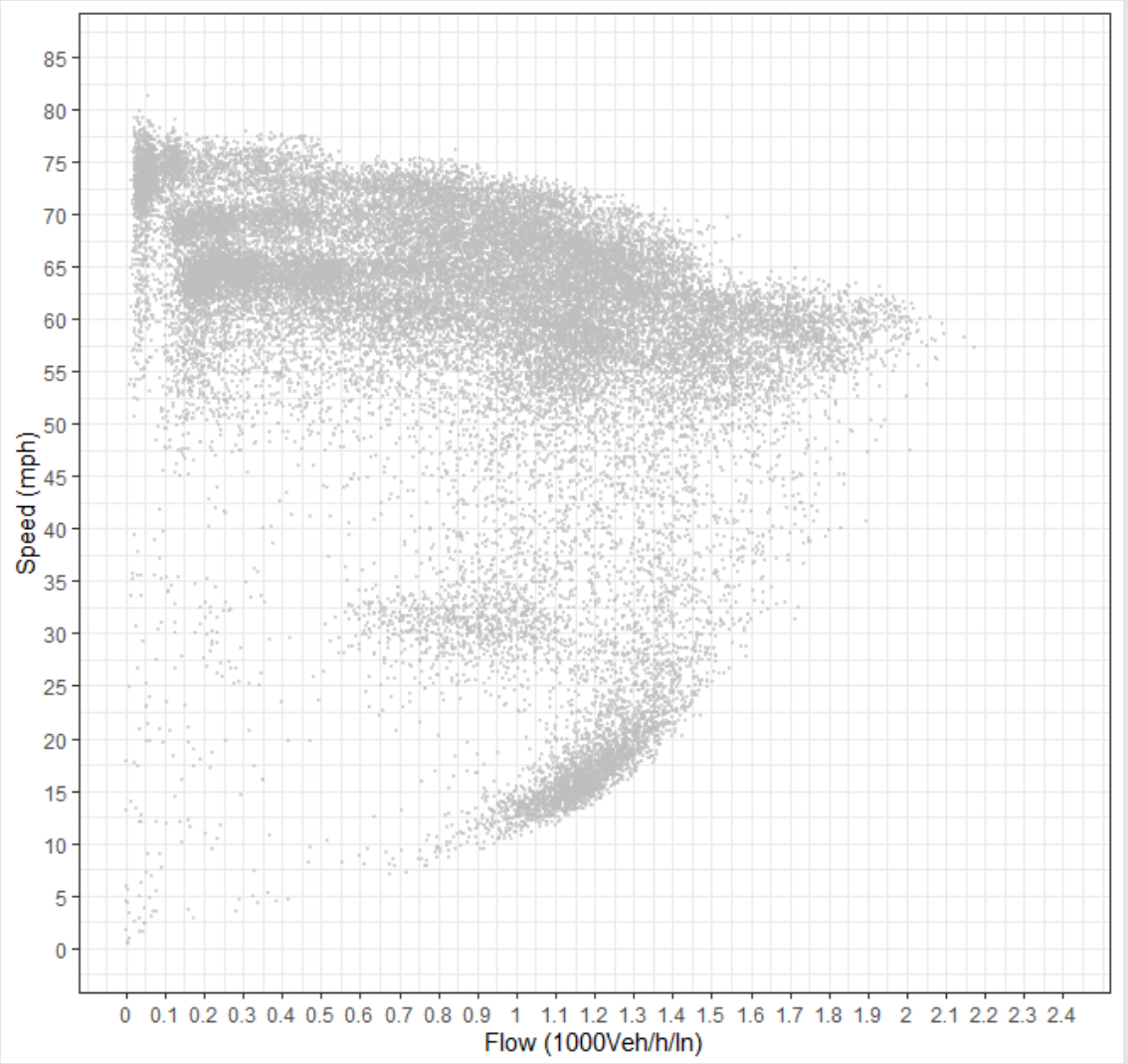
20-second, 15-minutes, …

Oregon Department of Transportation

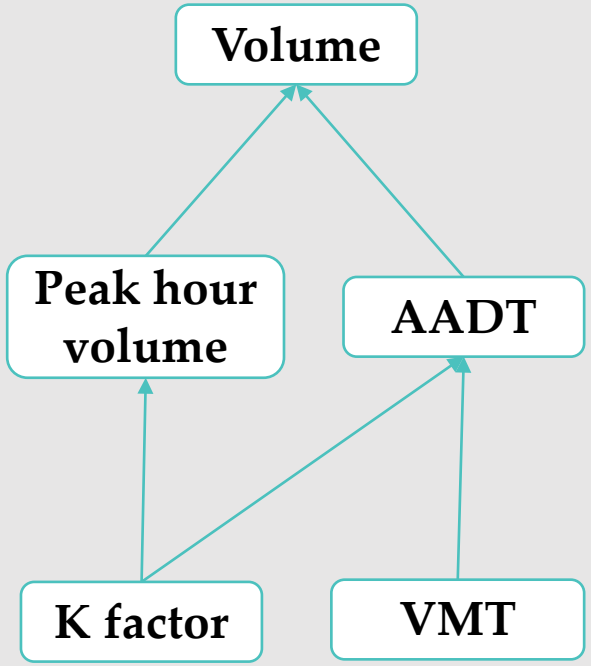
ITS-CRMS

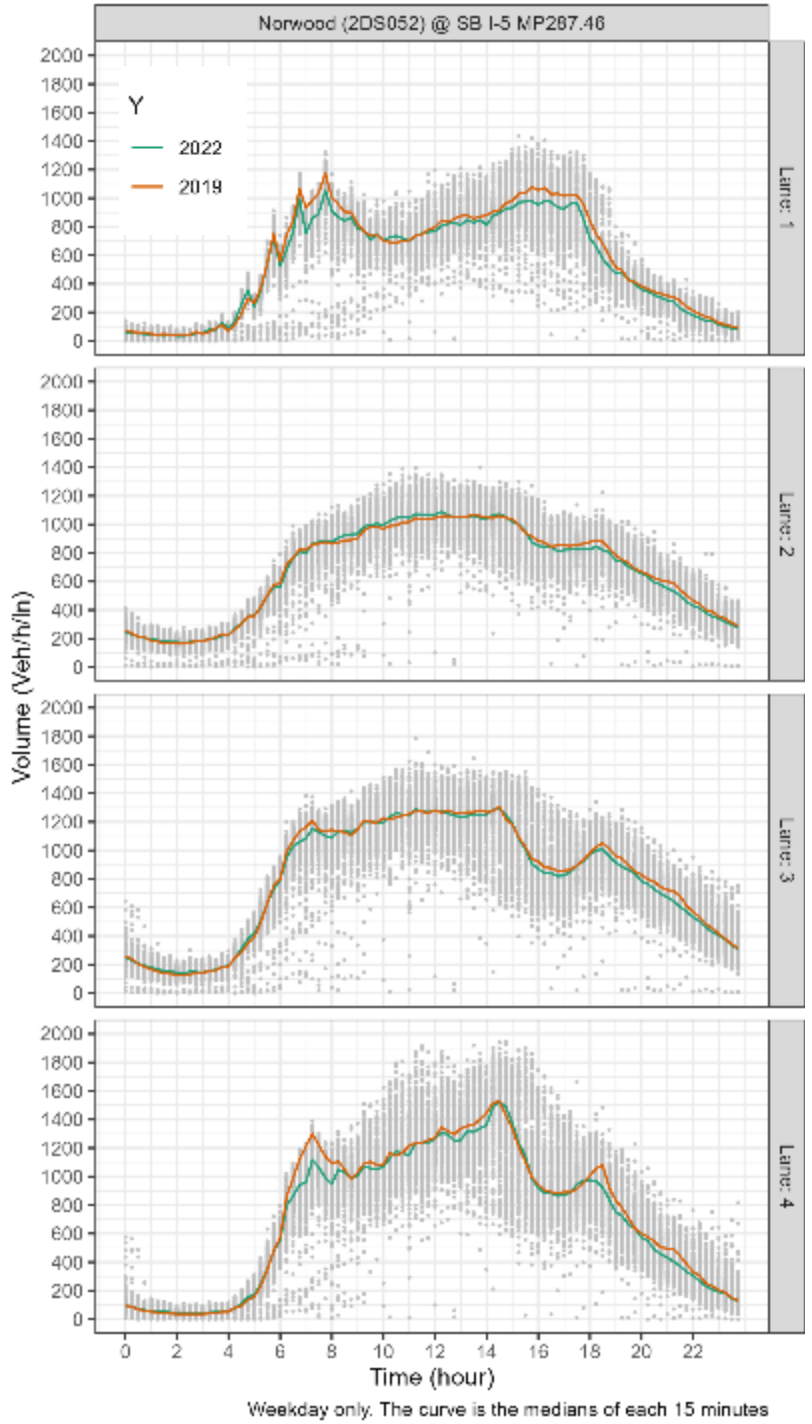


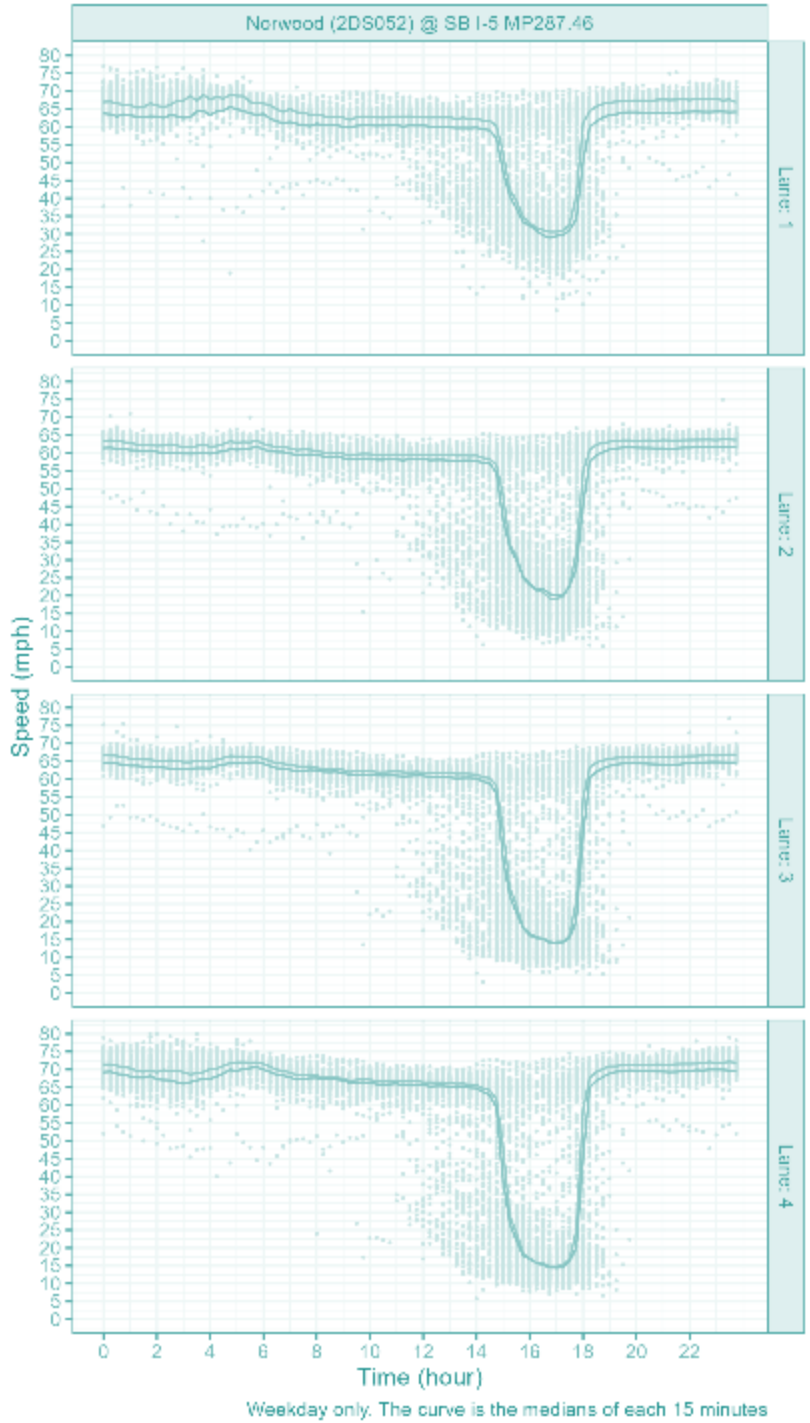



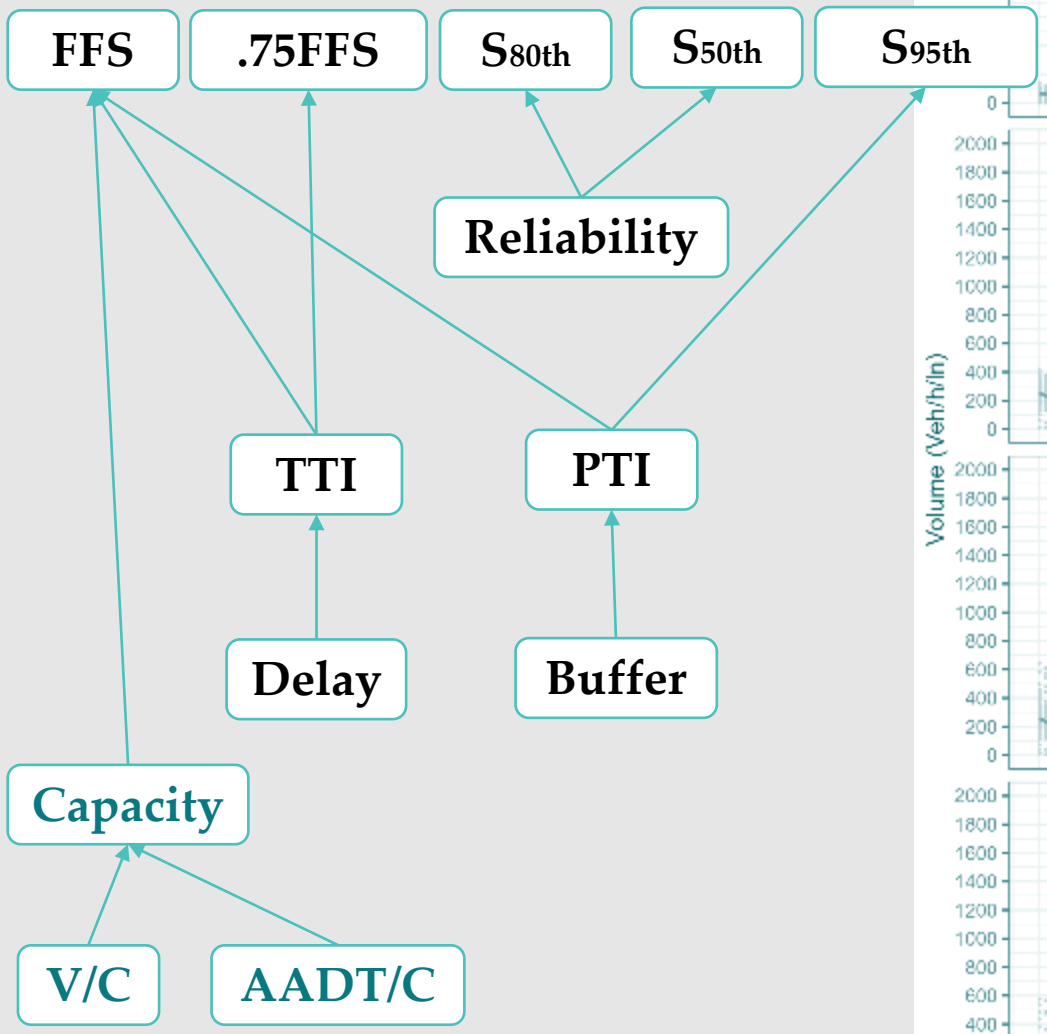
# Flow Perspective

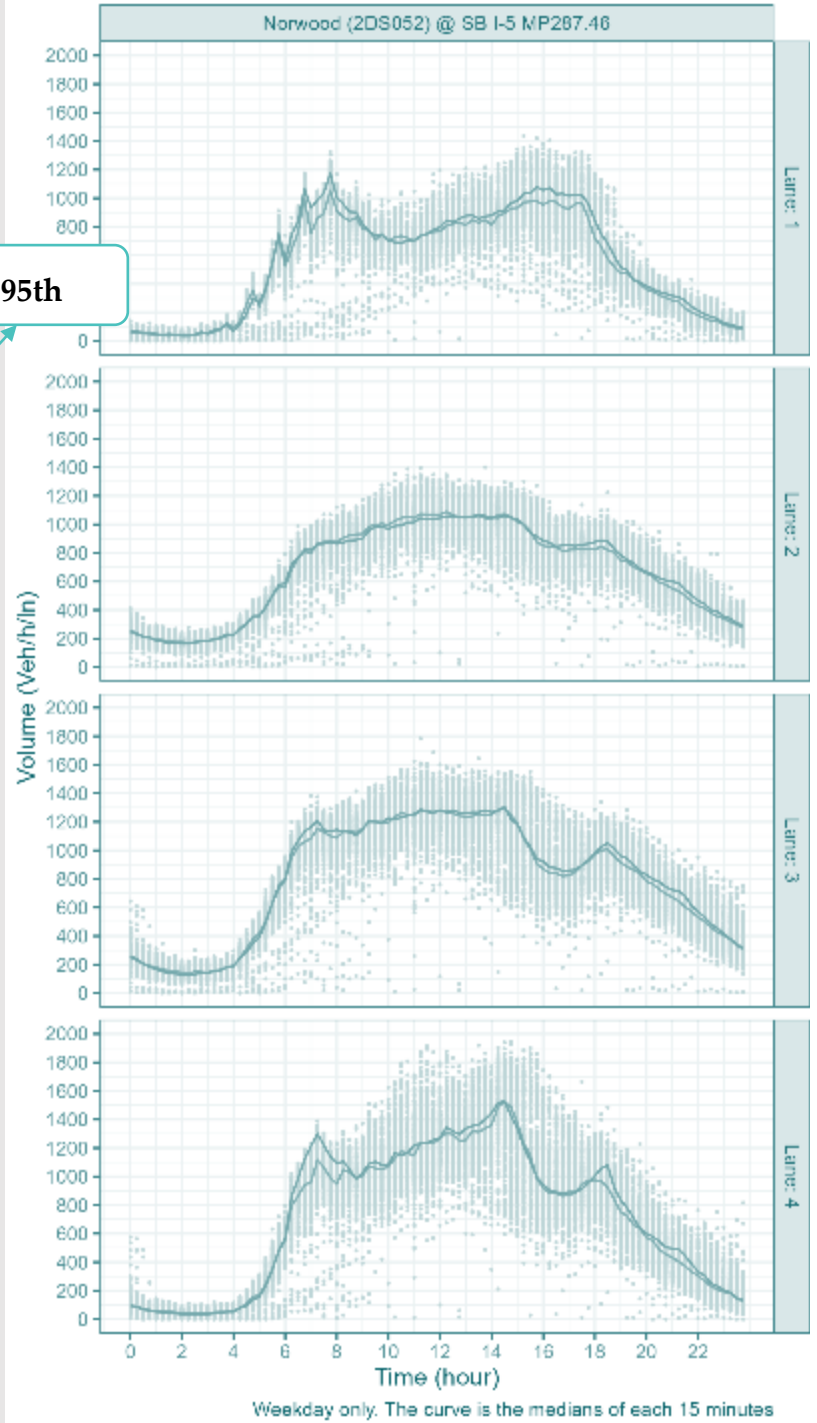


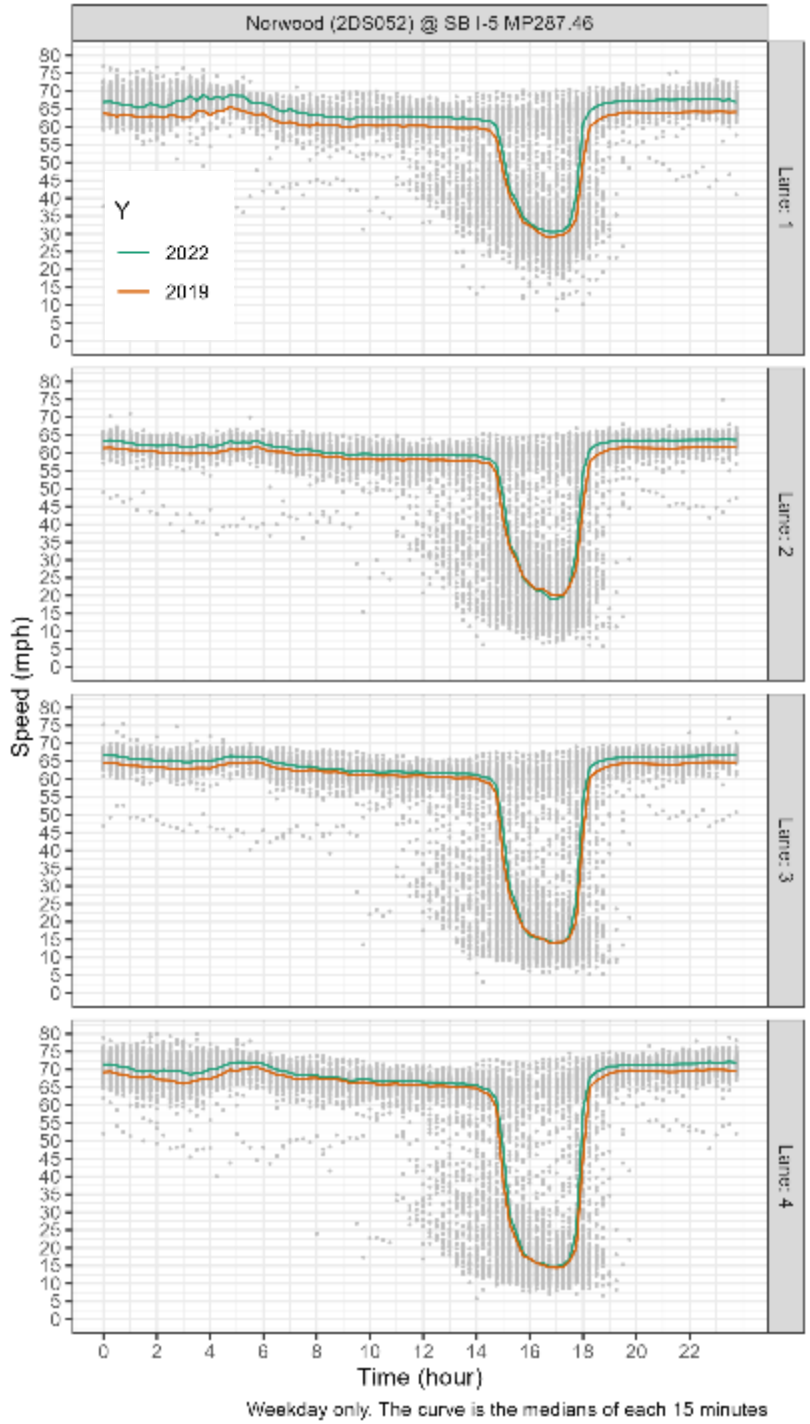



# Speed Perspective



# Speed-Flow

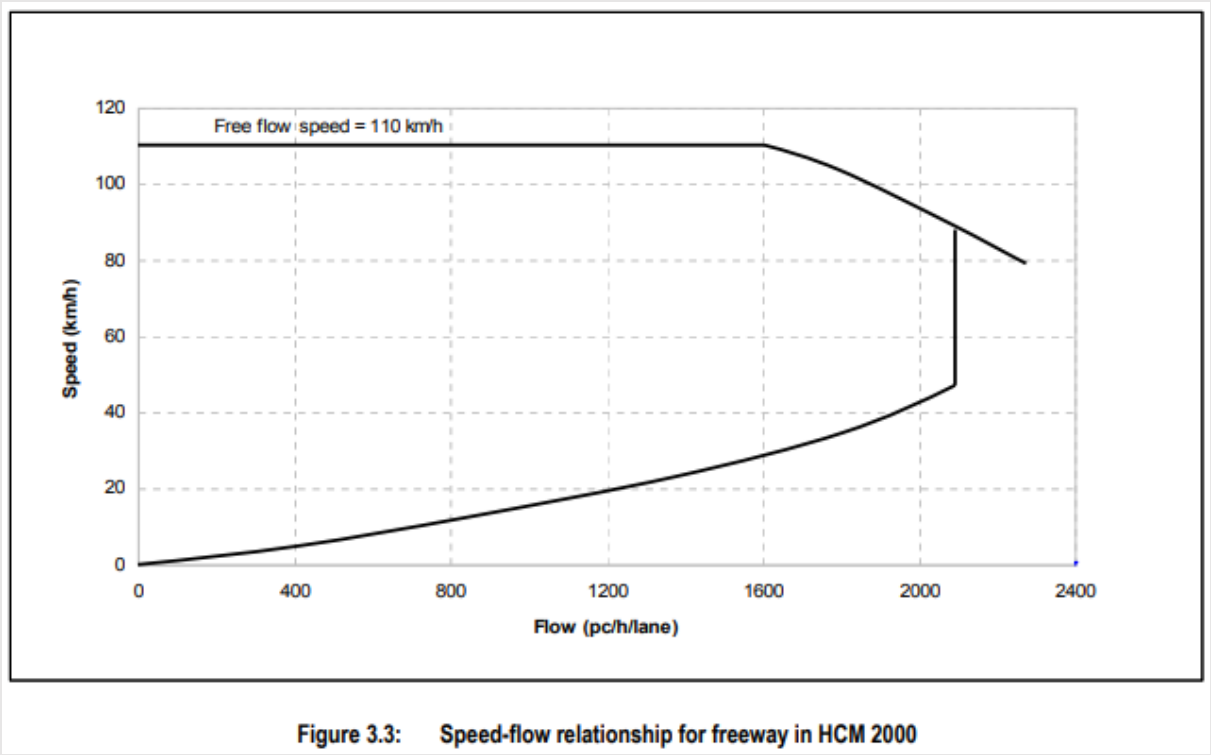
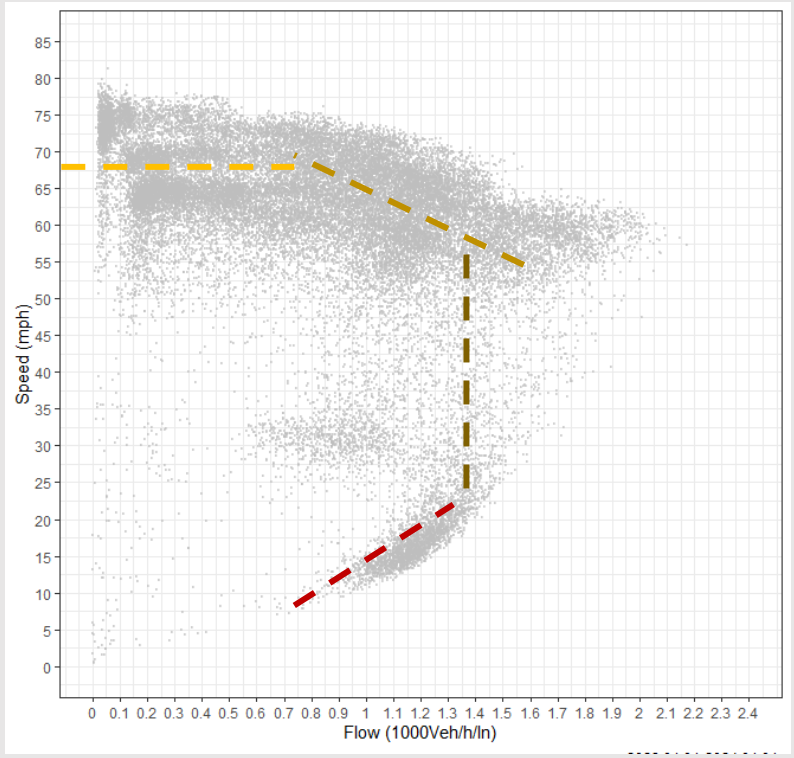



Figure 3.3: Speed-flow relationship for freeway in HCM 2000




- Capacity Basic freeway segment

$$c = 2200 + 10 \times (FFS - 50)$$

$$FFS = BFFS - f_{LW} - f_{RLC} - 3.22 \times TRD^{0.84}$$

$$c_{adj} = c \times \mathbf{CAF}$$

$$FFS_{adj} = FFS \times \mathbf{SAF}$$

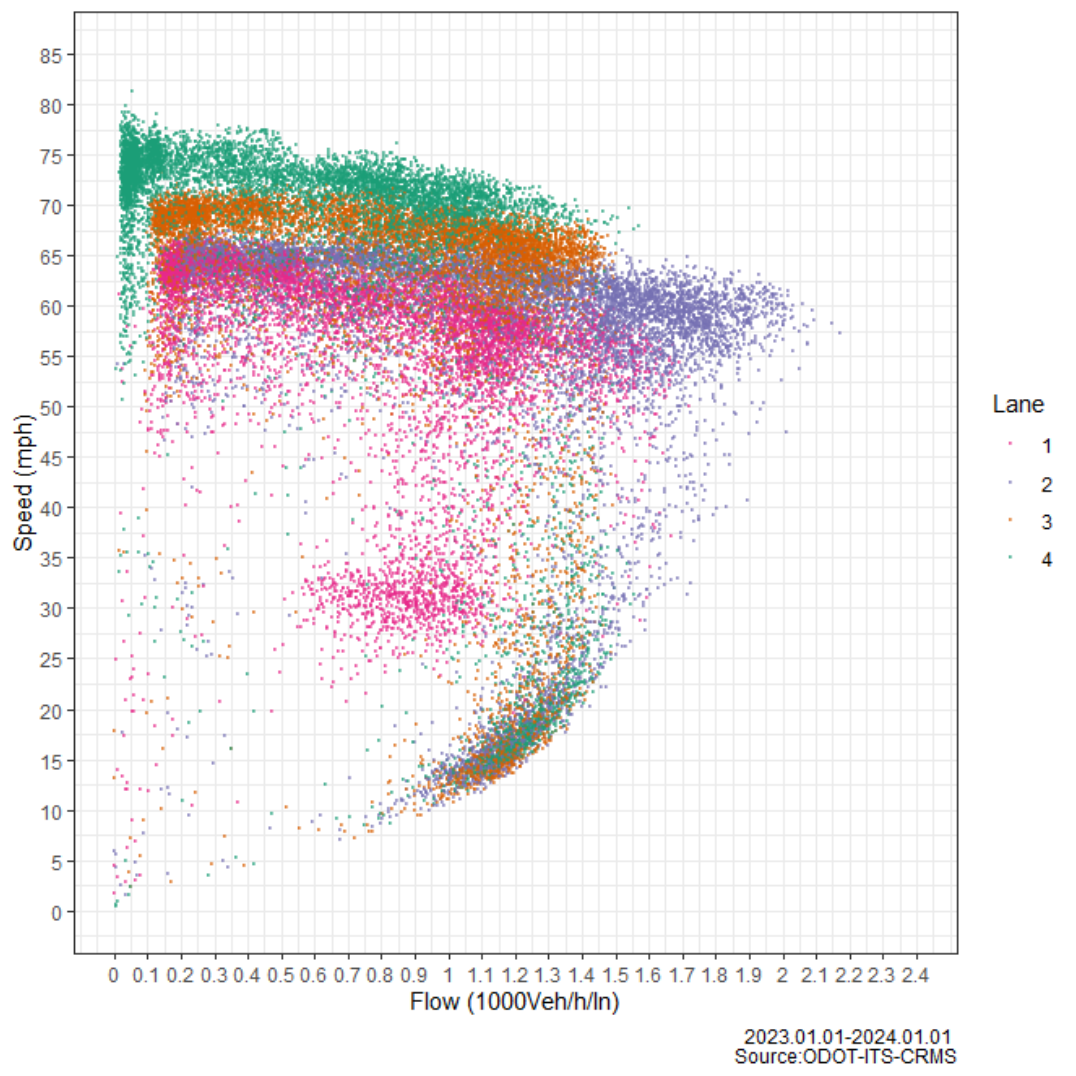
- Demand flow

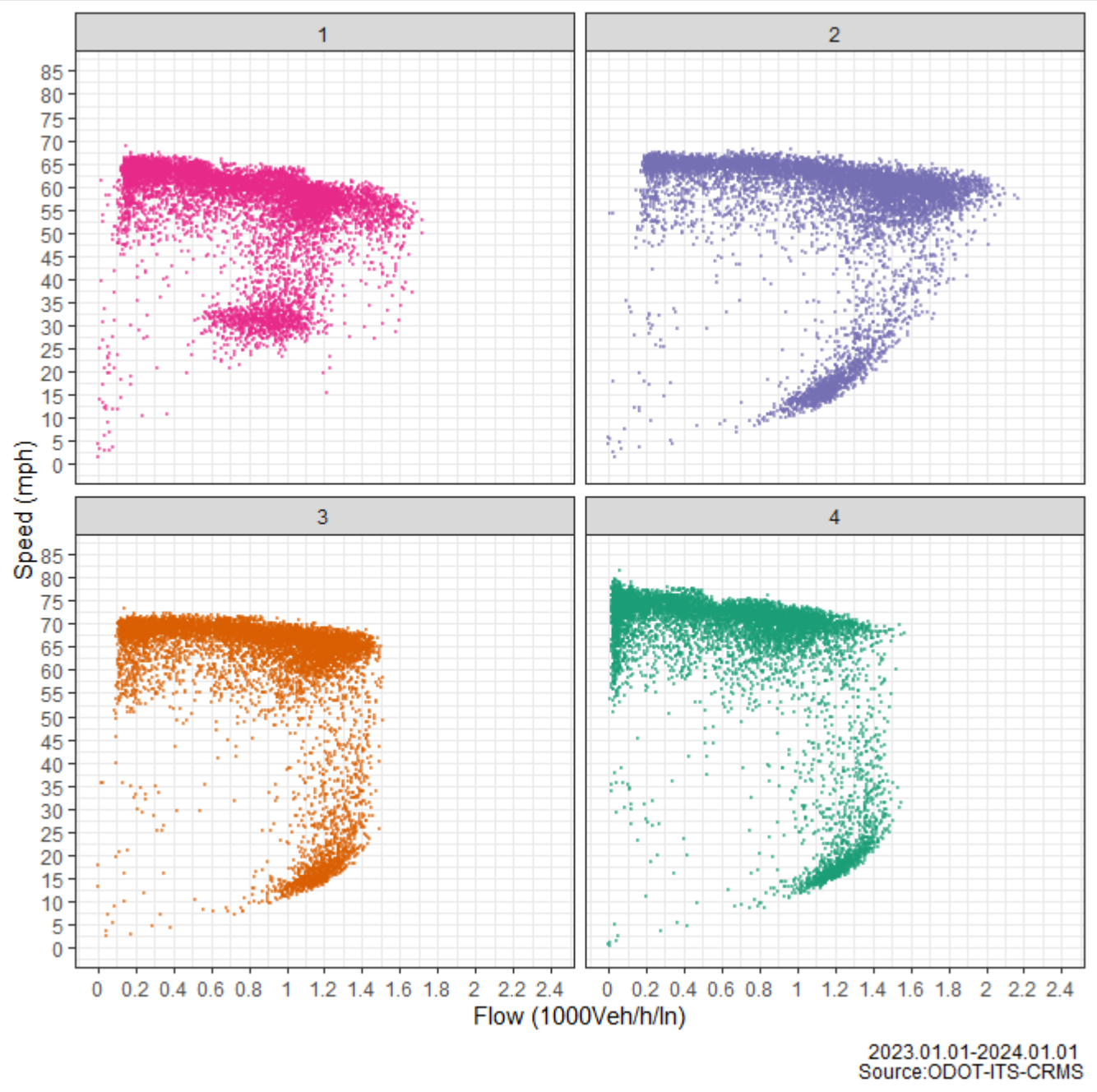
$$v_p = \frac{V}{PHF \times N \times f_{HV}}, \quad PHF = \frac{V}{4 \times V_{15}}$$

$$v_{adj} = v \times \mathbf{DAF}$$

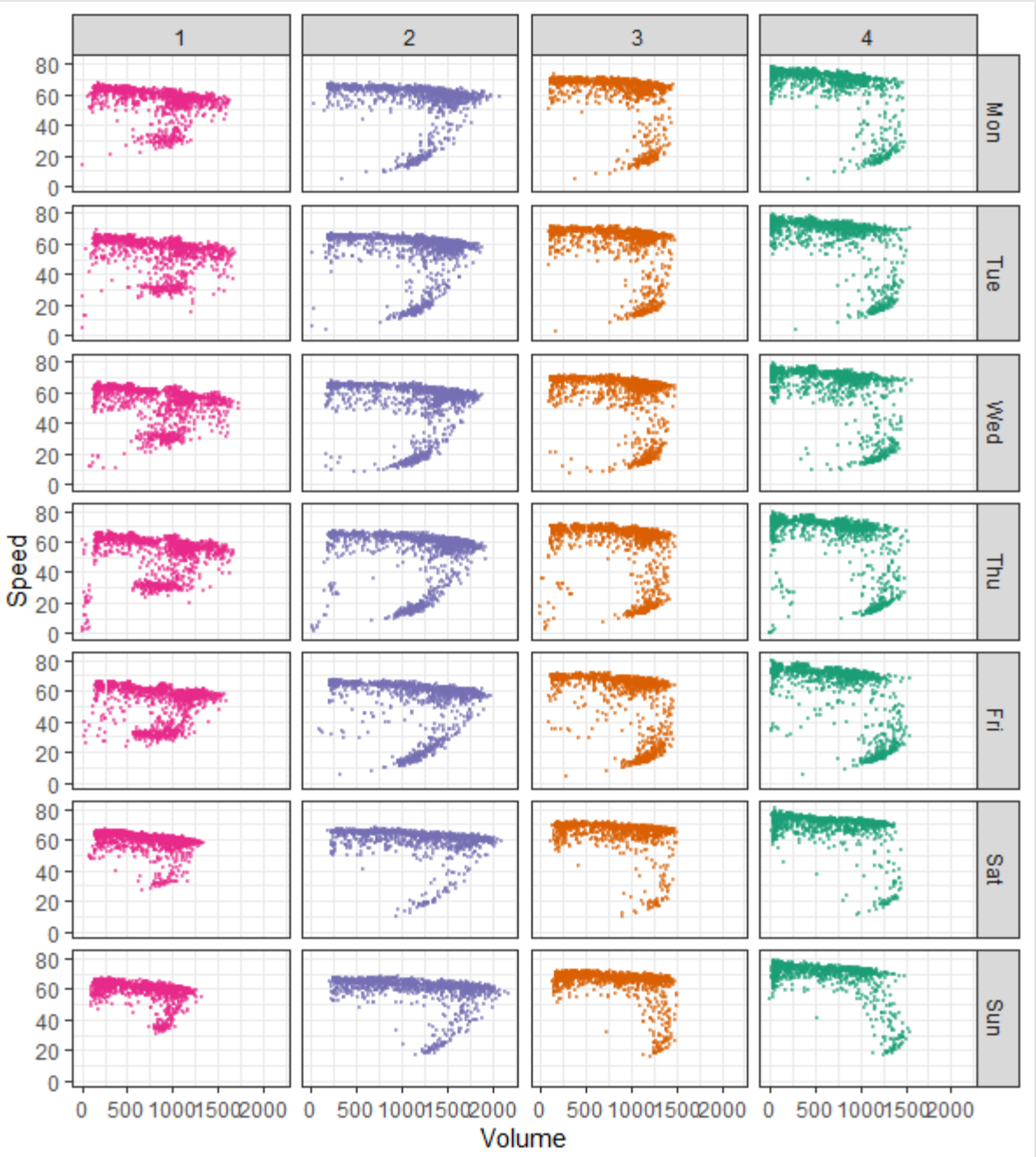
HCM, Chp.10~12/HCS

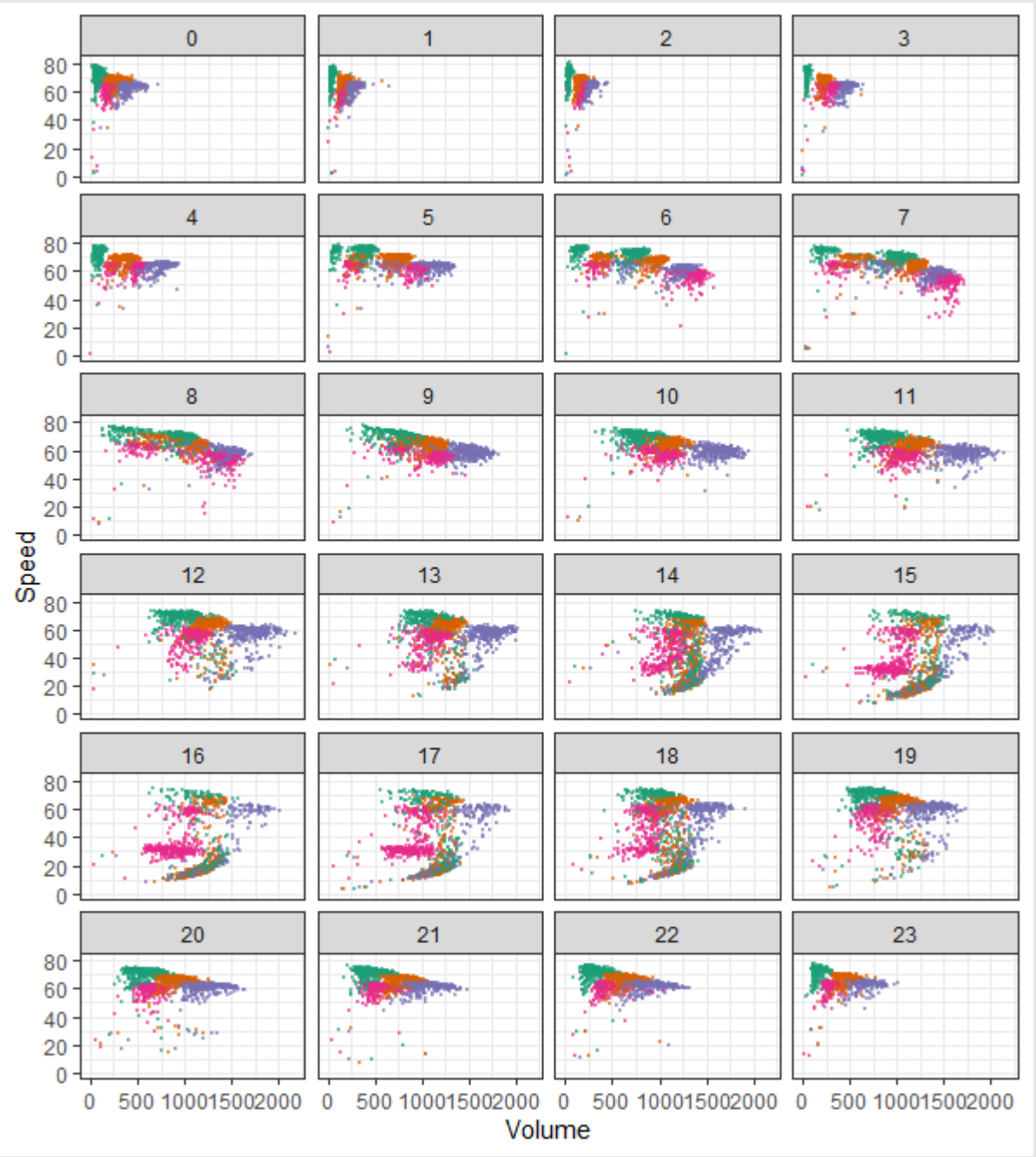
# + Lanes


Speed (mph)
Flow (1000Veh/h/ln)
Lane
1
2
3
4
2023.01.01-2024.01.01
Source:ODOT-ITS-CRMS


1
2
3
4
Speed (mph)
Flow (1000Veh/h/ln)
2023.01.01-2024.01.01
Source:ODOT-ITS-CRMS

# + Time


1
2
3
4
Mon
Tue
Wed
Thu
Fri
Sat
Sun
Speed
Volume
0
20
40
60
80
0
500
1000
1500
2000

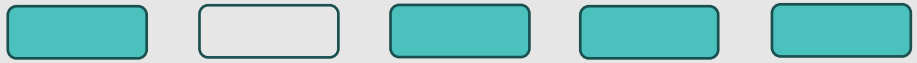

0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Speed
Volume
0
20
40
60
80
0
500
1000
1500
2000

# Occupancy

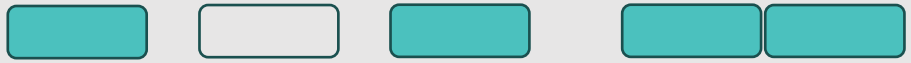
"Roadway occupancy is frequently used as a **surrogate** for density." –HCM v7, p.4-6

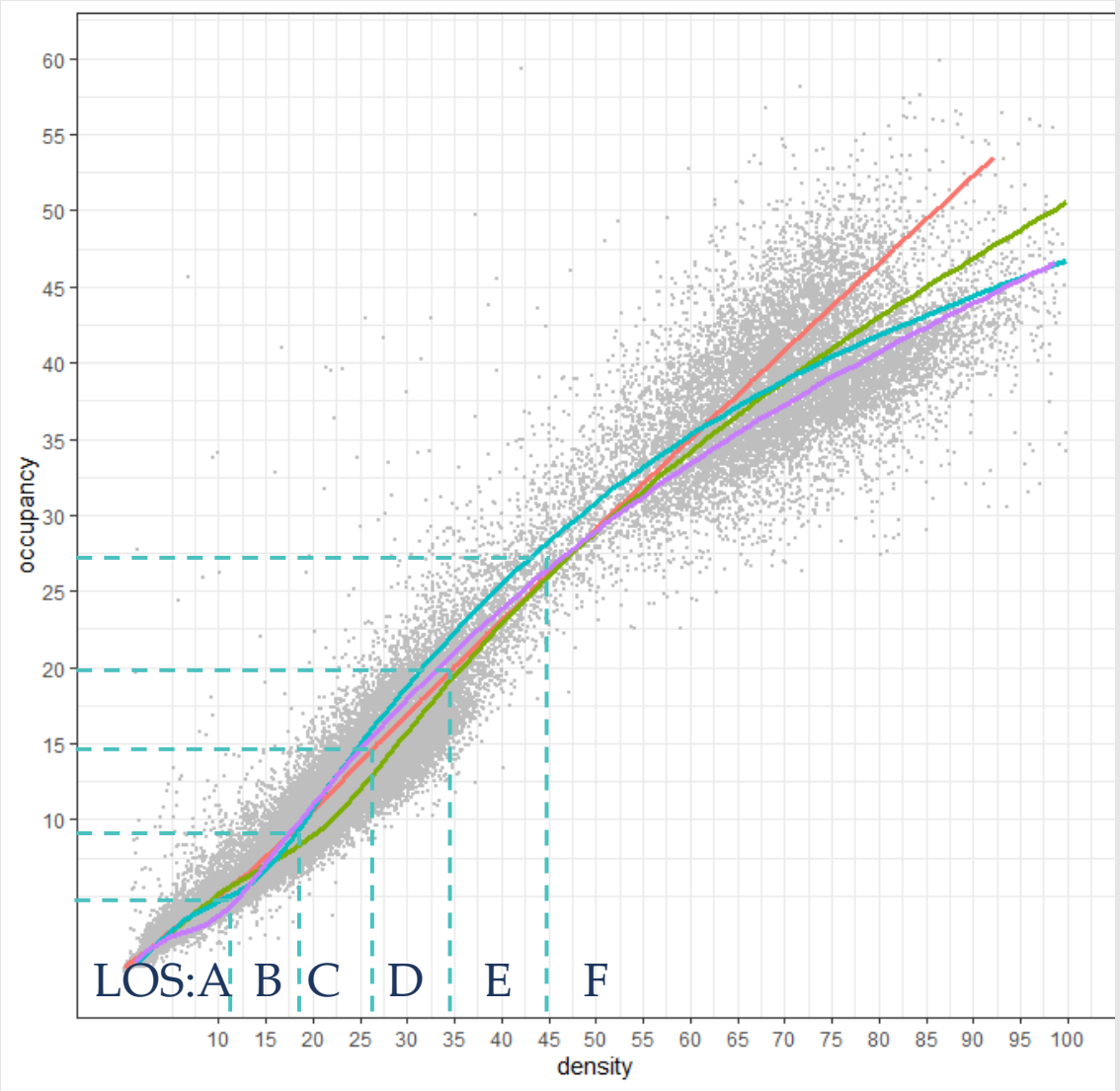
Vehicle vs. Passenger Car

D=0=4



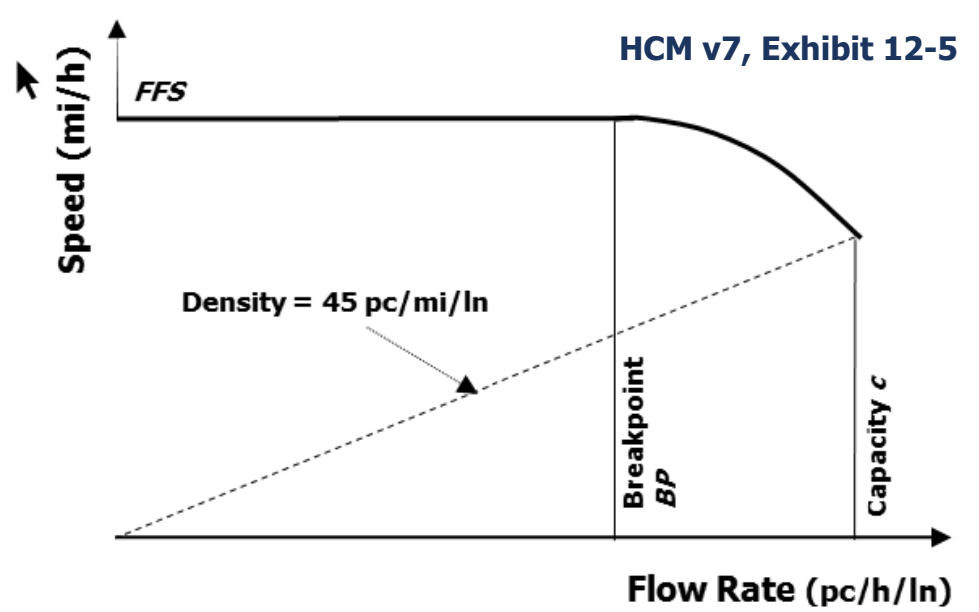
D=3; 0=4

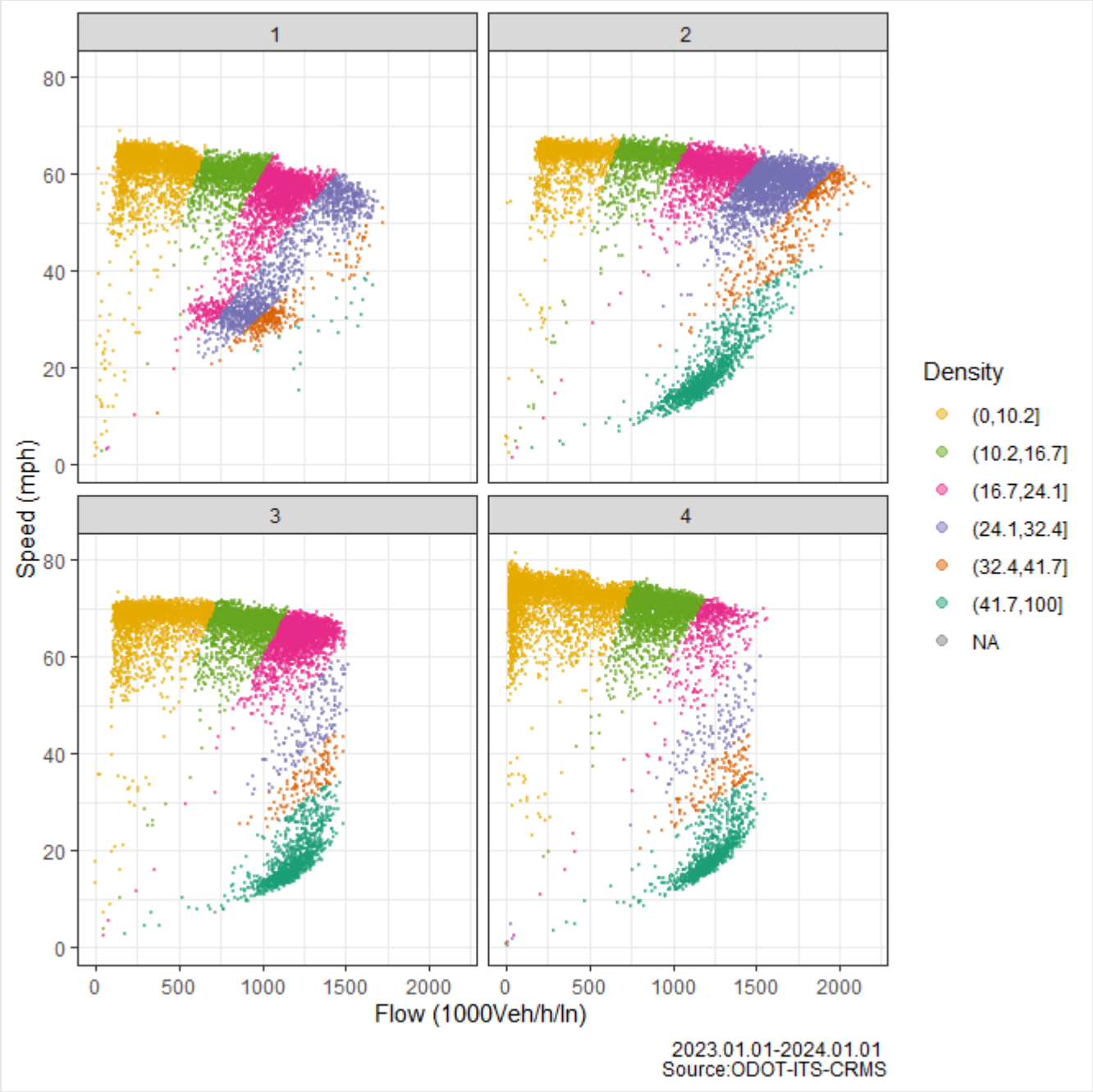




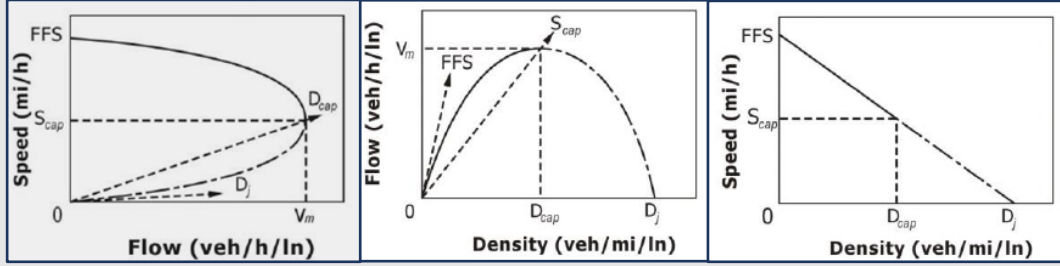

11-18 - 26- 35 - 45

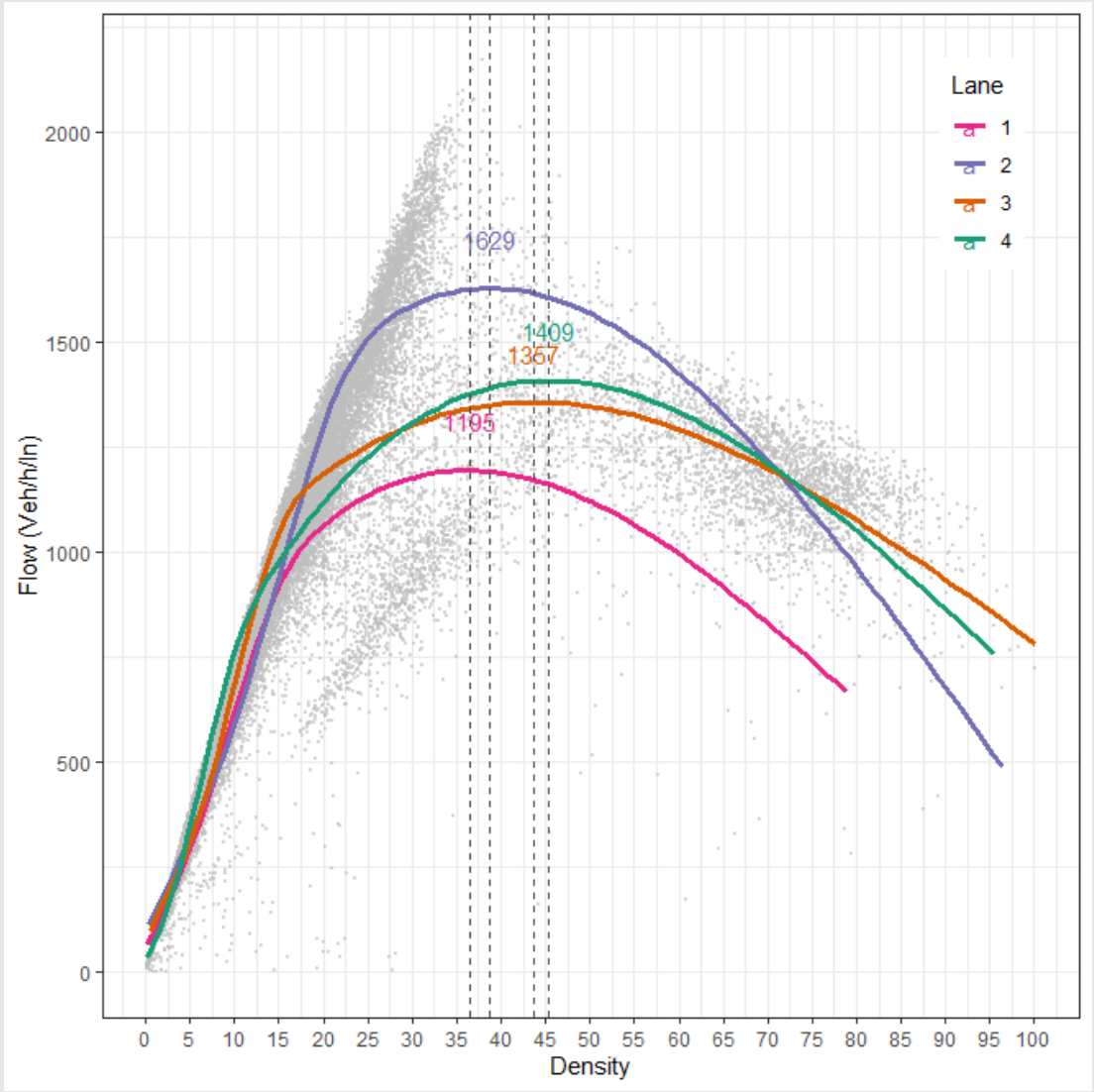
# Capture the critical points

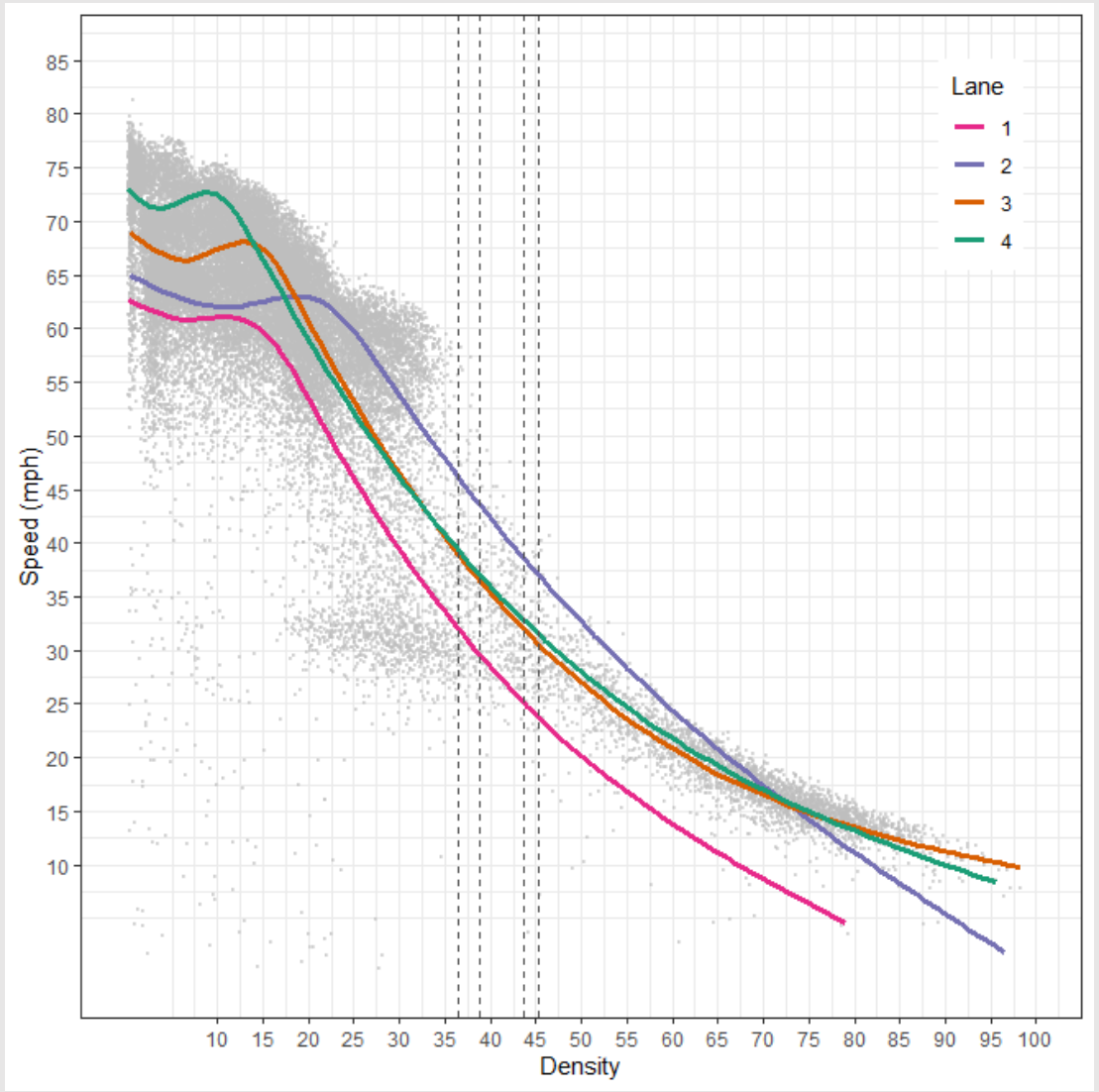


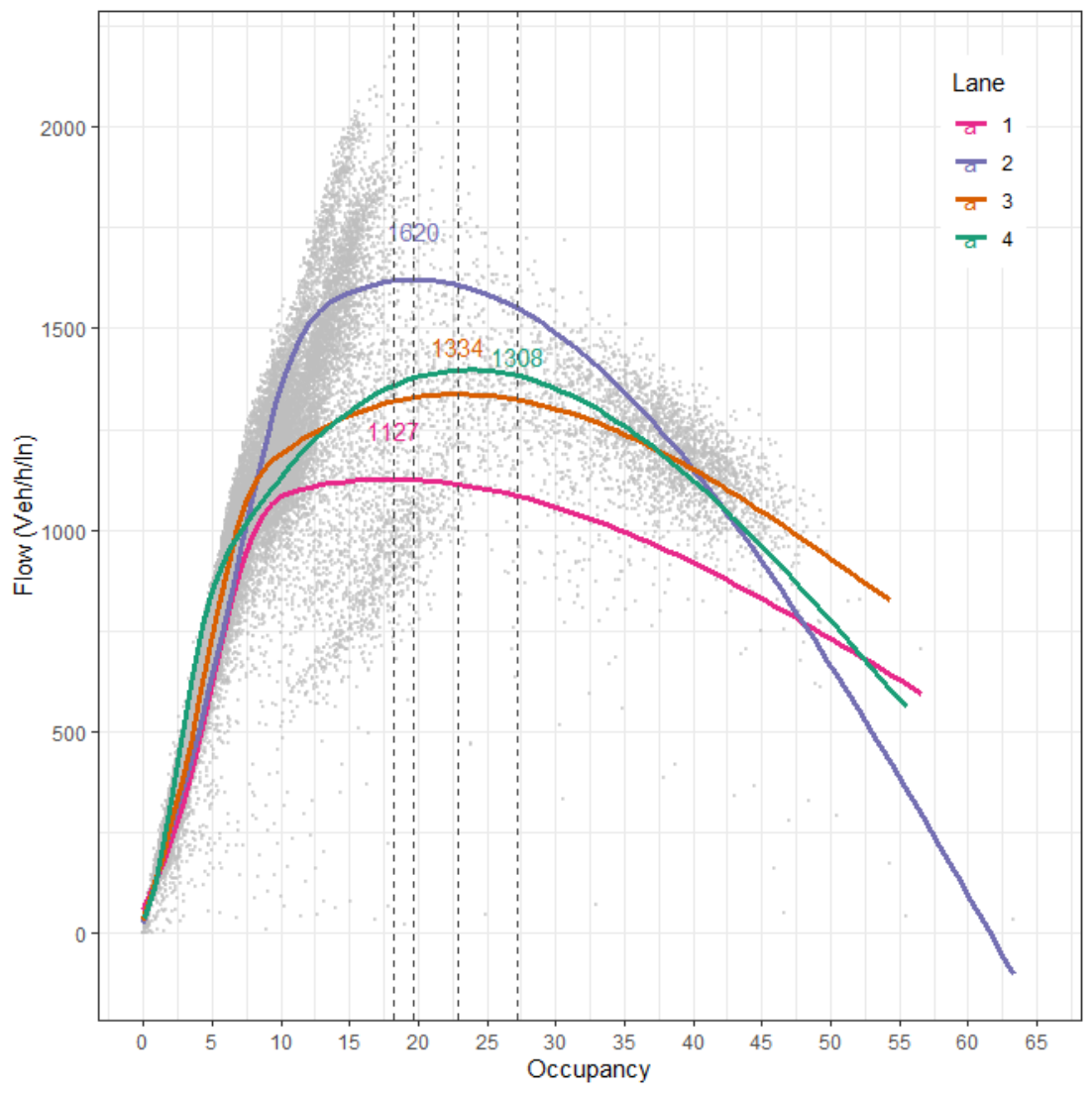
# By Density

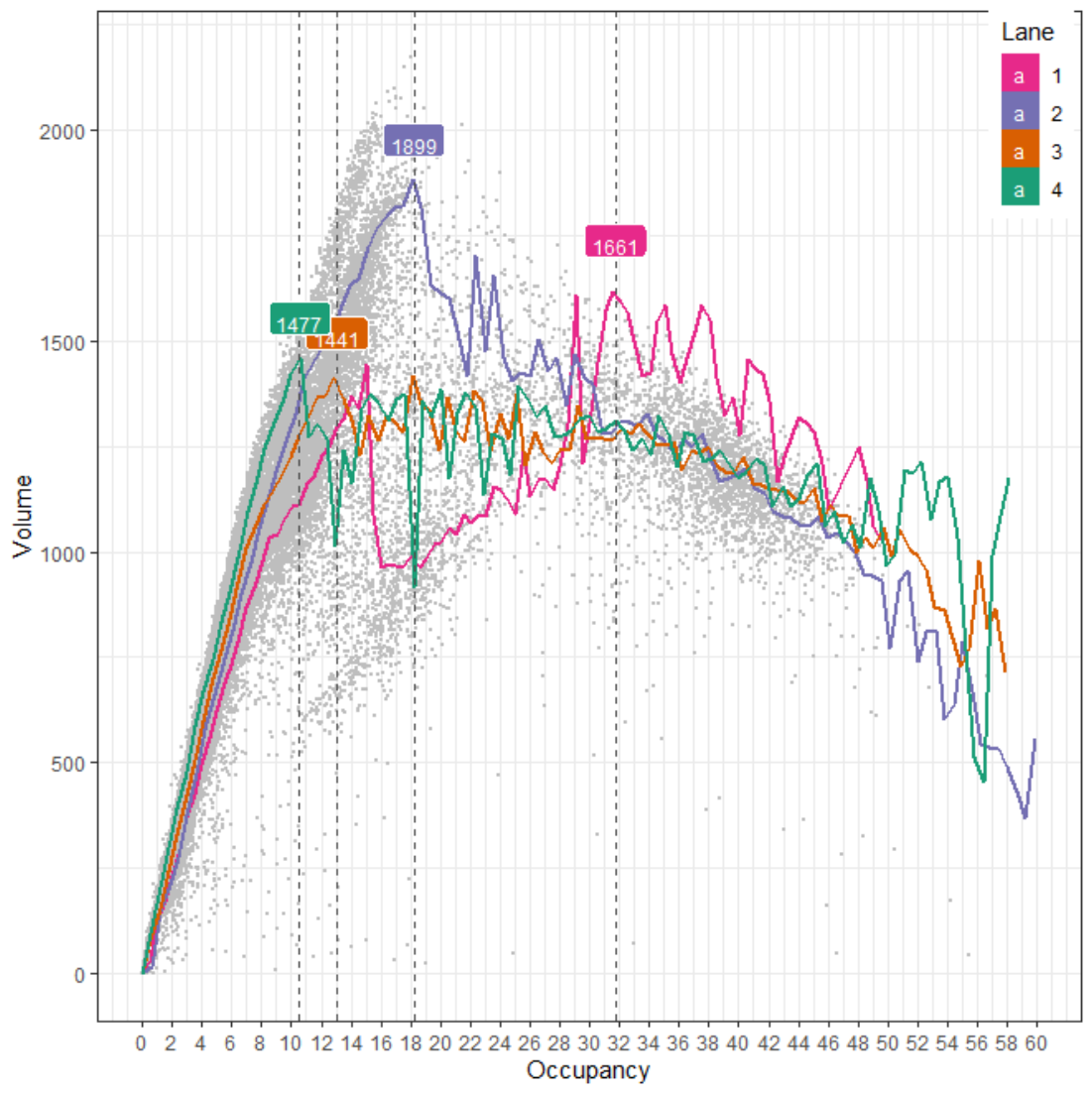

FFS
Speed (mi/h)
$S_{cap}$
$D_{cap}$
$D_j$
0
$V_m$
Flow (veh/h/ln)
$V_m$
FFS
$S_{cap}$
Flow (veh/h/ln)
0
$D_{cap}$
$D_j$
Density (veh/mi/ln)
FFS
Speed (mi/h)
$S_{cap}$
0
$D_{cap}$
$D_j$
Density (veh/mi/ln)


Lane
1
2
3
4
1629
1409
1357
1195
Flow (Veh/h/ln)
Density


Lane
1
2
3
4
Speed (mph)
Density

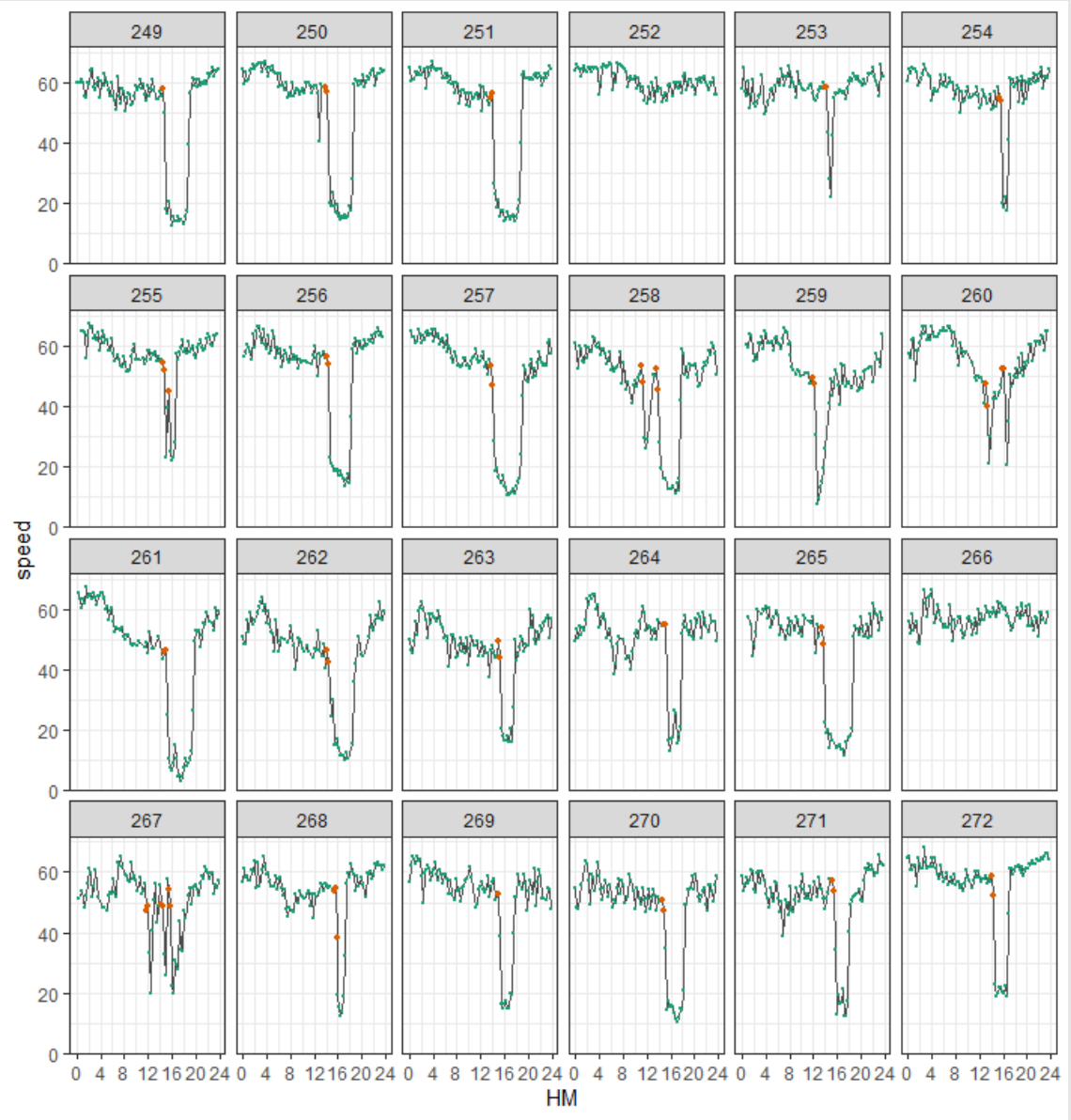
# By Occupancy



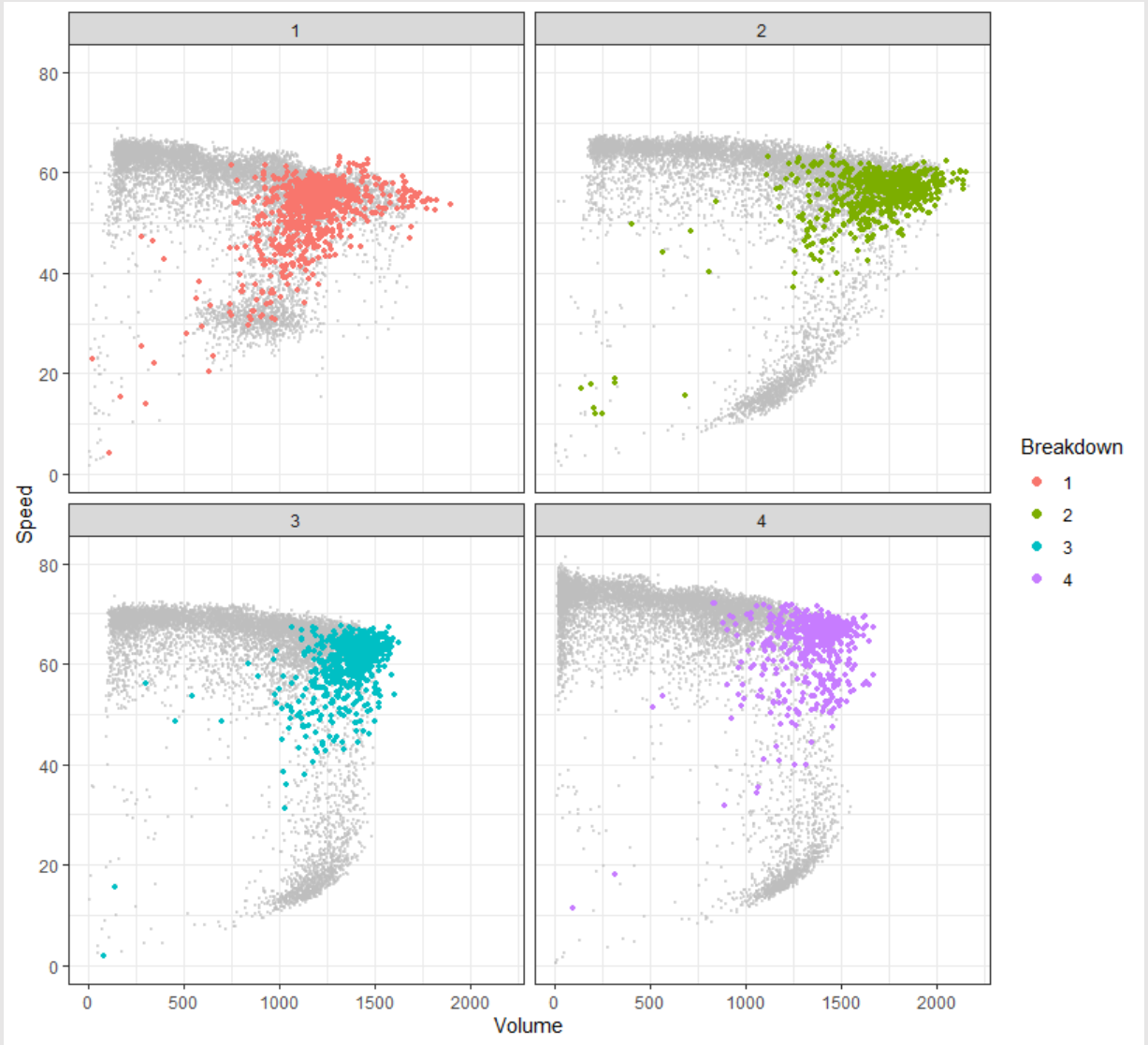
# Capture Breakdown (HCM v7, Chp.26)

"A sudden drop in speed of at least **25% below the free-flow speed** for a sustained period of **at least 15 min** that results in queuing upstream of the bottleneck."
–HCM v7, p.10-14

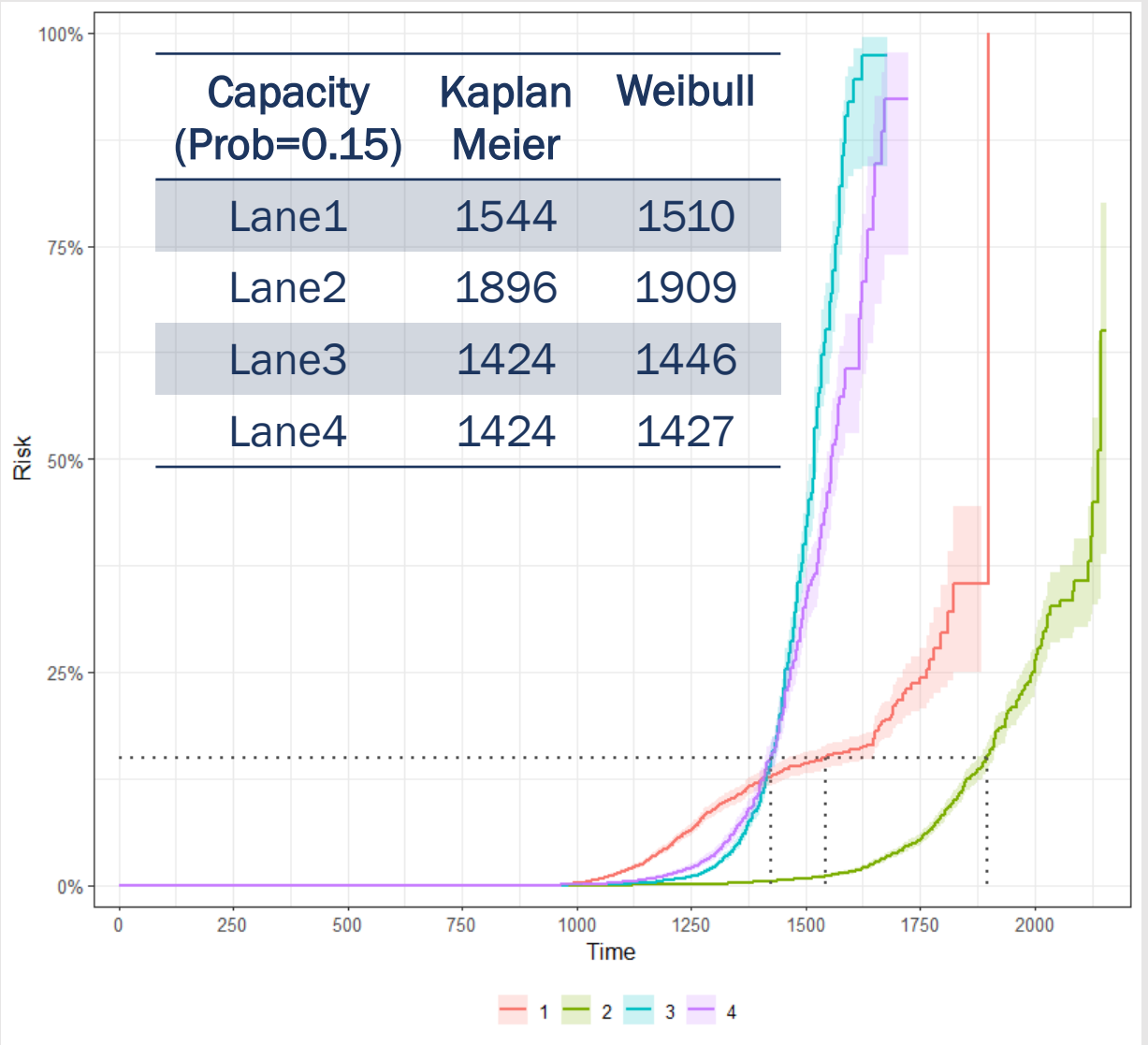


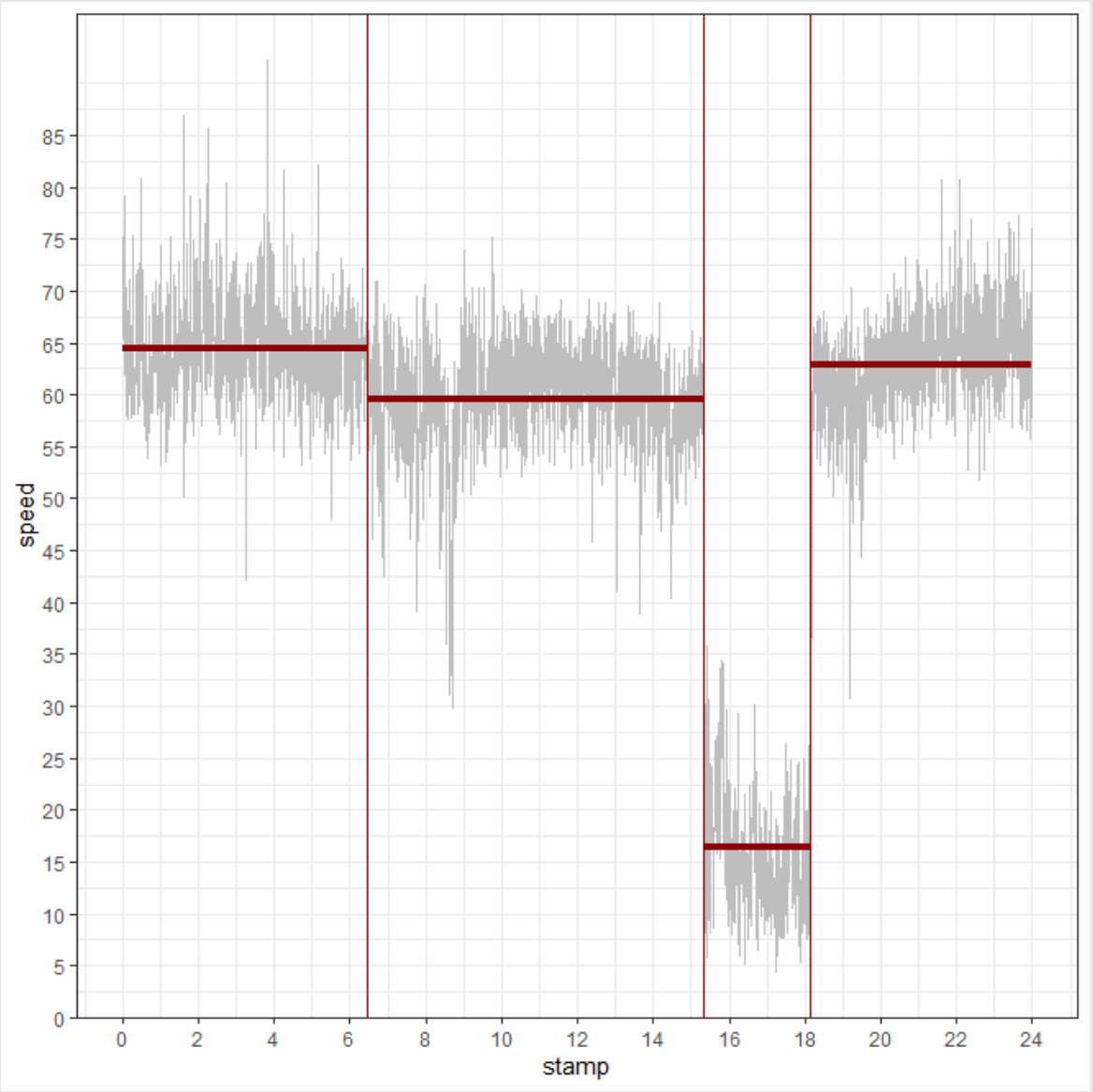

Speed>.75FFS & lead(Speed)<.75FFS & lead(Speed,2)<.75FFS

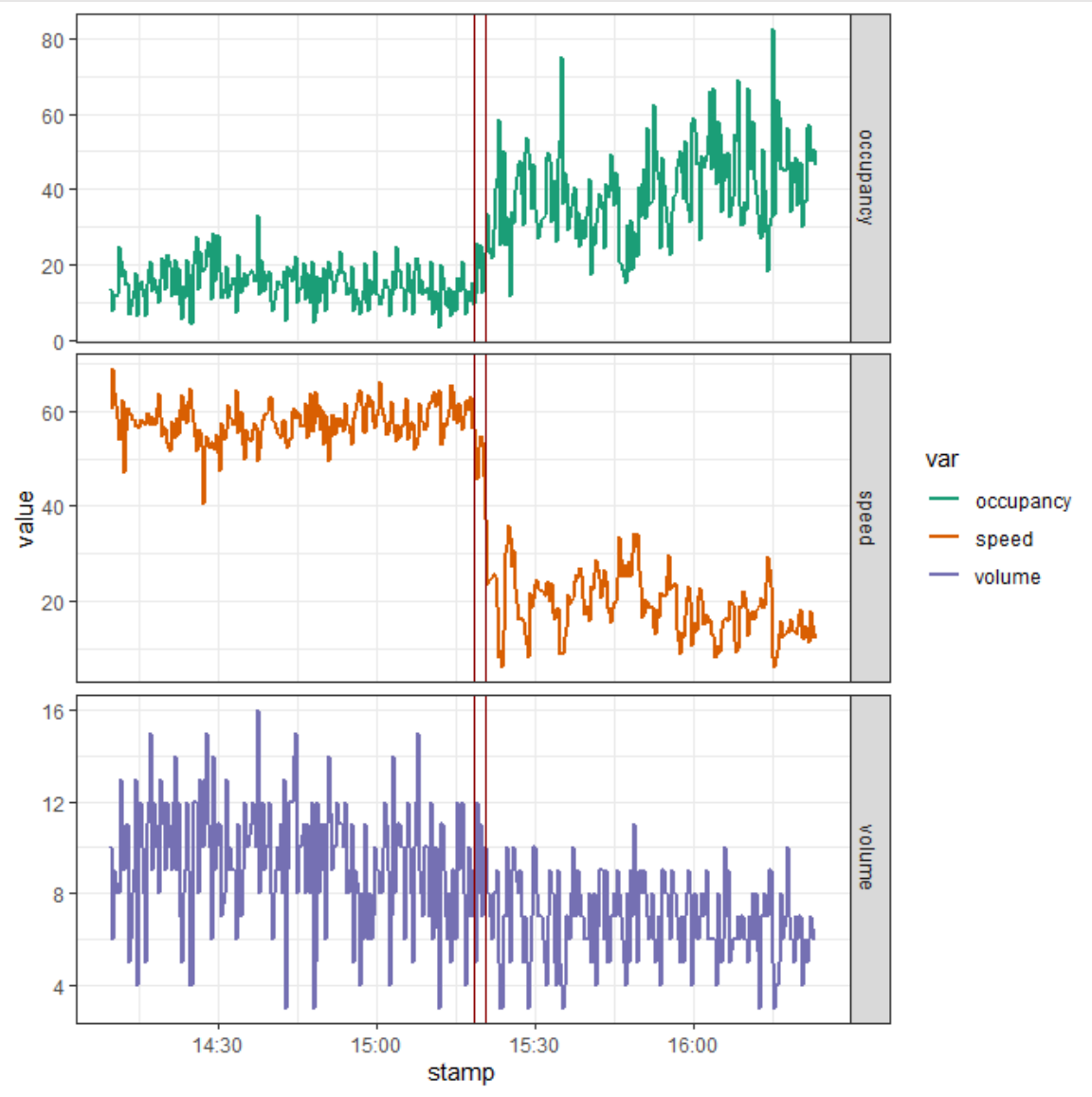
# By Breakdown




| Capacity (Prob=0.15) | Kaplan Meier | Weibull |
|---|---|---|
| Lane1 | 1544 | 1510 |
| Lane2 | 1896 | 1909 |
| Lane3 | 1424 | 1446 |
| Lane4 | 1424 | 1427 |




speed
stamp
0
2
4
6
8
10
12
14
16
18
20
22
24
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85


value
stamp
occupancy
speed
volume
14:30
15:00
15:30
16:00
0
20
40
60
80
4
8
12
16
var
occupancy
speed
volume

# Furthermore

- Data Quality
  - Aggregating errors
  - Missing records
  - Outliers
- Stochastic Methods
- Critical Occupancy
- Corridor Analysis
  - Merge, diverge, weave
  - Speed-Flow Typology

Email: Shen.QU@odot.oregon.gov