Project - Report

TNM098 - Advanced Visual Data Analysis

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Introduction

Twenty-five years ago, the Boonsong Lekagul Nature Preserve was created to preserve the wildlife habitat and flora species that are native to the area. The preserve is open year round and offer both hiking, cycling and camping, to birdwatching, photography and nature and conservation studies.

When visiting the preserve you have to abide by some rules. Pets are not allowed, fires are only allowed in pits in camping areas. The main focus of the preserve is conservation, therefore there is not allowed to destroy any of the plants or trees. The wildlife is not to be hunted, trapped or harassed in any way. No new flora or fauna is to be introduced to the preserve either.

Research questions

The visitors are not to disturb any of the flora or fauna in the preserve but how does the traffic affect the wildlife? This will be analyzed more thoroughly in this project by answering the following three question:

- Which gates is the most visited and why?
- What type of cars visits the preserve and where do they go?
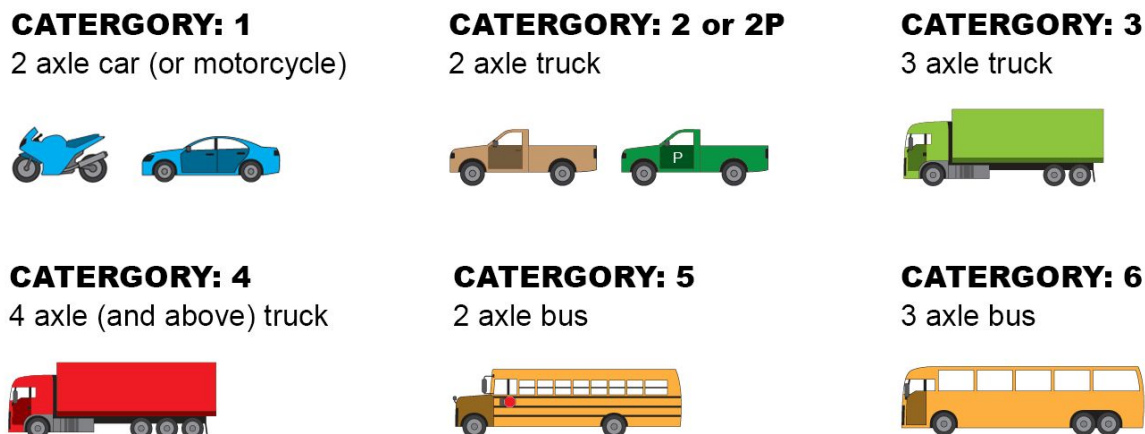- How will all of this traffic affect the wildlife in the preserve?

Data

The data used in this project is data recorded from sensors around the Boonsong Lekagul Nature Preserve and a map over the locations of the roadways and sensors in the preserve.

Sensor data

Each vehicle that enters the preserve will receive a ticket and a vehicle class. The cost of this ticket depends on the vehicle class. The ticket contains a RF-tag that enables the sensors to see how the vehicle moves. It is then returned when exiting the preserve.

There are six different vehicle categories; 2 axle cars or motorcycles, 2 axle trucks (both visitors and park service vehicles), 3 axle trucks, 4 axles (and above) trucks, 2 axle buses and 3 axle buses. These vehicle types can also be seen in Figure 1.

CATERGORY: 1
2 axle car (or motorcycle)

CATERGORY: 2 or 2P
2 axle truck

CATERGORY: 3
3 axle truck

CATERGORY: 4
4 axle (and above) truck

CATERGORY: 5
2 axle bus

CATERGORY: 6
3 axle bus

Figure 1: The six different vehicle categories.

There are also five different types of sensors in the preserve. Entrances; that all vehicles pass through when entering or leaving, general gates; that all vehicles may pass through, gates; that only preserve ranger vehicles may pass through, ranger stops (and one ranger base); working areas for the rangers and campings; campgrounds for visitors.

The data is saved in a comma-separated values file, CSV for short, and look like the example in Figure 2.The file has four different fields; timestamp, car ID, car type and gate name. Timestamp is the date and time of the sensor reading. The car ID is a unique number that is assigned when entering the preserve. The car type is a number that correspond to one of the six categories. A "P" is appended if t is a park service vehicle, for example "2P". The data is from May 2015 to May 2016 and does not observe "Daylight Savings Time".

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2015-05-01 00:15:13,20151501121513-39,2,entrance4
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Figure 2: Example of the data with the four data fields.

There is data from over a year but since that takes a lot of computer time, only a week during the summer, when a lot of people visits the preserve, is used. During this week 6 % of all visitors are at the preserve.

The map

The map provided shows the locations of the roadways in the preserve and where the different sensors are located on the 200x200 gridded area and can be seen in Figure 3. The area is 12 miles by 12 miles in real life.
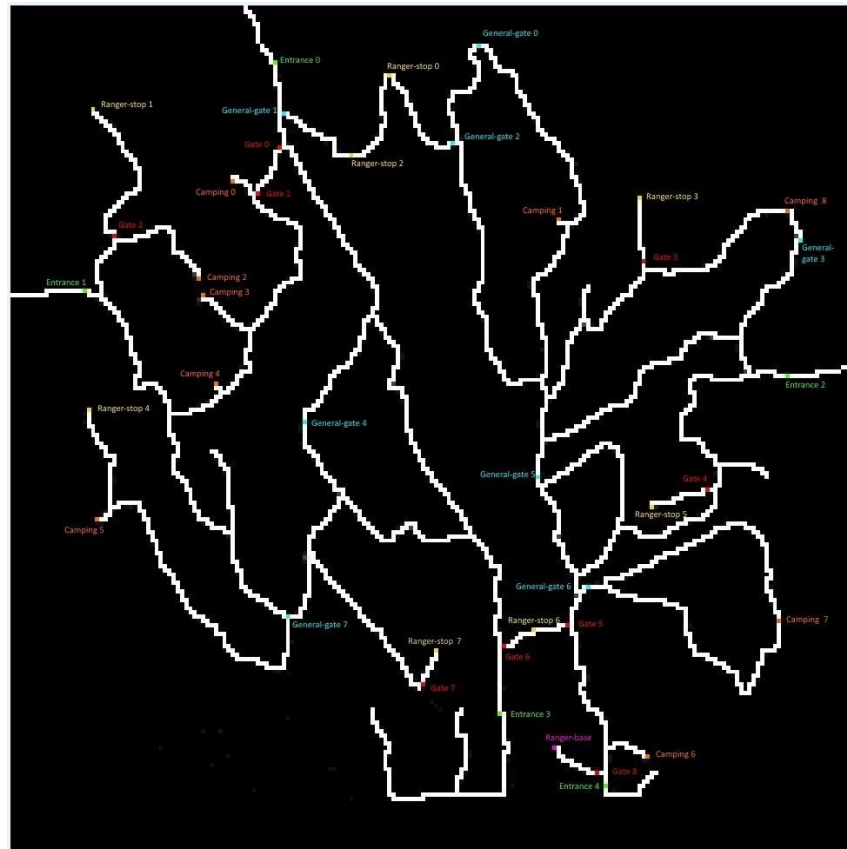
Figure 3: The map over the preserve provided for this project.

Additional data

Some additional information that is provided about the dataset is that traffic either pass through the preserve or stay either a day or longer at one of the campgrounds. When they are not working, the preserve rangers stay at the ranger base. The speed limit in the preserve is 25 mph, which is approximately 40 km/h.

Methods

Firstly all of the variables, such as the coordinates, the data from the sensors and the car specific data was ordered and put into new matrices. After this a few different visualisations was created to answer the three questions for this project. All of this was done in MATLAB.

Gate coordinates

The coordinates for each of the sensor locations was retrieved from the map that was provided for the project. The map was inserted into an image with the size 1000 x 1000 pixels. Dots for each sensor location was then placed in the picture and the position was extracted as coordinates. The coordinates matrix included three fields; the name of the gate, x coordinate and y coordinate.

Sensor data matrix

The sensor data recorded is a timestamp containing both a date and a time, a unique car ID, the car type and the name of the gate the car passes. All this data was loaded into MATLAB and put into a matrix. From this matrix, the unique car ID was used to see the different routes each car has taken. The car type was used to see what kind of cars move in what areas. The name of the gate was combined with the gate coordinates to be able to visualize both each cars movement and the different car types movements.

Car data

To be able to see where a specific car has been each sensor reading has to be connected to a car ID. The car matrix includes three fields; the car ID, what car type is has been classified as and the different locations it has been to. A car can either go from one entrance to another and then exit the preserve or it will move around and then end up in a camping or exit after a day in the preserve. This means that the number of sensors the car has passed can be either two, eight or fifteen, it will simply vary from car to car. The matrix will therefore fill out the rest with empty cells.

Visualisations

The number of times a gate is passed can be calculated by iterating through the data set and counting the passes for each of the gate sensors. This gives each gate a number which does not say much. This is therefore visualised by using different sized dots on the map. To easier show where the cars are more often the color of the dot is also dependent on the size.

To answer the question of why the gates are the most visited the movements from gate to gate needs to be considered. To show this each of the cars movements are visualised as lines from place to place. This will not show the exact route of the car since there might be more than one way to go between to gates, but it will give an approximation.

This is done for all of the cars but also on car type level to see what type of cars move in what area of the preserve.

Results

On July 13, 2015 there is a total of 202 unique cars that enters the preserve. The distribution of the different types can be seen in Table 1.

Table 1: The distribution of the different vehicle types in the preserve during one day, 13 July, 2015..

Car type	1	2	2P	3	4	5	6
Number of vehicles	94	61	2	30	8	5	2
Percentage of total	46,5 %	30,2 %	1,0 %	14,9 %	3,9 %	2,5 %	1,0 %

From July 13 to July 19, 2015 there is a total of 1 093 unique cars that enters the preserve. The distribution of the different types can be seen in Table 2.
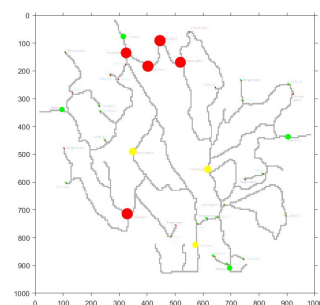
Table 2: The distribution of the different vehicle types in the preserve during week 29, 13 July to 19 July, 2015.

Car type	1	2	2P	3	4	5	6
Number of vehicles	507	292	14	192	50	31	7
Percentage of total	46,4 %	26,7 %	1,3 %	17,6 %	4,6 %	2,8 %	0,6 %

The gates where most people passed can be seen in Figure 4, for a day in Figure 4a and for a week in Figure 4b. These visualisations are for all car types and larger images can be seen in Appendix A.
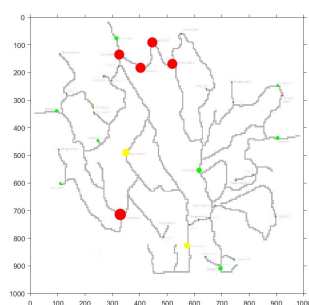
Figure 4a: July 13, 2015.	Figure 4b: From July 13 to July 19, 2015.

Figure 4: Most visited gates in one day and in one week.

The distribution of the different car types can be seen in Figure 5 and Figure 6. This is for a day respectively a week and the images can be seen in a larger size in Appendix B and Appendix C.
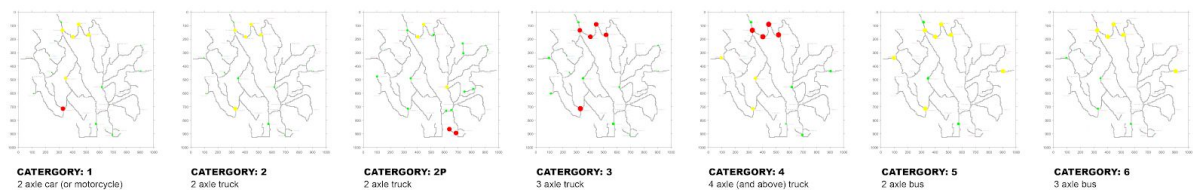
Figure 5: The distribution of where the different car types spend most time in a day.
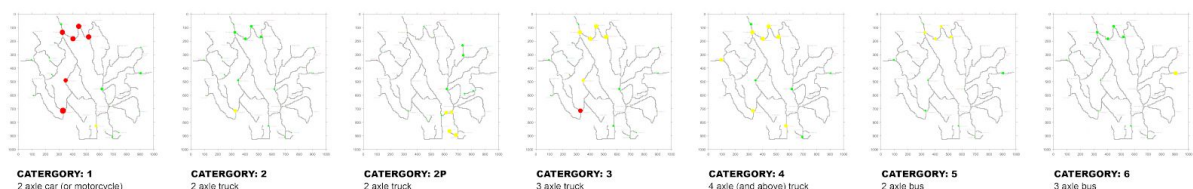
Figure 6: The distribution of where the different car types spend most time in a week.

A sample of what routes the vehicles use in one day can be seen in Figure 7. This have been done by taking 5 of the different types and visualising the movements. The routes can be seen in larger images in Appendix D. A sample of the images used to calculate the movements of the vehicles can be seen in Appendix E.

| CATERGORY: 1 | CATERGORY: 2 | CATERGORY: 2P | CATERGORY: 3 | CATERGORY: 4 | CATERGORY: 5 | CATERGORY: 6 |
| 2 axle car (or motorcycle) | 2 axle truck | 2 axle truck | 3 axle truck | 4 axle (and above) truck | 2 axle bus | 3 axle bus |
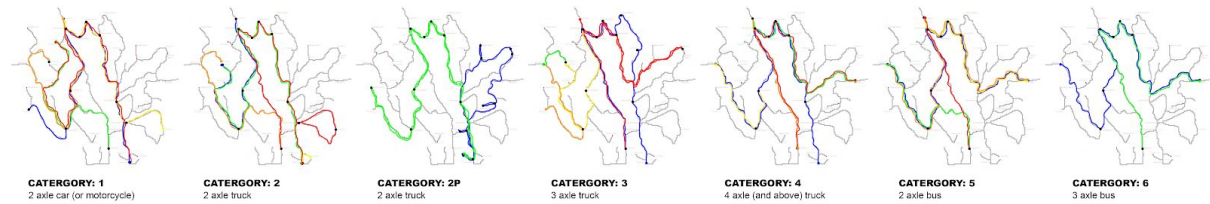
Figure 7: A sample of what roads the different types of vehicles use in the preserve.

Discussion and Conclusion

Three questions were asked in the beginning of the project and will be analyzed and answered below using the visualisations as a foundation.

- Which gates is the most visited and why?

The most visited gates were the four in the top of the map; General-gate 1, Ranger-stop 2, Ranger-stop 0 and General-gate 2 and the one in the bottom left corner; General-gate 7. One of the entrances; Entrance 3 and two gates on routes through the preserve; General-gate 4 and General-gate 5 are also passed a lot. On the maps showing the routes taken it is possible to make out that the route between Entrance 0 and Entrance 3 is heavily used, as well as the one parallel to it. This can explain why these are the most visited gates.

- What type of cars visits the preserve and where do they go?

Approximately 75 % of all visitors drive a 2 axle car, motorcycle or truck, park service vehicles included. Where they go are very similar to the general answer. One of two big differences that can be seen is that the park vehicles tend to visit the area around the Ranger-base a lot, due to the fact that they always start and stop there. The second is that Entrance 0 and 3 are more used by cars and trucks but the buses tend to use Entrance 1 and 2 instead.

- How will all of this traffic affect the wildlife in the preserve?

Looking at the amount of vehicles that pass through the preserve every day it is impossible to think that it would have no impact on the wildlife at all. The amount however is difficult to analyze without more data on where the animals prefer to be, if they avoid certain areas and so on. But the most heavily used roads should be a problem for the animals, both because of the noise and the emissions from all the vehicles.
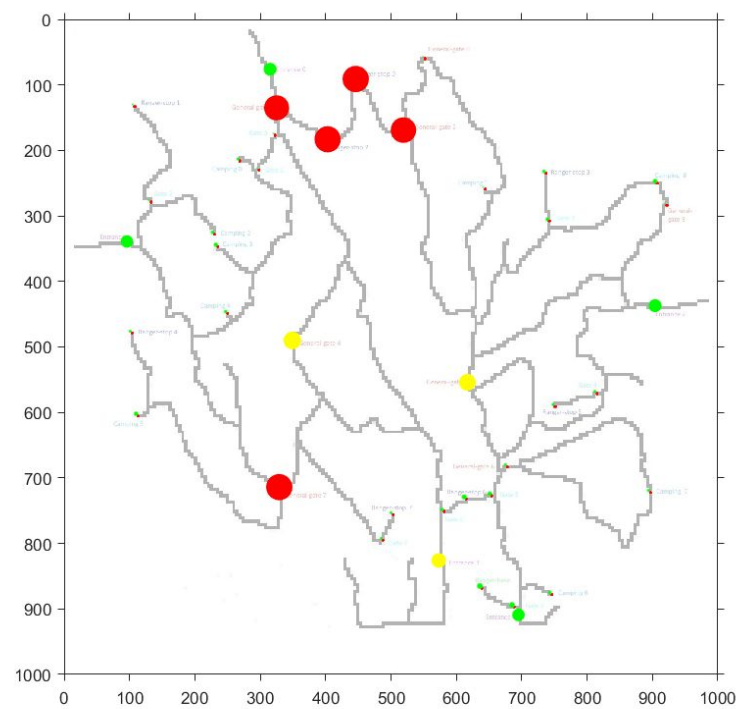
It was interesting to see the data for this preserve and it would have been useful to have more, for example the animals behaviour in the preserve. The timestamps are not used at all at this point and that could be used to see how long the vehicles tend to stay in one place.

Appendix

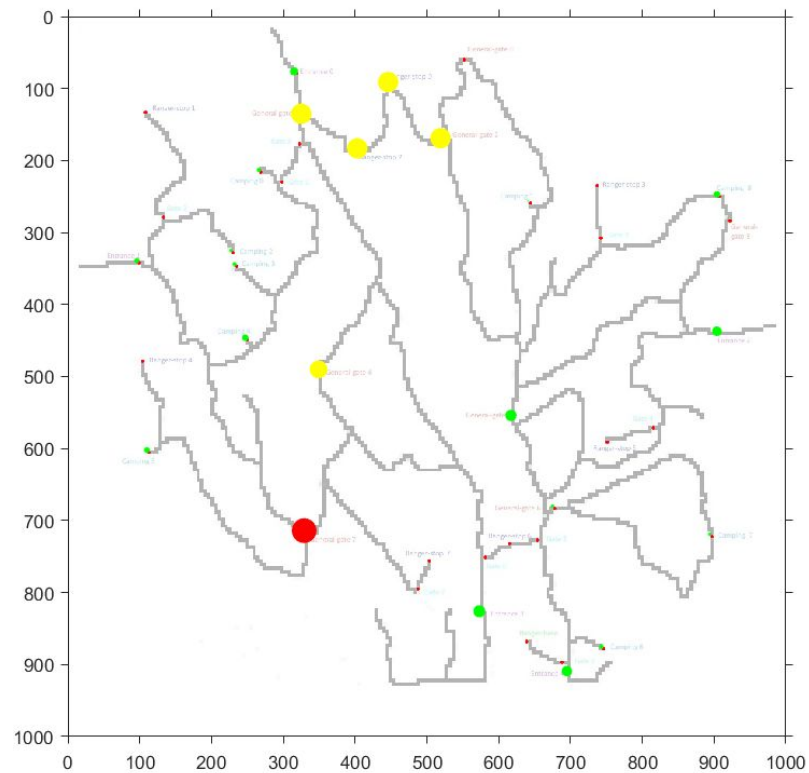## Appendix A - Most visited gates in one day and in one week
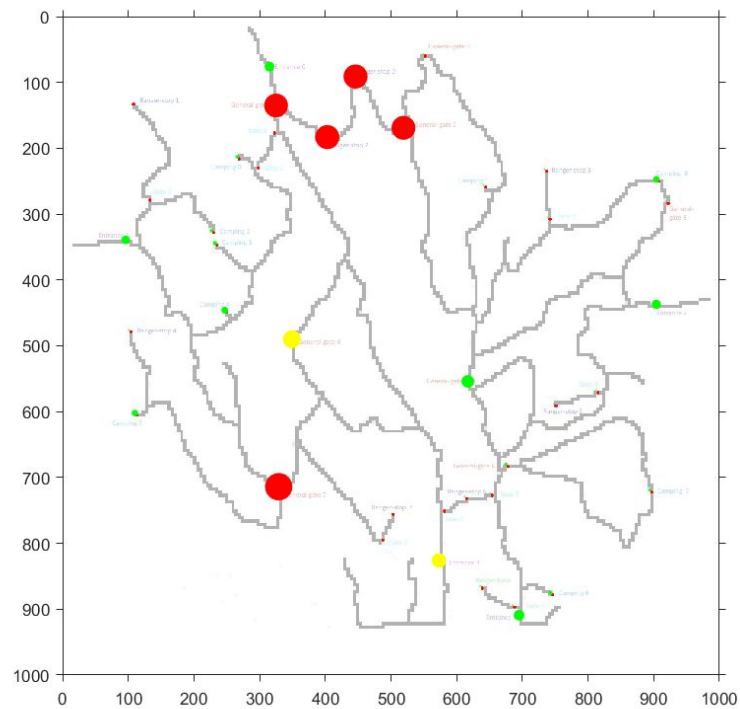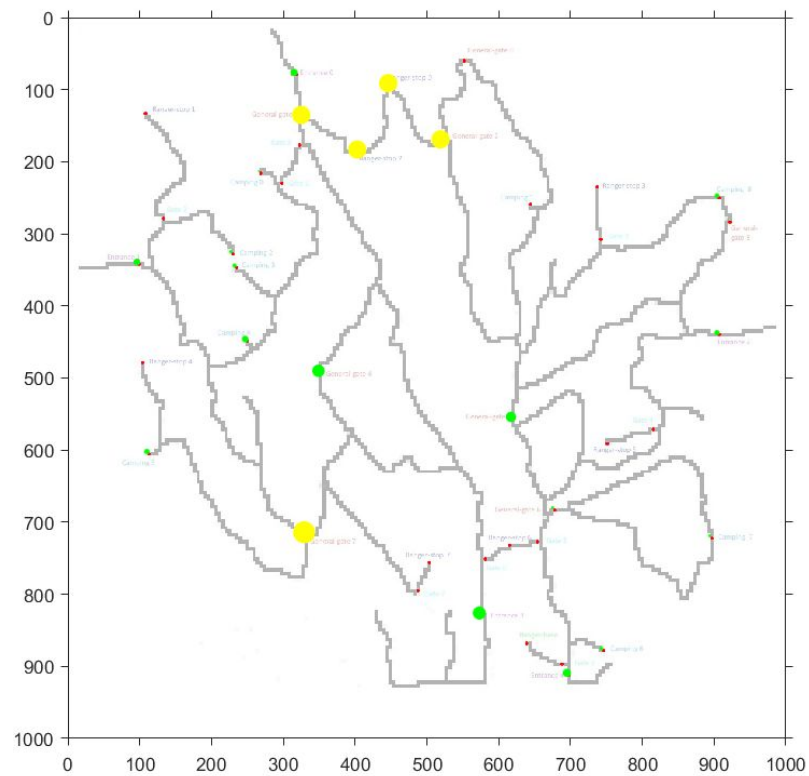

A1: July 13, 2015.

A2: From July 13 to July 19, 2015.

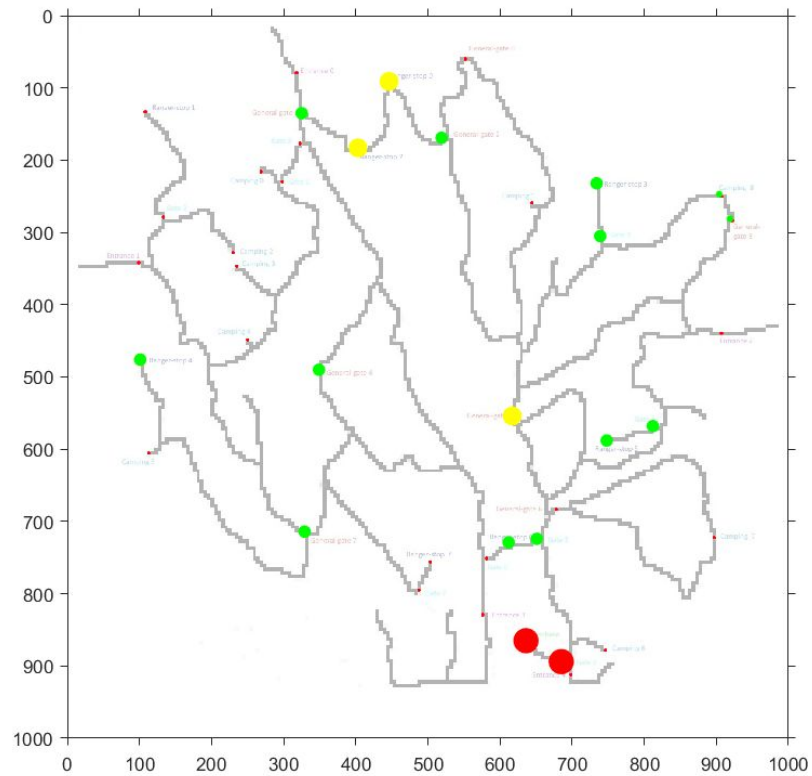# Appendix B - Most visited gates in one day, by vehicle type

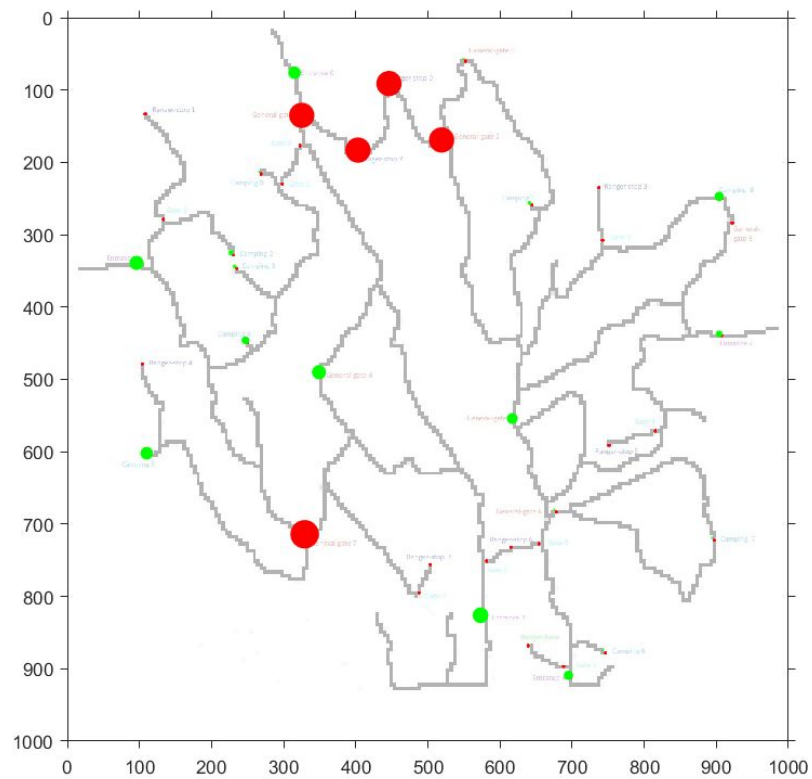*B1: Category 1, 2 axle car (or motorcycle)*
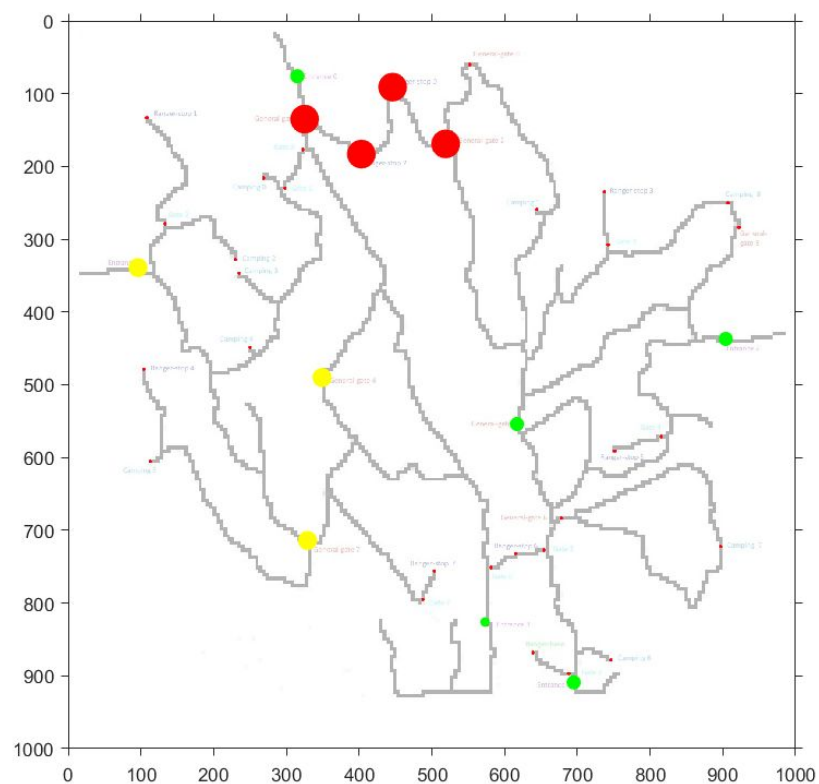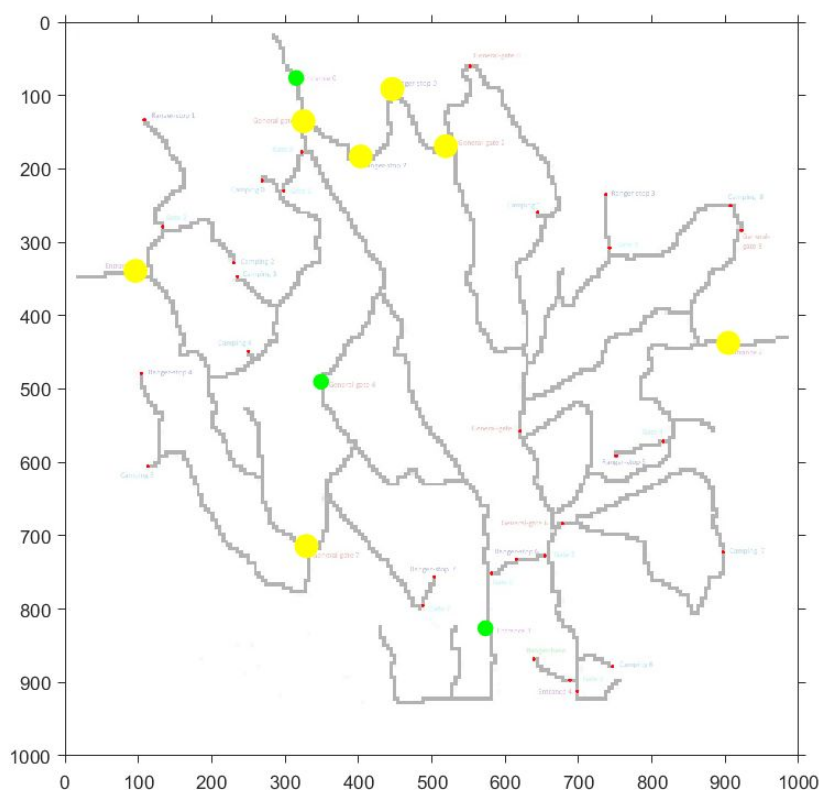

B2: Category 2, 2 axle truck

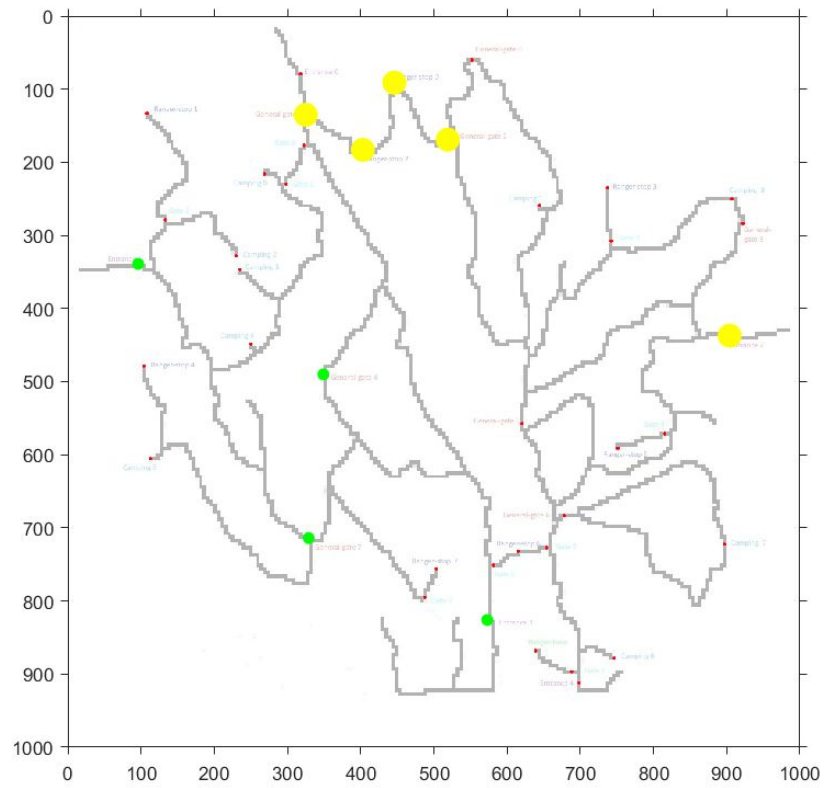*B3: Category 2P, 2 axle truck (park service vehicle)*

B4: Category 3, 3 axle truck
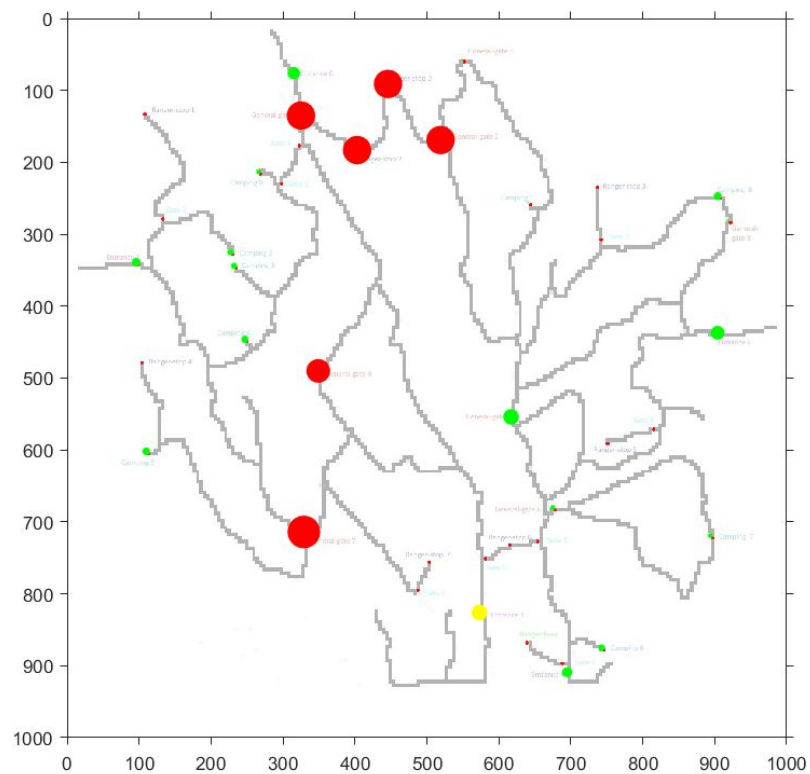
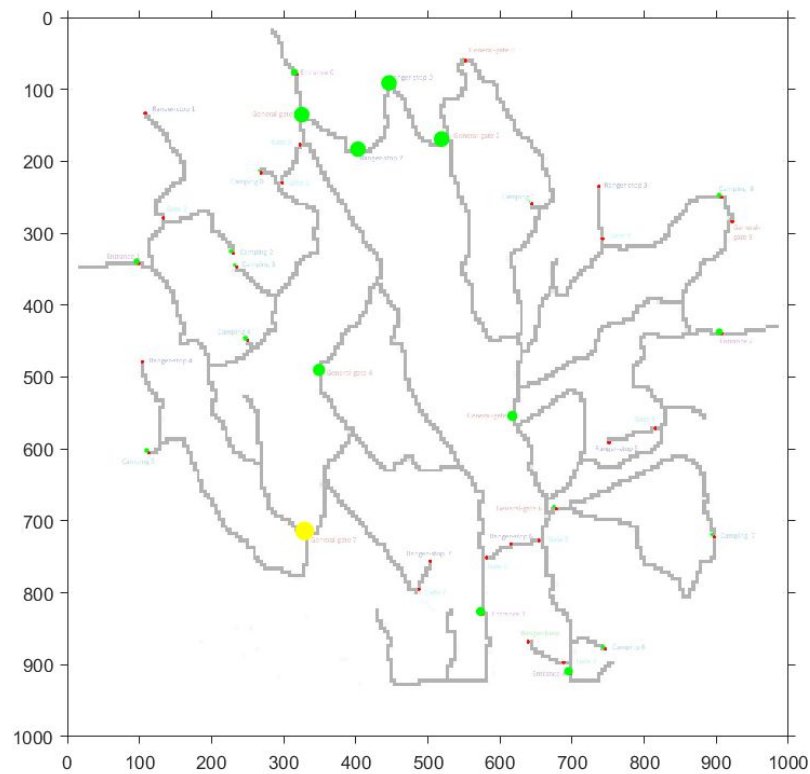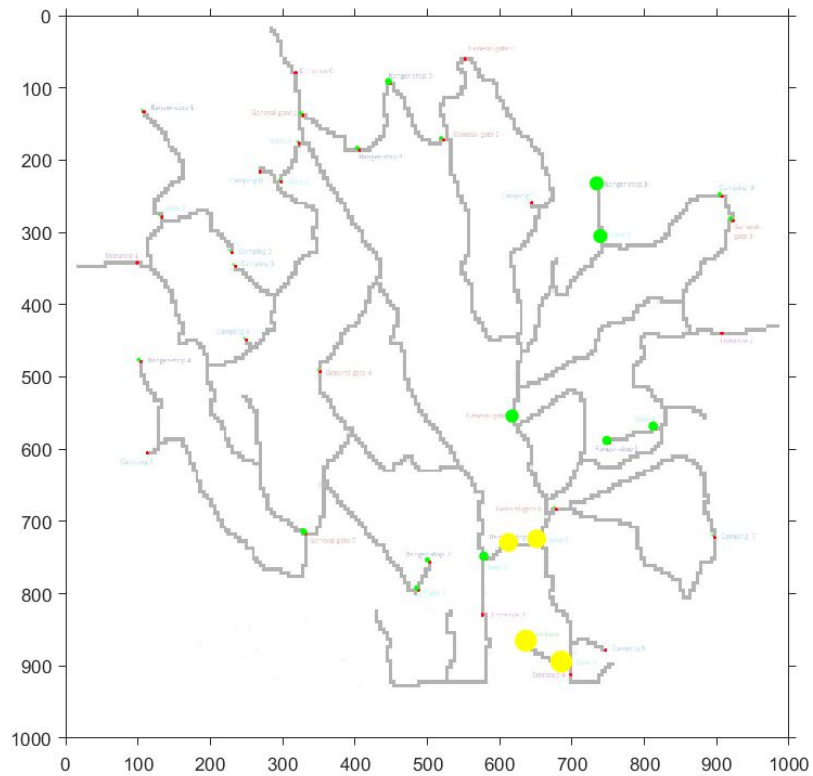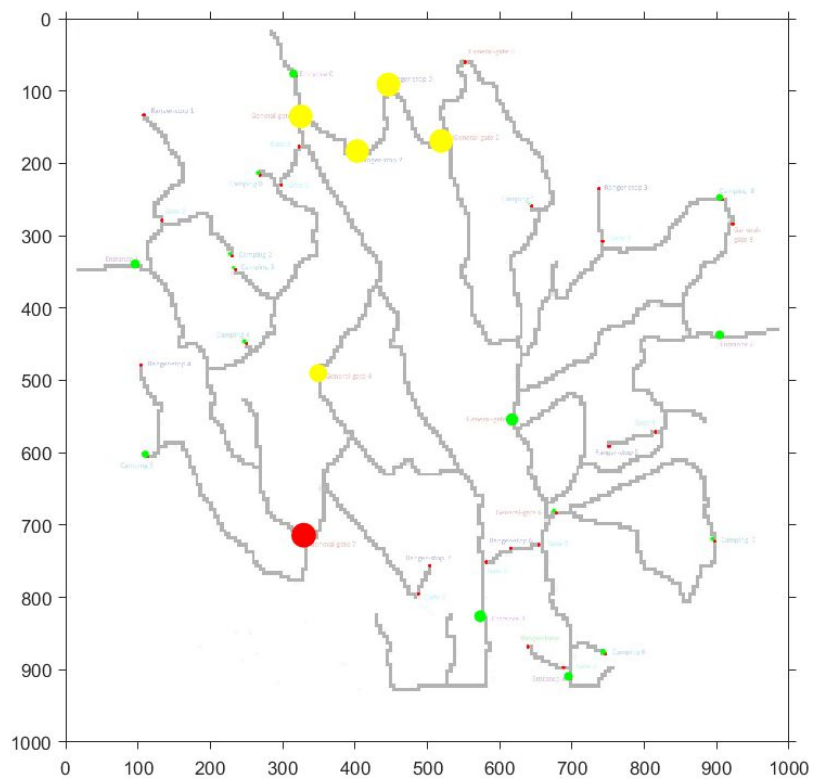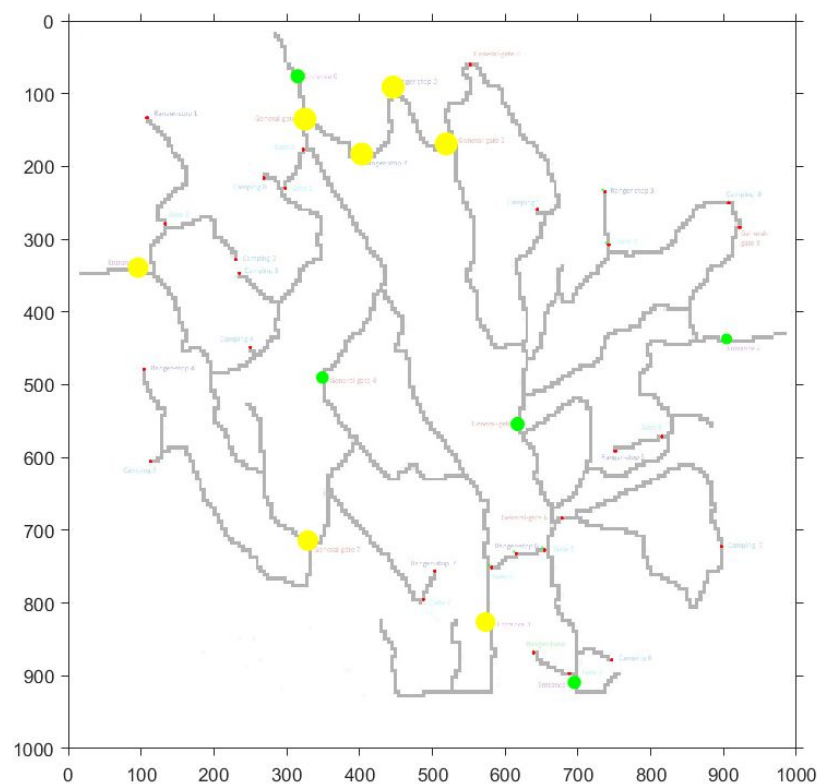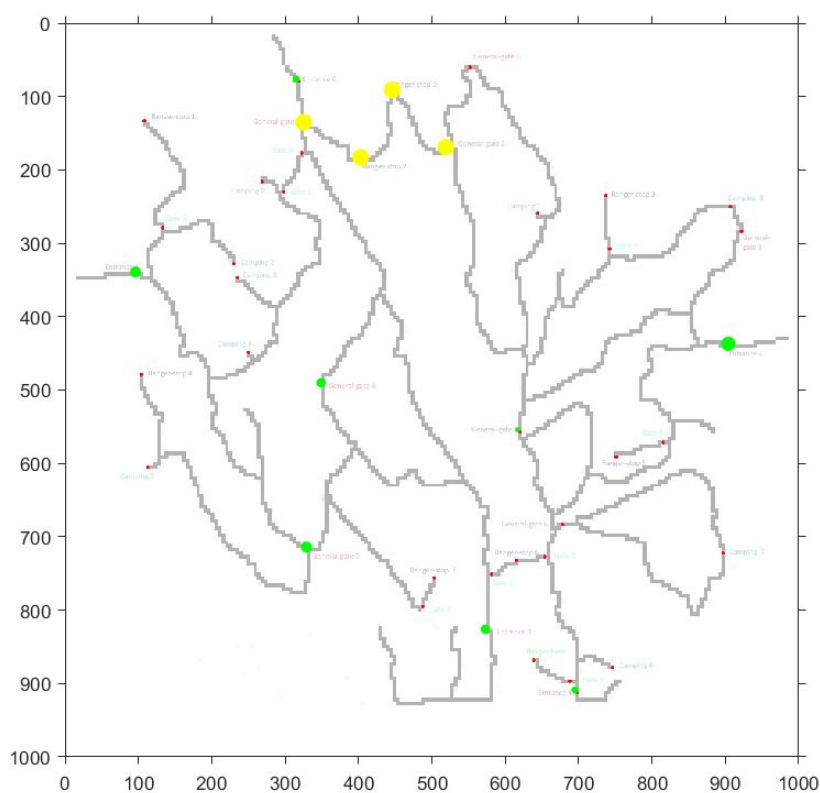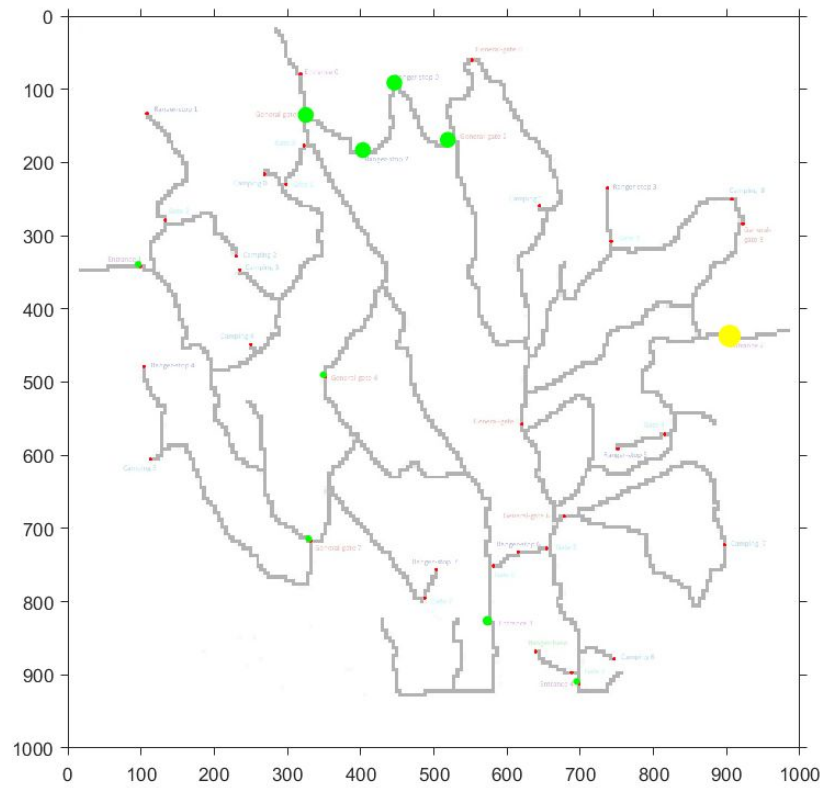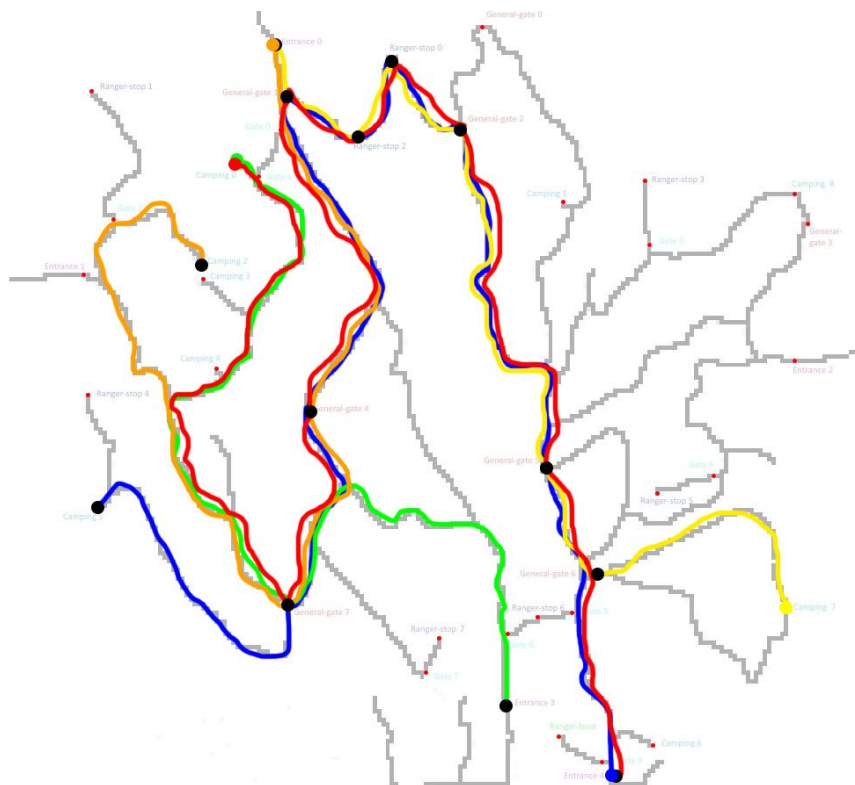*B5: Category 4, 4 axle (and above) truck*
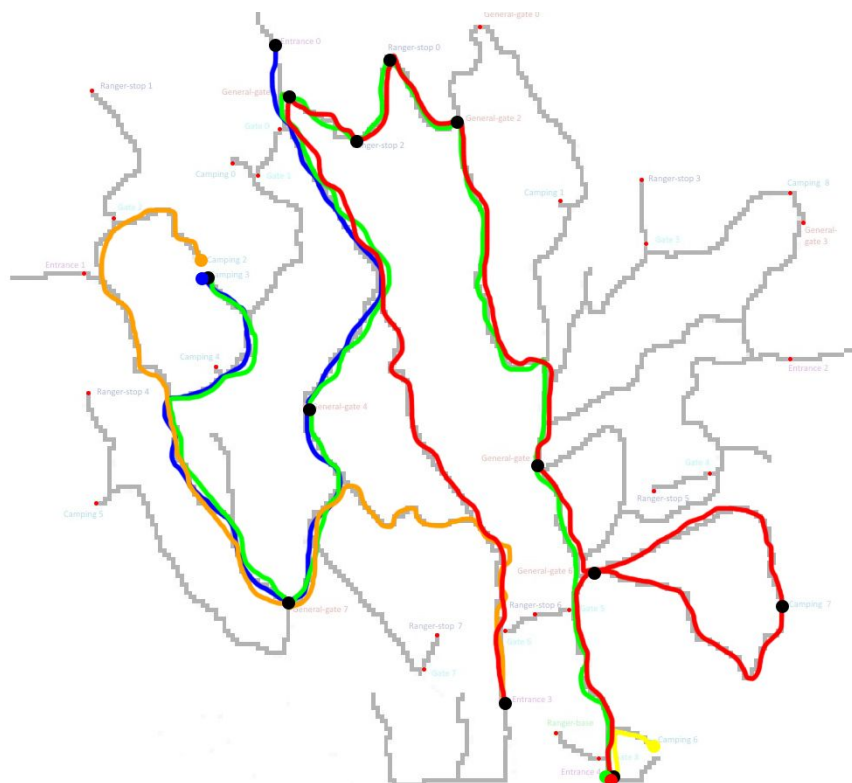

B6: Category 5, 2 axle bus

B7: Category 6, 3 axle bus

# Appendix C - Most visited gates in one week, by vehicle type

C1: Category 1, 2 axle car (or motorcycle)

C2: Category 2, 2 axle truck

C3: Category 2P, 2 axle truck (park service vehicle)

C4: Category 3, 3 axle truck

C5: Category 4, 4 axle (and above) truck

C6: Category 5, 2 axle bus

C7: Category 6, 3 axle bus

Appendix D - Routes used in the preserve, by type
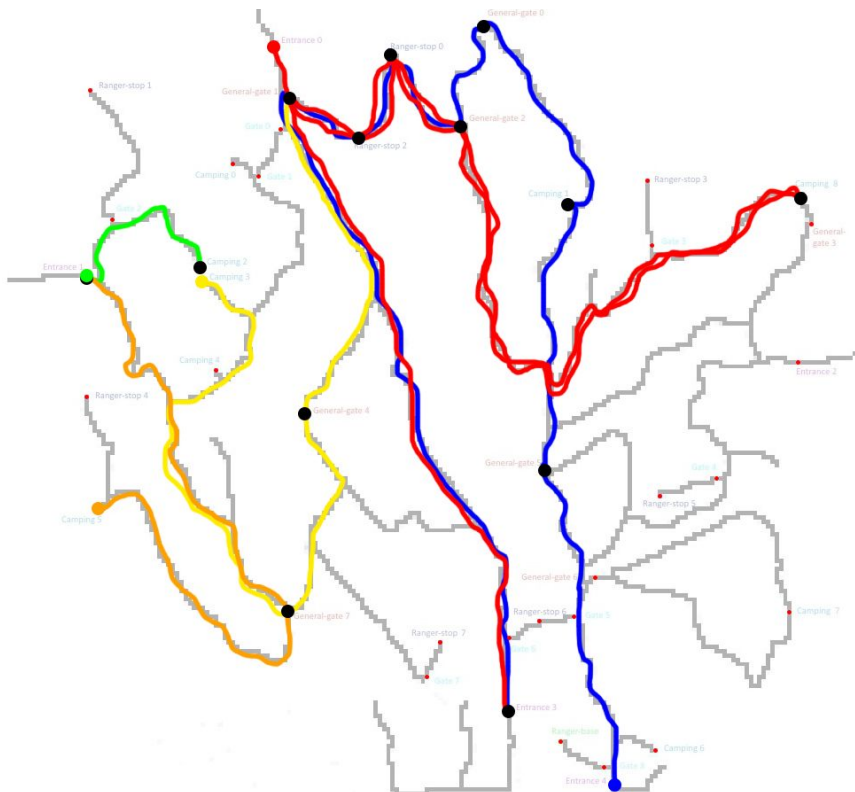

D1: Category 1, 2 axle car (or motorcycle)
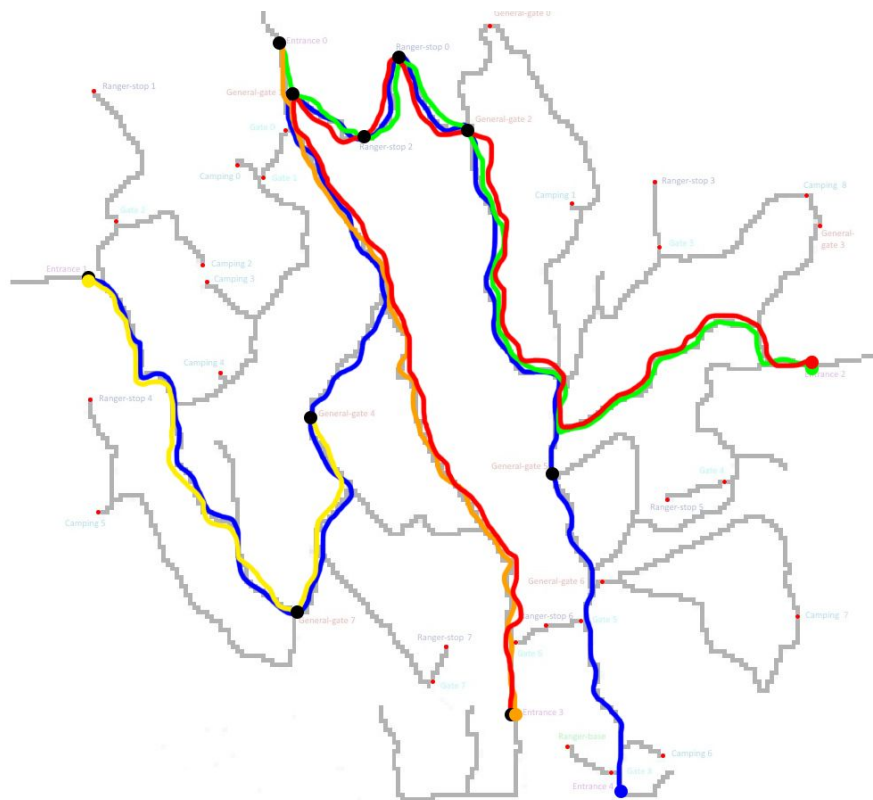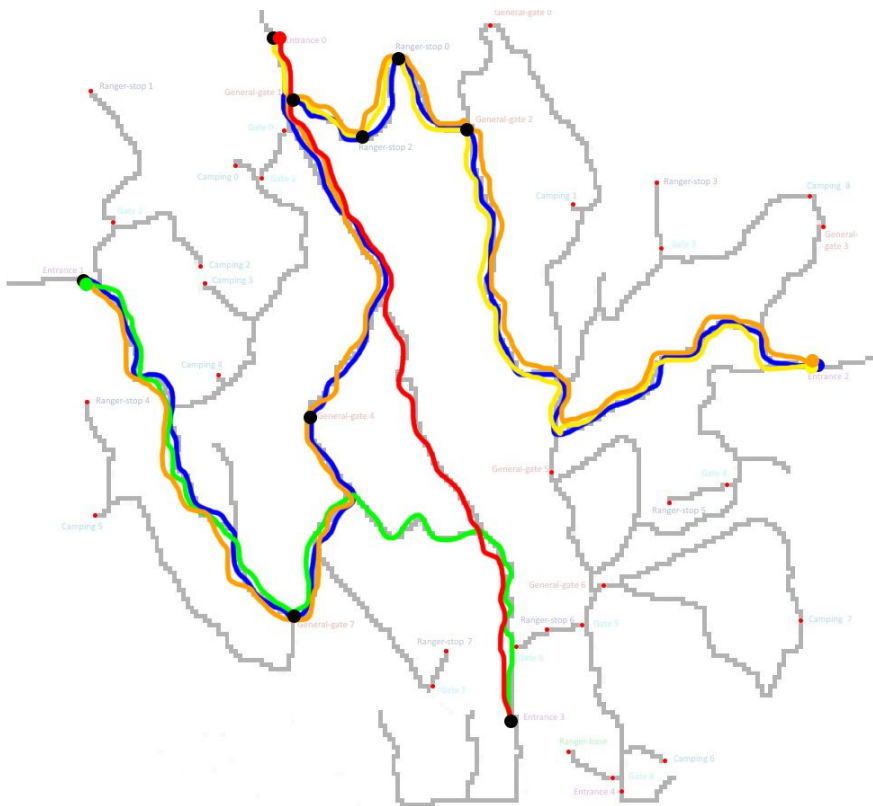

D2: Category 2, 2 axle truck
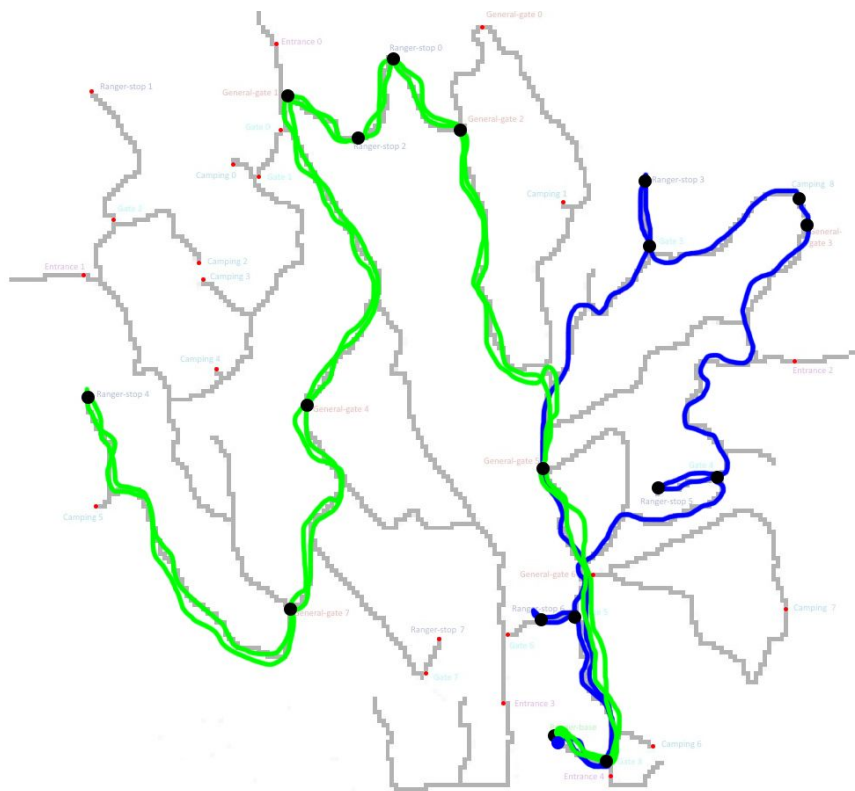
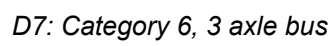*D3: Category 2P, 2 axle truck (park service vehicle)*

D4: Category 3, 3 axle truck

D5: Category 4, 4 axle (and above) truck

D6: Category 5, 2 axle bus

D7: Category 6, 3 axle bus

Appendix E - Visualisations used to calculate the routes