**DATA SUMMARY**

說明：

使用的獼猴資料皆符合**6分鐘內且100m內且調查日在調查季(約53~188)內**之標準，也刪掉距離過近的猴群資料。

**\*\*\*包括非森林內的資料**

猴群於各縣市的分布

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 縣市 | 資料筆數 | | | | | 樣區數 | | | | | 樣點數 | | | | |
| 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 |
| 宜蘭縣 | 4 | 1 | - | 2 | 1 | 2 | 1 | - | 2 | 1 | 3 | 1 | - | 2 | 1 |
| 新北市 | 1 | - | - | 2 | - | 1 | - | - | 2 | - | 1 | - | - | 2 | - |
| 桃園市 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 |
| 苗栗縣 | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 1 |
| 台中市 | 6 | 2 | 2 | 3 | 3 | 4 | 2 | 1 | 3 | 2 | 6 | 2 | 2 | 3 | 2 |
| 南投縣 | 2 | 5 | 3 | 7 | 10 | 2 | 5 | 2 | 7 | 6 | 2 | 5 | 2 | 7 | 10 |
| 雲林縣 | 8 | 5 | 7 | 9 | 7 | 3 | 1 | 4 | 2 | 2 | 7 | 5 | 7 | 7 | 5 |
| 嘉義縣 | 1 | 1 | - | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 2 | 1 |
| 台南市 | - | - | 2 | 3 | 1 | - | - | 1 | 1 | 1 | - | - | 2 | 2 | 1 |
| 高雄市 | 2 | 3 | 5 | 5 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 5 | 5 | 2 |
| 屏東縣 | 3 | 3 | 6 | 2 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 2 | 5 | 2 | 1 |
| 花蓮縣 | 15 | 16 | 10 | 12 | 12 | 9 | 9 | 4 | 7 | 8 | 14 | 15 | 9 | 11 | 11 |
| 台東縣 | 2 | 1 | 1 | 13 | 16 | 2 | 1 | 1 | 6 | 9 | 2 | 1 | 1 | 12 | 13 |
| 合計 | 45 | 37 | 36 | 61 | 56 | 29 | 25 | 18 | 36 | 34 | 42 | 35 | 33 | 56 | 49 |

孤猴於各縣市的分布

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 縣市 | 資料筆數 | | | | | 樣區數 | | | | | 樣點數 | | | | |
| 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 |
| 宜蘭縣 | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - |
| 新北市 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 |
| 苗栗縣 | 1 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - |
| 台中市 | 2 | 1 | 1 | 4 | - | 2 | 1 | 1 | 4 | - | 2 | 1 | 1 | 4 | - |
| 南投縣 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 2 |
| 雲林縣 | 4 | - | 5 | - | 1 | 2 | - | 2 | - | 1 | 4 | - | 5 | - | 1 |
| 嘉義縣 | 3 | - | - | 2 | - | 2 | - | - | 1 | - | 3 | - | - | 2 | - |
| 台南市 | - | - | - | - | 2 | - | - | - | - | 1 | - | - | - | - | 1 |
| 高雄市 | 4 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 4 | 3 | 1 | 1 | 2 |
| 屏東縣 | - | 3 | 2 | 1 | 1 | - | 2 | 1 | 1 | 1 | - | 3 | 2 | 1 | 1 |
| 花蓮縣 | 8 | 3 | 2 | 11 | 3 | 4 | 3 | 2 | 7 | 2 | 6 | 3 | 2 | 11 | 3 |
| 台東縣 | - | 1 | - | 4 | 1 | - | 1 | - | 4 | 1 | - | 1 | - | 4 | 1 |
| 合計 | 23 | 13 | 12 | 26 | 14 | 13 | 11 | 8 | 21 | 11 | 21 | 13 | 12 | 26 | 12 |

**\*\*\*only 森林 (用來統計分析的data)**

猴群於各縣市的分布

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 縣市 | 資料筆數 | | | | | 樣區數 | | | | | 樣點數 | | | | |
| 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 |
| 宜蘭縣 | 4 | 1 | - | 2 | 1 | 2 | 1 | - | 2 | 1 | 3 | 1 | - | 2 | 1 |
| 新北市 | 1 | - | - | 2 | - | 1 | - | - | 2 | - | 1 | - | - | 2 | - |
| 桃園市 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 |
| 苗栗縣 | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - | 1 | 1 |
| 台中市 | 6 | 2 | 2 | 2 | 3 | 4 | 2 | 1 | 2 | 2 | 6 | 2 | 2 | 2 | 2 |
| 南投縣 | 2 | 5 | 3 | 7 | 10 | 2 | 5 | 2 | 7 | 6 | 2 | 5 | 2 | 7 | 10 |
| 雲林縣 | 8 | 5 | 7 | 9 | 7 | 3 | 1 | 4 | 2 | 2 | 7 | 5 | 7 | 7 | 5 |
| 嘉義縣 | 1 | 1 | - | 2 | 1 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 2 | 1 |
| 台南市 | - | - | 2 | 3 | 1 | - | - | 1 | 1 | 1 | - | - | 2 | 2 | 1 |
| 高雄市 | 2 | 3 | 4 | 5 | 2 | 2 | 3 | 1 | 2 | 1 | 2 | 3 | 4 | 5 | 2 |
| 屏東縣 | 3 | 3 | 6 | 2 | 1 | 2 | 2 | 3 | 2 | 1 | 3 | 2 | 5 | 2 | 1 |
| 花蓮縣 | 14 | 16 | 10 | 11 | 12 | 8 | 9 | 4 | 6 | 8 | 13 | 15 | 9 | 10 | 11 |
| 台東縣 | 2 | 1 | 1 | 12 | 14 | 2 | 1 | 1 | 6 | 8 | 2 | 1 | 1 | 11 | 11 |
| 合計 | 44 | 37 | 35 | 58 | 54 | 28 | 25 | 17 | 34 | 33 | 41 | 35 | 32 | 53 | 47 |

孤猴於各縣市的分布

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 縣市 | 資料筆數 | | | | | 樣區數 | | | | | 樣點數 | | | | |
| 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 | 2015 | 2016 | 2017 | 2018 | 2019 |
| 宜蘭縣 | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - |
| 新北市 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 |
| 苗栗縣 | 1 | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - |
| 台中市 | 2 | 1 | 1 | 4 | - | 2 | 1 | 1 | 4 | - | 2 | 1 | 1 | 4 | - |
| 南投縣 | 1 | 1 | 1 | 3 | 3 | 1 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 3 | 2 |
| 雲林縣 | 4 | - | 5 | - | 1 | 2 | - | 2 | - | 1 | 4 | - | 5 | - | 1 |
| 嘉義縣 | 3 | - | - | 2 | - | 2 | - | - | 1 | - | 3 | - | - | 2 | - |
| 台南市 | - | - | - | - | 2 | - | - | - | - | 1 | - | - | - | - | 1 |
| 高雄市 | 4 | 3 | - | - | 2 | 1 | 2 | - | - | 2 | 4 | 3 | - | - | 2 |
| 屏東縣 | - | 3 | 2 | 1 | 1 | - | 2 | 1 | 1 | 1 | - | 3 | 2 | 1 | 1 |
| 花蓮縣 | 7 | 3 | 1 | 10 | 3 | 3 | 3 | 1 | 6 | 2 | 5 | 3 | 1 | 10 | 3 |
| 台東縣 | - | - | - | 4 | 1 | - | - | - | 4 | 1 | - | - | - | 4 | 1 |
| 合計 | 22 | 12 | 10 | 24 | 14 | 12 | 10 | 6 | 19 | 11 | 20 | 12 | 10 | 24 | 12 |

2015~2019年各分區的猴群數及樣點數

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 年 | 旅次 |  | 分區 | | | | | | 總計  (台灣本島) |
| 北部 | 中彰投 | 雲嘉南 | 高屏 | 花蓮 | 台東 |
| 2015 | 1 | 猴群 | 4 | 4 | 4 | 2 | 5 | 2 | 21 |
| 樣點 | 704 | 439 | 201 | 144 | 170 | 59 | 1717 |
| 2 | 猴群 | 2 | 4 | 5 | 3 | 9 | 0 | 23 |
| 樣點 | 636 | 432 | 198 | 144 | 170 | 59 | 1639 |
| 2016 | 1 | 猴群 | 0 | 4 | 1 | 2 | 6 | 1 | 14 |
| 樣點 | 668 | 471 | 187 | 159 | 162 | 59 | 1706 |
| 2 | 猴群 | 1 | 3 | 5 | 4 | 10 | 0 | 23 |
| 樣點 | 560 | 460 | 182 | 156 | 140 | 59 | 1557 |
| 2017 | 1 | 猴群 | 0 | 1 | 3 | 4 | 6 | 1 | 15 |
| 樣點 | 516 | 473 | 184 | 129 | 169 | 55 | 1526 |
| 2 | 猴群 | 0 | 4 | 6 | 6 | 4 | 0 | 20 |
| 樣點 | 501 | 466 | 184 | 129 | 161 | 45 | 1486 |
| 2018 | 1 | 猴群 | 2 | 5 | 6 | 3 | 7 | 4 | 27 |
| 樣點 | 603 | 518 | 156 | 164 | 154 | 75 | 1670 |
| 2 | 猴群 | 3 | 4 | 8 | 4 | 4 | 8 | 31 |
| 樣點 | 502 | 503 | 150 | 157 | 153 | 75 | 1540 |
| 2019 | 1 | 猴群 | 1 | 5 | 4 | 3 | 9 | 8 | 30 |
| 樣點 | 495 | 503 | 153 | 175 | 166 | 75 | 1567 |
| 2 | 猴群 | 2 | 8 | 5 | 0 | 3 | 6 | 24 |
| 樣點 | 448 | 491 | 151 | 168 | 166 | 74 | 1498 |
| 總計 | | 猴群 | 15 | 42 | 47 | 31 | 63 | 30 | 228 |
| 樣點 | 5633 | 4756 | 1746 | 1525 | 1611 | 635 | 15906 |
| 相對密度  (群/樣點數) | | 平均值 | 0.003 | 0.009 | 0.028 | 0.021 | 0.040 | 0.042 | 0.014 |
| 標準差 | 0.002 | 0.003 | 0.012 | 0.012 | 0.016 | 0.041 | 0.004 |
| 絕對密度  (群/km2) | | 平均值 | 0.083 | 0.280 | 0.885 | 0.672 | 1.257 | 1.327 | 0.458 |
| 標準差 | 0.070 | 0.105 | 0.392 | 0.372 | 0.497 | 1.296 | 0.115 |

2015~2019年各森林類型內的猴群數及樣點數

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 年 | 旅次 | 總調查  樣點數 |  | 森林 | | | | | 非森林 |
| 闊葉林 | 針葉林 | 混淆林 | 竹林 | 合計 |
| 2015 | 1 | 2876 | 猴群 | 15 | 2 | 2 | 2 | 21 | - |
| 樣點 | 1180 | 164 | 183 | 190 | 1717 | 1159 |
| 2 | 2746 | 猴群 | 17 | 1 | 4 | 1 | 23 | 1 |
| 樣點 | 1116 | 162 | 182 | 179 | 1639 | 1107 |
| 2016 | 1 | 2921 | 猴群 | 12 | 1 | 1 | - | 14 | - |
| 樣點 | 1196 | 144 | 163 | 203 | 1706 | 1215 |
| 2 | 2714 | 猴群 | 15 | 2 | 3 | 3 | 23 | - |
| 樣點 | 1077 | 142 | 157 | 181 | 1557 | 1157 |
| 2017 | 1 | 2659 | 猴群 | 11 | 1 | 2 | 1 | 15 | - |
| 樣點 | 1040 | 141 | 157 | 188 | 1526 | 1133 |
| 2 | 2583 | 猴群 | 13 | 1 | 2 | 4 | 20 | 1 |
| 樣點 | 1013 | 133 | 154 | 186 | 1486 | 1097 |
| 2018 | 1 | 2853 | 猴群 | 18 | 1 | 6 | 2 | 27 | 2 |
| 樣點 | 1164 | 131 | 169 | 206 | 1670 | 1183 |
| 2 | 2631 | 猴群 | 21 | - | 6 | 4 | 31 | 1 |
| 樣點 | 1065 | 125 | 163 | 187 | 1540 | 1091 |
| 2019 | 1 | 2785 | 猴群 | 23 | 1 | 2 | 4 | 30 | 1 |
| 樣點 | 1095 | 136 | 160 | 176 | 1567 | 1218 |
| 2 | 2663 | 猴群 | 12 | 1 | 1 | 10 | 24 | 1 |
| 樣點 | 1052 | 120 | 153 | 173 | 1498 | 1165 |
| 總計 | | 27431 | 猴群 | 157 | 11 | 29 | 31 | 228 | 7 |
| 樣點 | 10998 | 1398 | 1641 | 1869 | 15906 | 11525 |
| 相對密度  (群/樣點數) | | | 平均值 | 0.014 | 0.008 | 0.018 | 0.017 | 0.014 | - |
| 標準差 | 0.004 | 0.004 | 0.010 | 0.016 | 0.004 | - |
| 絕對密度  (群/km2) | | | 平均值 | 0.455 | 0.245 | 0.557 | 0.544 | 0.458 | - |
| 標準差 | 0.111 | 0.111 | 0.331 | 0.493 | 0.115 | - |

2015~2019被Julian Day所移除掉的資料

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Julian Day** | Year | Survey | 猴群 | 樣點 |
| **199** | 2019 | 2 | 0筆 | 7筆 |

2015~2019年Data Summary之boxplot (都是10個點畫出來的)

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**GLMM**

Full model:

m1 <- glmer(猴群數 ~ 森林類型 + 年 + 海拔 + 調查日 + 分區 + (1|Site\_N), family = binomial, data = df)

1. 年為連續變數：2015~2019 年。

2. 森林類型為類別變數：分別為闊葉林、針葉林、混淆林、竹林等4 種。

3. 海拔為連續變數：。

4. 調查日為連續變數：調查日為當年度的第n天，範圍53~188。因為調查季有前後1星期的緩衝。

5. 分區等為類別變數：分別為北部、中彰投、雲嘉南、高屏、花蓮、臺東等六區；

1. 北部為基隆市、臺北市、新北市、桃園市、新竹縣、苗栗縣、宜蘭縣；
2. 中彰投為臺中市、彰化縣、南投縣；
3. 雲嘉南為雲林縣、嘉義縣、嘉義市、臺南市；
4. 高屏為高雄市、屏東縣；
5. 花蓮縣；
6. 臺東縣。

6. 樣區為隨機變數。

7. 分析總筆數：15906筆；猴群228群。

Model selection table

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (Intercept) | 海拔 | 調查日 | 分區 | 森林類型 | 年 | df | logLik | AICc | delta | weight |
| -6.646 | 0.419 |  | + |  | 0.101 | 9 | -976.698 | 1971.4 | 0 | 0.280 |
| -6.643 | 0.386 | 0.083 | + |  | 0.100 | 10 | -976.164 | 1972.3 | 0.93 | 0.175 |
| -6.308 | 0.409 |  | + |  |  | 8 | -978.622 | 1973.3 | 1.84 | 0.111 |

>importance(d1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 分區 | 海拔 | 年 | 調查日 | 森林類型 |
| Sum of weights: | 1 | 0.92 | 0.68 | 0.46 | 0.25 |
| N containing models: | 16 | 16 | 16 | 16 | 16 |

**\*\*\*因為森林類型在AIC中的結果顯示不重要，所以接下來的GLMM都不納入分析**

Analysis of Deviance Table (Type II Wald chisquare tests)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Chisq | Df | P-value(>Chisq) |  |
| 海拔 | 5.737 | 1 | 0.017 | \* |
| 年 | 3.518 | 1 | 0.061 |  |
| 調查日 | 1.507 | 1 | 0.220 |  |
| 分區 | 42.832 | 5 | < 0.001 | \*\*\* |

AIC = 1995.5

> summary(glht(m1, linfct = mcp(Region = "Tukey")))

Multiple Comparisons of Means: Tukey Contrasts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Estimate | Std. Error | z value | P-value(>|z|) |  |
| 雲嘉南 - 中彰投 == 0 | 0.689 | 0.559 | 1.232 | 0.817 |  |
| 花蓮 - 中彰投 == 0 | 1.941 | 0.519 | 3.737 | 0.002 | \*\* |
| 臺東 - 中彰投 == 0 | 2.934 | 0.708 | 4.146 | < 0.001 | \*\*\* |
| 北部 - 中彰投 == 0 | -0.726 | 0.500 | -1.452 | 0.689 |  |
| 高屏 - 中彰投 == 0 | 0.877 | 0.596 | 1.471 | 0.677 |  |
| 花蓮 - 雲嘉南 == 0 | 1.252 | 0.585 | 2.139 | 0.262 |  |
| 臺東 - 雲嘉南 == 0 | 2.245 | 0.761 | 2.951 | 0.036 | \* |
| 北部 - 雲嘉南 == 0 | -1.415 | 0.567 | -2.494 | 0.123 |  |
| 高屏 - 雲嘉南 == 0 | 0.189 | 0.647 | 0.292 | 1.000 |  |
| 臺東 - 花蓮 == 0 | 0.993 | 0.709 | 1.401 | 0.721 |  |
| 北部 - 花蓮 == 0 | -2.667 | 0.521 | -5.121 | < 0.001 | \*\*\* |
| 高屏 - 花蓮 == 0 | -1.063 | 0.605 | -1.757 | 0.487 |  |
| 北部 - 臺東 == 0 | -3.660 | 0.710 | -5.155 | < 0.001 | \*\*\* |
| 高屏 - 臺東 == 0 | -2.056 | 0.773 | -2.661 | 0.081 |  |
| 高屏 - 北部 == 0 | 1.604 | 0.590 | 2.717 | 0.070 |  |

Correlation of Fixed Effects:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (Intr) | 海拔 | 年 | 調查日 | Regin2雲嘉南 | Region2花蓮 | Region2台東 | Region2北部 |
| 海拔 | -0.409 |  |  |  |  |  |  |  |
| 年 | -0.4 | 0.037 |  |  |  |  |  |  |
| 調查日 | -0.006 | -0.184 | -0.012 |  |  |  |  |  |
| Regin2雲嘉南 | -0.457 | 0.253 | 0.045 | -0.023 |  |  |  |  |
| Region2花蓮 | -0.574 | 0.342 | 0.045 | 0.008 | 0.413 |  |  |  |
| Region2台東 | -0.507 | 0.296 | 0.003 | 0.003 | 0.297 | 0.365 |  |  |
| Region2北部 | -0.537 | 0.325 | 0.053 | -0.006 | 0.431 | 0.479 | 0.349 |  |
| Region2高屏 | -0.458 | 0.325 | 0.016 | -0.017 | 0.374 | 0.418 | 0.307 | 0.432 |

**Estimate**

森林總面積=21536.41(km2)

方法：bootstrap

重複抽樣：10,000次

|  |  |
| --- | --- |
| 單位面積的半徑 | 100m |
| 絕對密度(群/ km2) | 0.4562 |
| 絕對密度(95% CI) | 0.3982 ~ 0.5143 |
| **群** | **9825群** |
| **猴群數(95% CI)** | **8577 ~ 11076群** |

**Rtrim**

Region:分為北部、中彰投、雲嘉南、高屏、花蓮、台東，與GLMM同。

Altitude : 分為低(<1000m)、中(1000~2500m)、高(>2500m)海拔。

最小的scale：樣點

m1 <- trim(number ~ SP + Year + Region2 + Altitude\_f, weights = "weight",df, model = 2,

changepoints = "all", overdisp = F, serialcor = F, autodelete = T, stepwise = F)

> Goodness of fit

**Goodness of fit:**

Chi-square = 513.08, df=522, p=0.6014

Likelihood Ratio = 438.94, df=522, p=0.9965

AIC (up to a constant) = -605.06

> Wald-test

**Wald test for significance of covariates**

Covariate W df p

Region2 29.245972 15 0.0149505

Altitude 6.131395 6 0.4086334

**Wald test for significance of changes in slope**

Changepoint Wald\_test df p

2015 7.357242 8 0.49862443

2017 13.032310 8 0.11074274

2018 15.853663 8 0.04452318

> overall

from upto slope se p meaning

2015 2019 3.222033 2.871753 0.2806674 Uncertain