**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(僅3~6月)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 | - | - | 2 | - | 2 | - | - | 2 | - | 3 | - | - | 2 | - |
| 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 | - | 3 | 3 | 4 | 2 | - | 3 | 2 | 6 | 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 | - | 2 | 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 | 5 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 4 | 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 | 44 | 36 | 33 | 61 | 55 | 28 | 24 | 16 | 36 | 33 | 41 | 34 | 30 | 56 | 48 |

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 | 1 | - | - | 2 | - | 1 | - | - | 1 | - | 1 | - | - | 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 | - | 2 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 2 | 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 | 21 | 12 | 12 | 26 | 14 | 12 | 10 | 8 | 21 | 11 | 19 | 12 | 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 | - | - | 2 | - | 2 | - | - | 2 | - | 3 | - | - | 2 | - |
| 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 | 4 | 2 | - | 2 | 2 | 6 | 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 | - | 2 | 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 | 5 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 4 | 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 | 43 | 36 | 32 | 58 | 53 | 27 | 24 | 15 | 34 | 32 | 40 | 34 | 29 | 53 | 46 |

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 | 1 | - | - | 2 | - | 1 | - | - | 1 | - | 1 | - | - | 2 | - |
| 台南市 | - | - | - | - | 2 | - | - | - | - | 1 | - | - | - | - | 1 |
| 高雄市 | 4 | 3 | - | - | 2 | 1 | 2 | - | - | 2 | 4 | 3 | - | - | 2 |
| 屏東縣 | - | 2 | 2 | 1 | 1 | - | 1 | 1 | 1 | 1 | - | 2 | 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 | 20 | 11 | 10 | 24 | 14 | 11 | 9 | 6 | 19 | 11 | 18 | 11 | 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 | 601 | 422 | 181 | 112 | 162 | 59 | 1537 |
| 2 | 猴群 | 2 | 4 | 4 | 3 | 9 | 0 | 22 |
| 樣點 | 541 | 415 | 175 | 112 | 162 | 59 | 1464 |
| 2016 | 1 | 猴群 | 0 | 4 | 1 | 2 | 6 | 1 | 14 |
| 樣點 | 549 | 454 | 153 | 123 | 149 | 59 | 1487 |
| 2 | 猴群 | 0 | 3 | 5 | 4 | 10 | 0 | 22 |
| 樣點 | 456 | 443 | 153 | 123 | 127 | 59 | 1361 |
| 2017 | 1 | 猴群 | 0 | 1 | 3 | 4 | 6 | 1 | 15 |
| 樣點 | 439 | 456 | 155 | 101 | 156 | 55 | 1362 |
| 2 | 猴群 | 0 | 2 | 6 | 5 | 4 | 0 | 17 |
| 樣點 | 429 | 424 | 155 | 101 | 148 | 45 | 1302 |
| 2018 | 1 | 猴群 | 2 | 5 | 6 | 3 | 7 | 4 | 27 |
| 樣點 | 547 | 500 | 132 | 121 | 141 | 75 | 1516 |
| 2 | 猴群 | 3 | 4 | 8 | 4 | 4 | 8 | 31 |
| 樣點 | 446 | 485 | 131 | 114 | 140 | 75 | 1391 |
| 2019 | 1 | 猴群 | 0 | 5 | 4 | 3 | 9 | 8 | 29 |
| 樣點 | 419 | 485 | 133 | 132 | 152 | 75 | 1396 |
| 2 | 猴群 | 2 | 8 | 5 | 0 | 3 | 6 | 24 |
| 樣點 | 377 | 473 | 133 | 125 | 152 | 74 | 1334 |
| 總計 | | 猴群 | 13 | 40 | 46 | 30 | 63 | 30 | 222 |
| 樣點 | 4804 | 4557 | 1501 | 1164 | 1489 | 635 | 14150 |
| 相對密度  (群/樣點數) | | 平均值 | 0.003 | 0.009 | 0.032 | 0.027 | 0.043 | 0.042 | 0.016 |
| 標準差 | 0.001 | 0.001 | 0.005 | 0.004 | 0.005 | 0.013 | 0.001 |
| 絕對密度  (群/km2) | | 平均值 | 0.083 | 0.277 | 1.007 | 0.844 | 1.363 | 1.327 | 0.500 |
| 標準差 | 0.028 | 0.037 | 0.146 | 0.132 | 0.172 | 0.410 | 0.039 |

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( EL ≥ 50) | | | | | 森林  ( EL <50) | 非森林 |
| 闊葉林 | 針葉林 | 混淆林 | 竹林 | 合計 |
| 2015 | 1 | 2869 | 猴群 | 15 | 2 | 2 | 2 | 21 | - | - |
| 樣點 | 1035 | 159 | 180 | 163 | 1537 | 180 | 1152 |
| 2 | 2740 | 猴群 | 17 | - | 4 | 1 | 22 | - | 1 |
| 樣點 | 982 | 151 | 179 | 152 | 1464 | 169 | 1107 |
| 2016 | 1 | 2913 | 猴群 | 12 | 1 | 1 | - | 14 | - | - |
| 樣點 | 1026 | 139 | 160 | 162 | 1487 | 216 | 1210 |
| 2 | 2714 | 猴群 | 14 | 2 | 3 | 3 | 22 | 1 | - |
| 樣點 | 925 | 137 | 154 | 145 | 1361 | 196 | 1157 |
| 2017 | 1 | 2659 | 猴群 | 11 | 1 | 2 | 1 | 15 | - | - |
| 樣點 | 914 | 136 | 154 | 158 | 1362 | 164 | 1133 |
| 2 | 2554 | 猴群 | 10 | 1 | 2 | 4 | 17 | 1 | 1 |
| 樣點 | 878 | 117 | 150 | 157 | 1302 | 159 | 1093 |
| 2018 | 1 | 2853 | 猴群 | 18 | 1 | 6 | 2 | 27 | - | 2 |
| 樣點 | 1047 | 126 | 166 | 177 | 1516 | 154 | 1183 |
| 2 | 2631 | 猴群 | 21 | - | 6 | 4 | 31 | - | 1 |
| 樣點 | 951 | 120 | 160 | 160 | 1391 | 149 | 1091 |
| 2019 | 1 | 2785 | 猴群 | 22 | 1 | 2 | 4 | 29 | 1 | 1 |
| 樣點 | 961 | 131 | 156 | 148 | 1396 | 171 | 1218 |
| 2 | 2663 | 猴群 | 12 | 1 | 1 | 10 | 24 | - | 1 |
| 樣點 | 923 | 115 | 149 | 147 | 1334 | 164 | 1165 |
| 總計 | | 27381 | 猴群 | 152 | 10 | 29 | 31 | 222 | 3 | 7 |
| 樣點 | 9642 | 1331 | 1608 | 1569 | 14150 | 1722 | 11509 |
| 相對密度  (群/樣點數) | | | 平均值 | 0.018 | 0.007 | 0.018 | 0.020 | 0.0157 | 0.002 | 0.001 |
| 標準差 | 0.002 | 0.001 | 0.003 | 0.005 | 0.001 | 0.001 | 0.0002 |
| 絕對密度  (群/km2) | | | 平均值 | 0.571 | 0.237 | 0.569 | 0.645 | 0.500 | 0.055 | 0.019 |
| 標準差 | 0.070 | 0.042 | 0.101 | 0.175 | 0.037 | 0.025 | 0.005 |

2015~2019被Julian Day所移除掉的資料

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Julian Day** | Year | Survey | 猴群 | 樣點 |
| **58** | 2015 | 1 | 0 | 7 |
| **60** | 2016 | 1 | 0 | 8 |
| **182** | 2015 | 2 | 1 | 6 |
| **182** | 2017 | 2 | 0 | 12 |
| **183** | 2017 | 2 | 2 | 17 |
| **199** | 2019 | 2 | 0 | 7 |
| **total** | | | 3 | 57 |

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，範圍海拔50m以上。

4. 調查日為連續變數：調查日為當年度的第n天。僅分析3~6月內的調查資料。

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：14150筆；猴群222群。

Model selection table

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (Intercept) | 海拔 | 調查日 | 分區 | 森林類型 | 年 | df | logLik | AICc | delta | weight |
| -6.404 | 0.342 |  | + |  | 0.0995 | 9 | -950.791 | 1919.6 | 0.00 | 0.239 |
| -6.402 | 0.310 | 0.076 | + |  | 0.0988 | 10 | -950.351 | 1920.7 | 1.12 | 0.136 |
| -6.073 | 0.331 |  | + |  |  | 8 | -952.644 | 1921.3 | 1.70 | 0.102 |
| -6.169 |  |  | + |  | 0.0963 | 8 | -952.775 | 1921.6 | 1.96 | 0.090 |

>importance(d1)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 分區 | 海拔 | 年 | 調查日 | 森林類型 |
| Sum of weights: | 1 | 0.73 | 0.69 | 0.39 | 0.22 |
| 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 | 3.122 | 1 | 0.077 |  |
| 年 | 3.644 | 1 | 0.056 |  |
| 調查日 | 0.881 | 1 | 0.348 |  |
| 分區 | 42.962 | 5 | < 0.001 | \*\*\* |

AIC = 1920.7

> 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 | 0.740 | 0.567 | 1.304 | 0.779 |  |
| 花蓮 - 中彰投 == 0 | 1.915 | 0.510 | 3.757 | 0.002 | \*\* |
| 臺東 - 中彰投 == 0 | 2.719 | 0.682 | 3.988 | < 0.001 | \*\*\* |
| 北部 - 中彰投 == 0 | -0.894 | 0.508 | -1.761 | 0.485 |  |
| 高屏 - 中彰投 == 0 | 0.992 | 0.609 | 1.629 | 0.573 |  |
| 花蓮 - 雲嘉南 == 0 | 1.175 | 0.596 | 1.971 | 0.353 |  |
| 臺東 - 雲嘉南 == 0 | 1.979 | 0.751 | 2.634 | 0.087 |  |
| 北部 - 雲嘉南 == 0 | -1.634 | 0.595 | -2.748 | 0.064 |  |
| 高屏 - 雲嘉南 == 0 | 0.252 | 0.678 | 0.371 | 0.999 |  |
| 臺東 - 花蓮 == 0 | 0.804 | 0.683 | 1.178 | 0.844 |  |
| 北部 - 花蓮 == 0 | -2.809 | 0.533 | -5.269 | < 0.001 | \*\*\* |
| 高屏 - 花蓮 == 0 | -0.923 | 0.623 | -1.483 | 0.670 |  |
| 北部 - 臺東 == 0 | -3.613 | 0.702 | -5.150 | < 0.001 | \*\*\* |
| 高屏 - 臺東 == 0 | -1.727 | 0.769 | -2.246 | 0.212 |  |
| 高屏 - 北部 == 0 | 1.885 | 0.624 | 3.023 | 0.029 | \* |

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 | -0.376 |  |  |  |  |  |  |  |
| 年 | -0.417 | 0.036 |  |  |  |  |  |  |
| 調查日 | -0.002 | -0.19 | -0.013 |  |  |  |  |  |
| Regin2雲嘉南 | -0.432 | 0.24 | 0.044 | -0.02 |  |  |  |  |
| Region2花蓮 | -0.573 | 0.347 | 0.049 | 0.008 | 0.391 |  |  |  |
| Region2台東 | -0.506 | 0.303 | 0.002 | 0 | 0.287 | 0.372 |  |  |
| Region2北部 | -0.498 | 0.302 | 0.051 | -0.005 | 0.393 | 0.451 | 0.333 |  |
| Region2高屏 | -0.426 | 0.298 | 0.017 | -0.016 | 0.337 | 0.391 | 0.293 | 0.387 |

**Estimate**

海拔50m以上的森林總面積=21028.14 (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) | 0.4993 |
| 絕對密度(95% CI) | 0.4342 ~ 0.5669 |
| **群** | **10500群** |
| **猴群數(95% CI)** | **9130 ~ 11921群** |

**Rtrim**

Region:分為北部、中彰投、雲嘉南、高屏、花蓮、台東，與GLMM同。

最小的scale：樣點

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

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

> Goodness of fit

**Goodness of fit:**

Chi-square = 498.15, df=518, p=0.7271

Likelihood Ratio = 439.27, df=518, p=0.9948

AIC (up to a constant) = -596.73

> Wald-test

**Wald test for significance of covariates**

|  |  |  |  |
| --- | --- | --- | --- |
| Covariate | W | df | *p* |
| Region | 21.788 | 10 | 0.016 |

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

|  |  |  |  |
| --- | --- | --- | --- |
| Change point | Wald test | df | *p* value |
| 2017 | 19.474 | 6 | 0.003 |
| 2018 | 12.92616 | 6 | 0.044 |

> overall

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| from | upto | add | se\_add | mul | se\_mul | p | meaning |
| 2015 | 2019 | 0.449 | 0.315 | 1.567 | 0.494 | 0.250 | Uncertain |