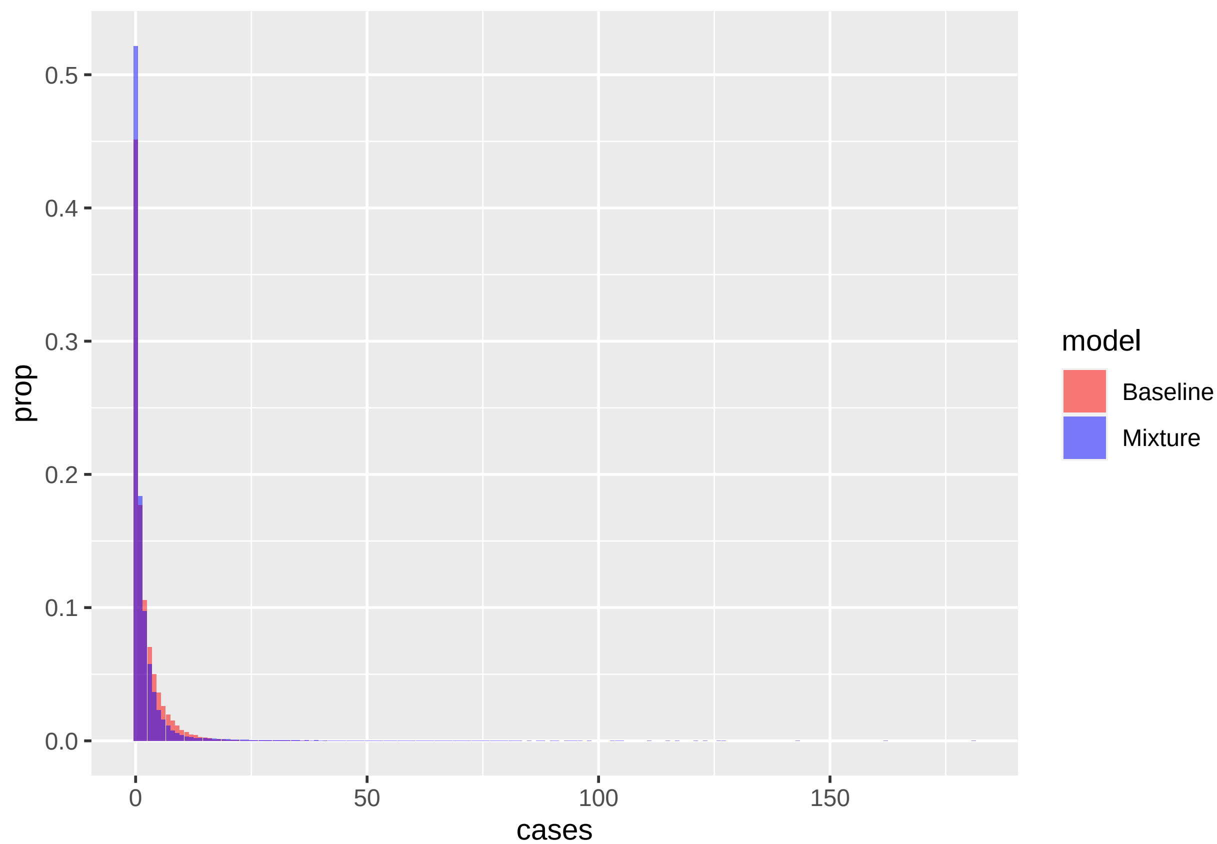
Superspreading negative binomial simulations




```
##     cases     n
## 1       0 52155
## 2       1 18382
## 3       2  9737
## 4       3  5745
## 5       4  3644
## 6       5  2320
## 7       6  1596
## 8       7  1130
## 9       8   780
## 10      9   581
## 11     10   426
## 12     11   320
## 13     12   275
## 14     13   224
## 15     14   204
## 16     15   194
```

```
## 17       16   177
## 18       17   173
## 19       18   134
## 20       19   114
## 21       20   122
## 22       21   103
## 23       22    88
## 24       23    85
## 25       24    86
## 26       25    73
## 27       26    69
## 28       27    62
## 29       28    61
## 30       29    45
## 31       30    56
## 32       31    50
## 33       32    51
## 34       33    41
## 35       34    50
## 36       35    48
## 37       36    31
## 38       37    46
## 39       38    34
## 40       39    39
## 41       40    18
## 42       41    16
## 43       42    25
## 44       43    19
## 45       44    13
## 46       45    20
## 47       46    15
## 48       47    13
## 49       48    18
## 50       49    17
## 51       50    22
## 52       51    16
## 53       52    12
## 54       53    12
## 55       54    12
## 56       55    12
## 57       56     9
## 58       57    13
## 59       58     9
## 60       59     3
## 61       60     6
## 62       61     6
## 63       62     9
## 64       63     4
## 65       64     9
## 66       65     8
## 67       66     6
## 68       67     8
## 69       68     2
## 70       69     6
```

```
## 71      70    10
## 72      71     5
## 73      72    10
## 74      73     2
## 75      74     4
## 76      75     5
## 77      76     3
## 78      77     1
## 79      78     3
## 80      79     4
## 81      80     2
## 82      81     3
## 83      82     2
## 84      83     4
## 85      85     2
## 86      87     4
## 87      88     1
## 88      90     2
## 89      91     5
## 90      93     1
## 91      94     1
## 92      95     1
## 93      96     1
## 94      98     1
## 95     103     1
## 96     104     1
## 97     105     1
## 98     111     1
## 99     115     1
## 100    117     1
## 101    121     1
## 102    123     1
## 103    126     1
## 104    127     2
## 105    143     1
## 106    162     1
## 107    181     1
```

If p is small but δ is large, then the range of cases is large.

Now we wish to plot typical chains.

First lets look at the mean size of small (clusters $<$ 10) and large clusters (>10). The median clusters are typically bigger in the standard model than the mixture model but the mean is smaller, and mean chain sizes conditioned on extinction are similar in both models. If chopping the chain should condition on extinction/non-extinction?

```
## [1]   8461.335      10.000 144973.000
```

```
## [1] 2504
```

```
## [1] 1.709763
```

```
## [1]  5526.246    10.000 38535.000
```

```
## [1] 3389
```

```
## [1] 1.666116
```

```
## [1] 57.73043
```

```
## [1] 30
```

```
## [1] 1.824859
```

```
## [1] 20.05
```

```
## [1] 16.5
```

```
## [1] 1.666667
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    1    1    1    1    1    1    1    1    1     1
##  [2,]    1    2    0    5    0    0    4    1    0     1
##  [3,]    1    5    0    6    0    0    8    2    0     0
##  [4,]    0    2    0   14    0    0    4    1    0     0
##  [5,]    0    0    0   13    0    0    1    2    0     0
##  [6,]    0    0    0   16    0    0    0    2    0     0
##  [7,]    0    0    0   15    0    0    0    2    0     0
##  [8,]    0    0    0   13    0    0    0    3    0     0
##  [9,]    0    0    0   20    0    0    0    1    0     0
## [10,]    0    0    0    7    0    0    0    0    0     0
## [11,]    0    0    0   11    0    0    0    0    0     0
## [12,]    0    0    0    7    0    0    0    0    0     0
## [13,]    0    0    0    2    0    0    0    0    0     0
## [14,]    0    0    0    1    0    0    0    0    0     0
## [15,]    0    0    0    0    0    0    0    0    0     0
## [16,]    0    0    0    0    0    0    0    0    0     0
## [17,]    0    0    0    0    0    0    0    0    0     0
## [18,]    0    0    0    0    0    0    0    0    0     0
## [19,]    0    0    0    0    0    0    0    0    0     0
## [20,]    0    0    0    0    0    0    0    0    0     0
## [21,]    0    0    0    0    0    0    0    0    0     0
```

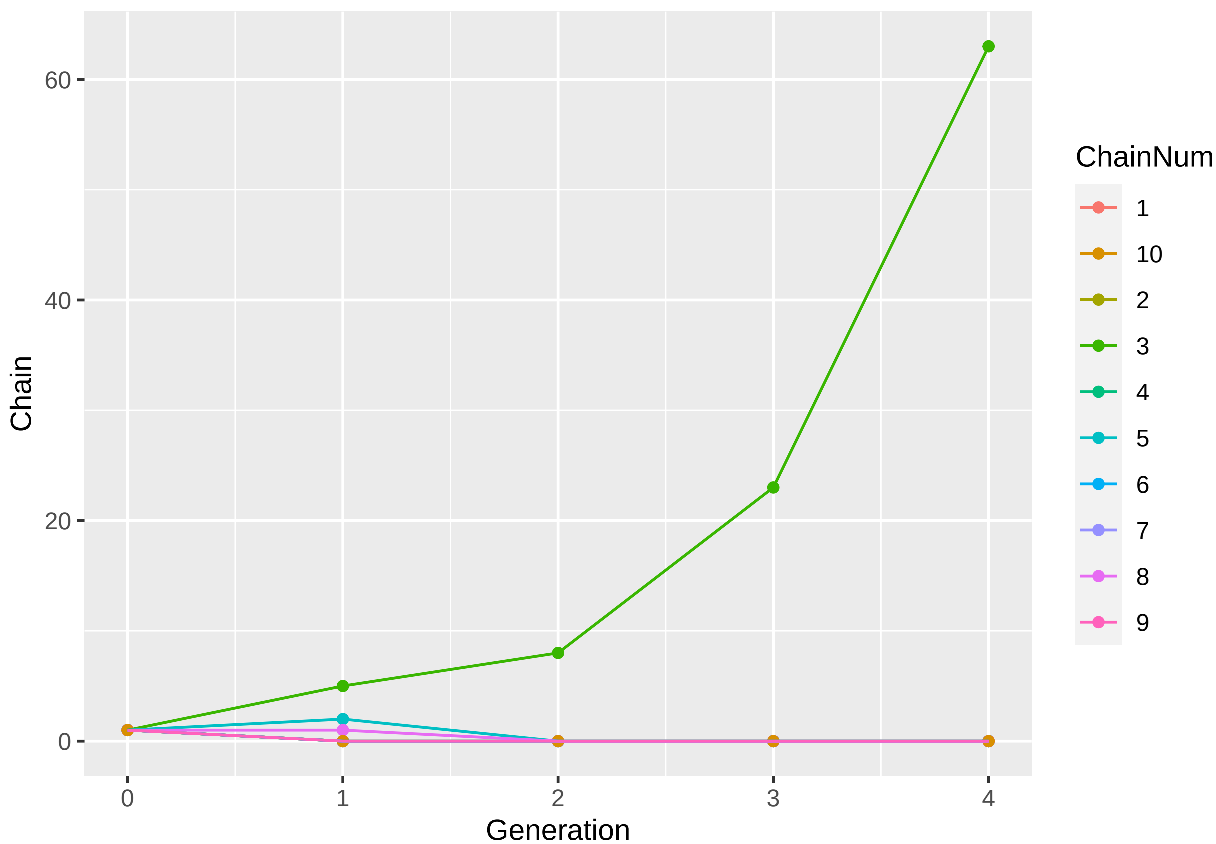
Probability of a major outbreak for mixture model is about 0.1.

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    1    1    1    1    1    1    1    1    1     1
##  [2,]    0    0    5    0    2    0    0    1    0     0
##  [3,]    0    0    8    0    0    0    0    0    0     0
##  [4,]    0    0   23    0    0    0    0    0    0     0
##  [5,]    0    0   63    0    0    0    0    0    0     0
##  [6,]    0    0  299    0    0    0    0    0    0     0
##  [7,]    0    0  773    0    0    0    0    0    0     0
##  [8,]    0    0 1247    0    0    0    0    0    0     0
##  [9,]    0    0 2503    0    0    0    0    0    0     0
## [10,]    0    0 4698    0    0    0    0    0    0     0
## [11,]    0    0 9545    0    0    0    0    0    0     0
```

Probability of a major outbreak for standard model is about 0.4. Here four have taken off, but none are as large as the mixture that has taken off?

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    1    1    1    1    1    1    1    1    1     1
##  [2,]    0    0    0    0    1    0    0    0    6     0
##  [3,]    0    0    0    0    3    0    0    0   13     0
##  [4,]    0    0    0    0    9    0    0    0   22     0
##  [5,]    0    0    0    0    5    0    0    0   64     0
##  [6,]    0    0    0    0    8    0    0    0  111     0
##  [7,]    0    0    0    0   17    0    0    0  243     0
##  [8,]    0    0    0    0   41    0    0    0  499     0
##  [9,]    0    0    0    0   61    0    0    0 1022     0
## [10,]    0    0    0    0  120    0    0    0 2015     0
## [11,]    0    0    0    0  279    0    0    0 3946     0
```

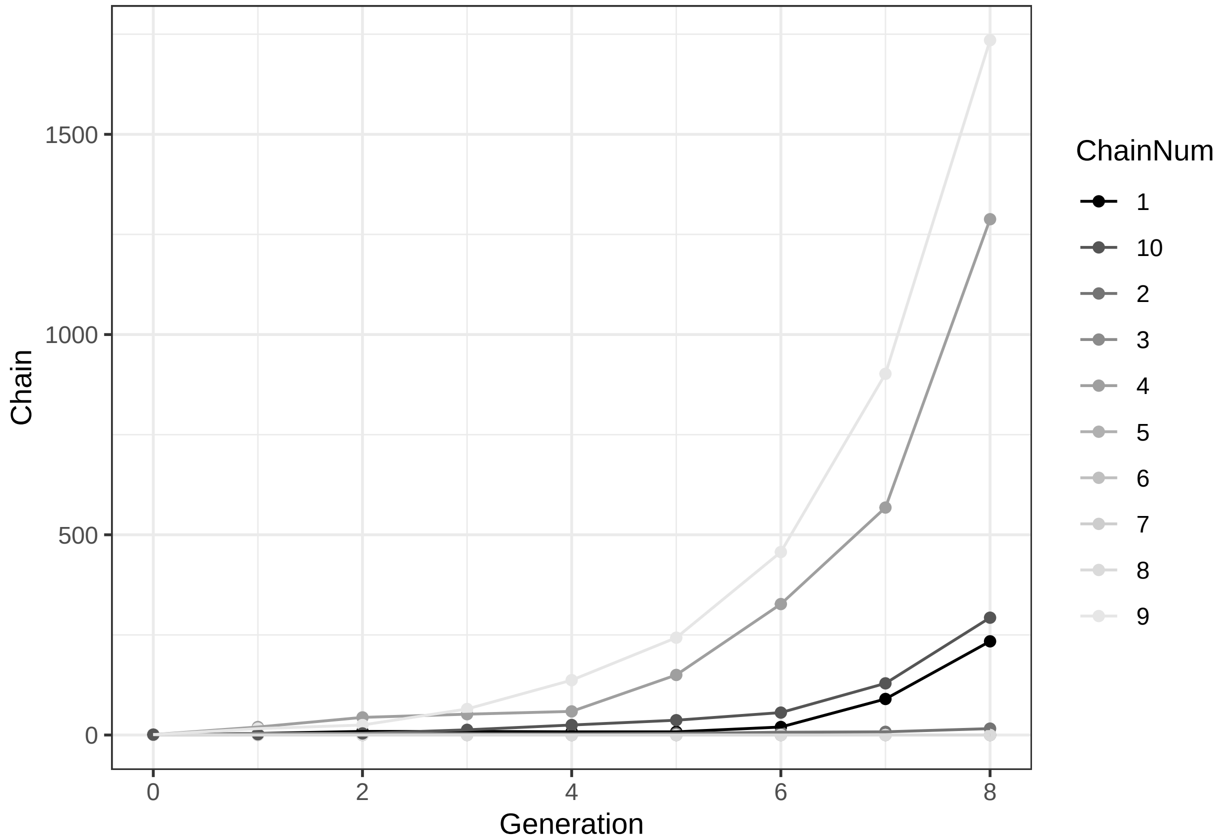
Plot the mixture chains assuming $k=1/2:

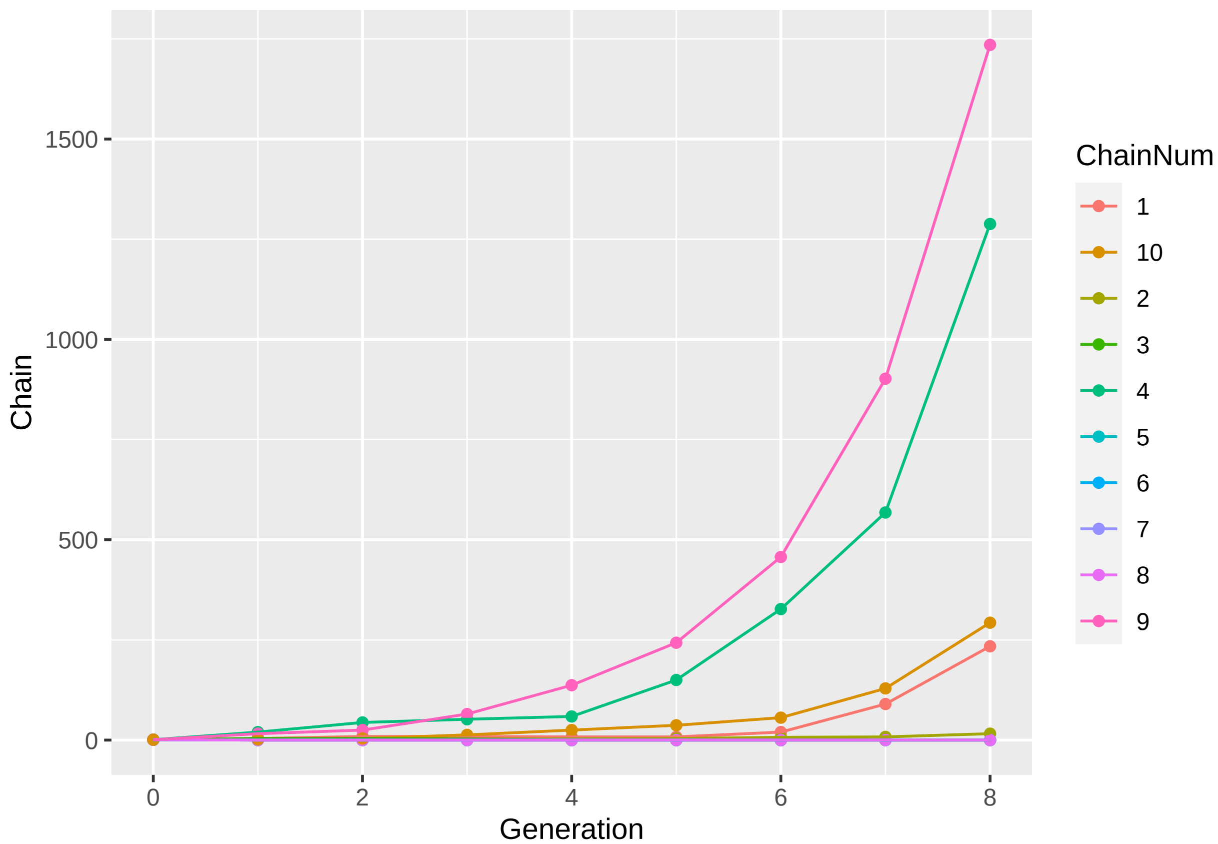



```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]    1    1    1    1    1    1    1    1    1     1
##  [2,]    4    1    4   20    0    0    0    0   16     2
##  [3,]    9    2    4   44    0    0    0    0   25     4
##  [4,]    9    3    3   52    0    0    0    0   65    13
##  [5,]    8    3    0   59    0    0    0    0  137    25
##  [6,]    8    4    0  150    0    0    0    0  243    37
##  [7,]   20    7    0  327    0    0    0    0  457    56
```

```
##  [8,]   90    8    0  568    0    0    0    0  902   129
##  [9,]  234   16    0 1288    0    0    0    0 1735   293
## [10,]  412   22    0 2446    0    0    0    0 4001   589
## [11,]  948   45    0 4897    0    0    0    0 8064  1228
```

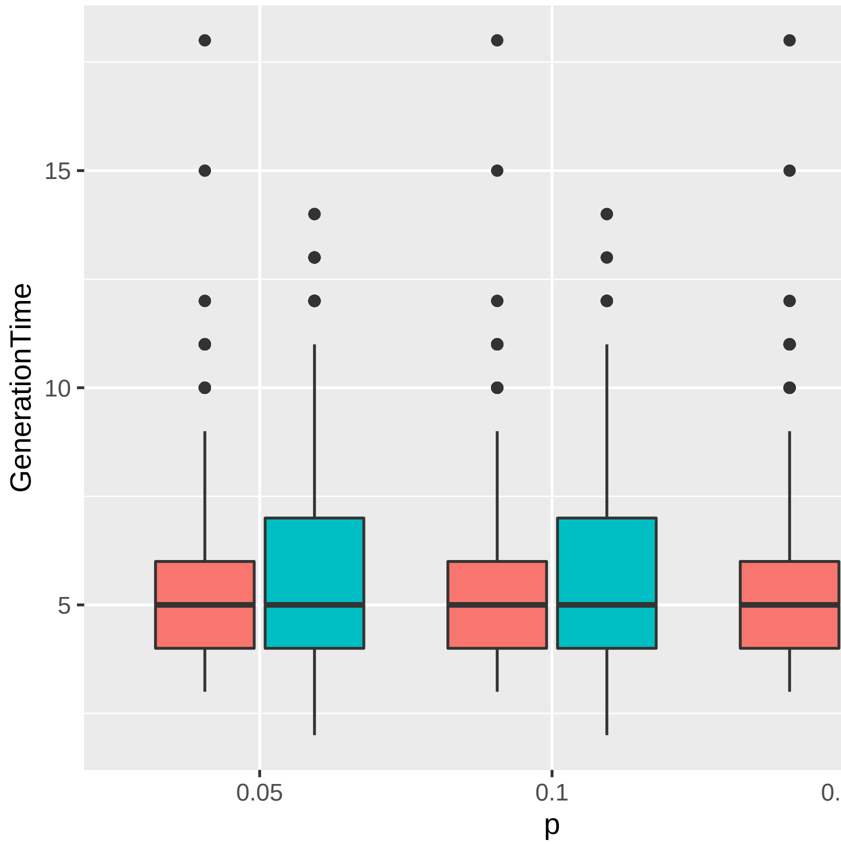
Plot the mixture chains assuming $k=2:






```
##        [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
##  [1,]     1    1    1    1    1    1    1    1    1     1
##  [2,]     5    3    7    0    4    0    0    1    5     0
##  [3,]     9    8   17    0    7    0    0    1   21     0
##  [4,]    17   27   28    0    8    0    0    3   47     0
##  [5,]    22   64   46    0   20    0    0    2  107     0
##  [6,]    39  123  103    0   35    0    0    6  197     0
##  [7,]    91  270  195    0   64    0    0   11  407     0
##  [8,]   172  541  352    0  107    0    0   18  831     0
##  [9,]   322 1085  686    0  165    0    0   34 1571     0
## [10,]   667 2250 1309    0  278    0    0   77 3198     0
## [11,]  1299 4474 2482    0  542    0    0  174 6234     0
```

Median generation time same for all mixtures. Generation time has most variability for p=0.05, with 25% taking 11 generations or more to take off. 25% take 3 generations or less (most explosive for p =0.05, 0.1). 75%



take 9 generations or less if p=0.1 (most explosive?)